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# INDIANA 305 (b) REPORT 1990-91


INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

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# EXECUTIVE SUMMARY

The 1990 - 91 305 (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 35,673 miles of rivers, streams, ditches and drainageways in Indiana. Of these approximately 21,094 miles have sufficient all-weather flow and other physical characteristics necessary to support both the fishable and swimmable uses. Approximately 32% of these miles were assessed for this report. Additional stream miles could support the fishable use during high flow periods but the majority of these remaining miles are dry much of the year.

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, 70% 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 64% and the fishable goal was supported in 70%. 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, organic enrichment, pesticides, priority organic compounds and ammonia. The sources of substances most often contributing to nonsupport of uses were: industrial and municipal/semi-public point sources, combined sewer overflows, and agricultural nonpoint sources. Impacts due to nonpoint sources were considered major.

In the past two years, the state has done monitoring for toxic substances in fish tissue and sediments. Over 5,335 stream miles and approximately 78,818 inland lake and reservoir acres were monitored in some way for toxics. Of the river and stream miles monitored, about 35% were considered to have elevated levels of toxic substances. Most of the these miles were due to the occurrence of fish consumption advisories or to the presence of sediment contamination at medium to high levels of concern. Pesticides, PCBs and metals were the substances most often causing these problems. Only 3% of the inland lake and reservoir acres monitored were found to have toxic substances (primarily metals) in sediments at levels of medium to high 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 1991, while the percentage served by advanced treatment facilities increased from 0% to 53% in the same time period. About 37% 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 280 claims for more than $1,217,244,746 in tax exemptions for industrial wastewater treatment or control facilities in 1991. 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 839 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 qualities 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 35,673 total miles of water courses in Indiana, only 21,094 miles of streams and rivers are large enough to support all designated uses throughout most of 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, waterways in Indiana have been divided into seven drainage basins.

Indiana has approximately 575 publicly-owned lakes, ponds, 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). Indiana's publicly-owned lakes, ponds and reservoirs 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. Wetland 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 1990 - 91.

# II. SURFACE WATER QUALITY

### Current Status and Designated Use Support

In this 1990-91 305 (b) Report the water resources information was updated to incorporate the current guidelines fromU.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 reflect features on the 1:100,000 USGS hydrologic maps. The use of RF3 has decreased Indiana total stream miles compared to previous reports. However, the computerized databases are considered to be accurate and will produce consistent estimates for reporting purposes. 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. This total includes ditches and drainageways as well as permanent streams. All of which are "Waters of the State" protected by the Indiana Water Pollution Control Laws. There are an estimated 21,094 miles of permanently flowing streams in Indiana which appear on a 1:100,000 scale USGS map. All of these 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, 8,409 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) |
|---|---|---|---|
| Ag. Fish and Wildlife | 35,673* ~~(21,094)**~~ | 106,203 | 43 |
| Domestic Water Supply | *** | 32,000 | 43 |
| Recreation | 35,673* ~~(21,094)~~ | 106,203 | 43 |
| Industrial | 35,673* ~~(21,094)~~ | 106,203 | 43 |
| Navigation | -- | -- | 43 |
| Nondegradation | 35,673* ~~(21,094)~~ | 106,203 | 43 |
| Other (Specify) | -- | -- | -- |
| Unclassified | -- | -- | -- |

Although it has been estimated that there are approximately 90,000 mi of streams, ditches and drainageways in Indiana

* *~~These~~ 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 ~~accurate,~~ consistent, computerized method for summing State waters.*

** *Although there are approximately 35,673 miles of watercourses and drainageways in Indiana ~~which would technically fall under the jurisdiction of the water quality standards, only about 21,094 miles could reasonably be expeted to meet these designated uses during most of the year due to natural conditions. (See text for further explanation).~~*

*** *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 < 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, 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). The state is planning a study to determine what the natural background levels of this substance are throughout the state.

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" during most of the year. Approximately 32% of these miles were assessed for support of aquatic life uses. Of those miles assessed, 70% were judged to be fully supporting of aquatic life uses. Only 6% of the miles assessed were considered fully supporting but threatened. Another 5% were partially supporting these uses, while 19% did not support these uses.

Approximately 20% of these 21,094 miles were assessed for attainment of whole body contact recreational uses. About 21% of the waters assessed fully supported this use designation, about 3% partially supported it, and 75% did not support this use due to frequent high E. coli levels. Of the river and stream miles assessed, 331 miles are currently under some type of fish consumption advisory and do not fully support the fish consumption use.

For the 1992 cycle 305(b) Report a total of ~~6,710~~ 6712 river miles were assessed for the degree of use support. This was an increase of 364 miles assessed when compared to the 1988-1989 reporting period. ~~Most of the non-supportive waters were due to high concentrations of E. coli found at many of the stations sampled.~~

Based on Digital Line Graph computerized databases, U.S. EPA estimates that there are 142,871 acres of lakes in Indiana. Of those acres 106,203 are public lakes. Enough information was available to assess ~~74% of the total acreage~~ of the state's publicly ~~owned inland~~ lakes and reservoirs. All but 1% of the lake reservoir acreage assessed fully supported 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 | 4,748 | -- | -- | 331 | -- | -- |
| Shellfishing | -- | -- | -- | -- | -- | -- |
| Aquatic Life Support | 4,748 | 377 | 343 | 1,304 | 77 | -- |
| Swimming | 937 | -- | 127 | 3,246 | -- | 2,462 |
| Secondary Contact | | | | | | |
| Drinking Water Supply | | | | | | |
| Agriculture | 21,094 | | | | | |
| Industrial | 21,094 | | | | | |
| Nondegradation | 21,094 | | | | | |

*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 | -- | -- | -- | 12 | -- | -- |
| Shellfishing | [illegible] | -- | -- | -- | -- | -- |
| Aquatic Life Support | 78,089 | -- | 88 | 101 | -- | 4,195 |
| Swimming | 97,372 | -- | 88 | 89 | -- | 8,654 |
| 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 | | | | | |
| State Defined | 43 | | | | | |
| Industrial Navigation | 43 | | | | | |

TABLE 4. *Overall Use Support Summary*

## RECREATIONAL RIVERS

| Degree of Use Support | Assessment Basis | | Total Assessed |
|---|---|---|---|
| | Evaluated | Monitored | |
| Size Fully Supporting | 218 | 719 | 937 |
| Size Threatened | 0 | 0 | 0 |
| Size Partially Supporting | 6 | 121 | 127 |
| Size not Supporting | 104 | 3,142 | 3,246 |
| TOTAL | 328 | 3,982 | 4,310 |

## AQUATIC LIFE RIVERS

| Degree of Use Support | Assessment Basis | | Total Assessed |
|---|---|---|---|
| | Evaluated | Monitored | |
| Size Fully Supporting | 1,153 | 3,595 | 4,748 |
| Size Threatened | 281 | 96 | 377 |
| Size Partially Supporting | 154 | 189 | 343 |
| Size not Supporting | 60 | 1,244 | 1,304 |
| TOTAL | 1,648 | 5,124 | 6,772 |

* *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 | 27.818 | 97,372 | 74,089 | 0 | 101,907 | 97,372 | -- | -- | -- | 43 | -- | 43 |
| Size Threatened | 0 | 0 | * | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Size Partially Supporting | 88 | 88 | 0 | 0 | 88 | 88 | -- | -- | 43 | -- | 43 | -- |
| Size Not Supporting | 101 | 89 | 0 | 0 | 101 | 89 | -- | -- | -- | -- | -- | -- |
| TOTAL | 28,007 | 97,549 | 74,089 | 0 | 102,008 | 97,549 | -- | -- | 43 | 43 | 43 | 43 |

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

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 5). 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 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

TABLE 5. *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 5. *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 5. *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 5. *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..*

Environmental Management is responsible for review of projects requiring Section 401 Water Quality Certification.

From January 1, 1986 to December 31, 1991 IDEM reviewed 620 projects involving approximately 605 acres of fill. Of the 620 projects reviewed, IDEM waived Section 401 Water Quality Certification for 470, denied 143 and simply made comments on 7. Of the 605 acres of fill, 500 acres were proposed fill and 105 acres were already filled with the applicant requesting an "after-the-fact" permit. IDEM allowed 153 acres of fill while requiring 483 acres of wetland restoration/creation as mitigation.

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 start an investigation into approved mitigation plans and when necessary, enforce the correct execution of these plans.

Of the 620 projects, approximately 74% involved filling or proposed filling of less than 0.1 acre of wetland or open water (Table 6). Only 4% of the projects involved wetland fills of greater than five acres. The greatest amount of proposed fill was 71 acres with the majority of this acreage being open waters. If seawall projects are excluded from the data, the number of projects that involved less than 0.1 acre of fill drops to approximately 44%. Although this is a drop of 30% the data still indicate that the largest percentage of projects reviewed involved extremely small amounts of fill.

Of the projects reviewed, approximately 30% involved a seawall as part of the project (Table 7). Dredging was involved in approximately 29% of the projects reviewed, with riprap and commercial development projects representing 15% each.

The majority of the projects reviewed occurred in northern Indiana or within two counties in the central part of the state (Table 8). The significant number of proposals in the northern portion of the state is understandable given the significant amount of wetlands and lakes in that area. The number of projects for Marion and Hamilton counties in central Indiana is due to heavy shoreline development on two manmade reservoirs. Approximately 66% of the projects for Kosciusko, Marion and Hamilton counties involved the construction of seawalls with only minimal backfill. Seawalls represented only about 5% of the projects reviewed in Lake County.

Tables 9 and 10 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, organic enrichment/DO, metals , ammonia, other inorganics (primarily cyanide),

**TABLE 6.** *Percentage of Projects Reviewed Vs. Size of Fill*

| SIZE OF FILL (acres) | | % OF PROJECTS REVIEWED |
|---|---|---|
| 0.0 - 0.1 | | 74% |
| 0.1 - 0.25 | | 5% |
| 0.25 - 0.5 | | 5% |
| 0.5 - 1.0 | | 2% |
| 1.0 - 5.0 | | 10% |
| 5.0 - 10.0 | | 1% |
| 10.0 - 15.0 | | 1% |
| 15.0 - 80.0 | | 2% |

TABLE 7. *Number and types of projects reviewed for Section 401 Water Quality Certification**

| TYPE | # OF PROJECTS REVIEWED |
|---|---|
| Bridge | 34 |
| Beach | 38 |
| Bank Protection | 16 |
| Boat Ramp | 43 |
| Coal Mining | 3 |
| Channel Relocation | 12 |
| Clearing and Snagging | 4 |
| Dam | 14 |
| Disposal | 31 |
| Dredging | 179 |
| Flood Control | 2 |
| Farming | 10 |
| Golf Course | 3 |
| Landfill | 4 |
| Levee | 8 |
| Marina | 9 |
| Peat Mining | 1 |
| Pipeline | 9 |
| Pond | 11 |
| Road | 24 |
| Riprap | 91 |
| Seawall | 185 |
| Site Development Commercial | 91 |
| Site Development Public | 23 |
| Site Development Residential | 63 |
| Wetland Restoration/Creation | 6 |

**TABLE 8.** ***Counties With the Greatest Number of Projects Requiring Section 401 Water Quality Certification***

| COUNTY | # OF PROJECTS |
|---|---|
| Kosciusko | 94 |
| Marion | 65 |
| Hamilton | 55 |
| Lake | 47 |
| LaPorte | 26 |
| Elkhart | 23 |
| Steuben | 23 |
| Clark | 22 |
| Porter | 19 |
| Vanderburgh | 16 |

TABLE 9. *Total Sizes of Waterbodies Not Fully Supporting Uses Affected by Various Cause Categories*

| | RIVERS AND STREAMS (MILES) | | LAKES (ACRES) | | LAKE (SHORELINE MILES) | |
|---|---|---|---|---|---|---|
| *CAUSE CATEGORY* | *MAJOR* | *MODERATE/MINOR* | *MAJOR* | *MODERATE/MINOR* | *MAJOR* | *MODERATE/MINOR* |
| Unknown | --- | --- | --- | --- | --- | --- |
| Unknown toxicity | --- | --- | --- | --- | --- | 43 |
| Pesticides | 245 | 116 | 12 | --- | --- | --- |
| Priority organics | 288 | 150 | 12 | --- | --- | --- |
| Nonpriority organics | 1 | --- | --- | --- | --- | --- |
| Metals | 440 | 130 | --- | 45 | --- | --- |
| Ammonia | 121 | 81 | 22 | 100 | --- | --- |
| Chlorine | --- | --- | 22 | 77 | --- | --- |
| Other inorganics | 284 | 48 | --- | --- | --- | --- |
| Nutrients | --- | --- | 122 | 12 | --- | --- |
| pH | 4 | --- | 30 | --- | --- | --- |
| Siltation | --- | 40 | --- | 88 | --- | --- |
| Organic enrichment/DO | 653 | 45 | 59 | 63 | --- | --- |
| Salinity/TDS/chlorides | 13 | --- | --- | --- | --- | --- |
| Thermal modification | --- | --- | --- | --- | --- | --- |
| Flow alteration | --- | --- | --- | --- | --- | --- |
| Other habitat alterations | --- | 35 | --- | --- | --- | --- |
| Pathogen indicators | 2644 | 648 | 45 | 77 | --- | --- |
| Radiation | --- | --- | --- | --- | --- | --- |
| Oil and grease | 12 | --- | --- | --- | --- | --- |
| Taste and odor | --- | --- | --- | --- | --- | --- |
| Suspended solids | 53 | 180 | --- | --- | --- | --- |
| Noxious aquatic plants | --- | --- | --- | --- | --- | --- |
| Filling and draining | --- | --- | --- | --- | --- | --- |

TABLE 10. *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 | 90 | 27 | --- | --- | --- | 43 |
| Municipal point sources | 292 | 507 | 59 | 63 | --- | 43 |
| Combined sewer overflow | 114 | 182 | 22 | 23 | --- | 43 |
| Agriculture | 512 | --- | 12 | --- | --- | 43 |
| Silviculture | --- | --- | --- | --- | --- | --- |
| Construction | --- | --- | --- | --- | --- | --- |
| Urban runoff/storm sewers | 77 | --- | 35 | 22 | --- | --- |
| Resource extraction | 4 | --- | 30 | --- | --- | --- |
| Land disposal | 31 | 30 | --- | --- | --- | --- |
| Hydro/habitat modification | 31 | * | --- | 40 | --- | --- |
| Other (Aerial Deposition) | --- | --- | --- | --- | --- | 43 |
| Unknown | --- | --- | --- | --- | --- | --- |

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

organochlorine pesticides, and priority organics (mostly PCBs). 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.

**Public Health/Aquatic Life Concerns**

The release of toxic materials into the aquatic environment produces 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 directly 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. Any of these situations results in greater public concern than many other types of water pollution problems.

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 1990 - 1991, to discover the scope of the toxic problems and the causes 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 monitored for toxics and determined to have elevated levels of toxics is shown in Table 11. Of the 815 total lake acres shown to have elevated levels of toxics, most are included only because contaminants in bottom sediments were founds at levels judged to be of medium or high concern. 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 salmonid, yellow perch, carp and longnose sucker collected from

TABLE 11. *Total Size of Waterbodies Affected by Toxics*

| WATERBODY | SIZE MONITORED FOR TOXICANTS | SIZE WITH ELEVATED LEVELS OF TOXICANTS |
| --- | --- | --- |
| Rivers (miles) | 5,335 | 1,845 |
| Lakes (acres) | ~~23,500~~ 78,818 | 815 |
| Estauries (miles$^2$) | --- | --- |
| Coastal Water (miles) | --- | --- |
| Great Lakes (miles) | 43 | 43 |
| Freshwater Westlands (acres) | --- | --- |
| Tidal Wetlands (acres) | --- | --- |

Lake Michigan in 1990 also contained some residuals of total PCBs and pesticides, but all were below FDA Action Levels.

Nearly 24% of the 1,845 river and stream miles determined to have elevated levels of toxics substances were place in this category, at least in part, due to fish consumption advisories. Most of the remainder of these miles are due to contaminants in sediment at medium to high levels of concern. In most instances, these rivers and streams supported diverse communities of aquatic organisms.

Fishkill Reports

A diverse healthy fish population is considered an indication of good water quality. Serious public concern is generated when dead and dying fish are noted in the aquatic environment since this is usually evidence of a severe water quality problem and may indicate the long-term loss of use of affected waters for a fishery.

A fishkill can result from the accidental or intentional spill of a toxic compound or oxygen-depleting material into the aquatic environment. Fishkills may also occur downstream of a continuous industrial or municipal discharge which may release, due to a system upset, an atypical effluent containing high concentrations of pollutants.

A total of 72 fishkills were reported in 1990 and 91 (Table 12), a decrease of three kills from the 1988-89 period. Many of these fishkills were agricultural related such as confined feeding operational problems and misapplication of livestock waste; runoff of animal manure; fertilizer, herbicides or pesticides applied prior to rainfall events; and intentional dumping of fertilizer or livestock manure. Enforcement efforts in these areas have been increased in an effort to reduce these problems.

Although many of the causes of fishkills were unknown (24%), livestock manure from feeding operations (21%), municipal sewer/sludge (10%), liquid fertilizer spills (4%) and other sources (12%) were responsible for most of the fishkills reported (Figure 1). The causes grouped in the "other" category include industrial chemicals, chlorine, and thermal. Natural causes accounted for 15% of the reported kills.

In the 72 fishkills reported, 170,364 fish were reported killed. Table 13 categorizes the reported 1990-91 fish kills as to size (number of fish killed) and the number of kills in each size category. Clinton and Marion counties each reported seven fishkills, Decatur, Miami, Pike, Cass and Posey counties each reported three (3) kills and nine counties reported two (2) each.

TABLE 12. *FISH KILLS REPORTED IN 1990-91*

| COUNTY | RECEIVING WATER | MATERIALS | NUMBER KILLED | MILES AFFECTED |
|---|---|---|---|---|
| Adams | Holthouse Creek | Ice-Cream Byproducts | 500 | 2 |
| Boone | Whitelick Creek | Liquid Fertilizer | 6,009 | 10 |
| Cass | Deer Creek | Low Natural D.O. | 1,000 | 10 |
| | No Name Creek | Low D. O. Natural | 75 | 1 |
| | Little Deer Creek | Swine Waste | 22 | 1 |
| Clay | Strip Pit | Diesel Fuel | 20 | 20,000 sq. ft. |
| Clinton | Heavilon Ditch | Unknown | 600 | 0.5 |
| | Campbell's Run | Swine Waste | 1,000 | 4 |
| | Potato Creek | Unknown | 20 | Unknown |
| | Jenkins Ditch | Swine Waste | 3 | 145 |
| | Reagans Run | Unknown | 3 | 300 |
| | South Fork Wildcat Creek | Industrial Waste | 1,600 | Unknown |
| | Prairie Creek | Natural | 600 | 0.5 |
| Daviess | Dinken Creek | Swine Waste | 170 | 0.75 |
| Decatur | Falls Fork | Swine Waste | 5,015 | 8 |
| | Muscatatuck River | Swine Waste | 250 | Unknown |
| | Unknown | Unknown | 1,650 | 2 |
| Gibson | Sand Creek | Swine Waste | 254 | 3.5 |
| Grant | Taylor Creek | Fertilizer | 12 | 1 |
| Green | Unnamed Ditch | Amonia-Nitrogen | 160 | 1.5 |
| | Miller Creek | Swine Waste | 276 | 5 |
| Hamilton | White River Ditch | Swine Waste | 52 | 1 |
| | Williams Creek | Pesticide | 10,000 | <5 |
| Harrison | Big Indian Creek | Unknown | 1,070 | Unknown |
| Hendricks | W. F. White Lick Creek | Natural | 1,000 | 5 |
| Howard | Deer Creek | Swine Waste | 500 | Unknown |
| Huntington | Clear Creek | 28% LNF | 126 | 2 |
| Jackson | White Creek | Natural | 100 | 2 |
| Jay | Salomonie River | Unknown | 15 | 300 ft. |
| Jefferson | Ramsey Creek | Raw Sewage | 872 | 0.25 |
| Johnson | Pleasant Creek | Chlorinated Water | 2,800 | 0.25 |
| | Canary Creek | Unknown | 100 | 0.5 |
| Kosciusko | Center Lake | Asphalt Sealant | 1 | 3,500 sq. ft. |
| | Jacob Maicch Ditch | Storm Water | 100 | 1/4 |
| Lawrence | E. White River | Unknown | 500 | 15 |
| Madison | Stoney Creek | Chlorine | 700 | 0.5 |

| COUNTY | RECEIVING WATER | MATERIALS | NUMBER KILLED | MILES AFFECTED |
|---|---|---|---|---|
| Marion | Unnamed Ditch | Gasoline | 9 | 10,000 sq. ft. |
| | No Name Creek | Unknown | 200 | 200 sq. ft. |
| | Fishback Creek | Natural | 33 | 1/8 |
| | Oil Creek | Jet Fuel | 125 | 2 |
| | Retention Pond | Waste Flamables | 250 | 1,500 sq. ft. |
| | Muesing Creek | Sewage | 35 | 300 sq. ft. |
| | Pond Branch Tributary | Unknown | 380 | 0.25 |
| Marshall | Gilbert Lake | Natural | 1,000 | 38 acres |
| Miami | Unnamed Ditch | Unknown | 6 | 525 sq. ft. |
| | McDowell Ditch | Fire Fighting Foam Residue | 10 | 0.5 |
| | McDowell Ditch | Heat Related | 80 | 100 ft. |
| Montgomery | Unnamed Creek | Hog Waste | 9,053 | 4 |
| Monroe | Monroe Creek | Lime Sewage Mortar | 50 | 0.25 |
| | Jacks Defeat | Clarifier Solids | 100 | 0.25 |
| Newton | Morrison Ditch | Wastewater | 547 | Unknown |
| Owen | Lick Creek | Swine Waste | 100 | 1 |
| Pike | Flat Creek | Natural | 12 | 0.25 |
| Posey | Pitcher Lake | Unknown | 1,000 | Unknown |
| | McFadden Creek | Unknown | 600 | 2 |
| | Ohio River | Gasoline | 2 | 0.5 |
| Pike | Swamp Pit Area 1 | Natural | 200 | 4 acres |
| Putnam | Unnamed Ditch | Cattle Waste | 100 | 100 sq. ft. |
| Randolph | Campground Water | Herbicide | 3,500 | 5 acres |
| | Price Creek | Kerosene | 50 | 6 |
| | Little Mississippi | Unknown | 25 | 300 sq. ft. |
| Ripley | Lawfry Creek | Sewage Bypass | 50 | 1 |
| Spencer | Lindley Ditch | Unknown | 250 | 400 lin. ft |
| Shelby | McDougall Creek | Swine Waste | 102,952 | 1.5 |
| | Conns Creek | Natural | 20 | Unknown |
| Tipton | Turkey Creek | Unknown | 500 | 40,000 sq. ft. |
| Union | Kitchel Creek | Liquid Fertilizer | 500 | 1.75 |
| | Richland Creek | Unknown | 100 | 300 ft. shoreline |
| Vermillion | Wabash River | Thermal | 10,000 | Unknown |
| | Wabash River | Thermal | 200 | Unknown |
| Vigo | Prairie Creek | Natural | 938 | Unknown |
| | Unnamed Ditch or Stream | Jet Fuel Oil | 5 | 2 |
| Wabash | Charlie Creek | Diesel Fuel | 7 | Unknown |
| | Lagro Creek | Chicken Manure | 200 | 1 |

FIGURE 1. *Causes of 1990-91 Fishkills*

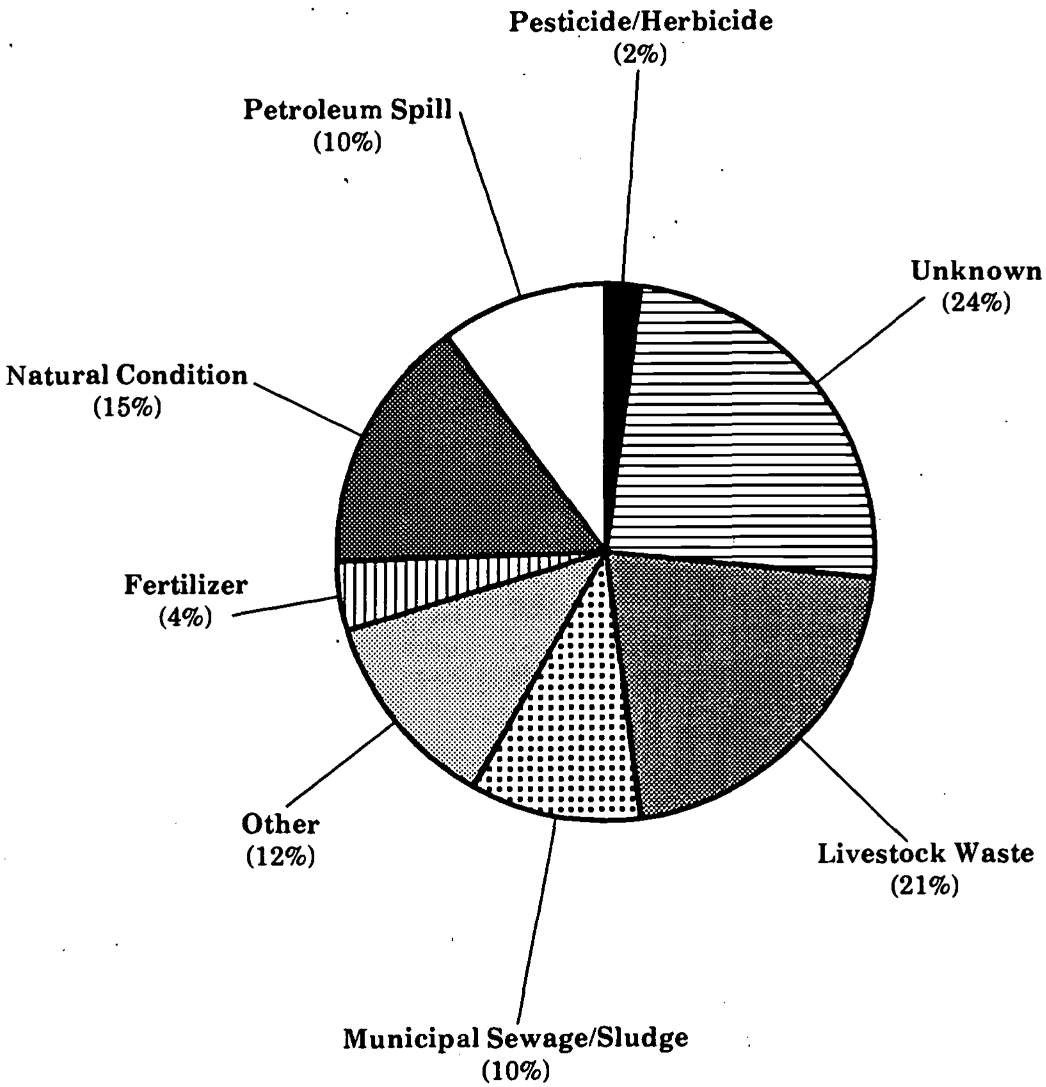


**TABLE 13.** *Size categories (number of fish killed) and number of fishkills reported per category in 1990-91.*

| NUMBER OF FISH KILLED | NUMBER OF FISHKILLS REPORTED |
|---|---|
| Unknown | 0 |
| 0 - 500 | 49 |
| 500 - 1,000 | 12 |
| 1,000 - 10,000 | 10 |
| 10,000 - 100,000 | 0 |
| More than 100,000 | 1 |
| TOTAL | 72 |

## Toxicity Testing Program

Toxicity tests are used by the state to screen wastewater for potentially toxic effects of effluents discharged to Indiana's waters. These tests can measure both acute (short term) and chronic (long term) effects on aquatic life. The present procedure for all toxicity reports submitted to IDEM by all NPDES permit holders includes a complete review of the submitted laboratory report for compliance to approved laboratory methods and compliance to all Quality Assurance and Quality Control procedures. This technical review is performed by the state environmental toxicologist.

This procedure was implemented during the period covered by this report. These procedural changes and reduced staffing along with the marked increase in permit compliance bioassay reports submitted to the agency has resulted in a less comprehensive presentation of these data for this report. The toxicity data as presented in this report do not present the data as in the previous 305(b) Report which included the complete results with the presentation of all the respective toxicity end-points for all toxicity tests. This 305(b) Report presents the toxicity data as recorded in the Permit Compliance System (PCS) showing just the number of tests recorded with the number of tests showing toxicity. It must be noted that "toxicity" as recorded may or may not be a NPDES permit violation depending on the permit limits of the particular discharger. Table 14 shows where acute and chronic toxicity tests were taken, the number of tests taken and the number of tests showing toxicity.

**TABLE 14.** *Acute and Chronic Toxicity Tests 1990-1991 As Reported by the Permit Compliance System (Number of Tests Showing Toxicity[1]/Number of Tests)*

| LAKE MICHIGAN BASIN | ACUTE TESTS | CHRONIC TESTS |
|---|---|---|
| Dana Corporation Weatherhead Division<br>Angola, Steuben County<br>Little Center Lake | -- | 3/4 |
| Elkhart Municipal STP<br>Elkhart, Elkhart County<br>St. Joseph River | 0/4 | 4/4 |
| Goshen Municipal STP<br>Goshen, Elkhart County<br>Elkhart River | 0/4 | 2/4 |
| Kendallville Municipal STP<br>Kendallville, Noble County<br>Henderson Lake | 0/2 | 0/2 |
| Lever Brothers<br>Hammond, Lake County<br>Wolf Lake Channel | 0/8 | 0/8 |
| LTV Steel Company<br>East Chicago, Lake County<br>Indiana Harbor Canal | 1/8 | 4/8 |
| Michigan City Sanitary District<br>Michigan City, LaPorte County<br>Trail Creek | 2/4 | 2/4 |
| National Steel, Midwest Division<br>Portage, Porter County<br>Burns Ditch | 0/1 | 1/1 |
| South Bend Municipal STP<br>South Bend, St. Joseph County<br>St. Joseph River | 6/6 | 9/9 |
| Syndicate Store Fixtures, Inc.<br>Middlebury, Elkhart County<br>Mather Ditch | 0/6 | 3/6 |
| Valparaiso Municipal STP<br>Valparaiso, Porter County<br>Salt Creek | 0/8 | 2/8 |
| **MAUMEE DRAINAGE** | | |
| Rieke Corporation<br>Auburn, DeKalb County<br>Cedar Creek | 0/6 | 1/6 |
| Universal Tool and Stamping<br>Butler, DeKalb County<br>Teutsch Ditch | 2/2 | 2/2 |
| Vulcraft Division, Nucor Corporation<br>Saint Joe, DeKalb County<br>St. Joseph River | 2/2 | 2/2 |

TABLE 14. *Cont.*

| KANKAKEE DRAINAGE | ACUTE TESTS | CHRONIC TESTS |
|---|---|---|
| | (None | Conducted) |
| **WABASH DRAINAGE** | | |
| Eli Lilly and Company<br>Lafayette, Tippecanoe County<br>Wabash River | 0/5 | 0/3 |
| Frankfort Municipal STP<br>Frankfort, Clinton County<br>Prairie Creek | 0/7 | 1/7 |
| Hercules, Inc.<br>Terre Haute, Vigo County<br>Spring Creek | 6/17 | -- |
| Heritage Environmental Service<br>Roachdale, Putnam County<br>Big Raccoon Creek | 0/4 | -- |
| Landis & Gyr Metering, Inc.<br>Lafayette, Tippecanoe County<br>Wabash River | 0/12 | -- |
| Logansport Municipal STP<br>Logansport, Cass County<br>Wabash River | 0/2 | 2/3 |
| Midstates Wire<br>Crawfordsville, Montgomery County<br>Whitlock Springs | 1/7 | 6/7 |
| Princeton Municipal STP<br>Princeton, Gibson County<br>Richland Creek | 0/6 | 2/6 |
| R. R. Donnelley & Sons Company<br>Warsaw, Kosciusko County<br>Jacob M Ditch | 0/4 | 2/4 |
| Vincennes Municipal STP<br>Vincennes, Knox County<br>Wabash River | 0/6 | 0/6 |
| Warsaw Municipal STP<br>Warsaw, Kosciusko County<br>Big Walnut Creek | 1/6 | 3/6 |
| Wabash Alloys<br>Wabash, Wabash County<br>Wabash River | 0/8 | 3/8 |
| **WEST FORK WHITE RIVER** | | |
| Mooresville Municipal STP<br>Mooresville, Morgan County<br>White Lick Creek | 1/8 | 1/8 |

TABLE 14. *Cont.*

| | | |
|---|---|---|
| Muncie Municipal STP<br>Muncie, Delaware County<br>W. F. White River | 0/2 | 0/2 |
| **EAST FORK WHITE RIVER** | | |
| Columbus Municipal STP<br>Columbus, Bartholomew County<br>E. F. White River | 0/6 | 3/6 |
| Edinburgh Municipal STP<br>Edinburgh, Johnson County<br>Big Blue River | 0/6 | 2/6 |
| Greensburg Municipal STP<br>Greensburg, Decatur County<br>Gas Creek | 0/6 | 0/6 |
| USDN Naval Weapons Support Center<br>Crane, Martin County<br>Boggs Creek | 0/9 | 0/9 |
| **OHIO RIVER DRAINAGE** | | |
| Booneville Municipal STP<br>Booneville, Warrick County<br>Cypress Creek | 0/6 | 0/6 |
| Evansville STP-Eastside<br>Evansville, Vanderburgh County<br>Ohio River | 1/9 | -- |
| General Electric Company<br>Mount Vernon, Posey County<br>Ohio River | 11/31 | -- |
| New Albany Municipal STP<br>New Albany, Floyd County<br>Falling Run Creek | 0/9 | -- |
| Richmond Power & Light<br>Richmond, Wayne County<br>Dubners Ditch | 0/4 | 0/4 |

[1] "Toxicity" as recorded may or may not be an NPDES permit violation (see text)

Fish Tissue Contamination Monitoring Program

During the 1990 - 91 biennium, the State compiled data on contaminants in the tissue of fish in 143 samples collected from one reservoir and 30 locations on 19 streams in 18 counties. Table 15 lists the locations where fish tissue samples were collected during the 1990 - 91 reporting period. The stream sampling effort represents a 50% reduction in number of samples collected and submitted for analysis, a 61% reduction in locations visited, and 20% reduction in the level of streams sampled. These reductions are mainly due to the recession motivated State contract freeze (there was no contract laboratory to analyze the samples) and increased activities in other monitoring programs. The 1990 fish tissue samples were not submitted to a contract laboratory until November 1991 and the 1991 samples were not submited until March 1992.

All fish tissue samples were analyzed for percent lipid, percent mosture, organochlorine pesticides, polychlorinated biphenyls (PCBs), cadmium, lead and mercury. Thirty-five percent of the samples were also analyzed for additional metals, acid extractable organic compounds, base/neutral extractable organic compunds and volatile organic compounds listed in Table 16. Fourteen percent of the samples were also analyzed specifically for polycyclic aromatic hydrocarbons (PAHs). Most samples were analyzed as skin-on, scaleless fillets. Catfish were analyzed as skin-off fillets. Small samples were analyzed as whole fish. Figure 2 shows those locations which are sampled biennially for fish tissue contaminants analysis.

Chlordane and dieldrin, environmentally persistent organochlorine pesticides banned from general agricultural use in 1980 and 1972, respectively, have also been common contaminants in fish (dieldrin contamination is now prevalent only in Lake Michigan fish). Extensive sampling of sediments, sludge and effluents throughout the state has revealed very few point sources of these pesticides. Because of the agricultural use bans, the incidence of chlordane and dieldrin contamination in fish flesh has declined over the years in response to decreasing exposure from nonpoint sources such as farm field run-off. No concentrations of these pesticides in excess of FDA Action Levels were found in any 1988, 1989 or 1990 river and stream fish tissue samples. A few were found in 1987.

Fish samples collected in 1989 (laboratory analysis completed in June, 1990) for Lake Michigan by the Indiana Department of Natural Resources and analyzed by the Indiana State Department of Health showed that large coho salmon, chinook salmon and steelhead had residues of PCBs and certain pesticides but the levels did not exceed the FDA Action Levels for those compounds. Samples of yellow perch, carp and longnose sucker collected in 1990 also contained levels of these contaminants below FDA Action Levels. All of these samples contained some residues of total PCBs. Carp and longnose sucker contained detectable residues of chlordane, DDT and metabolites of DDT. Most Lake Michigan fish samples collected in Indiana waters still contain some levels of detectable residues of chlordane, DDT, metabolites of DDT, dieldrin, endrin and mercury.

Table 15. *Fish Tissue Collections 1990 - 91 Sorted by Hydrologic Unit*

| Site | Location | Collection Date | Hydrologic Unit | Latitute | Longitude | Ecoregion | Drainage Segment | IASNRI + |
|---|---|---|---|---|---|---|---|---|
| Lake Co. | Indiana Harbor Canal South of Dickey Road | 08/15/90 | 04040001 | 41 39' 18.0" | 87 27' 33.0" | 54G | 1 | 2B |
| Allen Co. | St. Mary's River U/S Spy Run @ Ft. Miami's Park | 07/18/90 | 04100004 | 41 4' 58.0" | 85 9' 1.0" | 55G | 21 | 5C |
| | Maumee River @ Landin Road, New Haven, IN | 07/10/90 | 04100005 | 41 5' 6.0" | 85 1' 14.0" | 57G | 19 | 6 |
| Dearborn Co. | Great Miami River Indiana Portion, Lawrenceburg | 08/08/90 | 05080002 | 39 6' 55.0" | 84 49' 38.0" | 71G | 99 | 11C |
| | Whitewater River @ S.R. 46 Bridge | 08/02/90 | 05080003 | 39 16' 47.0" | 84 52' 29.0" | 55G | 89 | 11C |
| Fayette Co. | West Fork Whitewater River D/S Connersville, IN | 07/31/90 | 05080003 | 39 37' 2.0" | 85 8' 33.0" | 55G | 88 | 11C |
| | U/S Connersville, IN | 08/01/90 | 05080003 | 39 42' 13.0" | 85 6' 54.0" | 55G | 88 | 5B |
| Wayne Co. | East Fork Whitewater River D/S Richmond, IN | 08/02/90 | 05080003 | 39 47' 18.0" | 84 54' 34.0" | 55G | 87 | 11C |
| | Middle Fork Reservoir U/S Richmond, IN | 08/01/90 | 05080003 | 39 51' 34.0" | 84 52' 7.0" | 55G | 86 | 5B |
| Carrol Co. | Deer Creek D/S Delphi, IN STP Outfall* | 09/05/91 | 05120105 | 40 34' 28.0" | 86 40' 59.0" | 55G | 41 | 5B |
| | U/S Delphi, IN STP @ Riley Park* | 09/06/91 | 05120105 | 40 35' 3.0" | 86 40' 20.0" | 55G | 41 | 5B |
| | Wabash River* D/S Deer Creek | 09/05/91 | 05120105 | 40 34' 3.0" | 86 41' 43.0" | 55G | 41 | 5A |
| | U/S SR18/39@ Pittsburg, IN* | 09/04/91 | 05120105 | 40 35' 26.0" | 86 41' 54.0" | 55G | 41 | 5A |
| Parke Co. | Big Raccoon Creek U/S Lafayette Road @ Armiesburg* | 08/27/91 | 05120108 | 39 45' 33.0" | 87 21' 4.0" | 72G | 50 | 5A |
| Tippecanoe Co. | Wabash River D/S Lafayette, IN* | 08/13/91 | 05120108 | 40 24' 14.0" | 86 57' 30.0" | 55G | 43 | 5A |
| | U/S Lafayette, IN* | 08/14/91 | 05120108 | 40 25' 32.0" | 86 53' 47.0" | 55G | 43 | 5A |
| Warren Co. | Big Pine Creek C.R.125N near Mudlavia Springs* | 08/28/91 | 05120108 | 40 20' 7.0" | 87 17' 57.0" | 54G | 22 | 5A |

Table 15. *Fish Tissue Collections 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydrologic Unit | Latitute | Longitude | Ecoregion | Drainage Segment | IASNRI + |
|---|---|---|---|---|---|---|---|---|
| Vigo Co. | Otter Creek<br>C.R. 24W* | 08/27/91 | 05120111 | 39 32' 33.0" | 87 23' 11.0" | 72G | 49 | 7B |
| | Wabash River<br>D/S Terre Haute, IN @ Darwin* | 08/15/91 | 05120111 | 39 16' 59.0" | 87 36' 35.0" | 72G | 51 | 12 |
| | U/S Terre Haute, IN* | 08/26/91 | 05120111 | 39 27' 28.0" | 87 25' 9.0" | 72G | 51 | 12 |
| Hamilton Co. | Fall Creek<br>U/S Geist Res. @ Florida Road* | 08/22/91 | 05120201 | 39 56' 51.0" | 85 53' 26.0" | 55M | 63 | 5B |
| Hendricks Co. | East Fork White Lick Creek<br>D/S C.R. 700S, U/S Mooresville | 11/15/90 | 05120201 | 39 39' 30.0" | 86 20' 28.0" | 55M | 56 | 5B |
| | White Lick Creek<br>U/S C.R. 900S | 11/15/90 | 05120201 | 39 38' 0.0" | 86 23' 31.5" | 55M | 56 | 5B |
| Madison Co. | Fall Creek<br>D/S Dowden Landfill @ S.R.13* | 08/22/91 | 05120201 | 39 57' 57.0" | 85 50' 33.0" | 55M | 63 | 5B |
| | Falls Park, Pendleton, IN* | 08/23/91 | 05120201 | 40 0' 28.0" | 85 44' 28.0" | 55M | 63 | 5B |
| Marion Co. | West Fork White River<br>Broad Ripple Park* | 08/21/91 | 05120201 | 39 52' 22.0" | 86 7' 56.0" | 55G | 64 | 5B |
| Morgan Co. | West Fork White River<br>Henderson Ford Bridge* | 08/20/91 | 05120201 | 39 29' 58.0" | 86 21' 17.0" | 55G | 64 | 5B |
| | White Lick Creek<br>Brooklyn, IN Bridge* | 11/16/90 | 05120201 | 39 32' 18.0" | 86 22' 0.0" | 55G | 56 | 5B |
| Putnam Co. | Big Walnut Creek<br>U/S Reelsville, IN* | 08/29/91 | 05120203 | 39 35' 12.0" | 86 56' 22.0" | 72G | 66 | 9A |
| Starke Co. | Yellow River<br>D/S Knox, IN @ C.R. 300E | 07/17/90 | 07120001 | 41 18' 22.0" | 86 38' 22.0" | 54G | 17 | 3C |
| Newton Co. | Iroquois River<br>100 West Road Bridge | 08/14/90 | 07120002 | 40 49' 52.0" | 87 24' 10.0" | 54G | 15 | 3A |

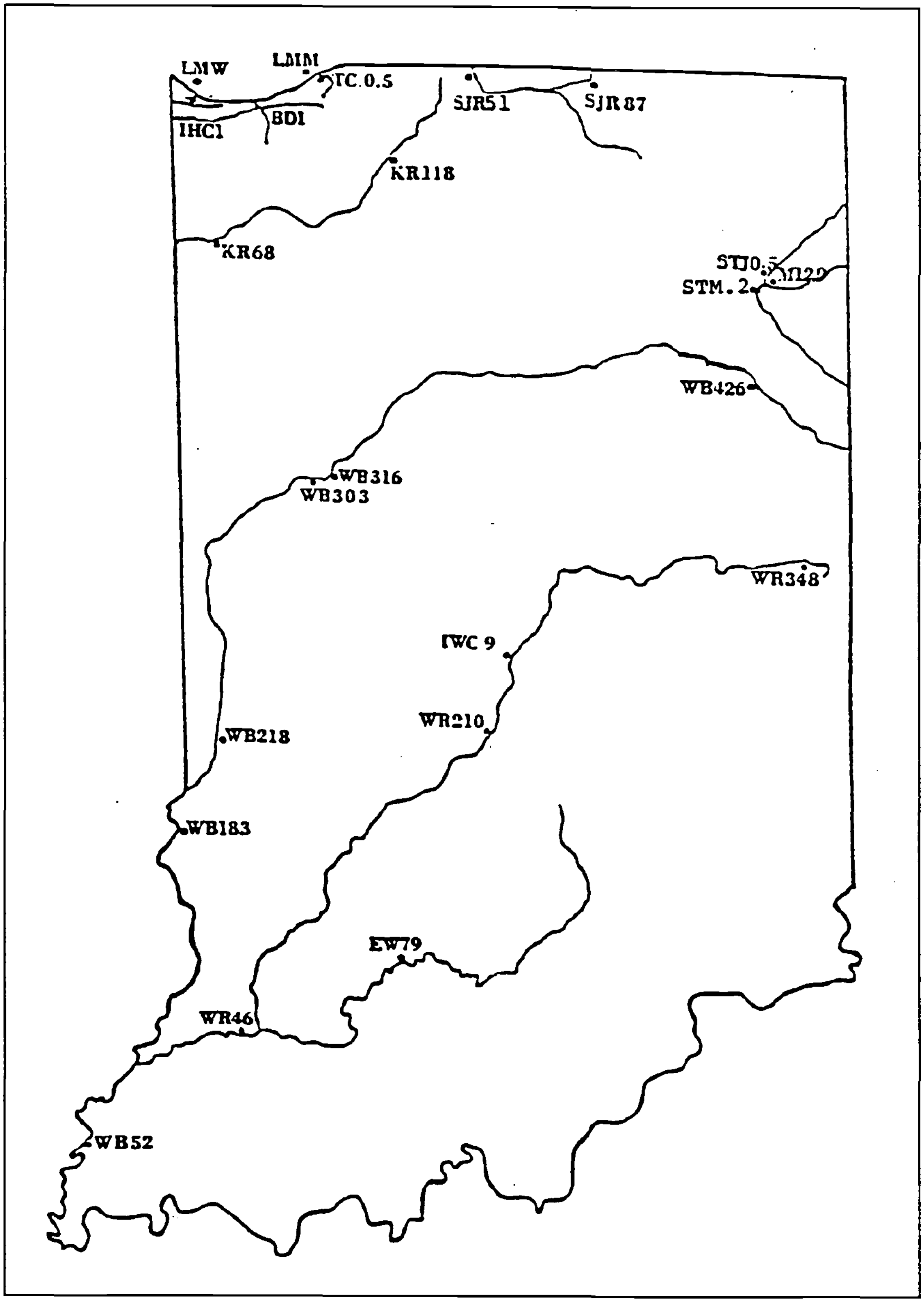
+IASNRI = Indiana Academy of Science Natural Region Index (Homoya, 1985)
* = Samples from these locations have not been analyzed as of this print date

**TABLE 16.** *List of Parameters for which Fish Flesh Samples Were Analyzed*

%LIPIDS

| *Metals* | *Pesticides* | *PCBs* | *Base/Neutral Extractables* |
|---|---|---|---|
| Aluminum | Aldrin | Total PCB | Acenaphthylene |
| Antimony | alpha-BHC | | Acenaphthene |
| Arsenic | beta-BHC | *Volatile Organic Compounds* | 4-Chloroaniline |
| Barium | delta-BHC | Acetone | 2-Nitroaniline |
| Beryllium | gamma-BHC (Lindane) | Benzene | 3-Nitroaniline |
| Cadmium | alpha-Chlordane | Chlorobenzene | 4-Nitroaniline |
| Calcium | gamma-Chlordane | Ethylbenzene | Anthracene |
| Chromium | cis-Nonachlor | 2-Butanone | Benzo(a)anthracene |
| Cobalt | trans-Nonachlor | Carbon disulfide | Dibenzo(a,h)anthracene |
| Copper | Oxychlordane | Chloroethane | 3,3'-Dichlorobenzidene |
| Iron | p,p'-DDD | 1,1-Dichloroethane | 1,2-Dichlorobenzene |
| Lead | o,p'-DDD | 1,2-Dichloroethane | 1,3-Dichlorobenzene |
| Magnesium | p,p'-DDE | 1,1,1-Trichloroethane | 1,4-Dichlorobenzene |
| Manganese | o,p'-DDE | 1,1,2-Trichloroethane | 1,2,4-Trichlorobenzene |
| Mercury | p,p'-DDT | 1,1,2,2-Tetrachloroethane | Hexachlorobenzene |
| Nickel | o,p'-DDT | 1,1-Dichloroethylene | Nitrobenzene |
| Potassium | Dieldrin | 1,2-Dichloroethylene (trans) | Benzyl alcohol |
| Selenium | Endosulfan I | Trichloroethylene | Chrysene |
| Silver | Endosulfan II | Tetrachloroethylene | n-Nitrosodiphenylamine |
| Sodium | Endosulfan sulfate | 2-Hexanone | n-nitroso-di-n-Propylamine |
| Thallium | Endrin | Bromomethane | Hexachloroethane |
| Vanadium | Endrin aldehyde | Tribromomethane (Bromoform) | Bis(2-chloroethyl)ether |
| Zinc | Endrin ketone | Bromodichloromethane | Bis(2-chloroisopropyl)ether |
| | Heptachlor | Dibromochloromethane | 4-Bromophenyl-phenylether |
| | Heptachlor epoxide | Chloromethane | 4-Chlorophenyl-phenylether |
| | Hexachlorobenzene | Dichloromethane | Fluoranthene |
| | Methoxychlor | (Methylene chloride) | Fluorene |
| | Pentachloroanisole | Trichloromethane (Chloroform) | Benzo(beta)fluoranthene |
| | Toxaphene | Tetrachloromethane | Benzo(kappa)fluoranthene |
| | | (Carbon tetrachloride) | Dibenzofuran |
| *Acid Extractable Compounds* | | 4-methyl-2-Pentanone | Bis(2-chloroethoxy)methane |
| Benzoic acid | | 1,2-Dichloropropane | Isophorone |
| Phenol | | cis-1,3-Dichloropropylene | Naphthalene |
| 2-Chlorophenol | | trans-1,3-Dichloropropylene | 2-Chloroaphthalene |
| 2,4-Dichlorophenol | | Styrene | 2-Methylnaphthalene |
| 2,4,5-Trichlorophenol | | Toluene | Hexachlorocyclopentadiene |
| 2,4,6-Trichlorophenol | | Vinyl acetate | Benzo(ghi)perylene |
| Pentachlorophenol | | Vinyl chloride | Phenanthrene |
| 2-Methylphenol | | total Xylene | di-n-Butylphthalate |
| 4-Methylphenol | | | Diethylphthalate |
| 2,4-Dimethylphenol | | | Dimethylphthalate |
| 4-chloro-3-Methylphenol | | | di-n-Octylphthalate |
| 4,6-dinitro-2-Methylphenol | | | Bis(2-ethylhexyl)phthalate |
| 2-Nitrophenol | | | Butylbenzylphthalate |
| 4-Nitrophenol | | | Pyrene |
| 2,4-Dinitrophenol | | | Benzo(alpha)pyrene |
| | | | Ideno(1,2,3-c,d)pyrene |
| | | | 2,4-dinitrotoluene |
| | | | 2,6-dintirotoluene |
| | | | Hexachlorobutadiene |

*FIGURE 2. LOCATION OF INDIANA'S CORE MONITORING STATIONS*



Lake Michigan fish have been exposed to PCBs from both point and nonpoint sources, many of which are in other states bordering the Lake. PCB contaminated salmonid fish collected in the past from Burns Ditch and from Trail Creek, which are direct tributaries to Lake Michigan, were suspected to have received their exposures to PCBs in the lake prior to migration into the stream. The most recent monitoring of aquatic sediments from Burns Ditch and Trail Creek found Aroclors of PCBs (See Sediment Contaminant Monitoring Program section). No compound analyzed for in fish samples collected from Burns Ditch exceeded FDA Action Levels. However residues of PCBs, DDT and metabolites, chlordane and mercury were measured in all of the samples. The FDA Action Level for PCBs was exceeded in one carp sample from Trail Creek. Residues of DDT, chlordane, mercury and endrin were also measured in this Trail Creek sample.

Sites at which samples exceeded FDA Action Levels are listed in Table 17. This list represents results only on 1990 collections as 1991 sampled results are not complete as of yet and will therefore not be reported until the next 305(b) Report. Table 18 listed those sites from 1987 - 89 sampling efforts.

The Indiana Harbor Canal and the Grand Calumet River are known to have PCB contaminated sediments but specific sources have not yet been identified. All carp samples from all collection stations on the Grand Calumet River and Indiana Harbor Canal exceeded the FDA Action Level for total PCBs.

Starting in 1987, tissue analysis for semi-volatile and volatile compounds were performed on some fish samples. 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, tetrachloroethylene, carbon disulfide, napthalene, 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, 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. 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. Napthalene 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 processes.

**TABLE 17.** *River Sites Where Fish Tissue Samples Collected in 1990 Exceeded FDA Action Levels*

| STREAM | COUNTY | CONTAMINANT | SPECIES |
|---|---|---|---|
| Great Miami River | Dearborn Co. | PCBs | channel catfish |
| Indiana Harbor Canal | Lake Co. | PCBs | carp, goldfish |
| St. Joseph River | Allen Co. | PCBs | channel catfish |
| St. Joseph River | St. Joseph Co. | PCBs | carp |
| Trail Creek | LaPorte Co. | PCBs | carp |

**TABLE 18.** *River Sites Where Fish Tissue Samples Collected in 1987 - 89 Exceeded FDA Action Levels*

| STREAM | COUNTY | CONTAMINANT | YEAR SAMPLED |
|---|---|---|---|
| Lake Michigan | | PCBs | 1987- 89 |
| Lake Michigan Basin | | | |
| Indiana Harbor Canal | Lake | PCBs<br>PCBs | 1987<br>1988 |
| Grand Calumet River | Lake | PCBs | 1987 |
| St. Joseph River | St. Joseph | PCBs | 1988 |
| East Fork White River Basin | | | |
| Muddy Fork of Sand Cr. | Decatur | Dieldrin | 1987 |
| Sand Creek | Decatur | Chlordane<br>Dieldrin | 1987 |
| Clear Creek | Monroe | PCBs | 1987 |
| Pleasant Run Creek | Lawrence | PCBs | 1987 |
| East Fork Mainstem | Lawrence | PCBs<br>Chlordane<br>PCBs | 1987<br><br>1989 |
| Salt Creek | Monroe | PCBs | 1987 |
| Wasbash River Basin | | | |
| Kokomo Creek | Howard | PCBs | 1988 |
| Little Mississinewa R. | Randolph | PCBs | 1988 |
| Little Sugar Creek | Montgomery | PCBs<br>PCBs<br>Dibenzofurans | 1987<br>1989 |
| Mississinewa River | Randolph | PCBs | 1988 |
| Sugar Creek | Montgomery | PCBs<br>None | 1987<br>1988 |
| Wildcat Creek | Tippecanoe | PCBs<br>PCBs | 1987<br>1988 |
| West Fork of the White River Basin | | | |
| Stoney Creek | Hamilton | PCBs | 1987 |
| West Fort White River | Hamilton/<br>Marion | PCBs<br>Chlordane<br>None | 1987<br><br>1989 |

Polycyclics such as chrysene, pyrene, perylene, benzopyrene, dibenzoanthracene and benz (a) anthracene have few industrial uses. Crude oil contains high levels of various PAHs and MAHs. Oil contamination and heavy industry in the GCR/IHC is the most probable source for these contaminants in aquatic sediments and fish tissue. Combustion of coal and petroleum products are general atmospheric sources of these compounds.

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, 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).

To date there are no known point sources which have contributed to PCB contamination in fish from the St. Joseph River near South Bend, Indiana. 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. One carp sample exceeded the FDA Action Level for total PCBs and almost all fish sampled had detectable amounts. The 1990 samples from downstream of South Bend and upstream at Bristol, Indiana all had detectable amounts of total PCB residues with one carp sample from downstream of South Bend exceeding the FDA Action Level. A 1991 compliance sampling inspection (CSI) at the South Bend STP included toxics analysis of the final effluent and revealed no toxic organic contaminants.

Table 19 shows locations sampled where metals may be bioaccumulating in fish tissue at levels higher than at other locations. It was noted in the last 305(b) Report (1988-89) that fish tissue samples from the St. Joseph River had higher concentrations of lead than all samples from other streams. Samples collected in 1990 follow this same pattern for lead (3.000-5.910 ppm). Copper concentrations in these fish tissue samples were also much higher (up to 55.50 ppm) than at other locations.

Aquatic sediments were not collected from the Great Miami River or the East Fork Whitewater River fish sampling locations. Corresponding aquatic sediment analyses of samples taken from the St. Joseph River in Allen County do not indicate evelated levels of metals. Aquatic sediments from the IHC

**TABLE19.** *Locations Sampled in 1990 Where Metals May Be Bioaccumulating In Fish Tissue At a Higher Level Than Other Locations.*

| STREAM | COUNTY | METAL OF CONCERN |
|---|---|---|
| St. Joseph River | St. Joseph | lead, copper |
| Indiana Harbor Canal | Lake | aluminum, copper, lead, zinc |
| Great Miami River | Dearborn | copper, lead, manganese |
| East Fork Whitewater River | Wayne | aluminum, copper, lead |
| St. Joseph River | Allen | copper |
| Iroquois River | Newton | zinc |
| Maumee River | Allen | lead |
| White Lick Creek | Hendricks/Morgan | lead |
| E. Fork White Lick Dr. | Hendricks/Morgan | lead |

have elevated levels of a number of metals of concern including copper and lead. Although copper may accumulate in muscle it has been shown to accumulate at a much higher level in the liver and the gut wall. Lead accumulates at about equal rates in organs and muscle tissue. No separate tissue organic analysis studies have been undertaken by this office, only muscle tissue (edible portions) or mixed tissues (whole body) samples are analyzed.

Cadmium and chromium are two other metals of concern because of their toxicity to aquatic life. Cadmium generally accumulates in major fish organs rather than muscle. Most samples had levels below the laboratory detection limit. The highest concentration found was 0.111 mg/kg (whole fish basis) for a whole yellow bullhead sample from the East Fork of Whitelick Creek in Hendricks County. Chromium has been shown to not significantly accumulate in fish. Levels in fish tissue samples ranged from 0.11 to 0.52 mg/kg (whole fish basis).

Fish Consumption Advisories

The significance of fish flesh contamination is the potential health effects caused by repeated exposure to relatively low levels of contaminants which may accumulate in the human body over a lifetime. These lifetime, or chronic health effects are for the most part unknown in humans. Fish consumption advisories inform the public of the potential increased risk of consuming fish from named waters.

Approximately 331 stream miles, all of Indiana's portion of Lake Michigan (241 square miles) and 356 miles of the Ohio River are affected by fish consumption advisories. Table 20 lists the Indiana waters affected by such advisories, the pollutants of concern in these waters, the fish species included, and the scope of the

TABLE 20. *Current Indiana Fish Consumption Advisories*

| RIVER, STREAM OR LAKE | POLLUTANTS OF CONCERN | FISH SPECIES INVOLVED | SCOPE OF ADVISORY |
|---|---|---|---|
| Pleasant Run Creek and Salt Creek downstream of Monroe Reservoir Dam in Monroe and Lawrence Counties. | PCBs | all | No fish should be eaten. |
| Clear Creek in Monroe County. | PCBs | all | No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish. |
| Elliot Ditch and Wea Creek downstream of its confluence with Elliot Ditch in Tippecanoe County. | PCBs | all | No fish should be eaten. |
| East Fork of White River from Bedford to Williams Dam. | PCBs | all | No fish should be eaten. |
| East Fork White River below Williams Dam in Lawrence County. | PCBs and Chlordane | carp | No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish. |
| West Fork of White River from Noblesville downstream to the Hamilton/Marion County Line. | PCBs and Chlordane | all | No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish. |
| West Fork of White River in Delaware County. | PCBs and Chlordane | carp | Carp should not be eaten. |
| Stoney Creek downstream from Wilson Ditch south of Noblesville. | PCBs and Chlordane | all | Do not consume fish from this area. |
| Little Mississinewa River in Randolph County. | PCBs | all | Do not consume fish from this river. |
| Mississinewa River - 1 mile above the confluence of Little Mississinewa River and downstream to Ridgeville. | PCBs and Chlordane | carp catfish | Do not consume these species from this area. |
| St. Joseph River in Elkhart and St. Joseph Counties. | PCBs and Lead | carp | Do not consume carp from this area. Child-bearing age women and children should not consume any fish from this area. |
| Maumee River below Fort Wayne to the State line. | PCBs | carp | No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not consume fish from this area. |
| Sand Creek and Muddy Fork of Sand Creek near Greensburg and Decatur County Park Reservoir. | Chlordane Dieldrin | all | No more than 1 meal (½ lb.) per week. Child-bearing age women and children should not eat any fish. |
| The Grand Calumet River (East and West Branches) and the Indiana Harbor Ship Canal in Lake County. | PCBs | all | No fish should be eaten. |
| Sugar Creek in Montgomery County south of I-74 to SR 32 Bridge. | PCBs | all | No fish should be eaten. |
| Little Sugar Creek in Montgomery County. | PCBs | all | No fish should be eaten. |
| Wildcat Creek downstream of the Waterworks dam in Kokomo to the Wabash River. | PCBs | all | No fish should be eaten. |
| Kokomo Creek in Howard County from U.S. 31 to Wildcat Creek. | PCBs | all | No fish should be eaten. |
| Trail Creek, Burns Ditch and Lake Michigan* | PCBs, Chlordane Dieldrin, DDT | Brown Trout under 23" Chinook 21-23 inch. Coho over 26 inch. Lake Trout 20-23 inch. | Adult men and women not of child-bearing age should consume no more than 1 meal (½ lb.) per week of flesh of designated species from name waterways. Women of child-bearing age and children should not consume any of the fish listed. |
| Trail Creek, Burn Ditch, and Lake Michigan* | PCBs, Chlordane Dieldrin, DDT | Brown Trout over 23" Carp Catfish Chinook over 32 inch. Lake Trout over 23 inch. | No one should consume these species. |
| Ohio River | PCBs and Chlordane | Carp Channel catfish | No more than 1 meal (½ lb.) per week. Women of child-bearing age and children should not consume any of the fish listed. |

* Lake Michigan and tributaries are part of a joint Fish Consumption Advisory.

advisories. Of the 687 river and stream miles affected by fish consumption advisories, 436 miles are covered by an advisory which allows limited consumption by some indivuduals. Consumption of **no** fish is recommended to all individuals in 251 stream miles.

In order to adequately inform the public as to the potential risks of consuming sport fish from certain areas, fish consumption advisories are issued when either whole fish or skin-on fillet data show contaminant values in excess of FDA Action Levels, even though these action levels are based on edible portions of fish (fillets), Table 21 lists FDA Action Levels for compounds to which IDEM fish tissue sample results are compared. Some of the pollutants of concern for fish consumption advisories in Indiana waters are persistent insecticides that, for the most part, are no longer used in the agriculture, pest control or lawn care industry. In 1979, U.S. EPA banned the manufacture, processing, distribution and use of PCBs except in a totally enclosed system unless specificially exempted by U.S. EPA. Human exposure to these compounds continues since many of the PCB containing pieces of electrical devices such as transformers, capacitors, and fluorescent light fixtures that were made before the 1979 ban are still in use. Leaks from these devices or illegal dumping of the PCB fluids continue to be frequent sources of PCBs as do poorly maintained toxic waste sites. PCBs are also found in river and harbor sediments as well. 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. These pollutants of concern are concentrated in the fat of the fish and studies have shown that skinning and filleting fish and removing any excess fat before cooking can substantially reduce (20-50%) contaminant levels in these fish. Cooking fish in such a way as to allow fats and oils to drip away from the fish (broiling or baking on a rack) can further reduce the level of contaminants to which consumers are exposed. It is recommended that all fish caught in Indiana waters be skinned and filleted before consumption.

**TABLE 21**. *Compounds with FDA Action Levels for Fish Tissue (parts per million).*

| Compound | Action Level |
|---|---|
| Total PCBs | 2.0 |
| Total BHC | 0.5 |
| Total Heptachlor | 0.3 |
| Total Clordane | 0.3 |
| Aldrin/Dieldrin | 0.03 |
| Total DDT | 5.0 |
| Endrin | 0.3 |
| Mercury | 1.0 |
| Toxaphene | 5.0 |

## Sediment Contamination Monitoring Program

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 compiled over 600 records of sediment samples taken from lakes, reservoirs and streams throughout Indiana. These include samples collected in 1990 from 13 stream locations (Table 22). Chemical analyses for the elements, compounds, and mixtures of compounds listed in Table 23 were conducted on all of the sediment samples. Only a limited number of sediment samples (16) were collected in 1990 and none were collected in 1991. This represents an approximate 86% reduction in sediment collection and analyses from the last biennium and a 92% reduction from the 1986-87 biennium. This reduction in sampling effort was mainly due to there being no laboratory contract to allow for analysis of collected samples due to a freeze on contracts by the state in 1990.

Since no criteria for sediment concentrations of pollutants have been promulgated by the state or U. S. EPA, the following strategy was informally adopted to aid in the interpretation of the analytical results for cyanide, metals, PCBs and some organochlorine pesticides. The maximum state sediment background concentration was determined from the analysis of sediment samples from 86 background sites throughout Indiana. Each of these sediment samples was obtained from small streams (74) or lakes (9) at a location upstream of all known point sources of pollution including municipal or industrial discharges and combined sewer overflows. Aerial sources of contaminants and contamination from nonpoint sources may have impacted these sampling sites. However, since it is unlikely that any areas of the state are free of inputs from these sources, the background levels calculated are considered to represent the best possible estimate of "unpolluted" sediments in the state of Indiana. Table 24 presents maximum background concentrations of constituents of Indiana stream and lake sediments determined by this method. Sediments containing less than two times the maximum background concentration of these constituents were classified as "uncontaminated." Again, it must be noted that this method is only an interim technique until a more scientifically and statistically defensible evaluation of Indiana sediment data can occur.

