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INDIANA 305 (b) REPORT
1992-93

INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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EXECUTIVE SUMMARY

The 1992 - 93 305 (b) Report is organized into four major sections, and Indiana's activities and concerns in each area are summarized or discussed as follows:

1. **Surface Water Quality** - This section includes a discussion of the present status of water quality in Indiana rivers, lakes and streams that were assessed during this reporting period as well as any water quality trends that were apparent; a discussion of the toxics information which has been compiled; a discussion of the lake and nonpoint source assessments; and a summary discussion of the waters assessed in each major river basin.

2. **Water Pollution Control Program** - This section includes a discussion of the point source control programs including the construction grants, NPDES permitting, pretreatment, compliance, and enforcement programs; the nonpoint source control program; and the various monitoring programs used to obtain water quality data.

3. **Ground Water Quality** - This section describes Indiana's ground water resources; ground water quality; nonpoint source impacts; and geographic areas of concern.

4. **Special Concerns and Recommendations** - This section highlights Indiana's special concerns and includes proposed recommendations for future actions by the state and the federal government.

There are about 90,000 miles of rivers, streams, ditches and drainageways in Indiana of which 35,670 miles are listed in EPA's River Reach File 3 (RF3). Of these approximately 21,094 miles have sufficient all weather flow and other physical characteristics necessary to support both the fishable and swimmable uses year around.

There are approximately 575 public-owned inland lakes and reservoirs in Indiana with a combined surface area of some 106,203 acres. Indiana also controls 154,000 acres (43 shoreline miles) of Lake Michigan. Some assessment was made for nearly all of these waters.

Although much of Indiana's wetland resource has been lost, there are an estimated 813,000 acres of wetlands remaining, mostly in the northern part of the state. No formal water quality assessment has been made of these areas. However, the state is unaware of any wetland problems related to point source discharges. The main concern of the state regarding wetlands is preventing the future loss of these areas through draining and filling.

Of the waters assessed, 71% of the river and stream miles and over 99% of the total inland lake and reservoir acreage fully supported their aquatic life designated uses. All of Indiana's portion of Lake Michigan was considered to only partially support designated uses due to the lakewide fish consumption advisory for certain species.

Of the stream miles assessed it was estimated that the swimmable goal was supported in 18% and the fishable goal was supported in 71%. Although both the fishable and swimmable goals were supported in over 99% of the total lake and reservoir acres assessed, many are considered threatened by point and/or nonpoint sources of pollution. All of Lake Michigan governed by Indiana supported the "swimmable" goal but only partially supported the "fishable" goal due to the lakewide fish consumption advisory.

The major causes of nonsupport of uses were E. coli bacteria, priority organic compounds, organic enrichment, pesticides, and metals. The sources of substances most often contributing to nonsupport of uses were: agricultural nonpoint sources, municipal/semi-public point sources, urban runoff, individual point sources, and combined sewer overflows.

In the past two years, the state has done monitoring for toxic substances in fish tissue and sediments. Most of the 7,339 stream miles and approximately 1,649 inland lake and reservoir acres were monitored in some way for toxics. Of the river and stream miles monitored, about 8.4% were considered to have elevated levels of toxic substances. Most of the these miles were due to sediment contamination or the occurrence of fish consumption advisories or to the presence of sediment contamination. Pesticides, PCBs and metals were the substances most often responsible for these problems.

Approximately 66,092 inland lake and reservoir acres have been sampled for toxics since 1985. Data indicates that less than 1% of these acres monitored were found to have toxic substances in sediments at levels of concern. No fish tissue samples from lakes or reservoirs have been found to contain toxic substances at levels above Food and Drug Administration (FDA) Action Levels. All of Indiana's portion of Lake Michigan is considered to be affected by toxics due to the lakewide fish consumption advisory.

In order to improve water quality, an increased level of wastewater treatment has been provided by both municipalities and industries throughout the state. The percentage of the population served by primary treatment facilities decreased from 6% to 0% from 1972 to 1993, while the percentage served by advanced treatment facilities increased from 0% to 53% in the same time period. About 90% of Indiana's population has adequate individual septic tank disposal systems or are served by semi-public facilities. Since 1972, Indiana has received over $1.4 billion in federal construction grants money and has spent over $207 million in state money and $190 million in local matching funds for new or upgraded municipal wastewater treatment plants and sewer systems. There is no precise information on the amount of money spent for industrial waste treatment or control, but there were 322 claims for more than $1,334,466,191 in tax exemptions for industrial wastewater treatment or control facilities in 1993. There were only 102 claims for $369,187,000 in 1978.

Indiana has a plentiful ground water resource serving 60 percent of its population for drinking water and filling many of the water needs of business, industry and agriculture. Although most of Indiana's ground water has not been shown to have been adversely impacted by mans activities, over 863 sites of groundwater contamination have been documented.

The substances most frequently detected as drinking water well contaminants in the state are nitrates, volatile organic chemicals, and heavy metals. Monitoring wells at waste disposal sites most often indicate ground water pollution from inorganic chemicals such as heavy metals. Based on the ground water data regarding agricultural chemicals, about 7 - 10 percent of rural drinking water wells tested are expected to contain unacceptably high nitrate levels and some detectable concentration of a pesticide.

The sources of ground water contamination most commonly reported in the state are hazardous materials spills, underground storage tanks and waste disposal activities. However, there are a wide variety of both contamination sources and their associated chemical pollutants which have been documented in Indiana's ground water.

There are some geographic areas of concern in the state for prevention, detection and correction of ground water quality impacts. These include areas geologically vulnerable to contamination, priority public water supply well fields, and potential sole source aquifers. Special attention through continued and expanded ground water protection activities is being focused in these areas.

In 1987, Indiana completed a comprehensive Ground Water Protection Strategy which addresses the water quality problems documented in this report. Implementation of the 160 recommendations in this plan is an important goal for increased effort to safeguard the resource. The Indiana Ground Water Protection Act of 1989 formalizes an Inter-Agency Ground Water Task Force to coordinate the actions of five state agencies in this regard. The Act also authorizes a number of ground water protection activities and mandates the accomplishments of several key initiatives from the Ground Water Strategy.

I. INTRODUCTION

The State of Indiana, with a surface area of approximately 36,532 square miles, has approximately 5.5 million inhabitants. Although nearly 70 percent of the land in the state (16 million acres) is still devoted to agriculture, Indiana also has a diverse manufacturing economy. Most of these economic pursuits in some way depend on or affect Indiana's water resources. Also, much of the waste produced by Indiana's inhabitants is ultimately discharged to surface waterways after receiving some form of treatment.

In addition to the demands placed on the water resource by agriculture, industry, utilities and municipalities, the increased leisure time available to Indiana residents as a result of the many technological advances over the last few decades has produced a rapid growth in recreational usage of Indiana's waters. Boating, fishing, swimming, water skiing, and "enjoying nature" are recreational activities which have recently placed heavier demands for a share of the water resource. There is now much greater concern for the preservation of some of Indiana's waterways in their natural state and to protect the waters and riparian habitat for fish, other aquatic life forms, and wildlife.

Although the population of Indiana and its demands on the water resource have increased greatly since the turn of the century, the extent of the water resource remains essentially the same. Of the estimated 90,000 total miles of water courses in Indiana, only 21,094 miles of streams and rivers are large enough to support all designated uses throughout throughout the year (see Section II). These miles include 356 miles of the Ohio River, which forms the border between Indiana and Kentucky, and approximately 200 miles of the lower Wabash River, which forms the border between Indiana and Illinois. For purposes of this report, Indiana waterways have been divided into seven drainage basins. Assessment of the mainstem Ohio River is done by the Ohio River Valley Water Sanitation Commission (ORSANCO) and these miles are not included in Indiana's report.

Indiana has approximately 575 public lakes and reservoirs with a total area of approximately 106,203 acres. Three of these are over 5,000 acres in size (24,890 total acres) and have a gross storage capacity of around 606 billion gallons. Indiana also controls some 241 square miles (154,240 acres) of Lake Michigan and has approximately 43 miles of Lake Michigan shoreline.

Indiana has other wetland areas that are also a part of the water resource. These are commonly described as marshes, swamps, bogs, potholes, sloughs, and shallow ponds or remnant lakes. Wetlands are considered to be the most productive aquatic habitats for both plants and animals as they provide breeding and nesting areas, abundant food sources, and excellent protection or cover. They also serve as sediment and nutrient traps and provide flood control. Inventories now underway indicate that most of Indiana's wetlands have been filled or drained and are now utilized for other purposes. Of the non-open water wetlands remaining (estimated at a little over 813,000 acres) most are located in the northern two tiers of counties and along the Ohio River. Wetlands in the remaining part of the state consist of small widely scattered pockets or narrow bands along rivers and streams.

Section 305 (b) of the Clean Water Act requires the states to report to Congress every two years on their activities and the progress they have made toward meeting the goals of the Act. This report discusses Indiana's activities and progress in 1992 - 93.

II. SURFACE WATER QUALITY

Current Status and Designated Use Support

In this 1992-93 305 (b) Report the water resources information was modified to incorporate the current guidelines from U.S. EPA for estimating stream miles. Total stream miles were based on perennial stream miles in River Reach File 3 (RF3). RF3 was derived from computerized databases which list streams shown on the 1:100,000 USGS hydrologic maps which are greater than one mile in length. The use of RF3 has decreased Indiana total stream miles from the 90,000 listed in previous reports to approximately 35,673. The computerized databases will produce consistent estimates for reporting purposes. However, all streams, ditches, and waterways are "Waters of the State" protected by the Indiana Water Pollution Control Laws. Table 1 shows the total size of various types of waterbodies classified for various uses under the revised estimates.

Utilizing this format, there are approximately 35,673 miles of surface waterways in Indiana greater than one mile in length. This total includes some ditches, canals, and intermittent streams as well as permanent streams. An estimated 21,094 miles of these flowing streams in Indiana are assumed to have enough depth and habitat the year around to be "fishable and swimmable". The remaining 14,578 could be considered only intermittently flowing. Of this total, 8,429 miles are intermittent streams and 6,149 are ditches and canals. Many of these miles of intermittent surface drainage probably hold water only periodically following heavy rainfalls.

The goal of all water pollution control programs is to provide water quality sufficient to protect designated uses. For example, recreation (e.g. swimming and wading) and the propagation of aquatic life are designated uses for waters of Indiana. These waterbodies are often spoken of as having "swimmable" and "fishable" uses. To determine whether these uses are supported, a variety of physical, chemical and biological information must be assembled and applied with a degree of professional judgment. Table 2 summarizes how such information was used in this report to assess water quality. In addition, a "threatened" category was applied when a water body supported designated uses but had anticipated new sources or adverse trends of pollution.

Table 1. *Summary of classified uses for Indiana waterbodies*

TOTAL SIZE CLASSIFIED FOR USE

CLASSIFIED USE	RIVERS (MILES)	LAKES (ACRES)	LAKE MICHIGAN (SHORELINE MILES)
Aq. Fish and Wildlife	35,673*	106,203	43
Domestic Water Supply	***	32,000	43
Recreation	35,673*	106,203	43
Industrial	35,673*	106,203	43
Navigation	--	--	43
Nondegradation	35,673*	106,203	43
Other (Specify)	--	--	--
Unclassified	--	--	--

* Although it has been estimated that these are approximately 90,000 miles of streams, ditches, and drainageways in Indiana, these figures represent estimate totals of the U.S. Geological Survey (USGS) 1:100,000 Digital Line Graph (DLG) and U.S. EPA Reach File 3 (RF3) databases which project a consistent computerized method for summing State Waters.

*** Standards for domestic water supply apply at the point of withdrawal for use. Approximately 20 different rivers and streams have domestic water supply intakes.

Table 2. *Criteria for evaluating support of designated uses*

ASSESSMENT BASIS	ASSESSMENT DESCRIPTION	SUPPORT OF DESIGNATED USE		
		FULLY SUPPORTING	PARTIALLY SUPPORTING	NOT SUPPORTING
Evaluated	No site-specific ambient data or data more than five years old. Assessment is based on land use, location of sources, citizen complaints, etc. Predictive models use estimated inputs.	No sources (point or nonpoint) are present that could interfere with the use Data indicate or it is predicted that criteria are attained.	Sources are present but may not affect use or no sources present but complaints on record.	Magnitude of sources indicate use is likely to be impaired. Criteria exceedences predicted.
Monitored (Chemistry)	Fixed station sampling or survey sampling. Chemical analysis of water, sediment, or biota.	For conventional pollutants, criteria exceeded in $\leq$10% of measurements and mean of measurements is less than criteria. No fish consumption advisory exists. For toxicants no more than 1 violation of acute criteria in 3 years data.	For a conventional pollutant, criteria exceeded 11-25% and mean of measurements is less than criteria; or criteria exceeded $\leq$10% and mean is greater than criteria. A "general" fish consumption advisory exists.	For a conventional pollutant, criteria exceeded >25% or criteria exceeded 11-15% and mean of measurements is greater than criteria. A complete ban on consumption of fish is recommended. For toxicants no more than 1 violation of acute criteria in 3 years data.
Monitored (Biology)	Site visit by qualified biological personnel. Rapid bioassessment protocols may be used.	Use fully supported; no evidence of modification of community (within natural range of control/ecoregion).	Some uncertainty about use support; some modification of community noted.	Use clearly not supported; definite modification of community.

CLASSIFICATION GUIDELINES FOR MULTIPLE USE WATERBODIES

Fully Supporting = All uses are fully supported.
Partially Supporting = One or more uses partially supported and remaining uses are fully supported.
Not Supporting = One or more uses not supported.

For this report, the state has chosen to evaluate overall waterbody use support for aquatic life and recreational uses separately. There are two reasons for this decision:

1. Not as many miles of waterways were assessed as to support of recreational uses as for support of aquatic life uses.
2. Almost all field monitoring data were for E. coli but many NPDES permits in effect for most of this two year period were based on fecal coliform.

If the state evaluated the waters for aquatic life support and recreational use support in a single assessment, many waters would be placed in partial or non-support categories due only to the failure to meet the whole body recreational use criteria. Actual water quality may be the same or better than previously reported when most waters were evaluated at the partial body contact level.

The state is currently investigating the possible causes of the bacteriological problems affecting a major portion of the assessed streams. All NPDES permit holders that have disinfection requirement in their permits are required to meet limits to support recreational/swimmable uses. However, for many permit holders these limits are still in terms of fecal coliform bacteria, i.e., 200/100 ml as a monthly geometric means versus 125/100 ml E. coli as a geometric mean and 235/100 ml as a maximum for whole body contact. While some of the bacteriological problems may result from facilities not properly disinfecting the water, it is likely that most of the problems arise from combined sewer overflows (CSOs), storm water runoff, and/or nonpoint sources such as agricultural feedlots, poor septic tank disposal systems, urban runoff, etc. Little data are currently available that would allow the state to assess the relative contributions of each of these various sources to the problem.

When data from the fixed station Water Quality Monitoring Network were examined, arsenic concentrations were found to be rather high in all state waters sampled for this parameter. Every arsenic sample taken contained arsenic concentrations above the detection level of 0.2 ug/l and thus above the human health criteria of 0.175 ug/l (to provide protection at the 10^{-5} cancer risk level for consumption of aquatic life) adopted in the water quality standards. Some of these values ranged up to 4 or 5 ug/l in certain waters. These values probably represent background levels of arsenic for the most part, as point sources which discharge arsenic are quite limited and these high values occur throughout the state. No arsenic samples collected exceeded the chronic aquatic life criterion (190 ug/l) or the drinking water criterion (50 ug/l).

Indiana waterbodies including streams, inland lakes, and Lake Michigan were assessed for the degree of individual use support. These individual uses have replaced the fishable/swimmable Clean Water Act goals used in previous reporting cycles. Individual uses include fish consumption, aquatic life, swimming, secondary contact, drinking water supply, and industrial water supplies whose uses apply to defined waterbodies. The degree of designated use support is described in terms of full support/full support threatened, partial support, non-support and unassessed. However, not all of these uses were assessed in all waters.

Table 3 and 4 summarize the current status of individual and overall use support respectively, in waterbodies of Indiana. There are roughly 21,094 miles of rivers and streams in Indiana which are potentially both "fishable" and "swimmable" throughout the year. Approximately 35% of these miles were assessed for support of aquatic life uses. Of those miles assessed, 71% were judged to be fully supporting of aquatic life uses. Another 9% of the miles assessed were considered fully supporting but threatened. Another 4% were partially supporting these uses, while 16% did not support these uses.

Approximately 24% of these 21,094 miles were assessed for attainment of whole body contact recreational uses. About 18% of the waters assessed fully supported this use designation, about 3% partially supported it, and 78% did not support this use due to frequent high E. coli levels. Of the river and stream miles assessed, 315 miles are currently under some type of fish consumption advisory and do not fully support the fish consumption use.

For the 1994 cycle 305(b) Report a total of 7,339 river miles were assessed for the degree of aquatic life use support. This was an increase of 599 miles assessed when compared to the 1990-1991 reporting period.

Based on Digital Line Graph computerized databases, U.S. EPA estimates that there are 142,871 acres of lakes and reservoirs in Indiana. Of those acres, 106,203 are public. Enough information was available to assess nearly all of the state's public lakes and reservoirs. Less than 0.2% of the lake and reservoir acreage assessed failed to support designated uses. The number of acres considered not meeting the aquatic life or fishable goal was roughly equal to the number not meeting the recreational goals. No lakes in Indiana are designated for less than "swimmable" and "fishable" use.

A more complete discussion of the trophic classification, current status, trends and support of designated uses of Indiana lakes and reservoirs can be found in the Lake Information and Assessment Section. Additional information can be found in Appendix A.

There are 43 miles of Lake Michigan shoreline in Indiana. All of these miles were assessed by using a combination of physical, chemical and biological information. Because of the consumption advisory in effect for some fish species in Lake Michigan, all 43 miles were judged to be only partially supporting the fishable use. In addition, all 43 miles fully supported recreational uses. None of the lake has been designated for less than 'fishable" and "swimmable" uses.

Table 3. *Individual use support summary*

RIVERS (MILES)

USE	SUPPORTING	SUPPORTING BUT THREATENED	PARTIALLY SUPPORTING	NOT SUPPORTING	NOT ATTAINABLE	UNASSESSED
Fish Consumption	35,358	--	--	315	--	--
Shellfishing	--	--	--	--	--	--
Aquatic Life Support	5,236	624	303	1,176	77*	--
Swimming	934	--	159	3,979	--	
Secondary Contact						
Drinking Water Supply						
Agriculture	35,673					
Industrial	35,673					
Nondegradation	35,673					

* *Includes all streams designated as "limited use"* in state water quality standards.

LAKES (ACRES)

USE	SUPPORTING	SUPPORTING BUT THREATENED	PARTIALLY SUPPORTING	NOT SUPPORTING	NOT ATTAINABLE	UNASSESSED
Fish Consumption	106,191	--	--	12	--	--
Shellfishing	--	--	--	--	--	--
Aquatic Life Support	106,014	--	88	101	--	
Swimming	106,026	--	88	89	--	
Secondary Contact						
Drinking Water Supply	32,000					
Agriculture	106,203					
Industrial	106,203					
Nondegradation	106,203					

LAKE MICHIGAN (ACRES)

USE	SUPPORTING	SUPPORTING BUT THREATENED	PARTIALLY SUPPORTING	NOT SUPPORTING	NOT ATTAINABLE	UNASSESSED
Fish Consumption			43			
Shellfishing						
Aquatic Life Support			43			
Swimming	43					
Secondary Contact						
Drinking Water Supply	43					
Agriculture	43					
Industrial	43					
Nondegradation	43					

Table 4. *Overall use support summary*

RECREATIONAL USES - RIVERS (MILES)

Degree of Use Support	Assessment Basis		Total Assessed
	Evaluated	Monitored	
Size Fully Supporting	83	851	934
Size Threatened	0	--	--
Size Partially Supporting	13	146	159
Size not Supporting	112	3,867	3,979
TOTAL	208	4,864	5,072

AQUATIC LIFE USE - RIVERS (MILES)

Degree of Use Support	Assessment Basis		Total Assessed
	Evaluated	Monitored	
Size Fully Supporting	947	4,289	5,236
Size Threatened	347	277	624
Size Partially Supporting	123	180	303
Size not Supporting	59	1,117	1,176
TOTAL	1,476	5,863	7,339

* ***Size threatened is a distinct category of waters and is not a subset of the size fully supporting uses. It should be added into the totals entered in the last line.***

Degree of Use Support	LAKES (ACRES)						LAKE MICHIGAN (MILES)					
	Evaluated		Monitored		Total Assessed		Evaluated		Monitored		Total Assessed	
	Aqu. Life	Rec.	Aqu. Life	Rec.	Aqu. Life	Rec.	Aqu. Life	Rec.	Aqu. Life	Rec.	Aqu. Life	Rec.
Size Fully Supporting	87,734	106,026	18,280	0	106,014	106,026	--	--	--	43	--	43
Size Threatened			*			--	--	--	--	--	--	--
Size Partially Supporting	88	88	--	--	88	88	--	--	43	--	43	--
Size Not Supporting	101	89	--	--	101	89	--	--	--	--	--	--
TOTAL	87,923	106,203	18,280	0	106,203	106,203	--	--	43	43	43	43

* *All lakes are considered threatened to some extent by non-point urban and agricultural sources.*

Tables 5 and 6 summarize the causes and sources of non-support of uses in Indiana waterbodies, respectively. The major pollutant categories contributing to non-support of uses, in descending order of importance, were E. coli bacteria, priority organics (PCBs), organic enrichment, organochlorine pesticides, metals, other inorganics (primarily cyanide) and ammonia. Nonpoint runoff from agricultural practices and municipal or semi-public discharges were the sources which accounted for the largest number of miles or acres impacted, although many of these impacts were related to bacteriological concerns. Other important sources contributing to use impairment were combined sewer overflows, industrial discharges, urban runoff, and land disposal practices. The causes and sources of non-support of uses is discussed in more detail in the basin by basin summaries.

In 1991, the Indiana Department of Natural Resources (IDNR) used its Geographic Information System (GIS) to combine individual digital wetland maps with the U.S. Geological Survey's 1:250,000 digital county boundaries. Through this combination, the IDNR was able to determine that from the early-to-mid 1980's Indiana contained approximately 813,000 acres of wetlands and an additional 194,000 acres of deep-water habitat, excluding Lake Michigan (Table 7). Until the IDNR GIS project, the amount of wetlands in Indiana were based upon the best professional estimates of INDR field staff. These estimates were as low as 100,000 acres.

Wetland acreage was further classified into type of wetland. Forested wetland is the most common type of wetland in Indiana with 504,000 acres or 62% of the total wetland acreage. Forested wetland is followed by shallow marsh - 65,000 acres (8%), wet meadow - 57,000 acres (7%), shrub-scrub - 41,000 acres (5%) and deep marsh - 24,000 acres (3%).

Palustrine wetlands were also classified according to duration of flooding. "Temporarily flooded" was the most common duration of flooding. Approximately 460,000 acres or 57% of palustrine habitats were classified as temporarily flooded. "Seasonally flooded" was the next most common - 220,000 acres (27%), followed by "intermittently exposed" - 80,000 acres (10%), "semi-permanently flooded" - 40,000 acres (5%), and "saturated" - 24,000 acres (3%).

The IDNR project confirmed that the major concentration of wetlands were in the northeastern portion of Indiana, along river floodplains in southwestern Indiana, and in the Lake Michigan shoreline region in northwestern Indiana. Noble County contained the greatest number of wetland acres with approximately 27,500 acres or 3.38% of the states total wetland acreage. Noble County was followed by Kosciusko County 27,000 acres (3.32%), LaGrange County - 25,708 acres (3.16%), LaPorte County - 25,000 acres (3.07%), Jackson County - 24,000 acres (2.95), Gibson County - 23,500 acres (2.89%), Steuben County - 22,000 acres (2.71%), Pike County - 20,500 acres (2.52%), Posey County - 20,000 acres (2.46%), and

Table 5. *Total sizes of waterbodies not fully supporting uses affected by various cause categories*

	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKE MICHIGAN (SHORELINE MILES)	
CAUSE CATEGORY	*MAJOR*	*MODERATE/MINOR*	*MAJOR*	*MODERATE/MINOR*	*MAJOR*	*MODERATE/MINOR*
Unknown	---	---	---	---	---	---
Unknown toxicity	37	17	---	---	---	---
Pesticides	279	91	12	---	---	43
Priority organics	433	---	12	---	---	43
Nonpriority organics	48	50	---	---	---	---
Metals	250	55	---	45	---	---
Ammonia	45	63	22	100	---	---
Chlorine	---	---	22	77	---	---
Other inorganics	---	48	---	---	---	---
Nutrients	10	150	122	12	---	---
pH	---	---	30	---	---	---
Siltation	---	---	---	88	---	---
Organic enrichment/DO	381	220	59	63	---	---
Salinity/TDS/chlorides	16	---	---	---	---	---
Thermal modification	---	---	---	---	---	---
Flow alteration	20	---	---	---	---	---
Other habitat alterations	11	---	---	---	---	---
Pathogen indicators	4066	260	45	77	---	---
Radiation	---	---	---	---	---	---
Oil and grease	12	---	---	---	---	---
Taste and odor	---	---	---	---	---	---
Suspended solids	42	170	---	---	---	---
Noxious aquatic plants	---	---	---	---	---	---
Filling and draining	---	---	---	---	---	---

Table 6. *Total sizes of waterbodies not fully supporting uses affected by various source categories*

	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKE (SHORELINE MILES)	
SOURCE CATEGORY	*MAJOR*	*MODERATE/MINOR*	*MAJOR*	*MODERATE/MINOR*	*MAJOR*	*MODERATE/MINOR*
Industrial point sources	94	18	---	---	---	43
Municipal point sources	170	618	59	63	---	43
Combined sewer overflow	35	20	22	23	---	43
Agriculture	250	466	12	---	---	43
Silviculture	---	---	---	---	---	---
Construction	---	---	---	---	---	---
Urban runoff/storm sewers	80	5	35	22	---	---
Resource extraction	4	---	30	---	---	---
Land disposal	20	5	---	---	---	---
Hydro/habitat modification	31	*	---	40	---	---
Other (Aerial Deposition)	---	3	---	---	---	43
Unknown	---	---	---	---	---	---

* ***Many stream miles in the state have been moderately affected by habitat modification (amount is unknown).***

Table 7. *Area (acres) of wetland and deep-water habitats in Indiana counties during 1980-87*

COUNTY	WETLAND HABITATS							TOTAL WETLAND HABITATS	DEEP WATER HABITATS			
	Scrub-shrub	Forested	Wet meadow	Shallow marsh	Deep marsh	Open water	Other		Limnetic lake	Perennial riverine	Total deep water	Total
Adams	103	1,913	121	128	21	451		2,737	199	185	384	3,121
Allen	317	8,082	666	786	177	1,540	694	12,262	921	1,233	2,154	14,416
Bartholomew	486	10,436	188	128	21	1,316	80	12,654	877	750	1,627	14,281
Benton	80	467	474	312	19	123	1	1,475		114	114	1,589
Blackford	54	1,433	317	274	61	342		2,480		9	9	2,489
Boone	143	3,460	610	195	25	552	1	4,985	128	201	329	5,314
Brown	58	2,132	177	72	75	1,546	939	4,999	1,513	25	1,538	6,538
Carroll	322	4,085	928	380	40	355	154	6,264	574	1,784	2,358	8,622
Cass	395	4,600	1,460	957	145	436		7,993	210	1,435	1,644	9,637
Clark	112	3,377	153	98	16	1,315	11	5,082	1,459	136	1,594	6,676
Clay	78	4,657	239	183	21	3,260	16	8,453	337	622	958	9,412
Clinton	256	4,591	677	196	44	342		6,106	80	119	199	6,305
Crawford	50	654	11	56	38	485	9	1,303	2,505	167	2,672	3,975
Daviess	235	8,866	424	324	42	1,658	160	11,709	2,153	962	3,115	14,824
Dearborn	171	1,859	244	71	19	1,214	70	3,649	1,024	512	1,536	5,185
Decatur	48	2,494	68	27	16	683	9	3,345	361	19	380	3,724
Dekalb	455	6,710	1,557	2,137	216	1,069	879	13,023	316	104	420	13,443
Delaware	185	3,709	310	553	98	803		5,657	1,259	431	1,690	7,347
Dubois	584	8,256	322	303	261	1,752		11,478	2,499	797	3,297	14,774
Elkhart	1,318	7,522	1,053	1,979	837	1,065	1,013	14,786	1,332	917	2,249	17,035
Fayette	43	1,823	33	8	7	247	47	2,208	22	236	258	2,466
Floyd	25	446	48	60	27	558	36	1,200	378	28	406	1,696
Fountain	412	7,300	383	508	84	462	66	9,214	133	1,333	1,465	10,679
Franklin	93	2,276	77	26	4	721	128	3,325	3,051	645	3,696	7,021

Table 7. *Area (acres of wetland and deep-water habitats in Indiana counties during 1980-87 (cont.)*

COUNTY	WETLAND HABITATS							TOTAL WETLAND HABITATS	DEEP WATER HABITATS			
	Scrub-shrub	Forested	Wet meadow	Shallow marsh	Deep marsh	Open water	Other		Limnetic lake	Perennial riverine	Total deep water	Total
Fulton	944	4,982	2,012	2,685	579	694	95	11,990	1,427	438	1,865	13,855
Gibson	1,251	18,182	682	552	597	1,868	369	23,500	3,483	3,494	6,977	30,477
Grant	190	2,384	475	254	62	846		4,212	80	603	683	4,895
Greene	178	5,876	295	212	29	3,014	242	9,847	755	1,229	1,983	11,831
Hamilton	109	5,240	302	445	96	651	7	6,848	2,389	545	2,934	9,782
Hancock	37	2,447	117	138	36	404	3	3,182	112	11	123	3,305
Harrison	106	1,389	39	177	74	1,502	40	3,328	3,050	355	3,405	6,733
Hendricks	23	1,793	63	46	20	782	37	2,763	151	9	160	2,923
Henry	104	2,446	274	239	56	603	2	3,723	601	2	603	4,326
Howard	154	4,065	360	353	22	261	7	5,222	586	220	806	6,028
Huntington	160	2,042	290	353	55	566	59	3,524	2,519	587	3,106	6,630
Jackson	477	21,015	605	404	25	1,409	158	24,093	593	1,369	1,962	26,055
Jasper	582	3,256	1,249	1,960	322	574	364	8,307	431	305	736	9,043
Jay	115	4,235	195	267	41	440		5,293				5,293
Jefferson	1,041	5,585	117	40	28	859	112	7,782	1,226	142	1,368	9,150
Jennings	656	5,132	167	54	19	1,256	103	7,386	462	337	798	8,184
Johnson	65	2,847	106	83	35	1,095	15	4,246	420	360	779	5,025
Knox	291	13,512	928	942	74	1,947	125	17,818	790	3,418	4,208	22,026
Kosciusko	3,104	11,322	3,042	3,706	1,942	1,350	2,706	27,172	10,574	261	10,835	38,007
LaGrange	2,704	11,356	2,660	4,684	1,224	1,090	1,988	25,708	4,286	245	4,532	30,239
Lake	1,408	5,856	1,618	5,052	2,477	2,578	772	19,760	2,584	793	3,377	23,137
Laporte	1,648	13,402	2,872	3,147	1,775	1,849	690	25,383	2,028	241	2,269	27,652
Lawrence	59	3,166	265	219	14	857	6	4,587	1,101	729	1,830	6,417
Madison	225	5.155	472	393	73	696		7.014	158	289	447	7,461

Table 7. *Area (acres of wetland and deep-water habitats in Indiana counties during 1980-87 (cont.)*

COUNTY	WETLAND HABITATS							TOTAL WETLAND HABITATS	DEEP WATER HABITATS			
	Scrub-shrub	Forested	Wet meadow	Shallow marsh	Deep marsh	Open water	Other		Limnetic lake	Perennial riverine	Total deep water	Total
Marion	55	1,622	74	151	11	1,629	18	3,560	3,899	976	4,875	8,435
Marshall	574	10,598	1,732	3,246	559	1,166	166	18,039	2,998	194	3,192	21,231
Martin	72	3,904	137	161	49	558		4,882	969	1,481	2,450	7,332
Miami	192	2,729	567	713	53	417	100	4,771	454	910	1,364	6,135
Monroe	132	2,225	55	172	56	670	11	3,323	10,982	111	11,093	14,416
Montgomery	292	4,417	764	407	21	323	32	6,255	428	526	953	7,209
Morgan	116	4,606	465	368	22	2,085	172	7,832	610	1,249	1,859	9,691
Newton	484	4,807	682	1,093	716	646	538	8,965	28	462	491	9,456
Noble	3,651	11,389	2,109	4,829	776	1,359	3,354	27,467	3,723	103	3,827	31,294
Ohio	8153	153	72	66		305	30	633	1,021	206	1,227	1,860
Orange	129	1,284	129	416	59	617	237	2,871	4,519		4,519	7,389
Owen	143	3,709	450	136	15	1,936	113	6,501	1,010	897	1,906	8,408
Parke	196	4,205	164	139	5	762	98	5,568	2,524	756	3,279	8,848
Perry	147	1,361	48	88	28	742		2,414	4,472	121	4,594	7,007
Pike	1,693	13,362	446	541	421	3,915	130	20,510	721	1,717	2,438	22,948
Porter	1,414	9,791	1,034	2,519	1,365	1,445	532	18,100	672	285	956	19,056
Posey	966	16,155	465	232	88	1,181	950	20,036	3,014	2,965	5,979	26,015
Pulaski	374	7,241	2,204	1,383	123	335	65	11,725	40	827	867	12,592
Putnam	83	3,058	48	68	7	1,025	77	4,366	1,209	171	1,380	5,746
Randolph	125	5,996	264	122	23	428	4	6,962	74	28	102	7,063
Ripley	795	4,416	51	19	16	1,507	35	6,839	783	225	1,008	7,846
Rush	172	4,639	217	91	12	343	3	5,476	69	22	91	5,566
St. Joseph	577	6,279	1,064	1,139	747	925	219	10,95-	1,502	264	1,766	12,716
Scott	221	5,673	99	121	5	1,121	276	7,515	953	62	1,016	8,530

Table 7. *Area (acres of wetland and deep-water habitats in Indiana counties during 1980-87 (cont.)*

COUNTY	WETLAND HABITATS							TOTAL WETLAND HABITATS	DEEP WATER HABITATS			
	Scrub-shrub	Forested	Wet meadow	Shallow marsh	Deep marsh	Open water	Other		Limnetic lake	Perennial riverine	Total deep water	Total
Shelby	90	5,822	196	133	18	400	28	6,686	190	391	581	7,267
Spencer	396	7,845	350	188	29	1,993	27	10,829	1,398	260	1,657	12,486
Starke	312	7,940	1,187	1,312	254	414		11,419	1,847	185	2,032	13,450
Steuben	1,928	7,051	2,433	5,058	1,901	2,088	1,394	21,851	7,411	7	7,418	29,269
Sullivan	403	14,175	452	374	127	2,862	73	18,466	3,959	514	4,474	22,940
Switzerland	74	838	45	44	1	687	23	1,712	2,467	1	2,469	4,180
Tippecanoe	300	7,521	1,317	902	220	471	150	10,880	91	2,211	2,301	13,181
Tipton	96	3,103	201	144	9	103		3,656		1	1	3,657
Union	106	1,408	54	41	8	132	201	1,951	2,015	9	2,024	3,975
Vanderburgh	121	2,650	110	145	8	1,319	38	4,391	1,250	93	1,344	5,735
Vermillion	129	3,909	205	225	53	847	105	5,473	367	2,109	2,476	7,949
Vigo	233	11,902	228	358	25	2,406	25	15,176	1,397	1,797	3,194	18,369
Wabash	492	2,224	1,133	465	59	685	771	5,829	3,549	859	4,408	10,237
Warren	99	3,891	359	503	95	247	245	5,439	29	735	764	6,203
Warrick	1,522	11,618	364	417	433	5,473	130	19,957	2,780	192	2,972	22,929
Washington	140	5,999	192	194	20	1,086	8	7,639	500	415	915	8,554
Wayne	218	5,717	166	107	38	676	39	6,961	282	51	334	7,295
Wells	40	2,083	169	189	83	538		3,102	37	390	428	3,530
White	539	2,270	2,265	1,057	35	344	536	7,046	1,779	64	1,842	8,889
Whitley	634	4,923	561	1,328	158	870	1,465	9,939	1,376	42	1,418	11,357
TOTAL	42,131	504,336	55,071	67,564	20,730	98,565	24,633	813,032	140,532	53,630	194,162	1,007,194
	5.2%	62.0%	6.8%	8.3%	2.5%	12.1%	3.0%	100%	72.4%	27.6%	100.0%	

* *NWI habitat types were combined based on a scheme developed by the Illinois Natural History Survey.*

** *Includes palustrine emergent with undetermined water regime, littorial lake, and riverine unconsolidated shore..*

Warrick County - 19,957 acres (2.45%). The remaining 82 counties contained the remaining 71% of the wetland area. Ohio County contained the least amount of wetland area with 633 acres or only 0.08% of the states total wetland acreage. Forested wetlands were the most common type of wetland in all 92 counties.

The discharge of fill material into the waters of the United States requires a Section 404 permit from the U.S. Army Corps of Engineers and subsequently Section 401 water Quality Certification from the state in which the discharge is to occur. The Section 401 Water Quality Certification is to insure that the project will not violate state water quality standards. If a state determines that a discharge of fill material will violate state water quality standards, Section 401 Water Quality Certification can be denied. If a state denies Section 401 Water Quality Certification then the Corps of Engineers must deny the Section 404 permit. In Indiana, the Department of Environmental Management is responsible for review of projects requiring Section 401 Water Quality Certification.

From January 1, 1986, to January 20, 1992, IDEM reviewed 664 U.S. Army Corps of Engineers' public notices regarding projects that involve placement of fill material in waters of the State of Indiana. In total, the projects involved the filling of approximately 622 acres of wetlands or other waters of the State, or approximately 0.94 acres of fill per project. Of the 664 projects reviewed, IDEM waived or granted Section 401 Water Quality Certification for 520, denied 134 and simply made comments on 10. Of the 622 acres of fill, approximately 511 acres were proposed fill and approximately 111 acres were already filled with the applicant requesting an "after-the-fact" permit. IDEM allowed approximately 156 acres of fill while requiring 536 acres of wetland restoration/creation as mitigation.

On January 21, 1992, the Indiana Department of Environmental Management denied Section 401 Water Quality Certification for the following Nationwide Permits:

14. Road Crossing.

15. U.S. Coast Guard Approved Bridges.

16. Return Water.

23. Approved Categorical Exclusions.

26. Headwaters and Isolated Waters Discharges.

29. Reserved.

30. Reserved.

31. Reserved.

34. Cranberry Production Activities.

39. Reserved.

40. Farm Buildings.

Section 401 Water Quality Certification was denied for Nationwide permits 13. Bank Stabilization; and 18. Minor Discharges; for "Designated Salmonid Waters". "Indiana Trout Streams and Lakes", "State Resource Waters" and "Exceptional Use Streams." Nationwide Permit 18 was further conditioned by denying Section 401 Water Quality Certification for discharges into special aquatic sites including wetlands.

The majority of applicants that qualify for a nationwide permit that would require a site-specific Section 401 Water Quality Certification do apply for certification. However, there is evidence that some do not. If a nationwide permit is issued for an activity in a sensitive area or there is significant fill involved, and sufficient time has passed to safely assume the applicant is not going to apply for a site-specific Section 401 Water Quality Certification, then IDEM staff will write or call the applicant to inform them that they need to apply for this certification.

The denial of Section 401 Water Quality Certification for these nationwide permits has had a profound effect on the Section 401 Water Quality Certification program (Table 8). From January 1, 1986 to January 20, 1992, IDEM reviewed 664 projects or approximately 11 projects per month. All of these projects required an "individual" Section 401 Water Quality Certification. Of the 664 projects, approximately 80% were granted Section 401 Water Quality Certification or it was waived. From January 1, 1992, to May 11, 1994, IDEM has reviewed approximately 893 projects or about 34 projects per month. Of the 893 projects reviewed, 734 or approximately 82% were nationwide permits requiring a "site-specific" Section 401 Water Quality Certification and 159, approximately 18%, were individual permits. Of the 734 nationwide projects approximately 95% were granted or waived Section 401 Water Quality Certification. Of the individual permits, approximately 72% were granted or waived Section 401 Water Quality Certification.

Between January 1992 and May 1994, the 893 projects reviewed involved the filling of 346 acres. Of these acres, 276 were proposed fills and 70 were requested through "after-the fact" applications. Nationwide permits accounted for 90 acres of proposed fills and 33 acres of "after-the-fact" fills. As expected, the nationwide permit involved smaller acreage fills (0.17 acres/applicant) than did the individual permit applications (1.5 acres/applicant). IDEM approved 73 acres of fill and as mitigation, 226 acres of wetlands were restored, created, or enhanced. Of the 73 acres of fill approved, approximately 58 acres (80%) were through nationwide permits. Of the total of 226 acres of mitigation wetlands, 173 acres (77%) were from nationwide applicants.

Table 8. *Summary of permits reviewed before and after denial of Section 401 Water Quality Certification for selected nationwides*

	01/01/86 TO 01/20/92	01/21/91 TO 05/11/94
Number of Permits Reviewed	664	893
Monthly Average Reviewed	11	33
Percent NW	0	82
Percent Ind. Granted	78	72
Percent NW Granted (acres)	NA	95
Sum of Requested Ind. Fill	622	186
Sum of Requested NW Fill (acres)	NA	90
Sum of Requested ATF Ind. Fill	111	37
Sum of Requested ATF NW Fill (acres)	NA	33
Sum of Granted Ind. Fill	156	15
Sum of Granted NW Fill	NA	58
Sum of Ind. Mitigation	536	53
Sum of NW Mitigation (acres)	NA	173

NW = Nationwide Section 401 Review
Ind. = Individual Section 401 Review
ATF = After-the-fact
NA = Not applicable

According to the data, Indiana is obtaining approximately 3 acres of wetland as mitigation for every acre of wetland lost. Unfortunately, the actual, effective mitigation ratio is probably much lower. Wisconsin completed an investigation into projects which require a mitigation plan and it was found that a large percent of the mitigation plans were not started or were done incorrectly. Indiana has not done that type of investigation, but it is likely that we have similar problems. As resources allow, we hope to be able to follow-up on approved mitigation plans and when necessary, enforce the correct execution of these plans.

Of the 664 projects reviewed prior to the denial of the nationwide permits, approximately 75% involved filling or proposed filling of less than 0.1 acre of wetland or open water (Table 9). Only 4% of the projects involved wetland fills of greater than 5 acres. If seawall projects are excluded from the data, the number of projects that involved less than 0.1 acres of fill drops to approximately 50%. Although this is a drop of 25 percentage points, the data still indicate that the largest percentage of projects reviewed involved extremely small fills.

After the denial of the nationwide permits, there was a slight increase in the percentage of projects which were less than 0.1 acre of fill. This would be expected since the majority of the nationwide permits were developed to handle extremely small fills.

Prior to the denial of the nationwide permits, the most common type of projects reviewed were seawalls, and dredging projects. Each represented about 30% of the projects reviewed. After the denial of the nationwide permits, bridges became the most common type of project reviewed, representing 48% of all projects. They previously represented only 5%. After the denial, seawalls represented approximately 2% of the projects reviewed and dredging projects represented approximately 10%.

Public Health/Aquatic Life Concerns

The release of toxic materials into the aquatic environment can produce effects in several ways: 1) when present in sufficient amounts to be acutely toxic, they may directly kill fish and other aquatic organisms; 2) when present in lesser amounts, these substances can reduce densities and growth rates of aquatic organisms and/or bioaccumulate in their tissues until they are unsafe for human consumption; and 3) toxic materials in the water could potentially affect human health by contaminating public water supplies. At this time, we have no data which indicate that there have been any adverse human health effects from contaminated water supplies or primary contact recreation activities (e.g., swimming) due to toxic substances in surface waters.

TABLE 9. *Size of fill as a percentage of projects reviewed prior to and after denial of selected nationwides*

SIZE OF FILL (acres)	% OF PROJECTS REVIEWED PRIOR TO DENIAL OF NATIONWIDE PERMITS	% OF PROJECTS REVIEWED AFTER DENIAL OF NATIONWIDE PERMITS
0.0 - 0.1	75%	83%
0.1 - 1.0	12%	12%
1.0 - 5.0	11%	4%
5.0 - 10.0	<1%	<1%
10.0 - 15.0	<1%	<1%
>15.0	<1%	<1%

In the least several years, advances in analytical capabilities and techniques and the generation of more and better information as to the toxicity of these substances has led to an increased concern about their presence in the aquatic environment and the associated effects on human health and other organisms. The following portion of this report focuses primarily on the studies Indiana has done in 1992 - 1993, to discover the scope of problems caused by toxic substance and possible solutions to these problems.

Because many pollutants are likely to be found in fish tissue and bottom sediments at levels higher than in the water column, much of the data on toxic substances were obtained through the fish tissue and in-place sediment monitoring programs as well as the bioassay data and biosurvey studies. Other than for certain metals, cyanide and a few other substances, most priority pollutants were not found in detectable amounts in surface water samples.

The total size of the various types of waterbodies that were determined to have elevated levels of toxics is shown in Table 10. Toxic substances are only impairing the uses of the 12-acre Decatur County Park Reservoir at Greensburg which currently has a state issued fish consumption advisory. Fish samples collected from all other public lakes have been found to have tissue contaminant concentrations well below FDA Action Levels. Fish tissue samples of salmonids, yellow perch, carp and longnose sucker collected from Lake Michigan in 1990 also contained some residuals of total PCBs and pesticides, but all were below FDA Action Levels.

Nearly 51% of the 618 river and stream miles determined to have elevated levels of toxics substances were placed in this category, at least in part, due to fish consumption advisories. Most of the remainder of these miles are due to metals or other contaminants in sediment at levels of concern. In most instances, these rivers and streams supported diverse communities of aquatic organisms.

Table 10. *Total size of waterbodies affected by toxics - 1992-93*

WATERBODY	SIZE MONITORED FOR TOXICANTS	SIZE WITH ELEVATED LEVELS OF TOXICANTS
Rivers (miles)	7,339	618
Lakes (acres)	1,649	12
Estuaries (miles)	---	---
Coastal Water (miles)	---	---
Great Lakes (miles)	43	43
Freshwater Westlands (acres)	---	---
Tidal Wetlands (acres)	---	---

Fish Tissue Contamination Monitoring Program

The recreational sport of fishing and fish consumption is an important activity for many citizens. Health studies have shown fish to be good for people to eat, being high in protein and low in saturated fats. However, some fish may accumulate contaminants from the water and from the foods they eat. Some of these contaminants can actually build up in the edible portion of the fish. Exposure to these contaminants through consumption can also cause the build up of the contaminants in humans.

The fish tissue contaminant monitoring program has become a very important and highly profiled program in the state of Indiana. It is a widely used method of monitoring and assessing environmental contaminants and their bioavailability. Concentrations of some contaminants may be greater in tissues than in water because of bioconcentration, bioaccumulation, or biomagnification. Tissue contaminant monitoring provides us with a tool that measures contaminants in Indiana's environment that may not be detected in water or air. It also provides us with information on bioavailability of compounds that bioaccumulate. Tissue contaminant monitoring, when part of an integrated multimedia monitoring program, gives insight into exposure levels and allows IDEM to better develop its understanding into the complexities of contaminant distribution, fate, and effects.

One of the objectives of Indiana's fish tissue monitoring program is to provide the recreational fisher with information as to the risks associated with the consumption of sport caught fish. Indiana's Fish Consumption Advisory (FCA) Program issues advisories based on a U.S. Food and Drug Administration (FDA) Action and Tolerance Levels (Table 11). FDA Action Levels are based on edible portions (i.e. fillets). Indiana's advisories are not intended to discourage the general eating of freshwater fish, but they should be used as a guide to eating sport caught fresh water fish. Following the advisory over a lifetime will minimize exposure and reduce whatever cancer risk is associated with those contaminants. Other objectives of the program are to monitor the distribution and trends of persistent contaminants in the environment.

Long lasting contaminants such as PCBs, DDT, and mercury build up in your body over time. It may take years of regularly eating contaminated fish to build up amounts which are a health concern. Health problems which may result from the contaminants found in fish range from small changes in health that are hard to detect to birth defects and cancer. Females who eat highly contaminated fish for many years before becoming pregnant may have children who are slower to develop and learn. The meal advice advisories are intended to protect children from these potential developmental problems. Adults are less likely to have health problems at the low levels that can affect children.

Table 11. *Food and Drug Administration (FDA) Action Levels for poisonous and deleterious substances in fish and shellfish for human food and its tolerance level for PCBs.*

SUBSTANCE	ACTION/TOLERANCE LEVEL[b]
Metals	
Methyl Mercury (expressed as mercury)	1.0 ppm
Pesticides	
Chlordane (total)	0.3 ppm
DDT + DDE + DDD	5.0 ppm
Dieldrin + Aldrin	0.3 ppm
Endrin	0.3 ppm
Heptachlor + Heptachlor epoxide	0.3 ppm
Toxaphene	5.0 ppm
Industrial Chemicals	
PCBs	2.0 ppm

b
ppm = part per million

Many contaminants are found at higher levels in the fat of fish. Consumers can reduce the amount of these contaminants in a fish meal by properly trimming, skinning, and cooking the catch. It is recommended that the skin be removed and all fat trimmed away from the belly flap, the line along the sides of the fish, along the back, and under the skin.

Cooking does not destroy contaminants in fish, but heat from cooking melts some of the fat in the fish. It is recommended to broil, grill, or bake the trimmed, skinned fish on a rack so the fat drips away. Mercury (as well as other metals of concern) is found in fish's muscle tissue. Therefore, the only way to reduce mercury intake is to reduce the amount of contaminated fish you eat.

The primary pollutants of concern (PCBs and certain organochlorine pesticides) for fish in Indiana waters are persistent substances that, for the most part, are no longer used to any extent in agriculture or industry. The persistent nature of these substances has made them available to the aquatic life over a long period of time and they have bioconcentrated in the fish to levels which sometimes exceed the FDA Action Levels.

During the period of 1990 through 1993 the state compiled data on contaminants in the tissue of fish collected from 1 reservoir, Lake Michigan, and 76 unique river locations in 37 counties on 45 different streams or rivers. Table 12 lists the locations where 310 fish tissue samples were collected during these four sampling years (also see Figure 1). Tissue samples were submitted to a contract analytical laboratory (Hazleton Environmental Services, Inc. of Madison, WI) for determination of contaminant levels. All samples were analyzed for percent lipid, percent moisture, organochlorine pesticides, polychlorinated biphenyls (PCBs), cadmium, lead, and mercury. In addition 18% were analyzed for a more complete spectrum of metals, 23% analyzed for semivolatile and volatile organic compounds, and an additional 29% were analyzed for specific polycyclic aromatic hydrocarbons (PAH) by high pressure liquid chromatography (HPLC) methodology (Table 13). Most samples were analyzed as skin-on scaleless fillets, but catfish were analyzed as skin-off fillets. Samples of small fish such as some sunfish or creek chub samples were analyzed as whole fish.

There are twenty locations normally monitored on a biennial basis (Table 12), plus Lake Michigan. However due to a recession motivated freezing of state analytical laboratory contracts, and a hiring freeze some of these locations were not sampled in both of the bienniums (90 - 91, and 92 - 93) being reported.

For Lake Michigan both non-salmonid and salmonid tissue samples are analyzed. These samples are collected by IDNR's Division of Fish and Wildlife personnel. Only the non-salmonid species tissue samples are analyzed by IDEM's contract analytical laboratory. Some salmonids are submitted to the U.S. FDA lab, Minneapolis, Minnesota. The Indiana Department of Natural Resources (IDNR) also

Table 12. *Locations where fish tissue was collected for contaminant analysis during the period from 1990 through 1993*

SITE	COUNTY	LOCATION	YEAR
1. Big Pine Creek	Warren	C. R. 125N Near Mudlavia Springs	91
2. Big Raccoon Creek	Parke	U/S Lafayette Rd. @ Armiesburg	91
3. Big Walnut Creek	Putnam	U/S Reelsville, IN	91
4. Blue River	Harrison	Stage Stop Campground, H-C S.F.	92
5. Buck Creek	Delaware	Yorktown Lions Community Park	92
6. Burns Ditch (b)	Porter	U/S Lefty's Coho Landing	90,92
7. Clear Creek	Monroe	Country Club Rd.	93
8. Clear Creek	Monroe	Fluckmill Rd.	93
9. Clear Creek	Monroe	Harrodsburg, IN Gore Rd.	93
10. Deer Creek	Carroll	D/S Delphi, IN STP outfall	91
11. Deer Creek	Carroll	U/S Delphi, IN STP @ Riley Park	91
12. East Fork White Lick Cr.	Hendricks	D/S C.R. 700S, U/S Mooresville, IN	90
13. East Fork White River (b)	Lawrence	D/S Williams Dam	92
14. East Fork Whitewater R.	Wayne	D/S Richmond, IN	90
15. Eel River	Greene	S.R. 67	92
16. Elliott Ditch	Tippecanoe	D/S Alcoa-Lafayette, (C.R.100E)	93
17. Elliott Ditch	Tippecanoe	U/S Alcoa-Lafayette, (250S/250E)	93
18. Fall Creek	Hamilton	U/S Geist Res. @ Floria Rd.	91
19. Fall Creek	Madison	D/S Dowden Landfill @ S.R. 13	91
20. Great Miami River	Dearborn	Indiana Portion, Lawrenceburg, IN	90
21. Indiana Harbor Canal(b)	Lake	South of Dickey Rd.	90,92
22. Iroquois River	Newton	100 West Rd. Bridge	90
23. Kankakee River (b)	Lake	Lasalle Fish & Wildlife Area	90,92
24. Kankakee River (b)	LaPorte	Kingsbury Fish & Wildlife Area	90,92

Table 12. *Locations where fish tissue was collected for contaminant analysis during the period from 1990 through 1993 (cont.)*

SITE	COUNTY	LOCATION	YEAR
25. Killbuck Creek	Madison	Grand Avenue	92
26. Lake Michigan (a)	LaPorte	East	90,92
27. Lake Michigan (a)	Lake	West	90
28. Little Calumet River	Lake	Riverside Park, U/S U.S. 41	92
29. Little MississinewaR.	Randolph	D/S Union City STP, CR 700N	93
30. Little Mississinewa R.	Randolph	U/S Union City, Westinghouse Rd.	93
31. Little Sugar Creek	Montgomery	D/S P.R. Mallory Plant	93
32. Little Sugar Creek	Montgomery	U/S P.R. Mallory (C.R. 775E)	93
33. Maumee River (b)	Allen	Landin Rd., New Haven, IN	90,92
34. Middle Fork Reservoir	Wayne	U/S Richmond, IN	90
35. Mississinewa River	Randolph	D/S Ridgeville, C.R. 800N & 500W	93
36. Mississinewa River	Randolph	U/S Little Miss, C.R. 800E	93
37. Muscatatuck River	Washington	U/S S.R. 135, Milport, IN	92
38. Otter Creek	Vigo	C.R. 24W	91
39. Pigeon Creek	Steuben	U/S Pleasant Lake, IN	92
40. Pigeon Creek	Vanderburgh	Kleymeyer Park, Evansville, IN	92*
41. Pigeon Creek	Venderburgh	U/S Stringtown Rd. Evanville, IN	93*
42. Pipe Creek	Madison	C.R. 1000N	92
43. Pleasant Run Creek	Lawrence	D/S GMC, Peerless Rd.	93
44. Pleasant Run Creek	Lawrence	U/S GMC, Mt. Pleasant Rd.	93
45. Richland Creek	Monroe	D/S Confluence Conard's Branch	93
46. Salt Creek	Lawrence	D/S Confluence of Clear Creek	93
47. Salt Creek	Lawrence	S.R. 450	93
48. Silver Creek	Floyd	Armstrong Rd., New Albany, IN	92

Table 12. *Locations where fish tissue was collected for contaminant analysis during the period from 1990 through 1993 (cont.)*

SITE	COUNTY	LOCATION	YEAR
49. St. Joseph River (b)	Allen	U/S Dam @ Johnny Appleseed Park	90,92
50. St. Joseph River (b)	Elkhart	Bristol, IN	90,92
51. St. Joseph River (b)	St. Joseph	D/S South Bend, St. Patrick Park	90,92
52. St. Mary's River (b)	Allen	U/S Spy Run @ Ft. Miamis Park	90,92
53. Stoney Creek	Hamilton	S.R. 37A, Noblesville, IN	93
54. Stoney Creek	Hamilton	S.R. 38, U/S Firestone	93
55. Sugar Creek	Montgomery	D/S Crawfordsville, IN (US 136)	93
56. Sugar Creek	Montgomery	U/S Crawfordsville, (CR 275E)	93
57. Trail Creek (b)	LaPorte	D/S Michigan City STP	90
58. Wabash River	Carroll	D/S Deer Creek	91
59. Wabash River	Carroll	U/S SR 18/39 @ Pittsburg, IN	91
60. Wabash River (b)	Posey	New Harmony, IN	92
61. Wabash River (b)	Tippecanoe	D/S Lafayette, IN	91
62. Wabash River (b)	Tippecanoe	U/S Lafayette, IN	91
63. Wabash River (b)	Vigo	D/S Terre Haute, In @ Darwin	91
64. Wabash River (b)	Vigo	U/S Terre Haute, IN	91
65. Wabash River (b)	Wells	U/S Bluffton, IN	92
66. Wea Creek	Tippecanoe	D/S Elliott D., D/S Hwy 25	93
67. Wea Creek	Tippecanoe	U/S Elliott D., Old Romey Rd.	93
68. West Fork White River	Hamilton	D/S Stoney Creek	93
69. West Fork White River	Hamilton	Riverwood, IN	93
70. West Fork White River (b)	Marion	Broad Ripple Park	91
71. West Fork White River (b)	Morgan	Henderson Ford	91
72. West Fork White River (b)	Pike	Petersburg, IN	92

Table 12. *Locations where fish tissue was collected for contaminant analysis during the period from 1990 through 1993 (cont.)*

SITE	COUNTY	LOCATION	YEAR
73. West Fork White River (b)	Randolph	U/S Winchester, IN	92
74. West Fork Whitewater River	Fayette	D/S Connersville, IN	90
75. West Fork Whitewater River	Fayette	U/S Connersville, IN	90
76. White Lick Creek	Hendricks	U/S C.R. 900S	90
77. White Lick Creek	Morgan	Brookly, IN Bridge	90
78. Whitewater River	Dearborn	S.R. 46 Bridge	90
79. Yellow River	Starke	D/S Knox, IN @ C.R. 300E	90

(b) = Locations samples biennially
(a) = Location sampled annually for salmonids or nonsalmonids in alternating years
* = Samples also collected in 1993 but not analyzed yet due to insufficient funds
STP = Sewage Treatment Plant
U/S = Upstream
D/S = Downstream
C.R. = County Road
S.R. = State Road
H-C S.F. = Harrison Crawford State Forest

Figure 1. *Locations where fish tissue was collected for contaminant analysis during the period from 1990 through 1993*

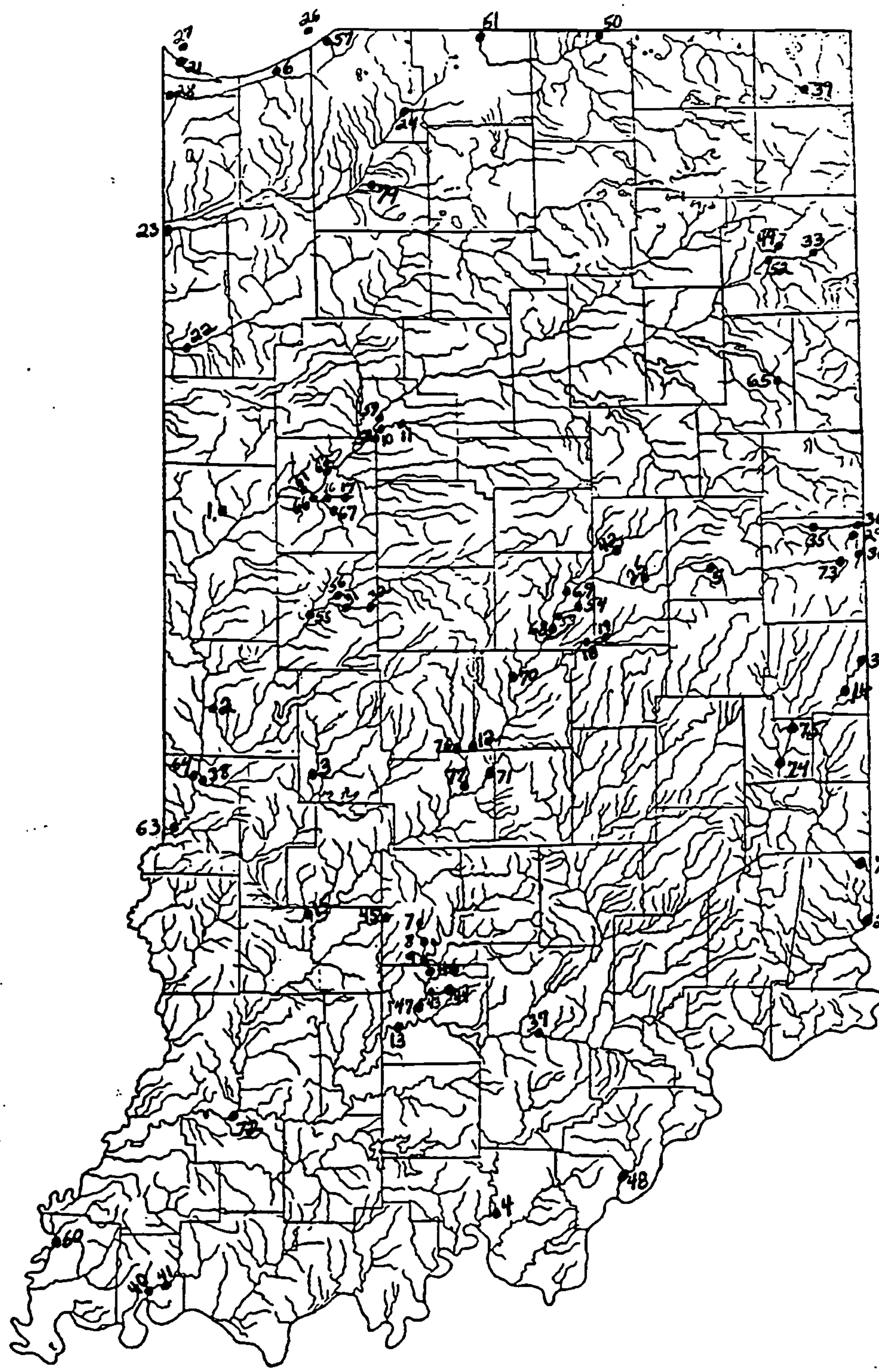


Table 13. *List of chemicals for which fish samples are analyzed by the State of Indiana*

METALS

Aluminum
Antimony
Arsenic
Barium
Berylium
Cadmium/*
Calcium
Chromium
Cobalt
Copper
Iron
Lead/*
Magnesium
Manganese
Mercury/*
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

PESTICIDES

Aldrin/*
alpha-BHC/*
beta-BHC/*
delta-BHC/*
gamma-BHC (Lindane)/*
alpha-Chlordane/*
gamma-Chlordane/*
cis-Nonachlor/*
trans-Nonachlor/*
Oxychlordane/*
p,p'-DDD/*
o,p'-DDE/*
p,p'-DDT/*
o,p'-DDT/*
Dieldrin/*
Endosulfan I/*
Endosulfan II/*
Endosulfan sulfate/*
Endrin/*
Endrin aldehyde/*
Endrin ketone/*
Heptachlor/*
Heptachlor epoxide/*
Hexachlorobenzene/*
Methoxychlor/*
Pentachloroanisole/*
Toxaphene

PCBs

PCBs/Total/*

VOLATILE ORGANICS

Acetone
Benzene
Chlorobenzene
Ethylbenzene
2-Butanone (MEK)
Carbon disulfide
Chloroethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachlorethane
1,1-Dichloroethylene
1,2-Dichloroethylene/Total
Trichloroethylene
2-Hexanone
Bromomethane
Tribromomethane(Bromoform)
Bromodichloromethane
Dibromochloromethane
Chloromethane
Dichloromethane
(Methylene chloride)
Trichloromethane (Chloroform)
Tetrachloromethane
(Carbon tetrachloride)
4-methyl-2-Pentanone
1,2-Dichloropropane
cis-1,3-Dichloroproylene
trans-1,3-Dichloroproylene
Styrene
Toluene
Vinyl acetate
Vinyl chloride
Xylene/Total

BASE/NEUTRAL EXTRACTABLES

Acenaphythylene
Acenaphthene
4-Chloroaniline
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Anthracene
Benzo (a) anthracene
Dibenzo (a,h) anthracene
3,3'- Dichlorobenzidene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2,4-Trichlorobenzene
Hexachlorobezene
Nitrobenzene
Benzyl alcohol
Chrysene
n-nitro-di-n-phenylamine
n-nitroso-di-n-Propylamine
Hexachloroethane
Bis (2-chloroethyl) ether
Bis (2-chloroisopropyl) ether
4-Bromopheyl-phenylether
4-Chlorophenyl-phenylether
Fluoranthene
Fluorene
Benzo (beta) fluoranthene
Benzo (kappa) fluoranthene
Dibenzofuran
Bis (2-chloroethoxy) methane
Isophorone
Naphthalene
2-Chlororonaphthalene
2-Methynaphthalene
Hexachlorocyclopentadiene
Benzo (ghi) perylene
Phenanthrene
di-n-Butylphthalate
Bis (2-ethylhexyl) phthalete (BEHP)
Butylbenzylphthalate
Pyrene
Benzo (alpha) pyrene

BASE/NEUTRAL EX (cont.)

Indeno (1,2,3-c,d) pyrene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Hexachlorotoluene
Carbazole

PAHs by HPLC

Naphthalene
1-Methyl naphthalene
2-Methyl naphthalene
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Fluoranthene
Pyrene
Benzo (a) anthracene
Chrysene
Benzo (b) fluoranthene
Benzo (k) Fluoranthene
Benzo (a) pyrene
Dibenzo (a,h) anthracene
Benzo (g,h,i) perylene
Indeno (1,2,3-c,d) pyrene

ACID EXTRACTABLES

Benzoic acid
Phenol
2-Chlorophenol
2,4-Chlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
Pentachlorophenol
2-Methylphenol
2-Methylphenol
2,4-Dimethylphenol
4-Chloro-3-methylphenol
4,-Dinitro-2-methylphenol
2-Nitrophenol
4-Nitrophenol
2,4-Dinitropheno

/* = Indicates minimum set analyzed

submits salmonid samples to the Indiana State Department of Health (ISDH) Consumer Health Lab for contaminant analysis.

Results of the Fish tissue contaminant analyses are presented to an interagency Fish Consumption Advisory Committee consisting of representatives from the ISDH, IDEM, and IDNR. This committee develops the Fish Consumption Advisory (FCA) which is issued officially by ISDH.

Table 14 is a general list of the sites where fish tissue samples collected during the 1990 - 93 period had exceedances of the U.S. FDA Action or Tolerance Levels for a compound. The 1993 fish collections represented a resampling of most of these stream locations to monitor the trend for contamination in fish in order to keep the FCA list up to date. Table 15 lists the stream reaches of the most current fish consumption advisory (Spring, 1994). Currently there are 669 miles of streams in and bordering the state (including the Ohio River) with fish consumption advisories. The Indiana Lake Michigan advisory includes 241 square miles. Many of these current fish consumption advisory locations have been on the list for a number of years and are due to the presence of total PCBs or chlordane in quantities exceeding the FDA Tolerance/Action level. However, compounds such as DDT and dieldrin contributed to FCAs in the past.

The advisory for the West Fork of the White River in Delaware County, originally issued in 1990, became significantly less restrictive in 1991. The 1991 advisory was limited to carp caught below the Yorktown Bridge at County Road 575W (6.7 river miles) and was a Group 2 Advisory. This advisory was based on the results from twelve fish samples reported to IDEM by the Muncie Bureau of Water Quality. These samples were analyzed by the same private laboratory using the same analytical and QA/QC procedures as IDEM's samples. The ISDH issued its most recent fish consumption advisory in 1993 and the advisory was not changed for this section of the White River in Delaware county since there were no newer data to evaluate from this stretch of river.

The most recent modifications to the Salt Creek advisories, reflected in the Fish Consumption Advisory list (Table 15) was based on consideration of 10 samples from the Monroe Reservoir tailwaters region of Salt Creek collected in late May 1992 by IDNR. These data resulted in 11.14 miles of Salt Creek being lowered from all species - level 3 to just three species - level 3, while the lower 14.92 miles of Salt Creek remain at all species - level 3.

In 1993, the existing fish consumption advisories were lifted for the Maumee River in Allen County and the St. Joseph River in Elkhart County. The existing fish consumption advisory on the East Fork of the White River below Williams Dam was expanded to also include channel catfish. New waterbodies added to the Fish Consumption Advisory list in 1993 were Buck Creek in Delaware County, Great Miami River in Dearborn County, and Pigeon Creek in Vanderburg County.

Table 14. *River sites where fish tissue samples collected (1990-93) exceeded FDA Action/Tolerance Levels**

STREAM	COUNTY	CONTAM-INANT(S)	YEAR SAMPLED	SPECIES
E.F. White R., Williams	Lawrence	PCB, Chlordane	1992	Carp., Channel Catfish, Smallmouth Buffalo
Pleasant Run Creek	Lawrence	PCB	1993	Creek Chub, Spotted Bass, White Sucker, Longear
Salt Cr. (D/S Monroe Res)	Lawrence	PCB	1993	Channel Catfish, Flathead Catfish
Ohio River Basin				
Great Miami River	Dearborn	PCB	1990	Channel Catfish
Pigeon Creek	Vanderburgh	Chlordane	1992	Carp, Channel Catfish
Wabash River Basin				
Elliott Ditch	Tippecanoe	PCB	1993	Creek Chub
L. Sugar Cr.	Montgomery	PCB	1993	Creek Chub, Rock Bass, White Sucker
Sugar Creek	Montgomery	PCB	1993	Smallmouth Bass
Wabash u/s Terre Haute	Vigo	PCB	1991	Smallmouth Buffalo
Wea Creek	Tippecanoe	PCB	1993	Black Redhorse, Northern Hogsucker, White Sucker
West Fork White River Basin				
Buck Creek, Yorktown	Delaware	PCB,Chlordane	1992	Carp
Clear Creek, Bloomington	Monroe	PCB	1993	Creek Chub, Green Sunfish, Longear Sunfish
L. Mississinewa R.	Randolph	PCB	1993	Creek Chub
Stoney Creek	Hamilton	PCB	1993	Carp,Channel Catfish
W.F. White R.	Hamilton	PCB	1993	Carp,Channel Catfish

PCB = Polychlorinated Biphenyl
D/S = Downstream
U/S = Upstream
** = See Table 1 for FDA Action Levels*

Table 15. *1994 Fish Consumption Advisories for Indiana waters (released by the Indiana State Department of Health)*

WATERBODY ADVISORY	STREAM MILES AFFECTED	CONTAM-INANT OF CONCERN	SPECIES INVOLVED	ADVI-SORY**	YEAR STARTED
Clear Creek in Monroe Co.	14.3	P	All	Group 2	1983
Salt Creek from Monroe Reservoir to Peerless in Lawrence County	11.1	P	Carp,Catfish, Drum	Group 3	1983
Salt Creek south of Peerless to East Fork of White River	14.9	P	All	Group 3	1983
Pleasant Run Creek in Lawrence County	4.6	P	All	Group 3	1983
Elliott Ditch and Wea Creek from its confluence with Elliott Ditch in Tippecanoe County	10.8	P	All	Group 3	1983
East Fork of White River from Bedford to Williams Dam	11.9	P	All	Group 3	1983
East Fork of White River below Williams Dam in Lawrence County	79.0	P,C	Channel Catfish, Carp	Group 3	1985
White River in Delaware County downstream from the Yorktown Bridge (C.R. 575W)	6.7	C,P	Carp	Group 2	1993
Buck Creek in Delaware County	18.6	C,P	Carp	Group 3	1993
West Fork of White River from Noblesville to Hamilton/Marion County line	10.0	P,C	All	Group 2	1985
Stoney Creek downstream from Wilson Ditch south of Noblesville	0.8	P	All	Group 3	1985
Little Mississinewa River in Randolph County	7..6	P	All	Group 3	1985
Mississinewa River from one mile above the confluence of Little Mississinewa River and downstream to Ridgeville	11.0	P,C	Carp, Catfish	Group 3	1985
St. Joseph River in St. Joseph County	18.8	P,C	Carp	Group 3	1985
Sand Creek and Muddy Fork of Sand Creek near Greensburg and Decatur County Reservoir	13.8	C,D	All	Group 2	1987
Grand Calumet River, East and West branches and the Indiana Harbor Ship Canal in Lake County	18.5	P	All	Group 3	1986

Table 15. *1994 Fish Consumption Advisories for Indiana waters (released by the Indiana State Department of Health) (cont.)*

WATERBODY ADVISORY	STREAM MILES AFFECTED	CONTAMINANT OF CONCERN	SPECIES INVOLVED	ADVISORY**	YEAR STARTED
Wildcat Creek downstream of the Waterworks Dam in Kokomo to the Wabash River	2.7	P	All	Group 3	1988
Little Sugar Creek in Montgomery County	15.3	P	All	Group 3	1988
Sugar Creek in Montgomery County south of I-74 to S.R. 32 bridge	8.7	P	All	Group 3	1988
Dugger Lake in Sullivan County	NA	P	Carp, Catfish	Group 2	1990
Great Miami River in Dearborn County	1.6	P	Channel Catfish	Group 3	1993
Pigeon Creek in Vanderburgh County 31.9	31.9	C	Carp, Channel Catfish	Group 2	1993

Lake Michigan and Tributaries (1985)
(241 square miles)

Species	Advisory**
Brown trout under 23"	Group 2
Brown trout over 23"	Group 3
Carp	Group 3
Catfish	Group 3
Chinook 21" - 32"	Group 2
Chinook over 32"	Group 3
Coho over 26"	Group 2
Lake trout 20" - 23"	Group 2
Lake trout over 23"	Group 3

Ohio River (1990)
(356 miles)

Species	Advisory**
Carp	Group 2
Channel Cafish under 19"	Group 2
Channel Catfish over 19"	Group 3

Group 1 These fish show the lowest levels of contaminants. Fish taken from these bodies of water do not warrent consumption advisories. Any lake, stream or species not mentioned should be considered Group 1.

Group 2 Consume no more than one meal per week (1/2lb.). Women of child-bearing age and children should not consume any of these fish.

Group 3 No one should consumer these species.

*P = PCB
C = Chlordane
D = Dieldrin

The Fish Consumption Advisory for Lake Michigan is the result of effort from all of the great lakes states to develop a consistent and uniform FCA. Data used includes salmonid species tissue samples collected and prepared by IDNR. The samples are submitted by IDEM to the U.S. Food and Drug Administration (FDA) as part of an interagency agreement in which the U.S. Environmental Protection Agency (EPA) arranges sample collection through IDEM and the FDA analyzes the samples pesticides and PCBs. This is the fifteenth year of the agreement.

Polychorinated biphenyls (PCBs) are a family of 209 individual chlorinated hydrocarbon compounds each referred to as a congener. The major U.S. producer, Monsanto Corporation, marketed PCBs under the trade name Aroclor from 1930 to 1977. The only other known manufacturer of PCBs in the U.S. was Geneva Industries of Houston, Texas, which operated from 1972 to 1974. Chemical and physical stability and electrical insulating properties led to the commercial utility of PCBs. PCBs were made for use in closed electrical and heat transfer fluids (approximately 60% of total use), plasticizers (25%), hydraulic fluids and lubricants (10%), printing inks, paints, dusting agents, pesticides, carbonless copy papers, and many other applications (U.S. EPA, 1987).

Their ubiquitous past use has led to widespread distribution of PCBs in the environment, causing great environmental concern due to their extreme persistence, bioaccumulation and adverse health effects (IJC, 1991). PCBs are known to cause reproductive and developmental effects in laboratory animals. Human investigations have confirmed that PCBs present in maternal blood cross the placenta and enter the fetal circulation. The PCB contamination of fish is often correlated with identifiable sources. Specific sources have been identified as contributory to PCB contamination. However because of the wide occurrence of PCBs in fish tissue samples., contamination is thought to be contributed from nonpoint and atmospheric sources as well. Total PCB was detected in 85.9% of the fish tissue samples analyzed for the period 1990 - 1993 (Table 16).

Lake Michigan fish have been exposed to PCBs from both point and non-point sources, many of which are in other states bordering the lake. PCB contaminated non-salmonids collected in the past from Burns Ditch and Trail Creek, which are direct tributaries to Lake Michigan, were thought to receive their exposures to PCBs in these tributaries, while the salmonids that migrated into these tributaries received exposure in the lake. The most recent monitoring of aquatic sediments from Burns Ditch and from Trail Creek found Aroclors of PCBs (See Sediment Contaminant Monitoring Program Section). The most recent fish tissue samples from these tributaries as well as the Little Calumet River did not exceed the FDA Tolerance Level for PCBs or Action Levels for pesticides and mercury.

Two non-salmonid samples collected in 1992 had PCB concentrations in exceedance of the FDA Tolerance Level and detections in all (including 1990) but one sample (yellow perch). Also, most Lake Michigan fish samples collected in Indiana

Table 16. *Percent detections of organochlorine pesticides and total PCBs in fish tissue samples analyzed (1990 - 93)*

COMPOUND	%DETECTION	# OF SAMPLES	DETECTION LIMITS
Aldrin	2.6	311	8.0 ug/kg
alpha-BHC	0.0	311	8.0 ug/kg
beta-BHC	0.0	311	8.0 ug/kg
delta-BHC	0.0	311	8.0 ug/kg
gamma-BHC	0.6	311	8.0 ug/kg
alpha-Chlordane	55.6	311	8.0 ug/kg
gamma-Chlordane	35.7	311	8.0 ug/kg
cis-Nonachlor	38.6	311	8.0 ug/kg
trans-Nonachlor	69.8	311	8.0 ug/kg
Oxychlordane	13.2	311	8.0 ug/kg
p,p'-DDD	21.9	311	10.0 ug/kg
o,p'-DDD	4.8	311	10.0 ug/kg
p,p'-DDE	56.6	311	10.0 ug/kg
o,p'-DDE	2.3	311	10.0 ug/kg
p,p'-DDT	5.5	311	10.0 ug/kg
o,p'-DDT	1.9	311	10.0 ug/kg
Dieldrin	68.8	311	10.0 ug/kg
Endosulfan I	0.0	311	20.0 ug/kg
Endosulfan II	0.3	311	20.0 ug/kg
Endosulfan Sulfate	0.0	311	20.0 ug/kg
Endrin	1.0	311	10.0 ug/kg
Endrin Aldehyde	0.3	311	10.0 ug/kg
Endrin Ketone	0.0	311	10.0 ug/kg
Heptachlor	1.6	311	8.0 ug/kg

Table 16. *Percent detections of organochlorine pesticides and total PCBs in fish tissue samples analyzed (1990 - 93) (cont.)*

COMPOUND	%DETECTION	# OF SAMPLES	DETECTION LIMITS
Heptachlor epoxide	17.4	311	8.0 ug/kg
Hexachlorobenzene	1.0	311	10.0 ug/kg
Methoxychlor	0.3	311	20.0 ug/kg
Pentachloroanisole	3.2	311	8.0 ug/kg
Toxaphene	0.0	311	10.0 ug/kg
Total PCB	85.9	311	50.0 ug/kg

waters still contain measurable levels of residues of chlordane, DDT, DDD, DDE, dieldrin, endrin, and mercury.

The Indiana Harbor Canal and the Grand Calumet river are known to have highly contaminated sediments but specific sources of PCBs have not yet been identified. Every 1990 and 1992 fish tissue sample from the Indiana Harbor Canal analyzed had concentrations exceeding the FDA Tolerance Level for PCBs. Although there has been no fish tissue sampling from the Grand Calumet River itself for several years, historically most every sample ever analyzed, whether whole fish or fillets, had PCB concentrations in exceedance of FDA Tolerance Levels.

To date, there are no known Indiana point sources which have contributed to PCB contamination in fish from the St. Joseph river near South Bend. Sediment testing in several tributaries of the river in 1985 indicated some evidence of contamination. Collections in 1988 revealed some PCBs in sediment upstream of Mishawaka. Some of the fish tissue samples collected in 1990 and 1992 had PCB concentrations above the FDA Tolerance Level.

Many of the stream sites sampled in 1993 were locations previously identified as having sources of PCB contamination in the watershed. These sites include:

1) The Little Mississinewa River and Mississinewa River near Union City in Randolph County

2) Elliott Ditch and Wea Creek near Lafayette in Tippecanoe County

3) Clear Creek, Richland Creek, Salt Creek, Pleasant Run Creek, and the East Fork of the White River near Bloomington and Bedford in Monroe and Lawrence counties

4) Stoney Creek and the West Fork of the White River near Noblesville in Hamilton County

5) Little Sugar Creek and Sugar Creek near Smartsburg and Crawfordsville in Montgomery County.

Although state and/or federal cleanups have occurred near some of these locations fish tissue continues to be highly contaminated. The PCB levels in the fish tissue from these locations are some of the highest levels found in any stream in the state sampled to date. Samples collected from Pleasant Run Creek, north of Bedford in Lawrence County had concentrations of PCB in creek chubs of as much as 330 ppm which is over 150 times the FDA Tolerance Level of 2.0 ppm. A spotted bass tissue sample with 220 ppm total PCB, and a white sucker tissue sample with 2670 ppm total PCB were also collected at this site in 1993.

In the 1980's, the Great Lakes Sport Fish Consumption Advisory Task Force was created. This task force is charged with developing a uniform sport fish consumption advisory protocol applicable to all Great Lakes. The advisory goals are to: 1) maintain the health benefit of fish consumption, 2) minimize the potential for angler toxic chemical exposure, 3) use credible and understandable science and, 4) present the information in a manner conducive to maximal voluntary compliance. The task force has spent considerable time reviewing and discussing the risk of adverse health effects from consumption of contaminated sport fish. The task force has chosen to focus advisory protocol on PCBs, the chemical contaminant most frequently encountered in Great Lakes fish which necessitates guidance. Their advisory approach (Anderson, et al. 1993) utilized a weight-of-evidence derived individual health protection value (HPV) of 0.05 ug/kg/day for PCBs residue ingested from fish tissue. The HPV is intended to encompass acceptable cancer and reproductive/developmental risk. Table 17 shows the theoretical placement of fish samples from various locations into consumption group categories based on the concentration of PCBs to limit exposure to PCBs from fish consumption to <0.05 ug/kg/day. Only fillet sample results were used for the lists.

DDT, dieldrin, and chlordane were widely used, environmentally persistent organochlorine pesticides banned from general agricultural use in 1969, 1972, and 1980, respectively. They have also been common contaminants in fish. These compounds are toxicants with long-term persistence in soil and water, and high lipophilicity (affinity for fatty tissue). Dieldrin, chlordane isomers, DDT, DDD, and DDE, like PCBs, are found ubiquitously, occurring in small amounts at least in most fish tissue samples analyzed (Table 16). Extensive sampling throughout the state has revealed very few point sources of these pesticides (IDEM, 1990). Because of the agricultural use bans, the incidence of DDT, dieldrin, and chlordane contamination in fish flesh has declined over the years in response to decreasing exposure from nonpoint sources such as farm field run-off. Chlordane was the only one of the three that has exceeded the FDA Action Level in the reporting period.

Levels of chlordane in excess of FDA Action Levels were found in fish from Pigeon Creek at Kleymeyer City Park in Evansville (Vanderburgh County), Buck Creek in Yorktown (Delaware County), East Fork White River at Williams (Lawrence County), and West Fork White River downstream of Noblesville (Hamilton County). However, the Pigeon Creek location is the only one that did not also have high PCB values associated with the same samples. Pigeon Creek in Evansville is said to be surrounded by many old, abandoned landfills of unknown contents.

Total DDT was quantitated in 40% of the fish tissue samples analyzed for the period 1990-1993 with p,'-DDE being the primarily detected breakdown isomer at 56.6% occurrence. Total chlordane was quantitated in 50.2% of fish tissue samples with trans-nonachlor (69.8%) and alpha chlordane (55.6%) being the two most highly detected isomers.

Heptachlor epoxide was detected in 17.4% of the fish tissue samples. However, none of these quantities exceeded the FDA Action Level for this compound.

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993)*

STREAM	COUNTY	LOCATION	SPECIES
Group 1: (0.00 - 0.05 ppm PCB)*			
Big Pine Creek	Warren	C.R. 125N, near Mudlavia Springs, IN	Black Redhorse Carp Channel Catfish
Big Raccoon Creek	Parke	U/S Lafayette Rd. at Armiesburg, IN	Black Redhorse Carp Spotted Bass
Big Walnut Creek	Putnam	U/S Reelsville, IN	Black Redhorse River Carpsucker Spotted Bass
Buck Creek	Delaware	Yorktown, IN	Smallmouth Bass
Deer Creek	Carroll	U/S Delphi, IN D/S Delphi, IN	Black Redhorse Black Redhorse
Eel River	Greene	S.R. 67	Bigmouth Buffalo Freshwater Drum
Fall Creek	Hamilton Madison	U/S Geist Reservoir Falls Park, Pendleton, IN	Black Redhorse Largemouth Bass White Sucker Smallmouth Bass
Iroquois River	Newton	100 West Rd. Bridge	Carp
Kankakee River	LaPorte Lake	Kingsbury Fish & Wildlife Area Lasalle Fish & Wildlife Area	Bigmouth Buffalo Carp Northern Pike
Killbuck Creek	Madison	Grand Avenue, Anderson, IN	Largemouth Bass
Lake Michigan	LaPorte	East	Yellow Perch
Middle Fork Res.	Wayne	U/S Richmond, IN	Black Redhorse Largemouth Bass
Pigeon Creek	Steuben	U/S Plesant Lake, IN	White Sucker

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lake Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
Silver Creek	Floyd	Armstrong, Rd, New Albany, In	Carp
St. Joseph River	Allen	U/S Dam, Johnny Appleseed Prk.	Black Redhorse
St. Joseph River	Elkhart	Bristol, IN	Black Bullhead
Wabash River	Wells	U/S Bluffton, In	Rock Bass
	Tippecanoe	U/S Lafayette, IN	Bigmouth Buffalo
			Largemouth Bass
	Posey	New Harmony, IN	Freshwater Drum
W.F. Whitewater River	Fayette	U/S Connersville, IN	Black Redhorse Smallmouth Bass
Yellow River	Starke	D/S Knox, IN	Rock Bass
Group 2: (0.06 - 0.20 PCB)*			
Big Raccoon Creek	Parke	U/S Lafayette Rd @ Armiesburg	Channel Catfish
Big Walnut Creek	Putnam	U/S Reelsville, IN	Carp
Deer Creek	Carroll	U/S Delphi, IN	Carp
Fall Creek	Madison	D/S Dowden Landfill, S.R. 13	Black Redhorse Smallmouth Bass
Great Miami River	Dearborn	Indiana portion, Lawrenceburg, IN	Largemouth Bass
Kankakee River	LaPorte	Kingsbury Fish & Wildlife Area	Bigmouth Buffalo Carp
	Lake	Lasalle Fish & Wildlife Area	Carp Quillback Carpsucker
Lake Michigan	LaPorte	East	Freshwater Drum White Sucker Yellow Perch
	Lake	West	Longnose Sucker Yellow Perch
Maumee River	Allen	Landin Rd., New Haven, IN	Carp

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
Middle Fork Res.	Wayne	U/S Richmond, IN	Carp
Muscatatuck River	Washington	U/S S.R. 135, Milport, IN	Bigmouth Buffalo Smallmouth Buffalo
Otter Creek	Vigo	C.R. 24W	Black Redhorse
Pipe Creek	Madison	C.R. 1000W	Carp White Sucker
Richland Creek	Monroe	D/S Confluence Conard's Branch	Rock Bass
Silver Creek	Floyd	Armstrong Rd., New Albany, IN	Freshwater Drum Smallmouth Bass
St. Joseph River	Allen	U/S Dam, Johnny Appleseed Park	Black Redhorse Carp
St. Joseph River	Elkhart	Bristol, IN	Black Redhorse Largemouth Bass Smallmouth Bass
	St. Joseph	D/S South Bend, IN at St. Patricks Park	Smallmouth Bass
Sugar Creek	Montgomery	U/S Crawfordsville, IN	Carp
Trail Creek	LaPorte	D/S Michigan City STP	White Sucker
Wabash River	Wells	U/S Bluffton, IN	Carp
	Carroll	D/S Deer Creek	Channel Catfish Shorthead Redhorse
		U/S S.R. 18/39 at Pittsburg, IN	Carp
	Tippecanoe	U/S Lafayette, IN	Channel Catfish
	Vigo	U/S Terre Haute, IN	Carp Flathead Catfish
		D/S Terre Haute, IN at Darwin	River Carpsucker
	Posey	New Harmony, IN	Channel Catfish
W.F. White River	Randolph	U/S Winchester, IN	Carp
	Hamilton	Riverwood, IN	Largemouth Bass
	Marion	Broad Ripple Park, Indpls	Largemouth Bass

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
W.F. Whitewater River	Fayette	U/S Connersville, IN D/S Connersville, IN	Quilback Carpsucker Black Redhorse Largemouth Bass
White Lick Creek	Hendricks Morgan	U/S C.R. 900S Brooklyn, IN	Carp Smallmouth Bass Carp
Whitewater River	Dearborn	S.R. 46	Black Redhorse
Yellow River	Starke	D/S Knox, IN @ C.R. 300E	Carp
Group 3: (0.21 - 1.00 ppm PCB)*			
Blue River	Harrison	Stage Stop Campground	Carp Channel Catfish Shorthead Redhorse
Buck Creek	Delaware	Yorktown, IN	Carp
Burns Ditch	Porter	U/S Lefty's Coho Landing	Carp Channel Catfish
E.F. White River	Lawrence	D/S Williams Dam	Channel Catfish
E.F. Whitewater River	Wayne	D/S Richmond, IN	Carp Channel Catfish
Eel River	Greene	S.R. 67	Carp Sauger
Fall Creek	Madison	D/S Dowden Landfill, S.R. 13	Carp Channel Catfish
Great Miami R.	Dearborn	Indiana portion, Lawrenceburg, IN	Carp
Iroquois River	Newton	100 West Bridge	Carp
Kankakee River	LaPorte Lake	Kingsbury Fish & Wildlife Area Lasalle Fish & Wildlife Area	Channel Catfish Bigmouth Buffalo

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
Killbuck Creek	Madison	Grand Ave., Anderson, IN	Carp
Lake Michigan	LaPorte	East	White Sucker
Maumee River	Allen	Landin Rd., New Haven, IN	River Redhorse Carp Shorthead Redhorse
Mississinewa River	Randolph	D/S Ridgeville, IN	Channel Catfish
Pigeon Creek	Steuben	U/S Pleasant Lake, IN	Carp
Pigeon Creek	Vanderburgh	Kleymeyer Park, Evansville, IN	Carp Channel Catfish
Pipe Creek	Madison	C.R. 1000W	Carp
Richland Creek	Monroe	D/S Confluence Conard's Branch	White Sucker
Silver Creek	Floyd	Armstrong Rd., New Albany, IN	Carp Channel Catfish
St. Joseph River	Allen	U/S Dam, Johnny Appleseed Park	Carp
St. Joseph River	Elkhart St. Joseph	Bristol, IN D/S South Bend, IN at St. Patricks Park	Carp Channel Catfish Shorthead Redhorse Black Redhorse Shorthead Redhorse
St. Mary's River	Allen	Ft. Miamis Park	Largemouth Bass Carp
Sugar Creek	Montgomery	D/S Crawfordsville, IN (US 136)	Carp

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
Wabash River	Wells	U/S Bluffton, IN	Carp Channel Catfish
	Carroll	U/S S.R. 18/39 at Pittsburg, IN	River Redhorse
		D/S Deer Creek	Carp
	Tippecanoe	U/S Lafayette, IN	Carp
		D/S Lafayette, IN	Carp Channel Catfish Freshwater Drum
	Vigo	U/S Terre Haute, IN	Carp
		D/S Terre Haute, IN at Darwin	Blue Sucker Carp
	Posey	New Harmony, IN	Carp
W.F. White River	Marion	Broad Ripple Park	Channel Catfish Quillback Carpsucker Spotted Sucker
	Morgan	Henderson Ford	Carp River Carpsucker
	Pike	Petersburg, IN	Carp River Carpsucker
	Randolph	U/S Winchester, IN	Carp
W.F. Whitewater River	Fayette	D/S Connersville, IN	Carp
Whitewater River	Dearborn	S.R. 46	Carp Channel Catfish
Group 4: (1.10 - 1.90 ppm PCB)*			
Burns Ditch	Porter	U/S Lefty's Coho Landing	Carp
Killbuck Creek	Madison	Grand Ave., Anderson, IN	Carp
Lake Michigan	LaPorte	East	White Sucker Longnose Sucker
Little Calumet River	Lake	Riverside Park, U/S U.S. 41	Carp

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
Maumee River	Allen	Landin Rd., New Haven, IN	Carp
Mississinewa River	Randolph	U/S Little Miss, C.R. 800E	Carp
Salt Creek	Lawrence	D/S Confluence of Clear Creek S.R. 450	Largemouth Bass Spotted Bass Largemouth
St. Joseph River	St. Joseph	D/S South Bend, IN at St. Patricks Park	Channel Catfish
St. Mary's River	Allen	Ft. Miamis Park	Carp
Wabash River	Tippecanoe	D/S Lafayete, IN	Carp
W. F. White River	Hamilton	Riverwood, IN	Carp
Group 5: (>1.9 ppm PCB)*			
Buck Creek	Delaware	Yorktown, IN	Carp
E.F. White River	Lawrence	D/S Williams Dam	Carp Channel Catfish Smallmouth Buffalo
Great Miami River	Dearborn	Indiana portion, Lawrenceburg	Channel Catfish
Indiana Harbor Canal	Lake	Dickey Road	Carp
Kankakee River	Lake	Lasalle Fish & Wildlife Area	Smallmouth Buffalo
Lake Michigan	LaPorte	East	Carp
Mississinewa River	Randolph	U/S Little Miss. C.R. 800E D/S Ridgeville, IN, C.R. 800N & 500W	Channel Catfish Carp
Salt Creek	Lawrence	D/S Confluence of Clear Creek S.R. 450	Channel Catfish Channel Catfish Flathead Catfish
St. Joseph River	Allen	U/S Dam, Johnny Appleseed Park	Channel Catfish
St. Joseph River	St. Joseph	D/S South Bend, IN at St. Parick Park	Carp

Table 17. *Theoretical placement of fish samples into consumption advisory groups based upon fish tissue concentration of PCB for 1990-1993 collections (fillet samples only), as per Great Lakes Fish Advisory Task Force Protocol (1993) (cont.)*

STREAM	COUNTY	LOCATION	SPECIES
Stoney Creek	Hamilton	S.R. 37A, Noblesville, IN	Carp Channel Catfish
Trail Creek	LaPorte	D/S Michigan City STP	Carp
Wabash River	Vigo	U/S Terre Haute, IN	Smallmouth Buffalo
W.F. White River	Hamilton	D/S Stoney Creek	Carp Channel Catfish

U/S = Upstream
D/S = Downstream
C.R. = County Road
S.R. = State Road
STP = Sewage Treatment Plant

*Group 1 - Unrestricted consumption
Group 2 - 1 meal/week
Group 3 - 1 meal/month
Group 4 - 6 meals/year
Group 5 - Do not eat

1 meal = 0.5 pounds (227 gms.)

Heptachlor epoxide is a microbially converted metabolite of heptachlor in the environment. Heptachlor is a broad spectrum insecticide introduced in 1948 as a contact insecticide under the trade names R 3314 and Velsicol 104. It was suspended for use on food crops and home use in 1976, however significant commercial use of heptachlor for termite control or in nonfood plants continues. Both heptachlor and heptachlor epoxide have been shown to be toxic to aquatic life, to accumulate in plant and animal tissues, and to persist in aquatic ecosystems (U.S. EPA, 1980). All of the other organochlorine pesticides were detected at a rate of less than 4% or not at all.

In addition to pesticides and PCBs, fish tissue samples are analyzed for up to 23 different elements including a number of metals of concern. Some of these metals (cadmium, lead, and mercury) are analyzed on every fish tissue sample. Others are analyzed for only in a limited number of selected samples. The only one of these for which there is an FDA Action Level is mercury (Table 11). Mercury can exist in a number of forms in the environment. Mercury has found widespread use in insecticides, fungicides, bactericides, pharmaceuticals, paint additives, tanning, batteries, applications in metallurgy and dental fillings, thermometers, and barometers. Use of mercury in pesticides is now banned except for some limited use in fungicides or preservatives (IJC, 1987). Mercury released in this century through human activities is almost ten times the calculated amount released due to natural weathering (Moore and Ramamoorthy, 1984). The consumption and discarding of mercury-containing goods is the largest source of mercury discharge to the environment.

Mercury is detected ubiquitously in fish tissue samples from Indiana waters. In the reporting period of 1990 - 1993 mercury was detected in 90% of all fish tissue samples analyzed. However, none of these quantities surpassed the FDA Action Level for mercury. The median value for all fish tissue samples collected 1990 - 1993 was 0.132 ppm with a range maximum value of 0.780 ppm. The FDA Action Level for mercury is 1.0 ppm. As stated earlier, since mercury tends to concentrate in the organ and muscle tissues, the only way to reduce intake from fish tissue is to reduce the amount eaten.

Lead is another of the metals of environmental concern. It is ubiquitous in nature. Lead has been in use for many centuries and is found in piping, building materials, solders, paint, and ammunition as well as other things. Today its main use has been in lead-acid storage batteries, metal products, chemicals (such as antiknock agents that used to be found in gasoline), and pigments. Important sources of lead in the environment include automobile exhaust (with leaded gasoline), smelting smoke and lead base paints (Moore and Ramamoorthy, 1984) (U.S. EPA, 1978).

The U.S. EPA reported that ingestion constitutes the major source of lead in people (U.S. EPA, 1980b). The hazard of lead to children is of considerable concern. There is little evidence of biomagnification in the food chain and fish consumption therefore does not constitute an unusually significant source of lead in the human diet. High levels in fish tissue samples are usually associated with point source contamination. Lead tends to accumulate equally in both organs and muscle tissue of fish. Table 18 lists locations, range of values, and species of fish involved for which lead was above the analytical detection limit. Lead was quantitated above the laboratory detection in 25% of the fish tissue samples analyzed in this reporting period (1990 - 1993).

Cadmium, is also found in low levels throughout the environment. The major routes of exposure of humans to cadmium are through food and tobacco smoke. Major uses of cadmium include electroplating, pigments, plastic stabilizers, batteries, and as cadmium phosphors as tubes in TVs, fluorescent lamps, x-ray screens, etc (U.S. EPA, 1980c). Cadmium is accumulated mainly in the organ tissues of fish rather than in muscle. Because levels are normally low in edible muscle, accumulation does not appear to be a threat to most of Indiana's fishery resources. In fact, only 17% of the fish tissue samples analyzed had detectable amounts of cadmium with a detected range of 0.010 - 0.093 parts per million (ppm or mg/kg). Most of these were at or just above the detection limit of 0.010 ppm.

Copper, like lead, is known to only bioaccumulate in muscle under conditions of moderate to extreme pollution and, although it can accumulate in the muscle tissue, it has been shown to accumulate at a much higher level in the liver and the gut wall (Moore and Ramamoorthy, 1984). Also, toxicity to fish is the more important problem before accumulation begins to occur. No separate organ analysis studies have been undertaken in the fish tissue contaminant monitoring program although organ studies may provide a better indication of metals bioaccumulation than fillet samples can provide. Locations where copper levels are elevated in fish fillet tissue samples analyzed include:

East Fork White River, Fayette County	137.00 ppm	common carp, fillets
Great Miami River, Dearborn County	92.90 ppm	white crappie, whole fish
St. Joseph River, Allen County	53.50 ppm	common carp, fillets
St. Joseph River, Elkhart County	55.50 ppm	common carp, fillets
St. Joseph River, St. Joseph County	27.90 ppm	common carp, fillets
Wabash River, Posey County	57.90 ppm	freshwater drum, fillets

Starting in 1987, tissue analysis for semi-volatile and volatile compounds were performed on some fish samples. Table 19 lists those locations where fish tissue

Table 18. *Occurrence of lead in fish tissue samples collected (1990 - 1993)*

SITE	COUNTY	LOCATION	RANGE (mg/kg)	SPECIES
Blue River	Harrison	Stage Stop Campground	0.020	channel catfish
Buck Creek	Delaware	Yorktown, IN	0.110	carp
Burns Ditch	Porter	U/S Lefty's Coho Landing	0.092 - 0.983	sucker, largemouth, bass crappie
Clear Creek	Monroe	All Locations	0.070 - 0.22	creek chub, longear and green sunfish
E.F. White Lick	Hendricks	U/S Mooresville	0.031 - 0.079	creek chub, hogsucker, yellow bullhead
E.F. White River	Lawrence	D/S Williams Dam	0.360	channel catfish
E.F. Whitewater River	Wayne	D/S Richmond	0.133 - 8.940	carp, channel catfish, smallmouth bass
Eel River	Greene	S.R. 67	0.340	channel catfish
Great Miami River	Dearborn	Lawrenceburg, IN	0.097- 6.800	carp, channel catfish, largemouth bass, crappie
Indiana Harbor Canal	Lake	South of Dickey Road	0.201 - 2.660	carp, goldfish
Iroquois River	Newton	C.R. 100w	0.160	northern pike
Kankakee River	Lake	LaSalle F & W Area	0.200	smallmouth buffalo
Lake Michigan	LaPorte	East	0.041 - 0.123	carp, longnose sucker
Lake Michigan	Lake	West	0.048	yellow perch
Little Sugar Creek	Montgomery	C.R. 775E	22.600	black redhorse
Maumee River	Allen	New Haven, IN	0.116 - 5.020	channel catfish, quillback carpsucker, rock bass
Middle Fork Reservoir	Wayne	U/S Richmond, IN	0.038 - 0.062	blk. redhorse, carp, largemouth bass
St. Joseph River	Elkhart	Bristol, IN	0.160 - 5.910	carp, channel catfish
St. Joseph River	St. Joseph	D/S South Bend	3.000	carp

Table 18. *Occurrence of lead in fish tissue samples collected (1990 - 1993) (cont.)*

SITE	COUNTY	LOCATION	RANGE (mg/kg)	SPECIES
St. Mary's River	Allen	Fort Miamis Park	0.299 - 0.328	bigmouth buffalo, white sucker
Stoney Creek	Hamilton	all locations	0.180 - 0.800	carp, channel catfish
Sugar Creek	Montgomery	all locations	0.160 - 1.000	black redhorse, rock bass
Trail Creek	LaPorte	D/S Michigan City STP	0.452	carp
Wabash River	Posey	New Harmony, IN	2.500	channel catfish
Wabash River	Vigo	Terre Haute area	0.040 - 0.390	channel & flathead catfish, shovelnose sturgeon
W.F. White River	Randolph	U/S Winchester, IN	1.200	gizzard shad
W.F. Whitewater River	Fayette	Connersville, IN	0.063 - 0.593	black redhorse, carp quillback carpsucker, smallmouth bass
White Lick Creek	Hendricks	C.R. 900S	4.650	channel catfish
White Lick Creek	Morgan	Brooklyn, IN	4.000	channel catfish
Whitewater River	Dearborn	S.R. 46	0.066 - 0.383	black redhorse, carp, channel catfish, freshwater drum
Yellow River	Starke	D/S Knox, IN	0.293	rock bass

D/S - Downstream
U/S = Upstream
C.R. = County Road
S.R.. = State Road
F & W - Fish and Wildlife Area

Table 19. *Semivolatile and volatile organic compound detections in fish tissue at various locations sampled (1990 - 1993)*

SITE	COUNTY	COMPOUNDS DETECTED
Big Pine Creek	Warren	di-n-butylphthalate, carbon disulfide
Big Raccoon Creek	Parke	carbon disulfide
Big Walnut Creek	Putnam	carbon disulfide
Blue River	Harrison	phenanthrene, fluorene
Burns Ditch	Porter	trichloroethylene
Clear Creek	Monroe	phenanthrene, fluoranthene, fluorene
Elliott Ditch	Tippecanoe	phenanthrene
Great Miami River	Dearborn	di-n-butylphthalate, diethylphthalate, carbon disulfide, trichloroethylene
Indiana Harbor Canal	Lake	naphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, fluoranthene, pyrene, chrysene, dibenzofuran, di-n-butylphthalate, butyl-benzyl-phthalate, 1,1-dichloroethane, 1,2-dichloroethane, 1,1,2,2-tetrachlorethane, trichloroethylene, bromodichloromethane, chloroform, tetrachloroethylene, ethylbenzene, trichloromethane, carbon disulfide
Iroquois River	Newton	di-n-buthylphthalate
Kankakee River	Lake	fluorene, toluene, di-n-butylphthalate, carbon disulfide
Lake Michigan		phenanthrene, anthracene, fluorene, trichloroethylene, toluene, di-n-butylphthalate
Little Mississinewa River	Randolph	phenanthrene
Maumee River	Allen	acenaphthylene, fluorene, phenanthrene, trichloroethylene, di-n-butylphthalate, toluene
Middle Fork Reservoir	Wayne	chrysene, fluorene, toluene, di-n-butylphthalate
Pigeon Creek	Vanderburgh	phenanthrene, fluorene
Pleasant Run Creek	Lawrence	phenanthrene
Silver Creek	Floyd	acenaphthene, phenanthrene

Table 19. *Semivolatile and volatile organic compound detections in fish tissue at various locations sampled (1990 - 1993) (cont.)*

SITE	COUNTY	COMPOUNDS DETECTED
St. Joseph River	Allen	fluorene, di-n-butylphthalate
St. Joseph River	Elkhart	acenaphthylene, fluorene, phenanthrene, di-n-butylphthalate, carbon disulfide
	St. Joseph	acenaphthylene, fluorene, chrysene, trichloroethylene, 1,1,1-trichloroethane, tetrachloroethylene, toluene
St. Mary's River	Allen	phenanthrene, fluorene, chrysene, toluene, trichloroethylene
Trail Creek	LaPorte	phenanthrene, chrysene, fluorene, tetrachloroethylene, toluene
Wabash River	Carroll Tippecanoe Posey Vigo	fluorene, carbon disulfide toluene carbon disulfide phenanthrene, fluorene, toluene
Wea Creek	Tippecanoe	phenahthrene
West Fork White River	Hamilton Marion Morgan Pike Randolph	phenanthrene carbon disulfide, toluene carbon disulfide carbon disulfide phenanthrene, fluorene
Whitewater River	Fayette	trichloroethylene
Yellow River	Starke	carbon disulfide

samples had detections of semivolatile or volatile organic compounds. A number of these compounds were detected in samples taken from the Grand Calumet River/Indiana Harbor Canal (GCR/IHC). Those detected compounds included: benzene, ethylbenzene, 2-butanone, trichlorethylene, tetrachloroethylene, carbon disulfide, naphthalene, toluene, 2-methyl-naphthalene, dibenzofuran, fluorene, fluoranthene, pyrene, acenaphthene, acenaphthylene, phenanthrene, and xylene. Most of these compounds are classed as monocyclic and polycyclic aromatic hydrocarbons (MAHs and PAHs). Although generally not considered very acutely toxic to forms of life (except in high concentrations), several are either known or suspected carcinogens. Both MAHs and PAHs are not very polar in physical nature (sparingly to insoluble in water) and are strongly sorbed to the organic component of suspended solids and sediments.

PAHs originate from both natural and anthropogenic sources and are generally distributed in plant and animal tissues, surface waters, sediments, soils, and air. They can be formed as a result of incomplete combustion of organic compounds with insufficient oxygen. Many PAHs can be found in smoked food, cigarette smoke, vegetable oils, and margarines as well as surface waters and fish. Residues in tissues from other studies have been observed to be very low except at site specific discharge points (Moore and Ramamoorthy, 1984). Naphthalene is used in the manufacture of chemicals such as solvents, lubricants, dyes, moth repellents, insecticides, vermicides, antihelmintics, and intestinal antiseptics. Acenaphthene is used in the manufacture of dyestuff, plastics, and pesticides. Phenanthrene is also used as an intermediate in these production uses. Polycyclics such as chrysene, pyrene, perylene, benzopyrene, dibenzoanthracene, and benzo(a)anthracene have few industrial uses. Crude oil contains high levels of various PAHs and MAHs. Oil contamination and heavy industry is the most probable source for these contaminants found in aquatic sediments and fish tissue from the GCR/IHC. Table 20 lists the PAH compounds analyzed by HLCP and detected in fish tissue samples collected (1990 - 1993).

Some of the more commonly produced monocyclic aromatic hydrocarbons include benzene, toluene, xylene, ethylbenzene, and chlorobenzenes. These compounds are used in the synthesis of pharmaceuticals and other chemicals such as styrene, detergents, pesticides, and cyclohexane in addition to being used as degreasers, antiknock fuel additives and solvents. Although there are no FDA Action Levels for these compounds in fish tissue, upper limit values are given for these as well as other toxic chemicals for the "protection of human health from the toxic affects which may result from the consumption of aquatic organisms and/or drinking water from a waterbody" in the Indiana State Water Quality Standards (327 IAC 2-1-6).

Fluorene was the most widely detected polycyclic aromatic compound occurring above the analytical detection limit at 23 of the sampled locations. The PAH compounds were detected at 25 of the locations. Benzene (a volatile organic compound known to be highly carcinogenic) was found in 24% of samples analyzed

Table 20. *Percent detections of polycyclic aromatic hydrocarbon compounds by HPLC detection method in fish tissue samples collected (1990 - 1993)*

COMPOUND	% DECTECTION	DETECTION LIMIT
Naphthalene	2	100 ug/kg
Acenaphthylene	6	125 ug/kg
Acenaphthene	2	50 ug/kg
Fluorene	49	10 ug/kg
Phenanthrene	33	5.0 ug/kg
Anthracene	2	7.5 ug/kg
Fluoranthene	6	7.5 ug/kg
Pyrene	4	7.5 ug/kg
Chrysene	8	5.0 ug/kg

(All other PAH compounds analyzed for had no detections in fish tissue samples for this reporting period.)

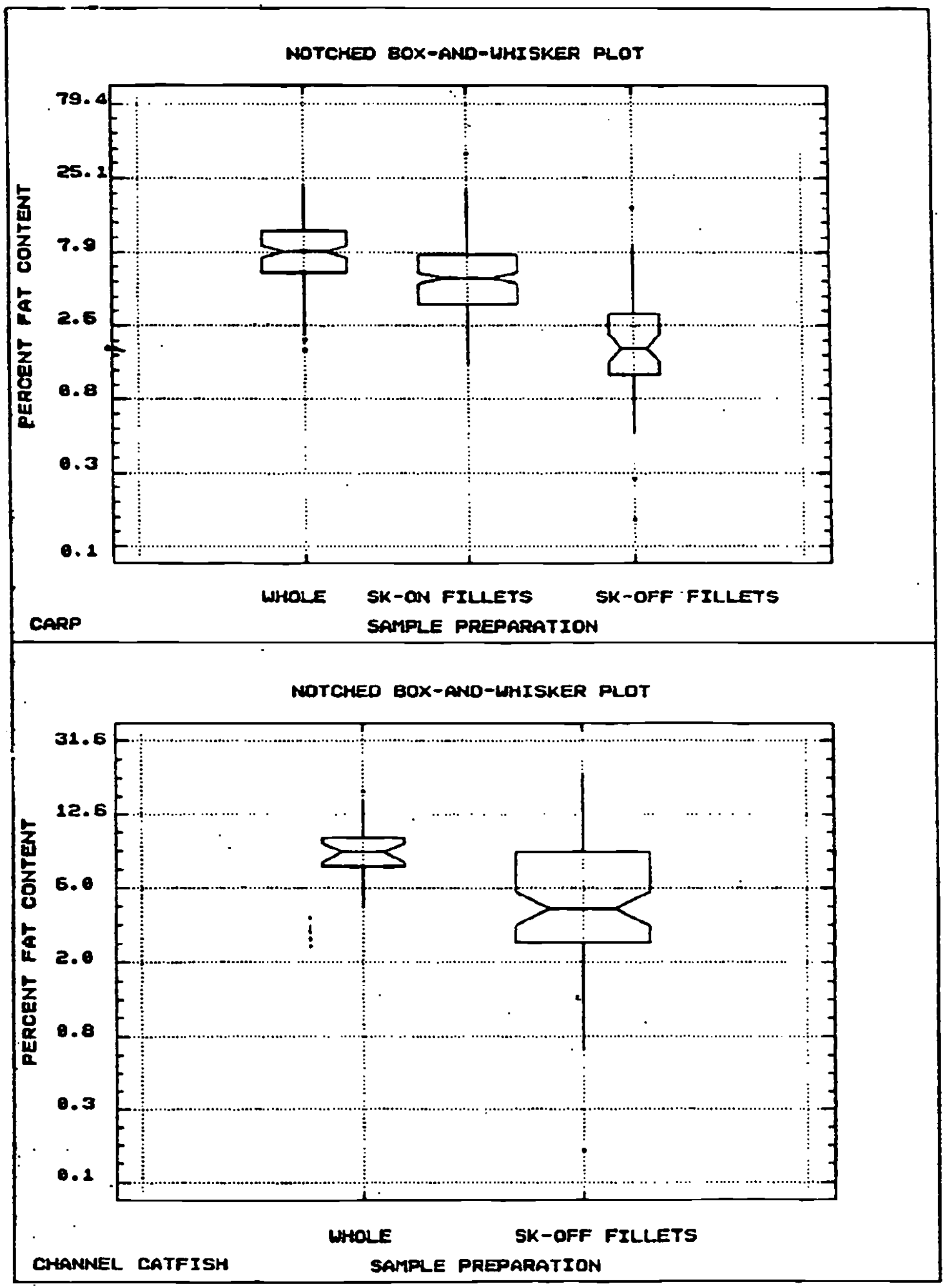
from 8 different locations while carbon disulfide (also a volatile organic compound) was detected in 28% of all samples analyzed from 22 different locations. Phenanthrene was detected at 18 different locations. Acetone occurs ubiquitously in almost all samples analyzed, however because it is also almost always detected in the associated laboratory blank it is suspected of being a laboratory contaminant.

Evaluating the trend for declining levels of PCBs as well as chlordane and dieldrin has been explored based on the decreasing number of exceedances of FDA Action/Tolerance levels, as well as graphs plotting concentrations (on a per fat basis) of a fish species (carp) over time. For example only four of the biennially monitored sites had fish which exceeded one or more FDA Action Levels in 1987 - 89 compared with 5 sites exceeding such levels from 1985 - 86 and 14 sites from 1979 - 84. Levels of total chlordane and dieldrin rarely exceed FDA Action Levels currently. Graphical presentations depicted levels of PCBs, total chlordane, and dieldrin in two to four pound carp samples over time from sites which have had fish consumption advisories issued. However, other compounds of importance as well as other sites monitored biennially were not evaluated (such as total DDT). One shortcoming in looking at trends was that the same species needed to be sampled time after time in order to develop a comparable dataset for a location. This was not always possible. Variability among the samples in the different years also added to the problem of interpretation of the data. Also, originally the fish tissue monitoring program analyzed samples prepared from whole fish and later switched to skin-off fillets and then skin-on scaleless fillets (except for catfish species). Thus, there was a lot of data not used in making interpretations on the trends occurring with these contaminants.

A more in-depth trend evaluation was performed on 16 of the biennially monitored locations. Most of these locations have fish tissue contaminants data dating back to 1979 or 80. An evaluation was first performed on the entire rivers and streams database for carp and for channel catfish to determine if the different sample preparation types (i.e., whole, skin-on fillets, and skin-off fillets) could be used together to evaluate a trend of decreasing or increasing (normalized to lipid weight) concentrations of PCBs and persistent organochlorine pesticides over time. Datasets of 388 carp samples, and 88 channel catfish samples were pulled from the fish contaminants database. Carp and channel catfish are the two most universally collected species, are omnivorous bottom dwellers, have a good fat content, and are the benchmark species for most of Indiana's fish consumption advisories.

A comparison was made of the percent lipid (fat) content of the different sample preparation types. As was expected (Figure 2) the percentage lipid content drops when a sample is prepared as a fillet, and dramatically drops if the skin is also removed. It is recommended that fish preparation for eating should include measures to minimize the fat by utilizing skin off filleting and broiling so that fat can drip away. The reason for this is that these contaminants of concern tend to concentrate in the fatty tissue. As far as human health is concerned, preparation helps to minimize uptake of lipophilic contaminants by the consumer. The hypothesis was that these contaminants tend to distribute evenly in the fatty tissue throughout the body and

Figure 2. *Lipid (fat) content for three types of common carp samples (top) and two types of channel catfish samples (bottom)*



we would therefore use whole fish and filleted samples together for a trend evaluation as long as the data was normalized to a lipid weight (per fat) basis. Figures 3, 4, 5, and 6 depict the means and confidence intervals for total PCB, total chlordane, total DDT, and dieldrin, respectively. The comparison of the sample preparations with these compounds' concentrations (expressed as ug/g on a per fat basis) shows little difference between mean concentrations implying a rather even distribution in the fatty tissue. Values less than the analytical detection limit and were treated as were assigned a value of one half the detection limit. Even though this method for treating "less thans" can skew means to the lower end this was not deemed important as a very small percentage of samples have less than detection limits for any one of these contaminants. For example, only 5.2% of common carp samples did not have a detection of some level of total PCB. Mean total DDT levels in channel catfish showed the most dramatic drop between whole fish and skin-off fillet preparations. For dieldrin in channel catfish the average level went up with preparation as skin-off fillets while for common carp all three samples types remained at nearly the same mean level. This allowed for the use of larger datasets for each location and also to evaluate trends at more locations than past 305(b) reportings.

Simple linear model regression analysis was used to evaluate the trends of concentrations of total PCB, total chlordane, total DDT, and dieldrin (see Figures 7 through 46). The sloping solid line indicates the general trend for the occurrence of the contaminant of concern for a location over time. The set of dotted lines nearest the regression lines are the confidence limits (95%). The dotted lines farthest away from the regression line are the prediction limits (95%) and represents the range within which the given percentage of observations will occur for each predictions. The closer the confidence limits are to the regression line the more confidence we can have in the given trend. For some locations the confidence limits are very wide (e.g. St. Joseph River at Bristol for total PCB, total DDT, and dieldrin) meaning there has been a lot of variability in the data and more data are needed to better evaluate the pictured trend. However, it can generally be concluded from these graphs that levels of these contaminants in the fish of Indiana's river and streams are diminishing.

A notable exception to a trend of decreasing levels of the above contaminants in fish is from the Indiana Harbor Canal (IHC). Long known for its PCB contaminated sediments, the IHC is the only location analyzed in which PCB levels in fish do not seem to be diminishing. Every sample collected here in 1992 had total PCB levels above the FDA Action Level. Total DDT and dieldrin levels also appear to not be declining. Total chlordane's drop is small, and with fewer data points for the earlier years its trend may also be the same way. The Wabash River at Lafayette also showed an increasing trend for total DDT and dieldrin in channel catfish but not in carp.

Indeed, to better understand if trends for decreased levels of these environmentally persistent contaminants in fish is occurring continued biennial monitoring will have to be done and further refinement of regressions and confidence

Figure 3. *Total PCB concentration lipid weight (per fat) basis for three types of common carp (top) and two types of channel catfish samples (bottom)*

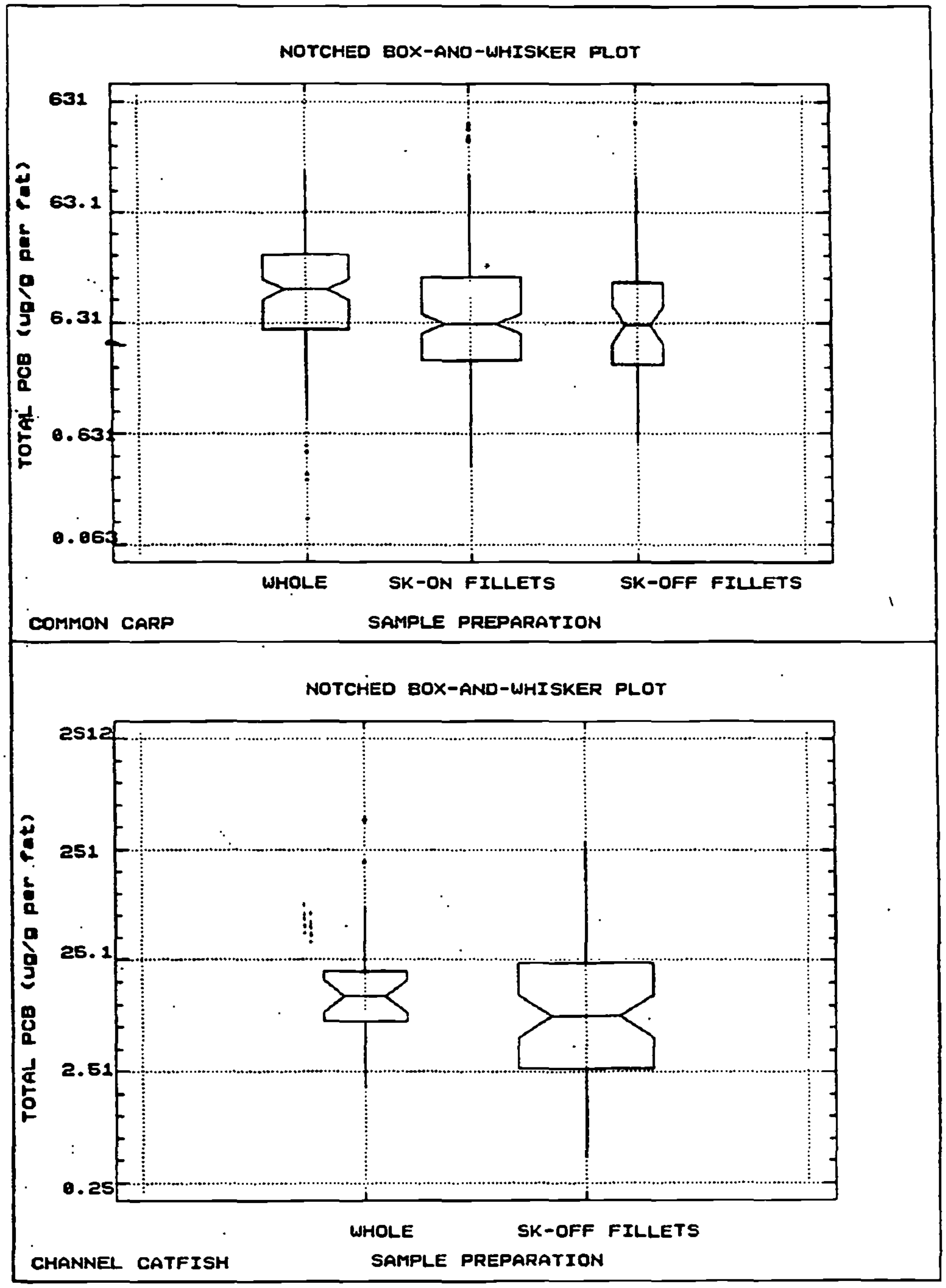


Figure 4. *Total chlordane concentration lipid weight (per fat) basis for three types of common carp (top) and two types of channel catfish samples (bottom)*

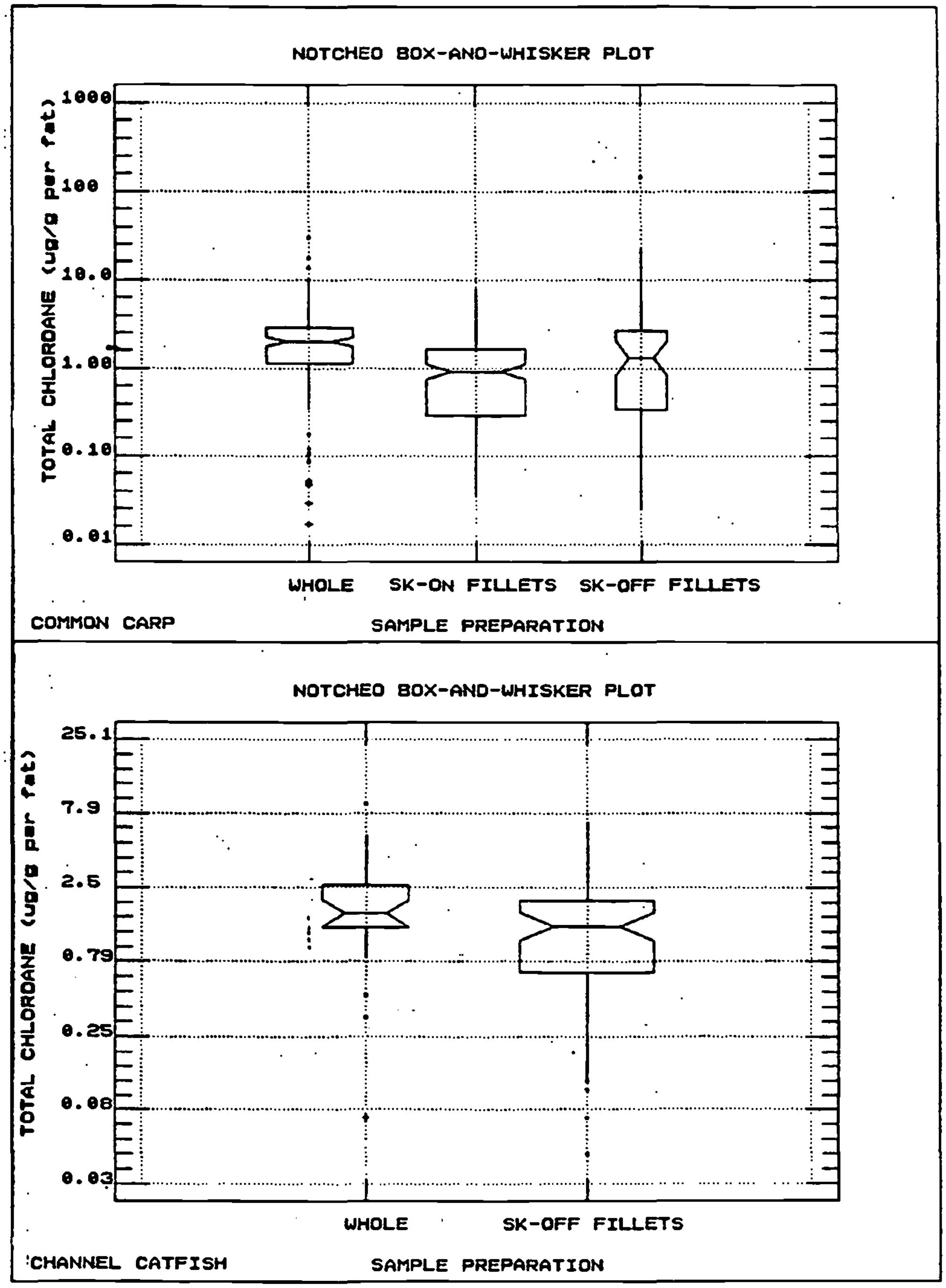


Figure 5. *Total DDT concentration lipid weight (per fat) basis for three types of common carp (top) and two types of channel catfish samples (bottom)*

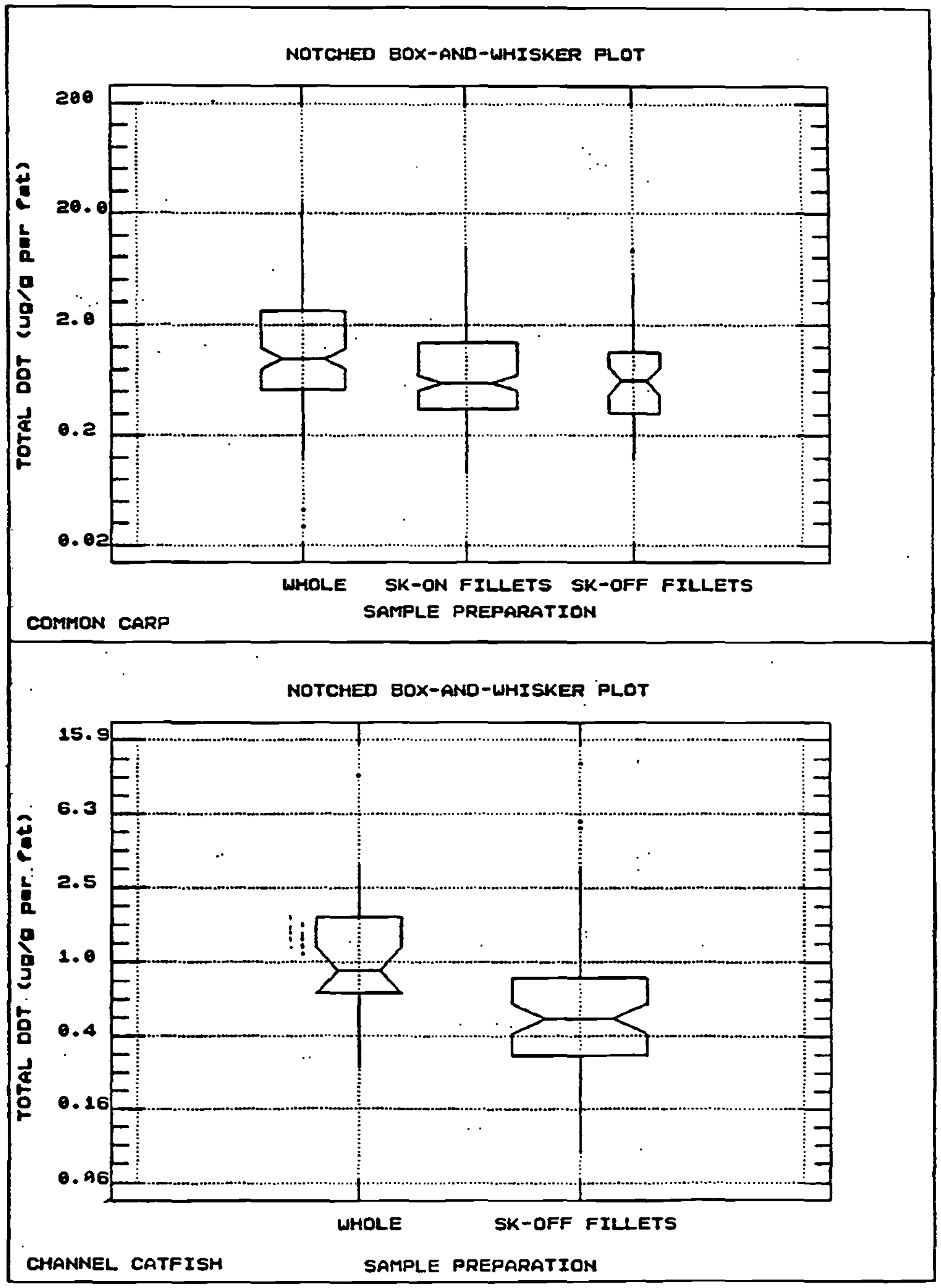


Figure 6. *Dieldrin concentration lipid weight (per fat) basis for three types of common carp (top) and two types of channel catfish samples (bottom)*

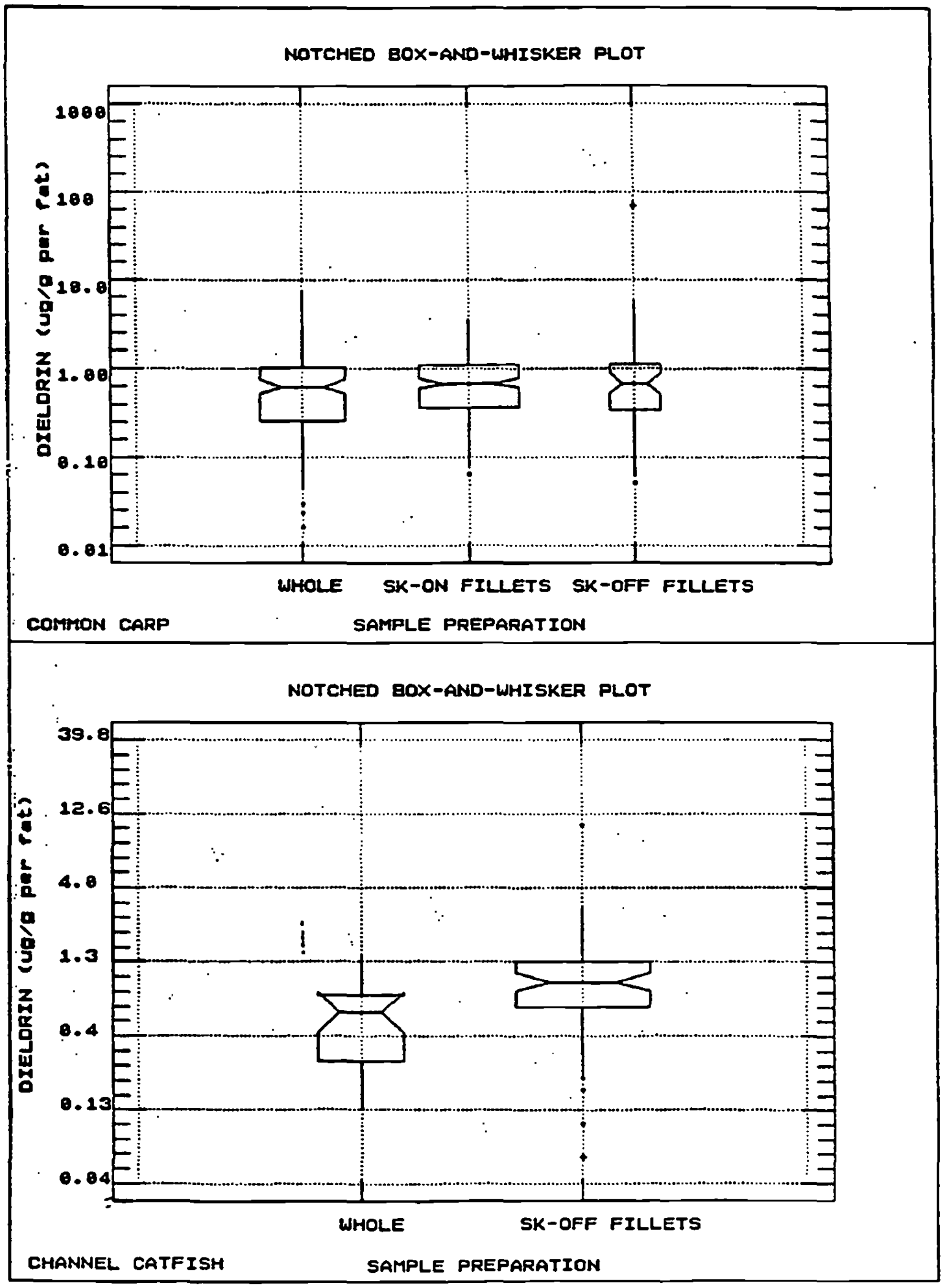


Figure 7. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from Burns Ditch, LaPorte County, upstream of Lefty's Coho Landing*

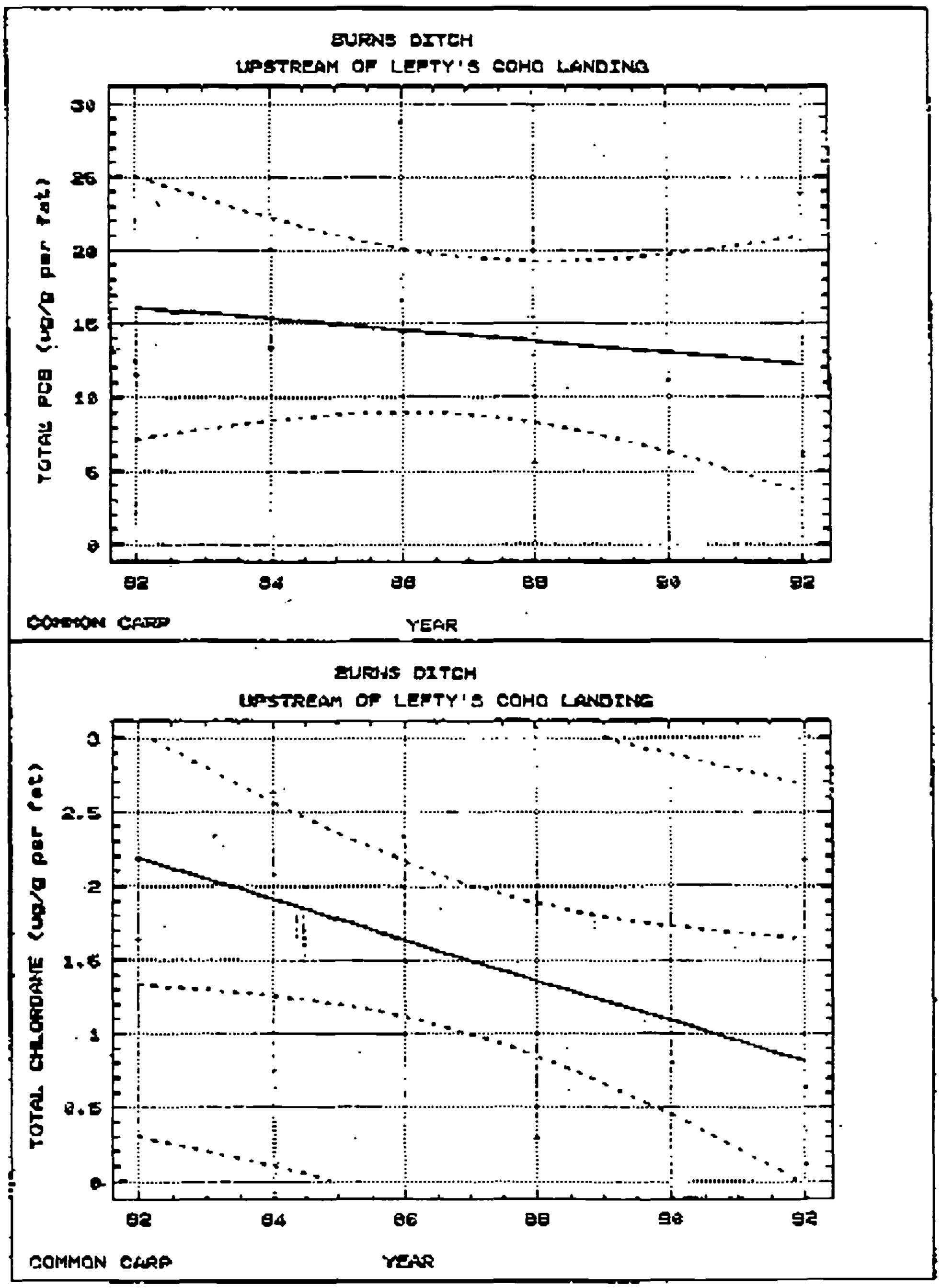


Figure 8. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from Burns Ditch, LaPorte County, upstream of Lefty's Coho Landing*

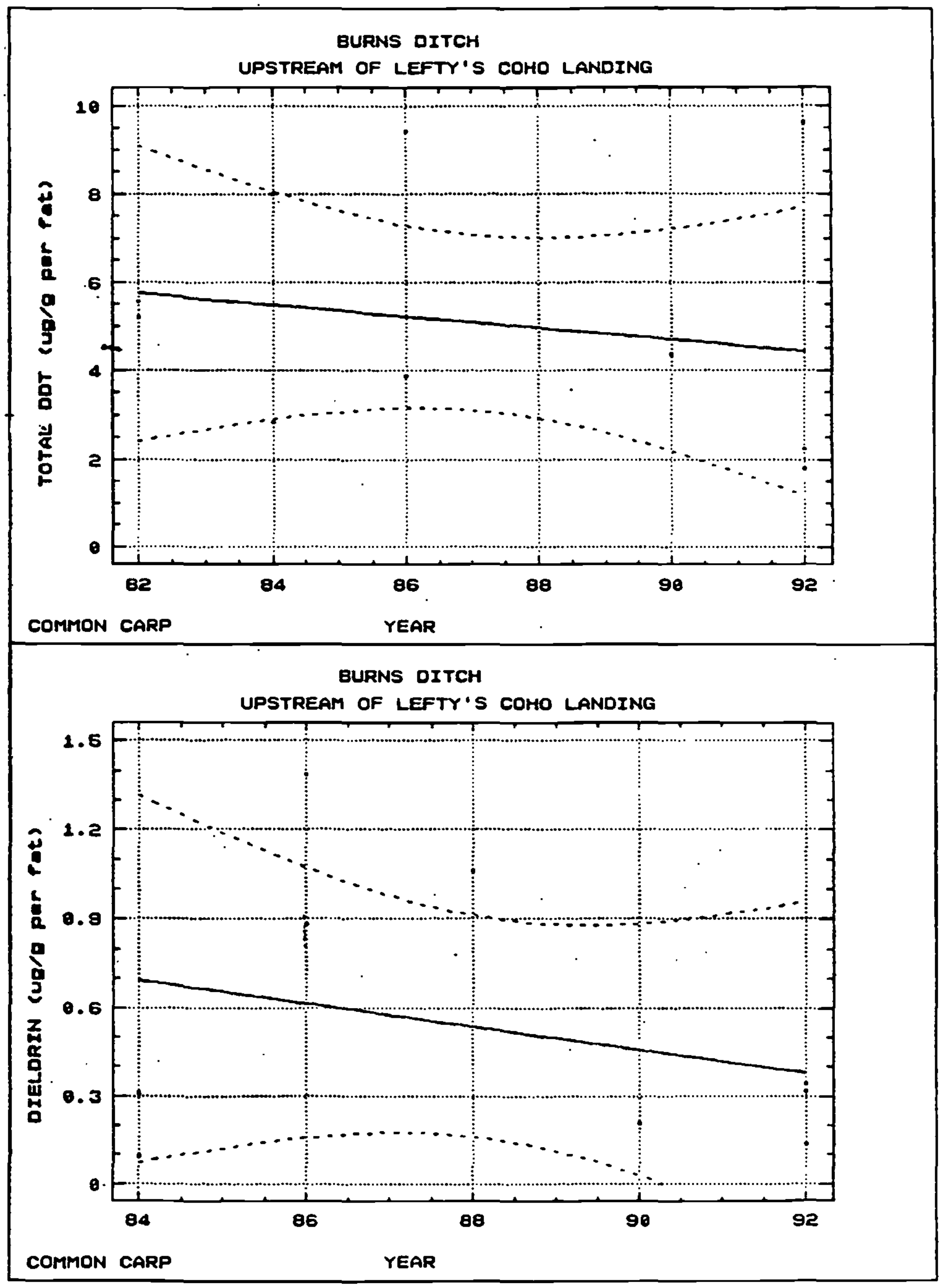


Figure 9. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the East Fork White River, Williams, IN in Lawrence County*

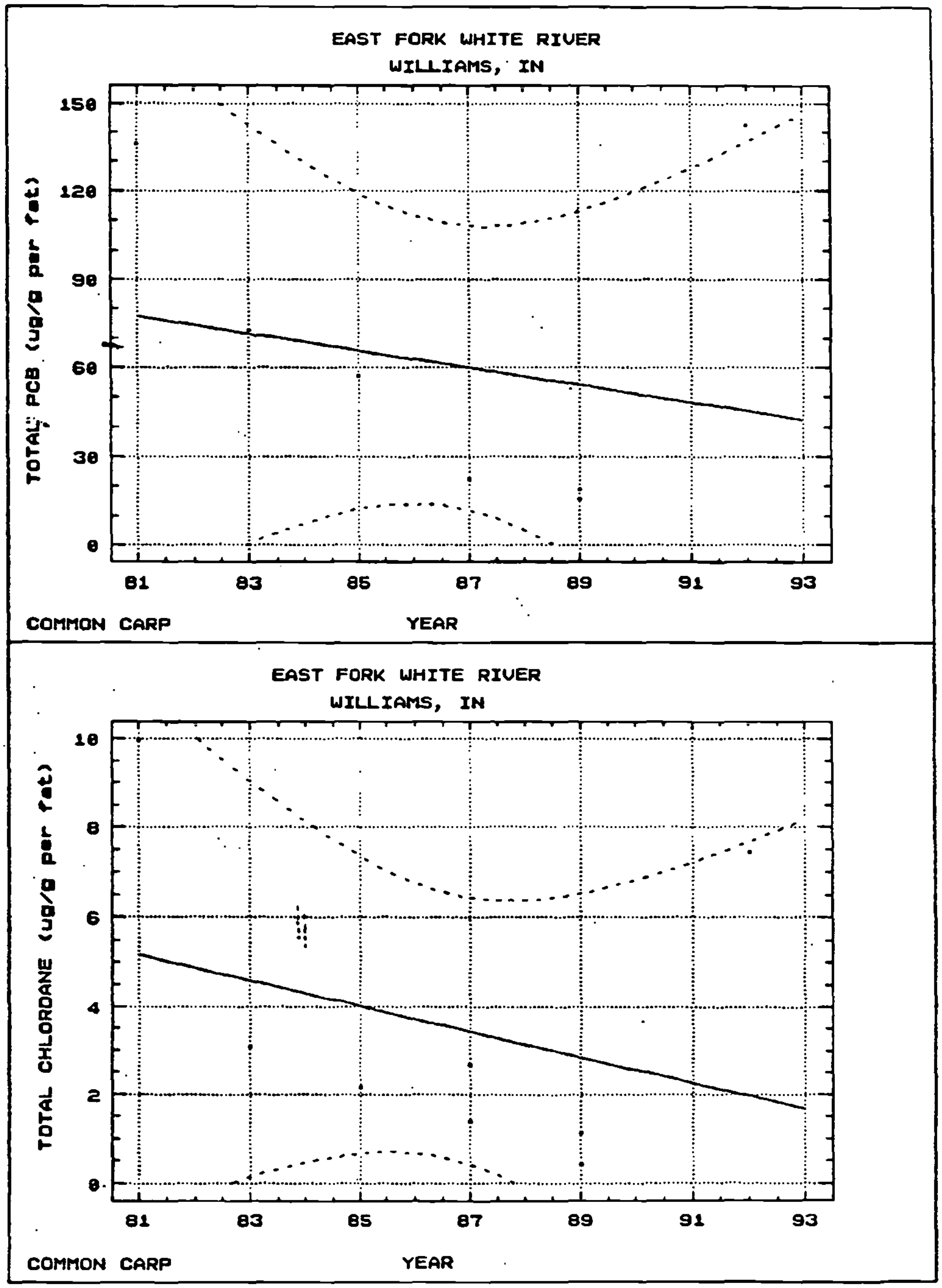


Figure 10. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the East Fork White River, Williams, IN in Lawrence County*