Lakes and reservoirs or stream sediments were grouped into four levels of concern (high, medium, low and unknown) based upon the presence and concentration of analytes. The criteria for grouping are presented in Table 25. If

Table 22. *Sediment Collection Locations 1990 - 91 Sorted by Hydrologic Unit*

| Site | Location | Collection Date | Hydrologic Unit | Latitute | Longitude | Ecoregion | Drainage Segment | IASNRI |
|---|---|---|---|---|---|---|---|---|
| Lake Co. | Indiana harbor Canal<br>Dickey Road | 06/12/90 | 04040001 | 41 39’ 18.0” | 87 27’ 33.0” | 54G | 1 | 2B |
| LaPorte Co. | Trail Creek<br>D/S Michigan city STP | 06/13/90 | 04040001 | 41 43’ 24.0” | 86 54’ 17.0” | 56G | 4 | 2C |
| Porter Co. | Burns Ditch<br>U/S Lefty’s Coho Landing | 06/12/90 | 04040001 | 41 37’ 20.5” | 87 10’ 34.4” | 54G | 3 | 2C |
| Elkhart Co. | St. Joseph River<br>Bristol, Indiana | 06/12/90 | 04050001 | 41 43’ 25.0” | 85 48’ 46.0” | 56G | 8 | 4 |
| St. Joseph Co. | St. Joseph River<br>D/S South Bend, St. Patrick Park | 06/12/90 | 04050001 | 41 45’ 24.0” | 86 16’ 17.0” | 56G | 8 | 4 |
| Allen Co. | St. Joseph River<br>U/S Dam @ Johnny Appleseed Park | 06/06/90 | 04100003 | 41 6’ 50.0” | 85 6’ 58.0” | 55G | 20 | 5C |
| Allen Co. | St. Mary’s River<br>Old Fort Wayne Bridge | 06/06/90 | 04100004 | 41 5’ 3.0” | 85 8’ 6.0” | 55G | 21 | 5C |
| | Maumee River<br>New Haven | 06/05/90 | 04100005 | 41 5’ 4.0” | 85 1’ 5.0” | 55G | 19 | 6 |
| Lake Co. | Kankakee River<br>Lasalle Fish & Wildlife Area | 06/06/90 | 07120001 | 41 9’ 59.0” | 87 31’ 20.0” | 54G | 14 | 3C |
| LaPorte Co. | Kankakee River<br>Kingsbury Fish & Wildlife Area | 06/07/90 | 07120001 | 41 29’ 30.0” | 86 34’ 35.0” | 54G | 14 | 3C |
| Marshall Co. | Yellow River<br>D/S Plymouth, Indiana | 06/07/90 | 07120001 | 41 19’ 4.0” | 86 19’ 29.0” | 56G | 13 | 4 |
| Starke Co. | Yellow River<br>D/S Knox, Indiana | 06/06/90 | 07120001 | 41 18’ 23.0” | 86 38’ 22.0” | 54G | 17 | 3C |
| Newton Co. | Iroquois River<br>SR 55 Bridge | 06/06/90 | 07120002 | 40 52’ 20.0” | 87 18’ 14.0” | 54G | 15 | 3A |

## TABLE 23. *List of Parameters for which Sediment Samples Were Analyzed*

%MOISTURE

| ***Metals*** | ***Pesticides*** | ***PCBs*** | ***Base/Neutral Extractables*** |
|---|---|---|---|
| Aluminum | Aldrin | Total PCB | Acenaphthylene |
| Antimony | alpha-BHC | | Acenaphthene |
| Arsenic | beta-BHC | ***Volatile Organic Compounds*** | 4-Chloroaniline |
| Barium | delta-BHC | Acetone | 2-Nitroaniline |
| Beryllium | gamma-BHC (Lindane) | Benzene | 3-Nitroaniline |
| Cadmium | alpha-Chlordane | Chlorobenzene | 4-Nitroaniline |
| Calcium | gamma-Chlordane | Ethylbenzene | Anthracene |
| Chromium | cis-Nonachlor | 2-Butanone | Benzo(a)anthracene |
| Cobalt | trans-Nonachlor | Carbon disulfide | Dibenzo(a,h)anthracene |
| Copper | Oxychlordane | Chloroethane | 3,3'-Dichlorobenzidene |
| Iron | p,p'-DDD | 1,1-Dichloroethane | 1,2-Dichlorobenzene |
| Lead | o,p'-DDD | 1,2-Dichloroethane | 1,3-Dichlorobenzene |
| Magnesium | p,p'-DDE | 1,1,1-Trichloroethane | 1,4-Dichlorobenzene |
| Manganese | o,p'-DDE | 1,1,2-Trichloroethane | 1,2,4-Trichlorobenzene |
| Mercury | p,p'-DDT | 1,1,2,2-Tetrachloroethane | Hexachlorobenzene |
| Nickel | o,p'-DDT | 1,1-Dichloroethylene | Nitrobenzene |
| Potassium | Dieldrin | 1,2-Dichloroethylene (trans) | Benzyl alcohol |
| Selenium | Endosulfan I | Trichloroethylene | Chrysene |
| Silver | Endosulfan II | Tetrachloroethylene | n-Nitrosodiphenylamine |
| Sodium | Endosulfan sulfata | 2-Hexanone | n-nitroso-di-n-Propylamine |
| Thallium | Endrin | Bromomethane | Hexachloroethane |
| Vanadium | Endrin aldehyde | Tribromomethane (Bromoform) | Bis(2-chloroethyl)ether |
| Zinc | Endrin ketone | Bromodichloromethane | Bis(2-chloroisopropyl)ether |
| | Heptachlor | Dibromochloromethane | 4-Bromophenyl-phenylether |
| | Heptachlor epoxide | Chloromethane | 4-Chlorophenyl-phenylether |
| | Hexachlorobenzene | Dichloromethane | Fluoranthene |
| | Methoxychlor | (Methylene chloride) | Fluorene |
| | Pentachloroanisole | Trichloromethane (Chloroform) | Benzo(beta)fluoranthene |
| | Toxaphene | Tetrachloromethane | Benzo(keppa)fluoranthene |
| | | (Carbon tatrachloride) | Dibenzofuran |
| ***Acid Extractable Compounds*** | | 4-methyl-2-Pentanone | Bis(2-chloroethoxy)methane |
| Benzoic acid | | 1,2-Dichloropropane | Isophorone |
| Phenol | | cis-1,3-Dichloropropylene | Naphthalene |
| 2-Chlorophenol | | trans-1,3-Dichloropropylene | 2-Chloroaphthalene |
| 2,4-Dichlorophenol | | Styrene | 2-Methylnaphthalene |
| 2,4,5-Trichlorophenol | | Toluene | Hexachlorocyclopentadiene |
| 2,4,6-Trichlorophenol | | Vinyl acetata | Benzo(ghi)perylene |
| Pentachlorophenol | | Vinyl chloride | Phenanthrene |
| 2-Methylphenol | | total Xylene | di-n-Butylphthalata |
| 4-Methylphenol | | | Diethylphthalata |
| 2,4-Dimethylphenol | | | Dimethylphthalata |
| 4-chloro-3-Methylphenol | | | di-n-Octylphthalata |
| 4,6-dinitro-2-Methylphenol | | | Bis(2-ethylhexyl)phthalate |
| 2-Nitrophenol | | | Butylbenzylphthalata |
| 4-Nitrophenol | | | Pyrene |
| 2,4-Dinitrophenol | | | Benzo(alpha)pyrene |
| | | | Ideno(1,2,3-c,d)pyrene |
| | | | 2,4-dinitrotoluene |
| | | | 2,6-dintirotoluene |
| | | | Hexachlorobutadiene |

**TABLE 24.** *Maximum Background Concentration of Pollutants in Indiana Stream and Lake Sediments*

| PARAMETER | MAXIMUM BACKGROUND (MG/KG) | PARAMETER | MAXIMUM BACKGROUND (MG/KG) |
|---|---|---|---|
| Aluminum | 9400 | Silver | <0.5 |
| Antimony | 0.49 | Strontium | 110 |
| Arsenic | 29 | Thallium | <3.8 |
| Beryllium | 0.7 | Zinc | 130 |
| Boron | 8.0 | Phenol | <0.2 |
| Cadmium | 1.0 | Cyanide | <0.1 |
| Chromium | 50 | PCB (Total) | 0.022 |
| Cobalt | 20 | Chlordane | 0.029 |
| Copper | 20 | Dieldrin | 0.033 |
| Iron | 57000 | DDT (Total) | 0.020 |
| Lead | 150 | BHC (Total) | 0.014 |
| Manganese | 1700 | Pentachlorophenol | 0.003 |
| Mercury | 0.44 | Heptachlor | 0.002 |
| Nickel | 21 | Aldrin | 0.0007 |
| Nitrogen (TKN) | 1500 | HCB | <0.001 |
| Phosphorus | 610 | Methoxychlor | < 0.001 |
| Selenium | 0.55 | Endrin | <0.001 |

Same table on next page

TABLE 24. *Maximum Background Concentration of Pollutants in Indiana Stream and Lake Sediments*

| PARAMETER | MAXIMUM BACKGROUND (MG/KG) | PARAMETER | MAXIMUM BACKGROUND (MG/KG) |
|---|---|---|---|
| Aluminum | 9400 | Silver | <0.5 |
| Antimony | 0.49 | Strontium | 110 |
| Arsenic | 29 | Thallium | <3.8 |
| Beryllium | 0.7 | Zinc | 130 |
| Boron | 8.0 | Phenol | <0.2 |
| Cadmium | 1.0 | Cyanide | <0.1 |
| Chromium | 50 | PCB (Total) | 0.022 |
| Cobalt | 20 | Chlordane | 0.029 |
| Copper | 20 | Dieldrin | 0.033 |
| Iron | 57000 | DDT (Total) | 0.020 |
| Lead | 150 | BHC (Total) | 0.014 |
| Manganese | 1700 | Pentachlorophenol | 0.003 |
| Mercury | 0.44 | Heptachlor | 0.002 |
| Nickel | 21 | Aldrin | 0.0007 |
| Nitrogen (TKN) | 1500 | HCB | <0.001 |
| Phosphorus | 610 | Methoxychlor | < 0.001 |
| Selenium | 0.55 | Endrin | <0.001 |

**TABLE 25.** *Criteria Used for Grouping Sediments into Levels of Concern*

| | |
|---|---|
| High Concern: | Any contaminant present in concentrations greater than 100 times background. |
| Medium Concern: | Any contaminant present in concentrations 10 - 100 times background. |
| Low Concern: | Any contaminant present in concentrations 2 - 10 times background. |
| Unknown Concern: | Contaminants present for which a background concentration has not been established. |

background concentrations of particular contaminants were unknown, the waterbody was placed into the "unknown" category of concern.

It is important to note that the categories of concern do not necessarily reflect priorities for remedial clean-up or amelioration strategies. In areas where sediment samples are grossly contaminated it may be determined that any disturbance, such as dredging, has the potential for adverse ecosystem impact via the resuspension and/or release of sediment-bound contaminants into the water column. Therefore, the best management strategy may be to leave the sediment reservoir intact. The primary value of this classification scheme is to identify waterbodies that are contaminated above background levels, to target waterbodies requiring additional sampling efforts, to identify sources of contaminants, and to confirm sites in which fish tissue contaminant analyses or toxicity tests indicate potential problems exist.

Table 26 shows other waterbodies with sediment contaminants above background levels classified as low, medium or unknown concern. Along with sediment data, there is sometimes enough complementary information (fish tissue data, biosurveys, water chemistry, etc.) to document that contaminated sediment may have contributed to non-support of uses. Areas where this is true are listed in Table 27. Since use impairment is confirmed, the table represents sites in which sediment contamination is of highest concern.

**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 trophic 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.

**TABLE 26.** *Waterbodies with Sediment Contaminants of Concern. (Based on Collections Between 1988-90)*

| WATERBODY | COUNTY | CONTAMINANT | DEGREE OF CONCERN | POSSIBLE SOURCES |
|---|---|---|---|---|
| Burns Ditch | Porter | Semi-VOC<br>VOC | Unknown | Unknown |
| Eel River | Cass | Semi-VOC | Unknown | Unknown |
| Eel River | Cass/Wabash | 4-Methylphenol | Unknown | Unknown |
| Eel River | Whitley | Pesticides<br>Cadmium | Low<br>Low | Unknown |
| Elkhart River | Elkhart | PCBs | Low | Unknown |
| Grand Calumet River | Lake | Cyanide<br>Metals<br>PCBs<br>PAHs<br>Phthalates | Medium<br>Low/Medium<br>High<br>High<br>Unknown | Multiple |
| Indiana Harbor Canal | Lake | Cyanide<br>Metals<br>PCBs<br>PAHs<br>Phthalates<br>Pesticides | Unknown<br>Low/Medium<br>High<br>High<br>Unknown<br>Low | Multiple |
| Kankakee River | Lake | Antimony<br>PCBs | Low<br>Low | |
| Kankakee River | LaPorte | DDT<br>Antimony | Medium<br>Low | Unknown |
| Maumee River | Allen | Metals<br>Pesticides<br>PCBs<br>PAHs<br>Phthalates | Low<br>Low<br>Medium<br>Unknown<br>Unknown | Unknown |
| Mississinewa River | Delaware | PCBs | Low | Multiple |
| Mississinewa River | Grant | Pesticides<br>Metals | Low<br>Low | |
| Mississinewa River | Randolph | Fluoranthene | Unknown | Unknown |
| Patoka River | Dubois | Phthalate<br>Fluoranthene<br>2-Butanone | Unknown<br>Unknown<br>Unknown | Unknown |
| Patoka River | Pike | Aluminum | Low | Unknown |

**TABLE 26.** *Waterbodies with Sediment Contaminants of Concern (cont.)*

| WATERBODY | COUNTY | CONTAMINANT | DEGREE OF CONCERN | POSSIBLE SOURCES |
|---|---|---|---|---|
| St. Joseph River | Allen | PCBs | Low | Unknown |
| St. Joseph River | St. Joseph | PCBs<br>PAHs | Low<br>Unknown | Unknown |
| St. Mary's River | Allen | Metals<br>Cyanide<br>PCBs | Low<br>Unknown<br>Low | Unknown<br>Unknown |
| Tippecanoe River | Fulton/Pulaski | PCBs | Low | Unknown |
| Tippecanoe River | Kosciusko | Pesticides | Medium | Unknown |
| Trail Creek | Porter | PCBs<br>Dieldrin<br>Metals | Low<br>Low<br>Medium | Unknown |
| Yellow River | Marshall | PCBs<br>DDT | Low<br>Low | Unknown |
| Yellow River | Starke | PCBs | Low | Unknown |
| Wabash River | Cass/Gibson/ Posey | PCBs | Low | Unknown |
| Wabash River | Tippecanoe | Pesticides<br>PCBs<br>2-Butanone<br>Methylene Chloride | Low<br>Low<br>Unknown<br>Unknown | Unknown |
| Wabash River | Vigo | 2-Butanone<br>4-Methylphenol | Unknown<br>Unknown | Unknown |

PAH = Polycylic Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyl
VOC = Volatile Organic Compound
SEMI-VOC = Semivolatile Organic Compound

**TABLE 27.** *Areas Where Sediment Contamination May Be Contributing to Non-Support of Uses (1988-1990 data) (High Concern).*

| WATERBODY | COUNTY | KNOWN CONTAMINANTS | ESTIMATED AREA (MILES) |
|---|---|---|---|
| Burns Ditch | Porter | PCBs | 2 |
| Grand Calumet River | Lake | Cyanide<br>Metals<br>PCBs<br>PAHs<br>Phthalates | 15 |
| Indiana Harbor Canal | Lake | Cyanide<br>Metals<br>PCBs<br>PAHs<br>Phthalates | 2 |
| Kokomo Creek | Howard | PCBs | 3 |
| Little Mississinewa River | Randolph | PCBs<br>Metals | 10 |
| Little Sugar Creek | Montgomery | PCBs | 12 |
| Maumee River | Allen | PCBs<br>Pesticides<br>Metals<br>Cyanide<br>PAHs<br>Phthalates | 25 |
| Mississinewa River | Randolph | PCBs | 11 |
| Sugar Creek | Montgomery/<br>Parke | PCBs | 9 |
| Trail Creek | LaPorte | PCBs<br>Cyanide<br>Metals<br>PAHs<br>Phthalates | 2 |
| Wildcat Creek | Howard/Carroll<br>Tippecanoe | PCBs | 65 |

PAH = Polycylic Aromatic Hydrocarbon
PCB = Polychlorinated Biphenyl

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.

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.

As part of IDEM's Clean Lakes Program, 186 lakes were monitored in 1990-91 through a Lake Water Quality Assessment Grant from the U.S. Environmental Protection Agency which is being implemented through a contract with Indiana University's School of Public and Environmental Affairs. Of the total, 83 lakes over 50 acres in size were monitored. Monitoring consisted of the collection and analysis of a single set of water quality samples for 10 parameters. The sample sets were collected from the deepest basin during stratification in July and August to facilitate comparison of results and to represent worst case water quality conditions. Representative data for those lakes monitored are presented in Table 28.

Data for the water quality parameters were used to calculate the trophic state of each lake using the IDEM Lake Eutrophication Index (TSI) (Table 29). Index values can range from zero (oligotrophic) to 75 (hypereutrophic). The Lake Eutrophication Index values for all 186 lakes monitored during 1990-91 along with index values determined for the same lakes during the mid 1970's are presented in Table 30. For 1990-91, eutrophy point values ranged from lows of 4 for Saddle Lake in Perry County and 5 for Patoka Lake (Jackson County) to highs of 70 for Skinner Lake (Noble County) and 71 for Caldwell Lake (Kosciusko County). Several lakes had significant trophic gains or losses when compared to mid-1970's data. Lakes with the largest increases were Mansfield Lake in Parke County (+38) and Cedar Lake in Whitley County (+36), while Scottsburg Lake (Scott County) and Henderson Lake (Noble County) both showed the largest decrease in eutrophy points (-45).

The lakes can be further grouped according to four broad trophic classifications. **Class I** lakes and reservoirs are considered to be Indiana's finest with the highest water quality and score between 0-25 points on the eutrophication index. They are generally meso-oligotrophic or mesotrophic 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.

TABLE 28. *Lake Water Quality Data: 1990-91*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Banning | Kosciusko | 1990 | 12 | 0.46 | 0.09 | 1.12 | 0.01 | 0.04 | 7.30 | 60.6 | 100.0 | 5.6 | 15.5 |
| Bartley | Noble | 1990 | 34 | 1.23 | 1.20 | 1.94 | 0.05 | 0.05 | 7.50 | 69.3 | 55.6 | 3.9 | 12.0 |
| Bass | St. Joseph | 1990 | 88 | 0.39 | 0.68 | 1.66 | 0.01 | 0.05 | 7.80 | 96.1 | 100.0 | 9.2 | 26.0 |
| Baugher | Noble | 1991 | 32 | 0.52 | 0.92 | 1.36 | 0.30 | 0.36 | 7.80 | 128.3 | 42.9 | 3.6 | 7.5 |
| Beaver Dam | Steuben | 1990 | 11 | 0.58 | 0.89 | 0.94 | 0.01 | 0.03 | 7.10 | 106.5 | 50.0 | 6.9 | 18.0 |
| Bell | Steuben | 1990 | 38 | 0.25 | 0.31 | 1.06 | 0.01 | 0.03 | 7.70 | 99.8 | 100.0 | 12.1 | 23.0 |
| Big | Noble | 1990 | 228 | 1.50 | 0.49 | 1.73 | 0.17 | 0.06 | 7.75 | 115.0 | 90.5 | 6.2 | 12.5 |
| Big Barbee | Kosciusko | 1990 | 297 | 1.25 | 0.55 | 1.20 | 0.02 | 0.06 | 7.60 | 69.2 | 46.2 | 4.6 | 17.0 |
| Big Turkey | Steuben | 1991 | 450 | 0.96 | 0.63 | 1.44 | 0.08 | 0.12 | 7.80 | 111.7 | 31.3 | 3.6 | 14.0 |
| Bixler | Noble | 1990 | 117 | 0.51 | 0.82 | 1.98 | 0.17 | 0.15 | 7.80 | 99.8 | 72.7 | 5.9 | 15.5 |
| Blue | Whitley | 1990 | 239 | 0.19 | 0.41 | 1.02 | 0.22 | 0.18 | 7.15 | 106.7 | 61.5 | 5.9 | 18.0 |
| Boner | Kosciusko | 1991 | 40 | 0.14 | 0.15 | 1.02 | 0.01 | 0.03 | 7.70 | 99.7 | 83.3 | 9.5 | 16.0 |
| Bowen | Noble | 1991 | 30 | 0.50 | 1.31 | 1.03 | 0.42 | 0.46 | 7.40 | 113.8 | 60.4 | 5.6 | 11.5 |
| Bower | Steuben | 1990 | 25 | 2.29 | 1.36 | 1.30 | 0.01 | 0.00 | 7.20 | 91.5 | 83.3 | 4.3 | 10.0 |
| Brokesha | LaGrange | 1990 | 36 | 0.14 | 0.04 | 0.91 | 0.01 | 0.03 | 7.30 | 100.5 | 83.3 | 9.2 | 17.0 |
| Brookville | Union | 1991 | 5260 | 1.68 | 0.50 | 0.86 | 0.02 | 0.05 | 7.88 | 113.4 | 100.0 | 3.9 | 17.5 |
| Brush Creek | Jennings | 1990 | 167 | 0.06 | 1.47 | 1.19 | 0.34 | 0.26 | 7.80 | 61.8 | 55.6 | 6.6 | 11.5 |
| Caldwell | Koscisuko | 1990 | 45 | 1.47 | 1.52 | 1.11 | 0.23 | 0.26 | 7.65 | 99.7 | 44.4 | 4.3 | 13.0 |
| Cedar | Whitley | 1990 | 144 | 0.42 | 0.13 | 0.93 | 0.08 | 0.09 | 7.70 | 92.7 | 81.8 | 19.7 | 45.0 |
| Center | Koscisuko | 1991 | 120 | 0.43 | 0.18 | 1.07 | 1.01 | 1.06 | 7.55 | 125.5 | 41.7 | 3.6 | 10.0 |
| Cicott | Cass | 1990 | 65 | 0.03 | 1.25 | 2.02 | 0.11 | 0.13 | 7.45 | 409.0 | 38.5 | 12.5 | 18.0 |
| Clare | Huntington | 1990 | 43 | 1.46 | 0.45 | 1.00 | 0.01 | 0.02 | 7.65 | 119.0 | 68.8 | 8.2 | 30.0 |
| Cline | LaGrange | 1991 | 20 | 1.54 | 0.29 | 1.01 | 1.00 | 0.03 | 7.75 | 103.5 | 100.0 | 14.4 | 26.0 |
| Cotton | LaGrange | 1991 | 31 | 0.47 | 0.46 | 3.01 | 0.13 | 0.29 | 8.15 | 107.7 | 100.0 | 1.0 | 4.0 |
| Crane | Noble | 1991 | 28 | 0.75 | 1.70 | 1.20 | 0.46 | 0.52 | 7.65 | 187.6 | 30.0 | 2.0 | 4.5 |
| Cree | Noble | 1990 | 58 | 1.14 | 0.79 | 1.41 | 0.02 | 0.04 | 8.05 | 73.7 | 66.6 | 5.6 | 14.5 |
| Crooked | Steuben | 1991 | 802 | 0.41 | 0.61 | 0.68 | 0.14 | 0.18 | 7.30 | 104.2 | 61.5 | 9.5 | 20.0 |
| Deam | Clark | 1991 | 195 | 0.07 | 0.21 | 0.84 | 0.01 | 0.09 | 6.85 | 97.9 | 70.0 | 15.4 | 23.0 |

TABLE 28. *Lake Water Quality Data: 1990-91 (cont.)*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Deer | Noble | 1990 | 36 | 1.94 | 0.75 | 2.15 | 0.03 | 0.05 | 7.45 | 112.2 | 83.3 | 3.0 | 10.0 |
| Diamond | Noble | 1990 | 105 | 1.16 | 3.23 | 0.89 | 0.30 | 0.25 | 7.45 | 67.5 | 36.4 | 3.9 | 13.0 |
| Dixon | Marshall | 1990 | 27 | 0.86 | 2.55 | 2.81 | 0.52 | 0.54 | 8.00 | 78.5 | 30.0 | 6.2 | 14.0 |
| Dock | Noble | 1991 | 16 | 0.44 | 0.83 | 1.78 | 0.24 | 0.33 | 7.80 | 140.4 | 62.5 | 3.9 | 10.5 |
| Dogwood | Daviess | 1991 | 1300 | 0.17 | 0.08 | 1.04 | 0.01 | 0.05 | 7.90 | 113.1 | 100.0 | 15.4 | 28.3 |
| Dollar | Whitley | 1991 | 10 | 0.42 | 0.75 | 0.68 | 0.23 | 0.25 | 7.55 | 107.2 | 73.3 | 16.4 | 21.0 |
| Duely | Noble | 1991 | 21 | 0.93 | 0.58 | 1.63 | 0.01 | 0.08 | 7.80 | 121.0 | 100.0 | 4.6 | 14.1 |
| Eagle Creek | Marion | 1991 | 1510 | 0.63 | 1.97 | 1.96 | 0.21 | 0.45 | 7.95 | 84.3 | 45.2 | 2.6 | 8.0 |
| Eddy | Marshall | 1991 | 16 | 0.72 | 0.05 | 2.06 | 0.00 | 0.11 | 7.85 | 44.3 | 100.0 | 2.0 | 4.5 |
| Eliza | Porter | 1991 | 45 | 0.52 | 0.76 | 1.96 | 0.03 | 0.30 | 7.75 | 65.3 | 100.0 | 2.3 | 5.8 |
| Elk Creek | Washington | 1990 | 41 | 0.15 | 0.03 | 1.23 | 0.01 | 0.03 | 7.65 | 110.9 | 100.0 | 9.8 | 18.5 |
| Emma | LaGrange | 1990 | 42 | 0.89 | 1.41 | 1.59 | 0.03 | 0.05 | 7.70 | 163.2 | 66.7 | 3.3 | 15.0 |
| Evertt | Allen | 1990 | 43 | 0.71 | 2.00 | 1.17 | 0.34 | 0.12 | 8.00 | 122.4 | 41.7 | 4.9 | 11.0 |
| Failing | Steuben | 1991 | 23 | 0.64 | 0.45 | 1.14 | 0.06 | 0.09 | 7.80 | 100.9 | 64.3 | 11.5 | 23.5 |
| Ferdinand | Dubois | 1990 | 36 | 0.75 | 1.38 | 0.48 | 0.03 | 0.08 | 7.55 | 79.9 | 16.7 | 1.0 | 3.5 |
| Fish | Elkhart | 1990 | 34 | 0.34 | 0.84 | 1.66 | 0.09 | 0.13 | 7.10 | 106.9 | 44.4 | 5.9 | 14.0 |
| Flat | Marshall | 1990 | 23 | 0.43 | 1.42 | 0.05 | 0.38 | 0.41 | 7.60 | 71.5 | 50.0 | 3.3 | 6.0 |
| Fletcher | Fulton | 1990 | 45 | 0.39 | 1.12 | 5.31 | 0.12 | 0.20 | 7.85 | 114.3 | 60.0 | 7.7 | 18.5 |
| Freeman | Carroll | 1991 | 1547 | 0.64 | 0.19 | 1.25 | 0.04 | 0.12 | 8.15 | 222.1 | 100.0 | 2.3 | 7.0 |
| French | Vigo | 1990 | * | 6.02 | 8.83 | 9.71 | 0.48 | 0.85 | 7.65 | 115.2 | 40.0 | 7.2 | 21.5 |
| Geist Res. | Marion | 1991 | 1800 | 0.56 | 0.02 | 1.68 | 0.00 | 0.11 | 8.05 | 82.6 | 100.0 | 1.3 | 5.5 |
| Gibson | Gibson | 1990 | 2950 | 0.53 | 0.02 | 1.79 | 0.01 | 0.13 | 7.50 | 100.9 | 100.0 | 1.2 | 7.3 |
| Gilbert | Marshall | 1990 | 35 | 3.26 | 5.96 | 3.89 | 0.01 | 0.05 | 8.00 | 114.3 | 47.1 | 3.0 | 14.5 |
| Gilbert | Noble | 1991 | 28 | 0.27 | 0.66 | 1.52 | 0.01 | 0.06 | 7.85 | 107.7 | 82.1 | 11.5 | 22.0 |
| Golden | Steuben | 1990 | 119 | 0.86 | 2.13 | 0.72 | 0.14 | 0.12 | 7.80 | 125.4 | 50.0 | 4.3 | 12.0 |
| Goose | Whitley | 1990 | 84 | 0.72 | 0.22 | 1.49 | 0.13 | 0.15 | 7.85 | 168.2 | 68.4 | 2.6 | 18.0 |
| Gordy | Noble | 1991 | 31 | 1.51 | 0.78 | 1.15 | 0.06 | 0.11 | 7.80 | 106.0 | 50.0 | 9.5 | 16.0 |
| Green Valley | Vigo | 1991 | 50 | 0.47 | 0.42 | 2.04 | 0.04 | 0.60 | 8.15 | 156.0 | 55.6 | 2.6 | 6.0 |

TABLE 28. *Lake Water Quality Data: 1990-91 (cont.)*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greybrook | Owen | 1990 | 33 | 0.24 | 0.77 | 2.04 | 0.00 | 0.05 | 7.55 | 89.7 | 80.0 | 5.3 | 9.5 |
| Griffy | Monroe | 1990 | 130 | 0.12 | 0.28 | 1.36 | 0.00 | 0.03 | 7.90 | 129.5 | 75.0 | 13.5 | 20.0 |
| Grouse Ridge | Bartholomew | 1991 | 20 | 0.13 | 0.15 | 0.78 | 0.00 | 0.04 | 7.55 | 97.5 | 61.0 | 10.2 | 8.2 |
| Hackenberg | LaGrange | 1990 | 42 | 0.67 | 1.20 | 1.12 | 0.16 | 0.18 | 7.75 | 101.1 | 63.6 | 4.9 | 14.0 |
| Hall | Noble | 1991 | 10 | 0.71 | 0.07 | 1.49 | 0.00 | 0.06 | 7.75 | 96.2 | 66.7 | 4.6 | 11.0 |
| Hamilton | Steuben | 19991 | 802 | 0.30 | 0.55 | 1.00 | 0.05 | 0.12 | 7.60 | 109.2 | 45.0 | 4.3 | 14.0 |
| Hardy Lake | Scott | 1990 | 705 | 0.21 | 0.82 | 0.81 | 0.01 | 0.03 | 7.10 | 85.1 | 45.5 | 5.8 | 16.4 |
| Harper | Noble | 1991 | 11 | 0.49 | 0.40 | 1.58 | 0.00 | 0.08 | 7.95 | 142.8 | 100.0 | 7.5 | 16.3 |
| Hartz | Starke | 1991 | 28 | 0.24 | 1.08 | 2.10 | 0.01 | 0.07 | 7.05 | 77.2 | 76.9 | 12.8 | 16.0 |
| Henderson | Noble | 1990 | 22 | 6.26 | 0.67 | 2.29 | 0.01 | 0.09 | 7.15 | 84.7 | 100.0 | 1.6 | 6.5 |
| High | Noble | 1990 | 123 | 0.72 | 1.50 | 2.59 | 0.16 | 0.27 | 7.50 | 134.4 | 57.1 | 2.0 | 5.0 |
| Hindman | Noble | 1991 | 13 | 2.12 | 0.15 | 1.44 | 0.01 | 0.05 | 7.85 | 96.8 | 100.0 | 9.2 | 12.0 |
| Hogback | Steuben | 1990 | 146 | 0.75 | 3.88 | 1.46 | 0.60 | 0.29 | 7.70 | 127.6 | 42.9 | 3.3 | 11.0 |
| Holem | Marshell | 1990 | 30 | 0.46 | 2.58 | 0.79 | 0.20 | 0.25 | 7.55 | 102.9 | 75.0 | 6.2 | 16.0 |
| Holland I | Dubois | 1991 | 17 | 0.28 | 0.02 | 1.16 | 0.01 | 0.06 | 8.50 | 134.6 | 100.0 | 3.9 | 7.8 |
| Holland II | Dubois | 1991 | 20 | 0.24 | 0.35 | 2.18 | 0.03 | 0.12 | 8.35 | 169.6 | 100.0 | 1.6 | 6.0 |
| Hominy Ridge | Wabash | 1990 | 11 | 0.30 | 0.39 | 1.50 | 0.02 | 0.12 | 7.75 | 80.3 | 60.0 | 3.3 | 10.0 |
| Horseshoe | Noble | 1991 | 18 | 0.30 | 1.35 | 1.83 | 0.19 | 0.25 | 7.65 | 105.3 | 63.3 | 10.2 | 12.5 |
| Hovey | Posey | 1990 | 242 | 0.27 | 0.18 | 2.92 | 0.02 | 0.06 | 7.60 | 36.4 | 100.0 | 1.3 | 5.0 |
| Hudson | LaPorte | 1991 | 432 | 0.45 | 0.22 | 0.84 | 0.01 | 0.08 | 7.85 | 98.6 | 100.0 | 16.1 | 24.5 |
| Huntington Re | Huntington | 1991 | 900 | 3.81 | 0.16 | 2.00 | 0.01 | 0.12 | 7.00 | 53.3 | 78.1 | 1.6 | 5.0 |
| Indian | Perry | 1991 | 149 | 0.18 | 0.27 | 1.05 | 0.01 | 0.05 | 7.80 | 98.3 | 68.2 | 10.5 | 17.0 |
| Irish | Kosciusko | 1990 | 143 | 0.83 | 2.21 | 0.61 | 0.01 | 0.03 | 7.70 | 97.1 | 50.0 | 3.3 | 20.0 |
| J.C. Murphy | Newton | 1990 | 1700 | 0.27 | 0.03 | 1.67 | 0.03 | 0.06 | 8.05 | 110.8 | 100.0 | 8.9 | 2.5 |
| John Hay | Washington | 1990 | * | 0.16 | 1.17 | 0.80 | 0.01 | 0.03 | 7.45 | 87.2 | 100.0 | 11.0 | 20.5 |
| Kickapoo | Sullivan | 1991 | 30 | 0.17 | 0.78 | 1.31 | 0.04 | 0.08 | 7.55 | 105.4 | 84.0 | 19.4 | 24.5 |
| King | Fulton | 1991 | 19 | 0.38 | 1.95 | 2.09 | 0.51 | 0.56 | 7.45 | 45.5 | 22.7 | 5.6 | 8.5 |
| Knapp | Noble | 1991 | 88 | 3.29 | 0.32 | 1.26 | 0.07 | 0.12 | 7.70 | 105.3 | 66.7 | 6.9 | 17.3 |

TABLE 28. *Lake Water Quality Data: 1990-91 (cont.)*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Koontz | Marshall | 1990 | 346 | 0.72 | 1.30 | 1.51 | 0.01 | 0.05 | 7.45 | 97.2 | 62.5 | 5.3 | 16.5 |
| Kreighbaum | Marshall | 1991 | 20 | 0.45 | 1.60 | 3.62 | 0.24 | 0.28 | 7.35 | 76.9 | 40.0 | 7.2 | 32 |
| Kuhn | Kosciuskko | 1990 | 118 | 0.51 | 1.02 | 0.81 | 0.00 | 0.02 | 7.45 | 76.9 | 62.5 | 6.6 | 25.0 |
| Kunkel | Wells | 1991 | 25 | 0.10 | 0.06 | 1.35 | 0.01 | 0.12 | 9.20 | 101.0 | 75.0 | 3.6 | 9.3 |
| Lake Anne | Steuben | 1991 | 17 | 0.09 | 0.78 | 1.85 | 0.06 | 0.11 | 7.45 | 108.6 | 79.6 | 9.5 | 17.0 |
| Lake of the W | Marshall | 1991 | 416 | 1.02 | 2.24 | 1.59 | 0.05 | 0.07 | 7.60 | 82.0 | 38.2 | 3.3 | 20.0 |
| Langenbaum | Starke | 1990 | 48 | 0.30 | 0.04 | 1.58 | 0.01 | 0.03 | 7.40 | 78.9 | 100.0 | 6.2 | 13.0 |
| Latta | Noble | 1990 | 42 | 0.17 | 1.13 | 1.11 | 0.17 | 0.15 | 7.65 | 109.6 | 60.0 | 4.3 | 7.0 |
| Lemon | Monroe | 1990 | 1650 | 0.10 | 0.36 | 1.38 | 0.03 | 0.06 | 7.00 | 90.3 | 66.7 | 3.3 | 10.0 |
| Lenape | Sullivan | 1991 | 49 | 0.13 | 0.99 | 0.85 | 0.13 | 0.17 | 7.95 | 143.1 | 36.6 | 7.5 | 10.5 |
| Little Barbee | Kosciusko | 1990 | 68 | 1.28 | 2.43 | 0.33 | 0.41 | 0.28 | 7.50 | 68.8 | 75.0 | 3.3 | 12.0 |
| Little Crooke | Whitley | 1990 | * | 0.64 | 1.53 | 1.40 | 0.40 | 0.35 | 7.30 | 106.1 | 73.3 | 9.5 | 15.0 |
| Little Long | Noble | 1990 | 71 | 0.88 | 0.99 | 2.46 | 0.16 | 0.10 | 7.90 | 95.3 | 68.4 | 4.9 | 21.0 |
| Little Otter | Steuben | 1990 | 34 | 0.64 | 1.89 | 1.04 | 0.33 | 2.09 | 7.85 | 111.9 | 50.0 | 6.9 | 12.0 |
| Little Pike | Kosciusko | 1991 | 25 | 0.30 | 0.06 | 1.51 | 0.01 | 0.07 | 8.10 | 96.6 | 65.8 | 2.3 | 5.0 |
| Long | Steuben | 1990 | 92 | 1.05 | 2.23 | 0.57 | 0.14 | 0.18 | 7.65 | 101.3 | 44.4 | 3.3 | 9.0 |
| Long | Noble | 1990 | 40 | 2.23 | 0.43 | 2.21 | 0.02 | 0.04 | 7.45 | 88.0 | 55.6 | 8.2 | 20.0 |
| Long | Wabash | 1990 | 48 | 0.51 | 1.98 | 0.74 | 0.13 | 0.17 | 7.80 | 111.0 | 80.0 | 3.3 | 18.0 |
| Loon | Kosciusko | 1991 | 40 | 1.15 | 2.67 | 1.90 | 0.27 | 0.32 | 7.80 | 129.4 | 100.0 | 3.3 | 10.0 |
| Lukens | Wabash | 1990 | 46 | 0.44 | 2.46 | 0.56 | 0.13 | 0.16 | 7.65 | 94.9 | 36.4 | 6.9 | 17.0 |
| Manitou | Fulton | 1991 | 713 | 0.65 | 2.05 | 1.24 | 0.32 | 0.33 | 7.65 | 99.8 | 43.8 | 4.3 | 12.0 |
| Mansfield | Parke | 1991 | 2060 | 0.83 | 1.14 | 1.24 | 0.01 | 0.06 | 8.00 | 160.6 | 32.9 | 2.6 | 4.8 |
| Martin | LaGrange | 1990 | 26 | 2.23 | 0.52 | 1.25 | 0.01 | 0.02 | 7.75 | 103.8 | 81.3 | 11.8 | 19.5 |
| McClure"s | Kosciusko | 1991 | 32 | 3.23 | 5.09 | 1.52 | 0.12 | 0.16 | 7.90 | 142.8 | 100.0 | 2.3 | 9.8 |
| Merom Gravel | Sullivan | 1990 | 55 | 1.74 | 0.17 | 1.63 | 0.00 | 0.02 | 8.05 | 115.9 | 100.0 | 9.2 | 29.5 |
| Meserve | Steuben | 1990 | 16 | 1.87 | 0.21 | 0.97 | 0.01 | 0.18 | 7.85 | 99.5 | 100.0 | 12.8 | 22.0 |
| Meteer | LaGrange | 1991 | 18 | 0.32 | 0.17 | 1.36 | 0.01 | 0.03 | 7.75 | 101.7 | 81.6 | 11.2 | >16 |
| Middle Fork | Wayne | 1990 | 277 | 3.27 | 3.41 | 3.63 | 0.09 | 0.08 | 8.00 | 200.8 | 45.5 | 2.3 | 10.0 |

TABLE 28. *Lake Water Quality Data: 1990-91 (cont.)*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mink | Porter | 1991 | 35 | 0.42 | 1.56 | 1.40 | 0.24 | 0.38 | 6.90 | 94.4 | 100.0 | 3.9 | 5.7 |
| Mississinewa | Miama | 1991 | 3180 | 2.62 | 0.11 | 1.01 | 0.02 | 0.05 | 8.00 | 138.1 | 82.6 | 5.3 | 48.0 |
| Mollenkramer | Ripley | 1990 | 93 | 0.09 | 0.18 | 1.56 | 0.01 | 0.07 | 8.15 | 175.0 | 75.0 | 1.3 | 3.5 |
| Monroe, Lower | Monroe | 1990 | 10750 | 0.08 | 0.08 | 0.57 | 0.00 | 0.03 | 7.20 | 101.0 | 100.0 | 5.6 | 23.0 |
| Monroe, Upper | Monroe | 1990 | 10750 | 0.07 | 0.03 | 0.68 | 0.01 | 0.03 | 7.45 | 103.4 | 100.0 | 3.3 | 13.0 |
| Morse | Hamilton | 1991 | 1465 | 3.05 | 0.53 | 1.32 | 0.01 | 0.07 | 7.60 | 161.5 | 53.1 | 3.3 | 12.5 |
| Moser | Wells | 1991 | 26 | 0.40 | 0.09 | 1.29 | 0.04 | 0.17 | 8.00 | 46.6 | 100.0 | 1.6 | 9.1 |
| Moss | Noble | 1991 | 9 | 1.95 | 0.23 | 1.32 | 0.00 | 0.06 | 7.80 | 88.52 | 100.0 | 7.2 | 23.6 |
| New | Whitley | 1990 | 50 | 0.05 | 0.45 | 1.26 | 0.07 | 0.05 | 7.35 | 116.4 | 91.7 | 8.2 | 27.0 |
| Norman | Noble | 1990 | 14 | 0.39 | 1.16 | 1.52 | 0.28 | 0.28 | 6.90 | 78.1 | 57.1 | 6.2 | 13.5 |
| North Little | Kosciusko | 1991 | 12 | 1.33 | 2.14 | 1.58 | 0.30 | 0.37 | 7.80 | 118.6 | 38.0 | 3.3 | 29.0 |
| Old | Whitley | 1990 | 32 | 1.22 | 1.47 | 1.39 | 0.38 | 0.29 | 7.70 | 97.9 | 36.4 | 5.6 | 10.0 |
| Paintmill | Vigo | 1990 | 82 | 0.28 | 0.37 | 1.92 | 0.05 | 0.09 | 7.80 | 60.6 | 80.0 | 1.3 | 5.0 |
| Patoka | Jackson | 1991 | 5000 | 0.10 | 0.05 | 0.59 | 0.00 | 0.02 | 7.65 | 105.0 | 84.1 | 14.4 | 34.8 |
| Pigeon | Steuben | 1990 | 61 | 1.71 | 1.19 | 1.14 | 0.02 | 0.16 | 7.45 | 80.3 | 50.0 | 2.3 | 7.0 |
| Pleasant | St. Joseph | 1990 | 29 | 1.28 | 0.22 | 2.55 | 0.02 | 0.10 | 6.95 | 34.3 | 37.5 | 2.6 | 5.0 |
| Port Mitchell | Noble | 1990 | 15 | 1.83 | 0.05 | 1.49 | 0.01 | 0.03 | 7.80 | 78.1 | 82.4 | 3.9 | 14.5 |
| Prairie Creek | Delaware | 1990 | 1216 | 0.34 | 0.53 | 1.86 | 0.02 | 0.09 | 7.75 | 88.6 | 75.0 | 3.0 | 7.0 |
| Price | Kosciusko | 1991 | 12 | 0.47 | 13.67 | 0.56 | 0.00 | 0.09 | 7.35 | 59.4 | 100.0 | 12.1 | 49.0 |
| Prides Creek | Pike | 1991 | 90 | 0.20 | 0.10 | 1.93 | 0.02 | 0.08 | 7.90 | 114.4 | 100.0 | 4.3 | 17.4 |
| Reservoir 26 | Sullivan | 1990 | 47 | 0.21 | 0.06 | 3.16 | 0.13 | 0.24 | 8.50 | 66.5 | 75.0 | 2.6 | 6.7 |
| Riddles | St. Joseph | 1990 | 77 | 0.57 | 0.78 | 1.84 | 0.20 | 0.30 | 7.00 | 58.2 | 75.0 | 3.0 | 7.5 |
| Rider | Noble | 1991 | 5 | 0.34 | 0.06 | 3.67 | 0.00 | 0.05 | 8.05 | 100.5 | 100.0 | 8.5 | 25.8 |
| Rivir | Noble | 1991 | 24 | 0.44 | 1.15 | 1.19 | 0.42 | 0.48 | 7.70 | 76.2 | 33.0 | 4.6 | 10.0 |
| Robinson | Whitley | 1990 | 59 | 0.80 | 0.53 | 1.34 | 0.06 | 0.10 | 7.15 | 53.6 | 20.0 | 2.3 | 9.0 |
| Rock | Kos/Fulton | 1991 | 56 | 0.92 | 0.09 | 2.58 | 0.00 | 0.13 | 7.85 | 82.0 | 75.0 | 1.6 | 5.0 |
| Rockville | Parke | 1991 | 100 | 0.98 | 2.23 | 1.49 | 0.15 | 0.19 | 8.05 | 24.7 | 33.9 | 2.3 | 12.0 |
| Round | Wabash | 1990 | 48 | 3.67 | 9.44 | 1.06 | 0.13 | 0.13 | 7.90 | 121.1 | 66.7 | 1.3 | 7.0 |

TABLE 28. *Lake Water Quality Data: 1990-91 (cont.)*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Round | Whitley | 1990 | 131 | 0.31 | 0.58 | 1.09 | 0.24 | 0.15 | 7.95 | 96.2 | 72.2 | 14.1 | 32.0 |
| Round B | Steuben | 1991 | 30 | 0.18 | 0.19 | 4.04 | 0.01 | 0.03 | 7.75 | 104.2 | 100.0 | 17.1 | 43.0 |
| Sacarider | Noble | 1990 | 33 | 2.65 | 0.62 | 2.57 | 0.14 | 0.04 | 7.25 | 90.2 | 25.0 | 5.6 | 15.0 |
| Saddle | Perry | 1991 | 41 | 0.08 | 0.04 | 0.59 | 0.00 | 0.02 | 8.10 | 109.0 | 100.0 | 15.4 | 33.8 |
| Salamonie Res | Huntington | 1991 | 2800 | 1.67 | 1.02 | 1.27 | 0.02 | 0.09 | 7.00 | 61.7 | 48.7 | 3.0 | 11.7 |
| Salinda | Washington | 1991 | 126 | 0.36 | 1.06 | 1.18 | 0.05 | 0.12 | 7.80 | 140.6 | 74.6 | 2.3 | 10.3 |
| Sawmill | Kosciusko | 1990 | 27 | 1.06 | 2.12 | 0.60 | 0.07 | 0.10 | 7.45 | 72.3 | 71.4 | 3.6 | 15.5 |
| Scales | Warrick | 1990 | 66 | 0.23 | 0.41 | 1.36 | 0.01 | 0.04 | 7.75 | 106.0 | 100.0 | 12.1 | 4.0 |
| Schafer | White | 1991 | 1291 | 0.90 | 0.14 | 1.29 | 0.03 | 0.14 | 7.80 | 152.5 | 100.0 | 2.3 | 7.1 |
| Schlamm | Clark | 1991 | 19 | 0.06 | 0.52 | 0.82 | 0.01 | 0.29 | 6.90 | 72.7 | 46.9 | 5.3 | 13.3 |
| Scott | Whitley | 1990 | 18 | 0.64 | 1.47 | 1.77 | 0.21 | 0.30 | 7.70 | 39.9 | 50.0 | 2.1 | 5.0 |
| Scottsburg | Scott | 1990 | 83 | 0.14 | 0.27 | 1.41 | 0.01 | 0.04 | 7.70 | 61.6 | 100.0 | 2.0 | 7.0 |
| Sechrist | Kosciusko | 1990 | 99 | 0.51 | 1.30 | 0.40 | 0.05 | 0.07 | 7.75 | 91.5 | 33.3 | 5.9 | 30.0 |
| Shakamak | Sullivan | 1991 | 56 | 0.67 | 2.92 | 1.8 | 0.67 | 0.11 | 7.25 | 50.2 | 28.6 | 5.6 | 8.25 |
| Schock | Kosciusko | 1991 | 37 | 0.30 | 0.93 | 1.34 | 0.25 | 0.27 | 7.60 | 75.4 | 94.4 | 5.9 | 16.7 |
| Skinner | Noble | 1990 | 125 | 3.24 | 1.43 | 1.38 | 0.07 | 0.09 | 7.70 | 95.6 | 33.3 | 3.6 | 9.0 |
| South | Vigo | 1990 | 45 | 3.35 | 0.30 | 2.03 | 0.01 | 0.03 | 7.60 | 65.3 | 100.0 | 2.6 | 11.0 |
| Sparta | Noble | 1991 | 31 | 0.22 | 0.02 | 1.43 | 0.01 | 0.06 | 8.00 | 118.0 | 100.0 | 7.5 | 37.5 |
| Spear | Kosciusko | 1991 | 18 | 0.23 | 1.03 | 1.10 | 0.20 | 0.22 | 7.50 | 85.1 | 41.7 | 6.9 | 72.5 |
| SPring Mill | Lawrence | 1991 | 28 | 1.25 | 0.03 | 2.15 | 0.01 | 0.18 | 8.30 | 101.0 | 83.3 | 1.8 | 2.2 |
| Stanton | Kosciusko | 1991 | 32 | 0.27 | 0.08 | 1.12 | 0.01 | 0.04 | 7.65 | 104.8 | 71.4 | 13.5 | 30.8 |
| Starve Hollo | Jackson | 1990 | 145 | 0.48 | 0.82 | 3.31 | 0.01 | 0.03 | 8.25 | 154.4 | 100.0 | 2.6 | 9.5 |
| Stick Pit 2 | Vigo | 1990 | 50 | 0.14 | 0.36 | 1.41 | 0.00 | 0.01 | 7.15 | 87.9 | 100.0 | 5.3 | 6.1 |
| Still | Lawrence | 1991 | 30 | 0.76 | 1.16 | 1.69 | 0.01 | 0.05 | 7.60 | 130.5 | 83.3 | 10.5 | 70.0 |
| Summit | Henry | 1990 | * | 0.34 | 0.41 | 1.19 | 0.01 | 0.03 | 7.95 | 105.7 | 53.9 | 13.1 | 31.5 |
| Sylvan | Noble | 1991 | 630 | 0.51 | 0.55 | 1.08 | 0.13 | 0.21 | 7.80 | 93.7 | 45.5 | 2.6 | 17.0 |
| Thomas | Marshall | 1991 | 16 | 0.05 | 2.45 | 1.61 | 0.22 | 0.27 | 2.90 | 102.2 | 11.5 | 4.9 | 25.0 |
| Tipsaw | Perry | 1991 | 131 | 0.11 | 0.02 | 0.95 | 0.02 | 0.04 | 8.00 | 107.7 | 100.0 | 13.8 | 32.7 |

TABLE 28. *Lake Water Quality Data: 1990-91 (cont.)*

| LAKE | COUNTY | YEAR SAMP. | LAKE AREA (a) | NO3 (ppm) | NH3 (ppm) | Org-N (ppm) | SRP (ppm) | Tot-P (ppm) | pH | % DO SAT. | % DO Oxic | Secchi (ft) | 1% Lev (ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Troy-Cedar | Whitley | 1990 | 93 | 3.59 | 0.11 | 2.37 | 0.08 | 0.06 | 7.85 | 117.7 | 70.8 | 5.3 | 12.5 |
| Twin | Wabash | 1990 | 81 | 0.87 | 0.12 | 1.27 | 0.01 | 0.11 | 7.85 | 69.0 | 100.0 | 2.0 | 7.0 |
| Versailles | Ripley | 1991 | 230 | 0.60 | 2.32 | 2.07 | 0.15 | 0.31 | 7.50 | 86.9 | 29.9 | 2.6 | 9.0 |
| Village | Noble | 1991 | 12 | 1.83 | 0.96 | 1.24 | 0.01 | 0.05 | 7.80 | 128.3 | 100.0 | 4.6 | 20.3 |
| Wabee | Kosciusko | 1991 | 117 | 1.39 | 0.83 | 0.87 | 0.06 | 0.09 | 7.70 | 113.0 | 52.6 | 9.2 | 33.3 |
| Walton | Vigo | 1990 | 216 | 1.70 | 1.28 | 2.39 | 0.04 | 0.05 | 7.70 | 95.0 | 100.0 | 3.3 | 13.0 |
| Wauhob | Porter | 1991 | 21 | 0.48 | 1.47 | 1.08 | 0.50 | 0.58 | 7.45 | 102.8 | 53.4 | 12.5 | 23.6 |
| Waveland | Montgomery | 1991 | 360 | 0.64 | 3.22 | 1.46 | 0.22 | 0.33 | 7.95 | 55.5 | 23.0 | 2.0 | 10.0 |
| Webster | Kosciusko | 1991 | 774 | 0.24 | 0.84 | 1.31 | 0.11 | 0.15 | 7.70 | 126.1 | 26.9 | 3.6 | 10.5 |
| Westwood | Henry | 1991 | 173 | 0.37 | 0.66 | 1.74 | 0.01 | 0.09 | 7.45 | 96.8 | 100.0 | 15.1 | 27.8 |
| White Oak | Knox | 1991 | 30 | 0.26 | 0.48 | 1.80 | 0.00 | 0.09 | 8.05 | 101.4 | 100.0 | 7.2 | 18.5 |
| Whitewater | Union | 1990 | 199 | 4.89 | 0.03 | 1.57 | 0.00 | 0.05 | 7.85 | 154.1 | 58.3 | 3.6 | 14.0 |
| Wible | Noble | 1990 | 49 | 1.33 | 2.05 | 3.02 | 0.39 | 0.34 | 7.80 | 102.3 | 45.9 | 2.3 | 7.0 |
| Williams | Noble | 1990 | 46 | 1.33 | 1.98 | 2.73 | 0.42 | 0.32 | 7.35 | 96.8 | 66.7 | 4.6 | 16.0 |
| Winona | Kosciusko | 1991 | 478 | 1.11 | 0.14 | 0.48 | 0.06 | 0.09 | 7.45 | 146.8 | 71.1 | 3.9 | 17 |
| Worster | St. Joseph | 1990 | 327 | 0.31 | 0.03 | 1.01 | 0.01 | 0.07 | 7.40 | 105.7 | 75.0 | 2.6 | 10.0 |
| Worster | St. Joseph | 1991 | 327 | 0.41 | 0.09 | 1.95 | 0.01 | 0.09 | 7.30 | 78.4 | 76.9 | 3.6 | 13.0 |
| Yellowwood | Brown | 1990 | 133 | 0.07 | 0.16 | 0.78 | 0.01 | 0.03 | 7.00 | 94.4 | 77.8 | 11.5 | 23.0 |

TABLE 29. *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 |
| ***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% to 149% | 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% | 2 |
| D. 66% to 75% | 1 |
| E. 76% to 100% | 0 |

TABLE 29. *Calculation of the IDEM Lake Trophic State Index (Cont.)*

| PARAMETER AND RANGE | | EUTROPHY POINTS |
|---|---|---|
| *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 |
| *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 - 5000,000 organisms/L | 20 |
| | J. greater than 5000,000 organisms/L | 25 |
| | K. Blue-Green Dominance additional points | 10 |

**TABLE 30.** *Trophic Classification of Lakes Monitored During 1990 - 91 Compared to Mid - 1970's Classification*

| LAKE | COUNTY | LAKE AREA (a) | YEAR SAMPLED | TROPHIC PTS (CLASS) 1990-1991 | TROPHIC PTS (CLASS) 1975 | POINT CHANGE |
|---|---|---|---|---|---|---|
| Banning | Kosciusko | 12 | 1990 | 13 (I) | * | * |
| Bartley | Noble | 34 | 1990 | 57 (III) | 35 (II) | 22 |
| Bass | St. Joseph | 88 | 1990 | 24 (I) | 17 (I) | 7 |
| Baugher | Noble | 32 | 1991 | 56 (III) | 54 (III) | 2 |
| Beaver Dam | Steuben | 11 | 1990 | 17 (I) | 27 (II) | -10 |
| Bell | Steuben | 38 | 1990 | 24 (I) | 24 (I) | 0 |
| Big | Noble | 228 | 1990 | 58 (III) | 38 (II) | 20 |
| Big Barbee | Kosciusko | 297 | 1990 | 38 (II) | 38 (II) | 0 |
| Big Turkey | Steuben | 450 | 1991 | 41 (II) | 44(II) | -3 |
| Bixler | Noble | 117 | 1990 | 24 (I) | 38 (II) | -14 |
| Blue | Whitley | 239 | 1990 | 31 (II) | 35 (II) | -4 |
| Boner | Kosciusko | 40 | 1991 | 9 (I) | 43 (II) | -34 |
| Bowen | Noble | 30 | 1991 | 34 (II) | 41 (II) | -7 |
| Bower | Steuben | 25 | 1990 | 27 (II) | 66 (III) | -39 |
| Brokesha | LaGrange | 36 | 1990 | 20 (I) | 11 (I) | 9 |
| Brookville | Union | 5260 | 1991 | 31 (II) | * | * |
| Caldwell | Kosciusko | 45 | 1990 | 71 (III) | 46 (II) | 25 |
| Cedar | Whitley | 144 | 1990 | 44 (II) | 8 (I) | 36 |
| Center | Kosciusko | 120 | 1991 | 24 (I) | 31 (II) | -7 |
| Cicott | Cass | 65 | 1990 | 33 (II) | * | * |
| Clare | Huntington | 43 | 1990 | 14 (I) | * | * |
| Cline | LaGrange | 20 | 1991 | 10 (I) | 9 (IV) | 1 |
| Cotton | LaGrange | 31 | 1991 | 40 (II) | 66 (III) | -26 |
| Crane | Noble | 28 | 1991 | 47 (II) | 45 (II) | 2 |
| Cree | Noble | 58 | 1990 | 36 (II) | 39 (II) | -3 |
| Crooked | Steuben | 802 | 1991 | 30 (II) | 23 (I) | 7 |
| Deam | Clark | 195 | 1991 | 9 (I) | 5 (I) | 4 |
| Deer | Noble | 36 | 1990 | 44 (II) | * | * |
| Diamond | Noble | 105 | 1990 | 56 (III) | 21 (I) | 35 |
| Dixon | Marshall | 27 | 1990 | 36 (II) | 30 (II) | 6 |
| Dock | Noble | 16 | 1991 | 35 (II) | 38 (II) | -3 |

TABLE 30. *Trophic Classification of Lakes Monitored During 1990 - 91 Compared to Mid - 1970's Classification (cont.)*

| LAKE | COUNTY | LAKE AREA (a) | YEAR SAMPLED | TROPHIC PTS (CLASS) 1990-1991 | TROPHIC PTS (CLASS) 1975 | POINT CHANGE |
|---|---|---|---|---|---|---|
| Dogwood | Daviess | 1300 | 1991 | 8 (I) | 16 (I) | -8 |
| Dollar | Whitley | 10 | 1991 | 33 (II) | 29 (IV) | 4 |
| Duely | Noble | 21 | 1991 | 25 (I) | 42 (IV) | -17 |
| Eagle Creek | Marion | 1510 | 1991 | 41 (II) | 40 (II) | 1 |
| Eddy | Marshall | 16 | 1991 | 20 (I) | 42 (II) | -22 |
| Eliza | Porter | 45 | 1991 | 23 (I) | 42 (II) | -19 |
| Elk Creek | Washington | 47 | 1990 | 35 (II) | 13 (I) | 22 |
| Emma | LaGrange | 42 | 1990 | 32 (II) | 44 (II) | -12 |
| Everett | Allen | 43 | 1990 | 66 (III) | * | * |
| Failing | Steuben | 23 | 1991 | 30 (II) | 20 (I) | 10 |
| Ferdinand | Dubois | 36 | 1990 | 40 (II) | 55 (III) | -15 |
| Fish | Elkhart | 34 | 1990 | 40 (II) | 35 (III) | 5 |
| Flat | Marshall | 23 | 1990 | 29 (II) | 35 (II) | -6 |
| Fletcher | Fulton | 45 | 1990 | 37 (II) | 45 (II) | -8 |
| Freeman | Carroll | 1547 | 1991 | 25 (I) | 38 (II) | -13 |
| French | Vigo | * | 1990 | 56 (III) | * | * |
| Geist Reservoir | Marion | 1800 | 1991 | 31 (II) | 37 (II) | -6 |
| Gibson | Gibson | 2950 | 1990 | 35 (II) | * | * |
| Gilbert | Marshall | 35 | 1990 | 39 (II) | 75 (III) | -36 |
| Gilbert | Noble | 28 | 1991 | 13 (I) | 28 (II) | -15 |
| Golden | Steuben | 119 | 1990 | 49 (II) | 66 (III) | -17 |
| Goose | Whitley | 84 | 1990 | 41 (II) | 61 (III) | -20 |
| Gordy | Noble | 31 | 1991 | 35 (II) | 43 (II) | -8 |
| Green Valley | Vigo | 50 | 1991 | 60 (III) | 36 (II) | 24 |
| Greybrook | Owen | 33 | 1990 | 28 (II) | * | * |
| Griffy | Monroe | 130 | 1990 | 24 (I) | 40 (II) | -16 |
| Grouse Ridge | Bartholomew | 20 | 1991 | 19 (I) | 25 (I) | -6 |
| Hackenberg | LaGrange | 42 | 1990 | 56 (III) | 29 (II) | 27 |
| Hall | Noble | 10 | 1991 | 23 (I) | 16 (I) | 7 |
| Hamilton | Steuben | 802 | 1990 | 26 (II) | 31 (II) | -5 |
| Hardy Lake | Scott | 705 | 1991 | 27 (II) | 19 (I) | 8 |

TABLE 30. *Trophic Classification of Lakes Monitored During 1990 - 91 Compared to Mid - 1970's Classification (cont.)*

| LAKE | COUNTY | LAKE AREA (a) | YEAR SAMPLED | TROPHIC PTS (CLASS) 1990-1991 | TROPHIC PTS (CLASS) 1975 | POINT CHANGE |
|---|---|---|---|---|---|---|
| Harper | Noble | 11 | 1991 | 29 (II) | 60 (III) | -31 |
| Hartz | Starke | 28 | 1991 | 26 (II) | 23 (II) | 3 |
| Henderson | Noble | 22 | 1990 | 28 (II) | 73 (III) | -45 |
| High | Noble | 123 | 1990 | 63 (III) | 52 (III) | 10 |
| Hindman | Noble | 13 | 1991 | 26 (II) | 52 (iV) | -26 |
| Hogback | Steuben | 146 | 1990 | 53 (III) | 58 (III) | -5 |
| Holem | Marshall | 30 | 1990 | 40 (II) | 23 (I) | 17 |
| Holland I | Dubois | 17 | 1991 | 44 (II) | 27 (II) | 17 |
| Holland II | Dubois | 20 | 1991 | 36 (II) | 25 (I) | 11 |
| Hominy Ridge | Wabash | 11 | 1990 | 47 (II) | 59 (III) | -12 |
| Horseshoe | Noble | 18 | 1991 | 34 (II) | 40 (II) | -6 |
| Hovey | Posey | 242 | 1990 | 30 (II) | 60 (IV) | -30 |
| Hudson | LaPorte | 432 | 1991 | 13 (I) | 23 (I) | -10 |
| Huntington Res. | Huntington | 900 | 1991 | 22 (I) | 25 (I) | -3 |
| Indian | Perry | 149 | 1991 | 12 (I) | 20 (I) | -8 |
| Irish | Kosciusko | 143 | 1990 | 36 (II) | 45 (II) | -9 |
| J.C. Murphy | Newton | 1700 | 1990 | 22 (I) | 47 (II) | -25 |
| John Hay | Washington | * | 1990 | 12 (I) | 13 (I) | -1 |
| Kickapoo | Sullivan | 30 | 1991 | 29 (II) | 21 (I) | 8 |
| King | Fulton | 19 | 1991 | 26 (II) | 35 (II) | -9 |
| Knapp | Noble | 88 | 1991 | 31 (II) | 43 (II) | -12 |
| Koontz | Marshall | 346 | 1990 | 17 (I) | 42 (II) | -25 |
| Kreighbaum | Marshall | 20 | 1991 | 25 (I) | 32 (II) | -7 |
| Kuhn | Kosciusko | 118 | 1990 | 27 (II) | 15 (I) | 12 |
| Kunkel | Wells | 25 | 1991 | 29 (II) | 59 (III) | -30 |
| Lake Anne | Steuben | 17 | 1991 | 27 (II) | 38 (II) | -11 |
| Lake of the Woods | Marshall | 416 | 1991 | 33 (II) | 42 (II) | -9 |
| Langenbaum | Starke | 48 | 1990 | 22 (I) | 41 (II) | -19 |
| Latta | Noble | 42 | 1990 | 56 (III) | 36 (II) | 20 |
| Lemon | Monreo | 1650 | 1990 | 30 (II) | 40 (II) | -10 |
| Lenape | Sullivan | 49 | 1991 | 41 (II) | * | * |

TABLE 30. *Trophic Classification of Lakes Monitored During 1990 - 91 Compared to Mid - 1970's Classification (cont.)*

| LAKE | COUNTY | LAKE AREA (a) | YEAR SAMPLED | TROPHIC PTS (CLASS) 1990-1991 | TROPHIC PTS (CLASS) 1975 | POINT CHANGE |
|---|---|---|---|---|---|---|
| Little Barbee | Kosciusko | 68 | 1990 | 41 (II) | 56 (III) | -15 |
| Little Crooked | Whitley | * | 1990 | 61 (III) | 32 (II) | 29 |
| Little Long | Noble | 71 | 1990 | 57 (III) | 32 (II) | 25 |
| Little Otter | Steuben | 364 | 1990 | 63 (III) | 58 (III) | 5 |
| Little Pike | Kosciusko | 25 | 1991 | 22 (I) | 31 (II) | -9 |
| Long | Steuben | 92 | 1990 | 48 (II) | 64 (III) | -16 |
| Long | Noble | 40 | 1990 | 43 (II) | 33 (II) | 10 |
| Long | Wabash | 48 | 1990 | 36 (II) | 30 (II) | 6 |
| Loon | Kosciusko | 40 | 1991 | 32 (II) | 52 (IV) | -20 |
| Lukens | Wabash | 46 | 1990 | 31 (II) | 30 (II) | 1 |
| Manitou | Fulton | 713 | 1991 | 33 (II) | 48 (II) | -15 |
| Mansfield | Parke | 2060 | 1991 | 59 (III) | 21 (I) | 38 |
| Martin | LaGrange | 26 | 1990 | 34 (II) | 35 (II) | -1 |
| McClure's | Kosciusko | 32 | 1991 | 32 (II) | 51 (III) | -19 |
| Merom Gravel | Sullivan | 55 | 1990 | 12 (I) | 5 (I) | - |
| Meserve | Steuben | 16 | 1990 | 14 (I) | 22 (I) | -8 |
| Meteer | LaGrange | 18 | 1991 | 6 (I) | 17 (I) | -11 |
| Middle Fork | Wayne | 277 | 1990 | 36 (II) | 18 (I) | 18 |
| Mink | Porter | 35 | 1991 | 41 (II) | 50 (II) | -9 |
| Mississinewa | miama | 3180 | 1991 | 25 (I) | 18 (I) | 7 |
| Mollenkramer | Ripley | 93 | 1990 | 24 (I) | 59 (III) | -35 |
| Monroe, Lower | Monroe | 10750 | 1990 | 10 (I) | 34 (II) | -24 |
| Monroe, Upper | Monroe | 10750 | 1990 | 17 (I) | 3 (I) | 14 |
| Morse | Hamilton | 1465 | 1991 | 29 (II) | 31 (II) | -2 |
| Moser | Wells | 26 | 1991 | 20 (I) | 55 (III) | -35 |
| Moss | Noble | 9 | 1991 | 13 (I) | 51 (IV) | -38 |
| New | Whitley | 50 | 1990 | 24 (I) | 7 (I) | 17 |
| Norman | Noble | 14 | 1990 | 27 (II) | 39 (II) | -12 |
| North Little | Kosciusko | 12 | 1991 | 43 (II) | 52 (III) | -9 |
| Old | Whitley | 32 | 1990 | 55 (III) | 48 (II) | 7 |
| Paintmill | Vigo | 82 | 1990 | 33 (II) | * | * |

TABLE 30. *Trophic Classification of Lakes Monitored During 1990 - 91 Compared to Mid - 1970's Classification (cont.)*

| LAKE | COUNTY | LAKE AREA (a) | YEAR SAMPLED | TROPHIC PTS (CLASS) 1990-1991 | TROPHIC PTS (CLASS) 1975 | POINT CHANGE |
|---|---|---|---|---|---|---|
| Patoka | Jackson | 5000 | 1991 | 5 (I) | * | * |
| Pigeon | Steuben | 61 | 1990 | 26 (II) | 60 (III) | -34 |
| Pleasant | St. Joseph | 29 | 1990 | 25 (I) | 29 (II) | -4 |
| Port Mitchell | Noble | 15 | 1990 | 55 (III) | 30 (II) | 25 |
| Prairie Creek | Delaware | 1216 | 1990 | 58 (III) | 36 (II) | 22 |
| Price | Kosciusko | 12 | 1991 | 27 (II) | 50 (II) | -23 |
| Prides Creek | Pike | 90 | 1991 | 30 (II) | 33 (II) | -3 |
| Reservoir 26 | Sullivan | 47 | 1990 | 25 (I) | * | * |
| Riddles | St. Joseph | 77 | 1990 | 29 (II) | 30 (II) | -1 |
| Rider | Noble | 5 | 1991 | 14 (I) | 55 (IV) | -41 |
| Rivir | Noble | 24 | 1991 | 32 (II) | 38 (II) | -6 |
| Robinson | Whitley | 59 | 1990 | 28 (II) | * | * |
| Rock | Kosciusko/Fulton | 56 | 1991 | 31 (II) | 61 (III) | -30 |
| Rockville | Parke | 100 | 1991 | 42 (II) | 47 (II) | -5 |
| Round | Wabash | 48 | 1990 | 44 (II) | 43 (II) | 1 |
| Round | Whitley | 131 | 1990 | 22 (I) | 30 (II) | -8 |
| Round B | Steuben | 30 | 1991 | 20 (I) | 23 (I) | -3 |
| Sacarider | Noble | 33 | 1990 | 45 (II) | 35 (II) | 10 |
| Saddle | Perry | 41 | 1991 | 4 (I) | 36 (II) | -32 |
| Salamonie Res. | Huntington | 2800 | 1991 | 26 (II) | 21 (I) | 5 |
| Salinda | Washington | 126 | 1991 | 38 (II) | 47 (II) | -9 |
| Sawmill | Kosciusko | 27 | 1990 | 40 (II) | 33 (II) | 7 |
| Scales | Warrick | 66 | 1990 | 27 (II) | 50 (II) | -23 |
| Schafer | White | 1291 | 1991 | 26 (II) | 23 (I) | 3 |
| Schlamm | Clark | 19 | 1991 | 15 (I) | 10 (I) | 5 |
| Scott | Whitley | 18 | 1990 | 29 (II) | 23 (I) | 6 |
| Scottsburg | Scott | 83 | 1990 | 18 (II) | 63 (III) | -45 |
| Sechrist | Kosciusko | 99 | 1990 | 28 (II) | 24 (I) | 4 |
| Shakamak | Sullivan | 56 | 1991 | 43 (II) | 38 (II) | 5 |
| Schock | Kosciusko | 37 | 1991 | 29 (II) | 28 (II) | 1 |
| Skinner | Noble | 125 | 1990 | 70 (III) | 45 (II) | 25 |

TABLE 30. *Trophic Classification of Lakes Monitored During 1990 - 91 Compared to Mid - 1970's Classification (cont.)*

| LAKE | COUNTY | LAKE AREA (a) | YEAR SAMPLED | TROPHIC PTS (CLASS) 1990-1991 | TROPHIC PTS (CLASS) 1975 | POINT CHANGE |
|---|---|---|---|---|---|---|
| South | Vigo | 45 | 1990 | 21 (I) | * | * |
| Sparta | Noble | 31 | 1991 | 10 (I) | 40 (II) | -30 |
| Spear | Kosciusko | 18 | 1991 | 38 (II) | 36 (II) | 2 |
| Spring Mill | Lawrence | 28 | 1991 | 25 (I) | * | * |
| Stanton | Kosciusko | 32 | 1991 | 14 (I) | 20 (I) | -6 |
| Starve Hollow | Jackson | 145 | 1990 | 38 (II) | 58 (III) | -20 |
| Stick Pit 2 | Vigo | 50 | 1990 | 12 (I) | * | * |
| Still | LaGrange | 30 | 1991 | 26 (II) | 19 (I) | 7 |
| Summit | Henry | * | 1990 | 15 (I) | * | * |
| Sylvan | NOble | 630 | 1991 | 40 (II) | 62 (III) | -22 |
| Thomas | Marshall | 16 | 1991 | 29 (II) | 51 (III) | -22 |
| Tipsaw | Perry | 131 | 1991 | 23 (I) | 19 (I) | 4 |
| Troy-Cedar | Whitley | 93 | 1990 | 35 (II) | 60 (III) | -25 |
| Twin | Wabash | 81 | 1990 | 33 (II) | 50 (II) | -17 |
| Versailles | Ripley | 230 | 1991 | 30 (II) | 52 (III) | -22 |
| Village | Noble | 12 | 1991 | 28 (II) | 59 (IV) | -31 |
| Wabee | Kosciusko | 117 | 1991 | 19 (I) | 60 (III) | -41 |
| Walton | Vigo | 216 | 1990 | 27 (II) | 40 (II) | -13 |
| Wauhob | Porter | 21 | 1991 | 38 (II) | 31 (II) | 7 |
| Waveland | Montgomery | 360 | 1991 | 36 (II) | 20 (I) | 16 |
| Webster | Kosciusko | 774 | 1991 | 41 (II) | 37 (II) | 4 |
| Westwood | Henry | 173 | 1991 | 16 (I) | * | * |
| White Oak | Knox | 30 | 1991 | 42 (II) | 55 (III) | -13 |
| Whitewater | Union | 199 | 1990 | 36 (II) | 29 (II) | 7 |
| Wible | Noble | 49 | 1990 | 37 (II) | 55 (III) | -18 |
| Williams | Noble | 46 | 1990 | 68 (III) | * | * |
| Winona | Kosciusko | 478 | 1991 | 35 (II) | 56 (III) | -21 |
| Worster | St. Joseph | 327 | 1990 | 29 (II) | * | * |
| Worster | St. Joseph | 327 | 1991 | 19 (I) | 25 (I) | -6 |
| Yellowwood | Brown | 133 | 1990 | 11 (I) | 10 (I) | 1 |

* = *Lake not sampled*

Class II lakes and reservoirs are moderately productive for Indiana waters. they include waterbodies that would generally be considered meso-eutrophic and score from 25-50 points. They are often noticeably affected by cultural eutrophication but trophic 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 receive or have received direct wastewater discharges.