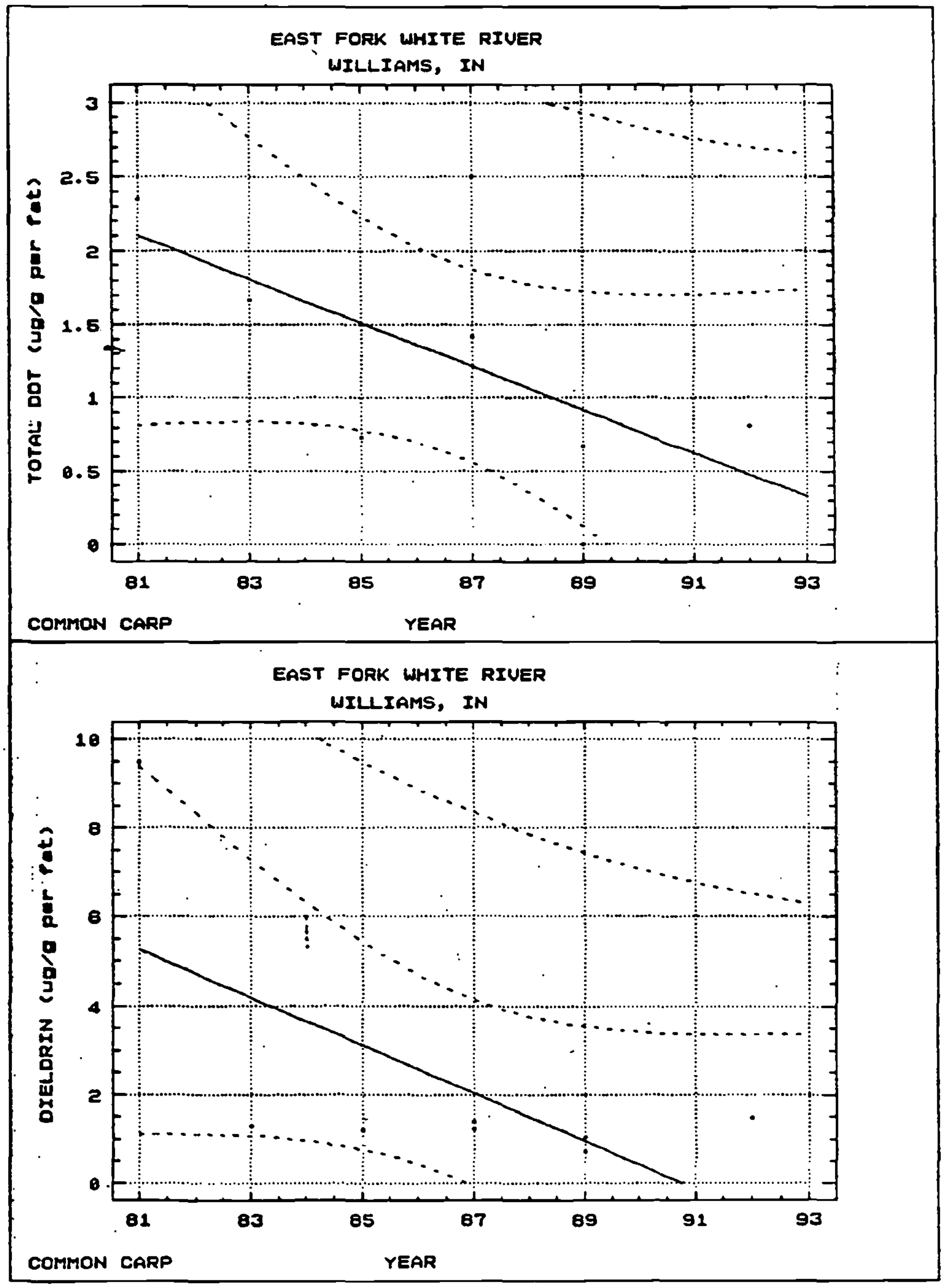


Figure 11. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in channel catfish from the East Fork White River, Williams, IN in Lawrence County*

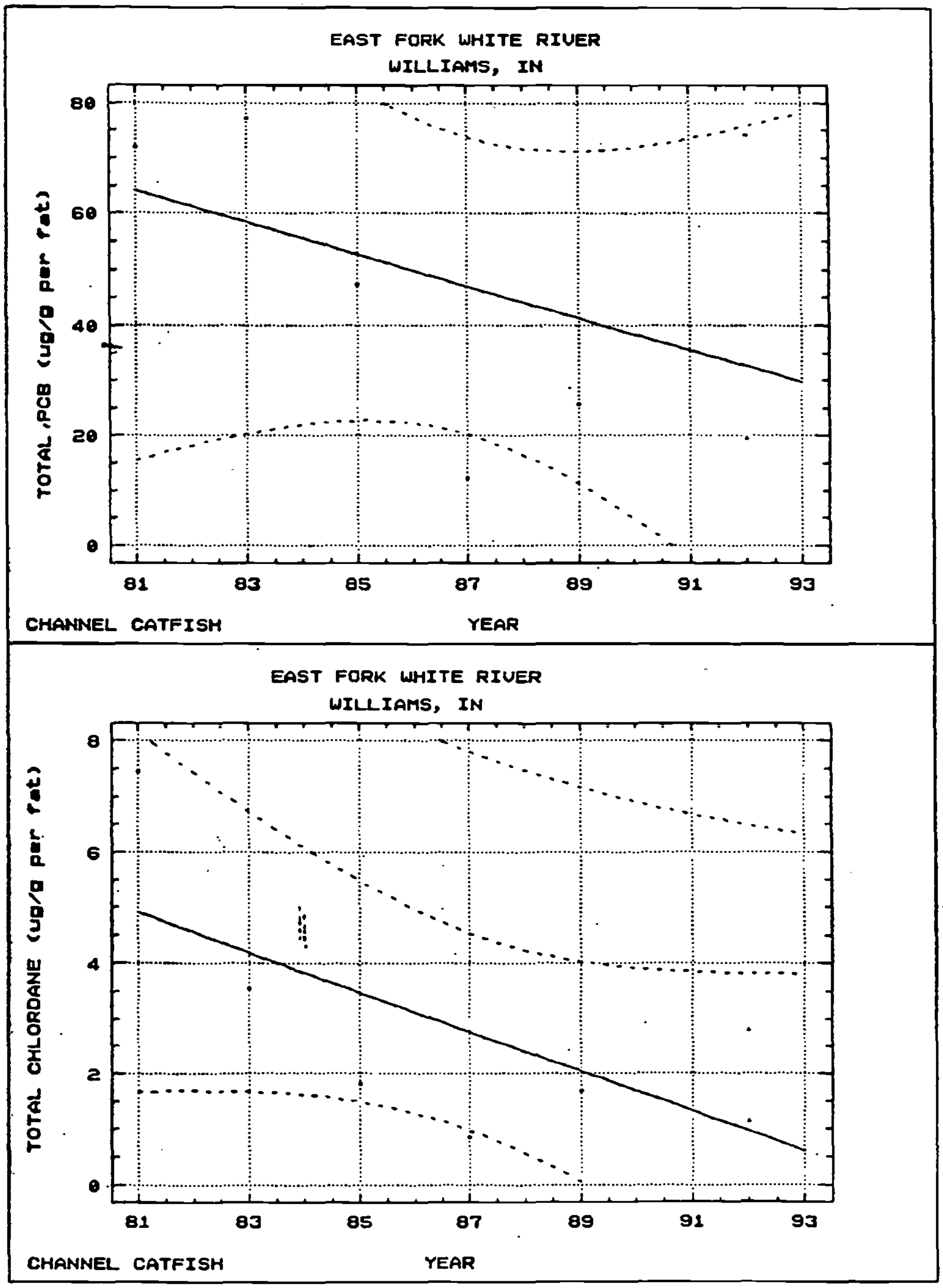
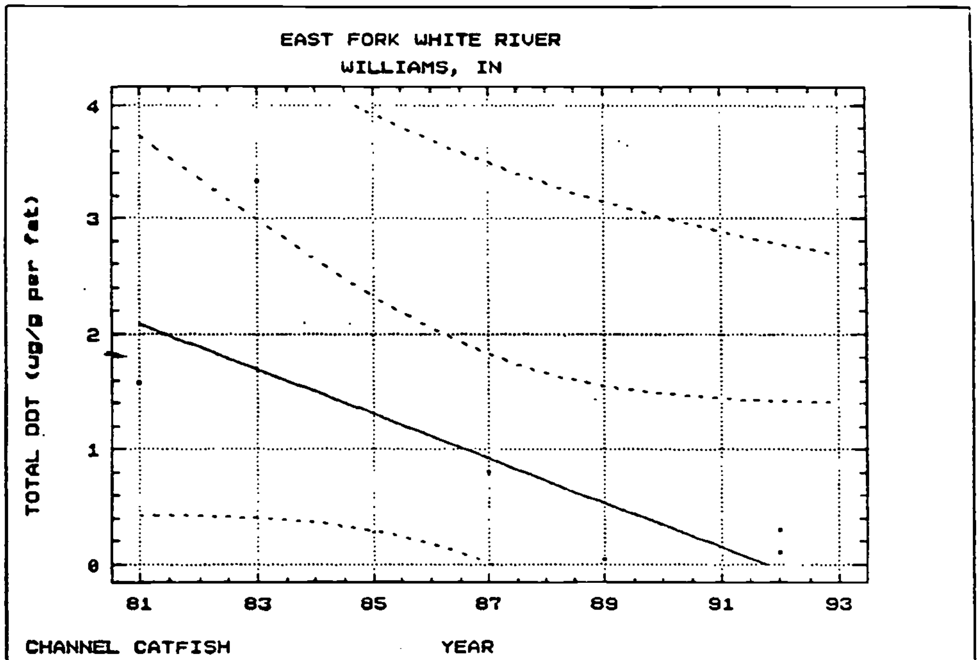


Figure 12. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in channel catfish from the East Fork White River, Williams, IN in Lawrence County*



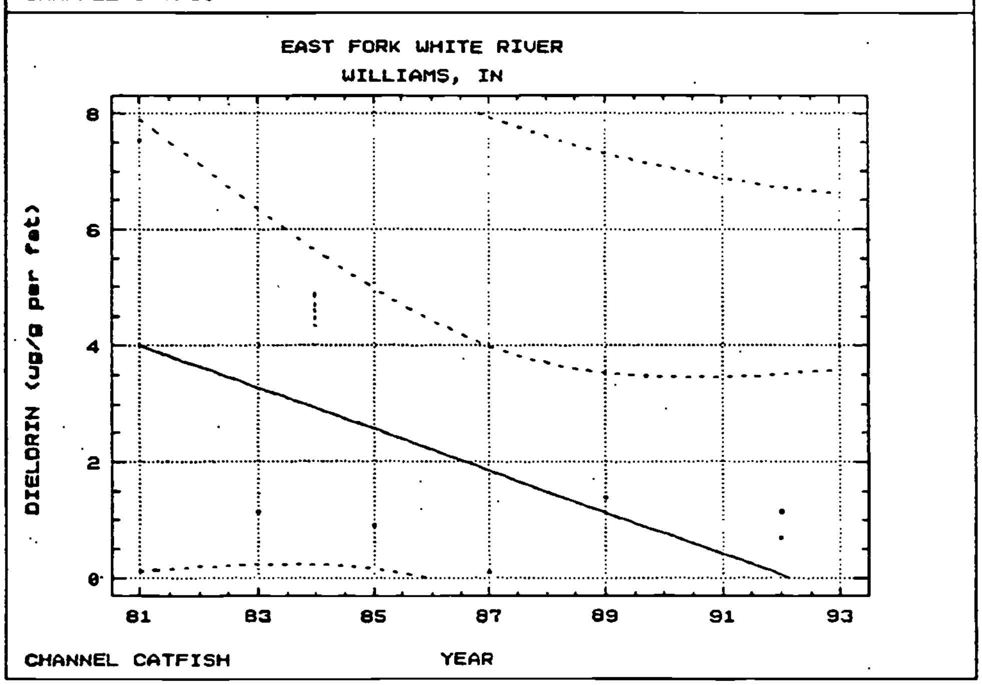


Figure 13. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Indiana Harbor Canal, Lake County*

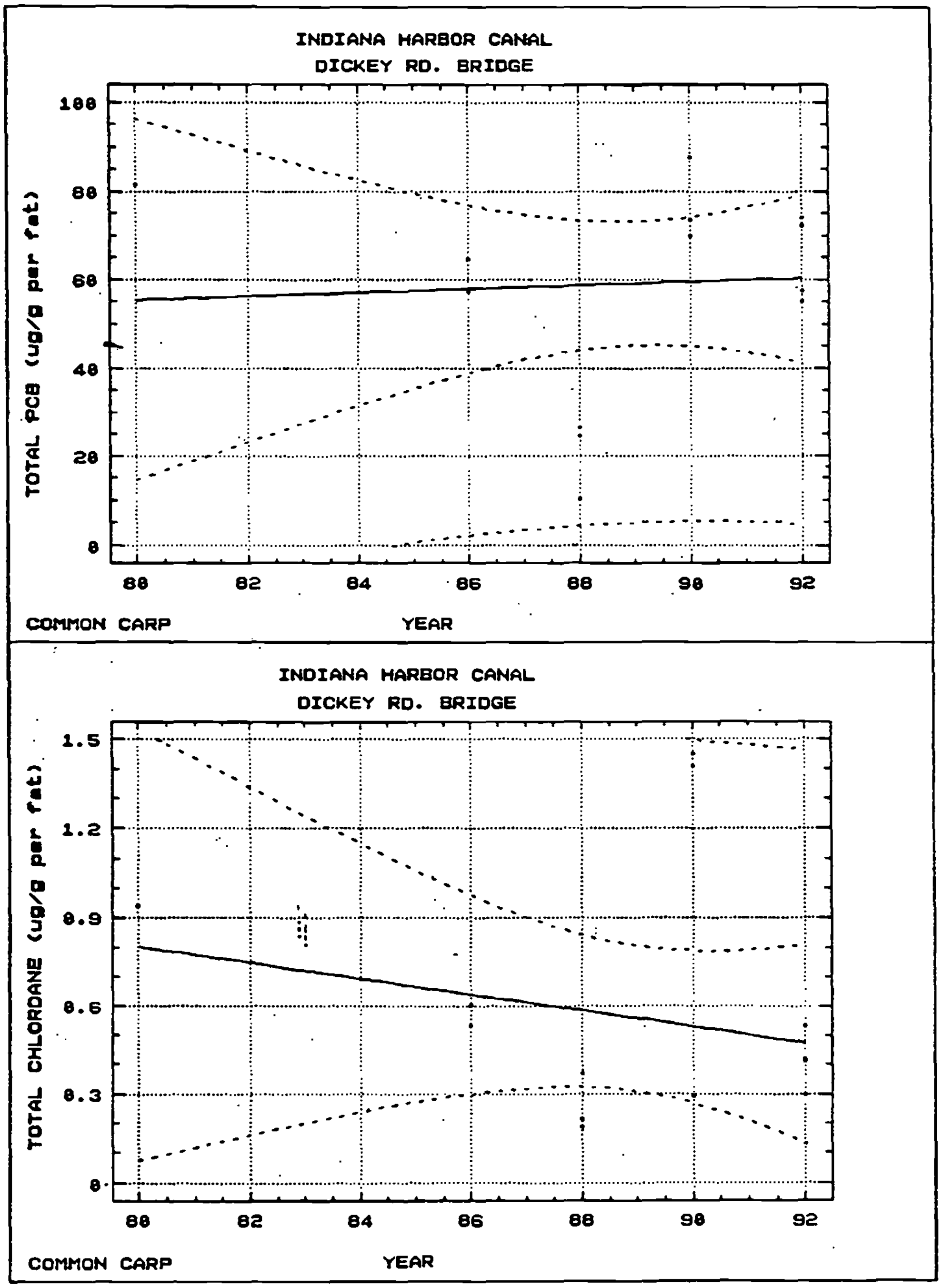


Figure 14. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Indiana Harbor Canal, Lake County*

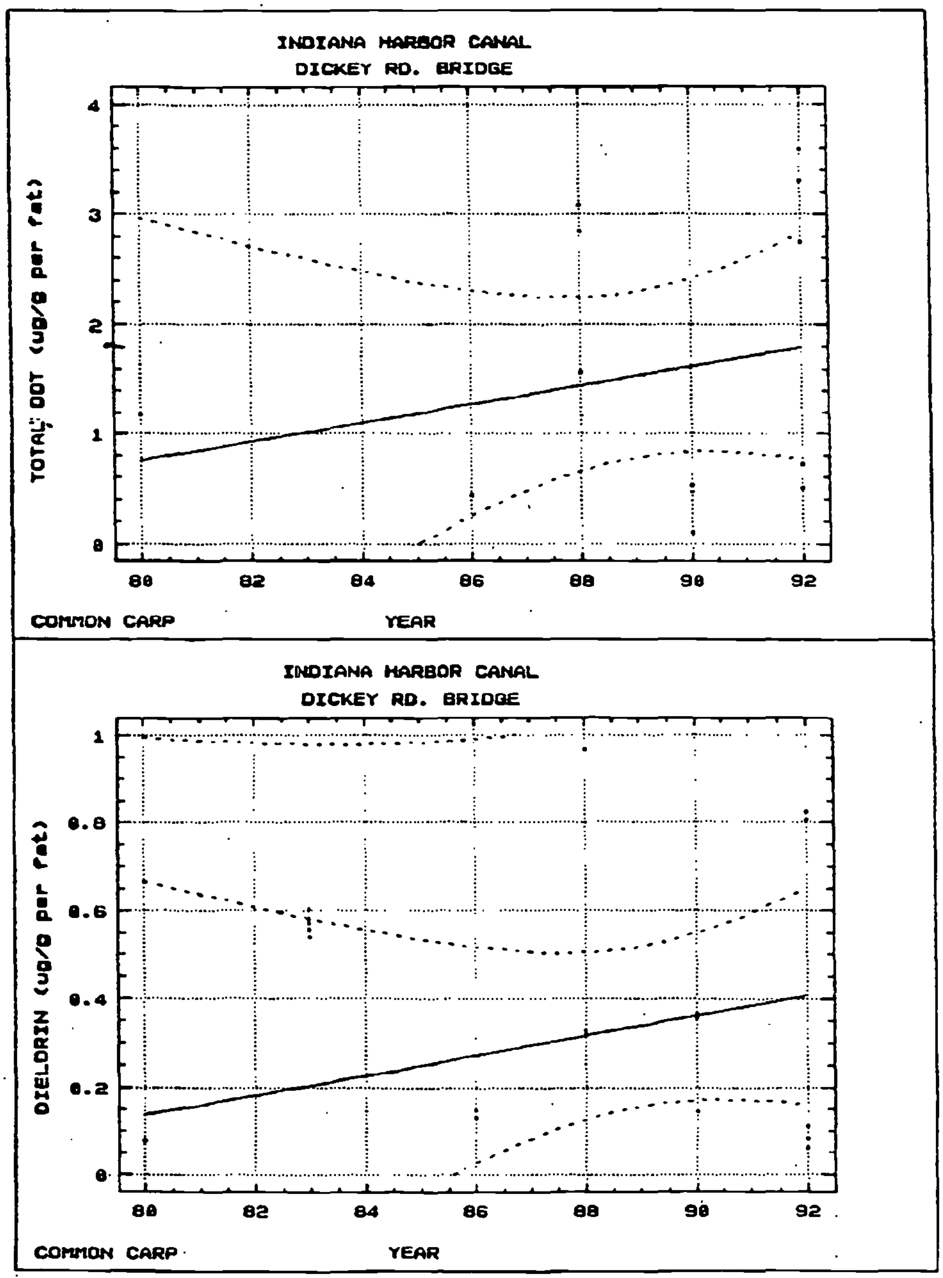


Figure 15. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Kankakee River at Kingsbury Fish and Wildlife Area in LaPorte County*

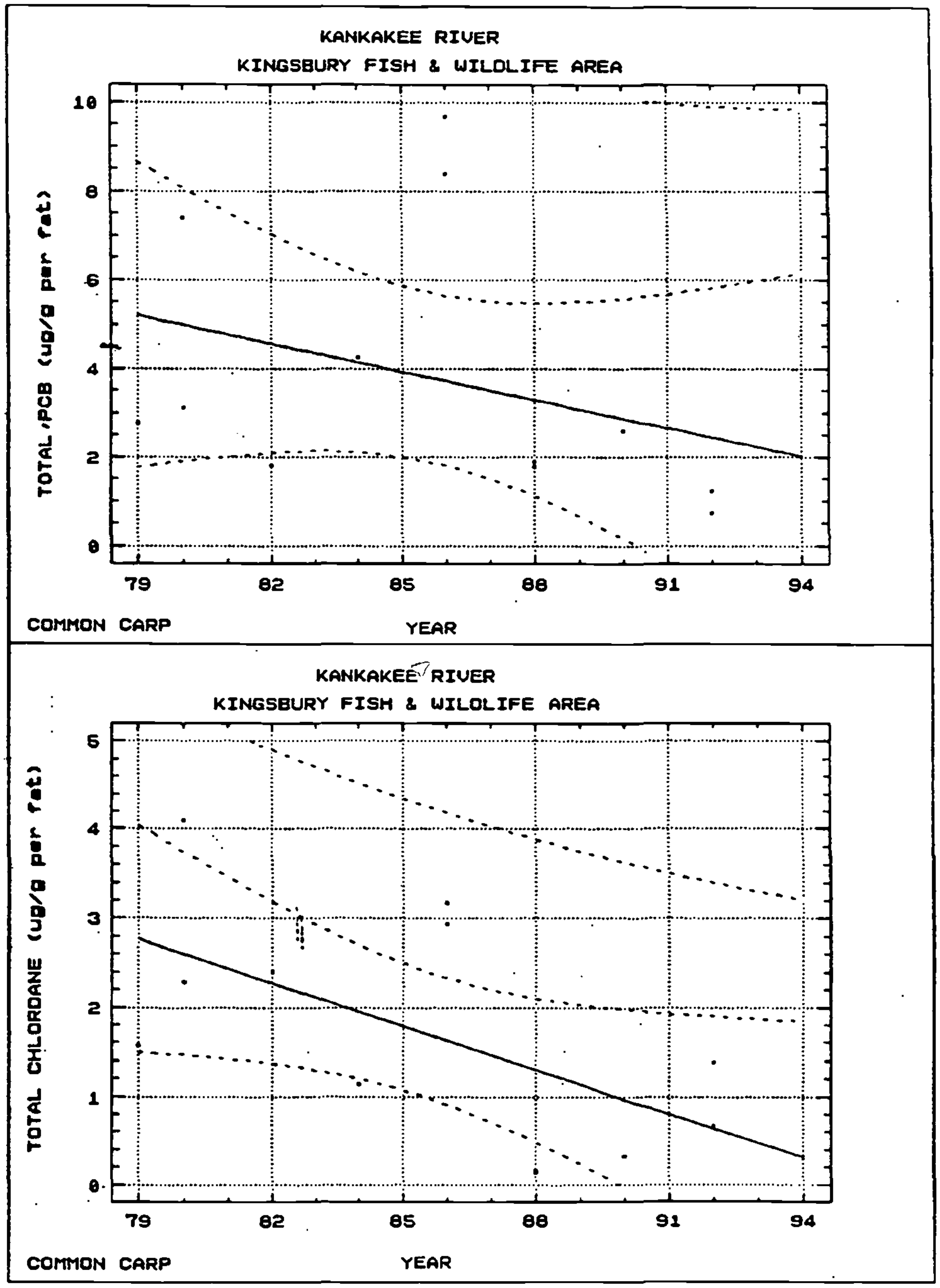
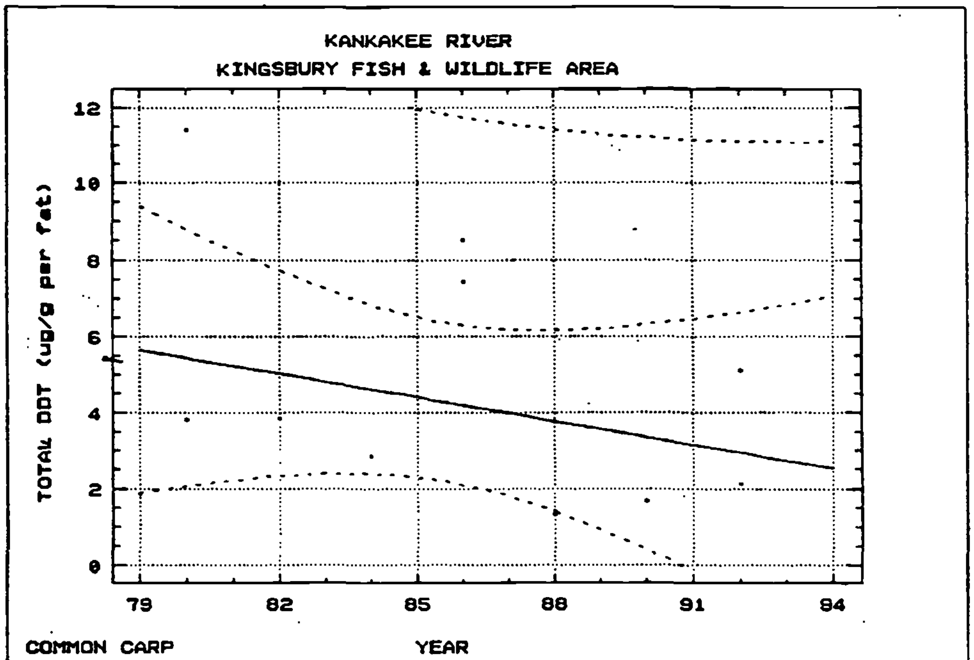


Figure 16. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Kankakee River at Kingsbury Fish and Wildlife Area in LaPorte County*



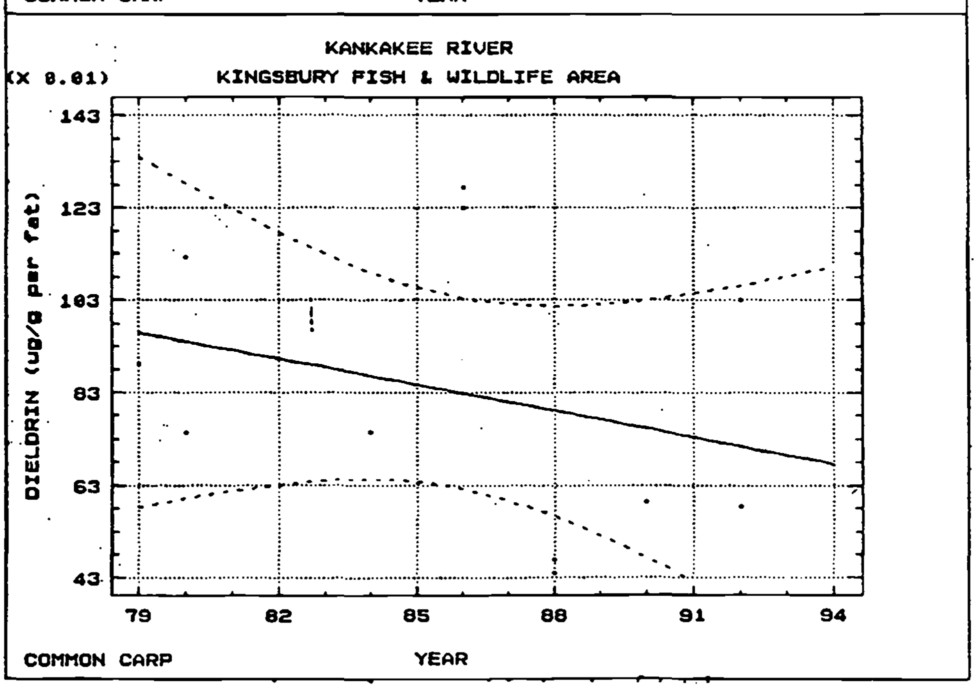


Figure 17. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Kankakee River at Lasalle Fish and Wildlife Area in Lake County*

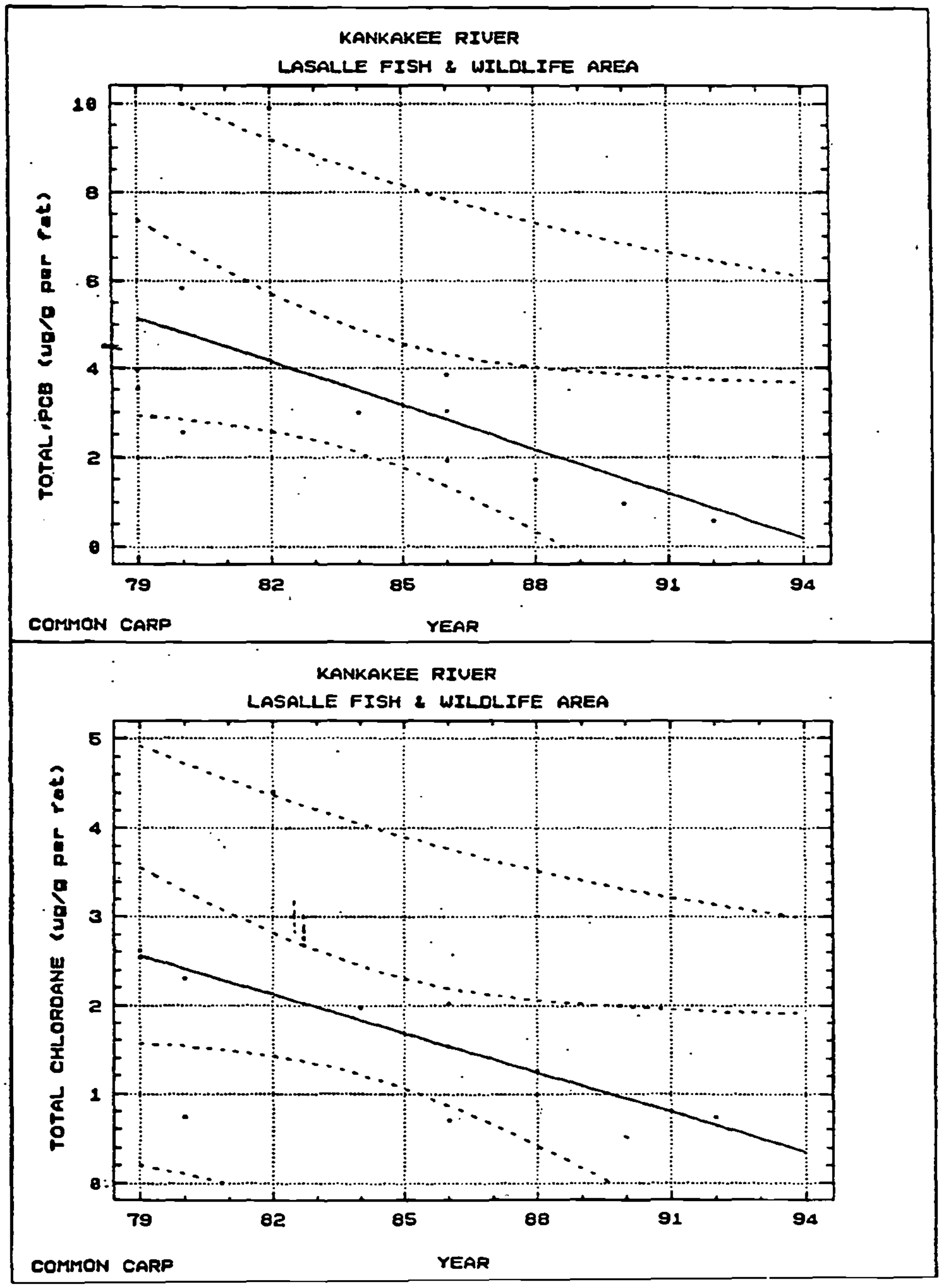


Figure 18. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Kankakee River at Lasalle Fish and Wildlife Area in Lake County*

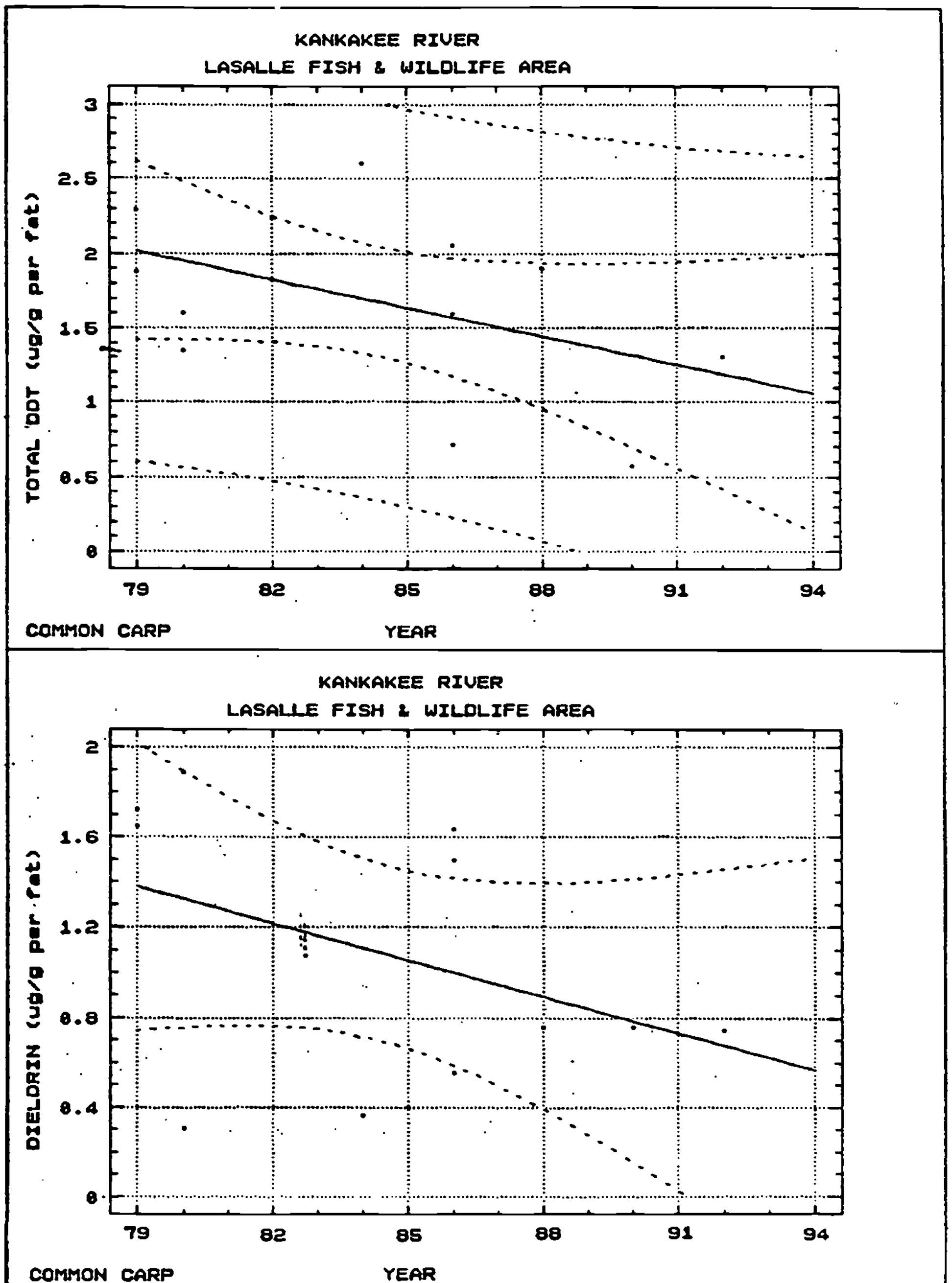


Figure 19. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Maumee River, New Haven, IN in Allen County*

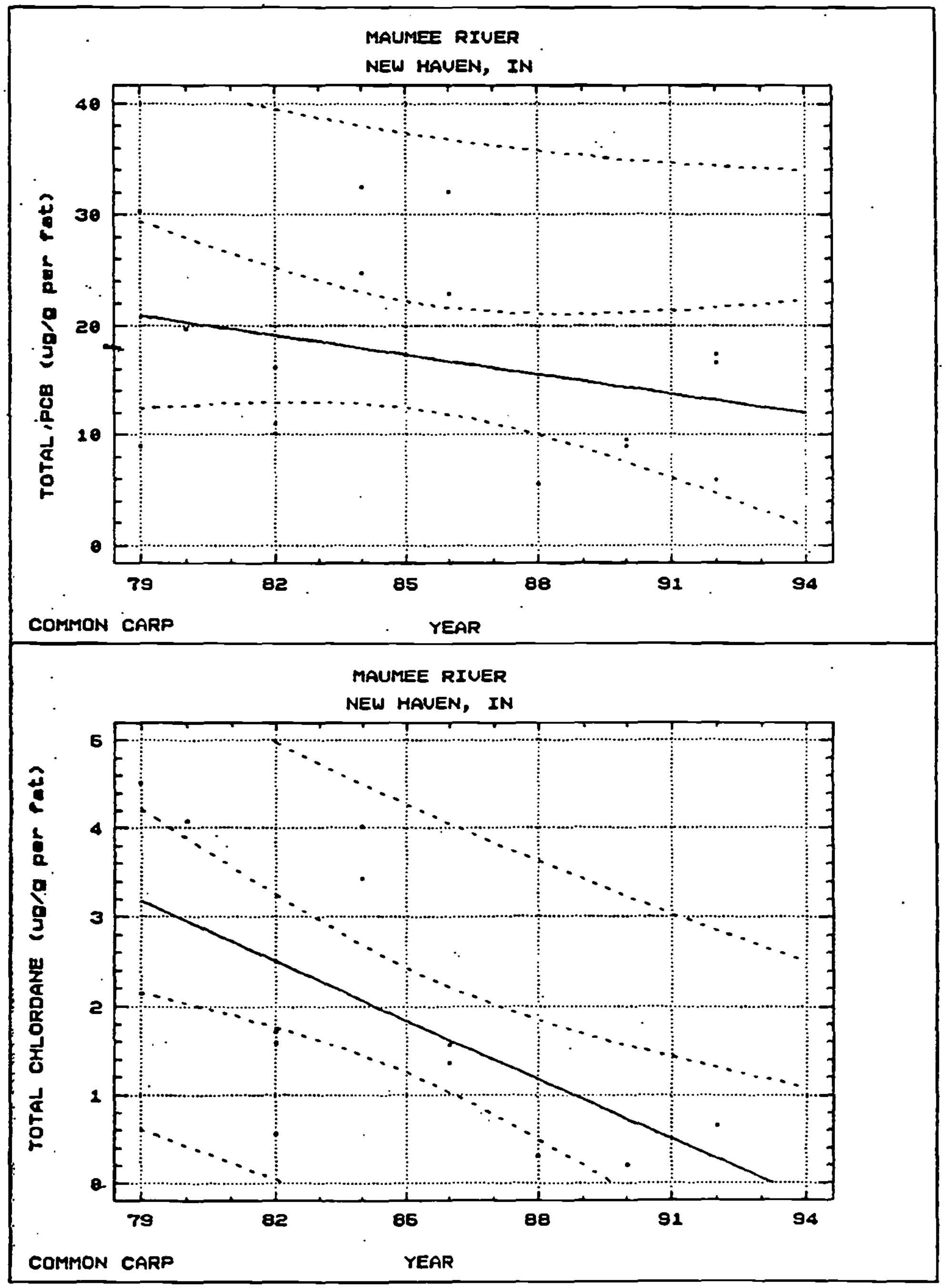


Figure 20. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Maumee River, New Haven, IN in Allen County*

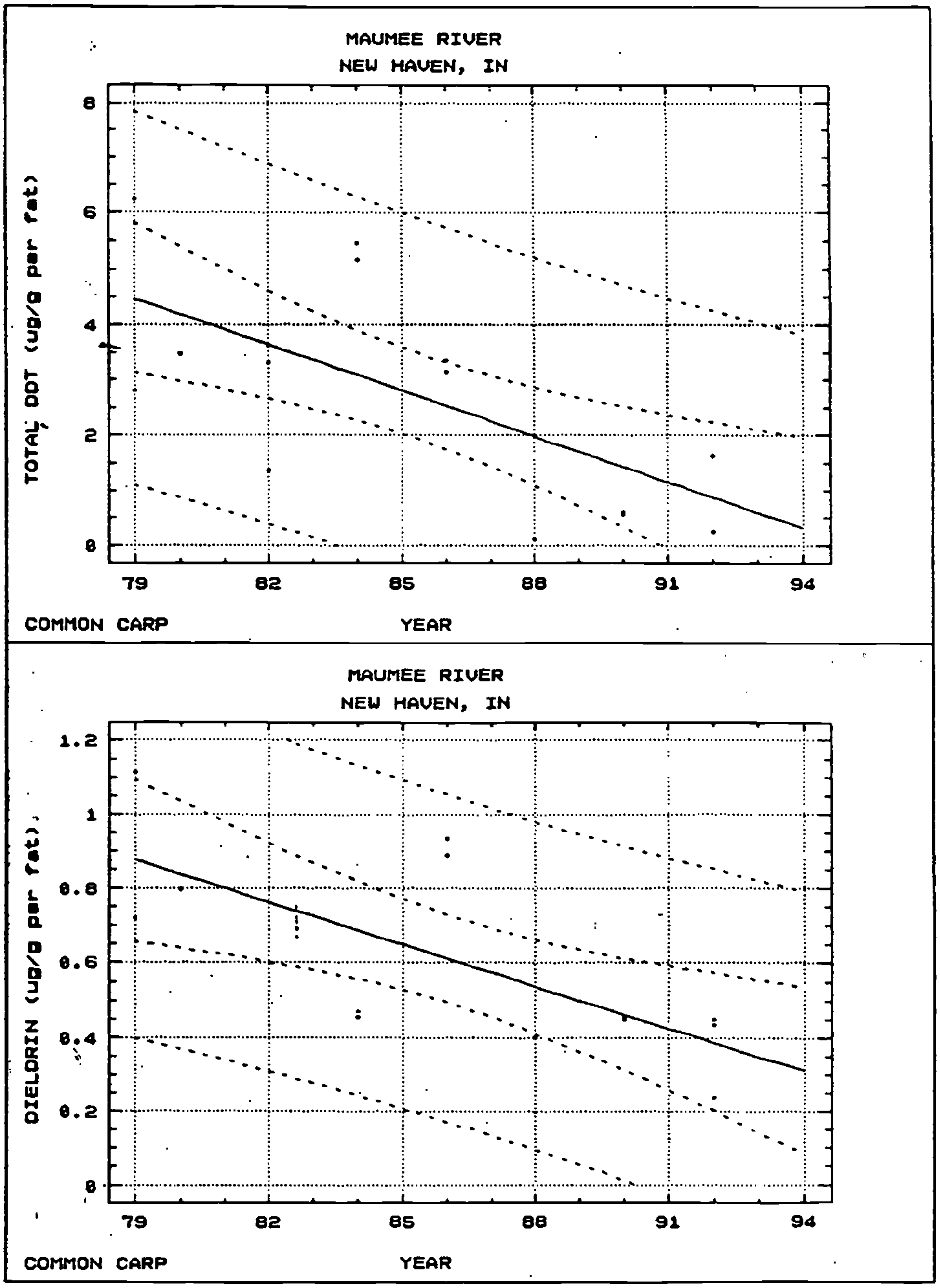


Figure 21. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the St. Joseph River, Bristol, IN in Elkhart County*

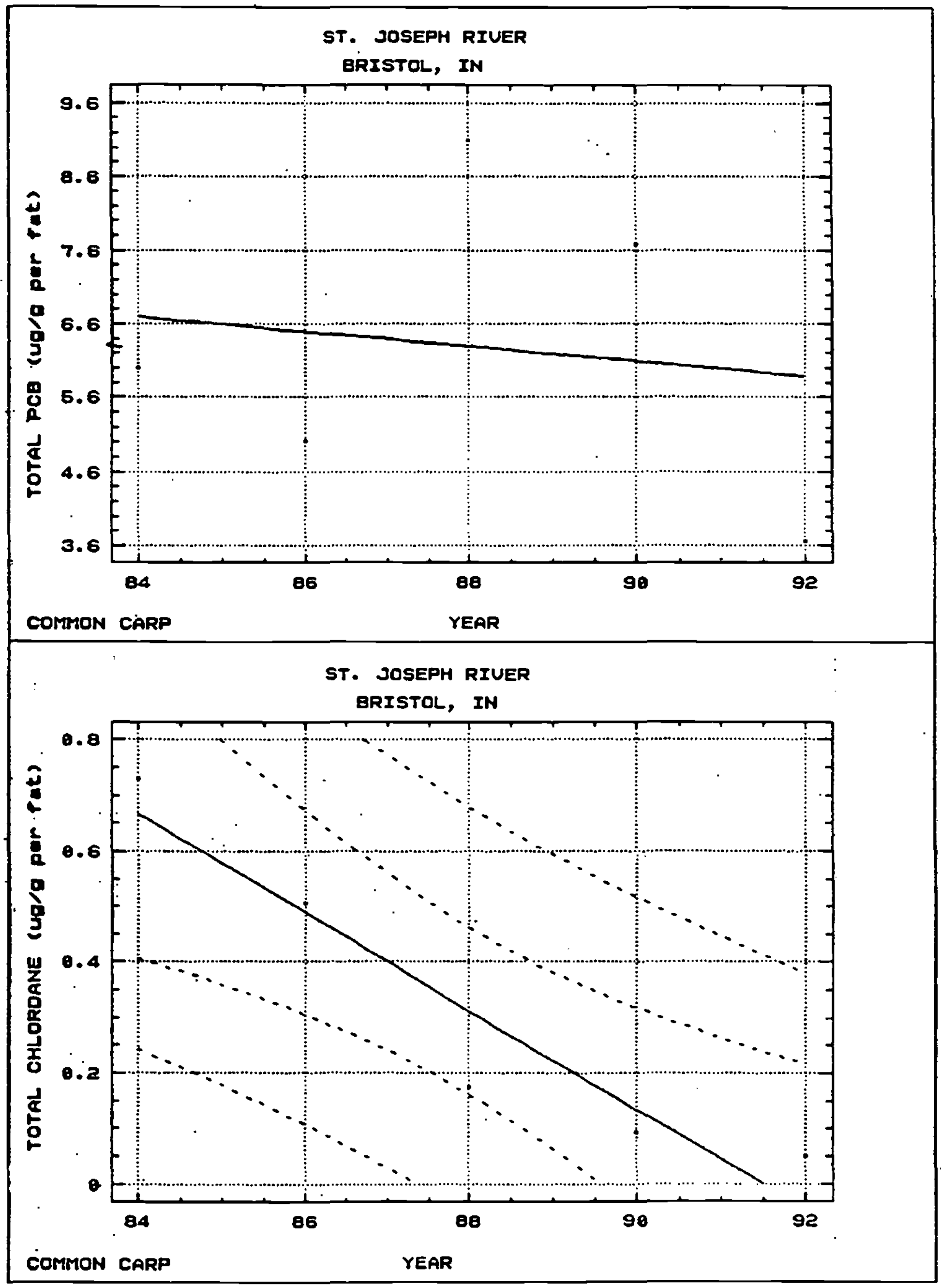


Figure 22. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the St. Joseph River, Bristol, IN in Elkhart County*

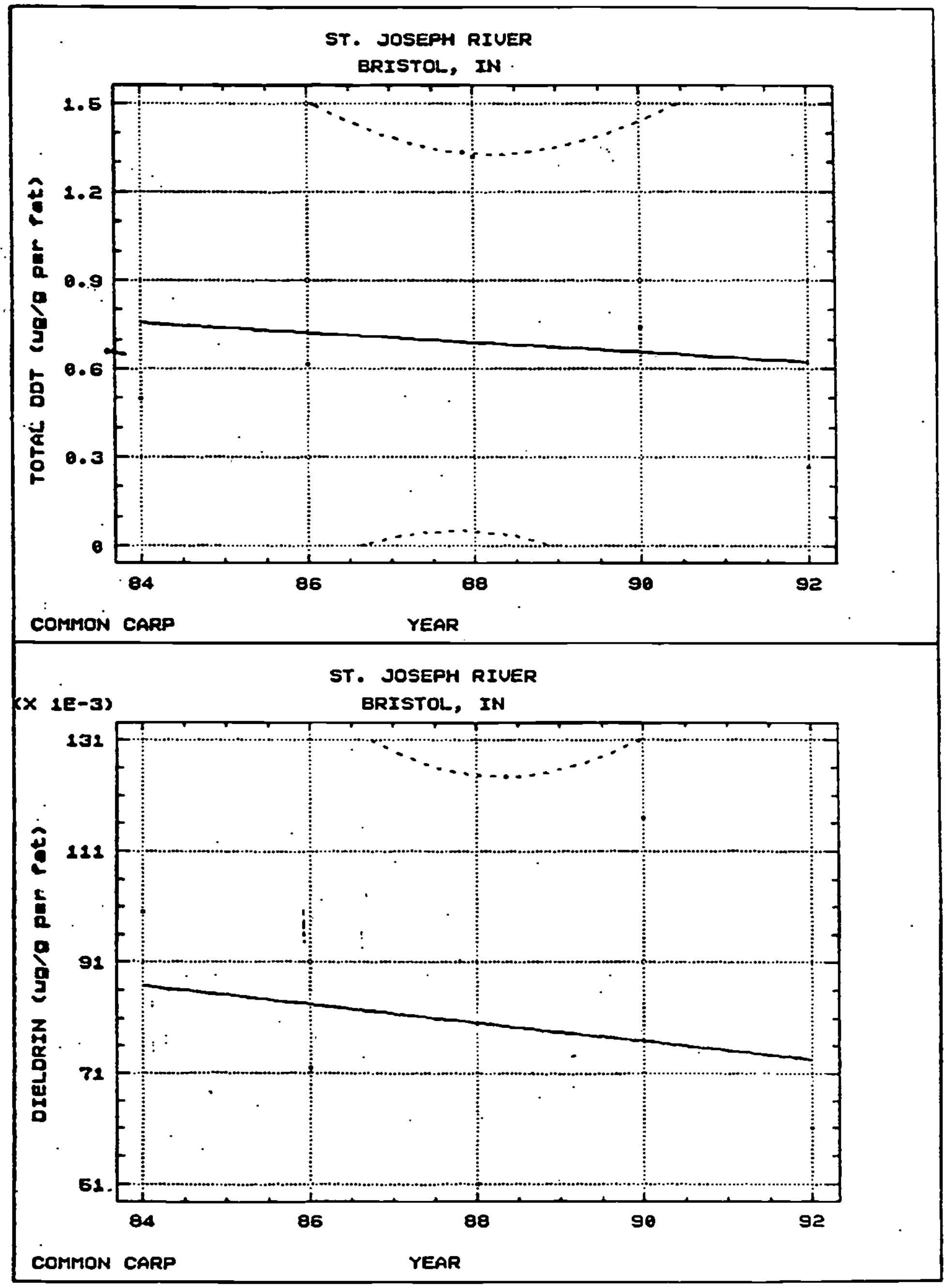


Figure 23. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the St. Joseph River, South Bend, IN in St. Joseph County*

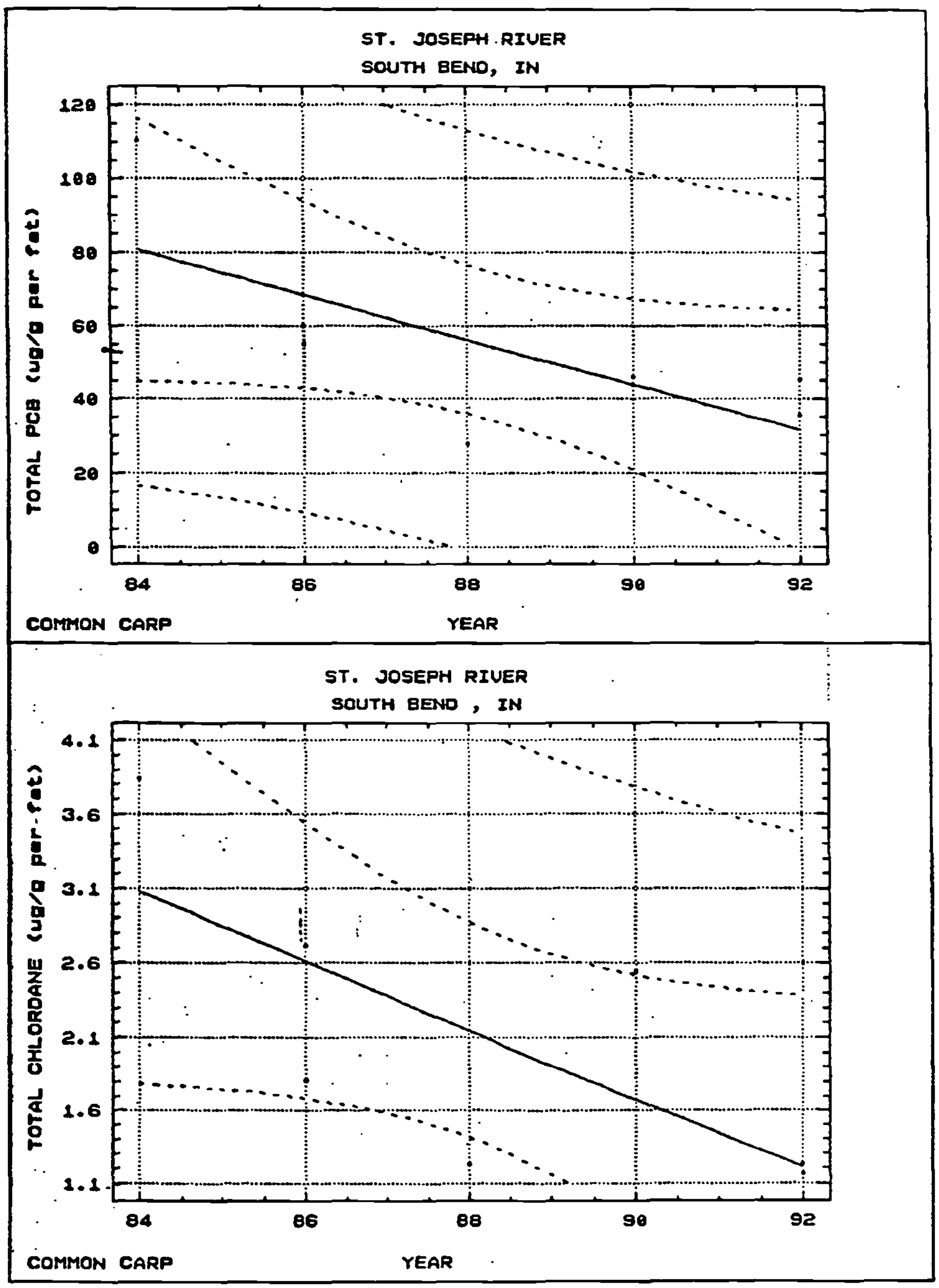


Figure 24. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the St. Joseph River, South Bend, IN in St. Joseph County*

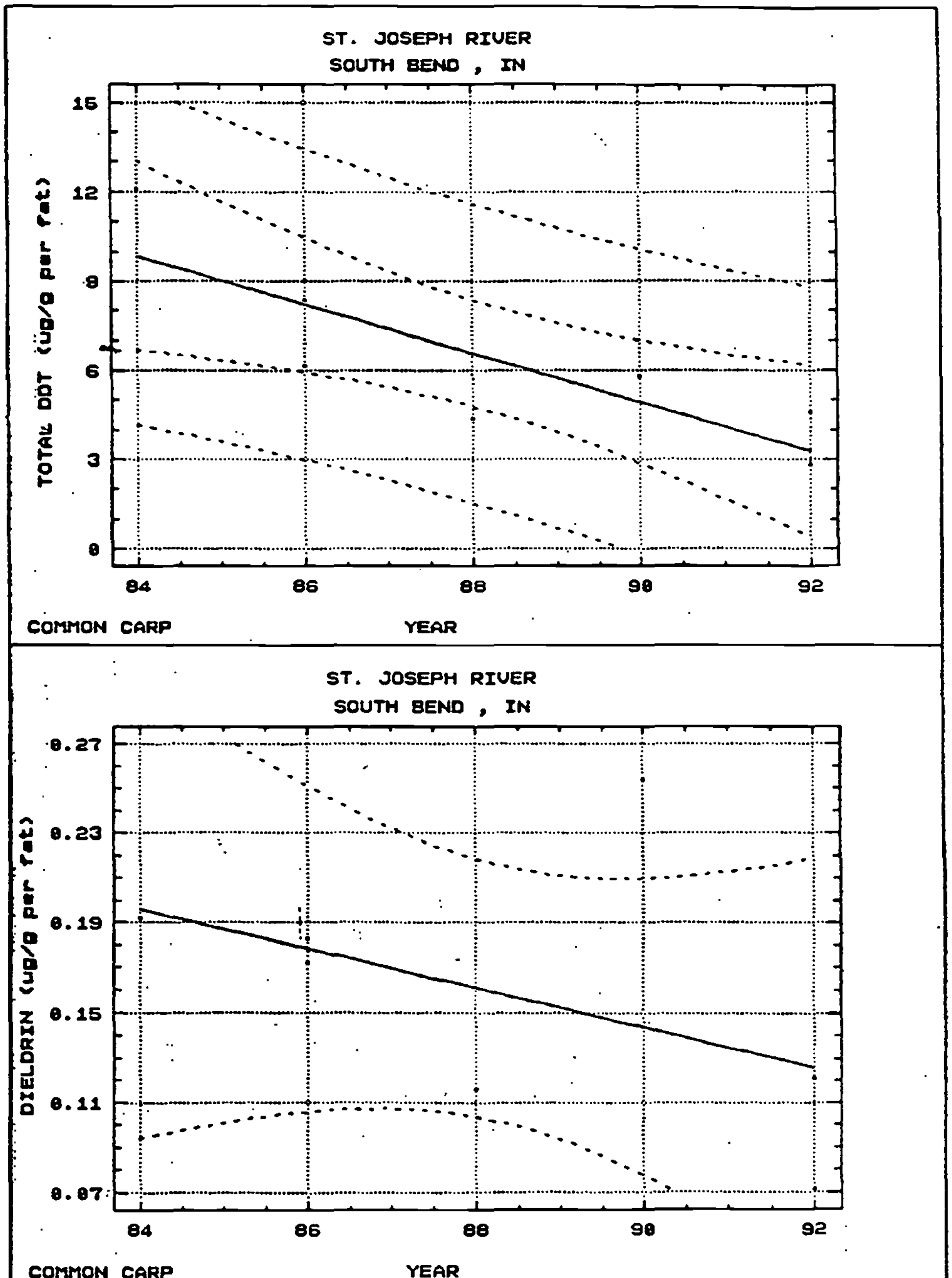


Figure 25. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the St. Joseph River, Fort Wayne, IN in Allen County*

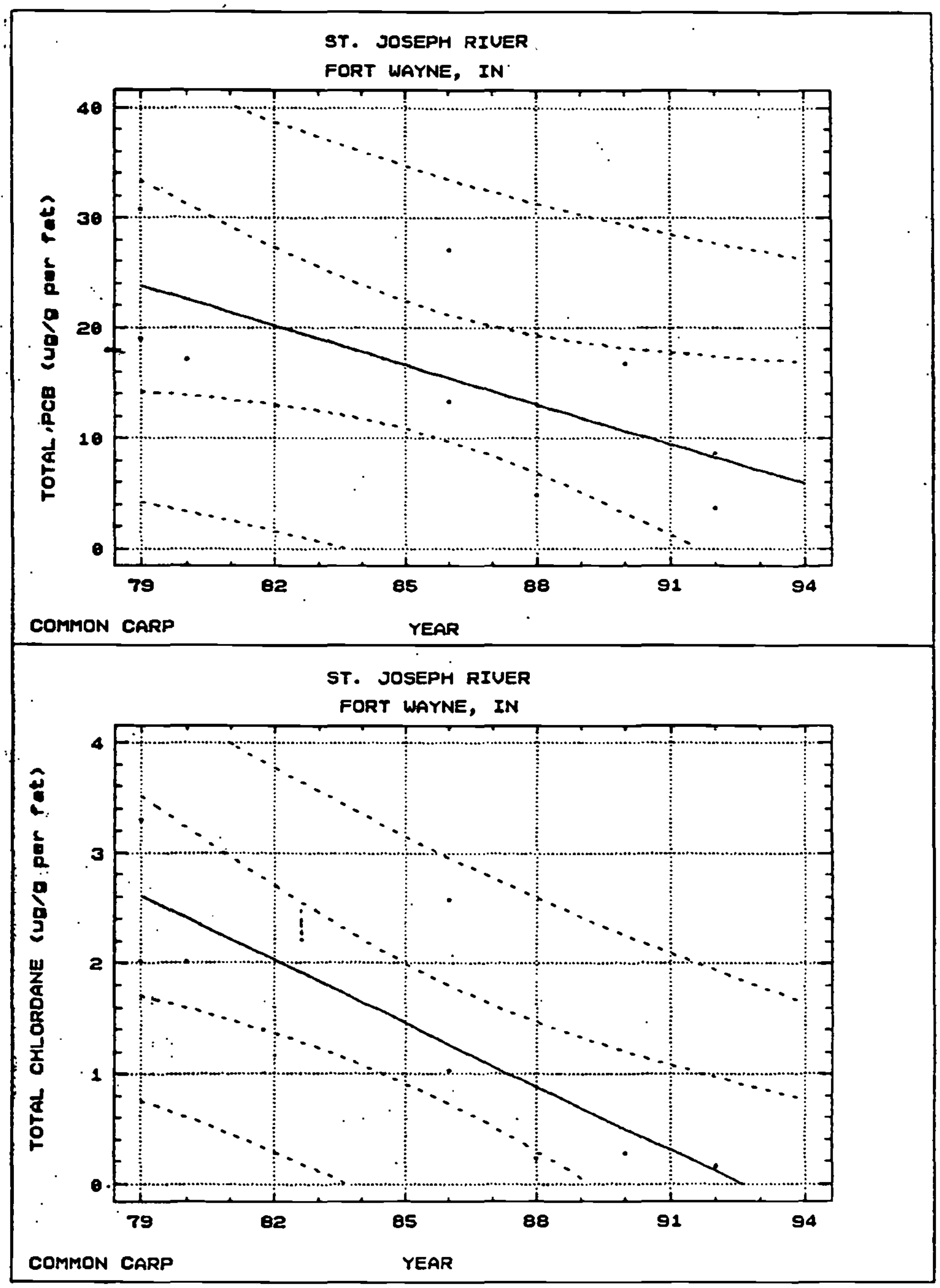


Figure 26. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the St. Joseph River, Fort Wayne, IN in Allen County*

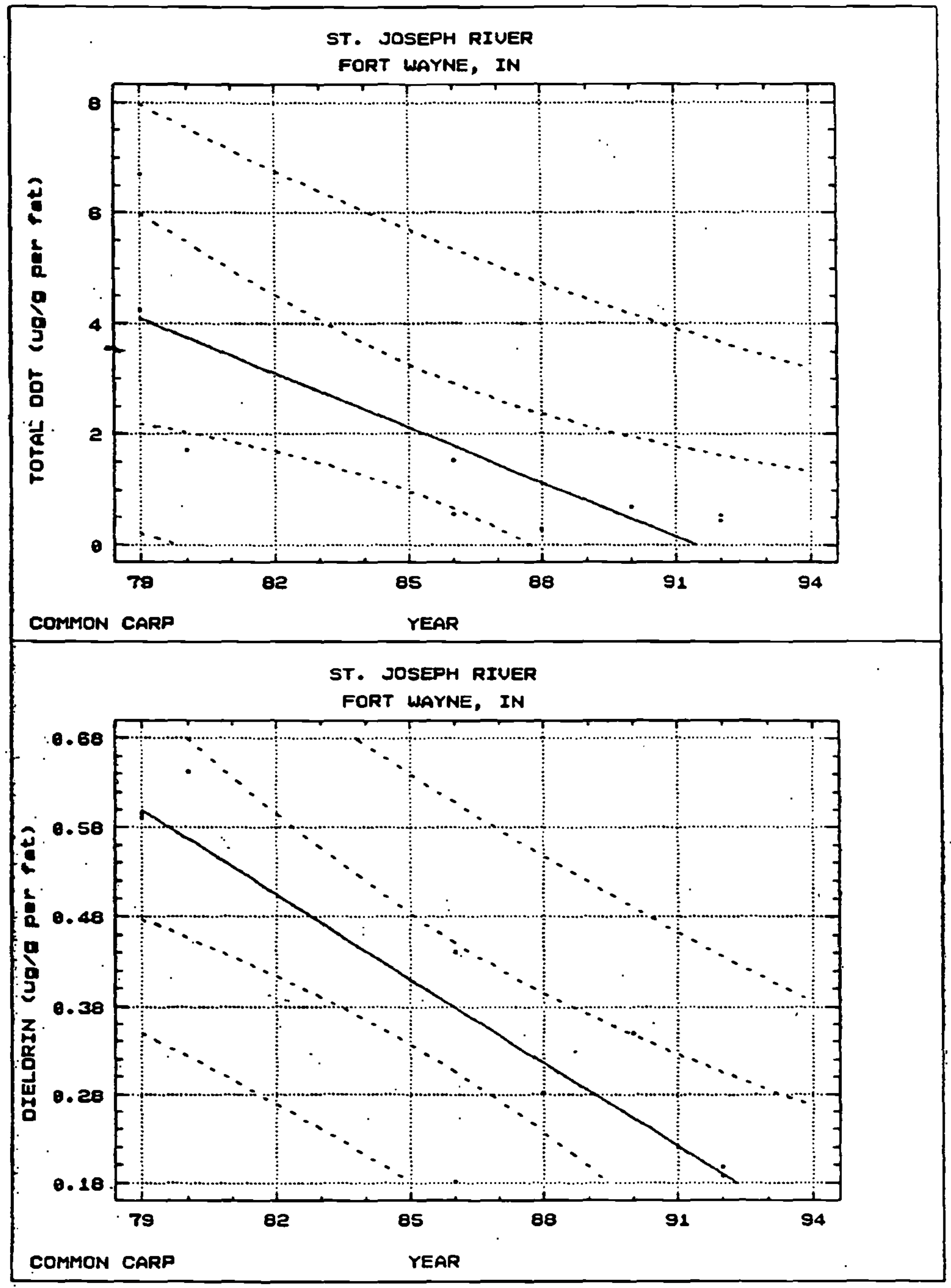


Figure 27. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Wabash River, Bluffton, IN in Wells County*

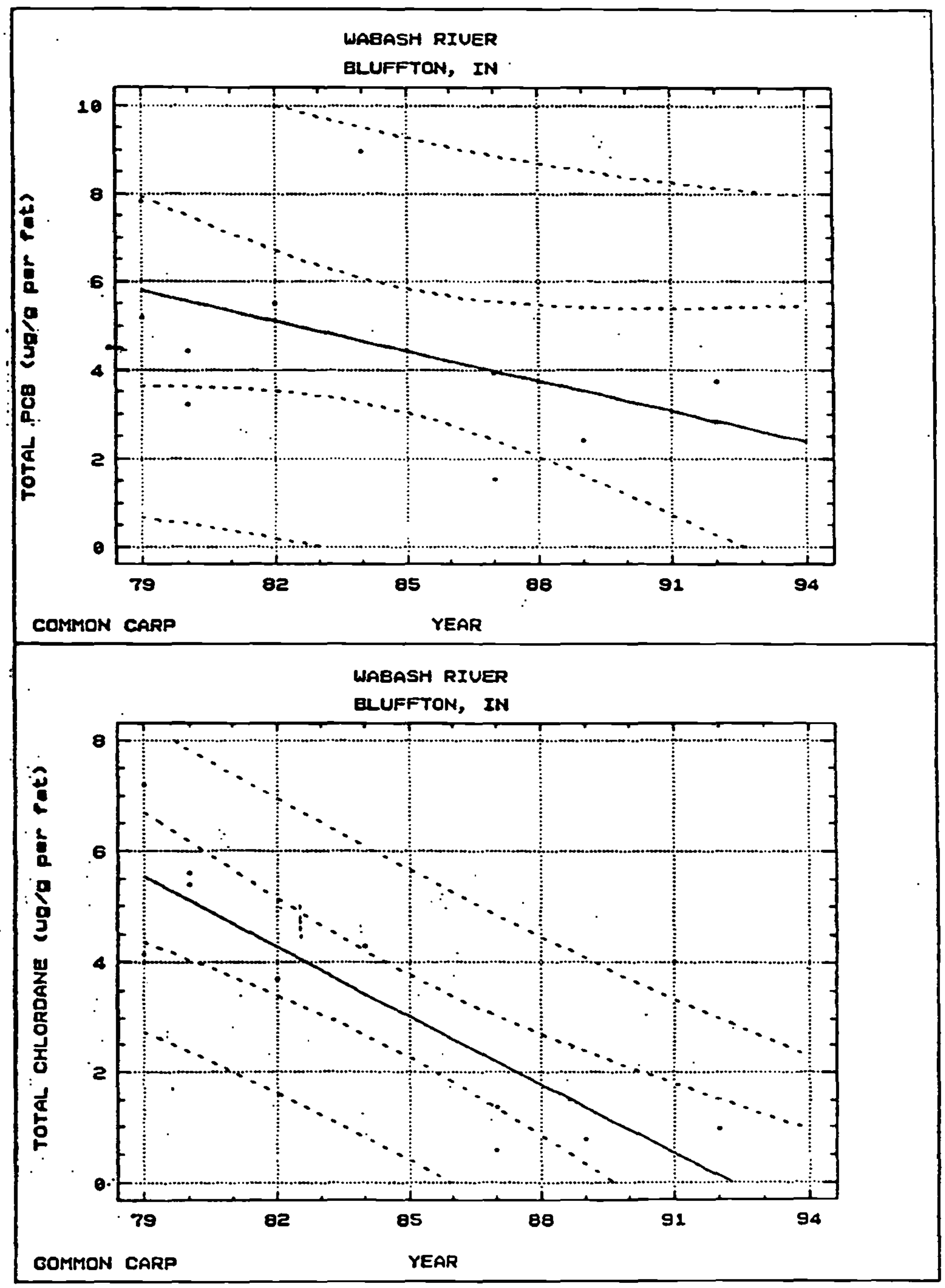


Figure 28. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Wabash River, Bluffton, IN in Wells County*

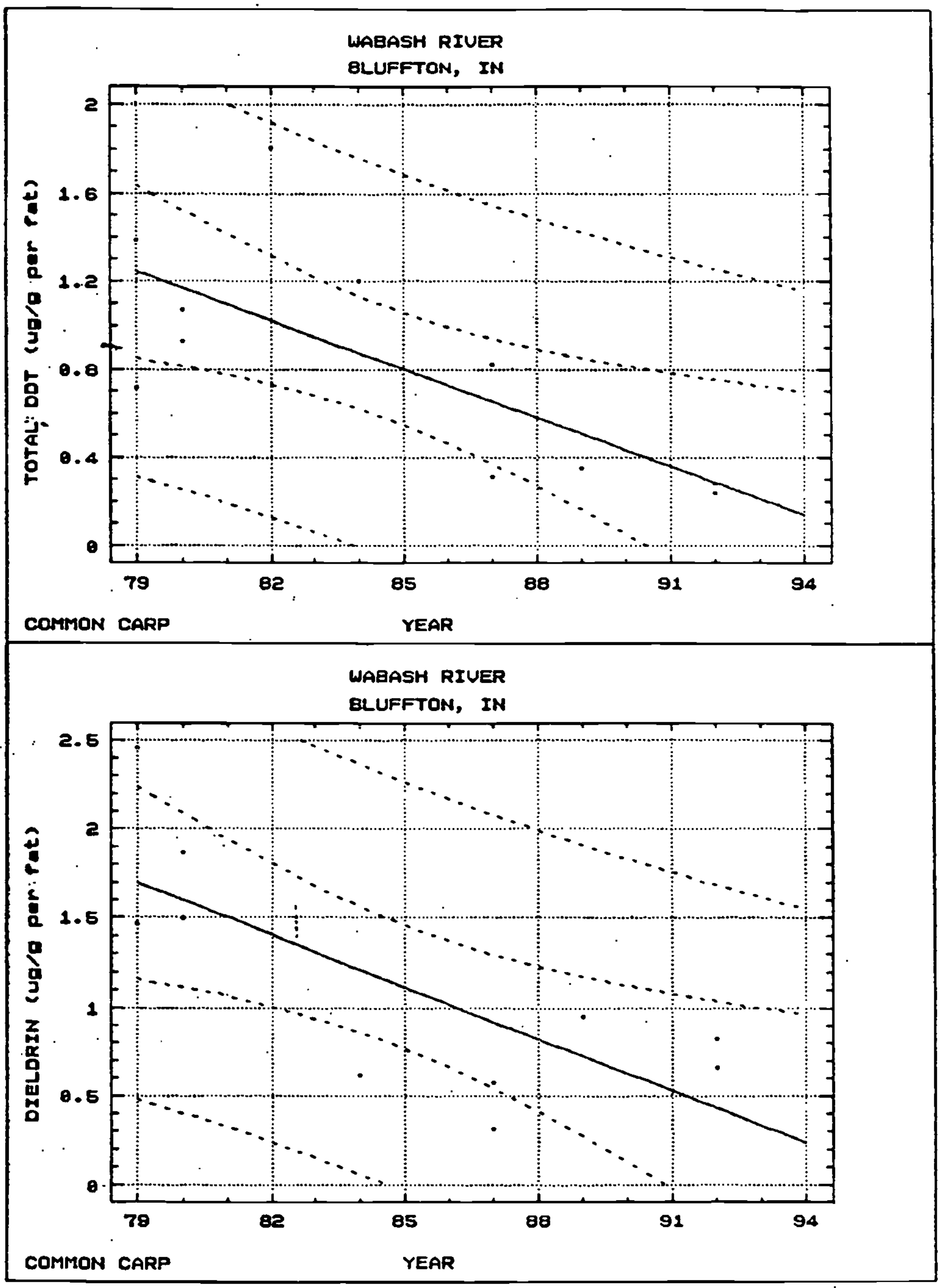


Figure 29. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Wabash River, Lafayette, IN in Tippecanoe County*

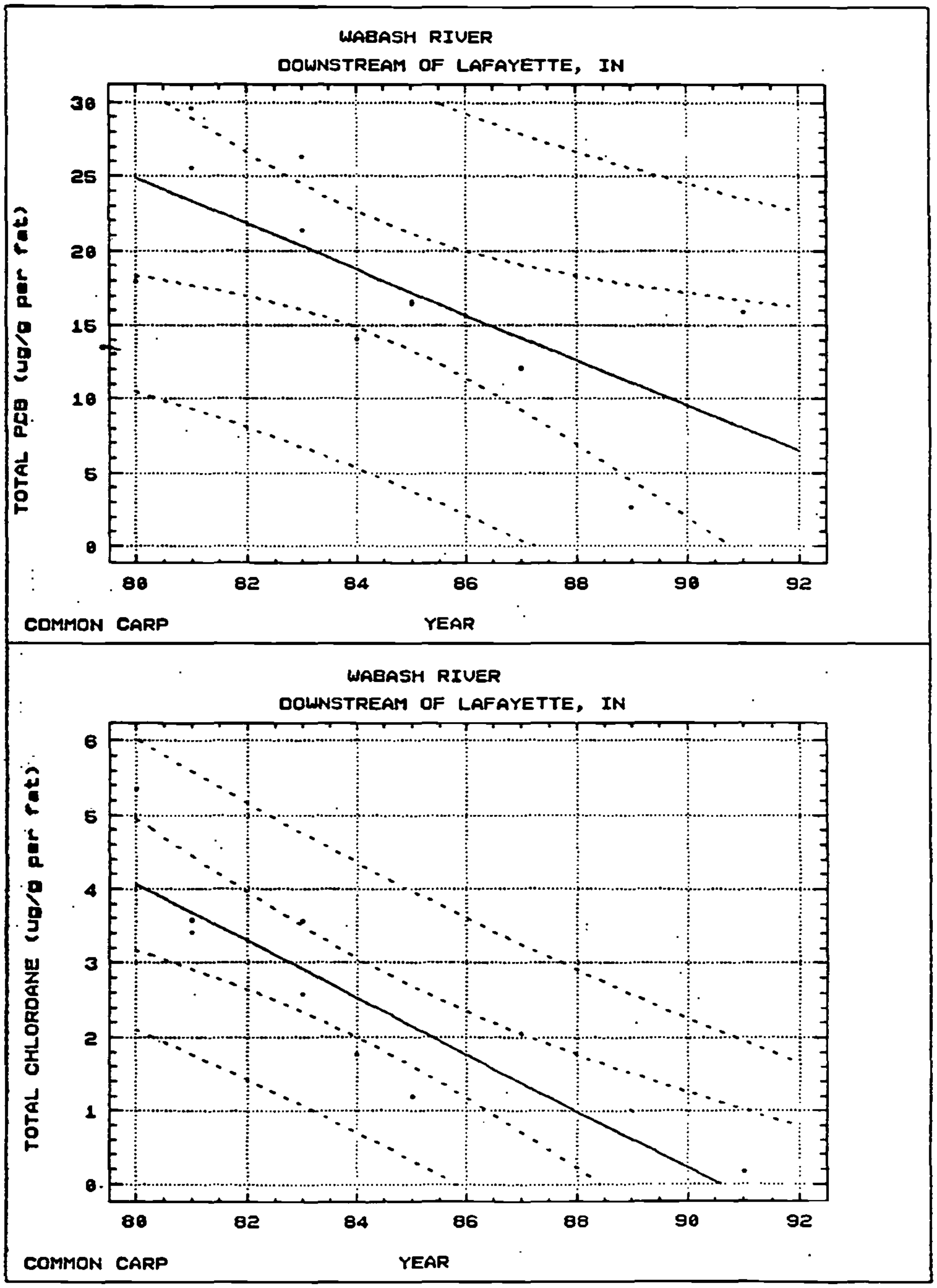
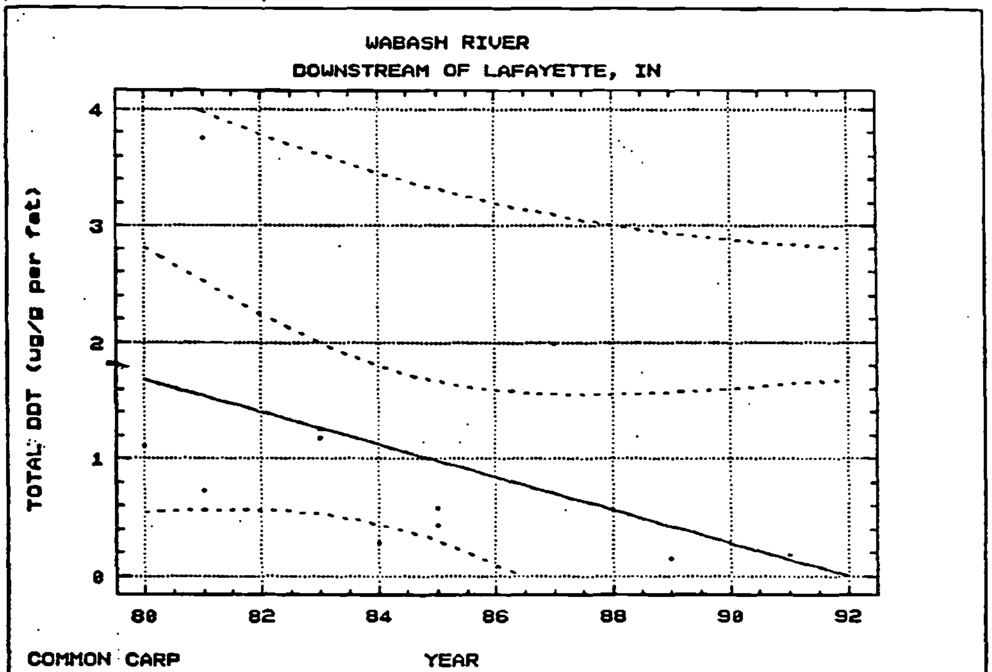


Figure 30. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Wabash River, Lafayette, IN in Tippecanoe County*



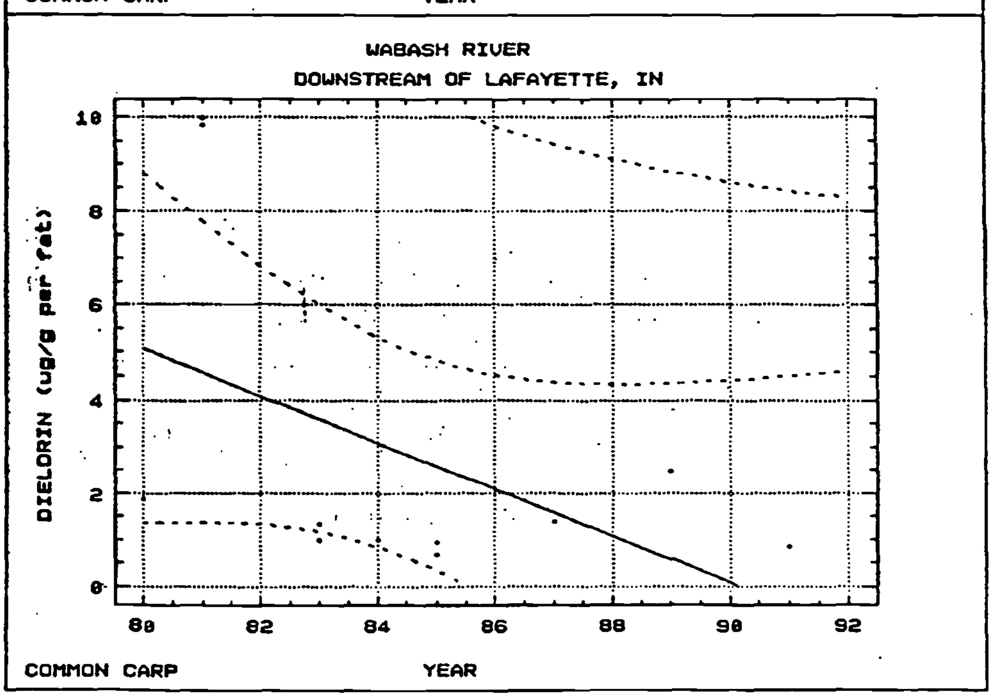


Figure 31. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in channel catfish from the Wabash River, Lafayette, IN in Tippecanoe County*

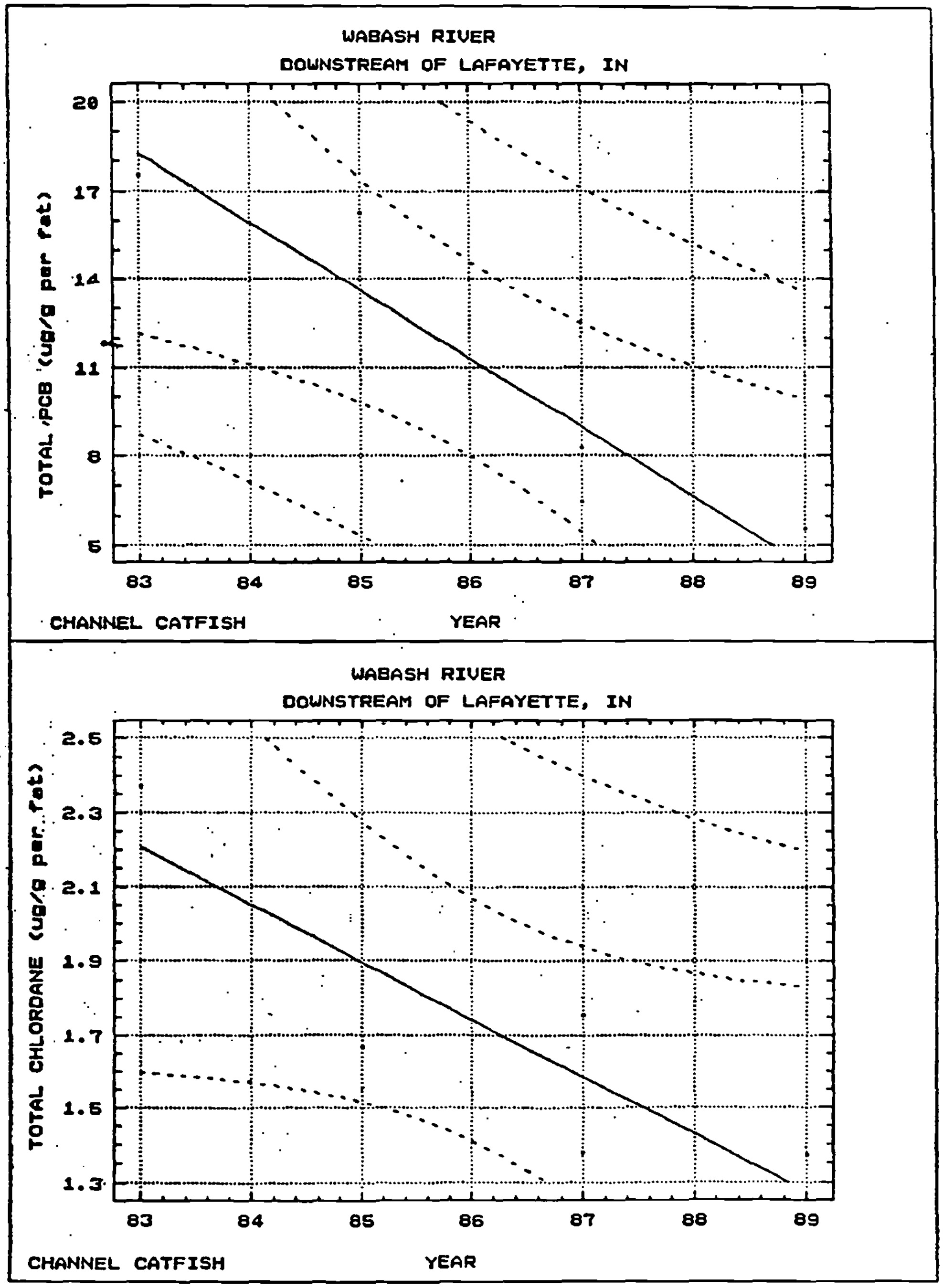


Figure 32. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in channel catfish from the Wabash River, Lafayette, IN in Tippecanoe County*

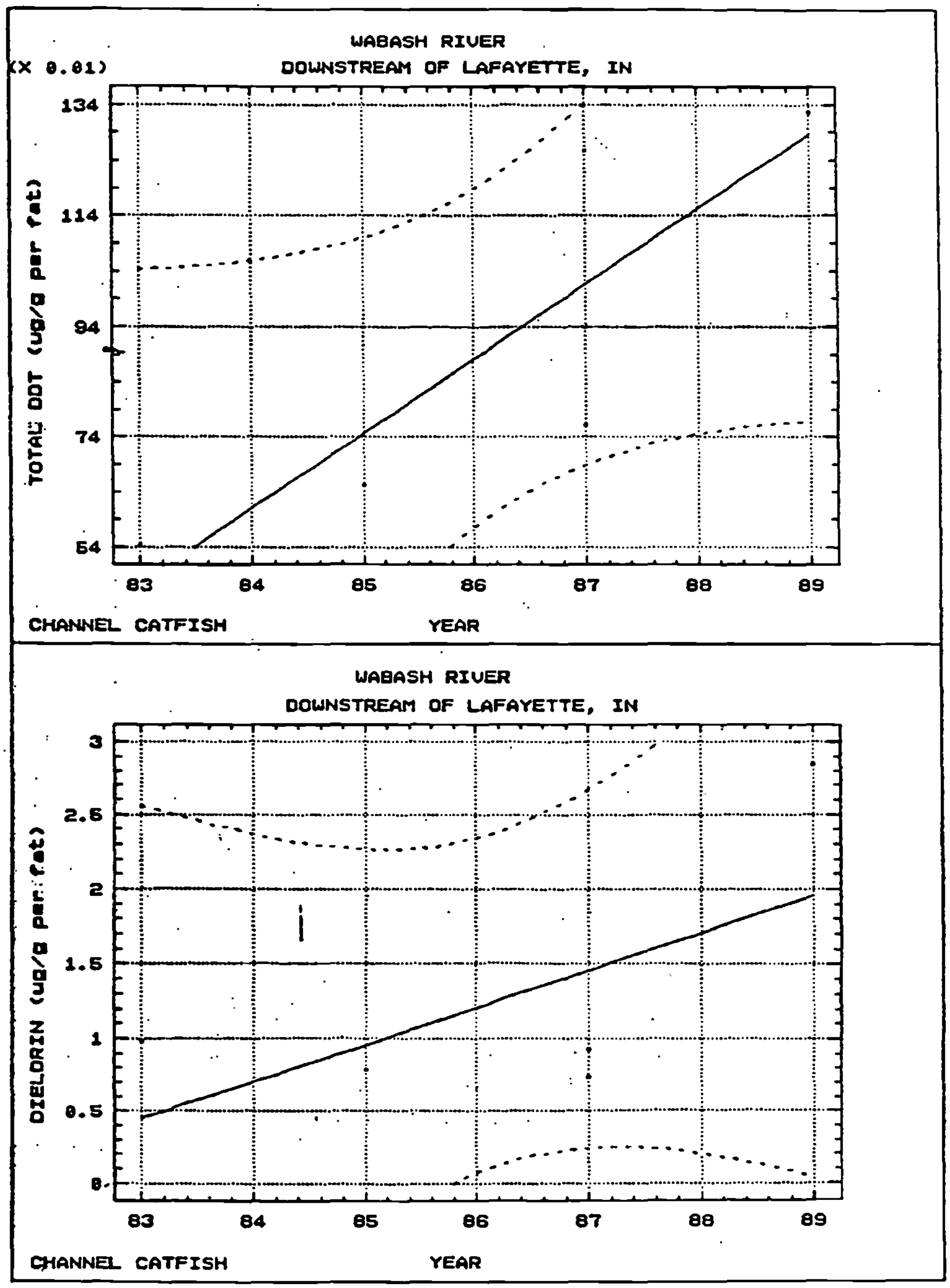


Figure 33. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the Wabash River, downstream of Terre Haute, IN in Vigo County*

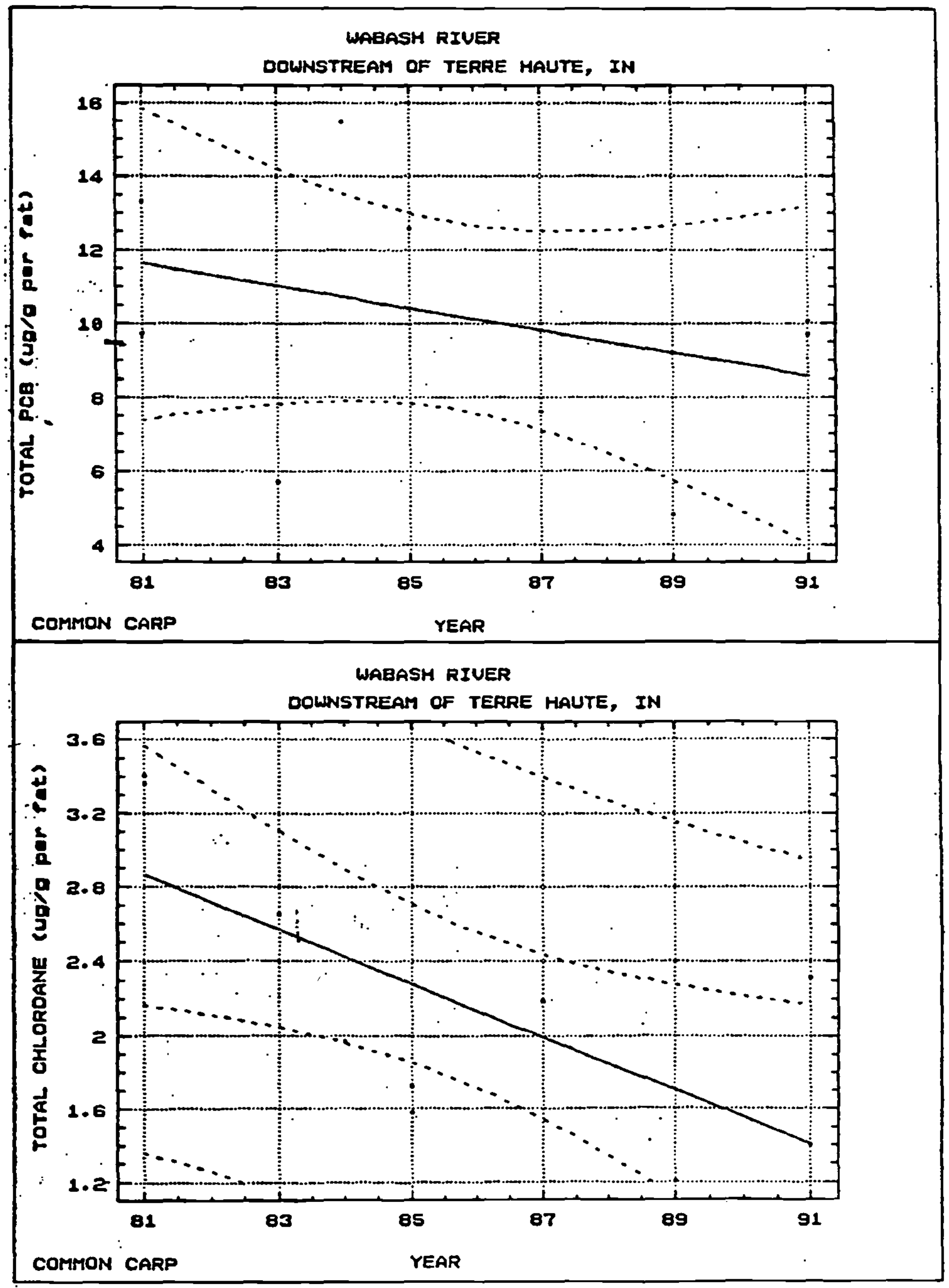


Figure 34. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the Wabash River, downstream of Terre Haute, IN in Vigo County*

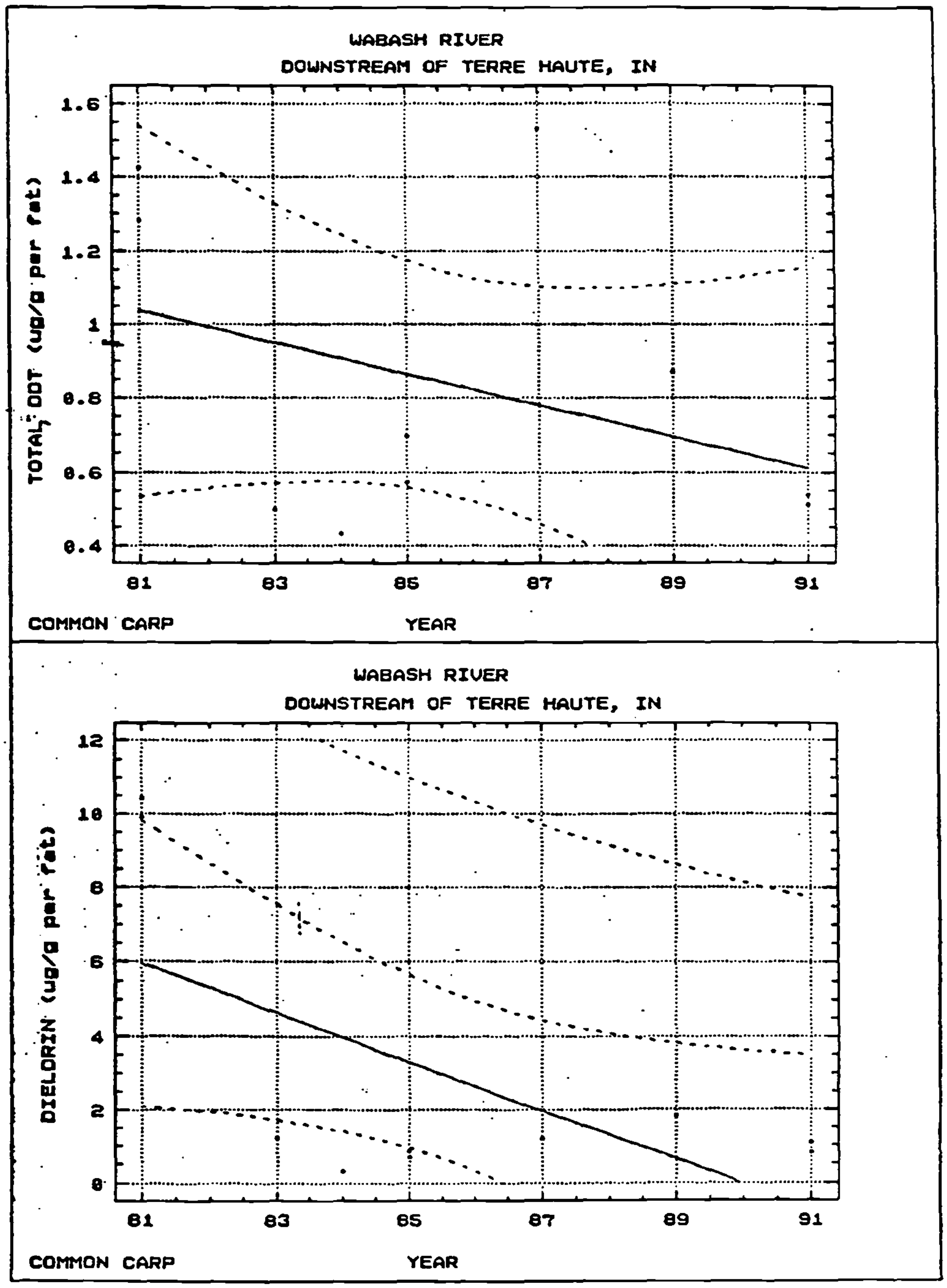


Figure 35. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in channel catfish from the Wabash River, downstream of Terre Haute, IN in Vigo County*

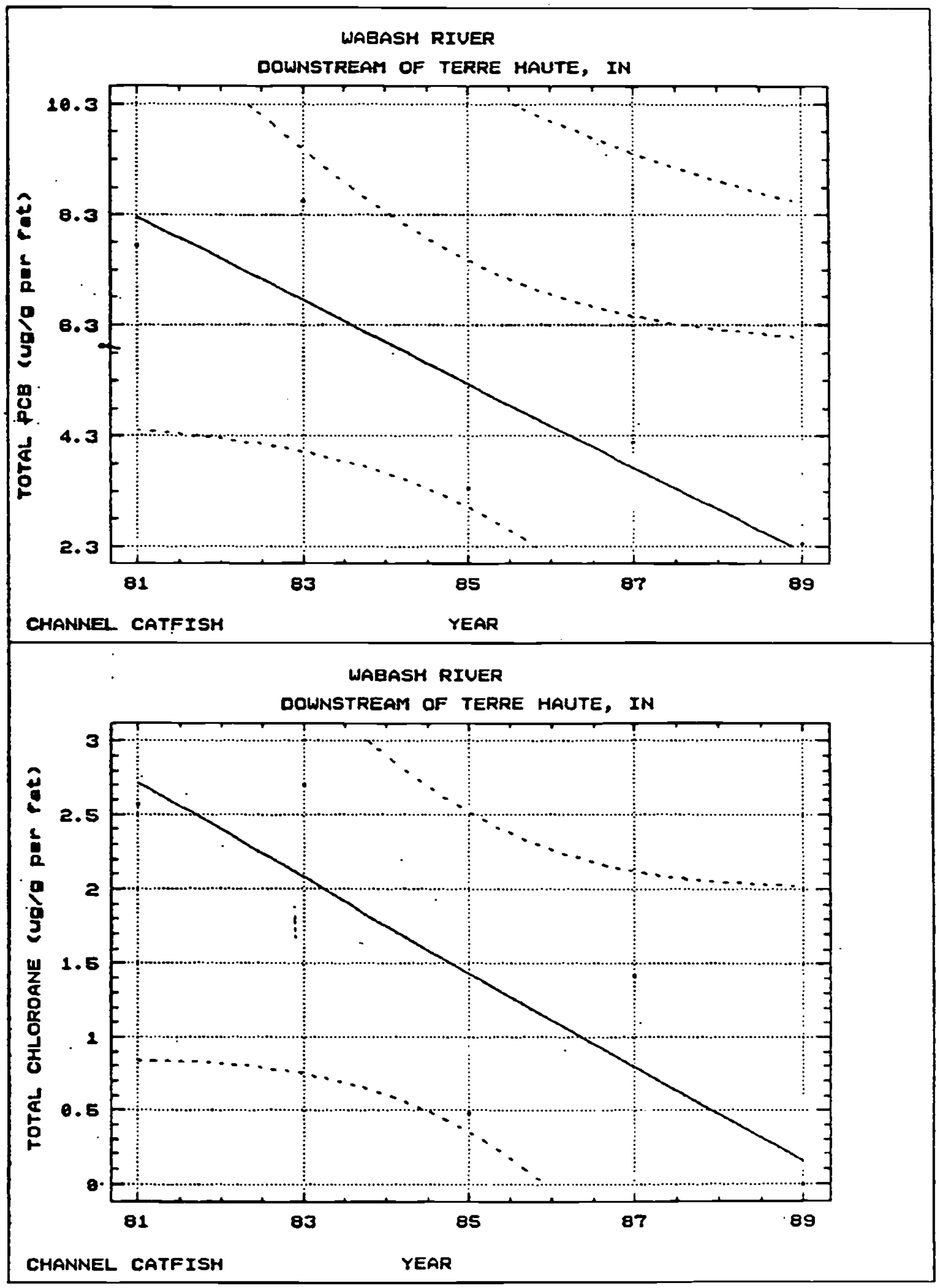


Figure 36. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in channel catfish from the Wabash River, downstream of Terre Haute, IN in Vigo County*

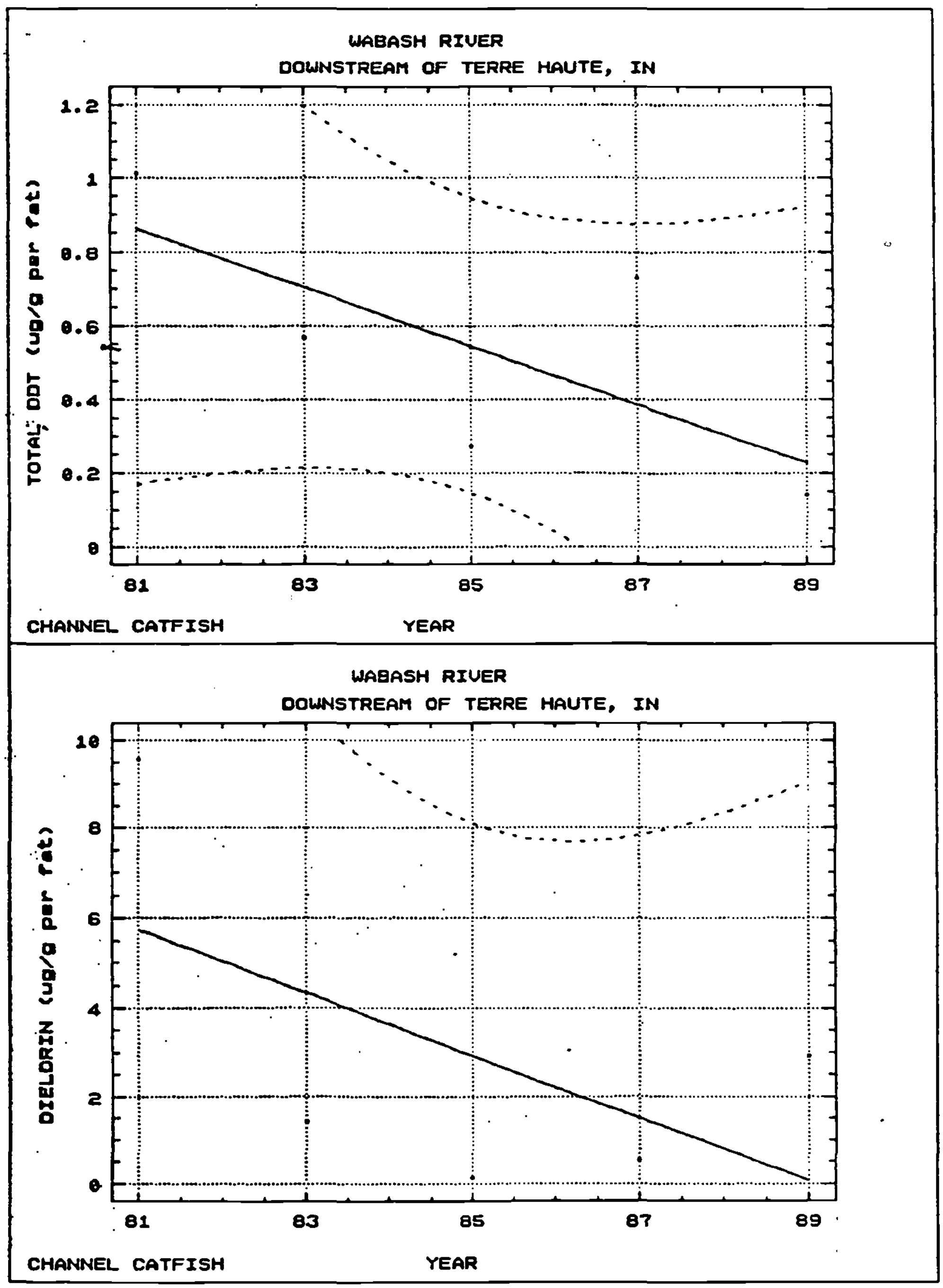
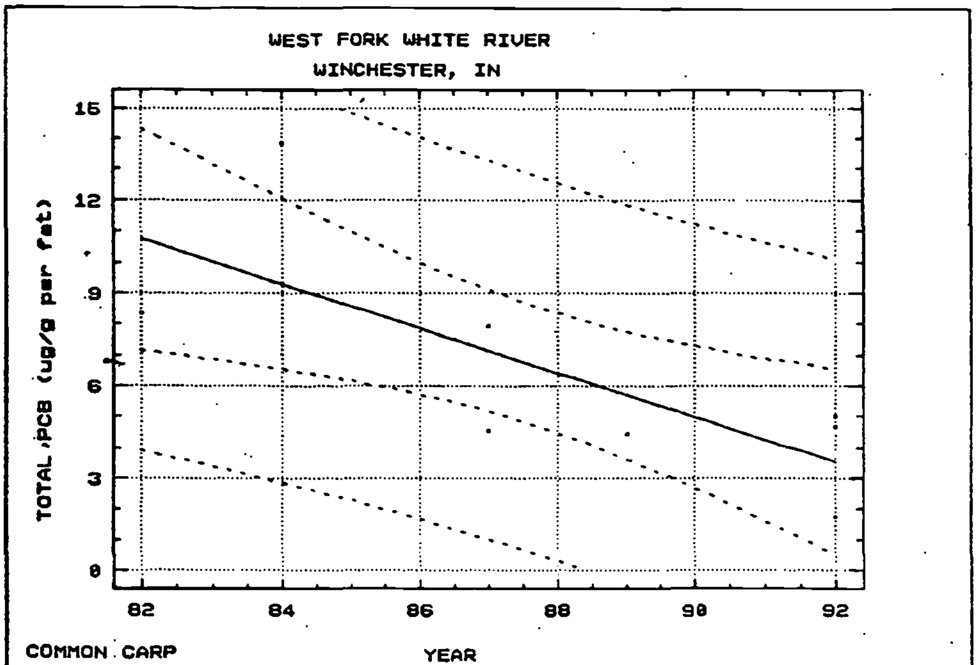


Figure 37. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Winchester, IN in Randolph County*



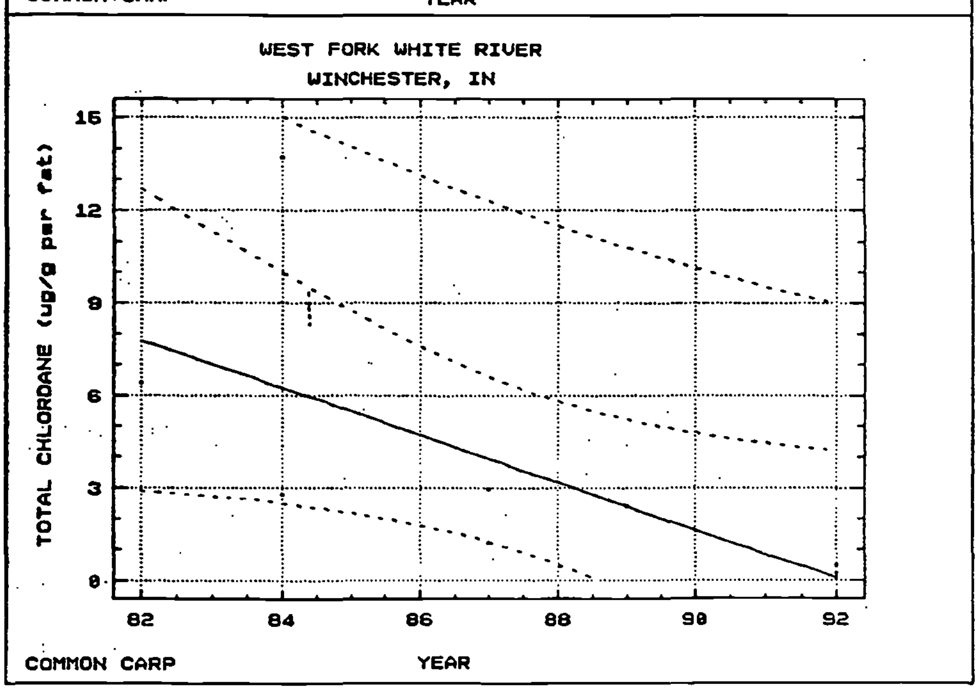


Figure 38. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Winchester, IN in Randolph County*

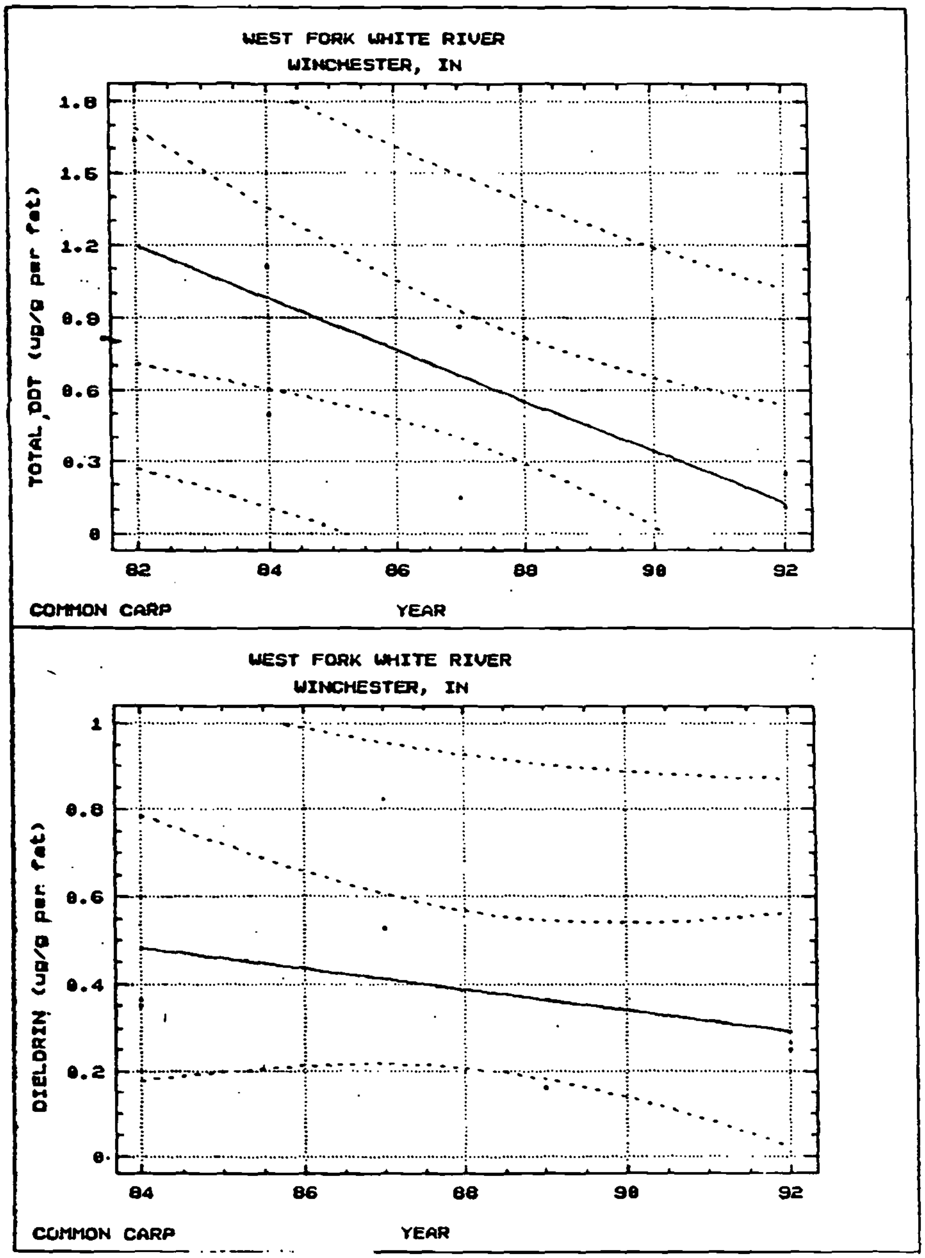


Figure 39. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Broad Ripple Park, Indianapolis in Marion County*

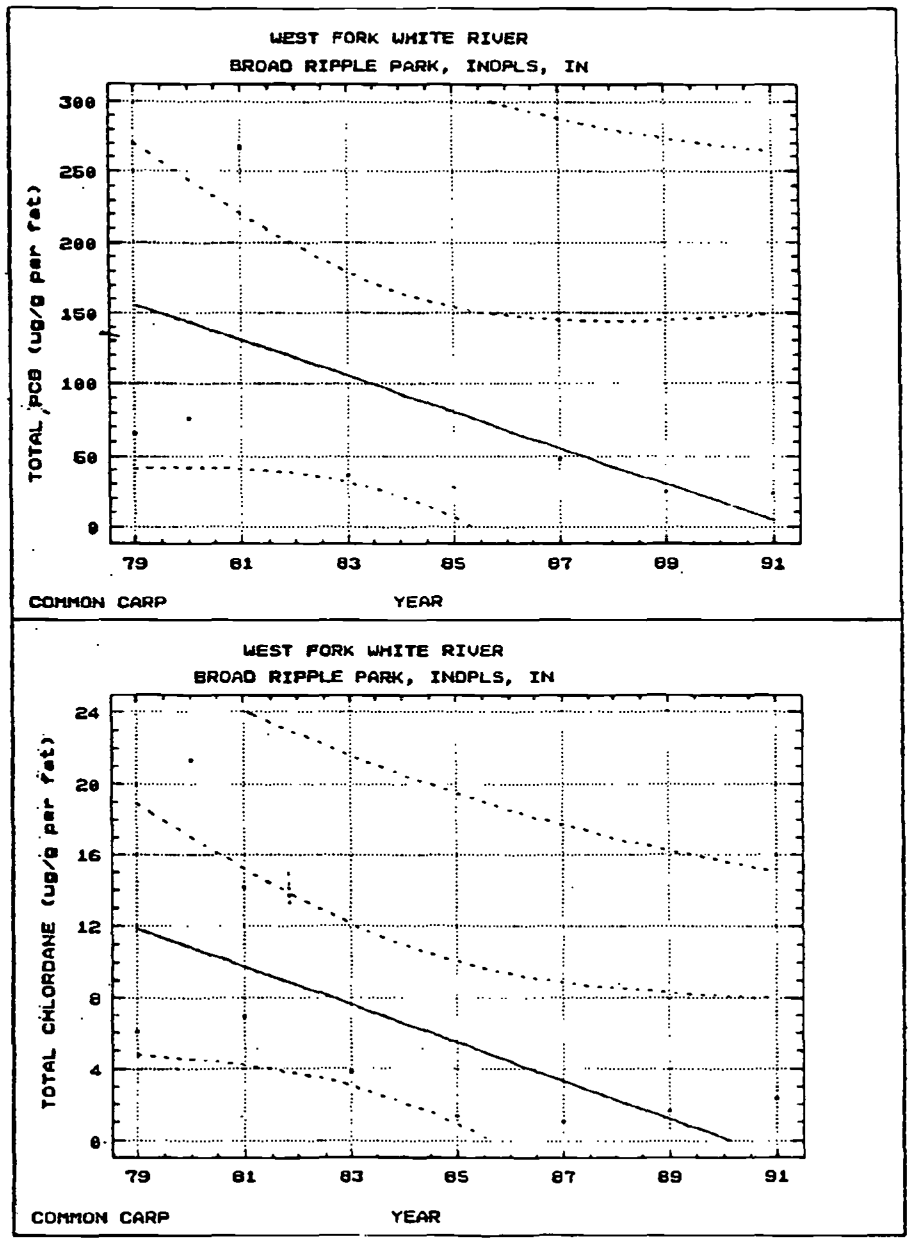


Figure 40. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Broad Ripple Park, Indianapolis in Marion County*

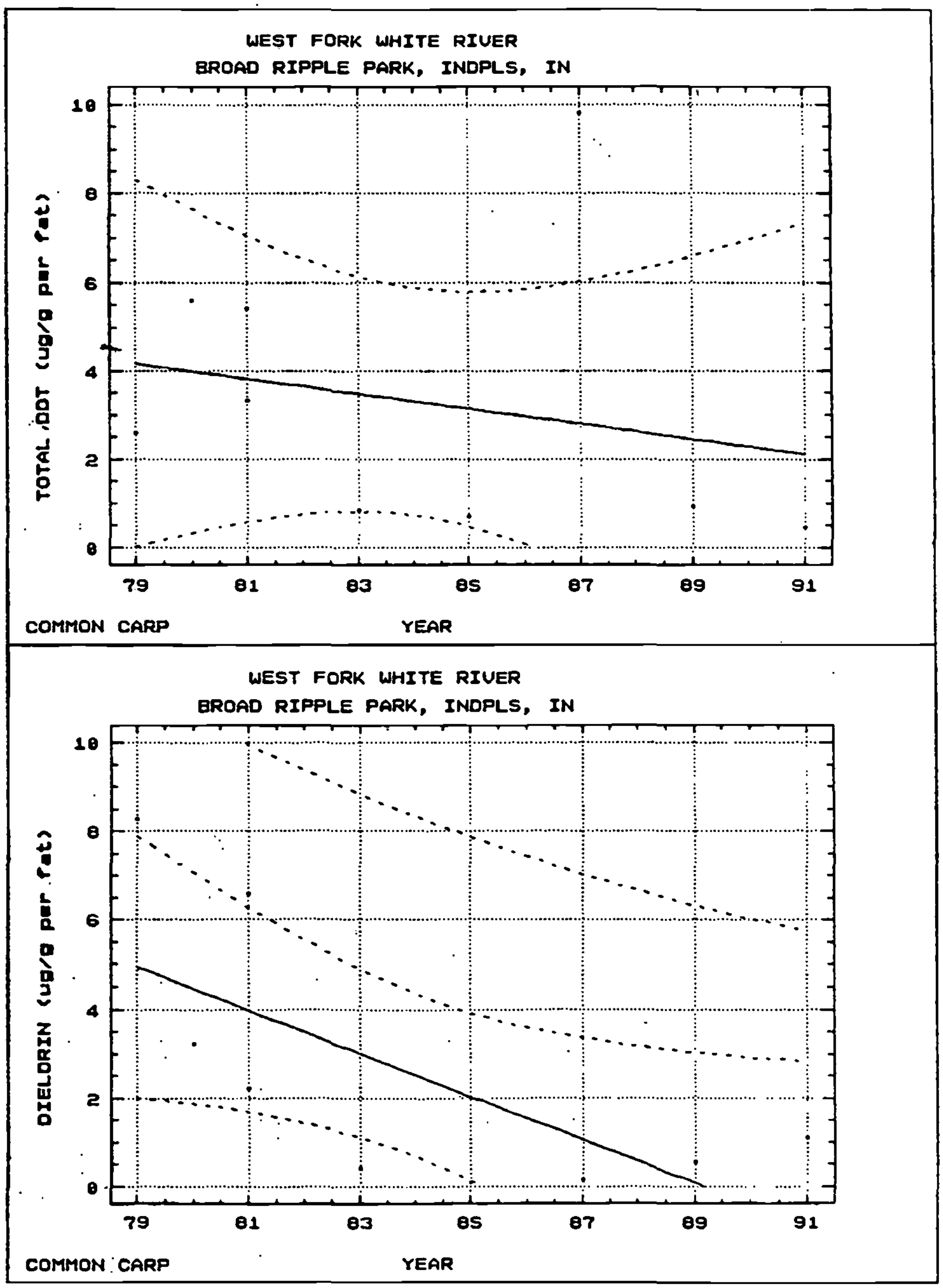


Figure 41. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Henderson Ford in Morgan County*

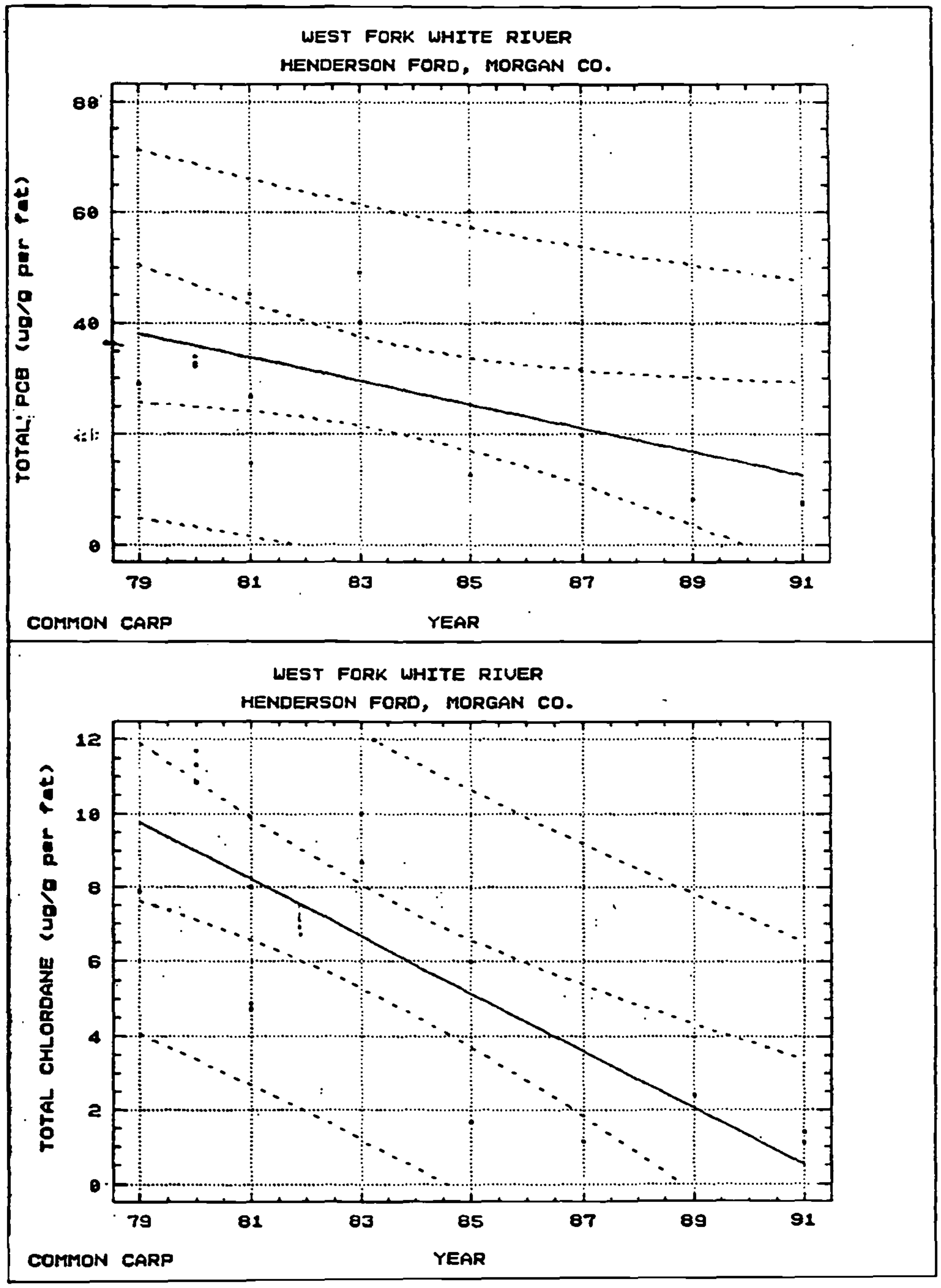


Figure 42. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from West Fork White River, Henderson Ford in Morgan County*

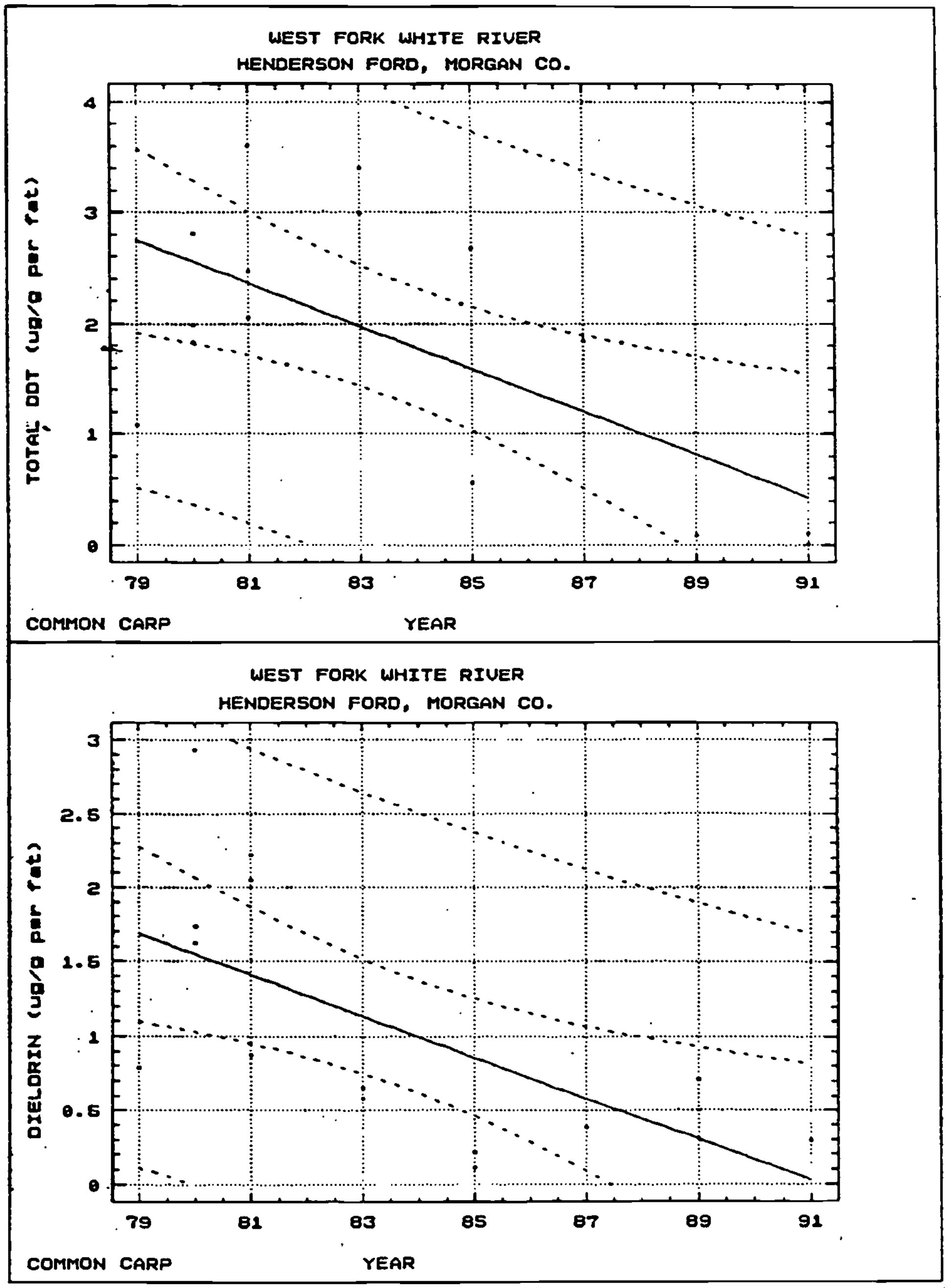


Figure 43. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in channel catfish from the West Fork White River, Henderson Ford in Morgan County*

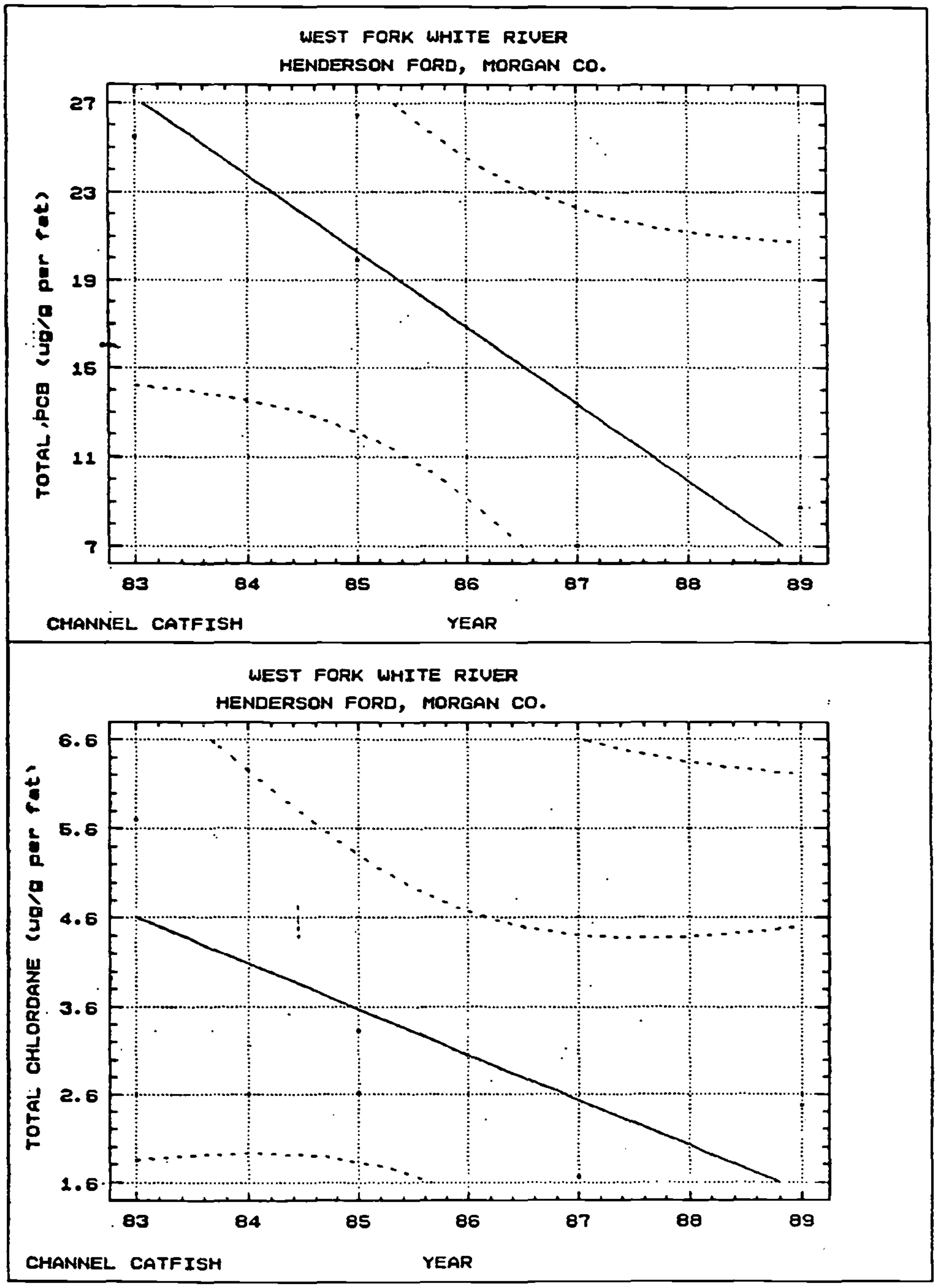


Figure 44. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in channel catfish from the West Fork White River, Henderson Ford in Morgan County*

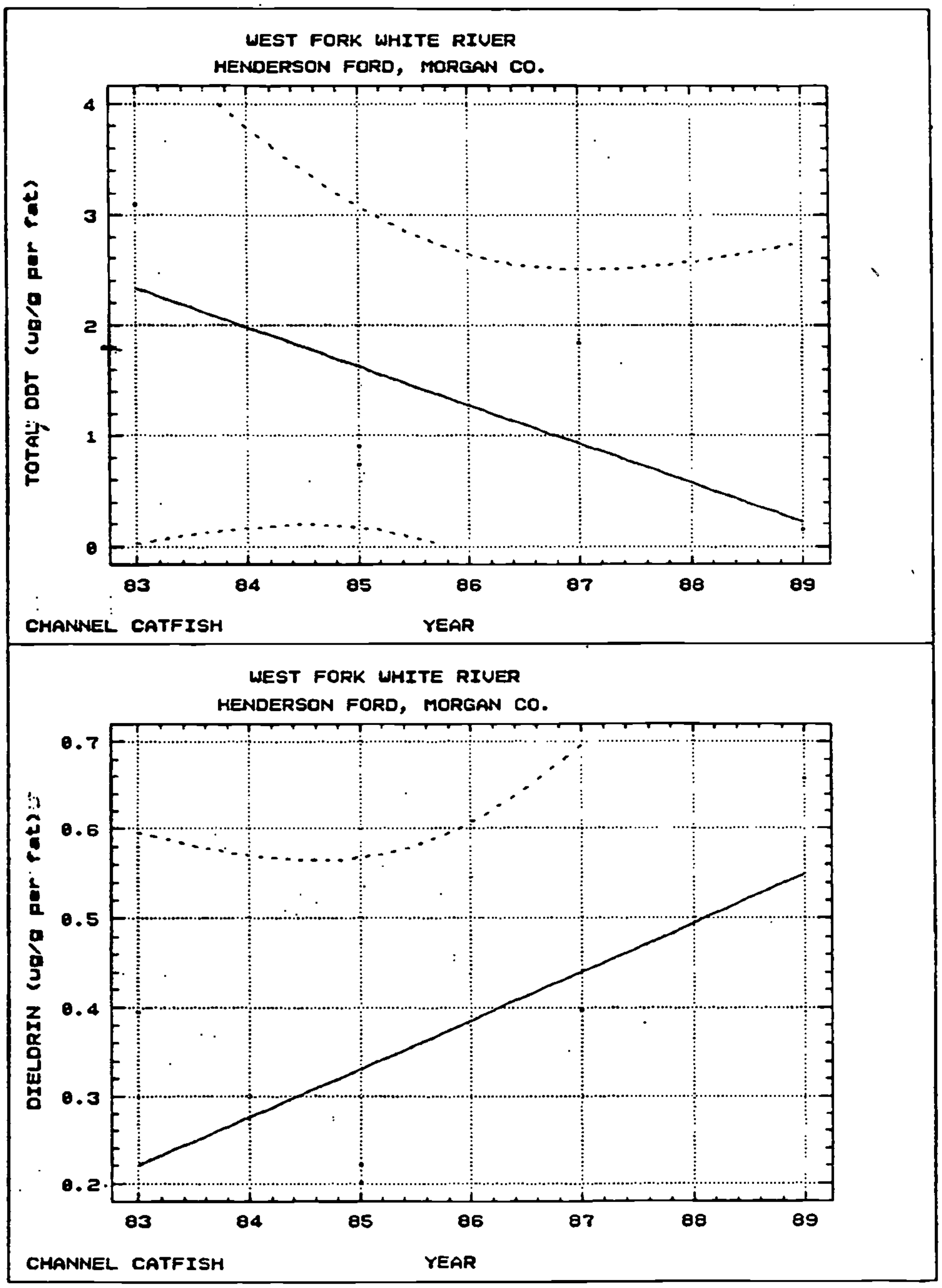


Figure 45. *Linear regression to show trend in levels of total PCB (top) and total chlordane (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Petersburg, IN in Pike County*

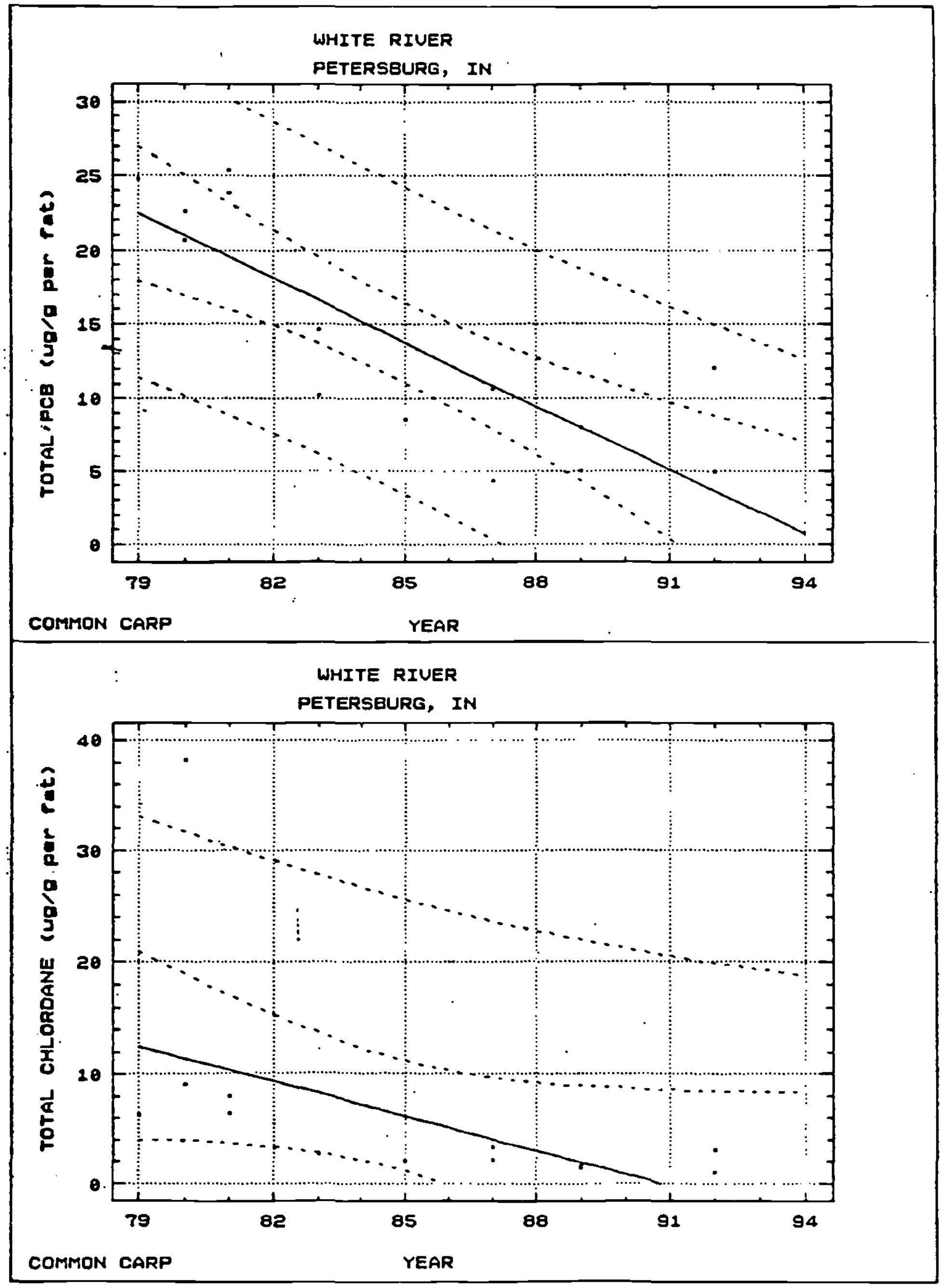
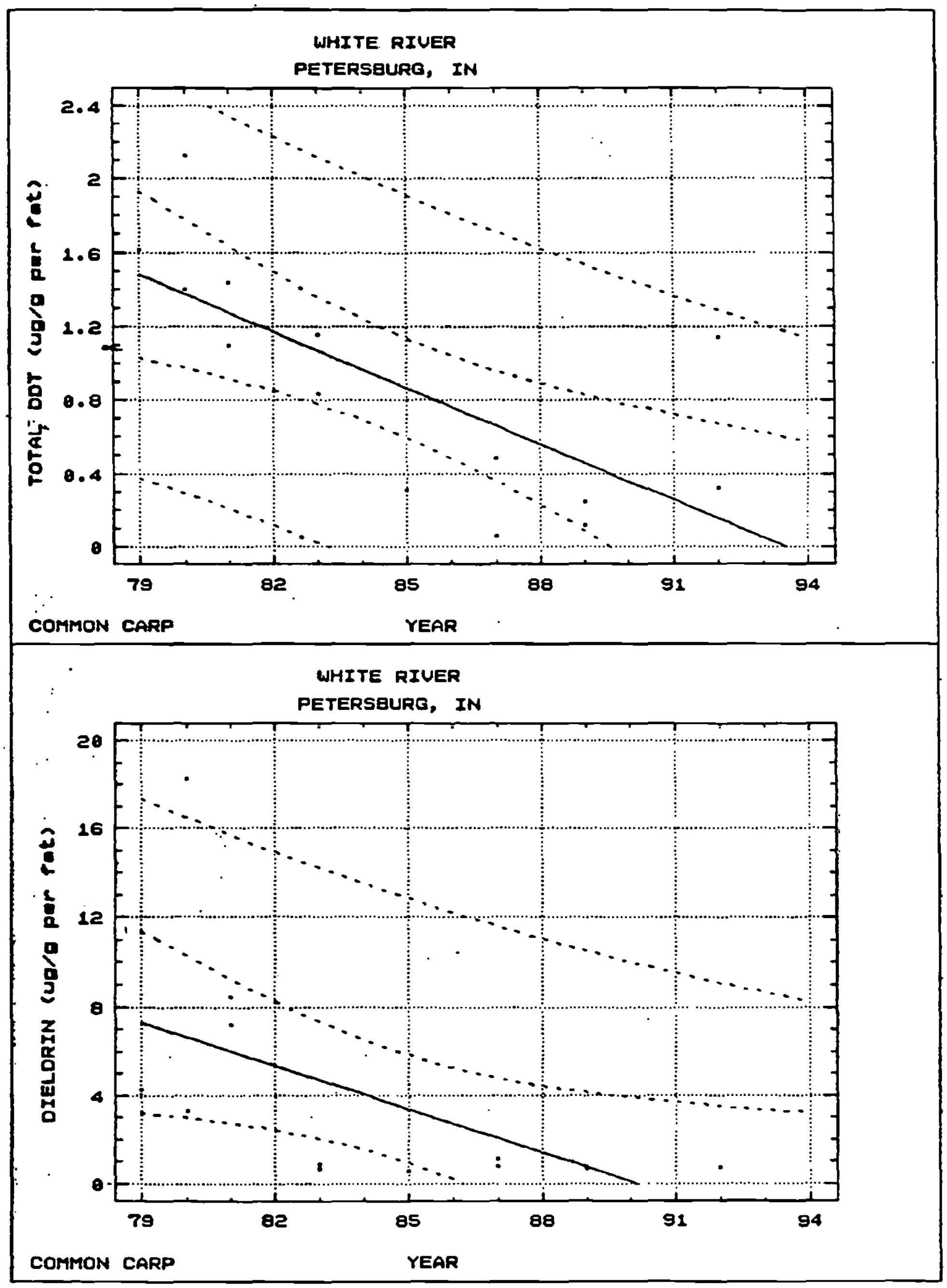


Figure 46. *Linear regression to show trend in levels of total DDT (top) and dieldrin (bottom) on a lipid weight (per fat) basis in common carp from the West Fork White River, Petersburg, IN in Pike County*



intervals evaluated. Consistent sample preparation protocols over the long run will also aid in evaluations.