Class III lakes and reservoirs are those that are the most productive and have the lowest water quality. They are considered eutrophic or in some cases hypereutrophic and score from 50-75 points. 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.

Class IV waterbodies include remnant and oxbow lakes. These include small, shallow, natural water bodies that are in an advanced state of senescence. Therefore, they cannot be realistically compared with other lakes. 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 inaccessiblity.

For the 1990-91 lakes, fifty-nine (32%) were in Class I, 106 (57%) were in Class II and 21 (11%) were in Class III (Table 31). Of the 186 lakes sampled in 1990-91, 157 were sampled previously in the mid-1970's and thus allow for comparisons. The mid-1970's values for the same lakes were 27% Class I lakes, 52% Class II lakes and 22% Class III lakes. This trend shows an overall improvement in water quality, with a decreased percentage of Class III lakes and an increased percentage of Class I and II lakes (Figure 3).

Of the 157 lakes for which direct comparison can be made to the mid-1970's, 31% moved to a better trophic class, 20% moved to a worse class and 49% remained in the same class (Table 32). Overall, 39% of the lakes showed an increase in eutrophy

FIGURE 3. *Lake Trophic Class Percentages*

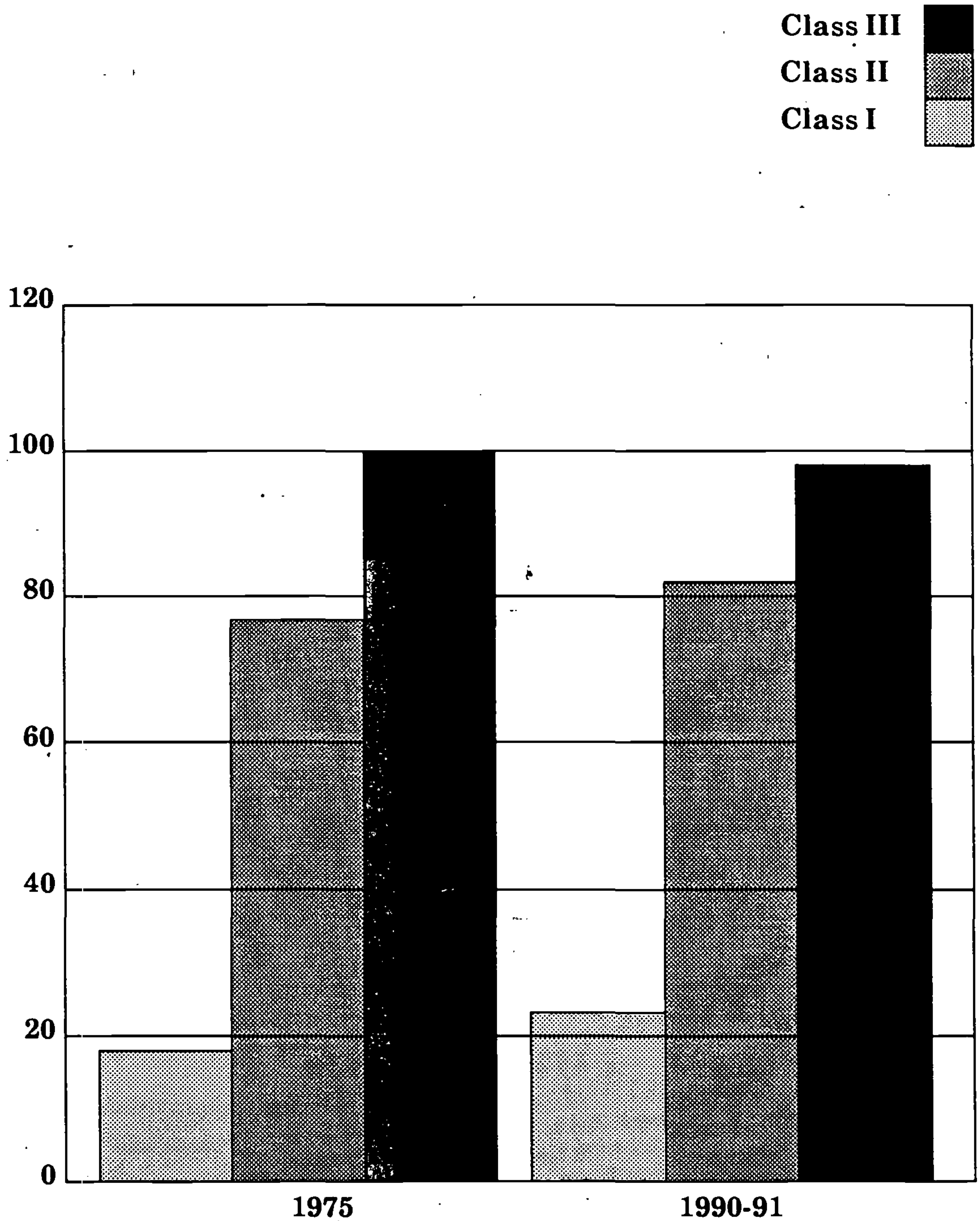


TABLE 31. *Shifts in Trophic Class*

| TROPHIC CLASS | TOTAL 1970's | TOTAL 1990-91 | MOVED TO CLASS I | MOVED TO CLASS II | MOVED TO CLASS III | NO CHANGE |
|---|---|---|---|---|---|---|
| Class I | 42 | 59 | 0 | 17 | 2 | 23 |
| Class II | 81 | 106 | 19 | 0 | 12 | 50 |
| Class III | 34 | 21 | 4 | 26 | 0 | 4 |
| **TOTAL** | **157** | **186** | **23** | **43** | **14** | **77** |

TABLE 32. *Overall Trophic Class Trends*

| TOTAL SURVEYED | MOVED TO BETTER CLASS | MOVED TO WORSE CLASS | REMAINED IN CLASS |
|---|---|---|---|
| 157 | 49 (31%) | 31 (20%) | 77 (49%) |

TABLE 33. *Changes in Eutrophy Points*

| TROPHIC CLASS | NUMBER SURVEYED | EUTROPHY POINTS INCREASED | EUTROPHY POINTS DECREASED | NO CHANGE |
|---|---|---|---|---|
| Class I | 42 | 30 (71%) | 11 (26%) | 1 (2%) |
| Class II | 81 | 29 (36%) | 51 (63%) | 1 (1%) |
| Class III | 34 | 3 (39%) | 31 (91%) | 0 (0%) |
| **TOTAL** | **157** | **62 (39%)** | **93 (59%)** | **2 (1%)** |

TABLE 34. *Changes in Eutrophy Points Compared to Lake Size (acres)*

| LAKE AREA (ac.) | NUMBER OF LAKES | MEAN EUTROPHY POINTS 1970s | MEAN EUTROPHY POINTS 1990-91 | NET POINT CHANGE |
|---|---|---|---|---|
| 0-25 | 38 | 38.0 | 27.6 | -10.39 |
| 26-50 | 49 | 37.7 | 35.2 | -2.55 |
| 51-100 | 20 | 44.6 | 32.8 | -11.80 |
| 101-500 | 35 | 36.7 | 33.0 | -3.71 |
| 501-1000 | 7 | 35.0 | 31.3 | -3.71 |
| >1000 | 14 | 28.9 | 29.1 | +0.14 |

points, 59% showed a decrease and 1% did not change (Table 33). The mean eutrophy point change for all lakes between the 1970's and 1990-91 was -5.35.

While surveys in past years have concentrated on Indiana's larger lakes, special effort was made in 1990-91 to include smaller lakes. Of the 186 lakes sampled during this period, 98 or nearly 53% had an area of 50 acres or smaller. Thirty-nine lakes (21%) were 25 acres or less.

Lakes less than 25 acres in size had the lowest mean eutrophy point value (27.6) of all lakes sampled during 1990-91 (Table 34). The largest lakes sampled had the next lowest mean eutrophy point total (29.1). The highest mean eutrophy points were recorded for lakes in the 26-50 acre and 101-500 acre classes, (35.2 and 33.0 eutrophy points, respectively.)

Between the 1970's and 1990-91 sampling periods, the mean eutrophy points for lakes in all size classes except those greater than 1000 acres decreased (Table 34). Lakes in the 51-100 acre size class decreased by an average of 11.80 eutrophy points and those in the 51-100 acre size class decreased by an average of 10.39 eutrophy points. These two size classes had the highest mean eutrophy points in the 1970's surveys and this again demonstrates that Indiana's worst lakes improved the most, on average, between the two periods. The largest Indiana lakes (those greater than 1000 acres), however, increased by an average of 0.14 eutrophy points during this period.

Because the apparent trophic condition of a lake or reservoir can fluctuate to some extent from year to year and, for that matter, even during a given summer season, a change in the TSI number of less than five points from one survey to the next may not always reflect an actual trend. In the same sense, an apparent shift from one trophic class to the next may not indicate a significant or permanent change in trophic condition if the lake or reservoir is near the dividing line between classes.

Volunteer Monitoring Program

During 1989, a statewide citizen Volunteer Monitoring Program was established as a part of the Indiana Clean Lakes Program. Citizen volunteers were equipped and trained to measure Secchi disk transparencies at their lakes as a low-cost, high-volume lake monitoring tool. A total of 53 lakes and reservoirs were monitored and a total of 377 individual measurements were made during this first year.

During 1990 and 1991, the Volunteer Lake Monitoring Program marked its second and third years as part of the Indiana Clean Lakes Program. 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 63 lakes were monitored in 1990 with 510 total observations. The 1991 figures were similar, with 62 lakes monitored and 499 individual observations. Tables 35 and 36 show the results of Secchi disk monitoring for 1990 and 1991. 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. 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 4 and 5 show how the July-August averages are distributed within the four water clarity categories for 1990 and 1991, respectively. In 1990, 42.8% of the lakes monitored were in either the good or very good categories, and 57.1% were classified as either poor or very poor. In 1991, 46.8% of the lakes were classified as either good or very good, while 53.2% were classified as either poor or very poor.

In 1990, Pretty Lake (21 ft.), Big Long Lake (15.4 ft.), and Seven Sisters Lake (14.2 ft), showed the greatest Secchi disk transparencies for the July-August average. Conversely, Cedar Lake, Lake County (0.067 ft.), Kokomo Reservoir (1.5 ft.), and Little Pike Lake, (1.58 ft.), had the lowest transparencies.

Pretty Lake (27.38 ft.) again had the greatest transparency in 1991, while Saugany Lake, (24.83 ft.), and Yellowwood Lake (15.71 ft.), ranked second and third. As in 1990, Cedar Lake (0.5 ft.), Kokomo Reservoir (1.25 ft.), and Little Pike Lake (1.67 ft.), had the lowest July-August average transparencies.

Forty-eight lakes which were monitored in 1990 were also monitored in 1991, therefore allowing for direct comparison of the data (Table 39). From 1990 to 1991, the July-August mean transparency increased in twenty-five lakes, twenty-two lakes had a decrease, while one remained the same. Looking at the data in terms of transparency categories, eight lakes moved to a better (more transparent) category,

TABLE 35. *1990 Summary Results - Volunteer Secchi Monitoring Program*

| LAKE | COUNTY | 1990 YEARLY MAXIMUM (FEET) | 1990 YEARLY MINIMUM (FEET) | 1990 JUL - AUG AVERAGE (FEET) | 1990 STATE RANK |
|---|---|---|---|---|---|
| Banning | Kosciusko | 5.50 | 3.50 | 4.90 | 36 |
| Barton | Steuben | 13.00 | 8.00 | 9.00 | 16 |
| Big Bass | Porter | 4.00 | 1.00 | 3.50 | 51 |
| Big Barbee | Kosciusko | 4.50 | 3.50 | 4.40 | 41 |
| Big Long | LaGrange | 18.50 | 12.50 | 15.40 | 2 |
| Big Otter | Steuben | 8.25 | 6.25 | 7.35 | 22 |
| Big Turkey | LaGrange | 9.00 | 4.50 | 5.56 | 31 |
| Cedar | Lake | 2.00 | 0.00 | 0.67 | 63 |
| Center | Kosciusko | 10.00 | 3.50 | 5.50 | 33 |
| Chapman | Kosciusko | 19.75 | 6.25 | 7.10 | 24 |
| Cook | Marshall | 6.50 | 2.25 | 2.91 | 57 |
| Crooked | Noble | 16.50 | 8.00 | 9.90 | 12 |
| Dewart | Kosciusko | 19.00 | 11.00 | 13.00 | 6 |
| Dixon | Marshall | 5.00 | 2.50 | 4.33 | 42 |
| Fish | LaGrange | 10.00 | 5.25 | 8.50 | 20 |
| Flat | Marshall | 8.75 | 4.50 | 6.13 | 29 |
| Flint | Porter | 12.25 | 6.75 | 11.00 | 8 |
| Galbraith | Marshall | 2.50 | 1.75 | 3.75 | 49 |
| Goose | Whitley | 10.00 | 2.75 | 4.00 | 46 |
| Hamilton | Steuben | 10.50 | 3.50 | 4.70 | 38 |
| Harper | Noble | 12.75 | 7.75 | 7.88 | 21 |
| Holem | Marshall | 12.00 | 2.75 | 9.06 | 14 |
| Indiana | Elkhart | 18.50 | 7.00 | 9.60 | 13 |
| Irish | Kosciusko | 4.50 | 4.00 | 4.10 | 44 |
| James | Steuben | 11.50 | 7.00 | 9.00 | 15 |
| Jimmerson | Steuben | 14.00 | 6.00 | 10.80 | 10 |
| Kickapoo | Sullivan | 14.25 | 12.00 | 13.50 | 5 |
| Knapp | Noble | 5.00 | 4.75 | 4.88 | 37 |
| Kokomo | Howard | 2.00 | 0.50 | 1.50 | 62 |
| Kreighbaum | Marshall | 12.00 | 4.50 | 8.63 | 18 |
| Kuhn | Kosciusko | 7.00 | 5.50 | 6.50 | 27 |
| Kunkle | Wells | 6.25 | 1.75 | 4.69 | 39 |

TABLE 35. *1990 Summary Results - Volunteer Secchi Monitoring Program (cont.)*

| LAKE | COUNTY | 1990 YEARLY MAXIMUM (FEET) | 1990 YEARLY MINIMUM (FEET) | 1990 JUL - AUG AVERAGE (FEET) | 1990 STATE RANK |
|---|---|---|---|---|---|
| Lake of the Woods | LaGrange | 6.75 | 3.00 | 4.50 | 40 |
| Lake of the Woods | Marshall | 6.00 | 2.00 | 2.40 | 58 |
| Lake on the Green | Porter | 3.25 | 2.00 | 2.38 | 59 |
| Lawrence | Marshall | 8.00 | 4.00 | 6.44 | 28 |
| Lemon | Monroe | 3.50 | 2.50 | 2.95 | 56 |
| Lenape | Sullivan | 7.00 | 4.00 | 5.38 | 34 |
| Little Barbee | Kosciusko | 4.00 | 3.50 | 4.06 | 45 |
| Little Otter | Steuben | 7.75 | 4.75 | 5.75 | 30 |
| Little Pike | Kosciusko | 2.75 | 1.50 | 1.58 | 61 |
| Little Turkey | LaGrange | 5.50 | 3.00 | 3.30 | 55 |
| Long | Noble | 9.00 | 1.00 | 5.13 | 35 |
| Loon | Whitley | 11.00 | 3.75 | 7.31 | 23 |
| McClish | Steuben | 19.50 | 4.00 | 10.90 | 9 |
| Mill Pond | Marshall | 15.00 | 4.50 | 8.75 | 17 |
| Monroe | Brown/Monroe | 5.50 | 2.50 | 3.38 | 54 |
| Myers | Marshall | 18.25 | 9.25 | 10.17 | 11 |
| Otter | Steuben | 4.75 | 2.75 | 3.75 | 48 |
| Patton Park | Morgan | 6.00 | 2.50 | 3.40 | 53 |
| Pike | Kosciusko | 3.00 | 1.00 | 1.83 | 60 |
| Pretty | Marshall | 21.75 | 10.25 | 21.00 | 1 |
| Sand | Noble | 10.25 | 7.0 | 8.63 | 19 |
| Sawmill | Kosciusko | 4.00 | 3.50 | 3.80 | 47 |
| Sechrist | Kosciusko | 7.00 | 6.00 | 6.60 | 26 |
| Seven Sisters | Steuben | 16.50 | 10.00 | 14.20 | 3 |
| Shakamak | Sullivan | 6.50 | 4.25 | 5.54 | 32 |
| Simonton | Elkhart | 11.00 | 5.50 | 6.95 | 25 |
| Springmill | Lawrence | 6.50 | 1.00 | 3.50 | 52 |
| Sylvan | Noble | 8.75 | 3.00 | 4.31 | 43 |
| Wawasee | Kosciusko | 15.00 | 7.75 | 11.56 | 7 |
| Worster | St. Joseph | 4.75 | 3.00 | 3.70 | 50 |
| Yellowwood | Brown | 14.75 | 6.00 | 13.60 | 4 |

TABLE 36. *1991 Summary Results - Volunteer Secchi Disk Monitoring Program*

| LAKE | COUNTY | 1991 YEARLY MAXIMUM (FEET) | 1991 YEARLY MINIMUM (FEET) | 1991 JUL - AUG AVERAGE (FEET) | 1991 STATE RANK |
|---|---|---|---|---|---|
| Barton | Steuben | 15.00 | 9.00 | 12.00 | 7 |
| Bass | Porter | 3.00 | 2.00 | 2.00 | 59 |
| Big | Noble | 9.00 | 3.25 | 3.92 | 44 |
| Big Barbee | Kosciusko | 5.50 | 4.00 | 4.75 | 38 |
| Big Long | LaGrange | 16.50 | 8.75 | 11.70 | 8 |
| Big Turkey | LaGrange | 7.00 | 3.50 | 4.50 | 39 |
| Cedar | Lake | 1.25 | 0.50 | 0.50 | 62 |
| Center | Kosciusko | 11.00 | 2.50 | 3.44 | 49 |
| Chapman | Kosciusko | 12.50 | 6.00 | 8.00 | 23 |
| Cook | Marshall | 13.75 | 4.75 | 5.13 | 37 |
| Crooked | Noble | 15.50 | 7.25 | 12.17 | 6 |
| Dewart | Kosciusko | 20.50 | 8.00 | 8.67 | 19 |
| Dixon | Marshall | 6.75 | 2.50 | 5.25 | 34 |
| Flat | Marshall | 8.75 | 4.50 | 7.88 | 24 |
| Flint | Porter | 13.50 | 12.00 | 13.50 | 4 |
| Galbraith | Marshall | 3.50 | 2.25 | 3.13 | 51 |
| Goose | Whitley | 5.50 | 2.25 | 4.00 | 43 |
| Hamilton | Steuben | 10.50 | 4.50 | 5.17 | 36 |
| Holem | Marshall | 10.25 | 3.25 | 9.13 | 15 |
| Indiana | Elkhart | 22.00 | 7.50 | 8.88 | 17 |
| Irish | Kosciusko | 5.00 | 3.75 | 4.25 | 41 |
| Kickapoo | Sullivan | 13.50 | 13.25 | 13.42 | 5 |
| Kokomo | Howard | 2.00 | 1.00 | 1.25 | 61 |
| Koontz | Starke | 7.00 | 2.00 | 3.64 | 47 |
| Kreighbaum | Marshall | 17.50 | 6.50 | 8.88 | 18 |
| Kuhn | Kosciusko | 10.00 | 7.00 | 8.00 | 22 |
| Lake of the Woods | LKaGrange | 13.50 | 2.50 | 8.50 | 21 |
| Lake of the Woods | Marshall | 4.00 | 1.50 | 2.06 | 58 |
| Lake on the Green | Porter | 6.50 | 1.50 | 3.83 | 45 |
| Lawrence | Marshall | 11.00 | 5.00 | 10.00 | 13 |
| Lemon | Monroe | 3.50 | 2.00 | 2.75 | 54 |
| Lenape | Sullivan | 11.00 | 10.25 | 10.75 | 11 |

TABLE 36. *1991 Summary Results - Volunteer Secchi Disk Monitoring Program (cont.)*

| LAKE | COUNTY | 1990 YEARLY MAXIMUM (FEET) | 1990 YEARLY MINIMUM (FEET) | 1990 JUL - AUG AVERAGE (FEET) | 1990 STATE RANK |
|---|---|---|---|---|---|
| Little Barbee | Kosciusko | 4.50 | 3.50 | 4.00 | 42 |
| Little Long | Noble | 14.00 | 3.00 | 4.38 | 40 |
| Little Otter | Steuben | 10.00 | 4.50 | 6.88 | 27 |
| Little Pike | Kosciusko | 2.50 | 1.50 | 1.67 | 60 |
| Little Turkey | LaGrange | 13.50 | 2.50 | 3.00 | 52 |
| Long | Steuben | 4.25 | 2.25 | 2.60 | 55 |
| Long | Noble | 7.50 | 5.00 | 5.69 | 33 |
| Loon | Whitley | 13.00 | 3.50 | 6.17 | 30 |
| McClish | Steuben | 18.00 | 2.00 | 5.83 | 31 |
| Mill Pond | Marshall | 14.50 | 5.75 | 6.75 | 28 |
| Myers | Marshall | 12.00 | 6.00 | 8.67 | 20 |
| North Otter | Steuben | 11.00 | 5.00 | 6.75 | 29 |
| Pike | Kosciusko | 3.00 | 2.00 | 2.25 | 57 |
| Pretty | Marshall | 32.00 | 10.25 | 27.38 | 1 |
| Round | Noble | 16.00 | 3.00 | 5.75 | 32 |
| Royer | LaGrange | 7.50 | 3.00 | 5.25 | 35 |
| Sand | Noble | 10.75 | 3.75 | 6.92 | 26 |
| Saugany | LaPorte | 32.50 | 20.00 | 24.83 | 2 |
| Silver | Steuben | 11.25 | 9.50 | 10.92 | 10 |
| Simonton | Elkhart | 10.00 | 6.25 | 7.00 | 25 |
| Snow | Steuben | 11.00 | 7.00 | 8.92 | 16 |
| Springmill | Lawrence | 5.50 | 2.50 | 3.75 | 46 |
| Syl-van | Steuben | 13.50 | 6.00 | 10.50 | 12 |
| Sylvan | Noble | 10.00 | 2.00 | 2.38 | 56 |
| Tippecanoe | Kosciusko | 3.75 | 2.75 | 3.50 | 48 |
| Upper Long | Noble | 10.00 | 4.50 | 9.25 | 14 |
| Wawasee | Kosciusko | 16.50 | 9.50 | 11.38 | 9 |
| West Otter | Steuben | 9.00 | 2.75 | 3.42 | 50 |
| Worster | St. Joseph | 4.50 | 2.75 | 2.88 | 53 |
| Yellowwood | Brown | 18.25 | 4.25 | 15.71 | 3 |

TABLE 37. *1990 Transparency Classification - Volunteer Secchi 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% | 0% | 100% | 0% | 6 |
| Barton | Steuben | 0% | 100% | 0% | 0% | 7 |
| Bass | Porter | 0% | 0% | 64% | 36% | 11 |
| Big Barbee | Kosciusko | 0% | 0% | 100% | 0% | 8 |
| Big Otter | Steuben | 0% | 85% | 14% | 0% | 7 |
| Big Turkey | LaGrange | 0% | 29% | 71% | 0% | 7 |
| Cedar | Lake | 0% | 0% | 0% | 100% | 6 |
| Center | Kosciusko | 0% | 44% | 56% | 0% | 9 |
| Chapman | Kosciusko | 21% | 71% | 7% | 0% | 14 |
| Cook | Marshall | 0% | 9% | 45% | 45% | 11 |
| Crooked | Noble | 14% | 86% | 0% | 0% | 7 |
| Dewart | Kosciusko | 67% | 33% | 0% | 0% | 6 |
| Dixon | Marshall | 0% | 0% | 90% | 10% | 10 |
| Fish | LaGrange | 0% | 80% | 20% | 0% | 5 |
| Flat | Marshall | 55% | 45% | 0% | 0% | 11 |
| Flint | Porter | 0% | 100% | 0% | 0% | 7 |
| Galbraith | Marshall | 0% | 0% | 73% | 27% | 11 |
| Goose | Whitley | 0% | 18% | 73% | 9% | 11 |
| Hamilton | Steuben | 0% | 29% | 71% | 0% | 7 |
| Harper | Noble | 0% | 100% | 0% | 0% | 4 |
| Holem | Marshall | 0% | 64% | 27% | 9% | 11 |
| Indiana | Elkhart | 31% | 69% | 0% | 0% | 13 |
| Irish | Kosciusko | 0% | 0% | 100% | 0% | 6 |
| James | Steuben | 0% | 100% | 0% | 0% | 4 |
| Jimmerson | Steuben | 29% | 57% | 14% | 0% | 7 |
| Kickapoo | Sullivan | 88% | 13% | 0% | 0% | 8 |
| Knapp | Noble | 0% | 0% | 100% | 0% | 4 |
| Kokomo | Howard | 0% | 0% | 0% | 100% | 10 |
| Kreighbaum | Marshall | 0% | 91% | 9% | 0% | 11 |
| Kuhn | Kosciusko | 0% | 50% | 50% | 0% | 6 |
| Kunkel | Wells | 0% | 0% | 50% | 50% | 8 |
| Lake of the Woods | LaGrange | 0% | 8% | 92% | 0% | 12 |

TABLE 37. *1990 Transparency Classification - Volunteer Secchi Monitoring Program*

| 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 | Marshall | 0% | 17% | 58% | 25% | 12 |
| Lake on the Green | Porter | 0% | 0% | 43% | 57% | 7 |
| Lawrence | Marshall | 0% | 50% | 50% | 0% | 8 |
| Lemon | Monroe | 0% | 0% | 50% | 50% | 10 |
| Lenape | Sullivan | 0% | 20% | 80% | 0% | 5 |
| Little Barbee | Kosciusko | 0% | 0% | 100% | 0% | 6 |
| Little Otter | Steuben | 0% | 29% | 71% | 0% | 7 |
| Little Pike | Kosciusko | 0% | 0% | 0% | 100% | 9 |
| Little Turkey | LaGrange | 0% | 0% | 89% | 11% | 9 |
| Long | Noble | 0% | 14% | 57% | 29% | 7 |
| Loon | Whitley | 0% | 45% | 55% | 0% | 11 |
| McClish | Steuben | 9% | 18% | 73% | 0% | 11 |
| Mill Pond | Marshall | 9% | 82% | 9% | 0% | 11 |
| Monroe | Monroe | 0% | 0% | 75% | 25% | 4 |
| Myers | Marshall | 20% | 80% | 0% | 0% | 5 |
| Otter | Steuben | 0% | 0% | 67% | 33% | 6 |
| Patton Park | Morgan | 0% | 0% | 88% | 13% | 8 |
| Pike | Kosciusko | 0% | 0% | 11% | 89% | 9 |
| Pretty | Marshall | 91% | 9% | 0% | 0% | 11 |
| Sand | Noble | 0% | 100% | 0% | 0% | 7 |
| Sawmill | Kosciusko | 0% | 0% | 100% | 0% | 6 |
| Schrist | Kosciusko | 0% | 86% | 14% | 0% | 7 |
| Seven Sisters | Steuben | 43% | 57% | 0% | 0% | 7 |
| Shakamak | Sullivan | 0% | 17% | 83% | 0% | 6 |
| Simonton | Elkhart | 0% | 56% | 44% | 0% | 9 |
| Springmill | Lawrence | 0% | 17% | 67% | 17% | 6 |
| Sylvan | Noble | 0% | 43% | 57% | 0% | 7 |
| Wawasee | Kosciusko | 45% | 55% | 0% | 0% | 11 |
| Worster | St. Joseph | 0% | 0% | 100% | 0% | 7 |
| Yellowwood | Brown | 36% | 55% | 9% | 0% | 11 |

TABLE 38. *1991 Transparency Classification - Volunteer Secchi Disk Monitoring Program*

| LAKE | COUNTY | VERY GOOD > 13 ft. | GOOD 6.5 - 13 ft. | POOR 3 - 6.5 ft. | VERY POOR > = 3 ft. | TOTAL OBS. |
|---|---|---|---|---|---|---|
| Barton | Steuben | 14% | 86% | 0% | 0% | 7 |
| Bass | Porter | 0% | 0% | 0% | 100% | 10 |
| Big | Noble | 0% | 80% | 20% | 0% | 10 |
| Big Barbee | Kosciusko | 0% | 0% | 100% | 0% | 4 |
| Big Long | LaGrange | 29% | 71% | 0% | 0% | 7 |
| Big Turkey | LaGrange | 0% | 25% | 75% | 0% | 4 |
| Cedar | Lake | 0% | 0% | 0% | 100% | 6 |
| Center | Kosciusko | 0% | 9% | 82% | 9% | 11 |
| Chapman | Kosciusko | 0% | 80% | 20% | 0% | 10 |
| Cook | Marshall | 10% | 20% | 70% | 0% | 10 |
| Crooked | Noble | 13% | 88% | 0% | 0% | 8 |
| Dewart | Kosciusko | 33% | 67% | 0% | 0% | 6 |
| Dixon | Marshall | 0% | 10% | 70% | 20% | 10 |
| Flat | Marshall | 0% | 60% | 40% | 0% | 10 |
| Flint | Porter | 29% | 71% | 0% | 0% | 7 |
| Galbraith | Marshall | 0% | 0% | 50% | 50% | 10 |
| Goose | Whitley | 0% | 0% | 60% | 40% | 5 |
| Hamilton | Steuben | 0% | 50% | 50% | 0% | 10 |
| Holm | Marshall | 0% | 40% | 60% | 0% | 10 |
| Indiana | Elkhart | 40% | 60% | 0% | 0% | 10 |
| Irish | Kosciusko | 0% | 0% | 100% | 0% | 4 |
| Kickapoo | Sullivan | 100% | 0% | 0% | 0% | 5 |
| Kokomo | Howard | 0% | 0% | 0% | 100% | 6 |
| Koontz | Starke | 0% | 5% | 63% | 32% | 19 |
| Kreighbaum | Marshall | 20% | 70% | 10% | 0% | 10 |
| Kuhn | Kosciusko | 0% | 100% | 0% | 0% | 4 |
| Lake of the Woods | Marshall | 0% | 0% | 20% | 80% | 10 |
| Lake of the Woods | LaGrange | 8% | 58% | 25% | 8% | 12 |
| Lake on the Green | Porter | 0% | 0% | 69% | 31% | 13 |
| Lawrence | Marshall | 0% | 80% | 20% | 0% | 5 |
| Lemon | Monroe | 0% | 0% | 14% | 86% | 7 |
| Lenape | Sullivan | 0% | 100% | 0% | 0% | 4 |

TABLE 38. *1991 Transparency Classification - Volunteer Secchi Disk 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. |
|---|---|---|---|---|---|---|
| Little Barbee | Kosciusko | 0% | 0% | 100% | 0% | 4 |
| Little Long | Noble | 11% | 0% | 89% | 0% | 9 |
| Little Otter | Steuben | 0% | 40% | 60% | 0% | 10 |
| Little Pike | Kosciusko | 0% | 0% | 0% | 100% | 10 |
| Little Turkey | LaGrange | 11% | 11% | 33% | 44% | 9 |
| Long | Steuben | 0% | 0% | 27% | 73% | 11 |
| Long | Noble | 0% | 14% | 86% | 0% | 7 |
| Loon | Whitley | 0% | 67% | 33% | 0% | 9 |
| McClish | Steuben | 33% | 33% | 25% | 8% | 12 |
| Mill Pond | Marshall | 10% | 80% | 10% | 0% | 10 |
| Myers | Marshall | 0% | 80% | 20% | 0% | 5 |
| North Otter | Steuben | 0% | 60% | 40% | 0% | 10 |
| Pike | Kosciusko | 0% | 0% | 100% | 0% | 10 |
| Pretty | Marshall | 80% | 20% | 0% | 0% | 10 |
| Round | Noble | 11% | 44% | 67% | 11% | 9 |
| Royer | LaGrange | 0% | 25% | 50% | 25% | 4 |
| Sand | Noble | 0% | 50% | 50% | 0% | 6 |
| Saugany | LaPorte | 100% | 0% | 0% | 0% | 8 |
| Silver | Steuben | 0% | 100% | 0% | 0% | 5 |
| Simonton | Elkhart | 0% | 60% | 40% | 0% | 10 |
| Snow | Steuben | 0% | 100% | 0% | 0% | 4 |
| Springmill | Lawrence | 0% | 0% | 71% | 29% | 7 |
| Syl-van | Steuben | 13% | 75% | 13% | 0% | 8 |
| Sylvan | Noble | 0% | 29% | 14% | 57% | 7 |
| Tippecanoe | Kosciusko | 0% | 0% | 40% | 60% | 5 |
| Upper Long | Noble | 0% | 40% | 60% | 0% | 5 |
| Wawasee | Kosciusko | 30% | 70% | 0% | 0% | 10 |
| West Otter | Steuben | 0% | 20% | 80% | 0% | 5 |
| Worster | St. Joseph | 0% | 0% | 25% | 75% | 4 |
| Yellowwood | Brown | 67% | 17% | 17% | 0% | 12 |

FIGURE 4. *Percent of Lakes in Transparency Class (July - August Means: 1990)*

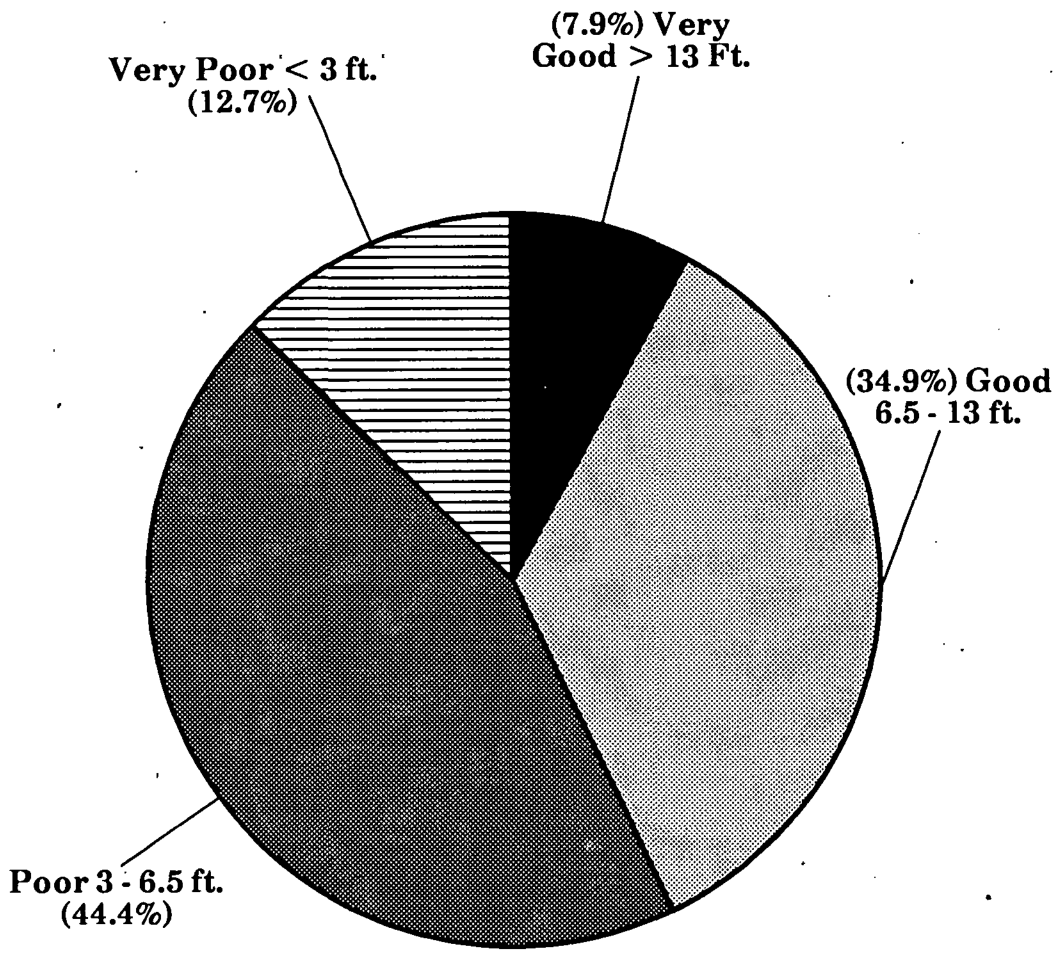


**FIGURE 5.** *Percent of Lakes in Transparency Class (July - August Means: 1990)*

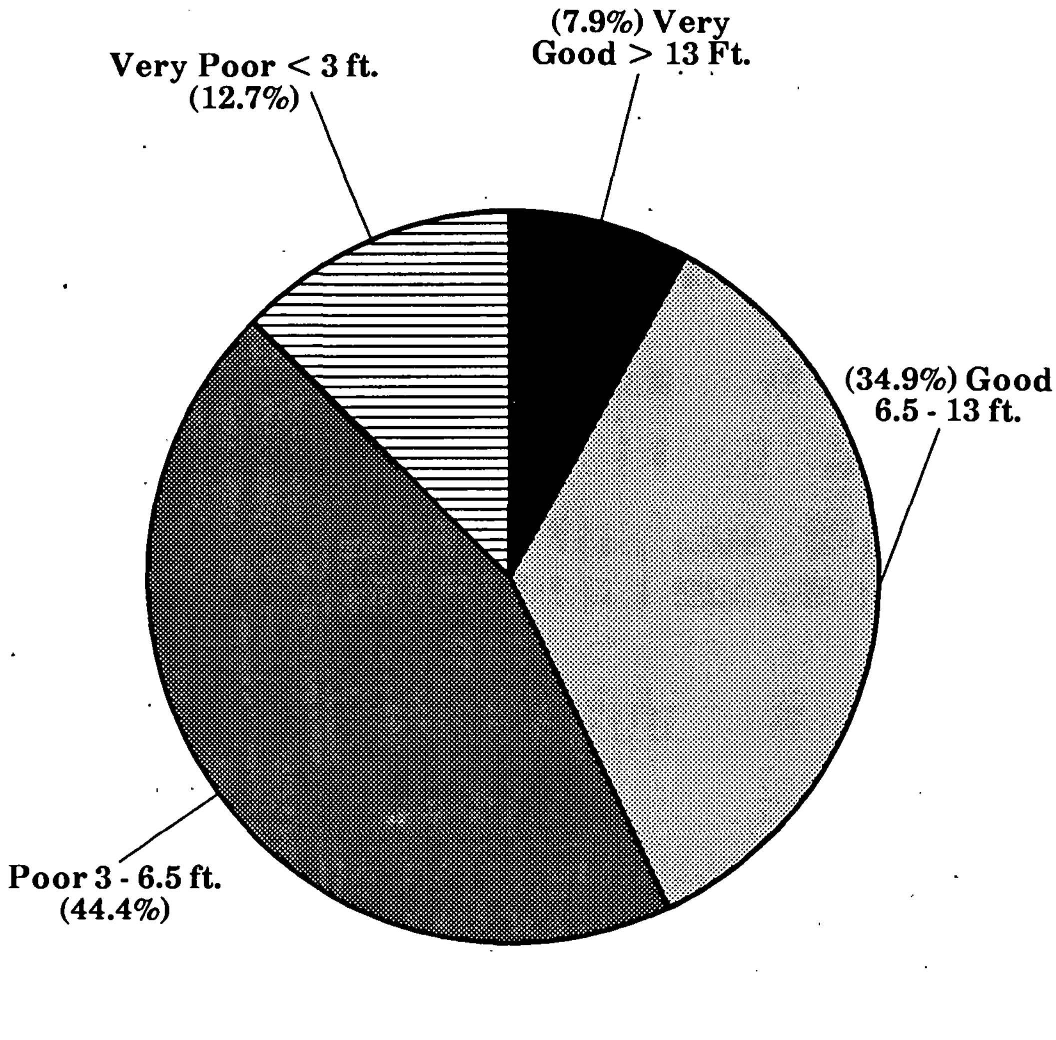


TABLE 39. *1990-91 Percent Change in July - August Mean*

| LAKE | COUNTY | 1991 JUL - AUG MEAN (Ft.) | 1990 JUL - AUG MEAN (Ft.) | 1990-1991 % CHANGE JUL - AUG MEAN |
|---|---|---|---|---|
| Barton | Steuben | 12.00 | 9.00 | 33% |
| Bass | Porter | 2.00 | 3.50 | -43% |
| Big Barbee | Kosciusko | 4.75 | 4.40 | 8% |
| Big Long | LaGrange | 11.70 | 15.40 | -24% |
| Big Turkey | LaGrange | 4.50 | 5.56 | -19% |
| Cedar | Lake | 0.50 | 0.67 | -25% |
| Center | Kosciusko | 3.44 | 5.50 | -37% |
| Chapman | Kosciusko | 8.00 | 7.10 | 13% |
| Cook | Marshall | 5.13 | 2.91 | 76% |
| Crooked | Noble | 12.17 | 9.90 | 23% |
| Dewart | Kosciusko | 8.67 | 12.00 | -33% |
| Dixon | Marshall | 5.25 | 4.33 | 21% |
| Flat | Marshall | 7.88 | 6.13 | 29% |
| Flint | Porter | 13.50 | 11.00 | 23% |
| Galbraith | Marshall | 3.13 | 3.75 | -17% |
| Goose | Whitley | 4.00 | 4.00 | 0% |
| Hamilton | Steuben | 5.17 | 4.70 | 10% |
| Holem | Marshall | 9.13 | 9.06 | 1% |
| Indiana | Elkhart | 8.88 | 9.60 | -7% |
| Irish | Kosciusko | 4.25 | 4.10 | 4% |
| Kickapoo | Sullivan | 13.42 | 13.50 | -1% |
| Kokomo | Howard | 1.25 | 1.50 | -17% |
| Kreighbaum | Marshall | 8.88 | 8.63 | 3% |
| Kuhn | Kosciusko | 8.00 | 6.50 | 23% |
| Lake of the Woods | LaGrange | 8.50 | 4.50 | 89% |
| Lake of the Woods | Marshall | 2.06 | 2.40 | -14% |
| Lake on the Green | Porter | 3.83 | 2.38 | 61% |
| Lawrence | Marshall | 10.00 | 6.44 | 55% |
| Lemon | Monroe | 2.75 | 2.95 | -7% |
| Lenape | Sullivan | 10.75 | 5.38 | 100% |
| Little Barbee | Kosciusko | 4.00 | 4.06 | -1% |
| Little Otter | Steuben | 6.88 | 5.75 | 20% |

TABLE 39. *1990-91 Percent Change in July - August Mean*

| LAKE | COUNTY | VERY GOOD > 13 ft. | GOOD 6.5 - 13 ft. | POOR 3 - 6.5 ft. |
|---|---|---|---|---|
| Little Pike | Kosciusko | 1.67 | 1.58 | 6% |
| Little Turkey | LaGrange | 3.00 | 3.30 | -9% |
| Long | Noble | 5.69 | 5.13 | 11% |
| Loon | Whitley | 6.17 | 7.31 | -16% |
| McClish | Steuben | 5.83 | 10.90 | -47% |
| Mill Pond | Marshall | 6.75 | 8.75 | -23% |
| Myers | Marshall | 8.67 | 10.17 | -15% |
| Pike | Kosciusko | 2.25 | 1.83 | 23% |
| Pretty | Marshall | 27.38 | 21.00 | 30% |
| Sand | Noble | 6.92 | 8.63 | -20% |
| Simonton | Elkhart | 7.00 | 6.95 | 1% |
| Springmill | Lawrence | 3.75 | 3.50 | 7% |
| Sylvan | Noble | 2.38 | 4.31 | -45% |
| Wawasee | Kosciusko | 11.38 | 11.56 | -2% |
| Worster | St. Joseph | 2.88 | 3.70 | -22% |
| Yellowwood | Brown | 15.71 | 13.60 | 16% |

six to a worse (less transparent) category and 34 remained in the same category (Table 40).

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.

The warm and drought like temperatures during the summer of 1990-91 provided conditions which encouraged the growth and expansion of rooted aquatic macrophytes and algae in many of Indiana's lakes and reservoirs. Aquatic herbicide permits issued by the IDNR for 1990-91 numbered 157 as compared to 235 for 1988-89. A total of 3,174 acres of water in 75 different lakes were treated, 1,061 acres during 1990 and 1,513 acres during 1991 (Table 41). The 3,174 acres treated during 1990-91 represents 5% of the total surface area of Indiana's public lakes and reservoirs. The lake with the most acres treated was Pike Lake where 203 acres were treated in 1990 and 103 acres were treated in 1991. 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.

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. The lake discharge policy also calls for the installation of phosphorus removal for any discharge of sanitary wastewater 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

**TABLE 40.** *Shifts in Water Clarity Category: 1990 to 1991*

| | |
|---|---|
| MOVED TO BETTER CATEGORY | 8 |
| MOVED TO WORSE CATEGORY | 6 |
| REMAINED IN SAME CATEGORY | 34 |

TABLE 41. *Aquatic Herbicide Permits*

| LAKE | COUNTY | DATE | ACRES TREATED | MACROPHYTES / ALGAE* |
|---|---|---|---|---|
| Lake Forest | Adams | 1990 | 9 | 4/MC |
| Lake Point | Allen | 1990 | 2 | 4/MC |
| Story | DeKalb | 1990 | 6 | 3/C |
| New Holland | Dubois | 1991 | 6 | 1/P |
| Old Holland | Dubois | 1990 | 11 | 4/C |
| Old Holland | Dubois | 1991 | 14 | 2/F |
| Eastview Channel | Elkhart | 1990 | 4 | 2/F |
| Eastview Channel | Elkhart | 1991 | 4 | 2/F |
| Heaton | Elkhart | 1990 | 25 | 4/M |
| Heaton | Elkhart | 1991 | 2 | 2/M |
| Simonton | Elkhart | 1990 | 28 | 2/C |
| Simonton | Elkhart | 1991 | 2 | 4/C |
| Simonton | Elkhart | 1991 | 25 | 3/M |
| Bruce | Fulton | 1990 | 16 | 3/MC |
| Bruce | Fulton | 1991 | 30 | 2/C |
| Morse Reservoir | Hamilton | 1990 | 20 | 1/PM |
| Beavor Dam | Kosciusko | 1990 | 40 | 2/M |
| Beaver Dam | Kosciusko | 1991 | 40 | 2/M |
| Big Barbee | Kosciusko | 1990 | 24 | 3/M |
| Big Barbee | Kosciusko | 1991 | 24 | 3/CP |
| Center Lake | Kosciusko | 1990 | 120 | 3/F |
| Center Lake | Kosciusko | 1991 | 120 | 1/M |
| Chapman | Kosciusko | 1990 | 5 | 4/M |
| Chapman | Kosciusko | 1990 | 7.5 | 4/C |
| Chapman | Kosciusko | 1991 | .5 | 2/C |
| Chapman | Kosciusko | 1991 | 18 | 2/F |
| Dewart | Kosciusko | 1990 | 4.5 | 2/F |
| Dewart | Kosciusko | 1990 | 4 | 4/M |
| Dewart | Kosciusko | 1991 | 4 | 2/P |
| Dewart | Kosciusko | 1991 | 5.5 | 2/F |
| Enchanted Hills | Kosciusko | 1990 | 30 | 3/F |
| Witmer | LaGrange | 1991 | 8 | 3/PC |
| Witmer | LaGrange | 1991 | 2 | 1/F |

TABLE 41. *Aquatic Herbicide Permits (cont.)*

| LAKE | COUNTY | DATE | ACRES TREATED | MACROPHYTES / ALGAE* |
|---|---|---|---|---|
| Webster | Kosciusko | 1990 | 5 | 2/M |
| Webster | Kosciusko | 1991 | 5 | 4/C |
| Webster | Kosciusko | 1991 | 89 | 4/M |
| Cedar | Lake | 1990 | 10 | 2/M |
| Cedar | Lake | 1990 | 2 | 3/C |
| Dalecarlia | Lake | 1990 | 3 | 2/F |
| Wolf | Lake | 1990 | 4 | 2F |
| Wolf | Lake | 1990 | 2 | 3/M |
| Wolf | Lake | 1991 | 1 | 3/C |
| Fish | LaPorte | 1990 | 3 | 2/F |
| Fish | LaPorte | 1991 | 100 | 2/F |
| Hidden Shores | LaPorte | 1991 | 10 | 2/M |
| Hudson | LaPorte | 1990 | 5 | 2F |
| Hudson | LaPorte | 1990 | 3 | 4/C |
| Pine | LaPorte | 1990 | 20 | 2/C |
| Pine | LaPorte | 1991 | 10 | 2/C |
| Pine | LaPorte | 1991 | 2 | 3/M |
| Stone | LaPorte | 1990 | 5 | 4/FC |
| Indianapolis Canal | Marion | 1990 | 3 | 4/C |
| Cook | Marshall | 1990 | 4.5 | 3/FC |
| Cook | Marshall | 1990 | 2.5 | 3/C |
| Cook | Marshall | 1991 | 10 | 3/M |
| Dixon | Marshall | 1990 | 1 | 3/P |
| Flat | Marshall | 1991 | 2 | 4/CM |
| Gilbert | Marshall | 1990 | 1 | 2/M |
| Gilbert | Marshall | 1991 | 3 | 2/M |
| Koontz | Marshall | 1990 | 25 | 2/F |
| Latonka | Marshall | 1991 | 4 | 3/P |
| Lake Lemon | Monroe | 1990 | 30 | 3/MC |
| Lake Lemon | Monroe | 1991 | 20 | 3/CM |
| Waveland | Montgomery | 1990 | 10 | 2/M |
| Bear | Noble | 1990 | 3 | 1/M |
| Bixler | Noble | 1990 | 4.5 | 4/C |

TABLE 41. *Aquatic Herbicide Permits (cont.)*

| LAKE | COUNTY | DATE | ACRES TREATED | MACROPHYTES / ALGAE* |
|---|---|---|---|---|
| Bixler | Noble | 1991 | 5 | 4/C |
| Hall | Noble | 1990 | 3 | 4/M |
| Hall | Noble | 1990 | 4 | 2/C |
| Hall | Noble | 1990 | 2 | 3/M |
| Henderson | Noble | 1990 | 3 | 4/MC |
| High | Noble | 1991 | 3 | 4/C |
| High | Noble | 1991 | 1 | 2/P |
| Little Long | Noble | 1991 | 5 | 4/PM |
| Lower Long | Noble | 1990 | 2 | 3/M |
| Lower Long | Noble | 1991 | 7 | 4/C |
| Tamarak | Noble | 1990 | 2 | 3/C |
| Billington | Porter | 1991 | 10 | 1/M |
| Bass | St. Joseph | 1990 | 3 | 2/F |
| Bass | St. Joseph | 1990 | 2 | 3/C |
| Riddles | St. Joseph | 1991 | 3 | 2/P |
| Riddles | St. Joseph | 1991 | 1 | 2/M |
| Barton | Steuben | 1990 | 3 | 2/M |
| Big Turkey | Steuben | 1991 | 7 | 2/M |
| Big Turkey | Steuben | 1991 | 80 | 3/F |
| Center | Steuben | 1990 | 15 | 3/C |
| Failing | Steuben | 1990 | 1 | 1/M |
| Fish | Steuben | 1990 | 3 | 4/C |
| Fish | Steuben | 1990 | 4 | 3/M |
| Gage | Steuben | 1990 | 20 | 1/M |
| Gage | Steuben | 1991 | 28 | 3/F |
| Jimmerson | Steuben | 1990 | 10 | 2/C |
| Little Center | Steuben | 1991 | 3 | 4/M |
| Snow | Steuben | 1990 | 2 | 4/MC |
| Snow | Steuben | 1990 | 20 | 4/C |
| Fowler Park | Vigo | 1990 | 7 | 2/C |
| Big Cedar | Whitley | 1990 | 1 | 2/P |
| Dollar | Whitley | 1991 | 3 | 1/M |
| Enchanted Hills | Kosciusko | 1991 | 25 | 2/M |

TABLE 41. *Aquatic Herbicide Permits (cont.)*

| LAKE | COUNTY | DATE | ACRES TREATED | MACROPHYTES / ALGAE* |
|---|---|---|---|---|
| Irish | Kosciusko | 1990 | 39 | 4/C |
| Irish | Kosciusko | 1991 | 39 | 2/M |
| James | Kosciusko | 1990 | 2 | 4/C |
| James | Kosciusko | 1991 | 1.75 | 4/C |
| Kuhn | Kosciusko | 1990 | 20 | 2/M |
| Kuhn | Kosciusko | 1991 | 20 | 2/F |
| Little Barbee | Kosciusko | 1990 | 13 | 2/FC |
| Little Barbee | Kosciusko | 1991 | 13 | 1/F |
| Loon | Kosciusko | 1990 | 40 | 1/M |
| McClures | Kosciusko | 1990 | 20 | 2/M |
| McClures | Kosciusko | 1991 | 32 | 4/C |
| North Little | Kosciusko | 1990 | 2 | 3/C |
| Oswego | Kosciusko | 1991 | 41 | 2/M |
| Papakeechie | Kosciusko | 1990 | 40 | 4/C |
| Pike | Kosciusko | 1990 | 203 | 2/M |
| Pike | Kosciusko | 1991 | 180 | 1/C |
| Ridinger | Kosciusko | 1990 | 10 | 1/FC |
| Ridinger | Kosciusko | 1991 | 12 | 4/C |
| Ridinger | Kosciusko | 1991 | 1 | 2/F |
| Sawmill | Koscisuko | 1990 | 10 | 4/C |
| Sawmill | Kosciusko | 1990 | 2 | 2/M |
| Sechrist | Kosciusko | 1990 | 15 | 1/M |
| Sechrist | Kosciusko | 1991 | 8 | 2/FC |
| Smalley | Kosciusko | 1991 | 4 | 1/M |
| Syracuse | Kosciusko | 1990 | 1 | 3/F |
| Tippecanoe | Kosciusko | 1990 | 12 | 2/F |
| Tippecanoe | Kosciusko | 1990 | 12 | 3/C |
| Tippecanoe | Kosciusko | 1991 | 12 | 3/C |
| Tippecanoe | Kosciusko | 1991 | 12 | 3/C |
| Waubee | Kosciusko | 1990 | 2.5 | 2/M |
| Waubee | Kosciusko | 1990 | 8 | 2/M |
| Waubee | Kosciusko | 1991 | 4 | 3/C |
| Wawasee | Kosciusko | 1990 | .5 | 3/C |

TABLE 41. *Aquatic Herbicide Permits (cont.)*

| LAKE | COUNTY | DATE | ACRES TREATED | MACROPHYTES / ALGAE* |
|---|---|---|---|---|
| Wawasee | Kosciusko | 1990 | 15 | 3/F |
| Wawasee | Kosciusko | 1991 | 4 | 2/M |
| Wawasee | Kosciusko | 1991 | .5 | 2/M |
| Adams | LaGrange | 1990 | 20 | 4/MC |
| Adams | LaGrange | 1991 | 16 | 4/P |
| Appleman | LaGrange | 1990 | 50 | 3/F |
| Cotton | LaGrange | 1991 | 20 | 2/C |
| Eve | LaGrange | 1990 | 25 | 3/C |
| Hayward | LaGrange | 1991 | 6 | 3/M |
| Lake of the Woods | LaGrange | 1990 | 136 | 2/P - 1/M |
| Lake of the Woods | LaGrange | 1991 | 136 | 2/C - 1/CM |
| Little Turkey | LaGrange | 1991 | 135 | 2/M |
| Messich | LaGrange | 1990 | 10 | 4/C |
| Meteer | LaGrange | 1991 | 10 | 3/C |
| Oliver | LaGrange | 1990 | 7 | 2/M |
| Oliver | LaGrange | 1991 | 4 | 4/C |
| Pretty | LaGrange | 1990 | 2 | 4/F |
| Pretty | LaGrange | 1991 | 1 | 1/C |
| Shipshewana | LaGrange | 1990 | 200 | 2/M |
| Shipshewana | LaGrange | 1991 | 20 | 2/M |
| Still | LaGrange | 1991 | 30 | 3/M |
| Weir | LaGrange | 1990 | 6 | 3/FC |
| Weir | LaGrange | 1991 | 6 | 2/C |
| Witmer | LaGrange | 1990 | 4 | 3/M |

* *Macrophytes*

*1. = Watermilfoil (Myrophyllum sp.)*
*2. = Elodea sp.*
*3. = Pondweed (Potomogeton sp.)*
*4. = Broadleafed*

*Algae*

*F = Filamentous*
*P = Planktonic*
*M = Mixed*
*C = Chara*

application of sludges and animal wastes. These requirements are designed to prevent or reduce runoff of these material 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 DEM.

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 a cigarette tax increase 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 non-point 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. It also receives the effluent from the small wastewater treatment plant of Ancilla Domini College. Gilbert Lake has been awarded the maximum possible score of 75 eutrophy 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 will 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 acre) state owned impoundment that has 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 aesthetics 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 tree 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 eutrophication 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 6). The St. Joseph River and its tributaries will be referred to as the Lake Michigan Basin-Northeast in this report (Figure 7). 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.

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 continguous harbor areas have been designated for multiple use purposes 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 Board of Health (ISBH). 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

**FIGURE 6.** *LAKE MICHIGAN BASIN - NORTHWEST*

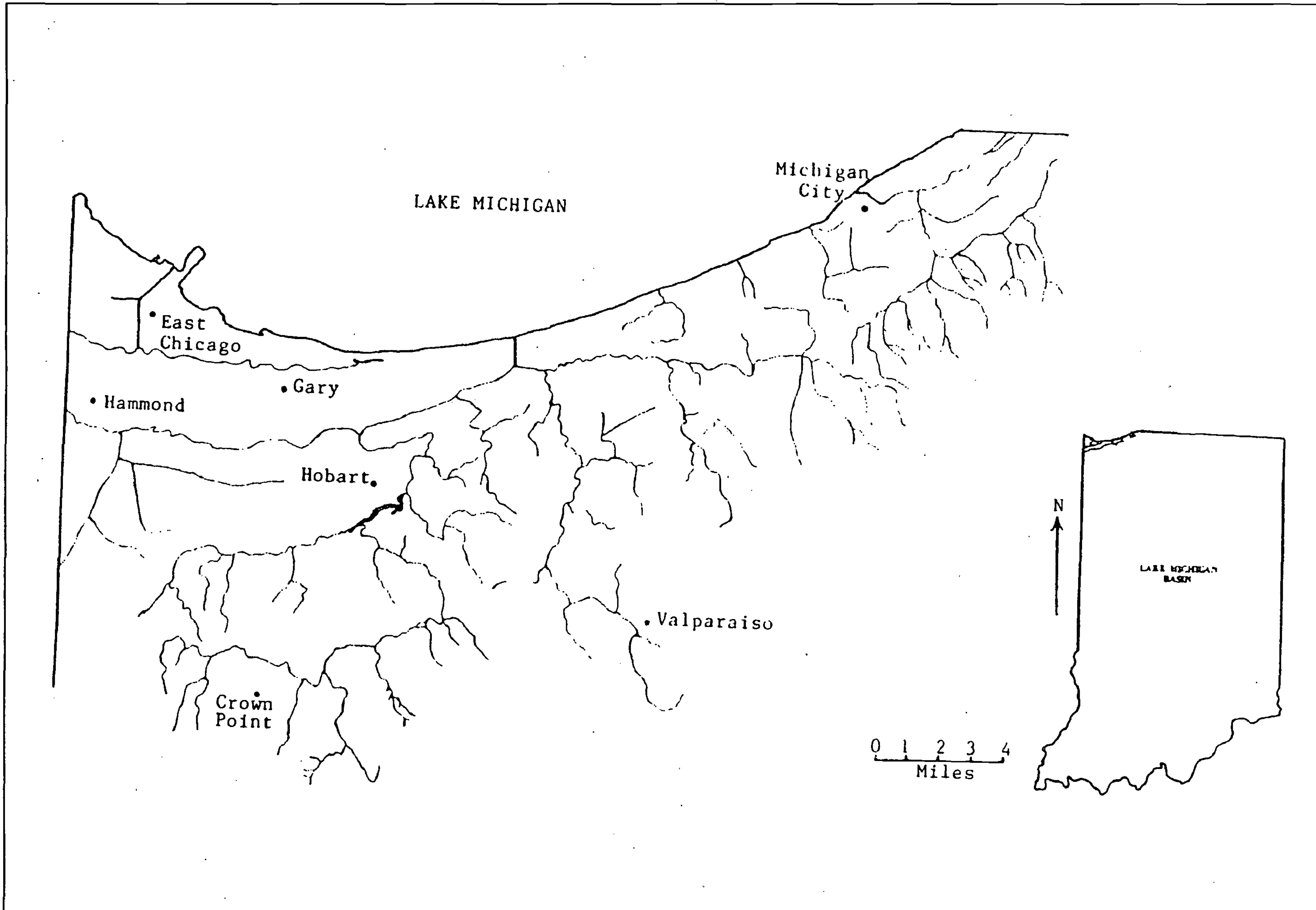
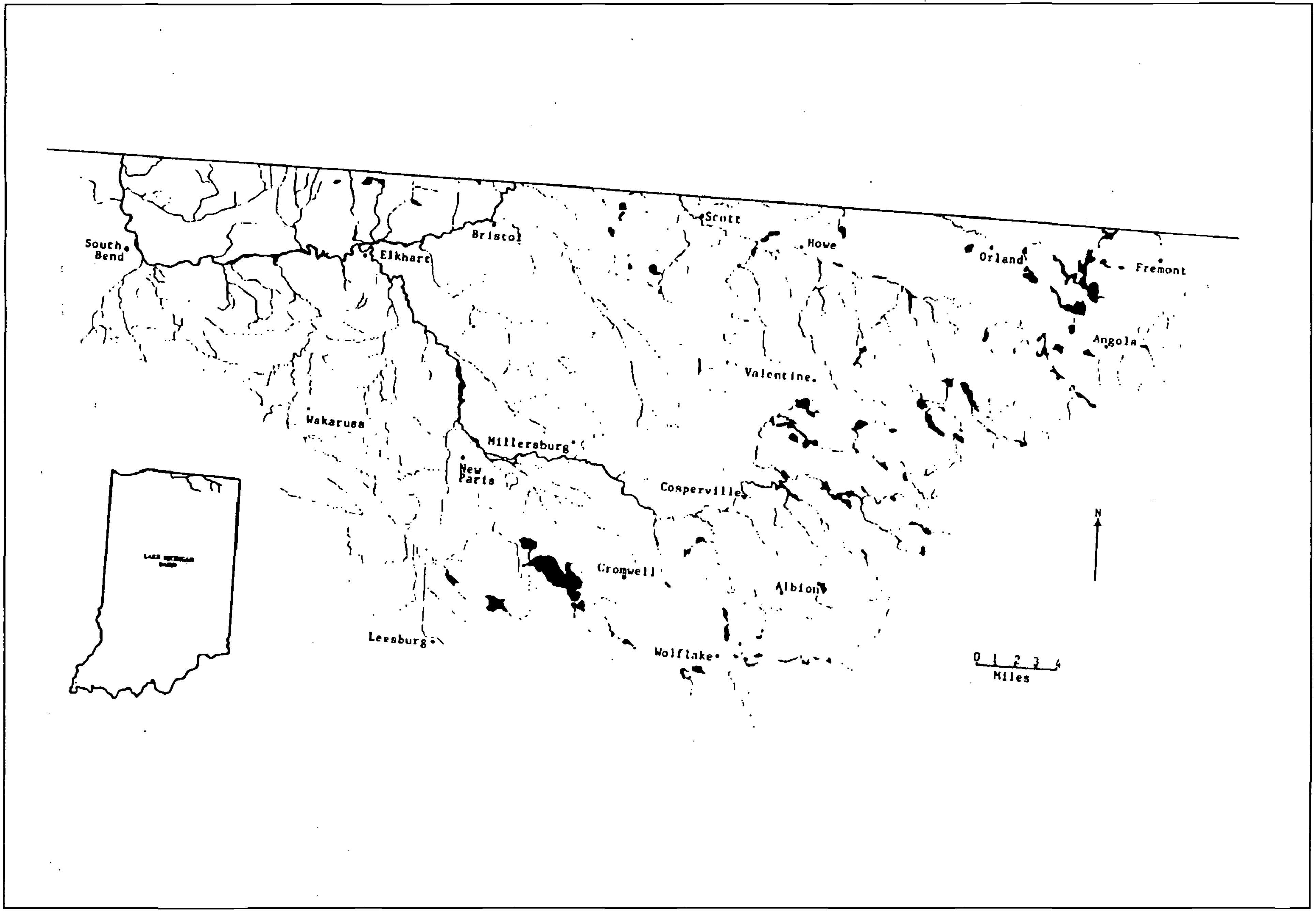


FIGURE 7. *LAKE MICHIGAN BASIN - NORTHEAST*



copper concentrations, Lake Michigan (43 shoreline miles) is determined to only partially support its designated aquatic life uses. Recreational uses are fully supported.

Lake Michigan Basin - Northwest

An assessment of designated aquatic life use support was made for 169 stream miles in this subbasin and 60 miles were assessed for recreational use. The waters assessed, support status, miles affected, and probable causes of impairment are shown in Table 42. Additional information for certain stream reaches are also provided.

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 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 fishkills, however, were reported from 1988 through 1991. 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. The City has also increased the capacity of the STP to handle larger volumes of wastewater which has reduced the frequency of bypassing.

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 tool Michigan City is using to accomplish that objective. The 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 developed in response to the need for reducing toxicity in complex effluents such as Michigan City, to acceptable levels consistently. 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. Violation in this reach of the stream were similar in frequency during

TABLE 42. *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)<br>NS (Recreational) | Monitored (b)(c) | D.O.<br>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<br>Portage | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | D.O.<br>E. coli | 4 | Biological Assessment "Poor". |
| Dunes Creek | Tremont | NS (Aquatic Life) | Monitored (b) | Channelization<br>E. coli | 5 | Biological Assessment "Poor". |
| Kintzele Ditch and its Tributaries | Michigan City | FS (Aquatic Life)<br>(Threatened) | Evaluated | Channelization | 5 | |
| Upper Trail Creek and its Tributaries | Michigan City | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Agricultural Run-off | 42 | |
| Lower Trail Creek | Michigan City | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | D.O.<br>E. coli<br>PCB'S | 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<br>Lalimere | FS (Aquatic Life) | Evaluated | | 13 | |
| Burns Ditch | Lake Station<br>Portage | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli<br>PCB's | 8 | a) Well operated facility. Some bypassing during wet weather. Portage and IDEM working on alternatives to bypassing.<br>b) Burns Harbor developing an operational control program to eliminate violations to NIPSCO facility.<br>c) Biological Assessment "Poor". |
| Little Calumet River | Gary | NS (Aquatic Life) | Monitored (b)(c) | Cyanide<br>E. coli | 7 | |

Table 42. *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 | Porter<br>Chesterton | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | E. coli<br>Cyanide | 6 | |
| Unnamed Trib of Little Calumet River | Pine | FS (Aquatic Life) | Monitored (b) | | 3 | Biological Assessment "Fair". |
| Little Calumet River | Hammond | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | E. coli<br>Cyanide | 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<br>Hobart POTW<br>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.<br>Run-off<br>Channelization | 10 | |
| Indiana Harbor Canal | Whiting<br>E. Chicago | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | PCB<br>D.O.<br>Mercury<br>E. coli | 4 | a) Fish Consumption Advisory.<br>b) Biological Assessment, "Very Poor". |
| Lake George Branch of Indiana Harbor Canal | East Chicago | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | Oil & Grease<br>E. coli<br>PCB's<br>D.O. | 1 | a) Multiple Sources<br>b) Fish Consumption Advisory<br>c) Oil Leachate from Amoco Oil and ECI property |
| E. Branch Grand Calumet River | Gary<br>East Chicago | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | Oil & Grease<br>E. coli<br>Lead<br>Cyanide<br>PCB | 10 | Biological Assessment, "Very Poor". |
| W. Branch Grand Calumet River | Hammond<br>East Chicago | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | E. coli<br>D.O.<br>PCB's<br>Lead<br>Ammonia<br>CSO's | 3 | a) The Hammond Sanitary District has caused severe degradation of the river in the past.<br>b) Biological Assessment, "Poor".<br>c) Fish consumption advisory. |

Table 42. *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 |
|---|---|---|---|---|---|---|
| Plum Creek | Dyer | FS (Aquatic Life) | Evaluated | | 4 | |
| Hart Ditch | Munster<br>Highland | FS (Aquatic Life) | Evaluated | | 2 | |
| Dyer Ditch | Dyer | NS (Aquatic Life) | Monitored (b) | Ammonia | 2 | a) Facility is undersized, the sewers inadequate. New wastewater treatment facility is starting Spring 1992. Current staff has made outstanding improvements in operations.<br>b) Biological Assessment, "Very Poor". |
| Kaiser Ditch | Lincoln Village | FS (Aquatic Life) | Evaluated | | 1 | |
| Beaver Dam Ditch | Crown Point | NS (Aquatic Life) | Monitored (b) | Crown Point POTW<br>Poor Habitat<br>Ammonia<br>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 - Note Supported. If a use is not listed, it was not monitored or evaluated.*

*b = biological, c = chemical.*

1988-89. Stations on the upper portion of the stream had dissolved oxygen concentrations below this criterion less than 10% of the time. The E. coli bacteria criteria were violated often enough during 1990-91 that the designated recreational uses were not supported. No violations of unionized ammonia standards occurred during this two 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.

Biological sampling in Trail Creek has been conducted since 1979. In 1984 and 1986, monitoring surveys found few individuals and species of fish in the lower reach of Trail Creek. Hester-Dendy macroinvertebrate samples collected in 1986 at the Franklin Street Bridge near the stream mouth had two to ten times higher density than in any previous year mostly due to increased numbers of midge larvae of types indicative of sewage pollution in slow moving waters. This station had always been dominated by organisms tolerant of low D.O. But in 1986 the water quality appeared to have declined further, perhaps due to the construction activities at the Michigan City sewage treatment facility. In 1988, the Hester-Dendy macroinvertebrate samples had improved significantly, perhaps reflecting the better treatment at the Michigan City STP. Organisms intolerant to toxics and suspended sediments were present. The midge, **Glyptotendipes**, was dominant, but in much smaller numbers than in 1986. There should have been more genera of midges present, however, and their absence indicates that dissolved oxygen concentrations of Trail Creek may still be periodically low enough to be limiting to some organisms. Macroinvertebrate samples were taken during 1990 in Trail Creek.

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 during the 1990-91 period. The cyanide criterion, however, was exceeded at the acute level often enough that this portion of the Little Calumet River is not supportive of the aquatic life designation. Violations of the bacteriological standard for whole body contact recreation occurred 90% of the time (as it did in 1988-89).

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 1991 for total solids and TBOD may be eliminated after completion of some on going 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 1991, plant construction plans include 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 should start in Spring 1992 and alleviate the exceedances for TSS and TBOD.

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 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. Recent fish community sampling, however, indicates that the biological integrity of Salt Creek is poor. These results cause the stream to be considered nonsupportive of aquatic life.

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 plan 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 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 of 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. During 1988-89, this facility had six NPDES violations, the most significant of these were exceedances of the monthly average value for iron. Mechanical problems were primarily responsible for these violations. Improved plant maintenance and an improved treatment process has recently proved beneficial in eliminating these violations.

Macroinvertebrate samples collected in 1988 were very similar to those collected in 1986. All the organisms were facultative for low dissolved oxygen tolerance, but toxics sensitive species were present. The major concern is the large increase in numbers of nardid oligochaetes which sometimes indicates silt stress. The 1988 Hester-Dendy samplers were covered with noticeably greater amounts of silt than those in 1986. Hester-Dendy samples were not collected in the 1990-91 period.

Burns Ditch is included in the fish consumption advisory for Lake Michigan and its tributaries. Also, 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 1990-91 were examined. Cyanide was prevalent in these waters, and violations of the acute criterion for this substance were found at three of the stations from 3% to 23% of the time. No violations for D.O. were found at any of the Grand Calumet River/Indiana Harbor Canal stations, however, a 1990 fish community sampling assessment indicates that D.O. levels may be of concern at times. 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 occassionally 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. 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 43.

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. Hammond received $5.0 million in construction grant funding in 1987 for plant expansion and advanced wastewater treatment, including ammonia removal.

Civil action is proceeding against the Hammond Sanitary District, as well as criminal investigations. The illegal bypassing issue is now resolved and the plant is working better than in the past years. Limits for phenols, sulfate and chlorides are exceeded regularly regardless of plant conditions. Action involving a Feasibility Study and Consent Decree against Hammond is also pending with IDEM and U.S. EPA. A final ruling has yet to be determined.

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 the pretreatment program has been effective.

The Gary STP has been involved in judicial proceedings throughout 1988 and 1989. Currently, the facility is meeting its permit limitations, but raw sewage bypassing from a lift station occurred frequently during 1989. 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 sewage discharges during wet and dry weather cause obvious degradation of the Grand Calumet River. Equipment problems are also a factor despite the new additions.

TABLE 43. *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<br><br>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.<br>● No known restriction on wildlife consumption. | - Contaminated Sediments<br>- Industrial and Municipal Effluents<br>- Combined Sewer Overflows<br>- Urban Runoff<br>- Input from Industries and Municipalities<br>- Spills<br>- Groundwater Contamination |
| ii) Tainting of fish and wildlife flavor<br><br>Use impairment confirmed | IDEM staff have identified degraded fish populations. Tainting of the fish has occurred. | - Contaminated Sediments<br>- Industrial and Municipal Effluents<br>- Combined Sewer Overflows<br>- Urban Runoff<br>- Input from Industries and Municipalities<br>- Spills<br>- Groundwater Contamination |
| iii) Degradation of fish a and wildlife populations<br><br>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<br>- Industrial and Municipal Effluents<br>- Combined Sewer Overflows<br>- Urban Runoff<br>- Input from Industries and Municipalities<br>- Spills<br>- Groundwater Contamination |

TABLE 43. *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<br><br>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<br>- Input from Industries |
| v) Bird or animal deformities or reproduction problems<br><br>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<br>- Contaminated Fish Tissue<br>- Degraded Water Quality<br>- Contaminated Sediments<br>- Combined Sewer Overflows<br>- Input<br>- Urban Runoff<br>- Groundwater<br>- Air Toxics |
| vi) Degradation of Benthos<br><br>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<br>- Industrial and Municipal Effluents<br>- Combined Sewer Overflows<br>- Urban runoff<br>- Input from Industries and Municipalities<br>- Spills<br>- Groundwater Contamination |
| vii) Restrictions on dredging activities<br><br>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 43. *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<br><br>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<br>- Urban Runoff<br>- Input from Industries and Municipalities |
| ix) Restrictions on drinking water consumption, or taste and odor problems<br><br>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.<br><br>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<br>- Industrial and Municipal Effluents<br>- Combined Sewer Overflows<br>- Urban Runoff<br>- Input from Industries and Municipalities<br>- Spills<br>- Groundwater Contamination |
| x) Beach closings<br><br>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.<br><br>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<br><br>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<br>- Groundwater Contamination<br>- Spills |

TABLE 43. *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<br><br>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<br><br>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.<br><br>Phytoplaton counts are very low in the Nearshore Lake Michigan waters in the Area of Concern. | - Contaminated Sediments<br>- Industrial and Municipal Effluents<br>- Combined Sewer Overflows<br>- Urban Runoff<br>- Input from Industries and Municipalities<br>- Spills<br>- Groundwater Contamination |
| xiv) Loss of fish and wildlife habitat<br><br>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<br>- Draining and Filling of Wetlands<br>- Degraded Water Quality<br>- Contaminated Sediments |

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, and 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 now being carried out 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.

Industrial discharges from U.S.X. Inland Steel, LTV Steel, DuPont, Vulcan Material, Material Handling and American Steel effect the quality of the river. Additional inputs are found along the river, and, 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 levels, 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.

In 1988, five stations of the Grand Calumet/IHC system were sampled for macroinvertebrates. The results were nearly the same as those in 1986 in 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. Streeses associated with toxic chemicals were indicated by most samples.

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 20) 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 segment 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 very poor (score of 12; three stations) to a high of fair (score of 45; one station) 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. Unlike the other basin segments, 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 achieved a fair evaluation of water resource classification.

The overall water quality of the Lake Michigan division ranged between a low of very poor (score of 12; numerous stations) to a high of fair (score of 44; one station) 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. Unlike the other basin segments, 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.

In summary, 210 stream miles were assessed for aquatic life uses in the Lake Michigan Basin - Northwest. Of these assessed waters, 66 miles (31%) fully supported their designated uses, 5 miles (2%) partially supported its designated uses, and 136 miles (65%) did not support designated uses. Only 5 miles (2%) were considered to be fully supporting but threatened. Of the 95 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 636 miles were monitored and/or evaluated to determine support of use designations. Table 44 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. Other point sources and nonpoint areas will be discussed at a later time. Four dams are located in the river for the purpose of hydro-electric power.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.

Although an apparently diverse fish community exists along the entire length of the St. Joseph River, the entire length of the river in Indiana 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.

The Bristol STP is a 0.23 MGD facility. At the time of sampling, the effluent met all permitted concentration 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.

TABLE 44. *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 | Syracuse Helmer | FS (Aquatic Life) NS (Recreational) | Monitored (c) | E. coli | 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 | 6.3 | High suspended solids as result of algae bloom. |
| Turkey Creek | Milford | FS (Aquatic Life) FS (Recreational) | Monitored (c) | | 6.0 | |
| 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 | 10 | |
| 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. |
| 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 44. *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)<br>FS (Recreational) | Monitored (c) | | 7.5 | |
| Little Elkhart Creek | South Milford | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 0.3 | |
| Little Elkhart Creek | South Milford | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 2.2 | |
| Little Elkhart Creek | South Milford | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.5 | |
| Little Elkhart Creek | Wolcottville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.6 | |
| Little Elkhart Creek | Wolcottville | FS (Aquatic Life)<br>(Threatened)<br>NS (Recreational) | Monitored (c) | E. coli | 0.7 | Wolcottville STP should be upgraded to alleviate treatment problems. |
| Little Elkhart River and tributaries | Topeka<br>Middlebury | FS (Aquatic Life)<br>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)<br>FS (Recreational) | Monitored (c) | | 3.2 | |
| Bixler Lake Ditch | Kendallville | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | E. coli | 2.0 | Cadmium slightly high but not affecting water quality. |
| Henderson Lake Ditch | Kendallville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.96 | |
| Tributary to Round Lake | Kendallville | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.9 | |
| Waterhouse Ditch | Albion | NS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | D.O.<br>Iron | 1.7 | |
| Oviatt Ditch | Rome City | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.7 | |
| Oliver Lake Outlet Tributary | Eddy | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.5 | |
| North Branch Elkhart River | Eddy | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 5.8 | |

TABLE 44. *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 Elkhart River | Cosperville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 5.1 | |
| North Branch Elkhart River | Cosperville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 6.1 | |
| Tributary to Jones Lake | Rome City | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Channelization | 5.0 | |
| Branch from Little Lake to Lake Jones | Rome City | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Marshland<br>Heavy Brush and Shrub Growth | 3.4 | |
| Gretzinger Ditch | Brimfield | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 4.1 | Insignificant flow. Bordered by farmland. |
| Tributary from Munk Lake to Clock Creek | Brimfield | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.9 | |
| Clock Creek | Brimfield | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.65 | Marshy/muddy conditions. |
| Dry Run | Brimfield | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 6.0 | |
| Boyd Ditch | Cosperville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1 | |
| Huston Ditch | Wawaka | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Channelization | 7.2 | |
| Jacobs Ditch | Cosperville | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 5.0 | |
| Thumma-Rousch Ditch | Bakerstown | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 6.0 | |
| Forker Creek | Burr Oak | FS (Aquatic Life)<br>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)<br>FS (Recreational) | Monitored (c) | | 6.6 | |
| Winebreenner Branch | Merriam | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 6.0 | |
| Carrol Creek | Wolflake | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 3.0 | |

**TABLE 44.** ***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)<br>FS (Recreational) | Monitored (c) | | 1.9 | |
| South Branch Elkhart River | Albion | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.9 | |
| South Branch Elkhart River | Albion | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.9 | |
| South Branch Elkhart River | Wawaka | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Low D.O.<br>Marshlands | 13.2 | |
| Rimmell Branch | Bakertown | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 7.3 | |
| Croft Ditch | Albion | FS (Aquatic Life)<br>(Threatened)<br>NS (Recreational) | Monitored (c) | D.O.<br>Ammonia<br>E. coli | 1.7 | |
| Croft Ditch | Albion | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 5.7 | Heavy algae growth. |
| Long Ditch | Albion | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Marshland | 4.0 | |
| Tributary from Lower Long Lake | Port Mitchell | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.4 | |
| Elkhart River | Ligonier | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.75 | Variety of fish found; bass, pike bluegill, etc. |
| Elkhart River | Ligonier | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.2 | |
| Elkhart River | Goshen | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 10.0 | |
| Elkhart River | Goshen | FS (Aquatic Life)<br>(Threatened)<br>FS (Recreational) | Monitored (c) | | 7 | |
| Eaton Creek | Fremont | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Marshland | 4.4 | |
| Unnamed tributary from Fremont STP | Fremont | NS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | pH<br>Chlorides<br>Copper | 3.0 | |

TABLE 44. *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)<br>FS (Recreational) | Monitored (c) | | 1.0 | |
| Follette Creek | Jamestown | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | .05 | |
| Follette Creek | Glen Eden | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 2.2 | |
| Unnamed tributary from Walters Lake | Angola | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 3.6 | |
| Crooked Creek | Jamestown | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.4 | |
| Crooked Creek | Nevada Mills | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 3.7 | |
| Crooked Creek from Tamarack Lake | Orland | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.3 | |
| Bell Lake Ditch | Nevada Mills | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.4 | |
| Unnamed tributary from Lime Lake | Nevada Mills | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Marshland | 1.5 | |
| Orland Tributary | Orland | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | Low D.O.<br>E. coli | 1.0 | |
| Fawn River from Fawn River Fish Hatchery | Greenfield Mills | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 4.8 | |
| South tributary to Lake James | Crooked Lake | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 0.4 | |
| Lake James/Lake Jimmerson Channel | Lake James | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | .1 | |
| Ditch to Little Center Lake | Angola | NS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Low D.O.<br>Copper<br>Lead<br>Zinc | 1.5 | Metals in sediment. Dana Corporation effluent discharges into this ditch. |
| East tributary to Crooked Lake | Glen Eden | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.9 | |

TABLE 44. *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)<br>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)<br>PS (Recreational) | Monitored (c) | | 1.1 | Insignificant flow during dry weather. |
| Tributary between the Third Basin of Crooked Lake and Lake Loon | Iverness | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 1.4 | |
| Lake Gage/Lime Lake Channel | Panama | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 0.3 | |
| Pigeon Creek | Angola | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 8.0 | |
| Pigeon Creek from Pigeon Lake | Angola | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 5.0 | E. coli counts of 420/100 ml. |
| Pigeon Creek from Mud Creek | Angola | NS (Aquatic Life)<br>(Recreational) | Monitored (c) | Ammonia<br>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)<br>FS (Recreational) | Monitored (c) | | 1.5 | |
| Pigeon Creek from Golden Lake | Angola | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 1.3 | |
| Pigeon Creek from Hogback Lake | Flint | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 5.4 | |
| Pigeon Creek from Otter Lake | Flint | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 2.6 | |
| Ewing Ditch | Angola | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.6 | E. coli counts of 1600/100 ml. |
| Berlin Court Ditch | Berlin | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | | 3.9 | |
| Mud Creek from Angola STP Discharge | Angola | NS (Aquatic Life)<br>(Recreational) | Monitored (c) | Ammonia<br>Low D.O.<br>E. coli | 3.0 | Poor treatment from Angola STP. |

TABLE 44. *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)<br>(Recreational) | Monitored (c) | E. coli<br>TSS<br>Low D.O.<br>Ammonia | 5.7 | Impairments from Pigeon Creek Rest Area. |
| Trout Creek | Bristol | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 1.0 | |
| St. Joseph River | Bristol | PS (Aquatic Life)<br>NS (Recreational) | Evaluated | PCBs<br>E. coli | 7.6 | River under Fish Consumption Advisory for carp. |
| St. Joseph River | Elkhart | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCBs<br>E. coli | 5.9 | Fish Consumption Advisory. |
| St. Joseph River | Elkhart | PS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 12.3 | Fish Consumption Advisory. |
| St. Joseph River | Mishawaka | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | | 3.2 | Salmonid classification. Fish Consumption Advisory. |
| St. Joseph River | South Bend | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCBs<br>E. coli | 2.6 | Fish Consumption Advisory. |
| Sheep Creek | Bristol | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 8.0 | |
| Pine Creek | Bristol | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 18.0 | |
| Peterbaugh Creek | Elkhart | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 6.0 | |
| Christianna Creek | Elkhart | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 6.0 | |
| Osborn-Manning Ditch | Elkhart | PS (Aquatic Life) | Monitored (c) | | 3.8 | |
| Cobus Creek | Elkhart | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 11.0 | |
| Crawford Ditch | Elkhart | NS (Aquatic Life)<br>(Recreational) | Monitored (c) | Metals<br>Oil | .75 | |
| Auten Ditch | South Bend | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Ammonia | 1.5 | Impacts from two mobile home parks and Berliner-Maux industry. |
| Juday Creek | South Bend | FS (Aquatic Life)<br>PS (Recreational) | Monitored (c) | | 24.6 | |

TABLE 44. *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)<br>NS (Recreational) | Monitored (c) | E. coli<br>Nonpoint source | 3.7 | Cromwell STP adds to E. coli count. |
| Cromwell Ditch | Cromwell | NS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 6.7 | Intermittent stream. |
| Meyer Ditch | Cromwell | FS (Aquatic Life)<br>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)<br>NS (Recreational) | Monitored (c) | E. coli | 2 | |
| Long Ditch/Dry Run | Millersburg | FS (Aquatic Life)<br>(Recreational) | Monitored (c) | | 8.0 | |
| Rock Run Creek and tributaries | Goshen | FS (Aquatic Life)<br>NS (Recreational | Monitored (c) | E. coli | 42.0 | |
| Turkey Creek | Bushy Prairie | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 6.0 | |
| Pigeon River | Mongo | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 2.3 | |
| Pigeon River | Howe | FS (Aquatic Life)<br>PS (Recreational) | Monitored (c) | E. coli | 1.7 | |
| Pigeon River | Scott | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | | 6.0 | |
| Fly Creek | LaGrange | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 10.1 | |
| E. Fly Creek | LaGrange | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 7.8 | |
| Rowe Ditch | Howe | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.3 | |
| West Buck Creek | Valentine | NS (Aquatic Life)<br>NS (Recreational) | Monitored | Low D.O.<br>E. coli | 4.0 | Low D.O. from lack of stream aeration after going through wetlands |
| Van Netta Ditch | Seyberts | FS (Aquatic Life)<br>NS (Recreational | Monitored (c) | E. coli | 2.0 | |
| Page Ditch | Shipshewana | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | TSS<br>E. coli | 6.0 | Impacts from Shipshewana Lake and STP. |

TABLE 44. *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 |
|---|---|---|---|---|---|---|
| Buck Creek | Seyberts | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.5 | |
| Unnamed tributary | Shipshewana | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | Ammonia<br>TSS<br>D.O. | 2.1 | Impacts from Shipshewana STP. |
| Fawn River | Scott | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 6.5 | |
| Barringer Ditch | Mill Creek | FS (Aquatic Life) | Monitored (c) | | 0.7 | |
| Dixon West Place Ditch | South Bend | FS (Aquatic Life) | Monitored (c) | | 8.0 | |
| Pine Creek | Walkerton | NS (Aquatic Life) | Monitored (c) (b) | | 29.0 | Biological Assessment "Poor". |
| Goyer 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<br>TSS | 11.5 | |
| Niespodziany Ditch | Crumstown | PS (Aquatic Life) | Monitored (c) | Ammonia<br>E. coli<br>D. O. | 6.0 | |
| Mill Creek | Union Mills | FS (Aquatic Life). | Monitored (c) (b) | | 8.0 | a) High BOD; no significant impacts to stream.<br>b) Biological Assessment, "Fair". |
| Potato Creek | North Liberty | NS (Aquatic Life) | Monitored (c) (b) | D. O. | 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 | Biological Assessment, "Fair". |
| Peter Sarbee Ditch | Tyner | NS (Aquatic Life) | Monitored (b) | | 12.0 | Biological Assessment "Poor". |
| 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) (b) | | 9.0 | Biological Assessment, "Good". |
| Wagner Ditch | Nappanee | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.5 | |

TABLE 44. *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 |
|---|---|---|---|---|---|---|
| Nunemaker-Township Ditch | Nappanee | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.0 | |
| Rogers Ditch | Nappanee | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 1.0 | |
| Mather Ditch | Middlebury | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 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.*

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 upstream and downstream of the STP. Although Sheep Creek is small, it would probably 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 would support 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 to 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 would be 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 the sediment and water. Results of lab analyses indicated that metal and organic values were not of concern in both the sediment and water samples.

Crawford Ditch, another St. Joseph River tributary, had an oily sheen from the sampling point to approximately 200 ft. downstream. The sediment is saturated with oil. Conrail Railroad is located at the headwaters of the ditch, and surface runoff can enter the ditch. Conrail 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 criteria but above the chronic criteria level. The sediment analysis 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. This ditch is non supportive of recreation and aquatic life uses.

Auten Ditch which flows through South Bend has three dischargers to it, the Clearwater Mobile Home Park, Berliner-Maux, and the Price Country Estates Mobile Home Park. The water quality would not support full body contact because of high E. coli counts. Ammonia levels were also high. Auten Ditch is impacted from

Clearwater MHP 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 1.0 foot deep. The physical description of Juday Creek includes grasses in the stream and steep banks in the upstream segment. Downstream of Grape Road, the creek is flatter and wide. Juday Creek should be able to support aquatic life but is not deep enough for swimming. Located in this stretch of Juday Creek is a pond discharge which is being supplied by private wells pumped out to discharge salt contamination from a state county garage. Metals and organics were also analyzed in the water and sediment at several sampling sites. None were found above detection or permit limits.

Turkey Creek originates at the outlet of a small chain of lakes in southwest Noble County. After flowing northwesterly for approximately 9.0 miles, Turkey Creek enters Lake Wawasee and Syracuse Lake. From the outlet of Syracuse Lake, the stream flows westerly and 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. The stream is extensively used for livestock watering in certain areas.

There were two (2) direct NPDES discharges to the main stem of Turkey Creek. 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.

The Town of Leesburg discharges sewage to the headwater of Coppes Ditch. Leesburg does not have a wastewater treatment plant at this time. Coppes Ditch enters Turkey Creek downstream of the Town of Milford STP.

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

Turkey Creek as it exits Village Lake, is supportive of all uses for approximately 9 miles until it enters Lake Wawasee. Here, E. coli values make it non-supportive for recreational uses but acceptable for aquatic life. At Syracuse, Turkey Creek had low dissolved oxygen values at a sampling point immediately downstream of the Syracuse STP. The stretch of Turkey Creek downstream and upstream of the STP is heavily algae choked. 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 to 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 indicated 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 should support all uses.

Coppes Ditch is an open, channelized, drainage ditch originating at Leesburg. Sewage from Leesburg STP 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 to 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 to 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. This reach, at best, may support lower food chain organisms. 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.

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 to Berlien 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, Berlien Court Ditch winds through cropland and pasture to the Turkey Creek confluence. The dissolved oxygen concentrations ranged diurnally from 20 or more 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. Aquatic life 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.

Six (6) stations were sampled in Baugo Creek. One low dissolved oxygen value (3.6 mg/l) was noted at the first station downstream of the 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 stretch of stream should support aquatic life. There were some diurnal dissolved oxygen variations at all stations but none were 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 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 has 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 in Werntz Ditch 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 partially supports aquatic life but is not fully supporting due to a lack of dilution water for the lagoon effluent during dry periods and due to impacts from dairy cattle operations.

Barkey Ditch and Grimes Ditch combine approximately 0.1 miles 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 support of aquatic life may be marginal at times due to lack of flow during dry periods. Full body contact recreation cannot be supported due to stream size and impacts 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.

This combined stream formed by Nunemaker and Township Ditches was sampled just downstream of the 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 full body contact recreation is not supported due to bacteriological concentrations.

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 and Albion all of which have NPDES discharges. The small community of Bear Lake also has an NPDES discharge. Small communities without NPDES discharges are South Milford, Witmer Manor, Cosperville, Wawaka, Brimfield, Wolf Lake, Port Mitchell and Kimmell.

This segment consists of the South Branch of the Elkhart River 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.

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 industrial NPDES 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 are 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 sediment 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 9.4 mg/l ammonia level in the undiluted effluent exceeds the calculated Final Acute Value (FAV). 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 was existent 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. found was 4.7 mg/l and the 24-hour average was 3.4 mg/l. Coating of 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 6 miles of Dry Run, near the Town of Brimfield which has a large sawmill. Except for the Brimfield area, this waterbody is predominately 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 predominately 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 a few marginal 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 areas which might account for the low D.O. The stream was bordered by pastureland 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 Conservation District bypass and, a sludge bank had formed immediately downstream. Tall brush, woodland, and cropland were the predominate 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 of Albion 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 predominately 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 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 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.

This study as a whole showed 30 of 47 sampled stream stations exceeded the Indiana stream standard of 235/100 ml for E. coli. These exceedences are very prevalent and 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 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 is undergoing complete reconstruction with a design flow of 1.5 MGD upon completion of the new plant.

The City of Goshen STP discharges at mile point 15.7. The design flow of this facility is 5.0 MGD. Both municipalities have some combined sewer overflows. (CSOs) The NPDES permits list six (6) CSO's each. 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 point. 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 to 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 from Waterford Mills to the St. Joseph River confluence.

Approximately 10 miles of the Elkhart River below Ligonier is supportive of aquatic life, however, E. coli violations do not support full body contact. 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 was discharging 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 source E. coli.

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 because of low flows.

Meyer Ditch is supportive to aquatic life but not full body contact recreation. This is a channelized drainage ditch with no point sources, however, 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 standard 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 which starts at Waterford Mills and ends at the Indiana Street Bridge, just upstream of the Goshen STP, is approximately 5 miles long. The water quality in this reach is fully supportive of all designated uses.

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. This exception was 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 basin includes rural, residential, and industrial areas. The stream is supportive of aquatic life but not of full body contact recreation. The stream was not suitable for recreation purposes 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 which flows into the St. Joseph River in Michigan. 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 8.3 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.

Mather Ditch includes tributaries from Cass Lake, Hunters Lake, East Lake and 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. A limiting factor in this section is the physical size of the stream.

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 Deutsch Kase Haus effluent is having an effect on the upper reach of Mathers Ditch.

The first sampling site downstream of Deutsch Kase Haus, but before the confluence of the lake tributaries, had a high C-BOD, (5.0 mg/l) E. coli (1500/100 ml) and phosphorus level (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 section has 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 from the liquid and sediment matrices. Copper and nickel levels in the sediment were above statewide background levels.

This section of Mathers Ditch does not support full body contact nor aquatic life due to the small physical constraints of the ditch and the high E. coli and low D.O. levels.

Another 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 above detection limits were the chemicals endrin (0.16 ug/l) and endosulfan I (0.100 ug/l).

The sampling site on Mathers Ditch is not supportive of full body contact due to high E. coli values and the small physical size of the stream. Mathers Ditch would support a small population of aquatic life because of water quality and habitat. Sediment samples show 25 ug/kg of DDT. Organic chemistry and heavy metals were analyzed from the liquid and sediment matrices. Copper and nickel in the sediment had elevated values from statewide maximum background levels.

The Middlebury STP discharges directly to the Little Elkhart River upstream of the Mather 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. There were no toxic organic parameters found downstream of the outfall, however, the sediment samples taken during the survey upstream and downstream of the outfall had elevated levels from local background values for arsenic, chromium and nickel. This section does not support full body contact because of the high E. coli count. The water quality would support aquatic life.

After 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 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 enters the St. Joseph River before it enters Michigan. 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 indicates that it is fully supporting of aquatic life, but only 2.3 miles would fully support recreational uses, 1.7 miles are partially supportive near Howe, Indiana where there is no sewage treatment plant. 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 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 completed new construction 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 to the confluence of the Pigeon River does not support recreational 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, the other large tributary of the Pigeon River, has its confluence with the Pigeon River west of Scott, Indiana. Shipshewana Lake is the headwater of Page Ditch. The Shipshewana STP discharges to an unnamed tributary of Page Ditch which has slow flows with no reaeration taking place. The land use is agricultural.

The Shipshewana STP is a 0.080 MGD facility. The facility consists of a flow equalization tank, oxidation ditch, and two tertiary ponds. The effluent violated its NPDES permit for ammonia (36 mg/l) and TSS (16 mg/l) and had a rather high phosphorus level of 1.56 mg/l. The Shipshewana STP is in dire need of expansion. The flows from a summer flea market put a heavy strain on the facility. The facility is hydraulically overloaded when the market is open, having particular problems handling the solids in the plant.

The tributary stream would not support 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 areas are located here. The northern watershed consists of a network of natural lakes and marshland interconnected by short stream reaches and tributaries. Major stream reaches in the northern 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 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 a warm water fishery.

The final effluent of the Dana Corporation discharges to an unnamed ditch which travels about 100 yards before entering Little Center Lake. The Dana Corporation discharge combines with a storm sewer and then discharges through a pipe on the north side and to the headwater of this ditch. 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 metals. Copper, lead and zinc were all found at levels exceeding water quality criteria in one or both of these samples at the hardness levels observed.

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 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 warm water aquatic life. Some degradation of Little Center Lake may also result due to these problems. Low E. coli levels would indicate this reach would be supportive of full body contact recreation.

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. Toxic samples for all priority pollutants were sampled at the STP effluent in addition to 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 counts 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 and warm water aquatic life.

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. The Johnson Ditch reach is predominantly cropland and is channelized in places. The banks are grassy and steep. The stream is shallow and the flow is slow. Some algae were 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 of full body contact and warm water aquatic life.

As a whole, this segment study showed 15 of 41 sampled stream stations exceeding the Indiana stream standard of 235/100 ml for E. coli. These exceedences are so prevalent, and in locations where no pollutant 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, 820 miles of streams were assessed as to support of aquatic life uses in the Northeast Lake Michigan Basin. Of these assessed water 641 miles (78%) fully supported their designated uses, 9 miles (1%) are fully supportive but threatened, 64 miles (8%) only partially support this use and 106 miles (13%) are not supportive. Six Hundred Eighty Nine (689) miles were assessed as to support of recreational use. Of these miles 257 (37%) were fully supporting, 27 miles (4%) were partially supportive and 405 (59%) were non supporting of recreational uses.

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 8). 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.

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 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 states toward Toledo and empties into Lake Erie.

The St. Mary's River originates near New Bremen, Ohio and flows northwest to Fort Wayne. Approximately 39 river miles are within Indiana. The St. Joseph River originates near Hillsdale, Michigan and enters Indiana from Ohio northeast of Fort Wayne. The St. Joseph River in Indiana covers approximately 41 river miles. 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 45. Additional comments are also given for certain reaches.

**FIGURE 8.** *MAUMEE RIVER BASIN*

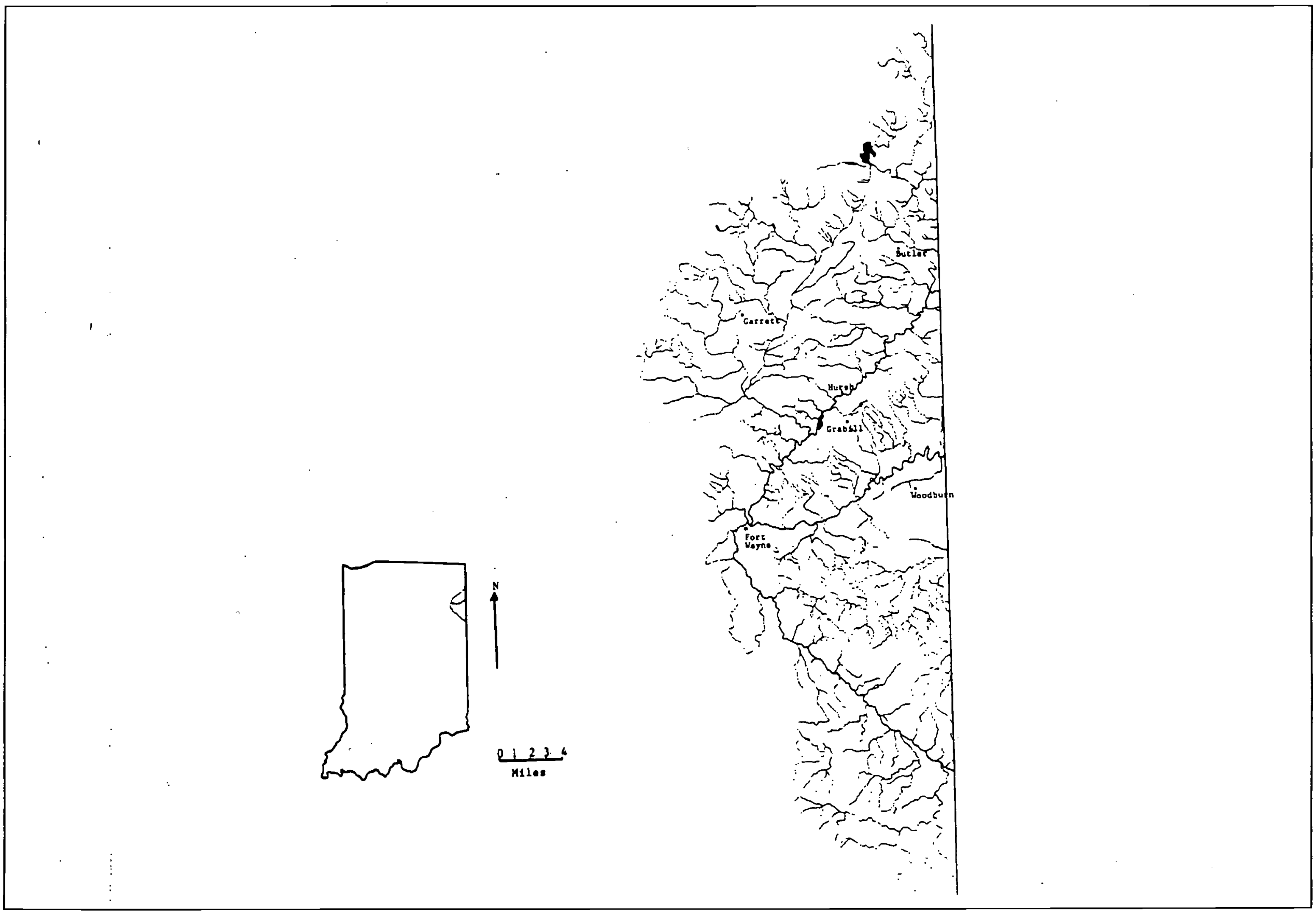


TABLE 4S. *Water Assessed, Status of Designated Use Support, Probable Causes of Impairment and Miles Affected in the Maumee River Basin*

| WATERBODY | NEAREST TOWN(S) | STATUS OF DESIGNATED USE SUPPORT | METHOD OF ASSESSMENT[2] | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| St. Mary's River | State line to near Fort Wayne | FS (Aquatic Life)<br>NS (Recreational) | Monitored (C) | E. coli | 28 | Ammonia and dechlorination problems at Decatur POTW. Construction nearly completed includes aeration tank, final clarifiers, and an ultra-violet disinfection unit sludge handling a problem. |
| St. Mary's River | Fort Wayne | FS (Aquatic Life)<br>NS (Recreational) | Monitored(C) | E. coli | 11 | |
| Yellow Creek | Monroe | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 3 | |
| St. Joseph River | State line to Allen County | FS (Aquatic Life)<br>NS (Recreational) | Monitored (C) | E. coli | 18 | |
| St. Joseph River | Allen County to mouth | FS (Aquatic Life)<br>NS (Recreational) | Monitored (C) | E. coli | 23 | |
| Willow Creek | Huntertown | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 1 | |
| Cedar Creek | Waterloo | FS (Aquatic Life) (Threatened)<br>NS (Recreational) | Evaluated | Metals | 1 | Indiana Decorative Products to install flow monitoring device at discharge points to include all discharged wastewater. |
| Cedar Creek | Waterloo to Auburn | FS (Aquatic Life) (Threatened)<br>FS (Recreational) | Evaluated | | 6 | |
| Cedar Creek | Auburn | PS (Aquatic Life)<br>NS (Recreational) | Monitored (C) | Suspended Solids<br>E. coli | 5 | a) Bypassing problems<br>b) Beatrice Cheese Company evaluating bids for sludge removal from lagoon. |
| Cedar Creek | River Mile 13.7 to mouth | FS (Aquatic Life) (Threatened)<br>FS (Recreational) | Evaluated | | 14 | Upstream industrial and municipal discharges threaten this State Resource Water. |
| Spy Run | Fort Wayne | FS (Aquatic Life) | Evaluated | | 1 | |
| Teutsch Ditch | Butler | PS (Aquatic Life) | Evaluated | Metals<br>Oil and Grease<br>Phenol<br>Chloride<br>Ammonia<br>TSS | 1 | |
| Big Run Creek | Butler | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 7 | |
| Hilkey Ditch | Auburn | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 1.5 | This is a limited use stream. |

Table 45. *Water 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[2] | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| Hindman Ditch | St. Joseph | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 0.5 | This is a limited use stream. |
| Bear Creek | St. Joseph | FS (Aquatic Life<br>FS (Recreational) | Evaluated | | 1 | |
| Haifley Ditch | Grabill | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 1 | |
| Witmer Ditch | Grabill | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 1 | |
| Maumee River | Fort Wayne to state line | PS (Aquatic Life)<br>NS ( Recreational) | Monitored (C) | Ammonia<br>E. coli<br>PCBs | 25 | a) Fish Consumption Advisory.<br>b) Increased monitoring of industry to locate areas of high metal content in inflow.<br>c) CSO problems. |
| Harvester Ditch | Fort Wayne | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 1 | |
| Flatrock Creek | Adams County | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 15 | |
| Blue Creek | Adams County | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 25 | |

The drainage area for the St. Mary's River is used heavily for agriculture. Although no major cities are located in this area, several small Ohio towns have affected water quality in the past. The Decatur STP is the only major municipal facility that discharges into the St. Mary's River within Indiana. Lift station failures and combined sewer overflows (CSOs) at this facility have caused problems in the past. However, recent renovations including significant combined sewer separation (although CSO's have not been blocked off completely) have improved conditions in the river. The facility appears to be well operated and is meeting most of its NPDES permit discharge limits. The Decatur STP has had difficulties meeting ammonia limits, as more stringent ammonia standards were necessary due to a change in the facility's design flow from 1.2 MGD to 2.8 MGD. New construction is still underway and the facility is under an enforcement compliance schedule. Present construction includes a new aeration system to handle the larger flows, final clarifiers, and an ultra-violet disinfection unit.

Currently, there are three fixed water quality stations to monitor the St. Mary's River. Station STM-0.2 was added in 1986 to monitor water quality downstream of CSOs and industry discharges in the Fort Wayne area.

Conditions have improved in the Upper St. Mary's River (STM-37) and in the Fort Wayne area (STM-11 and STM-0.2) where no violations of the water quality standards are evident. During the last reporting period violations of cyanide and the un-ionized ammonia criteria were found infrequently, but often enough to make these waters only partially supporting. While ammonia permit violations from the Decatur POTW minimally affect this reach, the waters fully support the aquatic life use. The levels of metals apppear to have decreased over the past two years. E. coli violations at these stations occurred often enough that the river was considered to not support its designated recreational use.

There are several dischargers that can potentially impact the water quality of the St. Mary's River. These include Central Soya (a soybean processor in Decatur); Schmitt Packing (a meat packing plant); B&B Custom Plating in Hoagland and Fort Wayne Wire Die, Inc., both involved in electroplating; and five minor municipal dischargers. None have had any recent documented water quality problems impacting the St. Mary's River.

A spill of ice cream by-products into Holthouse Creek, a tributary to the St. Mary's River, was responsible for a fishkill of approximately 500 fish over a two mile area during this reporting period.

The St. Joseph River originates near Hillsdale, Michigan and enters Indiana from Ohio northeast of Fort Wayne. The St. Joseph River in Indiana covers approximately 41 river miles and drains an area of predominantly agricultural use. The St. Joseph River area contains no major metropolitan areas except Fort Wayne at the confluence with the St. Mary's River. The St. Joseph River is dammed north of Fort Wayne in Allen County forming a shallow, eutrophic, water supply impoundment called Cedarville Reservoir.

The only current fixed water quality monitoring station on the St. Joseph River is in Fort Wayne at the Tennessee Avenue bridge just before its confluence with the St. Mary's River. This station is also near a water supply intake point. Data from this station indicate problems with E. coli over the acceptable criteria. The St. Joseph River is designated for whole-body contact recreation. Values for E. coli during the recreational season exceeded the State standard 39% of the time. This would indicate that the St. Joseph River is not supporting its designated recreational use.

The St. Joseph River near Fort Wayne was surveyed in 1989 by the Indiana Department of Natural Resources (IDNR). Fish population studies were conducted at Shoaff Park, Johnny Appleseed Park and the State Street Bridge. Results of these studies indicated that the St. Joseph River supported a diverse warm water fishery.

The IDNR also conducted fish population studies in Spy Run, a St. Joseph River tributary, at Vevay Park and Franke Parke in 1989. Results indicated that this stream supported a good recreational fishery. Spy Run is periodically stocked with trout for a put-and-take fishery and will support this use.

Cedar Creek is an important tributary of the St. Joseph River entering just below Cedarville Reservoir. A portion of Cedar Creek is a State Resource water, but portions of the waterbody upstream of the designated area continue to have minor water quality problems. The Splicer Clutch Division of the Dana Corporation manufactures light-heavy duty trucks. Its process and sanitary water goes to the Auburn STP. However, its effluent contains storm water from roof drains, parking lots, neighboring crop fields and a neighboring industry. A number of violations were documented in 1991 for total suspended solids and oil and grease at this facility.

The Auburn STP has a sludge disposal problem. All sludge goes through the south primary clarifiers. Heavy sludge accumulation in these primaries results in greasing. The plant's anaerobic digesters can not accommodate the sludge quickly enough to prevent a build up in the primaries. This facility is planning a solids handling study and will give attention to the digester capacity, land application and waste routing.

Kitchen-Quip, a discharger in the Cedar Creek watershed, has been in violation of copper, oil and grease, and total suspended solids routinely. Management has been exploring the use of chemicals to help settle solids and float oil for skimming. Although this facility is a small volume discharger (5,000 gallons/week), it discharges to Cedar Creek, a portion of which is classified as a State Resource Water. The Kitchen-Quip discharges to Cedar Creek consists of acid, vibrating finish rinse water, and caustic dip rinsewater. The cooling water discharge is now recycled. Plating operations were discontinued in 1988. More stringent limitations will likely be included in the renewal permit. In fact, the possibility of discharging to the Waterloo STP was considered. If this proves possible, then pre-treatment would be in order.

The Waterloo STP discharges to Cedar Creek. Hydraulic overloading is a constant problem and even during dry periods this facility is hydraulically overloaded and by-passing occurs. Two combined sewer overflows add to the volume of raw sewage entering Cedar Creek, making the total volume even greater. Waterloo plans to obtain funding for treatment plant and collection system upgrades either through the Build Indiana Fund (through the Department of Commerce) or through a bond issue. New permits for this plant will contain limits unobtainable under present operating conditions. Improvements will need to be made to the plant and collection systems. Also, a formal program should exist for preventive maintenance, and sewer and manhole rehabilitation.

The Butler Universal Tool and Stamping Company, a manufacturer of automobile jacks and parts, has been in non-compliance of NPDES permit limits for zinc, BOD, oil and grease, and chlorides. This industry discharges into Teutsch Ditch. Many of the chemicals used in treatment have been changed from chloride-containing to non-chloride compounds. Synthetic oils are now being used and during the first months of 1991 no oil and grease violations were encountered. $BOD_5$ treatment chemicals are also checked as an effort to eliminate $BOD_5$ violations. The company is currently changing its production process. The purpose of these changes is to eliminate the potential discharge of chrome and nickel plating waste and accomplish a reduction in the generation of hazardous waste. Two toxicity tests were conducted and both tests showed some toxicity.

Bohn Aluminum and Brass Company discharges into Teutsch Ditch near Butler, upstream of Universal Tool and Stamping. The company has had numerous $BOD_5$ and TSS violations. Sampling of incoming wastewater was performed to determine the excessive loadings and the $BOD_5$ sources responsible for standards violation. The apparent pollution sources included hydraulic oils and coolant leaking into pit areas where parts are dipped and coated. Several possible solutions to this problem are being examined by the company.

At the Butler STP a new chlorination system was installed during Spring 1990. Several violations occurred while staff learned to adjust the new equipment. The city has been in consultation with the town engineers looking at future needs of the STP as this facility is 40 years old. Future NPDES requirements, especially for unionized ammonia, may necessitate either upgrading or partial or total reconstruction of the facility. A sewer system survey should also be conducted to determine where problem areas are located as well as to construct accurate sewer maps.

The Maumee River originates in Fort Wayne at the confluence of the St. Joseph and St. Mary's rivers. The Fort Wayne sewage treatment facility, which discharges a short distance downstream from the city has a 60 MGD capacity with advanced treatment, phosphorus removal, and storm water retention ponds. Fort Wayne has an abundance of CSO's all the way to New Haven causing some water quality problems. The effluent from the wastewater treatment plant, however, is of good quality and does not appear to be causing significant degradation of the Maumee River.

Two Fixed Water Quality Monitoring Network stations are located on the Maumee River. Station M-129 is located in New Haven at the Linden Road Bridge over the Maumee River, six miles downstream from the Fort Wayne STP. The other fixed water quality monitoring station on the Maumee River (M-114) is located at the State Road 101 bridge north of Woodburn, 22 miles downstream of the Fort Wayne STP.

Chemical data from the two Maumee River stations during 1990-91 indicate that there were no violations of most chemical parameters examined. A partial fish consumption advisory still exists for the Maumee River due to the PCBs in carp tissue samples. The source of PCB contamination is thought to be an old landfill along the bank of the Maumee River which may be leaching substances into the River. This is currently under investigation. Results from sediment samples collected by the U.S. Army Corp of Engineers in 1985 from a site near this landfill indicate elevated levels of PCB's (3.3 mg/kg) and DDT (5.8 mg/kg) in the sediment. Sediment samples collected by IDEM staff between 1988 and 1990 show that sediments from the Maumee River still have a medium level of concern due to metals, pesticides, PCB's, PAH's, and phthalates. Violations of the E. coli criteria were numerous enough to place the Maumee River in nonsupport of the recreational use over this period.

One metropolitan Fort Wayne area industry that discharges to Harvester Ditch, a tributary of the Maumee River, is Phelps Dodge Magnet and Wire. Phelps Dodge Magnet Wire Company manufactures aluminum and copper magnet wire. Water is supplied to the company from the City of Fort Wayne's water utility and is discharged to the Fort Wayne's STP at rate of 70,000 gpd. This company has had severe TSS violations attributed to rust and trash interfering with an auto sampler.

Also included in this watershed segment is Flatrock Creek. It flows into Indiana from Ohio through southeastern Allen County. The only point discharger in the Flatrock Creek drainage basin is the Monroeville STP. A recent assessment of Flatrock Creek concluded that water quality of the stream was satisfactory. Except for occasional bypassing, the Monroeville STP is meeting its permit limits.

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 phosphorus 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). Efforts are now underway to verify these figures.

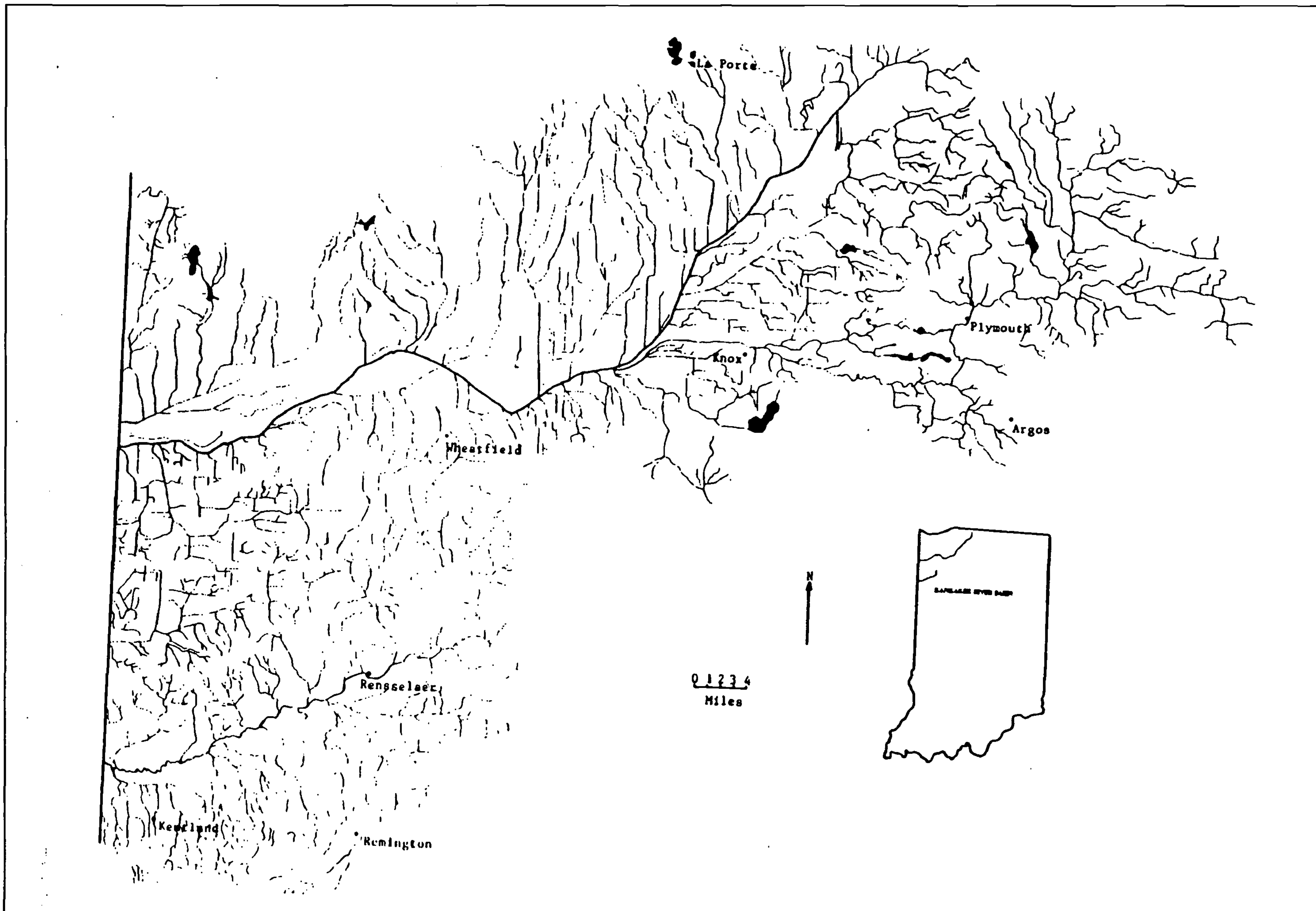
IDEM and U.S. EPA Region V staff sampled the Maumee River Basin during the 1991 field season as part of an ongoing fish community survey. Based on an Index of Biotic Integrity, fish species diversity will be used as an indicator of water quality at various points in the watershed. Results from the Maumee River Basin sampling are being tabulated and are, therefore, not yet available.

In summary, 190 miles were assessed in the Maumee River Basin. Of these total miles, 138 miles (73%) support the aquatic life designated use, another 21 miles (11%) were fully supporting, but threatened, 31 miles (16%) were only partially supported and 0 miles (0%) did not support the aquatic life designated use. Of the 188 miles assessed for recreational use, 77 miles (41%) fully supported its use, while 5 miles (3%) only partially supported recreational use and 106 miles (56%) did not support this use.

Kankakee River Basin

The Kankakee River Basin (Figure 9) 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

FIGURE 9. *KANKAKEE RIVER BASIN*



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 surrounding areas. Sand was deposited in this low area by the melting glacier, and much of this lowland became gigantic marsh. Beginning in the mid-1800s ditches were dug throughout the basin to improve drainage for farming. Today most of the 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 spieces 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 Kankaee 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 46. 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 near South Bend. 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 indiciated good water quality at the time of the 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.

TABLE 46. *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<br>LaPorte | NS (Aquatic Life)<br>PS (Recreational) | Monitored (c) (b) | D.O.<br>Ammonia<br>Metals<br>Dissolved Solids | 13.2 | LaPorte POTW Roll Coter, Kingbury Industrial Park. Biological Assessment "Very Poor" 3 miles south of LaPorte. |
| Kingsbury Creek | Kingsbury | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | Metals<br>TSS<br>E. coli | 9.3 | Biological Assessment, "Poor". |
| Kankakee River | Crumstown | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 15.8 | |
| Kankakee River | | PS (Aquatic life) | Monitored (c) | pesticides | 5.0 | |
| Kankakee River | Shelby | FS (Aquatic life) | Monitored (c) | | 23.0 | |
| Kankakee River | Hamlet | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 3.4 | |
| Kankakee River | Knox | FS (Aquatic Life)<br>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) | Low D.O. | 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) | D.O. | 29.0 | Biological Assessment, "Poor". |
| Geyer Ditch | New Carlislie | NS (Aquatic Life) | Monitored (c)(b) | | 11.2 | |
| Laskowski Ditch | Crumstown | FS (Aquatic Life) | Monitored (c) | | 6.0 | |
| County Line Ditch | Crumstown | PS (Aquatic Life) | Monitored (c) | Ammonia<br>TSS | 11.5 | |
| Niespodziany Ditch | Crumstown | PS (Aquatic Life) | Monitored (c) | Ammonia<br>D.O. | 6.0 | |
| 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 46. *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 | NS (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 | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 7.0 | |
| Yellow River | Inwood | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 6.4 | |
| Yellow River | Plymouth | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) (b) | E. coli | 4.5 | |
| Yellow River | Plymouth | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 7.5 | |
| Yellow River | Knox | FS (Aquatic Life)<br>NS (Recreational | Monitored (c)(b) | E. coli | 29.8 | |
| Yellow River | Knox | FS (Aquatic Life)<br>(Threatened)<br>NS (Recreational) | Monitored (c) | E. coli | 11.2 | |
| Newcomer, Anthony Gross, Lehman - Brink Ditches | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 24.0 | |
| Sara Hershberger Ditch | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 5.3 | |
| Kline Rouch | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 7.2 | |
| Armey Ditch | Bremen | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 10.0 | Biological Assessment, "Poor". |
| Heston Ditch | Lakeville | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 1.8 | |
| Kehman Ditch | Lapaz | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 3.9 | Includes Laville HIgh School STP discharge. |

Table 46. *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)<br>FS (Recreational) | Monitored (b) | | 4.7 | |
| Shidler - Hoffman Ditch | Wyatt | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 3.8 | |
| W. Branch Bunch Ditch | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 7.5 | Includes Lakeville STP Lagoon Discharge. |
| E. Branch Bunch Ditch | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 13.6 | |
| Martin & Walt Kimble Ditches | Linkville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 7.4 | |
| Isaac Sells Ditch | Linkville | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 4.1 | |
| Dausman Ditch | Bremen | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 30.7 | |
| Lemler Ditch | Bremen | FS (Aquatic Life )<br>FS (Recreational) | Monitored (c) | | 4.2 | |
| Brook Ditch | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 6.8 | |
| Border Ditch | Bremen | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | | |
| Crews Ditch | Inwood | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | | 20.2 | Biological Assessment, "Poor". |
| Elmer Selenright Ditch | LaPaz | NS (Aquatic Life) | Monitored (b) | | 2.0 | Biological Assessment, "Poor". |
| Elmer Seltenright Ditch | Plymouth | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 9.6 | Includes Gatewood Mobile Home Park STP Discharge. |
| Schuh Ditch | Plymouth | FS (Aquatic Life)<br>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)<br>FS (Recreational) | Monitored (c) | D. O. | 3.9 | |
| Origer Ditch | English Lake | FS (Aquatic Life) | Monitored (c) | | 10.8 | |

Table 46. *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 |
|---|---|---|---|---|---|---|
| Pitner Ditch and tributaries | LaCrosse | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 60.1 | |
| Payne Ditch | English Lake | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 13.2 | |
| Keller Arm and tributaries | English lake | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 2.0 | Only Lawton Ditch Sampled. |
| Davis Ditch | Wheatfield | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 7.2 | |
| Cook Ditch | LaCrosse<br>Kouts | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c)(b) | | 23.6 | |
| Reeves Ditch | Kouts | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c)(b) | | 9.7 | |
| Slocum/Topper Ditch | Wanatah | FS (Aquatic Life)<br>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)<br>NS (Recreational) | Monitored (b) | D.O.<br>E. coli | 2.0 | Biological Assessment, "Poor". |
| Crumpacker Arm/Wright Arm | Westville | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Ammonia<br>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 | PS (Aquatic Life)<br>NS (Recreation) | Monitored (c) | D.O.<br>E. coli | 1.5 | |
| Crooked Creek | Westville | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli<br>D.O. | 1.5 | Biological Assessment, "very Poor". |
| Crooked Creek | Valparaiso | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli<br>D.O. | 3.2 | |
| Crooked Creek, West Branch | Valparaiso | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli<br>D.O. | 4.1 | |
| Crooked Creek, West Branch | Kouts | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli<br>Non-point source | 47.4 | |
| Pleasant Township Ditch | Kouts | FS (Aquatic Life) | Monitored (c) | | 5.1 | |

Table 46. *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)<br>NS (Recreational) | Monitored (c) | E. coli | 5.1 | Impairment due to discharge From Kouts STP. |
| Sandy Hook (AH/grim Ditch | Kouts | NS (Aquatic Life) | Monitored (b) | D.O. | 3.0 | Biological Assessment, "Poor". |
| Sandy Hook / Cobb Ditches | Kouts | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 9.0 | |
| Phillips Ditch | Kouts | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 5.0 | |
| Carnell Ditch | Hobron | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | D.O.<br>E. coli | 5.0 | Low D.O. at time of sampling. |
| Cobb Creek | Hebron | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Nonpoint source | 4.7 | |
| Cobb Creek | Hebron | FS (Aquatic Life) | Evaluated | | 5.9 | |
| Cobb Creek | Hebron | NS (Aquatic Life) | Monitored (c)(b) | Ammonia<br>Low D.O.<br>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 (b) | Low D.O. | 4.0 | Biological Assessment "Very Poor". |
| Hodge Ditch and tributaries | DeMotte | FS (Aquatic Life)<br>PS (Recreational) | Monitored (c)(b) | E. coli | 70.4 | |
| DeHean and Tyler Ditches | DeMotte | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli<br>D.O. | 11.2 | DeMotte STP impacts stream. Biological Assessment "Poor" on Tyler Ditch. |
| Brent Ditch | DeMotte | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 4.0 | |
| Evers Ditch | DeMotte | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 6.0 | |
| Otis Ditch | DeMotte | FS (Aquatic Life)<br>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)<br>NS (Recreational) | Monitored (b)(c) | E. coli<br>Non-point source | 30.5 | |
| Lawler Ditch and tributaries | Lake Village | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 22.4 | |

Table 46. *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 | 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)<br>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)<br>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)<br>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) | | 3.0 | Biological Assessment was "Excellent" near confluence with Singleton Ditch. |
| Cedar Creek | Lowell | NS (Aquatic Life) | Monitored (b)(c) | Low D.O.<br>E. coli | 12.8 | Biological Assessment, "Poor". |
| Foss Ditch | Lake Dalecarlia | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Low D.0. | 4.5 | Occassional low D.O. |
| 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". |
| U.T. 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 | |
| Hunsely Ditch (Sheldon Amm) | Hanna | FS (Aquatic Life) | Monitored (b) | | 1.5 | |
| Bice Ditch | Rensselaer | FS (Aquatic Life) | Monitored (b) | | 10.2 | |

Table 46. *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 |
|---|---|---|---|---|---|---|
| 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 (c) | | 9.4 | |
| Mud Creek | Earl Park | FS (Aquatic Life) | Monitored (c) | | 14.0 | |
| Mud Lake Ditch | Enos | NS (Aquatic Life) | Monitored (c) | | 3.7 | |
| 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 | |
| Lawrence Pontius Ditch | Koontz Lake | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 3.4 | |
| Robbins Ditch | Koontz Lake | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 5.1 | |

Table 46. *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 |
|---|---|---|---|---|---|---|
| Best Ditch and tributaries | Lake Village | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 10.6 | Biological Assessment, "Poor". |
| Beaver Creek and tributaries | Eros | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | E. coli | 47.0 | |
| Beaver Creek | Morocco | NS (Aquatic life)<br>PS (Recreational) | Monitored (c)(b) | D.O.<br>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)<br>NS (Recreational) | Monitored (c)(b) | D.O.<br>E. coli | 44.7 | Biological Assessment, "Poor". |
| Bryant Ditch | LeRoy | FS (Aquatic Life)<br>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)<br>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)<br>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)<br>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". |
| Whaley Ditch | Kentland | FS (Aquatic Life) | Monitored (b) | | 3.0 | |
| Whitham Ditch | Kingsford | NS (Aquatic Life) | Monitored (b) | | 2.0 | Biological Assessment, "Poor". |

Table 46. *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 |
|---|---|---|---|---|---|---|
| Robbins Ditch | Hamlet | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) (b) | E. coli<br>D.O. | 26.2 | Biological Assessment, "Poor". |
| Robbins Ditch | Hamlet | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 1.3 | |
| Blad Ditch | Hamlet | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | Low D.O.<br>Ammonia<br>E. coli<br>Phosphorous | 1.4 | |
| Blad Ditch | Hamlet | FS (Aquatic Life) | Monitored (c) | | 3.5 | |
| Jain Ditch | Hamlet | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 27.2 | Biological Assessment, "Poor". |
| Danielson Ditch | Hamlet | NS(Aquatic Life)<br>NS (Recreational) | Monitored (c) | Low D.O.<br>E. coli | 12.5 | |
| Bailey Ditch | Hamlet | NS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Low D.O. | 33.5 | |
| Laramore Ditch | Knox | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | Monitored (c) | 19.0 | |
| Wolf Creek | Argos | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c)(b) | | 5.4 | |
| Wolf Creek | Argos | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c)(b) | E. coli | 6.9 | |
| Meyers Ditch | Argos | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | Ammonia<br>TSS<br>E. coli<br>Low D. O. | 15.9 | Argos STP permit violations causing degradation in streams. |
| Clifton Ditch | Hibbard | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | E. coli | 4.4 | |
| Lowry/Listenberger Ditch | Burr Oak | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 6.4 | |
| Harry Cool Ditch | Twin Laker | NS (Aquatic Life)<br>NS (Recreatinal) | Monitored (c)(b) | E. coli<br>D.O. | 6.0 | Biological Assessment, "Poor". |
| Gunnard Anderson Ditch | Ancilla Domini | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 6.4 | Ancilla Domini: STP discharge to Gilbert Lake which affect ditch. |
| Earl Gjemere | Ancilla Domini | FS (Aquatic Life)<br>FS (Recreational) | Monitored (c) | | 5.8 | |

Table 46. *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 |
|---|---|---|---|---|---|---|
| Cavanaugh Ditch | Knox | FS (Aquatic Life) (Threatened) | Monitored (c) | | 2.4 | Low Level toxic parameters in sediment threaten aquatic life. |
| Cavanaugh Ditch (IN 17-031) | Knox | FS (Aquatic Life) Threatened) NS (Recreational) | Monitored (c) | E. coli Toxics | 2.4 | Low level toxic parameters in sediment threaten aquatic life. |

*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.*

The bottom composition of the Kankakee River an 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 D.O. and pH values were satisfactory.

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 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. At the time of the 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 the reach of the stream.

Sherman Emmans and Peter Sarber Ditches form the second large tributary to the Upper Kankakee River, Pine Creek, 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 DO levels of 9.0 mg/l and neutral pH's of 7.7.Both ditches drain the Town of Lapaz which is currently on septic tanks. In the near future, the Town of Lapaz will be connecting to their municipal treatment plant.

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 123.2.

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 which were above the standard (4,600/100 ml).

The Walkerton STP is a multi-cell aerated lagoon system and the effluent was meeting all permit limits at the time of the 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 would indicate relatively good water quality, a fish community Index of Biotic Integrity score was rated poor in this stream.

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.

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 survey, the New Carlisle STP discharged a low quality effluent, and the stream bottom was covered with several inches of sludge and red worms. 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 levels were present at levels of 4.8 mg/l and 3.9 mg/l of TKN. 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 6 mg/l which indicate stream recovery. The Kankakee

River did not exceed water quality standards at river mile 127, 1.1 miles downstream from the County Line Ditch.

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 DO 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 matrix 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. The basin is a sparsely populated watershed with few significant municipal or industrial dischargers, of which none 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 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 1.0 mg/l. Of the 15 sites sampled, nine had values of less than 0.1 mg/l and six had values of 1.0 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 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. The standard deviation was 1.2 mg/l. Lowest dissolved oxygen values in the stream were detected during the periods of higher stream flows. It is felt that this was 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. Samples were collected from one area of field run-off and the dissolved oxygen value was 0.0 mg/l.

The washout of extremely fine suspended silt and sand also impeded light penetration and any signficant photosynthetic activity. This fine material could be observed as dregs in sample contaqiners after the containers had set for a few minutes, however, 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 sites where no point sources are located. These were attributed to lack of stream reaeration, algae induced diurnal variations, 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.

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. The $BOD_5$ and ammonia-N concentrations were 5.9 mg/l and 1.3 mg/l, respectively. Flow was 6.0 cfs.

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 fair with an average D.O. of 6.1 mg/l.

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 $Q_{7-10}$ 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 10 times the $Q_{7-10}$. 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.

Cobb Creek, which is a major tributary to Breyfogel Ditch, is the receiving stream for the Hebron STP. Breyfogel Ditch was sampled just upstream of its 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.

Three areas 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.

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. 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. The Kingsford Heights STP is 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, 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. Kingsbury Creek joins Travis Ditch approximately 6.0 miles upstream from the confluence of the Kankakee River with Travis Ditch.

Travis Ditch begins as a small stream but increases in size and flow (up to 50 cubic feet per second (cfs)) 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. Along its length 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. Also, the stream flows through Kingsbury Industrial Park, where Roll Coater and Kingsbury Industrial Park 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 (D.O.) 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.

Toxic analyses were performed on the water and sediment matrices at a majority of the sampling sites. The water matrix analyses for the priority pollutants did not show any concentrations at levels of concern. The sediment analysis does 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 staions 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 sourthern 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 approximatley 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 predominants 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.

Laville 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 is treated by a 1.3 MGD (Class III) combination trickling filter/biological oxidation tower with intermediate and final clarifiers, rapid sand filters, chemical addition facilities, chlorine contact tank, and post-aeration. The NPDES permit 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. A Compliance Sampling Inspection was conducted in conjunction with the segment study during the survey period.

The largest discharger in the area, the Bremen STP, was meeting all pretreatment and permit limits except for E. coli. A level of 8,900/100 ml could be attributed to a temporary dip in the chlorine residual which was measured at 0.1 ppm. Toxic analysis for priority pollutants at this facility revealed three volatile organic compounds (VOCs) at slightly over detection limits in the raw influent. 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 NPDES 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 in 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 sanalyses 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 E. coli 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 E. coli 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 ($Q_{7-10}$ 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 s 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 $Q_{7-10}$ of 0.0 at the discharge 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. Levels of atrazine, alachlor, cyanazine, simazine, and trifluralin were found to be below detection limits in both the water and 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 input water quality. 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 count 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 areas 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 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, located 1.4 mile downstream of the outfall, had recovered from the effects of the poor quality effluent.

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 $Q_{7\text{-}10}$ 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. The duckweed on the lagoon may have inhibited light penetration and therefore suppressed the D.O. 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.

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 parameters.

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 is 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. Financing problems exist but federal loans may be arranged. 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.

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 but 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 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. Kentland has experienced recent industrial growth yet Capitol Products of Kentland is the only NPDES industrial discharger in the segment.

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. There are five each of industrial, municipal and semi-public permittees. These facilities will be described in order of contribution point to the Iroquois River, beginning upstream.

Rensselaer Stone Company is a Class ASO Limestone quarry and processing plant on SR 114 at Pleasant Ridge, which discharges approximately 0.5 MGD to Ryan Ditch which flows to the Iroquois River. W.C. Babcock Construction Company is a Class ASO limestone quarry located on the east side of Rensselaer. It discharges to the Iroquois River at Melville Street.

Rensselaer Municipal Wastewater Treatment Plant is a new Class II, 1.2 MGD modified activated sludge facility with chlorination, dechlorination, and post aeration. All three previously used lagoons have been phased out, and the plant now discharges to the Iroquois River.

Howard Johnson's (formerly Carson Inn) STP is a Class I, 0.042 MGD semi-public facility, with extended aeration, secondary clarifiers, and polishing pond. It discharges to Bice Ditch, thence to Slough Creek and the Iroquois River.

Central Soya of Remington produces soy protein products. The discharge to Carpenter Creek is limited to non-contact waters, water softener regenerant water and storm water runoff.

The Remington STP is a new, Class II, 0.275 MGD extended aeration (Biolac) system with integral clarifiers and effluent chlorination and dechlorination. The discharge is to Carpenter Creek, then to Slough Creek and the Iroquois River.

McDonald's Restaurant (of Rensselaer) has a Class I, 0.007 MGD treatment system with surge tank, aeration tank, final clarifier, chlorine contact tank, and a 2.3 day polishing pond. The discharge is to Pancost Ditch, then to Yeoman Ditch, Curtis Creek and the Iroquois River.

Curtis Creek carries discharge waters from McDonald's Restaurant and the Trail Tree Inn, a Shell Service Station and motel. Limits were met, but the McDonald's restaraunt plant had a very high chlorine residual. The problem is being investigated.

The Trail Inn at Interstate 65 and S.R. 114 has a semi-public, 0.014 MGD system consisting of an extended aeration plant, rapid sand filter and chlorination facility. Discharge is to an unnamed ditch, then to Yeonian Ditch.

The George Ade Extended Care Facility, on S.R. 16 near Brook, operates a semi-public, Class I, 0.14 MGD, two-chamber septic tank, chlorination, and two 400 ft. open sand filters. Discharge is to the Iroquois River.

The Brook Wastewater Treatment Plant is a Class I, 0.100 MGD, two-cell waste stabilization lagoon system. Seasonal discharge is permitted to 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 1/2 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.

Newton County Stone is a limestone quarry with a Class ASO industrial wastewater treatment plant. Discharge is from a lagoon to Montgomery Ditch, then to the Iroquois River.

South Newton High School operates a Class I, semi-public, 0.0208 MGD extended aeration wastewater treatment facility with surge tank, final clarifier, sludge holding tank, chlorination equipment, dosing tank, and two open sand filters. Discharge is to Montgomery Ditch.

The Kentland STP is a 0.46 MGD, Class II, extended aeration facility. An ultraviolet disinfection system has replaced the chlorination system. The plant discharges to an unnamed tributary to Montgomery Ditch.

Capitol Products, Kentland, operates a Class C industrial wastewater treatment plant. Discharge is to Morrison Ditch, then to Montgomery Ditch and the Iroquois River. Effluent samples from this facility showed no NPDES violations. Sediment analyses for a sample collected from the stream bed at Capitol Product's outfall showed two metals, cadmium and nickel, above statewide background concentration maximums. Cadmium was 6 mg/kg (1.0 maximum) and nickel was 110 mg/kg (21.0 maximum). Downstream samples were not collected due to the gravel bed and swift current. A large population of minnows was noted in the downstream area.