Sediment Contamination Monitoring

Sediment monitoring is becoming increasingly important as a tool for detecting loadings of pollutants in streams and lakes. Many potential contaminants are easier to find in sediments because they are often found at far greater concentrations than normally found in the water column. Also sediments are usually less mobile than water and can be used more reliably to locate sources of pollutants. Nutrients, many organic compounds and heavy metals can become tightly bound to the fine particulate silts and clays of the sediment deposits where they remain until they are released to the overlying water and made available to the biological community through physical, chemical or bioperturbation processes. Remedial action projects may include the removal of contaminated sediment as a necessary step.

The Office of Water Management has compiled over 700 records of sediment samples taken from reservoirs, lakes and streams throughout the State of Indiana. These include samples collected through 1993. There were 16 samples collected during the 1990-91 biennium and 88 samples collected in the 1992-93 biennium. The 1990 sediment samples were taken from 13 locations on 9 streams from 9 counties in the northern one-third of the State. Sediment samples collected in 1992 were taken from 71 locations on 26 streams, 5 lakes and 1 reservoir from 29 counties Statewide. Sediment collection locations are listed in Table 21. Chemical analyses for the elements, compounds and mixture of compounds listed in Table 22 were conducted on the sediment samples. The 1990 samples were also analyzed for percent moisture and total organic carbon (TOC). The 1992 samples were analyzed for the following general chemistry parameters: total percent moisture, total organic carbon, total percent volatile solids, total percent solids, acid volatile sulfides and ammonia nitrogen.

As a result of budgetary constraints there were no sediment samples collected during the 1991 or 1993 field seasons. Fish tissue collections were conducted in 1991 and 1993 but, unfortunately, there are no sediment samples from these locations to compliment the fish tissue data for those years. The sediment sampling effort in the four year period of 1990 through 1993 represents a reduction of 24% in sediment collection and analysis efforts when compared to the 1988-89 biennium and 69% reduction in sediment activities when compared to the four year period of 1986 through 1989.

The U.S. EPA Region 5 Clean Lakes Program asked each state requesting funding for the preparation of a Lake Water Quality Assessment to include a lake sediment element valued at $10,000-$20,000 of total project costs. These efforts were to be used to compile existing lake sediment data in Indiana and to monitor sediments in lakes where the state had inadequate data and suspected that contaminated sediments may exist.

Table 21: *Sediment collection locations: 1990-1992*

WATERBODY	*COUNTY*	*LOCATIONS*	*YEAR SAMPLED*
Burns Ditch	Porter	Upstream Lefty's Coho Landing	1990
Indiana Harbor Ship Canal*	Lake	Dickey Road	1990
Iroquois River	Newton	State Road 55 Bridge	1990
Kankakee River*	Lake	LaSalle Fish and Wildlife Area	1990
Kankakee River*	LaPorte	Kingsbury Fish and Wildlife Area	1990
Maumee River*	Allen	New Haven, IN	1990
St. Joseph River*	Allen	Johnny Appleseed Park	1990
St. Joseph River*	Elkhart	Bristol, IN	1990
St. Joseph River*	St. Joseph	St. Patrick Park	1990
St. Mary's River	Allen	Old Fort Wayne Bridge	1990
Trail Creek*	LaPorte	Downstream Michigan City, IN STP	1990
Yellow River	Marshall	Downstream Plymouth, IN	1990
Yellow River	Starke	Downstream Knox, IN	1990
Big Pine Creek	Warren	County Road 125N, Kramer, IN	1992
Big Raccoon Creek	Parke	Lafayette Road, upstream Armiesburg, IN	1992
Big Walnut Creek	Parke	Upstream Reelsville, IN	1992
Blue River	Harrison	Stagestop Campground	1992
Buck Creek	Delaware	County Road 428W	1992
Burns Ditch	Porter	Upstream Lefty's Coho Landing	1992
Center Lake	Kosciusko	Water works	1992
Center Lake	Kosciusko	Inlet from Pike Lake	1992
Center Lake	Kosciusko	Lake basin composite	1992
Center Lake	Kosciusko	Lones Ditch outlet	1992
Deer Creek	Carroll	Downstream Delphi, IN STP	1992
Deer Creek	Carroll	Delphi City Park	1992
East Fork White Lick Creek	Hendricks	County Road 700S	1992
East Fork White River	Lawrence	Downstream Williams Dam	1992
East Fork Whitewater River	Wayne	Downstream Richmond, IN	1992
Eel River	Greene	State Road 67, Worthington, IN	1992
Fall Creek	Hamilton	Florida Road, upstream Geist Reservoir	1992
Fall Creek	Madison	State Road 13, upstream Dowden Landfill	1992
Fall Creek	Madison	Falls Park, Pendleton, IN	1992
Great Miami River	Dearborn	Lawrenceburg, IN	1992
Henderson Lake	Noble	Lake basin composite	1992
Henderson Lake	Noble	Bixler Lake outlet	1992
Henderson Lake	Noble	CSO bypass	1992
Indiana Harbor Ship Canal	Lake	Dickey Road	1992
Kankakee River	Lake	LaSalle Fish and Wildlife Area	1992
Kankakee River	LaPorte	Kingsbury Fish and Wildlife Area	1992
Killbuck Creek	Madison	Grand Avenue, upstream dam	1992
Lake Manitou	Fulton	Inlet at Graham Creek	1992

Table 21: *Sediment collection locations: 1990-1992 (cont.)*

WATERBODY	*COUNTY*	*LOCATIONS*	*YEAR SAMPLED*
Lake Manitou	Fulton	Inlet at Rain Creek	1992
Lake Manitou	Fulton	North basin	1992
Lake Manitou	Fulton	South basin	1992
Little Calumet River	Lake	Riverside Park, upstream U.S. 41	1992
Maumee River	Allen	Landin Road, New Haven, IN	1992
Middle Fork Reservoir	Wayne	Upstream Richmond, IN	1992
Muscatatuck River	Washington	State Road 135, Milport, IN	1992
Otter Creek	Vigo	County Road 24W	1992
Palestine Lake	Kosciusko	East basin composite	1992
Palestine Lake	Kosciusko	Inlet at Magee Ditch	1992
Palestine Lake	Kosciusko	Inlet at Sloan Ditch	1992
Palestine Lake	Kosciusko	Inlet at Trimble Creek	1992
Palestine Lake	Kosciusko	Inlet at Williamson Ditch	1992
Palestine Lake	Kosciusko	Outlet at West basin	1992
Palestine Lake	Kosciusko	West basin	1992
Pigeon Creek	Steuben	State Road 27	1992
Pigeon Creek	Vanderburgh	Kleymeyer Park, Evansville, IN	1992
Pipe Creek	Madison	Downstream Lilly Creek	1992
Silver Creek	Clark	Upstream of the Ohio River	1992
St. Mary's River	Allen	Spy Run at Ft. Miamis Park	1992
St. Joseph River	Allen	Johnny Appleseed Park	1992
St. Joseph River	Elkhart	Bristol, IN	1992
St. Joseph River	St. Joseph	St. Patrick Park	1992
Trail Creek	LaPorte	Downstream Michigan City, IN WWTF	1992
Trail Creek	LaPorte	Downstream Michigan City, IN WWTF	1992
Wabash River	Carroll	Downstream Deer Creek	1992
Wabash River	Carroll	State Road 18/39 at Pittsburg, IN	1992
Wabash River	Posey	New Harmony, IN	1992
Wabash River	Tippecanoe	Downstream Lafayette, IN	1992
Wabash River	Tippecanoe	Upstream Lafayette, IN	1992
Wabash River	Vigo	Darwin Ferry, downstream Terre Haute, IN	1992
Wabash River	Vigo	Upstream Terre Haute, IN	1992
Wabash River	Wells	Upstream Bluffton, IN	1992
Wabash River	Wells	Upstream Bluffton, IN	1992
West Fork White River	Marion	Broad Ripple Park	1992
West Fork White River	Morgan	Henderson Ford	1992
West Fork White River	Pike	State road 61, Petersburg, IN	1992
West Fork White River	Randolph	Upstream Winchester, IN	1992
West Fork Whitewater River	Fayette	Downstream Connersville, IN	1992

Table 21: *Sediment collection location: 1990-1992 (cont.)*

WATERBODY	*COUNTY*	*LOCATIONS*	*YEAR SAMPLED*
West Fork Whitewater River	Fayette	County Road 440N	1992
White Lick Creek	Hendricks	County Road 900S	1992
White Lick Creek	Morgan	Brooklyn, IN	1992
Whitewater River	Dearborn	State Road 46	1992
Whitewater River	Dearborn	State Road 46	1992
Williamson Ditch	Kosciusko	County Road 600W	1992
Winona Lake	Kosciusko	Eagle Creek outlet	1992
Winona Lake	Kosciusko	Manhole #1 upstream Dalton Foundry	1992
Winona Lake	Kosciusko	Manhole #2 downstream Dalton Foundry	1992
Winona Lake	Kosciusko	Manhole #3 downstream Dalton and Warsaw, IN	1992
Winona Lake	Kosciusko	Northwest end of main basin	1992
Winona Lake	Kosciusko	South end	1992
Winona Lake	Kosciusko	Storm sewer outlet at northeast end	1992

*-Indicates those locations that were replicated in 1992 sediment sampling efforts.

Table 22: *Complete list of sediment analytes for 1990-1993*

Metals

Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper/
Iron
Lead
Magnesium
Manganese
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc
Cyanide

Acid Extractables

Benzoic acid
Phenol
2-Chlorophenol
2,4-dichlorophenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
Pentachlorophenol
2--Methylphenol
4-methylphenol
2,4-Dimethylphenol
4-chloro-3-Methylphenol
4,6-dinitro-2-Methylphenol
2-Nitrophenol
4-Nitrophenol
2,4-Dinitrophenol

PCBs

Aroclor-1016
Aroclor-1221
Aroclor-1232
Aroclor-1242
Aroclor-1248
Aroclor-1254
Aroclor-1260
Aroclor-1262

Pesticides

Aldrin
alpha-BHC
beta-BHC
delta-BHC
gamma-BHC (Lindane)
alpha-Chlordane
gamma-Chlordane
cis-Nonachlor
trans-Nonachlor
Oxychlordane
Total Chlordane
p,p'-DDD
o,p-DDD
p,p'-DDE
o,p'-DDE
p,p'-DDT
o,p'-DDT
Dieldrin
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Endrin ketone
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Methoxychlor
Pentachloroanisole
Toxaphene

Base/Neutral Extractables

di-n-Octylphthalate
Acenaphthylene
Acenaphthene
Aniline
4-Chloroaniline
2-Nitronaniline
3-Nitroaniline
4-Nitroaniline
Anthracene
Benzo(a) anthracene
Dibenzo(a,h) anthracene
3,3-Dichlorobenzidene
1,2-Dichlorobezene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,2,4-Trichlorobenzene
Hexachlorobenzene
Benzyl alcohol
Carbazole
Chrysene
n-nitro-di-phenylamine
n-nitroso-di-n-Propylamine
Hexachloroethane
Bis(2-chloroethyl) ether
Bis(2-chloroisopropyl) ether
4-Bromophenyl-phenylether
4-Chlorophenyl-phenylether
Fluoranthene
Fluorene
Benzo(beta) fluoranthene
Benzo(kappa) fluoranthene
Dibenzofuran
Bis(2-chloroethoxy) methane
Isophorone
Naphthalene
2-Chloronaphthalene
2-Methylnaphthalene
Hexachlorocyclopentadiene
Benzo(g,h,i) perylene
Phenanthrene
di-n-Butylphthalate
Diethylphthalate
Dimethylphthalate
Pyrene
Bis (2-ethylhexyl) phthalate
Butylbenzyl-phthalate
Benzo (alpha) pyrene
Indeno (1,2,3-c,d) pyrene
1,2-Diphenylhydrazine
Hexachlorobutadiene
2,4-dinitrotoluene
2,6-dinitrotoluene

General Chemistry

Total Organic Carbon
Acid Volatile Sulfide
Ammonia - N
Percent Moisture
Percent Total Solids

Volatile Organics

Acetone
Benzene
Chlorobenzene
Ethylbenzene
2-Butanone (MEK)
Carbon disulfide
Chloroethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1-Dichloroethylene
1,2-Dichloroethylene
trichloroethylene
2-Hexanone
Bromomethane
Tribromomethane (Bromoform)
Bromodichloromethane
Dibromochloromethane
Dichloromethane (Methylene Chloride)
Xylene (Total)
Trichloromethane (Chloroform)
Tetrachloromethane
4-methyl-2-Pentanone
1,2-Dichloropopane
cis-1,3-Dichloropropylene
trans-1,3-Dichloropropylene
Styrene
Toluene
Vinyl acetate
Vinyl Chloride
Fuel oil
Gasoline

Region 5 went on to recommend that the lakes selected for monitoring would be prioritized on the basis of intensity of public recreational use of the lake, ecological impact and potential threat to human health. Using this guidance, the Indiana Clean Lakes Program contract manager selected 25 sampling locations for 28 samples from the watersheds of 5 northern Indiana lakes in 1992. These lakes were: Center Lake, Palestine Lake and Winona Lake in Kosciusko County; Henderson Lake in Noble County; and Lake Manitou in Fulton County. These lakes were also sampled in the 1985 to 1989 period.

A comparison of lake sediment results from 1992 and 1985-1989 sampling efforts on these waterbodies is shown in Table 23.

Lake Information and Assessment

Indiana has approximately 575 public lakes and reservoirs that have a combined surface area of about 106,203 acres. Three of these are reservoirs over 5,000 acres in size with a combined surface area of 24,890 acres. Although all of these water bodies are important and must be protected, Indiana's 404 public, natural lakes are irreplaceable resources and are in need of exceptional protection.

Although scientific investigations of some of Indiana's lakes were begun prior to the turn of the century, probably less than 100 had been studied prior to 1970. At that time the state recognized the need to generate physical, chemical and biological data from all of its public lakes and reservoirs that could be organized into a system that would permit the comparison of one lake to the next and the prioritization of them according to their need for protection and/or renovation. By the mid-1970's essentially every public lake and reservoir in the State had been surveyed and classified according to its tropic nature.

Although there have been a number of lake classification schemes developed over the years, those most universally used are based on nutrient concentrations and the associated level of productivity. An oligotrophic lake is one with low levels of nutrients and primary production. A eutrophic lake is rich in nutrients and is highly productive. The term meso-trophic has been applied to lakes of moderate productivity.

The level of nutrients (and consequently the level of productivity) can fluctuate to some extent from season to season and from year to year. For this reason there is no sharp line of demarcation between the different classes. In fact, some systems use the terms meso-oligotrophic and meso-eutrophic to describe lakes which are not clearly in one of the three basic classifications.

Table 23: *Comparison of lake sediment contaminants from the 1985-1989 and 1992 sample data*

WATERBODY	*YEAR OF SAMPLING*	*CONTAMINANTS DETECTED*
		Metals
Center Lake	1987	Copper
	1992	Copper
Henderson Lake	1987	Antimony, Cadmium, Copper, Lead,Mercury, Nickel, Silver
	1992	Antimony, Cadmium, Copper, Lead, Selenium, Silver, Zinc
Lake Manitou	1987	n/d*
	1992	Selenium
Palestine Lake	1985	Cadmium, Chromium, Copper, Selenium, Zinc
	1992	Antimony, Cadmium, Chromium, Copper, Selenium, Zinc
Williamson Ditch	1992	Cadmium and Zinc
Winona Lake	1987	Copper, Lead, Nickel, Silver, Zinc
	1989	Antimony, Cadmium, Selenium, Zinc
	1992	Antimony, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Zinc
		Pesticides
Center Lake	1987	o,p'DDD and o,p'-DDT
	1992	p,p'-DDD, p,p'-DDE, alpha BHC, and Heptachlor epoxide
Henderson Lake	1987	n/d
	1992	n/d
Lake Manitou	1987	Hexachlorobenzene
	1992	n/d
Palestine Lake	1985	n/d
	1992	gamma BHC (Lindane)
Williamson Ditch	1992	n/d
Winona Lake	1987	Hexachlorobenzene
	1989	p,p'-DDD, p,p'-DDE, alpha Chlordane, gamma Chlordane, cis Nonachlor, and Endosulfan sulfate
	1992	p,p'-DDD, and Endosulfan I
		Polychlorinated Biphenyls
Center Lake	1987	n/d
	1992	n/d
Henderson Lake	1987	n/d
	1992	n/d
Lake Manitou	1987	n/d
	1992	n/d
Palestine Lake	1985	Aroclor-1254
	1992	n/d
Williamson Ditch	1992	n/d

Table 23: *Comparison of lake sediment contaminants from the 1985-1989 and 1992 sample data (cont.)*

WATERBODY	*YEAR OF SAMPLING*	*CONTAMINANTS DETECTED*
Winona Lake	1987	n/d
	1989	Aroclor-1242, Aroclor-1254, and Aroclor-1260
	1992	n/d
		Volatiles
Center Lake	1987	Carbon disulfide and Tetrachloroethylene
	1992	n/d
Henderson Lake	1987	Carbon disulfide and Tetrachloroethylene
	1992	n/d
Lake Manitou	1987	Tetrachloroethylene
	1992	n/d
Palestine Lake	1985	n/d
	1992	n/d
Williamson Ditch	1992	n/d
Winona Lake	1987	Carbon disulfide, Tetrachloroethylene and Xylene
	1989	Benzene, Carbon disulfide and Dichloromethane
	1992	Dichloromethane
		Acid Extractables
Center Lake	1987	n/d
	1992	n/d
Henderson Lake	1987	n/d
	1992	n/d
Lake Manitou	1987	n/d
	1992	n/d
Palestine Lake	1985	n/d
	1992	n/d
Williamson Ditch	1992	n/d
Winona Lake	1987	2-Methylphenol
	1989	2,4-Dimethylphenol
	1992	n/d
		Base/Neutral Extractables
Center Lake	1987	Acenaphthylene, Anthracene, Benzo(a) anthracene, Chrysene, Fluoranthene, Phenanthrenee, Bis(2-ethylhexyl) phthalate, di-n-Butylphthalate, and Pyrene
	1992	Bis(2 ethylhexyl) phthalate
Henderson Lake	1987	Anthracene, Benzo(a) anthracene, Chrysene, Fluoranthene, Phenanthrene, Bix(2-ethylhexyl) phthalate, di-n-Butylphthalate, Pyrene, and Dimethylphthalate
	1992	Acenaphthylene, Anthracene, Chrysene, Fluoranthene, Phenanthrene, and Pyrene

Table 23: *Comparison of lake sediment contaminants from the 1985-1989 and 1992 sample data (cont.)*

WATERBODY	*YEAR OF SAMPLING*	*CONTAMINANTS DETECTED*
Lake Manitou	1987	Bix(2-ethylhexyl) phthalate and di-n-Butylphthalate
	1992	n/d
Palestine Lake	1985	n/d
	1992	n/d
Williamson Ditch	1992	n/d
Winona Lake	1987	Acenaphthene, Anthracene, Benxo(a) anthracene, Chrysene, n-Nitroso-diphenylamine, Fluoranthene, Benzo(beta) fluoranthene, Benzo(kappa) fluoranthene, Dibenzofuran, 2-Methylnaphthalene, Phenanthrene, di-n-Butylphthalate, Bix(2-ethylhexyl) phthalate, Pyrene, and Benzo(a) pyrene
	1989	Benzo(a) anthracene, Chrysene, Fluoranthene, Benzo(beta) fluoranthene, Benzo(g,h,i) perylene, Phenanthrene, di-n-Butylphthalate, Dimethylphthalate, Bis(2-ethylhexyl) phthalate, Pyrene, Benzo(a) pyrene, and Indeno(1,2,3-c,d) pyrene
	1992	Fluoranthene and 2-Methylnaphthalene

*n/d - Not determined due to either: below the laboratory detection limits, possible blank contamination during analysis or contaminants not present in the sample.

The **Indiana Lake Classification System and Management Plan** of the Indiana Department of Environmental Management (1986) describes the system used to classify Indiana lakes and reservoirs and places each in one of seven basic management groups and one of four trophic classes. In the classical sense, there are probably no lakes in Indiana which would be considered truly oligotrophic and only about 20% of the lakes and reservoirs would be considered either meso-oligotrophic or meso-trophic. The rest are either meso-eutrophic or eutrophic.

IDEM's Indiana Clean Lakes Program monitored water quality on a total of 151 Indiana lakes during 1992-1993. Staff and graduate students at Indiana University's School of Public and Environmental Affairs (SPEA) in Bloomington collected and analyzed the samples. Sampling consisted of a single set of water samples from each lake taken from the deepest basin during stratification in July and August. Sampling at that time facilitated comparison to past results and represented worst-case water quality conditions.

Analysis of water samples for chemical parameters was completed at the SPEA laboratory in Bloomington using methods outlined in *Standard Methods for the Examination of Water and Wastewater* (APHA, 1992). Dissolved oxygen, pH and water clarity values were determined in situ, and plankton counts were completed using a Sedgewick-Rafter counting cell as recommended by *Standard Methods*. Data collected for all lakes sampled are given in Table 24.

Water quality data were used to classify the lakes into three categories using the Indiana Trophic State Index (TSI) (Table 25). The Indiana TSI assigns eutrophy points for different concentrations of ten common water quality parameters. The total of all of these points for a particular lake is that lake's TSI. The potential TSI range is 0 (oligotrophic) to 75 (hypereutrophic) points. Class I lakes have the highest water quality and score between 0-25 points on the eutrophication index. They are generally meso-oligotrphic or mesoptrophic and rarely support concentrations of algae or rooted plants that interfere with any use. The chemical control of vegetation in these lakes is seldom necessary but may be initiated to eliminate shoreline weeds or shallow water weed beds that may be an inconvenience to a few property owners.

Class II lakes have intermediate water quality and score from 26-50 points. These lakes and reservoirs would generally be considered mesoeutrophic. They are often noticeably affected by cultural eutrophication but tropic changes are often subtle. Class II lakes and reservoirs would frequently support moderate growths of weeds and/or algae if not controlled chemically, but seldom to the extent that one or more uses would be threatened. Exceptions would include Class II lakes and reservoirs that received or have received direct wastewater discharges.

Table 24. *Lake water quality data: 1992-93*

LAKE	COUNTY	YEAR SAMPLE	LAKE AREA (a)	NO3 (ppm)	NH3 (ppm)	Org-N (ppm)	SRP (ppm)	Tot-P (ppm)	pH	%DO Sat.	%DO Oxic	Secch (m)	3 ft. Trans. (%)
Adams	Lagrange	1993	308	0.43	0.02	0.44	0.01	0.03	7.85	105.0	65.7	2.3	63
Appleman	Lagrange	1993	52	0/.02	0.31	1.28	0.09	0.20	7.60	71.0	41.1	1.2	23
Atwood	Lagrange	1993	170	0.10	0.29	0.53	0.00	0.04	7.90	100.0	55.6	1.8	58
Ball	Steuben	1992	87	1.54	0.47	0.35	0.04	0.11	7.35	101.4	52.9	1.2	19
Barton	Steuben	1992	94	0.57	0.41	0/53	0/01	0.01	7.35	99.1	87.9	2.8	50
Bass	Steuben	1992	61	0.79	0.03	0.44	0.01	0.03	8.03	111.6	100.0	4.2	47
Beanblossom	Monroe	1992	17	0.06	0.02	0.53	0.01	0.05	6.55	68.3	100.0	1.9	55
Bear	Noble	1993	136	0.03	0.86	1.52	0.17	0.20	7.90	106.0	30.3	1.5	31
Bear Creek	Brown	1992	7	0.07	0.02	0.49	0.01	0.04	7.10	96.8	100.0	3.3	57
Beaver Dam	Steuben	1992	11	0.69	0.09	0.29	0.00	0.02	8.10	95.0	95.9	2.4	35
Beck	Noble	1993	10	0.02	0.02	5.03	0.01	0.16	7.60	99.-	80.0	2.5	42
Bell	Steuben	1992	38	0.09	0.06	0.54	0.01	0.02	7.40	105.0	100.0	3.6	45
Big Long	Lagrange	1993	388	0.14	0.17	0.36	0.09	0.11	8.00	100.0	72.0	2.9	59
Big Otter	Steuben	1992	69	1.42	0.69	0.96	0.02	0.05	7.75	100.0	49.6	2.9	48
Big Turkey	Lagrange	1992	450	1.24	1.15	0.31	0.07	0.09	7.93	121.0	20.8	1.2	19
Bixler	Noble	1993	120	0.02	1.36	1.72	0.42	0.45	8.05	107.0	50.0	1.8	37
Blackman	Lagrange	1993	67	0.07	0.55	0.70	0.11	0.15	8.05	98.0	50.0	4.3	75
Bower	Steuben	1992	25	3.15	0.46	1.11	0.00	0.08	7.50	85.8	66.7	0.9	21
Brazil Water Works	Clay	1992	15	1/13	3.43	2.84	0.98	1.43	7.75	4.7	34.5	0.4	2
Brokesha	Lagrange	1993	36	0.05	0.03	0.35	0.01	0.02	7.75	91.0	82.0	3.3	54
Bryants Creek	Monroe	1992	9	0.07	0.03	0.64	0.01	0.05	7.25	92.7	88.9	3.6	58
Buck	Lagrange	1993	18	1.95	0.15	0.36	0.02	0.13	7.75	112.0	83.3	1.3	16
Buck	Steuben	1992	20	0.39	1.24	1.53	0.10	0.15	6.95	99.5	48.0	2.5	55
Cass	Lagrange	1993	89	0.21	0.22	0.61	0.01	0.03	8.00	100.0	78.1	3.1	63
Cedar	Lagrange	1993	120	1.54	0.17	0.32	0.00	0.09	7.90	98.0	85.4	2.4	42
Center	Steuben	1992	46	4.31	0.23	7.40	0.32	0.49	7.50	39.4	25.9	0.4	2
Charles	Steuben	1992	150	1.11	0.04	1.08	0.01	0.19	8.60	97.9	82.0	0.8	11
Cherry	Monroe	1993	4	0.02	0.62	0.23	0.01	0.04	6.85	67.0	100.0	1.7	31

Table 24. *Lake water quality data: 1992-93 (cont.)*

LAKE	COUNTY	YEAR SAMPLE	LAKE AREA (a)	NO3 (ppm)	NH3 (ppm)	Org-N (ppm)	SRP (ppm)	Tot-P (ppm)	pH	%DO Sat.	%DO Oxic	Secch (m)	3 ft. Trans. (%)
Clear	Steuben	1992	800	0.21	0.08	0.82	0.01	0.02	8.00	32.3	100.0	3.3	40
Cree	Noble	1993	58	0.16	0.34	3.61	0.03	0.16	7.20	101.0	63.3	3.7	45
Crooked	Steuben	1992	828	0.62	0.49	1.40	0.07	0.09	7.70	98.6	52.6	4.3	55
Crooked Creek	Brown	1993	13	0.02	0.23	0.25	0.03	0.07	7.00	116.0	100.0	2.1	51
Crosley	Jennings	1992	14	0.06	0.15	1.26	0.03	0.02	7.50	126.8	49.2	1.6	44
Cypress	Jackson	1992	200	0.29	0.16	1.94	0.03	0.12	7.00	70.3	100.0	0.8	12
Dallas	Lagrange	1993	283	0.32	0.47	0.44	0.13	0.13	7.75	100.0	78.6	2.1	53
Deep	Steuben	1992	12	0.34	0.15	0.81	0.01	0.05	7.93	115.6	100.0	1.2	34
Deer	Noble	1993	36	0.12	1.01	0.67	0.33	0.30	7.49	128.0	46.9	0.6	28
Diamond	Noble	1993	105	0.27	0.38	1.33	0.02	0.04	8.10	105.0	25.0	1.6	37
Duely	Noble	1993	21	0.37	0.56	1.06	0.00	0.10	7.75	91.0	52.7	1.5	24
Eagle	Noble	1993	81	0.09	1.10	0.77	0.17	0.20	8.00	117.0	25.8	1.0	48
Emma	Lagrange	1993	42	0.31	0.98	0.41	0.20	0.23	7.95	119.0	41.0	2.6	55
Engle	Noble	1993	48	0.03	0.64	1.17	0.01	0.03	7.75	100.0	56.8	3.0	33
Failing	Steuben	1992	20	0.66	0.61	0.29	0.07	0.07	7.73	98.1	64.3	4.6	54
Fennel	Lagrange	1993	17	0.02	0.26	1.30	0.02	0.16	7.55	86.0	33.9	2.7	33
Fish	Elkhart	1993	34	0.06	0.12	1.43	0.44	0.56	7.70	108.0	20.6	1.2	28
Fish	Steuben	1992	59	0.23	1.51	1.67	0.21	0.28	7.05	90.9	36,6	2.2	33
Fish (Plato)	Lagrange	1993	100	1.41	0.04	0.62	0.08	0.09	7.90	108.0	80.9	1.9	35
Fish (Scott)	Lagrange	1993	139	0.23	0.23	1.43	0.09	0.12	7.75	82.0	56.3	1.3	24
Fowler Park	Vigo	1992	50	2.30	0.27	0.80	0.02	0.06	7.75	70.3	76.9	2.6	40
Fox	Steuben	1992	140	0.61	0.69	0.40	0.05	0.03	7.25	97.9	34.5	2.7	57
Gage	Steuben	1992	327	0.75	0.66	1.06	0.01	0.03	7.70	95.9	70.0	4.7	45
George	Steuben	1992	509	0.52	0.18	0.45	0.01	0.03	7.60	99.2	88.2	2.8	50
Gilbert	Noble	1993	28	0.02	0.85	0.42	0.01	0.02	7.83	95.0	72.7	5.3	70
Golden	Steuben	1992	119	2.03	1.56	0.48	0.13	0.17	7.80	147.4	35.3	0.8	15
Gooseneck	Steuben	1992	25	0.99	0.60	0.22	0.01	0.03	7.83	108.3	70.8	1.4	47
Gordy	Noble	1993	31	0.03	1.45	1.98	0.04	1.27	7.50	86.0	57.1	3.2	44

Table 24. *Lake water quality data: 1992-93 (cont.)*

LAKE	COUNTY	YEAR SAMPLE	LAKE AREA (a)	NO3 (ppm)	NH3 (ppm)	Org-N (ppm)	SRP (ppm)	Tot-P (ppm)	pH	%DO Sat.	%DO Oxic	Secch (m)	3 ft. Trans. (%)
Gravel	Steuben	1992	12	2.30	2.16	0.35	0.30	0.36	8.35	220.4	47.6	1.6	33
Gravel Pit	Steuben	1992	38	0.68	0.06	0.36	0.00	0.04	8.48	130.7	100.0	6.1	50
Green	Lagrange	1993	62	0.03	0.03	0.39	0.00	0.12	8.10	99.0	100.0	2.3	56
Greensburg SFA	Decatur	1993	23	0.02	0.06	2.09	0.22	0.57	9.00	4.0	41.7	0.5	6.3
Hackenberg	Lagrange	1993	42	0.13	1.04	0.53	0.25	0.28	7.80	85.0	43.1	2.4	47
Hall	Noble	1993	10	0.02	0.02	1.49	0.00	0.05	7.90	97.0	100.0	2.0	42
Hamilton	Steuben	1992	802	0.17	0.50	0.17	0.17	0.22	7.40	98.4	33.8	1.2	30
Handy	Steuben	1992	16	0.13	0.26	0.63	0.04	0.07	7.15	92.1	62.5	3.5	48
Harper	Noble	1993	11	0.25	2.28	0.52	0.02	0.09	7.68	107.0	68.5	3.3	56
Hayward	Lagrange	1993	6	0.11	2.69	2.80	0.27	0.47	7.95	1.0	22.2	0.1	0
Henderson	Noble	1993	22	2.92	0.25	1.61	0.00	0.15	7.95	164.0	100.0	0.5	8
Henry	Steuben	1992	20	1.54	0.05	0.75	0.02	0.06	7.83	164.7	86.2	0.9	20
High	Noble	1993	123	0.02	0.17	1.14	0.01	0.05	8.10	93.0	24.4	0.7	8
Hindman	Noble	1993	13	0.86	0.59	1.01	0.00	0.07	7.85	135.0	51.7	1.9	52
Hog	Steuben	1992	48	0.52	0.46	0.42	0.01	0.02	7.25	102.7	65.8	2.7	51
Hogback	Steuben	1992	146	2.41	2.48	0.22	0.29	0.32	8.35	163.6	54.6	0.8	12
Horseshoe	Noble	1993	18	0.83	0.72	1.03	0.00	0.02	7.40	92.0	65..6	2.2	44
Howard	Steuben	1992	27	0.22	0.03	0.29	0.01	0.03	8.08	130.2	100.0	2.7	45
Hunter	Elkhart	1993	99	0.03	0.75	0.29	0.01	0.02	7.90	98.0	85.7	2.7	53
James	Steuben	1992	1034	0.93	0.16	0.84	0.00	0.05	8.05	94.4	91.6	3.6	57
Jimmerson	Steuben	1992	283	0.67	0.24	1.10	0.00	0.03	7.80	96.8	58.8	3.9	60
Jones	Noble	1993	115	0.02	0.71	3.11	0.22	0.33	8.05	101.0	66.7	1.0	28
Knapp	Noble	1993	88	1.28	1.31	0.23	0.36	0.32	7.50	96.0	22.2	1.7	45
Koontz	Marshall	1993	346	0.02	0.03	0.47	0.00	0.02	8.00	111.0	65.8	1.2	26
Lake Pleasant	Steuben	1992	424	0.35	0.45	0.26	0.01	0.02	7.70	106.2	52.6	1.9	20
Latta	Noble	1993	42	0.02	1.44	0.46	0.26	0.46	7.85	97.0	63.6	4.1	80
Lime (Gage)	Steuben	1992	30	0.23	0.21	0.80	0.00	0.04	7.55	89.1	82.2	4.0	52
Lime (Orland)	Steuben	1992	30	3.29	0.24	0.33	0.01	0.03	7.88	102.3	100.0	3.2	60

Table 24. *Lake water quality data: 1992-93 (cont.)*

LAKE	COUNTY	YEAR SAMPLE	LAKE AREA (a)	NO3 (ppm)	NH3 (ppm)	Org-N (ppm)	SRP (ppm)	Tot-P (ppm)	pH	%DO Sat.	%DO Oxic	Secch (m)	3 ft. Trans. (%)
Limekiln	Steuben	1992	25	1.86	1.67	0.19	0.00	0.08	8.08	92.4	100.0	1.2	22
Little Bower	Steuben	1992	15	4.21	0.69	1.06	0.04	0.13	7.33	71.1	59.7	1.1	7
Little Long	Noble	1993	71	0.02	1.72	0.99	0.17	0.17	7.75	09.0	25.6	1.5	73
Little Otter	Steuben	1992	34	1.13	1.96	1.07	0.14	0.10	8.00	106.0	56.6	2.0	30
Little Turkey	Lagrange	1993	135	0.19	1.38	0.67	0.27	0.32	7.85	110.0	37.4	1.1	32
Little Turkey	Steuben	1992	58	3.35	1.78	0.31	0.25	0.37	7.45	128.1	38.0	0.9	7
Lk of the Wds	Lagrange	1992	136	1.60	0.06	0.45	0.00	0.02	8.40	128.3	32.0	1.0	57
Long (Clear)	Steuben	1992	154	0.35	1.51	0.13	0.16	0.21	7.23	95.6	56.2	3.0	43
Long (Pleasant)	Steuben	1992	92	2.86	0.21	1.29	0.00	0.36	7.85	112.2	69.0	0.7	7
Loon	Steuben	1992	138	0.71	0.22	1.42	0.00	0.04	7.66	97.1	72.7	2.3	60
Manitou	Fulton	1993	13	0.02	1.57	1.78	0.33	0.35	7.85	104.0	42.9	1.1	25
Marsh	Steuben	1992	56	1.07	0.69	0.19	0.02	0.03	8.20	135.2	35.3	2.2	27
Martin	Lagrange	1993	26	1.20	0.26	0.24	0.00	0.18	7.70	104.0	65.5	3.8	49
Mateer	Lagrange	1993	18	0.03	0.03	0.87	0.00	0.01	7.90	88.0	80.0	3.9	48
Maxinkuckee	Marshall	1993	1864	0.02	0.55	0.36	0.00	0.01	7.90	105.0	40.0	2.2	55
McClish	Steuben	1992	35	0.51	1.01	0.13	0.13	0.16	7.55	164.9	41.8	1.6	50
Meserve	Steuben	1992	16	1.47	0.07	0.57	0.00	0.05	7.82	115.1	100.0	3.3	41
Messick	Lagrange	1993	68	0.21	0.66	0.28	0.17	0.17	7.55	90.0	100.0	2.0	52
Mirror	Noble	1993	7	0.02	0.40	6.09	0.17	0.40	7.60	86.0	76.9	3.3	62
Mirror	Steuben	1992	9	0.13	0.27	0.61	0.01	0.10	7.38	73.4	71.8	2.9	44
Mongo	Lagrange	1993	24	0.98	0.06	0.76	0.01	0.06	7.88	74.0	100.0	1.1	19
Moss	Noble	1993	9	0.89	0.60	1.25	0.00	0.08	7.80	96.0	54.4	1.9	52
Mud (Orland)	Steuben	1992	25	0.49	0.04	0.44	0.00	0.03	7.88	115.4	100.0	2.5	41
Mud (Rock)	Steuben	1992	16	10.18	0.47	1.08	0.10	0.17	7.03	31.2	73.0	0.4	5
Nasby MP	Lagrange	1993	35	0.88	0.05	0.24	0.01	0.08	7.70	74.0	100.0	1.1	20
Nauvoo	Lagrange	1993	38	0.02	0.68	0.61	0.12	0.16	8.15	120.0	36.6	0.9	23
North Twin	Lagrange	1993	135	0.29	0.29	0.51	0.00	0.01	7.90	92.0	80.4	1.8	52
Ogle	Brown	1992	20	0.13	0.02	n/a	0.01	0.08	7.10	107.9	70.3	3.5	47

Table 24. *Lake water quality data: 1992-93 (cont.)*

LAKE	COUNTY	YEAR SAMPLE	LAKE AREA (a)	NO3 (ppm)	NH3 (ppm)	Org-N (ppm)	SRP (ppm)	Tot-P (ppm)	pH	%DO Sat.	%DO Oxic	Secch (m)	3 ft. Trans. (%)
Olin	Lagrange	1993	103	1.17	0.12	0.36	0.03	0.03	7.85	89.0	82.0	2.5	56
Oliver	Lagrange	1993	362	0.74	0.08	0.46	0.01	0.01	7.85	91.0	100.0	1.7	53
Ontario MP	Lagrange	1993	38	0.94	0.04	0.44	0.01	0.17	7.90	76.0	100.0	1.0	15
Otter (West)	Steuben	1992	118	0.58	0.20	1.07	0.01	0.05	7.00	115.2	70.6	1.4	37
Pigeon	Steuben	1992	61	2.39	0.83	0.87	0.08	0.08	7.55	102.3	36.4	2.9	28
Pigeon	Lagrange	1993	61	0.45	2.40	0.68	0.08	0.12	7.80	109.0	40.8	1.9	34
Pleasant	Steuben	1992	53	0.29	1.18	0.60	0.03	0.07	7.85	108.4	48.0	2.0	21
Pretty	Lagrange	1993	184	0.05	0.23	0.60	0.05	0.07	8.05	106.0	65.9	3.5	60
Rainbow	Lagrange	1993	16	0.27	1.70	1.33	0.19	0.23	7.75	81.0	17.7	1.0	23
Rider	Noble	1993	5	0.77	0.11	2.23	0.01	0.09	7.70	85.0	66.7	2.4	46
Round	Noble	1993	99	0.02	1.07	1.83	0.17	0.18	7.85	106.0	24.9	1.6	67
Round (Clear)	Steuben	1992	30	0.49	0.10	1.29	0.01	0.03	7.65	98.3	71.4	4.0	55
Royer	Lagrange	1993	69	0.53	0.82	0.58	0.13	0.17	7.85	117.0	25.3	1.4	28
Sacrider	Noble	1993	33	0.17	0.83	0.43	0.26	0.28	7.80	104.0	29.9	0.9	30
Shipshewana	Lagrange	1993	202	0.03	0.03	3.35	0.06	0.34	9.00	123.0	100.0	0.2	0
Shockapee	Noble	1993	21	0.02	1.13	0.93	0.40	0.42	7.80	124.0	26.3	1.7	35
Silver	Steuben	1992	238	0.31	0.36	0.57	0.01	0.05	8.18	102.6	60.3	3.2	60
Skinner	Noble	1993	125	0.33	1.42	0.49	0.39	0.41	7.85	117.0	100.0	0.8	10
Smalley	Noble	1993	69	0.02	1.33	0.68	0.66	0.58	7.59	109.0	27.4	1.3	39
Snow	Steuben	1992	310	1.20	0.58	1.00	0.07	0.02	7.85	90.9	88.0	3.2	65
South Twin	Lagrange	1993	116	0.31	0.30	0.18	0.00	0.06	7.75	100.0	93.8	1.5	62
Sparta	Noble	1993	31	0.02	0.02	1.54	0.00	0.01	8.85	122.0	100.0	1.8	45
Spectacle	Lagrange	1993	6	0.05	0.03	0.80	0.02	0.08	7.30	196.0	83,3	2.3	45
Staynor	Steuben	1992	5	0.54	0.18	0.65	0.01	0.03	8.03	103.6	100.0	3.1	31
Steinbarger	Noble	1993	73	0.79	1.18	0.96	0.24	0.29	7.90	109.0	34.8	2.0	44
Still	Lagrange	1993	30	0.26	0.72	0.59	0.00	0.20	7.90	107.0	100.0	2.7	58
Stone	Lagrange	1993	116	0.61	0.05	0.50	0.01	0.03	8.15	105.0	82.4	3.3	62
Strahl	Brown	1992	6	0.12	0.02	0.38	0.01	n/a	6.60	94.9	100.0	2.7	40

Table 24. *Lake water quality data: 1992-93 (cont.)*

LAKE	COUNTY	YEAR SAMPLE	LAKE AREA (a)	NO3 (ppm)	NH3 (ppm)	Org-N (ppm)	SRP (ppm)	Tot-P (ppm)	pH	%DO Sat.	%DO Oxic	Secch (m)	3 ft. Trans. (%)
Tamarack (Rome)	Noble	1993	50	0.43	0.99	1.06	0.13	0.30	8.05	125.0	36.4	1.3	35
Tamarack (Wol)	Noble	1993	84	0.02	0.61	1.53	0.07	0.27	7.90	97.0	41.1	0.6	17
Village (Indian)	Noble	1993	12	0.57	1.04	1.47	0.00	0.03	7.85	124.0	59.7	1.6	42
Waldron	Noble	1993	216	0.02	1.23	0.56	0.34	0.39	8.00	113.0	29.9	0.8	26
Wall	Lagrange	1992	141	0.30	0.59	0.19	0.00	0.03	8.00	112.9	85.1	3.9	50
Walters	Steuben	1992	53	0.10	0.60	0.67	0.09	0.08	7.25	81.5	52.6	2.8	32
Warner	Steuben	1992	17	0.21	0.34	2.28	0.06	0.15	7.00	80.4	57.1	1.5	20
Westler	Lagrange	1993	88	0.18	0.62	0.34	0.09	0.11	7.88	106.0	100.0	1.6	26
Whirledge	Noble	1993	5	0.03	1.38	1.57	0.01	0.08	7.65	89.0	61.0	2.5	52
Wible	Noble	1993	49	0.03	1.63	1.26	0.32	0.40	7.98	83.0	41.1	0.6	22
Witmer	Lagrange	1993	204	0.25	0.41	0.45	0.11	0.18	7.85	98.0	100.0	1.2	34
Yellowwood	Brown	1992	133	0.13	0.02	0.38	0.01	0.06	7.15	97.3	100.0	4.3	44

(a) = Acres

Table 25. *Calculation of the IDEM lake trophic state index*

PARAMETER AND RANGE		EUTROPHY POINTS
I.	**Total Phosphorus (ppm)**	
	A. At least 0.03	1
	B. 0.04 to 0.05	2
	C. 0.06 to 0.19	3
	D. 0.2 to 0.99	4
	E. 1.0 or more	5
II.	**Soluble Phosphorus (ppm)**	
	A. At least 0.03	1
	B. 0.04 to 0.05	2
	C. 0.06 to 0.19	3
	D. 0.2 to 0.99	4
	E. 1.0 or more	5
III.	**Organic Nitrogen (ppm)**	
	A. At least 0.5	1
	B. 0.6 to 0.8	2
	C. 0.9 to 1.9	3
	D. 2.0 or more	4
IV.	**Nitrate (ppm)**	
	A. At least 0.3	1
	B. 0.4 to 0.8	2
	C. 0.9 to 1.9	3
	D. 2.0 or more	4
V.	**Ammonia (ppm)**	
	A. At least 0.3	1
	B. 0.4 to 0.5	2
	C. 0.6 to 0.9	3
	D. 1.0 or more	4

Table 25. *Calculation of the IDEM lake trophic state index (cont.)*

PARAMETER AND RANGE			EUTROPHY POINTS
VI.	**Dissolved Oxygen**		
	Percent Saturation at 5 feet from surface		
	A.	114% or less	0
	B.	115% to 119%	1
	C.	120% to 129%	2
	D.	130% or more	3
	E.	150% or more	4
VII.	**Dissolved Oxygen**		
	Percent of measured water column with at least 0.1 ppm dissolved oxygen		
	A.	28% or less	4
	B.	29% to 49%	3
	C.	50% to 65%	1
	D.	66% to 75%	1
	E.	76% to 100%	0
VIII.	**Light Penetration (Secchi Disk)**		
	A.	Five feet or under	6
IX.	**Light Transmission (Photocell)**		
	Percent of light transmission at a depth of 3 feet		
	A.	0 to 30%	4
	B.	31% to 50%	3
	C.	51% to 70%	2
	D.	71% and up	0

Table 25. *Calculation of the IDEM lake trophic state index (cont.)*

PARAMETER AND RANGE		EUTROPHY POINTS
X.	**Total Plankton per liter of water sampled from a single vertical tow between the 1% light level and the surface**	
	A. Less than 3,000 organisms/L	0
	B. 3,000 - 6,000 organisms/L	1
	C. 6,001 - 16,000 organisms/L	2
	D. 16,001 - 26,000 organisms/L	3
	E. 26,001 - 36,000 organisms/L	4
	F. 36,001 - 60,000 organisms/L	5
	G. 60,001 - 95,000 organisms/L	10
	H. 95,001 - 150,000 organisms/L	15
	I. 150,001 - 500,000 organisms/L	20
	J. Greater than 500,000 organisms/L	25
	K. Blue-Green Dominance	10 additional points

Lakes with the poorest water quality (51-75 euthrophy points) are listed in Class III. These lakes and reservoirs are considered eutrophic or in some cases hypereutrophic. Without chemical control programs many of these waterbodies would support extensive weed and/or algal growth during the summer months. Swimming, boating and fishing may be impaired occasionally but seldom precluded. Nuisance blooms of blue-green algae commonly occur in Class III lakes and reservoirs and may persist for much of the warm weather months. In the most highly productive of these water bodies, dissolved oxygen depletion may cause fish kills during extended periods of hot weather or winter kills during periods of ice and snow cover. Waterbodies that are presently receiving direct wastewater discharges or those that have received such discharges in the past generally belong to this class.

A fourth lake class (Class IV) includes remnant and oxbow lakes that are in an advanced state of senescence. Their tropic status depends on lake history and cannot be compared to other lakes using the eutrophiciation index.

They are frequently nearly filled with aquatic weeds and organic sediments and are often well on their way to becoming a swamp, bog, or marsh. Although shallow and weedy, many remnant lakes have excellent water quality. Remnant lakes are often a small open water area surrounded by marsh and other wetlands. Oxbow lakes are shallow, elongate ponds in an old river bed that are formed when a river cuts new channels and leaves them isolated. The water level in an oxbow commonly rises and falls with the level in the main river. The most common uses of Class IV lakes are fishing, hunting, trapping, and wildlife habitat. Other uses are usually precluded in these lakes by their small size, lack of depth, and inaccessibility.

Trophic state ranking results of the 1992 - 1993 survey are presented in Table 26. TSI scores ranged from lows of 4 for Bear Creek Lake in Brown County and Bell Lake in Steuben County to 65 for Hayward Lake in LaGrange County. Several lakes had significant trophic gains or losses when compared to the last state-wide lake survey results from the mid-1970s. Lakes with the largest TSI increases (worsening water quality) since the 1970s were Appleman Lake in LaGrange County (+ 23), Hayward Lake in Lagrange County (+ 22), and Lake of the Woods in LaGrange County (+ 22). Lakes with the largest TSI decreases (improving water quality) were Howard Lake (-53), Staynor Lake (-43), Mud Lake and Loon Lake (-42), all in Steuben County.

For the 1992 - 93 lakes, eighty-six (57%) were in Class I, fifty-five (36%) were in Class II and ten (7%) were in Class III (Table 27, Figure 47). Of the 151 lakes sampled in 1992 - 93, 131 were sampled previously in the mid-1970s and thus allow for comparisons. The mid-1970s values for the same lakes were 31% Class I lakes, 47% Class II lakes and 22% Class III lakes. This trend shows an overall improvement in water quality, with a decreased percentage of Class II and III lakes and an increased percentage of Class I lakes. (Figure 47).

Table 26. *Trophic classification of lakes monitored in 1992 - 93 compared to mid-1970's classification*

LAKE	COUNTY	YEAR SAMPLED	AREA (acres)	TROPHIC PTS (CLASS) (1970's)	TROPHIC PTS (CLASS) (1992-93)	POINT CHANGE
Adams	Lagrange	1993	308	28 (II)	20(I)	-8
Appleman	Lagrange	1993	52	30 (II)	53 (III)	23
Atwood	Lagrange	1993	170	na	18 (I)	na
Ball	Steuben	1992	87	34 (II)	22 (I)	-12
Barton	Steuben	1992	94	32 (II)	10 (I)	-22
Bass	Steuben	1992	61	33 (II)	6 (I)	-27
Beanblossom	Monroe	1992	17	na	5 (1)	na
Bear	Noble	1993	136	46 (II)	37 (II)	-9
Bear Creek	Brown	1992	7	15 (I)	4 (I)	-11
Beaver Dam	Steuben	1992	11	27 (II)	8 (I)	-19
Beck	Noble	1993	10	na	25 (I)	na
Bell	Steuben	1992	38	24 (I)	4 (I)	-20
Big Long	Lagrange	1993	388	33 (II)	11 (I)	-22
Big Otter	Steuben	1992	69	52 (III)	17 (I)	-35
Big Turkey	Lagrange	1992	450	44 (II)	29 (II)	-15
Bixler	Noble	1993	120	38 (II)	23 (I)	-15
Blackman	Lagrange	1993	67	20 (I)	14 (I)	-6
Bower	Steuben	1993	25	66 (III)	33 (II)	-33
Brazil Works	Clay	1992	15	67 (III)	57 (III)	-10
Brokesha	Lagrange	1993	36	11 (I)	14 (I)	3
Bryants Creek	Monroe	1992	9	15 (I)	7 (I)	-8
Buck	Lagrange	1993	18	na	18 (I)	na
Buck	Steuben	1992	20	30 (II)	19 (I)	-11
Cass	Lagrange	1993	89	na	6 (I)	na
Cedar	Lagrange	1993	120	9 (I)	19 (I)	10
Center	Steuben	1992	46	na	44 (II)	na
Charles	Steuben	1992	150	52 (III)	30 (II)	-22

Table 26. *Trophic classification of lakes monitored in 1992 - 93 compared to mid-1970's classification (cont.)*

LAKE	COUNTY	YEAR SAMPLED	AREA (acres)	TROPHIC PTS (CLASS) (1970's)	TROPHIC PTS (CLASS) (1992-93)	POINT CHANGE
Cherry	Monroe	1993	4	15 (I)	10 (I)	-5
Clear	Steuben	1992	800	25 (I)	15 (I)	-10
Cree	Noble	1993	58	39 (II)	17 (I)	-22
Crooked	Steuben	1992	828	23 (I)	19 (I)	-4
Crooked Creek	Brown	1993	13	10 (I)	23 (I)	13
Crosley	Jennings	1992	14	na	na	na
Cypress	Jackson	1992	200	49 (II)	30 (II)	-19
Dallas	Lagrange	1993	283	28 (II)	15 (I)	-13
Deep	Steuben	1992	12	51 (III)	15 (I)	-36
Deer	Noble	1993	36	na	41 (II)	na
Diamond	Noble	1993	105	21 (II)	33 (II)	12
Duely	Noble	1993	21	42 (II)	35 (II)	-7
Eagle	Noble	1993	81	na	39 (II)	na
Emma	Lagrange	1993	42	44 (II)	23 (I)	-21
Engle	Noble	1993	48	26 (II)	13 (I)	-13
Failing	Steuben	1992	20	20 (I)	26 (II)	6
Fennel	Lagrange	1993	17	na	22 (I)	na
Fish	Elkhart	1993	34	35 (II)	59 (II)	15
Fish	Steuben	1992	59	54 (III)	24 (I)	-20
Fish (Plato)	Lagrange	1993	100	39 (II)	26 (II)	-13
Fish (Scott)	Lagrange	1993	139	na	41 (II)	na
Fowler Park	Vigo	1992	50	50 (II)	12 (I)	-38
Fox	Steuben	1992	140	27 (II)	22 (I)	-5
Gage	Steuben	1992	327	8 (I)	13 (I)	5
George	Steuben	1992	509	9 (I)	8 (I)	-1
Gilbert	Noble	1993	28	28 (II)	17 (I)	-11
Golden	Steuben	1992	119	66 (III)	33 (II)	-33

Table 26. *Trophic classification of lakes monitored in 1992 - 93 compared to mid-1970's classification (cont.)*

LAKE	COUNTY	YEAR SAMPLED	AREA (acres)	TROPHIC PTS (CLASS) (1970's)	TROPHIC PTS (CLASS) (1992-93)	POINT CHANGE
Gooseneck	Steuben	1992	25	15 (I)	17 (I)	2
Gordy	Noble	1993	31	43 (II)	39 (II)	-4
Gravel	Steuben	1992	12	19 (II)	39 (II)	20
Gravel Pit	Steuben	1992	28	12 (I)	11 (I)	-1
Green	Lagrange	1993	62	51 (III)	16 (I)	-35
Greensburg SFA	Decatur	1993	23	60 (III)	55 (III)	-5
Hackenberg	Lagrange	1993	42	29 (II)	34 (II)	5
Hall	Noble	1993	10	16 (I)	10 (I)	-6
Hamilton	Steuben	1992	802	31 (II)	37 (II)	6
Handy	Steuben	1992	16	35 (II)	31 (II)	-4
Harper	Noble	1993	11	60 (III)	25 (I)	-35
Hayward	Lagrange	1993	6	43 (II)	65 (III)	22
Henderson	Noble	1993	22	73 (III)	44 (II)	-29
Henry	Steuben	1992	20	38 (II)	36 (II)	-2
High	Noble	1993	123	53 (III)	39 (II)	-14
Hindman	Noble	1993	13	52 (III)	21 (I)	-31
Hog	Steuben	1992	48	na	6 (1)	na
Hogback	Steuben	1992	146	58 (III)	36 (II)	-22
Horseshoe	Noble	1993	18	40 (II)	27 (II)	-13
Howard	Steuben	1992	27	64 (III)	11 (I)	-53
Hunter	Elkhart	1993	99	20 (I)	16 (I)	-4
James	Steuben	1992	1034	22 (I)	10 (I)	-12
Jimmerson	Steuben	1992	283	22 (I)	10 (I)	-12
Jones	Noble	1992	115	na	56 (III)	na
Knapp	Noble	1993	88	43 (II)	34 (II)	-9
Koontz	Marshall	1993	346	42 (II)	24 (I)	-18
Lake Pleasant	Steuben	1992	424	40 (II)	10 (I)	-30

Table 26. *Trophic classification of lakes monitored in 1992 - 93 compared to mid-1970's classification (cont.)*

LAKE	COUNTY	YEAR SAMPLED	AREA (acres)	TROPHIC PTS (CLASS) (1970's)	TROPHIC PTS (CLASS) (1992-93)	POINT CHANGE
Latta	Noble	1993	42	28 (II)	26 (II)	-8-10
Lime (Gage)	Steuben	1992	30	10 (I)	6 (I)	-4
Lime (Orland)	Steuben	1992	30	na	17 (I)	na
Limekiln	Steuben	1992	25	42 (II)	40 (II)	-2
Little Bower	Steuben	1992	15	na	37 (II)	na
Little Long	Noble	1993	71	32 (II)	34 (II)	2
Little Otter	Steuben	1992	34	58 (III)	25 (I)	-33
Little Turkey	Lagrange	1993	135	36 (II)	39 (II)	3
Little Turkey	Steuben	1992	58	na	55 (III)	na
Lk of the Wds	Lagrange	1992	136	18 (I)	40 (II)	22
Long (Clear)	Steuben	1992	154	24 (I)	19 (I)	-5
Long (Pleasant)	Steuben	1992	92	64 (III)	44 (II)	-20
Loon	Steuben	1992	138	53 (III)	11 (I)	-42
Manitou	Fulton	1993	713	48 (II)	41 (II)	-7
Marsh	Steuben	1992	56	65 (III)	36 (II)	-29
Martin	LaGrange	1992	26	35 (II)	13 (I)	-22
Mateer	Lagrange	1993	18	17 (I)	15 (I)	-2
Maxinkuckee	Marshall	1993	1864	18 (I)	17 (I)	-1
McClish	Steuben	1992	35	18 (I)	35 (II)	17
Meserve	Steuben	1992	16	22 (I)	22 (I)	0
Messick	Lagrange	1993	68	26 (II)	22 (I)	-4
Mirror	Noble	1993	7	na	17 (I)	na
Mirror	Steuben	1992	9	19 (I)	11 (I)	-8
Mongo	Lagrange	1993	24	54 (III)	27 (II)	-27
Moss	Noble	1993	9	51 (III)	30 (II)	-21
Mud (Orland)	Steuben	1992	25	48 (III)	6 (I)	-42
Mud (Rock)	Steuben	1992	16	59 (III)	27 (II)	-32

Table 26. *Trophic classification of lakes monitored in 1992 - 93 compared to mid-1970's classification (cont.)*

LAKE	COUNTY	YEAR SAMPLED	AREA (acres)	TROPHIC PTS (CLASS) (1970's)	TROPHIC PTS (CLASS) (1992-93)	POINT CHANGE
Nasby MP	Lagrange	1993	35	41 (II)	28 (II)	-13
Nauvoo	Lagrange	1993	38	50 (II)	46 (II)	-4
North Twin	Lagrange	1993	135	13 (I)	13 (I)	0
Ogle	Brown	1992	20	8 (I)	21 (I)	13
Olin	Lagrange	1993	103	10 (I)	18 (I)	8
Oliver	Lagrange	1993	362	10 (I)	16 (I)	6
Ontario MP	Lagrange	1993	38	na	21 (I)	na
Otter (West)	Steuben	1992	118	35 (II)	19 (I)	-16
Pigeon	Steuben	1992	61	57 (III)	32 (II)	-25
Pigeon	Lagrange	1993	61	26 (II)	25 (I)	-2
Pleasant	Steuben	1992	53	20 (I)	13 (I)	-7
Pretty	Lagrange	1993	184	26 (I)	20 (I)	-5
Rainbow	Lagrange	1993	16	31 (II)	43 (II)	12
Rider	Noble	1993	5	55 (III)	16 (I)	-39
Round	Noble	1993	99	24 (I)	31 (II)	7
Round (Clear)	Steuben	1992	30	23 (I)	12 (I)	-11
Royer	Lagrange	1993	69	26 (II)	31 (II)	5
Sacrider	Noble	1993	33	35 (II)	54 (III)	19
Shipshewana	Lagrange	1993	202	51 (III)	58 (III)	7
Shockapee	Noble	1993	21	30 (II)	27 (II)	-3
Silver	Steuben	1992	238	28 (II)	15 (I)	-13
Skinner	Noble	1993	125	45 (II)	44 (II)	6
Smalley	Noble	1993	69	34 (II)	40 (II)	6
Snow	Steuben	1992	310	20 (I)	15 (I)	-5
South Twin	Lagrange	1993	166	8 (I)	13 (I)	5
Sparta	Noble	1993	31	40 (II)	21 (I)	-19
Spectacle	LaGrange	1993	6	52 (III)	26 (II)	-26

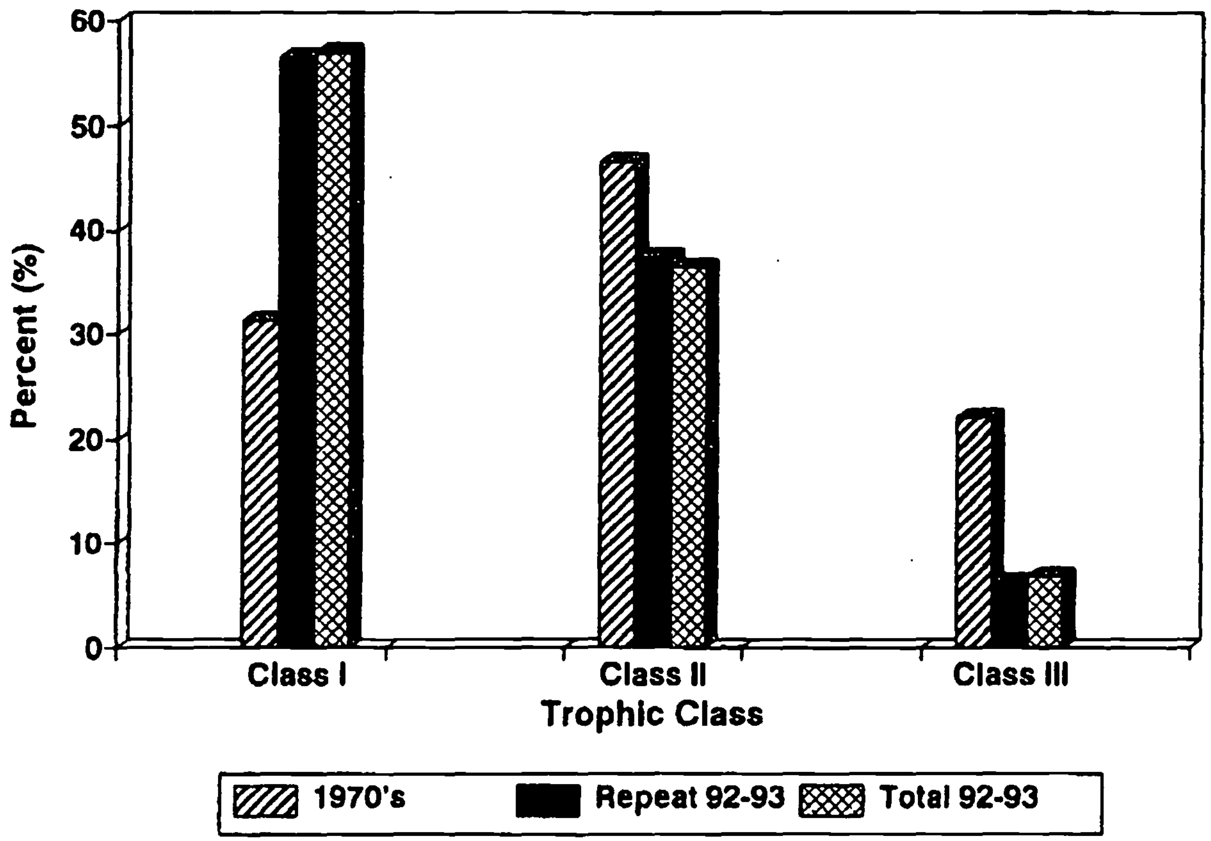
Table 26. *Trophic classification of lakes monitored in 1992 - 93 compared to mid-1970's classification (cont.)*

LAKE	COUNTY	YEAR SAMPLED	AREA (acres)	TROPHIC PTS (CLASS) (1970's)	TROPHIC PTS (CLASS) (1992-93)	POINT CHANGE
Staylor	Steuben	1992	5	51 (III)	8 (I)	-43
Steinbarger	Noble	1993	73	39 (II)	36 (II)	-3
Still	Lagrange	1993	30	19 (I)	10 (I)	-9
Stone	Lagrange	1993	116	2 (I)	17 (I)	15
Strahl	Brown	1992	6	10 (I)	15 (I)	5
Tamarack (Rome)	Noble	1993	50	42 (II)	59 (III)	17
Tamarack (Wol)	Noble	1993	84	na	39 (II)	na
Village (Indian)	Noble	1993	12	59 (III)	51 (III)	-8
Waldron	Noble	1993	216	43 (II)	31 (II)	-12
Wall	Lagrange	1992	141	13 (I)	9 (I)	-4
Walters	Steuben	1992	53	26 (II)	21 (I)	-5
Warner	Steuben	1992	17	30 (II)	28 (II)	-2
Westler	Lagrange	1993	88	25 (I)	18 (I)	-7
Whirledge	Noble	1993	5	na	25 (I)	na
Wible	Noble	1993	49	55 (III)	43 (II)	-12
Witmer	Lagrange	1993	204	27 (II)	27 (II)	0
Yellowwood	Brown	1992	133	10 (I)	8 (I)	-2

Table 27. *Percent in trophic class*

TROPHIC CLASS	TOTAL 1970's	% TOTAL 1970's	REPEAT 1992-93	% REPEAT 1992-93	TOTAL 1992-93	% TOTAL 1992-93
Class 1	41	31.3	74	56.5	86	57.0
Class II	61	46.6	49	37.4	55	36.4
Class III	29	22.1	8	6.1	10	6.6

Figure 47. *Percentage of lakes in each trophic class for 1970's and 1992-93*



Of the 131 lakes sampled both in the mid-1970s and 1992-93, 39% moved to a better trophic class, 6% moved to a worse class and 55% remained in the same class (Table 28, Figure 48). Overall, 22% of the lakes showed an increase in TSI, 76% showed a decrease and 2% had no change (Table 29). The mean TSI change for all lakes between the 1970s and 1992-93 was -9.0. This suggests an overall improvement in lake TSI since the 1970s.

While surveys in past years have concentrated on Indiana's larger lakes, the current sampling protocol includes all public lakes, regardless of size. Of the 151 lakes sampled during this period, 76, (50%) had an area of 50 acres or smaller. Forty-seven lakes (31%) were 25 acres or less.

In the 1992-93 survey, small lakes were generally more productive (higher TSIs) than larger lakes. Lakes less than 25 acres in size had the highest mean TSI (26.7) of all lakes sampled during 1992-93 (Table 30, Figure 49). The largest lakes sampled had the lowest mean TSI (21.0). Lakes with areas between 26-50 acres, 51-100 acres, and 101-500 acres had mean TSIs of 25.3, 25.5, and 23.4, respectively.

Between the 1970s and 1992-93 sampling periods, the mean TSIs for lakes in all size classes decreased. Lakes in the 51-100 acre size class displayed the largest mean decrease, 11.0 points. Lakes less than 25 acres and those in the 26-50 acre class had average decreases of 10.1 and 9.3 points, respectively. Lakes in the largest (greater than 500 acres) and the 101-500 acres classes exhibited smaller decreases of 4.1 and 7.3 points, respectively.

It is also useful to use lake volume as a means of classifying lakes by size (Table 31, Figure 50). Intermediate size lakes with volumes 501-1000 acre-ft. had the highest mean TSI, 39.2 and 29.2, for 1970's and 1992-93, respectively. The largest lakes, with volumes greater than 10,000 acre-ft., had the lowest mean TSI for both surveys with values of 21.4 and 16.6 for 1970's and 1992-93, respectively. The smallest lakes, with volumes less than 250 acre-ft., had the greatest average decrease in TSI (11.6), while the largest lakes had the lowest average TSI decrease (4.8).

The watershed area to lake volume ratio is important when considering nutrient loading to the lake by the watershed. A lake with a large watershed area to lake volume ratio will be influenced by the watershed more (less dilution of runoff) and may be expected to have a higher TSI than a lake with a small ratio if the watershed is the main contributor of nutrients. We calculated watershed area:lake volume ratios (WS/V) for all lakes sampled and divided them into five groups: <0.50, 0.50-1.50, 1.51-3.00, 3.01-10.00, and >10.00. These are designated as WS/V Group Numbers 1, 2, 3, 4, and 5, respectively. For both the 1970's and 1992-93 data, mean TSI increased with increasing watershed area to lake volume ratios (Table 32, Figure 51). Lowest mean TSIs of 23.4 and 15.2 for 1970's and 1992-93, respectively, occurred for lakes with ratios less than 0.5. Lakes with the highest ratio, greater than 10, also had the highest mean TSIs of 45.3 and 31.1 for 1970's and 1992-93, respectively. The greatest decreases in mean TSI, 14.2 and 11.1, occurred for those lakes with the

Table 28. *Overall trophic class trends*

TOTAL SURVEYED	MOVED TO BETTER CLASS	MOVED TO WORSE CLASS	REMAINED IN CLASS
131 100%	51 38.9%	8 6.1%	72 55.0%

Figure 48. *Overall trophic class trends of lakes sampled in 1970's and 1992-93*

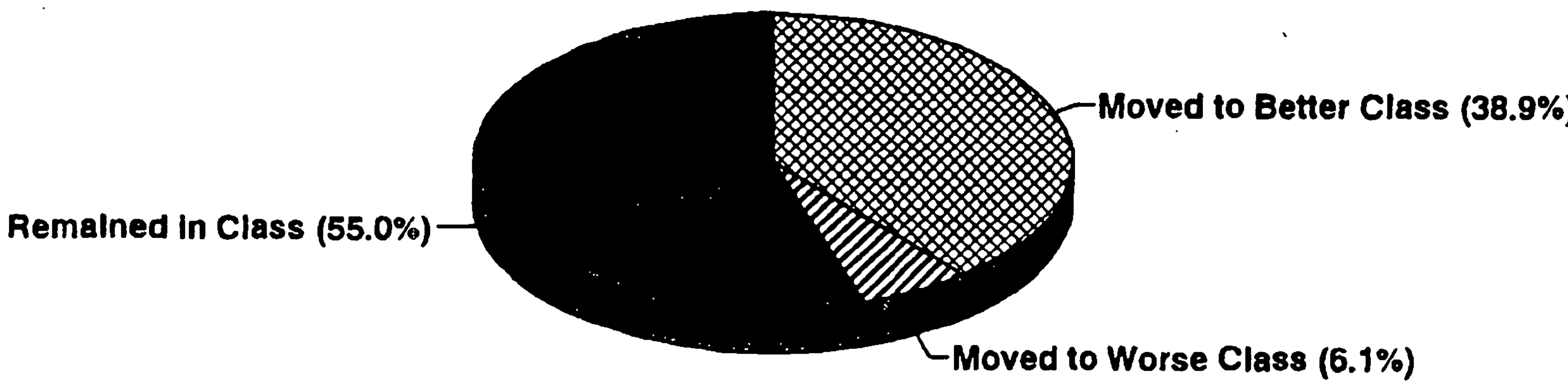


Table 29. *Changes in eutrophy points*

TROPHIC CLASS	NUMBER SURVEYED	EUTROPHY POINTS INCREASED	EUTROPHY POINTS DECREASED	EUTROPHY POINTS UNCHANGED
Class I	75	11 (14.7%)	62 (82.7%)	2 (2.7%)
Class II	48	13 (27.1%)	34 (70.8%)	1 (2.1%)
Class III	8	5 (62.5%)	3 (37.5%)	0 (0%)
Total	131	29 (22.1%)	99 (75.5%)	3 (2.3%)

Table 30. *Lake area by acres vs mean eutrophy points*

LAKE AREA (ACRES)	NUMBER OF LAKES	MEAN EUTROPHY PTS. 1970's	MEAN EUTROPHY PTS. 1992-93	NET POINT CHANGE
0-25	38	36.8	26.7	-10.1
26-50	24	34.5	25.3	-9.3
51-100	25	36.5	25.5	-11
101-500	37	30.7	23.4	-7.3
>500	7	25.2	21.0	-4.1

Figure 49. *Lake area vs. mean eutrophy points*

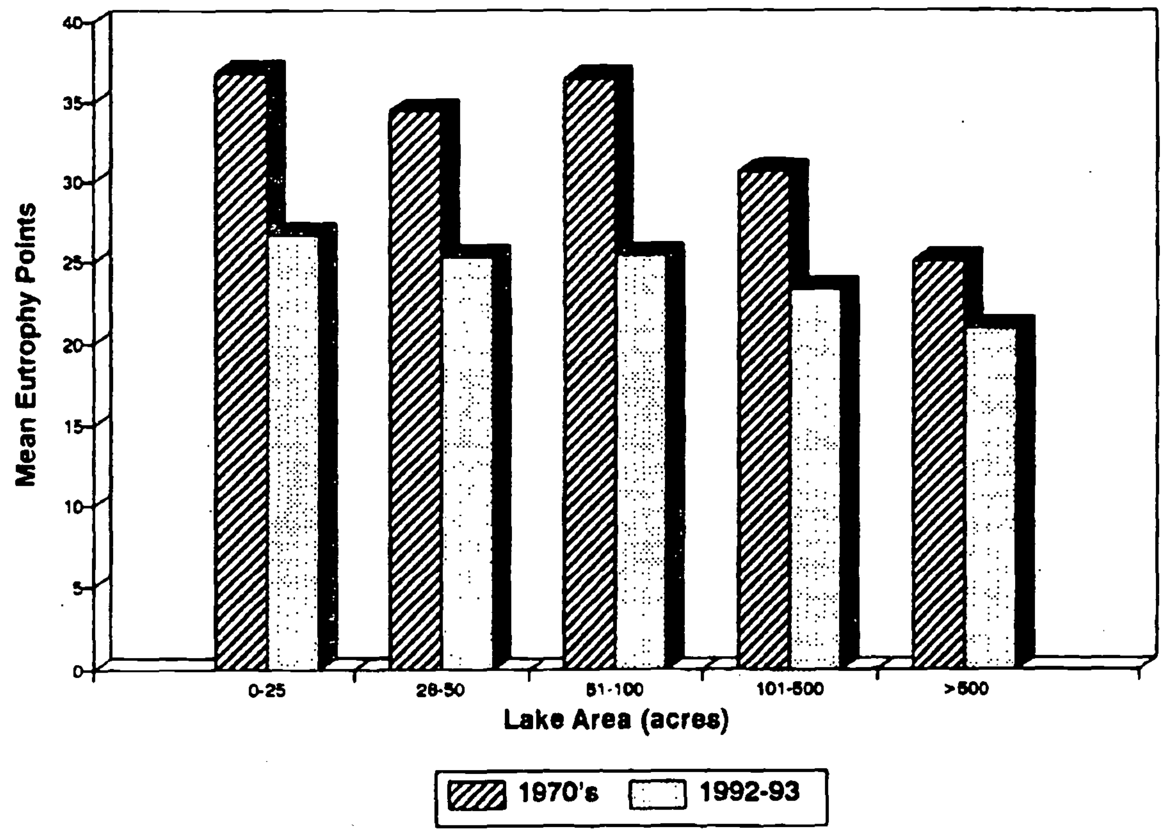


Table 31. *Lake area vs. mean eutrophy points*

LAKE AREA (ACRE FT,)	NUMBER OF LAKES	MEAN EUTROPHY PTS. 1970's	MEAN EUTROPHY PTS. 1992-93	NET POINT CHANGE
0-250	29	36.3	24.8	-11.6
251-500	19	32.5	23.8	-8.7
501-1000	21	39.2	29.2	-10.0
1001-5000	42	33.5	25.7	-7.8
5001-10000	11	28.2	22.0	-6.2
>10,000	8	21.4	16.6	-4.8

Figure 50. *Lake volume vs. mean euthrophy points*

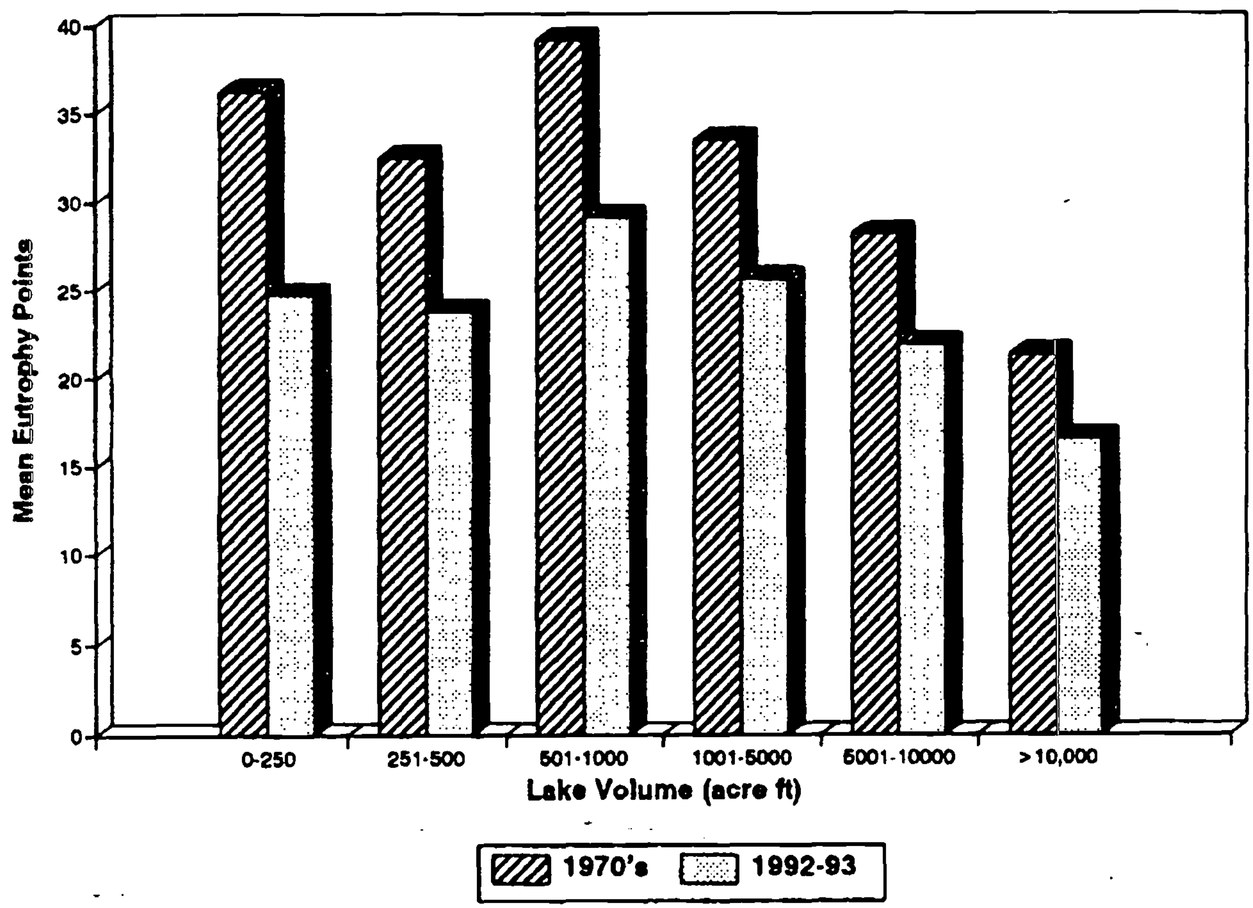
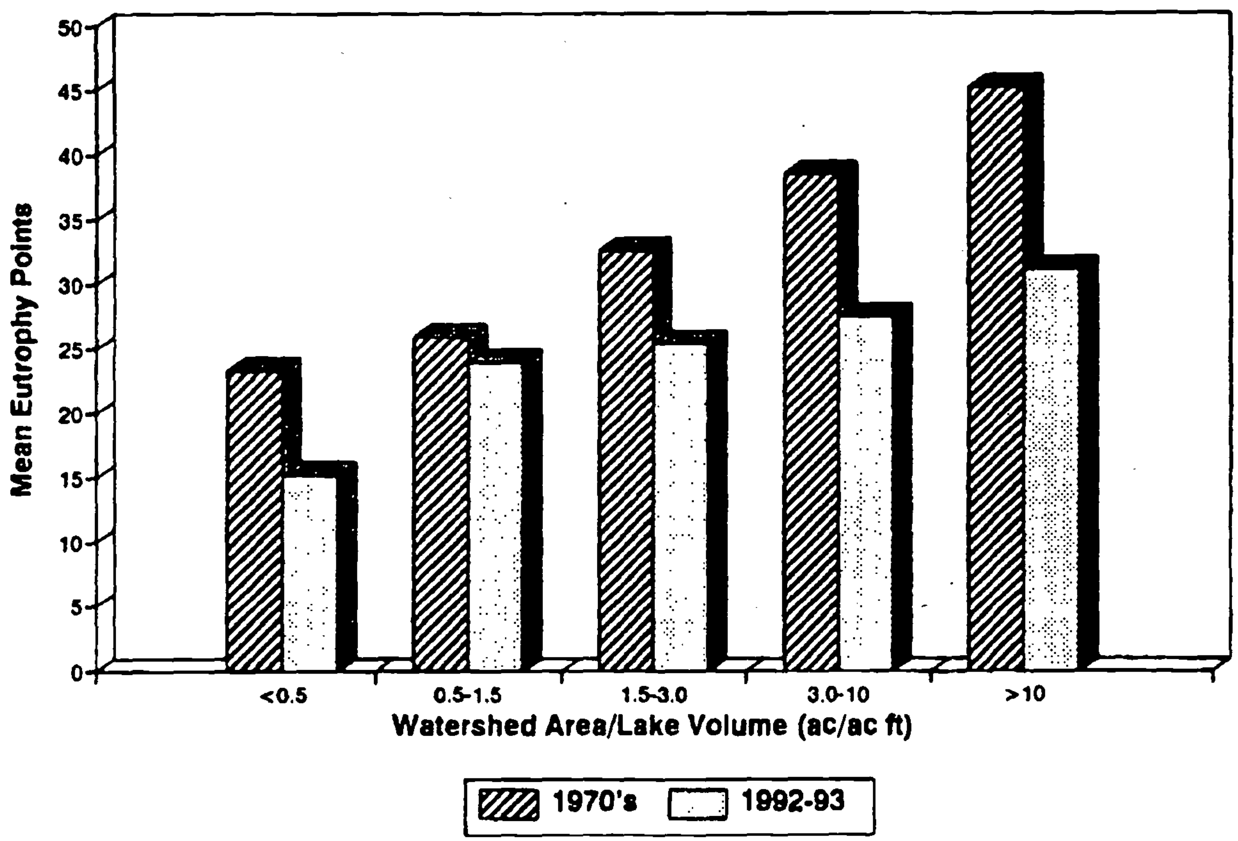


Table 32. *Watershed area/lake volume vs. mean eutrophy points*

WATERSHED AREA PER LAKE VOLUME (ACRE/ACRE FT.)	NUMBER OF LAKES	MEAN EUTROPHY PTS. 1970's	MEAN EUTROPHY PTS. 1992-93	NET POINT CHANGE
>0.5	15	23.4	15.1	-8.2
0.5-1.5	15	26.0	24.0	-2.0
1.5-3.0	13	32.6	25.4	-7.2
3.0-10	12	38.6	27.5	-11.1
>10	15	45.3	31.1	-14.2

Figure 51. *Watershed area/lake volume vs. mean eutrophy points*



largest WS/V ratios, greater than 10 and 3.0-10.0, respectively, perhaps indicating that watershed management programs implemented since the 1970s have been effective.

Statistical analysis was performed to determine the significance of the differences in mean TSI between the 1970's and 1992-93 data for the 5 WS/V groups. The decreases in mean TSIs for WS/V groups 1, 3, 4, and 5 were determined to be significant at the $\alpha = 0.025$ level (Table 33).

T-tests were also performed on neighboring groups using the 1970's data to determine if the difference between groups was significant. Results show that differences between WS/V groups 3-4 and 4-5 are significant at the $x = 0.10$ level (Table 34).

During 1992 and 1993, the Volunteer Lake Monitoring Program marked its fourth and fifth years as part of the Indiana Clean Lakes Program. Each volunteer monitor was equipped and trained to measure Secchi disk transparencies at their lake as a low-cost, high-volume lake monitoring tool. In addition to contributing useful information to assist in monitoring the long-term trends of lake water quality, the Volunteer Lake Monitoring Program also provides information to volunteers about lake science, and helps to promote a sense of direct citizen involvement with lake management issues.

Secchi disk measurements of water transparency can assist in evaluating lake water quality. The transparency of natural waters is decreased by suspended sediments and organic matter, for example algae, in the water column. While the Secchi disk technique alone cannot distinguish among the potential causes of low transparencies, the data suggest that lakes with highly variable transparencies have been affected by sudden, transient events, such as suspended sediment input from individual storm events or by plankton blooms. Management efforts at these lakes may be more successful in identifying and correcting the specific problem causing the low transparencies.

A total of 79 lakes were monitored in 1992 with 517 total observations. The 1993 figures were similar, with 76 lakes monitored and 528 individual observations. Tables 35 and 36 show the results of Secchi disk monitoring for 1992 and 1993. Included are the maximum and minimum Secchi disk measurements, the July-August average transparencies, and the relative state rank for that average for those lakes having at least 4 Secchi disk measurements. The July-August average is considered important because it is taken during summer stratification at a time when water transparency is likely to be at its lowest due to a high concentration of suspended organic and inorganic matter.

Tables 37 and 38 show the yearly distribution of measured Secchi disk transparencies according to four water clarity categories used in the U.S.

Table 33. *Significance of eutrophy point differences between 1992-93 and 1970's*

WATERSHED AREA PER LAKE VOLUME	WS/V GROUP NUMBER	DEGREES OF FREEDOM	CALCULATED T-VALUE	T 0.025
>0.5	1	28	3.0	2.05
0.5-1.5	2	28	0.5	2.05
1.5-3.0	3	24	2.6	2.06
3.0-10	4	22	4.2	2.07
>10	5	28	2.8	2.05

Table 34. *Significance of mean eutrophy points increases between 1970's groups*

WS/V GROUPS COMPARED	DEGREES OF FREEDOM	CALCULATED T-VALUE	T 0.10
1-2	28	0.5	1.31
2-3	26	1.2	1.31
3-4	23	1.5	1.32
4-5	25	1.4	1.32

Table 35. *1992 Summary results-Volunteer Secchi Monitoring Program*

LAKE	COUNTY	YEAR	1992 YEARLY MAXIMUM (FEET)	1992 YEARLY MINIMUM (FEET)	1992 JUL.-AUG. MEAN (FEET)	WATER CLARITY CLASSIFICATION	1992 STATE RANK
Bass	Porter	1992	3.50	2.00	2.20	Very Poor	60
Bear	Noble	1992	7.50	2.00	6.88	Good	31
Big	Noble	1992	9.00	2.25	3.38	Poor	50
Big Long (NW)	LaGrange	1992	18.75	11.50	13.31	Very Good	7
Big Long (SE)	LaGrange	1992	21.50	11.50	14.31	Very Good	5
Big Otter	Steuben	1992	9.00	5.00	8.67	Good	24
Big Turkey	LaGrange	1992	5.25	2.50	3.70	Poor	46
Cedar	Lake	1992	1.50	0.50	0.50	Very Poor	64
Center	Kosciusko	1992	7.25	2.50	3.58	Poor	49
Chapman	Kosciusko	1992	16.50	7.00	8.00	Good	26
Clear	Steuben	1992	15.50	11.50	13.31	Very Good	7
Cook	Marshall	1992	7.00	3.25	4.33	Poor	43
Crooked	Noble	1992	14.00	10.50	12.63	Good	9
Dewart	Kosciusko	1992	19.25	5.00	10.00	Good	18
Dixon	Marshall	1992	5.00	2.50	3.31	Poor	51
Flat	Marshall	1992	6.50	4.25	5.08	Poor	37
Flint	Porter	1992	14.50	12.25	14.00	Very Good	6
Galbraith	Marshall	1992	4.25	1.75	2.92	Very Poor	56
Goose	Whitley	1992	6.00	3.50	4.67	Poor	38
Hamilton	Steuben	1992	13.75	4.00	4.33	Poor	43
Holiday	Lake	1992	2.75	1.50	1.88	Very Poor	63
Holm	Marshall	1992	12.75	8.75	10.83	Good	15
Indiana	Elkhart	1992	22.00	7.00	11.00	Good	14
Jimmerson	Steuben	1992	14.75	10.00	12.56	Good	10
Koontz	Starke	1992	8.00	2.75	4.41	Poor	42

Table 35. *1992 summary results-Volunteer Secchi Monitoring Program (cont.)*

LAKE	COUNTY	YEAR	1992 YEARLY MAXIMUM (FEET)	1992 YEARLY MINIMUM (FEET)	1992 JUL.-AUG. MEAN (FEET)	WATER CLARITY CLASSIFICATION	1992 STATE RANK
Kreighbaum	Marshall	1992	12.50	8.25	8.83	Good	22
Kunkel	Wells	1992	4.75	1.75	2.31	Very Poor	59
Lake of the Woods	LaGrange	1992	16.00	3.50	7.90	Good	27
Lake of the Woods	Marshall	1992	3.50	1.50	2.33	Very Poor	57
Lake on the Green	Lake	1992	5.00	2.25	3.25	Poor	52
Lawrence	Marshall	1992	16.50	9.25	12.00	Good	11
Lemon	Monroe	1992	3.75	3.25	3.67	Poor	48
Little Long	Noble	1992	21.00	3.00	5.13	Poor	36
Little Otter	Steuben	1992	9.00	7.00	7.83	Good	28
Little Pike	Kosciusko	1992	2.50	1.50	1.92	Very Poor	62
Little Turkey	LaGrange	1992	12.00	3.00	3.25	Poor	52
Long	Noble	1992	9.00	5.25	7.58	Good	29
Long	Steuben	1992	9.00	2.25	3.19	Poor	55
Loon	Whitley	1992	8.00	3.50	6.13	Poor	33
Lower Fish	Laporte	1992	11.50	7.00	8.19	Good	25
Manitou	Fulton	1992	5.00	4.00	4.56	Poor	41
McClish	Steuben	1992	15.00	5.50	10.25	Good	17
Mill Pond	Marshall	1992	11.00	8.50	9.17	Good	21
Monroe	Monroe	1992	6.00	4.25	5.25	Poor	35
Myers	Marshall	1992	11.00	6.00	9.67	Good	19
Nyona	Fulton	1992	4.50	3.00	3.25	Poor	52
Otter	Steuben	1992	7.75	2.75	3.50	Poor	50
Pike	Kosciusko	1992	2.75	1.50	2.17	Very Poor	61
Pretty	Marshall	1992	23.75	17.75	18.92	Very Good	2
Round	Noble	1992	16.50	4.00	4.63	Poor	39

Table 35. *1992 summary results-Volunteer Secchi Monitoring Program (cont.)*

LAKE	COUNTY	YEAR	1992 YEARLY MAXIMUM (FEET)	1992 YEARLY MINIMUM (FEET)	1992 JUL.-AUG. MEAN (FEET)	WATER CLARITY CLASSIFICATION	1992 STATE RANK
Royer	LaGrange	1992	4.50	2.50	3.75	Poor	45
Sand	Noble	1992	10.00	5.00	6.63	Good	32
Saugany	Laporte	1992	32.00	17.50	19.44	Very Good	1
Shriner	Whitley	1992	19.50	8.50	17.13	Very Good	4
Silver	Kosciusko	1992	6.00	1.50	2.33	Very Poor	57
Silver	Steuben	1992	13.50	7.00	8.75	Good	23
Simonton	Elkhart	1992	8.75	5.75	6.13	Poor	33
Skinner	Noble	1992	6.50	2.50	3.70	Poor	46
Snow	Steuben	1992	13.75	8.00	9.25	Good	20
Summit	Henry	1992	12.00	7.00	11.50	Good	12
Sylvan	Steuben	1992	16.25	9.50	11.08	Good	13
Tippecanoe	Kosciusko	1992	10.50	5.00	7.10	Good	30
Wawasee	Kosciusko	1992	17.00	8.50	10.33	Good	16
Winona	Kosciusko	1992	10.00	3.50	4.63	Poor	39
Yellowwood	Brown	1992	18.50	14.75	17.33	Very Good	3

Table 36. *1993 summary results-Volunteer Secchi Monitoring Program*

LAKE	COUNTY	YEAR	1993 YEARLY MAXIMUM (FEET)	1993 YEARLY MINIMUM (FEET)	1993 JUL.-AUG. MEAN (FEET)	WATER CLARITY CLASSIFICATION	1993 STATE RANK
Banning	Kosciusko	1993	8.50	5.00	5.38	Poor	37
Bear	Noble	1993	10.25	4.75	5.44	Poor	36
Big Bass	Porter	1993	3.00	1.25	1.88	Very Poor	59
Big Cedar	Whitley	1993	16.00	12.00	10.25	Good	11
Big Lake	Noble	1993	12.00	3.50	7.71	Good	24
Big Long	Lagrange	1993	15.50	8.00	10.25	Good	9
Big Otter	Steuben	1993	11.00	5.25	7.63	Good	25
Big Turkey	Lagrange	1993	11.50	2.50	6.05	Poor	31
Caldwell	Kosciusko	1993	8.25	4.00	6.21	Poor	30
Center	Kosciusko	1993	9.25	6.25	8.44	Good	18
Chapman	Kosciusko	1993	13.00	6.50	7.63	Good	26
Clear	Steuben	1993	13.50	11.00	11.83	Good	8
Crooked	Noble	1993	15.75	11.25	15.38	Very Good	3
Dewart	Kosciusko	1993	11.00	7.50	8.42	Good	21
Dixon	Marshall	1993	5.00	2.50	3.17	Poor	53
Fish	Lagrange	1993	7.00	4.00	5.00	Poor	34
Freeman	Carroll	1993	3.50	2.00	3.25	Poor	52
Goose	Whitley	1993	12.00	5.00	9.67	Good	13
Hamilton	Steuben	1993	7.50	4.00	4.75	Poor	40
High	Noble	1993	12.50	2.50	2.75	Very Poor	54
Holiday	Lake	1993	2.75	1.50	2.25	Very Poor	56
Indiana	Elkhart	1993	23.50	9.50	12.84	Good	4
Irish	Kosciusko	1993	9.25	3.50	4.06	Poor	46
Jimmerson	Steuben	1993	21.50	8.25	9.88	Good	12
Koontz	Starke	1993	14.00	3.00	5.29	Poor	44

Table 36. *1993 summary results-Volunteer Secchi Monitoring Program (cont.)*

LAKE	COUNTY	YEAR	1993 YEARLY MAXIMUM (FEET)	1993 YEARLY MINIMUM (FEET)	1993 JUL.-AUG. MEAN (FEET)	WATER CLARITY CLASSIFICATION	1993 STATE RANK
Koontz	Starke	1993	14.00	3.00	4.29	Poor	44
Lake of the Woods	Lagrange	1993	10.00	3.50	5.80	Poor	32
Lake of the Woods	Marshall	1993	6.25	1.00	2.00	Very Poor	58
Lemon	Monroe	1993	3.75	3.25	3.58	Poor	49
Little Long	Noble	1993	9.00	4.00	5.75	Poor	33
Little Otter	Steuben	1993	10.75	3.25	4.63	Poor	42
Little Pike	Kosciusko	1993	2.25	1.25	2.00	Very Poor	57
Little Turkey	Lagrange	1993	5.50	3.00	4.25	Poor	45
Long	Noble	1993	9.75	4.50	8.42	Good	19
Long	Steuben	1993	4.50	3.25	3.88	Poor	47
Long	Wabash	1993	10.50	3.50	8.07	Good	23
Lower Fish	Laporte	1993	8.50	4.00	4.63	Poor	43
Lukens	Wabash	1993	12.00	7.00	8.42	Good	20
Manitou	Fulton	1993	6.00	3.50	3.67	Poor	48
Martin	Lagrange	1993	13.25	5.50	11.96	Good	7
McClish	Steuben	1993	13.00	5.00	6.88	Good	27
Myers	Marshall	1993	13.50	7.00	10.25	Good	10
Olin	Lagrange	1993	18.75	5.50	8.33	Good	22
Oliver	Lagrange	1993	17.50	5.75	6.54	Good	28
Pike	Kosciusko	1993	2.75	1.25	2.50	Very Poor	55
Round	Noble	1993	7.00	3.50	5.50	Poor	35
Royer	Lagrange	1993	5.25	2.50	4.63	Poor	41
Saugany	Laporte	1993	25.50	12.50	21.83	Very Good	1
Shriner	Whitley	1993	18.75	11.50	16.63	Very Good	2
Silver	Steuben	1993	10.00	7.00	8.83	Good	16

Table 36. *1993 summary results-Volunteer Secchi Monitoring Program (cont.)*

LAKE	COUNTY	YEAR	1993 YEARLY MAXIMUM (FEET)	1993 YEARLY MINIMUM (FEET)	1993 JUL.-AUG. MEAN (FEET)	WATER CLARITY CLASSIFICATION	1993 STATE RANK
Skinner	Noble	1993	9.00	2.00	3.30	Poor	51
Snow	Steuben	1993	12.00	8.50	9.13	Good	14
Stanton	Kosciusko	1993	13.25	10.50	12.19	Good	6
Summit	Henry	1993	11.00	7.00	8.50	Good	17
Tippecanoe	Kosciusko	1993	11.00	4.00	5.13	Poor	39
Wawasee	Kosciusko	1993	19.00	6.50	9.11	Good	15
West Otter	Steuben	1993	7.50	3.75	6.42	Poor	29
Winona	Kosciusko	1993	7.00	4.00	5.25	Poor	38
Yellowwood	Brown	1993	11.00	16.00	12.40	Good	5

Table 37. *1992 Secchi Disk Transparency Classification Volunteer Lake Monitoring Program*

LAKE	COUNTY	VERY GOOD > 13 FT.	GOOD 6.5-13 FT.	POOR 3-6.5 FT.	VERY POOR < = 3 FT.	TOTAL OBS.
Bear	Noble	0%	75%	25%	0%	4
Big	Noble	0%	40%	40%	20%	10
Big Bass	Porter	0%	0%	22%	78%	9
Big Long (1)	Lagrange	63%	37%	0%	0%	8
Big Long (2)	Lagrange	88%	12%	0%	0%	8
Big Otter	Steuben	0%	67%	33%	0%	6
Big Turkey	Lagrange	0%	0%	83%	17%	6
Cedar	Lake	0%	0%	0%	100%	6
Center	Kosciusko	0%	20%	50%	30%	10
Chapman	Kosciusko	22%	78%	0%	0%	9
Clear	Steuben	60%	40%	0%	0%	5
Cook	Marshall	0%	40%	60%	0%	5
Crooked	Noble	20%	80%	0%	0%	5
Dewart	Kosciusko	25%	66%	8%	0%	12
Dixon	Marshall	0%	0%	86%	14%	7
Flat	Marshall	0%	0%	100%	0%	5
Flint	Porter	60%	40%	0%	0%	5
Galbraith	Marshall	0%	0%	40%	60%	5
Goose	Whitley	0%	0%	100%	0%	8
Hamilton	Steuben	11%	56%	33%	0%	9
Holiday	Lake	0%	0%	0%	100%	6
Holm	Marshall	0%	100%	0%	0%	5
Indiana	Elkhart	40%	60%	0%	0%	10
James	Steuben	75%	25%	0%	0%	4
Jimmerson	Steuben	45%	55%	0%	0%	11
Koontz	Starke	0%	12%	82%	6%	17

Table 37. *1993 Secchi Disk Transparency Classification Volunteer Lake Monitoring Program (cont.)*

LAKE	COUNTY	VERY GOOD > 13 FT.	GOOD 6.5-13 FT.	POOR 3-6.5 FT.	VERY POOR < = 3 FT.	TOTAL OBS.
Kreighbaum	Marshall	0%	100%	0%	0%	5
Kunkel	Wells	0%	0%	29%	71%	7
Lake of the Woods	Lagrange	22%	33%	44%	0%	9
Lake of the Woods	Marshall	0%	0%	20%	80%	10
Lake on the Green	Lake	0%	0%	63%	37%	8
Lawrence	Marshall	40%	60%	0%	0%	5
Lemon	Monroe	0%	0%	100%	0%	7
Little Long	Noble	22%	22%	56%	0%	9
Little Otter	Steuben	0%	100%	0%	0%	6
Little Pike	Kosciusko	0%	0%	0%	100%	11
Little Turkey	LaGrange	0%	29%	71%	0%	7
Long	Noble	0%	67%	33%	0%	6
Loon	Whitley	0%	57%	43%	0%	7
Lower Fish	LaPorte	0%	100%	0%	0%	8
Manitou	Fulton	0%	0%	100%	0%	4
McClish	Steuben	22%	44%	33%	0%	9
Mill Pond	Marshall	0%	100%	0%	0%	5
Monroe	Monroe	0%	0%	100%	0%	10
Myers	Marshall	0%	80%	20%	0%	5
Nyona	Fulton	0%	0%	100%	0%	5
Otter	Steuben	0%	20%	60%	20%	5
Pike	Kosciusko	0%	0%	0%	100%	12
Pretty	Marshall	100%	0%	0%	0%	5
Round	Noble	11%	11%	78%	0%	9
Royer	Lagrange	0%	0%	75%	25%	4
Sand	Noble	0%	80%	20%	0%	5

Table 37. *1992 Secchi Disk Transparency Classification Volunteer Lake Monitoring Program (cont.)*

LAKE	COUNTY	VERY GOOD > 13 FT.	GOOD 6.5-13 FT.	POOR 3-6.5 FT.	VERY POOR < = 3 FT.	TOTAL OBS.
Saugany	Laporte	100%	100%	0%	0%	11
Shriner	Whitley	75%	25%	0%	0%	4
Silver	Kosciusko	0%	0%	57%	43%	7
Silver	Steuben	14%	86%	0%	0%	7
Simonton	Elkhart	0%	86%	14%	0%	7
Skinner	Noble	0%	22%	56%	22%	9
Snow	Steuben	14%	86%	0%	0%	7
Summit	Henry	0%	100%	0%	0%	7
Sylvan	Steuben	44%	33%	22%	0%	9
Tippecanoe	Kosciusko	0%	83%	17%	0%	12
Wawasee	Kosciusko	36%	64%	0%	0%	14
Winona	Kosciusko	0%	17%	83%	0%	12
Yellowwood	Brown	100%	0%	0%	0%	6

Table 38. *1993 Secchi Disk Transparency Classification Volunteer Lake Monitoring Program*

LAKE	COUNTY	VERY GOOD > 13 FT.	GOOD 6.5-13 FT.	POOR 3-6.5 FT.	VERY POOR < = 3 FT.	TOTAL OBS.
Banning	Kosciusko	0%	33%	67%	0%	6
Bear	Noble	0%	30%	70%	0%	10
Big Turkey	Lagrange	0%	36%	55%	9%	11
Big	Noble	0%	53%	47%	0%	15
Big Bass	Porter	0%	0%	0%	100%	8
Big Cedar	Whitley	43%	57%	0%	0%	7
Big Long	Lagrange	11%	89%	0%	0%	9
Big Otter	Steuben	0%	56%	44%	0%	9
Caldwell	Kosciusko	0%	50%	50%	0%	6
Center	Kosciusko	0%	90%	10%	0%	10
Chapman	Kosciusko	0%	88%	12%	0%	8
Clear	Steuben	20%	80%	0%	0%	5
Crooked	Noble	67%	33%	0%	0%	6
Dewart	Kosciusko	0%	100%	0%	0%	12
Dixon	Marshall	0%	0%	60%	40%	10
Goose	Whitley	0%	88%	12%	0%	8
Hamilton	Steuben	0%	25%	75%	0%	8
High	Noble	0%	20%	30%	50%	10
Holiday	Lake	0%	0%	0%	100%	5
Indiana	Elkhart	62%	38%	0%	0%	16
Irish	Kosciusko	0%	33%	67%	0%	6
Jimmerson	Steuben	29%	71%	0%	0%	7
Koontz	Starke	10%	14%	71%	5%	21
Lemon	Monroe	0%	0%	100%	0%	10
Little Long	Noble	0%	25%	75%	0%	8
Little Pike	Kosciusko	0%	0%	0%	100%	8

Table 38. *1993 Secchi Disk Transparency Classification Volunteer Lake Monitoring Program (cont.)*

LAKE	COUNTY	VERY GOOD > 13 FT.	GOOD 6.5-13 FT.	POOR 3-6.5 FT.	VERY POOR < = 3 FT.	TOTAL OBS.
Lake of the Woods	Lagrange	0%	27%	73%	0%	11
Lake of the Woods	Marshall	0%	0%	43%	57%	7
Long	Noble	0%	80%	20%	0%	5
Long	Steuben	0%	0%	100%	0%	10
Long	Wabash	0%	71%	29%	0%	7
Lower Fish	Laporte	0%	29%	71%	0%	7
Little Otter	Steuben	0%	22%	78%	0%	9
Little Turkey	Lagrange	0%	0%	75%	25%	4
Lukens	Wabash	0%	100%	0%	0%	7
Manitou	Fulton	0%	0%	100%	0%	5
Martin	Lagrange	8%	85%	8%	0%	13
McClish	Steuben	0%	55%	45%	0%	11
Myers	Marshall	9%	91%	0%	0%	11
Olin	Lagrange	46%	23%	30%	0%	13
Oliver	Lagrange	15%	46%	38%	0%	13
Pike	Kosciusko	0%	0%	0%	100%	8
Round	Noble	0%	12%	88%	0%	8
Saugany	Laporte	89%	11%	0%	0%	9
Skinner	Noble	0%	10%	50%	40%	10
Silver	Steuben	0%	100%	0%	0%	7
Snow	Steuben	0%	100%	0%	0%	8
Stanton	Kosciusko	17%	83%	0%	0%	6
Summit	Henry	0%	100%	0%	0%	5
Tippecanoe	Kosciusko	0%	58%	42%	0%	12
Wauhob	Porter	0%	100%	0%	0%	4

Table 38. *1993 Secchi Disk Transparency Classification Volunteer Lake Monitoring Program (cont.)*

LAKE	COUNTY	VERY GOOD > 13 FT.	GOOD 6.5-13 FT.	POOR 3-6.5 FT.	VERY POOR < = 3 FT.	TOTAL OBS.
Wawasee	Kosciusko	24%	71%	6%	0%	17
West Otter	Steuben	0%	50%	50%	0%	6
Winona	Kosciusko	0%	12%	88%	0%	8
Yellowwood	Brown	20%	80%	0%	0%	5

EPA's National Eutrophication Survey. These data indicate how consistent or variable the transparencies in each lake were during the May-October monitoring period. Figures 52 and 53 show how the July-August means are distributed within the four water clarity categories. In 1992, 49.2% of the lakes monitored were in either the good or very good categories, and 50.7% were classified as either poor or very poor. In 1993, 48.3% of the lakes were classified as either good or very good, while 51.7% were classified as either poor or very poor.

In 1992 Saugany Lake (19.44ft.)Pretty Lake (18.92 ft.), and Yellowood Lake (17.33 ft.), showed the greatest Secchi Disk transparencies for the July-August mean. Conversely, Cedar lake, Lake Co. (0.50 ft.), Holiday Lake (1.88 ft.), and Little Pike lake, (1.92 ft.), had the lowest transparencies.

Saugany Lake (21.83 ft.) again had the greatest transparency in 1993, while Shriner Lake (16.63 ft.), and Crooked Lake (15.38 ft.), ranked second and third. Big Bass lake (1.88 ft.), Lake of the Woods in Marshall County (2.00 ft.), an Little Pike Lake (2.00 ft.), had the lowest July-August average transparencies.

The excessive growth of weeds in a lake or reservoir can interfere with various designated uses. Aquatic weeds will occupy an open water area of a lake or reservoir that is shallow enough to permit light to reach the bottom at the beginning of the growing season. Since plant remains contribute to the filling process, those lakes and reservoirs with substantial shallow water areas are most vulnerable to filling. Some lake property owners believe that "the only good weed is a dead weed" and tend to initiate unnecessary controls. A review of the weed control permits issued by the Indiana Department of Natural Resources (IDNR) provides some indication of the extent of aquatic weed problems in the state. However, there may be some lake areas where one or more potential uses may be impaired by aquatic weed growth, but these uses may not be important to those using that portion of the lake or reservoir and no weed control is initiated. It is also recognized that a small shoreline area may be treated by an individual owning adjacent property without a permit and a few lake associations may have mechanical weed harvesting equipment.

Aquatic herbicide permits issued by the IDNR for 1992-93 numbered 149 as compared to 159 for 1990-91. A total of 2,897 acres of water in 62 different lakes were treated, 1,207 acres during 1992 and 1,690 acres during 1993. The 2,897 acres treated during 1992-93 represents 2% of the total surface area of Indiana's public lakes and reservoirs. The lakes with the most acres treated were Lake Lemon where 60 acres were treated in 1992 and Pike Lake where 90 acres were treated in 1993. Indiana's Clean Lakes Program is encouraging lake associations to address the causes of excessive plant growth in lakes, and when necessary, to consider non-chemical control methods.

Figure 52. *Percent of lakes in transparency classes (July-Aug. Means, 1992)*

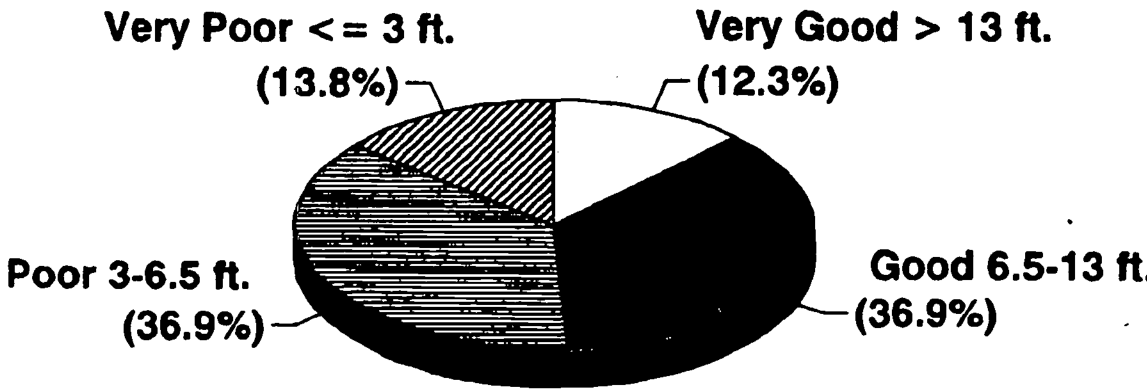
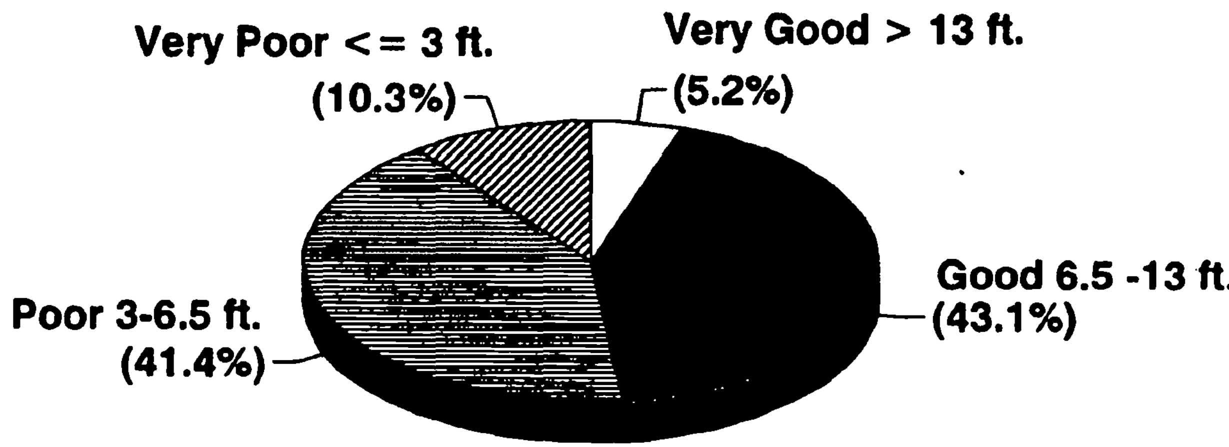


Figure 53. *Percent of lakes in transparency classes (July-Aug. Means, 1993)*



Indiana has developed several programs which work toward reduction of nutrient input's to lakes and reservoirs. One of the most important of these is the enactment of the Indiana Phosphate Detergent Law (IC 13-1-5.5 as amended) which became fully effective in 1973. This law limits the amount of phosphorus in detergents to that amount incidental to manufacturing (not to exceed 0.5% by weight). Additionally, Regulation 327 IAC 5, governing the issuance of NPDES permits, required phosphorus removal for all discharges containing ten pounds or more of total phosphorus per day if the discharge is located in the Lake Michigan or Lake Erie basins, or on a tributary of a lake or reservoir within 40 miles upstream. This rule also calls for the installation of phosphorus removal by a point source if the discharge is directly to a lake or reservoir or within two miles upstream. Advanced treatment for oxygen demanding wastes and ammonia removal is also required for these discharges.

The Indiana Confined Feeding Control Law (IC 1971, 13-1-5.7) and Land Application Regulation (327 IAC 6) contain provisions governing the land application of sludges and animal wastes. These requirements are designed to prevent or reduce runoff of these materials to lakes and reservoirs and their tributary streams and thus reduce contributions of nutrients and other materials from these non-point sources.

Indiana recognizes the important role that wetlands have in maintaining the water quality of lakes and reservoirs. These wetlands act as nutrient and sediment traps which "filter out" these materials before they reach the open water of a lake or reservoir and cause problems. Substantial effort is made to protect wetlands, especially those contiguous to lakes and reservoirs or their tributaries, through the Section 404/Section 401 Water Quality Certification process and the early environmental coordination of proposed construction not requiring Section 401 certification. A goal of preventing a net loss in wetland acres has been established by the IDEM.

As a result of a soil erosion study by the Governor's Soil Resources Study Commission, the 1986 legislature established a new Division of Soil Conservation in the Indiana Department of Natural Resources and a State Conservation Board to serve as a policy-making body for the Division. Erosion control measures instituted by these bodies will include both agricultural and non-agricultural land and will eventually be part of a regulatory program. A lake enhancement program administered by the Division of Soil Conservation is funded by a portion of the cigarette tax and boat license fees. This program supports projects that are generally smaller than those funded under the Federal Clean Lakes program. These, and related programs will help prolong the life of many lakes and reservoirs in the State.

Additionally, representatives of the Indiana Departments of Environmental Management and Natural Resources co-chaired a committee of professionals who developed a Nonpoint Source Assessment and management

Plan required under Section 319 of the Clean Water Act as amended. The programs developed by the plan should eventually result in the further reduction of nonpoint source contributions of nutrients and other contaminants to Indiana lakes and reservoirs. Nonpoint source problems and control programs are discussed at some length later in this report.

Programs designed to assess the extent of contamination of fish tissue and bottom sediment with toxic and/or bioconcentrating substances are described elsewhere in this report. While concentrations of some contaminants in the bottom sediments of a few lakes and reservoirs are high enough to be of concern, with one exception, there is no evidence that they impair water uses.

Four public lakes, and reservoirs, totaling 101 acres, do not support designated uses because of contaminants entering from either point or nonpoint sources. Each of these is discussed below.

A fish consumption advisory for the 12-acre Decatur County Park Reservoir near Greensburg is based on high concentrations of contaminants in samples of fish tissue collected from the Muddy Fork of Sand Creek upstream and from Sand Creek downstream. Chlordane, dieldrin and PCBs were present in tissue samples in concentrations exceeding Federal Food and Drug Administration (FDA) Action Levels.

Pit 29 is a 30-acre strip pit in Greene-Sullivan State Forest. It supports no visible aquatic life due to acid mine drainage from old strip mine workings.

Gilbert Lake is a small, 37 acre, natural lake in Marshall County. It has no tributary streams and receives only runoff from the surrounding terrain and the effluent from the small wastewater treatment plant of Ancilla Domini College. Gilbert Lake has been awarded the maximum possible score of 75 euthrophy points and it has a history of poor water quality and occasional fish kills. Most uses are precluded by the heavy weed and algae growth it supports.

Henderson Lake, which is presently about 22 acres in size, receives the direct discharge from the Kendallville wastewater treatment plant. It also receives untreated wastewater from a treatment plant bypass and combined sewer overflow. As a result, it has a long history of poor water quality and fish kills. A recent attempt to eliminate the large resident carp and bullhead catfish populations and to restock Henderson Lake with game fish was largely unsuccessful. Although a second attempt may be made, there may be little chance for success until better control and treatment of combined sewer overflows are provided. Swimming is precluded by the frequently elevated bacterial concentrations and boating is limited by esthetic considerations.

There are three small public lakes with a total of 88 acres that are considered to be only partially supporting the designated uses. These are discussed below.

Greensburg Reservoir is a small (23 acres) state owned impoundment that periodically received overflow from a lift station in the Greensburg municipal sewer system for several years. It also receives urban runoff and drainage from an industrial area. The lake supports nuisance, warm weather blooms of blue-green algae and there have been several fish kills over the years. The lake supports a fishery of limited value, however, it is still used by the general public to some extent. Swimming potential is limited by anesthetics and the lift station bypass.

Hawks Lake (Lost Lake) (40 acres) receives the discharge from the Culver municipal wastewater treatment plant which provides the only flow into the lake during dry-weather. Although the condition of the lake has improved significantly due to treatment plant improvements, some problems remain.

Kunkel Lake is located in Wells County in Quabache State Park. This 25 acre lake has a 180 acre watershed which is about one-third agricultural and residential and the rest in trees and grasses. A sediment trap constructed upstream of the lake in the 1920s has now filled with silt and is no longer functioning. The lake is a focal point for the state park and fishing demand is high. considerable money is spent each year on chemical weed control in order to partially maintain use.

The remaining lakes and reservoirs in Indiana are all threatened to some degree. Any significant change in watershed land use practices which would result in increased sediment and/or nutrient loading would speed the rate of euthrophication of any of these waterbodies.

Basin Information and Summaries

Lake Michigan Basin

The Lake Michigan drainage basin includes four major waterways in Indiana: The Grand Calumet River-Indiana Harbor Ship Canal (GCR/IHC), the Little Calumet River, Trail Creek and the St. Joseph River. The first three compose what is referred to as the Lake Michigan Basin - Northwest in this report, and empty into Lake Michigan within the boundaries of Indiana (Figure 54). The St. Joseph River and its tributaries will be referred to as the Lake Michigan Basin-Northeast in this report (Figure 55). The St. Joseph River flows into Lake Michigan approximately 25 miles north (downstream) of the state line at the towns of St. Joseph-Benton Harbor, Michigan.

Figure 54. *Lake Michigan Basin - Northwest*

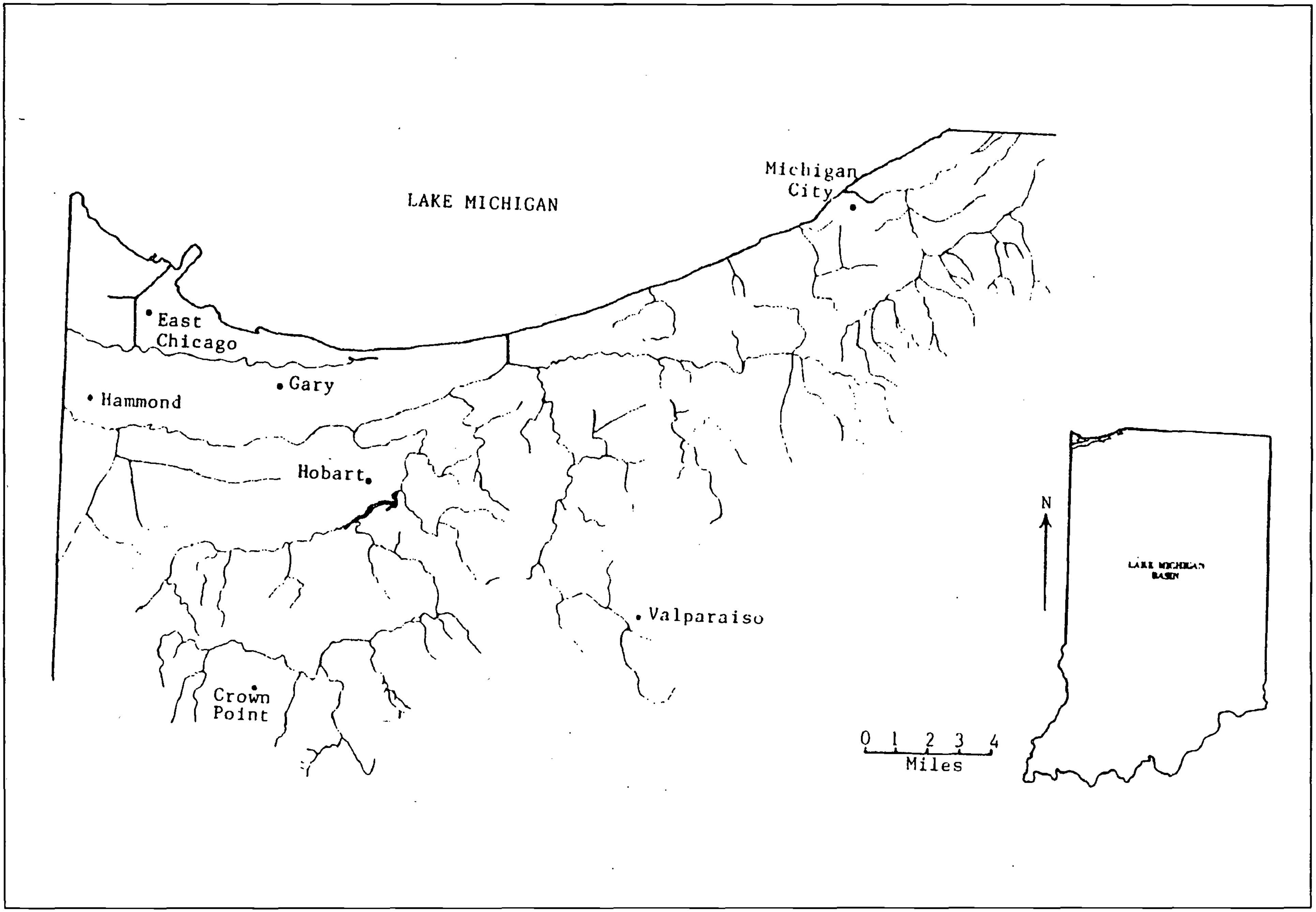
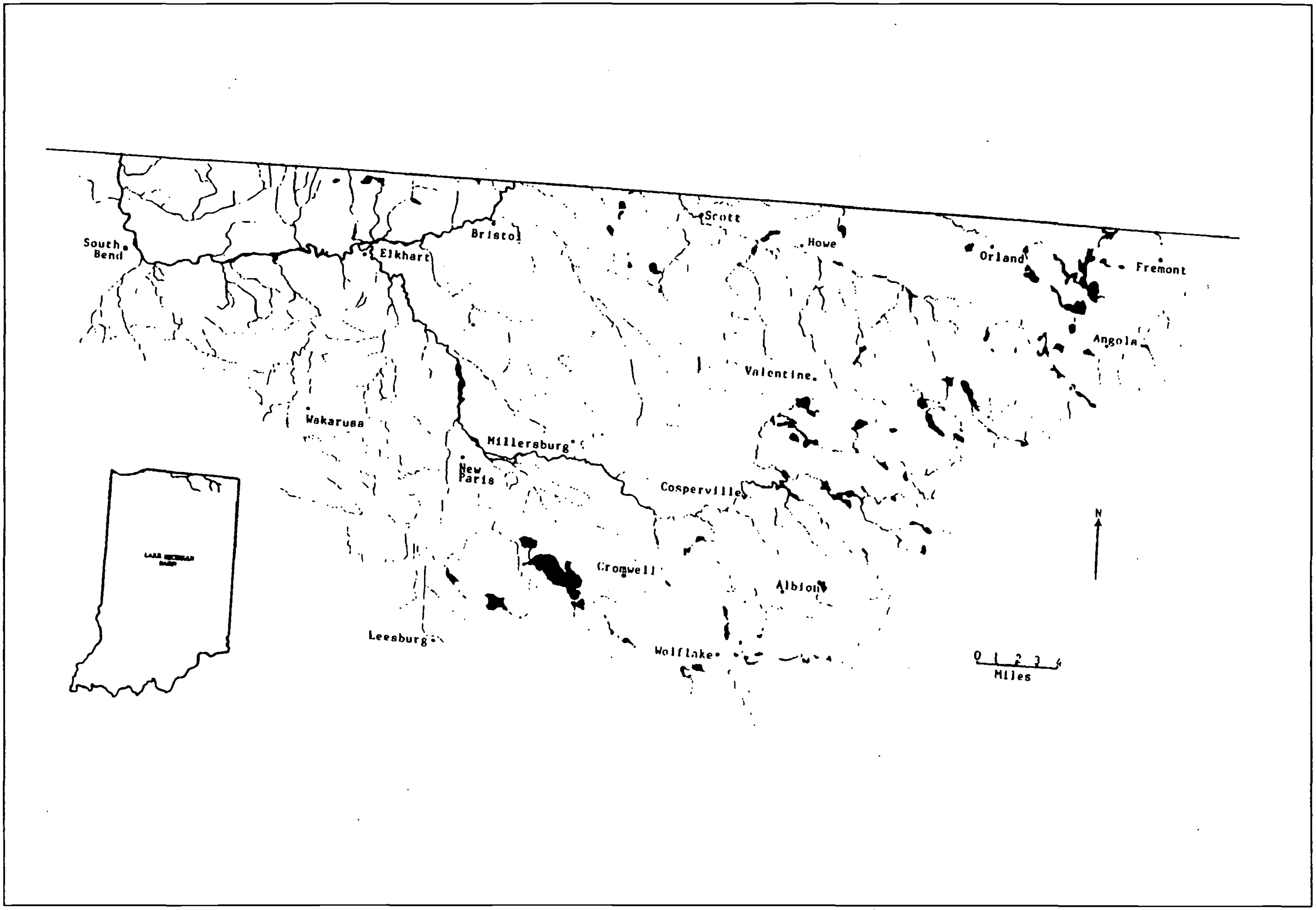


Figure 55. *Lake Michigan Basin - Northeast*



Five major Indiana municipalities (Michigan City, East Chicago, Gary, Hammond, and Whiting) use Lake Michigan for potable water supply and several return treated municipal wastewater to the lake via a tributary. In addition, a number of industries also use the lake as a raw water source. Lake Michigan and its contiguous harbor areas have been designated for multiple uses including recreation, aquatic life, potable water supply, and industrial water supply in regulation 327 IAC 2-1. This regulation outlines the criteria and minimum standards of water quality that must be maintained in the lake.

Water quality in Lake Michigan does vary in the Indiana portion. Concentrations of substances in the near shore zone reflect the effects of wastewater and tributary contributions from the watershed and are nearly always higher than in the "open water" lake samples.

Tissue from some species of fish in Lake Michigan have contained concentrations of contaminants in excess of FDA Action Levels since testing began in the early 1970s. Fish samples are collected for metals, pesticide and PCB analyses in the fall of each year by the Indiana Department of Natural Resources (IDNR) and analyzed by the Indiana State Department of Health (IDOH). PCBs, chlordane, dieldrin, and DDT are found in excess of their FDA Action Levels in certain sizes and species of fish on a lakewide basis although no fish collected from Indiana waters over this two year period exceeded these levels. A revised lakewide fish consumption advisory for fishermen and consumers of these fish is issued each spring. The most current advisory is shown in Table 20. Due to this consumption advisory and some high copper concentrations, Lake Michigan (43 shoreline miles) is determined to only partially support its designated aquatic life uses. Recreational uses have been fully supported.

Lake Michigan Basin - Northwest

An assessment of designated aquatic life use support was made for 210 stream miles in this subbasin and 102 miles were assessed for recreational use. The waters assessed, support status, miles affected, and probable causes of impairment are shown in Table 39. Additional information for certain stream reaches are also provided

The major streams in the basin, the Grand Calumet River, Trail Creek, the Little Calumet River, and Lake Michigan tributaries including Kintzele Ditch and the Indiana Harbor Canal, are under a fish consumption advisory as detailed in Table 15. However, fish tissue samples collected from five locations within this basin during 1990-1993 did not exceed FDA Action Levels.

Trail Creek is located in LaPorte County in the northwest corner of the state and flows into Lake Michigan at Michigan City. The drainage area is 59.1 square miles, with an approximate average annual flow of 75 cfs. It is

Table 39. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Lake Michigan Basin - Northwest*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Coffee Creek and its tributaries	Chesterton	NS (Aquatic Life)	Monitored (b)		10	Biological Assessment "Poor".
Coffee Creek	Chesterton	NS (Aquatic Life)	Monitored (b)	Urban Runoff	2	Biological Assessment "Poor".
Damon Run	Chesterton	NS (Aquatic Life)	Monitored (b)	D.O.	7	Biological Assessment "Poor".
Upper Salt Creek	Valparaiso	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	D.O. E. coli	4	Valparaiso STP plans to initiate a Land Application Program. Salmonid Stream.
Sager Creek	Valparaiso	NS (Aquatic Life)	Monitored (b)		2	Biological Assessment "Very Poor".
Lower Salt Creek	McCool Portage	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	D.O. E. coli	4	Biological Assessment "Poor".
Dunes Creek	Tremont	NS (Aquatic Life)	Monitored (b)	Channelization E. coli	5	Biological Assessment "Poor".
Kintzele Ditch and its Tributaries	Michigan City	NS (Aquatic Life) (Threatened)	Evaluated	Channelization PCBs Pesticides	5	Fish Consumption Advisory.
Upper Trail Creek and its Tributaries	Michigan City	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli PCBs Agricultural Run-off Pesticides	42	Fish Consumption Advisory.
Lower Trail Creek	Michigan City	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli PCB'S Pesticides	3	Michigan City STP effluent, discharged into Trail Creek, is clear and Bluegill, Largemouth Bass, Steelhead, and Chinook are observed in outfall. Trail Creek water quality reflects improvements in wastewater treatment. Fish consumption advisory.
Willow Creek	Michigan City	NS (Aquatic Life)	Monitored (b)		3.7	Biological Assessment "Poor".
Galena River and its Tributaries	Heston Lalimere	FS (Aquatic Life)	Evaluated		13	
Burns Ditch	Lake Station Portage	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli PCB's Pesticides	8	a) Well operated facility. Some bypassing during wet weather. Portage and IDEM working on alternatives to bypassing. b) Burns Harbor developing an operational control program to eliminate violations to NIPSCO facility. c) Biological Assessment "Poor". d) Fish consumption advisory

Table 39. *Waters assessed, status of designated use sup., prob. causes of impairment and miles aff. in the Lake Michigan Basin - NW (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Little Calumet River	Gary	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	Cyanide PCB's E. coli Pesticides	7	Fish Consumption Advisory.
Little Calumet River	Porter Chesterton	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli PCB's Cyanide Pesticides	6	Fish Consumption Advisory.
Unnamed Trib of Little Calumet River	Pine	FS (Aquatic Life)	Monitored (b)		3	Biological Assessment "Fair".
Little Calumet River	Hammond	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli PCB's Cyanide Pesticides	10	CSO problems occasionally.
Kemper Ditch	Pine	NS (Aquatic Life)	Monitored (b)		3.4	Biological Assessment, "Poor".
Deep River	Hobart	NS (Aquatic Life)	Monitored (b)	Run-off Hobart POTW Poor Habitat	4	Biological Assessment, "Poor".
Deep River	Lake Station	NS (Aquatic Life)	Monitored (b)	Sewage	4	Severe bypassing. Biological Assessment, "Poor".
Deer Creek	Merrilville	NS (Aquatic Life)	Monitored (b)		4	Biological Assessment, "Poor".
Turkey Creek	Hobart	NS (Aquatic Life)	Monitored (b)	D.O. Run-off Channelization	10	
Indiana Harbor Canal	Whiting E. Chicago	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	PCB Pesticides D.O. Mercury E. coli	4	a) Fish Consumption Advisory. b) Biological Assessment, "Very Poor".
Lake George Branch of Indiana Harbor Canal	East Chicago	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Oil & Grease E. coli PCB's D.O. Pesticides	1	a) Multiple Sources b) Fish Consumption Advisory c) Oil Leachate from Amoco Oil and ECI property

Table 39. *Waters assessed, status of designated use sup., prob. causes of impairment and miles aff. in the Lake Michigan Basin - NW (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
E. Branch Grand Calumet River	Gary East Chicago	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	Oil & Grease E. coli Lead Cyanide PCB Pesticides	10	Biological Assessment, "Very Poor". Fish consumption advisory.
W. Branch Grand Calumet River	Hammond East Chicago	NS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli D.O. Cyanide PCB's Lead Ammonia CSO's Pesticides	3	a) The Hammond Sanitary District has caused severe degradation of the river in the past. b) Biological Assessment, "Poor".
Plum Creek	Dyer	FS (Aquatic Life)	Evaluated		4	
Hart Ditch	Munster Highland	FS (Aquatic Life)	Evaluated		2	
Dyer Ditch	Dyer	NS (Aquatic Life)	Monitored (b)	Ammonia	2	a) New facility in chronic violation of NPDES TSS criteria. b) Biological Assessment, "Very Poor".
Kaiser Ditch	Lincoln Village	FS (Aquatic Life)	Evaluated		1	
Beaver Dam Ditch	Crown Point	NS (Aquatic Life)	Monitored (b)	Poor Habitat D.O.	7	Biological Assessment, "Very Poor".
Niles Ditch	Crown Point	NS (Aquatic Life)	Monitored (b)	D.O.	5.6	Biological Assessment, "Poor".
Carver Ditch	Pine	NS (Aquatic Life)	Monitored (b)		3.0	Biological Assessment, "Poor".
Reynolds Creek	Pine	FS (Aquatic Life)	Monitored (b)		1	Biological Assessment, "Fair".
Reynolds Creek	LaPorte	NS (Aquatic Life)	Monitored (b)		2	Biological Assessment, "Poor".
Sand Creek	Chesterton	NS (Aquatic Life)	Monitored (b)		4.5	Biological Assessment, "Poor".

FS = Fully Supported, PS = Partially Supported, NS = Not Supported. If a use is not listed, it was not monitored or evaluated

b = Biological, c = Chemical.

Indiana's most noted salmonid stream due to an IDNR stocking program that began in the early 1970s and is designated for cold water fish.

Historically, many water quality problems have been associated with Trail Creek. Inadequately treated sewage, combined sewer overflows (CSOs), industrial discharges and chemical spills have contributed to its poor condition and resulted in periodic fish kills. In 1986 and 1987, four fish kills occurred due to low dissolved oxygen, high temperature, and ammonia. No fish kills, however, were reported from 1988 through 1993. Significant modifications to the Michigan City sewage treatment plant (STP) were recently completed to prevent the plant from discharging raw or inadequately treated wastewater into Trail Creek. The Michigan City Sanitary District has plugged many CSOs and has built a storage basin for stormwater which will reduce the amount of raw sewage entering Trail Creek.

In those instances where an effluent has been consistently demonstrated to be toxic, IDEM requires an effort aimed at reducing that effluent's toxicity to acceptable levels. A Toxicity Identification/Reduction Evaluation (TI/RE) is a step-by-step, sequenced procedure which is designed to characterize and ideally, to identify the toxic constituent(s) in a complex effluent so that toxicity reduction methods can be implemented. The TI/RE process has been utilized effectively by Michigan City, and the Michigan City STP is currently meeting its NPDES permit limits.

Because Trail Creek is designated as a salmonid stream, a more stringent set of water quality standards applies than for general use streams. Dissolved oxygen concentrations were below the 6 mg/l criterion in the lower reaches of the creek 18% of the time during 1990-91 according to the Fixed Water Quality Monitoring Network data. Violations in this reach of the stream were similar in frequency during 1988-89. Stations on the upper portion of the stream had dissolved oxygen concentrations below this criterion less than 10% of the time. None of stations monitored during 1992-93 showed any violations of the dissolved oxygen criteria. The E. coli bacteria criteria were violated often enough during 1990-93 that the designated recreational uses were not supported. No violations of unionized ammonia standards occurred during this four year period. Temperature standards are almost always exceeded in June, July, and August and violations will continue as these standards appear to be lower than background or ambient temperatures.

Trail Creek is still under a fish consumption advisory for carp, catfish and several salmonid species which enter the stream from Lake Michigan. The pollutants of concern are PCBs, chlordane, dieldrin and DDT.

In 1992, IDEM staff investigated a sewage discharge to Trail Creek which came from a Michigan City public boat launch. This discharge resulted in a chronic problem of elevated E. coli bacteria counts and high BOD in Trail

Creek. To prevent future reoccurrences of sewage bypass from the marina, its management staff has implemented several steps to clean and maintain sewer lines.

The Little Calumet River flows through Lake and Porter counties in northwest Indiana. This river basin is a highly populated urban area. The steel industry is the major economic provider in the basin, with the large plant of Bethlehem Steel the most visible. Supportive industries and the population base that subsequently developed encompass most of this watershed. Urban runoff, combined sewer overflows, and municipal and industrial wastewater effluents are common, especially in the West Branch of the Little Calumet River.

A portion of the West Branch of the Little Calumet River drains to Lake Michigan via Burns Ditch, while a flow divide near Griffith directs a portion of the flow into Illinois and eventually to the Illinois River. Deep River is the major tributary to the portion of the West Branch that drains to Lake Michigan. The section that flows into Illinois includes Hart Ditch.

Samples from the portion of the Little Calumet River that flows west into Illinois have shown violations of water quality standards for a number of years. Poor treatment at Schererville and Dyer, as well as CSOs from Hammond, were major problems in this reach. Dissolved oxygen violations at the fixed water quality station at Holman Avenue have gone from less than 4.0 mg/l more than 50% of the time during 1984-85 to fewer violations in 1988-89 and none in the 1990 to 1993 period. Cyanide was found at levels above the acute criterion in 13% of the samples in the 1990-93 period in this portion of the river. This portion of the Little Calumet River is not supportive of the aquatic life use due to cyanide concentrations which also applies to the lake's tributaries. Whole body contact recreational uses were also not supported due to high E. coli counts in 90% of the samples taken.

Schererville upgraded its wastewater treatment plant from 2.0 mgd to 3.5 mgd and now provides nitrification. This upgrading was completed in 1987. Recent inspections have shown that the final effluent has improved since that time. Several exceedances which occurred in 1992 for total solids and TBOD may be eliminated after completion of some ongoing construction as the increased plant capacity will prevent hydraulic overloading. No adverse effects from the plant discharge have been noted in nearby Brown Ditch.

During 1988 and 1989, the Dyer sewage treatment plant was experiencing some bypassing to Plum Creek (Hart Ditch). High values of ammonia were also found during 1989, but the facility has since taken corrective measures to ensure that the ammonia concentrations are within the NPDES limits. During 1991, violations of TSS and TBOD and several bypasses were areas of concern. The bypassing is due to excessive rainfall-induced flow which backed up the treatment facility and threatened property damage. As of December 1993, plant construction plans included changes to the design flow which will be increased from 1.5 to 1.8 mgd with peak flow of 5.0 mgd. This project, started in the Spring of 1992, should alleviate the exceedances for TSS and TBOD. The Dyer facility and IDEM have entered into an Agreed Order to limit TSS parameters and this facility will be under increased scrutiny.

The East Branch of the Little Calumet River and its tributaries drain the cities of Porter, Chesterton and Valparaiso in Porter County. This portion of the East Branch of the Little Calumet River and Salt Creek are designated as salmonid streams.

Salt Creek receives the effluent of the Valparaiso sewage treatment facility. Chronic violations of the facility's NPDES permit in the past have caused poor water quality in this salmonid stream. Advanced waste treatment, including nitrification and dechlorination, was completed in 1985 at the facility and helped to alleviate many problems. Control of combined sewer overflows was also required. From 1988 through 1991 no violations of chemical water quality standards were reported at the fixed water quality monitoring stations located on Salt Creek. Bacteriological standards, however, were exceeded often enough that the stream does not support the recreational use designation. Additionally, recent fish community sampling indicates that the biological integrity of Salt Creek is poor. These results cause the stream to be considered nonsupportive of the aquatic life use.

The Crown Point sewage treatment facility has been meeting it's NPDES limits for several years. The most recent sampling inspection indicated both low BOD and suspended solids in the effluent (97% and 99% removal). Improved water quality in Beaver Dam Ditch and Deep River is partly attributable to the improvements at this advanced treatment plant. The city installed fine air diffusers to treat ammonia and plans to achieve ammonia limits using more efficient oxygen transfer from fine bubbles. Current ammonia levels have been low. Regionalization of the Hobart wastewater treatment plant with Gary has been completed, and the elimination of this discharge to Deep River has further improved water quality in this stream. The biological integrity of Deep River is poor, however, based on fish community sampling.

Sewage related problems still exist in the Little Calumet River, however. One serious problem is in the Black Oak area of Gary which is served by antiquated sewers. These sewers frequently discharge raw sewage to the Little Calumet River.

The wastewater treatment plant in Chesterton often has hydraulic overloads caused by inflow and infiltration (I/I). The town has aggressively pursued this problem and had a Facilities Plan drafted which included a sewer system evaluation survey and an I/I study. Among many of the findings, I/I was a primary problem. The report identifies two areas of greatest concern, combined sewers and the lack of storm sewers. In late 1993, the town spent more than 4.7 million dollars on three projects to eliminate I/I and identified one of the greatest remaining sources. With the completion of these projects, a major portion of the I/I in that system will be eliminated.

The East Branch of the Little Calumet River receives effluent from Bethlehem Steel. One of these is a high flow (80-100 mgd) cooling water discharge that enters the river upstream of its confluence with Salt Creek. It appeared that this warmer water was inhibiting salmonid migration in the late summer and fall, possibly diverting some fish up Salt Creek. Bethlehem Steel contracted with a consultant to conduct thermal avoidance studies in 1984 and 1985 in this area. These studies indicated that occasional summer violations for temperature limits of their cooling water discharge into the Little Calumet River, possibly resulting in thermal avoidance by the salmon, are a direct result of increased lake water intake temperature. Bethlehem Steel's thermal violations were relatively minor and are being addressed through modification of the permit. Currently, this facility has some occasional metals violations but complies with its permit most of the time.

Midwest Steel discharges wastewater to Burns Ditch. Occassional NPDES violations have occurred in the recent past primarly due to mechanical problems. Improved plant maintenance and an improved treatment process has recently proved beneficial in eliminating these violations. IDEM staff is currently investigating an oil sheen in Burns Ditch coming from Midwest Steel. Whether this water quality violation is periodic or ongoing has not been determined at this time.

Burns Ditch is included in the fish consumption advisory for Lake Michigan and its tributaries. A fish community sampling survey conducted in 1990 on Burns Ditch produced a "poor" Index of Biotic Integrity score also indicating nonsupport of aquatic life uses.

The Grand Calumet River (GCR) in Lake County consists of an east and west branch, with the two branches meeting to form the Indiana Harbor Ship Canal (IHC). The east portion originates in Gary at the outlet of the Marquette Park Lagoons just upstream from the outfalls of the U.S. X. Corporation mill. It flows west and empties into Lake Michigan via the Indiana Harbor Ship Canal. The west portion, like the Little Calumet River, flows both east and west, with the divide located just west of Indianapolis Boulevard. The western flow into Illinois eventually reaches the Illinois River Basin and the Mississippi River.

The Grand Calumet River Basin drainage area is small but includes some of the most industrialized and populated areas in the state. The Grand Calumet River-Indiana Harbor Ship Canal (GCR/IHC) has been designated as a Class A Area of Concern (AOC) by the International Joint Commission (IJC).

Data from samples collected from the seven fixed water quality monitoring stations on the GCR/IHC system in 1991-93 were examined. Cyanide concentrations exceeded the acute criterion for this substance at three of the stations from 17% to 33% of the time. Two D.O violations for were found at the Grand Calumet River/Indiana Harbor Canal stations and a 1990 fish community sampling assessment indicates that D.O. levels may be of concern. Unionized ammonia criteria were not violated at any station at the acute level. The E. coli bacteriological criterion was exceeded up to 86% of the time at each of the monitoring stations. Thus, concentrations of cyanide and E. coli appeared to be of concern throughout much of the GCR/IHC system.

While problems have existed in these waters for many years, some past pollutant problems have been resolved, and the concentrations of many substances have been reduced even though criteria violations still occasionally occur.

As a result of these water quality problems and the designation of this area as a Class A AOC by the IJC, a concerted effort was begun to address these problems. The "Master Plan for Improving Water Quality in the Grand Calumet River and Indiana Harbor Canal" was prepared in 1985 by U.S. EPA with cooperation from the State of Indiana. The Master Plan calls for programs which will focus U.S. EPA and State of Indiana water quality control efforts on problems related to these streams. These programs include tightening NPDES permit limits, pretreatment program development and compliance actions (both municipal and industrial) to ensure that permit limits are met. Longer-term investigations to evaluate the effectiveness of existing and new control programs for enhancing water quality conditions in the GCR/IHC system will be conducted. A status report on the implementation of this plan was issued in 1986. Intensive biological and sediment sampling was conducted in 1986, 1987 and 1988, and sampling of effluents and surface waters in the GCR was done in 1988.