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 were comprised of bullheads and centrarchids. These areas were generally degraded due to fluctuating flows which prohibited 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.

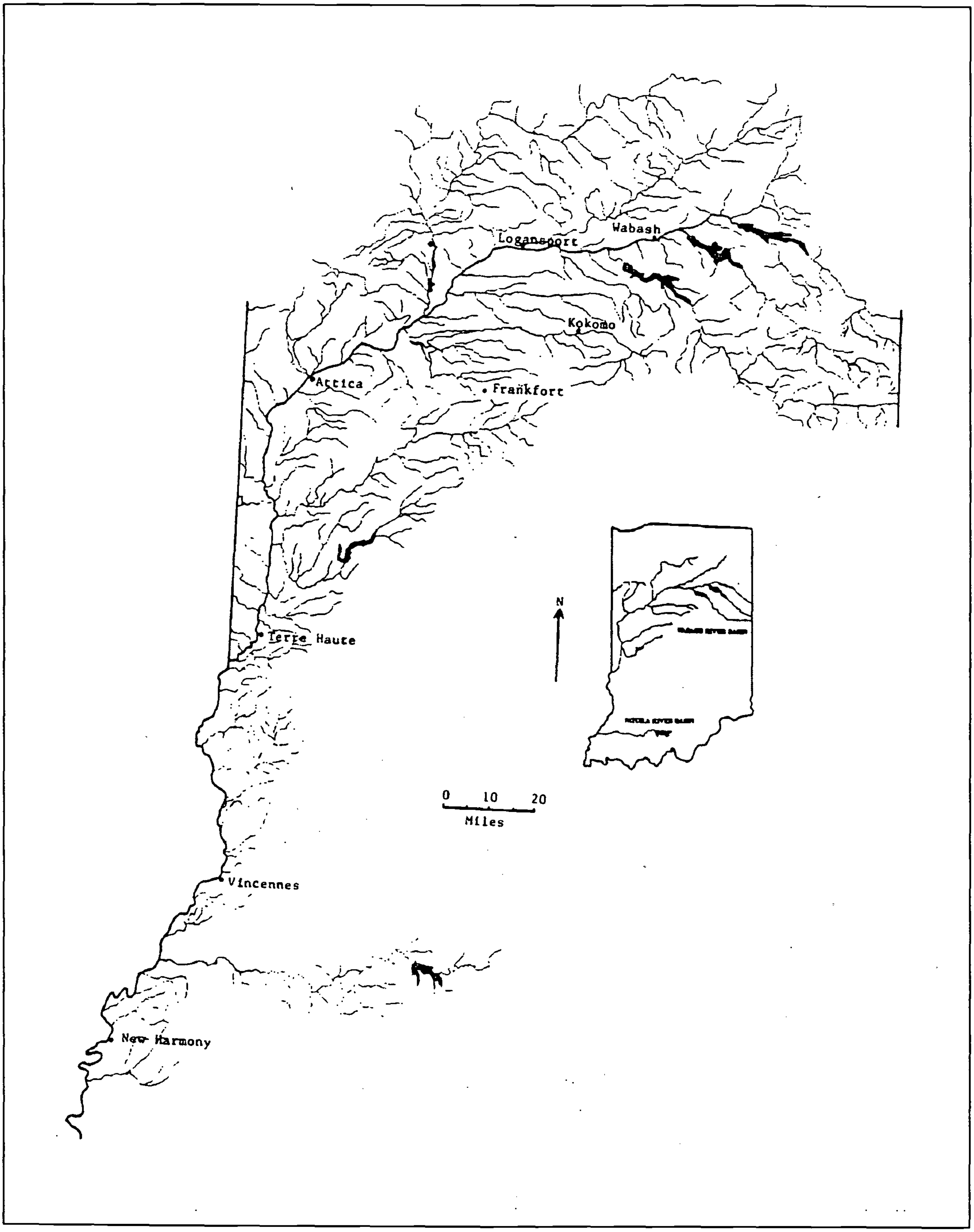
The Iroquois basin has been and continues to be dredged in order to maintain agricultural irrigation capability. A high proportion of the sites have recovered and have the resemblance of a quality riffle, run, and pool habitat. The ability of species colonization from the mainstem Iroquois into tributary 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 1,667 stream miles were assessed in the Kankakee River Basin in 1990 and 1991. With regard to aquatic life uses, 1,151 miles (69%) fully support and 14 miles (1%) fully support this use but are threatened, 2 miles (0.1%) are partially supportive and 476 miles (29%) were not supportive. There were 1,124 miles assessed for recrational uses. Of those miles, 426 (38%) were supporitive, 85 miles (6%) were partially supporting and 613 miles (55%) 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 10). 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.

**FIGURE 10.** *WABASH RIVER BASIN (INCLUDING PATOKA RIVER BASIN)*



There is one large Corps of Engineers (C.O.E.) impoundment on the 450 mile river mainstem 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.

A number of streams within the basin have been designated as exceptional use waters and their quality must be maintained without degradation. Eight of the ten streams which are designated for exceptional use (Table 47) are in the Wabash River Basin.

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 or whole body contact activities for most of the year. The limited use streams in the Wabash River Basin are listed in Table 48. Surface water intakes for public water supplies are located on the waters shown in Table 49.

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 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.

Water quality monitoring in the basin during 1990 and 1991 included:

1. Monthly or quarterly chemical and bacteriological sampling at 35 Fixed Water Quality Monitoring Stations.

2. Fish tissue collection on the Wabash River, Walnut Creek and Otter Creek. Macroinvertebrate sampling was conducted at these stations.

3. Compliance Sampling Inspection records.

4. Special fish tissue and sediment sampling studies at several sites on the Eel River, Tippecanoe River and Wabash River.

TABLE 47. *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 48.** *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 49.** *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 |

**Patoka River Basin**

| | |
|---|---|
| Huntingburg | Huntingburg Lake |
| Jasper | Patoka River |
| Oakland City | Oakland City Lake |
| Winslow | Patoka River (plus purchases) |

5. Macro invertebrate sampling at several sites on the Little Mississinewa and Mississinewa Rivers, Eel River, and Wabash River.

A total of 1,661 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 50. 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 were subsequently collected in 1989. The fish consumption advisory for the Wabash River has now been entirely lifted 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 FDA Action Levels for residual PCB's. These areas are included in the 1991 fish consumption advisory (Table 20), 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 are being 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 POTW 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.

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. Data from 15 fixed water quality monitoring stations

**TABLE 50.** *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)<br>NS (Recreational) | Monitored (c) | E. coli | 16 | |
| Wabash River | Markle | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 3 | |
| Wabash River | Huntington | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>TSS | 6 | |
| Wabash River | Andrews | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 16 | a) Some infrequent bypassing at Andrews STP.<br>b) Awarded 1990 IDEM Operation and Maintenance award. |
| Wabash River | Wabash<br>Peru | FS (Aquatic Life)<br>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.<br>b) Plans underway to build new Wabash STP plant.<br>c) Wastewater treatment plant improvement project underway at Peru. |
| Wabash River | Georgetown | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 27 | |
| Wabash River | Upstream Lafayette | FS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | E. coli | 30 | PCB contaminated sediments in Wabash (low concern). |
| Wabash River | Lafayette<br>Terre Haute<br>Darwin | FS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | E. coli | 73 | |
| Wabash River | Darwin to Mouth | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 185 | |
| Salamonie River | Portland | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 23 | ANR Pipeline Company will monitor for PCB's which were once used in manufacturing compressor engines. |
| Salamonie River | Upstream Lancaster to Mouth | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 54 | |
| Little Mississenewa River | Union City | NS (Aquatic Life) | Monitored (c) | PCB's<br>Chlordane | 7 | Past problems at Union City POTW have been resolved for the time. |

Fish Consumption Advisory

Table 50. *Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment and Miles Affected In the Wabash River Basin (Including Patoka River) (Con't)*

| WATERBODY | NEAREST TOWN(S) | STATUS OF DESIGNATED USE SUPPORT1 | METHOD OF ASSESSMENT2 | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| Little 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) FS (Recreational) | Evaluated | | 5 | |
| Eel River | Near headwaters to upstream South Whitney | FS (Aquatic Life) FS (Recreational) | Evaluated | | 20 | |
| Eel River | South Whitney | FS (Aquatic Life) FS (Recreational) | Evaluated | | 2 | |
| Eel River | 2 miles D/S South Whitley to Roann | FS (Aquatic Life) FS (Recreational) | Monitored | | 24 | |
| Eel River | Roann to Mouth | FS (Aquatic Life) NS (Recreational) | Monitored | E. coli | 41 | |
| Williamson Ditch | Upstream Palestine Lake | FS (Aquatic Life) (Threatened) | Evaluated | Metals | 2 | |
| Tippecanoe River | Headwater to Rochester | FS (Aquatic Life) FS (Recreational) | Evaluated | | 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 Mouth | FS (Aquatic Life) NS (Recreational) | Monitored (c) | E. coli | 102 | |
| Wildcat Creek | Headwater to Kokomo | FS (Aquatic Life) FS (Recreational) | Monitored (c) | | 16 | |

Table 50. *Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment and Miles Affected In the Wabash River Basin (Including Patoka River) (Con't)*

| 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)<br>NS (Recreation) | Monitored (c) | PCB's<br>E. coli | 65 | Fish Consumption Advisory for all species. |
| Kokomo Creek | Kokomo | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCB's<br>E. coli | 2 | Fish Consumption Advisory for all species. |
| South Fork Wildcat Creek | Entire length | NS (Aquatic Life)<br>(Recreational) | Monitored (c) | Cyanide<br>PCB's<br>E. coli | 41 | |
| Elliot Ditch and Wea Creek | Lafayette | NS (Aquatic Life)<br>(Recreational) | Monitored (c) | PCB's<br>E. coli | 27 | Contaminated sediments from Alcoa to be removed from Elliot Ditch. |
| Big Pine Creek | Pine Village | FS (Aquatic Life)<br>NS (Recreational) | Monitored (b)(c) | E. coli | 77 | |
| Vermillion River | Cayuga | PS (Aquatic Life)<br>NS (Recreation) | Monitored (c) | E. coli | 8 | Past cyanide problems. |
| 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)<br>NS (Recreational) | Monitored (c) | E. coli | 30 | |
| Little Sugar Creek | Near Crawfordsville | NS (Aquatic Life) | Monitored (c) | PCB's | 10 | Fish Consumption Advisory due to PCB's. |
| Big Racoon Creek | Entire length (except for 1 mile) | FS (Aquatic Life) | Monitored (b) | | 82 | Based on DePauw University fish population study. |
| Big Racoon Creek | Coxville | FS (Aquatic Life)<br>(Threatened) | Evaluated | Acid Mine Drainage | 1 | |
| Otter Creek (Upper) | Vigo and Clay Counties | FS (Aquatic Life)<br>(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. |

Table 50. *Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment and Miles Affected In the Wabash River Basin (Including Patoka River) (Con't)*

| WATERBODY | NEAREST TOWN(S) | STATUS OF DESIGNATED USE SUPPORT1 | METHOD OF ASSESSMENT2 | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| Coal Creek | Vigo County | PS (Aquatic Life) | Evaluated | Acid Mine Drainage, Silt | 7 | |
| Blue River | Columbia City | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | BOD<br>TSS | 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 | |
| Sulphur Creek | Sullivan County | NS (Aquatic Life) | Evaluated | Acid Mine Drainage | 7 | |
| Patoka River | Jasper to Mouth | FS (Aquatic Life)<br>NS (Recreational) | Evaluated | E. coli<br>TSS | 86 | Minor grease and oil deposits in storm ditches add to a TSS problem. |
| South Fork of Patoka River and Tributaries | Pike, Warrick, and Gibson Counties | FS (Aquatic Life) (Threatened) | Evaluated | Acid Mine Drainage | 40 | Oakland City STP has severe bypassing problems. |
| South Fork Smalls Creek | Bruceville | NS (Aquatic Life) | Evaluated | Acid Mine Drainage | 8 | |
| 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 River | Roanoke | FS (Aquatic Life) (Threatened) | Evaluated | Metals in Roanoke STP Lagoons | 21 | |

Table 50. *Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment and Miles Affected In the Wabash River Basin (Including Patoka River) (Con't)*

| WATERBODY | NEAREST TOWN(S) | STATUS OF DESIGNATED USE SUPPORT1 | METHOD OF ASSESSMENT2 | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| Humbert Ditch | Fowler | FS (Aquatic Life) | Evaluated | | 1 | |
| Round Prairie Creek | Windfall | FS (Aquatic Life) | Evaluated | | 1 | |
| Townsand 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) | Evaluated | | 5 | a) Warsaw STP in excess of cyanide limits. A dozen volatile organic compounds were found in influent/effluent (small concentrations). b) A pesticide (DDD) found in influent. c) 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 | |
| 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 | |

Table 50. *Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment and Miles Affected In the Wabash River Basin (Including Patoka River) (Con't)*

| WATERBODY | NEAREST TOWN(S) | STATUS OF DESIGNATED USE SUPPORT1 | METHOD OF ASSESSMENT2 | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| Trimble Creek (Mentone) | (Mentone) | PS (Aquatic Life)<br>PS (Recreational) | Evaluated | BOD<br>TSS<br>Ammonia<br>E. coli | 4 | Problems from past procedures remain. Poultry plant is now closed. |
| Yellow Creek | Mentone | FS (Aquatic Life) | Evaluated | | 1 | |

*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*

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.

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 and these violations here have not impacted the Wabash River. 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. They are still in the process of obtaining permits for this operation.

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 in Roanokes' wastewater treatment system.

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 recontamination 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.

The Eel River fully supports the aquatic life use along its entire length. From Roann downstream to its mouth, high E. coli concentrations occur frequently enough to cause non-support of the recreational use. The Indiana Department of Natural Resources conducted fish population studies on the Eel River in Miami and Cass counties at seven stations. These studies reveal that the Eel River was supporting a recreational fishery in 1988 and 1989. Significant improvement was noted in the smallmouth bass fishery which had been previously depressed.

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%. Recent inspections have shown improved operations and a recent toxicity test showed that toxicity is greatly reduced from previous tests. 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.

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. The Town of Mentone recently completed construction of a 0.12 MGD treatment plant.

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.

Wildcat Creek is considered to fully support the aquatic life and 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.

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 tisue 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, however, occasional high E. coli levels prevent Sugar Creek from supporting its designated recreational use.

The Patoka River receives acid mine drainage and organic loading from the Jasper and Oakland City STP's, but aquatic life uses are supported. Frequent high E. coli levels in the Patoka River prohibit this stream from meeting its recreational use designation.

The Jasper STP has problems consistantly meeting permit limits for cyanide, lead, residual chlorine and fecal coliform bacteria. However, impacts to the Patoka River have apparently been minimal at present. The Town is working to resolve these problems by trying to identify sources of these substances in the waste stream. Once the sources have been identified, they can be addressed.

Inflow and infiltration (I and I) in the sanitary sewer system causes bypassing of raw sewage and hydraulic loading problems at the wastewater treatment plant at Oakland City. Oakland City has a plan for the systematic identification and removal of I and I sources, but this will require time to implement.

Fish tissue and sediment samples were analyzed from three sites on the Patoka River in 1989. Although a few organics were detected in the sediments, no pollutants were found which would cause concern. No fish were found which exceeded FDA Action Levels for any substances.

In summary, 1,661 miles were assessed in this basin as to support of the aquatic life use. Of these miles, 1,308 (79%) fully supported, 81 (5%) were fully supportive but threatened, 73 (4%) were only partially supportive, and 199 (12%) did not support this use. Only 1,209 of these miles were assessed as to support of recreational uses. Of these miles 163 (13%) fully supported, 8 (0.7%) partially supported, and 1,038 (86%) did not support the recreational use.

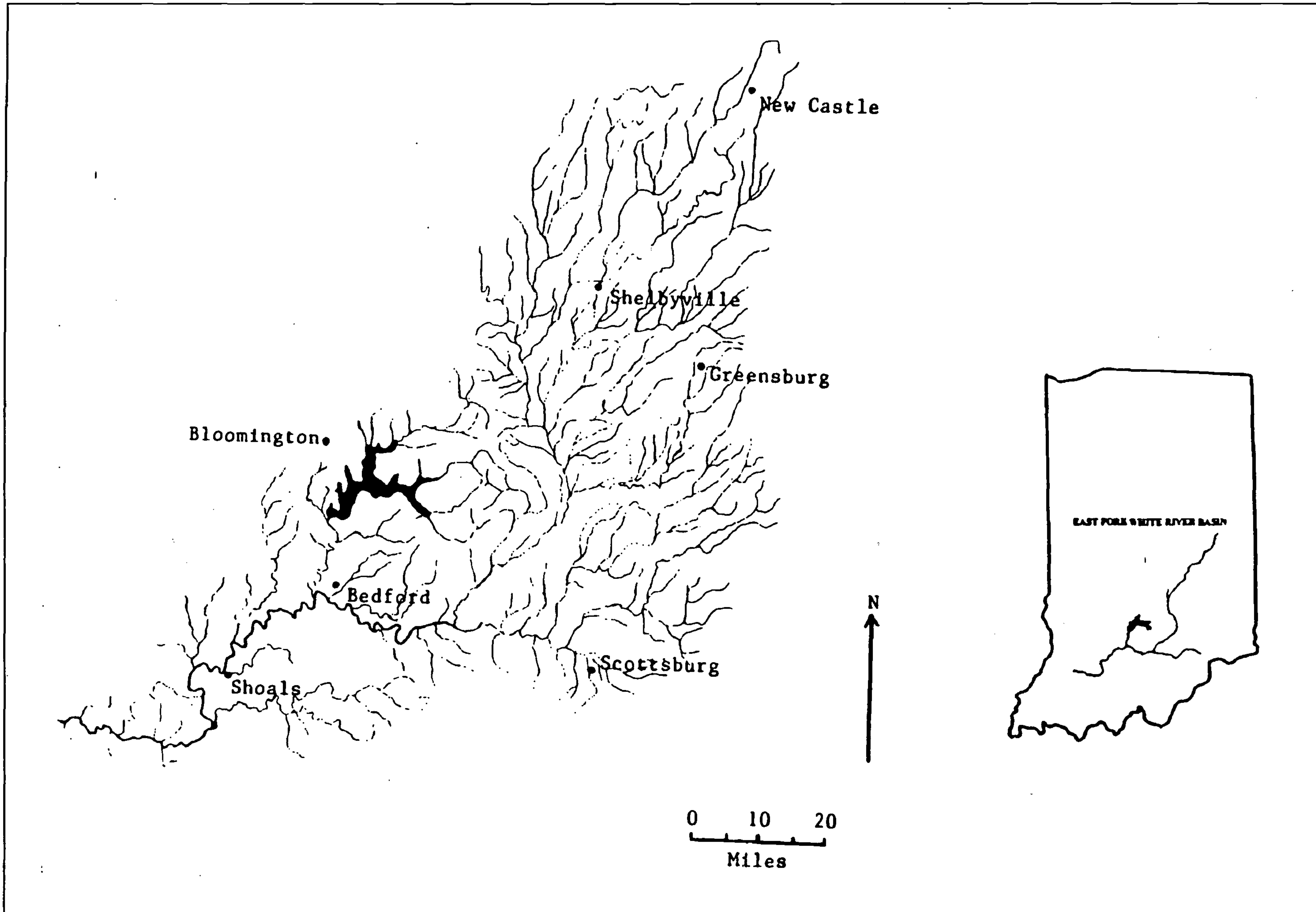
East Fork of the White River Basin

The East Fork of the White River drains approximately 5,600 square miles of southern Indiana (Figure 11). 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 fish continues, justified by state records for sucker and smallmouth 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 used in the cultured pearl industry.

**FIGURE 11.** *EAST FORK OF WHITE RIVER BASIN*



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 river is designated for whole body contact recreation and must meet bacterial standards for this use as well.

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, and a portion of Ackerman Branch and Mill Creek at Jasper.

Water quality monitoring in the basin during 1990 and 1991 included:

1. Monthly or quarterly chemical and bacteriological sampling at ten fixed stations

2. Toxicity tests at Columbus, Edinburgh, and Greensburg Municipal STPs and the Crane Naval Weapons Support Center.

3. Surface Water Pesticide Study of 17 sites.

Those waters assessed, the status of designated use support, the method of assessment, probable causes of nonsupport, and miles affected are shown in Table 51. 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

TABLE 51. *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)<br>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)<br>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<br>Shelbyville<br>Edinburg<br>Knightstown | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>BOD | 60 | Some CSO's from Shelbyville National Guard STP. Edinburgss 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. |
| Clear Creek/Salt Creek/East Fork White River from Bedford to Williams | Bloomington<br>Bedford<br>Williams | NS (Aquatic Life)<br>NS (Recreational | Monitored (c) | PCB's<br>D.O.<br>E coli<br>Chlordane | 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. |
| Pleasant Run | Bedford | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Metals<br>PCBs<br>Chlordane | 4 | Good water treatment in area by Central Foundary and Bedford STP. Area under Fish Consumption Advisory. |
| Gas Creek/Sand Creek/Muddy Fook | Greensburg | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | Chlordane<br>Dieldrin<br>E. coli | 15 | New Greensburg STP. Some by passing still occurs. Fish Consumption Advisory. |
| Sand Creek | Below Greensburg | NS (Aquatic Life) | Monitored (c) | Chlordane<br>Dieldrin<br>TSS<br>Atrazine | 15 | Fish Consumption Advisory. |
| Muscatatuck River | Austin<br>Scottsburg | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 25 | New facility. Good treatment is achieved. |
| Lick Creek | Paoli | PS (Aquatic Life) | Evaluated | TSS<br>D.O. | 5 | Solids often get into Creek from STP. |

Table 51. *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 |
|---|---|---|---|---|---|---|
| Underground Lost River | Orleans | PS (Aquatic Life) | Evaluated | D.O.<br>Ammonia | 5 | |
| Rock Lick Branch | Mitchell | FS (Aquatic Life) | Evaluated | | 4 | |
| E. Fork White River (Lawrence County Line to Mouth) | Shoals<br>Petersburg | PS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 75 | |
| E. Fork White River (Williams to Lawrence County Line) | Williams | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCBs<br>E. coli<br>Chlordane<br>Metals | 5 | Fish Advisory for Carp. |
| E. Fork White River | Seymour<br>Brownstown<br>Medora | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCBs<br>D.O.<br>E. coli | 74 | a) Medora plant under construction. No evidence of contamination of E. Fork White River from town STP.<br>b) Fish Consumption Advisory. |
| E. Fork White River | Columbus | FS (Aquatic Life)<br>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 | Greenfield STP currently experimenting with Innovative Sludge Reduction Technology. |
| Underground Carter's Creek | Campbellsburg | PS (Aquatic Life) | Evaluated | Ammonia<br>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 | |
| Brewer Ditch | Whiteland | FS (Aquatic Life) | Evaluated | | 3 | Limited use stream. |
| North Fork of Salt Creek | Nashville | FS (Aquatic Life)<br>NS (Recreational) | Evaluated | E. coli | 3 | |
| Heddy Run | Seymour | PS (Aquatic Life) | Evaluated | Metals<br>Pesticides | 1 | Additional sludge processing and storage work being contracted. Repairs on Seymour STP underway. |
| Sugar Creek | Edinburg | FS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli | 5 | |

**Table 51.** *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 | |
| Clifty Creek | Hartsville | FS (Aquatic Life) (Threatened) | Evaluated | BOD<br>TSS<br>$NH_3$-N | 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) | | | 5 | |
| Luther McDonald Ditch | Seymour | FS (Aquatic Life) | | | 3 | |
| Goose Creek | Oolitic | FS (Aquatic Life) | Evaluated | | 2 | |
| Six Mile Creek | Jennings County | FS (Aquatic Life) | Evaluated | | 6 | |
| Youngs Creek | Franklin | FS (Aquatic Life) (Threatened) | Evaluated | Pesticides | 10 | Pesticides and low D.O. levels. |
| Cooks Creek/Little Sand Creek | Elizabethtown | FS (Aquatic Life) | Evaluated | | 5 | |
| Flatrock River | Columbus, Rushville | FS (Aquatic Life) (Threatened)<br>NS (Recreational) | Monitored (c) | E. coli | 40 | Pesticides from over application and run off. |
| Grassy Creek | New Whiteland | FS (Aquatic Life) | Evaluated | | 3 | |

Table 51. *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 | PS (Aquatic Life) | Evaluated | Chlordane | 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.*

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 1990-91 fish consumption advisory (Table 20) 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. 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 will be taken in the fall of 1991 and spring of 1992 to try to determine the amount of these substances still reaching the surface waters.

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 revealed high metals concentrations immediately downstream of the Allegheny Ludlum outfall. Elevated levels of chromium, copper, lead, mercury, nickel, and zinc were observed. 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 has obtained a new NPDES permit with lower metals limits which should improve water quality in the Big Blue River. 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 is experiencing high levels of copper, lead, zinc 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.

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 in the second tank. 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.

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 under construction. It's discharge point will be changed and the plant will have a controlled discharge. The current system is 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 has notified major restaurants that the sewer ordinance will be enforced and estimates have been obtained for grease removal from sewers by a contractor. 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 violated TSS and BOD limits. Brownstown, although under a Consent Decree, has had several equipment related violations.

The Westport STP which discharges to Millstone Creek has been operating well and the effluent is usually well below the NPDES permits limits.

Recent inspections have shown that the Mitchell STP, aside from occasional equipment malfunction, is operating well. 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 Loogootee STP in Martin County has had made several improvements including the 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.

The Orleans STP which discharges to the Lost River sinkhole, is a new plant and is in compliance with its permit limits. Major improvements have been made to its laboratory facilities.

In summary, 814 miles of stream were assessed as to meeting aquatic life uses in the East Fork of White River Basin in 1990 and 1991. Of these, 458 miles (56%) fully supported designated uses, 160 miles (20%) were fully supportive but threatened, 48 miles (6%) partially supported its uses, and 148 miles (18%) did not support the designated uses. Accumulation of high levels of PCBs and pesticides in fish accounted for 20% of the stream miles not meeting or only partially meeting the designated uses. In terms of recreational uses, 431 miles were assessed. All 431 miles 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 and flows through eleven counties to join 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 12).Table 52 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 Muncie upstream of the Publicly Owned Treatment Works (POTW).

Water quality of the West Fork of White River declines in the reach from Muncie to Martinsville, and neither aquatic life nor whole-body contact recreational uses are supported. This reach of the river 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 also problems.

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 and chlordane 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 for either PCBs or chlordane so this portion of the advisory has been lifted.

In the reach of the river from the Delaware County line to Martinsville, cyanide concentrations exceeding water quality standards occur frequently enough to contribute to the non-support of aquatic life uses. The source of the cyanide is currently not known. High E. coli concentrations were found often enough throughout this entire reach that whole body contact recreational uses were not supported.

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 had major renovation done

FIGURE 12. *WEST FORK OF WHITE RIVER BASIN*

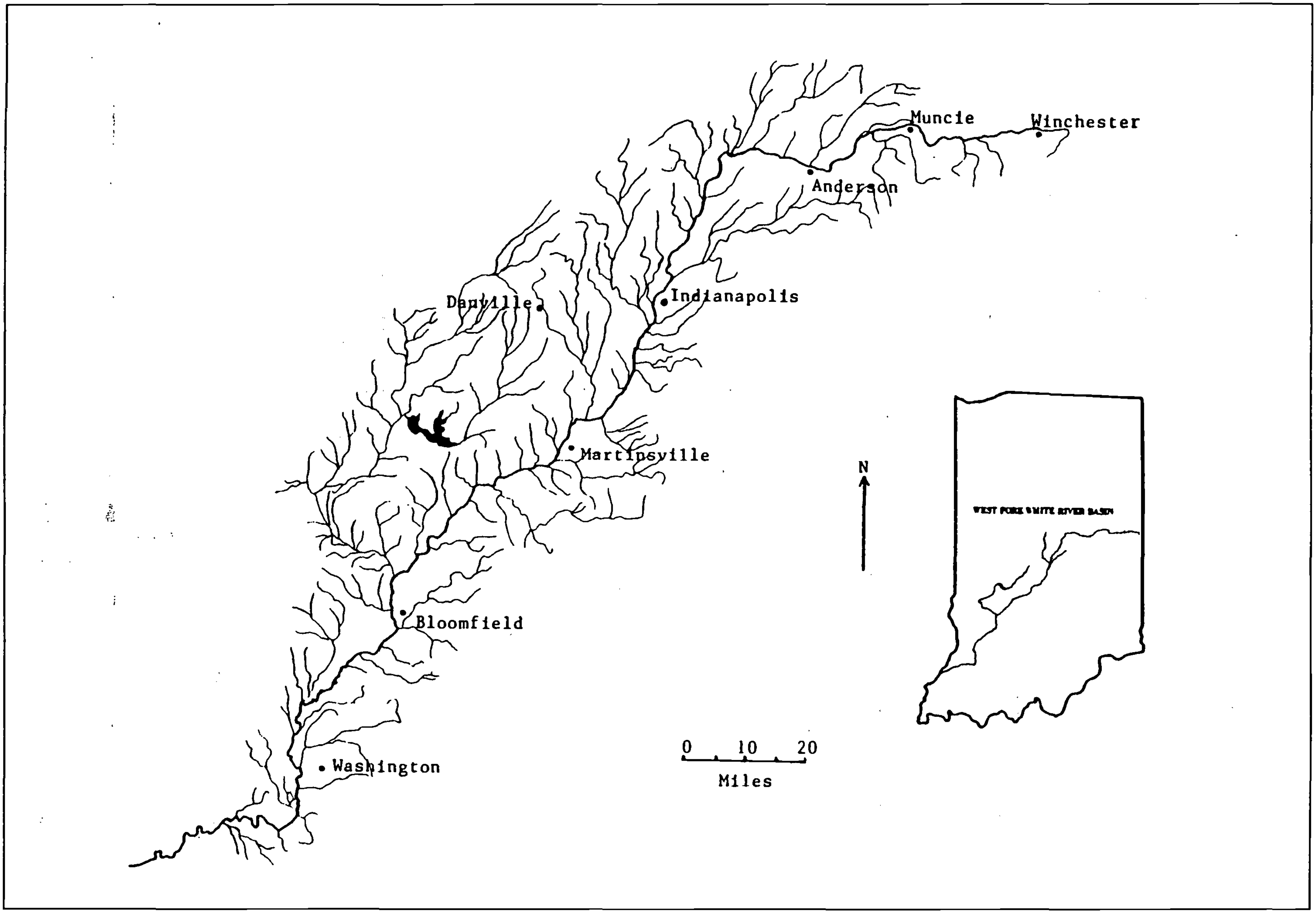


**TABLE 52.** *Water Assessed, Status of Designated Use Support, Probable Causes of Impairment, and Miles Affected in the West Fork of White River Basin*

| 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)<br>NS (Recreational) | Monitored (c) | E. coli | 25 | |
| W. F. White River | Delaware County | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>CSO's<br>PCB's<br>Cyanide<br>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 | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCB's<br>Pesticides<br>E. coli<br>Cyanide | 40 | New system for solids handling at the Anderson facility. Fish Consumption Advisory. |
| W. F. White River | Noblesville to North Marion County Line | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | PCB<br>E. coli<br>Pesticides | 20 | Fish Consumption Advisory.<br>Firestone/Bridgestone (under RCRA Consent Order) in Noblesville will eliminate an outfall and drain system which has residual PCB's in discharge.<br>Noblesville STP has new sludge handling facility designed, submitted, and approved by IDEM. |
| W. F. White River | No. Marion County to Martinsville | NS (Aquatic Life)<br>NS (Recreational) | Monitored (b, c) | E. coli<br>Mercury<br>Copper<br>Pesticides | 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)<br>NS (Recreational) | Monitored (c) | E. coli | 142 | |
| White River (Main Stem) | Petersburg to Wabash River | FS (Aquatic Life)<br>NS (Recreation) | Monitored (c) | E. coli | 48 | |
| Lilly Creek | Orestes | FS (Aquatic Life)<br>NS (Recreational) | Evaluated | E. coli | 1 | |
| Duck Creek | Elwood | NS (Aquatic Life)<br>NS (Recreational) | Evaluated | E. coli<br>Bypassing<br>CSO's | 3 | Remediation plans to correct bypasses discussed with Director of Utilities. |

Table 52. *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 (lower 8 miles) | Strawtown | FS (Aquatic Life)<br>(Threatened) | Evaluated | Bypassing | 8 | Periodic bypassing from Elwood POTW threatens this reach of stream. |
| Fall Creek (Headwaters through Geist Reservoir) | Pendleton | FS (Aquatic Life)<br>NS (Recreational) | Monitored (b) | E. coli<br>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 | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | CSO<br>Metals<br>E. coli | 5 | |
| Fall Creek | Immediately Downstream Geist Reservoir | NS (Aquatic Life)<br>NS (Recreational) | Evaluated | Copper<br>E. coli<br>Mercury | 6 | |
| Eagle Creek | Indianapolis | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Nonpoint Source<br>Cyanide<br>Ammonia<br>Pesticides | 4 | Several industrial discharges to this stream. |
| Eagle Creek | Zionsville Headwater to Eagle Creek Reservoir | NS (Aquatic Life)<br>NS (Recreational) | Monitored (c) | E. coli<br>Copper | 25 | |
| East Fork of White Lick Creek for 3 miles downstream of Indianapolis | Indianapolis | 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)<br>PS (Recreational) | Evaluated | E. coli<br>High BOD<br>Ammonia<br>Low D.O. | 2 | No recent violations. |
| White Lick Creek | Plainfield | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 2 | |
| White Lick Creek | Mooresville to Confluence with W.F. White River | FS (Aquatic Life)<br>FS (Recreational) | Monitored (b) | | 7 | |

Table 52. *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 |
|---|---|---|---|---|---|---|
| West Fork White Lick Creek | Danville | FS (Aquatic Life)<br>(Threatened)<br>FS (Recreational) | Evaluated | Nonpoint<br>CSO's<br>BOD<br>TSS<br>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 | Pittsboro | FS (Aquatic Life)<br>FS (Recreational) | Evaluated | | 5 | |
| Wilson Ditch and Stoney Creek | Noblesville | NS (Aquatic Life) | Monitored (c) | PCB<br>D.O. | 1 | Complete Fish Consumption Advisory. New sludge handling facility of STP to be constructed in Spring 1993. |
| 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<br>Zinc<br>D.O.<br>Ammonia | 4 | Bypassing problems with Linton POTW. |
| Indiana Creek | Bickne II | NS (Aquatic Life) | Evaluated | Acid Mine Drainage | 4 | |
| Hawkins Creek | Washington | NS (Aquatic Life) | Evaluated | Low D.O.<br>Ammonia<br>High BOD<br>E. coli<br>CSO | 4 | Bypassing problems. Some sewer improvements include grit removal system. Three sanitary sewers eliminated. One CSO closed. |
| Pipe Creek | Alexandria | FS (Aquatic Life)<br>(Threatened) | Evaluated | CSO | 20 | Sludge handling and storage problems occur at Alexandria Municipal Treatment Plant. CSO's to Pipe Creek. |
| Jacks Defeat Creek | Elletsville | FS (Aquatic Life) | Evaluated | Bypasses | 6 | Working with Northern Richland Sewer District to limit amount of inflow and infiltration to correct problem. Caused fishkill. |

Table 52. *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 |
|---|---|---|---|---|---|---|
| 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 | FS (Aquatic Life) | Monitored (c) | | 10 | Solids handling at STP addressed. Plant runs more efficiently. |
| 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.<br>TSS<br>Sewage | 8 | Wastewater bypassed into Mud Creek. Enforcement against violations pursued. |
| Arbogast Ditch | Park City | FS (Aquatic Life) | Evaluated | | 1 | |
| Cabin Creek | Farmland | FS (Aquatic Life) | Monitored (c) | | 10 | |
| Cicero Creek | Cicero | FS (Aquatic Life) (Threatened) | 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 | |

Table 52. *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 SUPPORT[1] | METHOD OF ASSESSMENT[2] | PROBABLE CAUSE OF IMPAIRMENT | MILES AFFECTED | COMMENTS |
|---|---|---|---|---|---|---|
| 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*

to its two POTW's. Many of the problems in this reach of the river may be more attributable to past conditions or to CSO's and nonpoint source problems than to the major municipal point sources. From below Martinsville 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 supports aquatic life. However, recreational uses are impared 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 periods the water temperatures downstream of these plants may force 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 severally 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.

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 PCB's appear not to come from manufacturing processes, but from roof and surface drains which combine with their 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. It is thought that 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 also 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.

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. While there have been no recent permit violations, a high ammonia level is often found in the effluent. The facility is scheduled to start construction on ammonia removal facilities. Sample results suggest that Eagle Creek is being impacted by this facility. The total ammonia levels have been high (averaging 2.6 mg/l) at the downstream monitoring station (approximately 0.25 miles downstream). The upstream samples average less than 0.1 mg/l of ammonia. This level could cause problems at higher water temperatures. All downstream parameters had elevated levels compared to the upstream samples. This reach of Eagle Creek does not support aquatic life or 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 dissolved oxygen. Its aerated lagoons are full of sludge and bypassing occurs during rain events. These gross violations occur often and are complicated by a General Electric facility which fails 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.

Presently, only noncontact cooling water goes to the outfall untreated. All contact water has been piped with other process waste streams to the Linton wastewater treatment plant. This stream only partially supports aquatic life uses.

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 operates legally by treating 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 referenced in the 1988-89 305(b) Report 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 are scheduling sewer and manhold rehabilitation. Field surveys are now being conducted to determine the rehabilitation needs for 110 manholes in Mooresville. The project will include cleaning and television inspection of approximately 49,000 feet of sewers, and the grouting of sewer joints. Completion of this effort is expected by September 1992.

Avon Utilities which also discharges to White Lick Creek has had problems meeting permit limits in the past. Indiana 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.

The City of Washington recently completed renovations and improvements to the wastewater treatment plant. The former trickling filter plant is now 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.

Three of the six dry weather permitted sanitary sewer overflows (SSO) in Washington have been eliminated. The city is ahead of schedule regarding the order for the elimination of all SSOs. One combined sewer overflow has also been closed, but the system still has inflow and infiltration problems.

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.

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. 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. The stream is fully supportive of aquatic life but is threatened.

Chlordane and PCBs in fish tissue and occasional to frequent high levels of cyanide, 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 mainstem of the East Fork, West Fork and lower White River. Tributary sampling, however, has yet to be performed. The assessment of results cannot be accomplished until tributary sampling has been completed.

In summary, 808 miles of streams were assessed in the West Fork of White River for support of designated aquatic life uses. Of this total 540 miles (67%) fully supported this use, 49 miles (6%) were fully supportive but threatened, 9 miles (1%) partially supported this use, and 210 miles (26%) did not support aquatic life uses. Only 451 miles were assessed for recreational use. Of these miles 14 miles (3%) were fully supportive, 2 miles (0.4%) were partially supported, and 435 miles (96%) did not support the recreational designation.

Ohio River Basin

The Ohio River and its Indiana tributaries (excluding the Wabash River) drain approximately 5,800 square miles in Indiana (Figure 13). 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.

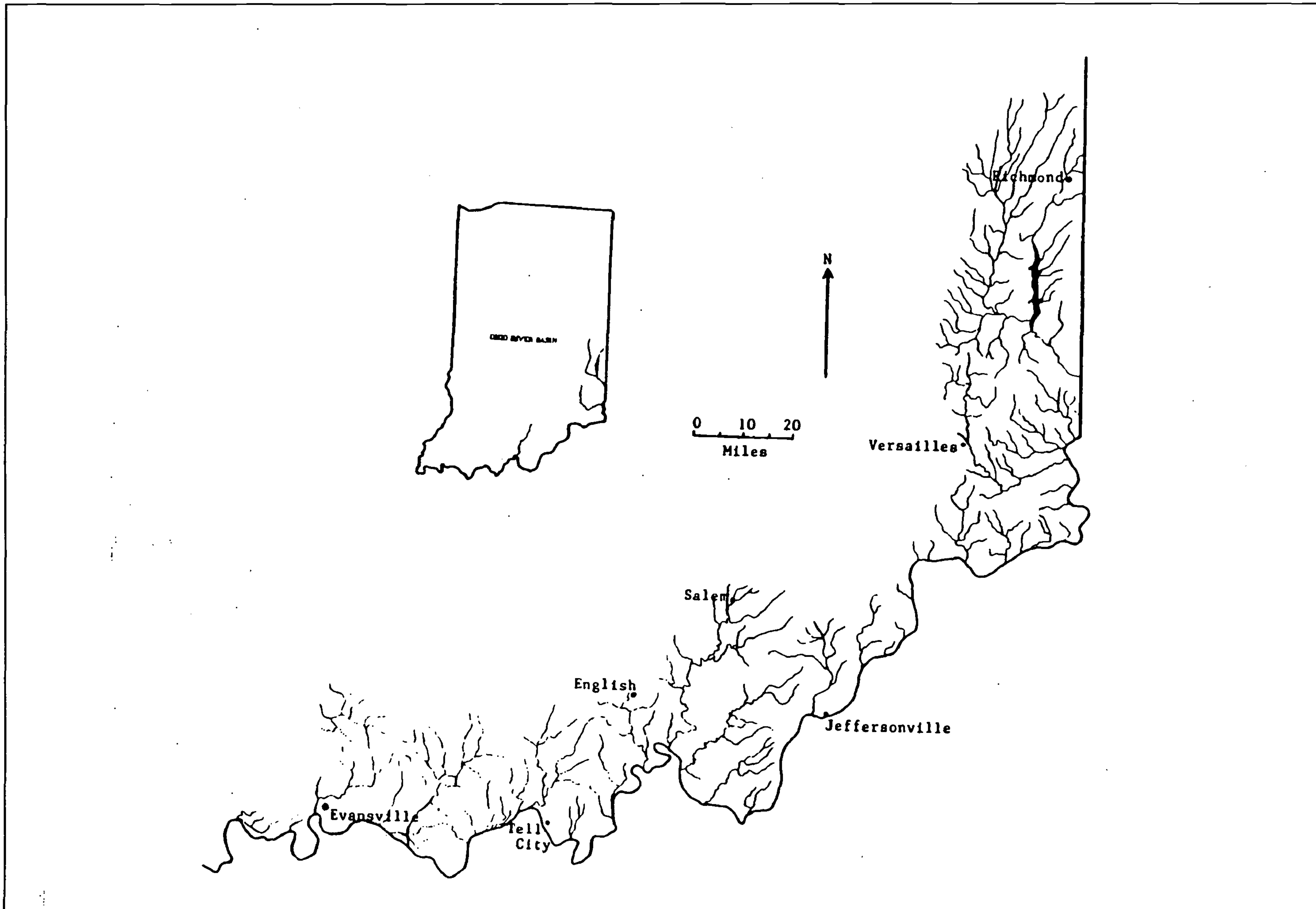
Water quality monitoring of the Ohio River itself, which forms the southern boundary of 13 Indiana counties from about river mile points 492 to 848 (356 miles), is done by the Ohio River Valley Water Sanitation Commission (ORSANCO), a consortium composed of eight states, six of which border the Ohio 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.

ORSANCO is the agency mainly responsible for the monitoring of the Ohio River mainstream. A detailed discussion of the water quality conditions in the Ohio River mainstem can be found in the 1990-91 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 Compact as "available for safe and satisfactory use of public and industrial water supplies after

FIGURE 13. *OHIO RIVER BASIN*



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 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.

Several Indiana streams tributary to the Ohio River comprising 600 stream miles have been assessed. Table 53 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 become non-compliant in meeting permit limits. The South Dearborn STP has state enforcement action pending against it due to almost continuous non-compliance. Facility effluent in the past always looked poor and very rarely met limits for Total Suspended Solids. High organic loadings had made this an ongoing problem.

The Madison STP has 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 station problems. During 1991 many new items of equipment were repaired or replaced, reducing bypassing considerably.

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.

**TABLE 53.** *IN 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) | Monitored (b.c.) | | 40 | The Connersville STP has continued to operate within its permit limits but has I and I problems. |
| E. F. Whitewater River | Richmond | PS (Aquatic Life)<br>NS (Recreational) | Monitored (b.c.) | E. coli<br>Cyanide | 48 | Richmond's STPexperiences difficulties during wet weather. |
| Whitewater River | Brookville | FS (Aquatic Life)<br>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 | |
| 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 53. *IN Tributary Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment 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) | Evaluated | Municipal (POTW) organics | 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) (Recreation) | Monitored (b.c.) | CSO's<br>Nonpoint<br>Acid Mine drainage<br>Chlordane<br>E. coli | 10 | Boonville STP has been upgraded but CSO's discharge to creek. |
| Pigeon Creek | Evansville | PS (Aquatic Life) | Monitored (c) | Municipal (POTW organics<br>Habitat alteration<br>Nonpoint | 30 | Haubstadt has completed construction of STP improvements, but still has occasional sludge problems. Haubstadt discharges to a limited use stream. |
| Tributary of Ripley Creek | Sunman | NS (Aquatic Life) | Evaluated | Municipal (POTW) organics<br>Low D.O. | 2 | State working with Sunman on new treatment system. |
| Little Pigeon Creek | Dale | NS (Aquatic Life) (Recreation) | Monitored (b.c.) | Municipal (POTW) organics<br>Low D.O.<br>Ammonia<br>E. coli | 5 | Construction completed on new plant but bypassing still occurs. |
| Oil Creek | Perry County | PS (Aquatic Life) | Evaluated | Institutional treatment plant<br>Organic unknowns | 7 | |
| Cane Run | Clarksville Jeffersonville | NS (Aquatic Life) (Recreation) | Evaluated | Municipal (POTW) organics<br>Low D.O.<br>Ammonia,<br>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. |
| Stollsburg Dirch | Chandler | FS (Aquatic Life) | Evaluated | | 2 | Chandler has completed construction for advanced treatment, expansion, and ammonia removal. |
| Black River | Griffin | FS (Aquatic Life) | Evaluated | | 10 | |
| Little Blue River | English | FS (Aquatic Life) | Evaluated | | 20 | |

Table 53. *IN Tributary Waters Assessed, Status of Designated Use Support, Probable Causes of Impairment 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 |
|---|---|---|---|---|---|---|
| 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 | Troy wastewater now goes to Tell City STP. |
| Deer Creek | Cannelton | FS (Aquatic Life) | Evaluated | | 5 | Cannelton wastewater now goes to Tell City STP. |
| 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 | | 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.) | | 10 | Ammonia limits met under interim limits. |
| Blue River | Fredericksburg | FS (Aquatic Life)<br>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) (Recreation) | Monitored (b.c.) | Municipal (POTW)<br>Low D.O.<br>Ammonia<br>E. coli<br>Organics | 2 | Severe hydraulic overloads. Working with OATS. |
| Barr Creek | Kassor | PS (Aquatic Life) | Evaluated | Nonpoint Source | 8 | a) Stream bank erosion.<br>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*

The Rockport STP has not been in compliance for at least two years and the state has pursued enforcement actions against it. Bypasses occur due to lift station malfunctions. Also the plant's force main is exposed to the Ohio River and would be a source of pollution if this main should break. The force main needs to be rerouted as a preventative action according to IDEM inspectors.

The City of Charleston is in the process of initiating a project that will reduce the amount of inflow entering the sanitary sewer system. Additional backup plans are being considered as this is a constant problem here. 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 Water Treatment Plant which discharges directly to the Ohio River has not experienced any bypassing during this reporting period and 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, habitat modifications caused by channelization, and strip mining. 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 impacts resulting from discharges from the STP's in these towns. Oldenburg has severe hydraulic overloadings, and Versailles has very poor plant mechanics and operating conditions at the old plant. 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 branch.

Cane Run in Clark County does not currently support its designated uses. Cane Run receives discharges from the Jeffersonville STP. This facility currently has a very high inflow and infiltration problem. Permit limits for copper and cyanide have occasionally been difficult to attain, and a pretreatment program is currently being established. 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 Cane Run or the Ohio

River. Cane 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 steps are underway to formally protect this area.

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. This stream only partially supports aquatic life uses. The Elberfield STP has 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 is discharging heavy sludge (mixed liquor) to Pigeon Creek via Strollsburg 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 have been initiated by the State.

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 type 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.

Pigeon Creek has been severely channelized and also receives a large volume of agricultural nonpoint runoff. The combined effects of the channelization, nonpoint runoff, and STP effluents cause Pigeon Creek to only partially support its designated uses for about 30 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 raw sewage discharges were causing degradation to Cypress Creek. The discharge from the plant's south CSO showed a D.O. of 0.1 mg/l, $BOD_5$ was 57 mg/l, ammonia 15 mg/l, suspended solids 48 mg/l, and E. coli of 2,600,000/100 ml. The Ohio River is not impacted by these stream conditions due to the 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 Total Suspended Solids.

Silver Creek near Sellersburg and the Middle Fork of the Blue River near Salem fully support their designated uses but are threatened due to STP problems at these towns. The Town of Sellersburg currently operates a Class II, 0.7 MGD, trickling filter plant followed by a rotating biological contactor and effluent chlorination. The plant discharges to Silver Creek which has a $Q_{7-10}$ of 0.0 CFS at the point of discharge.

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. The problems of this plant are numerous and varied. A new activated sludge facility is being planned, but the projected starting date of June 1990, was not met. The new plant, which should be under construction soon, will help alleviate the pollution of 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.

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 and the Town of English, the only community on the Little Blue River, has been nearly destroyed twice in recent years.

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.

In summary, 600 miles of Indiana tributaries to the Ohio River were assessed in this report. Of these miles, 446 (74%) fully support the aquatic life use, and 38 miles (8%) are considered threatened. Eighty-seven miles (14%) only partially support the aquatic life use, and 29 miles (5%) do not support this use. None of the 123 miles assessed for whole body contact recreational uses supported this use.

# 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 received 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 54 depict the changes in the degree of wastewater treatment provided by municipal facilities in Indiana in the period from 1972 to 1991. During this time, the percentage of people who are served by municipal treatment plants has changed slightly. The degree of treatment has improved considerably, however, 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 1991, over half the population was being served by these types of systems. Of the 37% 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 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.

In order to achieve this increased level of wastewater treatment and resulting improved water quality, large sums of money have been spent by various governmental agencies. Since 1972, Indiana has received nearly 1.4 billion dollars in federal construction grants money and has spent over 207 million dollars in state money to construct new wastewater treatment facilities, upgrade and expand existing facilities, construct sewer systems, eliminate combined sewer overflows, etc. In addition, local governmental agencies have spent over 190 million dollars in matching funds for these projects. A summary of state and federal grants awarded in 1990 and 1991 is shown in Table 55.

Industrial Facilities

By July 1, 1977, industrial dischargers were required to meet Best Practicable Control Technology Currently Available (BPT) or achieve waster 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,

**TABLE 54.** *Changes in Degree of Wastewater Treatment Provided by Municipal Facilities to the Population in the Period 1972 - 1991.*

| | 1972 | 1982 | 1985 | 1988 | 1989 | 1991 |
|---|---|---|---|---|---|---|
| Pop. Size | 5,195 | 5,490 | 5,500 | 5,510 | 5,556 | 5,551,795 |
| No Mun. Treatment | 40% | 40% | 38% | 38% | 37% | 37% |
| Primary Treatment | 6% | 0.4% | 0.4% | 0% | 0% | 0% |
| Secondary Treatment | 54% | 41% | 17% | 11% | 10% | 10% |
| Advanced Treatment | 0% | 18% | 45% | 51% | 53% | 53% |

TABLE 55. *State and Federal Grants Awarded in Fiscal Years 1990 - 91.*

| APPLICANT | INITIAL AWARD ELIGIBLE PROJECT | INITIAL AWARD FEDERAL AMT. | INITIAL AWARD STATE AMT. | EXPECTED COMPLE-TION DATE | NEED |
|---|---|---|---|---|---|
| Advance | 1,194 | 657 | 239 | Feb '92 | B |
| Gosport | 1,645 | 904 | 329 | March '92 | B |
| Palmyra | 963 | 530 | 193 | Oct '91 | A C N |
| Markle | 1,539 | 812 | 308 | May '92 | D A X |
| Holton | 1,835 | 1,009 | 367 | Aug '92 | B |
| Greenwood | 3,358 | 1,847 | 672 | Oct '92 | New Sewers |
| Tri Lakes | 6,238 | 3,431 | 1,248 | Aug '92 | B |
| Turkey Run | 4,458 | 2,452 | 892 | Sept '93 | B |
| Jeffersonville | 15,350 | 8,443 | 3,070 | July '92 | Plant & Sewer Rehab |
| Middletown | 1,950 | 1,072 | 390 | Jan '93 | F X |
| Wheatfield | 1,928 | 1,060 | 386 | May '92 | B |
| Winslow | 3,713 | 2,042 | 743 | Aug '92 | B |
| Loogootee | 2,384 | 1,311 | 477 | Sept '92 | A N |
| Burnettsville | 1,656 | 911 | 331 | Dec '92 | B |
| English | 2,677 | 1,472 | 5,354 | Aug '92 | B |
| Francesville | 2,834 | 1,491 | 5,668 | June '93 | B |
| Medaryville | 2,938 | 1,616 | 588 | June '93 | B |
| Milan | 650 | 363 | 130 | June '93 | A |
| Lagro | 2,171 | 1,194 | 434 | July '93 | B |

A = Advanced Waste Water Treatment
B = New Plant
C = Disinfection
D = Dechlorination
F = Phosphorous Removal
N = Ammonia Removal
X = Expansion

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 provided some idea of these expenditures. The number of claims and total amounts claimed for each year from 1978 - 1991 by by Indiana industries are shown in Table 56. This amount has more than tripled in this time period.

In the past, industrial wastewaters have cause 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.

**TABLE 56.** *The Number of Tax Exemption Claims and the Total Dollars Claimed by Indiana Industries for Wastewater Treatment Facilities from 1978 to 1991.*

| 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 |

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 permitee inside 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 to 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.

Minor dischargers experience a lower compliance rate due to their greater available number (90%) 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 how worked with IDNR in conducting enforcement actions against facilities which have bad spills resulting in fish kills, resulting 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**

Throughout 1990-91 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.

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 anticipates utilizing the $75,000 Section 319 funds sometime during the 1992 or 1993 phases of the project with IDNR providing in-kind services for testing, engineering, and construction inspection. Cost, uses, and timing will be developed when additional details of the construction schedule are established.

The design work for the project is completed. A contract for the reclamation work is anticipated to be signed by June 1, 1992 with reclamation commencing shortly thereafter. The expected completion date for construction is May 1994. A major groundbreaking ceremony is planned involving local and state VIPs in conjunction with the local and state press.

The site occupies approximately 200 acres unable to support vegetation or wildlife. The acid drainage from the site pollutes West Little Sugar Creek through West Terre Haute all the way to the Wabash River. The mine began operating in 1947 and ceased operations in 1963 when existing laws did not require reclamation. The project will reclaim 90 acres of gob, 42 acres of slurry, 27 acres of haul roads, several concrete foundations, and one partially filled shaft. The project will include grading, covering, revegetating with grasses and legumes, and constructing a thirteen-acre lake in a borrow area which will be open to public fishing.

Wetlands Evaluation

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. To date, SPEA has conducted a thorough literature search and determined, designed, and tested the equipment needs for continuous stream discharge monitoring. The equipment support structures and instrument housing have been installed in the field pending a spring thaw when the actual instruments will be installed.

Eel River Evaluation and Education

Through the use of $20,000 of Section 319 funds, Dr. James Gammon, DePauw University has conducted an intensive ecological survey of the upper portion of the Eel River watershed to identify biological NPS impacts and their causes. Analyses of existing suspended sediment data, as well as historic records of fish kills and chemical spills within the Eel River watershed, were used to evaluate possible impacts of NPS source influence from agricultural fields.

The final report stated that the 1990 fish community was much improved compared to the community found in 1982. However, this improvement is believed to be temporary and is probably the result of a series of recent years when both river discharge and suspended sediment concentrations were lower than normal.

From a longer time perspective, the fish community is substantially lessened, with many species which were common 50 years ago now either absent or very severely reduced. Rainbow darter, orangethroat darter, bluebreast darter, and stonecat were not collected at all. Sculpin, greenside darter, blackside darter, silver shiner, rosyface shiner, longear sunfish, and smallmouth bass were very restricted in distribution. Copies of the final report have been previously forwarded to the U.S. Environmental Protection Agency (U.S. EPA).

The Whitley County Soil and Water Conservation District (SWCD) has begun 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 has collected all relevant written information on the watershed and collected physical data through walking, canoeing, driving, and flying the Eel River and tributaries. She has developed a foundation of local landowners to lead the conservation efforts needed to affect water quality and also established a support base through the local, area, and state levels of the Soil Conservation Service (SCS).

Working with the local drainage board, she derived an environmentally sound maintenance program which included enough data to influence the county engineer's management style. Other tasks accomplished to date have been: the soliciting of additional funding by writing four grant proposals in order to carry on the work of reducing sediment; the development of public awareness through public speaking and news articles; the designing of three source documents for demonstration plots for local landowners; and the negotiation of agreements with three landowners to put in 1000 foot filter strips.

Upper Tippecanoe River Project

The Kosciusko County Health Department was awarded $10,000 of Section 319 funds to buy equipment for surface water sampling in FY 1991-92. In-kind services to take the samples are being provided by the Kosciusko County Health Department with the Indiana State Department of Health providing in-kind services to analyze the samples. This is to provide data to help support the U.S. Department of Agriculture (USDA) Upper Tippecanoe River hydrologic unit area (HUA) project described later in this report. Samples were taken in April and June/July at 26 different areas of the HUA. The timing of sampling was intended to be representative of conditions prior to and after crops were planted. Some of the sample sites were influenced by multiple pollution sources including domestic septic systems.

Samples were analyzed for bacteria, nitrate, phosphate, ammonia, Alachlor, Atrazine, pH, total dissolved solids, dissolved oxygen, and temperature. Flow measurements were not taken. Sampling results for the pre-plant and post-plant time frame during the spring of 1991 were obtained by the Indiana Department of Environmental Management (IDEM). Analysis showed that in June/July, the nitrate numbers increased at several sites. Ammonia was also up marginally. One site had a high bacteria count in April which was determined to be a residential sewage pipe; the count was down in July as the problem had been corrected. Another site which had a high bacteria count in April had cleared by June and was presumed to be caused by animal waste.

LaGrange County

Cost share payments have been made to landowners for integrated crop management through pest and nutrient management and control of sheet erosion utilizing no-till practices. In addition, the watershed study on the Oliver, Olin, and Martin Lake chain was completed by the water quality technician funded by $25,000 of Section 319 funds for the project. Conclusions of the study were:

1. Several areas were identified as having potential water quality problems. In these cases, plans were developed using grant money assistance, the landowners invested their own money to correct the problem, or work will continue with other cost-share programs as the landowner becomes eligible.

2. Some problems identified with the county drainage system were referred to the appropriate county department with SCS assisting as needed.

3. There is a large sediment problem in Martin Lake which comes from one particular ditch fed by county and farm tile. Further investigation, including sampling, will be needed to identify the causes.

4. By using several different methods of communication to residents about the project, it was found that one-on-one or small groups were the most effective. Newspaper articles were the second most effective.

The grant monies have assisted in identifying and correcting some NPS problems, increased public awareness of water quality within the watershed and how it is affected by various use practices, and provided information about what the public can do to protect it.

Forestry Education

The IDNR Division of Forestry is utilizing $10,000 of Section 319 funds and providing in-kind services to develop a demonstration project area and a video to illustrate timber harvesting practices that will limit NPS pollution. A committee was established to design the project and define parameters. A literature/video search was then conducted of similar Best Management Practice (BMP) projects in other states and locations for the demonstration area were discussed. After a potential demonstration area at Morgan-Monroe State Forest was examined, it was determined that the video filming would be best done separately from the final demonstration area because of seasonal timing constraints. A video company was selected and script development begun.

Urban Runoff Demonstration Project

The Lake County SWCD signed two subcontracts, one with Purdue University and the other with the Grand Cal Task Force. Purdue University staff are compiling existing information to create a map depicting current land uses and their relative contributions to water quality problems in the Grand Calumet River Basin. The 1:24,000 scale U.S. Geological Survey (USGS) topographic maps of the project area have been prepared and photographed onto mylar sheets at a 1:15,840 scale. The mylar maps are being used for digitizing because they are more accurate and durable than paper and also allow for overlapping. Once the data are mapped, a report will be prepared following the methodology described in the U.S. EPA document entitled "Urban Targeting and BMP Selection - An Information and Guidance Manual for State NPS Program Staff Engineers and Managers". The report will describe the targeting of critical land use areas, prioritization of areas responsible for generation of NPS pollutants, and an implementation plan delineating BMPs needed to eliminate identified problems.

The Grand Cal Task Force agreed to organize, promote, and conduct two single-day workshops to be used as a forum for explanation and discussions regarding stormwater and urban NPS pollution problems and BMP selection, with emphasis on problems identified in the targeting/prioritization workshops. The workshops will provide an opportunity to discuss U.S. EPA NPS/stormwater regulations and their application to the river with the general public and to involve and educate local government officials. The entire process will be publicized through local information media and explanatory brochures produced for general public utilization. The Task Force has hired a designer/writer team to prepare a brochure entitled "Where Does the Rain Go?"; the draft was distributed for approval to appropriate organizations. The time for the first meeting has been set for April 29, 1992. A list has also been compiled of present and former industrial, municipal, and waste sites along the Grand Calumet River/Indiana Harbor Ship Canal with addresses, map location, and contact person when available.

In addition to the $75,000 of Section 319 funds, the Lake County SWCD also received $5,000 of 205(j) funds to install a BMP demonstration project. The local Board of Public Works and Safety in Gary granted permission to build a rock line channel. Permits will now be secured from the U.S. Army Corps of Engineers and the INDR.

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. The primary thrust of the project was to develop a computer program usable by lay persons but which follows a more complex and detailed soils evaluation procedure consistent with Indiana regulations. The program utilizes both soil structure and texture in determining a loading rate for various soil layers. A total of ten topsoil layers can be entered in the soil profile.

The program was publicized at the county sanitarians' state conference in February and provided hands-on training in the exhibit area. The program is currently being used by ten counties who have reported good results. After final editing, copies will be sent to all 92 Indiana counties and to all county extension offices, if desired. Copies will also be provided for the IDEM and U.S. EPA. Other state health departments and current RWASTE users will be notified of the new version's availability. While the program can be freely copied, copies of the diskette and the accompanying user guide can be obtained from Purdue University for a $15 charge for handling, copying, and distribution. Individuals will be encouraged to order from Purdue so that the program user can be notified in event of program errors or subsequent releases. Copies of the current diskette and user guide have previously been supplied to the U.S. EPA for their comments; these comments were forwarded to the program developers.

FFY 1991 Section 319 Grant

The State has been awarded $1,018,509 of Section 319 funds in addition to a special Great Lakes Set Aside of $60,000 to be used for implementation of the FFY 1991 NPS Work Program. This will involve several different organizations representing a variety of interests. Following is a list of the eleven projects with a brief description of each one:

1. **Trail Creek.** $100,000 will be used to install two demonstration sediment traps on Trail Creek in Michigan City.

2. **Urban Erosion.** IDNR's Division of Soil Conservation will use $41,000 to (1) conduct a series of regional workshops and (2) develop regional demonstration sites to educate builders, developers, planners, regulators and the public about construction-related erosion control.

3. **IDEM.** The Ground Water Section is using $135,000 for a variety of activities related to implementation of the state Ground Water Protection Strategy.

4. **Constructed Wetlands.** Purdue University will use $59,299 to evaluate the performance of three wetlands constructed as components of animal waste treatment systems.

5. **Juday Creek.** The St. Joseph River Basin Commission will use $89,000 to implement a watershed protection plan for Juday Creek.

6. **Farmstead Assessment.** Purdue University will use $91,356 to adapt and apply the "Farm-A-Syst" program in Indiana. This is an assessment system to evaluate groundwater pollution potential on farms. The program will be revised to include provisions which will explain how Indiana's law and regulations specifically may affect farm activities.

7. **Indiana Dunes Drywells.** The Indiana Geological Survey will use $22,500 to cooperate with the State Department of Health in an evaluation of the performance of drywells used for wastewater disposal in the Indiana Dunes region.

8. **Fish Creek.** The Nature Conservancy will use $98,340 to implement a protection program in the Fish Creek watershed, the only known habitat of an endangered species of mussel.

9. **Hoosier Heartland.** The Hoosier Heartland RC&D will use $45,100 to continue its well monitoring and protection program.

10. **Mill Creek.** The Soil Conservation service will use $125,000 in the Mill Creek watershed to demonstrate agricultural management practices suitable for karst areas; they will also assist with water pollution control conservation activities in Lake County using the Great Lake Set Aside Funds.

11. **Atmospheric Deposition.** The U.S. Geological Survey will use $211,914 to establish a three-year program in the Grand Calumet River Basin to appraise the water quality impacts of atmospheric deposition.

Farmstead Assessment System (FAS) Program

IDEM staff contacted Mr. Gary Jackson, National Farm-A-Syst Coordinator (University of Wisconsin - Extension), to discuss steps involved in implementaion of the FAS program, and items to be addressed to ensure its success. In addition, Ground Water Section staff have reviewed aquifer studies conducted by the Indiana Geological Survey to determine low risk and high risk areas of potential ground water contamination.

IDEM staff also met with Mr. Joe Eigel, Purdue University Farm-A-Syst Coordinator to ensure a comprehensive effort between IDEM and Purdue.

Although FAS has become a national program based on Wisconsin's efforts, it was decided that Purdue would revise the 12 worksheets developed by Wisconsin into a format that is less demanding for the farmer. The IDEM-Allen County project will be used as a pilot to evaluate Purdue's revised worksheets, whereas, both the Wisconsin and Purdue worksheets will be used in the Allen County risk assessment.

Comparison of risk rankings between the Wisconsin and Purdue methods will be made and the discrepancies evaluated. Feedback from assessment comparison with the Allen County project will be used to help Purdue develop worksheets toward a statewide program consistent with the national FAS program.

The Allen County extension agricultural agent, has also been contacted concerning the Allen County FAS project. It was determined that a coordinated effort between IDEM and the county would enhance the program while the presence of local agricultural leaders would increase participation and acceptance of the project. Visibility of the program should be increased through local newspaper and agricultural newsletters. Moreover, a cover letter from the county agricultural agent will accompany distributed questionnaires.

Upper Kankakee River Basin Demonstration Project

Gathering hydrogeologic information and water quality data has begun for the purpose of identifying priority agricultural areas which are vulnerable to ground water contamination from agricultural practices. This information in conjunction with the "Drastic Modeling Technique" has identified hydrogeologically vulnerable areas for ground water quality sampling.

The selected and mapped sampling area lies within the Kankakee Aquifer System and is located due west of South Bend in the low lying area between the towns of Lydick and New Carlisle. This aquifer system consists of unconfined deposits of fine to medium grained sand which is interbedded with gravel zones and clay lenses. The well logs in this area show that the aquifer system thickness ranges from approximately 150 - 200 feet. Due to the absence of clay deposits, and the high occurrence of irrigation in this area, this aquifer system is highly susceptible to surface contamination. Review of existing nitrate data acquired from prior water quality sampling events shows that the selected sampling area is indeed vulnerable as elevated concentrations of nitrate have been detected in this area in the past.

Maumee Basin Farm-A-Syst Study

Ground Water Section staff in conjunction with the Indiana Geological Survey determined that the Huntertown Aquifer System represented the best choice for sampling for pesticides and isotopes for the following reasons.

1. A major regional recharge system is emplaced in the valley train fill and outwash of the ancient Eel River Jokulhlaup.

2. Infiltration rates and hydraulic conductivity, as well as the ages of connate and recharge water can be determined with the use of isotopes in the Cedarville and Harlan Quadrangle. The Harlan Quadrangle represents a regional discharge area for the Huntertown Aquifer System. It was determined that water quality sampling should occur at farms that lie between the regional recharge and discharge areas.

Arrangements were made with Waterloo Laboratories in Ontario, Canada to analyze the isotope samples, whereas local contract laboratories will analyze for approximately 50 different pesticides.

Agricultural Chemicals in Indiana Ground Water Data Base

The pesticide data compilation and computer entry portion of the project has been completed. The statistical summaries and other descriptive analyses were completed for records in the data base for the period December 1985 through April 1991. A preliminary draft report with tables and illustrations was prepared and the report is currently undergoing review at the U.S. Geological Survey. A copy will be submitted to the Ground Water Section for review during the second quarter. An additional 1,400 nitrate records from the DNR's Water Resource Assessment studies in five basins from 1986-90 were entered into the database as well as data tapes from the 1986 Non-Community Water Supply Survey for Indiana which contain nitrate analyses, water supply well information, and other site characteristics.

Other Nonpoint Source Pollution Activities

Clean Lakes Program

The IDEM has contracted with SPEA to administer certain elements of the Clean Lakes program. This ongoing program is currently using $24,808 of Section 106 funds and $53,192 of state funds. Dissemination of information and education regarding lakes is being accomplished through distribution of a quarterly newsletter, publishing technical fact sheets, and conducting an annual conference in the spring. Staff are available to provide technical assistance to lake associations or groups interested in initiating lake studies, interpreting water quality data, and identifying lake management techniques. SPEA also collects and analyzes water samples each summer from public lakes and reservoirs. During 1990-91, a total of 186 water bodies were sampled. These results are discussed in the Lake Assessment portion of this report.

The contract between the IDEM and Indiana University SPEA in conducting the Indiana Clean Lakes program has provided both practical experience and financial assistance to a number of students at SPEA. In most of the cases, the experience of working with the Clean Lakes Program ultimately influenced the student's career choices once they finished college. All eight students represented below are in the water resources field and half of them are employed in the state of Indiana. The current positions of all are as follows:

- Water Resources Planner/Scientist, Cape Cod Commission, Barnstable, Massachusetts
- Environmental Scientist, Heritage Environmental Services, Indianapolis, Indiana
- Water Resources Specialist, Donan Engineering, Inc., Jasper, Indiana
- Lake Management Biologist, IDNR/Soil Conservation Div., Indianapolis, Indiana
- Inorganics Lab Manager, SIECO, Columbus, Indiana
- Ph.D. Student, Miami University, Oxford, Ohio
- Wetlands Scientist, U.S. EPA, Chicago, Illinois
- Lake Management Specialist, Lake County Health Dept., Waukegan, Illinois

SPEA also conducts the Volunteer Lake Monitoring Program which is currently utilizing $52,400 of Section 314 funds and a state in-kind match. The program ended its third year during the fall of 1992 and is beginning its fourth year. The program helps determine the water quality of the lakes, serves as an early warning system for lake problems, and also involves citizens in water quality issues. During its third year, citizen volunteers made 524 Secchi disk transparency measurements on 62 lakes. (See Lake Assessment Section).

The contract was finalized in February for the Lake Monroe diagnostic/feasibility study to begin utilizing $50,000 in Section 314 funds and $60,295 of an in-kind match. Contracts are being written for Wolf Lake and Lake George to begin diagnostic/feasibility studies for those lakes in the City of Hammond.

Four Mile Creek Watershed

The Four Mile Creek Watershed is located on the Indiana-Ohio border and discharges into Acton Lake in Ohio. The lake is the primary recreational facility at Hueston Woods State Park which hosts up to 2.5 million visitors each year.

Acton Lake is impacted by nonpoint source pollution, primarily in the form of sedimentation as a result of cropland erosion, although inflow of nutrients and bacteria from agricultural production also exist. Over two million cubic yards of impounded sediment exist in the lake. The result of this sedimentation in the lake is high turbidity which impairs the recreational value of boating, fishing, and swiming activities.

Annual dredging is being done on the lake to alleviate the sedimentation. However, projections from the USDA SCS indicate that 200 acres in the upper lake will have an average depth of less than three feet with continued dredging and under current watershed conditions.

Presently Ohio has a Section 319 funded project in the watershed to provide pollution control measures. During the two years since its inception, the project has achieved a high rate of participation and is becoming very successful. The program focuses on conservation tillage in an effort to prevent erosion.

The Four Mile Creek Watershed in Union and Wayne counties in Indiana is a high priority area in which to address further nonpoint source water pollution control measures in this watershed. If introduced, these measures will help to alleviate the sedimentation of Acton Lake.

319 Funded Positions

Section 319 funds were used to fund three positions for IDEM. These positions have been a great aid in helping IDEM's Water Quality Surveillance and Standards (WQSS) Branch accomplish their tasks of improving water quality in the state.

These grant funds have been used to support a staff person who has developed and is implementing a surface water agricultural pesticide monitoring program. That person has proceeded well into the project; and a description of the work accomplished is found elsewhere in this report under the heading of "Surface Water Pesticide Study".

Within the WQSS Branch, IDEM's Office of Water Management conducts an environmental review program that address many types of activities that can affect water quality. These include, among other things, Section 404 dredge and fill projects, construction projects that could cause off-site erosion problems, agricultural watershed projects, stream bank erosion control projects, and construction of hydroelectric facilities. Inadequate staffing in the past had allowed for only a limited number of on-site inspections, so the vast majority of project proposals or reported unlawful actions were subjected to little more than a desktop review. Since July of 1990, however, the addition of two staff positions has enabled IDEM to more adequately appraise project proposals; one of the positions was funded by Section 319.

Since the latter position was created, the two staff persons have evaluated 162 proposals, the majority of which have been Section 404 permit applications. The staff members have conducted on-site appraisals for 144 of the proposals, which are categorized within OWM as one or more of twenty-five project types. As a result of the more stringent review procedures now in place, applicants are often required to alter project plans to incorporate best management practices which will reduce erosion or otherwise protect off-site water quality. The vast majority--perhaps 90%--of the Section 404 applications involve wetlands. By meeting directly with applicants, either on-site or in a conference setting, it has been possible to logically determine the best possible means to either prevent or mitigate wetland destruction attributable to the projects. This has resulted in alternative plan implementation which has reduced environmental impacts.

Another benefit of increased staffing has been the agency's enhanced ability to monitor compliance, particularly for projects for which approvals were denied or which were approved with modification. Staff has also been able to follow-up more actively on the implementation of required mitigation for unavoidable wetland loses.

Having the additional staff person enables IDEM to interact more directly with the Corps of Engineers on Section 404 permitting issues, thereby allowing IDEM to participate more actively in the program--improving communications between the agencies, preventing misunderstandings, and generally enhancing the permitting process. Interagency cooperation has also increased between IDEM and other agencies (U.S. Fish and Wildlife Service, Indiana Department of Natural Resources, etc.) who may be involved in the permitting process.

As anticipated in the initial grant work program, the success of this position was to be gauged by the ability of the staff person to interact with persons involved with projects, and influence their activities to provide greater water quality protection. In that regard, funding the position must be judged a successful endeavor, even if some intangible aspects of job performance may be difficult to quantify (such as the extent to which inter-agency cooperation may have improved).

The work program envisioned progress being measured by the increased number of project proposals that could be more thoroughly evaluated and for which actual inspections could be performed. From that perspective, there is no question regarding the benefits derived from acquiring an additional staff person: the percentage of sites for which field inspections were performed has increased from approximately 15 - 20 percent previously to virtually all of the sites for which an inspection is deemed necessary.

Now that the position has been created, it is now being funded with combined Section 106/state monies. Thus, IDEM will continue to derive benefits from the creation of the position.

FY 90 Section 319 funds were also used to create and fill a computer data entry position within the WQSS Branch. A full time employee is responsible for entering data into a variety of electronic files including those for fish tissue contaminants, aquatic sediment contaminants, benthic macroinvertebrates and surface water pollutants. In addition, the employee is assisting in the development of the Water Body System data base.

Prior to creation of the position, there were no personnel available to perform the work, so it was not feasible to manage and evaluate the information that had been acquired. Even after the Section 319 funds for the position have been expended, the position will be sustained with funds from other sources, so that the work can be continued.

Surface Water Pesticide Study

In May 1991, sampling began in the surface waters of the state to evaluate the extent of potential pesticide problems in Indiana. The initial funding of the work was done using $231,793 of Section 205(j) funds and $154,528 of a state in-kind match. The study was designed to collect three sets of samples over a year's time.

The first set of samples was collected in late spring shortly after pesticide application. This is when surface runoff of the chemicals from fields to waterways would be expected to be the greatest. This sampling episode was then supplemented by a sample collection in autumn and samples will be collected again in the spring of 1992 prior to chemical application.

One hundred stations around the state were sampled and the samples were analyzed for 129 pesticides. In the spring 1991 samples, thirty-nine (39) different pesticides were found at detectable levels. Four of these pesticides, (Atrazine, Alachlor, Cyanazine, and Metolachlor) were found at a much greater frequency than the other chemicals.

Atrazine was detected at 93 sites and 38 of these sites had levels equal to or greater than 3 ug/l which is the U.S. EPA's Maximum Contaminant Level (MCL) for finished drinking water. The highest detected level for Atrazine was 22 ug/l in the Blue River at Fredericksburg.

Alachlor was detected at 63 sites and has a drinking water MCL of 2 ug/l. Alachlor exceeded the MCL at 18 of the sites.

Two other chemicals, Cyanazine and Metolachlor were found at a large number of sites at low levels. Cyanazine was found at 68 sites and Metolachlor was found at 89 sites. Neither of these chemicals has an EPA drinking water MCL at this time. However, the EPA did issue a water quality advisory for Metolachlor in March of 1986. The advisory concentration for Metolachlor in ambient water for the protection of human health is estimated to be 44 ug/l. Even though Metolachlor was found at 89 sites, none of these sites had levels close to this advisory concentration. The site with the highest concentration was Killbuck Creek in Gaston which had a level of 7.8 ug/l.

Pentachlorophenol was the only other chemical that was detected above a drinking water MCL. It was detected at three sites, two of which were near the MCL of 1 ug/l (0.9 and 1.4 ug/l). The third site, on the South Fork of Wildcat Creek at the Highway 26 bridge in Tippecanoe County, had a level of 58 ug/l. This was the highest concentration of any chemical detected in this sampling period.

There are a few conclusions that can be drawn from these preliminary findings. The most heavily impacted areas are heavily farmed. However, pesticides such as Atrazine and Metolachlor that are widely used are found throughout the state. The Upper Wabash River Basin, the East Fork of White River Basin and the West Fork of White River Basin had the most sites with concentrations of Atrazine and Alachlor over the MCL. The Upper and Middle Wabash River Basins and the West Fork of White River Basin have the greatest number of sites with multiple chemicals found per site. Sites with detectable levels of several chemicals were found in all basins. Data from the second and third sampling period are not yet available for interpretation but these samples have been collected and are being analyzed. A final report will be developed when the study has been completed.

Indiana Association of Soil and Water Conservation Districts (IASWCD) Regional Workshops

Funding in the amount of $13,136 from the Section 205(j) program was granted to the IASWCD to conduct regional workshops addressing agricultural NPS water pollution. This was supplemented by $13,000 of local in-kind services. Four meetings were held during the month of February 1992 and targeted farmers and other landusers/landowners who are required to make management decisions regarding cropping practices that can affect water quality. The purpose of the workshops was to promote conservation tillage practices in order to improve and maintain surface water quality. Six more meetings will be held during the spring of 1992.

The IASWCD organized the regional meetings through its five area SWCD associations that each represents 17-19 counties. The associations coordinated program planning with the Purdue University Extension

T-by-2000 soil conservation education staff in cooperation with the IDNR, the SCS, and the Agricultural Stabilization and Conservation Service (ASCS).

IDEM Office of Water Management (OWM) - Land Application Group

Within the OWM Permits Section a small group of employees is responsible for approving the application of industrial and municipal wastewater treatment residuals and animal waste to designated parcels of land. The approval program has been historically underdeveloped and inadequately staffed. Through the use of a Section 205(j)(5) grant the group was able to create two new staff positions that were funded from July 1990 to September 1991. (Funding of the positions has since been continued with Section 106/state monies).

One of the positions was dedicated to sludge application issues and the other to confined animal feeding facility approvals. Because other staff positions have become vacant within the land application area, the acquisition of the grant-funded staff person has merely allowed the program to be sustained, without any real opportunity to increase work output. As vacant positions are filled, the benefits of having the additional position should begin to accrue.

In contrast, a dramatic increase in the number of confined feeding facility reviews has resulted from the addition of the other grant-funded staff person. That person is also being utilized to increase awareness regarding proper manure management throughout the state.

For FFY 90, the group reviewed plans, conducted inspections, and provided approvals for 153 confined feeding facilities. For the previous fiscal year only 48 were done. By having the additional staff person, the group has been able to not only conduct the initial plan review site inspections, but to also conduct twenty follow-up inspections and ten routine inspections of other facilities. During FFY 1991, the approvals also increased dramatically.

The staff person also participates in proceedings of a multi-agency agricultural waste committee and one of its subcommittees. This includes efforts to update state animal waste management guidelines that are nearly twenty years old.

Groundwater

The Groundwater Task Force was instituted by the Indiana State legislature to:

1. Study groundwater contamination in Indiana.

2. Coordinate efforts among the agencies to address groundwater pollution problems.

3. Coordinate the implementation of the Indiana groundwater quality protection and management strategy.

4. Develop policies to prevent groundwater pollution.

The IDEM, representatives of various state agencies, and representatives of other interest groups continue to meet regularly. A framework has been recently adopted which will be used to develop regulation proposals. These policies, in turn, will direct the crafting of rules for groundwater protection in the state.

Agricultural Activities

In addition to Section 319 fund activities, different organizations in the state are continuing their pursuit of other NPS control endeavors, some of which have been in place for a number of years. The most expansive of these is undoubtedly the multidisciplinary agricultural erosion control effort that has been underway for several decades. More recently, the various agencies whose primary interest has been in the soil conservation arena have begun to expand their efforts to specifically address and remediate the water quality impacts of agricultural activities.

T-by-2000

T-by-2000 is a comprehensive, state-funded initiative aimed at significantly reducing soil erosion and resulting sedimentation throughout Indiana by the year 2000. The name is derived form the program's two goals, which are:

1. 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).

2. To control all off-site sedimentation using the best practical technology.

T-by-2000 is administered at the state level by the Division of Soil Conservation, IDNR under guidelines set by the SCS board. It is carried out at the local level through the 92 county SWCD's which are locally organized and operated divisions of state government that promote the protection, maintenance, improvement, and wise use of soil and water resources within each county.

There are currently five components of Indiana's T-by-2000 program:

1. Soil conservation education assistance - Accomplishments are achieved by the five regional Extension Soil Conservation Education Specialists plus a coordinator. Annually they provide educational programs through SWCDs that directly reach 15,000 landusers, youth, and other interested parties and indirectly many others through resource materials and the media.

2. Agricultural erosion control technical assistance - The number of IDNR agricultural erosion technicians have been increased from 46 to 61 staff. Working with SWCD and SCS personnel, they annually assist 500 landusers installing erosion control measures and thousands more implementing conservation farm plans.

3. Cropland erosion control cost-sharing - Since 1988, this program has cost-shared with 865 land users on 491 projects in 87 counties. This is an increase from 612 land users on 368 projects in 80 counties. When all projects are completed, these projects will save over 2 million tons of soil at a cost to the state of only $1.95 per ton.

4. Urban erosion control technical assistance -Five regional IDNR urban conservation specialists annually provide technical assistance for approximately:

   - 140 soils interpretations for specialized land use and 140 development projects
   - 90 urban erosion training sessions
   - 165 erosion control-related landfill reviews

5. Lake Enhancement - The goal of Lake Enhancement is to ensure the continued viability of Indiana's public-access lakes by (a) controlling sediment and associated nutrient inflows, and (b) where appropriate, forestalling or reducing the impacts of such inflows through remedial actions. To accomplish that, the IDNR provides technical and financial help for qualifying projects which may involve the lake proper, its inlets, or upstream areas but which also considers the surrounding watershed.

IDNR's Division of Soil Conservation has calculated that T-by-2000 cost-share program funds expended in the state fiscal year ending June 30, 1991, allowed 16,535 tons of soil to be saved from erosion statewide. The cumulative total for soil saved since the program began in 1987 is 158,212 tons that are now retained each year.

Not all of that soil would necessarily have entered lakes or streams, had its erosion not been prevented, but some portion would. That amount would be dependent upon several variables such as soil type, topography, and land use. Erosion values can be calculated rather accurately for given plots of land, but the variability can be tremendous between any two given sites. When attempting to evaluate the eroded soil's actual water quality impact, the situation becomes even more complex because of differing amounts of eroded soil that actually leave a given field and are "delivered" to surface water bodies.

By selecting a reasonable "average" value from the range of sediment delivery rates observed in the state, it is possible to calculate the approximate total soil load that was prevented from entering lakes and streams by virtue of T-by-2000 efforts. The chosen factor, 20%, when multiplied by 158,212 tons, yields a value of 31,642 tons of soil.

The state erosion and sedimentation control program administered by IDNR's Division of Soil Conservation has continued to be popular with landowners, as virtually all of its $1 million annual cost-share allotment is sought for structural erosion control measures. Unfortunately, though, statewide budgetary concerns have caused the dedicated fund to be indefinitely frozen until the State's administration is able to determine the condition and direction of the economy. Salaries for the division's staff have not been jeopardized, however, and field personnel continue to interact with and assist farmers with technical matters.

The program's "Lake Enhancement" component has brought disparate parties such as farmers and lake property owners together to work cooperatively to resolve sedimentation and eutrophification problems by curtailing erosion in lake watersheds. The original $300,000 annual Lake Enhancement budget has been supplemented by a boat tax which can generate $1 million or more per year. As with the basic "T-by-2000" program, the dedicated funds have been frozen.

Within the past year a new element has been incorporated into the Lake Enhancement program, which is perceived as being vital to its overall success: approval was granted by the Soil Conservation Board for consideration of use of Lake Enhancement Funds for soil and water conservation measures within lake watersheds. This is a departure from the program's original philosophy, when fewer funds were available for the program.

Since January 1988, the program has funded a total of 56 projects involving 90 lakes in 22 counties throughout the state. They include 42 preliminary investigations and feasibility studies, eight design plans, three construction actions, two special projects, and one lake watershed land treatment project. At present, several potential projects are in various stages of the application and/or formation process.

U.S. Department of Agriculture (USDA)

Through its many programs, the USDA has also made a substantial contribution to water quality protection in the state. It has been calculated that for FY 1991, USDA efforts have resulted in the following reduction (which include T-by-2000):

- Soil loss reduction of 1,487,000 tons
- Sediment (delivered) reduction of 297,400 tons
- Phosphorus (delivered) reduction of 477 tons

These reductions are primarily attributed to an increase of approximately 750,000 acres now under conservation tillage and the application of such measures as cover crops, grassed waterways, WASCOBs, terraces, grade stabilization structures, filter strips, and tree plantings. Other measures also contributed to water quality improvement: integrated crop management was applied to 9600 acres in 1991, and 58,700 acres of cropland were converted to grass land and woodland through the Conservation Reserve Program. The Soil Conservation Service (SCS) also provided assistance for the installation of more than 80 livestock waste systems to reduce the introduction of waste into surface and ground waters.

At the federal level, the Department of Agriculture has elevated the issue of water quality to make it one of its highest priorities. One of the results has been the initiation of a national program of agricultural watershed level projects with a water quality emphasis.

Indiana has two hydrologic unit area (HUA) projects that are being implemented under the U.S. Department of Agriculture's Water Quality Initiative. Both projects were listed as priority watersheds for nonpoint source pollution control assistance in the Indiana Nonpoint Source Management Program. The HUA projects have a funding timeframe of three to five years and are administered cooperatively by the USDA Agricultural Stabilization and Conservation Service, USDA Soil Conservation Service, and Purdue University Cooperation Extension Service. The objective of both HUA projects is to promote the voluntary adoption of technically and economically effective crop and livestock management practices to protect water quality.

The Upper Tippecanoe River HUA is located in the northern Indiana counties of Kosciusko, Noble and Whitley. Much of this area is vulnerable to groundwater contamination due to permeable soils, a shallow water table, and intensive agricultural land use. Groundwater is the source for all municipal water supplies within the HUA with the exception of the city of Warsaw

(21,000 pop.) which draws about 30% of its supply from a lake. In addition, about 30% of the HUA is highly erosive land and sediment transport to surface waters is a significant problem in certain places. There are 217 natural lakes and impoundments within the HUA that are over one surface acre in size, many of which are heavily used for recreation.

A primary goal in the Upper Tippecanoe HUA project is to demonstrate the value of manure as a nutrient source for crop production and proper manure storage and application practices. Other primary goals are: to teach concepts of soil fertility and the efficient use of fertilizer; to demonstrate crop scouting techniques that will encourage use of integrated pest management; and to promote the use of conservation tillage and other sediment control practices. The project began in FY 90 and is now entering its third year. Progress has been slow overall with the exception of large gains in Conservation tillage acreage and enrollment in the Conservation Reserve Program. Farmer cooperators have been selected to host field day activities where water quality protection practices will be demonstrated. Several other educational activities have been promoted, including: field days to demonstrate manure management, farmstead well protection, poultry carcass composting, nitrogen management and sediment control. Water quality monitoring is being conducted on a limited basis by the Kosciusko County Health Department using Section 319 funds in cooperation with IDEM.

In FY 1991 the SCS contacted 350 landowners out of a total of 1,160 landowners and operators in the project area to discuss opportunities and need for land treatment. The application of structural and management practices using special Agricultural Conservation Program (ACP) Funds continued at a steady pace with large increases in acreage under conservation tillage and the Conservation Reserve Program (CRP). In particular, the CRP acreage increased by 1,900 acres and conservation tillage by 19,104 acres. Nutrient and pest management were incorporated in conservation plans covering 7,898 acres. About 23,097 tons of soil were saved as a result of land treatment practices applied in FY 1991.

Educational meetings and two field days focused on fertilizer and manure management topics with an emphasis on water quality protection. A nitrogen management plot was established as an ongoing demonstration site. Participants learned how to calculate nutrient application areas when spreading manure. Nitrogen meters were made available through the county extension office to do on-farm analysis of nitrogen in manure samples. The Farm-A-Syst procedure was demonstrated on four farms to assess the impact of farmstead activities and structures on groundwater quality. Publication of a newsletter for all agricultural landowners and operators in the project area began on a bimonthly basis.

Six farmers enrolled in the MAX program in 1991. This computer program is designed to help farmers track and compare economic returns from management options for corn and soybean production. The program started in Indiana in 1988 and was expanded nationwide in 1991 with sponsorship from Successful Farming magazine and statewide by agencies cooperating with the T-by-2000 conservation effort. The 1991 program had 175 participants who enrolled 349 fields (191 corn, 158 soybeans) compared to just 41 fields during the first year. The MAX program has three primary goals:

1. Economic - maximize the net economic return per acre.

2. Erosion - maintain soil erosion losses within the tolerable or "T" limit.

3. Environment - minimize other related environmental concerns associated with agricultural land use.

The annual Northern Indiana Conservation Progress Show was held in the HUA and focused on water quality protection practices. About 1,000 people attended and went on wagon tours with stops for nitrogen management, manure management, groundwater protection on the farmstead, erosion control, tillage options, wetlands values, and many other wetlands topics. The Upper Tippecanoe River HUA received a great deal of publicity at the show.

The Upper Tippecanoe River HUA was also selected for the National Impact Assessment being conducted by the SCS. Baseline data describing the "pre-project situation" were assembled and submitted to SCS Headquarters and to the Texas Agricultural Experiment Station Blackland Research Center in Temple, Texas which is helping with the computer modeling effort.

The Upper Kankakee River HUA is located in St. Joseph, LaPorte and Marshall counties in northern Indiana. This HUA covers an unconsolidated aquifer system and much of the area has a high to moderately high susceptibility to groundwater contamination. Like the Upper Tippecanoe HUA, intensive agriculture is the dominant land use. Groundwater is also the sole source of drinking and domestic water supplies for all residents within the HUA. This HUA project began in FY 91. A primary goal is to encourage the adoption of nutrient and pesticide management practices that will reduce the potential for groundwater contamination from nutrient and chemical leaching, particularly on organic soils where specialty crops are grown. Other primary goals include promotion of sediment control practices for wind and water erosion problem areas, utilization of manure for crop production and education on farmstead well protection. A well testing program is planned.

A demonstration project area has been constructed . Also plans on individual farms regarding areas suitable for no-till have been formulated for individual landusers. Plans have also been done on whole farm management for livestock producers.

A field day has been sponsored with about 45 persons participating with more planned for the future. The first program focused on nitrate problems related to livestock and fertilizer application. A workshop was held during the winter months which related to underground storage tanks and nitrate problems associated with cattle. Approximately 30 persons participated.

Agricultural Fertilizers

Although Indiana has surpassed its phosphorus reduction goal for the Maumee River Basin (in accordance with the IJC agreement) as the result of implementation of conservation tillage practices in the watershed, promotion of the practices continues in an effort to further reduce the introduction of nutrients into Lake Erie. Conservation tillage is encouraged in the rest of the state, as well, as a basic soil and water conservation and NPS pollution control measure.

Table 57 shows the most current data (FY 1991) regarding implementation of conservation tillage in the three Indiana counties (Adams, Allen and DeKalb) involved in the IJC agreement. This data is compared to the FY 1990 data and demonstrates the real increase in conservation tillage in these three counties. The data was obtained from the national Conservation Technology Information Center. It shows an actual increase of 46,537 acres in conservation tillage (from 80,365 acres to 126,902 acres) and a total percentage increase of 8.2 percent (from 14.6 percent to 22.8 percent).

Table 57. *FY 1990-91 Conservation Tillage Acres*

| | Total Acres Planted | | Total Conservation Tillage Acres | | Percent in Tillage | |
|---|---|---|---|---|---|---|
| | **FY 1990** | **FY 1991** | **FY 1990** | **FY 1991** | **FY 1990** | **FY 1991** |
| Adams | 150,650 | 169,000 | 19,900 | 41,000 | 13.2 | 24.3 |
| Allen | 252,800 | 252,201 | 37,780 | 58,402 | 14.9 | 23.2 |
| DeKalb | 146,300 | 135,100 | 22,685 | 27,500 | 15.5 | 20.4 |
| **TOTAL** | **549,750** | **556,301** | **80,365** | **126,902** | **14.6** | **22.8** |

Urban Erosion Control

IDNR's Division of Soil Conservation, through implementation of the

"T-by-2000" program, continues to provide technical assistance to planners, developers, local governments and others to assess soil suitability for "non-agricultural" uses and to solve development site erosion problems. In addition, a number of counties utilize resident USDA-SCS and Soil and Water Conservation District employees for their expertise in selecting BMPs for erosion control on development sites.

A number of counties and some larger municipalities have begun to adopt ordinances that control the quantity and quality of stormwater leaving development sites. The stormwater regulations promulgated by U.S. EPA within the past year have evoked a great deal of serious thought and discussion regarding stormwater management. IDEM, not having the resources to initiate an adequate regulatory program, is pursuing the alternative of having a "general permit" program for construction sites subject to the federal regulations. A draft rule had its basis in the Highway Extension Research Project for Indiana Counties and Cities (HERPICC) model erosion control ordinance.

The State Water Pollution Control Board has preliminarily adopted the draft regulations which would require developers of sites of five acres or larger to prepare and implement erosion control plans for those areas. The proposed regulations would allow for SWCD involvement with the IDEM in the plan review and compliance inspection processes. This would not only utilize the expertise available in the SWCDs, but would also enhance their role and visibility in the urban conservation arena. Public hearings were conducted in three different locations in Indiana and final promulgation is expected in October, 1992.

Local Ordinances

A number of counties and some larger municipalities have begun to adopt ordinances that will control the quality and quantity of stormwater leaving development sites. It is difficult to ascertain the exact number, but is believed that perhaps four or five local jurisdictions now have meaningful enforceable ordinances; there may be as many as ten more which have ordinances in varying stages of development.

Biological Monitoring

Fish Community Sampling

IDEM is working cooperatively with U.S. EPA Region 5's Central Regional Laboratory to develop an enhanced biological monitoring program. The final report detailing part of this work has been published. It is titled the "Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana. I. Central Corn Belt Plain" and is available under Document

Number EPA-905/9-91/025. A total of 197 headwater and wading stream sites were sampled in the Central Corn Belt Plain ecoregion in order to develop and calibrate an Index of Biotic Integrity for use in Indiana.

Based on inherent variance within the ecoregion, three sub-basins were established based on the concept of natural areas. These sub-basins included the major drainage units of northwest Indiana: the Kankakee River, the Iroquois River, and the Lake Michigan drainages. Graphical analysis of the data enabled the construction of maximum species richness lines for calibrating the Index of Biotic Integrity for 17 metrics as modified for application to the region of Indiana.

Separate metrics were developed for headwater and wading site drainage areas. Additionally, separate scoring criteria and batteries of metrics were developed for the Lake Michigan drainage, while the Kankakee and Iroquois River drainages were evaluated with similar metric categories. Within the Lake Michigan drainage, two divisions were recognized which were based primarily on the presence of salmonid species as trout and salmon determine the fish community where they are residents. The East Branch of the Little Calumet River division included salmonid metrics and encompassed the area form Burns Ditch, the East Branch of the Little Calumet River, and all tributaries. The Lake Michigan division included the West Branch of the Little Calumet River and its tributaries and the Grand Calumet River basin. This division did not include a salmonid metric for headwater sites.

The water resources of the three drainages were evaluated based on criteria calibrated for the Central Corn Belt Plain ecoregion using the Indiana Index. A water resource distribution approximating a normal curve was observed for the Kankakee and Iroquois River drainages with respect to site water classification. A trend toward improved water quality with increasing drainage area was evident. The Lake Michigan drainage showed a highly skewed site distribution toward the lower extremes of water resource quality. The trend was toward a declining water resource with increasing drainage area in both divisions, although the East Branch of the Little Calumet River division possessed a considerably better resource at the headwaters. Site specific data, locality information, species specific scoring criteria for tolerance classification, trophic guilds, and reproductive guild were included in the report.

IDEM is also currently involved in efforts to use macroinvertebrates as water quality indicators. IDEM staff members are in the process of collecting samples at a number of locations in different ecoregions in the state while simultaneously evaluating the habitat available at each site. This long-term effort will eventually lead to a data base which will also allow for evaluation of NPS impacts.

IDEM personnel have collected macroinvertebrate samples from approximately 400 stream sites in the northern half of the state in 1990 and 1991. Following the collection of the 1990 samples, taxonomic identification of all organisms was performed down to the family level. As with the fish data, the information will ultimately be used to describe pollution-impacted stream segments.

This multiphase program will be used for establishing levels of expectation for trend monitoring and provide comparative data for ecological integrity assessments for enforcement actions into the 21st century. To date approximately 48 percent of the state has been sampled including 341 sites on 244 rivers and streams. The data set includes over 1,530 benthic macroinverterbrate samples which are currently being processed and analyzed.

As improvements continue to be achieved in the quality of point source discharges within the state, the overall ecological integrity of the streams and rivers will be controlled by more subtle sources of pollution such as nonpoint sources. Biological monitoring integrates the cumulative effects of all environmental stressors and provides an appropriate and timely tool to measure and detect this pollution.

Fish Tissue Contamination Monitoring Program

During the 1990-91 biennium, the State of Indiana compiled data on contaminants in the tissue of fish in 143 samples collected from one reservoir and 30 locations on 19 streams in 18 counties. The stream sampling effort represents a 50 percent reduction in number of samples collected and submitted for analysis, a 61 percent reduction in locations visited, and a 20 percent reduction in the level of streams sampled. Reductions are due to the recession-motivated State contract freeze which resulted in no contract being executed to obtain laboratory services to analyze the samples. Additionally, new staff positions were eliminated, but monitoring programs were increased.

The 1990 fish tissue samples were not submitted to a contract laboratory until November 1991; the 1991 samples are to be submitted in March 1992. All fish tissue samples were analyzed for percent lipid, percent moisture, organochlorine pesticides, polychlorinated biphenyls (PCBs), cadmium, lead, and mercury. Thirty-five percent of the samples were also analyzed for additional metals, acid extractable organic compounds, base/neutral extractable organic compounds, and volatile organic compounds. Fourteen percent of the samples were also analyzed specifically for polycyclic aromatic hydrocarbons.

Because of the agricultural use bans, the incidence of chlordane and dieldrin contamination in fish flesh has declined over the years in response to decreasing exposure from nonpoint sources such as farm field run-off. No concentrations of these pesticides in excess of Food and Drug Administration (FDA) Action Levels were found in any 1988, 1989, or 1990 rivers and streams fish tissue samples. A few were found in 1987. Results of this sampling program are discussed in the Fish Tissue Monitoring portion of this report.

Indiana Cooperative Water Testing Program

The Indiana Farm Bureau is conducting a drinking water well testing program which is intended to help wellowners, county and state officials, and others better understand the quality of drinking water in Indiana. The organizations that assist with the program are county Farm Bureaus, SWCDs, the SCS, Resource Conservation Development Areas, County Extension Services, health departments, county cooperatives, and service organizations. The Water Quality Laboratory of Heidelberg College in Tiffin, Ohio, analyzes the samples and returns the confidential information to each wellowner while providing general information to the county organizations.

The results, after the first year of tests, indicate very little contamination in drinking water in the wells tested. More than 3,000 samples from 18 counties revealed that 98 percent of the tests were less than the Health Advisory Standard for nitrates, triazine and lasso/dual. Of the two percent that were over the Health Advisory standard, most were less than 30 feet in depth and located in sandy soil. Others were located in such a way so as to allow water to enter the well at the surface. The program will be continued in 1992, partially utilizing Section 319 funds, with a 1992 goal of taking approximately 10,000 samples in 70-80 counties.

Hoosier Heartland Resource Conservation & Development Council (RC&D)

The Hoosier Heartland RC&D is preparing a Home Builders Guide. It is intended to provide residential contractors information on techniques to use in controlling NPS pollution from migrating off construction sites. It will address: dust and mud control, septic field protection, trees and vegetative protection, erosion and sediment control, and drainage of home sites. The committee will pursue funding to support the printing of 5,000 copies. The booklet will be distributed through the state and local builders association meetings.

Rivers Advisory Group

In January 1992 the IDNR organized the first Rivers Advisory Group. Those attending the first meeting included members of environmental groups, fishing and canoeing clubs, canoe livery businesses, river stewardship groups, a wetland restoration group, and representatives from the IDNR and the IDEM. The IDNR Director addressed the group stating that local involvement is crucial if the state is to be effective in cleaning and protecting Indiana's rivers. He challenged the groups to find creative ways to achieve that goal and find funding for more programs.

The advisory group decided that an appropriate name for the program, which is designed to emulate the Adopt-A-Highway effort, would be Hoosier Riverkeepers. The group then set to work determining four specific goals for improving and protecting Indiana's rivers:

1. The need to educate the public of existing regulations and government activities;

2. The need for stricter enforcement of existing regulations;

3. The need for political action to fund existing and new river protection programs; and

4. The need to call Indiana's citizens to action locally to clean and protect their own rivers.

These four requirements were formulated into 11 specific goals:

- Develop designated funding for river initiatives
- Develop a volunteer network
- Develop a water quality database using biological indicators
- Develop a river education and public relations effort
- Coordinate and target river cleanup efforts
- Develop a volunteer support pool of personnel, equipment and service providers, and media supporters
- Define public river use and access rights
- Enhance enforcement capabilities
- Provide more opportunities for involvement in river stewardship activities locally
- Create more awareness of the value of rivers
- Develop a program plan for all river stewardship initiatives

Hoosier Heartland Resource Conservation & Development Council

Although the Hoosier Heartland RC&D had requested FFY 1991 funds to develop a private well sampling program, and it will be receiving the money, the group was also able to acquire some other funds which it used to initiate the sampling on a cost-share basis with individual well owners. To date, several hundred samples have been collected throughout the ten county area and analyzed by Heidelburg College for nitrates, pesticides and other contituents.

## 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 58.). 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.

Table 58. *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 |
| Area of Wetland Restored | Acres |
| Amount of Wetland Restored | 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 |

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 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 sources of pollution 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.

In the autumn of 1985, a comprehensive review of the Fixed Station Water Quality network was conducted. Changes in sampling locations, additions, deletions, and parametric coverage were based on the following:

1. Existing and/or recommended water quality standards.

2. Monitoring requirements established by the IDEM or by U.S. EPA.

3. The maintenance of data bases for essential parameters.

4. The ability to obtain representive samples at convenient locations.

5. A review of water quality trends and standards exceedances between 1979 and 1985.

One hundred and six (106) stations were sampled during 1990 - 1991, monitoring approximately 2,055 stream miles in Indiana. Of the 106 stations, 91 are sampled once each month, and 15 are sampled quarterly. Thirty-seven (37) of these stations are sampled quarterly for toxic pollutants. These stations and their descriptions are listed in Table 59 and in Figures 14 and 15. A list of the parameters for which analysis are run is given in Table 60.

**TABLE 59.** *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 |
| 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 59. *INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK* (con't)

| 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 | Miller Road Bridge, 2 Milles West of S. R. 57 Bridge |
| P-76 (Q) ★ | Patoka River at Jasper | 38 19 40/86 57 59 | County Road West of State Highway 45 |
| PC-21 (Q) | Big Pine Creek, Pine Village | 40 25 19/87 20 30 | S. R. 55 Bridge, Pine Village |
| PGN-37 | Pigeon River, Mongo | 41 42 00/85 21 08 | S. R. 3 Bridge, Mongo |
| SJ-0 | Salamonie River - Largo | 40 49 46.5/85 43 06 | Division Road, near Largo |
| S-25 ★ | Salamonie River - Lancaster | 40 43 45/85 30 26 | C.R. 300W, 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 |

TABLE 59. *INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK (con't)*

| STATION | NAME | LAT/LONG | LOCATION |
|---|---|---|---|
| SGR-1(Q) | Sugar Creek at Edinburg | 39 21 39/85 59 51 | Road to Atterbury from Edinburg |
| 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 |
| V-.8 ★ | Vermillion River at Cayuga | 39 57 40/87 27 07 | State Highway 63 Bridge, Cayuga |
| WB-52 (C) | 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 59. *INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK (con't)*

| 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-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 | Abington Pike 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 |
| WC-60 (WC-63) ★ | Wildcat Creek at Kokomo | 40 28 26/86 11 02 | County Road 300W 1 Miles 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) ★ | West Fork, Whitewater River- Abington | 39 43 57/84 57 35 | Abington Pike Rd. 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 | S. R. 56 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 PWR General 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 | State Highway 100 Bridge, East of Nora |
| WR-279 (WR-280) ★ | West Fork White River, Perskinsville | 40 08 30/85 52 48 | State Highway 13 Bridge |

TABLE 59. *INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK (con't)*

| STATION | NAME | LAT/LONG | LOCATION |
|---|---|---|---|
| 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. 24 Bridge, East of Winchester |

(C) CORE Station
(Q) Quarterly Sampling Station
★ Quarterly Toxics Scan

**FIGURE 14.** *LOCATIONS OF INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK STATIONS (EXCEPT NORTH WEST INDIANA)*

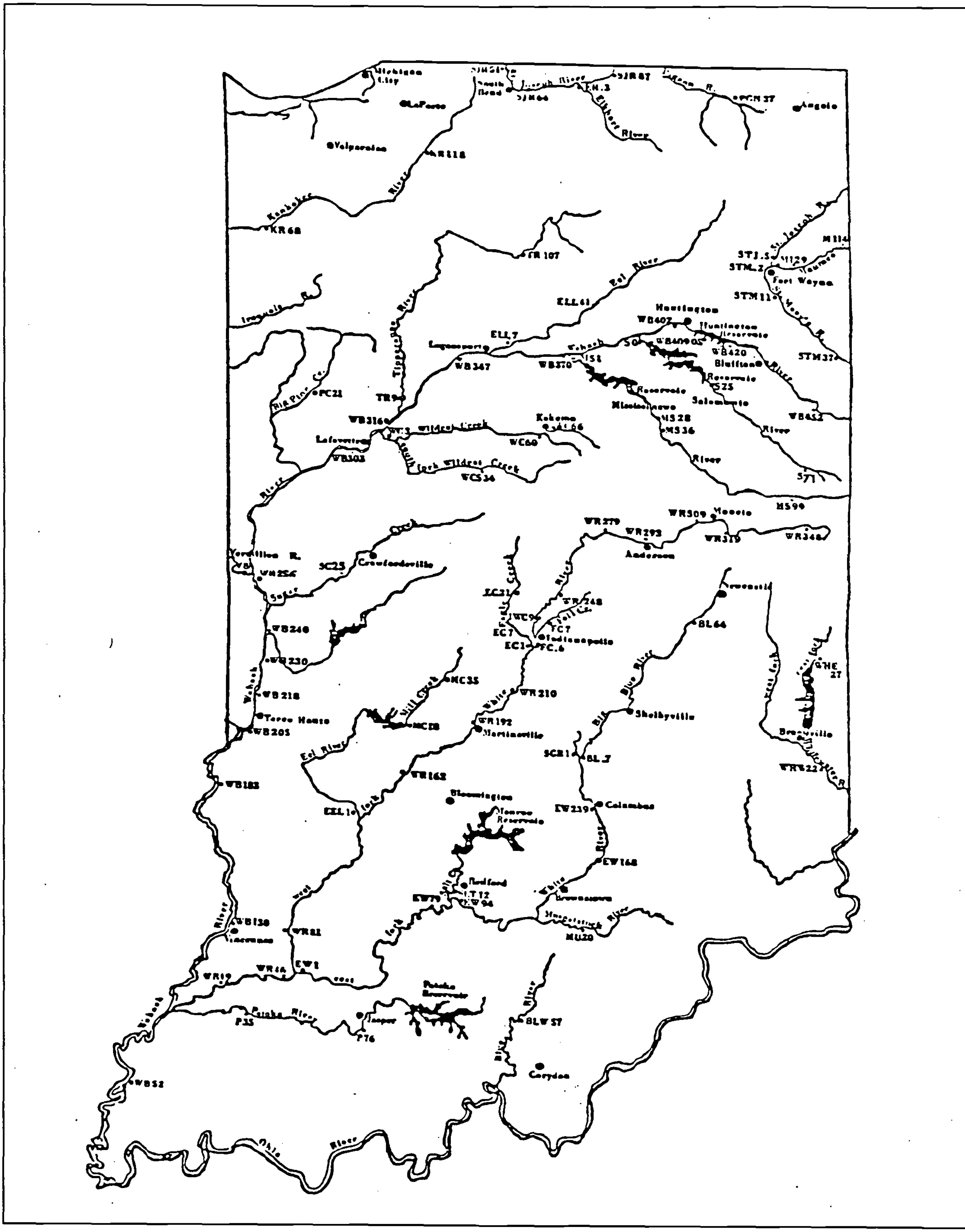


FIGURE 15. *LOCATIONS OF INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK STATIONS IN NORTHWEST INDIANA*

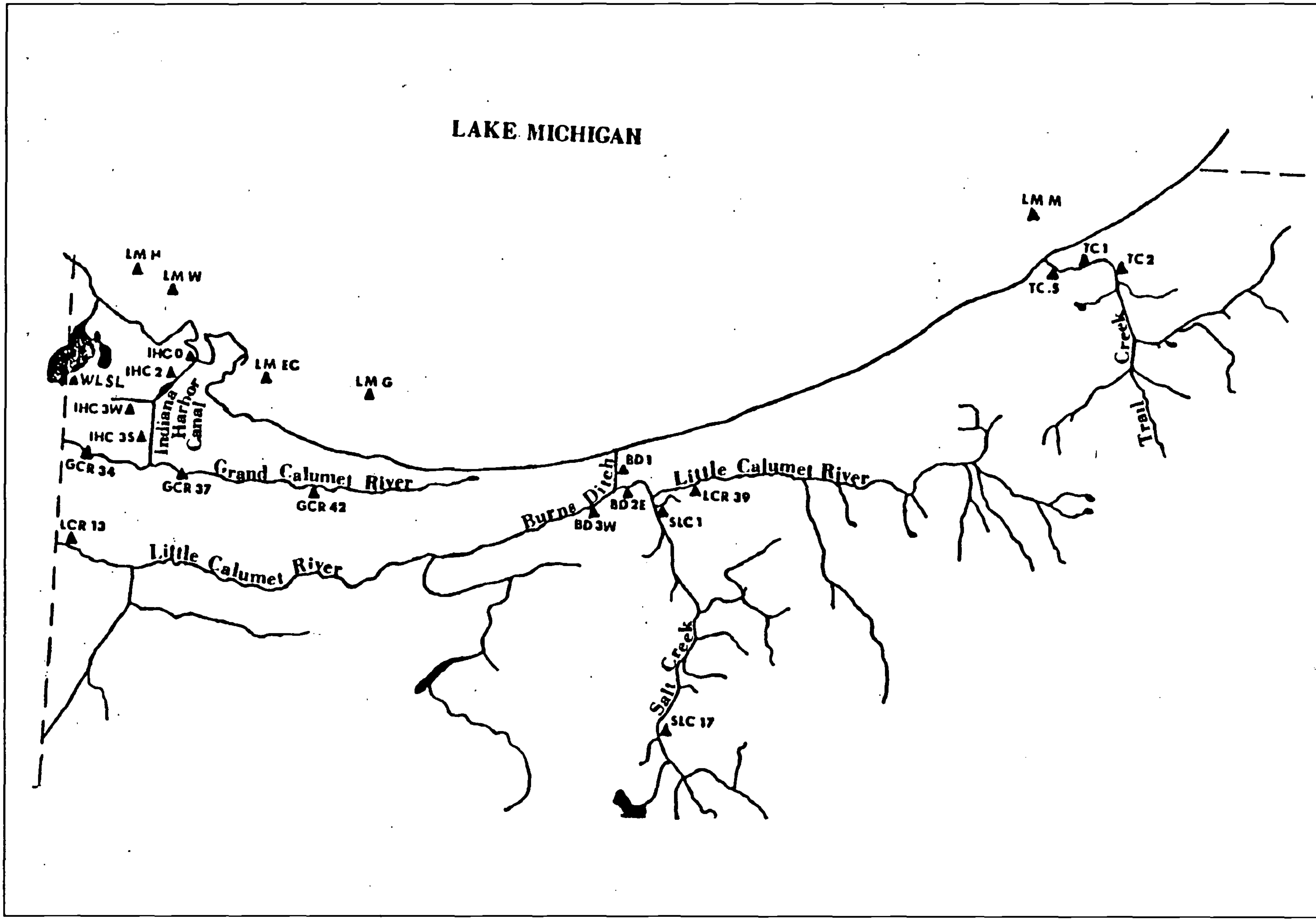


**TABLE 60.** *A. Analyses Conducted at Indiana's Fixed Water Quality Monitoring Stations. (Not All Parameters are Sampled and Analyzed at Each Station)*
*B. Sampling for These Parameters Done Once Every Three Months*

*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**

**Halogenated**
Methylene Chloride
1,1-Dichloroethylene
1,1-Dichloroethane
Chloroform
Carbon Tetrachloride

1,2-Dichloropropane
Trickloroethylene
1,1,2-Trichloroethane
Dibromochloromethane
Tetrachloroethylene
Chlorobenzene
Trichlorofluoromethene
Trans-1,2-Dichloroethylene
1,2-Dichloroethane
1,1,1-Trichloroethane
Bromodichloromethane
Trans-1,3-Dichloroepropene
Cis-1,3-Dichloropropene
Bromoform
1,1,2,2-Tetrachloroethane
2-Chloroethylvinylater

**Nonhalogenated**
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)

**Aromatic**
Benzene
Toluene
Ethyl benzene
Xylenes (MO P)

**BASE/NEUTRAL FACTION**

Bis (2-Chloroethyl)ether
1,3--Dichlorobenzene
1,4-Dichlorobenzene
1,2-Dichlorobenzene
n-Nitroso-n-Dipropylamine
Nitrobenzene

Hexachloroethane
Isophorone
Bis (2-Chloroethoxy) Methane
1,2,4-Trichlorobenzene
Naphthalane
Hexcachlorobutadiene
Hexachlorocyclopentadiene
2-Chloronaphthalene
2,6-Dinitrotoluene
Dimethylphthalate
Acenaphthalene
Acenaphtene
2,4-Dinitrotoluene
Diethylphthalate
Fluorene
N-Nitrosodiphenylamine
4-Bromophcnylphenylether
Hexachlorabenzene
Phenathrene
Anthracene

Di-N-Butylphthalate
Fluoranthene
Pyrene
Butylbenzylphthalate
Benzo (A) anthracene
Chrysene

Di-N-Octylphthalate
Benzo (A) Pyene
Benzidine
3,3-Dichlorobenzidine
4-Chlorophenylphenylether
Bis (2-Chloroisopropyl) Ether
N-Nitrosoodimethylamine
Pentachloroanisole
Benzo (b) Fluoranthene
Benzo (ghi) Perylene
Dibenzo (a,h) Anthracene
Indeno (1,2,3-cd) Pyrene
Aniline
Benezl alcohol
4-Chloroaniline
2-Methylnaphthalene
3-Nitroaniline
Dibenzofuran
4-Nitroaniline
2-Nitroaniline

**ACID EXTRACTABLES-PHENOLS**

Phenol
2-Chlorophenol
2-Nitrophenol
2,4-Dimethylphenol
2,4-Dichlorophenol
p-Chloro-m-Cresol
2,4,6-Trichlorophenol
4-Nitrophenol
4,6-Dinitro-O-Cresol
Penta chlorophenol
2,4-Dinitrophenol
Benzonic Acid
o-Cresol
p-Cresol
2,4,5-Trichlorophenol

**PCBs**
PCB-1221
PCB-1232
PCB-1016
PCB-1242
PCB-1248
PCB-1254
PCB-1260

**ORGANOCHLORINE PESTICIDES**

Alpha-BHC
Beta- BHC
Gama-BHC (Lindane)
Delta-BHC
Heptachlor
Heptachlor Expoxide
Aldrin
Endosulfin I
PP' (4,4") DDE
Dieldrin
Endrin
PP' (4,4") DDD
Endosulfin II
PP' (4,4") DDT
Endosulfin Sulfate
Methoxychlor
Chlordane
Toxaphene
Endrin Aldehyde

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 From 3510-2C for permit applications, (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 the fish tissue and sediments collected once biennially at the 23 CORE program stations (Table 51 and Figure 20). 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 fillets, 5 fish each, if possible) are collected at each station. Skin-on, scaleless fish (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 16. Sediment samples collected are analyzed for 150 pollutants (Table 23). 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. 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 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 antagoistic effects, the permit may include a toxicity testing requirement.

The State also requires toxicity reduction eveluations (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 its 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 13 years. Periodic comprehensive studies of entire watersheds have been conducted as needed to evaluate the status of the entire 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 uses be maintained and no activities be permitted which would interfere with, or become injurious to, existing and potential uses of our surface waters. Specific surface waters of the state also have been designated for specific multiple uses. If a particular body of water has several designated multiple 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, support unique assemblages of aquatic organisms, etc. 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 streams reaches (77 stream miles) are designated for "Limited Use" and 11 are designated for "Exceptional Use" (181 stream miles).

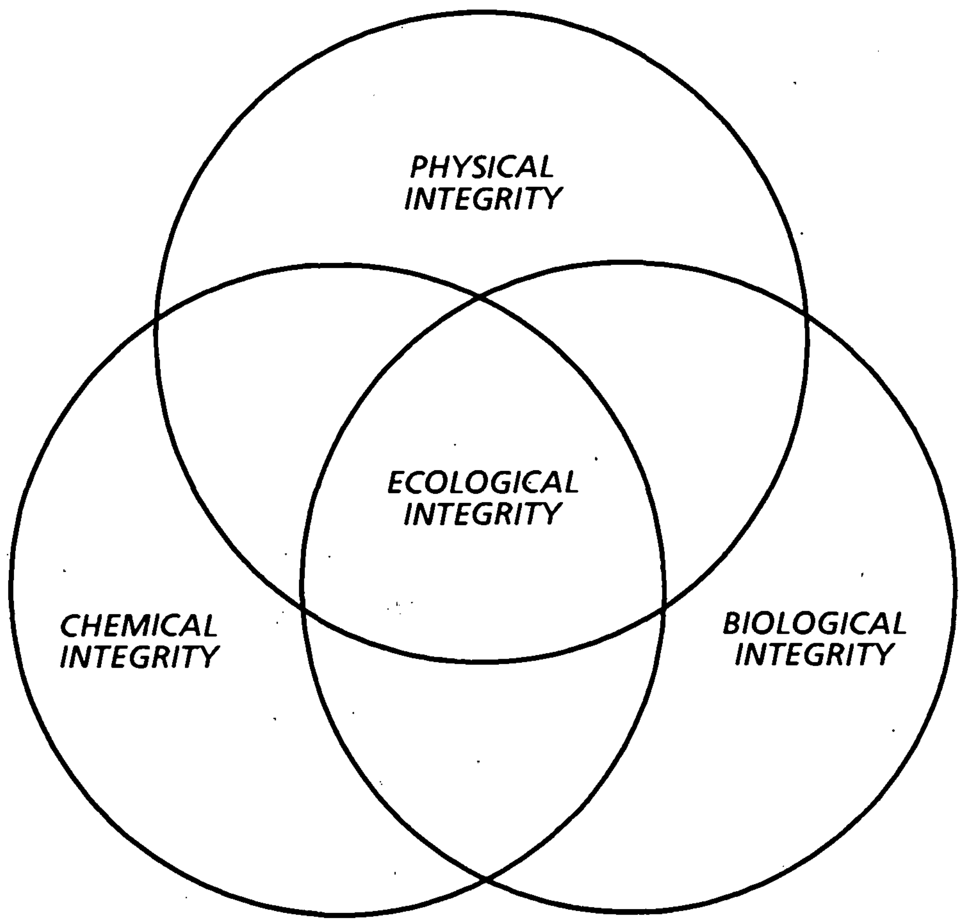
The biological monitoring program includes a comprehensive habitat assessment component using two different numerical assessments. These assessments are performed at all sites where biological sampling and/or evaluations are carried out. During these habitat assessments numerical evaluations are made regarding the physical, chemical, and riparian/watershed character of the stream. These habitat assessment 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 16). 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.

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 nonpoint pollution. Biological monitoring, since by its nature it 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 effluents by this agency and is discussed in the Toxic Monitoring Programs Section and will not be discussed further here.

**FIGURE 16.** *ECOLOGICAL INTEGRITY OF INDIANA LAKES AND STREAMS*



During this two year period, IDEM personnel have been sampling the benthic macroinvertebrate communities living within Indiana rivers and streams using Rapid Bioassessment Protocols (RBP's). 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 2 years over 1500 benthic macroinvertebrate samples have been collected at 341 different sites on 244 different rivers and streams of Indiana. These sampling sites are presented in Figure 17. At this time about 48% of the geographical area of the state has been sampled. These samples represent about 17,000 square miles of the state. A complete list of these sampling sites can be found in Table 61.

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 into 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 18 presents the stages of an observational ecological study such as this present project. 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, such studies by their nature 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 and, as such, data analysis can proceed at multiple levels. This results in data useable 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 RBPIII study utilized 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 this project can be presented here. Biological samples which require several thousand fragmentation of each of the original samples results in a QA/QC challenge and relies heavily on strict sample labeling and tracking protocols. Only a general overview of these protocols can be addressed in this report.

FIGURE 17 *IDEM AQUATIC MACRONVERTEBRATE COLLECTION SITES*

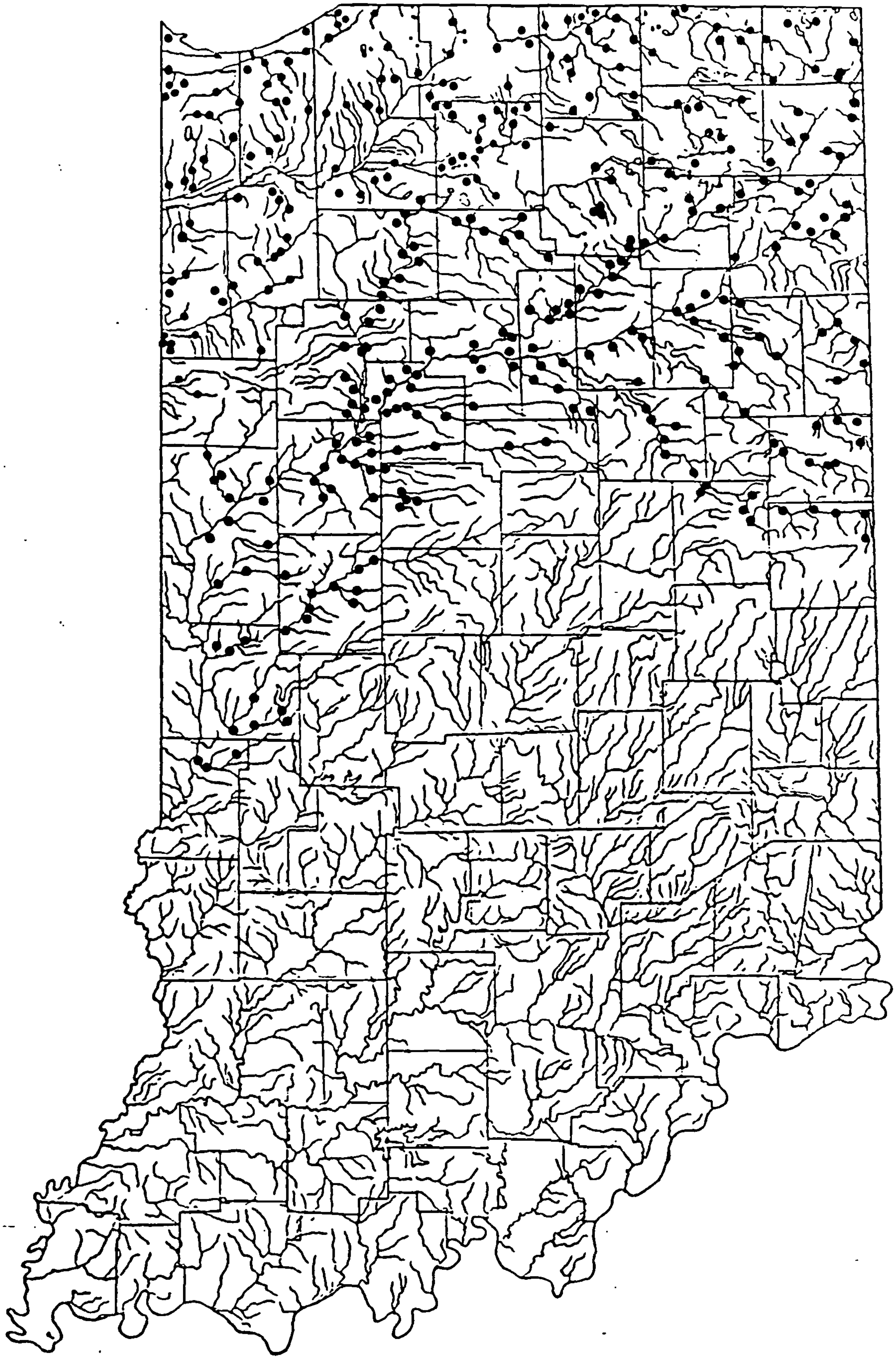


**Table 61.** *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Lake Co. | Deep River<br>Deep River County Park | 09/24/90 | 04040001 | 41 28' 37.0" | 87 13' 15.0" | 54G | 2 | 2A | 107 | 73 |
| | Main Beaver Dam Ditch<br>S.R. 53, D/S Crownpoint, IN | 09/07/90 | 04040001 | 41 25' 43.0" | 87 20' 8.0" | 54G | 2 | 2A | 56 | 29 |
| | S.R. 53, U/S Crownpoint, IN | 09/07/90 | 04040001 | 41 26' 17.0 | 87 21' 53.0" | 54G | 12 | 2A | 46 | 30 |
| | Turkey Creek<br>S.R. 55 | 09/25/90 | 04040001 | 41 29' 55.0" | 87 21' 54.0" | 54G | 2 | 2A | 89 | 57 |
| | Wolf Lake Channel<br>S.R. 12/20, @ AM. Maize Co. | 09/06/90 | 04040001 | 41 41' 30.0" | 87 30' 51.0" | 54G | 1 | 2B | 59 | 39 |
| LaPorte Co. | Galena River<br>C.R. 125E Bridge | 06/21/90 | 04040001 | 41 44' 53.0" | 86 40' 32.0" | 56G | 4 | 2A | * | * |
| | C.R. 125E Bridge | 09/04/90 | 04040001 | 41 44' 53.0" | 86 40' 30.5" | 56G | 4 | 2A | 110 | 75 |
| | Trail Creek<br>S.R. 35 Bridge | 09/05/90 | 04040001 | 41 42' 20.0" | 86 51' 23.0" | 56G | 4 | 2B | 85 | 78 |
| | Tributary of Trail Creek<br>Karwick Road | 09/26/90 | 04040001 | 41 42' 54.5" | 86 51' 19.5" | 56G | 4 | 2C | 78 | 37 |
| | Warnke Road | 09/26/90 | 04040001 | 41 42' 3.5" | 86 50' 33.5" | 56G | 4 | 2C | 69 | 38 |
| | West Branch Trail Creek<br>I-94 & Johnson Road | 09/04/90 | 04040001 | 41 40' 27.5" | 86 50' 44.0" | 56G | 4 | 2A | 90 | 67 |
| | West Fork Trail Creek<br>I-94 & Johnson Road | 06/21/90 | 04040001 | 41 40' 29.0" | 86 50' 42.0" | 56G | 4 | 2B | * | * |
| Porter Co. | Coffee Creek<br>C.R. 1100 N. | 09/19/90 | 04040001 | 41 35' 37.0" | 87 2' 24.0" | 56G | 3 | 2B | 79 | 65 |
| | Damon Run<br>C.R. 100W | 09/19/90 | 04040001 | 41 33' 37.0" | 87 5' 8.0" | 56G | 3 | 2B | 90 | 71 |
| | E. Fork Little Calumet<br>Federal Heron Rookery | 09/20/90 | 04040001 | 41 37' 29.0" | 86 8' 38.0" | 56G | 3 | 2B | 114 | 82 |

*Table 61. Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kintzele Ditch | | | | | | | | | |
| | Beverly Shores Road | 06/21/90 | 04040001 | 41 42' 5.0" | 86 56' 25.5" | 56G | 3 | 2C | * | * |
| | Beverly Shores Road | 09/05/90 | 04040001 | 41 42' 5.5" | 86 56' 25.5" | 56G | 4 | 2C | 96 | 91 |
| | Sagers Creek | | | | | | | | | |
| | Outfall of Sager's Lake | 06/20/90 | 04040001 | 41 27' 17.0" | 87 3' 27.0" | 54G | 3 | 2A | * | * |
| | Outfall of Sager's Lake | 09/19/90 | 04040001 | 41 27' 17.0" | 87 3' 27.0" | 54G | 3 | 2A | 111 | 85 |
| | Salt Creek | | | | | | | | | |
| | D/S I-94 | 09/20/90 | 04040001 | 41 36' 10.0" | 87 8' 53.0" | 56G | 3 | 2B | 109 | 88 |
| | U.S. 6 (Valparaiso) | 09/25/90 | 04040001 | 41 33' 1.0" | 87 7' 17.0" | 54G | 3 | 2A | 83 | 51 |
| | U/S Valparaiso POTW | 09/25/90 | 04040001 | 41 27' 52.0" | 87 4' 15.0" | 54G | 3 | 2A | 92 | 49 |
| | Willow Creek | | | | | | | | | |
| | U.S. 20 | 09/24/90 | 04040001 | 41 35' 32.0" | 87 12' 36.0" | 54G | 2 | 2B | 86 | 77 |
| Elkhart Co. | Baugo Creek | | | | | | | | | |
| | Roosevelt Road | 08/16/90 | 04050001 | 41 35' 39.0" | 86 1' 48.0" | 56G | 5 | 4 | 44 | 38 |
| | Christiana Creek | | | | | | | | | |
| | Heaton Lake Road | 08/15/90 | 04050001 | 41 43' 29.0" | 85 59' 8.0" | 56G | 8 | 4 | 107 | 73 |
| | Cobus Creek | | | | | | | 4 | | |
| | C.R. 8 | 08/15/90 | 04050001 | 41 42' 36.0" | 86 3' 8.0" | 54G | 8 | | 95 | 61 |
| | Darkwood Ditch | | | | | | | | | |
| | U.S. 6 | 08/14/90 | 04050001 | 41 26' 34.0" | 85 56' 52.0" | 56G | 5 | 4 | 58 | 38 |
| | Dausman Ditch | | | | | | | | | |
| | C.R. 21 | 08/28/90 | 04050001 | 41 29' 12.0" | 85 50' 58.0" | 56G | 5 | 4 | 48 | 38 |
| | Elkhart River | | | | | | | | | |
| | S.R. 13 | 08/17/90 | 04050001 | 41 30' 27.0" | 85 41' 35.0" | 56G | 9 | 4 | 109 | 67 |
| | Hoke Ditch | | | | | | | | | |
| | At Mouth | 08/16/90 | 04050001 | 41 36' 30.0" | 85 56' 14.0" | 56G | 9 | 4 | 42 | 24 |
| | Little Elkhart River | | | | | | | | | |
| | D/S Bonneyville Mill Dan | 08/09/90 | 04050001 | 41 43' 9.0" | 85 45' 57.0" | 56G | 10 | 4 | 76 | 78 |
| | River Bend Park U/S Middlbury | 08/02/90 | 04050001 | 41 40' 29.0" | 85 41' 59.0" | 56G | 10 | 4 | 79 | 59 |

*Table 61.* *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pine Creek<br>C.R. 27E | 08/09/90 | 04050001 | 41 38' 17.5" | 85 48' 25.0" | 56G | 10 | 4 | 70 | 49 |
| | S.R. 20 Bridge | 08/09/90 | 04050001 | 41 40' 0.0" | 85 52' 48.5" | 56G | 10 | 4 | 92 | 82 |
| | Puterbaugh Creek<br>C.R. 8 | 08/15/90 | 04050001 | 41 42' 43.0" | 85 56' 19.0" | 56G | 8 | 4 | 73 | 53 |
| | Rock Run Creek<br>C.R. 35 | 08/27/90 | 04050001 | 41 35' 46.0" | 85 44' 1.0" | 56G | 5 | 4 | 113 | 69 |
| | Solomon Creek<br>C.R. 48 | 08/27/90 | 04050001 | 41 28' 50.0" | 85 44' 24.0" | 56G | 9 | 4 | 73 | 56 |
| | Washington Township Ditch<br>Heaton Lake Road | 08/15/90 | 04050001 | 41 43' 28.0" | 85 51' 40.0" | 56G | 8 | 4 | 77 | 68 |
| | Yellow Creek<br>C.R. 32 | 08/16/90 | 04050001 | 41 34' 49.0" | 85 55' 46.0" | 56G | 9 | 4 | 89 | 50 |
| Lagrange Co. | East Fork Fly Creek<br>D/S U.S. 20 At Plato, IN | 08/01/90 | 04050001 | 41 38' 32.0" | 85 20' 23.0" | 56G | 10 | 4 | 84 | 50 |
| | Fawn River<br>C.R. 600 W Near Scott, IN | 08/01/90 | 04050001 | 41 45' 3.0" | 85 32' 40.0" | 56G | 10 | 4 | * | * |
| | Little Elkhart River<br>C.R. 100 W | 08/09/90 | 04050001 | 41 37' 40.0" | 85 37' 10.0" | 56G | 10 | 4 | 69 | 56 |
| | Pigeon River<br>Mongo Lake Dam | 08/08/90 | 04050001 | 41 41' 0.5" | 85 16' 51.0" | 56G | 10 | 4 | 110 | 83 |
| | Ontario Lake Dam | 08/08/90 | 04050001 | 41 42' 25.5" | 85 22' 34.0" | 56G | 10 | 4 | 116 | 80 |
| | Scott, IN D.N.R. Public Access | 08/01/90 | 04050001 | 41 44' 23.0" | 85 33' 23.0" | 56G | 10 | 4 | 87 | 53 |
| | Turkey Creek<br>Highway 20 Brushy Prairie, IN | 08/01/90 | 04050001 | 41 38' 27.0" | 85 15' 16.0" | 56G | 10 | 4 | * | * |
| Noble Co. | Croft Ditch<br>S.R. 9 Bridge U/S Albion, IN | 08/07/90 | 04050001 | 41 22' 38.0" | 85 25' 30.0" | 56G | 6 | 4 | 70 | 40 |

*Table 61.* *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Dry Run<br>C.R. 900 N. | 08/08/90 | 04050001 | 41 28' 57.0" | 85 25' 7.5" | 56G | 6 | 4 | 67 | 51 |
| | Huston Ditch<br>C.R. 300 W. | 08/10/90 | 04050001 | 41 28' 10.0" | 85 30' 37.0" | 56G | 6 | 4 | 88 | 63 |
| | N. Fork Elkhart River<br>C.R. 450 W. | 08/10/90 | 04050001 | 41 28' 0.1" | 85 28' 55.0" | 56G | 10 | 4 | 71 | 60 |
| | Oviatt Ditch<br>C.R. 900 N. | 08/08/90 | 04050001 | 41 28' 55.0" | 85 18' 28.0" | 56G | 6 | 4 | 91 | 40 |
| | Rimmell Branch<br>C.R. 300 E. | 08/07/90 | 04050001 | 41 23' 0.5" | 85 22' 0.0" | 56G | 6 | 4 | 52 | 31 |
| | Thumma Ditch<br>C.R. 125 S. | 08/07/90 | 04050001 | 41 20' 1.0" | 85 20' 32.0" | 55G | 6 | 4 | 98 | 65 |
| | Winebrenner Ditch<br>C.R. 250 W. | 08/07/90 | 04050001 | 41 18' 14.5" | 85 28' 18.0" | 55G | 6 | 4 | 34 | 28 |
| St. Joseph Co. | BowmanCreek<br>Linden Road | 08/16/90 | 04050001 | 41 37' 56.0" | 86 16' 21.0" | 54G | 5 | 4 | 61 | 49 |
| | Harrison Ditch<br>Blackberry Road | 08/28/90 | 04050001 | 41 39' 18.0" | 86 6' 51.0" | 56G | 5 | 4 | 75 | 53 |
| | Willow Creek<br>Early Road | 08/15/90 | 04050001 | 41 41' 16.0" | 86 8' 0.0" | 54G | 8 | 4 | 67 | 39 |
| Steuben Co. | Crooked Creek<br>D/S Nevada Mills Dam | 08/01/90 | 04050001 | 41 43' 34.0" | 85 5' 4.0" | 56G | 7 | 4 | 122 | 76 |
| | Eaton Creek<br>D/S C.R. 100 E. | 07/31/90 | 04050001 | 41 43' 8.0" | 84 58' 18.0" | 56G | 7 | 4 | 65 | 41 |
| | Pigeon Creek<br>D/S S.R. 27 Bridge | 07/31/90 | 04050001 | 41 34' 36.0" | 85 0' 33.0" | 55G | 7 | 4 | 91 | 72 |
| | S.R. 327 D.N.R. Access | 08/02/90 | 04050001 | 41 39' 4.0" | 85 10' 28.0" | 56G | 10 | 4 | 63 | 46 |
| | Turkey Creek<br>S.R. 327 | 08/08/90 | 04050001 | 41 33' 22.5" | 85 10' 13.0" | 56G | 10 | 4 | 54 | 52 |
| Allen Co. | Cedar Creek<br>S.R. 1 | 07/11/90 | 04100003 | 41 12' 10.0" | 85 1' 40.0" | 55G | 18 | 5C | 80 | 69 |