In order to address the more widespread environmental concerns of this area, the Indiana Department of Environmental Management (IDEM) and Region V, U.S. EPA decided to expand the scope of the original "Master Plan" to include air quality and solid and hazardous waste issues as well as water quality. In 1986, a draft "Northwest Indiana Environmental Action Plan" (EAP) was prepared.

As a result of the designation of this area as a Great Lakes AOC, a Remedial Action Plan (RAP) was needed to address the water quality, aquatic habitat, and use impairment issues of the nearshore area of Lake Michigan.

IDEM's overall goal of the RAP is to define the approach and necessary activities needed to improve water quality in the Grand Calumet River/Indiana Harbor Canal so that the designated uses for Lake Michigan are maintained or restored. IDEM established a Remedial Action Plan Work Group and a draft plan was completed in January 1988.

In January 1991, Stage One of the RAP which identifies environmental problems in the Indiana Harbor and Canal, the Grand Calumet River, and the Nearshore Lake Michigan was submitted to IJC and will be updated as new information becomes available. A summary of environmental problems affecting this area of concern is found in Table 40. A draft of the Water Quality Component of the Stage II RAP was completed in May 1993 and is currently under review.

Three major sewage treatment plants, Gary, Hammond, and East Chicago, discharge to the Grand Calumet River. All three municipalities are involved in some type of enforcement action by the State and U.S. EPA.

Compliance inspections at the Hammond Wastewater Treatment Facility during this reporting period indicate that plant operations have improved considerably since 1988. Some problems were revealed but these should not overshadow the progress made. In June 1988 the Hammond Sanitary District entered into a contract with Ten-Ech Engineering of South Bend, Indiana, to operate the treatment facility. Field surveys conducted by this office in the Spring of 1988 indicated the receiving stream, the Grand Calumet River, was extremely polluted. Near the outfall, there was no instream dissolved oxygen. Biochemical oxygen demand (BOD) was greater than 200 mg/l in the river downstream of the Hammond Sanitary District outfalls. The river was black, and odors emanated from the river. Also, past inspections by this office disclosed that values for final effluent quality were being incorrectly reported. Since Ten-Ech Engineering has been in charge of the plant, final effluent discharge values have been correctly reported, the effluent quality is now closer to the NPDES limits, and the Grand Calumet River downstream of the Hammond Facility has improved remarkably. The river is now clear, dissolved oxygen levels have increased, and fish life has been observed downstream.

The East Chicago Sanitary District has a large, newly designed, activated sludge-oxidation ditch wastewater treatment facility. The plant is running well, but combined sewer overflows still effect the river. Periodic sampling analyses throughout 1991 showed no violations of NPDES permit limits. Samples sometimes contained elevated levels of dissolved solids, cyanide and several metals, but its pretreatment program has been effective. Samples from 1993 showed some violations for phosphorous, chloride, and sulfate. U.S. EPA is pressuring the city to investigate the industrial users.

Table 40. *Summary of environmental problems affecting the Indiana Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan area of concern*

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OF CAUSE OF THE PROBLEM
i) Restriction on Fish and Wildlife Consumption Use impairment confirmed	No fish should be eaten from the Grand Calumet River or the Indiana Harbor and Canal. In Lake Michigan, Brown Trout and Lake Trout over 23", Chinook over 32", Catfish and Carp should not be eaten. Chinook Salmon over 21", Lake Trout between 20 to 23 inches, Coho Salmon over 26 and Brown Trout up to 23" should not be eaten by children age 15 or under, pregnant women, women who may become pregnant, or nursing mothers. All others should limit their consumption to one meal per week. • No known restriction on wildlife consumption.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
ii) Tainting of fish and wildlife flavor Use impairment confirmed	IDEM staff have identified degraded fish populations. Tainting of the fish has occurred.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
iii) Degradation of fish a and wildlife populations Use impairment confirmed	Extremely pollution tolerant forms of fish such Carp and Oligochactes are dominant. There is a lack of a stable fish community in the river and harbor. As of yet, wildlife surveys have not been conducted.	Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination

Table 40. *Summary of environmental problems affecting the Indiana Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan area of concern (cont.)*

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OF CAUSE OF THE PROBLEM
iv) Fish tumors or other deformities Use impairment confirmed	IDEM Environmental scientist have discovered river and canal carp (bottom dwellers) with eroded fins, swollen eyes, swollen abdomens, deformed lower jaws and bloody fins. The bloody fins may be caused by internal hemorrhage.	- Contaminated Sediments - Input from Industries
v) Bird or animal deformities or reproduction problems Use impairment likely	The U.S. Fish and Wildlife will be conducting wildlife studies in this area in the near future. Great Lakes Studies have found deformities in migratory birds. The Area of Concern has many migratory species. Although it is not known if these birds were contaminated in this areas, bird and animal deformities or reproduction problems are likely.	- Toxics - Contaminated Fish Tissue - Degraded Water Quality - Contaminated Sediments - Combined Sewer Overflows - Input - Urban Runoff - Groundwater - Air Toxics
vi) Degradation of Benthos Use impairment confirmed	A sampling of benthic organisms showed that only sludge worms inhabited the Indiana Harbor, suggesting that severe pollution exist. Studies concluded that sediments were toxic or avoided by other benthic organisms.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
vii) Restrictions on dredging activities Use impairment confirmed	Due to the concern of contaminated sediments and the disposal concerns, no dredging activities have occurred in several years.	- Contaminated Sediments

Table 40. *Summary of environmental problems affecting the Indiana Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan area of concern (cont.)*

IMPAIRED USE EVALUATION	EXISTING CONDITIONS	SOURCE OF CAUSE OF THE PROBLEM
viii) Eutrophication or undesirable algae Use impairment confirmed	Species of diatoms, which favor eutrophic conditions, have increased in abundance in the near shore Lake Michigan waters. The waters of the Grand Calumet River and the Indiana Harbor and Canal have persistent water quality problems leave in and the near shore Lake Michigan and the river and the harbor have decreased water clarity.	- Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities
ix) Restrictions on drinking water consumption, or taste and odor problems Use impairment likely	The Area of Concern is serviced by public drinking water supply from Lake Michigan waters. There appears to be no public safety problems with this water. The CARE Committee anonymously voted that there were restrictions with drinking water from the Grand Calumet River and the Indiana Harbor, although this is not a public water supply.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
x) Beach closings Use impairment confirmed	Due to poor water quality, swimming is not recommended in the river or canal. Along the nearshore waters of Lake Michigan, the Hammond beach has been closed for several years. In 1990, Chicago beaches and the Indiana Dunes National Lakeshore were closed due to high coliform counts, but the source may or may not have been from the Area of Concern.	- Combined Sewer Overflows
xi) Degradation of anesthetics Use impairment confirmed	Debris litter the Banks of the Grand Calumet River and the Canal. The banks of the harbor appear to be saturated with petroleum. The river and the harbor often have an oily sheen. The nearshore Lake Michigan waters often appear murky.	- Contaminated Sewer Overflows - Groundwater Contamination - Spills

Table 40. *Summary of environmental problems affecting the Indiana Harbor and Canal, the Grand Calumet River and the Nearshore Lake Michigan area of concern (cont.)*

IMPAIRED USE EVALUATION		EXISTING CONDITIONS	SOURCE OF CAUSE OF THE PROBLEM
xii)	Added cost to agriculture or industry Use impairment confirmed	Due to the accumulation of sediments in the harbor, and restrictions for removal of the sediment due to environmental concerns, industry reports shipping capacity is reduced by 15% and therefore has a substantial increase in shipping cost.	- Contaminated Sediments
xiii)	Degradation of phytoplakton and zooplanton populations Use impairment confirmed	The lack of suitable habitat results in a scarcity of aquatic and terrestrial organisms associated with the Grand Calumet River and the Indiana Harbor Canal. Phytoplaton counts are very low in the Nearshore Lake Michigan waters in the Area of Concern.	- Contaminated Sediments - Industrial and Municipal Effluents - Combined Sewer Overflows - Urban Runoff - Input from Industries and Municipalities - Spills - Groundwater Contamination
xiv)	Loss of fish and wildlife habitat Use impairment confirmed	A combination of lack of food resources, low dissolved oxygen and toxic stress have resulted in the lack of a stable resident fish community in the Indiana Harbor and canal and the Grand Calumet River. The wildlife has greatly diminished this century.	- Industrialization - Draining and Filling of Wetlands - Degraded Water Quality - Contaminated Sediments

The Gary STP was involved in judicial proceedings throughout 1988 and 1989. Raw sewage bypassing from a lift station occurred frequently during 1989 impacting the Grand Calumet River. This facility has a history of poor management and efforts to correct these problems have met with little success. The sewer system is in a state of disrepair, as is the treatment facility. Combined sewer discharges during wet and dry weather have caused degradation of the Grand Calumet River. Equipment problems are also a factor despite the new additions. However, during 1991-92, the facility met its permit limitations.

Gary has agreed to accelerate the implementation of its pretreatment program by identifying industrial users, issuing permits to previously unpermitted industrial users, hiring more pretreatment personnel, revising its industrial pretreatment ordinance, and revising agreements with the cities of Hobart, Lake Station, Merrillville and outlying conservancy districts. In addition, the City of Gary will provide funds to clean up polluted sediment in the Grand Calumet River. This project will supplement and enlarge the sediment remediation project proposed by U.S.X. Corporation in Gary under a 1990 agreement with U.S. EPA. Finally, Gary is planning a clean up of the Ralston Street sludge lagoon which contains 60,000 lbs of PCB's and is next to the Grand Calumet River. The consent decree provides a schedule by which Gary must submit its cleanup plans to EPA for approval and by which Gary must complete the cleanup.

The Gary Sanitation District has obtained approximately $30 million (including a $15 million low interest loan from IDEM) to reduce water pollution and install sewers in the Black Oak area. About half the money is earmarked for projects aimed at complying with the federal consent agreement under which the Sanitary District is to clean up its sewage effluent discharged into the Grand Calumet River.

In December 1992, USX plant personnel were notified of a large number of fish floating down Calumet River near one of their outfalls. The Indiana Department of Natural Resources estimated that approximately 21,000 fish were killed, although U.S. Steel personnel did not agree with the IDNR estimate. Preliminary results from water samples showed an elevated ammonia level, but no conclusion has yet been reached as to the cause of this fish kill incident.

Although discharges from the major industries and municipalities affect the quality of the Grand Calumet River, additional inputs are found along the river. Although they may not be as great in magnitude as those previously mentioned, they do contribute to the degradation of the waterway. These inputs are not only from point sources but include ship traffic in the IHC, parking lot runoff, and other nonpoint sources.

Although the water quality is far from desirable, it is showing improvement. Resident fish populations are evident. Carp, goldfish, golden shiners, fathead minnow, central mudminnow, black bullhead, pumpkinseed and green sunfish were collected in 1986, 1987 and 1988, and even some salmonids are found in the river in the autumn.

Macroinvertebrate sampling (Hester-Dendy samplers) in the past has shown that five main groups of organisms were present at nearly every site. The most obvious characteristic of this assemblage of organisms is that each group is tolerant to moderate organic pollution and reduced dissolved oxygen concentrations. The presence of many "facultative" organisms (especially odonates, certain midges and snails) and a few intolerant species indicated that severe oxygen depletions do not occur frequently. Stresses associated with toxic chemicals were indicated by most samples.Hester - Dendy macroinvertebrates samples taken in October 1993 are yet to be analyzed.

Fish flesh sampling for toxics in the GCR/IHC system has been done every other year since 1980. The Grand Calumet River (East and West Branches) and the Indiana Harbor Ship Canal are under a fish consumption advisory (Table 15) and the consumption of any species of fish from these waterways is not advised.

IDEM and U.S. EPA Region V staff completed fish community sampling in the Lake Michigan Basin Northwest in 1990. Water quality trends as assessed by this sampling in the Lake Michigan basin will be categorized into two stream divisions (East Branch Little Calumet River and Other Lake Michigan Tributaries) in order to facilitate presentation.

The East Branch of the Little Calumet River division of the Lake Michigan drainage includes Burns Ditch, the East Branch of the Little Calumet River and its tributaries (e.g. Salt Creek, Reynold's Creek and the unnamed tributary in the river's headwater). A total of 28 headwater and wading sites were sampled for fish community structure analyses in the East Branch Little Calumet River division during Central Corn Belt Plain Ecoregion sampling in 1990. A total of 48 species were collected and were numerically dominated by centrarchid species (black bass and sunfish). The headwaters of the East Branch of the Little Calumet River, Reynold's Creek and the unnamed tributary, possessed high biological integrity comprised of many salmonid species and more tolerant species from Lake Michigan. These areas were the best observed in this basin although they only achieved a "fair" evaluation for water resource classification.

The overall water quality of the East Branch Little Calumet River division ranged between a low of 12 (very poor) to a high of 45 (fair) based on Index of Biotic Integrity scoring criteria developed during the current investigation. The biotic integrity of the East Branch Little Calumet River division declined with increasing drainage area. The number of sites approximated a highly skewed curve (towards degraded conditions) with respect to water quality as determined from index scores. The following was the percent occurrence of total East Branch Little Calumet River Division stations (28) within each index classification: fair 14.29% (4 stations); poor 46.43% (13 stations); very poor 39.29% (11 stations). Consequently, 86% of the sample sites in this basin failed to achieve use attainment standards for biologically assessed water quality. Fish were collected at all sites in the division. Sites which had low index values were primarily because of poor habitat and anthropogenic influences from industrial and municipal dischargers. The low flows of some tributaries caused the accumulation of soft substrates in adjacent riffle and pools, effectively reducing available habitat, and dredged streams reduced habitat complexity. Reynold's Creek was an exceptional stream in the East Branch division. An unnamed tributary in the Little Calumet headwaters, and the Little Calumet headwaters near the Indiana Dunes National Lakeshore's Heron Rookery had relatively high index of biotic integrity scores.

The other Lake Michigan Tributaries division of the Lake Michigan drainage includes the Grand Calumet River basin and the West branch of the Little Calumet River and its tributaries (e.g. Deep River, Turkey Creek and Hart Ditch).

A total of 20 headwater and wading sites were sampled for fish community structure analyses in the Lake Michigan division during Central Corn Belt Plain Ecoregion sampling in 1990. A total of 36 species were collected and were numerically dominated by centrarchid (black bass and sunfish) species. Nowhere in this divison were there outstanding reference locations. However, the single location which scored the highest was on the Little Calumet River at Cline Avenue. This area was the best observed in this basin segment although it only received a fair evaluation with respect to its water resource classification.

The overall water quality of the Lake Michigan division ranged between a low of 12 (very poor) to a high of 44 (fair) based on Index of Biotic Integrity scoring criteria developed during the current investigation. The biotic integrity of the Lake Michigan division was relatively degraded throughout, but a declining trend was evident with increasing drainage area. The number of sites approximated a highly skewed curve (towards degraded conditions) with respect to water quality. The following was the percent occurrence of total Lake Michigan Division stations (20) within each index classification: fair 5.0% (1 station); poor 10.0% (2 stations); very poor 85.0% (17 stations). This basin division produced the lowest IBI scores of those sampled. Within the Lake Michigan Division basin, 95% of the sample sites failed to meet use attainment standards for biologically assessed water quality. Fish were collected at all sites in the division. Sites which had low index values were due to poor habitat and toxic influences caused by industrial and urban land uses. The low flows of some tributaries caused the accumulation of soft substrates effectively reducing available habitat, and dredged streams reduced habitat complexity.

The West Branch of the Little Calumet River has a peculiar flow regime with a portion of the River flowing eastward towards Burns Ditch and a westward flowing segment towards Illinois. The hydrologic division between the two occurs near Indianapolis Boulevard depending on Lake Michigan level. The eastward flowing segment has relatively better quality potential than the westward flowing segment. The barriers to overall improvements in water resource quality include the presence of landfills and frequent oil and hazardous waste spills into the river. Waste diversions from municipalities also are quite frequent, resulting in only the most tolerant taxa existing as a resident community. The headwaters of Deep River are extremely degraded and can be attributed to municipalities along the upper portions of Niles Ditch, Main Beaver Dam Ditch, and Turkey Creek.

The Grand Calumet River has been a well-studied basin with numerous investigations conducted over the past three decades. The overall quality of the River is very poor even though a high proportion of cattail marsh wetland lies along the basins margins. Overall, habitat is not the limiting factor in the improvement of this basin since enough refuges exist to facilitate the colonization of impacted areas after the perturbations have been removed. The high degree of industrialization along the river's banks is the principal cause of toxic influence impacting the aquatic community.

The Grand Calumet River and the Indiana Harbor Ship Canal (GCR/IHC) receive 90% of their flow from municipal and industrial point sources. Treated industrial process water and effluent from municipal wastewater treatment facilities have been identified as major contributors to poor water quality in the GCR/IHC.

Effluent controls of point source discharges are being put in place to improve water quality as part of the National Pollution Discharge Elimination System (NPDES). However, at the present time there are two chronic problems which are not adequately addressed by the NPDES Program. They are (1) discharges from combined sewer overflows (CSOs) that remain uncontrolled, and (2) nonpoint source discharges, including urban and industrial runoff, that contain pollutants.

The Indiana Department of Environmental Management (IDEM) received a Grant from the United States Environmental Protection Agency (U.S. EPA) Region V to perform Whole Effluent Toxicity Testing (WETT) and selected chemical/metal analyses of CSOs and storm water runoff in the section of the Grand Calumet River east of the Roxanna Ditch. Objectives of this study were as follows:

- Determine the impact of pollution loading to the GCR during wet weather.
- Identify site specific pollutants originating from various types of industry in the GCR drainage area.
- Establish technical guidelines for IDEM to develop storm water discharge permit strategies for the study area.
- Establish a model for future testing of potential pollutants that impact the waters of Northwest Indiana.
- Provide data for IDEM to establish a long range plan to control combined sewer overflows for the study area.

The overall length of this study segment of the Grand Calumet River is approximately 11 miles. A map depicting the study area is shown in Figure 56.

The majority of the flow in the East Branch of the Grand Calumet River comes from USX Gary outfalls. The majority of the flow in the West Branch comes from East Chicago STP discharges.

The Indiana Harbor Ship Canal flows north toward Lake Michigan carrying all flows from the East Branch and partial flows from the West Branch of the Grand Calumet River. The Indiana Harbor Canal was not included in this study.

Water toxicity testing was done to determine the impact of CSO's and stormwater discharge samples as measured by acute toxicity to the freshwater species Ceriodaphia dubias and Pimephales promelas.

Table 41 presents a summary of the acute toxicity test results by sample location. The discharge locations are separated into three groups. The first group contains those locations which clearly exhibited acute toxicity (i.e. calculable LC50). The second group includes those locations which had one or more samples which indicated some degree of toxic effect (i.e. <90% survival in 100% sample), but not enough mortality to produce an LC50. The third group includes those locations which did not exhibit any toxic effects in the samples collected and tested.

Just six of the twenty-three sample locations had significant acute toxicity to at least one of the test species for the samples collected and tested. (Significant toxicity is indicated by an LC50 which is less than 100% concentration). Two of these locations had significant acute toxicity in both of the samples collected during this study.

Figure 56. *Map of study area with CSO and stormwater discharge locations around the Grand Calumet River*

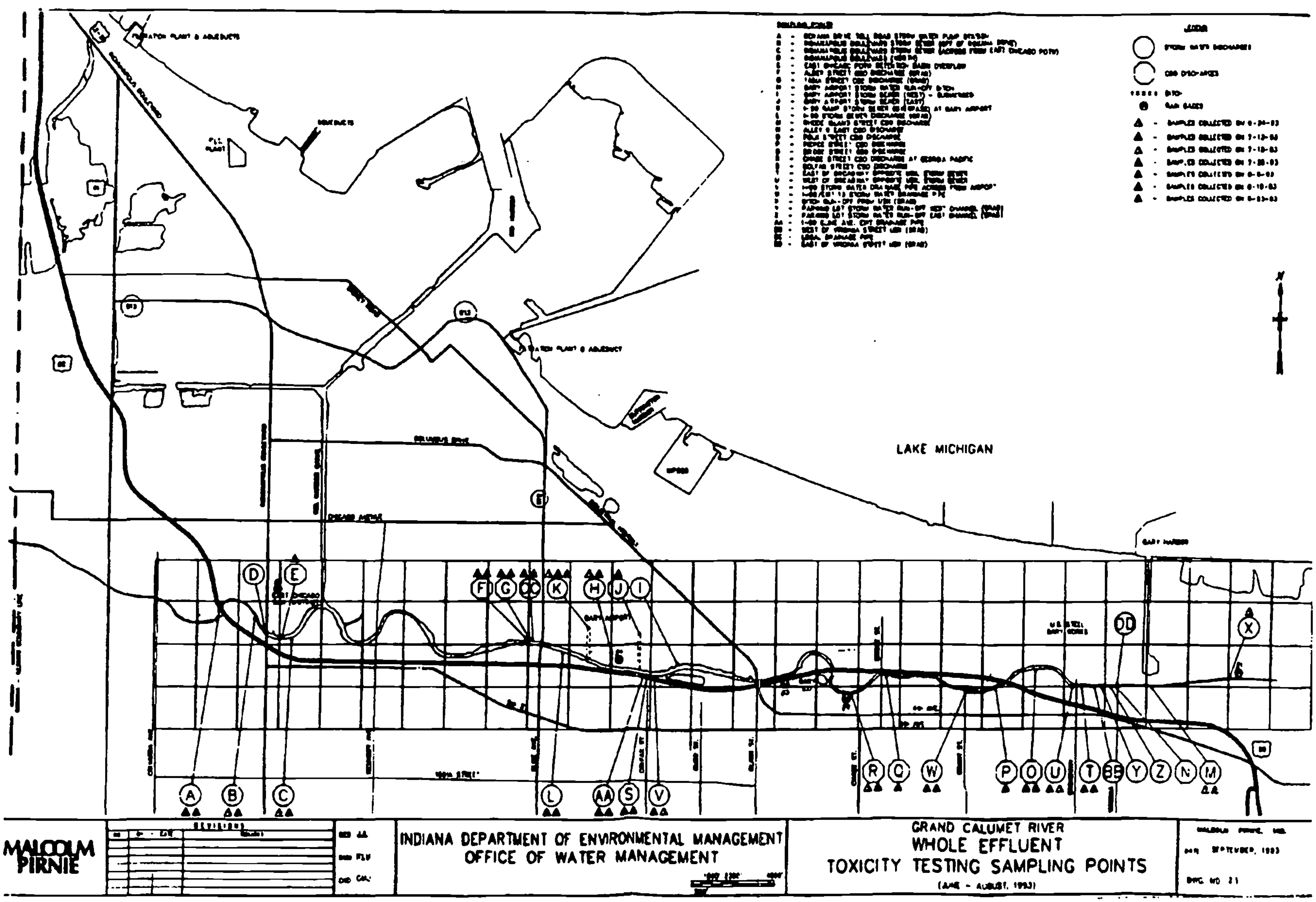


Table 41. *Summary of toxicity results by sample location*

SITE I.D.	SAMPLE SITE LOCATION	DISCH. TYPE	NUMBER OF SAMPLES	NUMBER OF TOXIC SAMPLES (1)	NUMBER OF SLIGHTLY TOXIC SAMPLES (2)
M	Gary S.D. Rhode Island St.	CSO	2	2	2
A	East Chicago S.D. pump station	SW	2	2	0
R	Gary S.D. Chase St. CSO	CSO	2	1*	1
F	Alder St. pump station	CSO	2	1*	1
S	Gary S.D. Colfax St. CSO	CSO	2	1	0
H	Gary Airport ditch	SW	2	1	0
C	E. Chicago sewer at power lines	SW	2	0	1
0	Gary S.D. Polk St. CSO	CSO	2	0	1
U	West of Broadway near USX	SW	2	0	1
AA	I-90 at Cline Avenue	SW	2	0	1
CC	Cline Avenue access road	SW	2	0	1
B	N. Roxanna/Indianapolis Blvd.	SW	2	0	0
E	E. Chicago S.D. retention basin	CSO	1	0	0
G	145th St/ pump station	CSO	2	0	0
J	Gary Airport runway sewer	SW	1	0	0
K	Gary Airport Toll Road	SW	3	0	0
L	Toll Road at Airport	SW	2	0	0
P	Gary S.D. Pierce St. CSO	CSO	1	0	0
Q	Gary S.D. Bridge St. CSO	CSO	1	0	0
T	East pf Broadway near USX	SW	2	0	0
V	Gary Airport at I-90	SW	2	0	0
W	Exit 13 I-90	SW	2	0	0
X	USX	SW	1	0	0

Notes: DISCHARGE TYPE: CSO = Combined Sewer Overflow Discharge
SW = Storm Water Discharge

(1) Toxic samples are those samples with LC50 less than 100% effluent.

(2) Slightly toxic samples are those samples with survival in 100% concentration > 50% but less than 90%.

* Toxic to both species.

"Slight toxicity" refers to those samples which had survial rates greater than 100%, but had survival in 100% sample concentration of greater than 50% but less than 90%. Five additional locations (other than those which also had significant toxicity) had at least one sample with slight toxicity.

The remaining twelve discharge locations did not have any samples collected which exhibited toxic effects. Thus, just over half of the stormwater and CSO discharge locations sampled had completely non-toxic discharges during this study.

A breakdown of the toxicity test results by type of discharge location is as follows:

	No. of Toxic	Slightly Toxic	No. of Non-Toxic	Total
CSO discharge:	4	1	4	9
Stormwater Discharge:	2	4	8	14

This breakdown suggests that the CSO discharges into the GCR are somewhat of a greater problem than the stormwater discharges. In addition, the CSO discharges were significantly greater in volume. The CSOs thus discharge more pollution and have more input on a particular section of the Grand Calumet River. Review of the specific chemical data (Table 42) for the twenty-nine parameters analyzed for this project suggests two general observations:

- The levels of these specific pollutants present are in general not very high in the samples collected for this study;
- The highest concentrations of any metal or cyanide in any of the toxic samples was less than the highest corresponding concentration found in any of the non-toxic samples.

These observations suggest that none of the specific chemical parameters analyzed for in this study were the primary cause for the acute toxic effects observed for these specific samples. Further study and analyses would be necessary to determine specific chemical pollutant cause(s) for toxicity.

Neither treatment nor control of all stormwater discharges into the Grand Calumet River (GCR) appears practical, as efforts to treat toxicity or control stormwater discharges would involve significant amounts of money. A more practical approach would be to locate and remove the source of the toxicity.

Pollution impact by discharges to the Grand Calumet River can be relative to the current stream quality of the river. Therefore, further toxicity testing as well as a benthic study on the river could help IDEM determine if the discharges further exacerbate the stream quality.

Table 42. *Summary of chemical analyses results for toxic samples*

PARAMETER	UNIT	SAMPLES WITH TOXICITY (LOCATION/EVENT)								MIN OR MAX OF SLIGHTLY TOXIC SAMPLES		MIN OR MAX OF NON-TOXIC SAMPLES	
		A/1 SW	M/1 CSO	R/3 CSO	H/4 SW	M/4 CSO	A/6 SW	S/6 CSO	F/7 CSO	MIN	MAX	MIN	MAX
Alkalinity	mg/L CACO3	22	230	205	265	160	70	118	170	42	-	25	-
Aluminum	mg/l	0.39	0.153	0.179	0.0272	0.281	0.583	0.777	6.45		1.84	2	6.09
Arsenic	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0106		<.005		0.006
Cadmium	mg/L	<.005	<.005	<.005	<.005	<.005	<.005	<.005	<.005		<.005		0.006
Calcium	mg/l	9.42	57.1	43.3	95.2	46	22.5	29.1	54.1		46.1		121
Carbonaceous BOD_5	mg/l	12.3	20	47.1	<2.0	84.4	32.1	26.7	133.3		41.4		21.9
Chemical Oxygen Demand	mg/l	45/3	70	150	45.3	175	138	91.6	886		256		1167
Chloride	mg/l	14	111	93	202	89	40.49	37.5	100		110.47		530
Chromium	mg/L	<.010	<.010	<.010	<.010	<.010	0.012	<.010	0.019		0.024		0.03
Copper	mg/L	0.022	0.014	0.011	<.010	<.010	0.038	0.016	0.069		0.021		0.215
Cyanide, total	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		<0.010		0.082
Grease & Oil	mg/L	<2.00	<2.00	6.437 J	<2.00 J	2.758 J	5.79	3.29	18.85		9.136 J		4.66
Hardness	mg/L CaCO3	31.2	202.7	162.9	321.7	162.2	72.3	101.7	181.6	65.2	-	32.2	-
Lead	mg/L	<.100	<.100	<.100	<.100	<.100	<.100	<.100	0.125		<.100		0.319
Magnesium	mg/l	1.86	14.6	13.3	20.4	11.5	3.9	7.04	11.3		11.2		48.9
Mercury	mg/l	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005		0.0033
Nickel	mg/L	<.020	<.020	<.020	<.020	<.020	<.020	<.020	<.020		<.020		0.105
Nitrate-Nitrogen	mg/L	0.88	<0.20	<0.20	0.83	<0.20	1.57	<0.20	<0.20		1.62		2.79
Nitrite-Nitrogen	mg/L	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.24	<0.20		<0.20		<0.20
Nitrogen-Ammonia	mg/L	0.72	4.64	10.3	6.41	3.28	0.43	3.05	4.59		3.15		7.8
Nitrogen-Total Kjeldahl	mg/L	1.56	8.75	16.7	8.21	8.81	2.27	5.82	21.4		8.36		9.21
pH	pH Units	6.83*	7.47	7.19	7.63	7.01	7.18	7.21	6.93	7.05	7.61	7.11	8.64
Phenolics, recoverable	mg/L	<0.02	<0.02	0.106	<0.02	0.034	0.052	0.061	0.0517		0.142		0.07
Phosphorous, total	mg/L	0.23	0.88	1.88	<0.20	1.07	0.57	0.62	6		1.33		1.41
Selenium	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		0.0057		<0.005
Sulfate	mg/L	11.3	47.9	23.2	86.2J	47.8	36.7	31.2	101		53		362
Total Organic Carbon	mg/L	13.84	50.16	50.68	19.64	60.85	41.18	28.96	146.6		30.43		60.11
Total Suspended Solids	mg/L	18	13	22	<10.0	40	26	69	620		232		864
Zinc	mg/L	0.09	0.068	0.136	0.067	0.144	0.179	0.187	0.533		0.387		0.884

It is recommended that an evaluation of actual flows treated at the STPs versus the design peak flows be conducted. STPs should begin to characterize their CSO systems and/or maximize flows to STPs for treatment.

In summary, 210 stream miles were assessed for aquatic life uses in the Lake Michigan Basin - Northwest. Of these assessed waters, 24 miles (11%) fully supported their designated uses, and 186 miles (89%) did not support designated uses. Of the 102 stream miles assessed for recreational uses, none supported this use. In addition all 43 shoreline miles (241 square miles) of Lake Michigan are considered to only partially support designated uses.

Lake Michigan Basin - Northeast

In the Lake Michigan Basin - Northeast, approximately 788 miles were monitored and/or evaluated to determine support of use designations. Table 43 summarizes the waters assessed, support status, miles affected, and probable causes of impairment. Additional information on certain stream reaches is also provided in this table.

The St. Joseph River enters Indiana from Michigan near Bristol in Elkhart County. From there it flows west through Elkhart and South Bend (St. Joseph County) where it turns north and returns to Michigan. The cities of Bristol, Elkhart, Mishawaka and South Bend operate wastewater treatment plants with direct discharges to the St. Joseph River. The largest industry which discharges to the St. Joseph is Uniroyal Inc., of Mishawaka. ConRail in Elkhart discharges to Crawford Ditch which flows into the St. Joseph River. Four dams are located in the river and are used to generate power during periods of peak demand.

Although the St. Joseph River segment in Indiana is less than 40 miles long, the Indiana drainage basin covers 1,778 square miles and six counties. Water quality data from fixed water quality monitoring stations at Bristol, Mishawaka, and South Bend show almost no violations of water quality standards except for E. coli.

A portion of the St. Joseph River from the Twin Branch Dam near Mishawaka to the Indiana-Michigan state line has been designated as a salamonid stream. Through a cooperative effort between Indiana and Michigan, fish ladders were built at dams in South Bend, Mishawaka and in Michigan, and a cold water hatchery is in operation at Mishawaka, Indiana. The salamonid stocking program and the removal of migration barriers will enable trout and salmon to move up the river from Lake Michigan to Mishawaka.

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Turkey Creek	Lake Vilage	FS (Aquatic Life) FS (Recreational)	Monitored (c)		9.0	
Turkey Creek	Syracuse	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.0	
Turkey Creek	Milford	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	9.3	High suspended solids as result of algae bloom.
Turkey Creek	Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		3.0	
Skinner Ditch	Syracuse	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.8	Ditch choked with lilly pads and heavy algae. Limited access.
Coppes Ditch (Lower reach)	Leesburg Milford	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Sewage Discharge	1.5	
Coppes Ditch	Leesburg Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		8.5	
Hoopingarner Ditch	Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.5	
Preston Miles Ditch	Milford Junction	FS (Aquatic Life) FS (Recreational)	Evaluated		4.2	
Kiefer Ditch	Milford Junction	FS (Aquatic Life)	Evaluated		6.1	
Dausman Ditch	Milford	FS (Aquatic Life)	Monitored (c)(b)		8.8	Biological Assessment "Fair".
Swoveland Ditch	New Paris	FS (Aquatic Life) FS (Recreational)	Evaluated		7.0	
Wisler Ditch and Tributaries	Wakarusa	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	17.8	
Werntz Ditch	Wakarusa	PS (Aquatic Life)	Monitored (c)		4.0	Lack of dilution water for Wakarusa STP lagoon waters. Stream also impacted by cattle operations. Limited use stream.
Grimes/Barkley Ditches	Wakarusa	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	25.0	Recreational uses impaired due to nearby cattle operations.
Baugo Creek	Wakarusa	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	10	
Baugo Creek	Jamestown	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.7	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Uhl Ditch	South Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		7.5	
Little Elkhart Creek	South Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		0.3	
Little Elkhart Creek	South Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		2.2	
Little Elkhart Creek	South Milford	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.5	
Little Elkhart Creek	Wolcottville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.6	
Little Elkhart Creek	Wolcottville	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli	0.7	Wolcottville STP should be upgraded to alleviate treatment problems.
Little Elkhart River and tributaries	Topeka Middlebury	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	30.0	Farm areas, Middlebury STP impact stream.
Tributary from Blackman Lake including trib from unnamed pond to Adams Lake	South Milford	FS (Aquatic Life) FS (Recreational)	Monitored (c)		3.2	
Bixler Lake Ditch	Kendallville	FS (Aquatic Life) FS (Recreational)	Monitored (c)		2.0	Cadmium slightly high but not affecting water quality.
Henderson Lake Ditch	Kendallville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.96	
Tributary to Round Lake	Kendallville	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.9	
Waterhouse Ditch	Albion	NS (Aquatic Life) FS (Recreational)	Monitored (c)	D.O. Iron	1.7	
Oviatt Ditch	Rome City	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.7	
Oliver Lake Outlet Tributary	Eddy	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.5	
North Branch Elkhart River	Eddy	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.8	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
North Branch Elkhart River	Cosperville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.1	
North Branch Elkhart River	Cosperville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.1	
Tributary to Jones Lake	Rome City	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.0	
Branch from Little Lake to Lake Jones	Rome City	FS (Aquatic Life) FS (Recreational)	Monitored (c)		3.4	
Gretzinger Ditch	Brimfield	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.1	Insignificant flow. Bordered by farmland.
Tributary from Munk Lake to Clock Creek	Brimfield	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.9	
Clock Creek	Brimfield	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.65	Marshy/muddy conditions.
Dry Run	Brimfield	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.0	
Boyd Ditch	Cosperville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1	
Huston Ditch	Wawaka	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.2	
Jacobs Ditch	Cosperville	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.0	
Thumma-Rousch Ditch	Bakerstown	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.0	
Forker Creek	Burr Oak	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.36	Occasional low D.O. due to heavy duckweed cover in areas.
Brown Ditch/Parker Ditch	Burr Oak	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.6	
Winebreenner Branch	Merriam	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.0	
Carrol Creek	Wolflake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.0	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
South Branch Elkhart River	Albion	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.9	
South Branch Elkhart River	Albion	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.9	
South Branch Elkhart River	Albion	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.9	
South Branch Elkhart River	Wawaka	FS (Aquatic Life) FS (Recreational)	Monitored (c)		13.2	Some low D.O. values due to Marshland.
Rimmell Branch	Bakertown	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.3	
Croft Ditch	Albion	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	D.O. Ammonia E. coli	1.7	
Croft Ditch	Albion	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.7	Heavy algae growth.
Long Ditch	Albion	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	4.0	
Tributary from Lower Long Lake	Port Mitchell	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.4	
Elkhart River	Ligonier	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.75	Variety of fish found; bass, pike bluegill, etc.
Elkhart River	Ligonier	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.2	
Elkhart River	Goshen	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	10.0	
Elkhart River	Goshen	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (c)		7	
Eaton Creek	Fremont	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	4.4	
Unnamed tributary from Fremont STP	Fremont	NS (Aquatic Life) FS (Recreational)	Monitored (c)	pH Chlorides Copper	3.0	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Toll Road Rest Stop Tributary	Fremont	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.0	
Follette Creek	Jamestown	FS (Aquatic Life) FS (Recreational)	Monitored (c)		.05	
Follette Creek	Glen Eden	FS (Aquatic Life) FS (Recreational)	Monitored (c)		2.2	
Unnamed tributary from Walters Lake	Angola	FS (Aquatic Life) FS (Recreational)	Monitored (c)		3.6	
Crooked Creek	Jamestown	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.4	
Crooked Creek	Nevada Mills	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.7	
Crooked Creek from Tamarack Lake	Orland	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.3	
Bell Lake Ditch	Nevada Mills	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.4	
Unnamed tributary from Lime Lake	Nevada Mills	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.5	
Orland Tributary	Orland	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Low D.O. E. coli	1.0	
Fawn River from Fawn River Fish Hatchery	Greenfield Mills	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.8	
South tributary to Lake James	Crooked Lake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	0.4	
Lake James/Lake Jimmerson Channel	Lake James	FS (Aquatic Life) FS (Recreational)	Monitored (c)		.1	
Ditch to Little Center Lake	Angola	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.5	Metals in sediment. Dana Corporation effluent discharges into this ditch.
East tributary to Crooked Lake	Glen Eden	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.9	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Southeast tributary to Crooked Lake	Crooked Lake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.7	E. coli counts of 940/100 ml.
South tributary to Crooked Lake	Crooked Lake	PS (Aquatic Life) PS (Recreational)	Monitored (c)	E. coli	1.1	Insignificant flow during dry weather.
Tributary between the Third Basin of Crooked Lake and Lake Loon	Iverness	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.4	
Lake Gage/Lime Lake Channel	Panama	FS (Aquatic Life) FS (Recreational)	Monitored (c)		0.3	
Pigeon Creek	Angola	FS (Aquatic Life) FS (Recreational)	Monitored (c)		8.0	
Pigeon Creek from Pigeon Lake	Angola	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.0	E. coli counts of 420/100 ml.
Pigeon Creek from Mud Creek	Angola	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Ammonia E. coli	1.5	Continuation of problems with ammonia and E. coli from Mud Creek. Also poor treatment from Angola STP.
Pigeon Creek from CR 400	Pleasant Lake	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.5	
Pigeon Creek from Golden Lake	Angola	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.3	
Pigeon Creek from Hogback Lake	Flint	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.4	
Pigeon Creek from Otter Lake	Flint	FS (Aquatic Life) FS (Recreational)	Monitored (c)		2.6	
Ewing Ditch	Angola	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.6	E. coli counts of 1600/100 ml.
Berlin Court Ditch	Berlin	PS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli D.O.	3.9	
Mud Creek from Angola STP Discharge	Angola	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Ammonia Low D.O. E. coli	3.0	Poor treatment from Angola STP.

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Johnson Ditch	Hudson	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli TSS Low D.O. Ammonia	5.7	Impairments from Pigeon Creek Rest Area.
Trout Creek	Bristol	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.0	
St. Joseph River	Bristol	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	7.6	
St. Joseph River	Elkhart	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.9	
St. Joseph River	Elkhart	FS (Aquatic Life) FS (Recreational)	Monitored (c)		12.3	
St. Joseph River	Mishawaka	PS (Aquatic Life) NS (Recreational)	Monitored (c)	PCBs E. coli	3.2	Salmonid classification. Fish Consumption Advisory.
St. Joseph River	South Bend	PS (Aquatic Life) NS (Recreational)	Monitored (c)	PCBs E. coli	2.6	Fish Consumption Advisory.
Sheep Creek	Bristol	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8.0	
Pine Creek	Bristol	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	18.0	
Peterbaugh Creek	Elkhart	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.0	
Christianna Creek	Elkhart	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.0	
Osborn-Manning Ditch	Elkhart	PS (Aquatic Life)	Monitored (c)		3.8	
Cobus Creek	Elkhart	FS (Aquatic Life) FS (Recreational)	Monitored (c)		11.0	
Crawford Ditch	Elkhart	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Metals Oil E. coli	.75	
Auten Ditch	South Bend	PS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Ammonia	1.5	Impacts from two mobile home parks and Berliner-Maux industry.
Juday Creek	South Bend	FS (Aquatic Life)	Monitored (c)		24.6	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Solomon Creek	Cromwell	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Nonpoint source	3.7	Cromwell STP adds to E. coli count.
Cromwell Ditch	Cromwell	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.7	Intermittent stream.
Meyer Ditch	Cromwell	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	20	Channelized drainage ditch with no point sources, but E. coli exceeds standard.
Stoney Creek	Millersburg	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2	
Long Ditch/Dry Run	Millersburg	FS (Aquatic Life) FS (Recreational)	Monitored (c)		8.0	
Rock Run Creek and tributaries	Goshen	FS (Aquatic Life) NS (Recreational	Monitored (c)	E. coli	42.0	
Turkey Creek	Bushy Prairie	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.0	
Pigeon River	Mongo	FS (Aquatic Life) FS (Recreational)	Monitored (c)		2.3	
Pigeon River	Howe	FS (Aquatic Life) PS (Recreational)	Monitored (c)	E. coli	1.7	
Pigeon River	Scott	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.0	
Pigeon River	Scott to State Line	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.0	
Fly Creek	LaGrange	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	10.1	
E. Fly Creek	LaGrange	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.8	
Rowe Ditch	Howe	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.3	
West Buck Creek	Valentine	NS (Aquatic Life) NS (Recreational)	Monitored	Low D.O. E. coli	4.0	Low D.O. from lack of stream aeration after going through wetlands
Van Netta Ditch	Seyberts	FS (Aquatic Life) NS (Recreational	Monitored (c)	E. coli	2.0	

Table 43. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the Lake Michigan Basin - Northeast (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Page Ditch	Shipshewana	FS (Aquatic Life) NS (Recreational)	Monitored (c)	TSS E. coli	6.0	Impacts from Shipshewana Lake and STP.
Buck Creek	Seyberts	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.5	
Unnamed tributary	Shipshewana	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Ammonia TSS D.O. E. coli	2.1	Impacts from Shipshewana STP.
Fawn River	Scott	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.5	
Wagner Ditch	Nappanee	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.5	
Nunemaker-Township Ditch	Nappanee	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.0	
Rogers Ditch	Nappanee	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.0	
Mather's Ditch	Middlebury	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli D.O. Endrin	10	

1 PS = Partial Support; NS = Non Support; FS = Full Support. If a use is not listed, it was not monitored or evaluated
2 b = biological; c = chemical.

Although an apparently diverse fish community exists along the entire length of the St. Joseph River, the portion of the river in St. Joseph County is rated as only partially supporting the aquatic life use because of a fish consumption advisory on carp due to high PCB levels in tissue of this species. The source of these pollutants are not known. Due to the frequency of high E. coli levels, the designated recreational use is not supported throughout the river. A possible source of some of these high E.coli levels could be dry weather bypassing at the Elkhart wastewater treatment plant caused by a series of mechanical failures and electrical outages. There was also nearly 100 sewer overflow (CSOs) found along much of the river which may contribute to this problem.

Stream sampling during 1992 consisted of sampling the entire length of the St. Joseph River and tributaries in Indiana from the Michigan/Indiana line north of Bristol, Indiana to the Indiana/Michigan state line north of South Bend.

The Bristol STP is a 0.23 MGD facility. At the time of sampling, the effluent met all permit limits, but the ammonia and phosphorus content was found to be rather high. This discharge may have an immediate effect in the mixing zone but it is not evident downstream because of the high dilution in the St. Joseph River. A late 1992 inspection found ammonia at 7.3 mg/l and phosphorus at 23.3 mg/l. High levels of ammonia and phosphorus are representative of conditions typical for an organically overloaded wastewater treatment plant. This problem was occurring as a result of the inability to remove adequate amounts of sludge from the treatment system. For this facility, it may be necessary to investigate the sources for these high phosphorous concentrations to determine if pretreatment is necessary, especially before recommending an upgrade to it's treatment facilities. Ammonia removal, although improved over the 1991 inspections, is still inadequate.

Sheep Creek, located three miles west of Bristol, flows through Timberbrook Mobile Home Park and a small pond before it receives the effluent from the mobile home park sewage treatment plant, and enters the St. Joseph River. High E. coli values were found both upstream and downstream of the STP. Although Sheep Creek is small, it would support aquatic life downstream of the mobile home park pond.

Pine Creek meanders through wooded residential and farm areas to its confluence with the St. Joseph River. The creek supports aquatic life but high E. coli concentrations, probably from runoff and animal access to the creek, make the creek nonsupportive of recreational uses.

Peterbaugh Creek is another tributary to the St. Joseph River. The two miles of Peterbaugh Creek upstream from Heaton Lake does not support recreational uses due to high E. coli counts but aquatic life is fully supported. The last 3.8 miles from Heaton Lake to the St. Joseph River is fully supportive of both recreational and aquatic life uses.

Located near the headwaters of Osborn-Manning Ditch, northwest of Elkhart, is an abandoned Himco landfill. Two sites were grab-sampled for heavy metals and organic chemicals from both the sediment and water. Results of lab analyses indicated that neither metals nor organics were present in concentrations of concern in either the sediment or water samples. However, levels of metals in the sediments at the site downstream of the landfill were considerably higher for all metals sampled than at the site upstream of the landfill. This may indicate that metals are getting into the stream from the landfill.

Crawford Ditch, another St. Joseph River tributary, had an oily sheen from State Road 33 to approximately 200 ft. downstream. The sediment is saturated with oil. Conrail Railroad Yards is located at the headwaters of the ditch, and surface runoff can enter the ditch. Conrail Yards was not discharging during the survey, but surface runoff and leaking around the Conrail baffle contributed a trickle flow. Although there are no other dischargers to the stream, there are other industries near Crawford Ditch that can contribute surface runoff to the stream.

Metal and organic parameters were analyzed at several sites in Crawford Ditch. The copper value at one sampling site was below the acute aquatic life criteria but above the chronic criteria level. The sediment analysis, while still classified as a low concern, shows the copper level at the upstream station as being nearly 10 times the maximum state background level. PCB's (aroclor 1260) were found at 500 ug/kg in the sediment, 20 times the maximum state background value. Crawford Ditch is full of weeds and full of black sludge near the headwaters but has a sandy bottom near the St. Joseph River. The black sludge probably comes from the oily runoff from the ConRail Railroad Yards. This ditch is nonsupportive of recreation and aquatic life uses.

Auten Ditch which flows through South Bend receives discharges from the Clearwater Mobile Home Park, Berliner-Maux, and the Price Country Estates Mobile Home Park. The water quality would not support full body contact recreation because of high E. coli counts. Ammonia levels were also high. Auten Ditch is impacted from Clearwater Mobile Home Park and Berliner and Maux discharges as the phosphorus and E. coli levels were elevated downstream of these two facilities.

Juday Creek above Grape Road is approximately 10 feet wide and less than one foot deep. There are grasses in the stream and it has steep banks in the upstream segment. Downstream of Grape Road, the creek is flatter and wider. Juday Creek supports both aquatic life and recreational uses.

Turkey Creek originates at the outlet of a small chain of lakes in southwest Noble County. After flowing northwesterly for approximately nine miles, Turkey Creek flows through Lake Wawasee and Syracuse Lake. From the outlet of Syracuse Lake, the stream flows generally northwesterly to its confluence with the Elkhart River south of Goshen. The drainage basin of 182 square miles is primarily agricultural in nature. Much of the watershed is devoted to pasture and other livestock operations, and stream is extensively used for livestock watering in certain areas.

The Towns of Syracuse and Milford operate municipally owned sewage treatment plants (STPs) that discharge directly to the stream. Syracuse Rubber Products discharges cooling water to Skinner Ditch approximately a mile upstream of the confluence of Skinner Ditch and Turkey Creek. This confluence is upstream of the Syracuse STP. All NPDES permit parameters were within limits at this discharge.

The New Paris Creamery has a wastewater treatment system that is a direct discharge to Turkey Creek. This is a lagoon system and due to its size discharges are infrequent if at all.

Turkey Creek, as it exits Lake Village is supportive of all uses for approximately nine miles. The water quality is also probably indicative of the lake water quality as the lake is fairly isolated (this lake was not monitored for water quality). From State Road 5 to Lake Wawasee, Turkey Creek flows through a series of wooded wetlands. Although there are no pollution sources along this path the water quality at the inlet to Lake Wawasee does not support full body contact as determined by the E.coli standards.

At Syracuse, Turkey Creek had low dissolved oxygen values at a sampling point immediately downstream of the Syracuse STP. The stretch of Turkey Creek both downstream and upstream of the STP is heavily choked with algae. From the Syracuse City limits to Milford the stream flows through rural areas which include crop, pasture, and woodlands. There are no point source discharges here, but E. coli concentrations in this reach are much higher than immediately below the Syracuse STP. The stream is therefore not supportive of full body contact recreation. The stream provides good aquatic habitat but very limited access.

Just upstream of the Milford Wastewater Treatment Plant, the stream flows through a combination of pasture, woods, and croplands. Three stations were sampled in this reach and all had very good water quality except for E. coli. The stream offers excellent aquatic life habitat and should fully support this use. Stream characteristics could also support full body contact if the bacteriological concentrations were lower. High E. coli concentrations occurred both upstream and downstream of the Milford STP. The last three miles of Turkey Creek to the confluence with the Elkhart River support all uses.

Coppes Ditch is an open, channelized, drainage ditch originating at Leesburg. Sewage from Leesburg is discharged to the headwaters. The first 1.5 miles of the stream has little flow and slope. In this stretch the stream is not supportive of aquatic life or recreational uses due to the sewage discharge.

Haverstick Ditch is a tributary of Darkwood Ditch. Both Ditches drain rural areas with no point source discharges. The water quality should support aquatic life if there is sufficient flow. Full body contact recreation would not be supported due to high E. coli concentrations.

Wagner Ditch is a wide, channelized, drainage ditch which is a tributary of Turkey Creek. It is algal choked and no visible flow was apparent upon inspection. The stream resembles a long narrow lake. Heavy algal growths created a dissolved oxygen range from 21 mg/l during daylight hours to 0.7 mg/l at night. The pH also varied from 9.5 to 7.4. The only life forms observed were frogs and turtles. This stream can probably support some aquatic life on a seasonal basis, but the stream would not support full body contact recreation due to high E. coli concentrations.

Berlin Court Ditch, upstream of Nappanee, is channelized with deeply cut banks. Flow is intermittent and the stream is weed choked. There is little or no recreational potential due to natural stream conditions. Two stations were sampled in this reach. The highest dissolved oxygen value recorded during sampling in 1991 was 3.3 mg/l. Berlin Court Ditch in Elkhart County from the Nappanee STP to two miles downstream is designated as a limited use stream.

The Nappanee STP is a fairly new plant and is producing good effluent. During dry periods, the plant effluent is practically the only flow in Berlin Court Ditch. As a result of the extended dry weather and low flow the stream was alternately long pools and short riffles. An algal bloom extended from approximately two (2) miles downstream of the STP to the Turkey Creek confluence. Stream flow actually decreased from just below the STP downstream.

After leaving the city limits, Berlin Court Ditch winds through cropland and pasture to the Turkey Creek confluence. The dissolved oxygen concentrations ranged diurnally from more than 20 mg/l to less than 4 mg/l. The pH values ranged from 9.5 to 7.4.

Even with the dissolved oxygen variations, fish and other aquatic life were observed in the pools. Body contact recreation is not supported due to E. coli concentrations and naturally occurring factors. The aquatic life use could be considered as partially supported.

Baugo Creek begins with the confluence of Wisler Ditch and Billman Ditch approximately 1.5 miles northwest of Wakarusa in southwestern Elkhart County and flows in a generally northerly direction to its confluence with the St. Joseph River at Osceola. The total drainage area is approximately 80 square miles.

Thirteen (13) stations were sampled in Baugo Creek. One low dissolved oxygen value (3.6 mg/l) was noted at the first station downstream of the Wakarusa STP effluent ditch in an early morning sample. Fish were observed in this area, and no other water quality problems were noted at any other sites except for some high E. coli concentrations.

Overall, this stream should support aquatic life. There were some diurnal dissolved oxygen variations at all stations but only one was below standard. Some stretches within this reach are very scenic. Full body contact recreation is not supported due to E. coli violations most likely caused by farm operations, STP effluent, and stock watering in the stream.

Land use in the Baugo Creek basin is primarily agricultural (approximately 92%), most of which is cropland and pasture. The remainder, which constitutes the lower end of the basin, is a transitional area from agricultural to suburban residential. Portions of Baugo Creek and its tributaries are heavily used for livestock watering.

Werntz Ditch and tributaries, from its headwater to Baugo Creek, frequently have no flow. Werntz Ditch is upstream of the small tributary which receives the effluent from the Wakarusa STP waste stabilization pond. This pond is not meeting permit limits for suspended solids due to a heavy algae bloom. This facility, the only point source discharge to Werntz Ditch, has a regulated discharge and flow is usually consistent at 0.360 MGD. The E. coli concentration in the effluent was below the permit limits.

Werntz Ditch was sampled at its confluence with Baugo Creek. At this point the only significant flow is the lagoon effluent. There was a wide range in dissolved oxygen values as a result of the algae bloom, but none of these values were less than 5 mg/l. Large carp were noted at this station. Werntz Ditch is a limited use stream and only partially supports the aquatic life use due to impacts from dairy cattle operations.

Barkey Ditch and Grimes Ditch combine approximately 0.1 mile upstream of the confluence with Baugo Creek. Both streams drain primarily agricultural land with occasional woodlands. There are no point sources on either stream. Samples collected from the combined stream just upstream of the Baugo Creek confluence determined that the water quality was good. These two streams therefore, support aquatic life. Full body contact recreation cannot be supported due to stream size and E. coli concentrations resulting from farm or cattle operations.

Nunemaker Ditch and Township Ditch combine approximately 0.6 miles upstream of their confluence with Baugo Creek. The stream characteristics and drainage basins of these two streams are essentially the same as that of Barkey and Grimes Ditches.

The stream formed by Nunemaker and Township Ditches was sampled just downstream of their confluence. Flow was less than one cubic foot/second (cfs) in the combined stream. Water quality was good except for E. coli violations. These violations are attributed to farm run-off and septic tank discharges. There are no point sources in the area. These streams can support aquatic life, but not full body contact recreation.

Rogers Ditch was sampled approximately 0.3 mile upstream of the confluence with Baugo Creek. This stream is impacted by farm and cattle operations. Water quality was very good except for E. coli concentrations. Water quality would support aquatic life, but full body contact recreation is not supported.

The Upper Elkhart River segment is situated primarily in Noble County except for a small northern portion which lies in southern LaGrange County. The major population center for this area is the City of Kendallville. This segment also includes the smaller Towns of Wolcottville, Rome City , Albion and the community of Bear Lake all of which have NPDES discharges. Small communities without NPDES discharges are South Milford, Witmer Manor, Cosperville, Wawaka, Brimfield, Wolf Lake, Port Mitchell and Kimmell.

This segment consists of both the South Branch and the North Branch of the Elkhart River which includes Little Elkhart Creek as a major tributary. These branches meet a few miles east of Ligonier to form the Elkhart River. Both branches are noncontinuous due to a network of lakes causing numerous interconnecting reaches. Both Elkhart River and Little Elkhart Creek have generally good water quality except for occasional violations of E. coli bacteria criteria.

Industrial activity is confined to two areas in this segment. A number of industries located in Kendallville discharge to the Kendallville STP. A few industries located in Albion discharge to the Albion STP. Except for Albion Wire, which is permitted for storm water runoff only, there are no direct industrial dischargers in this segment.

Lower than normal rainfall for the months of June and July correlated to the likewise significantly less than average stream flows during the survey period in late August and early September of 1990. The less than normal precipitation correlates to slower moving, pooled and, in some cases dry stream conditions. Algal blooms were more prevalent and increased variation in some field data (i.e., greater D.O. fluctuations and higher pH values) were found than might be obtained during a summer with more normal precipitation.

Little Elkhart Creek from Creek Lake to Tamarack Lake is bordered by marshland for its entire length. The flow was very slow and shallow. The sediment appeared to be heavy silt and mud, and minnows were observed in this reach. This waterbody can be considered supportive of warm water aquatic life but nonsupportive of full body contact recreation due to high E. coli concentrations.

From Tamarack Lake to Nauvoo Lake, Little Elkhart Creek is bordered predominately by marshland and has swampy characteristics. The flow is shallow and slow with rooted aquatic plants abundant. The bottom is muddy, the water was clear, and minnows were observed. This reach can be classified as supportive of warm water aquatic life but nonsupportive of full body contact recreation due to E. coli concentrations.

The Wolcottville STP discharge and a stream sampling station near the entry to Witmer Lake were sampled and used to assess the water quality of this reach of Little Elkhart Creek. The Wolcottville discharge was found to be violating $TBOD_5$ and total suspended solids permit limits. Poor removal was observed for phosphorus (3.67 mg/l or 36% removal) and a high ammonia level of 9.4 mg/l was found in the effluent. The Wolcottville STP is an old, outmoded plant, which should be upgraded in order to alleviate the treatment problems.

Based on an upstream flow, a 33.5:1 dilution ratio existed in Little Elkhart Creek on the survey date and the only observed water quality violation at the downstream sampling station was for E. coli which was also exceeded in the effluent sample. This waterbody should be classified as supportive of warm water aquatic life but not of full body contact recreation.

Bixler Lake Ditch from Bixler Lake to Henderson Lake is channelized through the southern part of Kendallville where some small businesses and industries are present. In addition to the routine stream station parameters, water samples for heavy metals were collected as were sediment samples for priority pollutant analysis. Laboratory analyses indicated antimony and cadmium sediment levels were slightly above maximum statewide background levels for non-polluted Indiana stream sediments. These levels were not adversely effecting water quality, however, since no elevated values were found for either metal in water samples. Carp, bass and minnows were observed during sampling. This stream should support both aquatic life and recreational uses.

Stream sampling stations located on Henderson Lake Ditch, which is the receiving waterbody for the Kendallville STP discharge, showed few water quality problems except for high E. coli levels. Water samples for heavy metals and a sediment sample to be analyzed for all priority pollutants were collected at the upstream station and there were no outfall pipes observed between the lake outlet and the sampling site. All water and sediment analyses at this stream station indicated no degradation. These findings classify this waterbody as being supportive of warm water fishery but non-supportive of full body contact recreation.

Waterhouse Ditch was found to have D.O. values below the water quality standard. The highest D.O. value found was 4.7 mg/l and the 24-hour average was 3.4 mg/l. An orange coating on the bottom throughout the stream indicated the presence of a high iron content. The low D.O. values, high iron content, and low temperatures seem to indicate that this stream is spring fed. None of the above conditions were existent at the outlet of Little Long Lake. Laboratory analyses revealed no other degradation was present. This stream should be considered non-supportive of warm water aquatic life due to low dissolved oxygen levels, but supportive of full body contact recreation as the stream standard for E. coli was not exceeded.

Clock Creek is predominately bordered by marshland and woodland. The water was very turbid and pooled and scum and dead algae clumps were prevalent. There was no fish life observed due to the turbid conditions. Based on the sample analyses, this stream can be designated as supportive of warm water aquatic life but non-supportive of full body contact recreation due to E. coli levels.

High E. coli counts were found along six miles of Dry Run, near the Town of Brimfield which has a large sawmill. Except for the Brimfield area, this waterbody is predominantly bordered by farmland. The water was clear with minnows observed. This stream should be designated as supportive of warm water aquatic life but non-supportive of full body contact recreation.

Huston Ditch was channelized and bordered predominately by cropland. The ditch had clear water with some algae growth on the bottom. Huston Ditch is supportive of warm water aquatic life but non-supportive of full body contact recreation due to high E. coli levels.

The Chain of Lakes Park STP discharge is located on the Thumma-Rousch Ditch. The STP discharges 36,000 gallons once every two weeks and was not discharging during this survey. The sample analyses indicated no degradation was present in this stream. Woodland predominantly borders the stream with some farmland present. The water was clear with some minnows observed. This stream can be classified as supportive of warm water aquatic life and recreational uses.

Sampling stations on Forker Creek had substandard D.O. values (low of 3.7 mg/l) and some high E. coli counts. Stream flow along this reach was very slow with some duckweed cover observed in some areas. The stream was bordered by pasture land and some heavily wooded areas on both sides. Fish were present at the sampling site. Forker Creek can be considered supportive of warm water aquatic life but non-supportive for full body contact recreation.

Winebrenner Branch is predominately bordered by cropland with some woodland present. Minnows and bluegill were observed in this slightly turbid stream. This waterbody can be considered supportive of warm water aquatic life but nonsupportive of full body contact recreation due to some high E. coli levels.

On Carrol Creek, a very small trickle of raw sewage was observed from the Bear Lake Conservancy District bypass and a sludge bank had formed immediately downstream. Tall brush, woodland, and cropland were the predominant bordering features for this stream. Bluegill were observed in an isolated pool. This stream would support aquatic life uses but not recreational uses due to high E. coli counts.

Samples from two stream stations located upstream and two stations located downstream of Albion were used to assess Croft Ditch. Both sampling stations on Croft Ditch upstream of Albion displayed high E. coli counts. The stream here is bordered predominantly by cropland and some woodland. The stream was observed to have some algal growth but no fish life was seen at either stream site. This reach of Croft Ditch should be classified as supportive of warm water aquatic life but threatened due to potential BOD and ammonia problems from a stock watering pond. Full body contact recreation is not supported due to the high E. coli concentrations.

The Albion STP, which is a controlled discharge facility, was not discharging due to the low flow conditions in Croft Ditch. The two Croft Ditch downstream stations showed high E. coli counts and significant diurnal D.O. fluctuations. Heavy patches of algae were observed at one of these sampling locations.

Croft Ditch is bordered predominately by cropland, woodland, and the Albion STP lagoons along this reach. Minnows were observed at a sampling station here. This waterbody can be classified as supportive of warm water aquatic life but not supportive of full body contact recreation.

The North Branch of the Elkhart River, which includes Boyd Ditch, begins at Waldon Lake. Samples from these streams had high E. coli counts but no other water quality problems. The water is slightly turbid with a brownish tint. Bass and minnows were observed at some sampling sites. This waterbody is supportive of a warm water fishery, but non-supportive of full body contact recreation.

The main stem of the South Branch of the Elkhart River is bordered almost exclusively by marshland. Flow is very slow with patches of duckweed in pockets where velocity is slow or nonexistent. The water was very turbid with a greenish tint at the time of inspection. Marginal D.O. values were observed at two sampling stations, which were probably due to an algae bloom and duckweed suppressing sunlight (and prohibiting photosynthesis) over portions of the stream. The waterbody can be classified as supportive of warm water aquatic life and all but a short portion supports full body contact recreation.

As the Elkhart River moves from the North and South Branch confluences, high E. coli counts were the only observed water quality problems. The water was lightly turbid with aquatic plants prevalent. A variety of fish, especially bass, pike and bluegill, were observed in this reach, which would support aquatic life but would not support recreational uses in most areas.

The Upper Elkhart River study as a whole showed 30 of 47 sampled stream stations exceeded the Indiana single sample stream standard of 235/100 ml for E. coli. These exceedences are very prevalent and may occur in locations where no apparent pollutant sources exist. It is assumed, therefore, that most of the observed levels occur as a result of nonpoint sources. The high level of agricultural activity may contribute to these levels in some locations.

The Lower Elkhart River segment begins just upstream of Ligonier and continues downstream to the confluence with the St. Joseph River at Elkhart. The drainage area within the segment is 411 square miles. This basin is predominantly agricultural with some forested areas and wetlands.

There are two (2) major pollution control facilities which discharge directly to the Elkhart River. The City of Ligonier STP discharges its effluent at mile point 41.2. This plant recently underwent complete reconstruction with a new design flow of 1.5 MGD.

The City of Goshen STP discharges at mile point 15.7. The design flow of this facility is 5.0 MGD. These municipalities have six combined sewer overflows (CSOs). Dry weather discharges from these overflows are prohibited.

Silgan Plastics Corporation at Ligonier has two cooling water discharges to the Elkhart River downstream of the Ligonier STP discharge. These discharges were very clear at the time of the inspection and met all permit limits.

Overall the water quality in this segment is supportive of aquatic life, but aquatic life forms are limited in some smaller streams due to flow variations, size of stream, and available habitat. The Elkhart River is supportive for full body contact recreation from Waterford Mills to the St. Joseph River confluence.

Approximately 10 miles of the Elkhart River below Ligonier are supportive of aquatic life; however, E. coli violations do not support full body contact recreation. One source of E. coli is the Ligonier Municipal STP which was under reconstruction during the sampling period. One combined sewer overflow was also discharging during the survey. This discharge is upstream of the STP.

Solomon Creek receives direct discharges from the Cromwell STP and the cooling water from the Maple Leaf Farms Duck Hatchery. Both facilities were within permit limits on all chemical parameters, but the Cromwell STP discharge contained 8200/100 ml of E. coli, which added to the bacteriological counts in Solomon Creek. Overall the water quality in Solomon Creek would fully support aquatic life. Full body contact is not supported due to E. coli concentrations from both point and nonpoint sources.

Cromwell Ditch is an intermittent stream and the Turkey Creek Regional Sewer District STP provides the only dry weather flow in certain reaches of the stream. Cromwell Ditch does not support aquatic life or recreational uses.

Meyer Ditch is supportive of aquatic life but not full body contact recreation. This is a channelized drainage ditch with no point sources, and the E. coli count exceeded the standard.

Stony Creek is the receiving stream of the tributary which carries the effluent from the Millersburg STP. Stony Creek is too small and inaccessible to provide significant recreational potential. The water quality should support aquatic life, as there were no standards violations, except for E. coli, at the time of sampling. These violations were noted both upstream and downstream of the tributary from the Millersburg STP. Stoney Creek flows into the Elkhart River approximately one mile south of Millersburg.

The reach of the Elkhart River from Goshen to the confluence with the St. Joseph River includes the discharge from the Goshen STP. Major tributaries within the stretch are Yellow Creek and Rock Run.

The Goshen STP is meeting all permit limits. There was little or no change in river water quality upstream to downstream of the discharge point. Mercury at 0.10 mg/l was detected in the raw sewage but not in the effluent. No other metals of concern were noted.

For the whole reach, ammonia-N values in the Elkhart River were less than 0.1 mg/l. The average dissolved oxygen value (of 54 total tests) for the river was 7.8 mg/l. No values of less than 4 mg/l were observed. One (1) of eleven (11) E. coli results was slightly above the 235/100 ml standard (250/100 ml). This reach is supportive for all uses based on the water quality during this survey.

Rock Run receives drainage from the east side of Goshen and enters the Elkhart River just downstream of the Goshen STP. The drainage system includes rural, residential, and industrial areas. The stream is supportive of aquatic life but not of full body contact recreation due to natural conditions and E. coli concentrations.

There are several municipal/industrial areas in the drainage area of the Little Elkhart River before it drains into the St. Joseph River near Bristol, Indiana, and the Pigeon River. The municipal areas are Shipshewana, LaGrange, Topeka and Middlebury. The largest industrial facility is Syndicate Store Fixtures of Middlebury which manufactures retail store display fixtures and metal specialty items.

The Little Elkhart River originates near Topeka, Indiana. This river flows through agricultural fields which are predominately Amish farmland. As the Little Elkhart River flows northeast to the St. Joseph River, the land use becomes urban. The river flows through the center of Middlebury which is located about eight river miles from the St. Joseph River. The Middlebury STP discharges directly to the Little Elkhart River. Syndicate Stores and Deutsch Kase Haus discharge to Mathers Ditch, a tributary of the Little Elkhart River.

Mathers Ditch includes tributaries from Cass Lake, Hunters Lake, East Lake and the Deutsch Kase Haus discharge. The three tributaries from the lakes in this section are quite small in size and flow. They do not support recreational uses because of high E. coli values and do not support aquatic life because of very low dissolved oxygen levels.

The Deutsch Kase Haus, which manufactures cheese products, did not meet its NPDES permit limits for BOD and TSS. The discharge is high in ammonia (5.1 mg/l) and E. coli (800/100 ml). The NPDES permit calls for these parameters only to be monitored. The total (33.0 mg/l) and ortho (28.8 mg/l) phosphorus values were extremely high. The first sampling site downstream of Deutsch Kase Haus, but before the confluence of the lake tributaries, had high

C-BOD (5.0 mg/l), E. coli (1500/100 ml), and phosphorus levels (15.8 mg/l), which can be attributed to the facility discharge. The average dissolved oxygen concentration (2.5 mg/l) is below the water quality standard.

The last sampling site in this reach of Mather's Ditch had a high E. coli value (5300/100 ml) and the phosphorus levels (0.45 mg/l) are above background value. Organics and heavy metals were analyzed in the water and sediment. Copper and nickel levels in the sediment were above statewide background levels. This section of Mathers Ditch does not support the full body contact recreation nor aquatic life uses due to the high E. coli and low D.O. levels.

The next 1.5 miles of Mathers Ditch includes the Syndicate Store Fixtures facility which discharges process water from a nickel-chrome electroplating line and detergent cleaning operation. Results of analysis indicated that all parameters were well within permit limits. Toxic organic compounds found in stream samples above detection limits were the chemicals endrin (0.16 ug/l) and endosulfan I (0.100 ug/l). The endrin value is slightly above Indiana's Water Quality Standards.

The Middlebury STP discharges directly to the Little Elkhart River upstream of the Mathers Ditch confluence. The facility met NPDES permit limits, but the ammonia (9.3 mg/l), E. coli (350/100 ml), and cyanide (0.037 mg/l) values were high. Samples from the stream did not show an impact from the facility. No toxic organic parameters were found above detection levels in the waters downstream of the outfall. However, the sediment samples taken upstream and downstream of the outfall had elevated levels, compared to state wide average maximum background values, for arsenic, chromium and nickel. This section does not support full body contact recreation because of the high E. coli count. The water quality would support aquatic life.

Below Middlebury, the Little Elkhart River flows to the St. Joseph River near Bristol, Indiana. This stretch of the river flows through a low, wet marshy area with some residential and agricultural land use. The entire 17.6 miles of the Little Elkhart River and several small tributaries are nonsupportive of full body contact recreation because of high E. coli levels. This stream does support warm water aquatic life.

The Pigeon River in Steuben and LaGrange counties, located in northeastern Indiana is 29 river miles in length. It flows through predominately agricultural land where it joins with the St. Joseph River in Michigan before it enters the state of Indiana. A fixed water quality monitoring station was placed on this put and take trout stream at the request of the Indiana Department of Natural Resources. Water quality data from this stream indicate that it is fully supporting of aquatic life, but only 2.3 miles would fully support whole body contact recreational uses. Approximately, 1.7

miles would partially support the recreational use near Howe, Indiana. Four miles of tributary ditches (Rowe and Vanetta) would not support recreational use due to high E. coli bacteria levels. Cattle often enter these ditches and may cause or contribute to the high E. coli levels.

Fly Creek, one of the two larger tributaries of Pigeon River, has its confluence with the Pigeon River southeast of Howe, Indiana. Fly Creek flows through agricultural land upstream and downstream of the City of LaGrange.

The LaGrange STP discharges into Fly Creek which flows through the city. The LaGrange STP recently had new construction completed and was meeting all NPDES permit limits at the time of sampling. However, there are numerous sewer overflow points along Fly Creek. Most of this reach downstream to the confluence of the Pigeon River does not support whole body recreational contact uses because of high E. coli values but does support aquatic life. The stream gets a little larger below the STP outfall and flows through low wetland areas.

Page Ditch, which begins at the Shipshewana Lake outlet is the other large tributary of the Pigeon River. It joins with the Pigeon River west of Scott, Indiana. The Shipshewana STP discharges to an unnamed tributary of Page Ditch. The land use in this area is largely agricultural.

The Shipshewana STP is a 0.080 MGD facility which consists of a flow equalization tank, oxidation ditch, and two tertiary ponds. The effluent exceeded its NPDES permit limit for ammonia (36 mg/l) and TSS (16 mg/l) and had a rather high phosphorus level of 1.56 mg/l. The flow from a summer flea market hydraulically overloads the facility when the market is open, which causes problems in handling the solids at the plant. During 1992, the town began expansion of the present wastewater treatment facility. This expansion, now completed, changed the design flow to 0.150 MGD and hopefully will eliminate these problems.

The tributary stream is not supportive of aquatic life nor recreational uses due to ammonia, D.O., and E. coli problems. Page Ditch is supportive of aquatic life uses but not full body contact recreation.

The Upper Pigeon Creek segment is situated in Steuben County, except for the southern tip which extends into DeKalb County and the northwestern corner which extends into LaGrange County. The major population center for this area is the City of Angola. This segment includes the smaller Towns of Fremont, Orland, Ashley and Hudson, in addition to many lake communities.

Two separate drainage systems are located here. The Fawn River watershed consists of a network of natural lakes and marshland interconnected by short stream reaches and tributaries. Major stream reaches in this watershed include Eaton Creek (the headwater of the watershed just south of Fremont), Follette Creek, Crooked Creek and Fawn River.

The second watershed is the Pigeon Creek main stem and tributaries which begin southeast of Fremont and flow southward and then westward through a chain of natural lakes in the south central portion of the segment. It then continues in a northwestern direction to the segment border at the Steuben-LaGrange County Line.

Three small industrial parks are located in this segment, one on the southwest side of Fremont, one on the southwest side of Orland, and one in the northwest quadrant of Angola. Only one facility within these industrial parks, Western Rubber in Fremont, has an NPDES Permit and it discharges to a small natural pond. One isolated NPDES discharger, Consolidated Freightways, is located in the northern portion of the segment and discharges to an unnamed tributary.

The Fremont STP effluent creates the headwater of an unnamed tributary to Eaton Creek. High influent levels of lead (270 ug/l) and mercury (3.3 ug/l) may be causing problems in the activated sludge process. Permit violations for total suspended solids and copper were found. Chloride levels in the effluent were also rather high (915 mg/l). The receiving ditch extends a short distance (less than 0.1 mile) before it enters a culvert under the Indiana Toll Road and then flows into Crane Marsh, a small Department of Natural Resources pond. Discharge from the pond is to a wetland area that merges with Eaton Creek. The physical characteristics of this reach are marginal for recreational use, but low E. coli counts would support full body contact recreation. The pH, chlorides, and copper levels in the Fremont final effluent indicate that this stream is non-supportive of the aquatic life use designation.

The Dana Corporation discharge combines with a storm sewer and then discharges through a pipe on the north side and to the headwater of an unnamed ditch which travels about 100 yards before entering Little Center Lake. On the southside and at the headwater is a storm sewer leading from the southeast. These two discharges create the total flow for this ditch. Based on instantaneous flows during the survey, the south pipe only made up about 5% of the flow to the ditch.

A Compliance Sampling Inspection (CSI) conducted at the Dana Corporation Facility revealed no permit violations, but other water quality concerns were observed. Based on samples of both the undiluted effluent and the storm sewer - plant effluent combined, there appeared to be water quality problems due to copper, lead, and zinc which were all found at levels exceeding water quality criteria in one or both of these samples.

Metals were also found in the sediment just downstream of the discharge at levels which were high compared to statewide maximum background levels. Copper was found at 2,000,000 ug/kg, lead at 340 ug/kg, and zinc at 1,800,000 ug/kg.

The south storm sewer water samples also had high lead levels as well as low D.O. values. Based on these findings, this ditch should be considered non-supportive of the warm water aquatic life use designations. Some degradation of Little Center Lake may also result due to these problems. Based only on E. coli levels, this reach would be supportive of the full body contact recreation use designation.

West Buck Creek, which flows from north of Oliver Lake to Buck Lake, is east of Shipshewana. This is a four mile stream which flows through wetlands. Water quality violations occurred for dissolved oxygen (2.8 mg.l) and E. coli (450/100). The low dissolved oxygen is probably due to the lack of stream reaeration after going through wetlands.

Three sampling sites were used to assess Mud Creek which receives the effluent from the Angola STP. Two were on Mud Creek and one was at the Angola STP outfall. Samples for all priority pollutants were collected from the STP effluent in addition to samples for routine parameters. An ammonia level of 8.6 mg/l in the final effluent exceeded the Angola STP permit limit. The Angola discharge creates the headwater of Mud Creek and no dilution water is present to counter the effects of the high ammonia. Based on field pH and temperature readings, ammonia was found to exceed chronic water quality standards at the two Mud Creek sampling stations. Additionally, ammonia was found to exceed the acute water quality standard at one of these two stations.

In addition to high ammonia, low D.O. levels were also observed in Mud Creek. One station had an average of 3.5 mg/l for the 24-hour compositing period (low value 1.1 mg/l) and another station had a 3.85 mg/l average (low value 2.3 mg/l). All of these values violate water quality standards. E. coli concentrations also exceeded water quality standards.

Mud Creek appeared degraded at all sampling locations. The water was very turbid and had a putrid odor. Mud Creek is a shallow stream which meanders through an agricultural area and has high grassy banks. There were no fish observed in this reach. Due to the stream degradation, Mud Creek is assessed as non-supportive of full body contact recreation and warm water aquatic life uses.

The Ashley STP is near the headwaters of Johnson Ditch. Due to maintenance at the Ashley STP, no discharge was taking place on the day of the survey. A treatment lagoon was being filled to facilitate the clearing of a second lagoon. Johnson Ditch flows predominantly through cropland and is channelized in places. The banks are grassy and steep. The stream is shallow and the flow is slow. Some algae was observed, but no fish life was evident. Sampling at two stations showed E. coli counts of 450/100 ml and 270/100 ml, respectively, which are above water quality standards.

The Pigeon Creek Rest Area STP discharges to an unnamed tributary upstream of the confluence with Johnson Ditch and just downstream of CR 500 South.The Pigeon Creek Rest Area final effluent contained an extremely high ammonia level (47.2 mg/l) and low D.O. levels (2.5 mg/l and 2.0 mg/l). Based on these findings, this waterbody is classified as non-supportive for warm water aquatic life uses.

As a whole, this segment study showed 15 of 41 stream stations sampled exceeded the single sample stream standard of 235/100 ml for E. coli. These exceedences are so prevalent, and occur in locations where no point sources were apparent, that many of the levels appear to be due to nonpoint sources. High farming activity and erosion may contribute to these high levels in some locations.

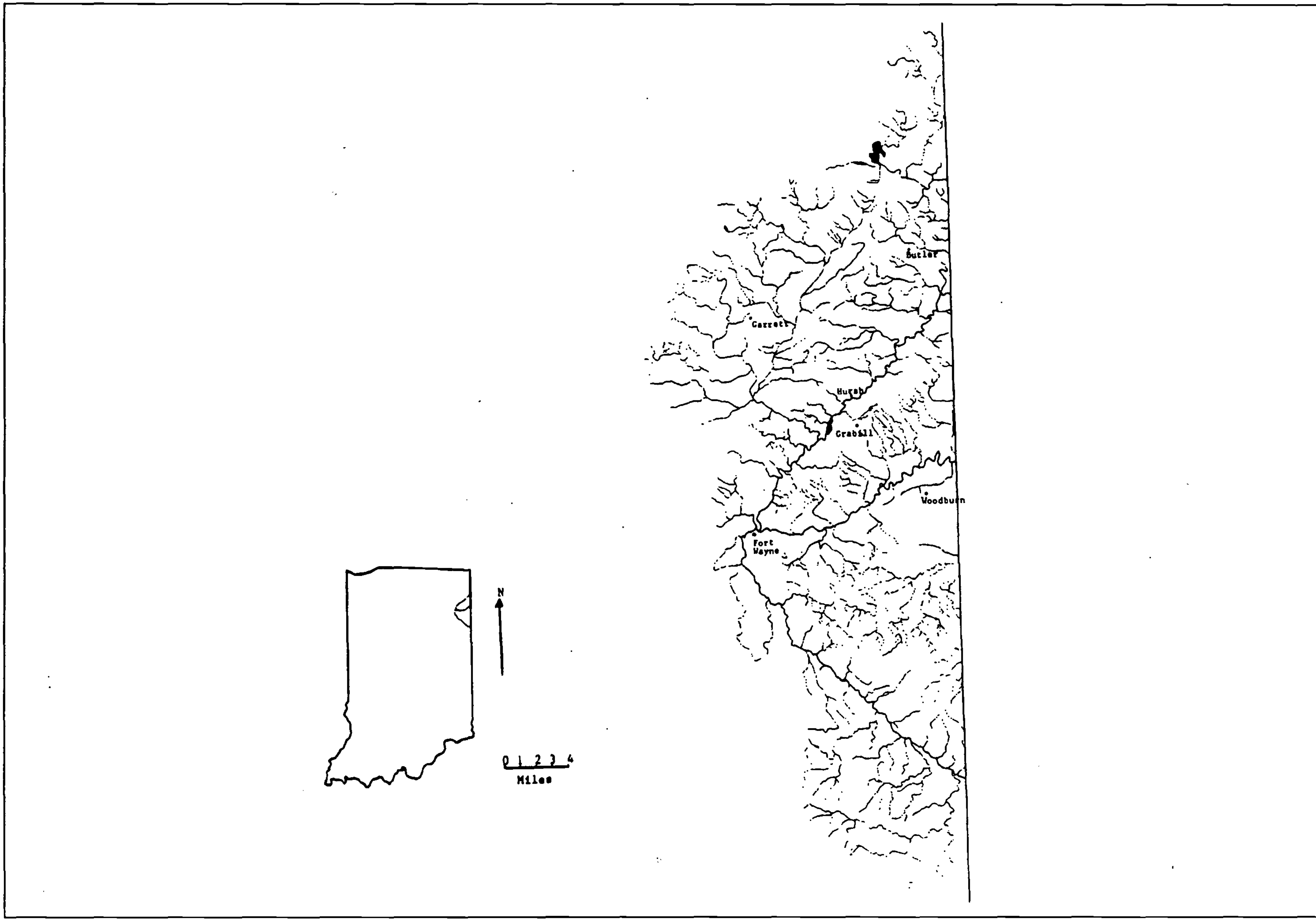
IDEM and U.S. EPA Region V staff collected fish community samples in the Lake Michigan Basin Northeast during the 1991 field season. These samples will be used to develop an Index of Biotic Integrity to be used as an indicator of water quality. Results from the 1991 sampling season are not yet available.

In summary, 788 miles of streams were assessed to determine the extent of support of aquatic life uses in the Northeast Lake Michigan Basin. Of these assessed waters, 639 miles (81%) fully supported this designated use, 10 miles (1%) are fully supportive but threatened, 57 miles (7%) only partially support this use and 82 miles (11%) are considered not supportive. Seven Hundred Eighteen (718) miles were assessed as to support of recreational use. Of these miles 287 (40%) were fully supporting, 3 miles (0.4%) were partially supportive and 428 (60%) were non supporting of recreational use designation.

Maumee River Basin

The Maumee River Basin is located in the northeastern portion of Indiana and drains portions of Adams, Allen, DeKalb, Noble, and Wells counties (Figure 57). The Maumee River drainage area within the borders of Indiana is approximately 1,216 square miles. The land use is approximately 80% agriculture, 10% urban, and the remaining 10% either forested or other classifications. This region is one of the major livestock and corn producing areas of Indiana. The watershed lies within the Tipton-Till and Lake Moraine geological regions.

Figure 57. *Maumee River Basin*



Water Quality Standards for the Maumee River Basin are covered under Regulation 327 IAC 2-1 of the Indiana Water Pollution Control Board. Cedar Creek is designated as an outstanding State Resource Water from river mile 13.7 in DeKalb County to its confluence with the St. Joseph River in Allen County. All streams in the basin are now designated for warm water aquatic life and whole-body contact recreational use. The waters assessed, the status of designated use support, probable cause of impairment and miles affected in the Maumee River Basin are shown in Table 44. Additional comments are also given for certain reaches.

The Maumee River Basin is comprised of three major rivers; the St. Joseph, the St. Mary's and the Maumee. The Maumee River originates in Fort Wayne at the confluence of the St. Joseph and St. Mary's Rivers. It then flows east into Ohio where it crosses the northern portion of the state toward Toledo and empties into Lake Erie.

The St. Mary's River originates near New Bremen, Ohio and passes through five small towns before entering Indiana near Pleasant Mills in Adams County. Upon entering Indiana, the St. Mary's River follows a northwesterly course through the town of Decatur in Adams County and on into Allen County and metropolitan Ft. Wayne where it meets with the St. Joseph River to form the beginning of the Maumee River. Major tributaries include Blue Creek, Yellow Creek, Borum Run, Holthouse Ditch, Gerke Ditch, Buhlman Ditch, Nickelsen Creek, Houk Ditch, Snyder Ditch, Harber/Fairfield Ditch, Junk Ditch and Newhaus Ditch/Spy Run. The total drainage area of the basin is approximately 400 square miles.

Land use in the St. Mary's River segment is predominantly agricultural which is divided nearly equally between cropland, pasture and untilled or wooded areas. There has been significant industrial development in and around incorporated communities in the basin. These include municipal, industrial and semi-public facilities. Most of the public water utilities in this segment use ground water as a source of supply. Ft. Wayne obtains water from the St. Joseph River, Cedarville Reservoir, and Hurshtown Reservoir.

From the Ohio State line, the first 10.8 miles of the St. Mary's River extends into the City of Decatur. This reach is predominately bordered by cropland and scattered residential homes. Water quality analyses of all the sampling sites revealed no degradation other than E. coli. Dissolved oxygen averaged 8.0 mg/l. Sediment samples were collected on the southeast side of Decatur and analyzed for heavy metals and organic chemical priority pollutants with no significant levels observed.

A survey conducted on the St. Mary's River during the late 1970's indicated major problems in the vicinity of Decatur. High E. coli counts and relatively high BOD_5 (averaged 9.6 mg/l in the Decatur area) were attributed

Table 44. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Maumee River Basin*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT	METHOD OF ASSESSMENT	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
St. Mary's River	State Line to Near Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	11.2	CSO problems and submergence of outlying septic systems during flooding. Decatur sewage problems.
St. Mary's River	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.5	Pesticide (dieldrin) found in sediment at low level of concern.
St. Mary's River	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	14.8	Copper found at low levels of concern in sediment.
St. Mary's River	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8.2	Pesticides in sediment is low level of concern. Polynuclear Aromatic Hydrocarbons (PAH's) in sediment at low level of concern. Copper and zinc found at medium concern levels in sediment. 4, menthylphenol found at low levels of concern in sediment.
Yellow Creek	Monroe	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli D.O.	14.3	Residential septic discharges. Sewage contamination. Agricultural run-off.
Blue Creek	Adams County	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli D.O.	14.9	D.O. <4.0
Habegger Ditch	Berne	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Ammonia D.O.	10.4	Agricultural run-off. CSO activity. Cadmium in sediment.
Little Blue Creek	Southeastern Adams County	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.8	Flooding and landwash contamination.
Blue Creek	Adams County	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	12.6	Agricultural run-off.
Twenty-Seven Mile Creek	Monroe	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.5	Agricultural run-off.
Borum Run	Southwest Decatur	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8.3	Whitehorse Mobile Home Park violating NPDES permit.
Koss Ditch	Decatur	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.3	
Holthouse Ditch	Decatur	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	20.4	Agricultural run-off.

Table 44. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Maumee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT	METHOD OF ASSESSMENT	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Gerke Ditch	Decatur	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli D.O. Ammonia	8.5	Slaughter house Septic tanks Pastureland
Bulhman Ditch		PS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Ammonia D.O.	8.9	D.O. ranged from 11.7 mg/l to 3.4 mg/l
Nickelson Creek	Preble	FS (Aquatic Life) FS (Recreational)	Monitored (c)		13.8	
Unnamed Tributary	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.2	Antimony found at medium concern levels in sediment.
Houk Ditch	Hoagland	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (c)	D.O.	2.6	D.O. level at 3.7 mg/l.
Houk Ditch	Hoagland	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	9.6	
Harber Ditch	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	11.8	
Harber-Fairfield Ditch	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	4.8	
Snyder Ditch	Ft. Wayne	NS (Aquatic Life) NS (Recreational)	Monitored (c)	D.O. E. coli	6.4	
Junk Ditch	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.9	Copper and zinc found in sediment at a level of low concern.
Newhaus Ditch	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.4	Dieldrin and chloroform were found in sediment samples at low levels of concern.
Spy Run	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)		7.2	
St. Joseph River	State Line to Allen County	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	18	TSS impact from nonpoint source.
St. Joseph River	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)	E. coli	23	TSS impact from nonpoint source.
Fish Creek	Hamilton	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	48.6	Farming practices.

Table44. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Maumee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT	METHOD OF ASSESSMENT	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Black Creek	Hamilton	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	4	Farming practices.
Teutsch Ditch	Butler	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.2	
Big Run Drain	Butler	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.3	
Big Run Drain	Butler	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli Ammonia	6.7	Ammonia from Butler STP.
Ayford Ditch	Butler	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.7	
Buck Creek	Butler	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3	Agricultural run-off.
Sol Shank Ditch	Newville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	15.6	Agricultural sources.
Swartz, Matson, & Smith Ditches	Waterloo	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	20.4	
McCullough Ditch	Waterloo	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.05	
Leins Ditch	Waterloo	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7	
Dibbling Ditch Hoffelder Ditch	Waterloo	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8	
John Diehl Ditch	Auburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	14.5	
Peckhart/Ober Ditch	Auburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8.9	
Grandstaff Ditch	Auburn	FS (Aquatic Life) FS (Aquatic Life)	Monitored (c)		1.5	
Garrett City Ditch	Garrett	NS (Aquatic Life) NS (Recreational)	Monitored (c)	D.O. Ammonia E. coli	3.7	Garrett STP.

Table 44. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Maumee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT	METHOD OF ASSESSMENT	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Dosch/Schnadel Ditch	Auburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.8	
Bear Creek	St. Joseph	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	15.2	Possible septic leaks from town of St. Joseph.
Hindman Ditch	St. Joseph	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.7	
Metcalf, Davis, Metcalf Ditch		FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	9.7	
Fisher Ditch	Spencerville	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.7	
Swartz-Carnahan Ditch	St. Joseph	NS (Aquatic Life) FS (Recreational)	Monitored (c)	D.O.	3.8	D.O. <4.0
Haifly Ditch	Grabil	FS (Aquatic Life(NS (Recreational)	Monitored (c)	E. coli	1.1	
Ely Run	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.5	
Tiernan Ditch	Ft. Wanye	NS (Aquatic Life) NS (Recreational)	Monitored (c)	D.O. E. coli	4	
Becketts Run	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.6	
Cedar Creek	Cedarville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	28.6	
Willow Creek	Huntertown	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli	13.5	Possible septic discharges.
Willow Creek Branch	Huntertown	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli D.O.	7	Septic tanks
Willow Creek Ditch	Huntertown	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli D.O.	7.3	Septic tanks
Little Cedar Creek		FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	32.5	

Table 44. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Maumee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT	METHOD OF ASSESSMENT	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
King Lake Ditch	Avilla	NS (Aquatic Life) NS (Recreational)	Monitored (c)	D.O. Ammonia E. coli	1	Avilla STP.
Black Creek Bilger Ditch	LaOtto	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	14	
King Lake Ditch	Avilla	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2	
Maumee River	Ft. Wayne	FS (Aquatic Life) FS (Recreational	Monitored (c)		20.7	
Maumee River	Woodburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.9	Fort Wayne CSO's wet weather bypasses
Harvester Ditch	Ft. Wayne	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (c)	Organics Metals	1.3	PAHs and metals in sediments.
Trier/BenderDoctor Ditch	Ft. Wayne	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	9.5	
Cochoit Ditch	Ft. Wayne	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.1	
Bullerman Ditch	New Haven	FS (Aquatic Life) NS Recreational	Monitored (c)	E. coli	7	
Martin Ditch	New Haven	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.1	
Six Mile Creek	New Haven	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3	Livestock.
Gar Creek	New Haven	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	11.4	Possibly from septic tank.
Summers Ditch	New Haven	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	1.9	Livestock.
Wilbur/Bottern Ditch	Woodburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	12.3	Nonpoint source run-off.
Grover Ditch	Harlan	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.6	Nonpoint source run-off.

Table 44. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Maumee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT	METHOD OF ASSESSMENT	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Black Creek	Woodburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	23.1	Possibly septic tanks.
Marsh Ditch/Edgerton-Carson Ditch	Woodburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.7	Woodburn STP wet weather bypasses
Viland Ditch	Woodburn	FS (Aquatic Life) FS (Recreational)	Monitored (c)		7.4	
Hamm Interceptor Ditch	Woodburn	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	15.72	Nonpoint source.
Flatrock Creek	Monroeville	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.45	
Flatrock Creek	Monroeville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8.0	
Adam-Shlemmer-Baker Ditch	Monroeville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.3	
Hoffman/Lepper/ McHenry/Bohnke Ditch	Monroeville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	27.5	Residual from recent flooding.

PS = Partial Support; NS = Non Support; FS = Full Support. If a use is not listed, it was not monitored or evaluated.

b = biological; c = chemical

to degradation near the mouth in Yellow Creek and a submerged bypass in Decatur. The 1992 Survey indicated that water quality had improved in Yellow Creek and that the submerged bypass had been discontinued. However, degradation was still existent as seen by high E. coli counts in the river. The average E. coli count for all the St. Mary's River sampling sites in the Decatur area was 15,800/100 ml.

Although the City of Decatur has discontinued their submerged bypass and made improvements at their CSO locations, they are still confronted with an antiquated main interceptor which runs alongside the St. Mary's River. This interceptor is subject to leaking during rain events and submergence during flooding which may account for the high E. coli counts found on this reach. The city is in the process of inspecting this interceptor using video equipment and may consider relocation if extreme deterioration is observed.

The next reach of the St. Mary's River is approximately 3.7 miles long. The initial portion of this reach begins in the City of Decatur and receives the discharges of the Decatur Sewage Treatment Plant and the Central Soya Company. During the survey, both were operating well and were in compliance with their NPDES permits. Monitoring sites within this area showed high E. coli counts (average 13,675/100 ml). As stated previously, the Decatur area reach was affected by the flooding and submergence of a main interceptor. Combined Sewer Overflow (CSO) activity and submergence of outlying septic systems during the flooding may have also contributed to the problem. Farther downstream from Decatur, progressively smaller counts of E. coli (700/100 and 350/100) were found. The average for dissolved oxygen was 8.9 mg/l, with no single reading below the stream standards.

A sediment sample taken downstream of Decatur revealed the pesticide dieldrin above detection limits at 3.3 ug/kg. There were no significant heavy metals concentrations found in the sediment at this location.

Another reach of the St. Mary's River extended 14.1 miles from the Adams/Allen County Line Road to the south side of Fort Wayne in Allen County. Except for two E. coli stream standard violations, the water quality is very good in this reach of the St. Mary's River. The average dissolved oxygen concentration was 10.2 mg/l for this entire reach. One unnamed tributary in this reach is reported to have been impacted by dumping of hazardous materials and this situation is being investigated by the Allen County Health Department. This same tributary has evidence of sewage contamination. The E. coli count was 42,000/100 ml, the highest level found in the St. Mary's River watershed. Water and sediment samples analyzed for heavy metals indicated no contaminants at levels causing concern.

The lower 8.2 miles of the St. Mary's River flows through Ft. Wayne before joining with the St. Joseph River to become the Maumee River. E. coli counts were relatively low for this reach of the St. Mary's River , but still above the standard.

Water quality of the St. Mary's River in the Ft. Wayne vicinity was of potential concern due to population and industrialization, and the inherent increase of discharges and municipal runoff associated with both. In a 1978 survey, dissolved oxygen was the only parameter monitored not meeting State Water Quality Standards. The dissolved oxygen levels were significantly improved in 1992 with all sites meeting standards for dissolved oxygen and all other parameters.

Sampling of water and sediments for toxic compounds indicated that a number of phthalate esters (plasticizers) were present at low levels at various sediment sampling locations, the highest being 2500 ug/kg. Low levels of pesticides were also found in the sediment in this reach. Dieldrin was found at one station at 5.6 ug/kg. DDT and its derivatives were found at levels slightly above detection (DDE at 2.6 ug/kg, DDD at 3.2 ug/kg, and DDT at 3.7 ug/kg).

Five polynuclear aromatic hydrocarbons (PAH) were found above detection limits in the sediment on the northwest side of Ft. Wayne. The compounds and their concentrations were naphthalene (470 ug/kg), phenanthrene (860 ug/kg), anthracene (9890 ug/kg), flouranthene (700 ug/kg), and pyrene (570 ug/kg). Although a particular point source for these compounds was not evident during the survey, they may have originated from one of the wire or steel industries upstream of this sampling site.

Bulhman Ditch begins near an isolated subdivision off U.S. Highway 27/33 and courses its way through cropland to its confluence with the St. Mary's River. An unnamed tributary and Schoder Ditch contribute to the Bulhman ditch watershed. A grab sample from the unnamed tributary downstream of a continuous septic discharge from a subdivision indicated stream degradation. The dissolved oxygen concentration was 3.5 mg/l, ammonia was 6.9 mg/l , and E. coli was 8,600/100 ml, all violations of Indiana standards for these parameters.

A grab sample collected on Schoder Ditch was found to have a dissolved oxygen concentration of 22.5 mg/l and sulfates at 920 mg/l, the latter exceeding the stream standard of 250 mg/l. There is no known source for the sulfates.

A third sampling site on Bulhman Ditch was located at U.S. Highway 27/33 situated downstream of the Oakridge Estates Mobile Home Park STP outfall. Water from this sampling site had a sulfate concentration of 280 mg/l, slightly in excess of the stream standard. The sulfate level may have been caused by a combination of the unknown source upstream on Schoder Ditch and a concentration of 490 mg/l in the Oakridge Estates Mobile Home Park outfall. The average dissolved oxygen was 6.5 mg/l, but a few individual samples were slightly below state standards. The Oakridge Estates Mobile Home Park was found to be in compliance with permit limitations.

The St. Joseph River originates near Hillsdale Michigan, flows southwest across the northwest corner of Ohio and enters Indiana in Dekalb County. It continues into Allen County where it joins the St. Mary's River, forming the Maumee River in Fort Wayne. The segment is predominately agricultural with significant industrial development located in and around the incorporated communities. The drainage area of this part of the St. Joseph River is 346 square miles. This drainage area includes the St. Joseph River and its small tributaries Fish Creek and Big Run Drain.

The only major population center in this segment is Ft. Wayne in Allen County. However, there are several small towns in this portion of the Maumee River Basin. They are Hamilton, in Steuben County; Leo and Cedarville in Allen County, and Butler, Newville, St. Joseph, and Spencerville in Dekalb County. Hamilton, Butler, Leo, Cedarville and Ft. Wayne are serviced by sanitary sewer systems. St. Joseph, Spencerville and Newville have septic tank systems.

Land use within the region is approximately 80% agricultural. Approximately 10% of the land is forested and the rest of the land is urban. Livestock and corn are major sources of income within this segment. The stream uses in this segment consist of boating and waterskiing, swimming, fishing and hydroelectric power. The City of Fort Wayne uses the St. Joseph River, Cedarville Reservoir and the Hurshtown Reservoir for its water supply. Most of the rural water supply comes from groundwater.

This segment is characterized by a flat to slightly rolling topography. Five lakes of significant size within the segment are Round Lake, Clear Lake, Long Lake, Ball Lake and Hamilton Lake, all located in Steuben County. The outlets of Round Lake and Clear Lake are to the north into Michigan. Long Lake's outlet is into Mill Stream Drain, which flows East into Michigan. Ball Lake and Hamilton Lake outlets are to Fish Creek in Hamilton, Indiana. This segment also has two reservoirs, Hurshtown Reservoir and Cedarville Reservoir. One closed county landfill is located near Hamilton, Indiana.

The majority of dischargers in this portion of the St. Joseph River watershed discharge to its tributary streams. The only industries discharging directly to the St. Joseph River are NUCOR Fastener and Vulcraft, Inc., which share a discharge point. In grab samples from several isolated areas, no water quality violations were found except for E. coli levels.

Vulcraft operates a facility which manufactures galvanized metal and receives coiled rolled steel which is processed and formed into corrugated decking. The sampling results from this discharge indicated a high concentration of sulfate (3,900 mg/l) and phosphorous (.01 mg/l). Although these levels are relatively high in the effluent, they are having no measurable effects in the St. Joseph River.

The NUCOR facility manufactures bolts from rod and bar steel stock. Plating facilities consist of acid-zinc and zinc-phosphating processes with chromate conversion coating. Treatment consists of chrome reduction, pH adjustments, metal hydroxide formation and precipitation and sand filtration. This effluent is discharged to the St. Joseph River through a pipe common to both NUCOR and Vulcraft. Samples taken from the St. Joseph River downstream of the outfall revealed no impact from the discharge.

The stream survey sampling results and Fixed Water Quality Monitoring Station data taken from the St. Joseph River indicates fairly good water quality. Mercury was found at levels just above detection (0.2 ug/l) at sites both upstream and downstream of the NUCOR - Vulcraft discharge. The discharge and all other samples in the river were below the detection level for mercury and these sample results may reflect analytical variation at these low levels. E. coli level in the river were above standards often enough that the river is nonsupportive of recreational uses. Samples collected from this station indicated E coli levels exceed standards 75% of the time.

The tributary streams in this drainage are elevating the E. coli values in the St. Joseph River. All of the tributary streams had E. coli concentrations well above the 235/100 ml water quality standard. The E. coli values in the St. Joseph River are elevated in comparison to sampling sites with no influence from tributary streams.

Another concern in the St. Joseph River is siltation. The concentration of total suspended solids (TSS) in the St. Joseph River is quite high. The mean TSS concentration for the sampling sites on the St. Joseph River was 54 mg/l. In this case the TSS in the stream is not an indicator of sewage pollution but of a problem with nonpoint source runoff or development along the stream banks. The increase in siltation can increase water temperatures, decrease oxygen levels, and destroy fish habitat. Upstream of the Cedarville Reservoir, the TSS concentration was slightly higher than downstream as a result of some settling in the reservoir. Heavy rains before the survey probably added to the increase of solids carried into the St. Joseph River.

The dissolved oxygen concentration in the St. Joseph River ranged from 7.0 to 10.0 mg/l, with a pH range of 7.5 to 8.8. St. Joseph River samples analyzed for ammonia, phosphorous and C-BOD, as well as metals and synthetic organic substances did not show concentrations of these parameters at levels of concern.

Fish Creek, a major tributary of the St. Joseph River, flows south toward Hamilton Lake from it's source near the Indiana Toll Road in Steuben County through agricultural areas and passes near the town of Hamilton. Fish Creek in Dekalb County is inhabited by the White Cat's Paw Mussel, a federally endangered species.

In general, the water quality here is good, except for several sites which had E. coli values above the 235/100 ml. water quality standard. The Hamilton Conservancy District is the only direct discharger to Fish Creek other than the Hamilton Lake outlet. High E. coli concentrations near Hamilton and downstream of the Hamilton Conservancy District STP may be due to runoff from a cattle slaughterhouse and the Hamilton Conservancy District discharge. The dissolved oxygen concentration in Fish Creek ranged between 6.6 mg/l and 8.9 mg/l, and the pH range was 6.7 to 8.8. Ammonia levels were less than 0.1 mg/l during the survey and also during quarterly monitoring. The metal analysis on samples from this area did not indicate any significant concentrations. Sediment samples also showed no high concentrations of heavy metals.

The Big Run Drain drainage area is comprised of Big Run Drain and its tributary Teutsch Ditch in the vicinity of Butler, Indiana. Five discharges are located within this drainage area. The general water quality in this area is good except for several isolated areas of high E. coli.. The Butler STP had relatively high effluent ammonia concentrations. Downstream of the outfalls, however, Big Run Drain does not indicate any impact from this effluent.

Cedar Creek originates in northwestern Dekalb County and flows generally south to its confluence with the St. Joseph River near Cedarville in Allen County. The drainage area is predominately agricultural with nearly equal portions of crops, pasture and untilled or wooded areas. The total drainage area of the segment is approximately 273 square miles.

There is significant industrial development in and around the incorporated communities. All major municipalities are served by wastewater treatment plants. Currently there are twenty-one (21) NPDES permit holders who discharge into segment water courses. Potable water supplies are obtained from groundwater.

The lower 13.7 miles of Cedar Creek is designated as a State Resource Water. Areas upstream from this portion have had some water quality problems attributed in part to discharges such as the Auburn STP, the Dana Corporation (also in Auburn) and Kitchen Quip in Waterloo. The Auburn STP has had some occasional compliance problems with total suspended solids and biochemical oxygen demand but has reduced heavy metal loadings into the stream. Samples collected as part of this survey also showed permit compliance for all parameters at the Dana Corporation which assembles automotive clutches. Kitchen Quip, an aluminum die casting operation, ceased discharging in January 1992.

Two of the six sampling sites on Cedar Creek were upstream of the Waterloo STP, spanning an approximate 14.3 mile reach.. Four sites downstream of the discharge were sampled. The first was approximately 0.4 miles downstream of the sewage treatment plant and the next three sites were approximately one mile apart thereafter. Average dissolved oxygen concentrations for the sites varied from 7.8 mg/l to 7.1 mg/l. The lowest average was noted upstream of Waterloo. The highest average was at the Dekalb CR 40 Bridge just upstream of Auburn. There was little effect from the Waterloo STP discharge on the stream.

Eight (8) sites spanning an 18 mile reach on the main stem of Cedar Creek to the confluence with Little Cedar Creek were also sampled .The water quality in this reach was very good except for E. coli concentrations. Average dissolved oxygen concentration at the sampling site in Auburn was 7.2 mg/l. The average increased to 8.3 mg/l at CR 68, which is approximately six (6) miles downstream of the Auburn STP.

From Little Cedar Creek to its confluence with the St. Joseph River, Cedar Creek passes through a heavily wooded, sparsely populated area. There are no point source dischargers within this reach. Willow Creek is the only tributary of significant size. Only two of the eight sample sites had ammonia-N concentrations above detection levels (<0.1 mg/l). The $CBOD_5$ concentrations ranged from <1.0 to 1.4 mg/l.

Four (4) sites were sampled on the main stem of Cedar Creek in this reach. All sites were characterized by heavily wooded, undercut banks; rocky, sandy bottom; and some fallen trees or brush in the channel. Water quality, including bacteriological parameters, was excellent.

Dissolved oxygen concentrations were very consistent with little diurnal variation. The average for all four sites was 7.6 mg/l. The highest and lowest individual values recorded (8.4 mg/l and 7.0 mg/l) were at a sampling site in Cedarville. Ammonia-N concentrations at all sites were <0.1 mg/l.

The dissolved oxygen values noted in Cedar Creek are significantly improved from the values found during the 1970's surveys. In 1992, the average dissolved oxygen value at each site was the approximate equivalent of the highest value recorded during the 1976 survey.

During the 1976 survey, a pronounced dissolved oxygen sag occurred downstream of Auburn. The sag did not occur in 1992. It is believed that the improvements made to the collection system and sewage treatment works by the City of Auburn were largely responsible for the elimination of the dissolved oxygen sag. No significant values for heavy metals or priority pollutants were noted in any water column samples or point source discharges.

High ammonia levels (7.4 mg/l) were found in Garrett City Ditch. Garrett City Ditch is a channelized man made stream which carries run-off from the Garrett-Altona area. It receives the discharge from the Garrett STP in addition to stormwater run-off. There is no flow in Garrett City Ditch upstream of the Garrett STP. Dissolved oxygen concentrations of <4.0 mg/l and E.coli counts of over 235/100 ml., were found in this ditch.

The significant water quality problem in Cedar Creek and its tributaries appears to be E.coli concentrations. Only seventeen (17) sites (24%) met the single sample criteria for E. coli concentrations. For the remainder of the samples, 39% had concentrations from 236-500, 21% had concentrations of 501-1000, and 17% had concentrations of over 1000.The sample sites varied from rural to urban, with all forms of land use. No correlation with any known point sources could be established in most cases.

The majority of the highest E. coli concentrations greater than 1,000/100 ml were found in Willow Creek, Willow Creek Ditch and Black Creek. Willow Creek and its tributaries flow through a combination of woodlands, croplands, and high density residential areas. There are no point source discharges in the area. Those discharges that were there in prior surveys have either been discontinued or now discharge to the City of Fort Wayne.

Willow Creek Ditch and its tributary Willow Creek Branch are both channelized drainage ditches. Both streams had dissolved oxygen deficiencies and high. E. coli concentrations indicating possible septic tank discharges to the stream. However, none were specifically identified.

Ten sites within the segment were selected for sediment metals analyses. These were chosen to include outlying areas as well as densely populated areas around point source discharges. No specific criteria are available for sediment evaluation. Samples are often collected upstream and downstream of suspected point sources to determine possible impacts.

The only substance of concern detected in the sediment samples was copper. Values for copper ranged from less than detection limits to 78 mg/kg. The maximum of 78 mg/kg was noted in Cedar Creek at the SR 8 site in Auburn. Further investigation revealed that a photography lab (no longer there) had leaked solutions into the stream at that point. This lab was moved in 1989 and now discharges pretreated wastes to the Auburn STP.

Little Cedar Creek is the largest tributary of Cedar Creek with a total drainage area of 72.8 square miles including its tributaries. The drainage area is agricultural in nature with many wooded areas. The stream banks generally are heavily wooded or grassy and sloped in reaches where the stream has been channelized.

There are only five (5) point source dischargers in the watershed and only one discharges directly to Little Cedar Creek. The other four discharge to named and/or unnamed tributaries. The five are comprised of one municipal STP, two mobile home park STPs, one campground STP (with seasonal discharge) and one school STP.

The major tributaries to Little Cedar Creek are Sycamore Creek, Frank Yarde Ditch, King Lake Ditch and Black Creek. On Sycamore Creek, water quality was fairly good. Somewhat high ammonia concentrations (3.2 mg/l) and E. coli counts (6600/100 ml) indicate an unknown sewage source upstream. Septic tank effluent is suspected but not confirmed. King Lake Ditch is the receiving stream for the Avilla Municipal STP and the Laotto School STP discharges to an unnamed tributary of Black Creek.

Two (2) sites were sampled on King Lake Ditch. The first site was approximately 0.3 miles upstream of King Lake and 0.5 miles downstream of Avilla Wastewater Lagoon outfall. Practically all the flow at this point is provided by the Avilla Lagoon.

This stream at this location was in poor condition. Heavy algae growth covered the rocks in the stream bed, and the water had a slight sewage odor. Dissolved oxygen was 2.4 mg/l, and the ammonia - N concentration was 5.5 mg/l. No aquatic life forms were observed. The flow was <0.1 CFS.

The second site sampled on King Lake Ditch was approximately 1.5 miles downstream of King Lake. At this point the water quality was improved, although the flow was still low (0.2 CFS). The dissolved oxygen concentration averaged 6.8 mg/l with a low of 6.0 mg/l. The ammonia - N concentration was 0.2 mg/l. However, the E. coli concentration was above limits and no aquatic life was noted.

The water quality on Little Cedar Creek is very good except for E. coli concentrations. Due to the heavily shaded nature of the stream, there is little diurnal dissolved oxygen variation. The average dissolved oxygen concentration at the three sampling sites was 6.7 mg/l and the lowest individual value was 5.8 mg/l.

The Maumee River originates in Allen County with the confluence of the St. Marys and St. Joseph River and flows generally east into Ohio. The Flatrock Creek watershed is also included in the Maumee River drainage area. Flatrock Creek flows in a northeast direction and discharges to the Maumee River in Ohio. This area is predominately agricultural, but there is a concentrated urban/industrial area located in the eastern portion of the Fort Wayne metropolitan area.

Currently, there are fifteen (15) NPDES permit holders who discharge into Maumee River water courses. Overall, the water quality of the Maumee River was generally very good, except for E.coli concentrations.

The average for all dissolved oxygen tests was 9.1 mg/l and the lowest value was 8.1 mg/l. The dissolved oxygen values noted in the Maumee River are significantly improved from the values evident during the 1974 and 1978 sampling surveys. Improvements to the Fort Wayne STP, which discharges directly to the river, and the closing of some other facilities probably resulted in the improved dissolved oxygen levels. The drainage area of this waterbody is heavily urbanized in its upstream section, but becomes progressively residential/rural farther downstream.

The most significant water quality problems in this portion of the Maumee River Basin were due to E.coli bacteria. Only 30% of the total sampling sites met the single sample criteria for E.coli concentrations (235/100 ml). For the remainder of the samples, 16% had concentrations from 236-500, 28% had concentrations of 501-1000, and 56% had concentrations of over 1000.

Most sampling stations in the Maumee River itself met the bacteriological criteria. The majority of the high concentrations were probably due to runoff, because some of the bacteriological grab samples were taken during or shortly after a rainfall. The majority of the stream samples had an ammonia -N value of <0.1 mg/l, and no sites on the Maumee River exceeded this value.

No significant values for heavy metals or priority pollutants were noted in any water column samples or point source discharges. The Rea Magnet Wire Company effluent did contain gasoline at 130 ug/l. Rea discharges to an unnamed tributary of Harvester Ditch, which is an underground storm sewer for approximately 1.5 miles. Downstream samples did not reveal any gasoline values above the laboratory detection limit of 20 ug/l.

Sediment samples were taken in outlying areas as well as densely populated areas around point source discharges. The sediment samples were analyzed for metals, and five of the sites were also analyzed for total toxic organic (TTO) parameters. No specific criteria are available for sediment evaluation. Samples were often collected upstream and downstream of suspected point sources to determine possible impacts.

The only area that revealed any high metals and/or TTO sediment concentrations was the Harvester Ditch watershed. Sediment metals found at relatively high concentrations at two sites were antimony, cadmium, copper, lead, nickel, and zinc. Polynuclear aromatic hydrocarbons (PAH's) were also found in the sediments at two sites. PAH's can be formed in hydrocarbon combustion processes such as heat and power generation, refuse burning, and the carbonization or coking of coal tar at high temperatures. PAH have also been found in coal refuse heaps.The concentrations of PAH's found in the sediment at the two sites are thought high enough to potentially pose a risk to aquatic life in Harvester Ditch. The most likely source of these PAH's is a storm sewer that discharges to an unnamed tributary of Harvester Ditch. The PAH's found at relatively high levels were fluoranthene (12,000 ug/kg), pyrene (10,000 ug/kg), and Benzo (g,h,i) pyrene (12,000 ug/kg). Aroclor 1260, a polychlorinated biphenyl, was also found in the sediment at one site. The source(s) of these contaminants is unknown.

Harvester Ditch, from the point where it starts flowing above ground to the confluence with the Maumee River, is a tree-lined, mostly shaded stretch with an all bedrock bottom. Three industrial discharges (ITT Corporation, Rea Magnet Wine and Phelps Dodge Magnet Wire) are located on this stream. Water quality along this stretch was generally good. Minnows were present upstream of the U.S. 30/24 sampling site. The dissolved oxygen average for the two Harvester Ditch stream sampling sites was 8.3 mg/l with a low of 7.6 mg/l. Estimated flow of Harvester Ditch was 1.7 CFS.

The tributaries Black Creek, Marsh Ditch, Viland Ditch, and Hamm Interceptor Ditch enter the Maumee River 7.5 miles from the Indiana-Ohio State Line. This reach of the Maumee drains predominately agricultural land. These ditches are all impacted by nonpoint source run off and possibly from wet weather bypasses from the Woodland STP and/or septic tanks as E.coli bacteria levels were fairly high (>1000/100 ml). All other parameters measured met water quality standards.

The Woodburn Christian Childrens Home is the only NPDES discharger located in this reach. This semi-public facility discharges to Hamm Interceptor Ditch. E.coli levels were high (880/100 ml) and dissolved oxygen levels low (3.7 mg/l) in the effluent. Because of the facility's low flow, no stream degradation was observed downstream. The three (3) sites sampled on Hamm Interceptor Ditch had good water quality except for elevated E. coli concentrations due to wet weather nonpoint source runoff. Dissolved oxygen values averaged 9.0 mg/l with a low of 7.8 mg.l.

As a result of the 1978 United States-Canada Great Lakes Water Quality Agreement, three northeast Indiana counties in the Maumee River Basin have been involved in a plan to reduce phosphorus loadings to Lake Erie. The primary point sources in the basin discharge phosphorus at levels well under their allowed limits. Therefore, agricultural runoff has been identified as Indiana's primary phophorus concern. Efforts by a variety of federal, state and local interests have helped to promote conservation tillage implementation in the northeastern part of the State over the last several years.

By establishing 1982 as the base year and using available cropping and soils information, the ANSWERS computer model was used to determine sediment and phosphorus loads in the Maumee River Basin from Adams, Allen and Dekalb counties. Increased application of conservation tillage practices in these three counties has resulted in Indiana achieving its 90 ton reduction goal in 1988 (according to figures completed by the National Association of Conservation Districts Conservation Technology Information Center).

IDEM and U.S. EPA Region V staff sampled 21 site in the Maumee River Basin during the 1991 field season as part of an ongoing fish community survey. A total of 54 species were collected and were numerically dominated by cyprinid, catostomid, and centrarchid species. Based on an Index of Biotic Integrity, fish species diversity was used as an indicator of water quality at various points in the watershed.

The fish assemblages of the Maumee River ranges from a low of no fish (score of 0; 1 site) to good-excellent (score of 55; 1 site) based on the Index of Biotic Integrity scoring criteria. Increasing biological integrity was observed from upstream to downstream, with declining conditions observed in the headwaters of the minor tributaries. The sites with low biological integrity were primarily headwater and mid-reach rivers. The highest biotic integrity was associated with the Maumee River, at the SR 24 bridge in New Haven (IBI = 55). This River segment deserves protection to ensure that the quality of the resource continues. Some of the northern tributaries are intermittent and were dry during the investigations in 1991.

The Maumee River possesses several species unique to the entire drainage; emerald shiner *Notropis atherinoides*, river shiner *Notropis blennius*, and flathead catfish *Pylodictis olivaris*. Of special interest was the collection of the river redhorse *Moxostoma carinatum*, largescale stoneroller *Campostoma oligolepis*, and smallmouth bass *Micropterus dolomieui*. *Moxostoma carinatum* is considered state threatened. The capture of *Campostoma oligolepis* is the first record for northeastern Indiana. Species such as the emerald shiner and river shiner are considered large river species. Several *Micropterus dolomieui* were collected from the Maumee River at the upper two stations, however, none were observed at Bull Rapids and at the Ohio state line.

A total of 33 wading and boat sites were sampled in the St. Joseph River drainage during 1991. This drainage possessed the most diverse fish community with 58 species. Numerically the subdrainage was dominated by cyprinids, centrarchid, and catostomid species. The tributaries of the St. Joseph River, including Fish Creek and Cedar Creek are extremely diverse and composed of cyprinids, darters, and catostomids. The mainstem St. Joseph River rated the highest biological integrity at Johnny Appleseed Park.

The fish community assemblage of the St. Joseph River drainage ranged from a low of very poor (score of 14; 3 stations) to good-excellent (score of 57; 1 station) based on IBI scoring criteria. The biotic integrity of the St. Joseph River varied with increasing drainage area. Stations above Fort Wayne scored considerably poorer than the furthest downstream site at Johnny Appleseed Park. Fish were collected at all sites in the St. Joseph River drainage. Sites which had low index values were primarily attributed to nonpoint sources (e.g., agriculture). Exceptional streams in the St. Joseph River drainage include the St. Joseph River at Johnny Appleseed Park (IBI = 57) and below Cedarville Reservoir (IBI = 45), and direct tributaries such as Fish Creek and Cedar Creek. Stations sampled in the lower portions of each of these tributaries had good biological integrity, however, the headwaters of these streams are degraded and need remediation to preserve biodiversity and biological integrity.

Unique species collected in the St. Joseph River include bowfin Amia calva, northern pike Esox lucius, steelcolor shiner Cyprinella whipplei, hornyhead chub Nocomis biguttatus, pugnose shiner Notropis anogenus, rosyface shiner Notropis rubellus, spotted sucker Minytrema melanops, brook silverside Labidesthes sicculus, warmouth Leopomis gluosus, eastern sand darter Ammocrypta pellucida, slenderhead darter Percina phoxocephala, and mottled sculpin Cottus bairdi. Many of these species are sensitive to low dissolved oxygen, siltation, and degraded habitat. They may have been reduced to low population densities or extirpated from the remainder of the Maumee River drainage. In addition, three State threatened species were collected during the study. The greater redhorse, Moxostoma valenciennesi, a state threatened species, was captured at several stations. The eastern sand darter was collected at a single location immediately adjacent to Johnny Appleseed Park. This station is immediately below the last of a series of dams which are able to filter much of the sediment bedload from the water column. Although the species benefits from the presence of the dam, the dam also blocks any future migration potential upstream. The pugnose shiner was also collected from a single location. This species typically inhabits lakes and is rarely collected from riverine sites. This is the first collection of this species from northeastern Indiana in over 50 years. Previously, the species was only known from Hamilton Lake, Steuben County, in the St. Joseph drainage. The largescale stoneroller was also documented from the St. Joseph River. This is the first collection of the species from this drainage.

A total of 23 sites were sampled in the St. Mary's River. A total of 47 species were collected and were numerically dominated by centrarchid, cyprinid, and catostomid species.

The fish community assemblage of the St. Mary's River ranged from a low of very poor (score of 12; 6 stations) to a high of good (score of 49; 1 station) based on IBI classification criteria. The biotic integrity of the St. Mary's River increased with increasing drainage area. Stations in the headwaters of the tributaries were generally degraded. IBI scores within the St. Mary's drainage were skewed towards lower water resource quality. Among the 23 stations 4.3% (1) were classified as good; good-fair 8.7% (2 stations); fair 13.0% (3 stations); fair-poor 13.0% (3 stations); poor 21.7% (5 stations); poor-very poor 13.0% (3 stations); and very poor 26.1 (6 stations). Fish were collected at all sites in the St. Mary's River drainage. Sites which had low IBI values were affected by significant nutrient input.

Species collected only in the St. Mary's River include river carpsucker Carpiodes carpio, redear sunfish Lepomis microlophus, and walleye Stizostedion vitreum, Creek chub (Semotilus atromaculatus), white sucker Catostomus commersoni, fathead minnow Pimephales promelas, bluntnose minnow Pimephales notatus, and green sunfish Lepomis cyanellus were the dominant species in the drainage. Several threatened and endangered species were documented from the St. Mary's subdrainage including river redhorse Moxostoma carinatum and greater redhorse M. valenciennesi. The majority of sites are dominated by omnivorous, pioneering, tolerant species

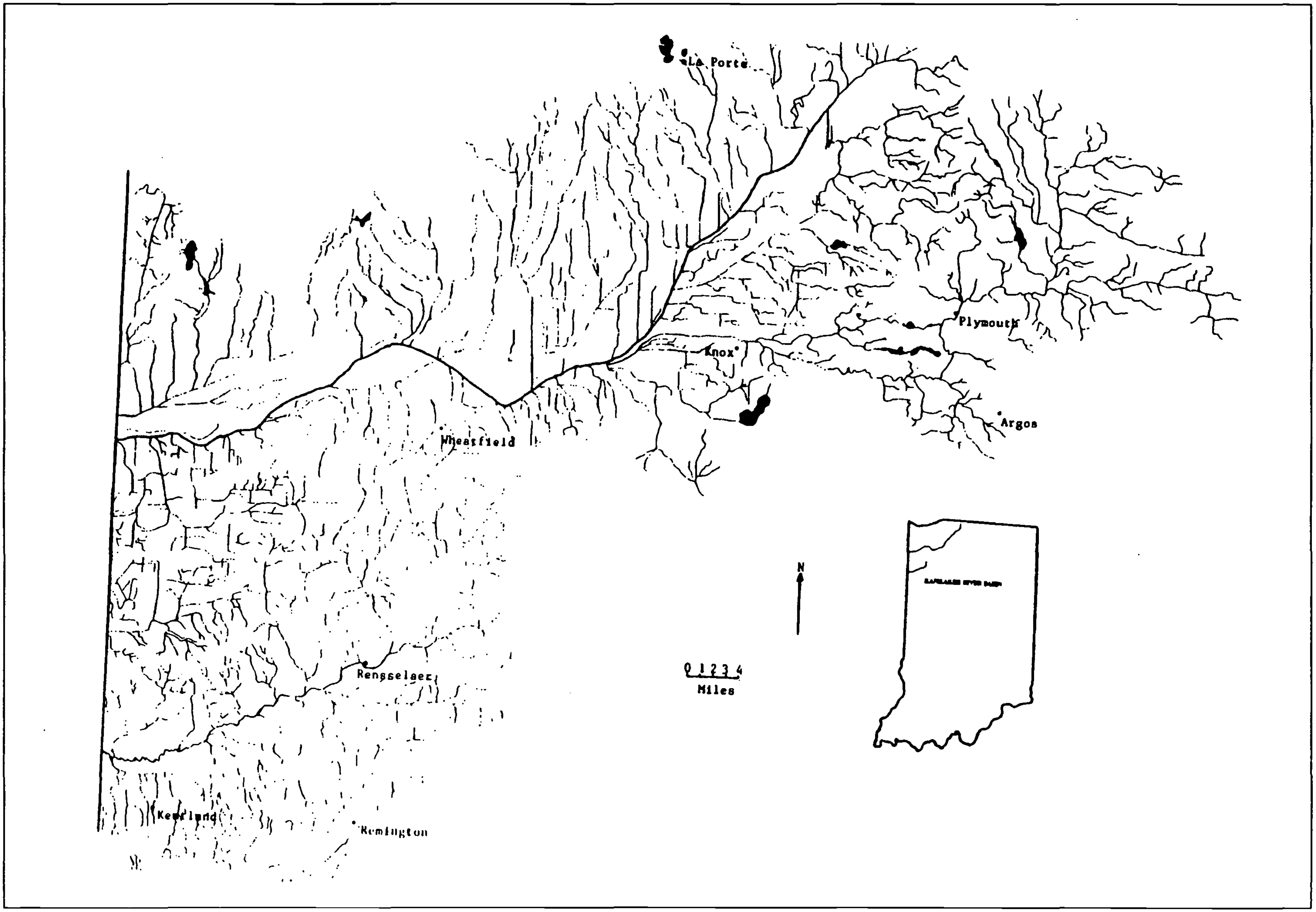
In summary, 764 miles were assessed for aquatic life uses in the Maumee River Basin. Of these total miles 649 miles (85%) support the aquatic life designated use, another 31 miles (5%) were fully supporting, but threatened, 9 miles (1%) were only partially supported and 75 miles (9%) did not support the aquatic life use. Of the 764 miles assessed for recreational use, 110 miles (14%) fully supported this use while the remaining 654 miles (86%) were not supportive.

Kankakee River Basin

The Kankakee River Basin (Figure 58) drains about 3,000 square miles of northern Indiana before flowing westward into Illinois. Major tributaries in Indiana include the Iroquois and Yellow rivers. The largest cities in the watershed are LaPorte and Plymouth, and most of the area is extensively farmed. There are relatively few industrial or municipal discharges in the basin, and even at low summer flows only about 3% of the flow in the Kankakee River, where it leaves Indiana, is treated wastewater.

Many of the present characteristics of the Kankakee Basin are due to the geologic history of the area. Glaciers flattened the region, and moraines formed by melting ice made the basin lower than surrounding areas. Sand was deposited in this low area by the melting glacier, and much of this lowland became a gigantic marsh. Beginning in the mid-1800s ditches were dug throughout the basin to improve drainage for farming. Today most of the

Figure 58. *Kankakee River Basin*



streams in the basin have been dredged and straightened. The basin is still flood-prone, but nearly all of it is farmed. Most of the streamflow is made up of groundwater, providing a relatively constant discharge of cool water throughout the year.

Despite extensive channelization, the Kankakee Basin still provides some excellent stream fisheries. The state record northern pike was taken from the Yellow River in 1983. Forty-eight species of fish, including a variety of game fish, were collected in the Kankakee River mainstem by the Indiana Department of Natural Resources in 1981. Parts of the river are used frequently for canoeing, and there are two commercial canoe liveries on the Kankakee. Most of the streams in the basin are designated to support warmwater fisheries, although the Little Kankakee (LaPorte County), Crooked Creek (Porter County), and Potato Creek (St. Joseph County) are put-and-take trout streams and are designated to support cold water fisheries. Limited use streams in the basin include portions of ditches downstream from the Kentland and Lakeville sewage treatment plants. All streams in the Kankakee River basin must meet water quality standards for whole-body contact recreation.

Those waterbodies assessed, the status of designated use support, probable causes of non-support, and miles affected are shown in Table 45. Additional comments concerning certain reaches are also given in this table.

The Kankakee River has its origin from the accumulated flow of several irrigation ditches and the outflow of a South Bend storm sewer detention pond. These ditches flow together to form Dixon West Place Ditch which then becomes the Kankakee River approximately 7.76 miles downstream. Samples collected on Dixon West Place Ditch indicated good water quality at the time of the 1990 survey.

This upper portion of the Kankakee River flows through agricultural areas only and involves no populated areas. There are no point sources to the Kankakee River in this area, but three major tributaries and numerous irrigation ditches flow into the Kankakee River in this segment. The major tributaries are Potato Creek, Pine Creek, and Breckenridge Ditch.

The bottom composition of the Kankakee River in this area is silt with no vegetation above the water level. The visual appearance is murky and the bottom cannot be seen. Trees replace the grasses and shrubs along the banks. The Kankakee River still flows through agricultural fields with an occasional home or farm located near the banks. The E. coli concentrations were below the water quality standard and dissolved oxygen (D.O.) and pH values were satisfactory.

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Travis Ditch	Kingsbury LaPorte	NS (Aquatic Life) PS (Recreational)	Monitored (c) (b)	E. coli	13.2	Biological Assessment "Very Poor" 3 miles south of LaPorte.
Kingsbury Creek	Kingsbury	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	9.3	Biological Assessment, "Poor".
Kankakee River	Crumstown	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	15.8	
Kankakee River		FS (Aquatic life)	Monitored (c)		5.0	Alachlor found above detection level at .12 ug/l.
Kankakee River	Shelby	FS (Aquatic life)	Monitored (c)		23.0	
Kankakee River	Hamlet	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.4	
Kankakee River	Knox	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.5	
Barringer Ditch	Mill Creek	FS (Aquatic Life)	Monitored (c)		0.7	
Dixon West Place Ditch	South Bend	FS (Aquatic Life)	Monitored (c)		8.0	
Little Kankakee	LaPorte	NS (Aquatic Life)	Monitored (b)		3.0	Biological Assessment "Very Poor" near headwaters.
Little Kankakee	Fish Lake	FS (Aquatic Life)	Monitored (c)(b)		7.0	
Pine Creek	Walkerton	NS (Aquatic Life)	Monitored (c)(b)		29.0	Biological Assessment, "Poor".
Geyer Ditch	New Carlislie	NS (Aquatic Life)	Monitored (c)(b)		11.2	Biological Assessment, "Poor".
Laskowski Ditch	Crumstown	FS (Aquatic Life)	Monitored (c)		6.0	
County Line Ditch	Crumstown	PS (Aquatic Life)	Monitored (c)	Ammonia TSS	11.5	
Niespodziany Ditch	Crumstown	PS (Aquatic Life)	Monitored (c)	Ammonia D.O.	6.0	New Carlisle STP
Mill Creek	Union Mills	FS (Aquatic Life)	Monitored (c)(b)		8.0	High BOD no significant impacts to stream.
Potato Creek	North Liberty	NS (Aquatic Life)	Monitored (c)(b)		7.0	Biological Assessment, "Poor".
Sherman Emmans Ditch	LaPaz	FS (Aquatic Life)	Monitored (c)		5.0	
Peter Sarber Ditch	LaPaz	FS (Aquatic Life)	Monitored (c)(b)		5.0	
Peter Sarber Ditch	Walkerton	NS (Aquatic Life)	Monitored (b)		12.0	Biological Assessment, "Poor".

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Breckenridge Ditch	Kingsbury	FS (Aquatic Life)	Monitored (c)		11.0	
Breckenridge Ditch	Stillwell	NS (Aquatic Life)	Monitored (b)		6.0	Biological Assessment, "Poor".
Yellow Bank Creek	Teegarden	FS (Aquatic Life)	Monitored (c)		9.0	
Yellow River	Bremen	FS (Aquatic Life)	Monitored (c)(b)		4.0	Includes Run-Off From Prairie View Landfill. Biological Assessment "Poor" north of Bremen.
Yellow River	Plymouth	FS (Aquatic Life)	Monitored (b)		13.0	Biological Assessment "Excellent" 4.5 miles south of Plymouth.
Yellow River	Breman	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	7.0	Biological Assessment "Poor".
Yellow River	Inwood	FS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	6.4	
Yellow River	Plymouth	FS (Aquatic Life) NS (Recreational)	Monitored (c) (b)	E. coli	4.5	
Yellow River	Plymouth	FS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	7.5	
Yellow River	Knox	FS (Aquatic Life) NS (Recreational	Monitored (c)(b)	E. coli	29.8	
Yellow River	Knox	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli D.O. Bypassing	11.2	Knox STP under Agreed Order for new construction.
Newcomer, Anthony Gross, Lehman - Brink Ditches	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		24.0	
Sara Hershberger Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.3	
Kline Rouch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		7.2	
Armey Ditch	Bremen	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli CSOs	10.0	Biological Assessment, "Poor".
Heston Ditch	Lakeville	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1.8	
Kehman Ditch	Lapaz	FS (Aquatic Life) FS (Recreational)	Monitored (c)		3.9	Includes Laville HIgh School STP discharge.

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Stock Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (b)		4.7	
Shidler - Hoffman Ditch	Wyatt	FS (Aquatic Life) FS (Recreational)	Monitored (c)		3.8	
W. Branch Bunch Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		7.5	Includes Lakeville STP Lagoon Discharge.
E. Branch Bunch Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		13.6	
Martin & Walt Kimble Ditches	Linkville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.4	
Isaac Sells Ditch	Linkville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	4.1	
Dausman Ditch	Bremen	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)(b)	E. coli D.O.	30.7	Mikel Mobile Home Park STP poorly operated and maintained.
Lemler Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.2	
Brook Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.8	
Border Ditch	Bremen	FS (Aquatic Life) FS (Recreational)	Monitored (c)		1	
Crews Ditch	Inwood	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	20.2	Biological Assessment, "Poor". Located 5 mile east of Plymouth.
Elmer Seltenright Ditch	LaPaz	NS (Aquatic Life)	Monitored (b)		2.0	Biological Assessment, "Poor".
Elmer Seltenright Ditch	Plymouth	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)(b)	E. coli	9.6	Gatewood Mobile Home Park STP poorly operated and maintained.
Schuh Ditch	Plymouth	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	4.4	
Bogus Run	English Lake	FS (Aquatic Life)	Monitored (c)(b)		30.0	
Bogus Run	Denham	NS (Aquatic Life)	Monitored (b)		6.0	Biological Assessment, "Poor".
Pine Creek	Denham	FS (Aquatic Life)	Monitored (c)		4.7	
Pine Creek	N. Judson	PS (Aquatic Life) FS (Recreational)	Monitored (c)	D. O.	3.9	

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Origer Ditch	English Lake	FS (Aquatic Life)	Monitored (c)		10.8	
Pitner Ditch and tributaries	LaCrosse	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	60.1	
Payne Ditch	English Lake	FS (Aquatic Life) FS (Recreational)	Monitored (c)		13.2	
Keller Arm and tributaries	English lake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.0	Only Lawton Ditch Sampled.
Davis Ditch	Wheatfield	FS (Aquatic Life) FS (Recreational)	Monitored (c)		7.2	
Cook Ditch	LaCrosse Kouts	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		23.6	
Reeves Ditch	Kouts	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		9.7	
Slocum/Topper Ditch	Wanatah	FS (Aquatic Life) NS (Recreational)	Monitored (c)(b)		23.0	
Tooper Ditch	Wanatah	NS (Aquatic Life)	Monitored (c)(b)		12.0	Biological Assessment, "Poor".
Topper Ditch	Wanatan	NS (Aquatic Life)	Monitored (b)		4.0	Biological Assessment, "Poor".
Geiger Ditch	LaCrosse	FS (Aquatic Life)	Monitored (c)		19.4	
Geiser Ditch	Kouts	NS (Aquatic Life) NS (Recreational)	Monitored (b)	D.O. E. coli	2.0	Biological Assessment, "Poor".
Crumpacker Arm/Wright Arm	Westville	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Ammonia D.O.	1.0	No Sample From Wright Arm, Degradation Due to Westville STP and WEstville Correctional STP. Occassional low D.O.
Forbes Ditch	Westville	NS (Aquatic Life) NS (Recreation)	Monitored (c)	D.O. E. coli	1.5	
Crooked Creek	Westville	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli D.O.	1.5	Biological Assessment, "very Poor".
Crooked Creek	Valparaiso	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli D.O.	3.2	Biological Assessment, "Poor".
Crooked Creek, West Branch	Valparaiso	PS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli D.O.	4.1	Biological Assessment, "Fair".
Crooked Creek, West Branch	Kouts	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)(b)	E. coli Nonpoint source	47.4	

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Pleasant Township Ditch	Kouts	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli	10.3	Threatened due to bypassing from Kouts STP.
Sandy Hook / Ahlgrim Ditch	Kouts	NS (Aquatic Life)	Monitored (b)	D.O.	3.0	Biological Assessment, "Poor".
Sandy Hook / Cobb Ditches	Kouts	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	9.0	
Phillips Ditch	Kouts	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.0	
Cornell Ditch	Hobron	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	D.O. E. coli	5.0	Low D.O. at time of sampling.
Cobb Creek	Hebron	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Nonpoint source	4.7	
Cobb Creek	Hebron	FS (Aquatic Life)	Monitored (c)(b)		5.9	
Cobb Creek/Breyfogel Ditch	Hebron	NS (Aquatic Life) NS (Recretional)	Monitored (c)(b)	Ammonia Low D.O. E. coli	3.4	Hebron STP impacts stream with low D.O. E. coli and occassional ammonia violations. Biological Assessment, "Poor".
Hodge Ditch	Wheatfield	NS(Aquatic Life)	Monitored (c)(b)	Low D.O.	4.0	Biological Assessment "Very Poor".
Hodge Ditch and tributaries	DeMotte	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		70.4	
DeHean and Tyler Ditches	DeMotte	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli D.O.	11.2	DeMotte STP impacts stream. Biological Assessment "Poor" on Tyler Ditch.
Brent Ditch	DeMotte	FS (Aquatic Life) FS (Recreational)	Monitored (c)		4.0	
Evers Ditch	DeMotte	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.0	
Otis Ditch	DeMotte	FS (Aquatic Life) NS (Recreational)	Monitored (c0	E. coli	7.6	
Knight Ditch	Lake Village	NS (Aquatic Life)	Monitored (b)		7.0	Biological Assessment "Very Poor" near Lake Village, "Fair" further upstream.
Beaver Lake Ditch and tributaries	Lake Village	FS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli Nonpoint source	30.5	

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Lawler Ditch and tributaries	Lake Village	FS (Aquatic Life) FS (Recreational)	Monitored (c)		22.4	
Best Ditch and tributaries	Lake Village	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	10.6	Biological Assessment, "Poor".
Beaver Creek and tributaries	Eros	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	47.0	
Beaver Creek	Morocco	NS (Aquatic life) PS (Recreational)	Monitored (c)(b)	D.O. E. coli	1.2	Morocco sewer system impacts stream. Biological Assessment, "Poor".
Beaver Creek	Morocco	FS (Aquatic Life)	Monitored (b)		2.4	1 mile east of Illinois border.
Singleton Ditch	Schneider	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	D.O. E. coli	44.7	Biological Assessment, "Poor".
Bryant Ditch	LeRoy	FS (Aquatic Life) NS(Recreational)	Monitored (c)	E. coli	6.2	Apply Valley Mobile Home Park impacts stream.
Brown Ditch	Hebron	FS (Aquatic Life)	Monitored (b)		3.0	
Brown / Tully Ditch	Shelby	NS (Aquatic Life) FS (Recreational)	Monitored (c) (b)	Low D. O.	32.2	Biological Assessment was "Poor" for Tully Ditch near Shelby.
West Creek	St. John	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		21.2	
Craigmile Ditch	Knox	FS (Aquatic Life)	Monitored (b)		2.0	
Bessler Ditch	LaCrosse	FS (Aquatic Life)	Monitored (b)		0.5	
Cedar Lake Ditch	N. Judson	NS (Aquatic Life)	Monitored (b)		4.0	Biological Assessment rated, "Poor".
Delehanfy Ditch	Wheatfield	NS (Aquatic Life)	Monitored (b)		4.1	Biological Assessment rated, "Poor".
Stony Run E. Branch	Leroy	NS (Aquatic Life)	Monitored (b)		5.0	Biological Assessment rated, "Poor".
Eagle Creek	Knox	FS (Aquatic Life)	Monitored (b)		6.8	
Eagle Creek	Knox	FS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	18.4	
Tuesburg Ditch (Hanna Arm)	Hanna	FS (Aquatic Life)	Monitored (b)		9.0	
Jordon Creek	Walkerton	FS (Aquatic Life)	Monitored (b)		1.0	
Kuehn Ditch	LaCrosse	FS (Aquatic Life)	Monitored (b)		1.5	
Long Ditch	Kingsford Hts.	NS (Aquatic Life)	Monitored (b)		4.0	Biological Assessment, "Poor".

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Whitham Ditch	Kingsford	NS (Aquatic Life)	Monitored (b)		2.0	Biological Assessment, "Poor".
Whaley Ditch	Kentland	FS (Aquatic Life)	Monitored (b)		3.0	
Whitham Ditch	Hanna	FS (Aquatic Life)	Monitored (b)		2.0	
Richman Ditch	Hanna	FS (Aquatic Life)	Monitored 9b)		6.8	
Rice Ditch	Hanna	NS (Aquatic Life)	Monitored (b)		2.2	Biological Assessment, "Poor".
Salisbury Ditch	Kingsford Height	NS (Aquatic Life)	Monitored (b)(c)		2.0	Biological Assessment, "very Poor".
Iroquois River	Rensselaer	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		51.4	
Iroquois River	Parr	NS (Aquatic life)	Monitored (b)		5.0	Biological assessment "Very Poor", but "Good" further downstream.
Carpenter Creek	Remmington	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		18.1	
Carpenter Creek	Egypt	NS (Aquatic Life)	Monitored (b)		7.0	Biological Assessment, "Poor".
Hunter Ditch	Goodland	FS (Aquatic Life) NS (Recreational)	Monitored (x)(b)	E. coli	3.1	
Darroach Ditch	Kentland	FS (Aquatic Life)	Monitored (b)		3.4	
Montgomery Ditch	Kentland	FS (Aquatic Life)	Monitored (b)		20.1	
Cedar Creek	Lowell	FS (Aquatic Life)	Monitored (b)		12..8	Biological Assessment was "Excellent" near confluence with Singleton Ditch.
Cedar Creek	Lowell	NS (Aquatic Life)	Monitored (b)(c)	E. coli	3.0	Biological Assessment, "Poor".
Foss Ditch	Lake Dalecarlia	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (c)	D.O.	4.5	Occassional low D.O. Center utilities STP.
Lost Creek	Nappanee	FS (Aquatic Life)	Monitored (b)		1.5	
Yellow Creek	Nappanee	NS (Aquatic Life)	Monitored (b)		1.8	Biological Assessment, "Poor".
Moffit Ditch	DeMotte	NS (Aquatic Life)	Monitored (b)		1.0	Biological Assessment, "Poor".
Unnamed Tributary of English lake	N. Judson	NS (Aquatic Life)	Monitored (b)		1.3	Biological Assessment, "Poor".
Geisel Ditch (Spring Run)	Lowell	FS (Aquatic Life)	Monitored (b)		2.0	

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Hunsely Ditch (Sheldon Amm)	Hanna	FS (Aquatic Life)	Monitored (b)		1.5	
Bice Ditch	Rensselaer	FS (Aquatic Life)	Monitored (b)		10.2	
Banham Ditch	Earl Park	NS (Aquatic Life)	Monitored (b)		3.7	Biological Assessment, "Poor".
Bruner Ditch	Rensselaer	FS (Aquatic Life)	Monitored (b)		2.7	
Curtis Creek	Rensselaer	FS (Aquatic Life)	Monitored (b)		7.0	
Curtis Creek	Rensselaer	NS (Aquatic Life)	Monitored (b)		7.0	Biological Assessment, "Poor".
Dexter Ditch	DeMotte	FS (Aquatic Life)	Monitored (b)		5.0	
Finigan Ditch	Benton	FS (Aquatic Life)	Monitored (c)		1.0	
Goshwa Ditch	Remington	FS (Aquatic Life)	Monitored (c)		8.7	
Hickory Branch	Newton	FS (Aquatic Life)	Monitored (c)		3.0	
Lateral Ditch #77	Lewiston	FS (Aquatic Life)	Monitored (c)		3.0	
Leuck Ditch	Fowler	FS (Aquatic Life)	Monitored (c)		9.4	
Leuck Ditch	Ambia	FS (Aquatic Life)	Monitored (b)		9.4	
Mud Creek	Earl Park	FS (Aquatic Life)	Monitored (c)		14.0	
Mud Lake Ditch	Enos	NS (Aquatic Life)	Monitored (b)		3.7	Biological Assessment, "Poor".
Narrows Ditch	Morrocco	FS (Aquatic Life)	Monitored (b)		2.4	
Oliver Ditch	Rennselaer	NS (Aquatic Life)	Monitored (b)		5.2	Biological Assessment, "Poor".
Oliver Ditch	Lewiston	FS (Aquatic Life)	Monitored (b)		1.1	
Oliver Ditch	Wheatfield	NS (Aquatic Life)	Monitored (b)		1.0	Biological Assessment, "Poor".
Ryan Ditch	Rennselaer	NS (Aquatic Life)	Monitored (b)		0.5	Biological Assessment, "Poor".
Ryan Ditch	Lewiston	FS (Aquatic Life)	Monitored (b)		1.0	
Slough Creek	Rennselaer	FS (Aquatic Life)	Monitored (b)		1.5	
Slough Creek	Rennselaer	NS (Aquatic Life)	Monitored (b)		1.0	Biological Assessment, "Poor".
Sugar Creek	Earl Park	FS (Aquatic Life)	Monitored (b)		6.0	
Thompson Ditch	Brooke	FS (Aquatic Life)	Monitored (b)		1.5	
Whaley Ditch	Kentland	FS (Aquatic Life)	Monitored (b)		0.5	

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Lawrence Pontius Ditch	Koontz Lake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.4	
Robbins Ditch	Koontz Lake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.1	
Robbins Ditch	Hamlet	NS (Aquatic Life) NS (Recreational)	Monitored (c) (b)	E. coli	26.2	Biological Assessment, "Poor".
Robbins Ditch	Hamlet	FS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	1.3	
Blad Ditch	Hamlet	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Low D.O. Ammonia E. coli Phosphorous	1.4	Jellystone Park STP having operational problems.
Blad Ditch	Hamlet	FS (Aquatic Life)	Monitored (c)		3.5	
Jain Ditch	Hamlet	NS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	27.2	Biological Assessment, "Poor".
Danielson Ditch	Hamlet	FS(Aquatic Life) FS (Recreational)	Monitored (c)		12.5	
Bailey Ditch	Hamlet	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (c)	Low D.O.	33.5	
Laramore Ditch	Knox	FS (Aquatic Life) FS (Recreational)	Monitored (c)		19.0	
Wolf Creek	Argos	FS (Aquatic Life) FS (Recreational)	Monitored (c)(b)		5.4	
Wolf Creek	Argos	FS (Aquatic Life) NS (Recreational)	Monitored (c)(b)	E. coli	6.9	
Meyers Ditch	Argos	PS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Low D. O.	15.9	Argos STP permit violations causing degradation in streams.
Clifton Ditch	Hibbard	FS (Aquatic Life) FS (Recreational)	Monitored (c)	E. coli	4.4	
Lowry/Listenberger Ditch	Burr Oak	FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.4	
Harry Cool Ditch	Twin Lakes	NS (Aquatic Life) NS (Recreatinal)	Monitored (c)(b)	E. coli D.O.	6.0	Biological Assessment, "Poor".

Table 45. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Kankakee River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Gunnard Anderson Ditch	Ancilla Domini	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.4	Ancilla Domini: STP discharge to Gilbert Lake which affects ditch.
Earl Gjemere	Ancilla Domini	FS (Aquatic Life) FS (Recreational)	Monitored (c)		5.8	
Cavanaugh Ditch	Knox	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.4	Low level toxic parameters in sediment.

1 PS = Partial Support; NS = Non Support; FS = FUlly Support. If a use is not listed, it was not monitored or evaluated.

2 b = biological; c = chemical.

Potato Creek has two direct dischargers, Potato Creek State Recreational Area STP and North Liberty STP. Potato Creek flows through the City of North Liberty which is the only major populated area along the course of the waterbody, and land use is predominately agricultural. Potato Creek is dammed near its headwaters to form Potato Creek Reservoir.

Water quality both upstream and immediately downstream of the reservoir is good. A short distance below the reservoir the stream receives the effluent from the Potato Creek State Recreation Area STP, a Class I 0.093 MGD extended aeration facility. At the time of the 1990 survey, the facility was discharging poor quality effluent with high ammonia levels, but effluent flow was not continuous.

The North Liberty STP is a Class I, 0.18 MGD oxidation ditch type plant. During the 1990 survey, the plant was meeting all NPDES limits except for E. coli (2,300/100 ml). Chemical samples taken in the stream indicate relatively good water quality, but a fish community assessment produced a poor Index of Biotic Integrity score in this reach of the stream.

Sherman Emmans and Peter Sarber Ditches form Pine Creek, the second large tributary to the Upper Kankakee River, almost 11 miles upstream of the confluence with the Kankakee River. Both ditches are small and full of weeds in the stream bed. The BOD levels are low with average levels at less than 1.0 mg/l. The streams have good D.O. levels (9.0 mg/l) and pH values (7.7).Both ditches drain the Town of Lapaz which now has a municipal sewage treatment plant. However, 12 miles of Peter Sarber Ditch were assessed as "poor" in a fish community biological assessment.

Pine Creek flows through agricultural areas, with the exception of the City of Walkerton. The Walkerton STP discharges to Pine Creek which then combines with Potato Creek just upstream of Kankakee River mile 123.

Near the Walkerton City limits, Pine Creek begins to widen and a flow increases. The bottom composition is sand and some large stones. A few minnows were observed in the slower part of the stream. Water quality was good upstream of the STP except for E. coli concentrations (4,600/100 ml) which were above the standard.

The Walkerton STP is a multi-cell aerated lagoon system and the effluent was meeting all permit limits at the time of the 1990 survey. The minor stream impacts of the STP are gone within 1.5 miles downstream of the discharge. Yellow Bank Creek has its confluence with Pine Creek at RM 5.1 and apparently has no impact on Pine Creek as values for Pine Creek parameters were unchanged. Although chemical sampling of Pine Creek in this reach would indicate relatively good water quality, a fish community Index of Biotic Integrity score for this reach was rated poor. Further downstream, Pine Creek at the North Judson STP only partically supports aquatic life due to D.O. variations.

Breckenridge Ditch drains the Kingsbury State Fish and Wildlife area. Prior to designation as a wildlife area, this land was used as an Army Ammunition Depot. There are fenced areas, off limits to the public, contaminated with explosives. Located within the area is Mixsawbah State Fish Hatchery which uses 0.8 MGD of water from groundwater wells in their salmon spawning and rearing operation. The hatchery then discharges to Turnarack Lake. The flow is comprised of clearwell overflow, biofilter cleaning and rearing pond overflows.

Water samples were taken within this wildlife area, the majority of which is considered wetland. These chemical samples revealed no evidence of negative impacts to Breckenridge Ditch. However, near the town of Stillwell, fish community sampling produced poor Index of Biotic Integrity scores. Geyer Ditch, which flows into the Kankakee River at river mile (RM) 131.61 was sampled chemically and only revealed bacteriological degradation. Fish community sampling produced a poor Index of Biotic Integrity score.

Five small tributaries flow into the Kankakee River within a five mile stretch. These Kankakee River tributaries were sampled near their confluence with the mainstem. Sampling at the confluence of each tributary was not possible due to limited accessibility.

Two of the five small tributaries, Laskowski Ditch and Niespodizany Ditch have good water quality at their confluence with the Kankakee River. However, the headwaters of Niespodziany Ditch are impacted by the New Carlisle STP which discharges to this stream. At the time of the 1990 survey, the New Carlisle STP discharged a low quality effluent, and the stream bottom was covered with several inches of sludge. Less than a half mile downstream recovery is evident. The STP has since been abandoned and New Carlisle is now pumping its sewage to South Bend.

The third small tributary of the upper Kankakee is the County Line Ditch. The headwaters of the County Line Ditch are south of the Bendix Proving Grounds. An instream water sample contained 8.1 mg/l of BOD and 240 mg/l of suspended solids. There may have been high ammonia levels instream at one time because the nitrate (4.8 mg/l) and TKN (3.9 mg/l) levels were high. Nitrification may be taking place in the stream. Approximately 2.3 miles downstream, samples show a BOD level of less than 2.0 mg/l and TSS level of 6 mg/l which indicate stream recovery.

The fourth and fifth small tributaries, Barringer Ditch and the Little Kankakee River do not significantly alter the water quality in the Kankakee

River. The D.O. level ranged from 6.3 mg/l to 10.2 mg/l and pH levels ranged from 7.3 to 8.9 in these tributaries.

An upstream site in the Kankakee River was selected for sampling metals, herbicides and pesticides. A sediment analysis was also done here on the same parameters. This location represents the farthest upstream sample in the Kankakee River and the least point source pollution.

Metals analysis for water revealed an elevated level of arsenic (1.7 ug/l) in the water sample. There were no herbicides and pesticides in the water but pesticides did show up in the sediment. These were DDE (59 ug/kg), DDD (52 ug/kg), DDT (23 ug/kg), and Dieldrin (19 ug/kg).

The lower Kankakee River begins at the Yellow River - Kankakee River confluence and continues downstream to the Indiana-Illinois State Line. The segment is approximately 41.6 stream miles in length. The total drainage area of the lower Kankakee River and its tributaries in Indiana is 672 square miles.

Two streams, Singleton Ditch and Beaver Creek, enter the Kankakee River in the State of Illinois. These streams and their tributaries were also sampled as part of the study. Their combined drainage areas are 279.4 square miles.

Land use within this portion of the Kankakee basin is typically 80% agricultural, 7% forest, and 13% urban and miscellaneous. This is a sparsely populated watershed with few significant municipal or industrial dischargers, none of which discharge directly to the main stem.

Surface water use is primarily for agriculture and recreation. Ground water is used for domestic water supplies. The area within the segment boundaries averages approximately 36-37 inches of rainfall annually. Of this total approximately 26" is consumed through evapotranspiration and 10" appears as stream flow.

Approximately 95% of the soil associations in the Kankakee Basin are classified as having moderate to severe soil wetness characteristics. These are poorly draining soils which hold excess precipitation in the root zone of crops.

To alleviate the drainage problems and also to facilitate crop production in dry years, an interfacing system of drains, laterals, and underground field drainage tiles has been constructed. Lift pumps are used to pump the water from the major drains, thereby lowering the water level in the laterals. This permits the field tiles to flow into the laterals, thus draining the field. During dry periods the process is reversed. By utilizing this type of water table control, most problems associated with excess or insufficient precipitation can be addressed.

Within the lower Kankakee River segment it is estimated that there are 4,820 miles of drainage ditches which have been constructed for water table control. This does not include individual installations of field drainage and underground tiles.

The construction of the control system created many miles of ditches (laterals) that serve no other purpose than regulation of the water table. They are typically long, straight, and narrow with little slope or natural drainage. These type of ditches were not sampled as part of the survey. Samples were taken in most drains which receive the discharge when the laterals are flowing. Some of these (called "catch basins") had little or no velocity but were wide and very deep. It is from these types of drains that the water is lift-pumped into a major, natural flowing, water course.

Approximately one hundred (100) sites on the lower Kankakee River and tributaries were sampled during 1990 for general water quality and bacteriological analyses. Nine (9) municipal and/or semi-public wastewater treatment plants were also sampled. None of the plants discharge directly to the Kankakee River.

Fifteen sites were sampled on the main stem of the Lower Kankakee River. This number is admittedly low for 41.6 miles of stream, however, access to the river is limited. Three of these sites were sampled from the bank and the remainder from bridges.

The overall water quality was very good. The average BOD_5 for the 15 sites was 1.3 mg/l with a high value of 2.6 mg/l and a low of less than 0.1 mg/l. The E. coli counts ranged from 20 to 220 colonies per 100 ml.

A total of sixty (60) field tests for dissolved oxygen were conducted on the main stem of the Kankakee River during the 1990 summer survey. The average value was 6.2 mg/l with a high value of 9.5 mg/l and a low value of 4.5 mg/l. Lowest dissolved oxygen values in the stream were detected during the periods of higher stream flows. This may be due to several factors. The slope of the stream is estimated to be less than one (1) foot per mile. There are no riffles or falls to aid in reaeration. The main contributors to the stream flow are groundwater, which is naturally low in dissolved oxygen, and the water which stands in the lateral ditches until it is pumped into the river. The water in the laterals is water which has drained through the field tiles into the laterals. This water is also low in dissolved oxygen.

The higher flows in the stream were naturally preceded by heavy rainfall. After the soil was completely saturated the rainfall accumulated in the fields (sometimes several feet deep). This water was also pumped into the river in some cases. A sample collected from one area of field run-off had a dissolved oxygen value of 0.0 mg/l.

The washout of extremely fine suspended silt also impeded light penetration and any significant photosynthetic activity. This fine material could be observed as dregs in sample containers after the containers had set for a few minutes, but this material was not readily visible in the moving stream.

Only localized significant pollution was noted on three of the tributaries, far upstream from the main stem. This pollution was partly due to wash out of solids from local wastewater treatment plants.

Substandard dissolved oxygen values were noted at several tributary sites where no point sources are located. These were attributed to lack of stream reaeration and the introduction of water which had stood in fields for days into the stream.

Crumpacker Arm of Forbes Ditch upstream of the Westville Municipal STP and the Westville Correctional Center STP, is a headwater stream with little or no flow much of the year. Due to the low flow and fairly heavy algae growths, the D.O. averages 3.9 mg/l.

Just downstream of the Westville Municipal STP, the stream is occasionally black and septic. Deep sludge deposits and stream gassing have been observed. The dissolved oxygen averaged 1.7 mg/l and the BOD_5 was 40.0 mg/l. The concentration of ammonia-N increased from 0.1 mg/l upstream to 4.2 mg/l at this station. Flow at this point was measured at 2.0 cfs. Westville is currently addressing the high ammonia. Throughout 1993, plant operators achieved a 40% drop in effluent ammonia concentration.

Crumpacker Arm, further downstream, is still severely depressed. The sludge deposits observed were not, however, as concentrated as they were at the upstream sampling points. The velocity of flow at this station is considerably higher, thereby reducing the settling out of the sludge. Dissolved oxygen values were still low (averaging 2.7 mg/l).

Crumpacker Arm and Wright Arm combine to create Forbes Ditch. Forbes Ditch was a fairly clear stream with a sandy bottom and light algae growths. The dissolved oxygen values averaged 4.4 mg/l with a low of 3.0 mg/l making this stream non supportive for aquatic life. The BOD_5 and ammonia-N concentrations were 5.9 mg/l and 1.3 mg/l, respectively. Flow was 6.0 cfs. E. coli concentrations were also above water quality standards.

The first sampling station on the main stem of Crooked Creek was established upstream of the confluence of Crooked Creek and Forbes Ditch. This is also a headwater area. Flow was measured at 1.25 cfs. The stream banks are heavily wooded with cropland on all sides. The water was clear and fish life was noted, however, the stream is being used as a "dump". Tires and other trash have been discarded into the stream. Water quality was monitored as fair with an average D.O. of 6.1 mg/l. However a biological assessment of Crooked Creek and the West Branch of Crooked Creek scored between "poor" and "fair". The West Branch improves as it nears Kouts but is threatened by nonpoint sources.

Pleasant Township Ditch also known as Benkie Ditch is the receiving stream for the Kouts Municipal STP. The stream originates in the northwest corner of the Town of Kouts and flows generally south and west into the Kankakee River. The estimated $Q_{7\text{-}10}$ of Benkie Ditch is 0.4 cfs. Total drainage area is 12.3 square miles.

The Kouts STP is a 0.25 MGD, Class II, extended aeration plant with effluent chlorination. Wastewater is collected through a combined sanitary and storm sewer system. There is one bypass point located near the plant on the east side of Benkie Ditch.

Prior to and during the survey heavy rains fell and the plant was bypassing constantly. The plant was taking 0.373 MGD through the treatment process. Due to the combined sewer system the raw sewage was practically rainwater. The raw plant influent BOD_5 was less than 20 mg/l and the suspended solids were 10 mg/l. It is assumed the bypassed sewage concentrations would be similar.

The plant was effectively reducing the ammonia-N and BOD_5, even under the overload condition. Suspended solids, however, were increased to 20 mg/l, possibly due to washout of solids.

Upstream of the STP the flow in Benkie Ditch was 2.4 cfs which is approximately six times the $Q_{7\text{-}10}$. The water was clear, but the stream was algae choked and strewn with garbage. The dissolved oxygen average was 5.8 mg/l with a low of 5.2 mg/l. The BOD_5 was less than 1.0 mg/l.

The first station downstream of the STP was approximately half a mile below the STP discharge point. The stream was algae choked and covered with duckweed. Fish and other aquatic life were noted. The D.O. at this station averaged 4.6 mg/l with a low of 3.8 mg/l.

Breyfogel and Cornell Ditches were sampled just upstream of their confluence with the Kankakee River. At the time of sampling all the fields bordering the Kankakee River were flooded. Water which had been standing in the fields was being pumped into Breyfogel Ditch, and this water had the odor of corn silage and was brown to black in color. The result of this run-off was a dissolved oxygen depletion in Breyfogel Ditch from Porter CR 400W all the way to the confluence. Although the D.O. was zero, the BOD_5 was only 14 mg/l and the ammonia-N was less than 0.1 mg/l.

Cobb Creek, which is a major tributary to Breyfogel Ditch, is the receiving stream for the Hebron STP. Three sites were sampled on Cobb Creek, one upstream of the Hebron STP and two downstream. At the bridge on SR 8, upstream of the STP, Cobb Creek had wooded banks and a rocky, sandy bottom. Water was clear and shallow with a flow of 1.55 cfs. There was visual evidence of recent flooding in the trees along the creek. Paper and other trash were caught high up in the limbs and branches. The average D.O. was 5.2 mg/l with a low of 5.0 mg/l. The BOD_5 and ammonia-N values were 1.5 mg/l and 0.3 mg/l, respectively. Recreational uses are not met due to high E.coli concentrations probably from nonpoint sources.

At the first downstream station, approximately one (1) mile below the STP discharge, the visual appearance of the stream was little changed from the upstream site. However, D.O. was reduced to an average of 2.6 mg/l with a low of 2.3 mg/l. BOD_5 and ammonia levels increased to 3.5 mg/l and 2.0 mg/l, respectively.

The second downstream site was approximately 2.25 miles below the STP discharge. At this station the water quality was essentially the same as the upstream site.

At the time of the survey, the Hebron STP was not doing a very good job of treating the sewage. A seven inch rain the week before had washed out the plant and it was not yet back to normal operating conditions. It is felt that conditions would have been worse had the stream not been recently flushed by flash flooding. High E. coli values make this stream nonsupportive of recreational uses. Construction of a new wastewater plant is proceeding. The improvements with the new facility are a major step forward. Initial improvements in plant performance were evident in May 1993 although substantial completion will not occur until early 1994. A fish community study on Cobb Creek at Hebron produced a poor Index of Biotic Integrity score.

Salisbury Ditch flows into the Kankakee River at RM 111.9. Porter Ditch, a tributary of Salisbury Ditch, receives the discharge from the Kingsford Heights STP, a Class II, 0.422 MGD facility which consists of primary settling, roughing filter and rotating biological contactors. During the survey, all NPDES effluent requirements were met. Porter Ditch flows through the Town of Kingsford Heights before entering Salisbury Ditch six miles above the Kankakee River. Porter and Salisbury Ditches are irrigation ditches with grasses and bushes covering the steep banks. The water quality was good throughout the six miles of stream with D.O. levels at 6.9 mg/l to 7.4 mg/l and pH values from 6.5 to 8.1. Fish community studies on these streams produced poor Index of Biotic Integrity scores, however.

Whitham Ditch meanders through agricultural fields for 7.8 miles before the confluence at R.M. 111.1 with the Kankakee River. The water quality was probably better in this section of stream than in any other in the area. There was good pool/riffle flow hydraulics in comparison to a typical slow moving pool. The D.O. levels were all above 7.5 mg/l, and pH values were below 7.6. BOD and ammonia levels were less than 0.1 mg/l.

The headwaters of Travis Ditch and Kingsbury Creek are in the vicinity of the City of LaPorte STP where a city storm sewer and treatment plant bypass form Travis Ditch. Travis Ditch then flows in a southerly direction into LaPorte's stormwater detention basin. Then the outflow of the basin and the discharge from the LaPorte STP (a Class IV, 7.0 MGD, two stage nitrification facility) once again form Travis Ditch. These waters then flow 12 miles to the Kankakee River.

Travis Ditch begins as a small stream but increases in size and flow (up to 50 cubic feet per second) before its confluence with the Kankakee River. The width of the stream varies from 10 feet at the headwaters to 20 feet near the confluence with average depths of 1 to 2 feet. The stream flows through agricultural fields and wooded areas most of its length to the Kankakee River. Approximately six miles upstream from the Kankaee River, it is joined by Kingsbury Creek, the only major tributary to Travis Ditch. A short distance downstream from this confluence, the stream becomes known as Long Ditch. The stream flows through Kingsbury Industrial Park, where Roll Coater and the Kingsbury Industrial Park STP have their discharges.

Roll Coater is a facility which paints and coats steel coils. The process includes coil washing, zinc phosphating, oxide coating, chrome rinsing and painting. It has a Class C industrial wastewater treatment facility. The other discharge is from the Kingsbury Industrial Park STP, a Class II, 2.5 MGD, two-stage trickling filter facility.

The sediment composition of Travis Ditch is sand. Water weeds and filamentous algae grow in the streambed. Once the stream reaches SR 6, it is used as an irrigation ditch with several laterals flowing into Long Ditch.

The water quality during the survey was generally acceptable. The dissolved oxygen measurements averaged 6.0 mg/l above Kingsbury Industrial Park and over 7.0 mg/l in downstream samples. The ammonia and BOD levels were low, and all NPDES dischargers (LaPorte STP, Roll Coater and Kingsbury Industrial Park) were meeting their permit limits.

Analyses for toxics were performed on the water and sediment at a majority of the sampling sites. The water analyses for the priority pollutants did not show any concentrations at levels of concern. The sediment analysis did reveal concentrations above maximum background levels for the metals and above detection limits for several organic parameters.

The highest concentrations of metals were detected in the sediment at the furthest upstream station before the storm water basin. This reach of Travis Ditch, from the bypass to the stormwater retention basin, was septic with silty black solids. At this point the highest concentrations of the metals were chromium (62,000 ug/kg) and silver (3,800 ug/kg). At the next sampling station, which is below both the storm water basin and the LaPorte STP outfall, copper (28,000 ug/kg) and silver (1,500 ug/kg) were still above maximum statewide background levels. The priority pollutants above detection limits at the upstream station were phenathrene, (4,000 ug/kg), Di-N-Butylphthalate (1,100 ug/kg), fluoranthene (5,100 ug/kg), pyrene (3,100 ug/kg), chrysene (71,100 ug/kg), Di-N-Octylphthalate (4,700 ug/kg), and benzo(b) fluoranthene (1000.0). As the sampling stations progressed downstream, the metals concentrations diminished and the priority pollutant organics dropped below detection limits.

Comparison of survey data from 1978, 1979 and 1990 provides an historical background on water quality in Travis Ditch. The most notable changes are downstream of the LaPorte STP. In 1978 and 1979, one mile downstream of the STP, the D.O. averages were less than or equal to 1.0 mg/l. In 1990 the average D.O. was 6.0 mg/l. Approximately 4.2 miles downstream, the D.O. average was less than or equal to 4.0 mg/l in 1978 and 1979. In 1990 the average D.O. was 6.5 mg/l. The BOD level has also decreased over this time period.

Although measured chemical parameters appear to be mostly satisfactory, fish community sampling on both Kingsbury Creek and Travis Ditch produced Index of Biotic Integrity scores considered "poor" on these streams. The reasons for these low ratings have not been determined.

The upper Yellow River is located at the eastern end of the Kankakee River Basin. This segment of the river is primarily situated in Marshall County. The northern portion extends into southern St. Joseph County and the easternmost tip extends into western Kosciusko County. The major population centers for this area include the cities of Plymouth and Bremen and the smaller towns of LaPaz and Lakeville. The estimated total population for the segment is approximately 50,000 people.

Agriculture is the predominant land use with more than 72 percent of the land devoted to this purpose. Approximately 8% of the land is forested while the remaining 20% is urban and miscellaneous use. Industrial parks located in the northwest portions of both Bremen and Plymouth are manufacturing sites containing numerous industries. Most of these industries discharge to the local municipal wastewater treatment plant.

Public and private water usage from the main stem Yellow River is very negligible in this segment. Public water supplies for Plymouth, Bremen and the small communities are provided by ground water sources. No irrigation pumps or ditches were observed at any of the numerous stream observation sites and sampling points in this study.

The Yellow River in this area begins upstream of Bremen and extends downstream of Plymouth, a distance of 26.1 miles. Major tributaries include Armey Ditch, Stock Ditch, Martin Ditch, Walt Kimball Ditch, Isaac Sells Ditch, Dausman Ditch, Schuh Ditch, and Elmer Seltenright Ditch. The total drainage area of this segment encompasses 318 square miles.

The quality of riparian habitat in rural areas is low to moderate according to the Indiana Water Resource Report of 1980. The most typical stream station physical description can be characterized as having steep banks with heavy vegetation which is mainly tall grasses with varying amounts of bushes and trees. The stream bed in most cases was sandy with some silt. The stream is meandering with pool, riffle, pool effects and considerable slope in some reaches. Except for a few tributaries, very little channelization exists in this segment. Cropland predominates the stream banks in rural locations. The Upper Yellow River segment currently has a total of 10 NPDES dischargers which include three semi-public, three municipal, and four industrial permittees.

Starting with headwater facilities, the Town of Lakeville is the northern most discharger. This facility is a Class I, 0.13 MGD, two cell waste stabilization lagoon with disinfection facilities. The effluent discharge is to Hoffman Ditch, which flows to West Branch Bunch Ditch, to Stock Ditch, and thence the Yellow River. This is a controlled discharge facility which was not flowing during the survey period and no samples were collected. The lagoons appeared to be well maintained and the receiving stream was in good condition with no observed degradation.

A portion of Hoffman Ditch, which receives discharge from the Lakeville wastewater-treatment plant in St. Joseph County, is designated as a limited-use stream because instream habitat, physical conditions, and stream flow are insufficient to support well balanced aquatic communities.

Lakeville High School is located in the northwestern portion of the Upper Yellow River segment. This school is serviced by a small extended aeration sewage treatment plant. Although the plant did not appear very well operated, the final effluent was clear. Stream degradation was not observed downstream of the outfall. The receiving stream is Lehman Ditch which flows to Stock Ditch and then to the Yellow River.

The City of Bremen's wastewater treatment plant, the largest discharger in the area, has an NPDES permit which requires pretreatment testing for heavy metals and cyanide in addition to the traditional effluent parameters. Bremen has bypass authorization for six wet weather combined sewer overflows (CSOs). The STP outfall discharges to the Yellow River with most CSO outfall locations existing along Armey Ditch. This facility was very well operated and maintained and was discharging a clear effluent during the survey period.

The Bremen STP, was meeting all pretreatment and permit limits except for <u>E. coli</u> during the 1992 survey. The 8,900/100 ml could be attributed to a temporary dip in the chlorine residual which was measured at 0.1 ppm. During 1993, copper exceedences were frequent due to high copper content from the water system. The town water department is currently adding sodium silicate to the water to coat the water lines in the water system. This is to stop the leeching of copper and other metals from the water lines. The average dissolved oxygen in the final effluent was 7.64 mg/l. However, fish community sampling results produced Index of Biotic Integrity scores in the poor range in this portion of the stream.

A second discharger located in Bremen is the Miller Bearing Company, which manufactures steel needle bearings, dowel pins, and screw matching parts. This Class B industrial wastewater treatment plant had received pretreatment authorization for discharge to the municipal STP. No effluent discharge was observed during presurvey or during the survey period. This facility had previously discharged to the Yellow River.

Water and sediment samples, which also included samples for toxic parameters, were collected from the Yellow River to bracket the Bremen STP and Miller Bearing. One semi-volatile, phenanthrene (2.8 ppb), was identified barely above detection limits in the upstream water sample. The downstream station revealed Bis 2-ethylhexyl-phthalate at a level of 170 ppb in the sediment. All other analyses were below detection at these stream sites.

A small semi-public STP which services the Mikel Mobile Home Park is located in the easternmost tip of this segment. This is a 10,000 gallon per day plant with extended aeration, chlorination facilities and a terminal lagoon. This facility appeared very poorly operated and maintained with a resultant cloudy effluent. This facility discharges near the headwater of Dausman Ditch which has a Q_{7-10} of less than 2.0 cfs at this point.

The BOD_5, suspended solids, and <u>E. coli</u> values in the effluent were all well above permit limits and ammonia levels were high (10 mg/l). Other than at the point of discharge, no adverse stream impact was observed due to the great dilution ratio on the day of the survey (approximately 375:1). A high <u>E. coli</u> count makes this stream nonsupportive for recreational uses.

The D.O. levels in Dausman Ditch were found to be sufficient for supporting aquatic life. No herbicide levels above detection were observed.

Two sampling stations on Yellow River bracketing Dausman Ditch were also found to be in good condition. Herbicide samples were collected from the water and sediment with no levels above detection limits observed.

The Gatewood Mobile Home Park is located due north of Plymouth and discharges to the headwater of Reese-Stough Drain ($Q_{7\text{-}10}$ of 0.0) which flows to Elmer Seltenright Ditch and then to the Yellow River. This 8,000 gallons per day sewage treatment system consists of a two cell lagoon with the first stage aerated. This facility had obviously been neglected for a considerable period of time as evidenced by poor maintenance practices. Discharge from the lagoon can be described as seepage from one corner of the lagoon into a wetland area. It appeared that evaporation from the lagoons was nearly equal to the influent flow, resulting in a negligible effluent flow. The quality of effluent appeared poor. The fish community Index of Biotic Integrity in this ditch was scored as "poor".

Plymouth Fertilizer which produces fertilizer and animal feed by rendering is located upstream of Plymouth. This facility no longer discharges due to recycling through the plant and land application of wastewater. A thorough inspection of the Yellow River behind the Plymouth Fertilizer plant indicated no releases or discharges were present.

R & J Manufacturing is located in northwest Plymouth and produces synthetic rubber. The discharge is limited solely to non-contact cooling water, free from process and other wastewater discharges. Permit parameters for this facility are oil and grease, temperature, and pH. The approximate flow of 0.05 MGD discharges to Schuh Ditch which has a $Q_{7\text{-}10}$ of 0.0 at the discharge point. E. coli concentrations were above the water quality standard at one sampling point.

Approximately 1.75 miles downstream of Schuh Ditch lies the outfall for Pilgrim Farms. This facility processes pickles, peppers, mustard, and other related products for the food service industry. The pickles are fermented in open top tanks in a salt and vinegar brine and taken from there for production. The outside pickle vats either overflow or spillage occurs during removal of pickles. The spillage flows to drains and, in turn, a catch basin which only discharges during heavy rain events. During the presurvey and survey period no discharge was present from this outfall.

The final NPDES discharger in this reach is the 3.5 MGD Plymouth STP. This Class III activated sludge facility has recently been expanded and renovated to include two roughing filters, a surge pond, and elimination of a portion of the infiltration, inflow, and bypassing. A pretreatment program is in effect at this facility, where heavy metals and cyanide are regularly analyzed in addition to the traditional STP parameters. This facility regularly receives pickle brine and low pH influent causing some difficulty in treatment. The STP appears well operated, however, and with the plant expansion, a very clear effluent was being achieved. A compliance sampling inspection was conducted in conjunction with the segment study during the survey period. This facility is located in the southwest corner of Plymouth and discharges to the Yellow River. Additionally, Plymouth is authorized to discharge from 19 wet-weather combined sewer overflows.

The Plymouth STP was operating very efficiently and meeting all pretreatment and permit limits during the survey. A number of toxic parameters were found above detection limits in the raw and final but none at significant levels.

The headwaters of the upper reach of the Yellow River appear to be in good condition based on 1990 sampling results. A potential nonpoint source of concern was Prairie View Landfill, located near the headwater of the Yellow River. No degradation of the river was observed in this area and samples for toxic parameters had results below detection limits.

A herbicide sampling site was located on Stock Ditch just before the confluence with the Yellow River. Minimal agricultural activity was observed just prior to and during the survey. Atrazine, alachlor, cyanazine, simazine, and trifluralin were in either the water or sediment.

All other stream stations including those on Armey Ditch bracketing CSO locations and downstream in Yellow River disclosed no deleterious levels of general chemistry or nutrient parameters. However, a 1990 fish community assessment of Armey Ditch indicates a poor Index of Biotic Integrity score.

Lake of the Woods feeder ditches (Martin Ditch and Walt Kimball Ditch) were sampled to evaluate water quality going into the lake. Laboratory analysis disclosed a high E. coli count (26,000/100 ml) in Martin Ditch just before entry to the lake. A concern of this lake community has been high bacterial counts in the lake caused by septic system failures. The outlet stream, Isaac Sells Ditch, was sampled near the confluence with the Yellow River with high E. coli counts as the only degradation observed.

The lower Yellow River segment is situated in west central Marshall County and the northern half of Starke County. The major population center for this area is the City of Knox and includes the smaller Towns of Argos and Hamlet. The estimated total population for the segment is approximately 28,000.

The predominant land use is agriculture with more than eighty percent of the land devoted to this purpose. Approximately seven percent is forested while the remaining thirteen percent is urban and miscellaneous land uses. The only industries of significance in this segment are located on the western edge of Knox along Cavanaugh Ditch and discharge to the Knox Sewage Treatment Plant.

Public water supply usage from the main stem (Yellow River) and tributaries does not exist in this segment. Public water supplies for Knox and the smaller communities are provided by groundwater. Private water usage is significant however, due to irrigation from practically all the streams and ditches in the western portion of this segment.

Two chains of lakes make up the drainage area for the east central portion of the lower Yellow River. Significant lakes in the northern chain include Dixon, Pretty, Gilbert and Flat lakes, which flow into Gunnard-Anderson Ditch. The southern chain of lakes which generally have larger surface areas than the northern chain includes Lawrence, Myers, Cook, Holem, Mill Pond, Thomas, and Lake Latonka. This southern chain of lakes flows into Harry Cool Ditch. Eagle Lake is located just downstream of the confluence of Harry Cool Ditch and Gunnard-Anderson Ditch. Koontz Lake is an isolated lake located in the northern portion of this Segment and is the largest lake in the area. Koontz lake has a surface area of 346 acres and gross storage area of 1,032 million gallons.

A short reach of the Kankakee River lies on the western edge of this segment and receives four tributaries which carry the flow from this segment. Starting to the north, Robbins Ditch, along with major tributaries of its own, drains the northern portion of this segment. Bailey Ditch and a small network of channelized ditches drains the west central area of this segment. The Lower Yellow River begins at river mile 34.9 and includes Wolf Creek which drains the Argos area, Eagle Creek which drains the Chain of Lakes area, the Knox area, and most of the southern portion of the segment. Kline Ditch drains a small network of channelized ditches in the southwestern corner of the segment. Kline Ditch, Yellow River, and the Kankakee River all meet at a confluence near English Lake. The total drainage area for this segment encompasses 255 square miles. The Lower Yellow River Segment currently has a total of 7 NPDES dischargers, which include four semi-public and three municipal permittees.

The furthest upstream facility, Jellystone Park, is a recreational campsite facility located west of Plymouth. This 0.105 MGD semi-public facility discharges to and creates the headwater of Blad Ditch which flows to Morse Ditch to Jain Ditch and thence Robbins Ditch. The treatment system consists of extended aeration, rapid sand filters, and chlorination facilities. This facility was experiencing numerous operational problems which resulted in obvious solids loss that created a cloudy effluent. Values for BOD_5 (58 mg/l) and suspended solids (42 mg/l) in the final effluent would not meet weekly or monthly limits, should these levels continue. Additionally, although there are no permit limits, ammonia (28 mg/l) and phosphorus (4.9 mg/l) were also at levels of concern. General operation, maintenance, and housekeeping did not appear very good at this facility and probably accounts for the permit violations. Blad Ditch had recovered from the effects of the poor quality effluent at the sampling point 1.4 miles downstream of the outfall.

The Town of Hamlet is located in the northwest quadrant of this segment. This small community operates a 0.1 MGD extended aeration plant with a two day polishing lagoon and effluent chlorination. This facility discharges to Danielson Ditch, which is channelized and has a Q_{7-10} of 0.1 cfs. Danielson Ditch flows into Robbins Ditch which flows into the Kankakee River. The polishing lagoon was noted to have numerous weeds and duckweed at the time of inspection. The Hamlet STP was found to be meeting permit limits for all parameters. Field analysis showed low D.O. (mean of 3.5 mg/l) in the final effluent from the polishing lagoon. Stream degradation was not found in downstream stations on Danielson Ditch.

The Starke County Airport is located in the west central portion of the Segment. This facility maintains a 1,800 gallons per day semi-public sewage treatment facility, consisting of an extended aeration plant followed by open sand filters and chlorination facilities. Discharge is to Newtson Ditch, thence to Bailey Ditch, and the Kankakee River. This facility had a very insignificant flow.

The Argos STP is a Class II, 0.20 MGD contact stabilization plant with effluent chlorination. Argos is situated in the extreme southeastern corner of the segment and the STP outfall forms the headwater of an unnamed tributary that flows to Myers Ditch, Wolf Creek and thence the Yellow River. An enforcement action has been initiated against this facility because of ammonia violations. At the time of the survey, only one side of the plant was in service, due to modifications required to meet new ammonia limits. Ammonia (17 mg/l) and suspended solids (58 mg/l) effluent values were both high and if continued, would result in violations of the permit. E. coli levels were high (28,000/100 ml) in the downstream location on Myers Ditch. Field analysis showed marginal D.O. values in the receiving stream downstream on Myers Ditch. Upon completion of this project, during 1991, the facility has consistently met the NPDES limits for ammonia. A 1992 agreement between the town and IDEM is in effect in an effort to halt future ammonia violations.

West Elementary School is situated in the east central area of this Segment. This school operates a 10,000 gallons per day semi-public sewage treatment facility consisting of extended aeration, rapid sand filters, and effluent chlorination. Discharge is to a tributary to Flat Lake. At the time of the survey, enforcement action was pending because of significant BOD and suspended solids violations. Samples were not collected at this facility due to inactivity at the school during summer vacation and an insignificant flow during the survey period.

The Ancilla Domini Convent wastewater treatment plant located just south of Donaldson is a 46,000 gallons per day semi-public sewage treatment system consisting of extended aeration, chlorination, and a terminal lagoon. Discharge from the terminal lagoon flows into Gilbert Lake near the lake outlet ditch. The actual treatment system appears very well operated, however the terminal pond is often covered in duckweed. The STP was found to be operating very well except for the disinfection process. An E. coli count of 15,000/100 ml was found in the final effluent. Total residual chlorine levels were quite low in the effluent indicating their chlorination system may not have been working well. The STP was meeting all other permit parameter limits.

The largest NPDES discharger in this area is the Knox STP located on the northern edge of town. This is a Class II 0.51 MGD activated sludge plant with effluent chlorination. Discharge is to the Yellow River which has a $Q_{7\text{-}10}$ of 71 cfs at this point. An enforcement action was pending against this facility for significant CBOD, suspended solids, and chlorine violations. The facility has significant I/I problems causing raw sewage bypassing in wet weather and, in general, is very poorly operated and maintained. In 1991, this facility entered into an Agreed Order with IDEM which required the City to begin new construction by November 1991. New limits were set for BOD and TSS until 1993 to cover the construction period.

Although the Knox STP does not currently have a pretreatment permit in effect for metals or toxics, there is some industrial input and priority pollutants were sampled at the STP. Several toxic parameters were found above detection limits in the raw, final, and sludge, but most were not at levels of concern. Cyanide was found at 0.09 mg/l in the effluent and 0.22 mg/kg in the sludge, and acrylonitrile was found at 27.0 mg/kg in the sludge. No significant metal levels were found. Recent inspections have found the plant operations to be much improved.

Cavanaugh Ditch was sampled downstream of an industrial area situated in the southwestern corner of Knox. Two locations showed cyanide levels in the sediment slightly above statewide maximum background concentrations. A few other toxics parameters were found over detection limits in both the water and sediment but none at significant levels. General chemistry and metals analysis at these two sites revealed no problems.

Dissolved oxygen levels in Robbins Ditch and on Bailey Ditch ranged from a high of 5.7 mg/l to a low of 3.8 mg/l. These streams were channelized and deep with little or no slope and little reaeration ability. They also receive high amounts of groundwater. These factors probably account for the marginal D.O. values since no discharges are impacting these streams.

In general this survey of the lower Yellow River segment disclosed very little stream degradation below the headwater facilities. However, some of the facilities did show significant permit violations. Throughout this segment, 29 of 33 stream stations exceeded the standard of 235/100 ml for E. coli. These exceedences are so prevalent and often found in locations where no point sources were apparent, that most appear to result from nonpoint sources such as field run-off and other agricultural activities.

Cedar Creek has its origin at the outlet of Cedar Lake in southwestern Lake County. It then flows south and is again impounded by a dam forming Lake Dalecarlia. Downstream of Lake Dalecarlia, Cedar Creek flows through the City of Lowell and then to its confluence with Singleton Ditch. The total drainage area at the confluence is 31.3 square miles. The watershed is primarily suburban residential and agricultural and supports its aquatic life uses for 3 miles. Chemical and biological assessments also show that another 12.8 miles are nonsupportive due to low dissolved oxygen.

Cedar Creek receives the effluents from the Dalecarlia STP and the City of Lowell Municipal STP. The Dalecarlia STP is a privately operated package plant. Foss Ditch, which is a tributary to Lake Dalecarlia, is the receiving stream for Center Utilities, a semi-public facility located northeast of Lake Dalecarlia.

The Center Utilities sewage treatment plant serves the Hermits Lake and Hidden Lake subdivisions and is located at the south end of Hermits Lake. The plant is a 0.088 MGD extended aeration facility with chlorination facilities and two (2) terminal lagoons. The discharge forms Foss Ditch.

The facility is old and maintenance is poor. A compliance sampling inspection was conducted five months prior to the segment survey. The overall condition of the plant was poor. The facility has been neglected and not maintained for what appears to be many years. The equipment was run down and rusty. A secondary clarifier wall has rusted through and liquid now runs into the activated sludge tank. The bar screen is full of paper and debris. In general, the facility is not operated or maintained in a manner which would allow it to achieve maximum effluent quality.

Enforcement activity by both IDEM and U.S. EPA is being pursued against this facility because of continuous non-compliance with the NPDES permit. High ammonia (25 mg/l), BOD_5 (64 mg/l) and suspended solids (60 mg/l) were detected in the flow to the lagoons.

Foss Ditch was sampled 1.1 miles downstream of the utility discharge area and at 3.0 miles downstream of the Center Utilities plant. At both sampling stations, dissolved oxygen values were very low. It would be difficult to attribute these values to the Center Utility facility alone because of the oxygen absorption characteristic of a shallow water wetland. The flow from the plant is small and is obstructed in the wetlands area. The E. coli concentrations and BOD_5 values at the downstream stations were at low levels, possibly due to the water passing through the wetlands.

There was no flow out of Cedar Lake at the time of sampling. The lake was experiencing a severe algae bloom and the water was peagreen in color with heavy concentrations of algae around the banks and boat docks.

Due to the lack of flow, only one site was sampled on Cedar Creek between Cedar Lake and Lake Dalecarlia. The dissolved oxygen was below standard; however, chemically and bacteriologically, the water quality was fair.

The water quality at the outlet of Lake Dalecarlia was excellent. The BOD_5 was slightly high (4.8 mg/l), but, ammonia and E. coli concentrations were very low. Flow was measured at 1.74 cfs. No algae bloom was evident at Lake Dalecarlia.

Just downstream of Lake Dalecarlia, Cedar Creek receives the effluent from the Dalecarlia Utility semi-public STP. The plant is a small extended aeration plant with effluent chlorination. The effluent quality was good. Additional wastewater treatment facilities are projected for this area to meet the demands of a growing population located on the southern end of the lake.

Five sites were sampled on Cedar Creek, between Lowell and the Lowell STP discharge. The water quality at all the sites was very similar. Dissolved oxygen values averaged from 7.3 mg/l to 8.2 mg/l. The BOD_5 concentrations ranged from 4.1 mg/l to 4.4 mg/l. All ammonia-N values were 0.2 mg/l. The general water quality was fairly good, however, E. coli counts did indicate some contamination within the city limits. Flow was measured upstream of the STP at 5.8 cfs. This is roughly four (4) times the Q_{7-10} of Cedar Creek at this point.

The City of Lowell operates a 2.0 MGD, Class III, activated sludge plant with rapid sand filters and effluent chlorination. All incoming flow is routed through the storm water retention basin after passing through the comminutor and bar screens. At the discharge point to Cedar Creek, the Q_{7-10} of the stream is 1.5 cfs. During the survey the plant flow was 2.286 MGD or approximately 3.5 cfs. The flow was steady throughout the survey because of the control provided by the storm water retention basin. The plant was in good condition and producing a good quality effluent. No operational problems were noted and all parameters were well within limits.

While chemical data collected at the time of the survey suggest that water quality in this reach is fair, the Index of Biotic Integrity Scores from fish community sampling rated the stream as poor near the Lowell STP.

The Iroquois River is situated in Jasper and Newton counties. The major urban center is Rensselaer, with small towns including Remington, Goodland, Brook, and Kentland. The projected 1990 population of the two counties is 48,000 people.

Land use in the region is predominantly agricultural (approximately 80%) with some forested areas (7%). The remainder is urban areas, with some miscellaneous use.

Public water supplies in the segment are from groundwater. Goodland treats the town's water for excess hydrogen sulfide. Irrigation requirements are limited to the headwater areas of the Iroquois River and Slough Creek, or the extreme northern and southeastern areas of the segment.

The quality of riparian habitat in the segment is rated from moderate to high in areas along the Iroquois River. This is a result of extensive areas of wooded swamps and upland woods. This provides excellent habitat for small and large game, upland game birds, and waterfowl. The grassy banks of the upstream reaches of the river and its tributaries offer habitat for game birds, especially pheasant. Most stream stations mirror this general description.

The Iroquois River headwaters are in Newton County, approximately 3.5 miles northwest of Rensselaer. The segment area is bordered downstream by the State of Illinois. Tributaries include Oliver Ditch, Ryan Ditch, Carpenter Creek, Curtis Creek, Mosquito Creek, Hunter Ditch, and Montgomery Creek. The total drainage area is 718 square miles.

The Iroquois River segment has a total of 15 NPDES permitted dischargers. None of these facilities appear to be having any impacts on their receiving stream or the Iroquois River.

The City of Goodland has no treatment system. Sewage disposal is to septic tanks which often overflow to drains which discharge to an unnamed tributary (through town) to Hunter's Ditch, then to the Iroquois River. E. coli counts of from 40,000 to 50,000/100 ml were reported for samples from the unnamed tributary in the Goodland area. Hunter's Ditch, into which this tributary flows, recovers approximately 1.5 miles downstream of Goodland where E. coli counts were 30/100 ml. Goodland has plans to build a treatment plant which will further enhance overall quality of water in the segment.

Montgomery Ditch is in good shape prior to its confluence with the Iroquois River. The Iroquois River at the Illinois State Line is in excellent shape with low E. coli counts, some suspended solids (from sediment loads) and low BOD. Copper and zinc were the only metals analyzed that were reported above detection limits and concentrations of those were low.

Although there are water quality problems in a few tributaries, water quality in the Iroquois River appears to be very good in most areas. However, a biological assessment of the fish community in the reach of the river near the Town of Parr produced a poor Index of Biotic Integrity score. Biological assessments of other portions of the river were good.

A total of 112 sites were sampled for fish community structure analysis in the Kankakee River basin during Central Corn Belt Plain Ecoregion sampling in 1990. A total of 82 species were collected and were numerically dominated by cyprinid species (carps and minnows). The headwaters of the Kankakee River were depauperate of cyprinids, and instead were comprised of carnivores and benthic insectivores.

The overall water quality of the Kankakee River ranges between a low of very poor (score of 12; numerous sites) to excellent (score of 57; Yellow River) based on Index of Biotic Integrity (IBI) scoring criteria developed during the current investigation. An increasing trend was evident in going from headwater to higher order tributaries in the overall water quality of the Kankakee basin. The number of sites approximated a normal curve based on water quality determination from index scores. The following was the percent occurrence of total Kankakee stations (112) within each index classification: excellent 1.78% (2 stations); good 16.07% (18 stations); fair 36.6% (41 stations); poor 28.57% (32 stations); very poor 16.07% (18 stations); no fish 0.89% (1 station). Sites classified as fair, good or excellent were considered to attain their biological uses and those classified as poor, very poor or no fish were considered not to attain their uses. In this basin 55% of the stations attained their uses and 45% did not. The sites which had low index values were primarily attributed to poor habitat and, to a limited extent, low dissolved oxygen levels. The Yellow River, a main tributary component of the upper Kankakee River, had very high Index of Biotic Integrity scores for almost all sites sampled.

Two stream types appear to exist in the Kankakee basin, those which possess stream flow, few aquatic macrophytes, and stable riparian bank vegetation; and those which have little to no flow causing the accumulation of soft substrates, heavy aquatic macrophyte growth, and little canopy cover. High numbers of intolerant taxa existed in these macrophyte-choked areas. The biological criteria developed during the current study recognizes the importance of these habitats for the maintenance of the species plus a number of other low-gradient taxa distributed in the Kankakee basin.

Although much of the Kankakee basin has been and continues to be dredged in order to maintain agricultural ditches, a high proportion of the sites have recovered and have the resemblance of a quality riffle, run, and pool habitat. The ability of species colonization from the mainstem Kankakee into most tributary segments enables the recovery of most stream reaches even after periods of severe degradation.

A total of 37 headwater and wading sites were sampled for fish communities structure analysis in the Iroquois River basin during Central Corn Belt Plain Ecoregion sampling in 1990. A total of 56 species were collected and were numerically dominated by catfish species. The headwaters of the Iroquois River, Oliver ditch and Ryan ditch, were depauperate of cyprinids. Instead, these waters contained bullheads and centrarchids. These areas were generally degraded due to fluctuating flows which prohibited a few species from maintaining permanent residence.

The overall water quality of the Iroquois River ranged between a low of very poor (score of 16; one station) to a high of excellent (score of 56; one station) based on Index of Biotic Integrity scoring criteria developed during the current investigation. The biotic integrity of the Iroquois River basin did not vary much with increasing drainage area. Like the Kankakee basin, the number of Iroquois basin sites approximated a normal curve with respect to water quality as determined from index scores. The following was the percent occurrence of total Iroquois stations (37) within each index classification: excellent 5.41% (2 stations); good 29.73% (11 stations); fair 45.95% (17 stations); poor 16.22% (6 stations); very poor 2.70% (1 station). Fish were collected at all sites in the Iroquois basin. Only 19% of the sample sites did not meet use attainment standards. The 81% with fair, good or excellent scores was the highest use attainment percentage of the three basins surveyed. Low index values of many sites were primarily attributed to poor habitat. The low flows of some tributaries caused the accumulation of soft substrates in adjacent riffles and pools effectively reducing available habitat. Likewise, dredged streams reduced habitat complexity. Sugar Creek was an exceptional stream in the Iroquois basin. Curtin and Carpenter Creek, main tributary components of the middle to upper Iroquois River, had very high index of biotic integrity scores for almost all sites sampled.

The Iroquois basin has been and continues to be dredged in order to maintain agricultural irrigation capability. A high proportion of the sites have recovered and have the resemblance of a quality riffle, run, and pool habitat. The ability of species colonization from the mainstem Iroquois into tributary segments is less than the Kankakee since several lowhead dams exist on the

River, and greater contributions of groundwater cause natural fluctuations in flow during various seasons.

In summary 1,661 stream miles were assessed in the Kankakee River Basin. With regard to aquatic life uses, 1,098 miles (66%) fully support this use, 92 miles (6%) fully support this use but are threatened, 49 miles (3%) are partially supportive and 421 miles (25%) were not supportive. There were 1,097 miles assessed for recreational uses. Of those miles, 402 (37%) were supportive, 85 miles (8%) were partially supporting and 610 miles (56%) did not support recreational uses. Metals and sewage related problems accounted for the large majority of stream miles not supporting their designated uses.

Wabash River Basin

The Wabash River Basin provides drainage for approximately 33,000 square miles of the surface area of Indiana, Illinois, and Ohio. The greatest portion of the basin is in Indiana where it drains two-thirds of the state's surface area (Figure 59). The portion of the river system addressed in this section excludes the White River Basin and is, therefore, limited to about 21,000 square miles.

There is one large Corps of Engineers (C.O.E.) impoundment on the 450 mile river mainstream and four on its tributaries. Two narrow lakes, Freeman and Shafer, were created on the Tippecanoe River by construction of hydroelectric power facility dams. All of these waterbodies provide a variety of uses which require a high degree of protection.

Regulation 327 IAC 2-1 establishes the water quality standards for the Wabash River Basin. The river and its tributaries are now designated for whole body contact recreation and maintenance of a warmwater fish community. In the Wabash River Basin, stretches of Wildcat Creek and the South Fork of Wildcat Creek are designated as Outstanding State Resource Waters.

Eight stream reaches within the basin have been designated as exceptional use waters and their quality must be maintained without degradation. (Table 46)

Limited use streams are those watercourses which, because of their shallow depths, lack of flow, or lack of habitat, cannot support a well balanced aquatic community. The limited use streams in the Wabash River Basin are listed in Table 47. Surface water intakes for public water supplies are located on the waters shown in Table 48.

This basin covers a large portion of the state and is subjected to a wide array of uses, some of which have more adverse impacts on water quality than

Figure 59. *Wabash River Basin (including Patoka River Basin)*

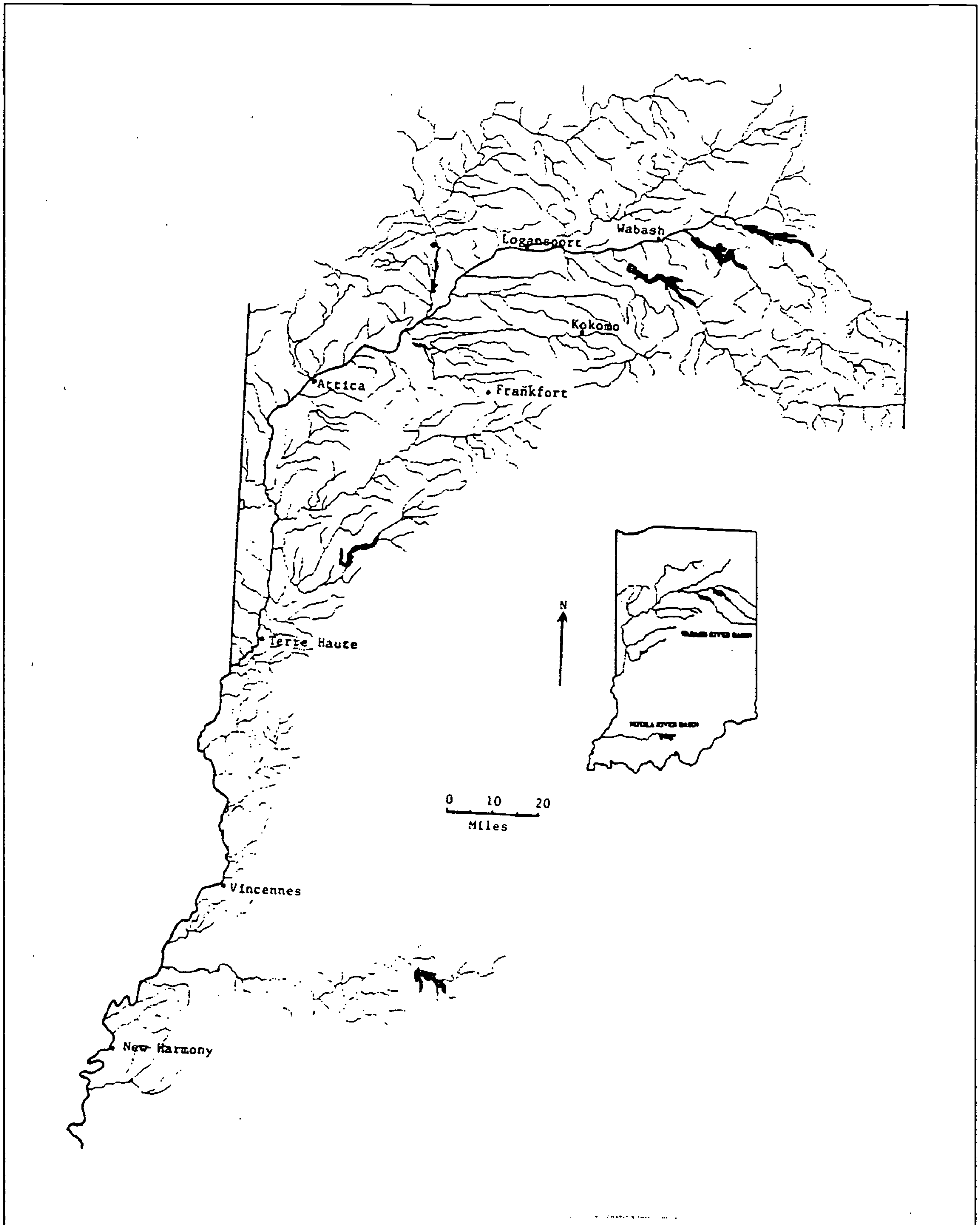


Table 46. *Exceptional use streams in Wabash River Basin*

STREAM	COUNTY	SPECIFIC PORTION
Big Pine Creek	Warren	Downstream State Road 55 to Wabash River
Mud Pine Creek	Warren	County Road Between Brisco and Ridgeville to confluence with Big Pine Creek
Fall Creek	Warren	One-half mile downstream from US 41 to confluence with Big Pine Creek
Indian Creek	Montgomery	From County Road 650 West downstream to confluence with Sugar Creek
Clifty Creek	Montgomery	Within Pine Hills Nature Preserve
Bear Creek	Fountain	From County Road 450 North to confluence with Wabash River
Rattlesnake Creek	Fountain	From County Road 450 North to confluence with Bear Creek
Unnamed tributary to Bear Creek	Fountain	Within Portland Arch Nature Preserve

Table 47. *Limited use streams in Wabash River Basin*

STREAM	COUNTY	SPECIFIC PORTION
Redkey Run and Halfway Creek	Jay	From Redkey POTW to a point 2 miles downstream
Buck Creek	Sullivan	From the Sullivan South POTW to 2.25 miles downstream
Jefferson Ditch	Grant	From the Upland POTW to its confluence with Lake Branch.
Unnamed Stream	Dubois	From Huntingburg City Lake Dam downstream to the Wabash River
Spring Creek	Vigo	From Hercules, Inc., outfall downstream to the Wabash River
Francis Dutro Ditch	Blackford	From the Blackford Canning Company discharge downstream to its confluence with Prairie Creek

Table 48. *Public water supply surface water intakes in Wabash River Basin*

Wabash River Basin	
Logansport	Eel River
Kokomo	Wildcat Creek (plus wells)
Terre Haute	Wabash River (plus wells)
Turkey Run State Park	Sugar Creek
Warsaw	Center Lake
Montpelier	Salamonie River
Huntington	Wabash River
Patoka River Basin	
Huntingburg	Huntingburg Lake
Jasper	Patoka River
Lynnville	Lynnville Lake (strip mine)
Oakland City	Oakland City Lake
Winslow	Patoka River (plus purchases)

others. Waters in this basin receive a diversity of wastes from municipal sewage treatment facilities, cropland runoff, chemical manufacturing facilities, coal fired electricity generating stations, steel processing plants, and coal mines.

A total of 1,839 miles of waterways, including the Patoka River, were assessed in the Wabash River Basin. The assessed waters, the status of designated use support, probable cause of impairment, and affected miles are shown in Table 49. Additional information is also provided in this table for certain reaches.

Based on fish data collected prior to 1985, a general fish consumption advisory was issued for a 73 mile reach of the Wabash River from Lafayette downstream to Darwin, Illinois due to high levels of chlordane, dieldrin, and PCBs. Subsequent fish samples collected in 1985-86 from the Wabash River indicated much reduced levels of these pollutants, and the advisory was revised in 1987 to include only carp. Samples from several locations along the river are collected biennally. The fish consumption advisory for the Wabash River has been entirely lifted since 1989 because of lowered levels of contaminants found in fish tissue samples collected in recent years.

Fish tissue samples collected from Elliott Ditch and Wea Creek downstream of the Elliott Ditch confluence in Tippecanoe County exceeded Food and Drug Administration (FDA) Action Levels for residual PCB's. These areas are included in the 1994 fish consumption advisory (Table 15), and places these portions of these streams in non-support of the aquatic life use designation. The source of PCB contamination is the Aluminum Company of America (ALCOA) facility which is known to have discharged low levels of PCB's to Elliott Ditch in the past.

ALCOA has implemented a remedial action program to eliminate PCB's from the processing plant areas. ALCOA has also done sampling and surveys of the stream sediment, fish and water from Elliott Ditch. The findings were used as the basis for requiring the cleanup of the discharge and the removal of a one mile stretch of contaminated sediment from the ditch.

Other streams in the Wabash River Basin which are affected by a consumption advisory include the Little Mississinewa River and nine miles of the Mississinewa River from one mile above the confluence of the Little Mississinewa River downstream to Ridgeville. Fish tissue samples from these stream areas exceeded FDA Action Levels for PCB's. The PCB's were discharged from the Union City STP but originated at the Westinghouse facility which was leased to the Dana Corporation. Fish sampled from two sites during 1988 revealed that the FDA Action Level for PCB's was still exceeded.

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected In Wabash River Basin (including Patoka River)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Wabash River	Geneva	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	16	
Wabash River	Markle	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3	
Wabash River	Huntington	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6	
Wabash River	Andrews	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	16	a) Some infrequent bypassing at Andrews STP but normal operation is good. b) Awarded 1990 IDEM Operation and Maintenance award.
Wabash River	Wabash Peru	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	28	a) No effluent violations due to overall recycling of waste streams by Container Corporation of America. Major problem in past. b) Plans underway to build new Wabash STP plant. c) Wastewater treatment plant improvement project underway at Peru.
Wabash River	Georgetown	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	27	
Wabash River	Upstream Lafayette	FS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli	30	
Wabash River	Lafayette Terre Haute Darwin	FS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli	73	
Wabash River	Darwin to Mouth	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	185	
Salamonie River	Portland	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	23	
Salamonie River	Upstream Lancaster to Mouth	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	54	
Little Mississenewa River	Union City	NS (Aquatic Life)	Monitored (c)	PCB's	7	Past problems at Union City POTW have been resolved for the time. Fish Consumption Advisory.

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Wabash River Basin (including Patoka River) (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Mississenewa River	Union City to Ridgeville	NS (Aquatic Life)	Monitored (c)	PCB's Chlordane	9	Fish Consumption Advisory - No fish should be eaten.
Mississenewa River	Ridgeville to Marion	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	20	Ridgeville has applied for grant for WWTP improvements.
Mississenewa River	Marion	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	36	
Mississenewa River	Jalapa to Mouth	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	37	
Eel River	Headwaters near Churusubso	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (b)(c)	Nonpoint source	5	
Eel River	Near headwaters to upstream South Whitney	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (b)(c)	Nonpoint source	20	
Eel River	South Whitney	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (b)(c)	Nonpoint source	2	
Eel River	2 miles D/S South Whitley to Roann	FS (Aquatic Life) (Threatened) FS (Recreational)	Monitored (b)(c)	Nonpoint source	24	
Eel River	Roann to Mouth	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (b)(c)	E. coli Nonpoint source	41	
Williamson Ditch	Upstream Palestine Lake	FS (Aquatic Life) (Threatened)	Evaluated	Metals	2	
Tippecanoe River	Headwater to Rochester	FS (Aquatic Life) (Threatened) FS (Recreational)	Evaluated	Nonpoint source	53	
Tippecanoe River	Rochester	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5	Flooding caused problems with compliance due to occasional bypassing.
Tippecanoe River	Downstream Rochester to Lake Shafer	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	102	
Wildcat Creek	Headwater to Kokomo	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	16	

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected In the Wabash River Basin (including Patoka River) (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Wildcat Creek	Below Kokomo to Mouth	NS (Aquatic Life) NS (Recreation)	Monitored (c)	PCB's E. coli	65	Fish Consumption Advisory for all species.
Kokomo Creek	Kokomo	NS (Aquatic Life) NS (Recreational)	Monitored (c)	PCB's E. coli	2	Fish Consumption Advisory for all species.
South Fork Wildcat Creek	Entire length	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	41	
Middle Fork Wildcat Creek	Hillisburg	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	33	Agricultural activity.
Silverthorn Tributary	Rossville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	2.6	Agricultural activity. Limited use stream.
Campbells Run	Rossville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	14	Agricultural activity.
Elliot Ditch and Wea Creek	Lafayette	NS (Aquatic Life) NS (Recreational)	Monitored (c)	PCB's E. coli	27	Contaminated sediments from Alcoa have been removed from Elliot Ditch. Fish Consumption Advisory continues.
Big Pine Creek	Pine Village	FS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli	77	Exceptional use stream.
Vermillion River	Cayuga	FS (Aquatic Life) NS (Recreation)	Monitored (c)	E. coli	8	
Black Creek	C-Ville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	11.5	
Dry Branch	C-Ville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.0	
Walnut Fork	C-Ville	FS (Aquatic Life)	Monitored (c)		22	
Lye Creek	Darlington	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	6.5	Lower reaches used as warm water fishery.
Honey Creek	Darlington STP	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	3.1	E. coli > 1,200/100.
Withe Creek	Colfax STP	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	7.7	Highest E. coli upstream of Colfax STP. Wide variety of small fish and aquatic life.

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected In the Wabash River Basin (including Patoka River) (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Goldberry Creek		FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5.8	E. coli > 3,200/100.
Wolf Creek		FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	12.5	Pastureland.
Prairie Creek	Lebanon	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	24.1	Septic systems.
Brush Creek		FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	9.1	Pastureland.
Spring Creek		FS (Aquatic Life) FS (Recreational)	Monitored (c)		6.3	Limited use stream.
Sugar Creek	Above Crawfordsville	FS (Aquatic Life)	Monitored (c)		35	
Sugar Creek	Near Crawfordsville	NS (Aquatic Life)	Monitored (c)	PCB's	7	Fish Consumption Advisory for all species due to PCB's.
Sugar Creek	Downstream Crawfordsville to Mouth	FS (Aquatic Life) FS (Recreational)	Monitored (c)		30	
Little Sugar Creek	Near Crawfordsville	NS (Aquatic Life)	Monitored (c)	PCB's	10	Fish Consumption Advisory due to PCB's.
Rattlesnake Creek	New Market	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	23.7	
Corner Creek	New Market	FS (Aquatic Life)	Evaluated		6.2	
Indian Creek	New Market	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	15.2	
Sugar Mill Creek	Wallace	FS (Aquatic Life) FS (Recreational)	Monitored (c)		36.6	
Roaring Creek	Marshall	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	8.1	
Rush Creek	West Union	FS (Aquatic Life) FS (Recreational)	Monitored (c)		10.7	
Big Racoon Creek	Entire length (except for 1 mile)	FS (Aquatic Life)	Monitored (b)		82	Based on DePauw University fish population study.

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Wabash River Basin (including Patoka River) (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Big Racoon Creek	Coxville	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	1	
Otter Creek (Upper)	Vigo and Clay Counties	FS (Aquatic Life) (Threatened)	Monitored (b)	Acid Mine Drainage	11	
Otter Creek (Lower)	Vigo County	FS (Aquatic Life)	Monitored (b)		9	
Philipps Ditch	Walton	PS (Aquatic Life)	Evaluated	Ammonia	2	Some violations from Walton STP may have impacted Phillips Ditch to a minor degree.
Coal Creek	Vigo County	PS (Aquatic Life)	Evaluated	Acid Mine Drainage, Silt	7	
Blue River	Columbia City	FS (Aquatic Life) FS (Recreational)	Evaluated		3	
Flack Ditch	Laketon	FS (Aquatic Life) (Threatened)	Evaluated		1	
Brouilletts Creek	Vigo and Vermillion Counties	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	2	
Honey Creek and Tributary	Terre Haute	PS (Aquatic Life)	Evaluated	Acid Mine Drainage	25	
Honey Creek	Terre Haute	PS (Aquatic Life)	Evaluated	Acid Mine Drainage	2	
Busseron Creek	Sullivan County	PS (Aquatic Life)	Evaluated	Acid Mine Drainage	23	
Mud Creek	Sullivan County	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	7	Heavy coal fine deposition observed.
Sulphur Creek	Sullivan County	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	7	Deposits of unknown origin observed and an effluent odor detected.
Patoka River	Jasper to Mouth	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli TSS	86	Minor grease and oil deposits in storm ditches add to a TSS problem.
South Fork of Patoka River	Pike, Warrick, and Gibson Counties	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	40	Oakland City STP has severe bypassing problems to tributary.

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected in the Wabash River Basin (including Patoka River) (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
South Fork Smalls Creek	Bruceville	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	8	Iron precipitate observed downstream of Smalls Creek to mouth.
Sugar Creek	Vigo County	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	9	
Turman Creek	Sullivan County	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	3	
Big Shawnee Creek	Attica	FS (Aquatic Life)	Evaluated		26	
Little Wabash River	Roanoke	FS (Aquatic Life) (Threatened)	Evaluated	Metals in Roanoke STP Lagoons	21	
Humbert Ditch	Fowler	FS (Aquatic Life)	Evaluated		1	
Round Prairie Creek	Windfall	FS (Aquatic Life)	Evaluated		1	
Towns and Lucas Ditch	Shamrock Lakes	FS (Aquatic Life)	Evaluated		6	
Hoagland Ditch	Wolcott	FS (Aquatic Life)	Evaluated		12	
Chippewanuk Creek	Akron	FS (Aquatic Life)	Evaluated		2	
Walnut Creek	Warsaw	FS (Aquatic Life) (Threatened)	Evaluated		5	a) Warsaw STP in excess of cyanide limits. A dozen volatile organic compounds were found in influent/effluent (small concentrations). b) High volume of metals concentrations found.
Danner Ditch	Etna Creek	FS (Aquatic Life)	Evaluated		5	
Little Pipe Creek	Converse	PS (Aquatic Life)	Evaluated		2	
Grant Creek	LaFontaine	FS (Aquatic Life)	Evaluated		3	
Burnetts Creek	Burnettsville	FS (Aquatic Life)	Evaluated		5	
Rock Creek	West Labanon	FS (Aquatic Life	Evaluated		4	
Mill Creek	Kingman	FS (Aquatic Life)	Evaluated		8	
N. Fork Coal Creek	Wingate	FS (Aquatic Life)	Evaluated		4	
Roaring Creek	Marshall	FS (Aquatic Life)	Evaluated		4	

Table 49. *Waters assessed, status of designated use support, probable causes of impairment and miles affected In the Wabash River Basin (including Patoka River) (ont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
East Fork Coal Creek	Waynetown	FS (Aquatic Life)	Evaluated		10	
Withe Creek	Colfax	FS (Aquatic Life)	Evaluated		5	
North Branch Otter Creek	Carbon	FS (Aquatic Life)	Evaluated		10	
Little Racoon Creek	Russellville	FS (Aquatic Life)	Evaluated		16	
West Fork Busseron Creek	Farmersburg	FS (Aquatic Life)	Evaluated		7	
Bond Ditch	Oaktown	FS (Aquatic Life)	Evaluated		3	
Lost Creek	Francisco	FS (Aquatic Life)	Evaluated		2	
Little Pine Creek	Green Hill	FS (Aquatic Life) (Threatened)	Evaluated	Nonpoint Source	16.2	
Indian Creek	Klondike	FS (Aquatic Life) (Threatened)	Evaluated	Nonpoint Source	9.4	
Trimble Creek	Mentone	PS (Aquatic Life) PS (Recreational)	Evaluated	BOD TSS Ammonia E. coli	4	Problems from past procedures remain. Poultry plant is now closed.
Yellow Creek	Mentone	FS (Aquatic Life)	Evaluated		1	Mentone completed an STP.

PS = Partial Support; NS = Non Support; FS = Full Support. If a use is not listed, it was not monitored or evaluated.

b = biological; c = chemical

The Wabash River originates in Mercer County, Ohio. It flows westward approximately 15 miles to the Indiana/Ohio state line at river mile 465.6, then through parts of four Indiana counties until it is dammed to form the 900-acre Huntington Reservoir. From there it flows through Wabash, Peru, Lafayette, Terre Haute and Vincennes to its confluence with the Ohio River at the southwest corner of the state. Data from 15 fixed water quality monitoring stations located along the Wabash River from Geneva to below Vincennes indicate that the river fully supports the aquatic life use but does not support the recreational use due to frequent high E. coli concentrations. The sources of these E. coli bacteria are not known, but it is suspected that most come from combined sewer overflows and nonpoint sources. Huntington Reservoir is impacted to some extent by nonpoint pollution, specifically soil erosion both upstream of the reservoir and along the reservoir's shoreline.

The Indiana Department of Natural Resources (IDNR) conducted a fishery survey of the Wabash River from the Indiana/Ohio state line to the Miami/Cass county line in 1989. Eighteen stations were electrofished and 61 species of fish were taken. Carp was the most abundant species collected and the only species found at every station. Several tributaries to Huntington Reservoir were also studied and appeared to support good warm water fisheries.

Below Huntington Reservoir, walleye, sauger and other game fish were abundant and carp were less numerous. Shovelnose sturgeon were collected at Andrews and Peru.

The Huntington STP has had several problems with TSS violations. These violations resulted partially from an industrial chemical spill which killed the microbial population in the STP treatment system. These TSS problems are more commonly related to storm water drainage problems in the town.

In June 1990, localized flooding began to cause sewage backup problems in the area of Amiss Ditch in Huntington. The backup of the sewage into homes along Salamonie Avenue can be attributed to two factors. First, during significant rainfall events which generally occur every several years, Amiss Ditch is unable to accommodate all of the storm water from its watershed. Second, the City of Huntington is serviced by a combined collection system which receives both storm and sanitary wastewater. When Amiss Ditch overflows, floodwater travels in a northerly direction toward the Huntington city limits. In the residential area near Salamonie Avenue, the floodwaters can enter the Huntington collection system through street catch basins. As a result, the collection system overloads, forcing the combination storm and sanitary wastewaters into homes through floor drains and sump pits. There are currently several projects being implemented to help alleviate this problem. A combined sewer overflow operational plan has been prepared and was submitted to Huntington and IDEM in early 1993 for approval.

The STPs at Terre Haute and Clinton are currently meeting permit limits. One industry in Clinton, Terrecorp, has occasionally not been able to meet its permits limits for lead but is working to resolve the problem. The industry has recently installed new resin exchange columns. The several industries which discharge to the Terre Haute reach of the Wabash River are all consistently meeting their limits.

In the past, low dissolved oxygen levels in the portion of the Wabash River between Cayuga and Montezuma have been found. One major fish kill and several smaller kills occurred in this reach of the river in the late 1970's. Several studies have been done on this portion of the river to try to determine the cause of these problems. It appears that several factors, including high algal counts at low flows, naturally sluggish flow, thermal inputs from the Cayuga Generating Station, and, possibly, increased sediment oxygen demand may all contribute to the problem.

Changes in the operation of the cooling towers at the Cayuga Generating Station in 1984-85 resulted in reduced thermal inputs to this reach of the river. An NPDES permit issued to this facility in 1987 contains more stringent thermal effluent limits which may require the facility to reduce generation at certain times. In fact, this facility shut down completely for several days during the summer of 1988 due to low flows and high water temperatures. Dissolved oxygen levels below 4.0 mg/l, however, were still found on a few occasions. Studies done in recent years by Dr. James Gammon of DePauw University indicate that the fish community had vastly improved in the middle Wabash River since the 1970s, especially in the area between Lafayette and Cayuga.

The Little Wabash River is the first major tributary in the upper reach of the Wabash River. It is fully supporting of its designated uses but threatened by metals inputs from the Roanoke STP lagoons. These metals apparently came from C & M Plating which discharged to the city sewer system. These lagoons are presently scheduled to be cleaned up, and IDEM has pursued criminal prosecution of C & M Plating. In the past, this firm had numerous violations which eventually resulted in the unprecedented arrest of the firm's president and the chairman of the board. C & M Plating is presently not operating. The company was to construct a wastewater treatment plant but requested time to remove metal-laden sludge stored on their property. A new NPDES permit signed in early 1993 was issued with effluent limitations based on construction of a new treatment facility.

Routine maintenance of the lagoons at the STP is not being performed. In June 1990, Indiana required PCB analysis of lagoon sludge before a cleanup plan of the C & M Plating facility was approved. An environmental consultant has proposed sampling sediment from Cow Creek upstream and downstream from C & M Plating. Money recovered from C & M's insurance company has been matched by Federal funds for improvements to Roanoke's wastewater treatment system. Remediation of C & M Plating's contaminated sludge is currently on hold due to an appeal on the limits for metals in the sludge.

The Salamonie River does not support recreational uses due to high E. coli levels but does support aquatic life. Again, the sources of E. coli are not entirely clear since the Portland STP operates relatively well, although there have been CSO problems in the past.

The Indiana Department of Natural Resources (IDNR) studied the fish communities in tributaries of the Salamonie Reservoir in 1988. These tributaries included the Little Majenica Creek, Back Creek, Small Rush Creek, Pond Creek, Rush Creek, Rockaway Creek and Majenica Creek. The fish communities indicated that these streams supported good warm water fisheries.

The Little Mississinewa River and approximately nine miles of the Mississinewa River (from near Union City downstream to Ridgeville) do not support the aquatic life use due to PCB's and chlordane found in fish tissue samples. A consumption advisory for all fish from the Little Mississinewa River and an advisory against carp and catfish consumption from this portion of the Mississinewa River are currently in effect. The PCB's apparently came from a Westinghouse facility which discharged to the Union City STP. This, in turn, discharged to the Little Mississinewa River, which is a tributary of the Mississinewa River. A.O. Smith purchased the Westinghouse facility in 1986 and began cleaning the site and the sewers leading to the Union City STP. In the course of the cleanup, additional PCB contaminated areas were found. At this time, A.O. Smith exercised an option in the purchase contract that required Westinghouse to repurchase the site if contamination was found. Westinghouse then did additional cleaning in 1989, but the effectiveness of the cleanup remains in question. Additional sampling is now being done and the site is currently being scored for CERCLA. Some samples indicate levels above 5 ppm below 12 inches. The Union City STP has been cleaned and PCBs are no longer being discharged from this facility.

The reach of the Mississinewa River from Ridgeville downstream to its mouth fully supports aquatic life but does not support recreational uses due to E. coli levels. Point source discharges in this reach have generally been in compliance with permit limits and the high E. coli levels detected probably result from combined sewer overflows and nonpoint sources.

A study of the fish communities and habitat of the entire Eel River and its larger tributaries was conducted in 1990 with funds provided by a federal nonpoint source grant. Fish and suspended solids data were collected from 25 sites in the river in an attempt to evaluate possible nonpoint source impacts. Fish community information from this study was also compared to historical data.

The study indicated that the fish community in 1990 was improved as compared to the community found in a 1982 study. However, the investigators feel that the improvements are temporary and primarily the result of a series of recent years when both river flows and sediment concentrations were below normal. From a longer time perspective, many species which were common 50 years ago were absent or had severely reduced populations in the current study. A summary of their findings would indicate the following:

- The Eel River appears to be negatively impacted by agriculture throughout most of its watershed.
- Turbidity and sediment loads are very high in periods of wet weather.
- Many species of fish known to be intolerant of sedimentation are absent or scarce in the river.
- Species which are tolerant to turbidity are widely distributed.
- Habitat was fairly good in the lower 48 kilometers of the mainstem, but poor elsewhere in the mainstem.
- The fish community is likely to continue to oscillate, being better during periods of dry summers but depressed following a series of wet summers.
- The removal of riparian trees in the upper third of the Eel River mainstem and dredging of many sections has resulted in increased nearstream erosion, elevated stream temperatures and increased sedimentation.

This study would indicate that continuance of agricultural practices which increase sediment loadings, reduce shade and increase temperatures threaten the recovery and maintenance of the type of fish community which could exist in this river.

The Eel River would currently support the aquatic life use along its entire length. but is threatened by nonpoint source pollution. From Roann downstream to its mouth, high E. coli concentrations occur frequently enough to cause non-support of the recreational use.

The Columbia City STP which discharges to the Blue River, a tributary of the Eel River, meets its NPDES permit limits, but dry weather bypassing has occurred fairly often. Since completion of plant improvements, dissolved oxygen violations have ceased. Columbia City also is developing an ongoing program for the removal of inflow and infiltration sources as well as the separation of combined sewers. The ultimate goal is to reduce discharges from combined sewer overflow locations.

In the past, several problems occurred at the Laketon Refining Corporation which discharges to Flack Ditch, a tributary of the Eel River. Permit violations occurred for BOD, COD, TSS, ammonia, sulfide, and phenolics which threatened the ability of Flack Ditch to support the designated aquatic life use. In response, IDEM initiated an enforcement action in 1985 which resulted in improved operation in 1986. Sediment collection from Flack Ditch in 1986 did not contain any contaminants at levels of concern. A bioassay conducted on effluent from this facility in 1987 produced some toxicity apparently due to cyanide and petroleum. During 1988 and 1989, the Laketon Refining Corporation had only infrequent violations for BOD and ammonia, substantial improvement from the previous reporting periods. Currently, the Laketon Refining Corporation is meeting its permit limits and plans to improve its wastewater treatment process, perhaps with a new plant.

In Kosciusko County, Warsaw Black Oxide in Burket discharges to Williamson Ditch, a tributary to Palestine Lake. In the past, sediment samples collected in this ditch and in the West Basin of the lake near the ditch mouth have revealed metals concentrations considerably above background levels. However, sediment samples collected in the West Basin of Palestine Lake in 1987 indicated that the concentration of metals and PCB's were considerably lower. In a 1986 bioassay, the LC50 concentration was 44% effluent. Recent inspections have shown improved operations and a recent toxicity test showed that toxicity is greatly reduced from previous tests. All cadmium plating operations have been discontinued as of March 1992. The new waste treatment process has improved effluent quality considerably. In 1988, IDNR repaired the dam at Palestine Lake. The fish populations were eradicated and the lake was restocked with sport fish.

Sediment samples collected from Winona Lake in 1987 revealed some organics and metals contaminants that were found at levels that were cause for concern. Investigation into the possible sources of these contaminants indicated that three industries, Dalton Foundry, Warsaw Plating Works, and Gatke Corporation (no longer in operation), were potential sources. In 1992, IDEM staff and staff from the Warsaw STP collected samples from sediments in a storm sewer which drained these properties and discharged into Winona Lake. Dalton Foundry also has a permitted non-contact cooling water discharge to this storm sewer. Samples were collected from three manholes, one upstream of both facilities (#1), one at the point of the Dalton Foundry non-contact cooling water discharge (#2), and one downstream of both Dalton Foundry and Warsaw Plating Works property (#3).

Only two organic compounds were found above detection levels in these sediment samples. Fluoranthene was found at levels of 2.7 mg/kg, 5.7 mg/kg, and 2.3 mg/kg at manholes #1, #2, and #3, respectively. At manhole #2, 2-

methylnaphthalene was found at 1.9 mg/kg. All other organics were below detection levels.

Several metals were found in the sediments at all three manholes. Highest concentrations were always found at manhole #2. Sediment concentrations at manhole #1 were at or near concentrations considered to be background levels for metals in stream sediments in Indiana. Concentrations of these metals at manhole #2 were two to 100 times the levels at manhole #1, and at manhole #3 these levels were back near the levels at manhole #1. Some metals found at concentrations which are of concern at manhole #2 are: cadmium (23 mg/kg), antimony (18 mg/kg), lead (1000 mg/kg) mercury (1.9 mg/kg) and silver (6.4 mg/kg).

In summary, these results indicate a potential for ongoing contamination of the Warsaw storm sewer system and Winona Lake. Sources of this contamination in the storm sewer, may be air emissions, poor storage and handling of ash, spent foundry sand, dust from the foundry grounds, and contamination of the non-contact cooling water discharge to the storm sewer. IDEM staff are working with the industries to determine these sources and eliminate them.

The outlet of Palestine Lake is Trimble Creek, a tributary to the Tippecanoe River which received the discharge from Kralis Brothers Poultry near Mentone. This operation in the past has had numerous permit violations for BOD, TSS, and fecal coliform. During 1989, this facility violated its ammonia limits often enough that the reach downstream of the discharge was considered not to support the aquatic life use. They have since ceased discharging. Samples taken from Trimble Creek downstream of the poultry facility during 1991 revealed that most ammonia levels were low.

Provimi Veal which discharged into Yellow Creek, another Tippecanoe River tributary, regularly violated its permit limits for fecal coliform bacteria and BOD in the past. A new wastewater treatment facility was put into operation at the plant in 1988, and the company ceased operation in 1991. The closing of these industrial dischargers which negatively impacted the Tippecanoe River in the past, and the completion of a new 0.12 MGD treatment plant for Mentone should reduce loadings that may have caused this reach to be non-supportive of recreational and aquatic life uses.

The Tippecanoe River mainstem is fully supportive of aquatic life uses for its entire length and supports recreational uses above Rochester. However, downstream of Rochester the E. coli levels were exceeded often enough that the recreation use is not supported. The aquatic life uses are threatened by nonpoint sources in the headwater areas above Rochester.

A compliance inspection was conducted during 1992 at the Kokomo sewage treatment plant along with the sampling of Wildcat Creek. One upstream site and five downstream sites to a point 5.1 miles downstream of the outfall, were sampled. Additionally, one site on Kokomo Creek, near the mouth, was sampled.

Wildcat Creek is considered to fully support the aquatic life but not recreational uses above Kokomo. Wildcat Creek downstream of Kokomo to its confluence with the Wabash River does not meet the criteria for aquatic life or recreational uses. High concentrations of E.coli, and a complete fish consumption advisory for all species due to high PCB levels in fish tissue samples are causes for this nonsupport. Approximately two miles of Kokomo Creek near Kokomo fail to support aquatic life uses due to a complete fish consumption advisory due to PCB's in fish tissue.

Analyses of the STP and stream samples included conventional water quality parameters (BOD_5, suspended solids, etc.) nutrients, metals, and priority pollutants. Priority pollutants were analyzed due to a history of industrial discharges in this stream reach.

The Kokomo STP was found to be meeting all permit limits and had no significant levels of any priority pollutant. All stream stations were meeting State stream standards for all parameters, except for E. coli. The mean E. coli concentration found for all stream stations was 827/100 ml with no single station meeting the 235/100 ml stream standards. No significant metals or toxic compounds were found in the stream samples.

The Middle Fork of Wildcat Creek originates in northeastern Clinton County near Hillisburg, Indiana. The stream flow is generally westward until its confluence with the South Fork of Wildcat Creek in Tippecanoe County. the total drainage area segment is 134 square miles

Land use in this area is nearly 100% agricultural. Streams in this segment are generally used for agricultural and recreational activities. The only populated area is the town of Rossville which is serviced by a wastewater treatment facility. This facility is currently the only NPDES permit holder to discharge into the Middle Fork of Wildcat Creek.

The Rossville STP discharges to the Silverthorn tributary. Although there was a fish kill just prior to the 1993 survey, this facility was meeting their NPDES permit requirements and there was no apparent effect from this facility on this stream. High E. coli values cause it to be non-supportive of recreational uses. The probable causes are agricultural activities. All 33 miles of the Middle Fork of Wildcat Creek and 10 miles of Camphill Run which meanders around the town of Rossville have good water quality except for E. coli concentrations.

Walnut Fork from its headwaters to the confluence with Little Sugar Creek is approximately 23 miles in length . An unnamed tributary to this reach receives an intermittent cooling water discharge and surface water run off from the Nu-Cor Steel Plant near Linsburg. Walnut Fork between the confluence of Little Sugar Creek and Sugar Creek has a fish consumption advisory.

During the 1993 sampling of the Upper Sugar Creek watershed, IDEM staff observed dead fish in Walnut Fork at a site near SR 32. This was the result of a fish kill which had occurred three days prior to the survey. An investigation by IDEM indicated the fish kill was allegedly caused by excessive land application of hog farm wastes. After a rain event the wastes were washed into a tributary of Walnut Fork. It is believed the stream was in a recovery mode from the impacts of the spill. Live fish as well as dead fish were observed at sites downstream of this tributary at SR 32. Water quality in the unnamed tributary which receives the Nu Cor discharge was good and minnows and other aquatic life were observed.

Little Sugar Creek and roughly seven miles of Sugar Creek near Crawfordsville do not support the aquatic life use because of a fish consumption advisory for all species due to PCB concentrations in fish tissue. The Mallory Landfill site is the source of the PCB contamination. This site has now been cleaned up. Recent fish tissue and sediment samples from these streams show reduced PCB concentrations but fish tissue concentrations still exceed FDA Action Levels.

With the exception of this seven mile reach, Sugar Creek upstream from Crawfordsville and downstream to its mouth fully supports the aquatic life use. Downstream of Crawfordsville, to it's mouth, Sugar Creek supports its designated full body contact recreational use. Sugar creek is a popular canoeing, fishing, and swimming stream.

There are four tributaries to Sugar Creek within this reach. Black Creek enters Sugar Creek from the north. The Black Creek watershed is primarily agricultural with both cropland and pasture on open untilled fields. Black Creek is fully supportive for aquatic life. Full body contact recreation is not supported due to high E. coli concentrations.

Dry Branch is a small drainage ditch originating on the southeast side of Crawfordsville and flows generally northwest to Sugar Creek. Water quality is good except for E. coli concentrations of 1,200/100. This stream is intermittent in some areas.

The Patoka River receives acid mine drainage and organic loading from the Jasper and Oakland City STPs, but aquatic life uses are supported.

Frequent high E. coli levels in the Patoka River prohibit this stream from meeting its recreational use designation. Excessive oil and grease has been discharged to the Oakland City sewer system and is causing operational problems at the wastewater treatment plant. Oakland City is investigating ways to enforce it's sewer use ordinance to prevent excessive discharges of oil and grease to the collection systems.

The Jasper STP has problems consistently meeting permit limits for cyanide, lead, residual chlorine and fecal coliform bacteria. Historically, total lead concentrations have been high in the effluent due to high background levels in the influent . A study done by consultants for the town identified the source of the problems as domestic and beyond the scope of the Jasper STP pretreatment program. However, impacts to the Patoka River have apparently been minimal at present. The Town is continuing to work on resolving these problems.

In summary, 1,839 miles were assessed in this basin as to the support of aquatic life. Of these miles, 1,317 (72%) were fully supportive, 267 (15%) were fully supportive but threatened, 66 (4%) were only partially supportive, and 189 (10%) did not support this use. Only 1,386 of these miles were assessed as to support of recreational uses. Of these miles 154 (11%) fully supported, 4 (0.2%) partially supported and 1,228 (89%) did not support the recreational use.

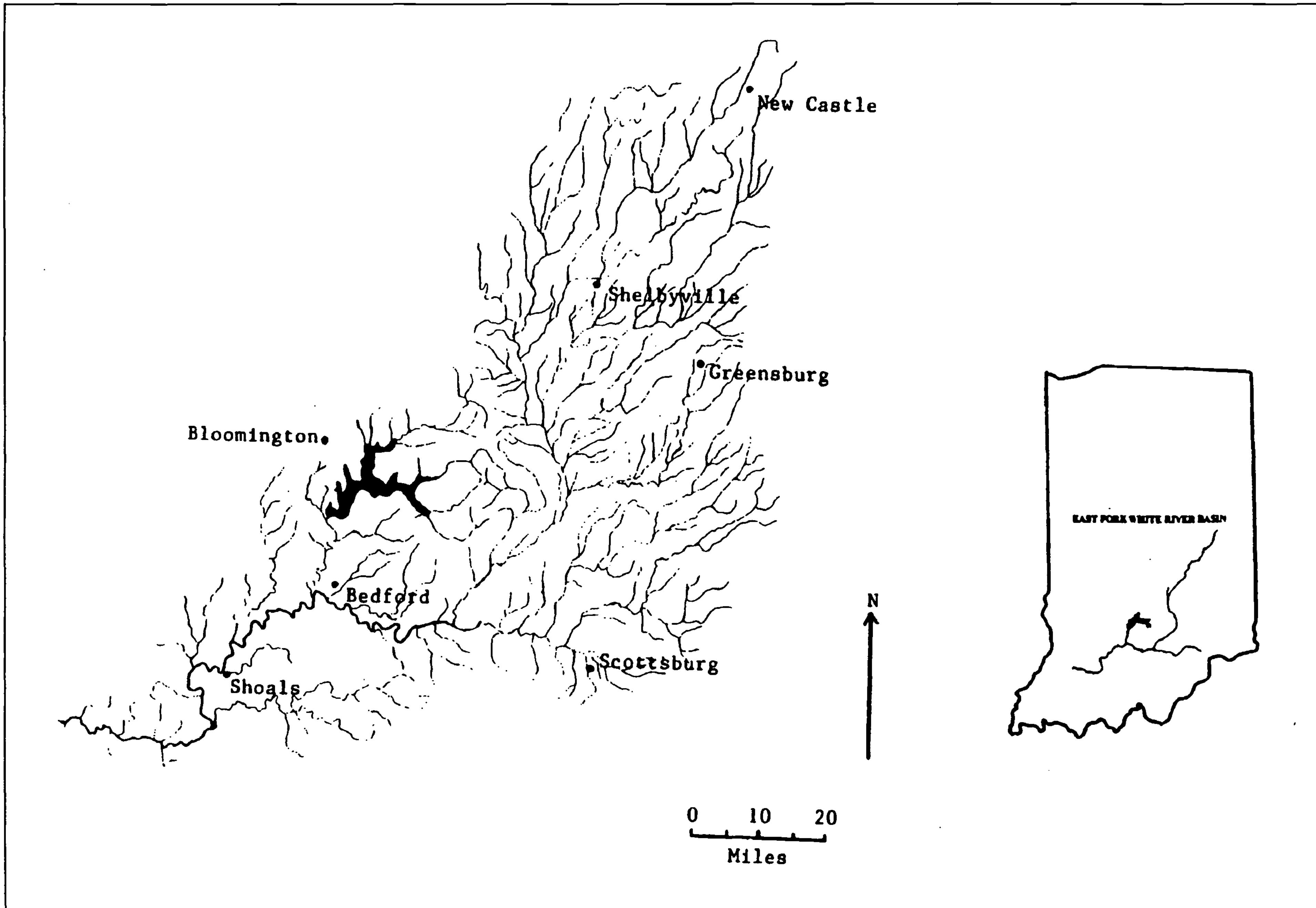
East Fork of the White River Basin

The East Fork of the White River drains approximately 5,600 square miles of southern Indiana (Figure 60). Sugar Creek, Big Blue River, Driftwood River, Flatrock River, the Muscatatuck River, and Salt Creek are the river's major tributaries. The largest cities in the watershed (populations greater than 15,000) are Columbus, Seymour, Bloomington, New Castle, Shelbyville and Bedford.

The topography of this basin ranges from flat to rugged as it crosses seven of southern Indiana's eight physiographic regions. The basin also includes unique underground streams in the karst region of Orange and Lawrence counties. Agriculture is important in the flatter regions, but much of the watershed is forested. The groundwater contribution to stream flow in the basin as a whole is low, so flow depends largely on rainfall and variations can be considerable. Compared to other basins, stream channelization projects in the East Fork of the White River Basin have been minimal.

The East Fork of the White River system has always supported an important sport fishery. State records for flathead catfish, freshwater drum, rock bass, flier, sucker, and smallmouth bass have all come from this river or one of its tributaries. The reputation of the river as one which supports large

Figure 60. *East Fork of White River Basin*



fish continues, justified by state records for sucker and small mouth bass set in 1984 and 1985. The lower reaches of the river are used as a commercial fishery. An important freshwater mussel fishery also exists in the lower portion of the river where the shells of certain mussels are collected for use in the cultured pearl industry.

There are municipal drinking water supply intakes on the East Fork of the White River at Bedford, Mitchell, and Seymour. Surface water supplies for drinking are also found at Greensburg, Paoli, West Baden, Bloomington, Westport, North Vernon, and Scottsburg on various tributaries of the river. Therefore, the water in this basin must meet the raw water standards for potable water supply at the municipal intakes.

The river and several of its tributaries are popular canoeing streams. The 1983 Indiana Canoeing Guide prepared by the Department of Natural Resources lists the Driftwood, Flatrock, and Muscatatuck rivers as especially good for this sport. At least one commercial canoe livery operates within the basin.

The Lost River and many of its tributaries in Orange and Martin counties have been designated for exceptional use. This designation should help preserve the water quality in the watershed and help protect several unusual aquatic animals, including blind cavefish which inhabit the underground portion of the river.

Several streams in the basin have been designated for limited use, based on their lack of sufficient habitat to support a well balanced aquatic community. These include Plasterers Creek at Loogootee, a portion of Brewer's Ditch at Whiteland, Huntingburg Lake Outlet Stream at Huntingburg, and a portion of Ackerman branch and Mill Creek at Jasper.

Water quality monitoring in the basin during 1992 and 1993 included:

1. Monthly or quarterly chemical and bacteriological sampling at ten fixed stations

2. Fish tissue contamination analysis downstream of Williams Dam

3. Sediment contamination monitoring downstream of Williams Dam

4. Surface Water Pesticide Study of 8 sites

5. Benthic Macronvertebrate community samples

Those waters assessed, the status of designated use support, the method of assessment, probable causes of nonsupport, and miles affected are shown in Table 50. Additional comments on certain reaches are also given in this table.

Tissue analysis of fish collected in 1983 from Big Blue River, Driftwood River, Sand Creek, Muddy Fork Sand Creek, Clear Creek, Richland Creek, Salt Creek, Pleasant Run, and the East Fork of the White River indicated a potentially serious PCB and pesticide contamination problem in the streams. As a result, fish consumption advisories were issued for certain reaches of these streams. More recent sampling of these and other streams in the basin disclosed that tissue concentrations of contaminants were much reduced and that the consumption advisories could be removed entirely or substantially reduced from many miles of stream.

The 1994 fish consumption advisory (Table 15) includes Clear Creek in Monroe County, Pleasant Run Creek near Bedford and Salt Creek downstream of Monroe Reservoir Dam in Monroe and Lawrence counties. The East Fork of the White River from Bedford downstream to the Lawrence County line is also included. PCBs are the pollutant of concern in these segments. Sand Creek, the Muddy Fork of Sand Creek and the small Decatur County Park Reservoir all near Greensburg are under an advisory for all fish. The pollutants of concern in these waters are chlordane and dieldrin.

The PCBs in Clear Creek, Salt Creek, Pleasant Run Creek and portions of the East Fork of the White River were associated with identified industrial inputs. Westinghouse Corporation in Bloomington began court-ordered hydrovacuuming of contaminated sediments in Clear Creek and Salt Creek during 1987. This clean-up has helped to reduce the PCB contamination of fish in these streams and in the East Fork of the White River below Bedford. However, fish tissue in these streams still exceed FDA Action Levels for PCBs.

The pesticides chlordane and dieldrin are no longer used in the United States but are highly persistent in the environment. No point source dischargers of these pesticides have been identified, so nonpoint runoff from previously contaminated upland sites is probably responsible for their presence in streams.

Of 17 sites sampled for pesticides in the East Fork White River Basin in May and June of 1991, thirteen sites in this basin had concentrations of Alachlor and Atrazine over maximum contaminant levels (MCLs). In addition, three sites had more than 6 pesticides which were found above detection levels. These were Sand Creek at Brewersville (12 chemicals), Sugar Creek at New Palestine (6 chemicals) and Clifty Creek at Hartsville (6 chemicals).

These samples were taken soon after pesticide application by farmers and reflect runoff from these operations. Additional samples taken in the fall of

Table 50. *Waters assessed, status of designated use support, probable cause of impairment, and miles affected in the East Fork of White River Basin*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Plasterers Creek/Friends Creek	Loogootee	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	4	Extensive reconstruction of wastewater treatment facility to be completed in 1992. Limited use stream.
Big Blue River	New Castle	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	10	Allegeny - Ludlum Steel has had occassional problem meeting permit limits for chromium, iron, nickel, copper. Not causing water quality violations.
Big Blue River	Carthage Shelbyville Edinburg Knightstown	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli BOD	60	Some bypassing from Shelbyville STP. Edinburg STP handles two hardwood lumber and veneer processing plants very well. Knightstown has a much improved facility since construction was completed. Control of treatment process during rainfall still a problem. Carthage's STP and the Container Corporation of America have oil grease problems. The town is investigating it's sewer ordinance to include grease traps in response to grease and oil going to Big Blue River.
Monroe Reservoir	Bedford Bloomington	FS (Aquatic Life) (Threatened) FS (Recreational)	Evaluated	Nonpoint Source	10,750 (acres)	Sedimentation and nutrient loading affect recreational uses in upper end.
Pleasant Run	Bedford	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Metals PCBs	4	Good water treatment in area by Central Foundary. Area under Fish Consumption Advisory.
Gas Creek/Sand Creek/Muddy Fork	Greensburg	NS (Aquatic Life) NS (Recreational)	Monitored (c)	Chlordane Dieldrin E. coli	15	New Greensburg STP. Some bypassing still occurs. Fish Consumption Advisory.
Sand Creek	Below Greensburg	NS (Aquatic Life)	Monitored (c)	Chlordane Dieldrin TSS	15	Fish Consumption Advisory.
Muscatatuck River	Austin Scottsburg	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	25	New facility. Good treatment is achieved.
Lick Creek	Paoli	PS (Aquatic Life) PS (Recreational)	Evaluated	TSS D.O. E. coli	5	Solids often lost to Creek from STP.
Underground Lost River	Orleans	PS (Aquatic Life)	Evaluated	D.O. Ammonia	5	

Table 50. *Waters assessed, status of designated use support, probable cause of impairment, and miles affected in the East Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Rock Lick Branch	Mitchell	FS (Aquatic Life)	Evaluated		4	
E. Fork White River (Lawrence County Line to Mouth)	Shoals Petersburg	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	75	
E. Fork White River (Williams to Lawrence County Line)	Williams	NS (Aquatic Life) NS (Recreational)	Monitored (c)	PCBs E. coli Metals	5	Fish Advisory for Carp.
Clear Creek/Salt Creek/East Fork White River from Bedford to Williams	Bloomington Bedford Williams	NS (Aquatic Life) NS (Recreational	Monitored (c)	PCB's D.O. E coli	40	Sediment samples revealed PCB in upstream samples. Downstream samples are still considered lower as documented in past 305 (B) reports. Presence is there but no increase in contamination. Area under Fish Advisory.
E. Fork White River	Seymour Brownstown Medora	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	74	a) Medora plant under construction. No evidence of contamination of E. Fork White River from town STP.
E. Fork White River	Columbus	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	71	a) New sludge pumps at Columbus STP. Head works construction started.
Leary Ditch/Little Sugar Creek	Greenfield	PS (Aquatic Life)	Monitored (c)	Ammonia	4	
Underground Carter's Creek	Campbellsburg	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	
Millstone Creek	Westport	PS (Aquatic Life)	Evaluated	D.O.	3	
Pee Dee Ditch	Wilkenson	FS (Aquatic Life)	Evaluated		2	
Brock Bezor Ditch	Spiceland	FS (Aquatic Life)	Evaluated		2	
Hominy Ditch	Crothersville	FS (Aquatic Life)	Evaluated		1	
North Fork of Salt Creek	Nashville	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	3	
Heddy Run	Seymour	PS (Aquatic Life)	Evaluated	Metals Pesticides	1	
Sugar Creek	Edinburg	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	5	

Table 50. *Waters assessed, status of designated use support, probable cause of impairment, and miles affected in the East Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Slate Creek	Alfordsville	PS (Aquatic Life)	Evaluated	Abandoned Mine Drainage (pH, metals)	7	
Little Blue River	Mays, Shelbyville	FS (Aquatic Life) (Threatened)	Evaluated		25	
Brandywine Creek	Greenfield	FS (Aquatic Life) (Threatened)	Evaluated		25	Greenfield STP currently experimenting with innovative sludge reduction technology.
Clifty Creek	Hartsville	FS (Aquatic Life) (Threatened)	Evaluated	BOD TSS Ammonia	10	
Boggs Creek	Martin County	FS (Aquatic Life) (Threatened)	Evaluated		15	
Lost River	Orange and Martin counties	FS (Aquatic Life)	Evaluated		40	
Montgomery Creek	Kennard	FS (Aquatic Life)	Evaluated		8	
Little Sugar Creek	Greenfield	FS (Aquatic Life)	Evaluated		10	
Six Mile Creek	Shirley	FS (Aquatic Life)	Evaluated		10	
Sulphur Creek	Martin County	FS (Aquatic Life)	Evaluated		10	
South Fork Salt Creek	Freetown	FS (Aquatic Life)	Evaluated		15	
Town Creek	Lexington	FS (Aquatic Life)	Evaluated		5	
Luther McDonald Ditch	Seymour	FS (Aquatic Life)	Evaluated		3	
Goose Creek	Oolitic	FS (Aquatic Life)	Evaluated		2	
Six Mile Creek	Jennings County	FS (Aquatic Life)	Evaluated		6	
Youngs Creek	Franklin	NS (Aquatic Life) (Threatened)	Evaluated	Ammonia	10	Franklin STP has repeatedly been in violation of ammonia limit. Fish kill.
Cooks Creek/Little Sand Creek	Elizabethtown	FS (Aquatic Life)	Evaluated		5	
Flatrock River	Columbus, Rushville	FS (Aquatic Life) (Threatened) NS (Recreational)	Monitored (c)	E. coli Pesticides	40	
Grassy Creek	New Whiteland	FS (Aquatic Life)	Evaluated		3	

Table 50. *Waters assessed, status of designated use support, probable cause of impairment, and miles affected in the East Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Conns Creek	Waldron	FS (Aquatic Life)	Evaluated		3	
Little Flatrock River	Milroy	FS (Aquatic Life)	Evaluated		7	
South Fork Otter Creek	Holton	FS (Aquatic Life)	Evaluated		10	
Haw Creek	Hope	FS (Aquatic Life) (Threatened)	Evaluated		10	Pesticides from over application and run off.
Sugar Creek	New Palestine to Edinburgh	FS (Aquatic Life) (Threatened)	Evaluated		25	Pesticides from over application and run off.
Driftwood River	Edinburg Columbus	FS (Aquatic Life)	Evaluated		15	
Sand Creek	Brewersburg	FS (Aquatic Life)	Evaluated		10	

PS = Partial Support; NS = Non Support, FS = Fully Support. If a use iis not listed, it was not monitored or evaluated.
b = biological; c = chemical.

1991 and spring of 1992 showed much fewer detections of these pesticides and none at levels above the MCLs.

The Big Blue River from its headwaters to downstream of New Castle was sampled for nutrients, BOD_5, suspended solids, and pesticides with no significant levels observed. All dischargers in metropolitan New Castle were sampled and bracketed for toxics analysis in addition to routine water quality parameters. All dischargers were meeting permit limits and no instream water quality impairment was observed. Sediment samples immediately downstream of the Allegheny Ludlum outfall had elevated levels of chromium, copper, lead, mercury, nickel, and zinc. The lower portion of the segment downstream of New Castle displayed no water quality or sediment impairment.

In the past, approximately ten miles of the Big Blue River near New Castle did not support aquatic life uses due partly to contamination of water and sediments by metals. These metals were believed to have originated primarily from two steel mills in New Castle. Previous effluent toxicity tests at Allegheny Ludlum Steel and Avesta, Incorporated confirmed the potentially toxic effect of these discharges on aquatic life. During the last three years Alegheny Ludlum Steel installed a new treatment system and was issued a new NPDES permit with lower metals limits which should improve water quality in the Big Blue River. Process wastewaters composed of acid rinses, spent pickle liquor, and spent salt bath solutions are treated and discharged into the Big Blue River. No NPDES or stream violations were detected during 1992 sampling inspections for toxics and metals. E. coli standards were violated in 75% of the samples. Avesta, Incorporated did contribute metals to the Big Blue River but no longer discharges to the waterbody. Avesta is now connected to the New Castle sewer system.

High total suspended solids and low dissolved oxygen levels have occasionally impaired the Muscatatuck River, though it currently is supportive of aquatic life. The North Vernon STP effluent often contains levels of copper, lead, E. coli and BOD which do not comply with its NPDES permit. The town has hired a consultant to do a pollutant loading study to determine the changes needed for complying with the NPDES permit. E. coli counts are high causing this river to be nonsupportive of recreational uses.

The Scottsburg STP, a new plant, began operation in October 1990. However, it currently has design problems which need to be corrected. One aeration tank was taken out of service and this resulted in a hydraulically overloaded condition in another tank, causing a malfunction. The loss of solids from the plant caused an accumulation of solids in McClain Ditch, a tributary of Stucker Fork of the Muscatatuck River. This facility has been referred to IDEM enforcement while the town attempts to correct the situation. The city will apply for a land application permit from IDEM. The Town of Scottsburg officials are also currently speaking with property owners to determine the availability of property on which to dispose of sludge from the plant.

Austin STP which discharges to Hutto Creek, a tributary of the Muscatatuck River, is a consistently good treatment facility and is meeting all permit limits. Improvements in water quality were evident due to improved wastewater treatment facilities. Campbellsburg STP has a new lagoon system completed in 1993 and now operates as a controlled discharge facility. The previous system was hydraulically overloaded. The Shirley STP now has three ponds in series and its discharge is controlled by stream flow via a hydrograph. The Greensburg STP is new and runs well.

At the Nashville STP, a new digester was recently completed. The town is attempting to clean up grease build up at the Brown County Inn lift station. Excess grease increases the strength of raw sewage and is detrimental to efficient wastewater treatment plant operation. To correct this situation, the town notified major restaurants that the sewer ordinance will be enforced and estimates were obtained from contractors for grease removal from sewers. The Nashville STP discharges into Salt Creek.

Crothersville STP has a new grit removal and flow control system which should reduce wet weather bypassing into Hominy Ditch. Seymour's STP is undergoing major renovation including new solids handling and pumps. In the past this plant violated NPDES limits for total phosphorus, TSS, and chlorine, but the recent changes have improved its operation.

Kieffer Paper Mills has a common discharge pipe with the Brownstown STP and both facilities have violated effluent limits. Kieffer Paper Mills has grossly violated TSS and BOD limits. As of July 1993, this facility is facing heavy fines from U.S. EPA and IDEM. Brownstown, although under a Consent Decree, has had several equipment related violations.

Recent inspections have shown that the Mitchell STP has had occasional equipment malfunctions which caused a sludge build up in Lick Creek and E. coli levels make the stream only partially supportive of recreational uses. The facility at Spring Mill State Park which discharges into Mill Creek near Mitchell is operating satisfactorily but is in need of mechanical renovation. The Westport STP which discharges to Millstone Creek has been operating well and the effluent is usually well below the NPDES permits limits.

The Loogootee STP in Martin County has made several improvements including a grit removal facility, stormwater retention basin, digester, oxidation ditch and boat clarifier, and new sand beds. The chlorine contact tank and dechlorination facility is the only major work not yet completed. At present, the facility is meeting its permit limits and running well. Laboratory analyses of stream samples and a bio-toxicity assessment taken during 1993 inspections found no stream degradation in it's receiving stream, Plasters Creek. Plasters Creek is designated a limited use stream.

The Orleans STP which discharges to the Lost River sinkhole, is a new plant and is usually in compliance with its permit limits. E coli levels have had been difficult to control based on a 1992 inspection. Major improvements have been made to the Orleans STP laboratory facilities.

In summary, 755 miles of stream were assessed as to meeting aquatic life uses in the East Fork of White River Basin in 1992 and 1993. Of these, 408 miles (54%) fully supported designated uses, 140 miles (19%) were fully supportive but threatened, 118 miles (16%) partially supported its uses, and 89 miles (12%) did not support the designated uses. Accumulation of high levels of PCBs and pesticides in fish accounted for 15% of the stream miles not meeting or only partially meeting the designated uses. In terms of recreational uses, 440 miles were assessed. None of the miles assessed fully supported the recreational use, only 5 miles (1%) were partially supportive, and 435 miles (99%) failed to support the designated full body contact use.

West Fork of White River Basin

The West Fork of White River begins near Winchester in Randolph County, Indiana, flows through eleven counties and is joined by the East Fork of White River near Petersburg. The main stem of White River then flows about 48 miles and joins the Wabash River. In total, the West Fork flows about 356 river miles and drains 5,600 square miles of Indiana watershed (Figure 61).Table 51 shows the waters assessed in this basin, the status of their support of designated uses, the probable causes of impairment, and the miles effected. Additional comments on some reaches are also provided.

The 25 mile stretch of the river from above Winchester to the Delaware County line supports its designated aquatic life use but does not support the whole body recreational use due to high E. coli concentrations. The fish collections from the upper river down to Muncie have been diverse and representative of a central Indiana river in good condition. A significant smallmouth bass sport fishery exists in the river in Muncie upstream of the Muncie STP.

Water quality of the West Fork of White River in the reach from Muncie to Martinsville, is affected by several large municipalities (Muncie, Anderson, Noblesville, and Indianapolis) as well as several smaller communities. Combined sewer overflows (CSOs), urban nonpoint runoff and fish tissue contamination are problems in some areas. E. coli concentrations exceed standards often enough that recreational uses are not met in this reach.

Figure 61. *West Fork of White River Basin*

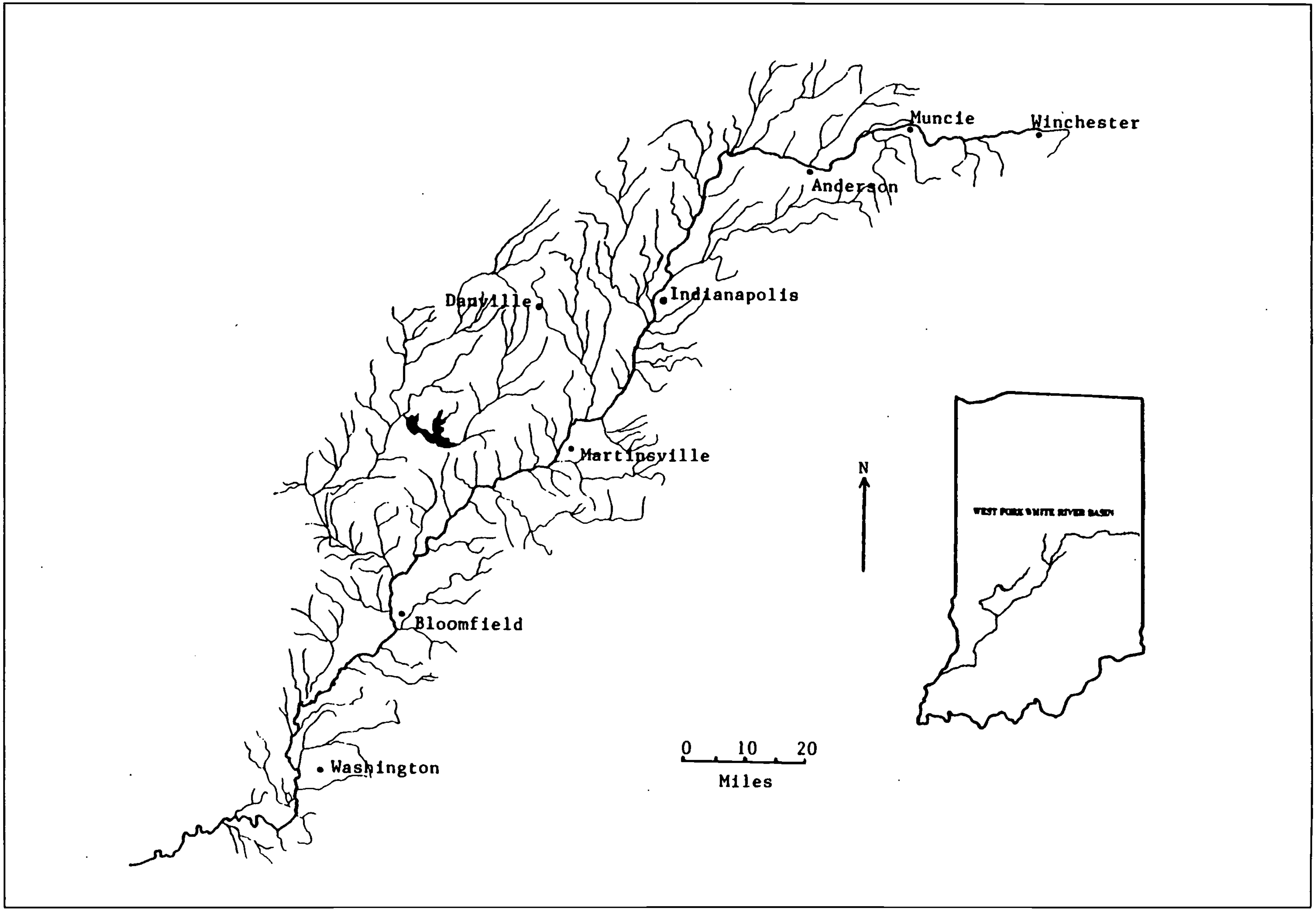


Table 51. *Water assessed, status of designated use support, probable causes of impairment, and miles affected in the West Fork of White River Basin*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
W. F. White River	Winchester to Delaware County Line	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	25	
W. F. White River	Delaware County	NS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli CSO's PCB's Pesticides	31	Fish Consumption Advisory for carp. After its upgrading and construction Muncie STP is achieving a clean, quality effluent.
W. F. White River	Delaware County Line to Noblesville	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	40	New system for solids handling at the Anderson facility.
W. F. White River	Noblesville to North Marion County Line	NS (Aquatic Life) NS (Recreational)	Monitored (c)	PCBs E. coli Pesticides	20	Fish Consumption Advisory. Firestone/Bridgestone (under RCRA Consent Order) in Noblesville will eliminate an outfall and drain system which has residual PCB's in discharge to Wilson Ditch. Noblesville STP has new sludge handling facility designed, submitted, and approved by IDEM.
W. F. White River	No. Marion County to Martinsville	FS (Aquatic Life) NS (Recreational)	Monitored (b, c)	E. coli	58	
W. F. White River	Martinsville to confluence of the West Fork of White River and the East Fork of White River near Petersburg	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	142	
White River (Main Stem)	Petersburg to Wabash River	FS (Aquatic Life) NS (Recreation)	Monitored (c)	E. coli	48	
Lilly Creek	Orestes	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	1	
Indianapolis Waterway Canal	Indianapolis	FS (Aqautic Life) NS (Recreational)	Monitored (c)	E. coli	4.5	

Table 51. *Waters assessed, status of designated use supported, probable causes of impairment, and miles affected in the West Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Duck Creek	Elwood	NS (Aquatic Life) NS (Recreational)	Evaluated	E. coli CSOs Bypassing	3	Remediation plans to correct bypasses discussed with facility.
Duck Creek (lower 8 miles)	Strawtown	FS (Aquatic Life) (Threatened)	Evaluated	Bypassing	8	Periodic bypassing from Elwood POTW threatens this reach of stream.
Fall Creek	Immediately Downstream Geist Reservoir	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	6	
Fall Creek (Headwaters to Geist Reservoir)	Pendleton	FS (Aquatic Life) NS (Recreational)	Monitored (b)	E. coli Nonpoint Source	17	Nutrients and sediments may be causing some impart to reservoir.
Fall Creek (The last seven miles before joining W.F. White River)	Indianapolis	FS (Aquatic Life) NS (Recreational)	Monitored (c)	CSO E. coli	5	
Eagle Creek	Indianapolis	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli Nonpoint Source	4	Several industrial discharges to this stream.
Eagle Creek	Zionsville Headwater to Eagle Creek Reservoir	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	25	
East Fork of White Lick Creek for 3 miles downstream of Indianapolis	Bridgeport	PS (Aquatic Life)	Monitored (b)	Urban, Industrial and Agricultural Nonpoint. Effects of past municipal and industrial discharges and spills. (Metals)	3	
Julia Creek	Indianapolis	NS (Aquatic Life)	Evaluated	Metals	1	
White Lick Creek	Brownsburg	PS (Aquatic Life) PS (Recreational)	Evaluated	E. coli Ammonia Low D.O.	2	No recent violations.
White Lick Creek	Plainfield	FS (Aquatic Life) FS (Recreational)	Evaluated		2	

Table 51. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the West Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
White Lick Creek	Mooresville to Confluence with W.F. White River	FS (Aquatic Life) FS (Recreational)	Monitored (b)		7	
West Fork White Lick Creek (South)	Danville	FS (Aquatic Life) (Threatened) FS (Recreational)	Evaluated	Nonpoint CSO's BOD TSS D.O.	2	Problems at Danville POTW as well as non-point run-off threaten this 2 miles of this stream. Facility problems isolated to heavy rain periods.
West Fork White Lick Creek (North)	Pittsboro	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	5	Wet weather overflows.
Wilson Ditch and Stoney Creek	Noblesville	NS (Aquatic Life)	Monitored (c)	PCB D.O.	1	Complete Fish Consumption Advisory.
Pleasant Run	Indianapolis	FS (Aquatic Life)	Evaluated		9	
Richland Creek	Whitehall, Monroe County to confluence with White River in Greene County	FS (Aquatic Life)	Monitored (c)(b)		19	
Stouts Creek	Bloomington	FS (Aquatic Life)	Monitored (c)		2	PCB Sediment contamination may still be present.
Beehunter Ditch	Linton	PS (Aquatic Life)	Monitored (c)	Copper Ammonia	4	Bypassing problems with Linton POTW.
Indian Creek	Bicknell	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	4	
Hawkins Creek	Washington	NS (Aquatic Life) NS (Recreeational)	Evaluated	Low D.O. Ammonia High BOD E. coli CSO	4	Bypassing problems. Some sewer improvements include grit removal system. Three sanitary sewers eliminated. One CSO closed.
Pipe Creek	Alexandria	FS (Aquatic Life) (Threatened)	Evaluated	CSO	20	Sludge handling and storage problems occur at Alexandria Municipal Treatment Plant. CSO's to Pipe Creek.

Table 51. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the West Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Jacks Defeat Creek	Elletsville	FS (Aquatic Life)	Evaluated		6	Working with Northern Richland Sewer District to limit amount of inflow and infiltration to correct problem. Caused fishkill.
Bean Blossom Creek	Bloomington to confluence with W.F. White River	FS (Aquatic Life) (Threatened)	Monitored (c)		12	
Latta Creek	Switz City	FS (Aquatic Life)	Evaluated		12	New facility to be constructed in 1991 or will hook up with Lyons STP.
Mill Creek	Stilesville to Cataract Lake	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	17	
Four Mile Creek	Lyons	FS (Aquatic Life)	Evaluated		4	
Black Creek	Sandborn	FS (Aquatic Life)	Evaluated		5	
Vertress Ditch	Elnora	FS (Aquatic Life)	Evaluated		3	
Kane Ditch	Odon	FS (Aquatic Life)	Evaluated		4	Funds for renovation approved. Plant under OATS program.
Smothers Creek	Plainsville	FS (Aquatic Life)	Evaluated		4	
South Fork Prairie Creek	Montgomery	FS (Aquatic Life)	Evaluated		5	
Wilson Creek	Monroe City	FS (Aquatic Life)	Evaluated		6	
Buck Creek	Yorktown	NS (Aquatic Life)	Monitored (c)	PCBs	10	Solids handling at STP addressed. Plant runs more efficiently. Fish Consumption Advisory.
Bell Creek	Yorktown	FS (Aquatic Life)	Monitored (c)		10	
York Prairie Creek	Muncie	FS (Aquatic Life)	Monitored (c)		5	
Killbuck Creek	Anderson	FS (Aquatic Life)	Monitored (c)		20	
Lick Creek	Ingalls	FS (Aquatic Life)	Evaluated		13	
Mud Creek	Summitville	NS (Aquatic Life)	Monitored (c)	D.O. TSS E. coli	8	Wastewater bypassed into Mud Creek. Enforcement against violations pursued to correct CSO structures.
Arbogast Ditch	Park City	FS (Aquatic Life)	Evaluated		1	
Cabin Creek	Farmland	FS (Aquatic Life)	Monitored (c)		10	

Table 51. *Waters assessed, status of designated use support, probable causes of impairment, and miles affected in the West Fork of White River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Cicero Creek	Cicero	FS (Aquatic Life) (Threatened) FS (Recreational)	Evaluated		7	Improvements made in sludge disposal program at Cicero, with the construction of drying beds. Nonpoint run-off threatens this stream.
Little Cicero Creek	Cicero	FS (Aquatic Life)	Evaluated		16	
Cool Creek	Westfield	FS (Aquatic Life)	Evaluated		11	
Williams Creek	Indianapolis	FS (Aquatic Life)	Evaluated		6	
Little Eagle Creek	Indianapolis	FS (Aquatic Life) (Threatened)	Evaluated		5	Urban nonpoint run-off periodically threatens this stream.
Mud Creek	Clayton	FS (Aquatic Life)	Evaluated		6	
East Fork Big Walnut Creek	North Salem	FS (Aquatic Life)	Evaluated		8	
West Fork Big Walnut Creek	North Salem	FS (Aquatic Life)	Evaluated		10	
Big Walnut Creek	Roachdale to Reelsville	FS (Aquatic Life)	Evaluated		35	
Eel River	Worthington	FS (Aquatic Life) NS (Recreational)	Monitored (c)	E. coli	10	Renovations to Worthington Packing Plant almost completed; will reduce NH_3-N.
North Prong Stotts Creek	Centerton	FS (Aquatic Life)	Evaluated		3	
Indian Creek	Morgantown	FS (Aquatic Life)	Evaluated		12	
Sycamore Creek	Centerton	FS (Aquatic Life	Evaluated		7	
Plass Ditch	Decker	FS (Aquatic Life)	Evaluated		5	

PS = Partial Support; NS = Non Support; FS = Full Support. If a use is not listed, it was not monitored or evaluated.

b = Biological; c = Chemical

A fish consumption advisory, recommending no consumption of carp, exists for the river in Delaware County due to high concentrations of PCBs and chlordane in the tissue of this species. In the reach of the river from Noblesville to the northern Marion County line, a fish consumption advisory is in effect recommending only limited consumption of all species, again due to PCB contamination. This advisory extended to Martinsville in the past, but fish tissue samples collected from the Marion County area downstream to Martinsville no longer exceed FDA Action Levels so this portion of the advisory has been lifted.

The major industrial and municipal dischargers from Muncie to Martinsville have significantly improved their facilities and generally produce high quality effluent. The City of Indianapolis has made major renovations to its two STPs. Many of the problems in this reach of the river may be more attributable to past conditions or to CSOs and nonpoint source problems than to the major municipal point sources. From below the Hamilton County Line to the confluence of the East Fork and West Fork of White River near Petersburg, the West Fork fully supports the designated aquatic life use. High E. coli concentrations in this reach prevent attainment of the recreational designated use. Again, the sources of these high E. coli concentrations are unclear as there are no major point sources on this reach of the river.

The lower 48 miles of the West Fork White River from Petersburg to its confluence with the Wabash River are of generally good quality chemically and support aquatic life. However, recreational uses are impaired due to high E. coli bacteria levels. There are two electrical generating stations located at Petersburg just downstream of the confluence of the East and West Forks. The NPDES permits recently issued for these generating stations contain more stringent thermal effluent limitations, including the requirement to reduce power generation, if necessary, to meet water quality standards. However, during recent summer low flow, high temperature periods the water temperatures downstream of these plants may have forced fish to move out of some portion of the river. There are no other major dischargers on this reach of the river, but some tributaries do receive periodic runoff from oil well operations and both active and abandoned mines.

Several tributaries of the West Fork of the White River have been assessed. Nearly all the tributaries receive agricultural nonpoint runoff which results in some degree of siltation, nutrient enrichment, and exposure to pesticides. The streams of the lower part of the West Fork White River Basin are more severely channelized for drainage than the streams of the upper basin. However, nearly all streams in the basin have undergone some type of habitat alteration. The severely channelized waterways usually support only low diversity aquatic life communities and are not attractive recreation resources.

Fish tissue samples collected from Buck Creek in Delaware County during 1990 - 1993 indicated that levels for PCBs in carp exceeds FDA Action Levels. Buck Creek was added to the Fish Consumption Advisory list in 1993.

Wilson Ditch and Stoney Creek near Noblesville do not support their aquatic life uses due to a fish consumption advisory on these streams. The fish are contaminated with PCBs from the Firestone Industrial Products facility which has a discharge to Wilson Ditch. The PCBs appear not to come from manufacturing processes, but from roof and surface drains which combine with the process water discharge. The source of the PCBs has been removed, and U.S. EPA, IDEM and Firestone are still working toward an agreement on a plan to clean up stream sediments and plant sludges which contain high PCB levels. This source has also contributed significantly to the PCB problems in the fish of the West Fork White River (see earlier discussion on mainstream fish advisory). High chlordane levels were once found in fish tissue collected from these streams. The source of this pollutant is not clear, but it may be from past usage of this substance on farm fields or as a termiticide in urban areas. Chlordane is no longer a problem here.

Conard's Branch in Monroe County and Richland Creek in Monroe and Greene counties also had past problems with PCBs in fish tissue. The source of the PCBs in these streams appeared to be Neal's Landfill which drains to Conard's Branch and then to Richland Creek. Neal's Landfill contained PCB contaminated wastes. A two mile reach of Stout's Creek, also in Monroe County, also contained high PCB levels in fish and sediment samples. These appear to have leached from Bennett's Stone Quarry Landfill. Both Neal's Landfill and Bennett's Landfill have now been capped with clay to prevent further leaching until a more complete cleanup can be performed. A leachate collection and treatment system has been installed at Neal's Landfill and sediments were dredged from Conard's Branch and Richland Creek. Sediments were also removed from Stout's Creek near Bennett's landfill. Following this excavation, sediment samples were taken from Richland Creek and Stout's Creek and these samples contained no detectable levels of PCBs. Recent (1988 - 90) fish tissue samples collected from Richland Creek and Stout's Creek showed PCB levels below FDA Action Levels and the fish consumption advisories for these streams have been lifted. Currently, IDEM is negotiating with Westinghouse for an Agreed Order to settle past violations and to insure that future violations do not occur.

The Speedway STP discharges to Eagle Creek. High ammonia levels were found in the effluent in the past, and Eagle Creek was impacted by this facility. Total ammonia levels in the stream have been high (averaging 2.6 mg/l) at the downstream monitoring station (approximately 0.25 miles downstream) compared to the upstream samples (average less than 0.1 mg/l). All parameters had elevated levels downstream as compared to the upstream samples. This plant recently completed construction of additional ammonia removal facilities during 1992-93, and no violations for ammonia have been detected in the stream. The Speedway STP removed an average of 8,688 pounds of ammonia during 1993 and has attained a 97.6 % compliance rate for this parameter. This reach of Eagle Creek is currently evaluated as being supportive of aquatic life and recreational uses.

Lower Fall Creek and Pleasant Run Creek in Marion County, Beehunter Ditch near Linton in Greene County and Hawkins Creek at Washington in Daviess County all have occasional problems with ammonia, BOD and TSS usually as a result of bypassing after rains. The Linton STP which discharges into Beehunter Ditch is not meeting permit limits for unionized ammonia and TSS. Its aerated lagoons are full of sludge and bypassing occurs into Beehunter Ditch during rain events. These gross violations occur often and in the past have been complicated by a General Electric facility which had failed to meet limits for copper and zinc. Zinc violations ceased in January 1990 while the copper violations continued. While influent monitoring had shown copper concentrations that fluctuate and are sometimes as high as the permit limitations, effluent copper concentrations at the outfall were consistently higher than the influent level. These copper concentrations resulted in NPDES violations which led to more strict copper limits based on an Agreed order between General Electric and IDEM. A mid-1992 facility inspection showed that the limits had not been violated since the Agreed Order was signed.

The City of Washington recently completed over a million dollars of renovations and improvements to the wastewater treatment plant and sewer system. The former trickling filter plant is now a combination of trickling filters and activated sludge (oxidation ditch) processes. A new chlorine contact tank with stair-step aeration has also been added. Sewer improvements include a new grit removal station at the point where Hawkins Creek emerges from under the city. All the flow is now channeled through the grit station which has influent and effluent flow measurement via Parshall flumes. Influent flows in excess of 6.0 MGD are bypassed at this point.

The city is ahead of schedule regarding a 1990 Agreed Order for the elimination of all sanitary sewer overflows (SSOs). Three of the six dry weather SSOs in Washington have been eliminated. One combined sewer overflow has also been closed, but the system still has inflow and infiltration problems. The City is presently in the design phase of storm water retention basins which will slow the storm water coming into the sewer system. This project is not yet completed. Within the last two years the City has worked hard to get CSO points removed on schedule. The water quality of Hawkins Creek, however, continues to be severely impacted by the combined sewer system. This creek is full of debris, oil, sludge deposits and does not meet bacteriological standards. IDEM is still pursuing enforcement action against this facility.

The elimination of dry weather bypassing and channeling of Hawkins Creek into the sewer system has increased the average hydraulic load at the plant to approximately 4.5 MGD. The plant is still operating under a 1.9 MGD design flow waste load allocation. In order to meet organic loading limits (lbs/day) the plant must produce an effluent that does not exceed 50% of the concentration permit limits.

Indian Creek near Bicknell in Knox county does not support aquatic life uses for roughly four miles due to acid drainage from abandoned mine land. This stream is impacted by acid mine drainage before it receives the discharge from the Bicknell STP.

The Town of Elwood has had serious sewer problems. Rainfall of half an inch affects the collection system such that infiltration and inflow fills the flow equalization basin causing bypassing. Duck Creek downstream of the Elwood STP has been described as an open sewer. The city treats only that portion of the influent which they can treat and still conform to permit limits. Given the massive infiltration problems of the antiquated sewer system, the new construction which has recently been completed represents very modest improvement. Much work is needed to eliminate CSO's in this area. Improvements should include construction of a 100% sanitary system, the elimination of storm water, and the elimination of residence downspout and sump pump input. A consulting firm has been acquired to recommend a CSO plan.

White Lick Creek in Hendricks County downstream of Brownsburg only partially supports the aquatic life use, but further downstream, near Plainfield, it is fully supportive of this use and facilities and industries are regularly meeting permit limits. Consulting engineers for the Town of Mooresville have completed a major sewer and manhole rehabilitation study. The project included cleaning and television inspection of approximately 49,000 feet of sewers, and the grouting of sewer joints. This effort was completed by September 1992.

Avon Utilities which also discharges to White Lick Creek has had problems meeting permit limits in the past. IDEM currently has an ongoing enforcement action with this facility. A sewer ban is currently in effect and conditions have very much improved over the past few years. Sediment samples taken 20-200 feet downstream from Avon Utilities indicated no negative effects on White Lick Creek.

The West Fork of White Lick Creek at Danville currently supports aquatic life and recreational uses fully but is threatened. The new Danville STP built in 1986 increased capacity and treatment levels. Much of this system is currently undergoing repair. Manholes in the Danville sewer system chronically overflow during heavy rains. However, 44% of the sewer system has been slip-lined and over 90% of illegal taps into the sewer have been removed. The Danville STP generally meets the weekly and monthly averages of the NPDES permit. Most violations have been isolated to a one or two day period when flows have exceeded design by a considerable margin. The town is still actively pursuing the removal of inflow and infiltration through evaluations of video tapes of the sewer system and prioritizing funds to be used for repair or replacement of existing sewer lines.

The Alexandria Wastewater Treatment Plant, which discharges to Pipe Creek, is hydraulically overloaded and continually has to treat flow volumes well in excess of the design capacity of the facility. A continuing program based on annual projects involving sewer separation, sewer renovation, and inflow and infiltration minimization would be beneficial in reducing hydraulic overloading at the treatment plant. Such a program would also minimize overflows in the collection system. Since June 1993, dry weather discharges to Pipe Creek have ceased. The overflow problem appears to have been controlled by extensive sewer cleaning which was started in June 1993. The stream is fully supportive of aquatic life but is threatened.

Mud Creek, near Summitville, is non supportive of aquatic life and recreational uses. Since May 1989, it appears that Summitville has bypassed all wastewater to Mud Creek. Some initial repairs have been made, but problems continue. IDEM Enforcement staff are monitoring ongoing CSO structure plans.

Chlordane and PCBs in fish tissue and occasional to frequent high levels of ammonia, and E. coli seemed to be the major problems in the basin. The exact sources of these pollutants are hard to determine, but they are probably spread across point, nonpoint and CSO problems.

Fish community sampling has been completed in the mainstems of the East Fork, West Fork and lower White River. Tributary sampling, however, has yet to be performed. The assessment of the mainstem results has not been completed.

In summary, 829 miles of streams were assessed in the West Fork of White River for support of designated aquatic life uses. Of this total 683.5 miles (82%) fully supported this use, 54 miles (6%) were fully supportive but threatened, 9 miles (1%) partially supported this use, and 82 miles (10%) did not support aquatic life uses. Only 486 miles were assessed for recreational use. Of these miles 23 miles (5%) were fully supportive, 2 miles (0.4%) were partially supported, and 461 miles (95%) did not support the recreational use designation.

Ohio River Basin

The Ohio River and its Indiana tributaries (excluding the Wabash River) drain approximately 5,800 square miles in Indiana (Figure 62). The major Indiana tributaries in the basin are: the Whitewater River (via the Great Miami River in Ohio), the Blue River, the Little Blue River, the Anderson River, Laughery Creek, Big Indian Creek, and Pigeon Creek. The major land use in the basin is agricultural, but a large portion of the land is hilly and rolling and much is still heavily forested. Strip mining operations are important in certain portions of the basin.

Water quality monitoring of the Ohio River itself, which forms the southern boundary of 13 Indiana counties from about river mile 492 to 848 (356 miles), is done by the Ohio River Valley Water Sanitation Commission (ORSANCO), a consortium composed of eight states, six of which border the Ohio River mainstem. ORSANCO maintains eight fixed water quality monitoring stations on the portion of the Ohio River which borders Indiana. The State of Indiana maintains fixed water quality monitoring stations on the Whitewater and Blue Rivers and Indiana Department of Environmental Management (IDEM) personnel conduct compliance sampling inspections and other water quality monitoring activities on Indiana facilities and waterbodies that discharge to the Ohio River.

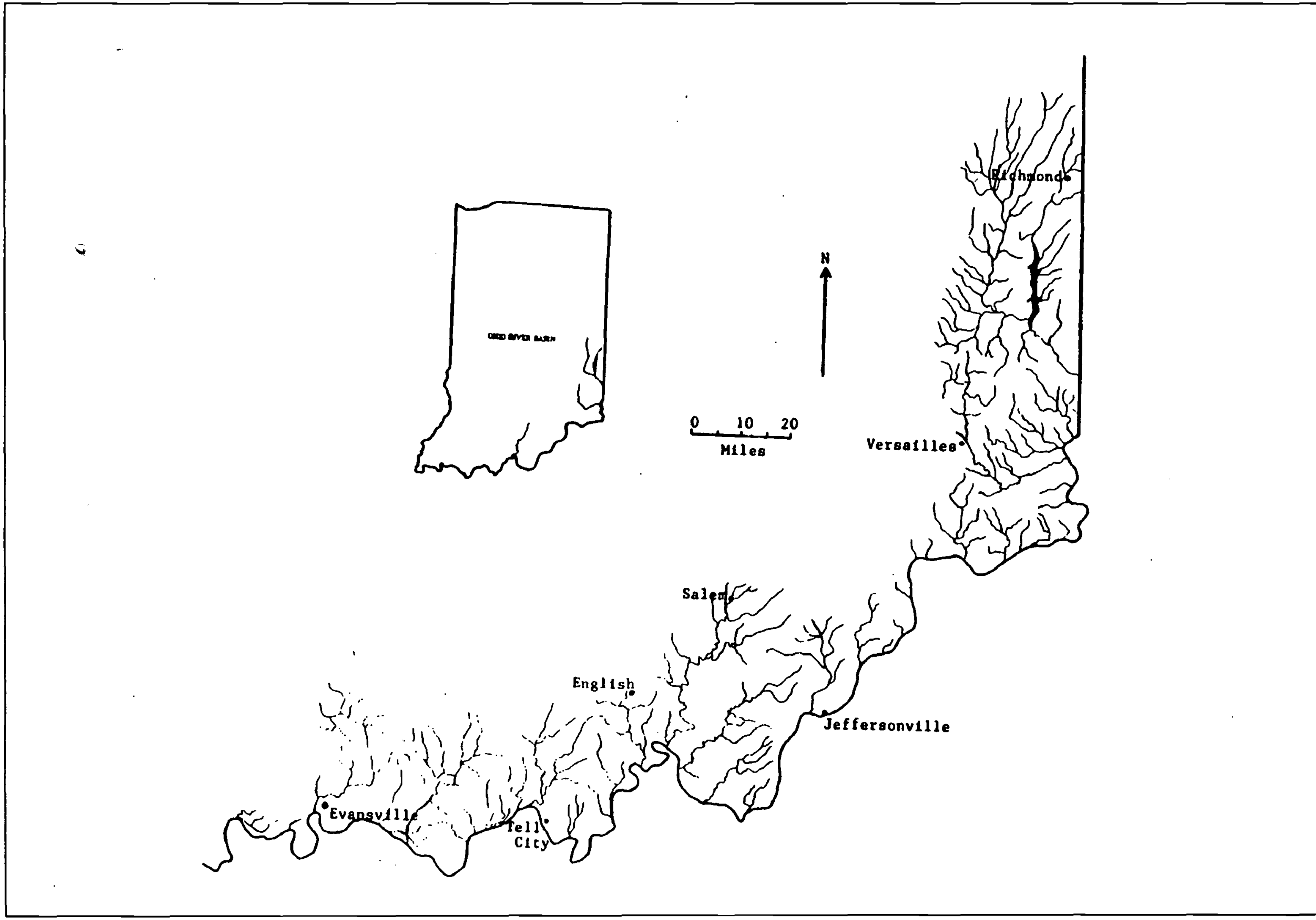
A detailed discussion of the water quality conditions in the Ohio River mainstem can be found in the 1992-93 ORSANCO 305(b) report. Therefore, this report will not address these waters.

The U.S. Army Corps of Engineers operates a series of 20 locks and dams on the Ohio River to allow year round navigation. Four of these are located along Indiana's southern boundary, and these dams create slowly flowing pools in the Ohio River which are similar to reservoirs.

Indiana Regulation 327 IAC 2-1 designates the Ohio River for general uses and whole body contact recreation. The Ohio River has also been designated by the Ohio River Valley Water Sanitation Commission as "available for safe and satisfactory use of public and industrial water supplies after reasonable treatment, suitable for recreational usage, capable of maintaining fish and other aquatic life and adaptable to such other uses as may be legitimate". Such other uses would include navigation and power generation.

Recreational uses occur all along the river. There are no designated swimming beaches, and whole body contact recreation consists mainly of water skiing and swimming from boats. The main stem of the Ohio and especially the tributary embayments created by the dams are extensively used for sport and commercial fishing. These recreational uses have increased in recent years due

Figure 62. *Ohio River Basin*



to increased leisure time, increased interest in water based recreation, and to improved water quality.

Indiana has 14 municipal water supply intakes on the Ohio River, three of which are greater than two million gallons per day (MGD): Indiana Cities Water Corporation at mile point (MP) 609; Evansville at MP 702.53 and Mount Vernon at MP 829.2. There are 17 municipal discharges and 13 industrial discharges to the Ohio River from Indiana, but only five are two MGD or greater (Jeffersonville, New Albany, Evansville, ALCOA-Warrick, and Newburg). There are three electrical generating stations and 13 Indiana river terminals that handle petroleum products or hazardous wastes.

The Ohio River which borders southern Indiana for 356 miles is currently under a fish consumption advisory for carp and catfish. Approximately 1.8 miles of the Great Miami River flows through southeastern Indiana from Ohio. This portion of the river is currently under a fish consumption advisory for channel catfish due to PCB concentration. Most of the Great Miami River originates from and flows through Ohio. The source of this contaminant is in that state.

Several Indiana streams tributary to the Ohio River, have been assessed. Table 52 shows the waters assessed, the status of designated use support, the probable causes of impairment, and the number of miles affected in the Ohio River Basin. Additional comments are also provided for certain reaches.

Although most of Indiana's dischargers do not appear to be causing problems in the Ohio River, some facilities which discharge directly to the river have recently had problems in meeting permit limits. The South Dearborn STP in Lawrenceburg has state enforcement action pending against it due to almost continuous non-compliance with limits for total suspended solids (TSS) and BOD.

As of December 1993, an Agreed Order between IDEM and Lawrenceburg addressed violations of the facility's NPDES permit and deficiencies which in turn caused problems in the Ohio River. ORSANCO had commented about the high solids content being discharged and the discoloration of the stream. IDEM staff have investigated the conditions at this facility for a couple of years including collecting water samples and filming the discoloration on video. The Ohio River was effected at least 50 yards downstream and 50 yards into the river. IDEM staff will continue to investigate the facility to ensure compliance with the Agreed Order and to monitor the mixing zone in the Ohio River.