*Table 61.* *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydrologic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Swartz-Carnahan Ditch Amstutz Road | 07/09/91 | 04100001 | 41 15' 25.0" | 85 1' 13.0" | 55G | 20 | 5C | 78 | 56 |
| | Tiernan Ditch St. Joe Road | 07/09/91 | 04100003 | 41 9' 51.0" | 85 3' 53.0" | 55G | 20 | 5C | 64 | 49 |
| | Willow Creek Shoaff Road | 07/12/91 | 04100003 | 41 14' 34.5" | 85 9' 59.0" | 55G | 18 | 5C | 89 | 53 |
| DeKalb Co. | Bear Creek C.R. 59 @ Wild Cherry Park | 07/11/91 | 04100003 | 41 19' 8.0" | 84 54' 22.0" | 55G | 20 | 5C | 86 | 67 |
| | Big Run Creek C.R. 79 | 07/10/91 | 04100003 | 41 25' 37.0" | 84 48' 42.0" | 55G | 20 | 5C | 96 | 71 |
| | Cedar Creek 19th Street, Auburn, IN | 07/11/91 | 04100003 | 41 21' 35.0" | 85 2' 57.0" | 55G | 18 | 5C | 91 | 71 |
| | C.R. 24 | 07/11/91 | 04100003 | 41 26' 23.0" | 85 2' 20.0" | 55G | 18 | 5C | 105 | 67 |
| | Fish Creek C.R. 18 | 07/10/91 | 04100003 | 41 27' 49.0" | 84 48' 41.0" | 55G | 20 | 5C | 68 | 52 |
| | John Diehl Ditch C.R. 32 | 07/11/91 | 04100003 | 41 24' 36.0" | 85 9' 19.0" | 55G | 18 | 5C | 75 | 48 |
| | Little Cedar Creek S.R. 327 | 07/12/91 | 04100003 | 41 17' 24.5" | 85 8' 8.5" | 55G | 18 | 5C | 69 | 62 |
| | St. Joseph River C.R. 60 | 07/11/91 | 04100003 | 41 18' 43.0" | 84 53' 7.0" | 55G | 20 | 5C | 68 | 44 |
| Steuben Co. | Black Creek S.R. 1 | 07/10/91 | 04100003 | 41 33' 37.0" | 84 54' 17.0" | 55G | 20 | 4 | 87 | 69 |
| | Fish Creek C.R. 40 S. | 07/10/91 | 04100003 | 41 38' 22.0" | 84 49' 1.5" | 55G | 20 | 4 | 95 | 62 |
| | Fish Creek (#2) C.R. 775 S. | 07/10/91 | 04100003 | 41 31' 56.0" | 84 54' 13.5" | 55G | 20 | 4 | 71 | 53 |
| Adams Co. | Blue Creek C.R. 200 S. | 07/15/91 | 04100004 | 40 43' 5.5" | 84 49' 36.5" | 57G | 21 | 5C | 70 | 39 |

*Table 61. Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Habegger Ditch D/S Berne, IN (C.R. 100 E.) | 10/29/91 | 04100004 | 40 40' 30.0" | 84 55' 2.0" | 57G | 21 | 5C | 49 | 37 |
| | Holthouse Dirch C. R. 200 W. | 07/16/91 | 04100004 | 40 49' 50.0" | 84 58' 32.0" | 57G | 21 | 5C | 81 | 49 |
| | St. Mary's River S. R. 101 | 07/16/91 | 04100004 | 40 46' 42.5" | 84 50' 29.5" | 57G | 21 | 5C | 86 | 69 |
| | U/S Central Soya, Decatur, IN | 07/16/91 | 04100004 | 40 50' 40.0" | 84 55' 42.0" | 57G | 21 | 5C | 78 | 91 |
| Allen Co. | St. Mary's River Foster Park, Ft. Wayne, IN | 07/16/91 | 04100004 | 41 2' 29.0" | 85 9' 53.0" | 55G | 21 | 5C | 101 | 71 |
| Allen Co. | Black Creek Schaeffer Road | 07/08/91 | 04100005 | 41 10' 59.5" | 84 52' 11.0" | 57G | 19 | 6 | 88 | 52 |
| | Bottern Ditch Thimlar Road | 07/09/91 | 04100005 | 41 8' 49.0" | 84 56' 9.0" | 57G | 19 | 6 | 71 | 50 |
| | Bullerman Ditch North River Road | 07/09/91 | 04100005 | 41 5' 17.0" | 85 0' 34.0" | 55G | 19 | 6 | 82 | 57 |
| | Gar Creek Berthaud Road | 07/08/91 | 04100005 | 41 5' 39.0" | 84 56' 11.0" | 57G | 19 | 6 | 83 | 50 |
| | Maumee River Bull Rapids Bridge | 07/08/91 | 04100005 | 41 9' 23.0" | 84 52' 40.0" | 57G | 19 | 6 | 102 | 75 |
| Allen Co. | Aboite Creek 7100 W. Hamilton Road | 07/31/91 | 05120101 | 41 1' 9.0" | 85 19' 15.0" | 55G | 35 | 5C | 106 | 75 |
| Cass Co. | Crooked Creek Georgetown, IN | 09/11/91 | 05120101 | 40 44' 23.0" | 86 30' 36.0" | 55G | 40 | 5A | 103 | 71 |
| | Minnow Creek Near Mouth | 08/28/91 | 05120101 | 40 44' 18.0" | 86 19' 7.0" | 55G | 33 | 5C | 84 | 63 |
| | Pipe Creek C. R. 225 S, Below Dam | 09/11/91 | 05120101 | 40 43' 48.0" | 86 13' 16.0" | 55G | 32 | 5C | 100 | 65 |

*Table 61. Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Wabash River<br>Kienly Island (South Side) | 08/28/91 | 05120101 | 40 44' 23.0" | 86 19' 15.0" | 55G | 33 | 5C | 92 | 70 |
| | Williams Ditch<br>Lewisburgh Road | 08/28/91 | 05120101 | 40 45' 17.0" | 86 13' 22.0" | 55G | 33 | 5C | 93 | 71 |
| Huntington Co. | Bull Creek<br>S. R. 24 | 07/31/91 | 05120101 | 40 54' 40.0" | 85 24' 24.0" | 55G | 35 | 5C | 91 | 51 |
| | Flat Creek<br>Mayne Road | 07/31/91 | 05120101 | 40 54' 50.0" | 85 22' 24.0" | 55G | 35 | 5C | 64 | 50 |
| | Little Wabash River<br>N. Broadway Street | 07/31/91 | 05120101 | 40 52' 53.0" | 85 28' 17.0" | 55G | 35 | 5C | 115 | 83 |
| | Rock Creek<br>50M U/S C. R. 100 S | 07/10/91 | 05120101 | 40 48' 46.0" | 85 21' 50.0" | 55G | 36 | 5C | 122 | 91 |
| | Wabash River<br>600 Yards U/S of Rangeline Road | 07/09/91 | 05120101 | 40 52' 36.0" | 85 32' 20.0" | 55G | 36 | 5C | 105 | 77 |
| | D/S Huntington Reservoir Dam | 07/09/91 | 05120101 | 40 50' 46.0" | 85 28' 16.0" | 55G | 36 | 5C | 102 | 70 |
| Jay Co. | Franks Drain (Bull Creek)<br>30 M U/S of C. R. 60 S. | 07/11/91 | 05120101 | 40 29' 56.0" | 84 51' 11.0" | 55G | 36 | 5C | 99 | 65 |
| | Limberlost Creek<br>70M U/S of C. R. 20 S. | 07/15/91 | 05120101 | 40 33' 21.0" | 84 56' 32.0" | 55G | 36 | 5C | 65 | 44 |
| | Wabash River<br>C. R. 215 E. | 07/16/91 | 05120101 | 40 34' 5.0" | 84 50' 55.0" | 57G | 36 | 5C | 55 | 43 |
| | Wolf Creek<br>S. R. 18 | 07/15/91 | 05120101 | 40 32' 51.0" | 85 1' 4.0" | 55G | 36 | 5C | 60 | 50 |
| Miami Co. | Honey Creek<br>D/S Amboy, C. R. 1050 S. | 09/10/91 | 05120101 | 40 36' 54.0" | 85 55' 16.0" | 55M | 32 | 5C | 84 | 61 |
| | Little Pipe Creek<br>C.R. 100 W. | 08/26/91 | 05120101 | 40 43' 35.0" | 86 5' 33.0" | 55G | 33 | 5C | 99 | 69 |
| | C. R. 100 W. | 08/26/91 | 05120101 | 40 43' 35.0" | 86 5' 33.0" | 55G | 33 | 5C | 99 | 69 |
| | C. R. 1100 S. | 09/10/91 | 05120101 | 40 36' 32.0" | 85 52' 56.0" | 55M | 32 | 5C | 83 | 63 |

*Table 61. Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pipe Creek<br>C.R. 300 E. | 08/29/91 | 05120101 | 40 38' 50.0" | 86 0' 5.0" | 55M | 32 | 5C | 100 | 65 |
| | Strawtown Road | 08/29/91 | 05120101 | 40 39' 39.0" | 86 3' 36.0" | 55M | 32 | 5C | 78 | 59 |
| | Prairie Ditch<br>Stone Road | 08/27/91 | 05120101 | 40 45' 51.0" | 86 7' 41.0" | 55G | 33 | 5C | 108 | 74 |
| Wabash Co. | Mill Creek<br>Mill Creek Road | 08/27/91 | 05120101 | 40 46' 3.0" | 85 53' 44.0" | 55G | 33 | 5C | 114 | 88 |
| | Treaty Creek<br>Waterworks Road | 08/27/91 | 05120101 | 40 47' 32.0" | 85 47' 38.0" | 55G | 33 | 5C | 90 | 60 |
| Wells Co. | Eightmile Creek<br>Aboite Road | 07/31/91 | 05120101 | 40 54' 53.0" | 85 19' 9.0" | 55M | 35 | 5C | 83 | 67 |
| | Mossburg Ditch<br>County Line Road | 07/10/91 | 05120101 | 40 43' 7.0" | 85 20' 7.0" | 55G | 36 | 5C | 84 | 64 |
| | Rock Creek<br>C. R. 200 N. | 07/12/91 | 05120101 | 40 46' 16.0" | 85 18' 32.0" | 55G | 36 | 5C | 118 | 67 |
| | Wabash River<br>1/4 Mile D/S of S. R. 1 | 07/09/91 | 05120101 | 40 44' 40.0" | 85 10' 25.0" | 57G | 36 | 5C | 112 | 80 |
| | C. R. 300 W. | 07/09/91 | 05120101 | 40 48' 7.0" | 85 16' 47.0" | 55G | 36 | 5C | 103 | 80 |
| Delaware Co. | Bosman Ditch<br>C. R. 450 E. | 07/19/91 | 05120102 | 40 18' 55.0" | 85 18' 13.0" | 55M | 39 | 5C | 113 | 83 |
| Huntington Co. | Salamonie River<br>S. R. 5 Bridge @ Warren, IN | 07/30/91 | 05120102 | 40 40' 50.0" | 85 25' 38.0" | 55G | 39 | 5C | 110 | 67 |
| Jay Co. | Brooks Creek<br>C. R. 74 S. | 07/17/91 | 05120102 | 40 28' 27.0" | 85 8' 40.0" | 55M | 37 | 5C | 54 | 45 |
| | Salmonie River<br>50 M. U/S of S. R. 1 | 07/17/91 | 05120102 | 40 29' 11.0" | 87 9' 1.0" | 55M | 37 | 5C | 81 | 52 |
| | D/S Portland, IN (C. R. 106 S.) | 10/29/91 | 05120102 | 40 25' 39.0" | 85 2' 20.0" | 55M | 37 | 5C | 80 | 55 |
| | S. R. 26 East of Portland, IN | 07/16/91 | 05120102 | 40 25' 57.0" | 84 57' 48.0" | 55M | 37 | 5C | 62 | 36 |
| | S. R. 26 West of Portland, IN | 07/16/91 | 05120102 | 40 26' 42.0" | 85 4' 14.0" | 55M | 37 | 5C | 76 | 48 |

*Table 61.* *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Wabash Co. | Salamonie River 300 M. D/S Salamonie Res. Dam | 07/30/91 | 05120102 | 40 48' 40.0" | 85 41' 0.0" | 55G | 38 | 5C | 110 | 76 |
| | Durnbaugh Road | 08/01/91 | 05120102 | 40 49' 48.0" | 85 43' 8.0" | 55G | 38 | 5C | 122 | 90 |
| Wells Co. | Salamonie River 1.5 Miles D/S Montpelier, IN | 07/30/91 | 05120102 | 40 34' 35.0" | 85 17' 33.0" | 55G | 38 | 5C | 109 | 77 |
| | 1/4 U/S S. R. 3 | 07/30/91 | 05120102 | 40 38' 3.0" | 85 22' 1.0" | 55G | 38 | 5C | 91 | 62 |
| Delaware Co. | Campbell Creek C. R. 525 E. | 07/18/91 | 05120103 | 40 15' 40.0" | 85 17' 22.0" | 55G | 39 | 5C | 97 | 80 |
| | Mississ inewa River 100 M. D/S C. R. 375 N. | 07/29/91 | 05120103 | 40 22' 20.0" | 85 27' 25.0" | 55M | 39 | 5C | 102 | 75 |
| | 100 M. D/S C. R. 375 W. | 07/29/91 | 05120103 | 40 22' 20.0" | 85 27' 25.0" | 55M | 39 | 5C | * | * |
| | 200 M. D/S C. R. 700 N. | 07/19/91 | 05120103 | 40 17' 33.0" | 85 18' 47.0" | 55M | 39 | 5C | 117 | 92 |
| | Pike Creek 25 M. U/S C. R. 1187 N. | 07/29/91 | 05120103 | 40 21' 46.0" | 85 27' 26.0" | 55M | 39 | 5C | 93 | 61 |
| Grant Co. | Lugar Creek C. R. 500 E. | 08/06/91 | 05120103 | 40 32' 42.0" | 85 34' 40.0" | 55M | 24 | 5C | 99 | 70 |
| | Mississinewa River D/S Highland Avenue Bridge, Marion | 08/07/91 | 05120103 | 40 34' 36.0" | 85 39' 34.0" | 55M | 24 | 5C | 105 | 67 |
| | S. R. 15, D/S Marion POTW | 08/07/91 | 05120103 | 40 36' 42.0" | 85 41' 35.0" | 55M | 24 | 5C | 107 | 72 |
| | S. R. 22 Bridge, Jonesboro, IN | 08/06/91 | 05120103 | 40 29' 15.0" | 85 37' 33.0" | 55M | 24 | 5C | 97 | 53 |
| | U/S S. R. 26 Bridge | 08/08/91 | 05120103 | 40 25' 20.0" | 85 30' 31.0" | 55M | 24 | 5C | 83 | 62 |
| | Walnutt Creek N. 1st Street Bridge, Gas City, IN | 08/06/91 | 05120103 | 40 30' 7.0" | 85 36' 56.0" | 55M | 24 | 5C | 110 | 75 |

*Table 61. Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | | | Longitude | | | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Miami Co. | Mississinewa River | | | | | | | | | | | | | |
| | S. R. 124 | 08/26/91 | 05120103 | 40 | 45' | 14.0" | 86 | 1' | 19.0" | 55G | 33 | 5C | 104 | 73 |
| Randolph Co. | Little Mississinewa River | | | | | | | | | | | | | |
| | C. R. 850 N. | 07/17/91 | 05120103 | 40 | 17' | 16.0" | 84 | 49' | 56.0" | 55M | 39 | 5C | 50 | 39 |
| | D/S Union City, IN (S. R. 28) | 10/29/91 | 05102103 | 40 | 12' | 56.5" | 84 | 49' | 16.5" | 55G | 39 | 5C | 78 | 48 |
| | Mississinewa River | | | | | | | | | | | | | |
| | 250 M. East of S. R. 1 | 07/18/90 | 05120103 | 40 | 16' | 44.0" | 85 | 8' | 44.0" | 55M | 39 | 5C | 87 | 51 |
| | C. R. 300 E. | 07/17/91 | 05120103 | 40 | 17' | 6.0" | 84 | 55' | 9.0" | 55M | 39 | 5C | 82 | 54 |
| | S. R. 28 @ Ridgeville, IN | 07/18/91 | 05120103 | 40 | 16' | 59.0" | 85 | 1' | 43.0" | 55M | 39 | 5C | 79 | 52 |
| Wabash Co. | Metocinah Creek | | | | | | | | | | | | | |
| | C. R. 380 W. | 08/07/91 | 05120103 | 40 | 39' | 26.0" | 85 | 45' | 1.0" | 55M | 24 | 5C | 115 | 86 |
| Allen Co. | Johnson Drain | | | | | | | | | | | | | |
| | Carroll Road | 07/17/91 | 05120104 | 41 | 11' | 19.0" | 85 | 17' | 28.0" | 55G | 34 | 4 | 75 | 44 |
| Cass Co. | Eel River | | | | | | | | | | | | | |
| | C. R. 925 E. (South of Hoover) | 07/30/91 | 05120104 | 40 | 47' | 46.0" | 86 | 11' | 57.0" | 55G | 31 | 4 | 103 | 76 |
| | Tick Creek | | | | | | | | | | | | | |
| | Bridge Nearest Mouth | 08/28/91 | 05120104 | 40 | 46' | 6.0" | 86 | 19' | 2.0" | 55G | 31 | 5C | 104 | 75 |
| | Twelve Mile Creek | | | | | | | | | | | | | |
| | C. R. 300 N. | 07/30/91 | 05120104 | 40 | 48' | 29.0" | 86 | 13' | 23.0" | 55G | 31 | 4 | 88 | 64 |
| Kosciusko Co. | Crazy Creek | | | | | | | | | | | | | |
| | S. R. 14 | 07/18/91 | 05120104 | 41 | 4' | 33.0" | 85 | 41' | 50.0" | 55G | 34 | 5C | 111 | 82 |
| | Plunge Creek | | | | | | | | | | | | | |
| | C. R. 600 E. | 07/19/91 | 05120104 | 41 | 3' | 52.0" | 85 | 43' | 23.0" | 55G | 34 | 5C | 101 | 78 |
| Miami Co. | Eel River | | | | | | | | | | | | | |
| | D/S Stockdale Dam | 07/29/91 | 05120104 | 40 | 54' | 47.0" | 85 | 56' | 43.0" | 55G | 31 | 5C | 92 | 74 |
| | S. R. 19, Chili, IN | 07/30/91 | 05120104 | 40 | 51' | 26.5" | 86 | 1' | 33.0" | 55G | 31 | 5C | 100 | 70 |
| | Flowers Creek C. R. 725 N (Chili, IN) | 07/30/91 | 05120104 | 40 | 51' | 31.0" | 86 | 1' | 27.0" | 55G | 31 | 5C | 96 | 67 |
| | Paw Paw Creek | | | | | | | | | | | | | |
| | Paw Paw Pike | 07/29/91 | 05120104 | 40 | 52' | 43.0" | 85 | 57' | 44.0" | 55G | 31 | 5C | 75 | 60 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | | | Longitude | | | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Weesau Creek<br>S. R. 16 Denver, IN | 07/30/91 | 05120104 | 40 | 51' | 58.0" | 86 | 5' | 5.5" | 55G | 31 | 5C | 102 | 70 |
| Wabash Co. | Beargrass Creek<br>Reahard Road | 07/30/91 | 05120104 | 40 | 56' | 32.0" | 85 | 53' | 20.0" | 55G | 31 | 5C | 102 | 82 |
| | Clear Creek<br>S. R. 114 | 07/18/91 | 05120104 | 41 | 0' | 1.0" | 85 | 48' | 31.0" | 55G | 34 | 5C | 94 | 58 |
| | Squirrel Creek<br>C. R. 700 N. | 07/29/91 | 05120104 | 40 | 55' | 41.0" | 85 | 55' | 57.0" | 55G | 31 | 5C | 103 | 85 |
| | Swank Creek<br>S. R. 13 | 07/19/91 | 05120104 | 41 | 1' | 30.0" | 85 | 45' | 9.0" | 55G | 34 | 5C | 72 | 53 |
| Whitley Co. | Blue Babe Branch<br>Airport Road | 07/17/91 | 05120104 | 41 | 10' | 46.0" | 85 | 28' | 52.0" | 55G | 34 | 4 | 53 | 45 |
| | Blue River<br>Morsche Park, Columbia City | 07/17/91 | 05120104 | 41 | 9' | 31.0" | 85 | 27' | 50.5" | 55G | 34 | 4 | 73 | 44 |
| | Eel River<br>C. R. 500 W | 07/18/91 | 05120104 | 41 | 5' | 38.0" | 85 | 35' | 13.0" | 55G | 34 | 4 | 49 | 35 |
| | Collamer Dam (C. R. 900 W.) | 07/18/91 | 05120104 | 41 | 4' | 27.0" | 85 | 39' | 51.0" | 55G | 34 | 5C | 81 | 68 |
| | Johnson Road | 07/17/91 | 05120104 | 41 | 10' | 26.0" | 85 | 20' | 39.5" | 56G | 34 | 4 | 73 | 57 |
| Carroll Co. | Bachelor Run<br>C. R. 300 N. | 09/04/91 | 05120105 | 40 | 35' | 28.0" | 86 | 34' | 12.0" | 55G | 41 | 5B | 73 | 48 |
| | Burnetts Creek<br>Tow Path Road | 09/11/91 | 05120105 | 40 | 42' | 3.0" | 86 | 34' | 8.0" | 55G | 40 | 5A | 88 | 71 |
| | Deer Creek<br>C. R. 300 N. | 09/04/91 | 05120105 | 40 | 35' | 23.0" | 86 | 37' | 18.0" | 55G | 41 | 5B | 101 | 82 |
| | D/S Delphi POTW | 09/04/91 | 05120105 | 40 | 34' | 28.0" | 86 | 40' | 59.0" | 55G | 41 | 5A | 70 | 62 |
| | U/S Delphi (Foot Bridge) | 09/04/91 | 05120105 | 40 | 35' | 10.0" | 86 | 40' | 8.0" | 55G | 41 | 5A | 81 | 66 |
| | Little Deer Creek<br>C. R. 300 N. | 09/04/91 | 05120105 | 40 | 35' | 24.0" | 86 | 28' | 4.0" | 55G | 41 | 5B | 102 | 79 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | | | Longitude | | | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pleasant Run C. R. 800 W. | 09/16/91 | 05120105 | 40 | 37' | 34.0" | 86 | 40' | 58.0" | 55G | 40 | 5A | 107 | 77 |
| | Rattlesnake Creek C. R. 700 W. | 09/16/91 | 05120105 | 40 | 40' | 50.0" | 86 | 39' | 34.0" | 55G | 40 | 5A | 108 | 79 |
| | Rock Creek C. R. 850 N. | 09/11/91 | 05120105 | 40 | 40' | 17.0" | 86 | 34' | 45.0" | 55G | 40 | 5B | 108 | 81 |
| | Wabash River Mouth Little Rock Creek | 09/11/91 | 05120105 | 40 | 41' | 44.0" | 86 | 33' | 24.0" | 55G | 40 | 5A | 97 | 74 |
| | Towpath Road | 09/16/91 | 05120105 | 40 | 38' | 54.0" | 86 | 39' | 27.0" | 55G | 40 | 5A | 75 | 59 |
| Cass Co. | Deer Creek Upper Deer Creek Church | 09/05/91 | 05120105 | 40 | 35' | 53.0" | 86 | 17' | 53.0" | 55G | 41 | 5B | 100 | 72 |
| Tippecanoe Co. | Buck Creek 5 Northeast Road | 09/26/91 | 05120105 | 40 | 29' | 47.0" | 86 | 48' | 29.0" | 55G | 43 | 5A | 85 | 56 |
| | Sugar Creek C. R. 775 E. | 09/26/91 | 05120105 | 40 | 30' | 55.0" | 86 | 45' | 26.0" | 55G | 43 | 5A | 100 | 64 |
| Carroll Co. | Tippecanoe River S. R. 18 | 08/08/91 | 05120106 | 40 | 35' | 39.0" | 86 | 46' | 14.0" | 55G | 28 | 5B | 109 | 80 |
| Fulton Co. | Chippewanuck Creek C. R. 250 N. | 07/25/91 | 05120106 | 41 | 5' | 30.0" | 86 | 8' | 51.0" | 55G | 30 | 4 | 84 | 54 |
| | Curtis Ditch C. R. 900 E. | 07/25/91 | 05120106 | 41 | 2' | 33.0" | 86 | 4' | 32.0" | 55G | 30 | 4 | 85 | 47 |
| | Eddy Creek C. R. 475 N. | 07/31/91 | 05120106 | 41 | 7' | 23.0" | 86 | 21' | 6.0" | 56G | 29 | 4 | 91 | 65 |
| | Mill Creek Olson Road | 07/31/91 | 05120106 | 41 | 5' | 30.0" | 86 | 13' | 53.0" | 55G | 29 | 4 | 92 | 71 |
| | Tippecanoe River C. R. 375 W. | 07/31/91 | 05120106 | 41 | 7' | 7.0" | 86 | 18' | 51.0" | 55G | 29 | 4 | 105 | 81 |
| | C. R. 900 W. | 07/31/91 | 05120106 | 41 | 8' | 41.0" | 86 | 24' | 56.0" | 55G | 29 | 4 | 97 | 70 |
| | Talma, IN (IDNR Fishing Site) | 07/25/91 | 05120106 | 41 | 9' | 13.0" | 86 | 8' | 20.0" | 55G | 30 | 4 | 107 | 74 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Kosciusko Co. | Deeds Creek C. R. 100 N. | 07/24/91 | 05120106 | 41 14' 55.0" | 47 30' 52.0" | 56G | 30 | 4 | 88 | 51 |
| | Peterson Ditch C.R. 225 S. | 07/24/91 | 05120106 | 41 12' 12.0" | 85 49' 57.0" | 56G | 30 | 4 | 104 | 59 |
| | Tippecanoe River C. R. 300 N. | 07/23/91 | 05120106 | 41 16' 39.0" | 85 51' 50.0" | 56G | 30 | 4 | 104 | 68 |
| | Walnut Creek S. R. 15 | 07/24/91 | 05120106 | 41 12' 15.0" | 85 52' 11.0" | 56G | 30 | 4 | 77 | 51 |
| | Wyland Creek Packerton Road | 07/24/91 | 05120106 | 41 12' 48.0" | 85 48' 26.0" | 56G | 30 | 4 | 107 | 72 |
| Noble Co. | Tippecanoe River Wilmot Dam | 07/23/91 | 05120106 | 41 18' 33.0" | 85 38' 41.0" | 56G | 30 | 4 | 117 | 84 |
| Pulaski Co. | Dilts-Anstis Ditch Tippecanoe River State Park | 08/01/91 | 05120106 | 41 8' 1.0" | 86 35' 30.0" | 55G | 29 | 3B | 75 | 33 |
| | Indian Creek S. R. 119 | 08/06/91 | 05120106 | 40 55' 18.5" | 86 39' 35.0" | 55G | 28 | 3B | 108 | 70 |
| | Mill Creek U.S. 35 (South of Winimac, IN) | 08/02/91 | 05120106 | 41 0' 45.0" | 86 34' 34.0" | 55G | 28 | 3B | 97 | 59 |
| | Mud Creek S. R. 119 | 08/02/91 | 05120106 | 41 59' 1.5" | 86 89' 51.0" | 55G | 28 | 3B | 100 | 66 |
| | Taylor Ditch C. R. 750 N. Near Tippecanoe | 08/01/91 | 05120106 | 41 9' 35.5" | 86 35' 15.0" | 55G | 29 | 3B | 79 | 47 |
| | Tippecanoe River D/S S. R. 14 Winamac, IN | 08/01/91 | 05120106 | 41 3' 19.5" | 86 35' 30.0" | 55G | 29 | 3B | 105 | 65 |
| | Pulaski | 08/06/91 | 05120106 | 40 58' 22.0" | 86 39' 35.0" | 55G | 28 | 3B | 108 | 81 |
| | Tyler-Weisjahn Ditch C.R. 150 E. | 08/01/91 | 05120106 | 41 4' 3.5" | 86 34' 24.0" | 55G | 29 | 3B | 79 | 49 |
| Starke Co. | House Ditch C. R. 850 S. | 07/31/91 | 05120106 | 41 10' 44.5" | 86 32' 26.0" | 55G | 29 | 3B | 62 | 32 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| White Co. | Ackerman Ditch | | | | | | | | | |
| | E. River Road N. of Buffalo, IN | 08/06/91 | 05120106 | 40 54' 15.0" | 86 42' 33.5" | 55G | 28 | 3B | 86 | 49 |
| | Big Creek | | | | | | | | | |
| | C.R. 300 E. | 08/07/91 | 05120106 | 40 41' 24.0" | 86 48' 49.0" | 54G | 28 | 3A | 70 | 32 |
| | Springboro Road | 08/07/91 | 05120106 | 40 38' 19.0" | 86 46' 23.0" | 55G | 28 | 5B | 117 | 88 |
| | Big Monon Creek | | | | | | | | | |
| | S. R. 16 | 08/09/91 | 05120106 | 40 50' 11.0" | 86 49' 33.0" | 54G | 27 | 3B | 70 | 38 |
| | Carnahan Ditch No. 2 | | | | | | | | | |
| | S. R. 39 | 08/08/91 | 05120106 | 40 50' 51.0" | 86 44' 45.5" | 55G | 28 | 3B | 69 | 51 |
| | Honey Creek | | | | | | | | | |
| | C. R. 225 N. | 08/07/91 | 05120106 | 40 47' 5.0" | 86 47' 39.0" | 55G | 28 | 3B | 74 | 62 |
| | Moots Creek | | | | | | | | | |
| | C. R. 300 E. | 08/08/91 | 05120106 | 40 34' 17.0" | 86 48' 43.0" | 54G | 28 | 3A | 115 | 88 |
| | Pike Creek | | | | | | | | | |
| | S. R. 39 | 08/07/91 | 05120106 | 40 46' 51.0" | 86 44' 42.0" | 55G | 28 | 3B | 91 | 70 |
| | Spring Creek | | | | | | | | | |
| | Tower Road | 08/08/91 | 05120106 | 40 35' 41.0" | 86 44' 31.0" | 54G | 28 | 5B | 106 | 80 |
| | Tippecanoe River | | | | | | | | | |
| | D/S Norway Dam. | 08/07/91 | 05120106 | 40 46' 42.0" | 86 45' 28.0" | 55G | 28 | 3B | 100 | 74 |
| Whitley Co. | Tippecanoe River | | | | | | | | | |
| | Ormas, IN | 07/23/91 | 05120106 | 41 17' 42.0" | 85 32' 35.0" | 56G | 30 | 4 | 88 | 59 |
| Carroll Co. | Wildcat Creek | | | | | | | | | |
| | C. R. 50 E. | 09/20/91 | 05120107 | 40 28' 58.0" | 86 30' 43.0" | 55G | 23 | 5B | 93 | 78 |
| | U. S. 421 | 09/18/91 | 05120107 | 40 27' 52.0" | 86 38' 13.0" | 55G | 23 | 5B | 90 | 73 |
| Clinton Co. | Kilmore Creek | | | | | | | | | |
| | Gasline Road | 09/08/91 | 05120107 | 40 19' 43.0" | 86 37' 5.0" | 55G | 23 | 5B | 87 | 65 |
| | Gasline Road | 09/18/91 | 05120107 | 40 19' 43.0" | 86 37' 5.0" | 55G | 23 | 5B | * | * |
| | Middle Fork Wildcat Creek | | | | | | | | | |
| | C. R. 680 W. | 09/19/91 | 05120107 | 40 25' 47.0" | 86 38' 0.0" | 55M | 42 | 5B | 75 | 58 |
| | South Fork Wildcat Creek | | | | | | | | | |
| | C. R. 600 W. | 09/18/91 | 05120107 | 40 19' 15.0" | 86 37' 7.0" | 55M | 23 | 5B | 83 | 66 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | | | Longitude | | | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | D/S Frankfort, IN @ U. S. 421 | 09/18/91 | 05120107 | 40 | 19' | 0.0" | 86 | 32' | 48.0" | 55M | 23 | 5B | 79 | 68 |
| | Spring Creek C. R. 200 N. | 09/17/91 | 05120107 | 40 | 18' | 58.0" | 86 | 37' | 51.0" | 55G | 23 | 5B | 106 | 79 |
| Howard Co. | Wildcat Creek C.R. 44 W., D/S Kokomo, IN | 09/24/91 | 05120107 | 40 | 28' | 53.0" | 86 | 12' | 32.0" | 55M | 23 | 5B | 93 | 75 |
| | D/S Kokomo Reservoir | 09/24/91 | 05120107 | 40 | 29' | 10.0" | 86 | 3' | 2.0" | 55M | 23 | 5B | 69 | 58 |
| Tippecanoe Co. | Middle Fork Wildcat Creek C. R. 900 E. | 09/09/91 | 05120107 | 40 | 24' | 28.0" | 86 | 43' | 56.0" | 55M | 42 | 5B | 115 | 74 |
| | South Fork Wildcat Creek 1 North Road | 09/17/91 | 05120107 | 40 | 25' | 55.0" | 86 | 47' | 20.0" | 55G | 23 | 5B | 98 | 76 |
| | C. R. 900 E. | 09/17/91 | 05120107 | 40 | 19' | 11.0" | 86 | 43' | 58.0" | 55G | 23 | 5B | 87 | 70 |
| | Wildcat Creek C. R. 900 E. | 09/19/91 | 05120107 | 40 | 27' | 17.0" | 86 | 43' | 20.0" | 55M | 23 | 5B | 101 | 71 |
| | Eisenhower Road | 09/19/91 | 05120107 | 40 | 26' | 23.0" | 86 | 49' | 49.0" | 55G | 23 | 5A | 93 | 78 |
| Fountain Co. | Bear Creek Portland Arch | 10/04/91 | 05120108 | 40 | 12' | 42.0" | 87 | 20' | 3.0" | 54G | 44 | 5A | 108 | 75 |
| | Big Shawnee Creek C. R. 125 W. | 10/02/91 | 05120108 | 40 | 14' | 56.0" | 87 | 17' | 15.0" | 54G | 44 | 5A | 103 | 75 |
| | Coal Creek S. R. 32 | 10/03/91 | 05120108 | 40 | 3' | 8.0" | 87 | 20' | 13.0" | 55G | 46 | 5A | 95 | 74 |
| | East Fork Coal Creek S. R. 32 | 10/15/91 | 05120108 | 40 | 5' | 50.0" | 87 | 18' | 37.0" | 55G | 46 | 5A | 78 | 63 |
| | North Fork Coal Creek C. R. 400 N. | 10/15/91 | 05120108 | 40 | 11' | 10.0" | 87 | 11' | 28.0" | 55G | 46 | 5A | 84 | 80 |
| | Opossum Hollow River Road | 10/01/91 | 05120108 | 40 | 19' | 44.0" | 87 | 9' | 30.0" | 55G | 43 | 5A | 82 | 64 |
| Montgomery Co. | East Fork Coal Creek Co. Line (West) | 10/15/91 | 05120108 | 40 | 5' | 23.0" | 87 | 5' | 29.0" | 55G | 46 | 5A | 87 | 74 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Parke Co. | Big Raccoon Creek | | | | | | | | | |
| | D/S Bridgeton Mill Dam | 10/22/91 | 05120108 | 39 38' 58.0" | 87 10' 35.0" | 72G | 50 | 7B | 104 | 70 |
| | D/S Mansfield Reservoir | 10/17/91 | 05120108 | 39 42' 40.0" | 87 4' 22.0" | 72G | 50 | 7B | 106 | 77 |
| | Thorpe Ford Bridge (Catlin Road) | 10/17/91 | 05120108 | 39 38' 17.0" | 87 16' 1.0" | 72G | 50 | 7B | 68 | 56 |
| | Little Raccoon Creek | | | | | | | | | |
| | C. R. 160 S. | 10/17/91 | 05120108 | 39 44' 19.0" | 87 11' 3.0" | 72G | 50 | 7B | 70 | 55 |
| | Rocky Fork Creek | | | | | | | | | |
| | D/S Straight Branch | 10/17/91 | 05120108 | 39 39' 38.0" | 87 4' 2.0" | 72G | 50 | 7B | 99 | 69 |
| Tippecanoe Co. | Burnett Creek | | | | | | | | | |
| | Burnett Road | 09/27/91 | 05120108 | 40 28' 52.0" | 86 52' 0.0" | 55G | 43 | 5A | 93 | 71 |
| | Elliott Ditch | | | | | | | | | |
| | S. R. 231 | 10/01/91 | 05120108 | 40 22' 16.0" | 86 54' 17.0" | 55G | 43 | 5A | 84 | 68 |
| | Wabash River | | | | | | | | | |
| | Mascouten Park | 09/26/91 | 05120108 | 40 26' 0.0" | 86 53' 45.0" | 55G | 43 | 5A | 80 | 66 |
| | Wea Creek | | | | | | | | | |
| | C. R. 1 B. West | 09/27/91 | 05120108 | 40 21' 39.0" | 86 54' 35.0" | 55G | 43 | 5A | 101 | 75 |
| | S. R. 25 | 10/01/91 | 05120108 | 40 23' 49.0" | 86 56' 8.0" | 55G | 43 | 5A | 91 | 70 |
| Warren Co. | Big Pine Creek | | | | | | | | | |
| | S. R. 55 | 09/25/91 | 05120108 | 40 17' 44.0" | 87 15' 47.0" | 72G | 22 | 5A | 99 | 84 |
| | Twin Bridges | 09/25/91 | 05120108 | 40 20' 25.0" | 87 18' 20.0" | 54G | 22 | 3A | 94 | 67 |
| | Little Pine Creek | | | | | | | | | |
| | Black Rock Road | 09/26/91 | 05120108 | 40 20' 58.0" | 87 7' 45.0" | 54G | 43 | 5A | 77 | 57 |
| | Mud Pine Creek | | | | | | | | | |
| | C. R. 850 N. | 09/25/91 | 05120108 | 40 26' 24.0" | 87 21' 30.0" | 54G | 22 | 3A | 78 | 55 |
| | Tributary of Big Pine Creek | | | | | | | | | |
| | Mudlavia Springs. | 09/25/91 | 05120108 | 40 20' 18.0" | 87 17' 36.0" | 54G | 22 | 3A | 103 | 60 |
| Montgomery Co. | Corner Creek | | | | | | | | | |
| | C. R. 550 W. | 10/08/91 | 05120110 | 39 58' 10.5" | 87 0' 21.5" | 55G | 47 | 5A | 96 | 63 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Little Sugar Creek<br>C. R. 425 E. | 10/02/91 | 05120110 | 40 3' 2.0" | 86 49' 25.0" | 55G | 48 | 5A | 97 | 70 |
| | Rattlesnake Creek<br>C. R. 400 W. | 10/08/91 | 05120110 | 39 59' 41.0" | 86 59' 14.0" | 55G | 47 | 5A | 112 | 78 |
| | Sugar Creek<br>C. R. 600 E. | 10/01/91 | 05120110 | 40 6' 28.0" | 86 47' 38.0" | 55G | 48 | 5A | 83 | 54 |
| | C. R. 950 E. | 10/01/91 | 05120110 | 40 8' 25.0" | 86 43' 26.0" | 55G | 48 | 5A | 87 | 47 |
| | S. R. 234 @ Deer Mill | 10/08/91 | 05120110 | 39 56' 45.5" | 87 3' 30.0" | 55G | 47 | 5A | 119 | 84 |
| | S. R. 32 | 10/02/91 | 05120110 | 40 1' 30.0" | 86 58' 19.0" | 55G | 47 | 5A | 110 | 73 |
| | Walnut Fork Sugar Creek<br>Division Road | 10/02/91 | 05120110 | 40 2' 23.0" | 86 51' 14.5" | 55G | 48 | 5A | 88 | 67 |
| | S. R. 47 | 10/01/91 | 05120110 | 40 3' 29.5" | 86 52' 28.0" | 55G | 48 | 5A | 83 | 67 |
| Parke Co. | Rush Creek<br>C. R. 775 N. (Last Bridge) | 10/09/91 | 05120110 | 39 51' 55.5" | 87 19' 33.0" | 55G | 47 | 5A | 91 | 59 |
| | Sugar Creek<br>C. R. 50 W. (Jackson Bridge) | 10/09/91 | 05120110 | 39 52' 47.0" | 87 16' 58.5" | 55G | 47 | 5A | 99 | 73 |
| | Sugar Mill Creek<br>C. R. 30 E. (Wilkins Mill Bridge) | 10/09/91 | 05120110 | 39 53' 52.0" | 87 14' 0.5" | 55G | 47 | 5A | 84 | 55 |
| Vigo Co. | North Branch Otter Creek<br>Private Bridge N.E. 1/4 Sec. 23 | 10/18/91 | 05120111 | 39 33' 35.0" | 87 15' 31.0" | 72G | 49 | 7B | 95 | 76 |
| | Otter Creek<br>C.R. 24 W. | 10/18/91 | 05120111 | 39 32' 33.0" | 87 24' 50.0" | 72G | 49 | 7B | 84 | 74 |
| | U. S. 41 (Business) | 10/18/91 | 05120111 | 39 31' 37.0" | 87 22' 14.0" | 72M | 49 | 7B | 64 | 67 |
| Jasper Co. | Dehaan Ditch<br>C. R. 950 W. | 10/03/90 | 07120001 | 41 12' 38.0" | 87 14' 15.0" | 54G | 14 | 3B | 88 | 59 |
| | Hickam Lateral<br>C. R. 100 N. | 06/20/90 | 07120001 | 41 12' 14.5" | 87 3' 53.0" | 54G | 14 | 3B | * | * |
| | Schatzley Ditch<br>S. R. 10 | 10/16/90 | 07120001 | 41 11' 15.0" | 87 7' 42.0" | 54G | 14 | 3B | 105 | 68 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| Kosciusko Co. | Armey Ditch C. R. 1025 W. | 08/29/90 | 07120001 | 41 25' 9.0" | 86 2' 40.0" | 56G | 13 | 4 | 68 | 41 |
| Lake Co. | Bruce Ditch Belshaw Road | 10/16/90 | 07120001 | 41 15' 27.0" | 87 26' 56.0" | 54G | 14 | 2A | 64 | 43 |
| | Cedar Creek Belshaw Road, U/S Lowell POTW | 09/05/90 | 07120001 | 41 16' 4.0" | 87 24' 58.0" | 54G | 16 | 2A | 43 | 23 |
| | Cline Avenue, D/S Lowell POTW | 09/05/90 | 07120001 | 41 14 46.0" | 87 25' 5.0" | 54G | 16 | 2A | 79 | 61 |
| | E. Branch Stoney Run U. S. 231 | 10/15/90 | 07120001 | 41 21' 9.0" | 87 15' 18.0" | 54G | 14 | 2A | 64 | 55 |
| | Spring Run Belshaw Road | 09/26/90 | 07120001 | 41 17' 4.0" | 87 21' 59.0" | 54G | 14 | 2A | 101 | 66 |
| | West Creek S. R. 2 | 10/05/90 | 07120001 | 41 14' 20.0" | 87 30' 14.0" | 54G | 14 | 2A | 73 | 62 |
| LaPorte Co. | Breckenridge Ditch Hupp Road Near Stillwell, IN | 09/06/90 | 07120001 | 41 33' 7.0" | 86 36' 39.5" | 56G | 12 | 3C | * | * |
| | Little Kankakee River C.R. 525 W. | 09/06/90 | 07120001 | 41 36' 7.0" | 86 35' 56.0" | 56G | 12 | 3B | 68 | 63 |
| | Maurey-Porter Ditch C. R. 1025 S. | 10/17/90 | 07120001 | 41 27' 31.0" | 86 41' 10.0" | 56G | 14 | 3C | 90 | 63 |
| | Mill Creek D/S Lower Fish Lake Dam | 09/07/90 | 07120001 | 41 33' 2.0" | 86 32' 44.0" | 56G | 12 | 3B | 99 | 68 |
| | Union Mills | 10/02/90 | 07120001 | 41 29' 36.0" | 86 46' 43.0" | 56G | 14 | 3B | 114 | 86 |
| | Pitner Ditch C. R. 875 W. | 09/28/90 | 07120001 | 41 17' 34.0" | 86 52' 3.0" | 54G | 14 | 3C | 62 | 38 |
| | Sheldon Arm C.R. 600 W. | 09/27/90 | 07120001 | 41 27' 27.0" | 86 48' 52.0" | 54G | 14 | 3B | 98 | 54 |
| | Slocum Ditch C.R. 1100 S. | 10/17/90 | 07120001 | 41 26' 54.0" | 86 54' 4.0" | 56G | 14 | 3B | 87 | 68 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | | | Longitude | | | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Travis Ditch C.R. 600 S. | 09/26/90 | 07120001 | 41 | 31' | 5.5" | 86 | 41' | 0.0" | 56G | 11 | 3C | 72 | 40 |
| Wabash Co. | Border Ditch N. Fir Road | 08/29/90 | 07120001 | 41 | 21' | 55.0" | 86 | 9' | 19.0" | 56G | 13 | 4 | 58 | 33 |
| | Clifton Ditch W. 14th Road Bridge | 09/13/90 | 07120001 | 41 | 16' | 0.0" | 86 | 21' | 53.0" | 55G | 17 | 4 | * | * |
| | Elmer-Seltenright Ditch Linkville | 08/30/90 | 07120001 | 41 | 24' | 58.0" | 86 | 17' | 8.0" | 56G | 13 | 4 | * | * |
| | Elmer-Seltenright Ditch Linkville | 08/30/90 | 07120001 | 41 | 24' | 58.0" | 86 | 17' | 8.0" | 56G | 13 | 4 | * | * |
| | West 6th Road | 08/29/90 | 07120001 | 41 | 23' | 22.0" | 86 | 18' | 38.0" | 56G | 13 | 4 | 104 | 79 |
| | Gunnard/Anderson Ditch S. Tulip Road | 09/18/90 | 07120001 | 41 | 19' | 44.0" | 86 | 25' | 48.0" | 54G | 17 | 4 | 78 | 62 |
| | Upas Road | 09/18/90 | 07120001 | 41 | 19' | 12.0" | 86 | 26' | 56.0" | 54G | 17 | 4 | 70 | 41 |
| | Harry Cool Ditch W. 12th Road | 09/13/90 | 07120001 | 41 | 18' | 9.0" | 86 | 27' | 17.0" | 55G | 17 | 4 | 82 | 41 |
| | Martin Ditch N. Kenilworth Road | 08/30/90 | 07120001 | 41 | 26' | 46.0" | 86 | 15' | 8.0" | 56G | 13 | 4 | 47 | 42 |
| | Meyers Ditch S. R. 10, West of Argos, IN | 09/19/90 | 07120001 | 41 | 14' | 16.0" | 86 | 16' | 56.0" | 55G | 17 | 4 | 54 | 38 |
| | Peter-Sarber Ditch W. Co. Line | 08/30/90 | 07120001 | 41 | 27' | 20.0" | 86 | 28' | 0.0" | 54G | 12 | 4 | 88 | 70 |
| | Sarah-Hershberger Ditch S. R. 331 | 08/29/90 | 07120001 | 41 | 28' | 14.0" | 86 | 9' | 23.0" | 56G | 13 | 4 | 67 | 58 |
| | Shermon Emmons Ditch Sycamore Road Bridge | 09/07/90 | 07120001 | 41 | 25' | 59.5" | 86 | 24' | 22.0" | 54G | 12 | 4 | 82 | 57 |
| | Wolf Creek Nutmeg Road | 09/12/90 | 07120001 | 41 | 16' | 11.0" | 86 | 19' | 24.0" | 55G | 17 | 4 | 89 | 64 |
| | Yellow Bank Creek Tamarack Road Bridge | 09/06/90 | 07120001 | 41 | 28' | 6.0" | 86 | 25' | 32.5" | 54G | 12 | 4 | 107 | 85 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Yellow River<br>11th Road, Plymouth, IN | 09/27/90 | 07120001 | 41 19' 2.0" | 82 20' 0.0" | 56G | 17 | 3C | 85 | 53 |
| | East First Road Bremen, IN | 09/27/90 | 07120001 | 41 27' 54.0" | 86 10' 41.0" | 56G | 13 | 3C | 82 | 59 |
| | Michigan Street Branch, Plymouth, IN | 09/27/90 | 07120001 | 41 20' 24.5" | 86 18' 4.0" | 56G | 17 | 3C | 97 | 59 |
| | North King Road Plymouth, IN | 09/28/90 | 07120001 | 41 22' 8.0" | 86 15' 42.0" | 56G | 13 | 3C | 49 | 32 |
| | S. R. 106 (Old 6) | 08/30/90 | 07120001 | 41 26' 44.0" | 86 10' 24.0" | 56G | 13 | 4 | 84 | 66 |
| Newton Co. | Beaver Lake Ditch<br>C. R. 700 N. at U. S. 41 | 10/04/90 | 07120101 | 41 6' 11.0" | 87 26' 58.0" | 54G | 14 | 3B | 101 | 75 |
| | North King Road Plymouth, IN | 09/28/90 | 07120001 | 41 22' 8.0" | 86 15' 42.0" | 56G | 13 | 3C | 49 | 32 |
| | Knight Ditch C. R. 800 N | 10/04/90 | 07120001 | 41 6' 56.0" | 87 24' 28.0" | 54G | 14 | 3B | 97 | 73 |
| Porter Co. | Cobb Creek<br>S. R. 8 | 10/16/90 | 07120101 | 41 19' 4.0" | 87 11' 24.0" | 54G | 14 | 2A | 79 | 60 |
| | Cornell Ditch<br>C. R. 750 S. | 10/03/90 | 07120001 | 41 19' 32.0" | 87 6' 48.0" | 54G | 14 | 3B | 78 | 60 |
| | Crooked Creek<br>C. R. 150 N. | 10/02/90 | 07120001 | 41 27' 22.0" | 86 57' 40.0" | 54G | 14 | 3B | 89 | 66 |
| | Wolf Creek<br>C. R. 100 W. | 10/03/90 | 07120001 | 41 21' 44.0" | 87 4' 59.0" | 54G | 14 | 3B | 72 | 53 |
| St. Joseph Co. | Geyer Ditch<br>Darden Road | 09/11/90 | 07120001 | 41 43' 48.0" | 86 25' 8.0" | 56G | 12 | 3C | 94 | 67 |
| | Kankakee River<br>Crumstown Road | 09/11/90 | 07120001 | 41 36' 21.0" | 86 24' 20.0" | 56G | 12 | 3C | 50 | 26 |
| | Kartoffel Creek<br>S. R. 4 Bridge | 09/05/90 | 07120001 | 41 32' 5.5" | 86 25' 13.0" | 54G | 12 | 4 | 82 | 63 |
| | Kline-Rouch Ditch<br>Riley Road | 08/28/90 | 07120001 | 41 30' 29.0" | 86 11' 12.0" | 56G | 13 | 4 | 62 | 46 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pine Creek S. R. 23 Bridge | 09/06/90 | 07120001 | 41 28' 12.0" | 86 25' 53.5" | 54G | 12 | 4 | 86 | 50 |
| | Potato Creek S. R. 4 Bridge | 09/05/90 | 07120001 | 41 32' 3.5" | 86 27' 13.0" | 54G | 12 | 4 | 94 | 72 |
| Starke Co. | Bogus Run C. R. 350 W. | 09/27/90 | 07120001 | 41 15' 14.0" | 86 46' 0.0" | 54G | 14 | 3C | 107 | 74 |
| | Craigmile Ditch C. R. 200 S. | 09/27/90 | 07120001 | 41 16' 24.0" | 86 41' 55.0" | 54G | 14 | 3B | 69 | 57 |
| | Origer Ditch C. R. 500 S. | 10/17/90 | 07120001 | 41 13' 51.0" | 86 48' 11.0" | 54G | 14 | 3B | 73 | 64 |
| | Pine Creek C. R. 350 W. | 10/17/90 | 07120001 | 41 13' 46.0" | 86 45' 59.0" | 54G | 14 | 3B | 89 | 58 |
| | Yellow River Public Access Knox, S. R. 8 | 09/13/90 | 07120001 | 41 18' 10.0" | 86 34' 17.0" | 54G | 17 | 3C | 109 | 82 |
| Benton Co. | Mud Creek C. R. 500 W. | 11/01/90 | 07120002 | 40 37' 33.0" | 87 25' 4.0" | 54G | 15 | 3A | 65 | 44 |
| | Sugar Creek C. R. 900 W. (S. R. 71) | 10/29/90 | 07120002 | 40 39' 40.0" | 87 29' 7.0" | 54G | 15 | 3A | 88 | 63 |
| Jasper Co. | Carpenter Creek C. R. 1800 S. | 10/30/90 | 07120002 | 40 45' 4.5" | 87 9' 17.0" | 54G | 15 | 3A | 88 | 55 |
| | Curtis Creek C. R. 400 S. | 10/03/90 | 07120002 | 40 57' 18.0" | 87 16' 3.0" | 54G | 15 | 3A | 90 | 70 |
| | Iroquois River 200 Meters U/S of S. R. 114 | 06/20/90 | 07120002 | 40 56' 25.0" | 87 7' 24.0" | 54G | 15 | 3A | * | * |
| | 200 Meters U/S of S. R. 114 | 10/02/90 | 07120002 | 40 56' 7.0" | 87 7' 38.0" | 54G | 15 | 3A | 75 | 68 |
| | S. R. 14 | 10/02/90 | 07120002 | 41 1' 37.0" | 87 9' 52.0" | 54G | 15 | 3A | 85 | 62 |
| | Lateral No. 77 C. R. 400 N. | 10/30/90 | 07120002 | 41 4' 15.0" | 87 2' 26.0" | 54G | 15 | 3A | 83 | 60 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

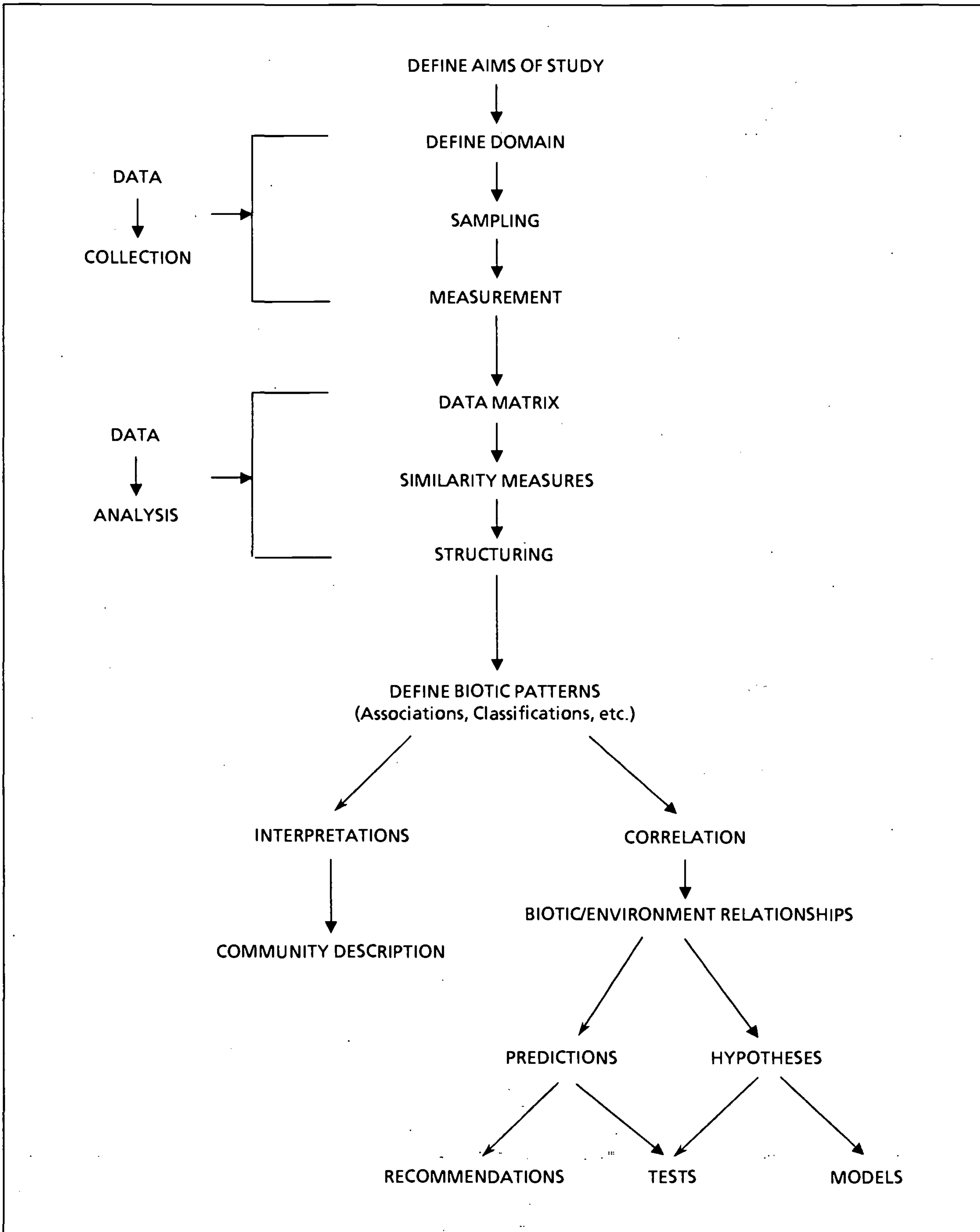
| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Oliver Ditch<br>C. R. 100 W. Just North of C. R. 225 N. | 06/20/90 | 07120002 | 41 2' 52.0" | 87 3' 55.0" | 54G | 15 | 3A | * | * |
| | C. R. 350 W. | 10/30/90 | 07120002 | 41 1' 46.0" | 87 6' 48.5" | 54G | 15 | 3A | 75 | 46 |
| | Ryan Ditch<br>C. R. 20 E. | 10/30/90 | 07120002 | 40 58' 4.0" | 87 2' 28.0" | 54G | 15 | 3A | 70 | 55 |
| | Wolf Creek<br>C. R. 1100 N. | 10/03/90 | 07120002 | 41 10' 21.0" | 87 2' 9.0" | 54G | 14 | 3B | 85 | 65 |
| Newton Co. | Beaver Creek<br>C. R. 600 W. | 10/04/90 | 07120002 | 40 57' 0.0" | 87 30' 29.0" | 54G | 14 | 3B | 78 | 48 |
| | U. S. 41 | 10/04/90 | 07120002 | 40 57' 57.0" | 87 27' 1.0" | 54G | 14 | 3B | 73 | 41 |
| | Bonham Ditch<br>C. R. 1500 S. | 10/31/90 | 07120002 | 40 46' 50.0" | 87 30' 17.0" | 54G | 15 | 3A | 67 | 50 |
| | Carlson Ditch<br>S. R. 114 | 10/15/90 | 07120002 | 40 56' 31.0" | 87 31' 4.0" | 54G | 14 | 3B | 79 | 57 |
| | Hickory Branch<br>C. R. 700 S. | 10/29/90 | 07120002 | 40 56' 41.0" | 87 20' 16.0" | 54G | 15 | 3A | 64 | 42 |
| | Montgomery Ditch<br>U. S. 41 | 10/29/90 | 07120002 | 40 48' 23.5" | 87 26' 23.0" | 54G | 15 | 3A | 73 | 50 |
| | Montgomery Ditch<br>S. R. 24, D/S Capitol Outfall | 09/05/90 | 07120002 | 40 46' 9.0" | 87 28' 51.0" | 54G | 15 | 3A | 75 | 58 |
| | S. R. 24, U/S Capitol Outfall | 09/05/90 | 07120002 | 40 46' 8.0" | 87 28' 51.0" | 54G | 15 | 3A | 88 | 49 |
| | Sheldon Ditch No. 1<br>C. R. 800 W. (State Line) | 10/31/90 | 07120002 | 40 46' 58.0" | 87 31' 34.0" | 54G | 15 | 3A | 84 | 53 |
| | Thompson Ditch<br>C. R. 1000 S. | 10/03/90 | 07120002 | 40 51' 6.0" | 87 27' 39.0" | 54G | 15 | 3A | 59 | 53 |
| | Turner Ditch<br>C. R. 700 S. | 10/31/90 | 07120002 | 40 53' 41.0" | 87 16' 29.5" | 54G | 15 | 3A | 87 | 64 |
| Lake Co. | Cady Marsh Ditch<br>Kennedy Avenue | 09/26/90 | 07120003 | 41 32' 55.0" | 87 27' 42.0" | 54G | 1 | 2B | 82 | 56 |

Table 61. *Aquatic Macroinvertebrate Sampling Locations 1990 - 91 Sorted by Hydrologic Unit (cont.)*

| Site | Location | Collection Date | Hydro-logic Unit | Latitute | Longitude | Eco-region | Drainage Segment | IASNRI | H.E.T. Score | QHEI Score |
|---|---|---|---|---|---|---|---|---|---|---|
| | Hart Ditch 213th Street Bridge, D/S Dyer, IN | 09/06/90 | 07120003 | 41 30' 30.0" | 87 30' 36.0" | 54G | 1 | 2B | 84 | 64 |
| | U. S. 30, U/S Dyer, IN | 09/06/90 | 07120003 | 41 29' 37.0" | 87 31' 10.0" | 54G | 1 | 2B | 85 | 55 |
| | Little Calumet River Riverside Park | 09/26/90 | 07120003 | 41 34' 14.0" | 87 30' 22.0" | 54G | 1 | 2B | 62 | 46 |
| | Schererville Ditch 65th & Commercial Drive, D/S POTW | 09/06/90 | 07120003 | 41 30' 2.0" | 87 28' 2.0" | 54G | 1 | 2B | 27 | 23 |

*IASNRI* = *Indiana Academy of Science Natural Region Index (Homoya, 1985)*
*H.E.T.* = *U.S. EPA Habitat Evaluation Technique Assessment Score (U.S. EPA, 1989) (Possible Score = 135)*
*QHE* = *Qualitative Habitat Evaluation Index (Ohio EPA, 1987) (Possible Score = 100)*
* = *No Habitat Evaluation Scoring Performed*

**FIGURE 18.** *INDIANA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT BIOCRITERIA DEVELOPMENT STAGES (Noy Meir 1970)*



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 One-square meter samples are composited into one sample which is preserved in the field. A second sample of the Course Particulate Organic Matter (CPOM) community is 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 10 sites a duplicate kick sample and CPOM sample are collected at that particular site.

Samples are logged into a data tracking, labeling, and report generating computer system designed for this project called MACOTRAK. Sample 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 and are designated 100-RG 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 MACRTRAK sample number.

As stated earlier this procedure has resulted in over 1500 sub-samples for the 341 sites sampled to date. These sub-samples are further fragmented within a 2 phase taxonomic identification and enumeration procedure. Phase I processing consists of enumerating 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) has been shown to provide biological data adequately sensitive to detect gross biological perturbations in the biological community. Phase II identifications will provide the date sensitivity to identify subtle differences in the biological integrity of the sites and systems sampled. Final metric development from which correlations and predictive relationships can be optimally made between all biotic/environmental parameters will be pending completion of both phases of this project.

During this two year period IDEM has also been working with U.S. EPA, Region V to evaluate the biological integrity of Indiana rivers and streams using the fish communities which are living within the various water bodies. The fish communities of the state's rivers and streams are being sampled and an Index of Biotic Integrity (IBI) is being calculated and calibrated specifically for our state. These data will supplement chemical information to document and better understand the long term and cumulative effects of successive perturbations on Indiana water bodies.

The objective of this study is to evaluate the biological integrity in Indiana water resources based on "least impacted" reference sites for establishing baseline conditions. Least impacted reference sites are optimal stream reaches, representative of the ecoregion under study, and represent the least disturbance by anthropogenic change. The following project goals will be addressed during the completion of the entire Indiana ecoregion project;

- Develop biological criteria for Indiana ecoregions using the Index of Biotic Integrity and habitat classification;
- Identify areas of least disturbance within the ecoregions for use as reference stations;
- Verify Indiana ecoregion boundaries;
- Develop maximum species richness lines from reference stations for each Index of Biotic Integrity metric considering differences in stream order and proximity to Lake Michigan;

Indiana has an area of 36,291 square miles, and drains the Ohio, the upper Mississippi, and Great Lakes Regions. These three regions were further subdivided into nine subregions, five of which drain 86% of the State. The state of Indiana lies within the limits of latitude 37° 46' 18" and 41° 45' 33" north, for an extreme length of 275.5 miles in a north-south direction; and between longitude 84° 47' 05" and 88° 05' 50" west with an extreme width in an east-west direction of 142.1 miles.

The State has a maximum topographic relief of about 273 m, with elevations ranging from about 91 m above mean sea level at the mouth of the Wabash River to slightly more than 364 m in Randolph County in east-central Indiana.

The current report considers only 1990 data collected in the Central Corn Belt Plain Ecoregion. The Central Corn Belt Plain Ecoregion has an area of 46,400 miles. The ecoregion is located in extreme northwestern Indiana and forms the primary ecoregion in the adjacent State of Illinois. In Indiana, the Central Corn Belt Plain drains direct tributaries to Lake Michigan, and the mainstream and tributaries of the Kankakee and Iroquois Rivers.

Three major drainage units occur in the Indiana portion of the Central Corn Belt Plain Ecoregion: The Calumet River basins, Kankakee River basin, and the Iroquois River Basin. The Calumet River basins include the Grand

Calumet River and the Little Calumet River and its tributaries. The Grand Calumet and Little Calumet River are small and drain less than 2% of the State. Flow reversals and streams which cross basin divides makes this basin an extremely difficult area to study. The East Branch of the Little Calumet River flows directly into Lake Michigan after the construction of Burns Ditch (a dredged modification of the original stream channel). A portion of the West Branch of the Little Calumet River likewise drains into Burns Ditch, while a portion flows west into Illinois. Of the Little Calumet tributary segments, Deep River and Salt Creek are the largest components, additional segments includes Hart Ditch, Kemper Ditch, Coffee Creek, Sand Creek, and a number of smaller tributary elements in the East Branch. The East Branch of the Calumet River includes much of the Indiana Dunes National Lakeshore and he Heron Rookery. A number of natural areas occur there as well,including the important Cowles Bog, Clark and Pine Lakes, and many of the dunal ponds studies by Shelford. Much of this area occupies the Northwestern Moraninal Natural Region, Chicago Lake Plan Section. It was formed by the ridge-and scale and lacustrine plain topography along Lake Michigan from the water level fluctuations of Lake Chicago. The flow regime of the grand Calumet River does not vary much, determined primarily by Lake Michigan levels.

The Kankakee River watershed is the primary basin in the ecoregion, containing the Kankakee River and its major tributary the Iroquois River. The Kankakee Basin encompasses 3,006 square miles, approximately 7% of the State. The Kankakee has been dramatically altered since the 1850's when it was changed from a meandering stream in a marshy wetland to a large channelized stream. Much of the baseflow derives from groundwater. Levees have been constructed along the length of the main stem and tributaries to reduce the chances of flooding. The Kankakee extends from South bend to the Illinois border flowing southwest, and includes number of tributary elements, including the Yellow River, Kingsbury Creek, and Cedar Creek. Some of the best water resource streams of this ecoregion occur on the Yellow River. A number of drainage ditches have modified the remainder of the streams and creeks to a relatively straight, homogeneous habitat. Surprisingly, a large amount of recovery has occurred, enabling the Central Corn Belt Plain to possess a diverse ichthyofauna. The majority of this area occurs in the Kankakee Sand Section and Kankakee Marsh Section. The Kankakee Sand Section is characterized by the predominance of prairie and savanna communities associated with sandy soils. This area consists primarily of sand dune and outwash plain sediments. The Kankakee Marsh Section is delineated by the high proportion of marsh, lake, and wet prairie communities which existed along the Kankakee River in presettlement times. The marsh was several miles wide on each side of the river for almost its entire course in Indiana. Extensive ditching began in the 1800's to enable agriculture and has all but eliminated the natural wetlands. Average discharge for the Kankakee River, near the Illinois border Shelby, Indiana, is 1,619 cubic feet per second with ranges of 417 cubic feet per second during 7 day, 10 year low flow and 6,950 cubic feet per second during 100 year flood periods.

The Iroquois River basin is a major tributary segment of the Kankakee River (comprising 780 square miles in Indiana) connecting with the main stem Kankakee River in Illinois near Watseka. The Iroquois River has been channelized, but unlike the Kankakee River it does not receive a substantial amount of its streamflow from groundwater. This is reflected in more extreme high and low flows, and in this regard the Iroquois resembles the Wabash River more than the Kankakee River. The Iroquois River is much shallower, and is not dredged as often as the Kankakee so the resident fish fauna has had a greater opportunity for colonization and stabilization. The major tributary segments of the Iroquois River includes: Ryan Ditch, Oliver Ditch, Howe Ditch, and Carpenter Creek. The Iroquois River occurs in two natural area sections, the Grand Prairie Section and the Kankakee Sand Section. The Grand Prairie section is characterized by the predominance of loamy soil and was previously considered the epitome of the vast tall grass prairie of presettlement periods. The Kankakee Sand Section portion is in extreme northern portions of the natural area and was discussed previously. The average discharge of the Iroquois River near Foresman (near the Illinois-Indiana political boundary) is 383 cubic feet per second with ranges of 11 cubic feet per second during 7 day, 10 year low flow and 5,660 cubic feet per second during 100 year flood periods.

A total of 197 sample locations were surveyed during July and August of 1990 in order to compile the data needed to evaluate the maximum species richness lines for calibration of the Index of Biotic Integrity. In order to answer the basin specific questions, and determine if ecoregion boundaries were adequately defined, a sufficient number of samples were required to calibrate the Index for various drainages.

Although great attention has been given to sampling design and procedures, biologists must exercise judgment to ensure that a sample is representative of the system being assessed. Gear must be capable of sampling all species in proportion to their relative abundance. As streams increase in size and structural complexity, sophisticated equipment such as long-lines, sport-yaks, and boat- mounted electrofishing equipment is required. However, only one electrofishing gear type need be used at each location. Long-line and sport-yak equipment was build following specifications of Ohio EPA and utilized the same generator, a T & J pulsed-DC generator capable of 300 volt output. Boat electrofishing equipment included the Coffelt 18 ft Jon boat rig with a bow-mounted stainless steel electrosphere. The boat power source was a 5000 watt Honda generator which was fished at 300 volt capacity through a VVP-15 transformer.

The fish community was sampled at approximately 200 sites to evaluate the water resource using the Standards Operating Procedures of the U.S. EPA Central Regional Laboratory. Sampling was conducted during low to moderate flow periods (June to September). A quantitative fish survey was conducted using the Index of Biotic Integrity and all comments in the proceeding sections will deal only with fish field procedures. A total of 5% of the total sites was resampled for precision and accuracy estimates. The station numbering system used for the project followed the methods of the Central Regional Laboratory.

When possible sites were located upstream from pollution sources and adjacent tributaries. Should the upstream portion of the stream be impacted, an alternate reference station was selected from another reach or adjacent stream with similar geological and hydrological conditions. Stations were selected from natural areas, parks (Federal, State, County, and Local), exceptional designated streams, and from historical sampling locations whenever available.

When non-impacted areas were not present, "least impacted" areas were selected based on the above criteria. Inferior impacts, sites which exhibit obvious attributable disturbances, may include channelization of rivers, and proximity to nonpoint sources. Sites were chosen which indicate recovery from channelization or potential nonpoint source areas, and which have a suitable riparian buffer on the shoreline. When a series of point source dischargers were located on a river, every effort was made to sample upstream of the discharger present on the highest upstream segment, or to search for areas of recovery between the dischargers.