The Madison STP has had inflow, infiltration and a solids problem due to old and poorly operating equipment. Bypassing sewage from the collection system occurred over ten times in 1990. Most bypasses occurred due to lift

Table 52. *Indiana tributary waters assessed, status of designated use support, probable causes of impairment and miles affected in the Ohio River Basin*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
W. F. Whitewater River	Connersville	FS (Aquatic Life) NS (Recreational)	Monitored (b.c.)	E. coli	40	The Connersville STP has continued to operate within its permit limits but has I and I problems which impacts stream.
E. F. Whitewater River	Richmond	PS (Aquatic Life) NS (Recreational)	Monitored (b.c.)	E. coli Cyanide	48	Richmond's STP experiences difficulties during wet weather.
Whitewater River	Brookville	FS (Aquatic Life) NS (Recreational	Monitored (b.c.)	E. coli	16	New facility in operation.
Nolands Fork	Centerville	FS (Aquatic Life)	Evaluated		20	
Greens Fork	Greens Fork	FS (Aquatic Life)	Evaluated		20	
Martindale Creek	Germantown	FS (Aquatic Life)	Evaluated		15	
Williams Creek	Connersville	FS (Aquatic Life)	Evaluated		10	
Salt Creek	Oldenburg	FS (Aquatic Life)	Evaluated		12	OATS helping to train staff. New facility.
Pipe Creek	Brookville	FS (Aquatic Life)	Evaluated		10	
Big Cedar Creek	Cedar Grove	FS (Aquatic Life)	Evaluated		4	
Village Creek	Alquina	FS (Aquatic Life)	Evaluated		6	
Richland Creek	Cedar Grove	FS (Aquatic Life)	Evaluated		1	Limited use stream.
Silver Creek	Liberty	FS (Aquatic Life)	Evaluated		12	
N. F. Tanner Creek	Lawrenceburg	FS (Aquatic Life)	Evaluated		16	
S. F. Tanner Creek	Lawrenceburg	FS (Aquatic Life)	Evaluated		4	
Great Miami River	Lawrenceburg	NS (Aquatic Life)	Monitored (b)	PCB	1.6	Fish Consumption Advisory.
North Hogan Creek	Aurora	FS (Aquatic Life)	Evaluated		10	
South Hogan Creek	Aurora	FS (Aquatic Life)	Evaluated		10	
Laughrey Creek	Ripley/Ohio County	FS (Aquatic Life)	Evaluated		30	Three miles of this stream in Ripley County downstream of Napoleon are designed for limited use.
Indian Creek	Vevay	FS (Aquatic Life)	Evaluated		5	
Plum Creek	Vevay	FS (Aquatic Life)	Evaluated		1	
Indian Kentuck Creek	Brooksburg	FS (Aquatic Life)	Evaluated		21	
Peter Creek	Dillsboro	FS (Aquatic Life)	Evaluated		3	New System running well since construction. Installation of 3 stage lagoon completed.

Table 52. *Indiana tributary waters assessed, status of designated use support, probable causes of impairment and miles affected in the Ohio River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Coles Creek	Tennyson	FS (Aquatic Life)	Evaluated		5	
Tributary of Laughrey Creek	Osgood	PS (Aquatic Life) PS (Recreational)	Evaluated	Municipal STP organics E. coli	2	State working with town on new treatment processes.
Otter Creek	Boonville	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	8	
Cypress Creek	Boonville	NS (Aquatic Life) NS (Recreation)	Monitored (b.c.)	CSO's Nonpoint Acid Mine drainage Chlordane E. coli	10	Boonville STP has been upgraded but CSO's discharge to creek.
Pigeon Creek	Evansville	NS (Aquatic Life)	Monitored (c)	Municipal STP organics Habitat alteration Nonpoint Chlordane	31.9	Fish Consumption Advisory.
Tributary of Ripley Creek	Sunman	NS (Aquatic Life)	Evaluated	Municipal STP organics Low D.O.	2	State working with Sunman on new treatment system.
Little Pigeon Creek	Dale	NS (Aquatic Life) NS (Recreation)	Monitored (b.c.)	Municipal STP organics Low D.O. Ammonia E. coli	5	Construction completed on new plant but bypassing still occurs.
Oil Creek	Perry County	PS (Aquatic Life)	Evaluated	Institutional treatment plant Organic unknowns	7	
Cain Run	Clarksville Jeffersonville	NS (Aquatic Life) NS (Recreation)	Evaluated	Municipal STP organics Low D.O. Ammonia, E. coli	1	The City of Clarksville STP now discharges to the Ohio River. Both of the old treatment facilities that used to serve the city have been closed down. The City of Jeffersonville STP still has inflow and infiltration problems.
West Fork Pigeon Creek	Fort Branch	FS (Aquatic Life)	Evaluated		5	New STW began operation Spring 1990.
Stollberg Ditch	Chandler	FS (Aquatic Life) (Threatened)	Evaluated	Sludge deposits Dump run-off	2	Chandler has completed construction for advanced treatment, expansion, and ammonia removal.

Table 52. *Indiana tributary waters assessed, status of designated use support, probable causes of impairment and miles affected in the Ohio River Basin (cont.)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Little Blue River	English	FS (Aquatic Life)	Evaluated		20	
Stinking Fork	Crawford County	FS (Aquatic Life)	Evaluated		3	
Anderson River	Troy	FS (Aquatic Life)	Evaluated		25	
Middle Fork Anderson River	Troy	FS (Aquatic Life)	Evaluated		12	
Deer Creek	Cannelton	FS (Aquatic Life)	Evaluated		5	
Holey Run	Ferdinand	FS (Aquatic Life)	Evaluated		2	
Fourteen Mile Creek	New Market	FS (Aquatic Life)	Evaluated		10	
Silver Creek	Sellersburg/ Clarksville	FS (Aquatic Life) (Threatened)	Evaluated	Sellerbrug STP	20	Sellersburg construction of new STP in June 1990 delayed.
Muddy Fork	Sellersburg	FS (Aquatic Life)	Evaluated		10	
Little Indian Creek	Lanesville	FS (Aquatic Life)	Evaluated		8	Town needs sludge management plan.
Big Indian Creek	Corydon	FS (Aquatic Life) (Threatened)	Monitored (b.c.)	Corydon STP	10	Ammonia limits met under interim limits.
Blue River	Fredericksburg	FS (Aquatic Life) NS (Recreational)	Monitored (b.c.)	E. coli	40	
Middle Fork Blue River	Salem	FS (Aquatic Life) (Threatened)	Evaluated		8	
South Fork Blue River	New Pekin	FS (Aquatic Life)	Evaluated		20	The community of New Pekin has expanded its STP. No new bypasses.
Georgetown Creek	Georgetown	FS (Aquatic Life)	Evaluated		2	
Harvey Branch	Oldenburg	NS (Aquatic Life) NS (Recreation)	Monitored (b.c.)	Municipal STP Low D.O. Ammonia E. coli Organics	2	Severe hydraulic overloads. Working with IDEM.
Barr Creek	Kassor	PS (Aquatic Life)	Evaluated	Nonpoint Source	8	a) Stream bank erosion. b) Excess nutrients from animal waste and flooding.

PS = Partial Support; NS = Non Support; FS = Full Support. If a use is not listed, it was not monitored or evaluated.

2 b = Biological; c = Chemical

station problems. During 1991, many items of equipment were repaired or replaced, reducing bypassing considerably. Only two bypasses were recorded in 1993. A problem with meeting NPDES limits for lead is currently being monitored.

The Towns of Cannelton and Troy are now sending their wastewaters to the Tell City STP, and Tell City has not been able to comply with their permit limits. Problems include frequent bypassing, sludge handling and collection, and overloading due to inflow and infiltration. Consulting engineers are investigating preliminary reports of an area of Tell City, near the Ohio River, where it is believed that sanitary sewage from residences and business are discharging directly into the Ohio River via the storm sewer system.

The Rockport STP has not been in compliance for at least two years and the state has pursued enforcement actions against it. Bypasses occurred due to lift station malfunctions. In 1992, plant inspections showed much improvement over any previous inspections. However, the effluent which is discharged to the Ohio River is not in compliance with permit limits. The City of Rockport has retained consulting engineers for the design phase of a wastewater treatment improvement project. The design will include the upgrading of several elements of the city's wastewater collection and treatment facilities. Rockport is also making application to the Department of Commerce for a $500,000 grant to assist with construction of the needed project.

The City of Charleston is in the process of initiating a sewer rehabilitation project that will reduce the amount of inflow entering the sanitary sewer system. Elimination of all wet weather bypasses by December 1994 is the scheduled goal.

Problems at the Mount Vernon STP are mainly due to operation and maintenance. An unpermitted discharge to Mill Creek is also under investigation at Mount Vernon.

The Clarksville STP, which discharges directly to the Ohio River, has not experienced any bypassing during this reporting period. The city is currently spending $50,000 on sewer upgrades.

Most Indiana tributary streams to the Ohio River fully support their designated uses. Those that do not are most often impaired by municipal discharges. Nonpoint runoff from agricultural fields and mined areas also impact some streams, particularly in the western portion of the basin.

Many of the streams in this basin are low gradient watercourses that are often very low or pooled during dry periods and are not capable of assimilating heavy organic loadings. Many waterways drain wetlands or former wetlands and have naturally low dissolved oxygen levels.

Harvey Branch downstream of Oldenburg, Laughery Creek below Versailles, a tributary of Laughery Creek below Osgood, and Little Pigeon Creek downstream of Dale are all relatively small streams which at present do not fully support designated uses due to discharges from the STPs in these towns. Oldenburg has severe hydraulic overloading, and Versailles has very poor plant mechanics and operating conditions at the old plant, although some improvements were noted during 1993 inspections. Very slow progress has been made on inflow/infiltration and lift station problems at the Dale STP which discharges an effluent that is basically raw sewage. All three STP's are being investigated by the IDEM enforcement office.

Cain Run receives discharges from the Jeffersonville STP and may not currently support its designated uses. This facility, in past years, has had very high inflow and infiltration problems. Permit limits for copper and cyanide were difficult to attain and a pretreatment program was established. While there were no violations or impacts to Cain Run during 1992 - 1993, it is still evaluated as being nonsupportive based on past degradation. The Colgate Palmolive Company has had occasional oil and grease problems, but their discharge is considered to be very good and has not adversely affected Cain Run or the Ohio River. Cain Run enters the Ohio in the section of the river known as the Falls of the Ohio. This is an exceptional natural historical resource and is now a State Park.

Pigeon Creek and its tributaries in Vanderburg and Warrick counties receive effluent from STP's in Elberfield, Haubstadt, Chandler, Fort Branch and Fransico, some of which is inadequately treated. The Elberfield STP had sewage bypassing to the creek, prompting enforcement action by the state. Some compliance has since been attained. Haubstadt has inflow and infiltration problems in the sanitary sewer which has caused bypassing at the wastewater treatment plant. The town has identified the worst areas for inflow and infiltration and is replacing leaking manholes and joints throughout the collection system. The town plans to significantly reduce inflow and infiltration over a five year period.

The wastewater treatment plant in Chandler discharged heavy sludge (mixed liquor) to Pigeon Creek via Stollberg Ditch. The creek is dark with sludge deposits. A large amount of oil was found at a dump owned by the town. Run off from this dump flows directly into the creek, and enforcement proceedings were initiated by the State in 1993.

The Town of Chandler is conducting an aggressive program to address the operation of its wastewater treatment facility. IDEM compliance sampling efforts identified two primary concerns within the facility: modifications to its sludge handling process and analysis of actual hydraulic capabilities. Analysis of samples taken in March 1993 in Stollberg Ditch upstream and downstream of the discharge, showed that the discharge elevated some chemical parameters, but not to the extent of causing Water Quality Standards violations. Inspections during 1992 and early 1993 revealed a large amount of solids being discharged into the creek. Due to the amount of the discharge, sludge deposits have formed in Stollberg Ditch.

The Fort Branch STP is subjected to high hydraulic overloads due to severe inflow and infiltration problems. The flow through this plant is often twice that for which it was designed. The plant is essentially receiving and discharging sewage and groundwater with little or no treatment. The town has recently replaced its old trickling filter plant with a new 0.655 MGD oxidation ditch, activated sludge facility. Chlorination and post-aeration capabilities were also added. A sewer system evaluation study is expected to be conducted to identify locations of inflow and infiltration into the sewer system. This facility still has difficulty meeting NPDES permit limits, although no violations occurred during July 1993. The town plans to build a storm water retention basin by Fall 1995.

Currently the portion of Pigeon Creek in Vanderburg County is under a fish consumption advisory due to chlordane which was found above FDA Action/Tolerance levels in carp and channel catfish. Past agricultural usage and the many old abandoned landfills near the stream in this area may be the sources of this pollutant.

Pigeon Creek has been severely channelized and also receives a large volume of agricultural nonpoint runoff. The combined effects of the high chlordane levels, channelization, nonpoint runoff, and various STP effluents cause Pigeon Creek to be non-supportive of its designated uses for about 32 miles.

Approximately ten miles of Cypress Creek near Boonville in Warrick County do not support designated uses. The Boonville STP discharges to Cypress Creek which flows to the Ohio River. This is a newly renovated facility but it is still providing poor treatment and permit limit violations occur. In addition to plant problems, CSO discharges were causing degradation to Cypress Creek. The discharge from the south CSO showed a D.O. of 0.1 mg/l, BOD_5 of 57 mg/l, total ammonia of 15 mg/l, suspended solids of 48 mg/l, and E. coli of 2,600,000/100 ml. Impacts to the Ohio River are probably minor due to its distance from the Boonville discharge (approximately ten miles). Acid mine drainage and agricultural nonpoint run-off also contribute to the degradation of Cypress Creek.

Elevated PCB and chlordane levels have been found in the sludge drying beds of the Boonville STP and in the sediments of Cypress Creek. Those sediments will be excavated and taken to a hazardous waste landfill. Newburgh which discharges to Cypress Creek has a new facility but often exceeds limits for TSS.

Silver Creek near Sellersburg generally supports its designated uses but is threatened due to STP problems. The Town of Sellersburg currently operates a Class II, 0.7 MGD, trickling filter plant followed by a rotating biological contactor and effluent chlorination. Field tests disclosed that the plant effluent was causing a dissolved oxygen sag in Silver Creek. At the point of discharge, the stream is one long pool with no discernible flow. Floating sludge and other sewage solids were observed in the stream and the bank was a grayish color with sewage fungi present in the vicinity of the outfall. The dissolved oxygen was reduced from 10.0 mg/l at the upstream station to 5.2 mg/l at the last downstream station approximately four miles downstream of the discharge. A new oxidation ditch sewage treatment plant with chlorination and dechlorination facility was completed during Spring 1993. The new plant even with its inflow and infiltration problems, should improve conditions in Silver Creek.

The Blue River in Washington, Harrison and Crawford counties is a high quality stream that seldom experiences pollution problems. This river, from the confluence of its West and Middle Forks in Washington County downstream to the Ohio River, as well as a portion of the South Fork of the Blue River, are designated as "Exceptional Use" streams.

The Blue River is the home of several of Indiana's unique, threatened or endangered animal species. This is the only stream system in Indiana in which the hellbender salamander (**Cryptobranchus alleganiensis**) is found, and it appears that there is a rather large, reproducing population there. Spotted darters (**Etheostoma maculatum**), variegate darters (**E. variatum**), rosefin shiners (**Notropis ardens**), and the cottonmouth water moccasin (**Agkistrodon piscivorous**) are other unique species which have been found in the Blue River and its environs.

During September 1993, IDEM staff attended a meeting of the Blue River Commission in New Salisbury to discuss activities of the Water Quality Surveillance and Standards Branch in the Blue River watershed and to listen to the concerns of the riparian owners present. Of major concern was what some believed was an increasing foaming problem and elevated bacteria concentrations in the river and some of its large feeder springs. They were also concerned about the presence of inadequate septic tank disposal systems and outhouses along this highly used recreational stream. Dumping is also a problem in this area.

In the same outing, IDEM staff accompanied representatives of the Indiana Department of Natural Resources on an inspection of a portion of the stream where problems were reportedly at their worst. No significant foaming was observed, but there was a heavy algal growth on the bottom of the stream and there appeared to be a general lack of aquatic invertebrates, with the exception of snails, in some places.

There were places where most large trees were cut from steep hillsides and stream banks causing erosion and dumping was still bad in some locations. In one location, more than one dozen old school buses and trucks had been converted to weekend dwellings and outhouses were right on the stream bank. Grey water was discharged to a corn field across the lane by garden hoses. Reportedly, some homes only a few feet from municipal sewers still are served by inadequate septic tank disposal systems.

Much needs to be done there and IDEM staff observed similar problems in other southern Indiana watersheds. These problems are becoming more noticeable as the major point sources are providing improved treatment. As development continues unregulated in some counties, the problems are becoming worse.

The Salem STP has an old lagoon system which is discharging high levels of ammonia and suspended solids into the Blue River. This plant needs to be upgraded to handle hydraulic overloads.

The Little Blue River in Crawford County experiences few water quality problems. The Little Blue River valley is periodically flooded during extended rains. The Town of English, the only community on the Little Blue River, has been nearly destroyed twice in recent years, and the townspeople have now decided to vacate the old site and rebuild the town in an upland area.

The water quality of the Little Blue River is generally very good, and the aesthetic qualities of the stream and its forested watershed are quite high. The stream is a unique resource and has been considered for designation as an "Exceptional Use" stream. The Indiana Department of Natural Resources has stated that the lower portion of the Little Blue River may support remnant populations of the endangered Ohio River muskellunge.

Biologists of the Indiana Department of Natural Resources conducted fish population surveys of the Anderson River in 1989. Fifty-two species of fish were collected. Longear sunfish, bluntnose minnow, bluegill and central stoneroller were most numerous. Gizzard shad, carp and freshwater drum dominated the biomass. The Anderson River is considered to fully support its aquatic life designation.

The Corydon STP discharges to Indian Creek and has, in the past, been consistently over its ammonia limits. Currently, the facility is meeting interim limits. The water quality remains fully supportive of uses but is threatened due to past practices.

In summary, 600 miles of Indiana tributaries to the Ohio River were assessed in this report. Of these miles, 443 (74%) fully support the aquatic life use, 30 miles (5%)are considered threatened, 33 miles, (6%) are only partially supportive and 95 miles (16%) did not support the aquatic life use. Recreational uses were assessed for 215 miles. Of these miles 10 miles (5%) were supportive of these uses, 60 miles, (28%) were partially supportive, and the remaining 145 miles (67%) were not considered to support the recreational uses designation.

III. WATER POLLUTION CONTROL PROGRAM

Point Source Control Program

The point source control program in Indiana primarily involves discharges from municipal or industrial wastewater treatment facilities. In order to meet the goals of the Clean Water Act, federal, state, and local governments, as well as industry, have spent considerable monies to improve the degree of wastewater treatment they provide and, in turn, the water quality of Indiana's lakes, rivers and streams. The concentrations of polluting materials in these discharges are regulated by the National Pollutant Discharge Elimination System (NPDES) permit program. All facilities which discharge to Indiana waters must apply for and receive an NPDES permit. The limits, set in the permit, are designed to protect all designated uses of the river, lake or stream into which the discharge flows.

Municipal Facilities

Table 53 depicts the changes in the degree of wastewater treatment provided by municipal facilities in Indiana in the period from 1972 to 1993. During this time, the percentage of people who are served by municipal treatment plants has changed slightly, but the degree of treatment has improved considerably. There are no more primary treatment plants in the state. The percentage of the population served only by secondary treatment plants has also decreased, whereas, the percentage served by advanced waste treatment facilities of some type has increased dramatically.

In 1972, there were no advanced wastewater treatment facilities operating in Indiana. In 1993, over half the population was being served by these types of systems. Of the 31% of the population not served by municipal wastewater treatment plants, the great majority (about 90%) have been determined to have adequate individual septic tank disposal systems or are

Table 53. *Changes in degree of wastewater treatment provided by municipal facilities to the population in the period 1972 - 1993*

	1972	1982	1985	1988	1989	1991	1993
Pop. Size	5,195,000	5,490,000	5,500,000	5,510,000	5,556,000	5,551,795	5,662,000
No Mun. Treatment	40%	40%	38%	38%	37%	37%	36%
Primary Treatment	6%	0.4%	0.4%	0%	0%	0%	0%
Secondary Treatment	54%	41%	17%	11%	10%	10%	11%
Advanced Treatment	0%	18%	45%	51%	53%	53%	53%

served by semi-public facilities. The effect of this increased level of wastewater treatment has been an improvement in the water quality of many of Indiana's lakes, rivers and streams.

Since the passage of the Federal Water Pollution Control Act in 1972, Indiana has processed over 351 grants under the federal construction grants program involving approximately 1.4 billion dollars. Each of these grants has also been "matched" with state monies totalling approximately 230 million dollars. In addition local governments have provided additional funds for construction of wastewater treatment facilities. This program is now being phased out, and Indiana issued the last federal grant in September of 1991. There are currently 43 construction grants that are not administratively completed in Indiana.

In place of the construction grants program, Indiana is now participating in the State Revolving Fund Program. This program makes low interest loans to qualified entities for water pollution control projects. As the principle and interest on these loans are repaid, they become available to loan for other projects. Table 54 shows the state revolving loans made in 1992 - 93.

Industrial Facilities

By July 1, 1977, industrial dischargers were required to meet Best Practicable Control Technology Currently Available (BPT) or achieve water quality standards, whichever was more stringent. Nearly all Indiana industries met BPT by this time. For those which did not comply, enforcement action was initiated and eventually resolved to achieve compliance. However, there was a concern that toxic pollutants, which are the primary focus of Best Available Technology Economically Achievable (BAT), were not sufficiently addressed. Many permittees now have installed treatment that can meet BAT, primarily because of an overriding site-specific water quality issue. Applicants for permit reissuance are required to specifically identify toxic substances which are or may be discharged to the waters of the state from their facility. The permit reissuance process involves the detailed review of these applications, and toxic pollutants are limited to safe levels. If there is a question as to the presence of a particular substance in sufficient quantities to be of concern, a monitoring requirement is established in the permit. A final permit limit is based on these additional monitoring data.

Although the total amount of money expended by industry for wastewater treatment has not been reported, it has been considerable. Data from claims for tax exemptions for wastewater treatment equipment provide some idea of these expenditures. The number of claims and total amounts claimed for each year from 1978 - 1993 by Indiana industries are shown in Table 55. This amount has more than tripled in this time period.

Table 54. *Loans made by the State Revolving Loan Fund (1992 - 1993)*

Applicant	Loan Amt.	Construction Start Date	Operation Start Date
Dyer I (town)	4,136,000	92/05/01	93/11/01
Dyer II (S.D.)	4,950,000	92/05/01	93/11/01
Evansville	2,247,000	93/04/22	94/01/15
Franklin II	2,282,000	93/07/27	94/12/31
Gary (Alley)	1,480,000	93/11/30	95/05/31
Gary (Black Oak)	13,602,000	93/09/30	95/02/28
Goshen	9,300,000	93/03/09	94/09/01
Hammond	23,394	93/01/31	95/01/31
Lake of Woods	4,126,000	92/06/01	94/01/01

Table 55. *The number of tax exemption claims and the total dollars claimed by Indiana industries for wastewater treatment facilities from 1978 to 1993*

YEAR	NUMBER OF CLAIMS	AMOUNT CLAIMED
1978	102	$369,186,717
1979	123	394,712,641
1980	113	400,895,352
1981	124	518,478,055
1982	126	607,093,628
1983	139	633,443,520
1984	145	797,153,029
1985	159	803,676,180
1986	184	867,057,770
1987	176	1,045,182,501
1988	188	1,055,619,253
1989	230	1,061,677,161
1990	241	1,111,971,008
1991	280	1,217,244,746
1992	297	1,311,708,561
1993	322	1,334,466,191

In the past, industrial wastewaters have caused water quality problems even though they were discharged to a municipal sewage treatment facility. These wastes would often "upset" the various treatment processes at the municipal sewage treatment facility to the extent that little or no wastewater treatment would occur. Also, some of these pollutants can pass through a wastewater treatment facility and remain at levels that are still toxic to the aquatic life in the receiving stream. Toxic substances can also accumulate in the municipal sludge at levels which make disposal much more expensive. Pass-through and interference at STPs can be caused by excessive quantities of conventional pollutants as well as toxic pollutants.

To prevent these occurrences, Indiana has developed a pretreatment program that requires industries to reduce concentrations of toxic or harmful substances to "safe" levels before releasing them to the sewer system. Municipalities with sewage treatment facilities which are designed to treat 1.0 MGD (majors) or more and have an adequate industrial base are required to develop their own pretreatment programs and work directly with the industries which need pretreatment to control these discharges. In general, the state works with the smaller municipalities and their associated industries to develop their pretreatment programs. Certain minor municipalities with significant industrial users are being required to develop partial or "hybid" pretreatment programs.

Indiana has identified 45 municipalities that need to have direct control of their industrial users (IUs). Approximately 800 IUs are controlled by these 45 municipalities, and their pretreatment programs are audited annually by the state. Also, there are approximately 100 IUs that discharge into smaller municipal sewage plants that are controlled directly by the state.

Compliance and Enforcement

In order to assure compliance with NPDES permit limits for pollutants in wastewater, a variety of data are reviewed. These data include such things as self-monitoring data submitted on monthly monitoring report forms, (and tracked by the federal database known as PCS), NPDES permit applications, data collected during compliance sampling inspections conducted by IDEM staff, water quality monitoring survey data, bioassay data and other information which may be available. When NPDES effluent or downstream water quality violations are found, appropriate enforcement action is taken. This enforcement action will ensure the quickest return to compliance by the permittee and may include such things as Notice of Violation letters, warning letters, prehearing conferences, formal enforcement hearings and, if necessary, judicial proceedings (through referral to the Attorney General).

In Indiana, compliance with NPDES permit effluent limitations is tracked with the assistance of computers. Tracking is performed monthly for each permittee identified on the state compliance monitoring priority list. The methods used to determine compliance rates for major discharges are based upon U.S. EPA's Significant Noncompliance (SNC) criteria. SNC predicates compliance of permitted effluent discharges with permit limits, permitted effluent discharges in excess of permit limits but not in reportable or significant noncompliance (SNC), and permittees in SNC, but under a state or federal Agreed Order or referral for court action. The SNC list is generated monthly for internal usage, and is retrieved by EPA from PCS quarterly in the form of the Quarterly Noncompliance Report (QNCR). This QNCR highlights the status of each permittee and provides a plan for returning noncomplying facilities to compliance. The 1991 compliance rate (4th quarter) for major dischargers (Oct-Dec, 1991) was 78% for municipalities, (83 of 107), 90% for industries, (64 of 71), and 50% for federal facilities (2 of 4). A number of major facilities appearing in SNC are due to application of the more stringent water quality standards adopted in 1990. For the time period October 1992 through September 1993 Indiana exceeded the level of formal enforcement attained in the prior year for major and minor NPDES dischargers, industrial users and unpermitted facilities.

The major dischargers compliance rate for 1993 (4th quarter, January through June) was 85.3% which is up 3.5% from the previous quarter (82%) ending in December 1992. The compliance rates for major municipal, industrial, and federal facilities were 79%, 97% and 75%, respectively. The State also conducted 852 inspections of minor dischargers. During the period of October through December 1993, thirty nine (39) municipal minor facilities were reviewed which had significant effluent violations. Recommendations were made which should return the facilities to compliance.

Minor dischargers often experience a lower compliance rate due to their greater number and the lower priority assigned this category with regard to state resources. As facilities return to compliance, improvements in water quality are expected, especially since most discharge permits in Indiana are based, at least in part, on water quality considerations.

In addition to compliance tracking, which focuses on significant noncompliance at all types of facilities holding NPDES permits, a considerable effort is being made to address a wide variety of other violations of state rules. Many violations of state rules by NPDES permit holders do not result in identification of noncompliance by PCS. These violations include improper operation and maintenance, improper sampling and reporting, bypassing, and operator misconduct. Non-NPDES violations involve improper spill reporting and response, land application issues, confined feeding issues, septic waste hauler issues, and unpermitted discharges. In the past year, enforcement staff have worked with IDNR in conducting enforcement actions against facilities which have had spills resulting in fish kills. This has resulted in the assessment of civil penalties under IDEM rules and compensation for natural resources damages under DNR rules. Enforcement staff have been working closely with U.S. EPA Region 5 on a number of enforcement cases on the Grand Calumet River/Indiana Harbor Ship Canal (GCR/IHC). This comprehensive effort is aimed at achieving compliance with NPDES permits and associated rules, and establishing a foundation for the GCR/IHC remedial action plan for removal of contaminated sediment for this waterbody.

In July 1992, the OWM Enforcement Section was joined with the enforcement section of other program areas to staff the new Office of Enforcement. This Office is intended to expedite and coordinate the enforcement activities of all program areas while maintaining the traditional working relationships with inspection and other compliance functions.

Nonpoint Source (NPS) Water Pollution Control Program

In the last several years there have been numerous activities which have aided the state's progress in its efforts to control NPS water pollution. The acquisition of Section 319 grant funds has probably had the most significant impact upon the overall program.

Wetlands Evaluation (Phase I)

The Indiana University School of Public and Environmental Affairs (SPEA), utilizing $50,000 of Section 319 funds, is evaluating the performance of two constructed wetlands designed as nonpoint source (NPS) water pollution treatment systems. The two sites are on Wilson Ditch near Lake Maxinkuckee and on Lawrence Pontius Ditch near Koontz Lake in Marshall County. The majority of SPEA's efforts are directed at obtaining the data needed to develop adequate hydrologic, nutrient, and sediment budgets for the two systems.

A no-cost extension for time was granted by the Indiana Department of Environmental Management (IDEM) so that there could be sufficient time to expend the funds. The majority of the original project has been completed on schedule; however, more time was needed to complete additional tasks and provide a smooth transition between this current phase and the second phase of the project which has been funded by an additional Section 319 grant.

Monthly trips have been made to the site to collect water quantity and quality data. Analyses were made of the samples collected during these sampling trips for total phosphorus, soluble reactive phosphorus, total nitrogen, ammonia-nitrogen, nitrate-nitrogen, alkalinity, pH, chlorophyll a, and total solids. Discharges from the wetlands were calculated based on the instantaneous measurements and the data entered into a spreadsheet program. Wetland vegetation surveys of both the Wilson Ditch and Koontz Lake systems were also conducted and categorized.

Upper Eel River Evaluation and Education

Through the use of $20,000 of Section 319 funds, DePauw University conducted and reported the results of an intensive ecological survey of the upper portion of the Eel River watershed to identify biological NPS impacts and their causes. This study, entitled "Fish Communities and Habitat of the Eel River in Relation to Agriculture", has been forwarded to the U.S. Environmental Protection Agency (USEPA), and the results have been discussed elsewhere in this report (see Wabash River Basin).

The Whitley County Soil and Water Conservation District (SWCD) continued the education and information program in the watershed based on the ecological survey of the Eel River completed by DePauw University. The SWCD water quality specialist hired with $30,000 of Section 319 funds continued collection of data by attaining support of Manchester College and obtaining access to 15 years of historical data on Eel River water quality. Also, a database was developed containing the name and address of every landowner with five acres or more in the Whitley County portion of the watershed.

Public awareness was enhanced by giving a filter strip demonstration to 1,200 landowners at demonstration sites at two field days. In addition, 4,000 Eel River newsletters, one urban brochure, two filter strip handouts, three newspaper articles, one magazine article, and 1,617 letters were distributed to reach and educate both urban and rural persons about the Eel River project. Three Water Quality Incentive Program proposals were also completed and submitted. These proposals are designed to bring in $555,000 of federal money, if funded, to apply conservation practices to the land to reduce sedimentation of the Eel River.

The "Resource Document and Environmental Assessment for Upper Eel River Watershed, Indiana" was completed. This document describes the water quality problems of the Eel River watershed and discusses land treatment measures needed to reduce sedimentation damages and improve water quality. This will be accomplished through control of soil erosion in the watershed. The land treatment measures consist of the following water quality and soil conservation practices: conservation tillage; grassed waterways; grade stabilization structures; and conversion of highly erodable land to other uses. The environmental impacts of the installed measures would include reduced sediment and improved water quality of the Eel River and its tributaries.

Upper Tippecanoe River Project

The Kosciusko County Health Department (KCHD) was awarded $10,000 of Section 319 funds to buy equipment for surface water sampling purposes. This was to provide data to help support the U.S. Department of

Agriculture (USDA) Upper Tippecanoe River hydrologic unit area project described later in this report. The Health Department purchased a microscope and a spectrophotometer. In-kind services to take the samples have been provided by the KCHD with the Indiana State Department of Health providing in-kind services to analyze the samples.

A change in the type of equipment purchased for this project was requested because of unforeseen problems concerning financial limitations of the Indiana State Department of Health to provide analyses of Kosciusko County samples, and the lack of local funding to pay for extensive contract laboratory analyses. Because of these problems with sample analyses, the KCHD will rely partially upon in-house analyses for routine monitoring of this watershed after the contract expires. However, to date, for the purposes of the project, the KCHD has relied upon either the State Department of Health or a contract laboratory to perform the analyses for the work required for the grant condition in order to have fulfilled quality assurance/quality control (QA/QC) requirements.

While the KCHD was not required to act upon any of the sampling results, it did order or recommend several discharges to be corrected. The sources included private septic systems, mobile home park package plants, and agricultural waste streams. The program proved to be very beneficial in this regard. Additionally, the KCHD plans to continue the program on a limited basis beyond the contract period.

Equipment was purchased with the grant funds in order to perform the future analyses in-house. This included computer hardware, software, and other equipment in order to assist with the QA/QC of their nutrient sampling. The other equipment included a microscope, vacuum pressure pump, incubator, ultraviolet sterilizer, and more minor equipment for a laboratory.

LaGrange County

This $25,000 project completed by the LaGrange County Soil and Water Conservation District (SWCD) had three major objectives. The first was the completion of a watershed study on Oliver, Olin, and Martin Lakes.

The second objective was utilizing funds to provide cost-share payments to landowners for integrated crop management through pesticide and nutrient management and control of sheet erosion utilizing no-till practices. Based upon the land use inventory completed during the watershed survey, approximately five percent of the agricultural acres were eroding above the tolerable soil loss level. The most economical way to address this was to recommend conservation tillage. Eighteen fields totaling 490 acres had conservation tillage applied through this program. Soil loss potential was reduced well below the tolerable soil loss level on these cropfields. Estimated soil savings were seven tons per acre per year totaling 3,430 tons of soil saved. Two of the participants now have no-till equipment after success with no-till in 1991 and 1992.

It was assumed that there would be leaching or runoff with over-application or improper application of nutrients and pesticides, but it was difficult to pinpoint the amount as the SWCP did not have the capability to do water sampling after a rain event. Consequently, the SWCD recommended that a certified agronomist collect proper soil samples, base fertilizer recommendations on a realistic yield, evaluate application methods of fertilizer and chemicals, scout for weeds and insects, and made chemical recommendations with consideration for the soil sensitivity for leaching and runoff. Through landowners using this practice, it was assumed that the leach and runoff potential should be greatly reduced. In most cases, it was estimated that there was a 20 percent reduction. The nutrient management plans covered 185 acres of land, while the pesticide management plans included 343 acres of land. Besides reduction in the amounts of nutrients and pesticides applied, the four participants now have a better understanding of various application methods resulting in less potential for runoff and leaching.

A 120 acre grain and livestock farm was selected as the setting for a model farm to provide conservation education and demonstration of water quality Best Management Practices (BMPs). This was the third major objective of the project. With cooperation from many volunteers, agencies, and the landowners, the SWCD hosted a field day at the farm. This all day event featured over 20 conservation practices from rotational grazing to timber stand improvement. Structural practices like water and sediment control basins, spring development, grade stabilization structure, and a grassed waterway were all under construction during the event. The model farm was very successful and was visited by nearly 400 persons. Although the farm was subsequently sold to another owner, the new owners are maintaining the erosion control measures installed.

Forestry Education

The Indiana Department of Natural Resources (IDNR) Division of Forestry utilized $10,000 of Section 319 funds to develop a video to illustrate timber harvesting practices that will limit NPS pollution. It was narrated by Chris Schenkel and entitled "Best Management Practices and Harvesting with the Forest". It focused on demonstrating methods of protecting water quality using forest management practices to private landowners. The video was previously sent to U.S. EPA Region 5 for inclusion in its library. Approximately 250 copies of the video were distributed locally within Indiana, including copies to the State Stewardship Committee, USDA offices, Indiana Forest Industry Council, U.S. Fish and Wildlife Service (USFWS), selected libraries and universities, and others.

In conjunction with the video project, in-kind services were provided by the IDNR to develop a demonstration timber harvesting site in the Morgan-Monroe State Forest. The demonstration area was completed during the fall of 1992 and was located in conjunction with the Three Lakes Hiking Trail which will assure that the demonstration will receive additional exposure.

Abandoned Mine Lands

The Division of Reclamation of the Indiana Department of Natural Resources (IDNR) received a $2.6 million federal grant through the Abandoned Mine Lands Program to reclaim the Green Valley Mine in Vigo County. The IDNR has been utilizing Section 319 funds in addition to providing in-kind services for testing, engineering, and construction inspection. The reclamation is currently under construction and a water quality improvement measure now in place is a gabion detention basin.

Test treatments have been applied to plots on site while samples of compacted/treated material were gathered for lab analyses. Test plots were selected and treatments completed using varying implements, number of trips, and soil/gob activities. The treatments were done using sheep-foot roller, vibrating drum roller, hydrated lime, and agricultural lime.

It was decided to incorporate lime into the soil in order to neutralize the effects of the acid-mine drainage. Currently, lime is being delivered to the site prior to its application. It will be applied at the rate of approximately 200 tons per acre on the 60 acre site. Although the Section 319 funds will only pay for $75,000 of this cost, the IDNR has made a commitment to invest a much larger amount into the project. The goal of this supplemental reclamation work is to improve the quality of water leaving the Green Valley site to the highest degree possible.

Urban Runoff Demonstration Project

The Lake County SWCD was awarded $75,000 to complete an urban demonstration project in the Grand Calumet River watershed. Additionally, the SWCD received $5,000 of Section 205 (j) funds to install a BMP demonstration project. Two subcontracts have been utilized for the project, one with Purdue University and the other with the Grand Cal Task Force. Information about one of the completed activities was published in the April 1993 issue of **EPA NPS News-Notes**.

Final results were published by Purdue University regarding targeting of critical land use areas, prioritization of these areas responsible for generation of NPS pollutants, and the implementation plan delineating BMPs needed to eliminate identified problems.The Purdue University portion of the project was completed on schedule without utilizing all of the remaining funding. The remaining funding was utilized in several ways. A literature review was completed regarding BMPs for bridges and highways. Additionally, two other methods regarding land use and soil classification as related to NPS runoff were examined.

This included the r.mass-load program which calculates pollutant mass loads within an urban watershed based upon event mean concentration (EMC) values and the Soil Conservation Service (SCS) runoff method. The program can be run for any pollutant, as long as the user can produce EMC values based upon land use classifications. In addition, several pollutants have default EMC values built into the program. The program allows the user to declare special areas within the watershed that will have EMC values much higher/lower than those expected based upon land use. Work is currently being done to refine the r.mass-load program, and they are working on a program that will target specific areas of a watershed for BMP implementation (based upon pollutant mass loadings and a cost/benefit analysis of BMPs).

Additionally, the SWCD staff ran AGNPS, an agricultural nonpoint source pollution model, which is an event-based watershed analysis computer model. It works for a single storm event of known volume and intensity. For the Grand Calumet watershed, a two year 24 hour rainstorm event of 2.8 inches was used with an intensity of 45 foot-tons per acre-inch. This represents conditions that would occur during a 24-hour storm with a frequency of once every two years. Results similar to one of Purdue's methods were found.

On-Site Waste Disposal Project

The final version of the computer program RWASTE IV was developed using $60,000 of Section 319 funds. It is used by local governments to design and approve individual on-site waste disposal systems. To date, 120 copies of RWASTE IV have been distributed both locally and nationally. The final report has been completed. The only remaining task for the project is the presentation of several regional workshops over the state covering use of the program in on-site system siting and design. These will be done in conjunction with the Indiana State Department of Health.

Tentative dates for four workshops have been planned for the RWASTE-IV program, and each should consist of 15-20 county health personnel. The "Train the Trainer" concept to be utilized in the workshops is intended to make the local sanitarian the primary resource person for local installers. This should improve response time on program questions and greatly decrease the need for future centrally held training programs.

Trail Creek

Michigan City received $100,000 to help prevent NPS water pollution on Trail Creek. The watershed management plan for the area was completed in October 1993 through another grant award which was a prerequisite of beginning work on this project. The watershed planning was coordinated by the Northwestern Indiana Regional Planning Commission (NIRPC). Upon completion of the watershed management plan, several alternatives to the scope of work were discussed which would be consistent with the plan.The revised scope of work will consist of stabilizing several eroding stream bank sites, conducting an alternative septic system demonstration and education program, and demonstrating urban runoff control BMPs. Preliminary work toward these items have begun, with actual installation of BMPs to occur during the summer of 1994.

Urban Erosion

The IDNR's Division of Soil Conservation was awarded $41,000 to develop regional workshops, an urban handbook and urban conservation demonstrations. A series of ten workshops was held on urban conservation at various sites throughout in Indiana. Approximately 2,000 persons representing units of government, engineering and consulting firms, developers, contractors, and conservation organizations attended. Each program was co-hosted by a local SWCD and a home builders association. The sites where the workshops were held were: Fort Wayne, Warsaw, Kokomo, Valparaiso, Indianapolis (2 sessions) Columbus, New Albany, Terre Haute, Bloomington, and Jasper.

The seminars primarily focused on Rule 5, Indiana's rule to address the stormwater regulations. The seminars detailed the requirements of Rule 5, agency roles/responsibilities, the erosion process, and construction site erosion control principles and practices. Also discussed were erosion/sediment control plan elements, implementation of the plan, and various types of BMPs.

The benefits of the sessions are still evident. There has been an increase in awareness of the problems associated with soil erosion and sedimentation and the methods required to control and reduce the impacts from these events.

The "Indiana Handbook for Erosion Control in Developing Areas" was also published and distributed by the IDNR as a part of this project. The handbook discussed Indiana's Rule 5 governing its construction activities permits program and detailed principles, plans, and practices that related to urban erosion and sediment control. As of July 1993, 850 handbooks had been distributed. The recipients have included local, state, and federal government agencies, engineering firms, consultants, developers, builders, contractors, private citizens, and environmental, conservation, and professional organizations.

The third portion of the project was the development of regional demonstration sites to educate builders, developers, planners, and the public about construction-related erosion. The following are the demonstration sites:

Location	Attendance	Date
Allen County SWCD	100+	August, 1993
LaPorte County SWCD	30	October, 1992
Harrison County SWCD	32	May, 1993
Tippecanoe County SWCD	55	November, 1992
Dekalb County SWCD	30	June, 1993
Monroe County SWCD	50	August, 1993
Vigo County SWCD	50	October, 1992
Knox County SWCD		(To be scheduled)
Clark County SWCD		(To be scheduled)

The erosion control project field day held in Allen County was of particular note. Other field days focused on erosion control projects in residential developments, while this was the first one which focused on erosion control during highway construction. The demonstration consisted of tours of various areas of the I-469 construction site in order to view various management practices. The event was attended by over 100 persons who represented highway contractors, the Indiana Department of Transportation, other State and federal agencies, and the State legislature.

Juday Creek

The St. Joseph River Basin Commission (SJRBC) is using $89,000 to implement a watershed management protection plan for Juday Creek. The creek is one of only a few Indiana streams having a naturally-reproducing trout population. It is twelve miles long, drains a 38 square mile area, and empties into the St. Joseph River which is a part of the Great Lakes watershed.

Sedimentation has affected the quality of portions of Juday Creek, either as a result of erosion from adjacent agricultural areas or as the result of transformation of these areas into residential development. The focus of the project is to develop a comprehensive watershed analysis and the institutional structure to coordinate continued protection and improvement. The IDNR has halted the issuance of construction permits along the creek until the study has been completed.

The SJRBC continues to compile information generated during the course of the project into a resource file which will be available for general distribution. Subcontracts have been established with the University of Notre Dame and the U.S. Geological Survey (USGS) to coordinate the geographical and temporal aspects of contractual data collection activities. The subcontracts included wording that stipulated the necessity of QA/QC plans and documentation and that chemical data should be formatted to allow for entry into STORET.

The University has installed four borings or monitoring wells at each of five locations adjacent to the creek, with depths ranging from ten to thirty-five feet. Samples are being taken from the borings or wells for temperature on a weekly basis, with plans for sampling chloride, bromide, pH, alkalinity, sodium and calcium. Also, monitoring of water levels has been conducted for a period of time at ground water stations through the use of pressure transducers installed in the stream and a manually operated pygmy flow meter. A USGS gaging station was installed at the Izaak Walton League property, which is located at the west end portion of Juday Creek. A report is not expected until completion of at least one water year.

The SJRBC was instrumental in the organization of the Friends of Juday Creek, a group of interested riparian land owners along the creek. Commission staff have attended several meetings and explained the responsibilities of various agencies involved in water quality protection and watershed management. The Friends of Juday Creek have begun distribution of a newsletter to residents in the watershed.

The St. Joseph River Basin Commission, along with the U.S. Fish and Wildlife Service, the local Soil and Water Conservation Districts, and the local health departments conducted a workshop on wetlands restoration. The workshop included a half-day session dealing with the benefits of wetlands, and a half-day field tour, focusing on wetlands restoration, as well as other conservation methods to protect the watersheds. Approximately 50 people were in attendance.

The SJRBC staff continues to be in contact with those agencies involved in the project, either through meetings or through telephone conversations. The staff has been instrumental in insuring that those agencies involved in various aspects of evaluation of the creek are aware of what the other agencies are doing. The Commission is also making an effort to coordinate meetings with those groups as well.

Farmstead Assessment

Using $91,356, Purdue University is in the process of developing the "Farm-A-Syst" program in Indiana to evaluate groundwater pollution potential on farms. It will be adapted to Indiana's needs and include provisions which will explain how Indiana's laws and regulations may affect farm activities. Farm-A-Syst is now being simplified in order to reduce the time needed to complete an assessment, thereby increasing its attractiveness to farmers and enabling it to be implemented statewide.

To date, a review of Wisconsin Farm-A-Syst and Indiana regulations has been completed. A question format was developed as the basis for datasheet development. Drafts of risk reports have been completed in addition to the revision and completion of worksheets. Computer coding and debugging are also continuing. The pilot version is running and being field tested in the Tri-County and Upper Tippecanoe hydrologic unit area (HUA) projects.

Indiana Dunes Drywells

The Indiana Geological Survey was awarded $22,500 to cooperate with the Indiana State Department of Health in an evaluation of the performance of drywells in the Indiana Dunes region. Leachate from these drywells may be impacting local ground water, Lake Michigan, and interdunal wetlands. This project will provide qualitative identification of impacts on ground water quality at two sites below the town of Beverly Shores in Porter County.

Routine monitoring and installation maintenance at the two study sites have continued throughout the year. Following the recommendation of personnel at the Indiana State Department of Health, all soil water samplers and monitoring wells were disinfected. Tracer tests were conducted at both study sites by injecting a sodium bromide solution into the septic systems and periodically collecting samples from all soil water samplers and wells. The samples were then analyzed for elevated sodium content. Samples were also collected and analyzed from all soil water samplers and monitoring wells for E. coli testing and organic chemical analysis. An additional monitoring well was installed next to the drywell at one of the sites. A Guelph permeameter test for unsaturated zone hydraulic conductivity was performed on the soil at the other site.

Data is collected monthly during the winter and twice per month in the summer. More intensive monitoring is taking place at one of the sites due to a lack of landowner cooperation at the other site. Water samples have been analyzed for leachate from the drywell septic systems. To date, study results are inconclusive but very little contamination has been detected in the analyses.

Fish Creek

The Nature Conservancy was awarded $98,340 to implement a protection program in the Fish Creek watershed in Steuben and Dekalb Counties, the only known habitat in the world of the federally-endangered White Cat's Paw mussel. The Conservancy has hired an on-site project manager for two years to administer the development and implementation of the plan with portions of the draft strategic plan currently under review.

The Fish Creek Watershed Project is a partnership of landowners/users and public and private organizations to protect and enhance the unique ecosystem of Fish Creek through the implementation of economically viable solutions. The main goals of the partnership are to:

1. Ensure self-sustaining populations of federal and state listed species in the Fish Creek Watershed.

2. Reduce soil erosion and runoff through long-term, economically sustainable agricultural practices.

3. Ensure adequate water quality and quantity to meet the needs of the people, plants and animals of the Fish Creek Watershed.

4. Develop and maintain a cooperative Fish Creek partnership that includes watershed residents, government, and other individuals and organizations.

5. Increase awareness of the watershed residents so they know about the unique value of the Fish Creek watershed, the ways to improve it, and why it is important to do that.

A canoe trip was conducted in order to identify major gullies and streambank erosion along the creek and observe its natural features. An aerial survey was done of the watershed to identify critical erosion areas, potential reserve sites, and general landscape features. A plan to reforest the area along the creek was developed with the IDNR and a meeting was held with prospective tree planters to complete planning for the project. As a result, 58 acres of hardwood tree plantings occurred along the lower portions of Fish Creek. About 90 percent of the trees are surviving and the project has generated interest from landowners throughout the watershed.

The acquisition of 275 acres along the creek, known as Douglas Woods, occurred this year. The land contains 200 acres of forests and wetlands as well as 75 acres of tillable land. This preserve has over one mile of Fish Creek flowing through it. At this time, it is hoped that the tillable land can be used as a demonstration area for agricultural practices. The local advisory group has been meeting every other month to discuss the strategic planning process. Members of the group have been an asset to the project by promoting conservation to their neighbors and setting examples. Currently, eight farmers are participating in the conservation tillage/critical area treatment program. This represents over 2,000 acres with 75 percent of the funds committed.

The Hamilton Lake watershed land treatment project was awarded funding provided through the Great Lakes Program Office for the first year of the project. A resource conservationist has been hired to provide technical assistance with the project. A Fish Creek/Hamilton Lake Information Day was held with 55 people attending. Additionally the first watershed newsletter was mailed to over 500 landowners and community leaders. Monitoring is underway for pesticides and basic water chemistry through the IDNR Nongame and Endangered Wildlife Program.

A land use transect completed in the watershed showed that 38 percent of the corn, 44 percent of the soybeans, and 54 percent of the small grains are in no-till. This represents a total of 13,336 acres. Thirty-four percent of the total land in the watershed still remains in the Conservation Reserve Program (CRP).

Past monitoring efforts have been reviewed and a draft plan proposed for the type of monitoring needed in Fish Creek. The plan involves biological monitoring of the system that would be used to assess the progress towards securing viable populations of the federally-listed mussels, as well as other aquatic species. The draft plan also includes monitoring land use changes in the watershed and monitoring the zooplankton, fish, and mussel populations. These four indicators would be used to demonstrate the health of the ecosystem.

Hoosier Heartland Well Monitoring

The Hoosier Heartland Resource Conservation and Development (RC&D) Council is using $45,100 to continue the initial well monitoring and protection program in central Indiana begun by the Indiana Farm Bureau which is described later in this report. This Section 319 project will conduct further analysis on some of the wells.

The second round of retesting has been completed. These tests, designed to gather additional data on problem wells and verify the reliability of the first phase of testing, generally continue to show results with USEPA accepted limits for the key parameters of nitrates, triazines (Atrazine), and alachlor (Lasso/Dual). When all of the laboratory results are completed, materials will be available for display at county fairs in the RC&D area, water quality public meetings will be conducted, and a final report will be developed. A portion of the funding remains which can be reprogrammed into another project. Plans are now being made to do so.

Mill Creek

The USDA/SCS is using $125,000 in the Mill Creek watershed to demonstrate agricultural management practices and resource management systems that will maintain or improve the water quality in Lawrence and Orange counties suitable for karst areas in the region. To date, the land use inventory within the watershed has been completed. Below are the totals of types of land use for both counties combined:

Land Use	Acres
Crop	2,004
Pasture	1,861
Woodland	810
CRP	1,900
Idle	1,027
County Road	1,207
Spring Mill Park	1,319
Total	10,128

The steering committee has been meeting and are prioritizing those types of projects which will be the most beneficial. Plans for stabilization projects are also ongoing, and during the last six months 1,900 acres of cropland have been seeded into grassland in the project area. A waste management project around the horse barn has also begun in order to prevent NPS pollution into Spring Mill State Park.

A rural sociologist from the SCS Mid-West Technical Center visited the Mill Creek Watershed area at the start of the project. Fact sheets and news releases have been used. In December of 1993, an article for the "Indiana Prairie Farmer" magazine was written about Mill Creek. Several available cost-share programs have been utilized for this demonstration area including CRP, Agriculture Conservation Program, Forestry Stewardship Incentive Program, and Section 319 funds.

Work has begun for the production of an educational video about the project. The video will be about 15 minutes in length and is geared toward farmers. It will discuss karst and sinkholes and demonstrate the best management practices to use with sinkholes. The committee heard a report from the USFWS that not much knowledge is available on the effects of sinkhole pollution on the biota of underground streams. However herbicides and pesticides seem to be the most common offenders. The IDEM has begun a monthly sampling program of two sites in the area, Twin Caves and Blue Springs Cave.

Atmospheric Deposition

The USGS is utilizing $211,914 to establish a three-year program in the Grand Calumet River Basin to appraise the water quality impacts of atmospheric deposition, including toxic inorganic and organic compounds. This will be the first precipitation data collected in this watershed.

The USGS Water Resources Division has collected water samples for a one year time period. Estimated annual loadings, calculated using the median weekly loadings, were determined for copper (0.45 kg/acre), lead (0.35 kg/acre), and zinc (0.70 kg/acre). Loadings of these magnitudes could contribute a significant amount of contamination to the Gary and Lake Michigan areas and surrounding ecosystems.

The USGS is requesting funding for the installation of an additional site and continued sampling at the airport. It is proposed that the second site be located approximately 20 kilometers downwind from the airport. This new site, in conjunction with the airport site, will be used to investigate the transport characteristics of major ions and trace elements on a weekly basis. It is believed that investigation of the transport characteristics, especially for trace elements, is an important next step in determining the range of contamination resulting from atmosphere deposition in Lake County.

Constructed Wetland/Livestock Waste

Purdue University is using $59,299 to monitor the water quality effects that a constructed wetland system has on surface water runoff produced by a dairy facility in Kosciusko County in the Tippecanoe Lake watershed. Meetings were undertaken with the landowners of the farm on whose site the system was constructed to discuss various items of concern including location and design of the system, construction concerns, costs, and performance criteria.

Prior to the construction of the system, a two-phase program was begun to test and monitor the surface runoff that will be captured and remediated by the wetlands. This data will provide a baseline from which the database can be built. A second sister system, constructed by the USDA in nearby LaGrange County, is also being monitored. This system was previously constructed and consists of three single cells built in parallel. This system will provide an excellent comparison with the system constructed in Kosciusko County.

Water quality data have been collected biweekly at the LaGrange County site. Water samples showed that Total Kjeldahl Nitrogen (TKN), nitrate, orthophosphorous, and total phosphorous were significantly reduced by passing through the wetland. This wetlands system showed approximately a 40 percent reduction in all four of these parameters. It is anticipated that reductions will increase this year as wetland plants become better established in the cells.

Lake County Conservationist

Funded through $60,000 of a Great Lakes Set-Aside Grant, Lake County conservationists are continuing work on stormwater management issues and NPS water pollution control activities. Staff attended a Remedial Action Plan (RAP) meeting with other SWCDs in Milwaukee, Wisconsin, and an annual meeting of the Great Lakes Commission in Indianapolis. Additionally, guidance was provided to complete the Wolf Lake erosion control project. The SWCD also co-sponsored a TR-55 training session. A number of meetings have been held with various developers, assessors, surveyors, developers, engineers, and local units of government to provide technical assistance regarding Rule 5. The water quality component for the RAP was also reviewed. A meeting was held with the NIRPC to discuss the Trail Creek project; training was also held for the NIRPC and the U.S. Army Corps of Engineers on how to estimate erosion rates on Turkey and Trail creeks. The AGNPS computer program was also run on the Grand Calumet River Watershed.

Urban Erosion Control Training

Utilizing $48,000 in Section 319 funds, the IDNR Division of Soil Conservation is continuing the training seminars funded under a previous Section 319 grant to educate planners, developers, builders, and potential homeowners about water quality problems associated with urban erosion. Developers and contractors also receive education about the requirements of the stormwater regulations associated with Rule 5.

The Division has been planning for several urban conservation demonstration sites to be funded through this program. A demonstration site has started in Warsaw and a tour is scheduled for the fall. The Division is also evaluating several sites near Batesville. This project would be within the Laughery Creek watershed. This watershed is the one within which Versailles Lake, a Section 314 project, is located.

Farm Progress Show

The Indiana Association of Soil and Water Conservation Districts (IASWCD) sponsored a Farm Progress Show conservation area which was a tremendous success. It was aided by a $30,000 Section 319 grant. Over 350 volunteers representing 17 organizations participated in the demonstration area. The water quality model farm and adjacent soils pit attracted approximately 15,000 visitors. Among the guests were then U.S. Vice-President Dan Quayle and four USDA agency heads who were given guided tours of the farm. A complete report on the Farm Progress Show, including a video, has been sent to the US EPA, Region 5.

Upper Eel River Watershed

The Whitley County SWCD is developing new initiatives that implement a multi-phase program to improve water quality in the Upper Eel River watershed by reducing its sediment and nutrient loadings. This will utilize $59,000 of Section 319 funds. A newsletter is being published to furnish information about conservation practices. A local landowners public meeting was also held to inform landowners of conservation practices for which they are eligible. Media work for the meeting included two front page local newspaper articles with 522 letters being mailed to landowners inviting them to the meeting. Data is being collected to describe the specific erosion control practices needed within the 50,000 acre watershed, and coordinating efforts are taking place among the IDNR, the SCS, and the SWCD to have conservation practices applied on the land. Multi-agency efforts are being targeted to allocate $243,500 in other funds for agronomic and structural practices to reduce erosion.

A total of 74 contacts with landusers/owners have resulted in the implementation of 69,400 feet of filter strips. A demonstration filter strip was planted at the North Eastern Purdue Agricultural Center. Through the efforts of the Whitley County SWCD, and with cooperation from many other agencies, Columbia City is the first city to have a wetland restored within the city limits. A wetland ground breaking ceremony was organized which involved newspapers and three television stations. This complements the project because the wetland is located only about 200 feet from the Blue River. The wetland will be a factor in improving the river's water quality.

Nonpoint Source Specialist

Using $90,000 over a period of two (2) years, an experienced USDA/SCS employee continues to provide technical assistance and knowledge to the Office of Water Management/IDEM on a daily basis. The specialist has met with several SWCDs to discuss approved Section 319 projects and provide technical assistance and preliminary information for project start-ups. He has also initiated development of standard cost-share forms and procedures to be used in all current and future Section 319 best management practice cost-share payment projects. He has attended all Indiana State Soil Conservation Board meetings and provided updates to the Board on NPS activities, completed project site visits to Section 319 projects in the State to provide technical assistance and monitor progress, and completed numerous other NPS-related tasks.

Starve Hollow Watershed

Using $95,000, the Jackson County Soil SWCD is developing agricultural management practices within the watershed to reduce NPS pollution in Starve Hollow Lake. Several meetings of the Starve Hollow Lake Project Steering Committee have been held since the beginning of the project. Committee members include representatives from the USDA, SCS, Jackson County Extension Service, the IDNR Division of Soil Conservation, and the Jackson County SWCD. During the meetings a variety of topics was discussed including the purpose of the project, status of the grant, suggested needs and practice work, use of the district no-till drills, and a review of discussions with local landusers concerning the project.

In March of 1993, soil borings were done to determine the soil profile at potential project sites. The soils report indicated that the sand was at least twenty feet deep and that the sandy soil material has very severe limitations for structures, such as large dams. There is not enough clay or silty material present in the immediate area to provide a source of borrow material better than the current supply. After review, it was suggested that a topographic survey be done of areas near the watershed.

Thirty individuals attended a field day held at Starve Hollow Lake Nature Center. Topics discussed at the field day were soils of the watershed, the Starve Hollow Lake Recreation Area, local farming practices, watershed planning, and the Starve Hollow Watershed Project.

Lake Salinda

The Washington County SWCD, utilizing $30,000, is directing a project to reduce sediment and nutrient input into Lake Salinda by installing soil and water conservation measures on the most critical feedlot, pasture, and cropland areas in the watershed. This is being accomplished by providing cost-share funds to landusers in the watershed. This project, like all other Section 319 cost-share projects, is using a standardized format for cost-share funds for landusers which was developed by the IDEM.

Currently an area of critically eroding pasture is being fenced to exclude livestock from the adjacent Lake Salinda. As the fencing will exclude the approximately 175 head of cattle from their source of drinking water, a spring development is being installed as a part of the project. The farm where the BMPs are being installed is a family operated grain/livestock operation.

Urban Nonpoint Source Education and Training

Using $25,350 of Section 319 funds, the Center for Urban Policy and the Environment and the School of Public and Environmental Affairs of Indiana

University in Indianapolis continues to determine problems in implementation of nonpoint source programs in Indiana through the use of a statewide survey. Guidance booklets are being developed that summarize finance and enforcement options. Another portion of the project is to educate local officials about effective approaches to program implementation and management. In addition, staff have begun research to determine statutory authority for municipalities to establish stormwater user charges. A project team arranged cosponsorship of the survey with the Indiana Association of Cities and Towns (IACT), established an external professional peer review group, developed and tested the survey instrument, and initiated the survey.

The survey was mailed to 546 municipalities with the project team using the total design method survey methodology. Responses are still being received. Work to prepare a draft report that summarizes the results of the survey has begun. Response rates as of July 1993 were:

Population of Municipalities	Responses Received/ Total Mailed	Percentage Received/ Total Mailed
<5000	244/435	56%
5000-25,000	66/87	76%
$>25,000$	22/30	73%
Total	**332/552**	**60%**

Restoration of Wetlands

The U.S. Fish and Wildlife Service (USFWS) will use $25,000 to restore up to 50 wetlands within two watersheds to reduce the input of NPS pollutants. The two watersheds are the Baugo Creek watershed in St. Joseph County and the Lake of the Woods watershed in Marshall County. Several public meetings have been held in those areas to introduce the program and to solicit support and participation.

During 1993, information regarding restoration efforts was disseminated through news releases, workshops, and direct mail. In addition to general news releases, regional agricultural newspapers, including "Agri-news" and "The Farmer's Exchange" will be contacted regarding the watershed efforts.

Livestock Waste Management Software

Purdue University, utilizing $64,620, will develop and distribute a user-friendly computer software program which will assist producers in choosing an appropriate waste management system and provide guidelines for its design and operation. A framework for the program has been completed with work sheets which detail the content and function of the program. These work sheets have been through an initial review by both Cooperative Extension Service (CES) and SCS personnel working in the field directly with producers.

The program will be divided into two broad production sections, beef/dairy and swine/poultry. The program will be a decision making software for individual operators for manure storage and crop utilization. A manure budget will be emphasized specifying manure production, showing nutrient value of the manure produced and recommended rates of land application based on crop uptake.

The work sheets detailing the program are currently with six county CES agents for their review. A prototype of the program is scheduled to reach the field in early 1994. This program will provide an invaluable tool to both CES and SCS field personnel as they assist producers with animal waste management decisions.

Pesticide Analysis Database

A manuscript titled "A Summary of Government Agency Data on the Occurrence of Pesticides in Indiana Ground Water" was approved for publication in the proceedings of the Fourth National Pesticides Research Conference held in November 1993 in Richmond, Virginia. This manuscript covers a wider time period (August 1984 through August 1992) than the USGS publication which was previously prepared which summarizes information in the data base from December 1985 through April 1991. U.S. Geological Survey Open-File Report 93-133, summarizing the data base for the period 1985-91 is being formatted and illustrated and sent to the Government Printing Office for publication.

Remaining paper files from the Indiana Department of Environmental Management will be consolidated for entry in the data base. The first draft report titled "A Computer Data Base of Nitrate in Indiana Ground Water", will also be completed and distributed for colleague review.

Grand Calumet River Basin BMP Demonstrations

The Lake County SWCD will use $70,000 to participate with local communities in the implementation of BMP projects throughout the Grand Calumet River watershed to reduce surface water runoff and associated pollutants. Representatives of the SWCD have been meeting monthly with local units of government through the Remedial Action Plan meetings and other gatherings. The municipalities have been asked to identify sites for BMP demonstrations. The BMPs which will be demonstrated are grassed swales with and without check dams, filter strips along streams and tributaries, and sand filters at storm water discharges.

The Lake County SWCD has entered a supplemental assistance agreement for the services of an urban conservationist to concentrate efforts on this project. This conservationist will provide engineering assistance on a series of demonstration areas showing proper design, installation, and maintenance of BMPs in urban areas.

Irrigation Scheduling

Purdue University will use $13,343 to develop an irrigation scheduling computer program and users manual based on Indiana soil and climatic conditions. A CES publication on BMPs for crop production on irrigated fields will also be provided.

Development of the computer program is 80 percent complete. A draft version of the program has been written incorporating Indiana data in the previously developed Michigan State program. Indiana producers with the ability to irrigate have been surveyed to provide data on rainfall and irrigation for the 1993 crop year. The project is in its beginning stages. A more complete performance of the preliminary version of the program will be evaluated based on a comparison of the 1993 actual data from producers and available climatic data. Upon completion of this evaluation, de-bugging and a revision of the front end of the program will be done to make it more user friendly.

One modification which is being made in the Michigan State program will prompt the user for crop growth stage at intervals during the growing season. The program will regenerate the growth curve and recalculate the water needs of the crop. The current methodology broadcasts temperature, rainfall, and irrigation needs with only the date of crop emergence used as input.

The user guide is also essentially complete. The target release date of the program and user guide is for next crop season. The University is currently collecting and compiling irrigation BMP publications from other states and will be using this data to develop a CES publication on irrigation BMPs.

Constructed Wetland/Livestock Waste

This project is a continuation of a previous Section 319 project and has just recently begun. Construction of the wetlands was completed with aquatic plant establishment being delayed somewhat due to early cold weather. Water samples have been collected and analyzed biweekly.

Fall Creek Watershed

The Madison County SWCD is utilizing $69,682 to implement agricultural BMPs in the Fall Creek watershed. The Henry County SWCD is also cooperating with the project, as well as the Indianapolis Water Company which is providing financial support for the project. The two SWCDs will provide information, technical assistance, and financial cost-share incentives to landusers to install BMPs in the Fall Creek watershed in Madison and Henry counties. The BMPs targeted in the project include:

1. Fencing to exclude livestock from Fall Creek and its tributaries
2. Establishment of vegetated filer strips
3. No-till
4. Wetland restoration
5. Critical area seedings
6. Erosion control structures

The IDNR Division of Soil Conservation, the Cooperative Extension Service, and the SCS have agreed to assist the Madison and Henry county SWCDs in providing educational, and technical assistance through direct one-on-one landuser contacts to encourage the adoption of the BMPs. In addition, the US FWS will assist interested landusers with restoration of wetland sites.

The two SWCDs have formally established a joint project steering committee composed of two SWCD board members from each county. Also included are ex-offico technical advisors such as the SCS District Conservationists, CES agents from each county, and representatives of the IDNR, the IDEM, and the Indianapolis Water Company. The two SWCDs have entered a Memorandum of Understanding detailing the responsibilities of each party. A contract for services has also been entered by the Madison County SWCD with an individual to serve as project coordinator to provide assistance in publicizing, coordinating, and implementing the Fall Creek land treatment project.

Urban NPS Public Education

The Grand Cal Task Force will use $18,750 to work with various state and local organizations to promote awareness of nonpoint source problems and solutions on the Grand Calumet River/Indiana Harbor Ship Canal. This project has just begun.

Augusta Lake Anoxic Limestone Project

The USFWS will use $75,000 to address nationally significant NPS pollution problems resulting from past mining activities by implementing innovative, low-cost, passive reclamation and mine-water pollution control technology to improve the water quality of Augusta Lake in the Mill Creek Watershed.

Pesticide/Fertilizer Storage Program

The Purdue University Agronomy Department is utilizing $100,000 in Section 319 funds to further NPS water pollution control efforts by implementation of pollution prevention education programs for mangers of agricultural pesticide/fertilizer storage facilities.

Activities completed during the first quarter of the project included a demonstration of soil sampling tools to determine which manufacturer produced the most appropriate equipment for sampling at commercial agrichemical handling sites. Specifications for an all purpose drill rig for shallow soil and rock exploration were also completed.

During January 1994, a presentation was given to the Indiana Plant Food and Agricultural Chemicals Association board of directors. The board offered the assistance of a three person committee to work with the dealer survey and site sampling components of the project. A group has also been organized to establish the content validity of the dealer survey documenting the census.

Wetlands Evaluation (Phase II)

The Indiana University SPEA is utilizing $48,085 of Section 319 funds for Phase II of the program. They will continue to evaluate the performance of two constructed wetlands designed as NPS water pollution treatment systems. The two sites are on Wilson Ditch near Lake Maxinkuckee and on Lawrence Pontius Ditch near Koontz Lake in Marshall County. The majority of SPEA's efforts have been directed at obtaining the data needed to develop adequate hydrologic, nutrient, and sediment budgets for the two systems. Monthly water samples are being collected.

Little Four Mile Creek Watershed

The Union County SWCD is utilizing $48,806 for implementation of a land treatment project in the Little Four Mile Creek watershed. The Wayne County SWCD is cooperating with implementation of the project. The two SWCDs will provide information, technical assistance, and financial cost-share incentives to landusers to install BMPs in the Little Four Mile Creek watershed in Union and Wayne counties. The BMPs targeted in the project include:

1. Conservation tillage
2. Establishment of grass filter strips

3. Fencing to exclude livestock from Little Four Mile Creek and provide alternative livestock watering systems
4. Nutrient management

This approach provides some consistency with the State of Ohio Four Mile Section 319 project, which is implementing BMP's to reduce the inflow of sediment and attached nutrients and chemicals into Acton Lake. The Little Four Mile project, which is in the Acton Lake watershed, is enabling a more comprehensive approach to a watershed which not only crosses county boundaries but state lines as well.

The IDNR Division of Soil Conservation, the DES, and the SCS have agreed to assist the Union County and Wayne County SWCDs to provide conservation planning technical assistance with watershed participants. The two SWCDs have formally entered a Memorandum of Understanding detailing the responsibilities of each party.

Area of Concern

The SCS will use $48,805 to provide a program of technical assistance to the Lake County AOC in order to help implement the nonpoint source BMP plan developed by the Lake County SWCD. Baseline data of the BMPs effect on water quality will be collected to compliment the educational effort by the Grand Cal Task Force.

Reforestation of Bottomland Hardwoods

The USFWS will use $22,500 to expand its Wetland Restoration Program to include bottomland hardwood reforestation for water quality protection and wildlife habitat enhancement. Efforts will be made to restore forested wetlands along the lower Wabash River from Vigo County to the mouth in Posey County.

Maumee River Watershed

The Maumee River Basin Commission is utilizing $60,000 in Section 319 funds to prepare a plan for implementation of soil and water conservation measures within the priority area of the Maumee River watershed. The priority area is the land located within the Maumee River watershed located in Adams, Allen, DeKalb, Noble, Steuben, and Wells counties. Specific NPS pollution problems have already been identified within the watershed through sediment and associated pollutant loadings. Best management practices are being implemented to alleviate the nonpoint source problems.

An organizational meeting was held during November 1993 with the counties of Adams, Allen, DeKalb, Noble, and Steuben. Those in attendance included county surveyors, SWCD staff, SCS personnel, and the Maumee River Basin Commission. Guidelines were outlined for subwatershed eligibility, filter strip standards, payment schedules, and review procedures. Adams, DeKalb, Noble, and Steuben counties are currently completing the subwatershed prioritization procedure.

During the November 1993 meeting, it was decided the individual counties would administer the program instead of hiring another staff person. This would also allow additional filter strips to be installed. Administration is a cooperative effort between the SWCDs and county surveyors. Field visits and contract with landowners are expected to be completed by April 1994. Allen County is reviewing the potential of including one additional subwatershed due to availability of funds.

Indiana Dunes

The Indiana Geological Survey will use $49,848 to assess the threat of pollution by human waste along the Indiana National Lakeshore. This will help to provide the Indiana State Department of Health with a basis for evaluating the appropriateness of on-site septic tank absorption fields as a method of household waste disposal in dune sand and is somewhat of a continuatio of a previous Section 319 project.

Farming for Maximum Efficiency (MAX) Program

Purdue University will use $46,750 to gather, summarize, and distribute information to Indiana's farmers and the general public showing the economic and environmental benefits of implementing nutrient and pesticide BMPs to improve water quality and reduce soil erosion. Five education specialists with Indiana's T-by-200 Education Program will work within all 92 counties to enlist participation in the MAX Program.

Trail Creek Watershed Management Plan

A contract utilizing Section 205(j) funds is being used to prepare a watershed management plan for Trail Creek by the NIRPC. A subcontract with the LaPorte County SWCD was executed to provide the NIRPC with technical expertise for the watershed plan. Members of the USDA, the LaPorte County SWCD, and the NIRPC met to gather the technical data for the watershed management plan. The task force calculated the acreage of land use and inventoried wetlands from aerial photographs. They toured the watershed and interviewed property owners within the area. Farms and livestock operations within the watershed were also identified.

Based on this information, the SCS concluded that the non-urban areas contributed 2,000 tons of sediment per year. Based on the 6,000 tons of suspended sediment per year that was monitored at the USGS Springland Avenue gaging station, only one-third of the sediment load is attributable to upland agricultural practices. The SCS finalized the report for inclusion into the final watershed management plan.

A Trail Creek Watershed Management Resource Committee, associated with the Trail Creek Improvement Plan (TIP) committee, was also formed to provide information, guidance, and facilitation of public input for the development of the watershed management plan. Representatives on the committee are comprised of a LaPorte County commissioner, the major of Michigan City, and the executive director of the Save the Dunes Council.

The Trail Creek Watershed Management Resource Committee has identified four goals to be used as the framework in developing the Watershed Management Plan. Outlined below are the four goals and general objectives:

1. Reduce potential health hazards due to poor water quality in Trail Creek.
    a. Reduce priority pollutant loads delivered to Trail Creek to improve water quality conditions.
    b. Encourage proper stormwater and erosion control management in developing areas, and retrofit developed areas were feasible.

2. Improve aquatic life support.
    a. Promote agricultural best management practices.
    b. Protect and restore the ecological integrity of Trail Creek utilizing natural streambank restoration methods to stabilize eroding banks.

3. Increase quality/quantity of recreational opportunities to stimulate economic growth.
    a. Control debris, litter and obstructions from entering Trail Creek.
    b. Dredge the harbor.
    c. Enhance existing public access sites as well as identify and plan future sites.

4. Develop a public awareness of the unique and various opportunities that Trail Creek provides.
    a. Educate the citizens and local decision makers as to the sources and impacts of nonpoint source pollution and the concept of watershed management.
    b. Stimulate participation in maintenance and restoration activities within the watershed.
    c. Cultivate community appreciation for Trail Creek and its diverse wildlife and plant species.

The NIRPC has facilitated several brainstorming sessions and public meetings to receive input on refining and quantifying the objectives to achieve the goals of the Watershed Management Plan for Trail Creek. The brainstorming sessions and meetings are intended to identify potential maintenance and restorative programs to be implemented within the watershed. The plan was completed in the Fall of 1993.

Lake County Urban Conservationist

Funded with 104(b)(3) funds, an urban conservationist has been working in Lake County assisting with urban activities related to water quality. Many of his efforts have been put into informing interested parties of the newly implemented stormwater regulations in Indiana. This has included contacts with engineers, realtors, developers property owners associations, businesses, and builders.

A survey was also made of subdivisions in the area and photos were taken of soil erosion control problems. After erosion control practices were implemented in some of the subdivisions, inspections were made to evaluate the effectiveness of the projects. Recommendations concerning erosion control have also been given for several city projects (such as street construction), flood control plans, a highway interchange, and subdivisions. Additionally, the urban conservationist attended several training sessions concerning erosion control and soil and water conservation issues. He has also given a number of presentations about urban conservation and erosion control at various meetings and workshops.

The determination of the acres of wetlands, cropland, and forest areas in the Town of Merrillville was also completed. Additionally, detailed work plans for the Hammond Park Department for bank protection along the southeast section of Wolf Lake were completed.

Wellhead Protection Program Planning

Funded with Section 205(j) funds, the Michiana Area Council of Governments (MACOG) has been proceeding with the wellhead protection program. The inventory of land uses within the wellhead protection area is complete. A map of these land uses within the area is currently being produced. Work on the Elkhart County Potential Groundwater Contamination Site map is still progressing.

Opportunities for public participation and education have also been pursued through participating or speaking at local group meetings. A literature search has begun to determine specific best management costs to compare with cleanup and litigation costs. Work is also ongoing concerning the costs related to new well field development, economic development restrictions, or remediation costs not covered by responsible parties. Cost estimates for the drilling of observation wells necessary for delineating protection areas and identifying land uses within a wellhead protection area were also obtained.

Through conversations with individuals and continued collection and dissemination of information pertinent to ground water/wellhead protections, the MACOG staff is informing individuals about activities which impact the quality of ground water. A county well construction ordinance, which incorporates wellhead protection planning, is nearly complete. Upon completion, the MACOG staff will be involved in the final review prior to public hearings.

Surface Water Pesticide Study

The final report on the surface water pesticide study is now in the process of being written and edited. Based on the results of this statewide surface water summary, the IDEM plans to monitor smaller watersheds to further study surface water pesticide problems.

IDEM Permits

The IDEM continues to approve permits for confined animal feeding facilities. For FFY 1993, 185 permits were issued. Additionally, a permit process for a new type of facility has begun. This will be a treatment facility receiver company accepting waste sludge from other sources. The individual contributors would not be issued a permit, just the receiver company. this will be a privatized sludge processor facility.

Pathway to Water Quality

The IDNR, in conjunction with other agencies and groups, sponsored a demonstration at the 1993 Indiana State Fair entitled "Pathway to Water Quality". The project was modeled on the water quality demonstration presented at the Farm Progress Show held in 1992. This was an opportunity for fairgoers to view a working scale model of a watershed. It included a stream flowing through the site, demonstrations of BMPs, and the ultimate discharge of the stream into a community's drinking water supply. It is hoped that the display can become a permanent part of the fairground's exhibits.

Lake and River Enhancement Program

The goal of the IDNR's Lake and River Enhancement Program is to ensure the continued viability of Indiana's public-access lakes by controlling sediment and associated nutrient inflows by forestalling or reducing the impacts of such inflows, where appropriate, through remedial actions. To accomplish that, the IDNR provides technical and financial help for qualifying projects which may involve Indiana water bodies. The watershed land treatment program focuses on the watershed as a whole and encourages SWCDs to work together, sharing information and employees when needed. The Lake and River Enhancement Program chose five river watersheds and three lake watersheds to develop watershed land treatment projects for 1992-93 funding. These were:

- Otter Creek in Vigo County
- Upper Laughrey Creek in Ripley County
- Wildcat Creek in Clinton, Tippecanoe, and Carroll counties
- Barr Creek in Vanderburgh and Posey counties
- Eel River in Whitley and Noble counties

The projects chosen for the 1993-94 year are:

Lake design studies:
Lake Manitou
Lake Bruce
Lake James
Pretty Lake
Winoma Lake

Watershed land treatment (WLT):

West Boggs Lake
Lake Lemon
Adams Lake
Lakes of the Woods
Pigeon Creek

Second-year river WLT:

Upper Laughery Creek
Wildcat Creek
Blue River
Barr Creek
Cox Ditch

Second-year lake WLT:

Ridinger Lake
Lake Salinda
Cree/Schockopee Lakes

USDA Water Quality Program

The USDA has two major NPS hydrologic unit area (HUA) projects in Indiana, the Upper Tippecanoe River HUA and the Upper Kankakee (Tri-County) HUA. The projects are led by the SCS, assisted by the Agricultural Stabilization and Conservation Service, the Cooperative Extension Service, the IDNR, the IDEM, the USFWS, and local agrichemical dealers. Local landowners guide the effort of the program.

The Upper Tippecanoe River Water Quality project is in its fourth year of promoting the voluntary adoption of agricultural practices that protect ground and surface waters from nonpoint source pollution. To date, about 100 landowners in the project area have adopted some form of water quality protection practice. The second annual tour for interested parties took place in the summer of 1993 in order to view some of the water quality work in the project area. This included stops at an agrichemical dealership, a constructed wetland at a dairy farm (a Section 319 project), and wetlands restored by the USFWS. One of the more interesting projects this year was an open house for lake lot homeowners to learn about water quality protection practices.

Indiana MAX Program

In 1992, the MAX program in Indiana had approximately 200 participants who enrolled a total of 385 fields. This is a slight increase from 1991 which had 175 participants and 349 fields. When broken down by crop, 195 corn and 190 soybean fields were entered. In 1992, 50 counties were represented in the MAX program. The greatest concentration of participants is located in northeast Indiana, with Allen County having the most with 30 fields.

T-by-2000 Soil Conservation Education Program

T-by-2000 is a comprehensive, state-funded program aimed at significantly reducing soil erosion and resulting sedimentation throughout Indiana within a definite time period. The name is derived from the program's goals, which are to reduce erosion on each acre of land to its tolerable limit or T (The maximum level at which soil loss can occur without impairing crop productivity), and control all off-site sedimentation using the best practical technology by the year 2000. The program was authorized by the Indiana General Assembly in 1986 and given start-up funding in 1987.

The program presently provides educational, technical, and financial assistance to deal with erosion/sedimentation problems occurring on the land and in public waters. It is administered at the state level by the IDNR, Division of Soil Conservation under guidelines set by the State Soil

Conservation Board. It is carried out at the local level through the 92 county Soil and Water Conservation Districts.

A recently completed transect survey of 91 Indiana counties shows that 31 percent of the cropland is farmed using some form of conservation tillage system. This compares to 13 percent in 1990. The statistically valid survey method consisted of local teams evaluating 37,000 cropland fields by driving county roads and collecting data every one-half mile.

Farmers who use tillage systems that leave at least 30 percent residue cover after planting are considered to be practicing conservation tillage. Soil erosion rates under conservation tillage are only two-thirds of the erosion rate for moldboard plow systems. These tillage systems primarily include no-till and ridge-till. However, some chisel plow and disk systems also leave 30 percent or higher residue cover levels.

Moldboard plowing has drastically decreased in Indiana. Only nine percent of the cropland was plowed in 1993, compared to nearly 25 percent in 1990. The no-till system is being used on 25 percent of the cropland. This marks an 18 percent increase, or nearly one-half million acres, since 1990. The increase is mostly due to farmers adopting no-till drilling of soybeans which increased from eight percent in 1990 to 38 percent in 1993.

Soil and Water Conservation Districts

The Indiana Association of Soil and Water Conservation Districts (IASWCD) was awarded a three-year grant from the W.K. Kellogg Foundation to provide a facilitator for Indiana's new Leadership 2000 (L-2000) program. Co-sponsored by the IASWCD, the Purdue Extension, the Farm Bureau, and the League of RC&D Councils, L-2000 is a locally initiated leadership development experience designed for those who represent agricultural, renewable resource management and rural community interests. A portion of the grant funds fifty percent of a full-time IASWCD executive director to function as state L-2000 program coordinator. As coordinator, the executive director assists local sponsors in organizing, promoting, recruiting for, and conducting the four-session workshops. Such assistance is deemed critical to the program's long-term success.

Workshops have been held in four locations in Indiana and have involved 93 participants. Due to their success, eight more have been scheduled for the Fall of 1993, including one for youth. Through the four-session program, participants are made more fully award of their personal leadership abilities and how to develop them. They gain knowledge of important rural issues and how to network with others involved in those issues. At each of the program's sessions, participants learn a particular leadership skill, practice and evaluate it, then discuss how to integrate it into individual leadership styles. They also focus on honing communication skills in order to be more effective spokespersons for agriculture, their community, and the organizations they represent.

The other fifty percent of the executive director's time is funded through the IASWCD's treasury. Hired in January, 1993, the new director has been doing the following tasks:

- Helping secure the legislative funding needed to accomplish T-by-2000 and SWCD program goals.
- Serving as a clearinghouse for ideas and information of importance to member districts.
- Deepening relationships with traditional conservation partners and foraging links with new ones as appropriate.
- Helping provide training for SWCDs in areas spelled out in the district capacity-building program strategic plan.
- Supporting local efforts to establish and carry out L-2000 programs.

Conservation Tillage

Conservation tillage increased by 950,000 acres in Indiana between 1991 and 1992; this represented a 68 percent increase. Between 1992 and 1993 conservation tillage in Indiana increased by 568,315 acres. Conservation tillage is now being used on 41 percent of annually planted cropland in the state.

As a part of the Indiana program, conservation tillage practices continue to be implemented in accordance with the International Joint Commission (IJC) agreement in order to further reduce nutrients entering the Maumee River Basin. Table 56 shows the data for the last three years for those three Indiana counties involved in the IJC agreement. As can be seen, the total acres in conservation tillage for the past four years has more than tripled. The data are as follows:

Table 56. Acres in Conservation Tillage

	1990	1991	1992	1993
Adams County	19,900	41,000	50,600	71,260
Allen County	37,780	58,437	94,140	126,039
DeKalb County	22,685	29,625	54,050	48,707
Total	**80,365**	**129,062**	**198,790**	**246,006**

Indiana Cooperative Water Testing Program

The Indiana Farm Bureau began water testing about five years ago when several counties participated in a nitrate screening program. Some 2,000 water samples were screened using the Merckoquant nitrate test strip. Farmer members continued to express concern about well water and asked for information about water testing. Consequently, the Water Quality Laboratory at Heidelberg College in Tiffin, Ohio was hired to become involved in the project. Sponsors have included the Farm Bureau, SWCDs, local health departments, the Cooperative Extension Service, and the RC&Ds. In most cases, the well owners pay the costs of the test. The intent is to analyze test results from 10,000 samples.

Home Builders Guide

The Hoosier Heartland RC&D published the "Home Builders Guide" this past year. The booklet was printed with funds contributed by the private sector, SWCDs, and Indiana University/Purdue University Indianapolis. It is designed to help home builders design a development by avoiding problems during and after construction with erosion, surface water runoff, and underground drainage.

Site Erosion Control Regulations

In September, 1992, Rule 5, the state's regulations governing stormwater runoff from construction activities on parcels five acres or larger in size became effective. The agreement which will formalize arrangements among the local SWCDs, the IDNR and the IDEM to implement the rule is being finalized. Enforcement of the rule is the responsibility of IDEM.

Rivers Advisory Group

The IDNR organized the Rivers Advisory Group (or Hoosier River Keepers) in 1993. Currently, work is progressing on the publication of a newsletter. Additionally, funding is now being sought for the program. Local river stewardship groups have participated in the "National River and Trail Cleanup". Informational brochures were available at the Indiana State Fair in August to explain the various programs sponsored by the Rivers Advisory Group.

Ground Water Task Force

The Ground Water Task Force was instituted by the 1989 Indiana General Assembly's passage of the Ground Water Protection Act to manage Indiana's ground water resources. This legislation provides authority for the establishment of programs and activities to facilitate the implementation of Indiana's Ground Water Protection and Management Strategy which was adopted in 1987. A key provision of the Ground Water Protection Act was the establishment of a Ground Water Task Force to oversee and facilitate the implementation of Indiana's ground water strategy.

The Ground Water Standards Work Group has stated that the purpose of the standards are to protect human health and to establish enforcement and action levels. The work group has decided that possible actions to be taken when the levels are exceeded include: stopping the contamination, initiating more monitoring, and conducting a study of the contaminated ground water including risks. The work group has begun to determine factors which affect human health criteria such as exposure route, additive effects, exposure time and synergistic effects. The work group suggested that the standards address the ground water contamination threat from the following pollution sources:

1. Class V wells
2. Percolation ponds
3. Septic tanks
4. Brine ponds
5. All on-site sewage disposal systems
6. Spill prevention
7. Unregulated fuel tanks
8. Abandoned wells constructed prior to 1987
9. Junk and salvage yards
10. Leaking sewers
11. Wells contaminated by chemical containers used for carrying water to the well
12. Salt storage piles
13. Application of salt
14. Asphalt roads.

Interagency Watershed Task Force

Pursuant to House Enrolled Act 1318, the 12-member Interagency Watershed Task Force was established by the Indiana General Assembly to examine water resources from a comprehensive watershed viewpoint. Meetings have been held over the past year gathering information on water management issues and data relevant to the state's watersheds. Following is the vision statement developed by the Task Force:

> "The Task Force will develop a cooperative program recognizing that watersheds are a community composed of soil, water, air, plants, animals, and people, and that each member of the community must be respected and provided for in management schemes to ensure the survival of the community as a whole and for future generations."

The Task Force was charged with the following duties:

1. Compile and review existing data concerning Indiana watersheds, including the following types of information;
   a. Land use and development
   b. Nonpoint source pollution

c. The nature and authority of existing regulatory programs
d. Watershed management and planning approaches
e. Sedimentation rates
f. The impact of sewage effluent and watershed treatment processes
g. Erosion control
h. Recreational uses
i. Fish and wildlife habitats
j. The importance of surface water resources used for water supply purposes.

2. Gather necessary additional information concerning Indiana watersheds.

3. Compile information on existing federal, state, and local statutes and rules and regulations concerning the quality and quantity of water watersheds.

4. Establish a pilot program for watershed management programs and select an existing watershed or drainage area in Indiana to serve as the subject of the pilot program.

5. Develop comprehensive plans for watershed management programs in Indiana.

The goal of the pilot program is to establish both methodologies and criteria for assessing, managing, and monitoring water quality at a watershed scale. Techniques developed by this program may be applied to other watersheds through integrated watershed management.

The pilot demonstration watershed study consists of three interlocking parts: understanding the consequences of historic environmental change; experimental manipulation of watershed elements; and documenting the social, legal and jurisdictional conflicts that retard wise watershed ecosystem management. These parts taken together yield the interdisciplinary analysis which will provide guidance to the elements of a statewide integrated cooperative management program.

The watersheds chosen for the pilot study are the Indian/Pine Creek and Lake Monroe watersheds. These will provide a comparative approach to demonstrate the impact of different land uses, land use changes, and various management practices on water quality and ecosystem structure and function. The Indian/Pine Creek watershed represents Indiana's intensively farmed regions as well as its increasing urbanization, while the forested nature of the Lake Monroe watershed provides an excellent comparison of land uses. Additionally, intensive recreational use of natural areas and increasing suburban development around Lake Monroe provides other important comparisons.

Interagency Watershed Management Meetings

The USDA Soil Conservation Service initiated the formation of an Interagency Watershed Group which will meet on a periodic basis. The group will assist with coordination among various agencies with respect to water and related resource projects and studies. Agencies represented include the IDNR, the USFWS, the U.S. Army Corps of Engineers, the Purdue Cooperative Extension Service, the USGS, the Indiana Department of Transportation, the IASWCD, and the IDEM. Discussions for future meetings include the role of each agency in water resource projects in Indiana and discussions of projects which each agency is implementing related to watershed management. A database will also be constructed giving pertinent information about each project which will be made available to all the participants.

State Soil Conservation Board

The NPS Coordinator has been appointed as the IDEM's representative to the State Soil Conservation Board. The Coordinator reports at each meeting as to the activities taking place within the IDEM related to NPS activities. This is a great aid to communication between the IDEM and the Board and the other agencies which make reports at each meeting such as the IASWCD, the IDNR, the SCS, and the Agricultural Stabilization and Conservation Service. The USDA Specialist housed at the IDEM and partially paid with Section 319 funds also attends all State Soil Conservation Board meetings.

Section 314 Clean Lakes Project Program

Lake Monroe

The Monroe County Commissioners are utilizing $50,000 in Section 314 funds to do a diagnostic/feasibility study for Lake Monroe. A subcontract has been signed with Indiana University/SPEA to complete the study.

Water quality data collection and analysis has been ongoing from February 1993. Considerable effort has been made to sample spring runoff events in Lake Monroe's watershed. These runoff events carry the bulk of the annual sediment load. An additional set of lake samples was taken in May to partially compensate for some samples that could not be collected in February when thin lake ice and inaccessible boat ramps prevented access to the lake. All hydrology data (through April 1993) have been entered into the database and there has been a good relationship developed between instantaneous measurements and the continuous measurements from the USGS gage at Beanblossom, Indiana. Sediment loading data have also been correlated with discharge. Once the USGS provides the provisional data for the USGS gage, analysis will be complete.

All water quality data have been entered into the spreadsheet data base and appropriate graphs generated to illustrate important relationships in the data. Data for the Ramp Creek and Henderson Creek watershed have been collected, entered and run on the AGNPS computer model. Written sections on the population, economic structure, recreational use, climate, geology, and fisheries have been prepared for the draft report. Additionally, volunteers from the Monroe County Lake Task Force and the Monroe County Planning Department have solicited and recorded lake user's responses to a short Lake Monroe User Survey.

In April and May, a shoreline erosion control demonstration site was established at the Paynetown Boat Ramp on Lake Monroe. Although the site was readied for display at the Indiana Lake Management Conference, the intent was to also conduct a test of several shoreline erosion control measures that could be useful in correcting problems along the lake. The following measures was installed: articulated blocks, willow posts, and erosion control blankets. The vegetation cover has grown well.

A meeting was held in April of local, state and federal officials representing agencies having some jurisdiction over events in Lake Monroe's watershed. The meeting was an initial step to identify jurisdictions and responsibilities, to identify broad issues concerning the lake and watershed, and initiate dialogue among the parties in anticipation of cooperative management of the lake in the future.

Wolf Lake and Lake George

Diagnostic/feasibility studies are being done on both Wolf Lake and Lake George in Hammond through two Section 314 grants. The City of Hammond Park Department will receive a total of $100,000 in federal funds for each lake to complete the studies. Subcontracts have been signed with the Illinois State Water Survey to do both studies.

Monthly sampling of zooplankton and phytoplankton has been initiated and is ongoing. The macroinvertebrate sampling has been completed for both lakes. A survey of both lakes has been completed in which the rooted macrophyte beds were located and mapped. Routine water quality sampling has been conducted on both lakes and is in the process of being analyzed. Storm water sampling has been conducted on both lakes including metals and organics. Two water level recorders have been installed on Wolf Lake, one in Pool 3 near the mouth of Indian Creek, and the second in Pool 8 near the Sheffield pump station.

Access to USGS monitoring wells has been obtained and routine collection of ground water levels has continued. The Environmental Control Division of Amoco has agreed to supply data from their weather stations located at the Whiting refinery and monitoring wells located within the study area. Runoff samples have also been collected from the skyway and are being analyzed.

Versailles Lake

A diagnostic/feasibility study for Versailles Lake will be completed by the Historic Hoosier Hills RC&D using $50,000 of Section 314 funds, and matching funds from the IDNR, the Tyson Foundation, and the Versailles Town Board. A consultant has been selected to assist with the project. Legal assistance was obtained from a local attorney, bid specifications were developed and the project was advertised among various newspapers for a firm to complete the study. Four bids were received and reviewed by the steering committee. Coastal Environmental Services, Inc. was selected as the consultant to complete the required work elements for the study. A detailed work/quality assurance project plan for the Versailles Lake Phase I study is being developed and will be submitted to the IDEM shortly.

Indiana's Wetland Protection Program

Based on the U.S. Fish and Wildlife Service National Wetland Inventory Classification System, Indiana contains three major wetland system types: palustrine, lacustrine and riverine. Palustrine systems are usually situated shorewood of lakes, streams, river channels or in isolated depressions and are dominated by trees, shrubs, persistent emergents and emergent mosses or lichens. Lacustrine systems are permanently flooded lakes and reservoirs and intermittent lakes. In Indiana, common names for these areas are: wetland, marsh, fen, bog, swamp, slough, pothole, shallow pond, and remnant lake. Riverine systems includes the wetlands contained within the channel banks except those dominated by trees, shrubs, persistent emergents, emergent mosses and lichens.

There is no information available on the number and type of presettlement wetlands in Indiana, however, the U.S. Soil Conservation Service, using hydric soils, has estimated there were 5.6 million acres of wetlands in Indiana 200 years ago, covering approximately 25% of the State. A recent study by the Indiana Department of Natural Resources Division of Fish and Wildlife indicate that over 85% of these original wetlands have been destroyed. The majority of this destruction was by draining for agricultural purposes. Protecting the remaining wetlands is of major importance for the benefits they provide. These wetlands:

1. help purify water by filtering and trapping toxic chemicals, soil and excess nutrients that would otherwise enter our streams, rivers and lakes;

2. provide habitat and/or spawning grounds for fish and other aquatic life;

3. provide habitat for wildlife such as fur bearers, ducks, and endangered species;

4. act as natural sponges which minimize flood damage by storing and delaying floodwaters;

5. protect banks and shorelines against erosion by acting as buffer areas; and

6. provide areas for recreation, education and scientific research.

In Indiana, both the Department of Environmental Management and the Department of Natural Resources have legitimate interests in, and responsibility for, wetland protection. Although each agency's role in the protection of wetlands varies to some extent, there is also some overlap.

Section 404 of the Federal Clean Water Act requires an individual to obtain a permit from the U.S. Army Corps of Engineers (COE) for dredging and filling in waterbodies including wetlands. However, the COE cannot complete their processing of the permit until the State provides Section 401 Water Quality Certification or waives this right. Indiana Code 13-7-2, Section 15 designates the Indiana Department of Environmental Management (IDEM) as the water pollution control agency for all purposes of the Federal Water Pollution Control Act (Clean Water Act) and, therefore, gives it the responsibility to provide Section 401 Water Quality Certification of Section 404 permit applications. Indiana Code 13-1-3 Section 7(d) specifies that the Commissioner of the IDEM may take appropriate steps to prevent any pollution that is determined to be unreasonable and against public interests.

A review of Indiana's Environmental laws (IC 13-1-3 Section 4; IC 13-7-1 Section 7, Section 22, Section 26, and Section 27; and IC 13-7-4 Section 1) which became effective July 1, 1986, indicates that wetlands are waters of the State and that the discharge of dredged spoil or fill into wetlands does constitute water pollution. In making a determination of whether the pollution resulting from a proposed dredge and fill project would be unreasonable and against public interests, the Commissioner of the IDEM or the Commissioner's designee must decide if the pollution would violate sections of Water Pollution Control Board regulations which establish quality standards for various

Waters of the State including wetlands. Most wetland fills would violate one or more sections of Indiana's laws and regulations.

Since 1989, IDEM has placed a greater importance on wetland protection and directed greater resources into the Section 401 Water Quality Certification program. The enhanced role has demanded a greater efficiency in project tracking and the ability to examine trends in the management of the resource. To meet these new demands, Section 401 Water Quality Certification information is being entered into a personal computer in a Dbase IV format.

For each project, requiring Section 401 Water Quality Certification, 24 parameters are recorded (Table 57.). Parameters were chosen on their need for project tracking, trend analysis and ease in obtaining the information.

The **Indiana Lake Classification System and Management Plan** was adopted by the Indiana Stream Pollution Control Board in 1980 as part of its statewide water quality management plan. This plan was updated by the IDEM in 1986. The protection of all wetland areas contiguous to each lake or reservoir and their tributary streams is part of the generic restoration and management plan for each of the seven lake management groups.

In view of the above, the IDEM is reluctant to approve any wetland fill unless extensive mitigation is provided. Therefore, there is essentially no net loss of wetlands as a result of programs administered by IDEM.

The number of U.S. Army Corps of Engineers Public Notices on applications for Section 404 permits for placement of fill in Indiana's wetlands is steadily increasing. This probably is more a result of an increased awareness of the Section 401/404 permitting program than an increase in the desire to fill wetlands. To help handle the increased workload, staff will be developing guidelines which will not only increase the efficiency of reviewing COE public notices but can also be used by possible applicants in the planning stage of their projects. Another aid to applicants is the U.S. Fish and Wildlife Service National Wetland Inventory Maps which have been completed for the entire state in final or draft form.

The Indiana Department of Natural Resources (IDNR) has authority in wetland regulation through the Indiana Flood Control Act (IC 13-2-22) and the Indiana Lakes Preservation Act (IC 13-2-11.1). The Indiana Flood Control Act requires anyone who wishes to construct within the floodway of a river or stream and its adjacent wetlands to obtain a "Construction in the Floodway" permit from the IDNR. Also, the Indiana Lakes Preservation Act requires anyone involved in construction that would occur in or immediately adjacent to a public lake to obtain a permit from the IDNR for the work. Other IDNR regulatory programs which may involve wetland protection are the State

Table 57. *Section 401 water quality certification information placed in computer database*

PARAMETER	INFORMATION AND/OR SOURCE
Public Notice #	Source: Public Notice
Violation #	Source: Public Notice
Applicant #	Source: Public Notice
County	Source: Public Notice
Nearest Town	Source: Public Notice
After-the-Fact	Yes or no, Source: Public Notice
Project Type	Office Code: Ex. SW: Seawall
Waterbody	Source: Public Notice (If waterbody is wetland then use name of adjacent lake or stream.
Wetland Type	Unit: Classification of Wetlands and Deepwater Habitats of the United States (Cowardin, et al, 1979). Source: National Wetland Inventory Maps and on-site Investigation.
Area of Proposed Fill	Acres Source: Public Notice
Area of "After-the-Fact" Fill	Acres Source: Public Notice
Date of Public Notice	Source: Public Notice Day/Month/Year
Date Public Notice Received in Office	Day/Month/Year
Status of Review	Complete or pending
On-site Inspection Date	Day/Month/Year
Date Decision Letter Signed	Day/Month/Year
Decision on Certification	Waived or Denied
Amount of Wetland Restored/Created	Acres
Project Reviewer	Initials
Date of Post Project Inspection	Month/Day/Year
Comments	Projects Reviewer Comments
Amount of Allowed Fill	Acres
Corps District	Louisville or Detroit

Nature Preserve Program and the Endangered, Threatened, Special Concern, and Extirpated Species list.

There have been several bills introduced into the State legislature to further protect wetlands. The bills ranged from requiring a permit from the IDNR for the draining or filling of a wetland to tax credits for landowners who preserve their wetlands. However, the only wetland protection item to come out of the State legislature was a supplement to the budget of $1 million for wetland restoration and creation by the IDNR. The $1 million is to be matched by the U.S. EPA.

Monitoring Programs

Fixed Station Water Quality Monitoring Network

In April 1957, the Indiana State Board of Health established 49 stream sites for the bi-weekly collection of water samples for physical, chemical, and bacteriological analysis. Since 1957, various changes and improvements have been made and several stations have been added. Locations of historical stations for data collection may be found in the annual "Water Quality Monitoring of Rivers and Streams" publication of the Indiana Department of Environmental Management (IDEM).

The Fixed Station Water Quality Monitoring Network was established to provide basic information which would reveal pollution trends and provide water quality data for the many existing and potential users of surface water in Indiana. The monitoring program has these specific objectives:

1. To determine the chemical, physical, bacteriological, and biological characteristics of Indiana's water under changing conditions.

2. To indicate, when possible, the areas where pollution is entering a stream.

3. To compile data for future pollution abatement activities.

4. To obtain background data on certain types of wastes, such as sewage, industrial wastes, and radioactive materials, and to detect critical changes.

5. To obtain data useful for municipal, industrial, agricultural, and recreational users.

6. To compile data necessary to support enforcement action intended to preserve streams for all beneficial uses.

One hundred and six (106) stations were sampled during 1992 - 1993, monitoring approximately 2,055 stream miles in Indiana. Of the 106 stations, 91 are sampled once each month, and 15 are sampled quarterly. Forty-seven (47) of these stations were sampled quarterly for toxic pollutants. These stations and their descriptions are listed in Table 58 and in Figures 63 and 64. A list of the parameters for which analysis are run is given in Table 59.

Toxics Monitoring and Control Programs

The State uses a combination of chemical and biological monitoring to identify discharges of toxic pollutants. Chemical methods include toxicants identified by (1) EPA Form 3510-2C for permit application, (2) effluent sampling in compliance sampling inspections, (3) sludge sampling in land application permits and compliance sampling inspection, and (4) sediment and fish tissue sampling in receiving streams. Biological methods include the use of biosurveys and effluent toxicity tests.

Regular monitoring for toxic substances is conducted by the IDEM through analysis of the fish tissue and sediments collected once biennially at the 23 CORE program stations (Table 58 and Figure 65). These stations are also part of the Fixed Station Water Quality Monitoring Network. The stations are divided into two groups which are sampled on alternate years.

Three sets of fish samples (3 samples, 5 fish each, if possible) are collected at each station. Skin-on, scaleless fish fillet (skin-off for catfish) samples are submitted to the laboratory for analysis. A list of the parameters for which fish samples are analyzed is shown in Table 13. Sediment samples collected are analyzed for 150 pollutants (Table 22). In addition to the more routine monitoring, special studies of fish, turtles, crayfish, aquatic vegetation, sediment and in some cases, water may be conducted to monitor for toxic substances.

When waterbodies potentially affected by in-place pollutants are identified by sediment and/or fish tissue analysis, the site can be further evaluated by sediment toxicity testing, pollutant transport modelling, sediment criteria, caged fish bioaccumulation studies, or additional sampling. Remedial actions, if appropriate to reduce or remove in place toxicants, could include additional point source controls, dredging sediments, sealing contaminated sediments or leaking landfills, or construction of sediment traps.

Water quality is routinely sampled for a limited number of toxic parameters (mostly metals) at the fixed water quality monitoring stations and samples for organics analysis are collected quarterly at several of these stations (Table 59). Effluents from dischargers known or suspected to contain toxic materials are analyzed for these materials when compliance sampling is conducted at these localities. Toxicity tests are used by the State to screen

Table 58. *Indiana's fixed station water quality monitoring network*

STATION	NAME	LAT/LONG	LOCATION
BD-1(C) ★	Burns Ditch at Portage	41 37 20.5/87 10 34.4	Midwest Steel Truck Bridge, Portage
BD-2E	Burns Ditch At Portage	41 36 45/87 10 25	State Highway 249 Bridge (Chrisman Road)
BD-3W	Burns Ditch At Portage	41 36 9.3/87 11 37	Portage Boat Yard Dock, Portage
BL-.7 (BL-.1) (Q)	Big Blue River At Edinburg	39 21 29/85 59 01	U.S. Highway 31 Bridge, Edinburg
BL-64 (BL-61) (Q)	Big Blue River near Spiceland	39 52 256/85 26 20	County Road 450S Bridge
BLW-57 (BLW-53) (Q)	Blue River, West Fork-Fredericksburg	38 26 02/86 11 31	U. S. Highway 150, Fredericksburg
BS-O	Blue Springs Caverns		At Opening - Lawrence Co.
EC-1 ★	Eagle Creek at Indianapolis	39 44 11/86 11 48	Raymond Street, East of State Highway 67
EC-7	Eagle Creek at Speedway	39 46 41/86/15 02	Lynhurst Bridge near West 10th Street
EC-21 ★	Eagle Creek at Zionsville	39 54 37;/86 17 08	State Highway 100, South of Zionsville
EEL-1 (Q)	Eel River At Worthington	39 07 26/86 58 10	S. R. 67 Bridge, Worthington
ELL-7	Eel River near Logansport	40 46 55/86 15 50	C. R. 125N Bridge, NE of Logansport
ELL-41	Eel River near Roann	40 56 53/85 53 28	S.R. 15 NE of Roann
ER-.3 ★	Elkhart River at Elkhart	41 41 16/85 58 18	East Jackson Street Bridge, Elkhart
EW-1	East Fork, White River-Petersburg	38 32 22/87 13 22	S. R. 57 Bridge NE of Petersburg
EW-79 (EW-77)((C) ★	East Fork, White River-Williams	38 48 07/86 38 44	County Road South of State Highway 450
EW-94	East Fork, White River-Bedford	38 49 33/86 30 47	U. S. Highway 50 Bridge, S. of Bedford
EW-168 (EW-167) ★	East Fork, White River-Seymour	38 59 12/85 53 56	Seymour Waterworks Intake
EW-239	East Fork, White River-Columbus	39 12 02/85 55 35	S. R. 46 Bridge, Columbus
FC-.6 ★	Fall Creek-Indianapolis	39 46 54/86 10 36	Stadium Driver Bridge, Indianapolis
FC-7	Fall Creek-Indianapolis	39 50 05/86 07 19	Keystone Avenue near Water Intake
CGR-34 ★	Grand Calumet River-Hammond	41 37 12/87 30 31	Hohman Avenue Bridge at Hammond
GCR-37 ★	Grand Calumet River-East Chicago	41 36 50/87 27 41.4	Bridge on Kennedy Avenue, East Chicago
GCR-42 ★	Grand Calumet- Gary	41 36 33/87 22 20	Bridge Street Bridge, Gary
IHC-0	Indiana Harbor Canal at East Chicago	41-40 23/87 26 25	At Mouth of Ship Canal
IHC-2 (IHC-1) (C) ★	Indiana Harbor Canal at East Chicago	41 39 18/87 27 33	Bridge on Dickey Road, East Chicago
IHC-3S	Indiana Harbor Canal at East Chicago	41 38 22/87 28 16	Bridge on Columbus Drive, East Chicago
IHC- 3W	Indiana Harbor Canal at East Chicago	41 38 48/87 28 51	Bridge on Indianapolis Boulevard, East Chicago

Table 58. *Indiana's fixed station water quality monitoring network (cont.)*

STATION	NAME	LAT/LONG	LOCATION
IWC-9 (IWC-6.6) (C) ★	Indianapolis Waterway Canal at Indianapolis	39 52 07/86 08 30	Confluence of Canal and White River
KR-68 (KR-65) (C) ★	Kankakee River at Shelby	41 10 57/87 20 26	S.R. 55 Bridge, 1 Mile South of Shelby
KR-118 (KR-125) (C) ★	Kankakee River-Kingsbury Wildlife	41 28 39/86 36 16	U.S. 6 Bridge, South of Kingsbury Wildlife
LCR-13	Little Calumet River at Hammond	41 34 39/87 31 19	Hohman Avenue Bridge, Hammond
LCR-39	Little Calumet River-Porter 41	37 04/87 07 32	S.R. 149, South of U.S. Highway 12, NW of Porter
LM-EC	Lake Michigan at East Chicago	41 39 09/87 26 17	Raw Water, East Chicago Waterworks
LM-G	Lake Michigan at Gary	41 38 58/87 20 32	Raw Water, Gary Waterworks
Lm-H	Lake Michigan at Hammond	41 42 00/87 29 00	Raw Water, Hammond Waterworks
LM-M (C)	Lake Michigan at Michigan City	41 44 07/86 54 00	Raw Water, Michigan City Waterworks
LM-W (C) ★	Lake Michigan at Whiting	41 40 45/87 29 17	Raw Water, Whiting Waterworks
M-114 (M-95) ★	Maumee River at Woodburn	41 10 11/84 50 57	S. R. 101 bridge, 3 Miles North of Woodburn
M-129 (M-110) (C) ★	Maumee River at New Haven	41 05 06/85 01 14	Land in Road, .5 Mile North of New Haven
MC-18 (MC-17) (Q)	Mill Creek at Devore	39 26 00/86 45 47	U. S. Highway 231 Bridge, Near Devore
MC-35 (Q)	Mill Creek at Stilesville	39 38 12/86 38 25	U.S. Highway 40 Bridge at Stilesville
MS-1	Mississinewa River at Peru	40 45 14/86 01 23	State Highway 124, East of Peru
MS-28 ★	Mississinewa River at Jalapa	40 37 32/85 43 52	Izaak Walton Lodge
MS-36 (MS-35)	Mississinewa River at Marion	40 34 34/85 39 34	Highland Avenue bridge, Marion
MS-99 (MS-100)	Missisinewa River at Ridgeville	40 16 48/84 59 43	County Road 134E, 2 Miles East of City
MU-20 (MU-25)	Muscatatuck River near Austin	38 45/46/85 56 11	S.R. 39 Bridge West of Austin
P-35 (P-33) (Q)	Patoka River near Oakland City	38 22 57/87 20 00	
P-76 (Q) ★	Patoka River at Jasper	38 19 40/86 57 59	US 231 Bridge
PC-21 (Q)	Big Pine Creek, Pine Village	40 25 19/87 20 30	S. R. 55 Bridge, Pine Village
S-O	Salamonie River - Lagro	40 49 46.5/85 43 06	Division Road, near Lagro
S-25 ★	Salamonie River - Lancaster	40 43 45/85 30 26	IN 124, South of Lancaster
S-71	Salamonie River - Portland	40 25 42/85 02 17	106 South Road Bridge, Portland
SC-25 (SC-30)	Sugar Creek at Shades S tate Park	39 56 46/87 03 33	S. R. 234 Bridge, above Shades State Park
SGR-1(Q)	Sugar Creek at Edinburg	39 21 39/85 59 51	Road to Atterbury from Edinburg

Table 58. *Indiana's fixed station water quality monitoring network (cont.)*

STATION	NAME	LAT/LONG	LOCATION
SJR-51 (SJR-46) (C) ★	St. Joseph River at South Bend	41 44 40/86 16 22	Auten Road Bridge, South Bend
SJR-64 ★	St. Joseph River at Mishawaka	41 40 16.5/86 09 08	Petro Park bridge, Mishawaka
SJR-87 (SJR-76) (C) ★	St. Joseph River at Bristol	41 43 20/85 49 03	County Road through Bristol
SLC-1	Salt Creek, Portage	41 35 50/87 08 43	U. S. Highway 20 Bridge, Portage
SLC-17 (SLC-12) ★	Salt Creek near Valparaiso	41 29 56/87 08 29	S. R. 130 bridge, below Sewage Treatment Plant
SLt-12 (SLT-11)	Salt Creek near Oolitic	38 53 18/86 30 31	State Highway 37 Bridge
STJ-.5 (STJ-0) (C) ★	St. Joseph River at Fort Wayne	41 45 21.5/85 07 42	Tennessee Street Bridge
STM-.2 (C) ★	St. Mary's River at Fort Wayne	41 05 01/85 08 07	Spy Run Bridge over St. Mary's
STM-11 (STM-12)	St. Mary's River at Fort Wayne	40 59 17/85 06 01	Anthony Boulevard Bridge, South of Highway 27-33
STM-37 (STM-33)	St. Mary's River at Pleasant Mills	40 46 45/84 50 32	S. R. 101 bridge, North of Pleasant Mill
TC-.5 (TC-.3) (C)	Trail Creek at Michigan City	41 43 21/86 54 16	Franklin Street Bridge, Michigan City
TC-1 ★	Trail Creek at Michigan City	41 43 18/86 53 49	U. S. Highway 12 Bridge, Michigan City
TC-2	Trail Creek at Michigan City	41 43 21/86 52 32	Bridge Upstream STP at Krueger Park
TR-9 (TR-6)	Tippecanoe River near Delphi	40 35 40/86 46 14	S. R. 18 Bridge, 5 Miles West of Delphi
TR-107 ★	Tippecanoe River near Rochester	41 06 21/86 13 12	U. S. 31 Bridge, North of Rochester
TC	Twin Caves		At outlet in Spring Mill State Park
V-.8 ★	Vermillion River at Cayuga	39 57 40/87 27 07	State Highway 63 Bridge, Cayuga
WB-52 (#)	Wabash River at New Harmony	38 07 52/85 56 33	U. S. Highway 460 Bridge, new Harmony
WB-130 (WB-128)	Wabash River at Vincennes	38 42 26/87 31 09	U. S. Highway 50 Bridge, NW Edge of Vincennes
WB-183 (WB-175) (C)	Wabash River, West of Fairbanks	39 13 39/87 34 21	I & M Breed Generating Station
WB-205 ★	Wabash River, South of West Terre Haute	39 24 07/87 39 02	Dresser Sub-Station
WB-218 (WB-207) (C) ★	Wabash River near Terre Haute	39 30 24/87 24 50	Fort Harrison Boat Club
WB-230 (WC-219) ★	Wabash River at Clinton	39 39 26/87 23 42	S. R. 163 Bridge at Clinton
WB-240 (WB-228)	Wabash River At Montezuma	39 47 33/87 22 26	U. S. Highway 36 Bridge, West Edge of Montezuma
WB-256 (WB-245)	Wabash River at Cayuga	39 50 08/87 25 11	State Highway 234 Bridge, Cayuga
WB-303 (Wb-292) (C) ★	Wabash River near Lafayette	40 24 43/87 02 11	Granville Bridge, Sw of Lafayette on Road 700W
WB-316 (C) ★	Wabash River North of Lafayette	40 25 10/86 53 50	S. R. 225 (East Street) Bridge, Battleground

Table 58. *Indiana's fixed station water quality monitoring network (cont.)*

STATION	NAME	LAT/LONG	LOCATION
WB-347 (WB 336) ★	Wabash River at Georgetown	40 44 19/86 30 10	C. R. 675, West of Georgetown
WB-370 (WB 360)	Wabash River at Peru	40 44 32/86 05 48	Business U. S. Highway 31 Bridge, Peru
WB-402 (WB 390)	Wabash River at Andrews	40 52 08/85 36 06	S. R. 105 Bridge, North of Andrews
WB - 409	Wabash River at Huntington		
WB-420 (WB-409)	Wabash River at Markle	40 49 26/85 20 22	State Highway 3 Bridge
WB-452 ★	Wabash River at Geneva	40 37 00/84 57 15	U. S. 27 Bridge, 1.5 Miles North of Geneva
WC-3 (WC-1) ★	Wildcat Creek at Lafayette	40 27 12/86 51 05	S. R. 25 Bridge, NE of Lafayette
WC-60 (WC-63) ★	Wildcat Creek at Kokomo	40 28 26/86 11 02	County Road 300W,1 Mile West of Kokomo
WC -66 (WC-69)	Wildcat Creek at Kokomo	40 29 10/86 06 37	U. S. Highway 31 Bypass Bridge
WCS-34 (Q) ★	Wildcat Creek, South Fork-Frankfort	40 18 59/86 32 48	Highway 38 - 39 Bridge NW of Frankfort
WHE-27 (Q) ★	East Fork, Whitewater River-Abington	39 43 57/84 57 35	Pottershop Road Bridge, East Edge of Abington
WHW-22 (Q)	West Fork, Whitewater River, Cedar Grove	39 21 12/85 56 36	S. R. 1 Bridge, Cedar Grove
WLSL ★	Wolf Lake at Hammond	41 39 42/87 31 30	Culvert, South Edge of Dike W. of Calumet Avenue
WR-19 (Q)	West Fork White River at Hazelton	38 29 24/87 33 00	Old 41 Bridge, Hazelton
WR-46 (WR-48) (C) ★	West Fork White River at Petersburg	38 330 42/87 17 16	State Highway 61 Bridge, Petersburg
WR-81 (WR-80)	West Fork White River at Edwardsport	38 42 42/87 14 26	S. R. 358 Bridge, 1 Mile below Generating Station
WR-162 (WR-166)	West Fork White River at Spencer	39 17 16/86 44 45	S. R. 43 & 46 Bridge, South Edge of Spencer
WR-192 ★	West Fork White River, Martinsville	39 26 02/86 26 55	S. R. 39 Bridge West of Martinsville
WR-219 (C) ★	West Fork White River at Waverly	39 33 35/86 16 28	S. R. 144 Bridge, Waverly
WR-248 (WR-249)	West Fork White River at Nora	39 54 35/86 06 19	86th Street, East of Nora
WR-279 (WR-280) ★	West Fork White River, Perskinsville	40 08 30/85 52 48	State Highway 13 Bridge
WR-293 (WR-295)	West Fork White River at Anderson	40 06 22/85 40 22	10th Street at Waterworks
WR-309 (WR-310) ★	West Fork White River at Yorktown	40 10 42/85 29/40	County Road Bridge, North of Yorktown H.S.
WR-319	West Fork White River at Muncie	40 10 41/85 20 32	Memorial Drive, East Edge of Muncie
WR-348 (WR-350) (C) ★	West Fork White River, Winchester	4- 10 56/85 58 10	At U. S. 27 Bridge, East of Winchester

(C) CORE Station
(Q) Quarterly Sampling Station
★ Quarterly Toxics Scan
Tissue, Sediment & Biological Only

Figure 63. *Locations of Indiana's Fixed Station Water Quality Monitoring Network Stations (except Northwest Indiana)*

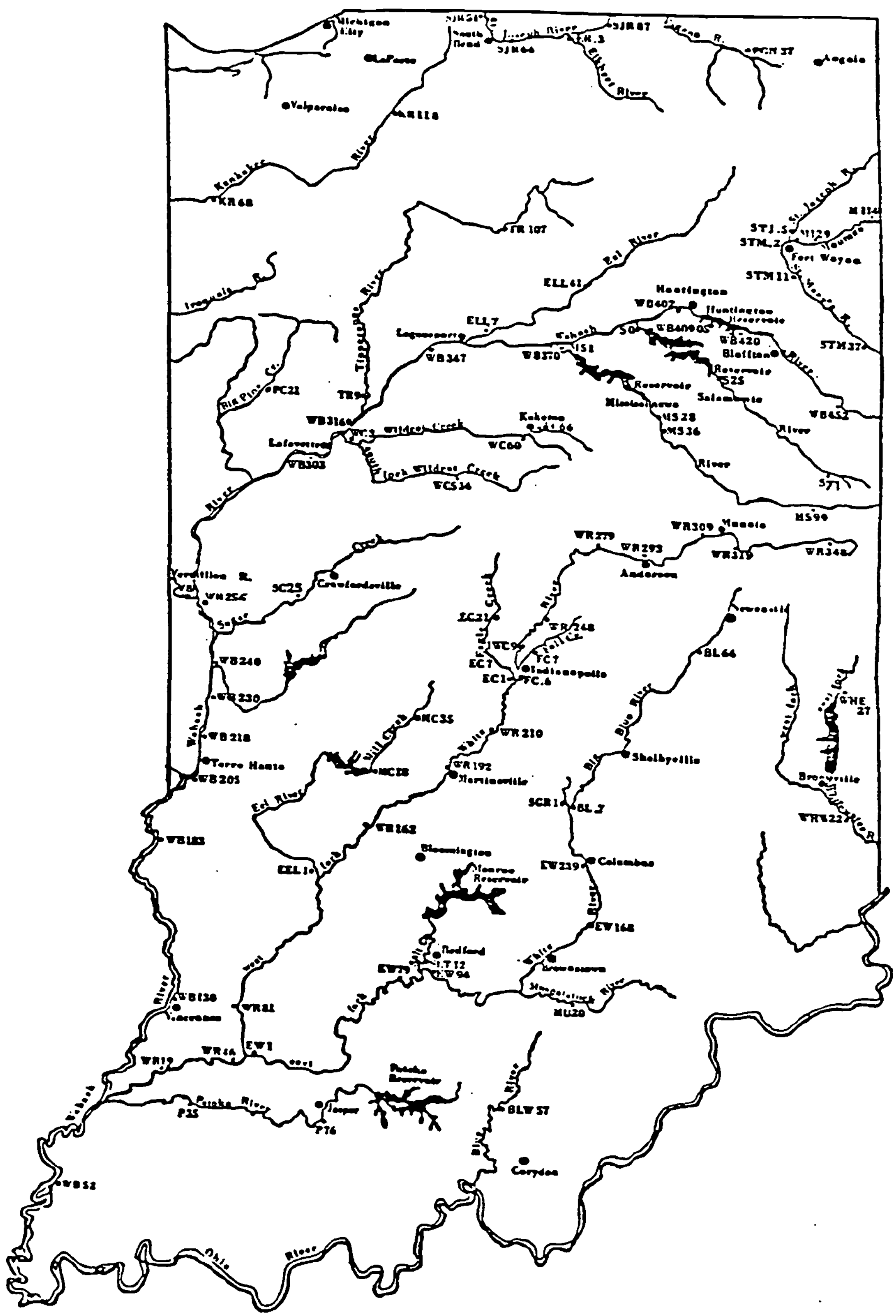


Figure 64. *Locations of Indiana's Fixed Station Water Quality Monitoring Network Stations in Northwest Indiana*

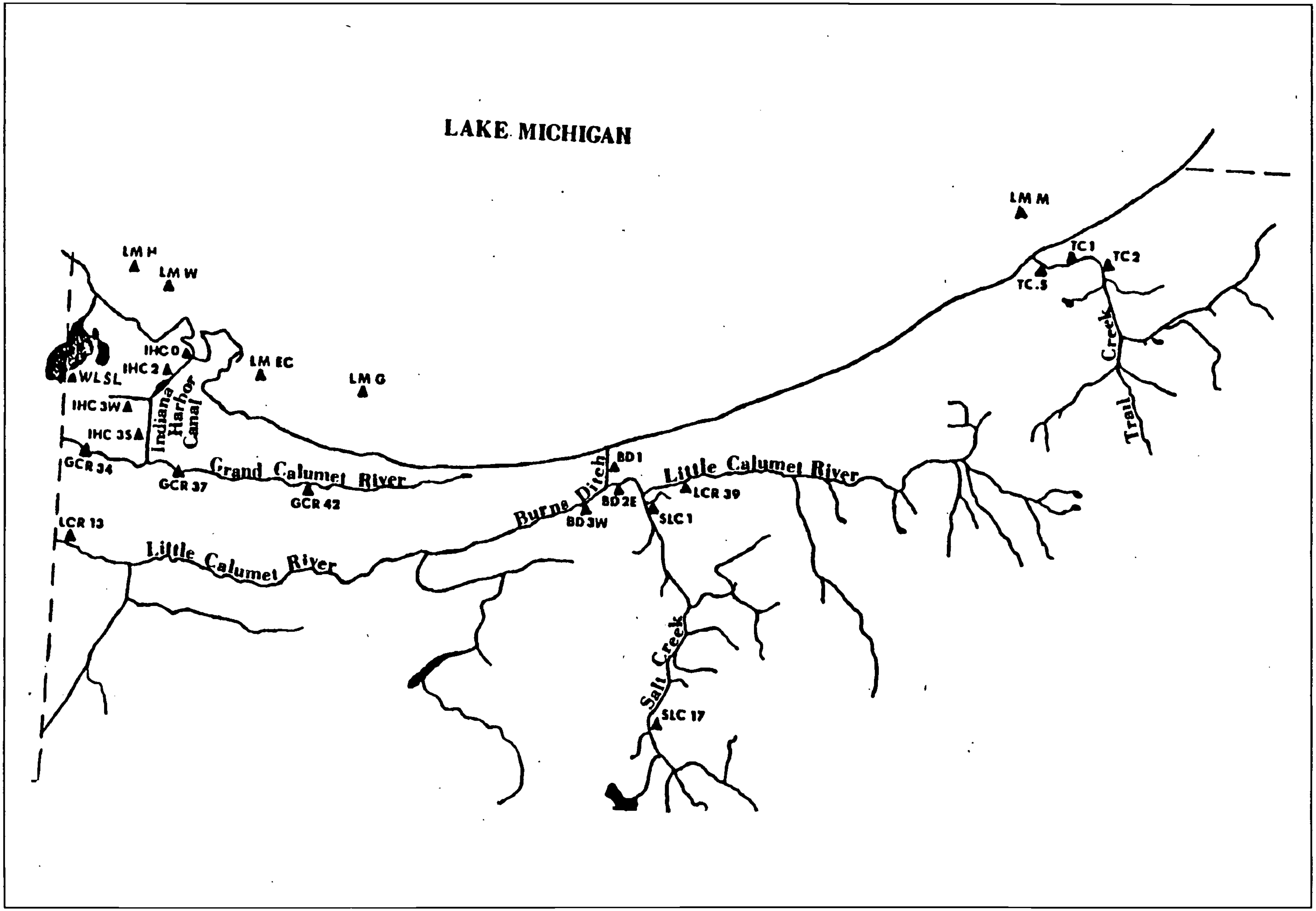


Table 59. *A. Analyses conducted at Indiana's fixed water quality monitoring stations. (not all parameters are sampled and analyzed at each station)*
B. Sampling for these parameters done once every three months

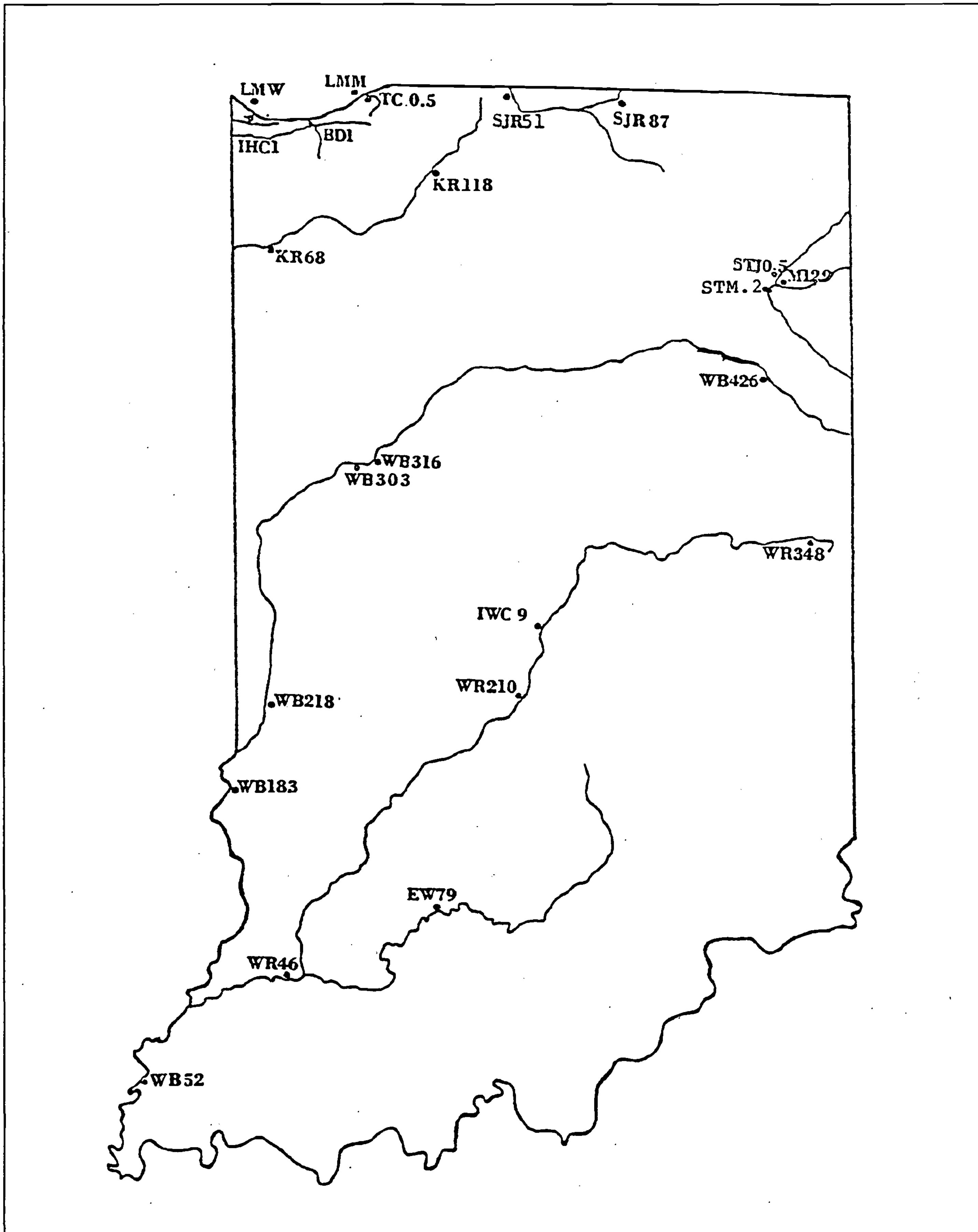
A.

Alkalinity (total)
Ammonia as NH_3-N
Arsenic as As (total)
Barium
Biochemical Oxygen Demand (BOD)
Calcium as CaCO3
Chemical Oxygen Demand (COD)
Cadmium as Cd
Chloride as Cl
Chromium as Cr_{+6} (hexavalent)
Chromium as Cr (total)
Coliform (E. Coli)
Copper as Cu (total recoverable)
Cyanide (total) as Cn
Dissolved Iron
Dissovled Oxygen (DO)
Fluoride as F
Hardness as CaCO3
Iron as Fe (total)
Lead as Pb (total recoverable)
Magnesium as $MgCO_3$
Manganese as Mn (total)
Mercury as Hg ↑
Nichel as Ni (total) recoverable)
Nitrate + Nitrite as N
Nitrogen, TKN (total)
Oil and Grease
Polychlorinate biphenyls (PCBs) see below
pH
Phenol
Phosphorus as P (total)
Phthalates see below
Selenium
Silica as SiO_2
Silver as Ag
Suspended Residue (nonfilterable reside)
Voltile Suspended Matter
Total Residue
Dissovled Residue (filterable residue)
Specific Conductance as micromhos/cm
Sulfate as SO_4
Total Organic Carbon (TOC)
Turbidity as NTU
Zinc as Zn (total recoverable)

B.

VOLATILE ORGANIC COMPOUNDS	BASE/NEUTRAL FACTION		ACID EXTRACTABLES-PHENOLS	ORGANOCHLORINE PESTICIDES
Halogenated	Bis (2-Chloroethyl)ether	Di-N-Octylphthalate	Phenol	Alpha-BHC
Methylene Chloride	1,3--Dichlorobenzene	Benzo (A) Pyene	2-Chlorophenol	Beta- BHC
1,1-Dichloroethylene	1,4-Dichlorobenzene	Benzidine	2-Nitrophenol	Gama-BHC (Lindane)
1,1-Dichloroethane	1,2-Dichlorobenzene	3,3-Dichlorobenzidine	2,4-Dimethylphenol	Delta-BHC
Chloroform	n-Nitroso-n-Dipropylamine	4-Chlorophenylphenylether	2,4-Dichlorophenol	Heptachlor
Carbon Tetrachloride	Nitrobenzene	Bis (2-Chloroisopropyl) Ether	p-Chloro-m-Cresol	Heptachlor Expoxide
1,2-Dichloropropane	Hexachloroethane	N-Nitrosoodimethylamine	2,4,6-Trichlorophenol	Aldrin
Trickloroethylene	Isophorone	Pentachloroanisole	4-Nitrophenol	Endosulfin I
1,1,2-Trichloroethane	Bis (2-Chloroethoxy) Methane	Benzo (b) Fluoranthene	4,6-Dinitro-O-Cresol	PP'(4,4") DDE
Dibromochloromethane	1,2,4-Trichlorobenzene	Benzo (ghi) Perylene	Penta chlorophenol	Dieldrin
Tetrachloroethylene	Naphthalane	Dibenzo (a,h) Anthracene	2,4-Dinitrophenol	Endrin
Chlorobenzene	Hexcachlorobutadiene	Indeno (1,2,3-cd) Pyrene	Benzonic Acid	PP'(4,4") DDD
Trichlorofluoromethene	Hexachlorocyclopentadiene	Aniline	o-Cresol	Endosulfin II
Trans-1,2-Dichloroethylene	2-Chloronaphthalene	Benezl alcohol	p-Cresol	PP'(4,4") DDT
1,2-Dichloroethane	2,6-Dinitrotoluene	4-Chloroaniline	2,4,5-Trichlorophenol	Endosulfin Sulfate
1,1,1-Trichloroethane	Dimethylphthalate	2-Methylnaphthalene		Methoxychlor
Bromodichloromethane	Acenaphthalene	3-Nitroaniline	**PCBs**	Chlordane
Trans-1,3-Dichloroepropene	Acenaphtene	Dibenzofuran	PCB-1221	Toxaphene
Cis-1,3-Dichloropropene	2,4-Dinitrotoluene	4-Nitroaniline	PCB-1232	Endrin Aldehyde
Bromoform	Diethylphthalate	2-Nitroaniline	PCB-1016	
1,1,2,2-Tetrachloroethane	Fluorene		PCB-1242	
2-Chloroethylvinylater	N-Nitrosodiphenylamine		PCB-1248	
	4-Bromophcnylphenylether		PCB-1254	
Nonhalogenated	Hexachlorabenzene		PCB-1260	
Methyl ethyl ketone (MEK)	Phenathrene			
Methyl isobutyl ketone (MIBK)	Anthracene			
	Di-N-Butylphthalate			
Aromatic	Fluoranthene			
Benzene	Pyrene			
Toluene	Butylbenzylphthalate			
Ethyl benzene	Benzo (A) anthracene			
Xylenes (MO P)	Chrysene			

Figure 65. *Location of Indiana's CORE Monitoring Stations*



wastewater for potentially toxic effects. These tests can measure both acute (short-term) and chronic (long-term) effects on aquatic life).

The elimination of the discharge of toxic substances in toxic amounts is accomplished for the most part through the NPDES permits program. After a potentially toxic discharge is identified, its toxicity is controlled by issuing water quality based discharge permits for individual toxicants identified in the effluent. Numerical criteria for approximately 90 substances and procedures for determining criteria for others were included in the State's water quality standards revisions which went into effect in 1990. When it is uncertain if toxic substances are present in a discharge, when site specific conditions are suspected to possibly increase or modify the toxic effects of a discharge, or when more than one toxicant may create additive or antagonistic effects, the permit may include a toxicity testing requirement.

The State also requires toxicity reduction evaluations (TREs) in the cases where toxicity requirements are not met. A TRE is used to determine what measures are necessary to control effluent toxicity. This could include bench scale treatability studies, spill control procedures or process modifications in which the identification of specific toxicants is not necessary.

Biological Monitoring Program

Biological monitoring involves the intermittent sampling of the biological resources of Indiana lakes, rivers, and streams to assess and monitor the various components of the biological community including fish, aquatic invertebrates, algae, and bacteria. These biological measurements are used to assess and monitor the long-term temporal changes of the ecological condition of our lakes, rivers and streams. Biological community data, by its nature integrates the cumulative effects of all successive environmental perturbations and stressors.

Biological data has been collected and analyzed by this agency and its predecessor for many years. Above and below comparisons of the actual effects point source discharges were having on the extant biological communities have served instrumental in providing the necessary data to have such point sources either removed or their effluent quality increased to an acceptable level. The agency has also been collecting and analyzing fish tissue samples to test for the presence of toxic substances for over 19 years. Periodic comprehensive studies of entire watersheds have been conducted, as needed, to evaluate the status of the complete cross section of biological communities. The state of Indiana has addressed and included narrative biological criteria in its water quality standards to prevent degradation of these biological resources for many years.

The Indiana Water Quality Standards (WQS) protect the surface waters of the state with regulations and policies of non-degradation. These non-degradation policies require that existing beneficial uses be maintained and protected and that no degradation be permitted which would interfere with, or become injurious to existing and potential uses of our surface waters. Specific surface waters of the state have also been designated for specific multiple uses. If a particular body of water has several designated uses, then the most protective of all the simultaneously applicable standards are applied to protect the waterbody. Both the warm water and cold water aquatic communities are recognized within the multiple use classification system and protected under Indiana's narrative biological criteria.

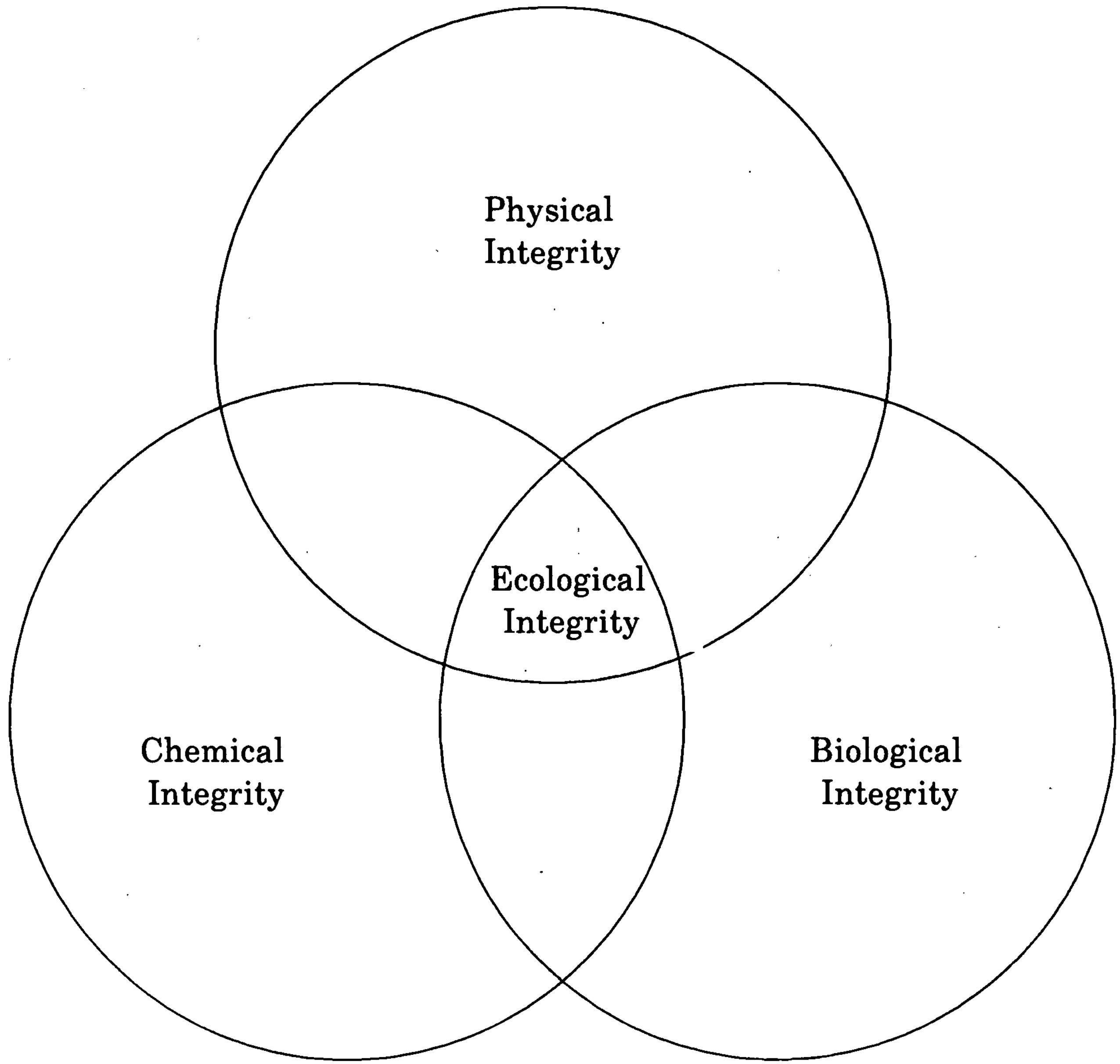
Indiana has an "Exceptional Use" classification to provide more stringent protection to waters which possess unusual aquatic habitat, which are an integral feature of an area of exceptional natural beauty or character, or support unique assemblages of aquatic organisms. Historically some streams have been found incapable of supporting diverse communities of fish and other aquatic life during much of the year simply because there is not enough water, food, or suitable habitat present to support them; no matter how high the water quality might be. The state has established a "Limited Use" designation for some of these streams. At present, 34 stream reaches (77 stream miles) are designated for "Limited Use" and 11 are designated for "Exceptional Use" (181 stream miles).

The biological monitoring program begins with a comprehensive habitat assessment component using two different numerical assessments. These assessments are performed at all sites where biological sampling and/or evaluations are carried out. During these habitat assessments numerical evaluations are made regarding the physical, chemical, and riparian/watershed character of the stream. These habitat assessments are used with the biological assessments to determine the overall ecological integrity of a stream or stream segment.

Biological monitoring, when used with chemical, and physical assessments, provide a holistic and complete picture of the ecological integrity of the lotic or flowing water system. "Ecological Integrity" is the condition of an unimpaired ecosystem, as measured by combined chemical, physical, and biological attributes (Figure 66). An ecological assessment is an evaluation of the condition of a waterbody using biological, water quality, and physical habitat evaluations. It should be noted that water quality is only one element of this complete picture.

In terms of measuring biological integrity the task becomes the collecting and interpretating of biological information in such a way as to be useful in evaluating the overall biological integrity of some defined segment of the aquatic community. the two aquatic communities typically used in biological assessments are the fish community (201 species within Indiana) and the benthic macroinvertebrate community. While the fish community is well known to the general public, the benthic macroinvertebrate community provides a much more diverse group of animals from which monitoring of

Figure 66. *Conceptual model of the ecological integrity of Indiana lakes and streams*



ecological integrity can be made. The macroinvertebrate segment of the aquatic community live mostly on the stream bottom and are exposed to all the chemical, physical, and biological stresses imposed on the aquatic system upstream of where they live. Biological integrity also integrates the affects of these stressors over an entire year since the compositional components of the invertebrate community complete their lifecycle under the degree of impairment imposed on them over their lifecycle, which is typically one year.

By their nature biological measurements are a collective measurement of all stresses on Ecological Integrity. The biological community imprints into its compositional, structural, and functional organization all stresses; not only reflecting the stresses at the immediate site sampled, but the collective "ecological integrity" of all aspects of the system upstream. Biological integrity therefore has three community components from which measurements can be made (Figure 67). These three components include compositional integrity, which is the species composition of the biological community; structural integrity, which is a description of how the numerical abundance of those species are arranged within the community; and functional integrity which is the organizational structure of groups of species having similar functional roles within the biological community. A numerical evaluation of the biological community and its biological condition would best be served by incorporating numerical characteristics from each of these three components.

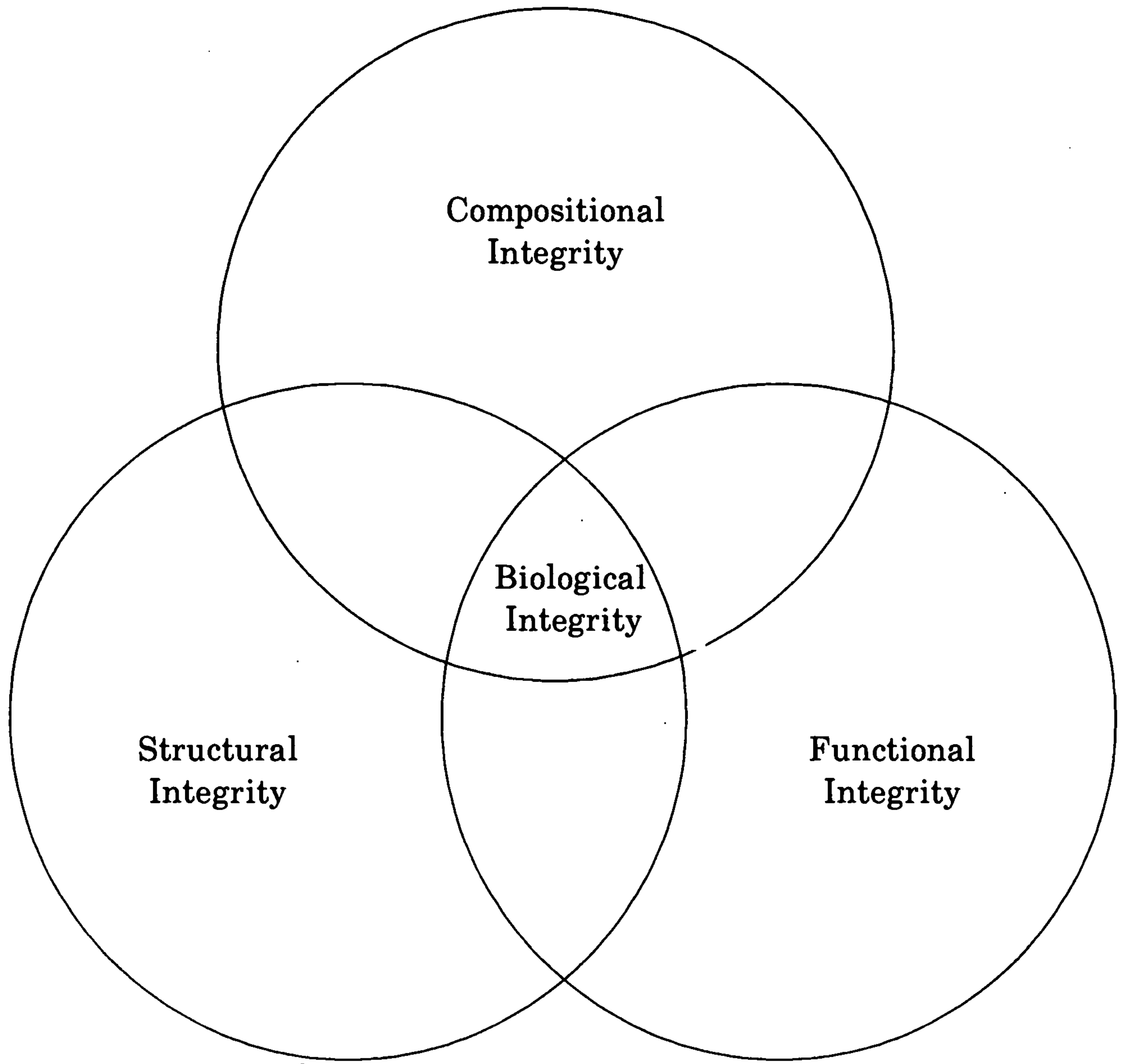
As we approach and enter the 21st century, and as we continue to achieve improvements in the quality of point source discharges within the state, the overall ecological integrity of our streams and rivers will be controlled by more subtle sources of pollution such as non-point pollution. Biological monitoring, which, by its nature integrates the cumulative effects of all environmental stressors, provides an appropriate and timely tool to measure and detect such forms of pollution.

The biological monitoring program also includes the bioassay testing of effluent by this agency, as discussed in the Toxic Monitoring Programs Section.

Fish Community Monitoring Program

During this four year period our agency has been working with U.S. EPA - Region V to establish an extensive and unified effort to evaluate the biological integrity of Indiana rivers and streams using the fish communities which are living within the various waterbodies. The fish communities of the state's rivers and streams are being sampled and a fish community Index of Biotic Integrity (IBI) is being calculated and calibrated specifically for our state (Simon, T.P. 1991, 1992, 1994). This data network will supplement

Figure 67. *Conceptual model of the three components of biodiversity used in deriving metrics for assessing biological integrity of Indiana lakes, rivers, and streams*



chemical information to document and better understand the long term and cumulative effective of successive perturbations on Indiana waterbodies.

Benthic Macroinvertebrate Program

IDEM personnel have been sampling the benthic macroinvertebrate communities living within Indiana rivers and streams using Rapid Bioassessment Protocols (RBP's) (Plafkin, J.L., et al 1989). These data will be used to provide a long term database to determine and establish a level -of-expectation data set, as well as provide a database from which changes in the biological integrity of our streams can be monitored.

In the last four years over 2000 benthic macroinvertebrate samples have been collected at 439 different sites on 305 different rivers and streams in Indiana. These sampling sites are presented in Figure 68. At this time about 81% of the geographical area of the state has been sampled. These samples represent about 28,663 square miles of the state.

This five year project entails a long term commitment of IDEM to accumulating an extensive unified database from which comparisons of ecological integrity can be made at this time and in the future. Constraints on resources, including staffing, necessitates a multi-phase program to provide a scientifically defensible database from which enforcement actions can be made in the future.

Figure 69 presents the stages of an observational ecological study such as this present project (Noy-Meir 1970). Such studies are multivariate and rely heavily on mathematical methods to elucidate and describe patterns in the data with the ultimate goal of correlating these patterns with environmental relationships. As can be seen by their nature such studies are complex and require a long term commitment to obtain the data which are necessary for acceptable data quality objectives. Data Quality Objectives (DQO's) are qualitative and quantitative statements developed by data users to specify the quality of data needed to support specific decisions. The IDEM macroinvertebrate program, as stated earlier, is a five year project just to complete the field sampling. The collections made each year, once these samples are enumerated and taxonomically processed and entered into our computer database, stand as an independent data set allowing analysis to proceed at multiple levels. This results in useable data for enforcement and management decision making, once each year's data set has been collected, processed and analyzed. Applicability and refinement of this data set, and thus its usability, increases as the project progresses.

The RBP III study utilizes the benthic macroinvertebrate communities which live within Indiana rivers and streams. Only a general overview of the experimental design and standard operating procedures (SOP's) being used in

Figure 68. *Benthic macroinvertebrate sampling sites sampled from 1990-1993*

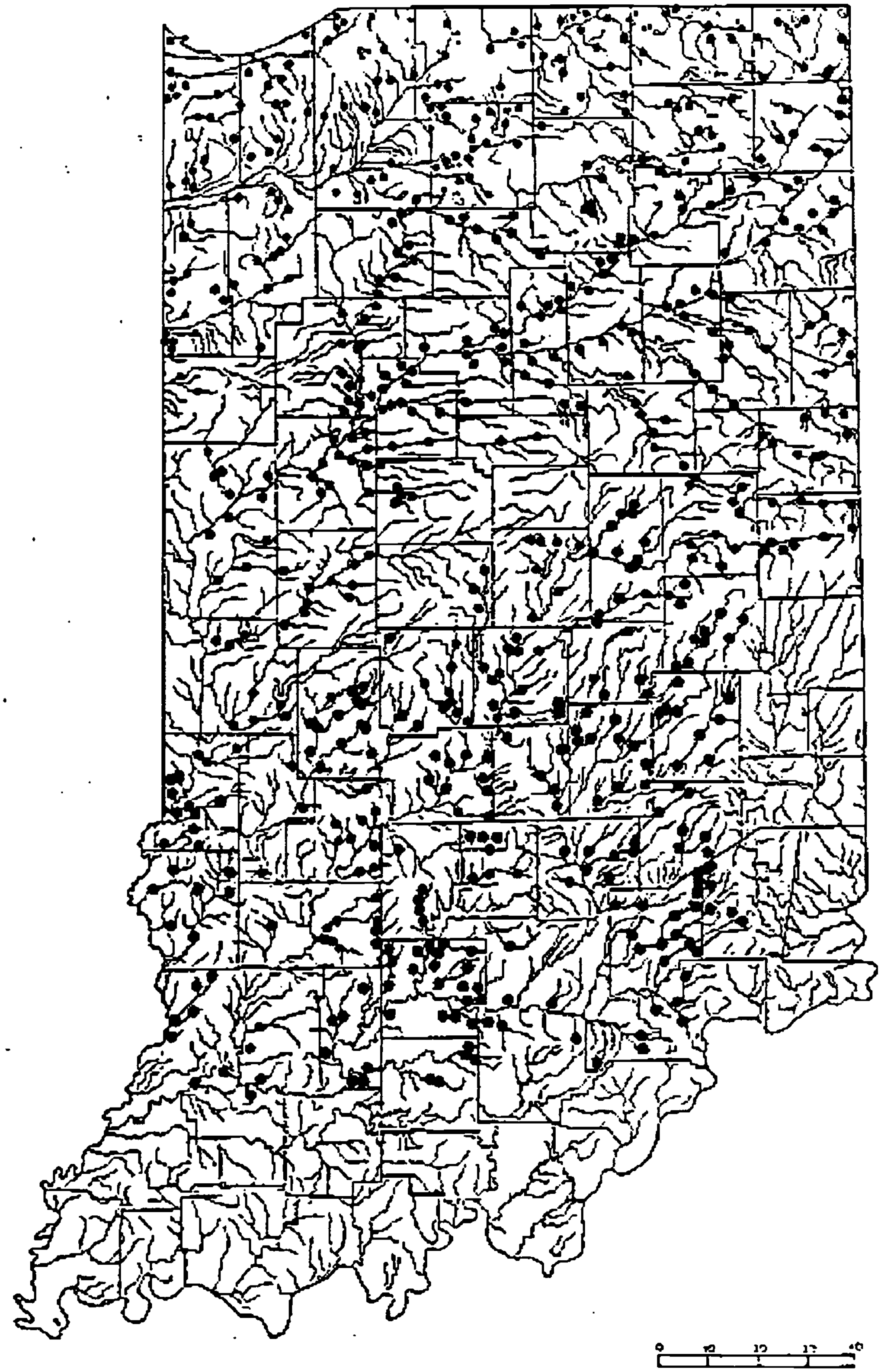
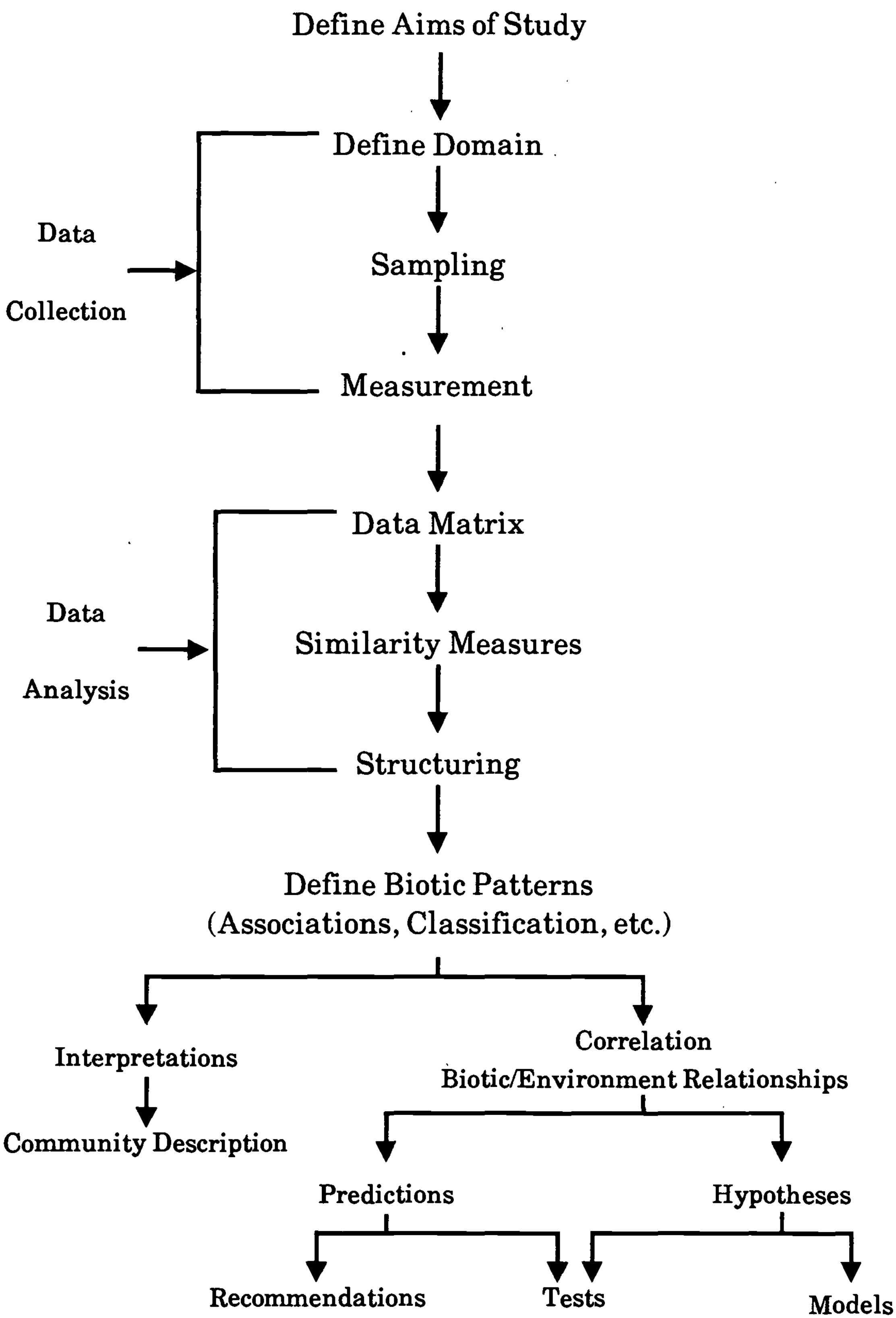


Figure 69. *IDEM biocriteria development stages*



this project can be presented here. Biological samples, which require several thousand fragmentations of each original sample result in a QA/QC challenge and rely heavily on strict sample labeling and tracking protocols. Only a general overview of these protocols can be addressed in this report. A complete QA/QC overview can be found in the project Quality Assurance Project Plan (QAPjP) (IDEM 1994a).

Data collection consists of sampling streams or rivers to obtain a representative benthic macroinvertebrate riffle-community sample using a standard kick-screen sampling device. Two 1 square meter samples are composited into one sample, which is preserved in the field. A second sample of the Coarse Particulate Organic matter (CPOM) community is also obtained at each site and preserved. These two samples are returned to the laboratory for sorting and processing. Quality control procedures require a 10% field duplicate rate, so for every ten sites duplicate KICK and CPOM samples are collected.

Samples are logged into a data tracking, labeling, and report-generating computer system designed for this project called MACROTRAK. Samples are logged into the system as soon as the field notebook is returned to the laboratory. Laboratory processing consists of sub-sampling each field sample. This sub-sampling results in two sub-samples for each field sample, which are designated 100-ORG and 15-MIN sub-samples. Laboratory duplicates are also carried out on 10% of the field samples and are flagged with the addition of 0.5 on the MACROTRAK samples number. The complete descriptions and methods can be found in the Biological Studies Section Standard Operating Procedures Manual (IDEM 1992).

As stated earlier, this procedure has resulted in over 2,000 sub-samples for the 439 sites sampled to-date. These sub-samples are further fragmented within a two phase taxonomic identification and enumeration procedure. Phase I processing consists of curation of sub-samples into 15 artificial groups; roughly along ordinal level taxonomic lines. Identifications and enumerations are made at the family taxonomic level. These family level identifications and counts are entered into a database for a preliminary round of community and biotic integrity metrics for preliminary site classification and analysis. Phase II involves the completion of all identifications to the lowest taxonomic level possible for all specimens collected. This two phase approach to specimen identification allows the greatest control over the QA/QC problems associated with non-continuity of taxonomic identification. This problem is minimized since all identifications within a homogeneous taxonomic group are completed by one taxonomist.

Family level identifications (Phase I) have provided data, in the course of the development of this program, usable for preliminary assessment, classification, and screening of sites to detect biological impairment. Figures

70 and 71 summarize the results of this project to-date and demonstrate how biological integrity measurements, in this case a provisional mIBI, can be used to evaluate "ecological integrity" of the 439 sites sampled on the 305 rivers and streams sampled so far.

The provisional Macroinvertebrate Index of Biotic Integrity (mIBI) is a provisional index developed to evaluate the condition of the sites sampled to-date and to evaluate a series of ten preliminary sub-metrics prior to the completion of a state-wide classificatory database. The provisional mIBI allows the classification of the family level information collected at each site to be evaluated on a 0-8 scale with 0 representing a severely impaired biological condition and 8 representing an unimpaired biological condition. The scoring criteria for each of the ten family level metrics were derived by using pentasection (Metric Scores = 0, 2, 4, 6, or 8) of the 95th percentile and the minimum value range (using nlog x or nlog x + 1) of the individual metrics for the 1990-1992 riffle kick samples. The mIBI is the average score of the sum of the ten family level metrics using these derived scoring criteria. The complete derivation and explanation of this procedure is presented in IDEM 1994b. The four impairment categories (Figures 70 and 71) were determined after scoring each sample relative to its mIBI. The horizontal categorical lines in Figure 70 delimit the four impairment categories for biological condition and the vertical lines delimit these categories in Figure 71. Figure 70 shows the extant database for Indiana, showing the QHEI habitat assessment as a function of the biological condition of the site as represented by the mIBI.

Barbour and Stribling (1990) propose a theoretical relationship between ambient stream biological communities when compared to reference condition. The statistical nature of the IDEM data set has allowed us to use this relationship and examine Indiana data. The proposed relationship (Barbour and Stribling 1990) suggests that a sigmoid relationship defines three general outcomes when measuring ambient biological condition when examined against habitat condition: 1) no biological effects, or effects due to habitat degradation, on the curve; 2) effects due to water quality, below the curve or 3) an artificial elevation of the perceived condition of the community beyond the expected relationship because of mild enrichment effects, above the curve. The relationship expressed in Figure 70 allows all biological samples and sites to be classified relative to this model. It results in four possible biologically measurable impairment categories and three habitat categories:

Biological Categories

1. Nonimpaired
2. Slightly Impaired
3. Moderately Impaired
4. Severely Impaired

Habitat Categories

1. Supporting
2. Partially Supporting
3. Nonsupporting

Figure 70. *The QHEI habitat score versus the provisional MIBI classification categories and theoretical relationship of biotic condition and habitat quality using the 1990-1992 benthic macroinvertebrate data*

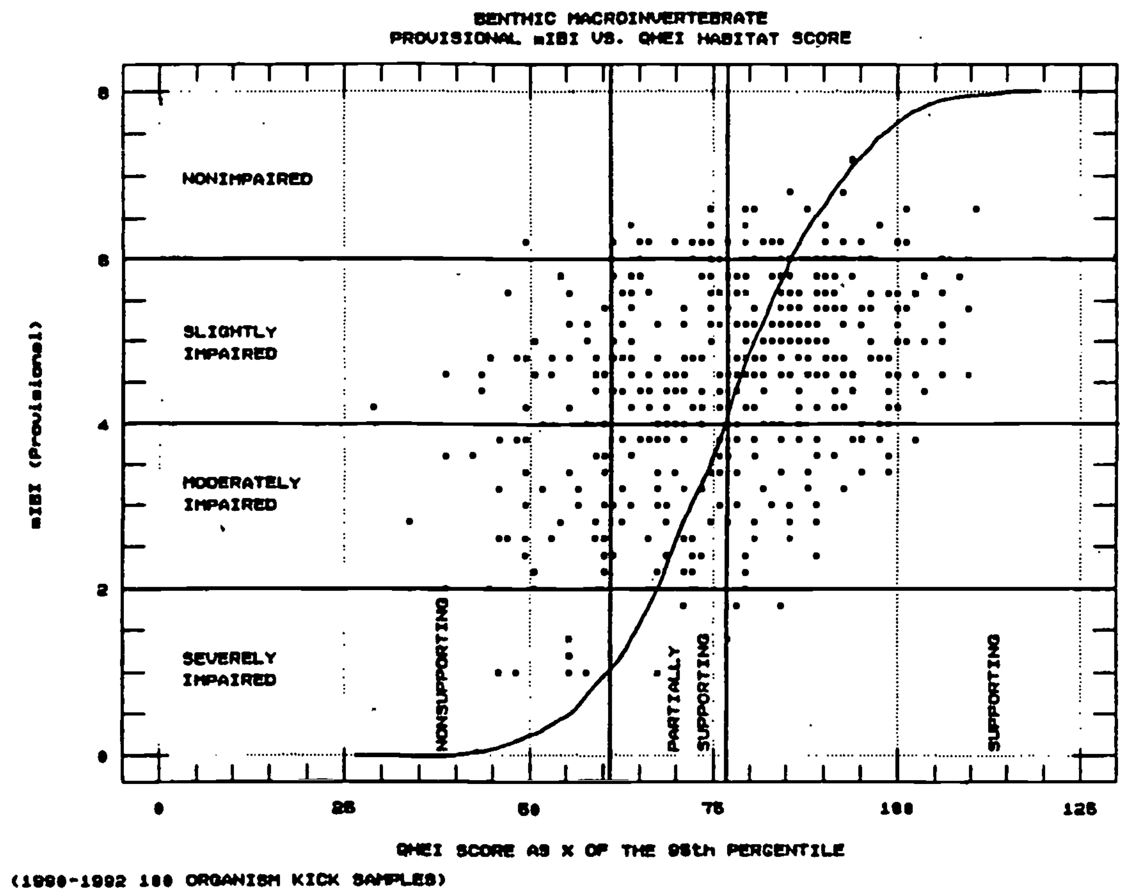
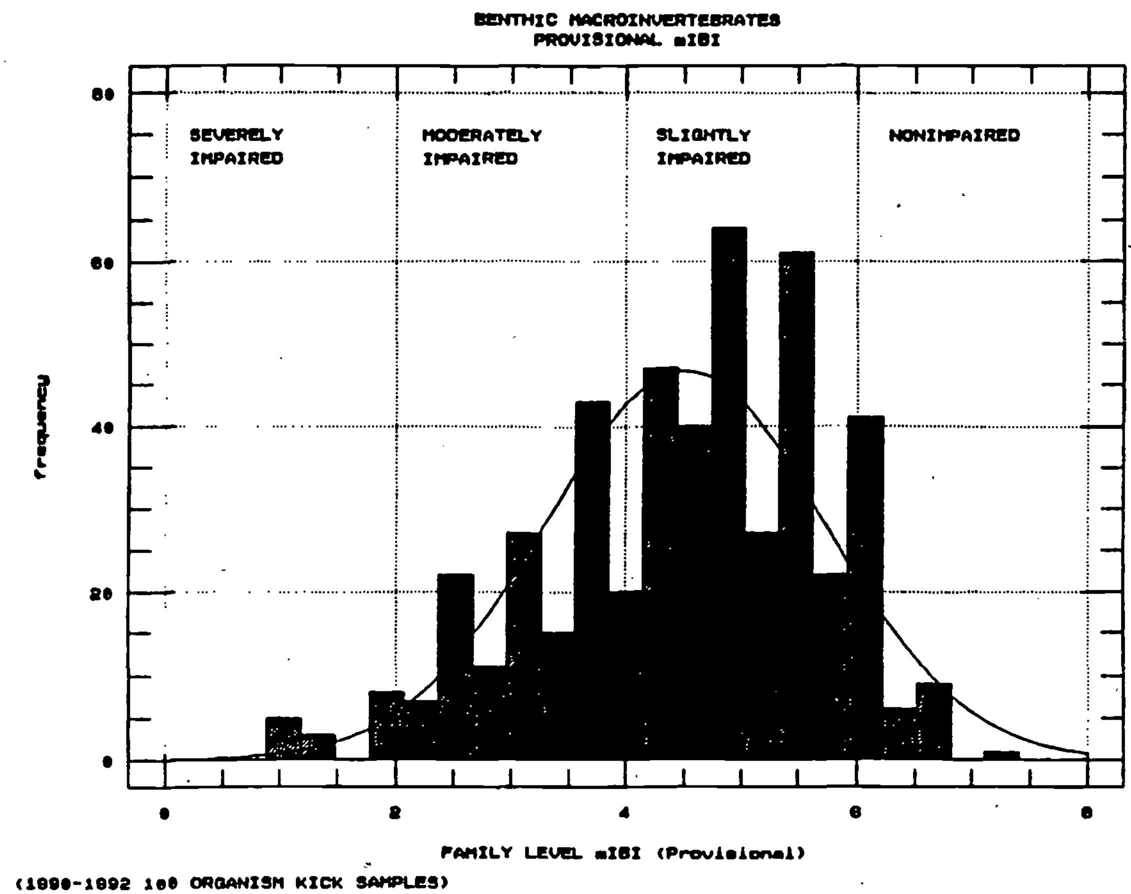


Figure 71. *The distribution of the biotic condition of indiana benthic macroinvertebrate samples using a provisional MIBI multimetric and the 1990 - 1992 100 organism kick samples*



For comparative purposes the QHEI habitat score in Figure 70 is expressed as percent of reference condition which, in this case, is the 95th percentile of the QHEI (QHEI = 83). The "theoretical" segmoid curve in this figure was determined by deriving the empirical ratio of the mIBI/QHEL, expressed as a cumulative frequency curve and positioned relative to the geometric mean of the QHEI. the QHEI classification categories are bounded by the geometric mean of the QHEI scores and less one log-normal standard deviation below the mean. This range is designated as "partially supporting", while the area above is designated "supporting" and the area below as "nonsupporting" relative to habitat. As can be seen in Figure 71, the "typical" sample found within the state to-date presents a "slightly impaired" condition. The habitat score or condition is then used to modify and/or explain the biological condition. Those sites which are " moderately" and "severely impaired" biologically are of concern. The sites which are in these two categories are of particular concern if the habitat quality is "partially supporting" to "supporting"; since the Barbour and Stribling model (1990) would suggest that they are biologically impaired due to water quality impairment such as toxicant(s) or organic pollution effects.

Using this technique, it is possible to initially screen those samples and sites which are possibly biologically impaired and target these watersheds for further investigation. It is important to remember that a biological measurement is a collective measurement of all aspects of the "ecological integrity" (Figure 66), not only of the site sampled but to some degree as reflection of the collective ecological integrity of all stressors upstream of the site being evaluated. Table 60 uses this multimetric classification procedure to examine all sites sampled in 1992. The sites sampled in 1993, due to staffing and other priorities, are yet to be processed within the laboratory. Table 61 provides a list of all sites and samples collected during the period of this report, 1992-1993.

It should be noted that in using a family level provisional mIBI, "cold water" effects can theoretically reflect a toxic type impairment signature. Thus, sites screened by this method, and showing impairment should be evaluated for the possibility of an in-stream coldwater biological community effect due to natural groundwater or spring fed habitat. Future sub-metrics or lower level taxonomic considerations should isolate these "false positive" signatures.

Family level identifications (Phase I) have been shown to provide biological data adequately sensitive for the detection of gross biological perturbations in the biological community. Phase II identifications will provide the data sensitivity to identify subtle difference in the biological integrity of the sites and systems sampled. Final metric development from which correlations and predictive relationships, between all

Table 60. *Bioassessment summary table including habitat assessment categories for the 1992 benthic macroinvertebrate samples*

LOCATION	COUNTY	HYDROLOGIC UNIT	*BIOLOGICAL IMPAIRMENT CATEGORY	@HABITAT IMPAIRMENT CATEGORY
Honey Creek Sections 16 & 17 Boundary	Vigo Co.	Mid/Lower Wabash Basin	Moderately Impaired	Partially Supporting
Trib. of Honey Creek Sec. 21 Between NS1/4 & SW1/4	Vigo Co.	Mid/Lower Wabash Basin	Slightly Impaired	Supporting
Bell Creek C.R. 350S	Delaware Co.	Upper W.F. White River Basin	Slightly Impaired	Supporting
Buck Creek C.R. 428W C.R. 700S	Delaware Co.	Upper W.F. White River Basin Upper W.F. White River Basin	Slightly Impaired Severely Impaired	Supporting Supporting
Cabin Creek Windsor Pike	Randolph Co.	Upper W.F. White River Basin	Slightly Impaired	Supporting
Cicero Creek Whistler Road	Hamilton Co.	Upper W.F. White River Basin	Moderately Impaired	Partially Supporting
Cool Creek E. 116th St.	Hamilton Co.	Upper W.F. White River Basin	Slightly Impaired	Partially Supporting
Crooked Creek W. 42nd St.	Marion Co.	Upper W.F. White River Basin	Moderately Impaired	Nonsupporting
Deer Creek Mechanicsburg Road	Henry Co.	Upper W.F. White River Basin	Nonimpaired	Supporting
Duck Creek Brehm Road	Hamilton Co.	Upper W.F. White River Basin	Slightly Impaired	Supporting
Eagle Creek S.R. 32	Boone Co.	Upper W.F. White River Basin	Slightly Impaired	Supporting
Eagle Creek Dandy Trail S.R. 40	Marion Co.	Upper W.F. River Basin Upper W.F. White River Basin	Slightly Impaired Moderately Impaired	Supporting Supporting
East Fork White Lick Cr. C.R. 800S	Hendricks Co.	Upper W.F. White River Basin	Moderately Impaired	Partially Supporting
Fall Creek Mechanicsburg Road Mechanicsburg Road (F) Mechanicsburg Road (F L)	Henry Co.	Upper W.F. White River Basin Upper W.F. White River Basin Upper W.F. White River Basin	Slightly Impaired Moderately Impaired Moderately Impaired	Supporting Supporting Supporting

Table 60. *Bioassessment summary table including habitat assessment categories for the 1992 benthic macroinvertebrate samples (cont.)*

LOCATION	COUNTY	HYDROLOGIC UNIT	*BIOLOGICAL IMPAIRMENT CATEGORY	@HABITAT IMPAIRMENT CATEGORY
Fall Creek C.R. 750W Falls Park, Pendleton, IN S.R. 109	Madison Co.	 Upper W.F. White River Basin Upper W.F. White River Basin Upper W.F. White River Basin	 Slightly Impaired Moderately Impaired Slightly Impaired	 Supporting Nonsupporting Partially Supporting
Fall Creek Emerson Ave., Indpls., IN	Marion Co.	 Upper W.F. White River Basin	 Nonimpaired	 Supporting
Hinkle Creek E. 216th St. E. 216th St. (F) E. 216th St. (F L)	Hamilton Co.	 Upper W.F. White River Basin Upper W.F. White River Basin Upper W.F. White River Basin	 Slightly Impaired Slightly Impaired Nonimpaired	 Supporting Supporting Supporting
Honey Creek C.R. 900N	Henry Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Supporting
Indian Creek C.R. 200N	Madison Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Supporting
Indian Creek Low Gap Road Taggart Crossing	Morgan Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Partially Supporting
Jackson Run West 146th (C.R. 300S)	Boone Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Supporting
Killbuck Creek Grand Ave., Anderson, IN	Madison Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Partially Supporting
Lick Creek S.R. 13	Madison Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Partially Supporting
Little Cicero Creek E. 266th St.	Hamilton Co.	 Upper W.F. White River Basin	 Moderately Impaired	 Supporting
Little Eagle Creek Michigan St., Indpls., IN	Marion Co.	 Upper W.F. White River Basin	 Moderately Impaired	 Partially Supporting
Little Killbuck Creek C.R. 360N	Madison Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Partially Supporting
Mounts Run C.R. 950E	Boone Co.	 Upper W.F. White River Basin	 Slightly Impaired Supporting	 Supporting
Mud Creek C.R. 1100N	Madison Co.	 Upper W.F. White River Basin	 Slightly Impaired	 Nonsupporting

Table 60. *Bioassessment summary table including habitat assessment categories for the 1992 benthic macroinvertebrate samples (cont.)*

LOCATION	COUNTY	HYDROLOGIC UNIT	*BIOLOGICAL IMPAIRMENT CATEGORY	@HABITAT IMPAIRMENT CATEGORY
Pipe Creek	Madison Co.			
C.R. 200W, D/S Alexandria, IN		Upper W.F. White River Basin	Moderately Impaired	Partially Supporting
U/S Alexandria, IN WWTP		Upper W.F. White River Basin	Moderately Impaired	Partially Supporting
Washington Ave., Frankton, IN		Upper W.F. White River Basin	Slightly Impaired	Partially Supporting
Pleasant Run Creek	Marion Co.			
South West St., Indianapolis		Upper W.F. White River Basin	Moderately Impaired	Partially Supporting
Sparrow Creek	Randolph Co.			
Base Road		Upper W.F. White River Basin	Slightly Impaired	Supporting
Stoney Creek	Randolph Co.			
Windsor Pike		Upper W.F. White River Basin	Slightly Impaired	Supporting
Stoney Creek	Hamilton Co.			
E. 166th St. & Cumberland Road		Upper W.F. White River Basin	Nonimpaired	Partially Supporting
Taylor Creek	Hamilton Co.			Partially Supporting
E. 266th St.		Upper W.F. White River Basin	Slightly Impaired	
West Fork White Lick Cr.	Hendricks Co.			
D/S Danville @ R.R.		Upper W.F. White River Basin	Slightly Impaired	Supporting
Martin Road Cartersburg, IN		Upper W.F. White River Basin	Slightly Impaired	Supporting
West Fork White River	Delaware Co.			
Camp Redwing		Upper W.F. White River Basin	Slightly Impaired	Supporting
High Street, Muncie, IN		Upper W.F. White River Basin	Moderately Impaired	Supporting
West Fork White River	Madison Co.			
Jackson Ave., Anderson, IN		Upper W.F. White River Basin	Moderately Impaired	Partially Supporting
Perkinsville, IN		Upper W.F. White River Basin	Nonimpaired	Supporting
West Fork White River	Marion Co.			
Holiday Park, Indpls., IN		Upper W.F. White River Basin	Slightly Impaired	Supporting
Holiday Park, Indpls., IN (F)		Upper W.F. White River Basin	Slightly Impaired	Supporting
Holiday Park, Indpls., IN (F L)		Upper W.F. White River Basin	Slightly Impaired	Supporting
Southwest Way Park		Upper W.F. White River Basin	Moderately Impaired	Supporting
West Fork White River	Randolph Co.			
C.R. 1100W		Upper W.F. White River Basin	Slightly Impaired	Supporting
Union City Pike		Upper W.F. White River Basin	Slightly Impaired	Supporting
White Lick Creek	Hendricks Co.			
C.R. 100N		Upper W.F. White River Basin	Slightly Impaired	Supporting
C.R. 100N (F)		Upper W.F. White River Basin	Nonimpaired	Supporting
C.R. 100N (F L)		Upper W.F. White River Basin	Slightly Impaired	Supporting
C.R. 500N (Tilden Road)		Upper W.F. White River Basin	Moderately Impaired	Supporting
C.R. 600S		Upper W.F. White River Basin	Slightly Impaired	Supporting

Table 60. *Bioassessment summary table including habitat assessment categories for the 1992 benthic macroinvertebrate samples (cont.)*

LOCATION	COUNTY	HYDROLOGIC UNIT	*BIOLOGICAL IMPAIRMENT CATEGORY	@HABITAT IMPAIRMENT CATEGORY
White Lick Creek (cont.)	Hendricks Co.			
C.R. 700E		Upper W.F. White River Basin	Slightly Impaired	Supporting
U.S. 40		Upper W.F. White River Basin	Slightly Impaired	Supporting
White Lick Creek	Morgan Co.			
C.R. 600N		Upper W.F. White River Basin	Moderately Impaired	Nonsupporting
Williams Creek	Marion Co.			
College Ave., Indpls., IN		Upper W.F. White River Basin	Nonimpaired	Partially Supporting
Buck Creek	Greene Co.			
S.R. 54 E. of Linton, IN		Lower W.F. White River Basin	Slightly Impaired	Nonsupporting
East Fork Fish Creek				
C.R. 475W	Owen Co.	Lower W.F. White River Basin	Moderately Impaired	Supporting
Vandalia, IN		Lower W.F. White River Basin	Slightly Impaired	Supporting
Hawkins Creek	Daviess Co.			
Conrail R.R., Maysville, IN		Lower W.F. White River Basin	Severely Impaired	Supporting
Jack's Defeat Creek	Monroe Co.			
Old Dutch Church Road		Lower W.F. White River Basin	Moderately Impaired	Supporting
Old Dutch Church Road (F)		Lower W.F. White River Basin	Slightly Impaired	Supporting
Old Dutch Church Road (F L)		Lower W.F. White River Basin	Slightly Impaired	Supporting
Kessinger Ditch	Knox Co.			
C.R. 1000E		Lower W.F. White River Basin	Slightly Impaired	Supporting
Limestone Creek	Owen Co.			
C.R. 325E		Lower W.F. White River Basin	Slightly Impaired	Supporting
Little Mill Creek	Owen Co.			
C.R. 25E		Lower W.F. White River Basin	Slightly Impaired	Supporting
Little Richland Creek	Greene Co.			
U/S Hendricksville, IN		Lower W.F. White River Basin	Slightly Impaired	Partially Supporting
U/S Hendricksville, IN (L)		Lower W.F. White River Basin	Slightly Impaired	Partially Supporting
McCormick's Creek	Owen Co.			
McCormick's Cr. State Park Falls		Lower W.F. White River Basin	Moderately Impaired	Supporting
Plass Ditch	Knox Co.			
S.R. 241, Decker, IN		Lower W.F. White River Basin	Slightly Impaired	Nonsupporting
Plummer Creek	Greene Co.			
C.R. 150E		Lower W.F. White River Basin	Slightly Impaired	Supporting
C.R. 200S E. Of Mineral City		Lower W.F. White River Basin	Moderately Impaired	Nonsupporting
S.R. 231		Lower W.F. White River Basin	Slightly Impaired	Supporting

Table 60. *Bioassessment summary table including habitat assessment categories for the 1992 benthic macroinvertebrate samples (cont.)*

LOCATION	COUNTY	HYDROLOGIC UNIT	*BIOLOGICAL IMPAIRMENT CATEGORY	@HABITAT IMPAIRMENT CATEGORY
Prairie Creek	Daviess Co.			
S.R. 57		Lower W.F. White River Basin	Moderately Impaired	Nonsupporting
Raccoon Creek	Owen Co.			
C.R. 75E		Lower W.R. White River Basin	Slightly Impaired	Supporting
Freeman, IN		Lower W.F. White River Basin	Slightly Impaired	Supporting
Rattlesnake Creek	Owen Co.			
C.R. 50S		Lower W.F. White River Basin	Moderately Impaired	Partially Supporting
Richland Creek	Greene Co.			
Furnace Road, E. Of Furnace, IN		Lower W.F. White River Basin	Slightly Impaired	Supporting
U/S Bridge C.R. 460E		Lower W.F. White River Basin	Moderately Impaired	Supporting
U/S Bridge C.R. 460E (F)		Lower W.F. White River Basin	Moderately Impaired	Supporting
U/S Bridge C.R. 460E (F L)		Lower W.F. White River Basin	Moderately Impaired	Supporting
Big Walnut Creek	Putnam Co.			
Reelsville, IN		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Wildwood Bridge		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Bledsoe Branch	Putnam Co.			
C.R. 380E		Eel River/Big Walnut/Mill Cr.	Moderately Impaired	Partially Supporting
Clear Creek	Putnam Co.			
C.R. 370E		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Partially Supporting
Croys Creek	Clay Co.			
6 East Road		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Deer Creek	Putnam Co.			
C.R. 350S		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
C.R. 350S (F)		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
C.R. 350S (F L)		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Falls Branch	Putnam Co.			
C.R. 250N		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Ferguson Branch	Putnam Co.			
C.R. 105S		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Jordan Creek	Clay Co.			
56 South Road		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Nonsupporting
Leatherman Creek	Putnam Co.			
1/4 Mile Above Mouth		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Little Dear Creek	Putnam Co.			
C.R. 350S		Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting

Table 60. *Bioassessment summary table including habitat assessment categories for the 1992 benthic macroinvertebrate samples (cont.)*

LOCATION	COUNTY	HYDROLOGIC UNIT	*BIOLOGICAL IMPAIRMENT CATEGORY	@HABITAT IMPAIRMENT CATEGORY
Little Walnut Creek C.R. 100S	Putnam Co.	Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Mill Creek U/S Lower Cataract Falls	Owen Co.	Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Mill Creek C.R. 1100S	Putnam Co.	Eel River/Big Walnut/Mill Cr.	Slightly Impaired	Supporting
Plum Creek C.R. 500N C.R. 500N (L)	Putnam Co.	Eel River/Big Walnut/Mill Cr.	Moderately Impaired Moderately Impaired	Partially Supporting Partially Supporting
Wabash and Erie Canal 113 West Road	Clay Co.	Eel River/Big Walnut/Mill Cr.	Nonimpaired	Nonsupporting

F = Field Duplicate, L = Laboratory Duplicate;
** = Biological Impairment Categories: Nonimpaired, Slightly Impaired, Moderately Impaired, Severely Impaired (See Text for Numeric Derivation and Definition)*
@ = Habitat Impairment Categories: Supporting, Partially Supporting, Nonsupporting (See Test for Numeric derivation and Definition.

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
Adams	St. Mary's River	US SR 101	4-Oct-93	04100004	40° 46' 45.0"/84° 50' 32.0"	57G	21	5C	550.0
Allen	Maumee River	US Sr 101	4-Oct-93	04100005	41° 10' 11.0"/84° 50' 59.0"	57G	19	6	206.4
	St. Joseph River	DS Tennessee Ave Bridge	5-Oct-93	04100003	41° 5' 21.0"/85° 7' 46.0"	55G	20	5C	1086.0
	St. Marys River	DS Spy Run Bridge	5-Oct-93	04100004	41° 5' 2.0"/85° 8' 9.0"	55G	21	5C	839.0
Bartholomew	Clifty Creek	Gladstone Rd	25-Aug-93	05120206	39° 10' 10.0"/85° 53' 36.0"	55G	74	11A	204.0
		SR 46	25-Aug-93	05120206	39° 13' 28.0"/85° 47' 46.0"	55G	74	11A	178.0
	Denios Creek	CR 150W	24-Aug-93	05120206	39° 9' 34.0"/85° 56' 22.0"	55G	74	11A	13.0
	Driftwood River	Lowell Bridge, State Access	23-Aug-93	05120204	39° 14' 16.0"/86° 58' 21.0"	55G	81	11A	1137.0
	Falls Fork	CR 1140E,DS Anderson Falls	13-Sept-93	05120206	39° 14' 16.0"/85° 41' 58.0"	55M	74	11B	37.4
	Haw Creek	CR 150E & CR 300N	27-Aug-93	05120206	39° 14' 45.0"/85° 52' 48.0"	55G	74	11A	53.0
	Little Sand Creek	SR 7 & CR 525E	27-Aug-93	05120206	39° 9' 3.0"/85° 48' 50.0"	55G	74	11A	16.5
	MF of Falls F. Clifty	CR 1200E & CR 300N	13-Sept-93	05120206	39° 14' 52.0"/85° 41' 15.0"	55M	74	11B	12.5
Boone	Eagle Creek	SR 32	17-Sept-93	05120201	40° 2' 26.0"/86° 17' 2.0"	55M	57	5B	27.0
	Jackson Run	West 146th (cr 300S)	17-Sept-93	05120201	39° 59' 51.0"/86° 17' 41.0"	55M	57	5B	7.0
	Mounts Run	CR 950E	17-Sept-92	05120201	40° 0' 55.0"/86° 17' 19.0"	55M	57	5B	16.0
Brown	Beanblossom Creek	Helmsburg Rd	7-Sept-93	05120202	39° 15' 40.0"/86° 17' 30.0"	71G	68	10B	32.5
	Bear Creek	Slippery Elm Shoot Rd	12-Oct-93	05120202	39° 16; 37.0"/86° 20' 44.0"	71G	68	10B	6.9
	Gnawbone Creek	Gnawbone Rd	2-Aug-93	05120208	39° 11' 17.0"/86° 10' 20.0"	71M	75	10B	14.0
	Jackson Creek	Yellow Wood Lake Spillway	29-Jul-93	05120208	39° 10' 35.0"/86° 20' 23.0"	71G	75	10B	6.9
	Lick Creek	Lick Creek Dr	12-Oct-93	05120202	39° 17' 7.0"/86° 17' 35.0"	71G	68	10B	5.0
	NF Bean Blossom Creek	Turner Rd	12-Oct-93	05120202	39° 16' 42.0"/86° 16' 29.0"	71G	68	10B	11.5
	North Fork Salt Creek	Green Valley Rd	29-Jul-93	05120208	39° 11' 18.0"/86° 15' 55.0"	71M	75	10B	81.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
Clay	Croys Creek	6 East Rd	15-Sept-93	05120203	39° 30' 22.0"/87° 1' 28.0"	72G	67	7B	27.0
	Jordan Creek	56 South Rd	15-Sept-93	05120203	39° 23' 11.0"/87° 0' 59.0"	72G	67	7B	39.0
	Wabash and Erie Canal	113 West Rd	16-Sept-93	05120203	39° 11' 54.0"/87° 8' 9.0"	72G	67	7B	1050.0
Crawford	Stinking Fork	W of SR 66 Hoosier NF	9-Jun-93	05140104	38° 12' 32.0"/86° 29' 12.0"	71G	96	9A	25.0
Daviess	Aikman Creek	Alex Hill Rd	26-Oct-93	05120208	38° 34' 15.0"/87° 10' 4.0"	72G	85	7A	20.0
	Hawkins Creek	Conrail RR Maysville	8-Oct-92	05120202	38° 39' 5.0"/87° 13' 36.0"	72G	70	7A	12.0
	Prairie Creek	SR 57	07-Oct-92	05120202	38° 43' 1.0"/87° 10' 1.0"	72G	70	8	120.0
Dearborn	Great Miami River	Bend US Mouth	12-Oct-93	05080002	39° 7' 1.0"/84° 49' 45.0"	71G	89	11C	2000.0
Decatur	Clifty Creek	CR 600N	14-Sept-93	05120206	39° 25' 40.0"/85° 29' 24.0"	55M	74	11B	47.0
		Vandalia Rd	13-Sept-93	05120206	39° 22' 2.0"/85° 35' 30.0"	55M	74	11B	66.5
	Cobbs Fork	CR 400S	15-Sept-93	05120206	39° 16' 43.0"/85° 26' 12.0"	55M	82	11B	12.5
	Little Flatrock River	CR 750N at CR 250W	20-Jul-93	05120205	39° 26' 36.0"/85° 31' 26.0"	55M	72	11B	54.0
	Muddy Fork	Harris City	15-Sept-93	05120206	39° 16' 56.0"/85° 31' 39.0"	55M	82	11B	19.7
	Sand Creek	CR 500S	15-Sept-93	05120206	39° 15' 52.0"/85° 32' 23.0"	55M	82	11B	52.0
	Square Run	CR 950S	19-Oct-93	05120207	39° 11' 58.0"/85° 26' 29.0"	55M	83	11B	5.6
DeKalb	Fish Creek	100 Yards US Oil Spill	5-Oct-93	04100003	41° 27' 48.0"/84° 49' 41.0"	55G	20	5C	98.0
		CR 18, DS CR 75	5-Oct-93	04100003	41° 27' 49.0"/84° 48' 41.0"	55G	20	5C	99.0
Delaware	Bell Creek	CR 350S	12-Aug-92	05120201	40° 8' 42.0"/85° 27' 3.0"	55G	61	5B	33.0
	Buck Creek	CR 428W	12-Aug-92	05120201	40° 9' 26.5"/85° 28' 3.5"	55G	61	5B	96.0
		CR 700S	12-Aug-92	05120201	40° 5' 29.0"/85° 21' 41.0"	55M	61	5B	27.0
	West Fork White River	Camp Redwing	11-Aug-92	05120201	40° 8' 42.0"/85° 19' 22.0"	55G	61	5B	213.0
		High Street Muncie	12-Aug-92	05120201	40° 11' 43.0"/85° 23' 28.0"	55G	61	5B	242.0
Dubois	Patoka River	DS 15th St Bridge E Jasper	13-Oct-93	05120209	39° 24' 3.0"/86° 54' 47.0"	72G	26	8	273.0
Elkhart	St. Joseph River	DS SR 15, Bristol	6-Oct-93	04050001	41° 43' 20.0"/85° 49' 6.0"	56G	8	4	2444.0
Gibson	Patoka River	DS SR 65	14-Oct-93	05120209	38° 23' 31.0"/87° 32' 56.0"	72M	54	8	845.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
Greene	Buck Creek	SR 54E of Linton	13-Oct-92	05120202	39° 2' 17.0"/87° 6' 61.5"	72M	70	7B	15.0
	Indian Creek	1 Mi E Hobbieville	2-Nov-93	05120208	39° 0' 9.0"/86° 41' 19.0"	71G	85	9B	24.4
		Jackson Twp. Sec 1 Bridge	2-Nov-93	05120208	39° 59' 27.0"/86° 41' 46.0	71M	85	9B	36.0
	Little Indian Creek	1st Bridge from Sec 36 Mouth	2-Nov-93	05120208	39° 0' 24.0"/86° 41' 10.0"	71G	85	9B	5.5
	Little Richland Creek	US Hendricksville	23-Oct-92	05120202	39° 7' 47.0"/86° 41' 45.0"	71G	69	9B	7.0
	Plummer Creek	CR 150E	15-Oct-92	05120202	38° 59' 35.0"/86° 54' 37.5"	71G	69	9A	65.0
		Cr 200S E of Mineral City	14-Oct-92	05120202	38° 59' 20.0"/86° 51' 57.0"	71G	69	9A	55.0
		SR 231	14-Oct-93	05120202	38° 59' 33.0"/86° 55' 44.0"	71G	69	9A	67.0
	Richland Creek	Furnance Rd	15-Oct-92	05120202	39° 0' 56.0"/86° 55' 11.0"	72G	69	9A	103.0
		US Bridge CR 460E	21-Oct-92	05120202	39° 3' 28.0"/86° 51' 35.0"	71G	69	9A	85.0
	West Fork White River	DS SR 157	15-Oct-93	05120202	39° 6' 42.0"/86° 57' 45.0"	72M	69	7B	4392.0
Hamilton	Cicero Creek	Whistler Rd	19-Aug-92	05120201	40° 10' 35.5"/86° 2' 48.0"	55M	58	5B	123.0
	Cool Creek	E 116th St	26-Aug-92	05120201	39° 5' 4.0"/86° 57' 22.0"	55M	65	5B	24.0
	Duck Creek	Brehm Rd	21-Aug-92	05120201	40° 8' 30.0"/85° 55' 13.5"	55M	59	5B	81.0
	Hinkle Creek	3 216th St	19-Aug-92	05120201	40° 6' 3.0"/86° 5' 11.0"	55M	58	5B	19.0
	Little Cicero Creek	E 266th St	19-Aug-92	05120201	40° 10' 59.0"/86° 0' 8.0"	55M	58	5B	40.0
	Stony Creek	E 166th St & Cumberland Rd	26-Aug-92	05120201	40° 1' 44.0"/85° 59' 42.0"	55M	65	5B	51.0
	Taylor Creek	E 266th St	19-Aug-92	05120201	40° 10' 32.0"/86° 3' 45.0"	55M	58	5B	8.0
	West Fork White River	US Cumberland Rd	18-Oct-93	05120201	40° 4' 27.0"/85° 59' 44.0"	55M	65	5B	858.0
Hancock	Little Sugar Creek	CR 100W	15-Jul-93	05120204	39° 42' 59.0"/85° 49' 9.0"	55M	78	5B	17.8
	Nameless Creek	CR 400S	29-Jul-93	05120204	39° 43' 41.0"/85° 40' 50.0"	55M	79	5B	16.5
	Sixmile Creek	CR 800E	29-Jul-93	05120204	39° 42' 55.0"/85° 39' 8.0"	55M	79	5B	45.6

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Sugar Creek	CR 1000N	20-Jul-93	05120204	39° 55' 51.0"/85° 41' 45.0"	55M	78	5B	38.0
		CR 100S DS Philadelphia	20-Jul-93	05120204	39° 46' 18.0"/85° 51' 42.0"	55M	78	5B	86.0
Harrison	Blue River	Stage Stop Campground	13-Oct-93	05140104	38° 12' 54.0"/86° 16' 12.0"	71M	96	9B	490.0
Hendricks	East Fork Mill Creek	CR 550W	4-Oct-93	05120203	39° 38' 43.0"/86° 37' 35.0"	55M	66	5B	24.4
	East Fork White Lick Creek	CR 800S	1-Oct-93	05120201	39° 38' 46.0"/86° 20' 48.0"	55M	56	5B	37.0
	Mud Creek	CR 1000S	4-Oct-93	05120203	39° 36' 56.0"/86° 34' 9.0"	55M	66	5B	18.0
	WF Big Walnut Creek	CR 900N	4-Oct-93	05120203	39° 53' 39.0"/86° 38' 39.0"	55M	66	5B	41.0
	West Fork White Lick Creek	DS Danville @ RR	11-Sept-92	05120201	39° 45' 12.0"/86° 30' 16.0"	55M	56	5B	29.0
		Martin Rd Cartersburg	28-Sept-92	05120201	39° 41' 57.0"/86° 27' 40.0"	55M	56	5B	44.4
	White Lick Creek	CR 100N	1-Oct-92	05120201	39° 46' 34.0"/86° 25' 15.0"	55M	56	5B	67.0
		CR 500N	25-Sept-92	05120201	39° 50' 8.0"/86° 23' 45.0"	55M	56	5B	35.0
		CR 600S	28-Sept-92	05120201	39° 40' 27.0"/86° 23' 27.0"	55M	56	5B	105.0
		CR700E	28-Sept-92	05120201	39° 41' 34.0"/86° 23' 56.0"	55M	56	5B	103.0
		US 40	17-Sept-92	05120201	39° 42' 6.0"/86° 24' 22.0"	55M	56	5B	102.0
Henry	Big Blue River	CR 400S	14-Jul-93	05120204	39° 52' 26.0"/85° 26' 20.0"	55M	71	5B	68.0
	Buck Creek	S Mill Rd	26-Jul-93	05120204	39° 48' 26.0"/85° 30' 52.0"	55M	79	5B	19.7
	Deer Creek	Mechanicsburg Rd	14-Aug-92	05120201	40° 1' 27.0"/85° 33' 22.0"	55M	63	5B	7.0
	Duck Creek	Greensboro Rd	28-Jul-93	05120204	39° 52' 22.0"/85° 33' 5.0"	55M	79	5B	27.3
	Fall Creek	Mechanicsburg Rd	14-Aug-92	05120201	40° 1' 30.0"/85° 33' 27.0"	55M	63	5B	33.0
	Flatrock River	CR 300N	15-Jul-93	05120205	39° 58' 31.5"/85° 14' 50.0"	55M	80	5B	4.5
		SR 38	15-Jul-93	05120205	39° 55' 2.5"/85° 17' 34.0"	55M	80	5B	13.4
	Honey Creek	CR 900N	14-Aug-92	05120201	40° 3' 43.5"/85° 30' 23.0"	55M	63	5B	7.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Little Blue River	SR 103	14-Jul-93	05120204	39° 57' 29.0"/85° 21' 19.0"	55M	71	5B	18.0
	Montgomery Creek	Knightstown City Park	29-Jul-93	05120204	39° 47' 30.0"/85° 32' 8.0"	55M	79	5B	22.0
	Westwood Run	Greensboro Pike	14-Jul-93	05120204	39° 53' 27.0"/85° 26' 5.5"	55M	71	5B	4.0
Jackson	Greasy Creek	CR 1050W	14-Oct-93	05120208	38° 47' 40.0"/86° 12' 40.0"	71G	84	10B	2.0
	Pond Creek	CR 650S	27-Oct-93	05120207	38° 46' 51.0"/86° 1' 56.5"	55G	76	11A	25.0
	South Fork Salt Creek	Kurtz Gaging Station	2-Aug-93	05120208	38° 57' 47.0"/86° 12' 16.0"	71M	75	10B	38.2
Jefferson	Big Creek	Rep. Twp Sec. 20 Brg NW 1/4	16-Sept-93	05120207	38° 46' 50.0"/85° 33' 1.0"	71G	76	11B	96.9
		SR 7	26-Oct-93	05120207	38° 51' 31.0"/85° 31' 10.0"	55G	76	11B	40.4
	Lewis Creek	CR 400N	27-Oct-93	05120207	38° 47' 37.5"/85° 38' 31.5"	71G	76	11B	15.0
	Little Creek	CR 850W (Rogers Rd)	26-Oct-93	05120207	38° 45' 12.0"/85° 32' 44.5"	71G	76	11B	34.7
Jennings	Brush Creek	CR 685E	18-Oct-93	05120207	39° 4' 12.0"/85° 29' 16.0"	55G	83	11B	11.4
	Flatrock Creek	CR 785E	19-Oct-93	05120207	39° 9' 52.0"/85° 27' 35.5"	55G	83	11B	3.0
	Graham Creek	CR 250S	26-Oct-93	05120207	38° 57' 26.5"/85° 29' 38.0"	55G	76	11B	45.9
		SR 7	17-Sept-93	05120207	38° 55' 44.0"/85° 33' 45.0"	55G	76	11B	77.2
	Leatherwood Creek	CR 925N	19-Oct-93	05120207	39° 7' 3.0"/85° 28' 21.0"	55G	83	11B	9.5
	Little Graham Creek	West Perimeter Jefferson PG	20-Oct-93	05120207	38° 56' 16.0"/85° 27' 53.0"	55G	76	11B	22.1
	Otter Creek	CR 190E Cherry Park Rd	15-Sept-93	05120207	38° 59' 20.0"/85° 34' 31.0"	55M	83	11B	71.0
	Sand Creek	CR 600E	14-Sept-93	05120206	39° 4' 7.0"/85° 47' 54.0"	55G	82	11A	248.0
	Sixmile Creek	SR 50	15-Oct-93	05120207	38° 58' 31.5"/85° 44' 6.0"	55G	83	11B	22.4
	Vernon Fork Muscatatuck	CR 1225N	15-Oct-93	05120207	39° 9' 53.5"/85° 27' 45.0"	55G	83	11B	38.0
		CR 225W	17-Sept-93	05120207	38° 57' 32.0"/85° 39' 8.0"	55G	76	11A	209.0
		DS Muscatatuck State	15-Oct-93	05120207	39° 2' 54.5"/85° 33' 5.0"	55G	83	11B	86.5
		SR 3	17-Sept-93	05120207	38° 58' 58.0"/85° 36' 22.0"	55G	76	11B	196.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Wyaloosing Creek	CR 400W	14-Sept-93	05120206	39° 5' 32.0"/85° 41' 4.0"	55M	82	11B	34.5
Johnson	Honey Creek	CR 550W	7-Oct-93	05120201	39° 36' 4.0"/86° 12' 25.0"	55G	64	5B	14.0
	Little Sugar Creek	CR 600N	22-Jul-93	05120204	39° 34' 2.0"/85° 58' 43.0"	55M	78	5B	20.5
	Sugar Creek	CR 650S	21-Jul-93	05120204	39° 22' 52.0"/86° 0' 21.0"	55G	78	5B	468.0
	Youngs Creek	CR 400S	21-Jul-93	05120204	39° 25' 8.0"/86° 0' 17.0"	55M	73	4B	107.0
		Foot Bridge	21-Jul-93	05120204	39° 28' 38.0"/86° 2' 59.0"	55M	73	5B	58.7
Knox	Kessinger Ditch	CR 1000E	7-Oct-93	05120202	38° 34' 14.0"/87° 16' 38.0"	72G	70	7B	58.0
	Maria Creek	Cr 1050S	2-Nov-93	05120111	38° 52' 53.0"/87° 20' 48.0"	72G	52	7B	22.0
	Marsh Creek	CR 500 NE Rd	3-Nov-93	05120111	38° 49' 40.0"/87° 24' 1.0"	72G	52	7B	23.0
	Plass Ditch	SR 241	7-Oct-93	05120202	38° 31' 10.0"/87° 31' 42.0"	72G	70	8	46.0
	Smalls Creek	Ford W of RR Sec 26 Washington	3-Noiv-93	05120111	38° 45' 6.0"/87° 29' 16.0"	72G	52	7B	18.0
		SR 550	4-Nov-93	05120111	38° 46' 18.0"/87° 25' 49.0"	72G	52	7B	5.8
	Snapp Creek	Iron Bridge 100 Ft DS	4-Nov-93	05120111	38° 42' 4.0"/87° 29' 57.0"	72G	85	7B	15.6
	Wabash River	Grand Rapids Locks	14-Oct-93	05120111	38° 26' 1.0"/87° 44' 28.0"	72G	52	12	16424.0
LaGrange	Fawn River	CR 600W	6-Oct-93	04050001	41° 45' 4.0"/85° 32' 38.0"	56G	10	4	162.0
Lake	Indiana Harbor Canal	129th St Bridge	7-Oct-93	04040001	41° 39' 17.0"/87° 27' 31.0"	54G	1	2B	35.0
LaPorte	Kankakee River	Kingsbury F & W Area	7-Oct-93	07120001	41° 29' 25.0"/86° 34' 52.0"	54G	12	3C	354.0
	West Fork Trail Creek	I-94 & Johnson Rd	6-Oct-93	04040001	41° 40' 27.0"/86° 50' 44.0"	56G	4	2B	23.9
Lawrence	Back Creek	Section 5 & 8 Line	4-Aug-93	05120208	38° 48' 8.0"/86° 18' 57.0"	71G	84	10B	30.0
	Crawford Creek	CR 250S	6-Aug-93	05120208	38° 49' 19.0"/86° 22' 52.0"	71G	84	10B	4.7
	East Fork White River	DS Williams Dam	15-Oct-93	05120208	38° 48' 6.0"/86° 38' 45.0"	71G	85	9A	4720.0
	Fishing Creek	CR 900S	5-Aug-93	05120208	38° 43' 51.0"/86° 22' 33.0"	71G	84	10A	9.7
	Goose Creek	CR 350N	13-Oct-93	05120208	38° 54' 45.0"/86° 33' 5.0"	71G	84	10A	5.0
	Gulletts Creek	Old SR 37	13-Oct-93	05120208	38° 56' 10.0"/86° 31' 57.0"	71G	84	10A	11.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Gutherie Creek	Leesville/Fort Ritner	6-Aug-93	05120208	38° 48' 8.0"/86° 17' 43.0"	71G	84	10B	31.5
		T4N R1E Section 12	6-Aug-93	05120208	38° 47' 22.0"/86° 21' 31.0"	71G	84	10B	68.0
	Henderson Creek	CR Off of SR 446	14-Oct-93	05120208	38° 57' 42.0"/86° 57' 8.0"	71M	84	10B	13.0
	Hooper Creek	DS Hooper Spring	1-Nov-93	05120208	38° 45' 24.0"/86° 40' 7.0"	71G	85	9A	2.0
	Indian Creek	DS SR 158	28-Oct-93	05120208	38° 51' 20.0"/86° 38' 56.0"	71G	85	9A	110.0
		DS SR 54	29-Oct-93	05120208	39° 57' 6.0"/86° 40' 28.0"	71M	85	9B	107.0
	Knob Creek	Bartlettsville	13-Oct-93	05120208	38° 58' 21.0"/86° 26' 50.0"	71G	84	10A	5.0
	Leatherwood Creek	Otis Park Golf Course	5-Aug-93	05120208	38° 51' 35.0"/86° 27' 34.0"	71G	84	10A	31.8
	Little Salt Creek	CR S of Bartlettsville	13-Oct-93	05120208	38° 57' 27.0"/86° 26' 56.0"	71G	84	10A	43.5
	Pleasant Run Creek	CR 50E	14-Oct-93	05120208	38° 54' 1.0"/86° 28' 10.0"	71G	84	10A	6.0
	Rock Lick Branch	DS Lehigh Cement Plt	14-Sept-93	05120208	38° 45' 15.0"/86° 27' 29.0"	71G	84	10A	9.2
	SF Leatherwood Creek	SR 150N	14-Oct-93	05120208	38° 53' 1.0"/86° 22' 18.0"	71G	84	10A	6.0
	Spring Creek	S of SR 58 Sec 32	28-Oct-93	05120208	38° 54' 32.0"/86° 39' 20.0"	71G	85	9B	13.0
	Sugar Creek	CR 800E	15-Sept-93	05120208	38° 43' 25.0"/86° 19' 40.0"	71G	84	10A	9.2
	Wolf Creek	CR 825N	13-Oct-93	05120208	38° 58' 35.0"/86° 28' 40.0"	71G	84	10A	1.5
Madison	Fall Creek	CR 750W	20-Aug-92	05120201	39° 57' 52.5"/85° 48' 50.5"	55M	63	5B	121.0
		Falls Park	20-Aug-92	05120201	40° 0' 21.0"/85° 44' 42.0"	55M	63	5B	99.0
		SR 109	20-Aug-92	05120201	40° 1' 17.5"/85° 39' 21.0"	55M	63	5B	67.0
	Indian Creek	CR 200N	13-Aug-92	056120201	40° 8' 6.5"/85° 45' 57.5"	55M	61	5B	19.0
	Killbuck Creek	Grand Avenue	13-Aug-92	05120201	40° 7' 6.0"/85° 40' 55.0"	55M	61	5B	104.0
	Lick Creek	SR 13	21-Aug-92	05120201	39° 57' 23.0"/85° 50' 33.0"	55M	63	5B	33.0
	Little Kill Buck Creek	CR 360N	13-Aug-92	05120201	40° 39' 33.0"/85° 39' 23.0"	55M	61	5B	18.0
	Muc Creek	CR 1100N	18-Aug-92	05120201	40° 15' 45.0"/85° 41' 34.0"	55M	60	5B	22.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Pipe Creek	CR 200W	18-Aug-92	05120201	40° 15' 43.0"/85° 42' 33.0"	55M	60	5B	83.0
		US Alexandria	18-Aug-92	05120201	40° 15' 47.0"/85° 42' 0.0"	55M	60	5B	82.0
		Washington Ave	18-Aug-92	05120201	40° 13' 32.0"/85° 46" 50.5"	55M	60	5B	114.0
	West Fork White River	Jackson Ave	13-Aug-92	05120201	40° 7' 8.0"/85° 40' 56.0"	55M	61	5b	510.0
		Perkinsville	13-Aug-92	05120201	40° 8' 33.0"/85° 51' 32.5"	55M	61	5B	555.0
Marion	Crooked Creek	W 42nd St	25-Aug-92	05120201	39° 49' 51.0"/86° 12' 23.0"	55G	65	5B	18.0
	Dollar Hid Creek	Mann Rd	6-Oct-93	05120201	39° 40' 26.0"/86° 14' 52.0"	55M	64	5B	4.0
	Eagle Creek	Dandy Trail	14-Sept-92	05120201	39° 48' 51.0"/86° 18/' 15.0"	55G	57	5B	165.0
		SR 40	14-Sept-92	05120201	39° 45' 45.0"/86° 13' 30.0"	55G	57	5B	178.0
	Fall Creek	Emerson Ave	20-Aug-92	05120201	39° 51' 11.0"/86° 4' 57.0"	55G	63	5B	298.0
	Indianapolis Water Canal	DS Ctrl Struct @ Broad Ripple	18-Oct-93	05120201	39° 52' 16.0"/86° 8' 32.0"	55G	65	5B	1230.0
	Little Buck Creek	SR 37	6-Oct-93	05120201	39° 39' 59.0"/86° 11' 46.0"	55G	64	5B	14.0
	Little Eagle Creek	Michigan St	14-Sept-92	05120201	39° 46' 24.0"/86° 13' 30.0"	55G	57	5B	27.0
	Pleasant Run Creek	South West St.	5-Oct-92	05120201	39° 43' 40.0"/86° 10' 4.0"	55G	64	5B	21.0
	West Fork White River	Holiday Park	25-Aug-92	05120201	39° 52' 10.0"/86° 9' 31.0"	55G	65	5B	1262.0
		Southwest Way Park	28-Oct-92	05120201	39° 38' 28.0"/86° 14' 19.0"	55G	64	5B	1947.0
	Wildcat Brook	Acton Rd @ Indian Creek	16-Jul-93	05120204	39° 40' 32.0"/85° 58' 15.0"	55M	78	5B	3.0
	Wildcat Run	Acton	16-Jul-93	05120204	39° 39' 26.0"/85° 58' 14.0"	55M	78	5b	4.8
	Williams Creek	College Avenue	25-Aug-92	05120201	39° 53' 37.0"/86° 8' 45.0"	55M	65	5B	21.0
Martin	Blue Creek	Blue Creek Rd	1-Nov-93	05120208	38° 32' 51.0"/86° 46' 42.0"	71G	77	9A	3.3
	Boggs Creek	1 MIle W Buck Knob	1-Nov-93	05120208	38° 44' 9.0"/86° 53' 59.0"	71M	85	9A	46.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Friends Creek	2 Mile S of Mt Pleasant	27-Oct-93	05120208	38° 37' 33.0"/86° 54' 3.0"	72G	85	9A	4.0
	Little Sulphur Creek	1 Mile N of Cale	28-Oct-93	05120208	38° 48' 26.0"/86° 44' 53.0"	71G	85	9A	5.0
	Lost River	Butler Bridge	1-Nov-93	05120208	38° 35' 46.5"/86° 45' 10.0"	71G	77	9A	345.0
		Last Bridge Crossing	1-Nove-93	05120208	38° 32' 14.0"/86° 48' 17.5"	71G	77	9A	374.0
	Seed Tick Creek	Perry Twp, Sec 5	1-Nov-93	05120208	38° 43' 38.0"/86° 52' 17.0"	71M	85	9A	13.7
Monroe	Clear Creek	Clear Creek Rd	28-Jul-93	05120208	39° 6' 24.0"/86° 32' 33.0"	71G	75	10A	14.0
		Country Club Rd	27-Jul-93	05120208	39° 8' 10.0"/86° 32' 0.0"	71G	75	10A	6.0
		Fluckmill Rd	28-Jul-93	05120208	39° 4' 23.0"/86° 34' 11.0"	71G	75	10A	59.5
	Jacks Defeat Creek	OOl Dutch Church Rd	29-Oct-92	05120202	39° 16' 7.0"/86° 37' 56.0	71G	68	10A	15.0
	Trib of Clear Creek	Victor Pike	27-Jul-93	05120208	39° 6' 42.0"/86° 32' 53.0"	71G	75	10A	5.0
Morgan	Bear Creek	SR 135	7-Oct-93	05120201	39° 21' 12.0"/86° 15' 40.0"	71G	68	10G	4.9
	Crooked Creek	DS SR 37	7-Oct-93	05120201	39° 21' 59.0"/86° 18' 10.0"	55M	64	5B	15.0
	Indian Creek	Low Gap Rd Taggart Crossing	29-Oct-92	05120201	39° 22' 45.0"/86° 24' 3.0"	71G	68	10B	76.0
	Lambs Creek	Middle Patton Lake Rd	5-Oct-93	05120201	39° 28' 10.0"/86° 30' 23.0"	55G	68	10B	16.0
	Mill Hollow Branch	SR 142 - 3/4 Mi W of SR 39	5-Oct-93	05120201	39° 30' 39.0"/86° 28' 9.0"	55G	64	10B	3.3
	North Prong Stotts Creek	CR 625E	6-Oct-93	05120201	39° 28' 0.0"/86° 18' 47.0"	55G	64	5B	21.9
	South Prong Stotts Creek	Nast Chapel Rd	6-Oct-93	05120201	39° 26' 47.0"/86° 30' 24.0"	55G	64	5B	30.0
	Sycamore Creek	US SR 67	5-Oct-93	05120201	39° 29' 26.0"/86° 25' 49.0"	55G	64	10B	18.6
	West Fork White River	DS Henderson Ford Bridge	19-Oct-93	05120201	39° 29' 56.0"/86° 21' 20.0"	55G	64	5B	2123.0
		US SR 39	8-Oct-93	05120201	39° 26' 3.0"/86° 26' 56.0"	55G	68	10B	2468.0
	White Lick Creek	CR 600N	1-Oct-92	05120201	39° 30' 48.0"/86° 22' 48.0"	55G	56	5B	290.0
Orange	Carters Creek	Potato Rd	2-Nov-93	05120208	38° 38' 15.5"/86° 21' 52.0"	71G	77	10A	9.2

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Lick Creek	DS Paoli	29-Oct-93	05120208	38° 33' 23.5"/86° 29' 36.0"	71G	77	9B	22.0
		Merea Radcliffe Park	29-Oct-93	05120208	38° 33' 21.0"/86° 28' 24.0"	71G	77	9B	24.0
	Lost River	Potato Rd	28-Oct-93	05120208	38° 38' 11.5"/86° 21' 57.0"	71G	77	10A	35.0
	South Fork Lost River	Bridge Sec 17	2-Nov-93	05120208	38° 26' 27.5"/86° 19' 18.0"	71M	77	10A	18.5
Owen	East Fork Fish Creek	CR 475W	27-Oct-92	05120202	39° 54' 13.0"/86° 51' 27.0"	72G	69	9A	16.0
		Vandalia	27-Oct-92	05120202	39° 18' 45.0"/86° 51' 19.0"	72G	69	9A	9.0
	Limestone Creek	CR 325E	28-Oct-92	05120202	39° 22' 15.0"/86° 42' 21.0"	55G	68	10A	11.0
	Little Mill Creek	CR 25E	27-Oct-92	05120201	39° 21' 32.0"/86° 23' 21.0"	72G	68	10A	6.0
	McCormicks Creek	McCormicks Cr State Park Falls	28-Oct-92	05120202	39° 43' 12.0"/86° 17' 26.0"	55G	68	10A	14.0
	Mill Creek	US Lower Cataract Falls	6-Oct-92	05120203	39° 26' 24.0"/86° 49' 0.0"	72G	66	9B	252.0
	Raccoon Creek	CR 75E	22-Oct-92	05120202	39° 12' 12.0"/86° 45' 30.0"	71G	69	9B	22.0
		Freeman	23-Oct-92	05120202	39° 11' 53.0"/86° 43' 47.0"	71G	69	9B	13.0
	Rattlesnake Creek	CR 50S	23-Oct-92	05120202	39° 16' 42.0"/86° 48' 5.0"	72G	69	9A	22.0
Perry	Sulphur Fork Creek	NE Tipsaw Lake	17-Jun-93	05140201	38° 8' 11.0"/86° 37' 33.0"	71G	95	9A	10.0
Pike	East Fork White River	DS SR 257	14-Oct-93	05120208	38° 32' 15.0"/87° 6' 35.0"	72G	85	8	5674.0
	Mud Creek	Southwest 1/4 Sec 21	26-Oct-93	05120208	38° 30' 1.0"/87° 11' 51.0"	72G	85	7B	8.5
	White River	US SR 61 Bridge	14-Oct-93	05120202	38° 30' 40.0"/87° 17' 18.0"	72G	70	8	11125.0
Putnam	Big Walnut Creek	Reelsville	15-Sept-92	05120203	39° 33' 17.0"/86° 57' 47.0"	72G	66	9A	318.0
		US SR 231	5-Oct-93	05120203	39° 40' 0.0"/86° 52' 2.0"	55G	66	5A	216
		Wildwood Bridge	30-Sept-92	05120203	39° 42' 11.0"/86° 47' 24.0"	55G	66	5A	164.0
	Bledsoe Branch	CR 380E	30-Sept-92	05120203	39° 42' 40.0"/86° 47' 1.0"	55G	66	5A	6.0
	Clear Creek	CR 370E	1-Oct-92	05120203	39° 41' 44.0"/86° 47' 5.0"	55G	66	5A	31.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Deer Creek	CR 350S	30-Sept-92	05120203	39° 36' 37.0"/86° 47' 16.0"	55G	66	10A	22.0
		SR 243	4-Oct-93	05120203	39° 34' 2.0"/86° 51' 59.0"	55M	66	5B	59.0
	Falls Branch	CR 250N	29-Oct-92	05120203	39° 41' 50.0"/86° 54' 38.0"	72G	66	9B	12.0
	Ferguson Branch	CR 1050S	29-Sept-92	05120203	39° 30' 56.0"/86° 49' 38.0"	72G	66	9B	6.0
	Leatherman Creek	1/4 Mile Above Mouth	29-Sept-92	05120203	39° 40' 19.0"/86° 56' 36.0"	72G	66	9B	6.0
	Little Dear Creek	CR 350S	29-Sept-92	05120203	39° 36' 30.0"/86° 46' 54.0"	55G	66	10A	9.0
	Little Walnut Creek	CR 100S	16-Sept-92	05120203	39° 38' 38.0"/86° 55' 51.0"	72G	66	9A	53.0
	Mill Creek	CR 1100S	6-Oct-92	05120203	39° 30' 3.0"/86° 56' 16.0"	72G	66	7B	386.0
	Plum Creek	CR 500N	30-Sept-92	05120203	39° 43' 53.0"/86° 46' 4.0"	55G	66	5A	10.0
Randolph	Cabin Creek	Windsor Pike	11-Aug-92	05120201	40° 9' 53.5"/85° 9' 41.0"	55M	62	5B	26.0
	Sparrow Creek	Base Rd	11-Aug-92	05120201	40° 9' 51.0"/85° 6' 12.0"	55M	62	5B	6.0
	Stoney Creek	Windsor Pike	11-Aug-92	05120201	40° 9' 15.5"/85° 12' 27.0"	55G	62	5B	48.0
	West Fork White River	CR 1100W	10-Aug-92	05120201	40° 9' 59.0"/85° 11' 1.5"	55M	62	5B	117.0
		CR 1100W	8-Jul-93	05120201	40° 9' 59.0"/85° 11' 1.5"	55M	62	5B	88.0
		SR 27W	18-Oct-93	05120201	40° 10' 59.0"/84° 58' 15.0"	55M	62	5B	34.5
		Union City Pike	11-Aug-92	05120201	40° 10' 55.5"/84° 57' 51.0"	55M	62	5B	34.0
Ripley	Graham Creek	CR 200W	20-Oct-93	05120207	39° 1' 43.0"/85° 17' 46.0"	55G	76	11B	12.0
	Honey Creek	CR 900W	19-Oct-93	05120207	39° 11' 32.5"/85° 25' 12.0"	55M	83	11B	3.4
	North Fork Graham Creek	CR 250S	20-Oct-93	05120207	39° 2' 19.0"/85° 20' 8.0"	55G	76	11B	10.8
	Otter Creek	cr 950W	18-Oct-93	05120207	39° 4' 29.5"/85° 25' 34.0"	55G	83	11B	37.0
	Sugar Creek	CR 500N	19-Oct-93	05120207	39° 8' 51.0"/85° 26' 14.5"	55G	83	11B	5.6
	Vernon Fork Muscatatuck	CR 900W	19-Oct-93	05120207	39° 12' 18.5"/85° 24' 57.0"	55M	83	11B	21.1
Rush	Beaver Meadow Creek	SR 52	27-Jul-93	05120204	39° 39' 0.0"/85° 36' 38.0"	55M	79	5B	7.1

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
	Ben Davis Creek	CR 250E	15-Jul-93	05120205	39° 38' 24.5"/85° 23' 48.0"	55M	80	5B	17.0
	Flatrock River	River Rd	22-Jul-93	05120205	39° 27' 46.0"/85° 32' 28.0"	55M	72	5B	215.0
		SR 44	16-Jul-93	05120205	39° 36' 30.5"/85° 25' 58.5"	55M	80	5B	167.0
	Linn Creek	Mouth	27-Jul-93	05120204	39° 39' 1.0"/85° 36' 42.0"	55M	79	5B	5.8
	Little Blue River	CR 300N	27-Jul-93	05120204	39° 39' 18.0"/85° 34' 15.0"	55M	79	5B	46.0
	Little Flatrock River	Railroad St.	16-Jul-93	05120205	39° 30' 1.0"/85° 27' 59.0"	55M	72	5B	24.0
	Three Mile Creek	Carthage Rd	24-Aug-93	05120204	39° 45' 44.0"/85° 32' 47.0"	55M	79	5B	13.0
	Turkey Creek	CR 250E	16-Jul-93	05120205	39° 39' 43.0"/85° 23' 57.5"	55M	80	5B	9.0
Scott	Big Ox Creek	Liberty Knob Rd	28-Oct-93	05120207	38° 35' 53.0"/85° 51' 20.0"	71G	76	10C	5.0
	Kimberlin Creek	SR 356	28-Oct-93	05120207	38° 38' 56.5"/85° 42' 31.5"	71G	76	11A	17.5
	Woods Fork	SR 56	28-Oct-93	05120207	38° 41' 6.5"/85° 41' 46.5"	71G	76	11A	28.2
Shelby	Big Blue River	Morristown	24-Aug-93	05120204	39° 33' 40.0"/85° 46' 17.0"	55G	79	5B	303.0
	Brandywine Creek	SR 9	25-Aug-93	05120204	39° 41' 13.0"/85° 46' 26.0"	55G	79	5B	65.8
	Buck Creek	CR 700N	16-Jul-93	05120204	39° 37' 25.0"/85° 56' 35.0"	55M	78	5B	82.6
	Conns Creek	CR 700S	22-Jul-93	05120205	39° 25' 12.0"/85° 40' 38.0"	55M	81	11B	80.0
		CR 750E	20-Jul-93	05120205	39° 29' 8.0"/85° 38' 30.0"	55M	81	5B	58.0
	Lewis Creek	CR 700S	23-Jul-93	05120205	39° 25' 22.0"/85° 46' 49.0"	55G	81	11A	80.0
		SR 252	23-Jul-93	05120205	39° 21' 49.0"/85° 51' 29.0"	55G	81	11A	81.5
	Little Blue river	CR 200N & Little Blue Rd	24-Aug-93	05120204	39° 33' 18.0"/85° 43' 7.0"	55M	79	5B	97.0
	Snail Creek	London Rd	20-Jul-93	05120204	39° 34' 23.0"/85° 55' 9.0"	755M	78	5B	37.3
	Sugar Creek	London Rd	22-Jul-93	05120204	39° 35' 17.0"/85° 55' 15.0"	55M	78	5B	235.0
	West Little Sugar Creek	I 74	16-Jul-93	05120204	39° 39' 20.0"/85° 55' 50.0"	55M	78	5B	15.0
St. Joseph	St. Joseph River	US Auten Rd	6-Oct-93	04050001	41° 44' 40.0"/86° 16' 20.0"	54G	8	4	3582.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
Sullivan	Big Branch	CR 825E	3-Nov-93	05120111	39° 8' 45.0"/87° 15' 20.0"	72G	51	7B	6.5
	Buck Creek	Washington St	3-Nov-93	05120111	39° 5' 41.0"/87° 25' 12.0"	72M	51	7B	4.4
	Busseron Creek	SR 58	2-Nov-93	05120111	38° 58' 21.0"/87° 25' 37.0"	72M	51	7A	228.0
	Little Turtle Creek	CR 600W	3-Nov-93	05120111	39° 2' 29.0"/87° 31' 21.0"	72G	51	7A	8.1
	Sulphur Creek	SR 48	3-Nov-93	05120111	39° 11' 13.0"/87° 16' 15.0"	72G	51	7B	5.0
	Turman Creek	CR 300N	9-Nov-93	05120111	39° 7' 40.0"/87° 35' 42.0"	72G	51	7B	70.0
	West Fork Turman Creek	SR 48	9-Nov-93	05120111	39° 11' 43.0"/87° 29' 22.5"	72M	51	7A	14.3
Tippecanoe	Tippecanoe River	Pretty Prairie Bridge	8-Oct-93	05120106	40° 32' 32.0"/86° 45' 53.0"	55G	28	5B	1896.0
	Wabash River	Granville Bridge	8-Oct-93	05120108	40° 24' 40.0"/87° 2' 14.0"	55G	43	5A	7489.0
Vanderburgh	Pigeon Creek	Franklin St Bridge	14-Oct-93	0514202	37° 58' 48.0"/87° 35' 16.0"	72M	94	8	368.0
Vigo	Clear Creek	Cook Rd	4-Nov-93	05120111	39° 26' 16.0"/87° 29' 35.0"	72G	51	7B	39.0
	East Little Sugar Creek	Ferguson Hill	4-Nov-93	05120111	39° 28' 52.5"/87° 28' 9.0"	72G	51	7B	12.0
	Honey Creek	Hotel St	10-Nov-93	05120111	39° 22' 20.0"/87° 28' 48.0"	72G	51	7B	83.5
		Sr 46	10-Nov-93	05120111	39° 24' 13.0"/87° 19' 13.0"	72G	51	7B	37.4
		Section 16 & 17	7-Oct-92	05120111	39° 23' 53.0"/87° 25' 32.0"	72G	51	7B	71.0
	Prairie Creek	Battlerow Plaza	10-Nov-93	05120111	39° 17' 4.5"/87° 32' 12.5"	72G	51	7A	30.2
		Trueblood Plaza	10-Nov-93	05120111	39° 19' 19.0"/87° 27' 40.0"	72G	51	7B	11.4
	Sugar Creek	Thorpe Plaza	4-Nov-93	05120111	39° 28' 11.0"/87° 29' 8.0"	72G	51	7B	66.7
	Trib of Honey Creek	1/4 mile US Confluence	10-Aug-93	05120111	39° 23' 42.5"/87° 25' 31.5"	72G	51	7B	5.0
		NW Corner of Sec 21	10-Aug-93	05120111	39° 23' 23.0"/87° 25' 31.5"	72G	51	7B	5.0
		Sec 21 Between NW1/4 & SW 1/4	7-Oct-92	05120111	39° 23' 1.0"/87° 25' 14.0"	72G	51	7B	6.0
	Turman Creek	Colglazier Rd	9-Nov-93	05120111	39° 15' 41.5"/87° 24' 20.0"	72M	51	7B	14.4
	Wabash River	Darwin Ferry	15-Oct-93	05120111	39° 16' 59.0"/87° 36'34.0"	72G	51	7B	12681.0
		Fairbanks Park Dock	15-Oct-93	05120111	37° 27' 35.0"/87° 25' 9.0"	72G	49	7B	12266.0

Table 61. *Collection sites for benthic macroinvertebrate assessments for the period of 1992-1993 (cont.)*

COUNTY	SITE	LOCATION	DATE OF COL-LECTION	HY-DROLOGIC UNIT	LATITUDE/ LONGITUDE	ECO-REGION	DRAINAGE SEGMENT	IASNRI	DRAINAGE AREA (sq mi.)
Warrick	Little Pigeon Creek	DNR Boat Ramp	13-Oct-93	05140201	37° 54' 36.0"/87° 17' 44.0"	72M	95	8	357.0
Washington	Clifty Creek	Sec 11 Bridge	15-Sept-93	05120208	38° 42' 56.0"/86° 15' 35.0"	71G	84	10A	6.0
	Elk Creek	SR 56	27-Oct-93	05120207	38° 41' 50.5"/85° 55' 31.0"	71G	83	10C	7.5
	Muscatatuck River	DNR Boat Ramp	13-Oct-93	05120207	38° 45' 57.0"/86° 6' 9.0"	55G	83	11A	1116.0
	Twin Creek	Cox Ferry Rd	14-Oct-93	05120208	38° 42' 38.0"/86° 13' 46.0"	71G	84	10C	35.5
Wells	Wabash River	SR 316	4-Oct-93	05120101	40° 43' 43.0"/85° 8' 16.0"	57G	36	5C	509.0

IASNRI = Indiana Academy of Science Natural Region Index (Homoya, 1985)
HD = Hester Dendy Artificial Substrate Sampler Location
BLLT = Black Light Collection
QUAL = Qualitative 15 Minute Pick
All Other Locations had Kick/Cpom Samples From

biotic/environmental parameters can be optimally made is pending completion of both phases of this project.

IV. Ground Water Quality Overview

Ground water in Indiana occurs in both unconsolidated and bedrock aquifer systems that can yield potable water in sufficient quantity to serve as a source of supply. The most productive aquifers are associated with glacially derived outwash sand and gravel deposits that occur in the major river valleys. Large diameter wells in these areas can produce up to 2,000 gallons per minute (gpm). Other good unconsolidated aquifers are found in the tick, inter-till sand and gravel deposits of central and northern Indiana. The withdrawal potential for properly constructed wells ranges from 400 to 2,000 gpm. The major bedrock aquifers include the Pennsylvanian age sandstones of southwest Indiana, Mississippian age limestones in the south central area, Devonian age limestone and dolomite units across the northern and mid-sections, and Silurian age limestones and dolomites in the north and central portions of the state. Well yields of the major bedrock aquifers can vary from 200 to 600 gpm.

The ambient ground water quality throughout Indiana is variable and dependent on the aquifer system, geologic setting, and depth of the formation. In general, the incidence of mineralized or even saline ground water increases rapidly at bedrock depths below 300 feet. The chemical quality of the potable water is adequate to meet the basic needs for household, municipal, industrial, and irrigation uses. However, the waters are normally very hard, exceeding 180 parts per million (ppm) hardness in a range from 100 ppm to over 600 ppm across the state. Other constituents of importance to natural water quality are iron, manganese, sulfate, fluoride and hydrogen-sulfide. most of Indiana's ground water contains more than the 0.3 ppm aesthetic threshold for iron. Manganese concentrations are often a nuisance associated with iron, but are lowest along the Wabash and Whitewater rivers and in Mississippian age limestone aquifers. Sulfate levels are dependent on the geologic deposits. Concentrations exceeding 600 ppm have been noted in Harrison, Orange, Vermillion and Lake counties. Hydrogen-sulfide is present in the ground water of sizeable areas in the northwestern region underlain by limestone bedrock. Small concentrations of Hydrogen Sulfide can be objectionable.

Nearly 60 percent of the state's population uses ground water for drinking water purposes. There are approximately 5,127 public water systems that are directly dependent on ground water for their supplies. About half of the population served by public water supplies use ground water. There are 731 community water systems, 631 non-transient non-community systems, and 3,765 transient non-community water systems in Indiana dependent upon ground water. (Non-community systems service a transient or non-residential population of at least 25 persons per day for 60 or more days per year). The distribution of public supply wells by county is shown in Figures 72 and 73. Approximately a half-million homes have private wells for their water supply. The 1990 census data for private wells per county is shown in Figure 74. Ground water also services the needs of Indiana's economy. Industry uses and average 190 million gallons per day, irrigation consumes 200 million gallons per day during the growing season, and livestock depends on an average of 45 million gallons per day.

The Indiana Ground Water Strategy of 1987

Indiana has a single water resource, composed of inter-related elements which include ground water. How ground water is treated or managed will ultimately affect Indiana's overall water resource.

Ground water is part of nearly all human, social, and economic activity. Because of this quality, no single law, agency or level of government can reasonably provide all the safeguards, research and guidance needed for ground water. In fact, at least fourteen programs in five state agencies administer provisions of nine federal laws and twelve state statutes, which affect ground water in some way.

A plan was needed which would address a large number of issues, to serve as a common reference for state agencies, governments, businesses, and citizens as they work toward the shared goal of ground water protection.

In early 1986, an Inter-Agency Ground Water Task Force was formed at the state level, with representatives from the Department of Environmental Management, Department of Natural Resources, State Board of Health, State Chemists Office, and State Fire Marshal's Office. This committee developed a ground water policy and list of issues which were presented at six state-wide meetings. With that public input, a draft planning document was issued in mid-1986, as a discussion tool for six more public meetings and a written comment period. This analysis of ground water issues, alternative solutions, and recommended actions was then revised by the Task Force, based on this public participation.

The Indiana Inter-Agency Ground Water Task Force adopted a final version of the State Ground Water Protection Strategy and draft Implementation Plan in early 1987. This document addresses 43 separate issues involving wells, ground water quality and water quantity, and makes 160 recommendations for improved safeguards and management of the resource. The plan calls for new and revised laws and rules, new as well as modified agency programs, research and information management, coordination efforts within and among all levels of government., and continued public participation. Implementation of the plan involves at least a five-year phase-in, affecting many state agency programs, along with the involvement

Figure 72. *Community water supply wells*

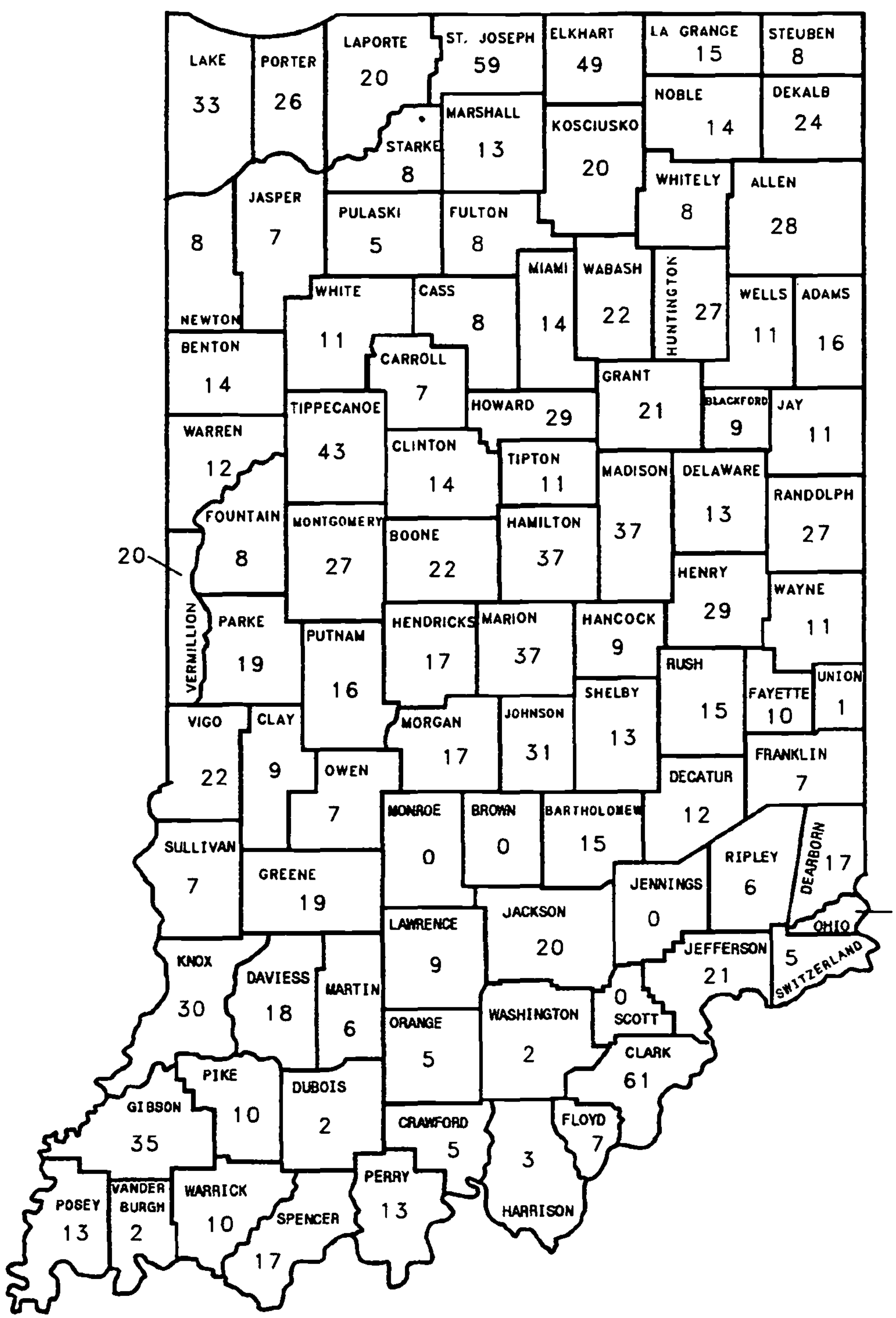


Figure 73. *Non-community ground water supply systems*

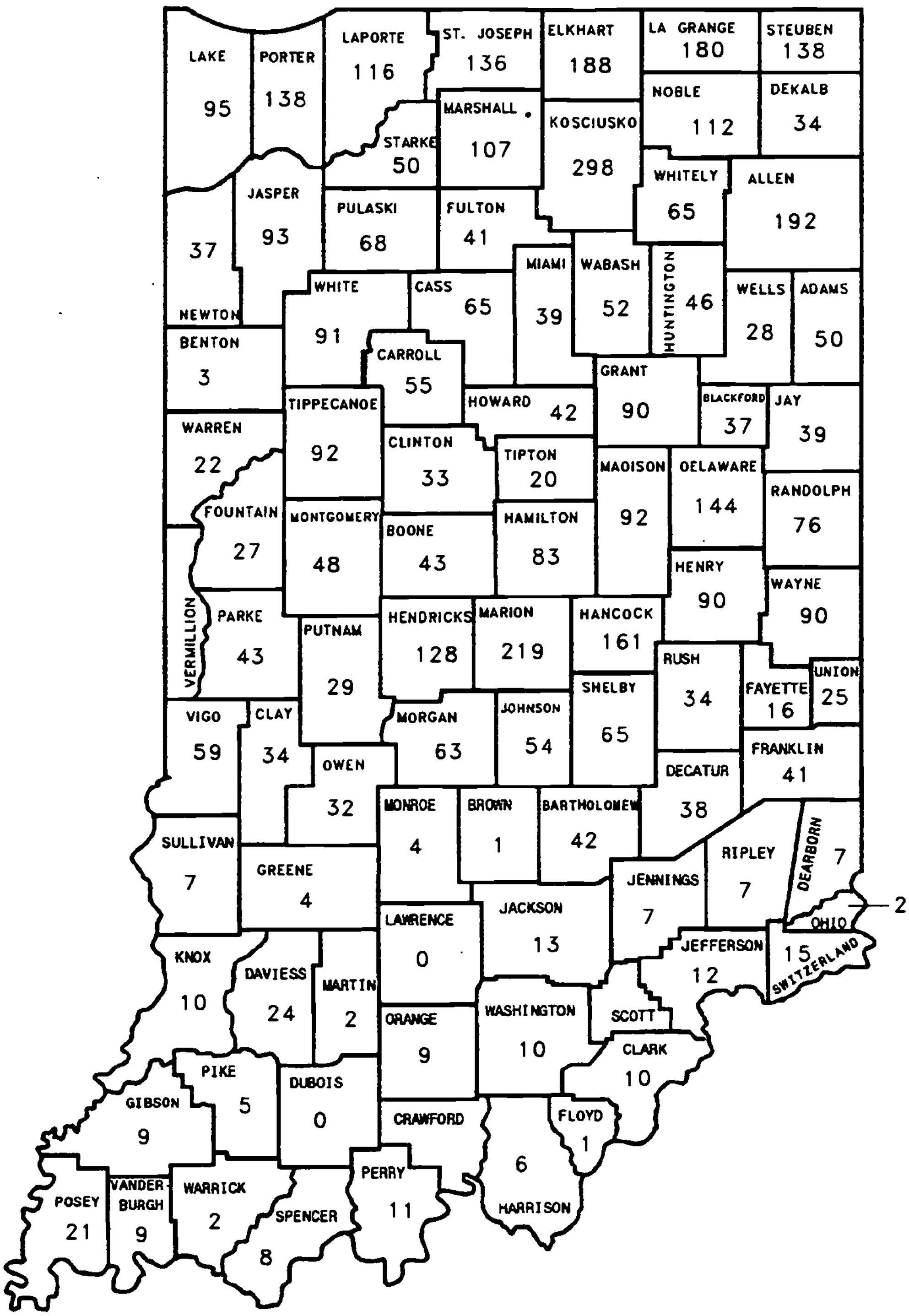
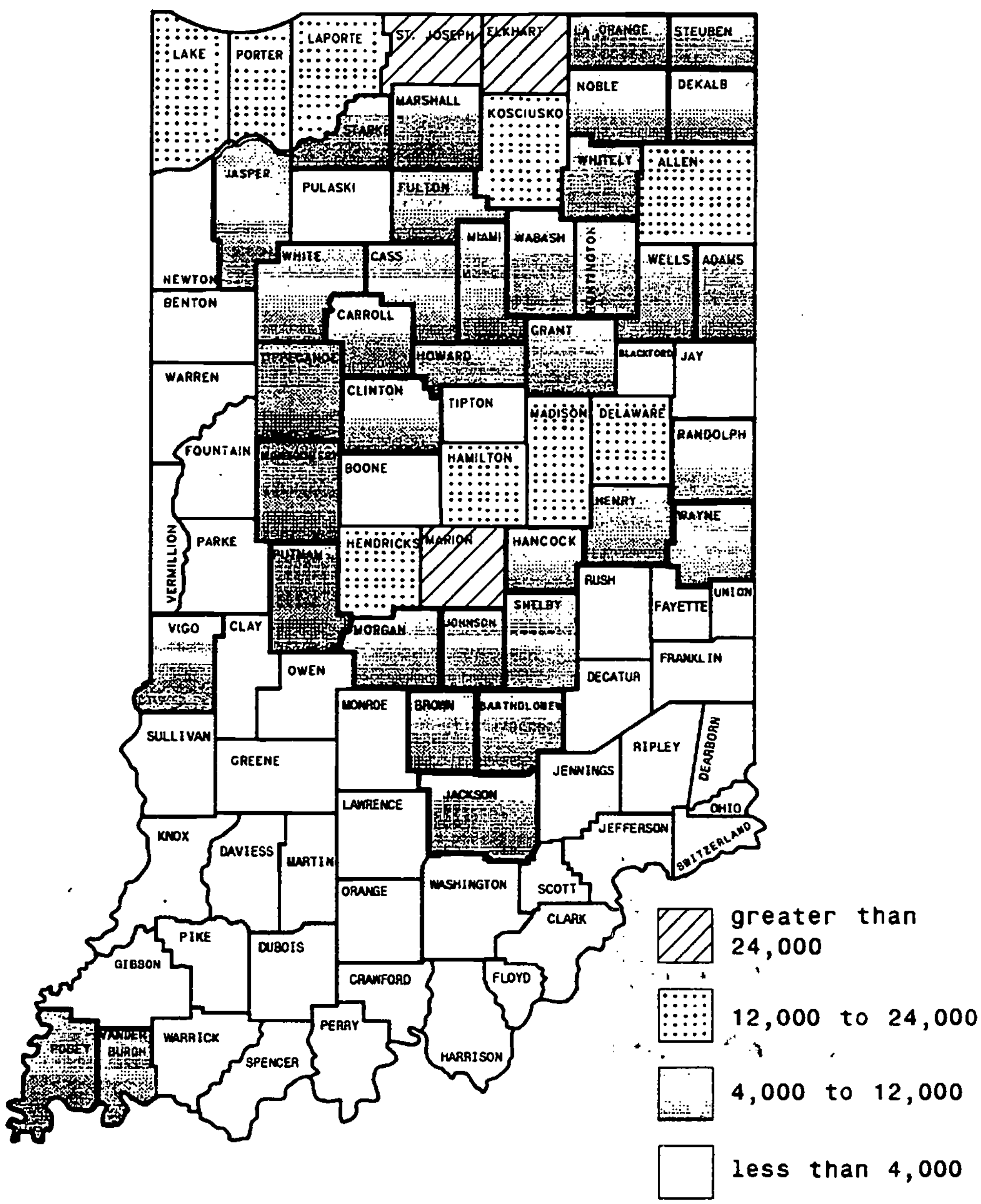


Figure 74. *Private water supply wells*



of local government, the U.S. Environmental Protection Agency, the State Legislature, Universities , and others.

The Indiana Strategy is an agenda for state action to prevent, detect, and correct contamination and depletion of ground water. The implementation plan identifies key steps, schedules, responsibilities, resources, outputs, and contingencies to accomplish the objectives of the strategy. This plan is to be adaptable to new federal requirements, responsive to emerging issues and proprieties, and subject to revision based on experience. The Inter-Agency Ground Water Task Force, with an expanded membership, has served as a group for coordination and review of strategy implementation during 1987-1989.

Priority Recommendations of the Strategy

- Department of Environmental Management: Obtain primacy for supervision of the public water supply and underground injection control programs. Implement a state program for cleanup of abandoned hazardous waste sites. Develop a program of protection zones for public water supply wells.

- Department of Natural Resources: Complete an Indiana Ground Water Atlas which maps and describes major acquifers. Implement a program for well driller certification and well construction standards.

- State Board of Health: Provide assistance to local health departments to improve ground water protection activities.

- Office of State Chemist: Implement a spill control and containment program for bulk fertilizer storage.

- Office of State Fire Marshal: Coordinate the response to leaking underground storage tanks and releases of hazardous materials.

The majority of these recommendations have been accomplished.

Indiana Ground Water Protection Act of 1989

The 1989 Indiana General Assembly passed comprehensive legislation concerning ground water protection in Indiana. It structures and formalizes many of the activities of the Indiana Ground Water Task Force, an inter-agency group which developed and coordinated implementation of the 1987 Indiana Ground Water Protection Strategy. The bill authorizes the Department of Environmental Management to operate several program initiatives on ground water quality. It also sets priorities and deadlines for accomplishing specific recommendations from the State's Ground Water Strategy.

The Indiana Inter-Agency Ground Water Task Force is formally established and its members are appointed by the Governor for a two year term. Successive terms are allowed. Non-State employees are allowed travel, per diem and other expense reimbursements. The heads of the following state agencies (or their proxies) are members of the Task Force; (these agency heads shall also provide staff support to the Task Force):

Department of Environmental Management (IDEM),
Department of Natural Resources (IDNR),
State Board of Health (ISDH),
State Chemist Office (ISCO), and
State Fire Marshal (SFM).

One representative each of the following groups are also appointed:

the business community,
the environmentalist community,
the agricultural community,
labor, and
local government.

The agency heads shall invite participation by the Governor's Office and U.S. Environmental Protection Agency. The principal purposes of the Task Force are to:

- study ground water contamination in Indiana.
- coordinate efforts among the agencies to address ground water pollution problems;
- coordinate implementation of the Indiana Ground Water Protection and Management Strategy; and
- develop policies to prevent ground water pollution.

The Task Force may adopt bylaws to govern the conduct of its activities, and must hold a public meeting at least once every four months. It shall also present an annual report on its activities to the Governor and the General Assembly.

The Act requires IDEM, with the assistance of other state agencies as appropriate, to conduct the following ground water program activities:

1. Contamination Investigation: IDEM is to investigate allegations of and confirmed incidents of ground water contamination that affect private water supply wells.

2. Contamination Response: IDEM (through its Commissioner) is to issue health hazard advisories to users and owners of wells found to be contaminated. The agency shall also take emergency action to reduce exposure to health threat contaminants in well water, and as appropriate, order abandonment of contaminated wells.

3. Contamination Site Registry: IDEM shall establish and maintain a registry of sites within Indiana at which contamination of ground water has been detected. The registry shall be continuously supplemented and clarified as additional information becomes available. The information is to be available for public inspection and copying during normal business hours.

4. Ground Water Quality Clearinghouse: IDEM must establish and operate a ground water quality clearinghouse to receive complaints and screen reports about ground water contamination, and ensure that they are investigated; to provide public information about ground water; and to coordinate ground water quality data management in the state.

Several priorities from the Ground Water Strategy are mandated for action by the IDEM through the Act:

1. Ground Water Quality Standards: IDEM's Water Pollution Control Board is to promulgate a rule establishing ground water quality standards. These standards are to apply to activities regulated by the five state agencies represented on the Task Force (IDEM, IDNR, ISDH, ISCO, OSFM). The standards are to be used for the following purposes:

    - to select targets for ground water cleanups;
    - to establish minimum compliance levels for ground water quality monitoring at regulated facilities;
    - to ban the discharge of effluent into potable ground water;
    - to establish health protection goals for untreated water supply wells; and
    - to establish concentration limits for contaminants in ambient ground water.

2. Public Wellfield Protection Zones: IDEM's Water Pollution Control Board is to promulgate a rule establishing protection zones around community water system wellfields. IDEM is also to establish and operate a program of education and assistance to local officials in developing and managing wellfield protection zones. The Act also states that the five agencies (IDEM, IDNR, ISDH, ISCO and OSFM)

may not permit activities within the zones, that would violate or interfere with the purposes of the rules for wellfield protection zones.

3. Surface Impoundments: IDEM's Water Pollution Control Board is to promulgate a rule that sets requirements for the construction and monitoring of surface impoundments (including pits, ponds, and lagoons) used for the storage or treatment of nonhazardous waste and waste water. The requirements of the rules must apply to activities regulated by the five state agencies.

Status of Ground Water Strategy Implementation 1992-1993

Inter-Agency

Ground Water Task Force: Work groups were active on the following issues: Cleanup Standards, Wellhead Protection, Surface Impoundments, Non-Point Source and Agricultural Chemicals. The task Force also drafted a Framework for ground water quality standards.

Safe Drinking Water Act Primacy: IDEM received full supervision of the public water supply program from EPA. The phase-in of this major new program will take about a year. Underground injection control primacy for IDNR from EPA was negotiated for Class II oil and gas wells. IDEM has discussed a Class V well program with EPA, but no primacy application has been made.

Wellfield Protection: Two regional planning agencies were funded to prepare local pilot projects for wellfield protection in 1990-91. These projects were completed in 1992-1993. The final wellhead protection program will be submitted to the EPA in December of 1994 for approval.

Aquifer Mapping: The U.S. Geological Survey has completed the Indiana Ground Water Atlas as a cooperative project with IDNR and IDEM. Mapping has been completed. Publication has be completed in 1994. IDNR has published the St. Joseph River Basin, Kankakee River Basin, Whitewater River Basin. Work is underway on the Lake Michigan Basin and the West Fork-White River Basin.

Public Education-Information Participation: The WPA establishes a ground water quality information clearinghouse at IDEM. Ground water displays by IDEM, IDNR, and other agencies were set at the 1992-93 Indiana State Fair. State personnel have presented dozens of lectures, classes and slide shows on ground water protection during 1992-93. IDEM and IDNR staff have participated in the Great Lakes Commission's Ground Water Education Task Force which is developing a regional policy statement, action strategy, and ground water education guidebook. IDEM and IDNR staff have also participated in the Ground Water Information System being developed by the Freshwater Foundation.

Indiana Department of Environmental Management

Abandoned Waste Site Cleanup: Legislative authority, funding, and staffing have been provided for a state operated cleanup program. The site prioritization rule was passed in 1989.

Nonpoint Source Pollution: IDEM coordinated completion of a Non-point Source Water Pollution Management Program plan in 1989 which addresses ground water concerns. IDEM continued it's study of agricultural chemicals in ground water during 1992-93. A work group under the Task Force has been helping coordinate activities.

Underground Storage Tanks: Legislative authority, a leaking storage tank cleanup fund, and staffing are in place to regulate tank inventories, leak detection and construction requirements, and cleanup/removal activities. IDEM is coordinating this with the Office of the State Fire Marshal.

Complaint Response: The IGWPA authorizes IDEM to continue its program for investigating contamination of public and private water wells. A "Guidebook for Ground Water Protection" has been updated, with input from the Ground Water Task Force. It was distributed state-wide in 1991 to aid a variety of local officials in the screening, referral and response to ground water complaints.

Indiana Department of Natural Resources

Well Driller Certification: Program was established in 1987-88 and over 900 licenses have been issued.

Well Construction and Abandonment Standards: Requirements were finalized in 1988 and statewide enforcement and regulatory activities are being conducted. Some counties are adopting their own standards, modeled upon the state program.

Indiana State Department of Health

Local Environmental Health Program: ISDH has evaluated all county health departments statewide for their capability, in part, to perform ground water protection functions. Improvement programs and grant assistance are being coordinated by ISDH to assist local health agencies in this regard. The most common local initiative identified is adoption of a well ordinance.

State Fire Marshal

Underground Storage Tanks: Memorandum of agreement with IDEM, outlining program coordination, was completed in 1989.

Ground Water Quality

Ground Water Contamination Site Registry

The IDEM Ground Water Section developed and maintains a data base for case histories of chemical contamination of ground water in Indiana. This registry is compiled from file records of state and federal environmental programs and county health agencies and updated as new information is acquired. Contamination is defines as a chemical concentration in the ground water which may or may not be above a final Maximum Contaminant Level (from the public water supply regulations) or an EPA-published Lifetime Health Advisory limit. Documentation such as laboratory analyses or site investigation reports must exist in order for a case history to be included in the data base. Information is recorded separately for each contamination incident, which typically involves more than one well. The registry is a listing of sites where evidence indicated the ground water was and/or is contaminated. It is not a library of ground water quality monitoring data. This summary of information in the registry forms the basis for this status report on Indiana's ground water quality problems.

At the time of this report, there were 863 sites of ground water contamination recorded. The number of documented sites of ground water contamination per county is displayed in Figure 75. Information sources for these case histories appear in Table 62. The greatest number of sites are found in the following counties: Elkhart, Lake, Vigo, Marion, Kosciusko and St. Joseph. The cases were documented between 1956 and 1993, with the majority after 1977. Figure 76 describes the types of wells affected by ground water contamination. Note that any program effort to deal with ground water contamination and keep records of contamination incidents has only been active for the past ten years.

Forty-four percent of the investigations into drinking water well contamination were initiated because of complaints of taste or odor in the water. At over 42 percent of the sites, contaminants were detected only as a result of sample analysis, not because of a direct complaint to a government agency. However, the sampling was conducted as part of a contamination investigation or monitoring activity by a government program. For recorded cases of drinking water well impacts, the remedies which were applied include long term monitoring, bottled water, point of use water treatment, public water connection or well replacement. Actual cleanup of the ground water was only reported for a small number of incidents. See Table 63 for a summary of

Figure 75. *Documented sites of ground water contamination*

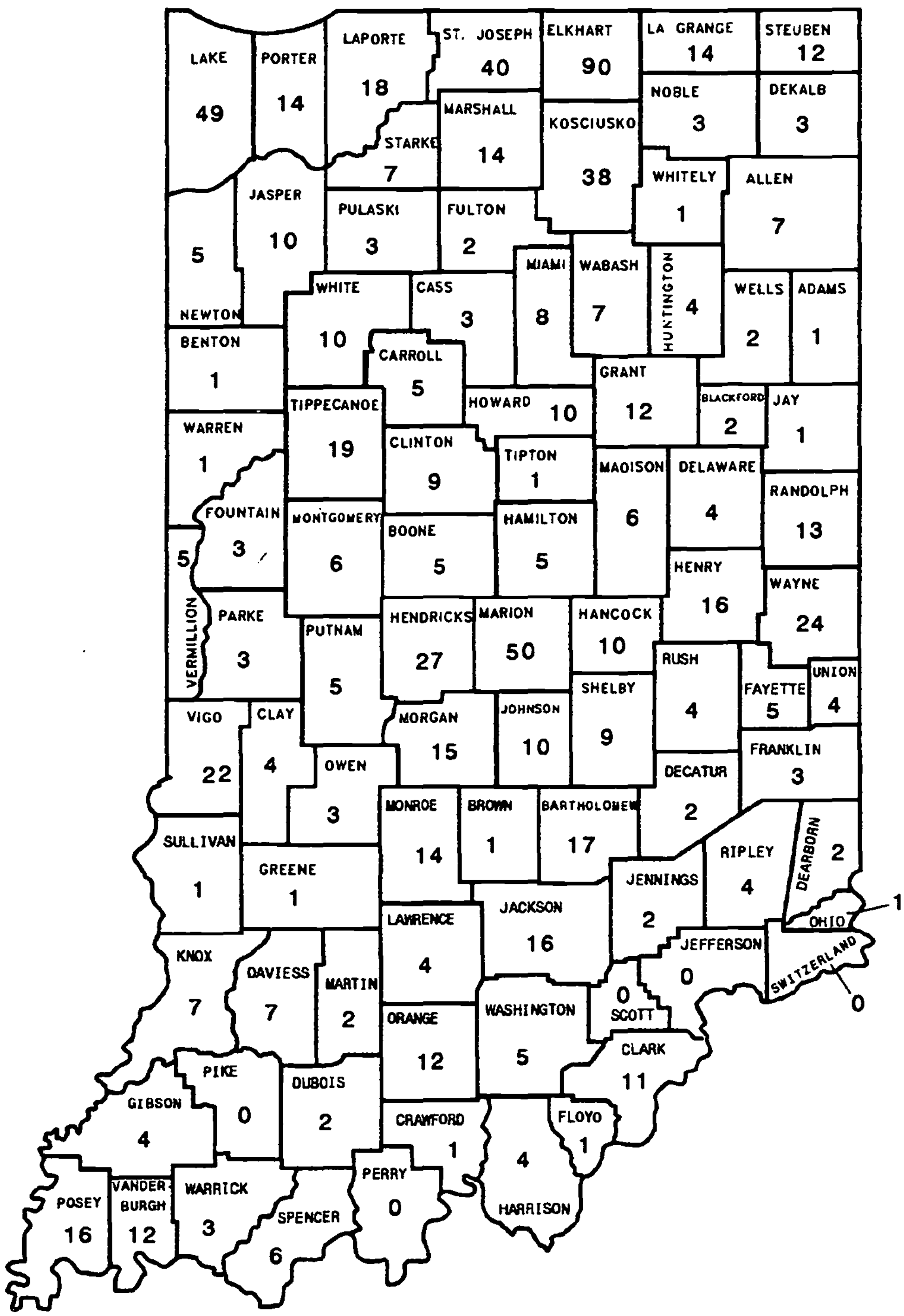


Table 62. *Case history information source*

ACTION	1956 - 1991		1956 - 1993	
	Number of Cases	Percent of Total	Number of Cases	Percent of Total
Ground Water Section - IDEM	253	33.9%	306	35.45%
Leaking Underground Storage Tank Section - IDEM	90	12.1%	144	16.7%
County Health Departments	78	10.4%	85	9.85%
Indiana University	73	9.8%	73	8.46%
Public Water Supply Section - IDEM	59	7.9%	59	6.8%
CERCLA (Superfund Cleanup Program) - IDEM	44	5.9%	44	5.1%
Department of Natural Resources	35	4.7%	35	4.0%
Underground Storage Tank Section - IDEM	34	4.6%	34	3.9%
Other Sources	26	3.5%	26	3.0%
RCRA (Hazardous Waste Management Program) - IDEM	23	3.1%	23	2.6%
CERCLIS (Site Investigation Program) - IDEM	16	2.1%	19	2.2%
Office of Environmental Response - IDEM	8	1.1%	8	0.9%
State Cleanup - IDEM	7	0.9%	7	0.8%
Total Sites	746		863	

Figure 76. *Documented ground water contamination*

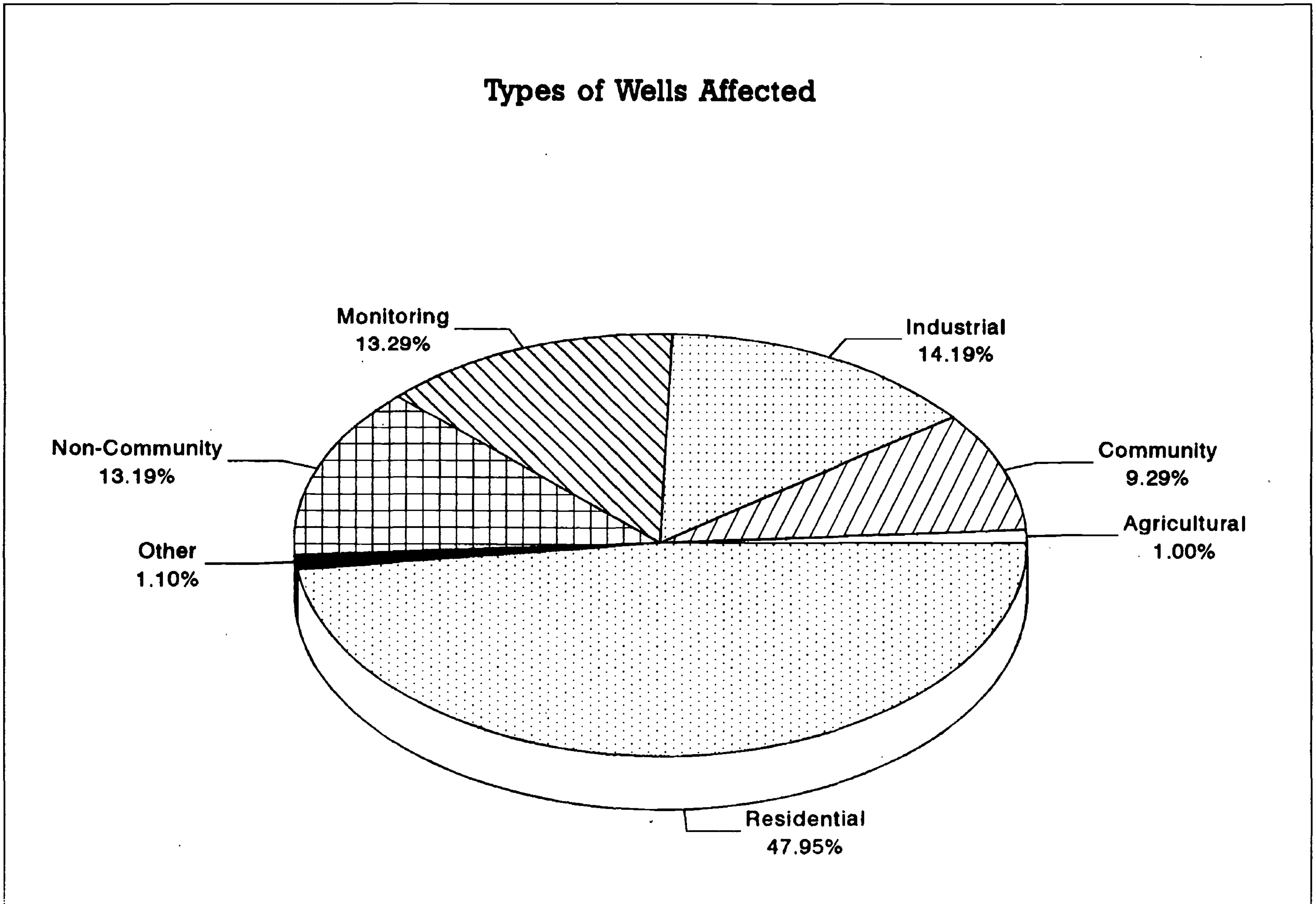


Table 63. *Ground water monitoring actions which documented contamination*

ACTION	ALL GROUND WATER CONTAMINATION (887 SITES)				DRINKING WATER CONTAMINATION (647 SITES)			
	NUMBER OF CASES		PERCENT OF CASES		NUMBER OF CASES		PERCENT OF CASES	
	1956 - 1991	1956 - 1993	1956 - 1991	1956 - 1993	1956 - 1991	1956 - 1993	1956 - 1993	1956 - 1993
Complaint response for objectional taste of water	115	120	13.7%	13.5%	104	109	20.4%	16.8%
Complaint response for objectional odor of water	136	138	16.2%	15.6%	121	123	23.7%	19.0%
Complaint response for color of water	20	21	2.4%	2.4%	16	17	3.1%	2.6%
Complaint response for sediment in water	6	6	0.7%	0.7%	6	6	1.2%	0.9%
Investigation of known pollution source	238	254	28.4%	28.6%	92	108	18.0%	16.7%
Investigation of suspected pollution source	108	133	12.9%	15.0%	87	112	17.0%	17.3%
Complaint response for health concern with water	44	60	5.2%	6.8%	41	57	8.0%	8.8%
Water sample analysis	232	234	27.7%	26.4%	212	214	41.5%	33.1%
Required ground water monitoring	123	194	14.7%	21.9%	21	93	4.1%	14.4%

(Percent totals will exceed 100 due to multiple sources for some cases.)

(Source: IDEM Ground Water Section Contamination Site Registry (1991) for time period 1956 - 1991)

ground water monitoring actions which documented contamination and Table 64 for a summary of remedial actions.

Sources of Ground Water Contamination

Information regarding sites and sources of ground water contamination is based principally on analysis of samples collected by agency staff from public or private water wells or from monitoring wells. Claims related to responsible sources are not yet possible for sites where ground water data has not been reported to the State.

Documenting the source for a particular incident of ground water contamination is not always possible. In about 17.9 percent of all case histories examined for this report, the source was unknown or unconfirmed. Many of these involved nitrate contamination. There are a wide variety of activities, events, structures, or facilities which have been shown to contaminate ground water in Indiana, as evidenced in Table 65. The most prevalent appear to be losses from underground storage tank systems, hazardous materials spills, and waste disposal activities. Table 66 shows a relative priority ranking for contaminant sources for the state of Indiana. The relative priority rankings were based on the identified ranking factors as depicted at the lower margin of Table 66. Relative priority of contaminant sources are rated on the following scale (VH = Very High, H = High, M = Medium, ML = Medium Low, and L = Low). Table 67 is a check list of substances contaminating Indiana's ground water for those sources identified in Table 66.

Hazardous Materials Spills

In general, it is reported that nearly half of the volume of hazardous materials lost to the environment each year is not recovered. Some of this is due to volatilization, dilution, or adsorption of the chemicals which inhibit the feasibility of recovery. Yet where large volume spills are not sufficiently contained or cleaned up, or where chronic small losses go unreported and unaddressed, these events have been shown to be one of the most common causes of ground water pollution in Indiana.

During 1990-1993 there were 20,514 hazardous materials spills reported to the IDEM Office of Environmental Emergency Response. The largest number occurred in heavily industrialized areas such as Marion County (3064 spills) and Lake County (1527 spills). The statewide distribution of these events is shown in Figures 77. The types of materials released most often have also been found to be common ground water contaminants. These are petroleum products, plus industrial and agricultural chemicals. When such materials impact ground water they are typically spilled at industrial, commercial, or agricultural sites. Details for 1992 spills are in Figures 78 and 79.

Table 64. *Remedial actions for drinking water well contamination*

REMEDIAL ACTION TAKEN	1956 - 1991		1956 - 1993	
	Number of Cases	Percent of Total	Number of Cases	Percent of Total
No other remedial action/health advisory	119	20.0%	169	18.0%
Long term monitoring	93	15.6%	194	20.0%
Bottled water	79	13.3%	86	9.2%
Point of entry/point of use water treatment	64	10.8%	73	7.8%
Public water connection	50	8.4%	56	6.0%
Well abandonment	38	6.4%	42	4.5%
New well	36	6.1%	57	6.1%
Miscellaneous	35	5.9%	61	6.5%
Contaminated soil removal	32	5.4%	102	10.9%
Well disinfection	15	2.5%	23	2.5%
Pump and decontaminate ground water	14	2.4%	29	3.1%
Contaminant recovery well	10	1.7%	32	3.4%
Well repair	7	1.2%	7	50.8%
Intercept/barrier well	2	0.3%	2	0.2%
Total number of cases	594		933	

Table 65. *Sources of ground water contamination*

TYPE OF CONTAMINANT SOURCE	All Ground Water Contamination (887 Sites)		Drinking Water Contamination (647 Sites)	
	Percent of Cases 1956 - 1991	Percent of Cases 1956 - 1993	Percent of Cases 1956 - 1991	Percent of Cases 1956 - 1993
Underground storage tanks	23.2%	22.5%	14.3%	11.6%
Spills including hazardous material	20.1%	19.6%	14.3%	12.1%
Unknown/not confirmed	16.1%	17.1%	19.4%	17.9%
Hazardous waste disposal	7.9%	9.0%	9.0%	9.3%
Solid waste disposal facility	6.2%	6.0%	6.8%	5.4%
Pesticide application	5.0%	4.8%	7.4%	6.0%
Pit, pond or lagoon	3.6%	3.6%	3.7%	2.9%
Above ground storage tank	3.3%	3.3%	3.7%	2.9%
Improper well construction	3.0%	2.8%	4.5%	3.6%
Septic system	2.4%	2.3%	3.5%	2.8%
Pesticide storage/disposal	1.5%	1.9%	2.3%	2.3%
Oil and gas recovery well	1.4%	1.6%	2.3%	1.7%
Liquid transport pipeline	1.3%	1.5%	1.4%	1.4%
Salt storage/handling facility	1.2%	1.1%	1.6%	1.2%
Wastewater disposal into a dry well	1.2%	1.1%	1.4%	1.2%
Injection well (for brine disposal)	0.6%	0.6%	1.0%	0.8%
Improper waste disposal well	-	0.7%	-	0.8%
Improperly abandoned hole/well (all associated with oil/gas)	1.2%	1.5%	2.0%	1.5%

Source: IDEM Ground Water Section Contamination Site Registry

Table 66. *Major sources of ground water contamination*

TYPE OF CONTAMINANT SOURCE	CHECK	RELATIVE PRIORITY	FACTOR
Animal Foodlots	X	H	1,2,4&6
Containers	X	H	1,2,3,4,5,6
Deep Injection Wells	X	L	1,2,3,4,6
De-icing Salt Storage Piles	X	H	1,2,3,6
Fertilizer Applications	X	VH	1,2,3,4,6,7
Irrigation Practices (return flow)	X	M	1,2,3,4,5,6
Land Application	X	M	1,2,3,4,5,6
Landfills (permitted and unpermitted)	X	H	1,2,3,4,5,6
Material Transfer Operations	X	L	1'2'3'4'5'6
Material Stockpiles	X	L	1,2,3,4
Mining and Mine Drainage	X	ML	1,2,3,4,5,6
Pesticide Applications	X	VH	1,2,3,4,5,6
Pipelines and Sewer Lines	X	M	1,2,3,4,5,6
Radioactive Disposal Sites	X	L	1,2,3,4,5,6
Salt-water Intrusion	X	L	8-N/A
Septic Tanks	X	VH	1,2,3,4,5,6
Shallow Injection Wells	X	L	1,2,3,4,5,6
Storage Tanks (above and below ground)	X	VH	1,2,3,4,5,6
Storm Water Drainage Wells	X	ML	1,2,3,4,5,6
Surface Impoundments	X	M	1,2,3,4
Transportation of Materials	X	L	1,2,3,4
Urban Runoff	X	ML	1,2,3,4
Waste Tailing	X	L	1,2,3,4,5
Materials Spills	X	VH	1,2,3,4,5

Factors for Establishing Relative Priority
(1) number of sources
(2) location of sources relative to ground water used as drinking water
(3) size of the population at risk from contaminated drinking water
(4) risk posed to human health and/or the environment from released substances
(5) high to very high priority in localized areas of State, but not over majority of State
(6) hydrogeologic sensitivity
(7) findings of the State's ground water protection strategy or other reports
(8) other criteria (please specify)

Table 67. *Ground water contaminants*

ORGANIC CONTAMINANTS	CHECK	INORGANIC CONTAMINANTS	CHECK
Pesticides	X	Pesticides	X
Other agriculture	X	Other agricultural	X
Petroleum compounds	X	Nitrate	X
Other Organic Chemicals:		Fluorides	
Volatile	X	Brine/Salinity	X
Semi-volatile	X	Arsenic	X
Miscellaneous		Other metals	X
Microbial Contaminants	X	Radionuclides	X
Bacteria	X	Other (specify)	
Protozoa			
Viruses			

Figure 77. *Reported hazardous materials spills per county 1990-1993*

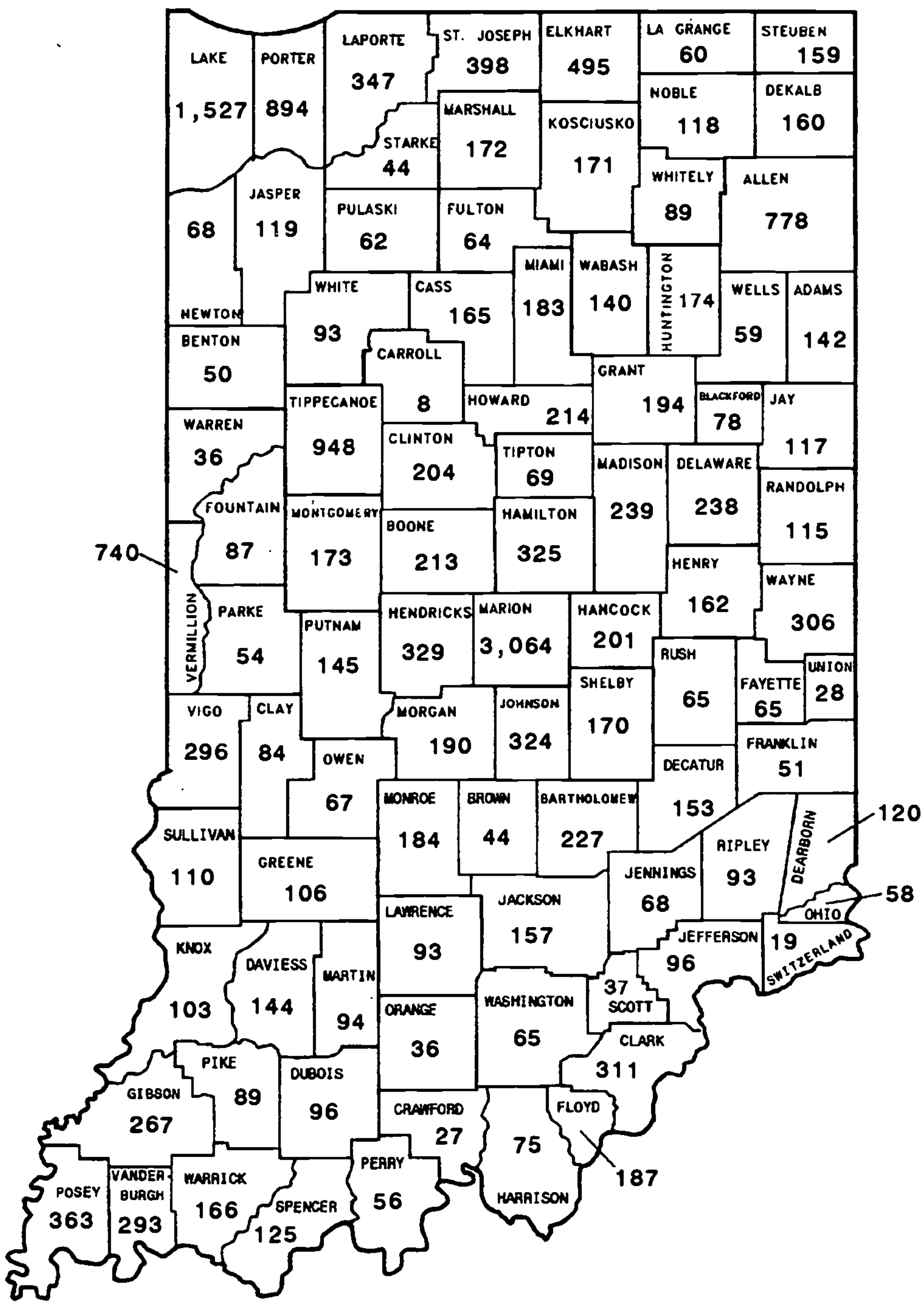


Figure 78. *Types of materials spilled*

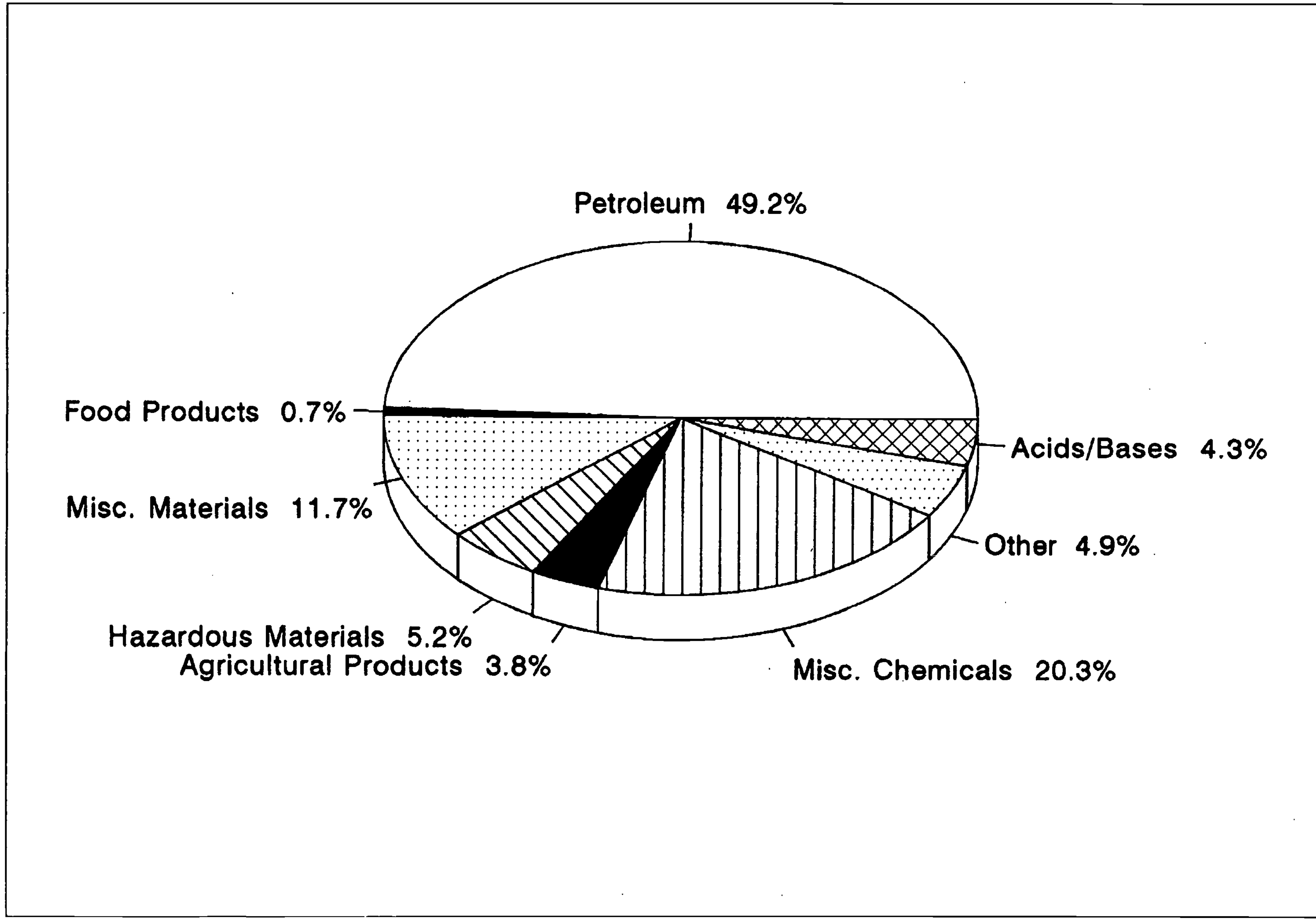
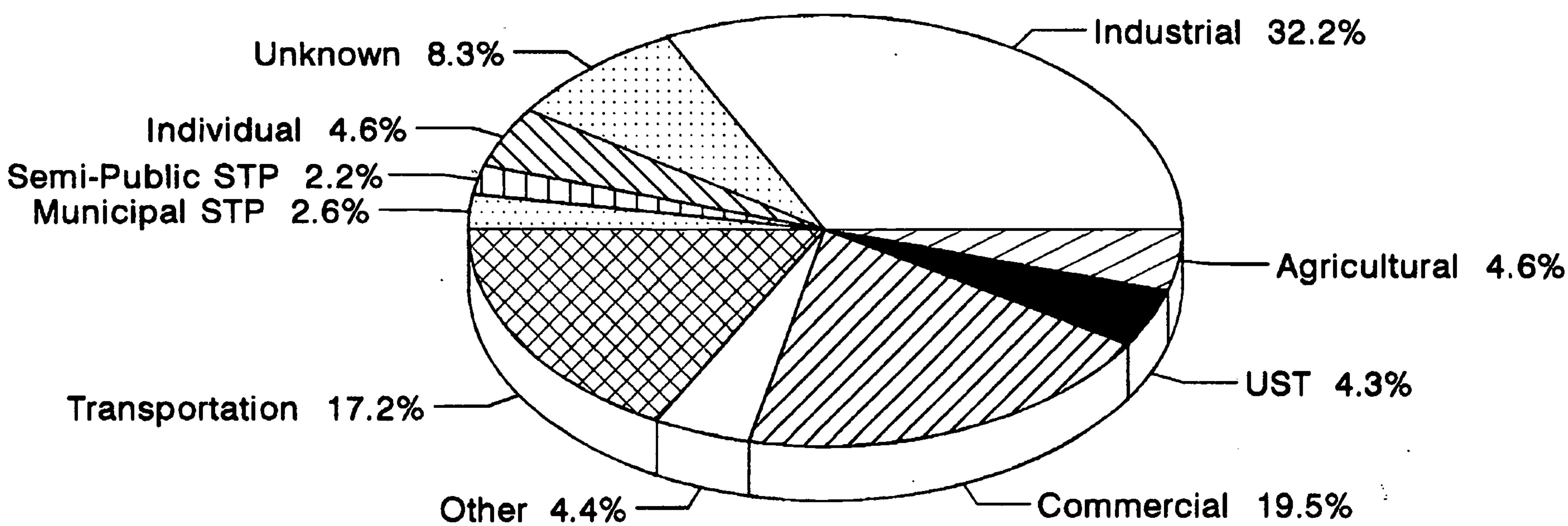


Figure 79. *Sources of materials spilled*



Underground Storage Tank Systems

Chronic leaks and sudden releases from buried storage tanks and their associating piping have resulted in the contamination of ground water and water supply wells for many cases in the registry used for this report. During the period form January, 1992 to December, 1993, 4,068 sites were reported to have leaking underground storage tanks although ground water contamination was not always documented. Figure 80 shows the total number of reported leaking underground storage tank sites per county through December, 1993.

Federal and State regulations require owners of underground storage tanks used for commercial or industrial purposes to notify IDEM of the tanks location, age and contents. (Tanks less than 1,100 gallons capacity, those containing heating oil, and those for residential and on-farm use are exempt). As of December 1993, some 45,774 tanks are regulated. The statewide distribution is shown in Figure 81.

During the time period of 1992 and 1993, a significant number of registered USTs occurred. This is due to the closure of USTs under 40 CFR Part 280 regulations. This is illustrated in Figure 82.

Dissolved and undissolved gasoline is the substance most often detected in ground water due to leaks from underground storage tanks, although heating fuel and chlorinated solvents have also been found. The health risks associated with these dissolved chemicals in well water used for drinking can be significant.

Solid and Hazardous Waste Disposal

Activities related to the disposal of solid and hazardous wastes have contributed to the contamination of ground water in Indiana. Thirty-five sites in the State are on the U.S. EPA's Superfund National Priorities List and Forty-one sites are on the list for State cleanup. See Figure 83 for their locations. Improper and unregulated hazardous waste disposal practices at these locations resulted in impacts on the ground water that are being addressed by state and federally funded, corrective actions or oversight cleanups conducted by responsible parties. There are some 1,500 sites in Indiana that have been placed on an inventory of potential Superfund or state-lead cleanup candidates. Investigations and assessments of the environmental hazards at these locations are still in progress, but additional ground water problems due to poor waste disposal practices in the past are expected to be discovered. Figures 84 and 85 list the names and locations of the sites found.

Figure 80. *Number of leaking underground storage tanks per county*

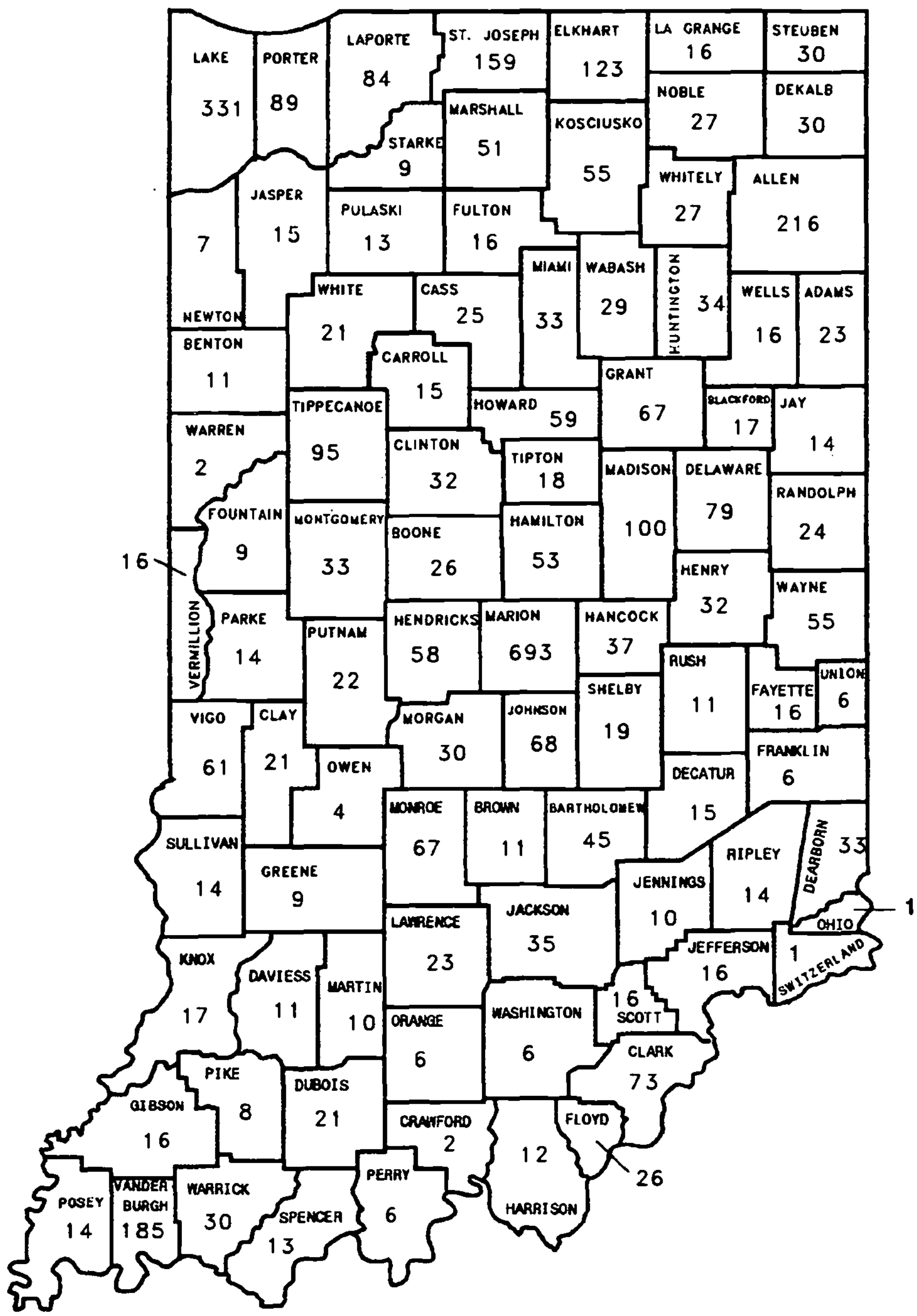


Figure 81. *Number of registered underground storage tanks-includes permanently closed USTs*

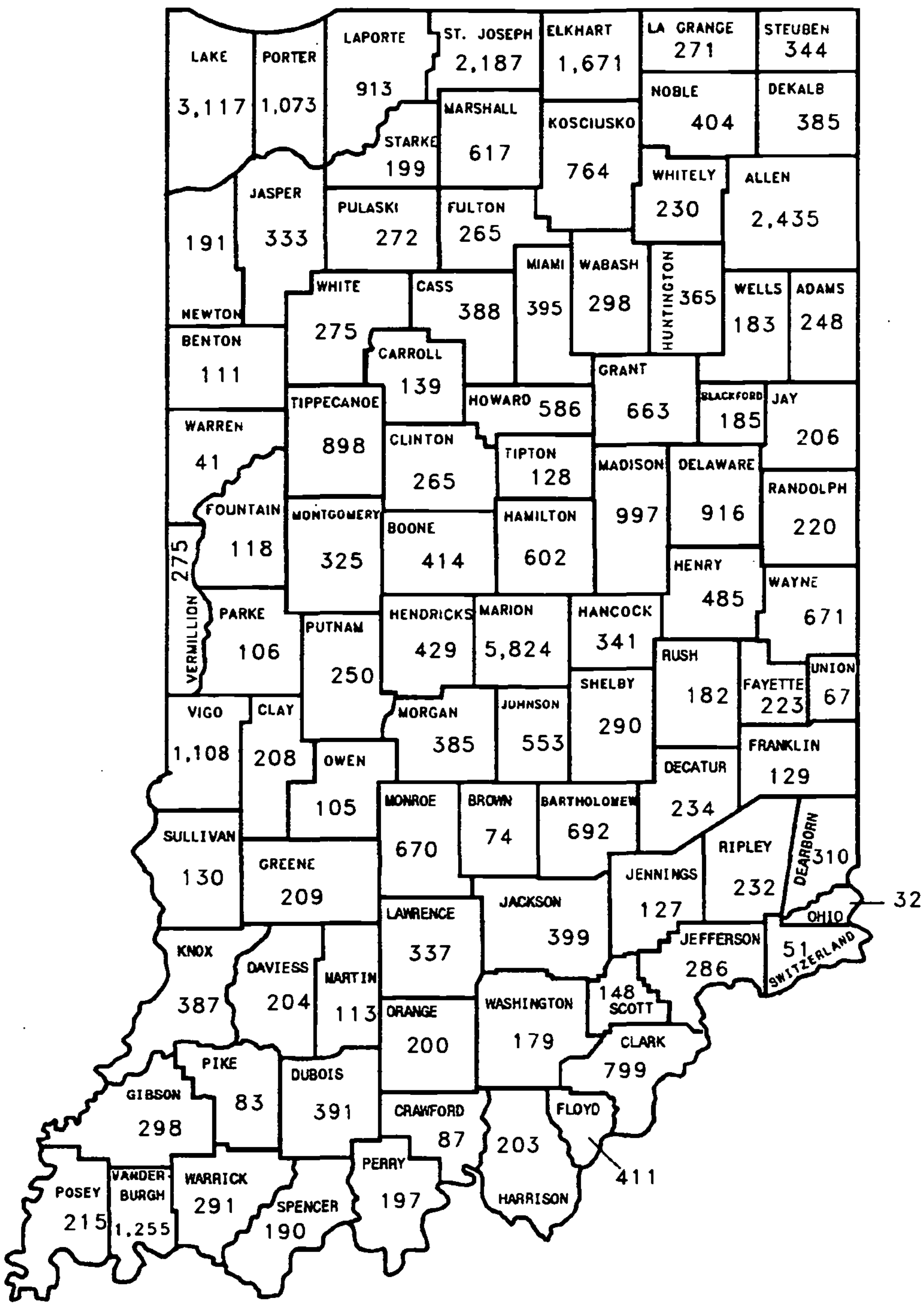


Figure 82. *Registered underground storage tanks*

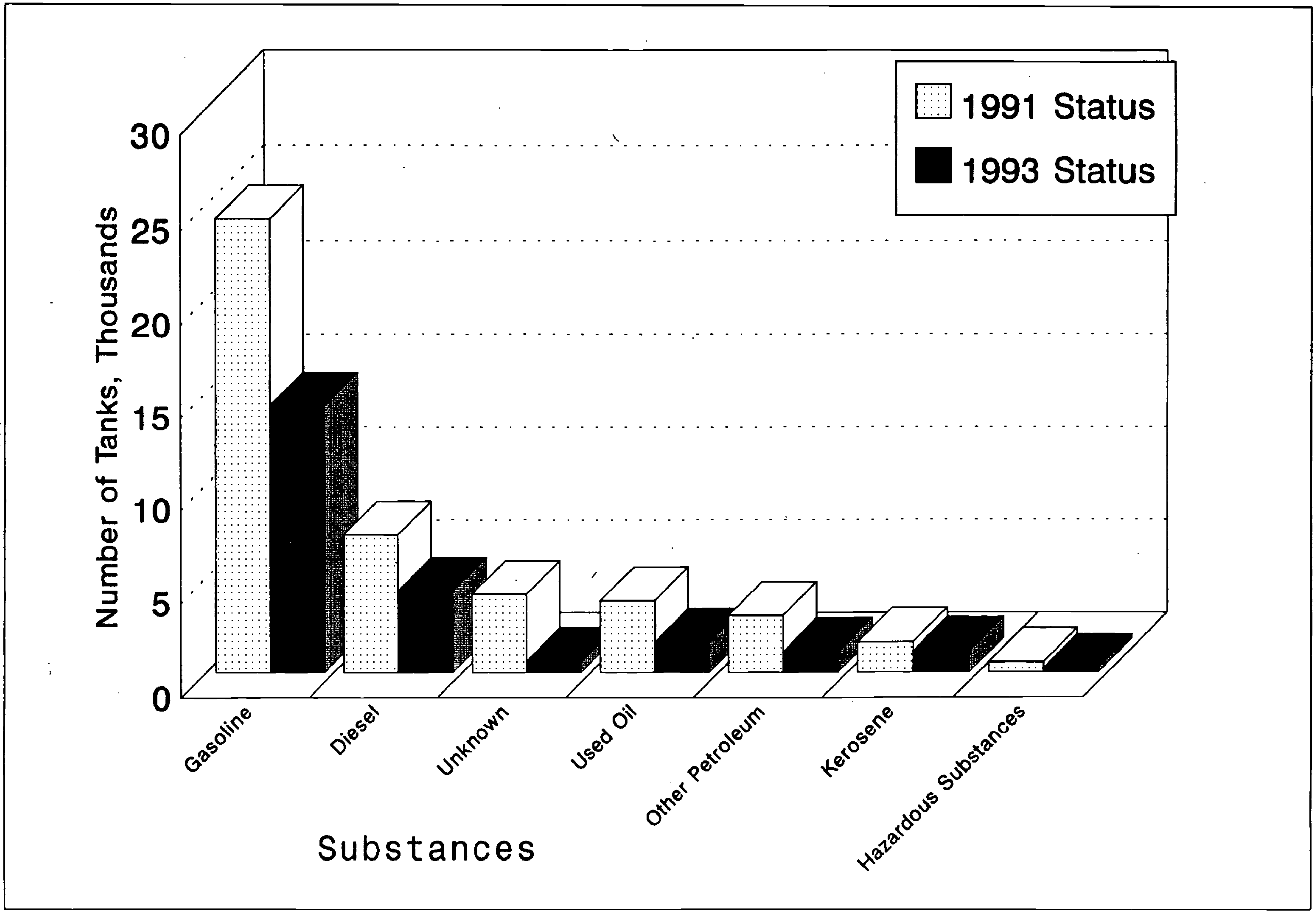


Figure 83. *Superfund sites - State cleanup sites - Defense Environmental Restoration Program sites*

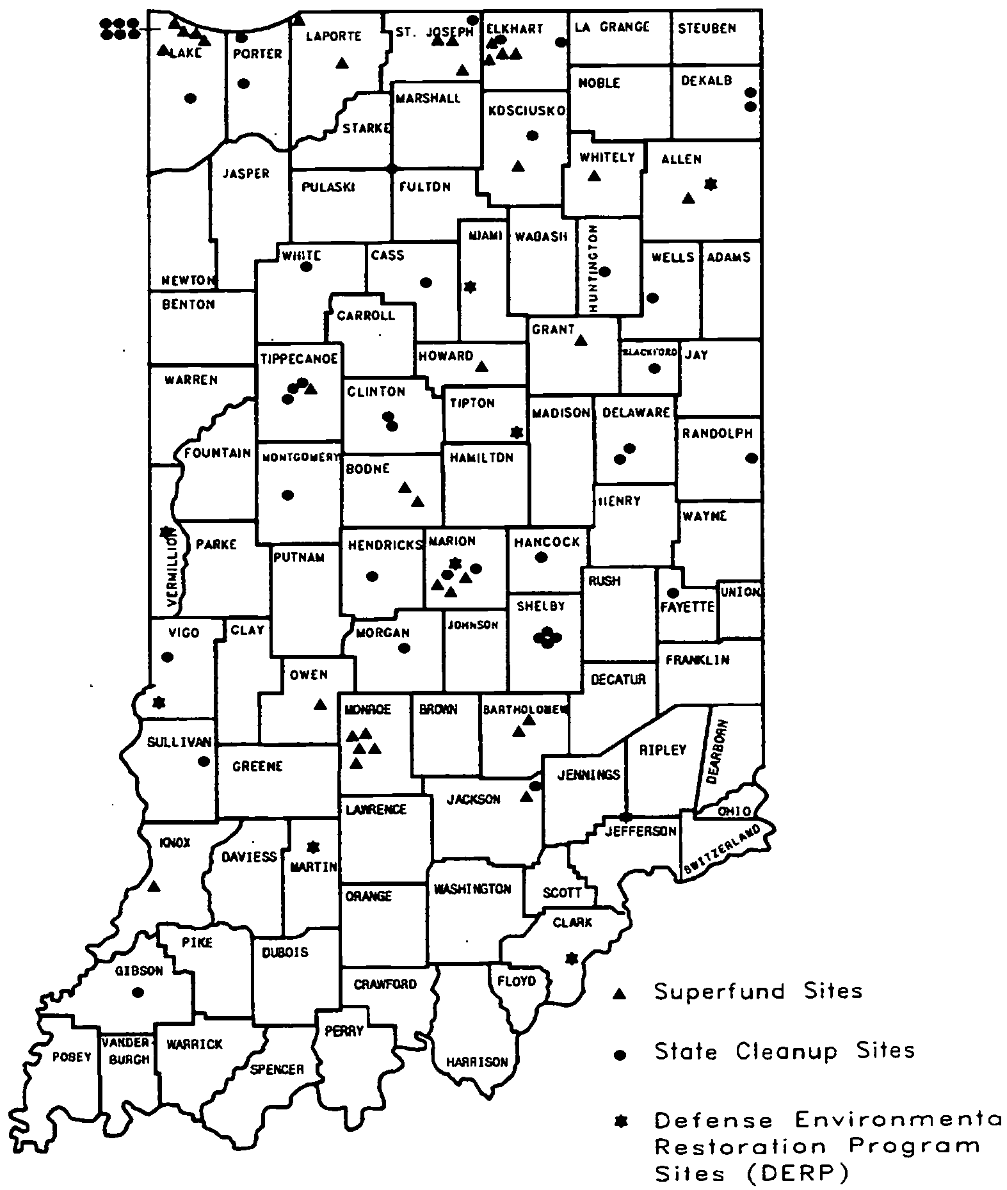


Figure 84. *Superfund sites*

Neal's Landfill, Bloomington
Seymour Recycling, Seymour
Envirochem Corp., Zionsville
Fisher-Calo, LaPorte
Lake Sandy Jo, Gary
Lemon Lane Landfill, Bloomington
Main Street Well Field, Elkhart
Marion (Bragg) Dump, Marion
Midco-I, Gary
Ninth Avenue Dump, Gary
Wayne Waste Oil, Columbia City
American Chemical Service, Griffith
Bennett Stone Quarry, Bloomington
Northside Sanitary Landfill, Zionsville
Reilly Tar & Chemicals, Indianapolis
Fort Wayne Reduction, Fort Wayne
Midco-II, Gary
Neal's Dump, Spencer
Waste Inc., Michigan City
Columbus Old Municipal LF #1, Columbus
Tri-State Plating, Columbus
Prestolite Battery, Vincennes
Douglas Road Landfill, Mishawaka
South Side Sanitary Landfill, Indianapolis
Carter Lee Lumber, Indianapolis
Conrail Rail Yard, Elkhart
Continental Steel Corp., Kokomo
Galen Myers Dump, Osceola
HIMCO, Inc., Elkhart
Whiteford Sales & Ser./Nat. Lease, South Bend
Tippecanoe Sanitary Landfill, Lafayette
Lakeland Disposal, Claypool
Anderson Road Landfill, Bloomington
Winston Thomas, Bloomington
U.S. Smelter & Lead Refinery, East Chicago

Defense Environmental Restoration Program (DERP) Sites

Fort Wayne MAP, Fort Wayne
Grissom Air Force Base, Peru
Hulman Field, Terre Haute
Fort Benjamin Harrison, Indianapolis
Indiana Army Ammunition Plant, Charlestown
Jefferson Proving Grounds, Madison
Indiana Army Ammunition Plant, Newport
Crane Naval Weapons Support Center, Crane

Figure 85. *State clean-up sites*

Calmet Containers, Hammond
P. R. Mallory, Crawfordsville
Shelbyville, Well Field, Shelbyville
TRW-Ross Gear, Lafayette
Indiana Refining, Princeton
Meridian Road Landfill, Connersville
Texas Eastern, Seymour
Crawfordsville Scrap & Salvage, Crawfordsville
Stout Battery, Muncie
J.I. Case, Terre Haute
Beal Street, Hammond
Monon Well Field, Monon
Davenport Dump, Martinsville
Warsaw Chemical Co., Warsaw
AMOCO, Granger
Clayton Wells, Clayton
Lusher Avenue, Elkhart
Augustus and Hook, Frankfort
Midwest Plating, Kokomo
Schrieber Oil, Cedar Lake
Midwest Plating, Logansport
Middlebury SR13, Middlebury
Huntington Terminals, Huntington
Norval Pickett Farm, Brazil
Alcoa, Lafayette
Dugger Electric, Dugger
ECI Refinery, East Chicago
Westinghouse, Union City
Wheeler Landfill, Wheeler
Julius Hancock Property, Plainfield
AMOCO, Whiting
Granger 8, Granger
Black Oak Drums, Gary
Indiana Harbor Shipping Canal, Lake County
Industrial Fuels & Asphalt, Hammond
G.S. Service Corp., Montpelier
Elmer Carrico Property, Washington
Solar Refractories, Portage
Spickelmeyer, Indianapolis
Rockford Wells, Rockford
Ingram-Richardson, Frankfort
Sadie, Tip, & Ray Sts., Wells, Indianapolis
Four-County Landfill, Fulton
Ind. Gas Co., PSI-Shelbyville
Knauf-Shelbyville
TRW-Shelbyville
Ind. Gas Co., -Lafayette

There are 648 operations in the state which generate treat, store, or dispose of hazardous waste. Figure 86 lists the number of facilities which generate, treat, store, or dispose of hazardous waste. Figure 87 indicates the geographic location and number of treatment, storage and disposal facilities. Approximately two million tons of hazardous waste are managed in the state each year. Stringent regulations of these activities includes monitoring of ground water quality at hazardous waste disposal facilities. Results of monitoring at these sites by IDEM staff indicates that impacts on ground water quality are occurring at 22 of them. Insufficiencies in the design, construction or operation of the waste management units at these sites are likely to have resulted in ground water pollution recorded. Similar deficiencies in the citing or management of 52 solid waste landfills in the state, most of them currently inactive, has also contributed to the ground water contamination documented through monitoring by IDEM staff.

Substances Contaminating Ground Water

At least 118 different chemicals have been detected through analysis of water samples from public or private water wells, or monitoring wells, at the sites of ground water contamination in the registry for Indiana. See Table 68 for the summary of the information from available state agency records showing the categories of contaminants which were documented. The substances which have been documented to contaminate ground water at the most sites in Indiana are aromatic, non-halogenated, and halogenated volatile organic chemicals, primarily solvents and dissolved petroleum products. Nitrates are also frequently found as contaminants in drinking water supply wells. Inorganic parameters, usually metals, are often found in monitoring wells at levels of significance.

Nitrates and Ammonia

Nitrate is the typical form of nitrogen compound detected in ground water and is the most frequent encountered category of drinking water contaminant in the state. Nitrate originates from a variety of sources, including septic system effluent, wastewater, animal manure, wastewater treatment sludge and agricultural fertilizer. Spills of fertilizer can be involved, as well as leaching from wastewater, sewage and manure pits, ponds and lagoons. Contamination by nitrate is identified as a concentration in excess of 10 milligrams per liter nitrate as nitrogen, which is the Maximum Contaminant Level for public water supplies. A longer discussion of nitrates in ground water occurs in the section on non-point source pollution. It is estimated that about 2 percent of the public water supply wells and from 7 to 10 percent of the private water supply wells in the state, if tested would exceed the 10 mg/1 level for nitrate. The highest concentration for nitrate documented is 1,190 mg/1.

Figure 86. *Regulated facilities which generate, treat, store, or dispose hazardous waste (large quantity generators)*

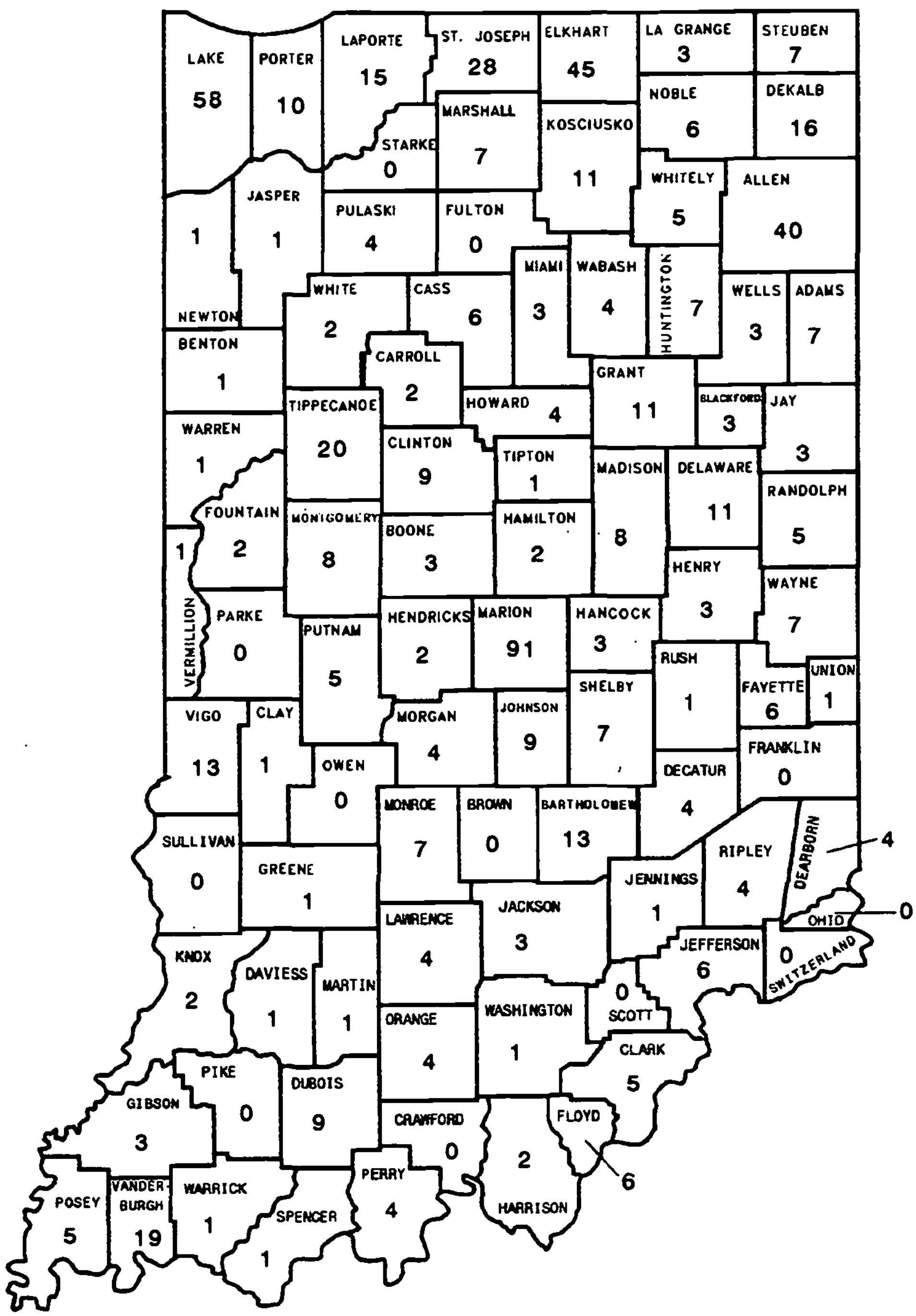


Figure 87. *Permitted hazardous waste treatment, storage, and disposal facilities*

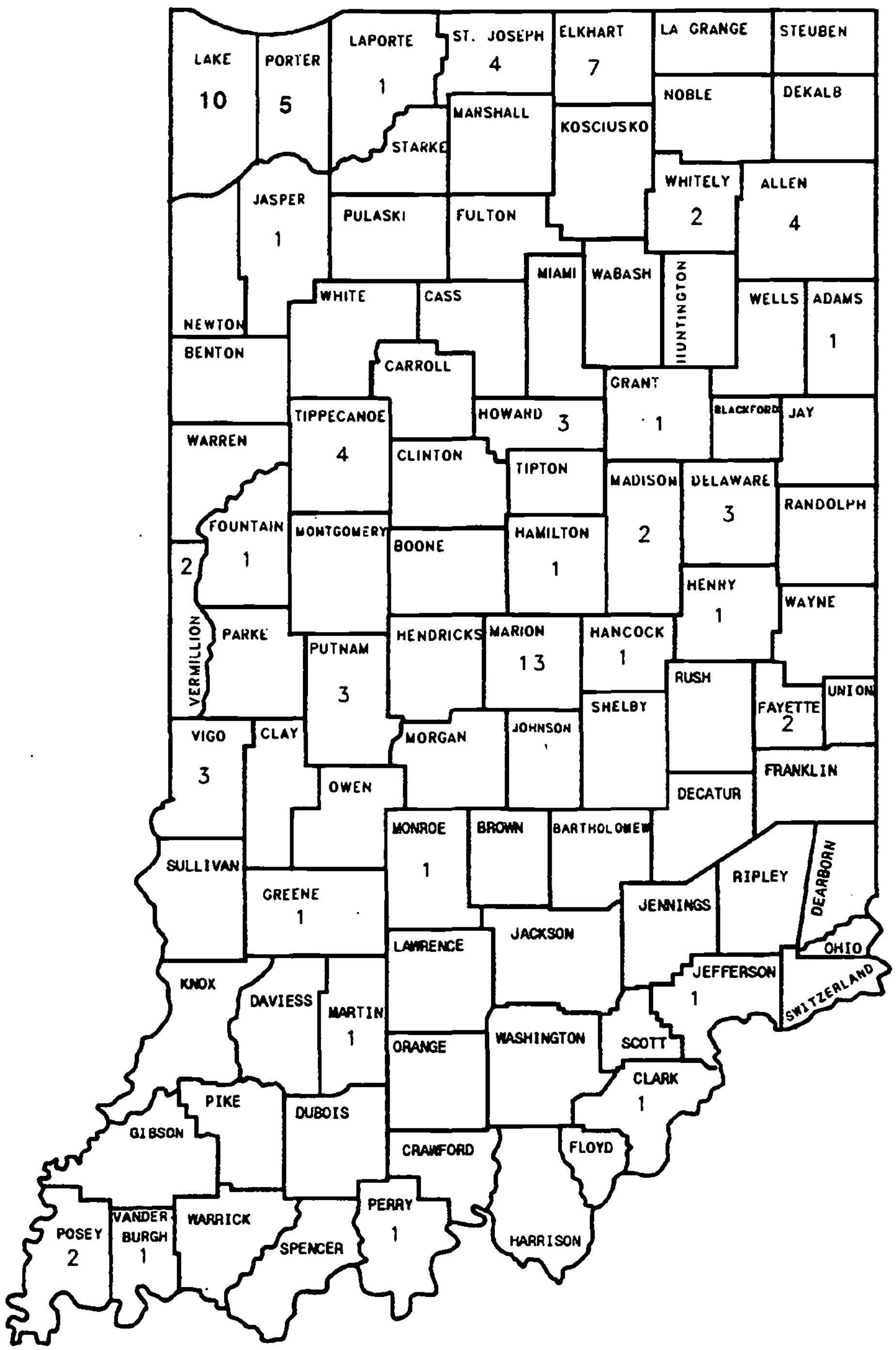


Table 68. *Chemical contaminants detected in Indiana ground water*

CHEMICAL TYPE CHEMICAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBREVIATION OR OTHER NAME
Halogenated Volatile Organics (490)a				
Trichloroethylene	20.0%	992,000 ppb	5 ppb MCL	TCE
1,1,1-Trichloroethane	15.1%	73,000 ppb	200 ppb MCL	1,1,1-TCA
Tetrachloroethylene	10.4%	22,700 ppb	5 ppb MCL	PCE, Perk
1,1-Dichloroethane	8.1%	50,000 ppb	------	1,1-DCA
1,2-Dichloroethane	8.8%	3,000,000 ppb	5 ppb MCL	1,2-DCA
1,1-Dichloroethylene	6.1%	1,800 ppb	7 ppb MCL	1,1-DCE
Methylene chloride	7.8%	227,000 ppb	5 ppb MCL*	MeCl2
Chloroform	6.1%	1,301 ppb	10 RfD	______
t-1,2-Dichloroethylene	5.1%	3,200 ppb	100 ppb MCL	t-DCE
Vinyl chloride	4.3%	40,000 ppb	2 ppb MCL	VC
Carbon tetrachloride	2.4%	6,860 ppb	5 ppb MCL	CC14
Bromodichloromethane	2.0%	2,000 ppb 20 Rdf	______	______
Trichlorofluoromethane	2.0%	340 ppb	______	TCF
1,1,2-Trichloroethane	1.0%	2,000 ppb	5 ppb MCL*	______
Dibromochloromethane	1.8%	26.0 ppb	______	DCM
1,1,2,2-Tetrachloroethane	1.4%	120 ppb	______	______
Bromoform	1.0%	1.42 ppb 20 RfD	______	______
Chlorobenzene	0.6%	9.0 ppb	______	______
1,2-Dichloropropane	0.2%	0.34 ppb	5 ppb MCL	______
Chloroethane	0.2%	540 ppb	______	______
Trichlorobenzene	0.8%	66 ppb	70 ppb MCL	______
Bromobenzene	0.4%	1 ppb	______	______

Table 68. *Chemical contaminants detected in Indiana ground water (cont.)*

CHEMICAL TYPE CHEMICAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBREVIATION OR OTHER NAME
Aromatic Volatile Organics (357)a				
Toluene	27.7%	free product	1,000 ppb MCL	—
Benzene	27.7%	free product	5 ppb MCL	—
Xylenes (o, m, & p)	22.4%	free product	10,000 ppb MCL	—
Ethylbenzene	20.4%	600 ppb	700 ppb MCL	—
Isopropyl benzene	0.6%	7.6 ppb	—	—
n-Propyl benzene	0.6%	7.6 ppb	—	—
1,3,5-Trimethyl benzene	0.3%	3.4 ppb	—	—
1,2,4-Trimethyl benzene	0.3%	54 ppb	—	—
Nonhalogenated Volatile Organics (32)a				
Acetone	40.6%	150,000 ppb	—	—
Methyl Ketone	37.5%	3,800 ppb	200 ppb HA	MEK
Methyl isobutyl ketone	21.9%	780,000 ppb	—	MIBK
Petroleum (114)a				
Gasoline	63.2%	free product	free product	—
Oil and Grease	12.3%	free product	free product	—
Crude Oil	3.5%	free product	free product	—
Heating Oil	7.0%	free product	free product	—
Diesel Fuel	14.0%	7,600 ppm	—	—
Base/Neutral Fraction (41)a				
Naphthalene	17.1 %	140 ppb	20 ppb HA	—
Di-N-Butylphthalate	9.6%	99 ppb	—	—
Diethylphthalate	7.3%	420 ppb	5 ppm HA	—
1,3-Dichlorobenzene	4.9%	74 ppb	600 ppb HA	—

Table 68. *Chemical contaminants detected in Indiana ground water (cont.)*

CHEMICAL TYPE CHEMICAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBREVIATION OR OTHER NAME
1,3-Dichlorobenzene	4.9%	74 ppb	600 ppb HA	—
Dimethylphthalate	4.9%	850 ppb	—	—
Pyrene	7.3%	62 ppb	0.03 RfD	—
Butylbenzylphthalate	4.9%	3.7 ppb	100 ppb PMCL	—
Styrene	9.6%	220 ppb	100 ppb MCL	—
1,4-Dichlorobenzene	2.4%	14 ppb	75 ppb MCL	—
1,2-Dichlorobenzene	2.4%	6,000 ppb	600 ppb HA	—
N-Nitro-N-Dipropylamine	2.4%	240 ppb	—	—
Acenaphthalene	2.4%	1 ppb	—	—
Acenaphthene	2.4%	100 ppb	—	—
Fluorene	2.4%	38 ppb	—	—
N-Nitrosodiphenylamine	2.4%	240 ppb	—	—
Phenanthrene	2.4%	81 ppb	—	—
Anthracene	2.4%	58 ppb	0.3 RfD	—
Fluoranthene	2.4%	40 ppb	—	—
Benzo(A)Anthracene	2.4%	30 ppb	0.1 ppb PMCL	—
Chrysene	2.4%	26 ppb	0.2 ppb PMCL	—
Benzo(A)Pyrene	2.4%	12 ppb	0.2 ppb PMCL	—
Tetrahydrofuran	2.4%	1,620 ppb	—	—
Pesticides (41)a				
Atrazine	34.0%	5,700 ppb	3.0 ppb MCL	Aatrex
Alachlor	24.3%	2,500 ppb	2.0 ppb MCL	Lasso
Dicamba	4.8%	230 ppb	200 ppb HA	Banvel
Chlordane	14.6%	92 ppb	2.0 ppb MCL	—

Table 68. *Chemical contaminants detected in Indiana ground water (cont.)*

CHEMICAL TYPE CHEMICAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBREVIATION OR OTHER NAME
Chlordane	14.6	92 ppb	2.0 ppb MCL	________
Lindane	2.4%	1.2 ppb	0.2 ppb MCL	g-BHC
Trifluralin	2.8%	0.04 ppb	5 ppb HA	________
Aldrin	2.4%	0.1 ppb	0.00003 RfD	________
Endosulfan sulfate	2.4%	0.083 ppb	________	________
a-BHC	0.7%	0.4 ppb	________	________
b-BHC	0.7%	0.8 ppb	________	________
Endosulfan I	0.7%	0.23 ppb	________	________
Prometon	0.7%	0.06 ppb	100 ppb HA	________
Methoxychlor	0.7%	0.09 ppb	40 ppb MCL	________
Linuron	0.7%	18 ppb	________	Linex, Lorox
Other Organic Chemicals (26)a				
PCB-----s (1016,1242,1248,1260)	42.3%	1,100,000 ppb	0.5 ppb MCL	________
Picoline	0.3%	1,100 ppb	________	________
Pyridine	0.2%	1,100 ppb	________	________
Metals (264)a				
Arsenic*	7.0%	50 ppm	0.05 ppm MCL	As
Lead*	5.5%	6,200 ppm	0.015 ppm AL	Pb
Sodium	8.2%	12,000,000 ppm	________	Na
Chromium*	4.0%	66,000 ppm MCL	________	Cr
Barium*	6.5%	18,350,000 ppm	2.0 ppm MCL	Ba
Zinc	5.5%	211,000 ppm	5 ppm SMCL	Zn
Nickel	1.6%	7,000 ppm	0.1 ppm MCL*	Ni
Cadmium*	1.5%	10,000 ppm	0.005 ppm MCL	Cd

Table 68. *Chemical contaminants detected in Indiana ground water (cont.)*

CHEMICAL TYPE CHEMICAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBREVIATION OR OTHER NAME
Copper	3.7%	15,000 ppn	1.3 ppm AL	Cu
Silver	0.6%	50 ppb	0.1 ppm HA	______
Selenium*	1.1%	200 ppm	0.05 ppm MCL	Se
Mercury	0.2%	6.8 ppb	0.002 ppm MCL	Hg
* Heavy Metals				
Nitrate	55.2%	1,190,000 ppm	10 ppm MCL	NO3
Chlorides	15.0%	22,000 ppm	250 SMCL	______
Sulfates	10.4%	2,000,000 ppm	400/500 ppm PMCL	______
Fluorides	9.2%	5,000 ppm	4 ppm MCL	______
Ammonia	8.1%	174,000 ppm	30 ppm HA	NH3
Nitrite	0.3%	0.1 ppb	1 ppm MCL	NO2
Sulfides	1.7%	41 ppm	______	______

a = Number in parenthesis denotes total number of detections per chemical type
MCL = Maximum Contaminant Level
RfD = Reference Dose (mg/Kg/Day)
Ha = Lifetime Health Advisory (Draft of Final)
AL = Action Level
SMCL = Secondary Maximum Contminant Level
PMCL = Proposed Maximum Contaminant Level

Ammonia has also been documented as a ground water contaminant, arising from the same sources and causes as nitrate. Excess ammonia only occurs when soil and microbiological capacity for conversion to nitrate is exceeded. Concentrations of ammonia in excess of .05 mg/1 are considered to be elevated above natural conditions. The registry includes a maximum value of nearly 175 mg/1 from a spill event. The majority of the non-point source monitoring records for ammonia above .05 mg/1 involve concentrations in the range from .05 to 2.0 mg/1.

Volatile Organic Compounds

Halogenated, non-halogenated, and aromatic volatile organic chemical compounds (VOCs) are the most common ground water contaminants. See Table 68 for a listing of these compounds and their distribution. The most frequently detected chlorinated (halogenated) VOCs are trichloroethylene (TCE) and 1,1,1 trichloroethane (TCA). Nearly 20 other halogenated chemicals have also been documented. This groundwater contamination is associated with spills, waste sites, and cases where the source is unconfirmed or unknown. Benzene and toluene are the most frequently encountered aromatic VOCs, typically from dissolved motor fuels. Seven other compounds have also been detected in cases of leaking underground tanks and petroleum product spills.

Petroleum and Petroleum Products

Besides dissolved petroleum products, undissolved petroleum and its refined products are frequently detected ground water pollutants. This category includes crude oil, gasoline, fuel oil, diesel fuel, and petroleum distillate solvents such as naphtha. Sites are contaminated with petroleum or petroleum products by underground storage tanks which leak motor fuel, heating oil or petroleum based solvents, spills from above ground storage tanks, crude oil present in private water wells near oil and gas drilling operations, and releases from petroleum product pipelines. The remaining locations can be attributed to spills from product handling or transportation accidents.

Metals and Inorganics

Typical inorganic analytical parameters for ground water monitoring at hazardous waste treatment, storage, and disposal facilities, and at sites under investigation through Superfund include heavy metals for which there are primary (health protection) public drinking water supply standards. These include arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver. Iron, manganese, copper, aluminum, molybdenum, nickel and zinc are other metals for which secondary (esthetic protection) public drinking water supply standards may exist.

Chlorides and Salts

Concentrations of chlorides in excess of the secondary public drinking water standard of 250 parts per million can exhibit objectionable taste in drinking water, particularly at levels of about 500 parts per million or greater. The 38 cases of public or private water wells impacted by chlorides were due to man's activities. Elevated levels of sodium, in excess of 150 parts per million, are typically found in conjunction with elevated chlorides. The majority of the problems resulted due to leaching of salt from uncovered storage piles of road deicing salt. The other sites are associated with crude oil exploration and production activities through brine disposal pits, brine disposal wells, and improperly constructed test wells.

Other Contaminants

Total coliform bacteria counts are routinely used as indicators of bacterial contamination of well water samples. Such tests are also useful as an index for the integrity of well constructing because properly constructed wells should be sanitary. Although thousands of bacteria samples are analyzed each year, with a significant number yielding unsatisfactory results, these have not been included in this report. The registry does include some historical incidents where multiple private wells in housing developments were apparently impacted by aquifer-wide contamination due to septic systems, which was documented by coliform bacteria tests.

There are a variety of other organic chemicals detected in Indiana ground water, arising from abandoned waste disposal sites, wastewater impoundments and industrial sites. These include semivolatile compounds such as naphthalene, styrene and phthalate esters, phenols and polychlorinated biphenyls (PCB's). Pesticides are discussed in the following section on nonpoint source pollution.

Ground Water Indicators

Volatile Organic Chemicals

Public drinking water standards (Maximum Contaminant Levels or MCLs) for the finished water were established by EPA for 21 volatile organic chemicals (VOCs). A monitoring schedule was implemented for these 21 VOCs and 20 other unregulated contaminants. Community systems with over 10,000 customers began their monitoring in 1988 and systems with 3,300 to 10,000 customers began to sample in 1989. The results of this two year span of monitoring includes at least one sample or few and finished water at 128 systems using ground water. Detectable VOCs were reported in 33 or 26 percent of the systems. Their location of community public water supplies with documented organic chemical contamination through December, 1993 is shown in Figure 88.

The most frequently reported VOCs in unfinished Ground Water for the systems monitored were trichloroethylene, dichloromethane, and 1,2, dichloroethane. These VOCs were detected at levels exceeding MCLs. Table 69 shows the number of violations and samples taken.

Pesticides

The only contaminant in this category detected at levels above MCL was Di(2 ethylhexyl) adipate. Since this compound could be introduces during the laboratory analysis or in the materials used to construct the wells or pumping equipment. These possibilities make it difficult to determine if this contaminant is present in Ground Water.

Inorganic Chemicals

Community Water Supplies in Indiana which use ground water are required to monitor the quality of water delivered to their customers at least once every three years for 17 regulated parameters (13 metals, nitrate, nitrite, and asbestos) and one unregulated parameter (sulfate).

Records indicate that MCL for nickel, fluoride, chromium, cyanide and barium were exceeded in several systems. At this time, the arsenic, barium and fluoride are believed to be naturally high levels associated with minerals in the bedrock, while the nitrate is considered to be non-point in origin. Only cyanide and chromium are believed point source in origin.

Ground Water Indicator 2: Public Water Supplies (PWS) with MCL monitoring violation.

Indiana has 731 PWS communities using Ground Water as the source of drinking water. These PWS serve a population of over 1,760,153. Presently 3.2% or 24 PWS communities have reported MCL violations within the past 12 month reporting period. These PWS communities serve a population of over 6,432. This is 3.2% of all the population being served by PWS utilizing ground water. Table 8 displays this data.

Pesticides

Detection of pesticides in the community supplies of these levels are very minute. The only contaminants detected are shown in Table 69. The data used to complete this table does indicate there are several pesticides being detected in Ground Water at levels below 50 percent of the MCL.

Figure 88. *Public water supply wells with detectable organics*

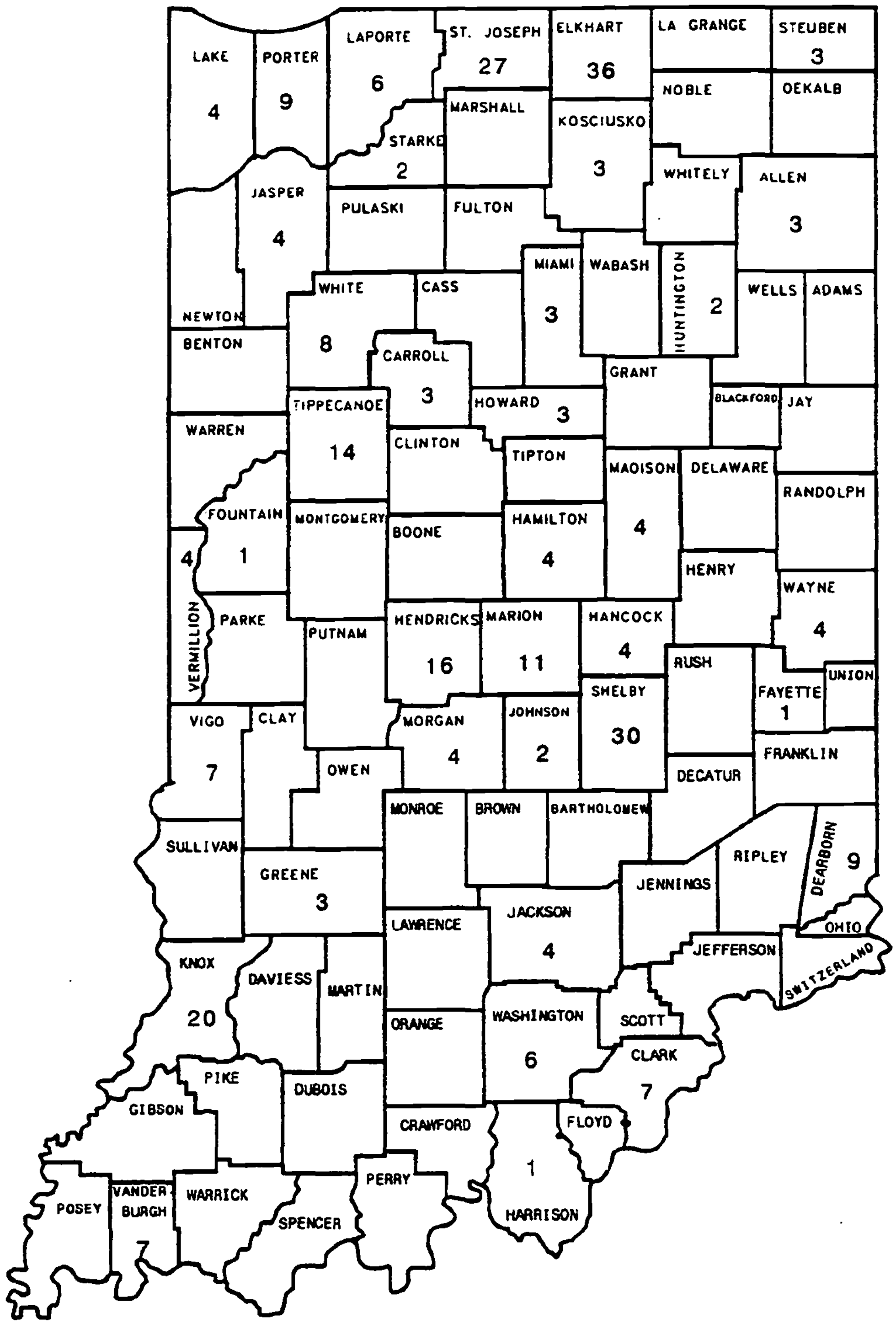


Table 69. *Number of MCL monitoring violations for ground-water-based community public water systems for selected contaminants in four contaminant groups*

CONTAMINANT GROUP	CONTAMINANT	NO. OF MCL VIOLATIONS	NO. OF SAMPLES
Metals/Inorganics	Floride	6	6
	Barium	4	4
	Cyanide	1	1
VOCs	Dichloromethane	1	1
	Trichloroethylene	3	3
	Cis-1,2-Dichloroethylene	3	3
	Tetrachloroethylene	1	1
	1,2-Dichloroethane	1	1
Pesticides	Di-(2-Ethyhexel) Phthalate	1	1
Nitrate	Nitrate	3	3

Inorganic

The inorganics are shown in tables 69 and 70.

Volatile Organic Compounds

Many of the same VOCs detected at PWS Ground Water sources at levels exceeding MCLs are detected of levels 50 percent of the MCL. Table 70 displays this data and the additional VOC, (vinyl chloride and 1,1-dichloroethylene(have been detected. Data shown in Table 71 indicates the possibility that a number of Ground Water based PWS could be in risk of MCL violations into the future.

Ground Water Indicator 4:

> Indiana has 731 Ground Water based PWS that serves population over 1,760,153 out of these only two PWS have a Wellhead Protection Program (WHPP). These communities have a population of over 54,050. Indiana has developed a draft WHPP plan. This plan is now being reviewed by the public and USEPA for comments. The final version of this plan will serve as the foundation for the WHPP regulations and implementation.

Wellhead Protection Program

Indiana has about 2,200 public water systems which use ground water as a source of supply. In continuing to assure that water from these systems is of high quality and safe to utilize, the IDEM is developing the Indiana Wellhead Protection Program.

Since the 1930's, an informal policy which requires a 200 feet minimum separation distance between a public water system well or wellfield and sources of bacteriological contamination has been a part of IDEM's Public Water System Construction Permitting Program. Once this condition is met, a well site approval is issued to assure compliance with this minimum distance. Recently, additional ground water contamination sources such as pesticides and other organic chemicals have been included in well siting approvals. Nevertheless, a more comprehensive approach using wellhead protection areas is essential to assure that wellfields are properly developed and maintained for the purpose of providing a continuous source of safe drinking water to Indiana communities.

A wellhead protection area can be defined, in part, as the surface and subsurface area surrounding a well or wellfield which supplies a public water system, through which contaminants are likely to migrate and eventually reach the well or wellfield. Wellhead protection areas (WHPA's) can be

Table 70. *Number of monitoring detections between 50 and 100 percent of MCLs for four contaminant groups*

CONTAMINANT GROUP	CONTAMINANT	NO. OF MCL SAMPLES BETWEEN 50 AND 100% OF THE MCL
Metals/Inorganics	Nickel	1
	Floride	120
	Chromium	1
	Cyanide	1
	Barium	4
VOCs	Dichloromethane	17
	Tetrachioroethylene	17
	Trichloroethylene	19
	1,2-cis.-Dichloroethylene	10
	1,2-Dichloroethane	1
	Vinyl Chloride	4
	1,1-Dichloroethylene	1
Pesticides	Simazine	1
	Di-(2-Ethyhexel) Phthalate	1
Nitrate	NO3	23

Table 71. *Number of ground-water-based community PWSs with MCL monitoring violations*

	GROUND WATER-BASED COMMUNITY PWSs	GROUND WATER-BASED COMMUNITY PWSs WITH MCL SAMPLING VIOLATIONS
Total No.	751	24
Population Served	1760153	60,432

delineated, among other methods, by assigning an arbitrary fixed radius, or by calculating a time-of-travel period using computer models. Once a WHPA has been identified the following conditions can be met:

1. The delineation process identifies the surface area to be regulated for the purpose of protecting the source of supply for the wellfield.

2. The delineated area allows the public water system and the community to identify pollution sources which may contaminate the supply.

In this regard, the IDEM Ground Water Section initiated a small outreach program in order to obtain the following goals.

1. Initiate a coordinated approach through the Indiana Wellhead Protection Program and the Indiana State Pesticide Management Plan.

2. Provide technical assistance to the Wellhead Protection Program, the Indiana Public Water System Supervision Program, and local communities and water utilities.

3. Supply information in determining staffing and funding needs in order to adequately administer the Wellhead Protection Program.

Description of Capture Zone Delineation Methods

As a part of the outreach program, WHPA's were delineated for seven public water systems. These systems were arbitrarily chosen based on a high degree of aquifer sensitivity and potential contamination, particularly from pesticides. Delineation was determined by assigning either a 2,000 or 5,000 feet fixed radius around the wellfield, and a calculated one, five, and ten year time-of-travel ground water capture zone. Potential sources of ground water contamination were identified within the delineated areas, and ground water quality samples were collected from a majority of the wells.

The WHPA time-of-travel ground water capture zones were identified by using the U.S. EPA computer code WHPA 2.1. Water well logs, pump test data, and general literature on describing local geology served as the primary sources of input data. The program WHPA 2.1 is a modular, semi-analytical ground water flow model designed to assist technical staff with WHPA delineations. This model consists of four independent computational models which may be used to delineate ground water capture zones surrounding public water system wellfields.

The wellfields sampled were modeled for capture zones using the general purpose particle tracking module called GPTRAC. Time-of-travel criteria was selected for delineation in order to provide the system with a known period of time for any correction or remedial actions.

The GPTRAC module is capable of handling multiple pumping and injection wells in addition to one or two parallel barrier and stream boundary conditions. It contains semi-analytical capture zone solution and makes the assumption that the aquifer is homogeneous and exhibits two-dimensional, steady-state ground water flow. Additional assumptions include uniform hydraulic gradient and constant physical properties. The model also accounted for confined, leaky confined, or unconfined aquifers with areal recharge or infiltration, and well interference.

Ground Water Quality Sampling

Ground water quality samples from the public water system wellfields were collected, unless otherwise mentioned in the individual reports, at the wellhead, before any treatment. The samples were then submitted to the IDEM's contract laboratory where analyses of pesticides and volatile organic chemicals was conducted using U.S. EPA drinking water methods as follows: volatile organic chemicals 524.2, semi-volatile organics-modified 525.2, chlorinated acide-modified 515.1, toxaphene 508, N-methylcarbamoyloximes, N-methylcarbamates 531.1.

The drinking water methods used permitted the water quality samples to be analyzed for over 100 different analytes at detection levels between 0.5 and 200.0 micrograms per liter (ug/L). Moreover, the number of analytes in the methods exceeds the number of analytes in other U.S. EPA methods, in addition to containing certain chemical compounds used in Indiana.

The water from certain wells was also analyzed for general chemistry, nutrients, and metals. These analyses were conducted by the Indiana Department of Health Environmental Laboratory.

Nonpoint Source Pollution of Ground Water From Agricultural Chemicals

The pollution of ground water with agricultural chemicals from nonpoint sources continues to be an issue which receives considerable attention in Indiana. About 70 percent of the land use in the state is agricultural while Indiana is a leading producer nationally of both field crops and animal agricultural products. Concerns over widespread application of agricultural chemicals onto farmland with regard to the potential effect on ground water quality prompted the U.S. Environmental Protection Agency to develop and implement a Pesticides and Ground Water Strategy.

In order to put the pesticide strategy key principles of prevention and state primacy into practice, EPA has offered states the option to exercise primary decision making authority through the vehicle of State Pesticide Management Plans to be developed and approved in cooperation with EPA. During the biennium, the Indiana Department of Environmental Management Ground Water Section has been following the lead of the Office of Indiana State Chemist in developing a State Pesticide Management Plan for Indiana. Subsequently, a revised version of this plan will be submitted to the EPA in September, 1994.

Goals of the Indiana State Pesticide Management Plan

In 1989, Indiana passed its Ground Water Protection Act which institutionalized the Indiana Ground Water Task Force as the oversight committee for implementing the Indiana Ground Water Protection Strategy. In 1992, the Ground Water Task Force adopted a policy framework for the protection of Indiana's ground water.

The State of Indiana shall protect ground water resources which currently meet criteria for human health protection from any further degradation. The State recognized that it may need to take into account a number of practical considerations in protecting ground water including, but not limited to: site characteristics, technical feasibility, cost and relative benefit.

I. The State of Indiana will protect water resources which currently meet criteria for human health protection from any further degradation by:

   A. The establishment of siting, design, and monitoring criteria for potential sources of ground water contamination and promoting the use of non-polluting materials or alternative management degradation. (i.e. pollution prevention and source reduction)

   B. The implementation of best management practices in potentially vulnerable areas for pesticide and nutrient use.

   C. Banning or restricting the use of pesticides and nutrients where best management practices and other pesticide management measures (i.e. pesticide state management plan) cannot protect ground water to the level of established health protection standards.

   D. Provide protection of wells use for public water supply be establishing criteria which mitigate existing and future potential threats of ground water contamination and which ensures the continued availability of the resource for present and future generations. Ground water protection zones should be established around community and non-community public water system wells.

II. For ground water resources contaminated to levels that pose a health threat.

   A. The first step in remediation should be to stop the body of contamination from spreading any further and to eliminate the cause of the contaminant release.

   B. Standards for ground water remediation shall ensure that the ground water resources meets criteria for the protection of human health, animal life, plant life, and the environment. The potential uses of the specific ground water resource and the technical and economic feasibility for meeting the standards must be evaluated and incorporated in the decision on the required remediation level.

   C. Remediation of the ground water resource shall be governed by Federal regulation for Superfund sites and State laws and regulations for non-Superfund sites (including leaking storage facilities containing petroleum products).

   D. Ground water remediation should be prioritized to limit the risk of adverse affects to humans.

Role of IDEM Ground Water Section

In the mid 1980's, the IDEM Ground Water Section began an ongoing program to determine the occurrence of pesticides in Indiana's ground water. As a result of this effort, the Section has continued it's lead role of monitoring ground water in Indiana. In the future, the Ground Water Section will continue to monitor for pesticides and fertilizer to provide any necessary base line or back ground water quality data in areas where a site-specific ground water quality assessment is deemed necessary to implement the Indiana State Pesticides Management Plan. Moreover, the Section will monitor for pesticides and fertilizers in response to alleged contamination events and to gather data in order to evaluate the effectiveness of prevention, response and enforcement measures.

During 1992-1993, the IDEM Ground Water Section conducted a series of ground water quality assessments to determine the occurrence of pesticides in ground water. These studies consisted of a continuation of the Indiana

Pesticide Survey, a pilot project to incorporate the Farmstead Assessment System in Indiana, and an evaluation of ground water quality and source identification around public water system wellfields in order to provide data to the Indiana Wellhead Protection Program.

Indiana Pesticide Survey

The Indiana Pesticide Survey is a multi-phase study to assess the occurrence of agricultural chemicals in drinking water supply wells statewide. The project is being conducted by the IDEM Ground Water Section, with grant support from the EPA, Region 5. By the end of spring, 1994, over 1050 ground water quality samples had been collected from 375 private water wells in 13 geologically diverse aquifer systems.

The purpose of the Indiana pesticide Survey is to determine which pesticides can be detected, their frequency and range of detection and geographic location; and to compare these findings with potential adverse health risk thresholds, Moreover, the frequency, location and concentration of nitrate, ammonia, phosphorus and other nutrient indicators are also being assessed, along with a suite of volatile organic chemicals that may be associated with the non-active ingredients of pesticide formulation.

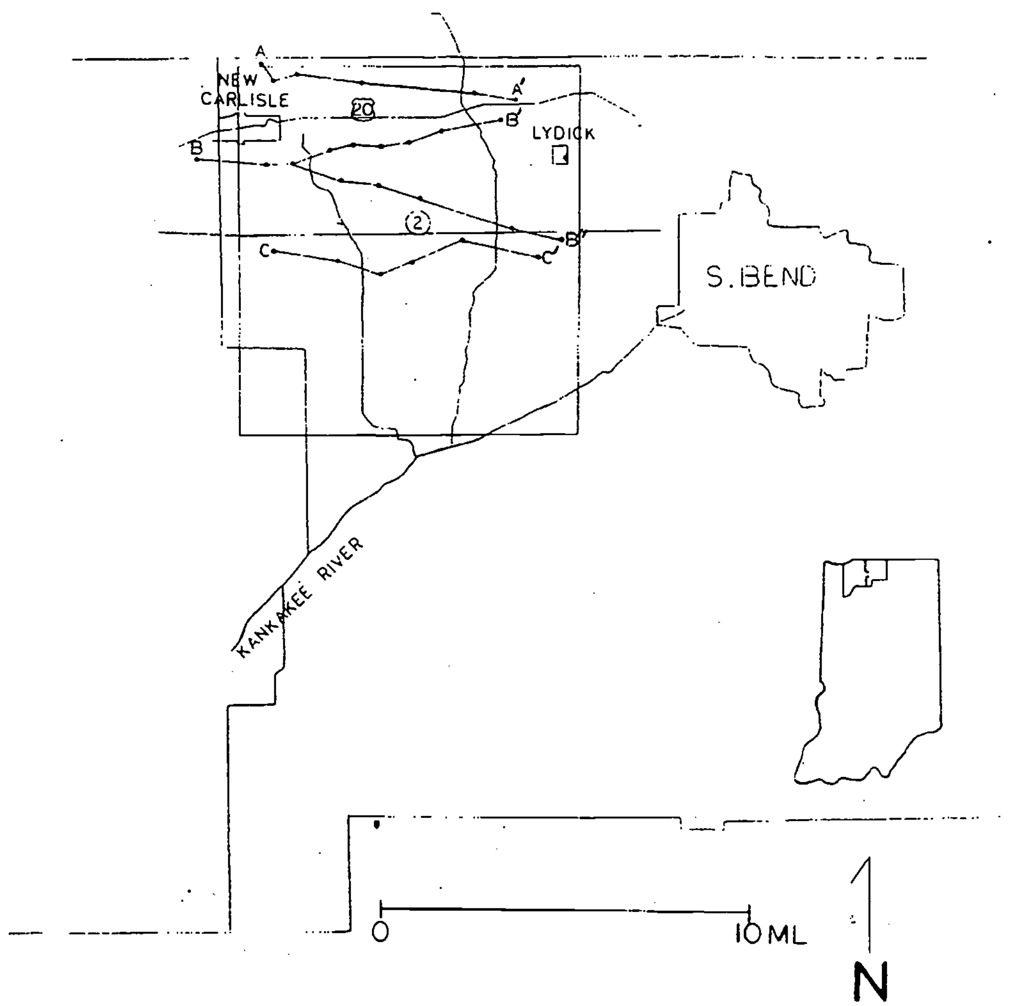
Data generated by the Survey will be used in the development and implantation of the Indiana State Pesticide Management Plan. This includes its use in designing a base line monitoring network for pesticides in Indiana ground Water, developing statewide aquifer sensitivity maps, in addition to supplying information to the Indiana Pesticide Data Base.

During 1992, the Ground Water Section conducted a pesticide survey in a portion of the upper Kankakee River Basin located in St. Joseph County. Detectable concentrations of pesticides were not found in the 27 water wells which were sampled.

This area was primarily selected for its high susceptibility to ground water contamination due to the physical properties of the unconsolidated material, and for elevated concentrations of nitrate based on existing ground water quality data.

The Upper Kankakee River Basin study area lies at the head waters of the Kankakee River Basin, approximately seven miles west of South Bend, Indiana in Saint Joseph County between the towns of New Carlisle and Lydick (Figure 89). The purpose of this study was to survey ground water quality for nitrate and pesticide impact in hydrogeologically vulnerable areas that are being intensively farmed. In addition, an evaluation of the long-term effect on ground water quality resulting from Soil Conservation Service "Best Management Practice" efforts was to be performed in this study area.

Figure 89. *Map showing locations of fence diagrams for the Upper Kankakee study area*



Initially, the upper Kankakee River Basin study consisted of gathering and assessing all pertinent hydrogeologic information and water quality data for the area. Data and information were acquired from geologic publications, water well logs, water resource reports, previous ground water quality studies, and personal communication with Indiana's leading geologists and ground water professionals. This information was utilized in conjunction with the National Water Well Association "Drastic Modeling Technique" to identify hydrogeologically vulnerable areas within the Upper Kankakee River Basin for a ground water quality survey.

The Drastic Modeling system utilizes a group of factors to assess the ground water pollution potential for a specific hydrogeologic setting. These factors include:

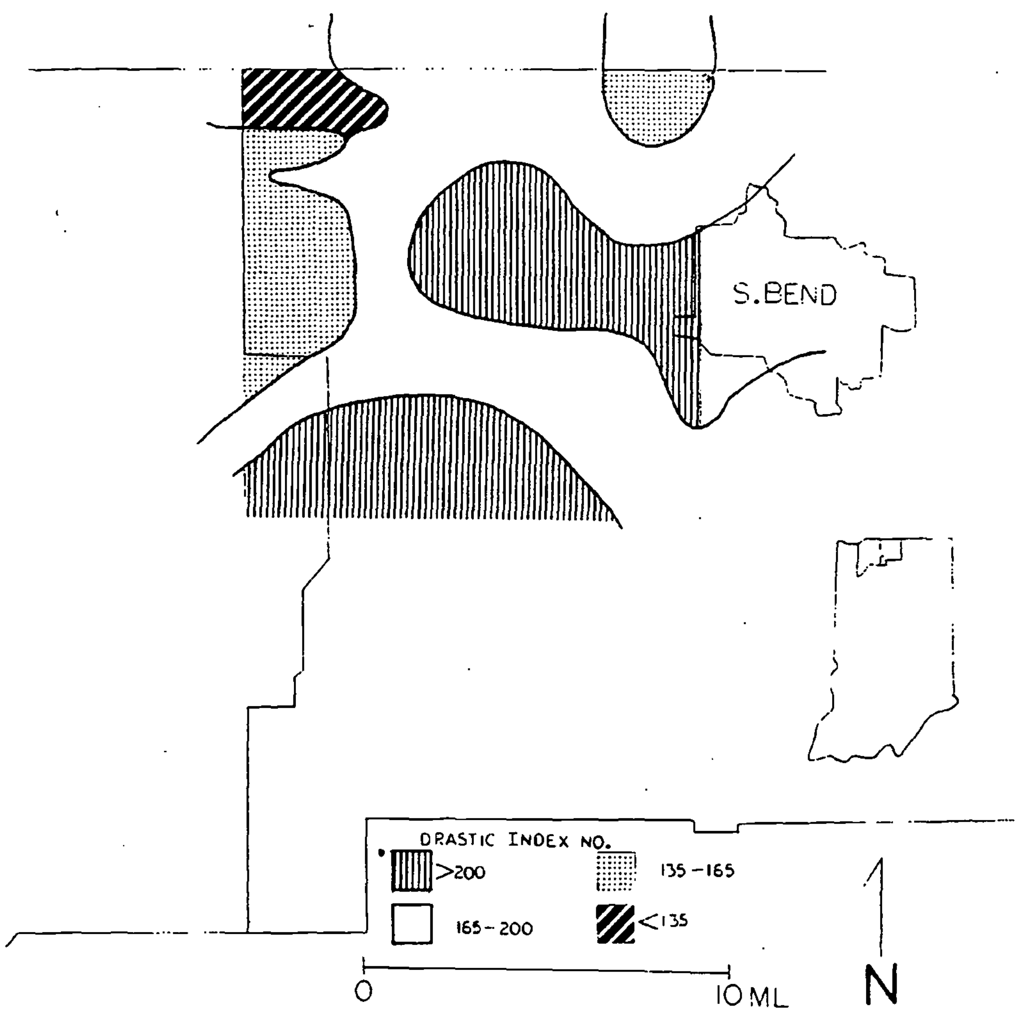
D - Depth to Water
R - (Net) Recharge
A - Aquifer Media
S - Soil Media
T - Topography (slope)
I - Impact of Vados Zone Media
C - Conductivity (Hydraulic) of Aquifer

Each DRASTIC factor is divided into ranges that are assigned numerical ratings to be inserted into the pollution potential formula :
$(D_R D_W + R_R R_W + A_R A_W + S_R S_W + T_R T_W + I_R I_W + C_R C_W =$ Pollution potential$)$
Where: R = rating
W = weight

The resulting DRASTIC Index numbers (Pollution Potential) can then be mapped to identify areas which are more susceptible to ground water contamination relative to one another. The higher the DRASTIC Index number, the greater the ground water pollution potential. The DRASTIC Index was calculated and mapped for over 75 data points within the Upper Kankakee River Basin. Mapping of the DRASTIC parameters was performed on a series of Mylar overlays upon 7 1/2 minute United States Geological Survey topographic quadrangle maps. See Figure 90 for an example of the selected DRASTIC rated study area. Final study area selection also took into consideration the occurrence of both agriculture and irrigation intensity.

Much of the land in the study area is used exclusively for row crop cultivation on which corn, wheat and soybeans are grown. Truck farming is performed at locations along the eastern edge of the study area while sod farms are present north of U.S. Highway 20 in the north central portion of the study area. The study area is also home to two large specialty steel factories (Intek

Figure 90. *Map showing Drastic Rated study area. The greater the index number, the greater the aquifer vulnerability*



and Carborundum) which utilize municipal sewers for waste water disposal and high capacity water wells for their water needs.

Hydrogeology

Most of the surficial deposits of the Kankakee River Basin are the result of the latest events of Wisconsinan age glaciation, which lasted from 24,000 to 10,000 years ago.

The South Bend area is located where three Wisconsinan age ice lobes met; the Erie Lobe, Sagubaw Lobe and the Michigan Lobe, all of which exerted their influence upon the local terrain. However, the study area located due west of South Bend was probably more influenced by the Michigan Lobe than by either of the other glacial lobes.

During the late stages of Wisconsinan age glaciation, the Kankakee River Basin was covered by a large glacial lake fed by meltwater off the nearby glacial front. Fine grained sediment (clay) was deposited upon the lake bed thus forming a distinctive clay layer which can be identified today. The Lake Michigan Lobe formed the Valparaiso End Moraine during the last major advance of the late Wisconsinan ice. The Valparaiso End Moraine runs along the northern boundary of the study area and marks the stopping point of the southward movement of the Michigan Lobe. Prograding deposits coming off the Valparaiso End Moraine formed an outwash apron of sand and gravel that washed southward over the deposited lacustrine clay. Subsequently, these sand and gravel outwash deposits were in-turn mantled by fine grained overbank alluvium and organic-rich mud deposited in the study area as the postglacial Kankakee River migrated across the floodplain.

Fence diagrams in Figures 91, 92, and 93 show the presence of the Holocene muds overlying the Valparaiso outwash sand and gravel apron. The Holocene muds are not present toward the center of the valley where erosion has removed them down to the sand and gravel. The fence diagram in Figure 76 also shows the presence of the underlying lacustrine clay beneath the sand and gravel apron.

Bedrock in the study area lies from 150 feet to over 250 feet below the surface and consists of alternating green and black shale beds of the Ellsworth Formation. All water wells in the study area are developed in the overlying unconsolidated deposits and there are no known wells in the entire Upper Kankakee River Basin that produce from the Ellsworth Formation.

Soils throughout the study area fall into four solid associations. The Tracy-Door-Lydick association developed on sandy outwash fan deposits containing sulfur rich shale particles. The Maumee-Gilford-Sebewa association developed on broad lacustrine and outwash plains found primarily

Figure 91. *Fence diagram A - A′ showing aquifer system in unconsolidated deposits - upper Kankakee River study area*

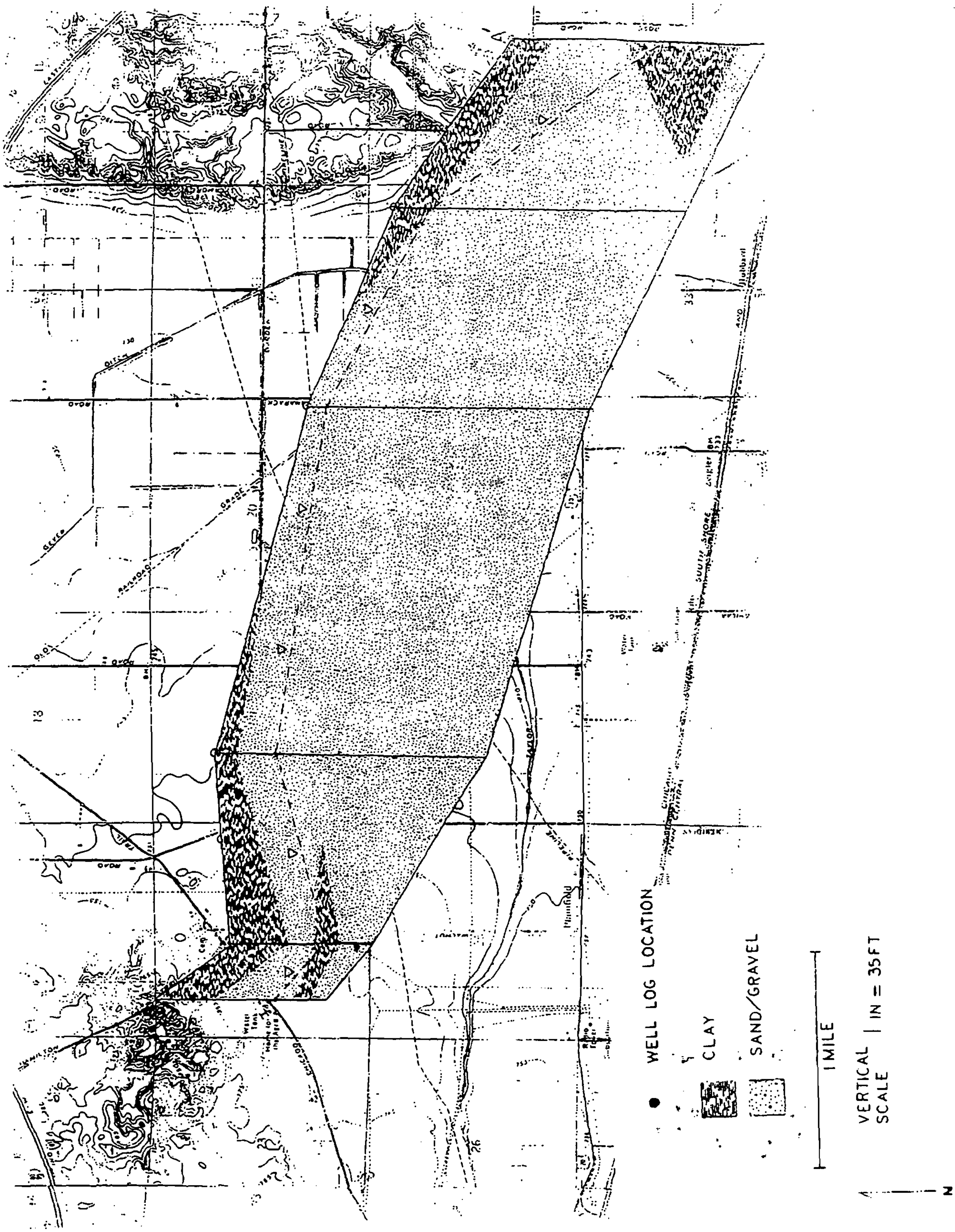


Figure 92. *Fence diagram B - B′ showing aquifer system in unconsolidated deposits - upper Kankakee River study area*

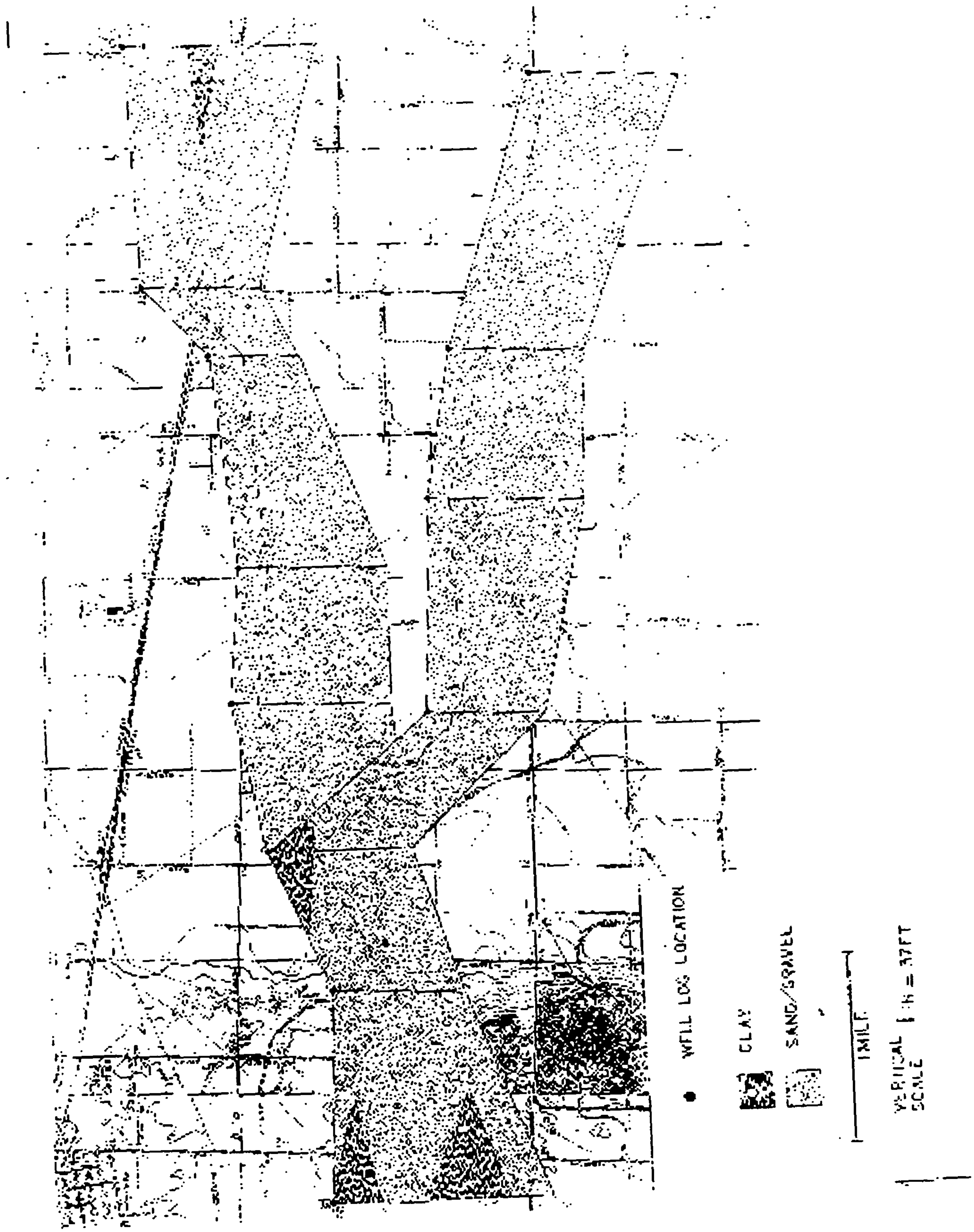
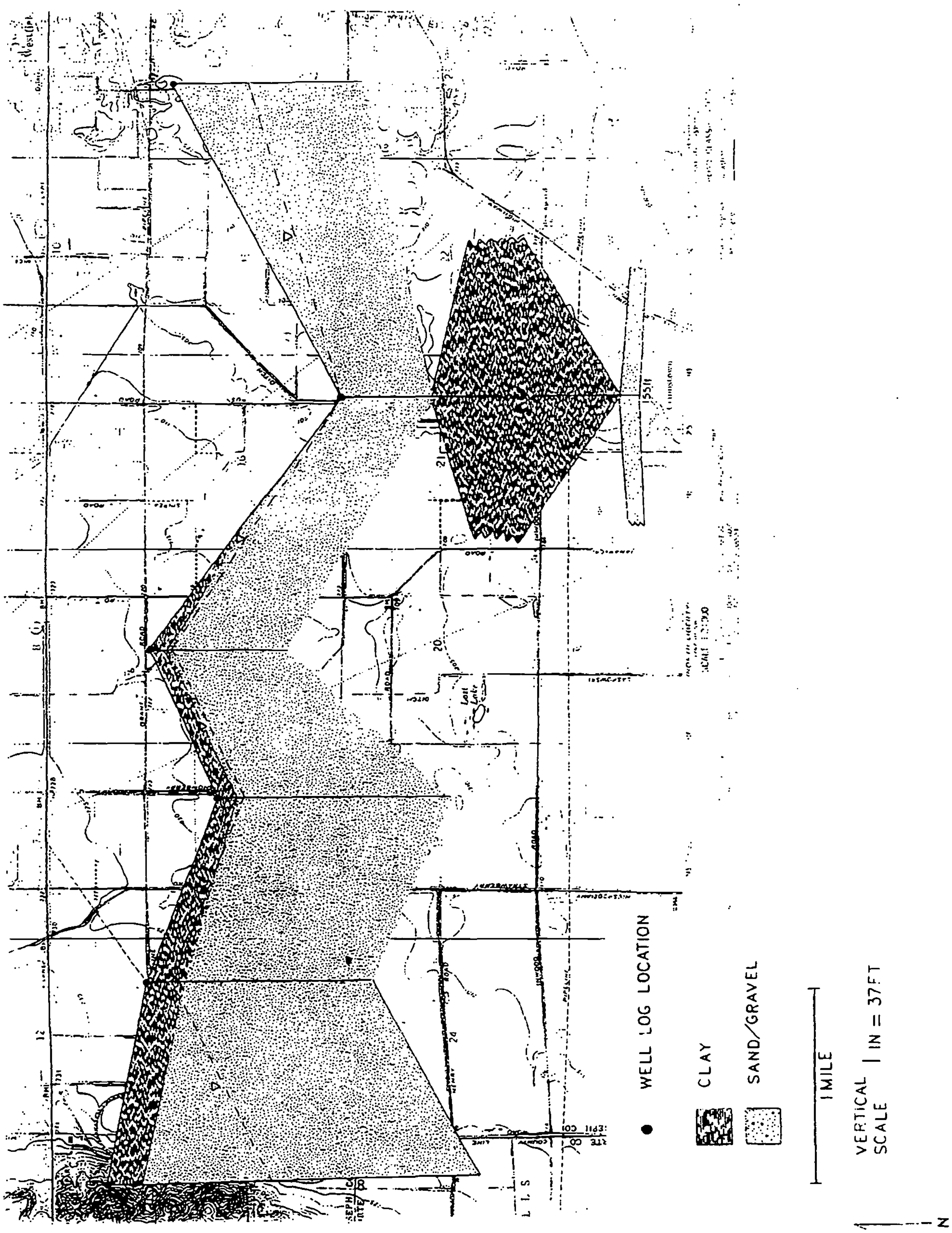


Figure 93. *Fence diagram C - C' showing aquifer system in unconsolidated deposits - upper Kankakee River study area*



in the main valleys and tributaries of the Kankakee River. Parent materials range from sand to loam in texture. The Plainfield-Maumee-Oshtemo association developed in eolian sands and sandy outwash deposits. These soils have a fine sandy texture and are typically found on 2 to 12 percent grade slopes. The Crosier-Brookston-Riddles association developed on a remnant of the Valparaiso End Moraine. The parent material is a calcareous loam till with up to 20 inches of loess cover.

Three major aquifer systems exist in the Upper Kankakee study area. Although all three aquifers are hydrologically connected, only two of the aquifer systems were actually sampled in this study. The two aquifer systems of primary concern are the Valparaiso Outwash Apron Aquifer System and the Kankakee Aquifer System, Figure 94.

The Valparaiso Outwash Apron Aquifer System is present along the west edge of the study area. This aquifer system is a wedge of outwash sediment forming the southern slope of the Valparaiso Moraine. The outwash apron consist of interbedded sand and fine grained gravel, clay lenses, zones of shale-rich gravels, and is dissected in places by the Kankakee Aquifer System.

Thickness of the Valparaiso Outwash Apron Aquifer System exceeds 130 feet in the study area. Water well depths typically range from 100 feet to 120 feet in depth with static water levels at 80 feet to 100 feet below the surface. Yields range from 15 gallons per minute to 60 gallons per minute for domestic wells and 100 gallons per minute to 600 gallons per minute for large diameter wells. Because there is no continuous clay cap, the Valparaiso outwash Apron Aquifer System is highly susceptible to surface contamination.

The Kankakee Aquifer System consist of an unconfined deposit of coarse sand with interbedded gravel units. The thickness of the aquifer system ranges from approximately 100 feet to 150 feet throughout the entire study area. Static water levels are shallow in the Kankakee Aquifer System with depths typically ranging between 6 feet to 15 feet below the surface in the study area. Domestic wells usually produce from 15 gallons per minute to 50 gallons per minute while high capacity wells may produce from 100 gallons per minute to 1500 gallons per minute. By mapping the static water levels, it was determined that ground water flow is toward Geyer Ditch and to the south toward the Kankakee river Figure 95.

The Kankakee Aquifer System has a gradational boundary with the Valparaiso Outwash Apron Aquifer System which causes these two systems to be hydrologically connected. The major distinction between these two aquifer systems is mostly topographic with the Valparaiso Outwash Apron Aquifer System being positioned at a higher elevation and possessing far more clay lenses and clay caps. Recharge to the Kankakee Aquifer System also comes in part from the Valparaiso Outwash Apron Aquifer System. Due to the absence

Figure 94. *Map showing Unconsolidated Aquifer Systems for the upper Kankakee study area*

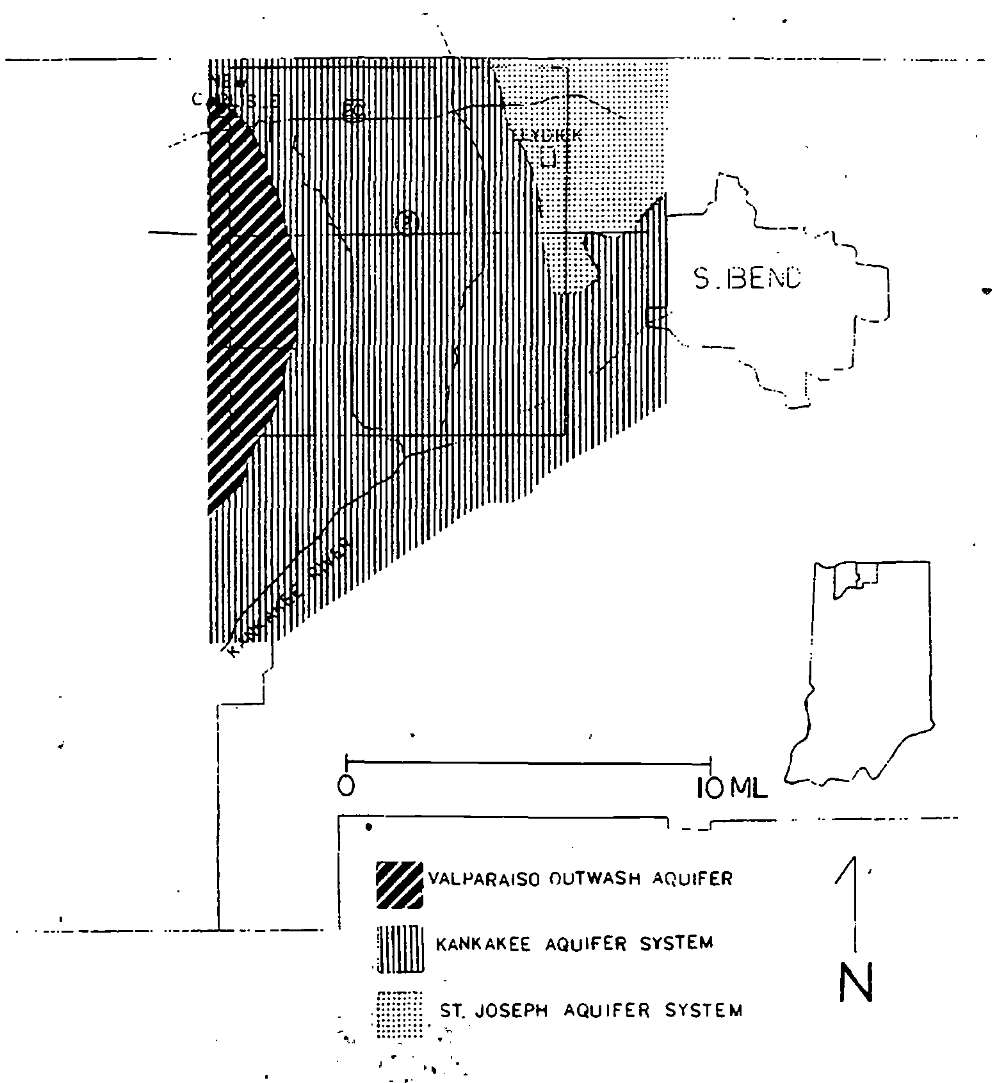
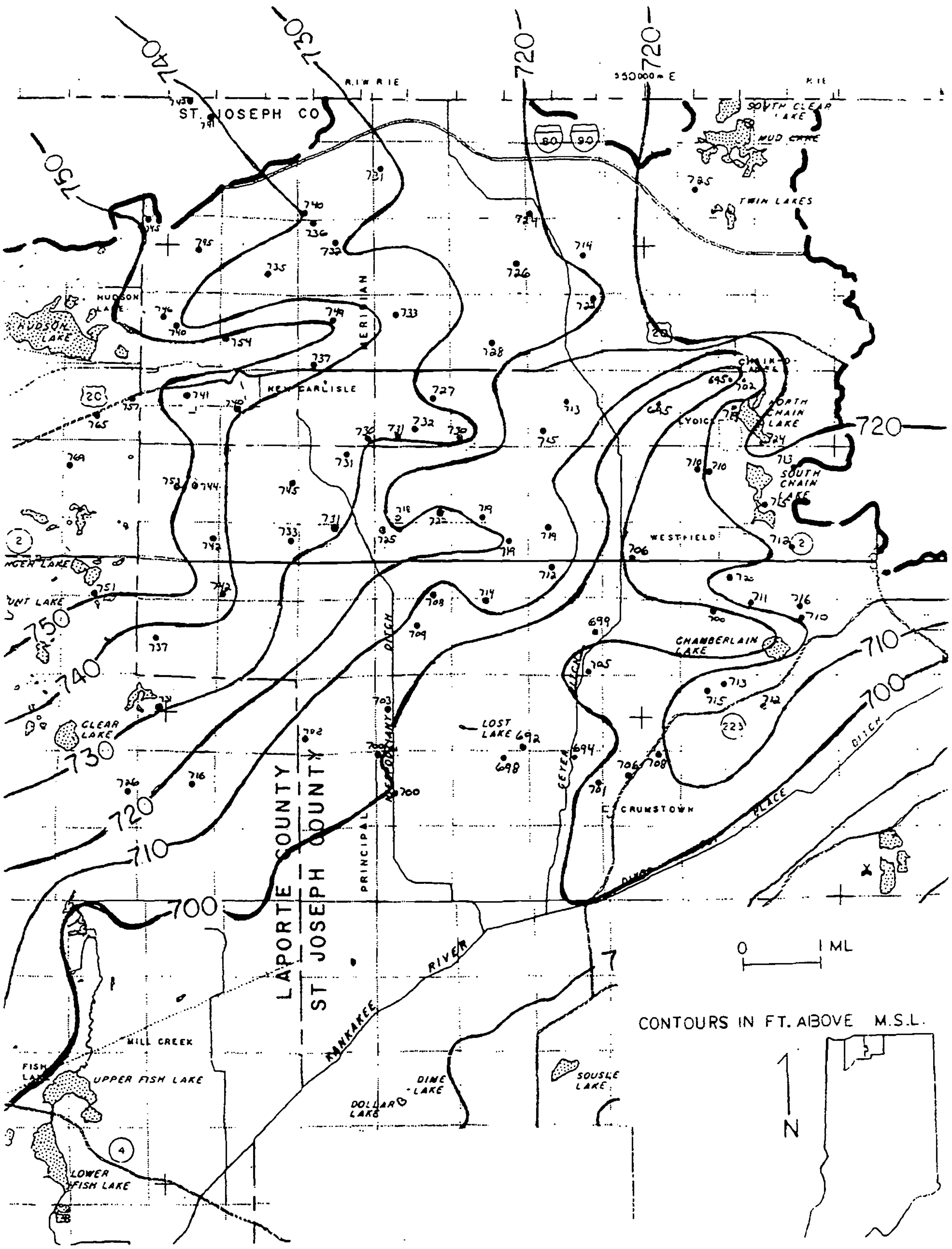


Figure 95. *Map showing potentiometric surface of upper Kankakee study area*



of clay deposits, the Kankakee Aquifer System is highly susceptible to surface contamination.

Ground Water Quality

During the weeks of March 9, 1992 and August 3, 1992, a total of 27 private water wells were sampled for bacteria, nutrients, volatile organic chemicals, and approximately 100 pesticides Figure 96. In general, the natural ground water quality in the Upper Kankakee River Basin study area is typical for glacial outwash aquifers in Indiana. This water is naturally very hard and contains elevated concentrations of iron, manganese, and total dissolved solids. The report of laboratory analysis showed that all sample sites tested above 170 milligrams per liter (mg/l) (as C_ACO_3) for hardness and above 300 mg/l for total dissolved solids. Ground water in the study area also contains elevated nitrate levels at specific locations in addition to low level detections of pesticides.

Nitrate as total nitrogen was detected in 11 of the 27 water wells sampled with detections ranging from 0.1 mg/l to 28.0 mg/l Table 72. Fairly good correlations exists for sample sites with nitrate detections in March as compared with detections in August. However, three sites which showed no detections in March, showed detections in August. This latter phenomenon would seem to indicate that the August detections were the result of the spring agricultural nutrient application. Only 2 of the 11 sites with detectable concentrations of nitrate exceeded the Maximum Contaminant level of 10 mg/l.

Nitrate as Total Kjeldahl Nitrogen (TKN) was detected at low concentrations in 19 of the 27 water wells sampled. TKN detections ranged from 0.1 mg/l to 0.6 mg/l, and appear to be evenly distributed throughout the study area. Moreover, a fairly good correlation exists for sample sites with positive concentrations of TKN in March, as compared to detections in August. All but one site with detections above 0.1 mg/l in March showed detections in August.

Ammonia as total nitrogen was fund in 5 of the 27 water wells sampled, ranging from 0.1 mg/l to 0.5 mg/l. Phosphorus as total P was detected in 5 of the 27 water wells with values ranging from 0.03 mg/l to 0.04 mg.l. Ammonia and phosphorus valves are consistent with most of the study areas done in conjunction with the Indiana Pesticide Survey.

The following organic compounds were detected in 9 of the 27 water wells sampled: 1, 3, 5 trimethylbenzene, 1,2,4 trimethylbenzene, benzene, chloroform, hexachlorobenzene, and bis (2-ethyhexyl) phthalate. Of those chloroform and hexachlorobenzene are known to be used as a fumigant around grain storage and as fungicide on wheat, respectively. Nevertheless, all six of

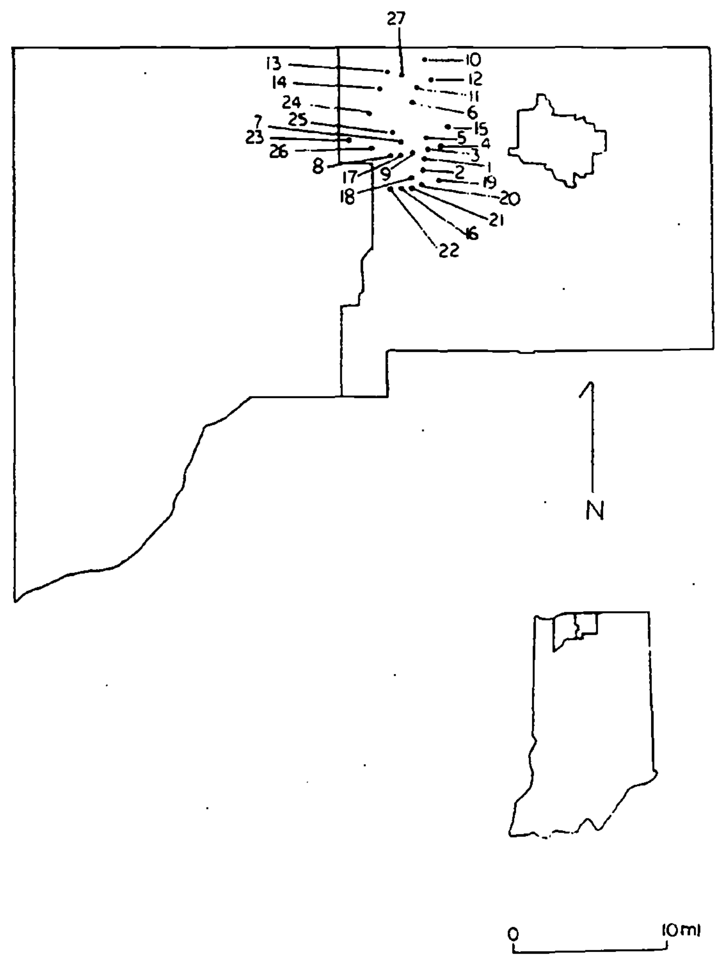
Table 72. *Summary of positive detection: Upper Kankakee River Basin study area*

SITE ID#	WELL DEPTH IN FEET	NITRITE-NITRATE AS N IN MG/L (A) SAMPLE DATE		AMMONIA AS N IN MG/L (A) SAMPLE DATE		PHOSPHORUS AS P I N MG/L (A) SAMPLE DATE		TKN AS N IN MG/L (A) SAMPLE DATE	
		3/92	8/92	3/92	8/92	3/92	8/92	3/92	8/92
1.	40	-	-	-	-	-	-	-	-
2.	30	-	-	-	-	-	-	0.2	0.2
3.	46	-	-	-	-	-	-	-	-
4.	ND	-	0.5	0.4	0.5	-	-	0.6	0.5
5.	33	-	-	-	-	-	-	-	-
6.	42	-	-	-	-	-	-	0.1	0.1
7.	35	3.8	-	-	-	-	-	-	-
8.	40	-	-	-	-	-	0.03	-	-
9.	30	ND	1.0	ND	ND	ND	ND	ND	ND
10.	35	8.2	7.7	ND	ND	-	-	0.1	-
11.	30	-	-	-	-	0.03	-	0.2	0.1
12.	ND	-	-	-	-	-	-	0.1	-
13.	70	-	ND	-	ND	-	ND	0.1	ND
14.	35	25.0	28.0	0.1	ND	-	-	-	-
15.	40	0.1	0.2	0.1	ND	-	-	0.2	0.1
16.	36	-	-	0.2	0.2	0.03	-	0.4	0.5
17.	45	-	-	-	-	-	-	0.2	0.1
18.	40	-	-	-	-	-	-	0.2	0.1
19.	40	-	-	-	-	0.03	-	0.2	0.1
20.	98	-	-	0.2	-	-	-	0.2	0.2
21.	33	-	-	-	-	-	-	0.1	0.2
22.	40	-	-	-	-	-	-	0.1	-
23.	130	-	6.3	-	-	0.04	-	0.1	-
24.	60	1.1	6.4	-	-	-	-	-	-
25.	52	0.6	1.4	-	-	-	-	-	0.1
26.	83	2.5	1.5	-	-	-	-	0.1	-
27.	ND	ND	10.5	ND	-	ND	-	ND	0.1

Note: (a) mg/l = milligrams per liter 9parts per million)
ND - No data
- = less than detection limit
detection limit = level at which a compound can be identified and qualified with a particular instrumentation
detection limit for Nitrite-Nitrate = 0.1 mg/l
Ammonia = 0.1 mg/l
Phosphorus = 0.03 mg/l
TKN = 0.1 mg/l

A:GL97

Figure 96. *Map showing sample locations for upper Kankakee study area*



these compounds were detected in trip and laboratory blanks, This is an indication that some of the water samples may have been contaminated during the sampling event, or in the laboratory during analysis.

In addition, no correlation exists for positive detections in either of the two sample rounds. organic compounds detected in March were not detected in August, while the sites with positive detections were widely distributed and not clustered near a source of contamination.

Conclusions

From a geologic standpoint, sample sites showing high concentrations of nitrate appear to be only slightly more susceptible to ground water contamination than are sites which sow low or even no nitrate detections. Nitrate contamination of water wells is probably occurring as a result of a combination of factors, where no single causal factor can be isolated. Nitrate detections appear to be related to the time of application, or even to the rate of application rather than to the degree of geologic susceptibility. Geologically, the entire study area appears to be susceptible to ground water contamination with only degrees of susceptibility existing for locations throughout the sample area. Sites with elevated nitrate detections (#10, 14 and 27) are located in the intensively farmed north central area which utilized center sites #10 and #14 also show signs of a persistent nitrate problem as elevated nitrate was detected at these two sites in both the March and August sample rounds. Nearly all the other sample sites with detectable nitrate showed an increase in the August sample round as compared to the March sample round. This increased occurrence of nitrate may, in fact, be a detection of the spring nutrient application.

Although nitrate was indeed fund in this study area, levels were not high enough to justify conducting isotope analysis as was originally planned. The lack of high nitrate also makes a long term monitoring program doubtful in this study area as Soil Conservation Service, designed nutrient management practices would be hard to evaluate.

V. SPECIAL STATE CONCERNS AND RECOMMENDATIONS

Although the discharge of inadequately treated conventional pollutants (BOD, ammonia, solids, etc.), in the past often resulted in highly visible evidence of water pollution, much has been done in the last 10-15 years to greatly reduce or eliminate these problems. This includes the construction of an increasing number of advanced wastewater treatment plants; the regular monitoring for toxic substances through fish tissue and sediment analysis;

implementation of the Municipal Compliance Strategy (MCS) which required all municipalities to be in compliance with water quality standards by 1988 regardless of the availability of construction grant funding; and the implementation of an operator training assistance program to help assure better operation of these wastewater treatment facilities. However, other problems or concerns continue, and new ones arise. Some of these concerns will be briefly listed below.

Combined Sewer Overflows and Stormwater

For the past several years, the state has been concerned about the effects of combined sewer overflows (CSOs) and storm water runoff on surface water and how to best deal with these problems. Since that time, the state has developed strategies to effectively handle these problems.

Indiana developed a CSO strategy which was approved by US EPA on May 13, 1991. There are about 130 municipalities that have combined sewer systems. As the NPDES permits for these municipalities expire, they will be reissued permits that include requirements for CSO control based on the approved strategy. The strategy is aimed at identifying and eliminating all nonstorm water discharges (dry weather flow) from CSOs. Also, municipalities are required to sample and analyze the receiving stream above and below the CSO points to identify the water quality impacts caused by the CSO events and develop plans to correct them.

Regulation 327 IAC Article 15, contains as the NPDES General Permit Rules. Rules 5 and 6 in Article 15 are the storm water general permits-by-rule. A Memorandum of Agreement between the IDEM, the IDNR, and local Soil and Water Conservation Districts (SWCDs) is currently being executed by all SWCD's in order to formalize the Rule 5 implementation process. All point source dischargers of storm water are automatically regulated by these permits-by-rule unless a facility applies for an individual permit or is included in a group application. Existing point source dischargers had until December 29, 1992, to submit the Notice of Intent (NOI) letter required by Article 15.

Semi-Public Facilities

There are many semi-public wastewater treatment facilities in the state. Many of these are not properly maintained and operated. With the limited staff available, the required monitoring of the major and significant minor dischargers does not leave enough time available to adequately monitor these smaller facilities. However, what monitoring has been done would indicate that many of these facilities may have significant impacts on receiving waters. In addition, there have been several instances where these facilities have been constructed to serve subdivisions or housing developments and then abandoned once all the available lots have been sold and major repairs are needed. IDEM is increasing the number of it's inspectors and is developing a strategy to allow for these facilities to be inspected and monitored on a more frequent basis.

Criteria for Contaminants in Fish Tissue and Sediment

The state has gathered considerable data on contaminants in fish tissue and sediments over the last several decades. Indiana currently uses FDA Action Levels for poisonous and deleterious substances in interpreting fish tissue data as to potential health effects. These action levels are only available for relatively few toxic pollutants. Health effects criteria for substances in fish tissue are being developed to allow the states to adequately assess the affects to the public of consuming contaminated fish tissue. The U.S. EPA is in the process of developing sediment criteria for some substances. These efforts need to be enhanced and expanded.

Great Lakes Water Quality Guidance (GLWQG)

Although the state has been involved in the process of developing the GLWQG, there are still concerns about the impacts that this guidance may have on the state. Although many of the criteria developed in the GLWQG do not appear to be substantially different than those Indiana already has in place, there is still concern expressed about these criteria and about some of the implementation procedures in the guidance. Once this guidance or regulation becomes final (Spring 1995?) the state will have two years to adopt this or equivalent criteria and procedures into Indiana's Water Quality Standards. The state will need to begin the rulemaking process soon after the guidance is finalized in order to get the process completed within the two year timeframe. One major issued to be determined is whether the guidance will apply statewide or only to those waters in the Great Lake Basin.

Biocriteria

The state is generating information necessary to develop numeric biocriteria based on both fish and macroinvertebrate community data to compliment existing narrative biocriteria. However, due to past personnel shortages, this process has fallen behind schedule, and the process may take longer than originally planned. These constraints need to be understood by EPA.

Data Analysis and Report Writing

The state is developing a strategy which will place more emphasis on data review, analysis, interpretation and reporting. Due to lack of adequate personnel, most staff time has been spent in the gathering of data and not processing and reporting. New staff is being added to assist in QA/QC and data analysis.

Nonpoint Source Pollution Program

The control of nonpoint source (NPS) pollution still poses a concern for the state. However, Indiana has developed several programs which are attempting to alleviate various NPS problems. Particularly active in this area are programs implemented on the local level by county planning and development groups and local soil and water conservation district (SWCD) offices, on the state level by the IDEM and the Indiana Department of Natural Resources (IDNR), and on the federal level by the U.S. Department of Agriculture (USDA). Volunteer cleanup efforts are also gaining importance. Indiana will continue these various programs with a particular emphasis being placed on education and demonstration projects which are focused at the local level. Regulatory efforts will be greatly enhanced by the proposed rules providing for permit requirements for stormwater runoff from construction and industrial activities.

Ground Water Protection

A principal objective is to establish a comprehensive state ground water protection program for Indiana. The development of the comprehensive state ground water protection program framework will build on Indiana's Ground Water Protection and Management Strategy and Implementation Plan of 1987.

One of the major components of the comprehensive ground water protection program is a data management strategy. This strategy should provide for coordination and collection of ground water data among all program areas and agencies which have responsibility for protecting and remediating ground water. This will allow the State to measure progress, identify problems, and set priorities.

Another important component of a comprehensive ground water protection program is improved public participation, education and awareness. Such a program should coordinate the efforts of all program areas and agencies which have responsibility for protecting and remediating ground water and involve other organizations and departments which oversee public and higher education.

The State of Indiana is in the process of establishing a wellhead protection program for the protection of public water supply well fields from known sources of contamination. This program will provide technical assistance to local wellhead protection program development and implementation. The wellhead protection program is an excellent example of comprehensive ground water protection because every type of facility within the wellhead protection area must place ground water protection as their highest environmental priority.

Dredge and Fill (wetlands) Program

Our wetlands program has evolved over the past 15 years in a way intended to provide the maximum protection possible with the limited staff available. Although there have been some recent staff increases, the workload has also become much greater with our denial of water quality certification for several nationwide permits that the U.S. Army Corps of Engineers had proposed to renew.

There are several modifications or additions to the program that will be considered in the near future, but the direction we take will depend upon the level of staffing provided for this program.

One of the first changes that will be made is the implementation of formal review procedures for projects requiring Section 401 Water Quality Certification. We will also recommend standard mitigation goals for various categories of projects.

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APPENDIX A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes*

The Eutrophication Index is derived from the parameters listed on pages 36 and 37 in the Indiana Lake Classification Systems and Management Plan.

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
ADAMS CO.								
Rainbow	Two	45	16.0	6.0	0.07	1.5	41	VII C
Saddle	Two	24	10.0	10.0	0.04	2.0	41	VII C
ALLEN CO.								
Cedarville Rex. (1989)	Two	245	20.0	4.0	0.12	0.9	24	VI A
Everett (1991)	Three	43	--	--	0.12	4.9	66	
BARTHOLOMEW CO.								
Grouse Ridge (1991)	One	20	25.0	10.0	0.04	10.2	25	VII A
BROWN CO.								
Bear Creek (1992)	One	7	27.0	10.0	0.04	3.3	4	V
Crooked Creek (1993)	One	13	27.0	10.0	0.07	2.1	23	VII A
Ogle (1992)	One	20	24.0	12.5	0.08	3.5	21	VII A
Strahl (1992)	One	6	23.0	9.0	N/A	2.7	15	VII A
Yellowood (1990)	One	133	30.0	14.2	0.06	4.3	8	V
CARROL CO.								
Freeman (1991)	One	1,547	44.0	16.0	0.12	2.3	25	III
CASS CO.								
Creott (1990)	Two	65			0.13	12.5	33	III
CLARK CO.								
Bowen	One	7	22.0	6.0	0.05			V
Deam (1991)	One	195	33.0	12.0	0.09	15.4	19	V
Franke	Two	9	18.0	7.8	0.05	4.0	35	V
Oak	One	3.5	13.0	8.0	0.03	8.0	8	V
Pine	Three	1.5	11.0	6.0	0.05	4.0	55	IV A
Schlamm (1991)	One	19	24.0	8.9	0.29	5.3	15	V
CLAY CO.								
Brazil Water-works Pond (1992)	Three	15	15.0	6.0	1.43	0.4	57	IV A
CRAWFORD CO.								
Sulphur	Two	1	10.0	5.0	0.03	5.0	26	VII A
DAVIESS CO.								
Dogwood (1991)	One	1,300	40.0	18.0	0.02	15.4	8	III

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Indian Rock	Two	100	20.0	10.0	0.06	10.5	37	VII A
DECATUR CO.								
Greensburg State Fishing Area Lake (1993)	Three	23	14.0	6.0	0.57	0.5	55	V
Surface Only (1985)		--	--	--	0.17	8 in.	65	IV A
DEKALB CO.								
Cedar	Three	28	30.0	8.2	0.08	2.5	40	VII C
Indian (1989)	Two	56	38.0	15.0	0.1	9.5	34	VII C
Lintz	Three	19	35.0	15.0	0.11	4.0	53	IV B
Story (1989)	One	77	32.0	13.2	0.32	6.4	23	VII A
DELAWARE CO.								
Prairie Creek Reservoir (1990)	Three	1,216	30.0	15.0	0.09	3.0	58	III
DUBOIS CO.								
Beaver Creek (1989)	One	205	15.0	11.5	0.03	7.9	21	VII A
Ferdinand (Ferdinand State Forest) (1990)	Two	36	23.0	10.5	0.08	1.0	40	VII A
Ferdinand 1	One	16	17.0	10.0	0.03	--	20	VII A
Holland 1 (1991)	Two	17	12.0	10.0	0.06	3.9	44	VII C
Holland 2 (1991)	Two	20	14.0	10.0	0.12	1.6	36	VII A
Huntingburg City Lake (1989)	Two	102	30.0	12.0	0.03	5.0	41	V
ELKHART CO.								
Fish (1993)	Two	34	30.0	10.0	0.56	1.2	50	IV B
Heaton (1989)	One	87	22.0	7.4	0.03	5.4	14	V
Hunter (1993)	One	99	29.0	11.3	0.02	2.7	16	V
Indiana (1989)	One	122	29.0	27.9	0.02	9.5	22	II A
Simonton (1989)	Two	282	40.0	5.5	0.02	5.0	31	VII A
Yellow Creek	Three	16	20.0	4.0	0.34	1.3	58	IV A
FRANKLIN CO.								
Brookville Res. 1979	One	5,260	120.0	25.0	0.02	4.0	23	I
Brookville Res. 1985	One	--	--	--	0.03	3.8	21	
FULTON CO.								
Anderson	Two	14	25.0	5.0	0.04	5.0	31	VII A
Barr	Two	5	48.0	12.0	0.06	5.0	35	VI A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Bruce (1989)	Two	245	18.0	14.0	0.12	2.5	35	IV B
Fletcher (1990)	Two	45	60.0	15.0	0.20	7.7	37	VII B
King (1976) Estimate (Low)	Two	18	35.0	10.0	--	5.0	35	IV B
King (1991)	Two	19	35.0	10.0	0.56	5.6	26	VII A
Lake 16	Two	27	30.0	8.1	0.10	6.0	32	V
Manitou (1993)	Two	713	35.0	8.0	0.35	1.1	41	VII A
Millark Pond	Four	15	6.0	5.0	0.06	5.0	65	IV A
Mt. Zion Mill Pond	Four	28	6.0	5.0	0.05	5.0	65	IV A
Nyona (S. Bas.)	Three	104	32.0	12.9	0.12	5.0	54	IV B
Rock (1991)	Two	56	16.0	11.0	0.13	1.6	31	VII A
South Mud	Three	94	20.0	10.9	0.25	1.0	66	IV B
Town	Three	22	16.0	9.6	0.21	4.0	64	IV B
Upper Summit	Two	6	40.0	15.0	0.04	6.0	42	VII B
Zink	Two	19	40.0	12.0	0.04	6.0	28	VII A
GIBSON CO.								
Gibson (1990)	Two	2,950	--	--	0.13	1.2	35	
HAMILTON CO.								
Morse Res. (1975)	Two	1,375	40.0	15.4	0.10	4.5	31	III
Morse Res. (1991)	Two	1,375	40.0	15.4	0.07	3.3	29	III
HENRY CO.								
Summit (1990)	One	--	--	--	0.03	13.1	15	
Westwood (1991)	One	173	--	--	0.09	15.1	16	
HOWARD CO.								
Kokomo Res. 2 (1988)	Two	484	22.0	7.0	0.117	2.5	29	VII A
HUNTINGTON CO.								
Clare (1990)	One	43	--	--	0.02	8.2	14	
Salamonie Res. (1975 Dam)	One	2,800	60.0	16.6	0.04	2.5	21	I
Salamonie Res. (1991)	Two	2,800	60.0	16.6	0.09	3.0	26	I
Salamonie Res. (1985 Dam)	Two	2,800	60.0	16.6	0.03	4.3	18	I
Huntington Res. (1985 Dam) (1991)	One	900	36.0	17.0	0.12	1.6	22	III
JACKSON CO.								
Cypress (1992)	Two	200	20.0	5.0	0.12	0.8	30	VII A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Patoka (1991)	One	5,000	--	--	0.02	14.4	5	I
Starve Hollow (1990)	Two	145	17.0	6.8	0.03	2.6	38	VII C
JENNING CO.								
Brush Creek Res. (1990)	Three	167	32.0	10.0	0.26	6.6	34	VII A
KNOX CO.								
Brodie	Four	19	12.0	4.0	0.36	1.0	64	IV A
Halfmoon Bed Pond	Four	38	8.0	5.0	0.19	1.0	55	IV A
Long Ponds	Four	38	8.0	4.0	0.29	1.0	58	IV A
Mariah Pond	Four	50	10.0	5.0	0.31	1.3	62	IV A
Oaktown Bed	Four	15	10.0	3.0	0.13	1.5	48	IV A
Sandborn Old Bed	Four	30	8.0	6.0	0.35	1.0	54	IV A
White Oak (1991)	Two	30	15.0	5.0	0.09	7.2	42	IV A
KOSCIUSKO CO.								
Banning (1990)	One	12	--	--	0.04	5.6	13	
Barrell	Four	7	50.0	35.0	0.08	5.0	46	IV D
Beaver Dam	Three	146	61.0	22.5	0.85	4.0	55	IV D
Big Barbee (1990)	Two	297	49.0	18.6	0.06	4.6	38	VI A
Big Chapman (W. Bas.)	One	581 (Total)	35.0	10.5	0.01	10.0	18	VII A
Big Chapman (N. Bas.)	--	--	30.0	10.5	0.01	10.0	19	VII A
Boner (1991)	One	40	60.0	9.2	0.03	9.5	9	V
Caldwell (1990)	Three	45	42.0	17.8	0.26	4.3	71	IV B
Carr (1989)	Two	79	35.0	17.0	0.05	5.6	31	VII B
Center (1991)	One	120	42.0	17.0	0.06	3.6	24	VI A
Crystal (1989)	Two	76	41.0	12.2	0.03	7.2	27	VII A
Daniels	Four	8	25.0	25.0	0.03	6.0	18	VII A
Dewart (NW Bas.)	Two	551 (Total)	70.0	16.3	0.03	5.5	36	VII B
Dewart (SE Bas.)	Two	--	--	--	0.03	6.0	36	VII B
Dewart (SW Bas.)	Two	--	--	--	0.03 / 0.03	6.0	36	VII B
Flatbelly	Three	326	49.0	13.3	0.02	8.0	54	IV B
Goose	One	27	61.0	20.0	0.03	9.0	15	VI A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Heron	Two	22	30.0	12.0	0.03	5.0	22	VII A
Hill	Two	66	35.0	19.4	0.12	12.0	31	VI A
Hoffman (1989)	Two	180	34.0	17.6	0.06	4.6	37	VII B
Irish (1990)	Two	182	35.0	12.8	0.03	3.3	36	VII C
James (1989)	Two	282	63.0	26.9	0.06	4.9	40	IV B
Kuhn (1990)	Two	137	27.0	9.4	0.02	6.6	27	VII A
Little Barbee (1990)	Two	74	26.0	13.0	0.28	3.3	41	VII B
Little Chapman (1989)	One	177	30.0	11.2	0.21	5.9	25	VII A
Little Pike (1991)	One	25	30.0	5.6	0.07	2.3	22	VII A
Loon (1991)	Two	40	30.0	16.8	0.32	3.3	32	VII B
Mc Clures (1991)	Two	32	30.0	12.8	0.16	2.3	32	VII B
Muskelonge	Two	32	21.0	9.4	0.14	1.8	40	VII C
North Little (1991)	Two	12	26.0	10.0	0.37	3.3	43	VII C
Oswego	Two	41	36.0	20.0	0.04	5.5	33	VI A
Palestine (East Basin) (1985)	Three	232 (Total)	25.0	8.0	0.91	0.5	41	IV B
Palestine (West Basin) (1985)	Three	--	--	--	0.48	0.5	36	IV B
Pike (1975)	Two	203	35.0	13.9	0.09	3.0	37	IV B
Pike (1985)	Two	--	--	--	0.12	3.0	45	IV B
Price (1991)	Two	12	40.0	20.0	0.09	12.1	27	VI A
Ridinger	Two	136	42.0	21.0	0.05	3.5	58	VII B
Sawmill (1990)	Two	36	26.0	10.3	0.10	3.6	40	VII C
Sechrist (1990)	Two	99	26.0	23.7	0.07	5.9	28	VI A
Shock (1991)	Two	37	59.0	32.7	0.27	5.9	29	II C
Shoe	Two	40	60.0	40.0	0.04	8.5	14	II C
Silver (1988)	Three	102	33.0	14.9	0.646	1.5	46	IV B
Spear (1991)	Two	18	34.0	25.0	0.22	6.9	38	VI A
Stanton (1991)	One	32	30.0	15.0	0.04	13.5	14	VI A
Syracuse	One	414	35.0	12.9	0.01	13.0	4	V
Tippecanoe (1989)	One	768	123.0	37.0	0.05	6.6	24	II B
Wabee (1991)	One	117	51.0	25.4	0.09	9.2	19	VI A
Wawasee (S. Bas.)	One 1987	3,060	77.0	22.0	0.04	8.0	7	I
Wawasee (SE Bas.)	One 1976	--	--	--	0.03	7.5	18	I
Webster (1991)	Two	774	45.0	7.0	0.15	3.6	41	VII A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Winona (1991)	Two	562	80.0	29.0	0.09	3.9	35	IV D
Yellow Creek	Three	151	60.0	31.3	0.09	2.5	67	IV D
LAGRANGE CO.								
Adams (1993)	One	308	91.0	25.0 (Atypical)	0.03	2.3	20	VI A
Appleman (1993)	Three	52	26.0	11.3	0.20	1.2	53	IV B
Atwood (1993)	One	170	33.0	18.0	0.04	1.8	18	VI A
Big Long (1993)	One	388	82.0	40.0	0.11	2.9	11	II B
Big Turkey (1992)	Two	450	65.0	25.0	0.09	1.2	29	VI A
Blackman (1993)	One	67	60.0	18.1	0.15	4.3	14	VI A
Brokesha (1993)	One	36	40.0	10.0	0.02	3.3	14	VII A
Cass (1993)	One	89	22.0	20.0	0.03	3.1	6	V
Cedar (1993)	One	120	30.0	8.5	0.09	2.4	19	VII A
Cline (1991)	One	20	31.0	17.5	0.03	14.4	10	V
Cotton (1991)	Two	31	25.0	--	0.29	1.0	40	
Dallas (1993)	One	283	96.0	35.2	0.13	2.1	15	II B
Emma (1993)	One	42	34.0	16.7	0.23	2.6	23	VII B
Eve	Two	31	42.0	21.6	0.03	8.0	18	VI A
Fish (Near Plato) (1993)	Two	100	78.0	40.5	0.09	1.9	26	II C
Fish (Near Scott) (1993)	Two	139	57.0	18.4	0.12	1.3	41	VII B
Green (Rawles) (1993)	One	62	10.0	5.0	0.12	2.3	16	V
Hackenberg (1993)	Two	42	38.0	12.1	0.28	2.4	34	VII B
Hayward (1993)	Three	6	20.0	15.0	0.47	0.1	65	IV B
Lake of the Woods (1992)	Two	136	84.0	40.2	0.02	1.0	40	II C
Little Turkey (1993)	Two	135	30.0	11.5	0.32	1.1	39	VII B
Martin (1993)	One	26	56.0	34.2	0.18	3.8	13	II B
Meteer (1993)	One	18	18.0	8.3	0.01	3.9	15	V
Messick (1993)	One	68	55.0/54.0	21.3	0.17	2.0	22	VI A
Mongo Res. (1993)	Two	24	15.0	5.0	0.06	1.1	27	VII A
Nasby Mill Pond (1993)	Two	35	15.0	10.0	0.08	1.1	28	VII A
Nauvoo (1993)	Two	38	40.0	25.0	0.16	0.9	46	IV D
North Twin (1993)	One	135	30.0	15.7	0.01	1.8	13	V

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Olin (1993)	One	103	82.0	38.0	0.03	2.5	18	II C
Oliver (1993)	One	362	91.0	40.0	0.01	1.7	16	II B
Pigeon (North) (1993)	One	61	35.0	19.0	0.12	1.9	25	VI A
Pretty (1993)	One	184	84.0	25.7	0.07	3.5	20	VI A
Rainbow (1993)	Two	16	40.0	15.6	0.23	1.0	43	V
Royer (1993)	Two	69	59.0/56.0	23.6	0.17	1.4	31	VI A
Shipshewana (1993)	Three	202	14.0	6.7	0.34	0.2	58	IV A
South Twin (1993)	One	116	52.0	31.0	0.06	1.5	13	II B
Spectacle Pond (1993)	Two	6	20.0	7.5	0.08	2.3	26	VII A
Star Mill Pond	Four	38	10.0	10.0	0.03	4.0	43	VII C
Still (1993)	One	30	58.0	20.7	0.20	2.7	10	VI A
Stone (1993)	One	116	58.0	14.7	0.03	3.3	17	V
Wall (1992)	One	141	34.0	11.0	0.03	3.9	9	V
Weir	Four	6	19.0	12.0	0.03	9.0	10	V
Westler (1993)	One	88	38.0	20.1	0.08	2.5	18	VI A
Witmer (1993)	Two	204	54.0	34.5	0.18	1.2	27	II C
LAKE CO.								
Cedar (1989)	Three	781	16.0	8.0	0.05	0.8	56	IV C
Dalecarlia	Three	193	--	6.0	0.30	1.0	51	IV A
George (N. Bas.) (1986)	Four	78 (Total)	12.0	3.0	0.03	5.0	11 (Atypical)	V
George (S.Bas.)	Four		12.0	3.0	0.04	3.0	26 (Atypical)	VII A
George (Hobart)	Three	282	14.0	5.0	0.19	1.0	55	IV A
Marquette Park Lagoons East (1986)	Four	100	10.0	7.0	0.035	5.5	22	VII A
Middle	Four	100	10.0	7.0	0.05	6.0	17	V
West	Four	100	10.0	6.0	0.10	1.5	33	VII A
Wolf (Ill. Bas.)	Three	385 (Total)	8.0	5.0	0.04	3.0	59	IV A
Wolf (Main Ind. Bas.)	--	--	15.0	5.0	0.09	3.0	58	IV A
LAPORTE CO.								
Clear (1989)	Two	106	12.0	7.2	0.05	9.2	32	VII A
Crane	Three	58	12.0	3.0	0.02	3.0	50	VII C

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Fishtrap	One	102	37.0	10.0	0.03	5.0	18	IV A
Hog	One	59	52.0	11.7	0.02	13.0	21	VII A
Horseshoe	Three	35	10.0	3.0	0.09	5.0	60	IV A
Hudson (1991)	One	432	42.0	11.7	0.08	16.1	13	V
Lily	Four	16	22.0	8.0	0.11	5.0	55	IV A
Lower Fish (1989)	Two	134	16.4	6.5	0.03	4.6	26	VII A
Pine (1989)	Two	282	71.0	13.0	0.09	9.5	30	VII A
Saugany (1989)	One	74	66.0	29.6	0.06	26.2	14	II A
Stone (1989)	Two	125	36.0	19.9	0.07	13.8	34	VI A
Swede	Two	33	15.0	8.0	0.04	4.5	32	VII A
Upper Fish (1989)	Two	139	24.0	7.5	0.05	7.5	35	VII A
LAWRENCE CO.								
Springmill (1991)	One	28	--	--	0.18	1.8	25	
MARION CO.								
Eagle Creek Res. (1975)	Two	1,500	35.0	12.5	0.19/0.10/0.06	4/5/4.0/2.0	42/44/34	III
Eagle Creek Res. (1991)	Two	1,500	35.0	12.5	0.45	2.6	41	III
Geist Res. (1973)	Two	1,800	220	12.0	0.14/0.06	2.5	37	III
Geist Res. (1991)	Two	1,800	220	12.0	0.11	1.3	31	III
MARSHALL CO.								
Cook (1989)	Two	93	64.0	17.7	0.27	2.3	41	VII B
Dixon (1990)	Two	33	48.0	14.5	0.54	6.2	36	VII B
Eddy (1991)	One	16	49.0	25.0	0.11	2.0	20	VI A
Flat (1990)	Two	26	24.0	8.1	0.41	3.3	29	VII A
Gilbert (1990)	Two	35	41.0	13.2	0.05	3.0	39	VII B
Holem (1990)	Two	30	74.0	0.8	0.25	6.2	40	VII C
Hawks (Lost)	Three	40	9.0	4.0	0.10	5.0	65	IV B
Koontz (1993)	One	346	31.0	9.2	0.02	1.2	24	VII A
Kreighbaum (1991)	One	20	28.0	20.0	0.28	7.2	25	VII A
Lake of the Woods (1991)	Two	416	48.0	16.0	0.07	33	48	VII B
Lawrence (1989)	Two	69	63.0	22.9	0.16	6.9	33	VI A
Maxinkuckee (1993)	One	1,864	88.0	24.5	0.01	2.2	17	III
Meyers (1989)	Two	96	59.0	20.8	0.15	9.8	36	VI A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Mill Pond (1989)	Two	136	36.0	6.1	0.1	3.3	32	VIII A
Pretty (1989)	One	97	40.0	22.1	0.06	13.8	23	VI A
Thomas (1991)	Two	16	58.0	15	0.27	4.9	29	VI A
MARTIN CO.								
Trinity Springs	Three	10	7.0	2.0	0.18	2.0	60	IV A
West Boggs Creek (1989)	Two	622	30.0	12.5	0.18	2.1	41	VII B
MIAMI CO.								
Mississinewa Res. (Dam) (1975)	One	3,180	45.0	17.5	0.02 / 0.03	6.5	20 16	I
Mississinewa Res. (Dam) (1991)	One	--	--	--	0.05	5.3	25	I
MONROE CO.								
Cherry (1993)	One	4	30.0	12.0	0.04	1.7	10	V
Bryants Creek Lake (1992)	One	9	23.0	10.0	0.05	3.6	7	V
Griffey Res. (1990)	One	130	30.0	10.0	0.03	13.5	24	VI A
Lemon (1990)	Two	1,650	28.0	10.0	0.06	3.3	30	III
Monroe Res. (Dam) (1976)	One	10,750	38.0	15.0 - 20.0	0.03	12.0	25	I
Monroe Res. (Dam) (1985)	--	--	--	--	0.03	7.0	3	I
Monroe Res. (Causeway)	--	--	--	--	0.04	6.0	34	I
Monroe Res. (Moores C.)	--	--	--	--	0.04	8.0	25	I
Monroe Rees. (N. Salt C.)	--	--	--	--	0.03	8.0	29	I
Monroe Res. (N. Salt Cr.) (1985)	--	--	--	--	0.04	2.0	19	I
Monroe Res. (Paynetown) (1976)	--	--	--	--	0.03	8.0	27	I
Monroe Res. (Paynetown) (1985)	--	--	--	--	0.03	3.3	15	I
Monroe Lower (1990)	One	10,750	38.0	15 - 20	0.03	5.6	10	I
Monroe Upper (1990)	One	10,750	38.0	15 - 20	0.03	3.3	17	I
MONTGOMERY CO.								
Waveland (1991)	Two	360	27.0	10.0	0.33	2.0	36	VII A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
NEWTON CO.								
J. C. Murphy (1990)	One	1,515	8.0	5.0	0.06	8.9	22 (Atypical)	III
NOBLE CO.								
Bartley (1990)	Three	34	34.0	12.6	0.05	3.9	57	IV B
Baugher (1991)	Three	32	36.0	12.2	0.36	3.6	56	IV B
Bear (1993)	Two	136	59.0	22.3	0.20	1.5	37	VI A
Big (1990)	Three	228	70.0	24.7	0.06	6.2	58	IV D
Bixler (1993)	One	117	43.0	17.4	0.45	1.8	23	VI A
Bowen (1991)	Two	30	36.0	15.0	0.46	5.6	34	VII B
Crane (1991)	Two	28	26.0	12.9	0.52	2.0	47	VII B
Cree (1993)	One	58	26.0	15.7	0.16	3.7	17	VI A
Crooked (1987)	One	206	108.0	43.0	0.065	10.0	12	II B
Deer (1993)	Two	36	[illegible]	[illegible]	0.30	0.6	41	[illegible]
Diamond (1993)	Two	105	81.0	14.0	0.4	1.6	33	VII B
Dock (1993)	Two	16	40.0	16.6	0.33	3.9	35	VII B
Duely (1993)	Two	21	19.0	8.6	0.10	1.5	35	VII A
Eagle (1989)	One	81	49.0	13.0	0.13	5.6	25	VII A
Engle (1993)	One	48	29.0	14.0	0.03	3.0	13	V
Gilbert (1993)	One	28	36.0	17.5	0.02	5.3	17	VI A
Gordy (1993)	Two	31	35.0	21.9	1.27	3.2	39	VI A
Hall (1993)	One	10	35.0	18.0	0.05	2.0	10	VI A
Harper (1993)	One	11	25.0	14.5	0.09	3.3	25	VII B
Henderson (1993)	Two	22	35.0	15.0	0.15	0.5	44	VII B
High (1993)	Two	123	25.0	10.1	0.05	0.7	39	VII C
Hindman (1993)	One	13	20.0	10.8	0.07	1.9	21	VII A
Horseshoe (1991)	Two	18	28.0	13.9	0.25	10.2	34	VII C
Indian (Village) (1991)	Two	12	22.0	13.3	0.05	4.6	28	VII B
Jones (1989)	Two	115	25	8.3	0.72	2.6	38	VII C
Knapp (1991)	Two	88	59.0	25.0	0.12	6.9	31	VI A
Latta (1990)	Three	42	38.0	21.4	0.15	4.3	56	IV D
Little Long (1990)	Three	71	32.0	24.6	0.10	4.9	57	IV D
Long (Chain of Lakes) (1990)	Two	40	32.0	15.8	0.04	8.2	43	VII B
Lower Long (1989)	One	66	55	23.6	0.15	8.9	20	VI A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Millers	Two	28	34.0	14.6	0.05	8.0	35	VII B
Moss (1993)	Two	9	19.0	8.9	0.08	1.9	30	VII A
Muncie	Two	47	37.0	12.3	0.09	3.0	46	VII C
Norman (1990)	Two	14	46.0	20.0	0.28	6.2	27	VI A
Pleasant	Two	20	67.0	27.0 / 22.5	0.21	8.0	29	VI A
Port Mitchell (1990)	Three	15	31.0	12.0	0.03	3.9	55	IV B
Rider (1993)	One	5	15.0	6.0	0.09	2.4	16	V
Rivir (Chain of Lakes) (1991)	Two	24	32.0	15.8	0.48	4.6	32	VII B
Round (1993)	Two	99	66.0	21.6	0.18	1.6	31	VI A
Sacarider (1993)	Three	33	60.0	22.4	0.28	0.9	54	IV D
Sand (Chain of Lakes) (1989)	Two	47	51.0	27.0	0.2	8.2	33	VI A
Shockopee (1993)	Two	21	26.0	13.3	0.42	1.7	27	VII A
Skinner (1993)	Two	125	32.0	14.0	0.41	0.8	44	VII B
Smalley (1993)	Two	69	49.0	22.0	0.58	1.3	40	VI A
Sparta (1993)	One	31	10.0	5.5	0.01	1.8	21	VII A
Stienbarger (1993)	Two	73	39.0	21.8	0.29	2.0	36	VI A
Sylvan (1991)	Two	575	36.0	14.0	0.21	2.6	40	VII B
Tamarak (1993)	Three	50	37.0	17.6	0.30	1.3	39	VII B
Upper Long (1989)	Two	86	54.0	22.1	0.15	6.4	32	VI A
Waldron (1993)	Two	216	45.0	14.4	0.39	0.8	31	VII B
Wible (1993)	Two	49	27.0	13.3	0.40	0.6	43	VII B
Williams (1990)	Three	46	--	--	0.32	4.6	68	
Wolf	Four	25	14.0	8.0	0.33	5.0	43	IV B
ORANGE CO.								
Springs Valley (1989)	One	141	26.0	8.0	0.07	12.1	21	VII A
Patoka (1987)	One	8000 +	50 (est.)					I
Main Basin East					0.032	14.0	3	
East Basin					0.042	14.0	3	
164 Basin					0.047	13.0	14	
Intake Basin					0.038	15.0	12	
OWEN CO.								
Grey Brook (1990)	Two	33	--	--	0.05	5.3	28	

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
PARKE CO.								
Raccoon (Cecil Harden) (1991)	Three	2,060	60.0	15.0	0.06	2.6	59	III
Rockville (1991)	Two	100	30.0	15.0	0.19	2.3	42	VII B
PERRY CO.								
Celina (1989)	One	164	38.0	23.5	0.02	9.2	11	VII A
Fenn Haven	Three	20	10.0	4.0	0.03	2.0	55	IV A
Oriole	Two	1	8.0	5.0	0.08	4.0	39	VII C
Indian (1991)	One	149	25.0	15.0	0.05	10.5	12	V
Saddle (1991)	One	41	20.0	15.0	0.02	15.4	4	V
Tipsaw (1991)	One	131	15.0	15.0	0.04	13.8	23	VI A
PIKE CO.								
West Lake	Two	15	25.0	10.0	0.03	7.0	7	V
Prides Creek (1991)	Two	90	20.0	10.0	0.08	4.3	30	VII A
PORTER CO.								
Billington	Two	11	10.0	10.0	0.13	5.0	35	VII A
Canada	Two	10	36.0	10.0	0.08	5.0	39	VII A
Clear	One	17	30.0	15.0	0.03	8.0	22	VI A
Deep	Two	7	7.0	10.0	0.03	5.0	28	VII A
Eliza (1991)	One	45	35.0	15.0	0.30	2.3	23	VI A
Flint	One	86	67.0	20.0	0.03	18.0	25	VI A
Long (1989)	Two	65	27.0	8.0	0.07	4.3	36	VII A
Loomis (1989)	Two	62	30.0	15.0	0.35	2.6	47	VII B
Mink (1991)	Two	35	24.0	10.0	0.38	3.9	41	VII C
Morgan	Two	12	15.0	15.0	0.04	5.0	28	VII C
Moss (1993)	Two	9	20.0	9.0	0.08	1.9	30	VII A
Spectacle	Two	62	30.0	8.7	0.09	5.0	40	VII C
Wahob (1991)	Two	21	48.0	35.0	0.58	12.5	38	II C
POSEY CO.								
Hovey (1990)	Two	242	51.0	4.0	0.06	1.3	30	VII A
PUTNAM CO.								
Cataract (Cagles Mill) (1986)	Three	1,400	36.0	20.0	0.063	4.0	37	III
RIPLEY CO.								
Bischoff (1988)	Three	200	27.0	15.0	0.143	2.5	52	IV B

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Feller	Three	6	8.0	4.0	0.28	3.0	64	IV A
Hahn	Two	8	12.0	6.0	0.04	5.0	46	VII A
Liberty Park	Two	11	18.0	7.0	0.06	5.0	26	VII A
Mollenkramer (1990)	One	93	10.0	5.0	0.07	1.3	24	VII A
Oser	Two	12	18.0	9.0	0.16	5.0	34	VII A
Versailles (1975)	Three	230	20.0	5.0	0.11	1.5	52	VII A
Versailles (1991)	Two	230	20	5.0	0.31	2.6	30	VII A
ST. JOSEPH CO.								
Bass (1990)	One	88	37.0	10.0	0.05	9.2	24	VII A
Chamberlain	Four	51	27.0	3.5	0.03	5.0	50	IV A
Czmanda	Four	90	9.0	5.0	0.06	5.0	50	IV A
Mud	Four	197	8.0	2.0	--	5.0	50	IV A
Pleasant (1990)	One	29	39.0	18.0	0.10	2.6	25	VI A
Potato Creek Res. 1990	Two	327	--	15.0	0.07	2.6	29	VII A
(Worster Lake) (1991)	One	327		15.0	0.09	3.6	19	VII A
Quarry	Two	43	64.0	15.0	0.04	6.0	30	VI A
Riddles (1990)	Two	77	20.0	8.3	0.30	3.0	29	VII A
Sously	Three	40	19.0	4.0	0.04	4.0	50	IV A
South Clear	Three	51	15.0	2.0	0.08	5.0	50	IV A
SCOTT CO.								
Hardy (1990)	Two	705	40.0	12.0	0.03	5.8	27	VII A
Scottburg Res. (1990)	One	83	16.0	4.0	0.04	2.0	18	VII A
SPENCER CO.								
Lincoln (1989)	One	58	24.0	12.0	0.03	10.2	19	V
STARKE CO.								
Bass (1988)	Two	1,400	30.0	10.0	0.08	0.6	44	III
Eagle	Two	24	12.0	6.7	0.04	5.0	40	VII C
Hartz (1991)	Two	28	40.0	13.2	0.07	12.8	26	VII A
Langenbaum (1990)	One	48	19.0	5.4	0.03	6.2	22	VII A
STEUBEN CO.								
Ball (1992)	One	87	66.0	40.5	0.11	1.2	22	II B
Barton (1992)	One	94	44.0	14.3	0.01	2.8	10	V
Bass (1992)	One	61	20.0	7.4	0.03	4.2	6	V
Beaver Dam (1992)	One	11	26.0	15.0	0.02	2.4	8	V
Bell (1992)	One	38	24.0	13.4	0.02	3.6	4	V

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Big Bower (1990)	Two (Atypical)	25	22.0	11.2	0.00	4.3	27	VII A
Big Otter (1992)	One	69	38.0	25.8	0.05	2.9	17	VI A
Big Turkey (1991)	Two	450	65.0	16.2	0.12	3.6	41	VII B
Black	Two	18	35.0	15.0	0.03	5.0	36	VII B
Booth	Four	10	40.0	14.0	0.04	5.0	55	IV B
Buck (1992)	One	20	57.0	15.0	0.15	2.5	19	VI A
Center (1989)	Two	46	19.0	8.5	0.49	0.4	44	VII C
Charles (1992)	Two	150	10.0	5.0	0.19	0.8	30	VII C
Cheesboro	Two	27	16.0	10.0	0.05	5.0	40	VII C
Clear (1992)	One	800	107.0	31.2	0.02	3.3	15	II B
Crockett	Four	5	15.0	15.0	0.05	5.0	49	VII B
Crooked (Middle Bas.) (1991)	One	802	77.0	12.0	0.18	9.5	30	VII A
Deep (1993)	One	12	28.0	10.0	0.05	1.2	15	V
Failing (1992)	Two	23	35.0	8.0	0.07	4.6	26	VII A
Fish (1992)	One	59	34.0	12.7	0.28	2.2	24	VII
Fox (1992)	One	142	55.0	22.2	0.03	2.7	22	VI A
Gage (1992)	One	332	70.0	30.6	0.03	4.7	13	II B
George (1992)	One	488	71.0	25.0	0.03	2.8	8	II B
Golden (1992)	Two	119	31	15.2	0.17	0.8	33	IV A
Gooseneck (1992)	One	25	28.0	20.0	0.03	1.4	17	VI A
Grass	Four	20	25.0	10.0	0.03	5.0	24	VII A
Gravel (1992)	Two	12	89.0	10.0	0.36	1.6	39	VII C
Gravel Pit (1992)	One	28	29.0	15.0	0.04	6.1	11	V
Green	One	24	27.0	10.0	0.02	9.5	15	VII A
Hamilton (E. Bas. 1992)	Two	802	70.0	20.0	0.22	1.2	37	VI C
Handy (1992)	Two	16	41.0	18.1	0.07	3.5	31	VI A
Henry (1992)	Two	20	25.0	15.0	0.06	0.9	36	VI A
Hog (1992)	One	48	26	11.8	0.09	8.9	19	VII A
Hogback (1992)	Two	146	26	10.1	0.32	0.8	36	VII A
Howard (1992)	Four	27	12.0	4.8	0.03	2.7	11	V
James (1992)	One	1,034	86.0	35.5	0.05	3.6	10	II B
Jimmerson (1992)	One	346	56.0	36.0	0.03	3.9	10	II B

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Johnson	Four	17	39.0	15.0	0.045	5.0	30	VI A
Lake Anne (Unique) (1991)	Two	17	31.0	16.5	0.11	9.5	27	VI A
Lake Pleasant (1989)	One	424	52.0	40.0	0.08	6.6	21	II B
Little Center	Three	25	10.0	8.0	0.22	1.0	52	IV B
Little Otter (1990)	One	34	37.0	21.8	0.10	2.0	25	VI A
Little Turkey (1992)	Three	58	30.0	13.4	0.37	0.9	55	IV B
Lime (Gage) (1992)	Four	30	29.0	11.0	0.03	10.0	10	V
Lime-Kiln (1992)	Two	25	22.0	10.0	0.08	1.2	40	VII C
Long A (Near Pleasant) (1992)	Two	92	33.0	16.7	0.36	0.7	44	VII B
Long B (Clear) (1992)	One	154	36.0	11.9	0.21	3.0	19	VII A
Loon (1992)	One	138	18.0	4.6	0.04	2.3	11	V
Marsh (1992)	Two	56	38.0 / 35.0	20.0	0.03	2.2	36	VI A
McClish (1992)	Two	35	57.0	34.6	0.16	1.6	35	II C
Meserve (1992)	One	16	25.0	14.0	0.05	3.3	22	V
Middle Center	Three	15	20.0	5.0	0.50	5.0	62	IV A
Mirror (1993)	One	9	60.0	13.3	0.10	2.9	11	VII A
Mud B (1992)	Two	16	40.0	18.0	0.17	0.4	27	VII B
Mud C	One	20	32.0	6.0	0.03	2.5	6	V
Perch	Four	12	36.0	18.0	0.04	5.0	30	VII B
Pigeon (1992)	Two	61	38.0	15.2	0.08	2.9	32	VI A
Pleasant (1992)	One	53	44.0	30.0	0.08	2.0	13	II A
Round A (Clear) (1992)	One	30	25.0	35.0	0.03	4.0	12	IIB
Round B (1991)	One	30	25.0	11.3	0.03	17.1	20	VII A
Round C	Two	12	30.0	10.0	0.05	7.0	38	VII A
Seven Sisters	Four	22	40.0	14.0	0.03	5.0	27	V
Shallow	Four	65	16.0	5.0	0.05	5.0	51	V
Silver (1992)	One	238	38.0	10.7	0.05	3.2	15	V
Snow (1992))	Two	310	84.0	30.0	0.02	3.2	15	V
Stayner (1992)	One	5	10.0	7.0	0.03	3.1	8	V
Tamarak	Two	47	14.0	5.0	0.04	7.0	30	VII A
Walters (1992)	One	53	29.0	10.4	0.08	2.8	21	VI A
Warner (1992)	Two	17	25.0	15.0	0.15	1.5	28	VI A
West Otter (1989)	One	118	31.0	16.6	0.05	1.4	19	VI A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
SULLIVAN CO.								
County Line Pit	Four	5	6.0	4.0	0.06	0.0	61	IV A
Jonay Res.	Three	11	18.0	6.0	0.07	6.0	32	VII C
Kelly Bayou	Four	40	6.0	3.0	0.19	1.5	64	IV A
Kickapoo (1991)	Two	30	40.0	23.0	0.08	19.4	29	VI A
Lake 29 (Acid)		--	--	--	0.10	--	--	--
Lake Sullivan (1989)	One	507	25.0	10.0	0.06	3.0	20	VII A
Lenape (1991)	Two	49	--	--	0.17	7.5	41	
Merom Gravel Pits (1990)	One	55	50.0	6.0	0.02	9.2	12	V
Reservoir 26 (1990)	One	47	--	--	0.24	2.6	25	
Shakamak (1991)	Two	56	26.0	10.9	0.11	5.6	43	VII C
Turtle Creek Res.	Three	1,550	25.0	10.0	0.60	2.0	50	III
UNION CO.								
Brookville (1990)	Two	5,260	--	--	0.05	3.9	31	
Whitewater Lake (1990)	Two	199	46.0	15.0	0.05	3.6	36	VII B
VIGO CO.								
Fowler Park (1992)	One	50	40.0	15.0	0.06	2.6	12	V
Greenfield Bayour	Four	61	12.0	5.0	0.11	5.0	52	VI A
French (1990)	Three	--	--	--	0.85	7.2	56	
Green Valley (1991)	Three	50	--	--	0.60	2.6	60	VII A
Hartman	Two	21	18.0	12.0	0.05	5.0	37	VII A
Izaak Walton	Two	83	60.0	25.0	0.07	5.0	40	VI B
Paint Mill (1990)	Two	82	--	--	0.09	1.3	33	
South (1990)	One	45	--	--	0.03	2.6	21	
Stick Pit 2 (1990)	One	50	--	--	0.01	5.3	12	
Walton (1990)	Two	216	--	--	0.05	3.3	27	
WABASH CO.								
Hominy Ridge (1990)	Two	11	20.0	8.0	0.12	3.3	47	VII C
Long (at Laketon) (1990)	Two	48	39.0	16.0	0.17	3.3	36	VII B
Lukens (1990)	Two	46	41.0	22.0	0.16	6.9	31	VI A
Round (at Laketon) (1990)	Two	48	25.0	11.2	0.13	1.3	44	VII C
Twin Lakes (1990)	Two	81	16.0	10.6	0.11	2.0	33	VII A

APPENDIX A. *Morphometric and Trophic Characteristics of Indiana Lakes (cont.)*

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
WARRICK CO.								
Scales (1990)	Two	66	20.0	7.0	0.04	12.1	27	VII A
WASHINGTON CO.								
Elk Creek (1990)	Two	47	32.0	12.5	0.03	9.8	35	VII A
John Hay (1990)	One	--	40.0	15.0	0.03	11.0	12	VI A
Salinda (1991)	Two	126	20.0	15.0	0.12	2.3	38	VII B
WAYNE CO.								
Middle Fork Res. (1990)	Two	277	30.0	15.0	0.08	2.3	36	VII B
WELLS CO.								
Kunkel (1991)	Two	25	19.0	6.0	0.12	3.6	29	VII A
Moser	One	26	12.0	6.0	0.17	1.6	20	VII A
WHITE CO.								
Shaffer Dam (1991)	Two	1,291	30.0	10.0	0.14	2.3	26	III
WHITLEY CO.								
Blue (1990)	Two	239	49.0	21.0	0.18	5.9	31	VI A
Cedar (Tri-Lake) (1990)	Two	144	75.0	30.0	0.09	19.7	44	VII B
Dollar (1991)	Two	10	59.0	15.0	0.25	16.4	33	VI A
Goose (1990)	Two	84	69.0	25.9	0.15	2.6	41	IV D
Little Crooked (1990)	Three	15	50.0	20.0	0.35	9.5	61	IV B
Loon (1989)	Two	222	96.0	25.8	0.05	9.5	35	VI A
New (1990)	One	50	44.0	17.6	0.05	8.2	24	VI A
Old (1990)	Three	32	42.0	19.4	0.29	5.6	55	IV B
Robinson (1990)	Two	59	--	--	0.10	2.3	28	
Round (Tri-Lake) (1990)	One	125	63.0	25.0	0.15	14.1	22	VI A
Scott (1990)	Two	18	22.0	5.0	0.30	2.1	29	VII A
Shriner (Tri-Lake) 1988	Two	111	61.0	45.0	0.23	7.5	28	II C
Troy-Cedar (1990)	Two	93	88.0	27.3	0.06	5.3	35	VI A