When impoundments or other physical habitat alterations had been installed on the river, sampling was conducted in the tailwaters of a dam (area immediately downstream). Tailwaters possess the greatest semblance of the unregulated lotic habitat. In areas where sampling cannot be accomplished downstream of the physical structure due to lack of access, stream tributary segments were located upstream of the dam away from the immediate influence of the pooled portion. Likewise, bridges were always sampled on the upstream side, away from the immediate vicinity of the structure and bridge construction effects.

Fish from each location were identified to species and enumerated. A voucher specimen of each taxa was retained. Likewise, all smaller and more difficult to identify taxa were preserved for later examination and identification in the laboratory. All fish collected were examined for the presence of gross external anomalies. Incidence of these anomalies were defined as the presence of externally visible morphological disorders, and is expressed as precent of affected fish among all fish collected. Incidence of occurrence was computed for each species at each station. Specific anomalies include: anchor worms; leeches; pugheadedness; fin rot; Aeromonas (causes ulcers, lesions, and skin growth, and formation of pus-producing surface lesions accompanied by scale erosion); dropsy (puffy body); swollen eyes; fungus; ich; curved spine; and swollen-bleeding mandible or opercle.

The ambient environmental condition was evaluated using the Index of Biotic Integrity. This index relies on multiple parameters (termed "metrics") based on community concepts, to evaluate a complex system. It incorporates professional judgment in a systematic and sound manner, but sets quantitative criteria that enables determination of what is poor and excellent based on species richness and composition, tropic and reproductive constituents, and fish abundance and condition. The twelve original Index of Biotic Integrity metrics reflect insights from several perspectives and cumulatively are responsive to changes of relatively small magnitude, as well as broad ranges of environmental degradation.

In general, the metrics utilized for this study are those developed by the State of Ohio for analysis of surface water use-attainment. This includes a slight modification of several of the original Index of Biotic Integrity metrics as proposed by Karr (1981). Table 62 shows the attributes of the Index of Biotic Integrity (IBI) classification. IBI scores and integrity classes used in this study. Sites rated poor, very poor, or no fish were considered not to support the aquatic life uses.

# IV. GROUND WATER QUALITY IN INDIANA

## Part I. The Ground Water Resource

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 thick, 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.

TABLE 62. *Attributes of the Index of Biotic Integrity (IBI) Classification. IBI Scores and Integrity Classes.*

| TOTAL IBI SCORE | INTEGRITY CLASS | ATTRIBUTES |
|---|---|---|
| 56-60 | Excellent | Comparable to the best situation without human disturbance; all regionally expected species for the habitat and stream size, including the most intolerant forms, are present with a full array of age (size) classes; balanced trophic structure. |
| 47-55 | Good | Species richness somewhat below Expectation, especially due to the loss of the most intolerant forms; some species are present with less than optimal abundances or size distributions; trophic structure shows some signs of stress. |
| 38-46 | Fair | Signs of additional deterioration include loss of intolerant forms, fewer species, highly skewed tropic structure (e.g. increasing frequency of omnivores and other tolerant species); older age classes of top predators may be rare. |
| 26-37 | Poor | Dominated by omnivores, tolerant forms, and habitat generalists; few top carnivores; growth rates and condition factors commonly depressed, hybrids and diseased fish often present. |
| 12-25 | Very Poor | Few fish present, mostly introduced or tolerant forms; hybrids common, disease, parasites, fin damage, and other anomalies regular. |
| | No Fish | Repeated sampling finds no fish. |

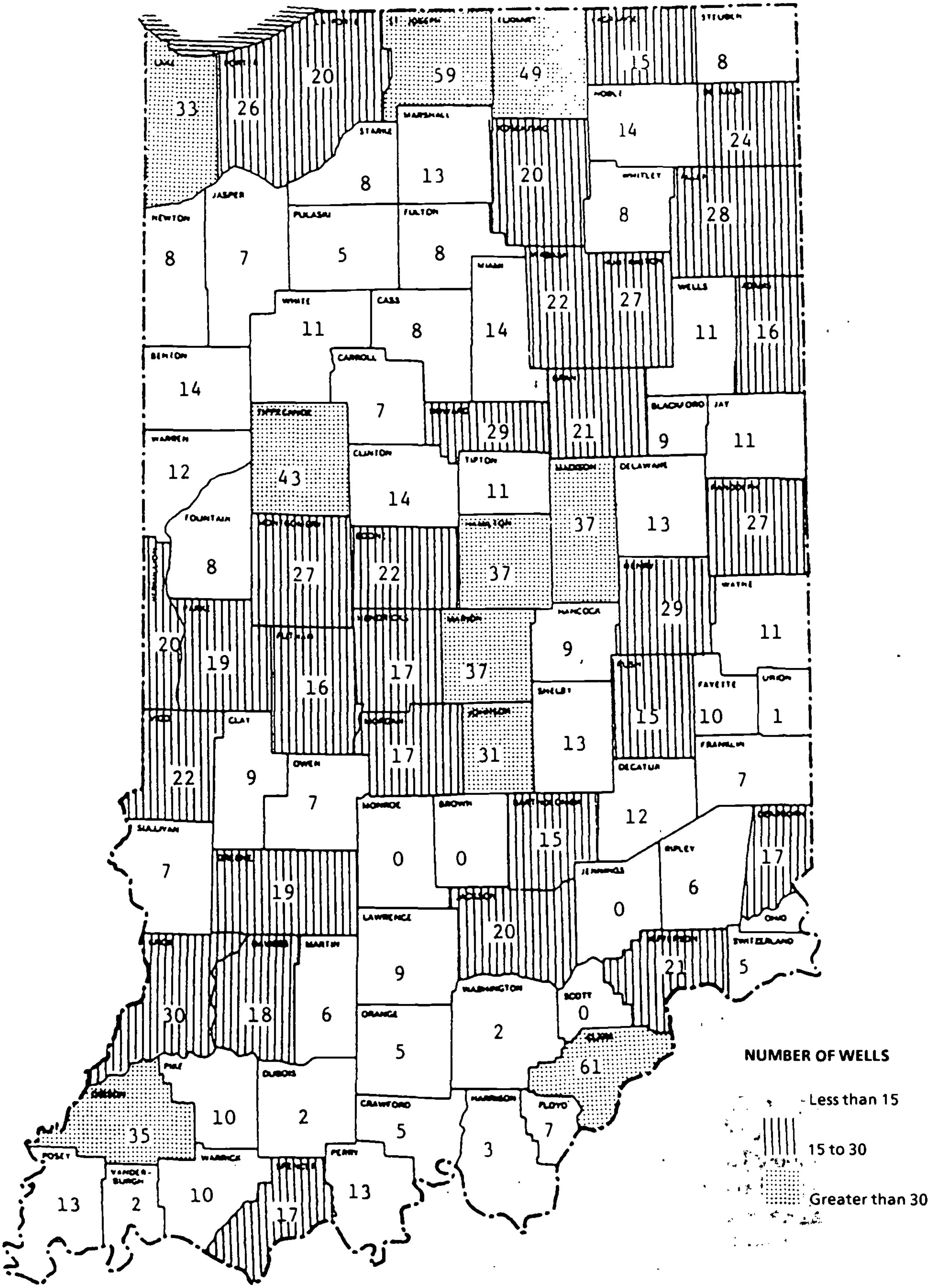
The ambient ground water quality throughout Indiana is variable and dependent on the aquifer system, geologic setting, and depth of the formation. In general, the incidence of mineralized or even saline ground water increases rapidly at bedrock depths below 300 feet. The chemical quality of the potable 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 4,655 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 917 community water systems, 972 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 water supply wells by county is shown in Figures 19 and 20. 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 21. Ground water also services the needs of Indiana's economy. Industry uses an 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.

## Indiana's Ground Water Programs

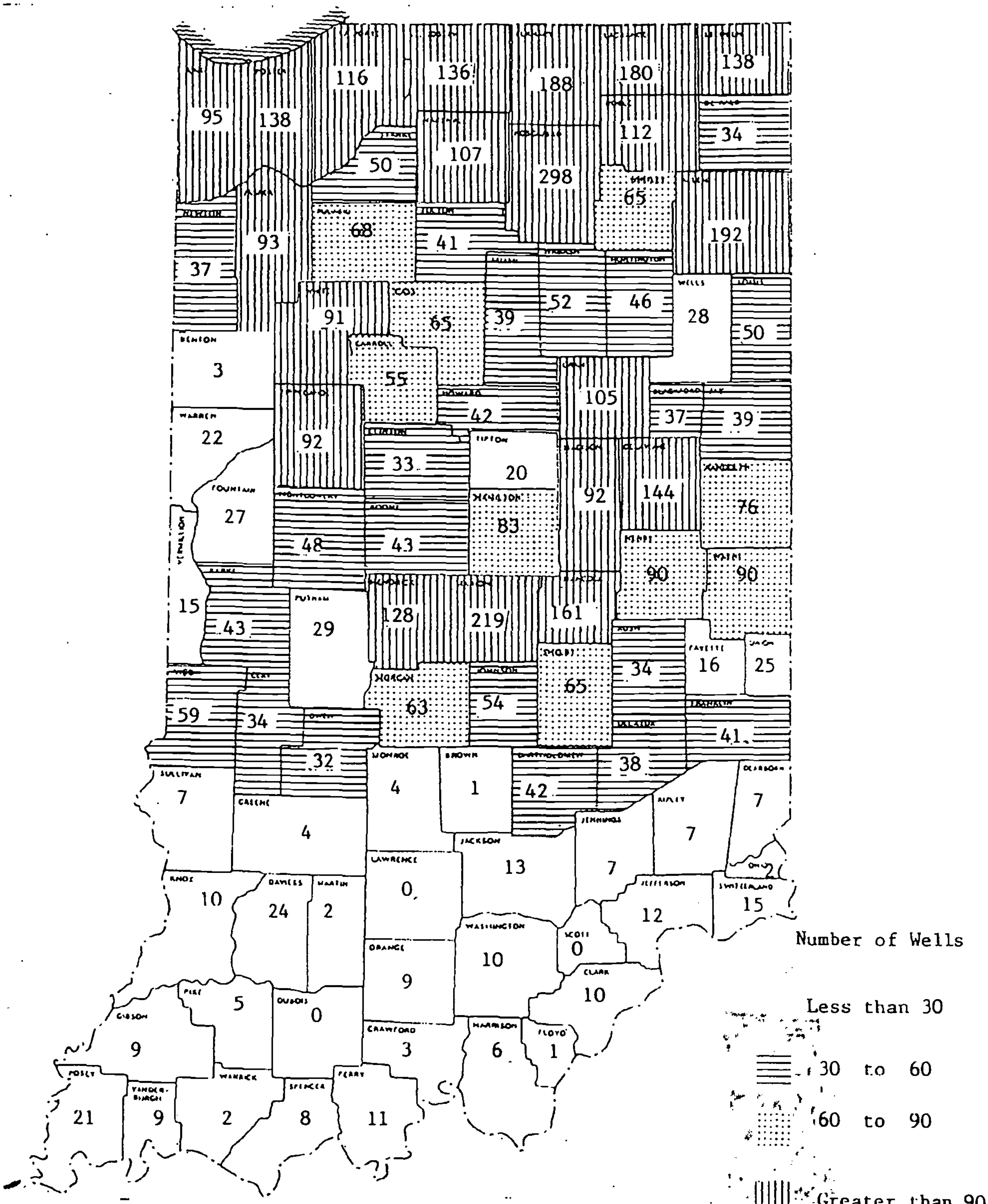
Indiana's primary ground water management and protection efforts reside within five state agencies. The Department of Environmental Management administers applicable state and federal laws through regulatory programs to protect the quality of ground water and drinking water supplies from potential pollution sources such as solid and hazardous waste disposal sites, wastewater, underground storage tanks, and hazardous materials spills. The Department of Natural Resources has authority for management of oil, gas and mining activities, water well drilling, ground water information, and aspects of water quantity. The State Department of Health's ground water function is administration of regulations for on-site

**FIGURE 19.** *COMMUNITY WATER SUPPLY WELLS*



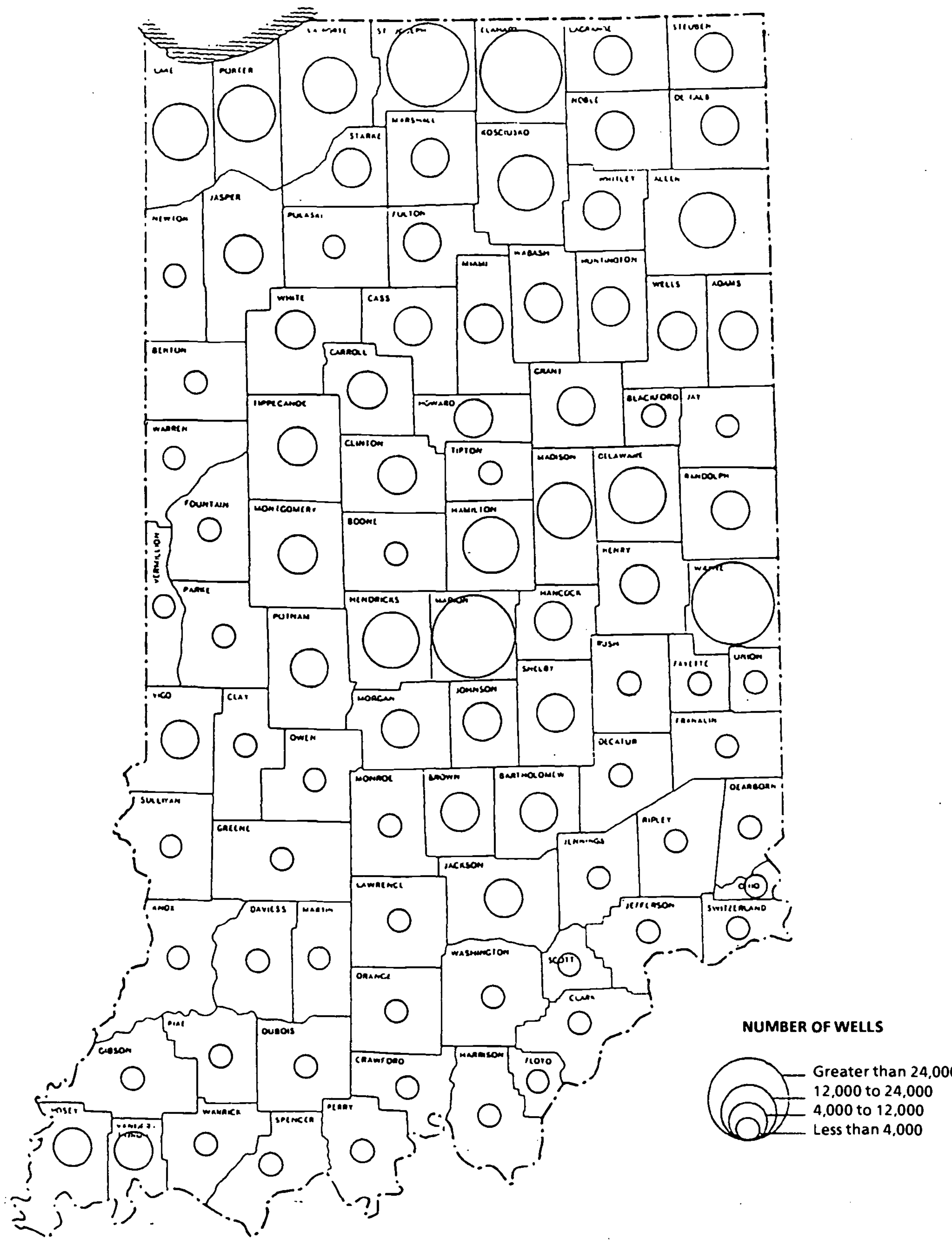

**SOURCE:** IDEM Public Water Supply Section

**FIGURE 20.** *Non-Community Water Supply Wells Per County*




Source: IDEM Public Water Supply Section

**FIGURE 21.** *PRIVATE WATER SUPPLY WELLS*




Information taken from 1990 Census on Population and Housing for Indiana, U.S. Dept. of Commerce, listing number of drilled are dug well per county.

sewage disposal systems through support of county health departments. The Indiana State Chemist Office regulates the sale, storage and handling of pesticides and fertilizers, along with the licensing and training of pesticide applicators. The State Fire Marshall regulates above ground storage tanks and underground storage tanks.

The role of the federal government is to establish laws, rules, policies, and to provide research and technical guidance for the State to use in administering programs for ground water protection. Typically, federal support includes grant assistance. In Indiana, the federal government directly regulates activities which affect ground water, such as underground injection control under the Safe Drinking Water Act.

On the local level, Indiana counties, townships, and municipalities have the authority to protect public health, safety, and welfare, by adopting land use restrictions and pollution control ordinances, and by properly managing water supply, sewage treatment and solid waste disposal facilities.

**Indiana's Ground Water Policy**

This policy has been adopted to coordinate the activities and authority of those agencies currently involved in ground water protection and management:

"A state-wide action plan will be implemented that will prevent ground water from being depleted and contaminated and which will correct or properly manage known or suspected problems."

These goals will be addressed within the context of the comprehensive ground water protection and management strategy:

- Coordination of the efforts of all state and local agencies which have ground water management responsibilities.

- Development and implementation of an information system for all programs involved with ground water that provides better access to existing and needed data.

- Development of a comprehensive understanding of Indiana's ground water environment and its relationships to current and potential threats.

- Establishment of adequate statutory and regulatory authority to accomplish the ground water protection and management tasks of the strategy.

- Promotion of local initiatives to safeguard public well water supplies and aquifers of critical concern.

**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 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 priorities, 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 aquifers. 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 (OSFM).

One representative each of the following groups are also appointed: the business community, the environmental 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 1990-1991**
**Interagency**

**Ground Water Task Force:** Work groups were active on the following issues: Cleanup Standards, Wellhead Protection, Surface Impoundments, Nonpoint 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. A wellhead protection program for Indiana was prepared by IDEM for EPA.

**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 will be completed in 1992. IDNR has published the St. Joseph River Basin, Kankakee River Basin, Maumee River Basin. Work is underway on the Lake Michigan Basin and the West Fork-White River Basin.

**Public Education-Information Participation:** The IGWPA establishes a ground water quality information clearinghouse at IDEM. Ground water displays by IDEM, IDNR, and other agencies were set at the 1990-91 Indiana State Fair. State personnel have presented dozens of lectures, classes and slide shows on ground water protection during 1990-91. 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 1990-91. 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.

# Part II. Ground Water Quality

## Ground Water Contamination Site Registry

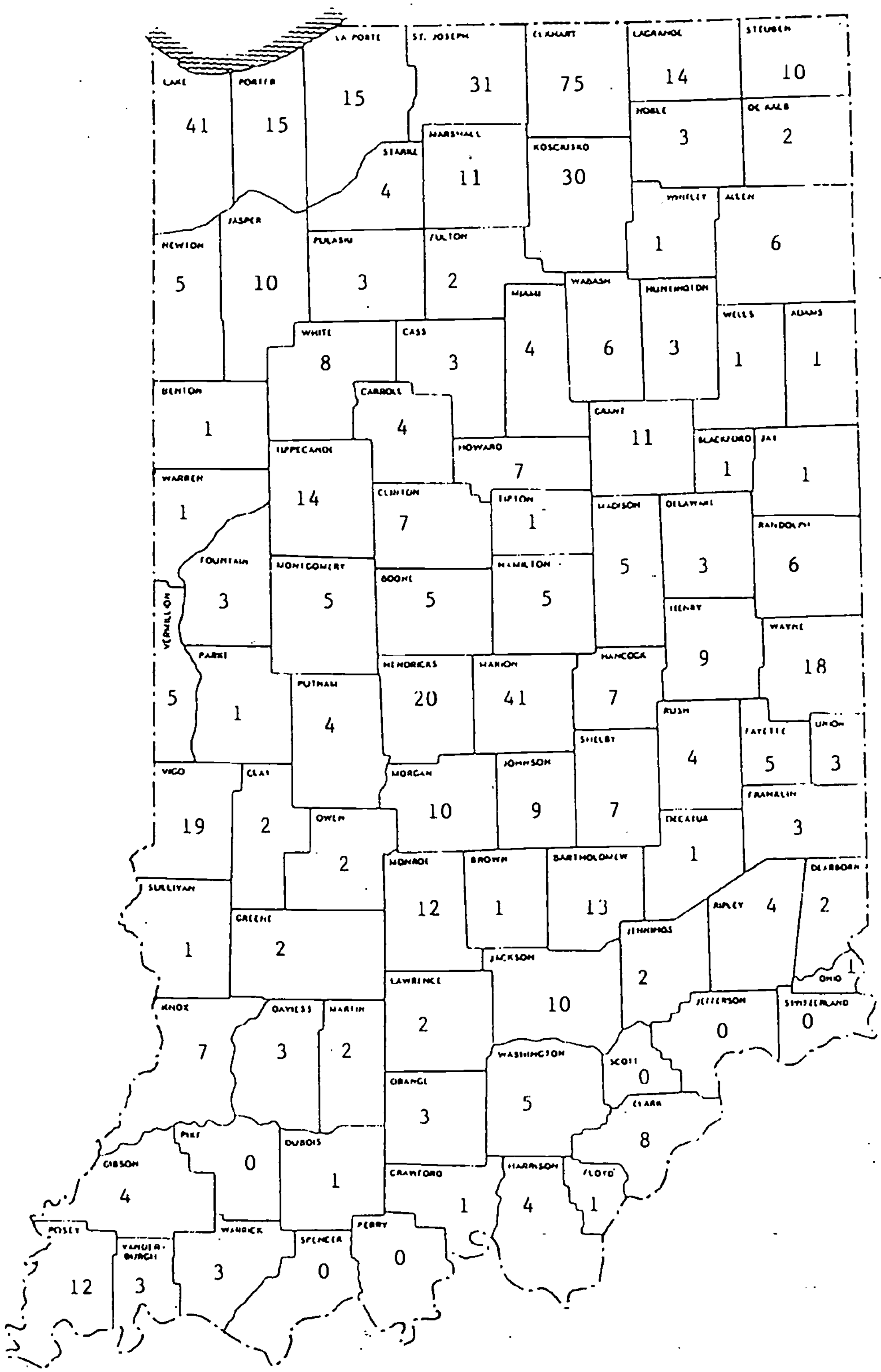
The IDEM Ground Water Section developed and maintains a data base for case histories of chemical contamination of ground water in Indiana. This registry is compiled from file records of state and federal environmental programs and county health agencies and updated as new information is acquired. Contamination is defined 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 839 sites of ground water contamination recorded. The number of documented sites of ground water contamination per county is displayed in Figure 22. Information sources for these case histories appear in Table 63. 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 1991, with the majority after 1977. Figure 23 shows the detections of contamination over the past fourteen years. 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.

Figure 24 describes the types of wells affected by ground water contamination. Figure 25 shows the number of ground water contamination complaints per county and Figure 26 shows the number of contamination complaints associated with drinking water.

Forty-Four percent of the investigations into drinking water wellc 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 64 for a summary of ground water monitoring actions which documented contamination and Table 65 for a summary of remedial actions.

**FIGURE 22.** *Documented Sites of Ground Water Contamination*



Source: IDEM Ground Water Section, Contamination Site Registry (1991) for time period 1956 - 1991

**TABLE 63.** *Case History Information Source*

| SOURCE OF INFORMATION | NUMBER OF CASES | PERCENT OF CASES |
|---|---|---|
| Ground Water Section - DEM | 253 | 33.9% |
| Leaking Underground Storage Tank Section - DEM | 90 | 12.1% |
| County Health Departments | 78 | 10.4% |
| Indiana University | 73 | 9.8% |
| Public Water Supply Section - DEM | 59 | 7.9% |
| CERCLA (Superfund Cleanup Program) - DEM | 44 | 5.9% |
| Department of Natural Resources | 35 | 4.7% |
| Underground Storage Tank Section - DEM | 34 | 4.6% |
| Other Sources | 26 | 3.5% |
| RCRA (Hazardous Waste Management Program) - DEM | 23 | 3.1% |
| CERCLIS (Site Investigation Program) - DEM | 16 | 2.1% |
| Office of Environmental Response - DEM | 8 | 1.1% |
| State Cleanup - DEM | 7 | 0.9% |
| TOTAL | 746 | |

Figure 23. *Documented Ground Water Contamination*

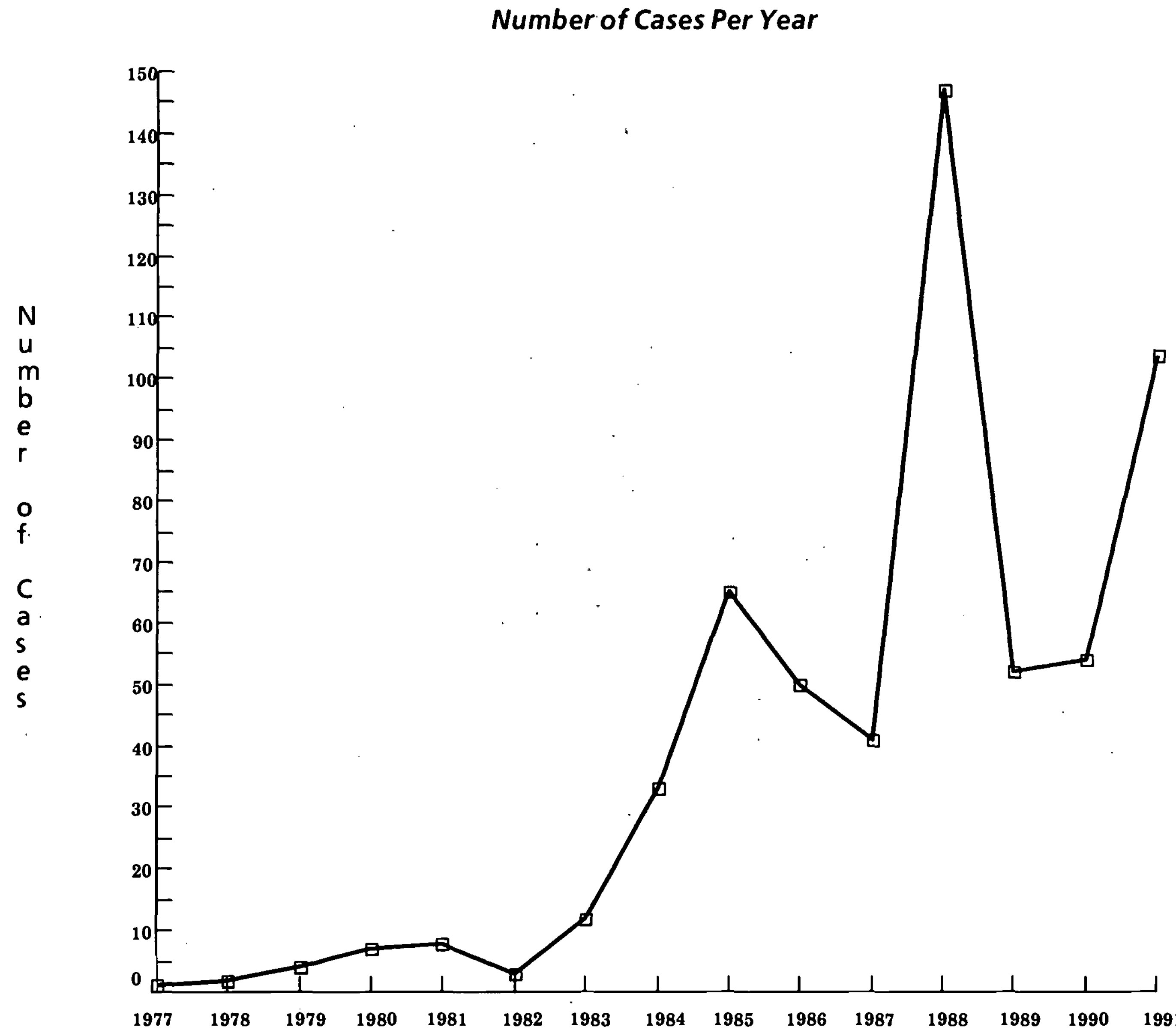
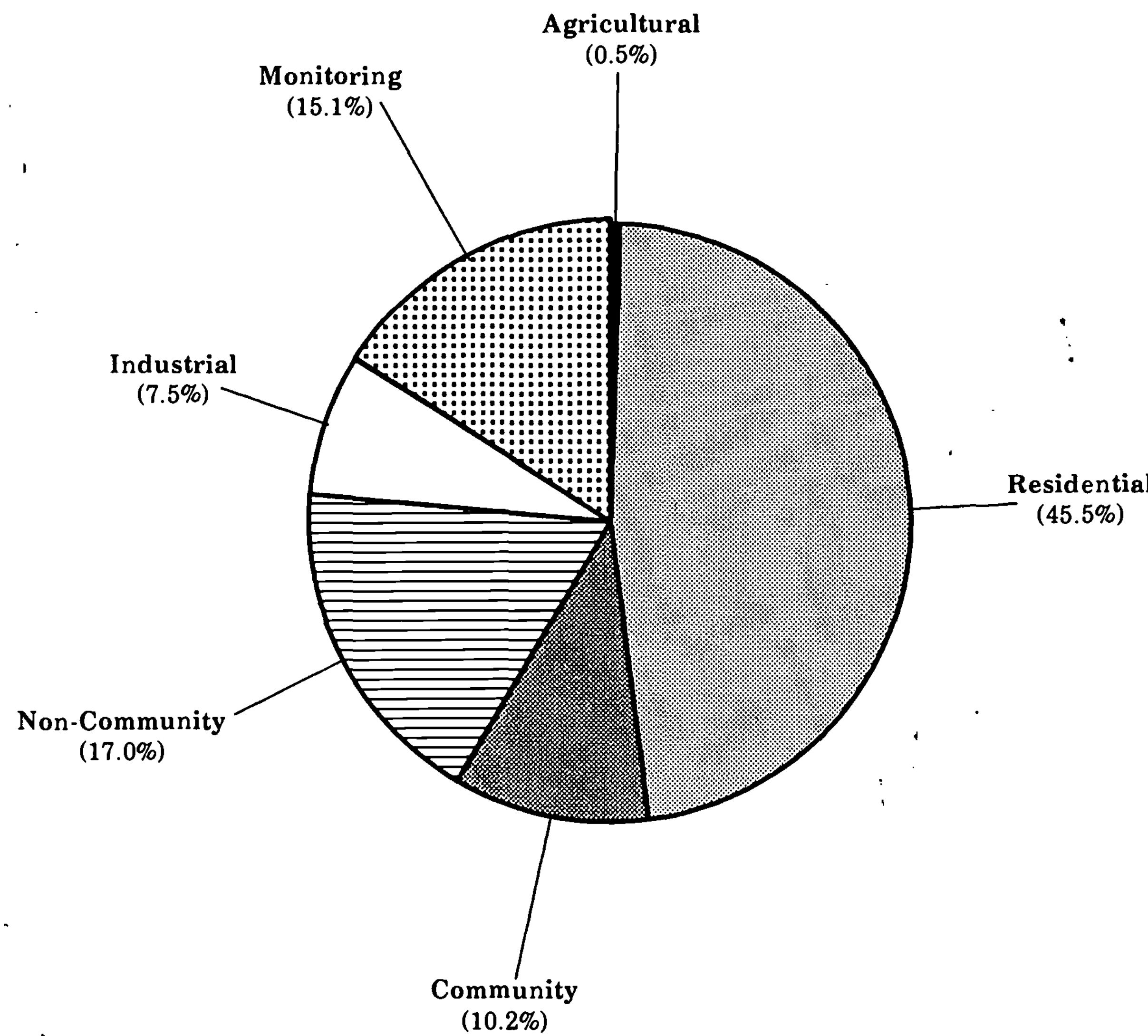


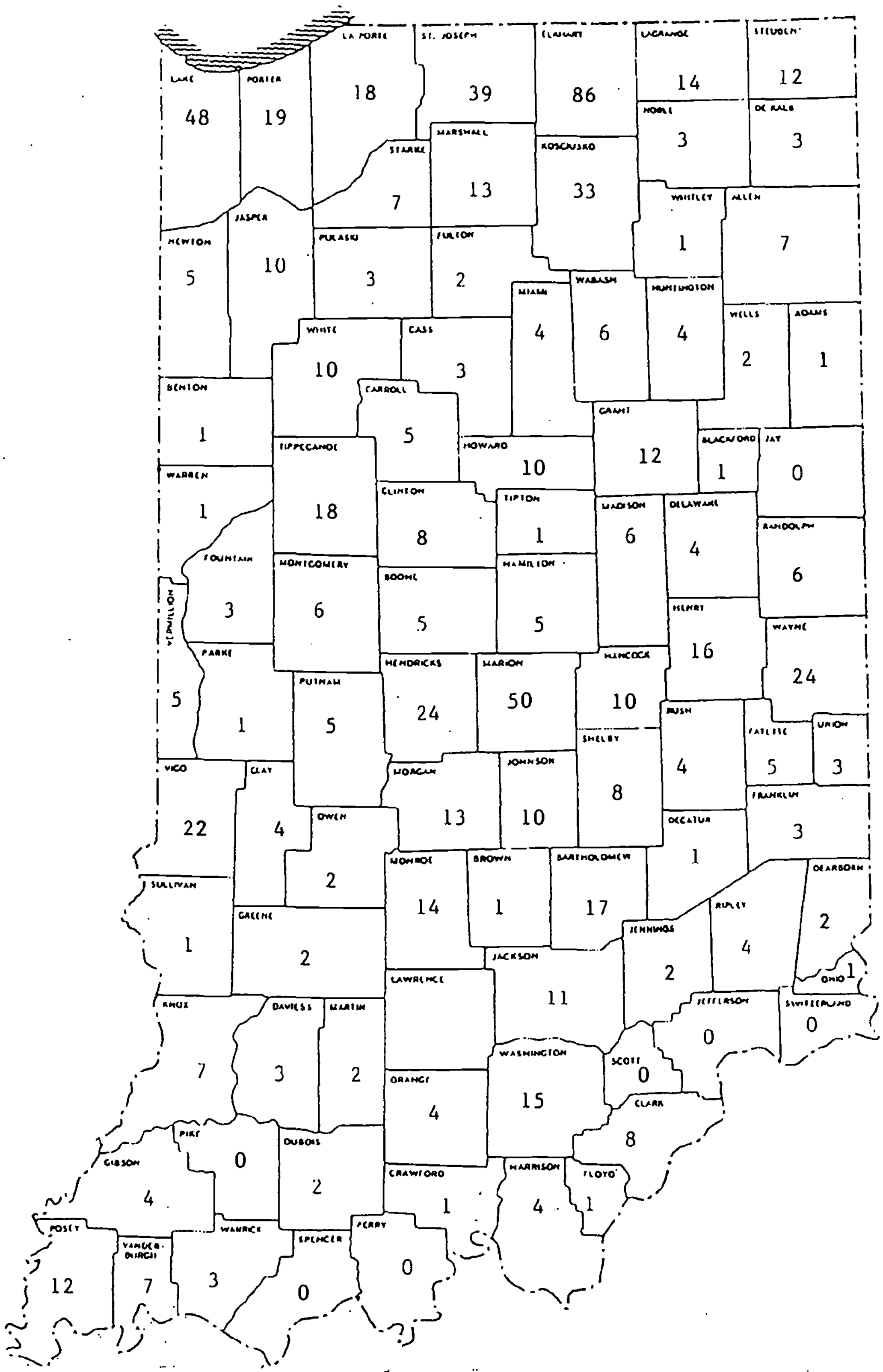
Figure 24. *Documented Ground Water Contamination*

*Types of Wells Affected*




Source: IDEM Ground Water Section, Contamination Site Registry (1989) for time period 1959-1991

**Figure 25.** *Ground Water Complaints Sites Per County*




Source: IDEM Ground Water Section, Contaminant Site Registry (1991), for time period 1956-1991

Figure 26. *Ground Water Complaints Drinking Water Sites Per County*

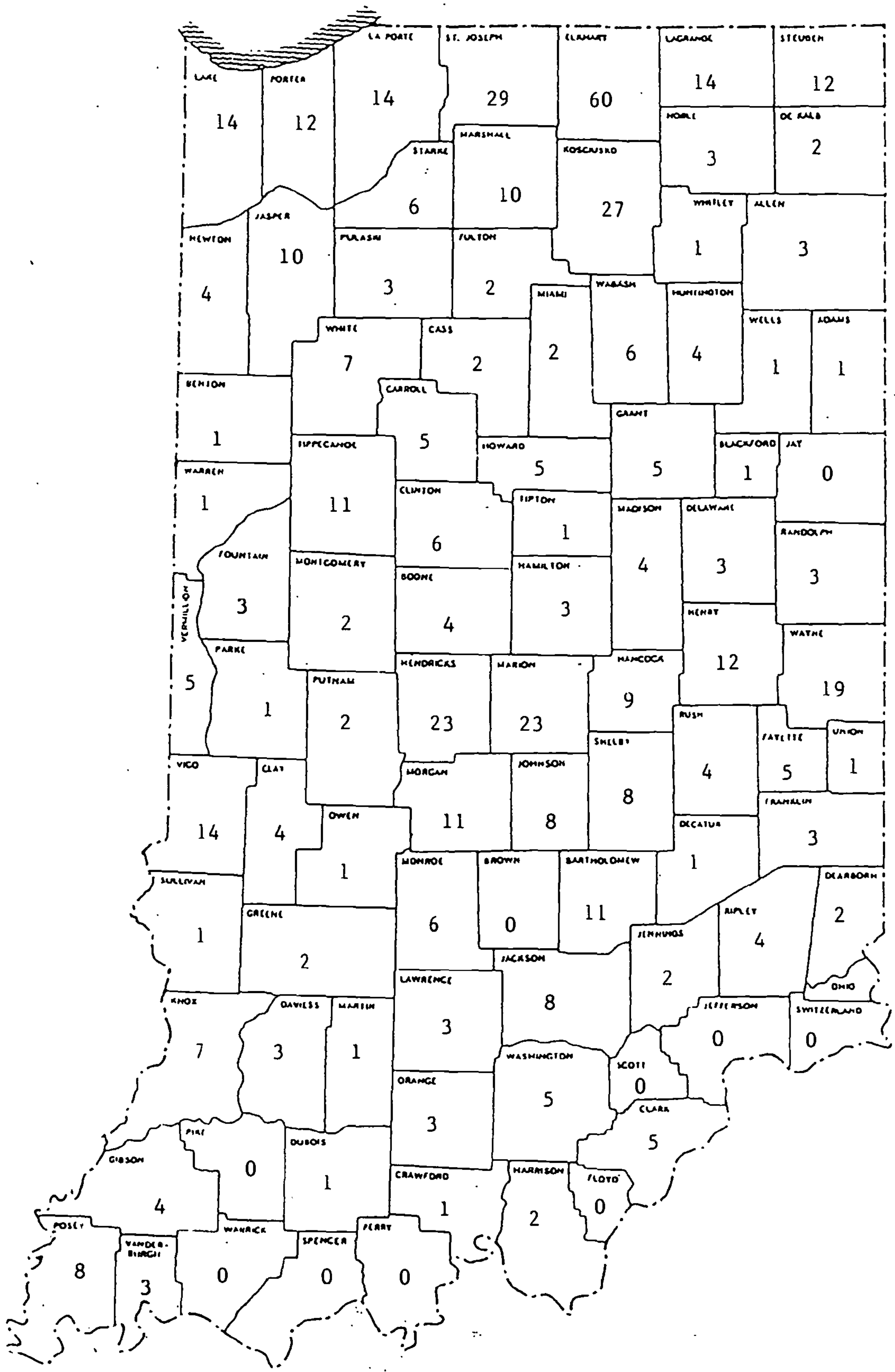


TABLE 64. *Groundwater Monitoring Actions Which Documented Contamination*

| All Ground Water Contamination (839 Sites) | | | Drinking Water Contamination Only (511 Sites) | | |
|---|---|---|---|---|---|
| ACTION | NUMBER OF CASES | PERCENT OF CASES | ACTION | NUMBER OF CASES | PERCENT OF CASES |
| Water Sample Analysis | 232 | 27.7% | Water Sample Analysis | 212 | 41.5% |
| Investigation of Known Pollution Source | 238 | 28.4% | Complaint Response for Objectionable Odor of Water | 121 | 23.7% |
| Complaint Response for Objectional Odor of Water | 136 | 16.2% | Complaint Response for Objection Taste of Water | 104 | 20.4% |
| Required Ground Water Monitoring | 123 | 14.7% | Investigation of Known Pollution Source | 92 | 18.0% |
| Complaint Response for Objectional Taste of Water | 115 | 13.7% | Investigation of Suspected Pollution Source | 87 | 17.0% |
| Investigation of Suspected Pollution Source | 108 | 12.9% | Complaint Response for Health Concern With Water | 41 | 8.0% |
| Complaint Response for Health Concern With Water | 44 | 5.2% | Required Ground Water Monitoring | 21 | 4.1% |
| Complaint Response for Color of Water | 20 | 42.4% | Complaint Response for Color of Water | 16 | 3.1% |
| Complaint Response for Sediment in Water | 6 | 0.7% | Complaint Response for Sediment in Water | 6 | 1.2% |
| Investigation of Unknown Pollution Source | 87 | 10.4% | Investigation of Unknown Pollution Source | 48 | 9.4% |

***(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)***

TABLE 65. *Remedial Actions for Drinking Water Well Contamination*

| ACTION | NUMBER OF CASES | PERCENT OF CASES |
|---|---|---|
| No other remedial action/health advisory | 119 | 20.0% |
| Long term monitoring | 93 | 15.6% |
| Bottled water | 79 | 13.3% |
| Point of entry/point of use water treatment | 64 | 10.8% |
| Public water connection | 50 | 8.4% |
| Well abandonment | 38 | 6.4% |
| New well | 36 | 6.1% |
| Miscellaneous | 35 | 5.9% |
| Contaminated soil removal | 32 | 5.4% |
| Well Disinfection | 15 | 2.5% |
| Pump and decontaminate ground water | 14 | 2.4% |
| Contaminant recovery well | 10 | 1.7% |
| Well repair | 7 | 1.2% |
| Intercept/barrier well | 2 | 0.3% |

***(Source: IDEM Ground Water Section Contamination Site Registry (1991) for time period 1956 - 1991)***

## Public Water Supply Monitoring

Volatile Organic Chemicals

In 1988, public drinking water standards (Maximum Contaminant Levels or MCLs) for the finished water were established by EPA for eight volatile organic chemicals (VOCs). A monitoring schedule was also implemented for these eight VOCs and 51 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 of raw and finished water at 128 systems using ground water. Detectable VOCs were reported in 33 (26 percent) of the systems sampled. Their location of community public water supplies with documented organic chemical contamination through December, 1991 is shown in Figure 27.

The top two most frequently reported VOCs in unfinished well water for the systems monitored were trichloroethylene (TCE) and 1,1,1-trichloromethane (1,1,1,-TCA). Other unregulated contaminants which were detected include tetrachloroethylene (PCE), 1,1-dichloroethylene (DCA), 1,2-dichloroethylene, and total xylenes. It must be noted that a detection of organic chemicals in the unfinished water does not mean that the finished water will have organic chemicals in concentrations above the maximum contaminant level (MCL). The finished water from public water supplies which have detected organic chemicals is routinely tested for those chemicals which were detected to ensure a safe drinking water supply.

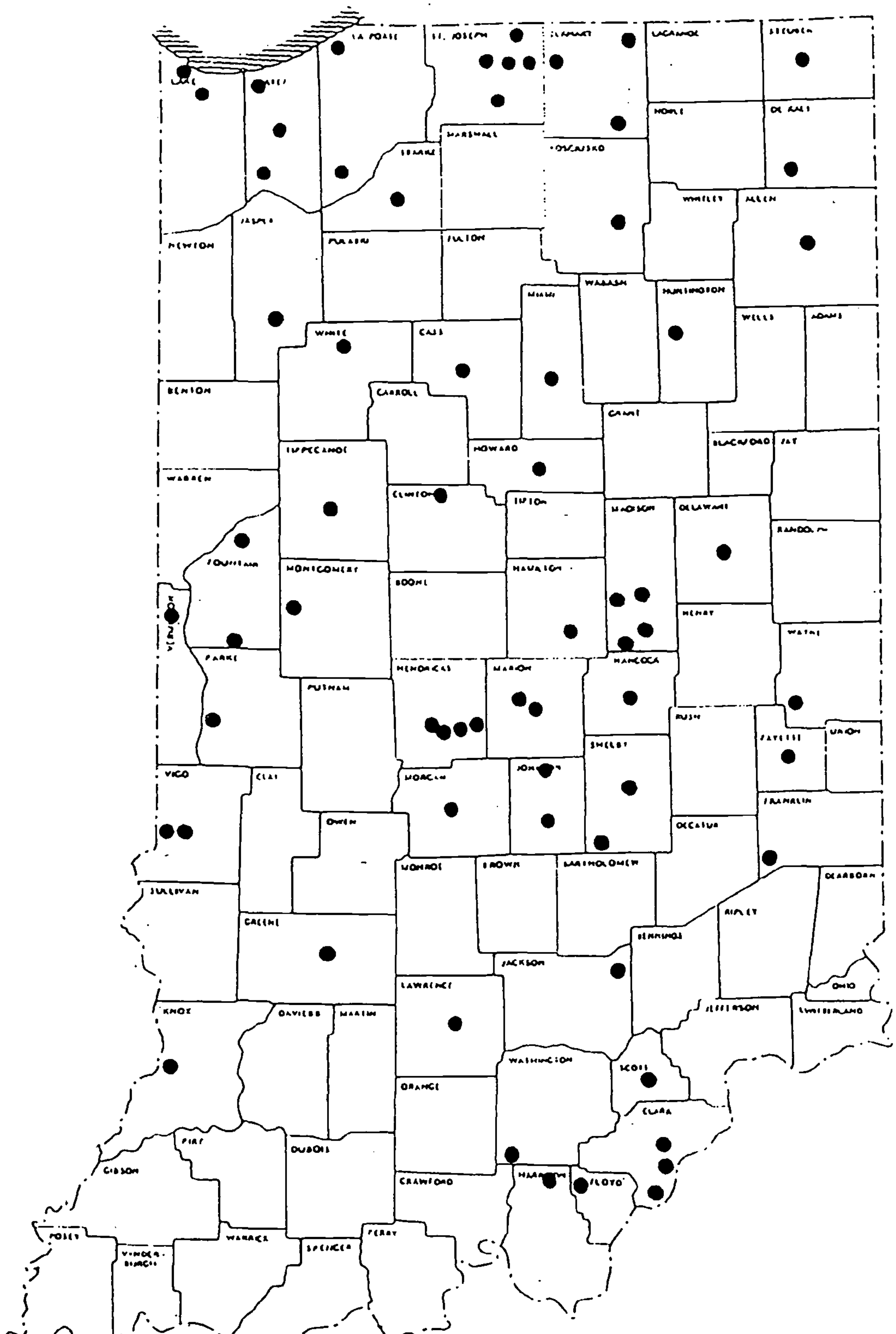
Inorganic Chemicals

Community Water Supplies in Indiana which ground water are required to monitor the quality of the water delivered to their customers at least once every three years for 10 inorganic parameters (8 metals, nitrate and fluoride). Records indicate that in the past seven years, only seven systems exceeded an MCL for an inorganic chemical. These were arsenic, nitrate, barium and fluoride. At this time, the arsenic, barium, and fluoride are believed to be naturally high levels associated with minerals in the bedrock, while nitrate is considered to be non-point in origin.

### 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.

**FIGURE 27.** *Public Water Supply Wells with Detectable Organic Chemicals*




Source: IDEM Ground Water Section, Contamination Site Registry (1991) for 1981-91 time period.

Documenting the source for a particular incident of ground water contamination is not always possible. In about 30 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 66. The most prevalent appear to be hazardous materials spills, losses from underground storage tank systems, and waste disposal activities.

## 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 1990-1991 there were 4,463 hazardous materials spills reported to the IDEM Office of Environmental Emergency Response. The largest number occurred in heavily industrialized areas such as Marion County (595 spills) and Lake County (363 spills). The statewide distribution of these events is shown in Figures 28 and 29. 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 1989 spills are in Figures 30 and 31. The circumstances which cause these events most often are equipment failure and employee error (Figure 32). This reinforces the need for spill prevention and containment engineering and employee safety training as a means of protecting ground water and the environment.

## Underground Storage Tank Systems

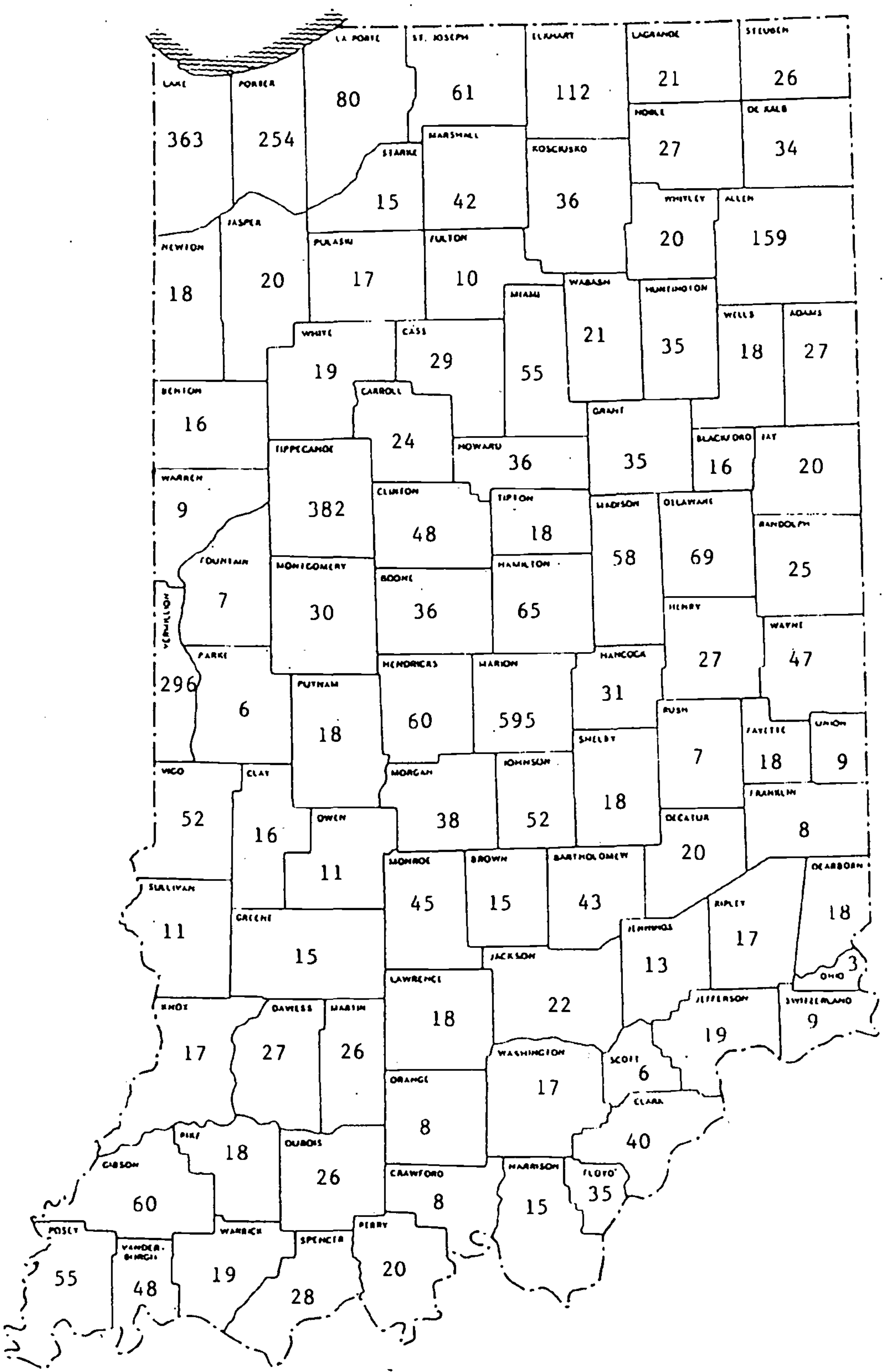
Chronic leaks and sudden releases from buried storage tanks and their associating piping have resulted in the contamination of ground water and water supply wells for many cases in the registry used for this report. During the period form January, 1990 to December, 1991, 1,756 sites were reported to have leaking underground storage tanks although ground water contamination was not always documented. As of December, 1991, 2,765 sites were reported to have at least one leaking underground storage tank. Figure 33 shows the total number of reported leaking underground storage tank sites per county through December, 1991.

TABLE 66. *Sources of Ground Water Contamination*

| All Ground Water Contamination (839 Sites) | | Drinking Water Contamination Only (511 Sites) | |
|---|---|---|---|
| TYPE OF CONTAMINANT SOURCE | PERCENT OF CASES | TYPE OF CONTAMINANT SOURCE | PERCENT OF CASES |
| Underground storage tanks | 23.2% | Unknown/not confirmed | 19.4% |
| Spills including hazardous material | 20.1% | Underground storage tanks | 14.3% |
| Unknown/not confirmed | 16.1% | Spills including hazardous material | 14.3% |
| Hazardous waste disposal | 7.9% | Hazardous waste disposal | 9.0% |
| Solid waste disposal facility | 6.2% | Pesticide application | 7.4% |
| Pesticide application | 5.0% | Solid waste disposal facility | 6.8% |
| Pit, pond or lagoon | 3.6% | Improper well construction | 4.5% |
| Above ground storage tank | 3.3% | Above ground storage tanks | 3.7% |
| Improper well construction | 3.0% | Pit, pond or lagoon | 3.7% |
| Septic system | 2.4% | Septic system | 3.5% |
| Pesticide storage/disposal | 1.5% | Pesticide storage/disposal | 2.3% |
| Oil and gas recovery well | 1.4% | Oil and gas recovery well | 2.3% |
| Liquid transport pipeline | 1.3% | Improperly abandoned hole/well (associated with oil and gas) | 2.0% |
| Improperly abandoned hole/well (all associated with oil and gas) | 1.2% | Salt storage handling facility | 1.6% |
| Salt storage/handling facility | 1.2% | Wastewater disposal into a dry well | 1.6% |
| Wastewater disposal into a dry well | 1.2% | Liquid transport pipeline | 1.4% |
| Naturally occurring contamination | 0.7% | Naturally occurring contamination | 1.2% |
| Injection well (for brine disposal) | 0.6% | Injection well (for brine disposal) | 1.0% |

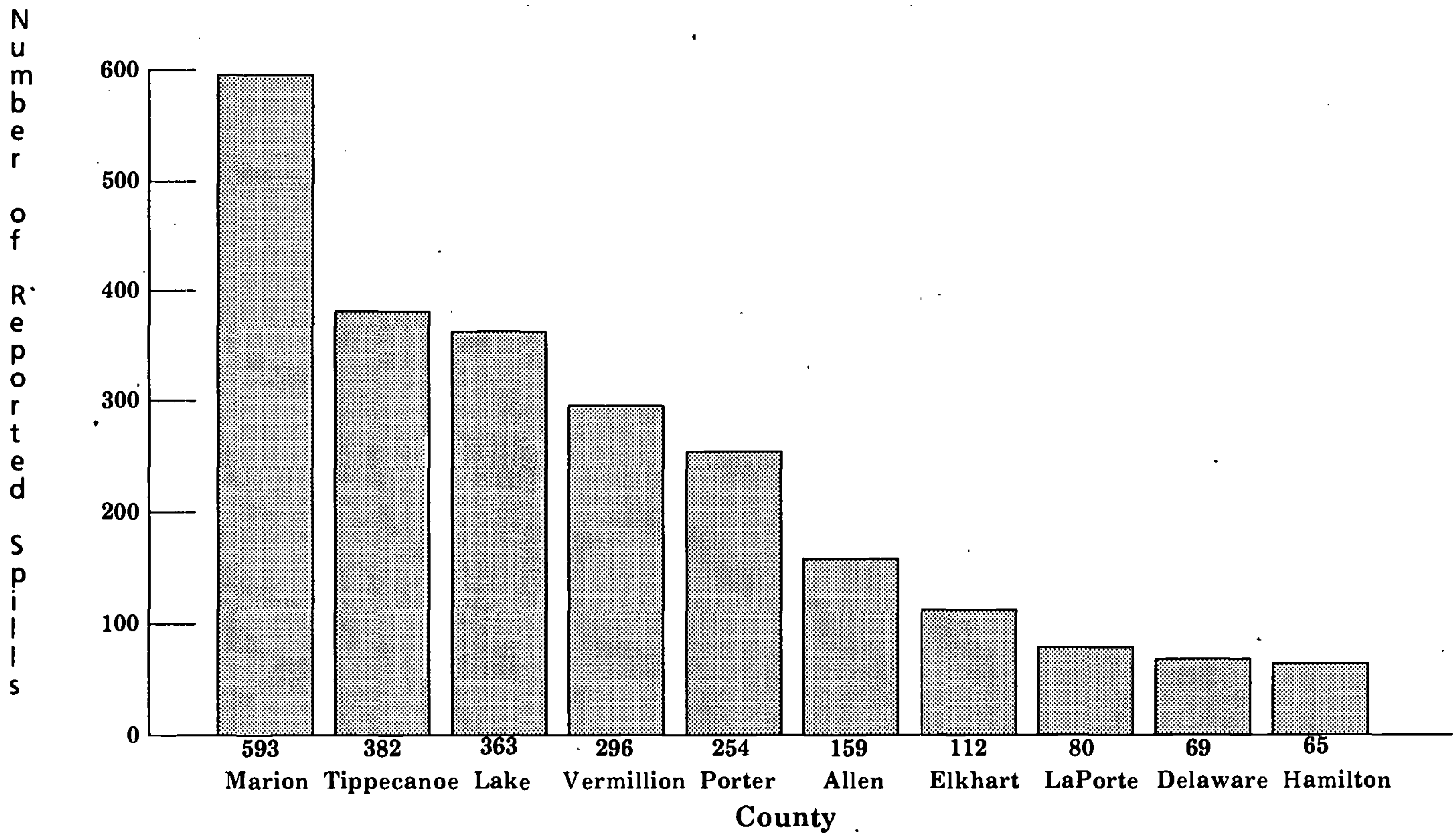
***(Source: IDEM Ground Water Section Contamination Site Registry (1991) for time period 1956 - 1991)***

**FIGURE 28.** *Reported Hazardous Materials Spills (per county) 1990 - 1991*




Source: IDEM Emergency Response Branch Data Base (1990 - 1991)

Figure 29. *(Top 10 Counties) Reported Haz Mat Spills 1990-1991*




Source: IDEM Emergency Response Branch Data Base (1991)

Figure 30. *Types of Materials Spilled*

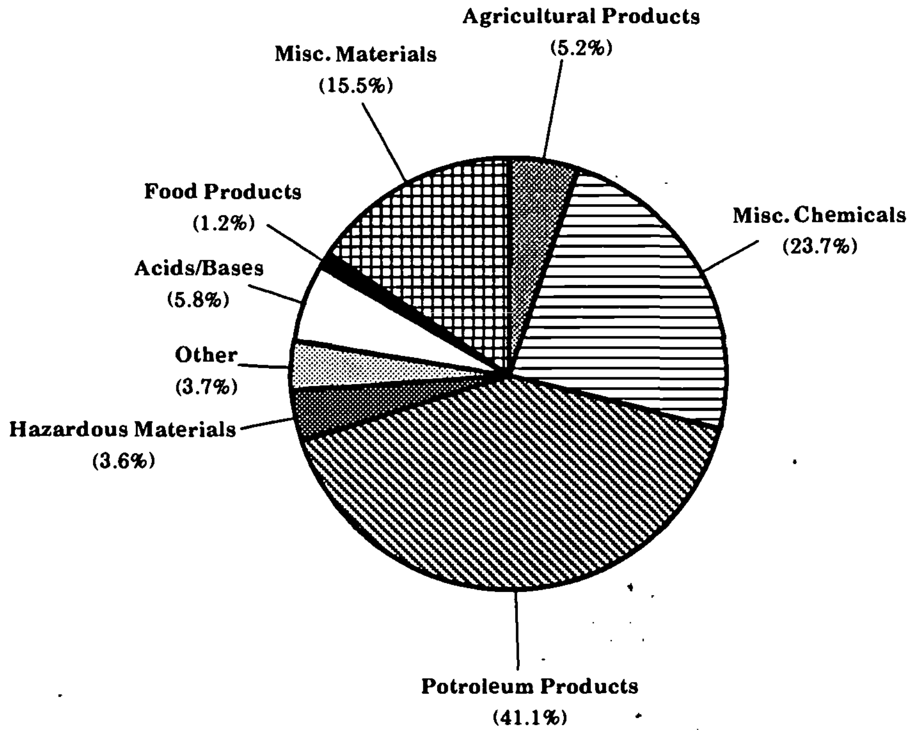
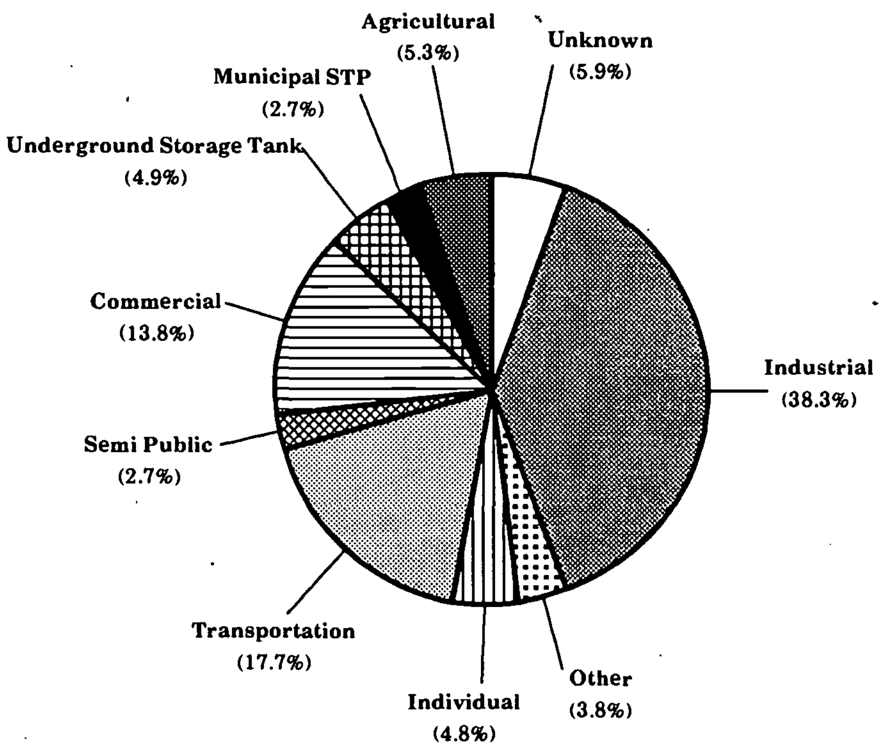



Figure 31. *Source of Materials Spilled*




Source: IDEM Emergency Response Branch Database

Figure 32. *Circumstances of Materials Spilled*

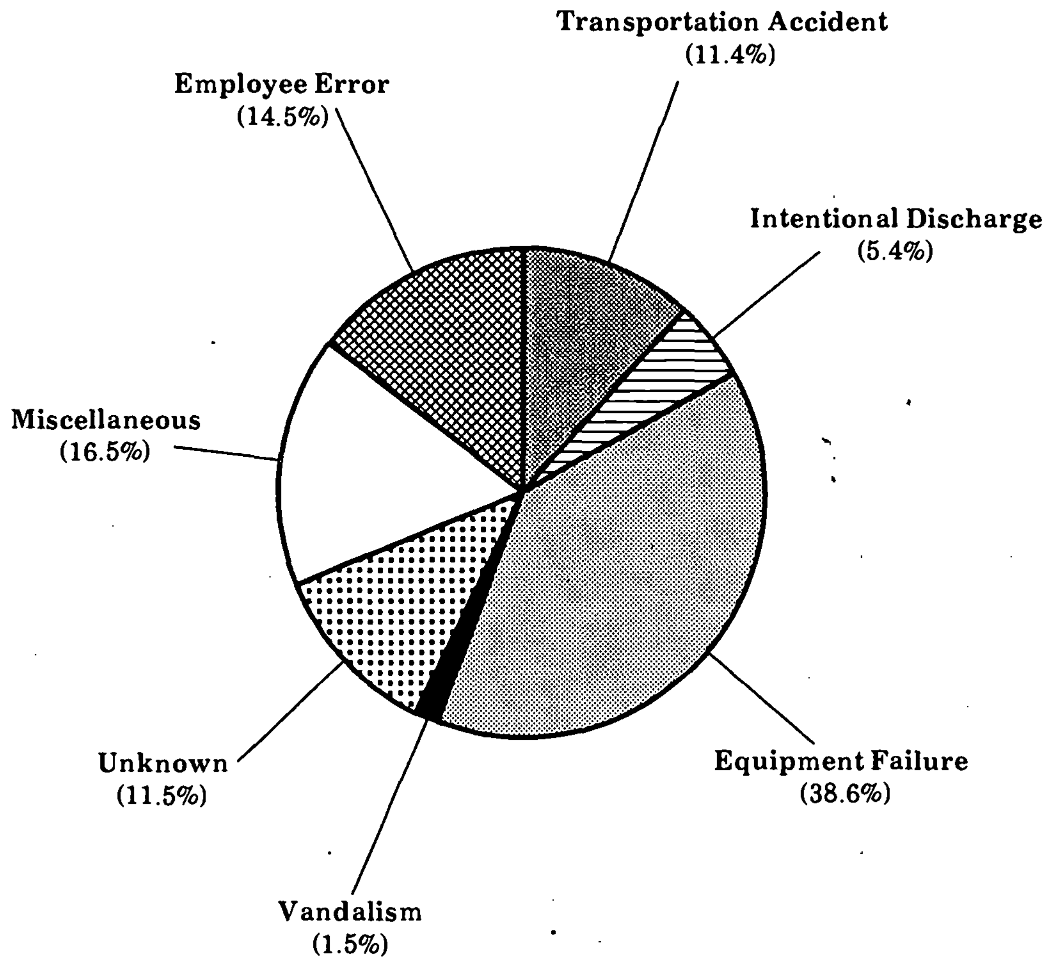
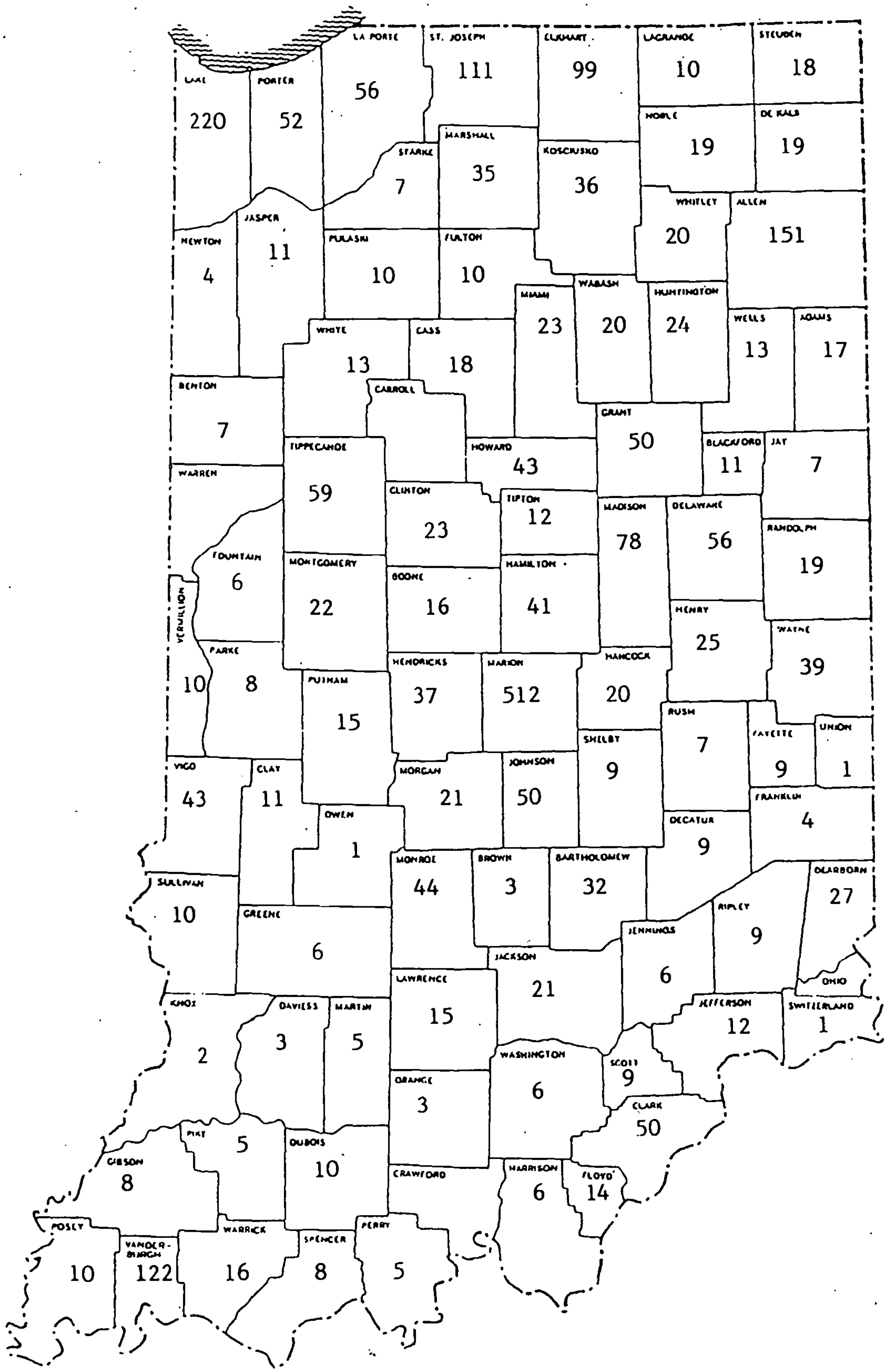


**FIGURE 33.** *Number of Leaking Underground Storage Tank sites*




Source: IDEM Lust Section

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 1991, some 31,268 tanks are regulated. The statewide distribution is shown in Figure 34. The counties with the largest number of underground storage tanks if shown in Figure 35.

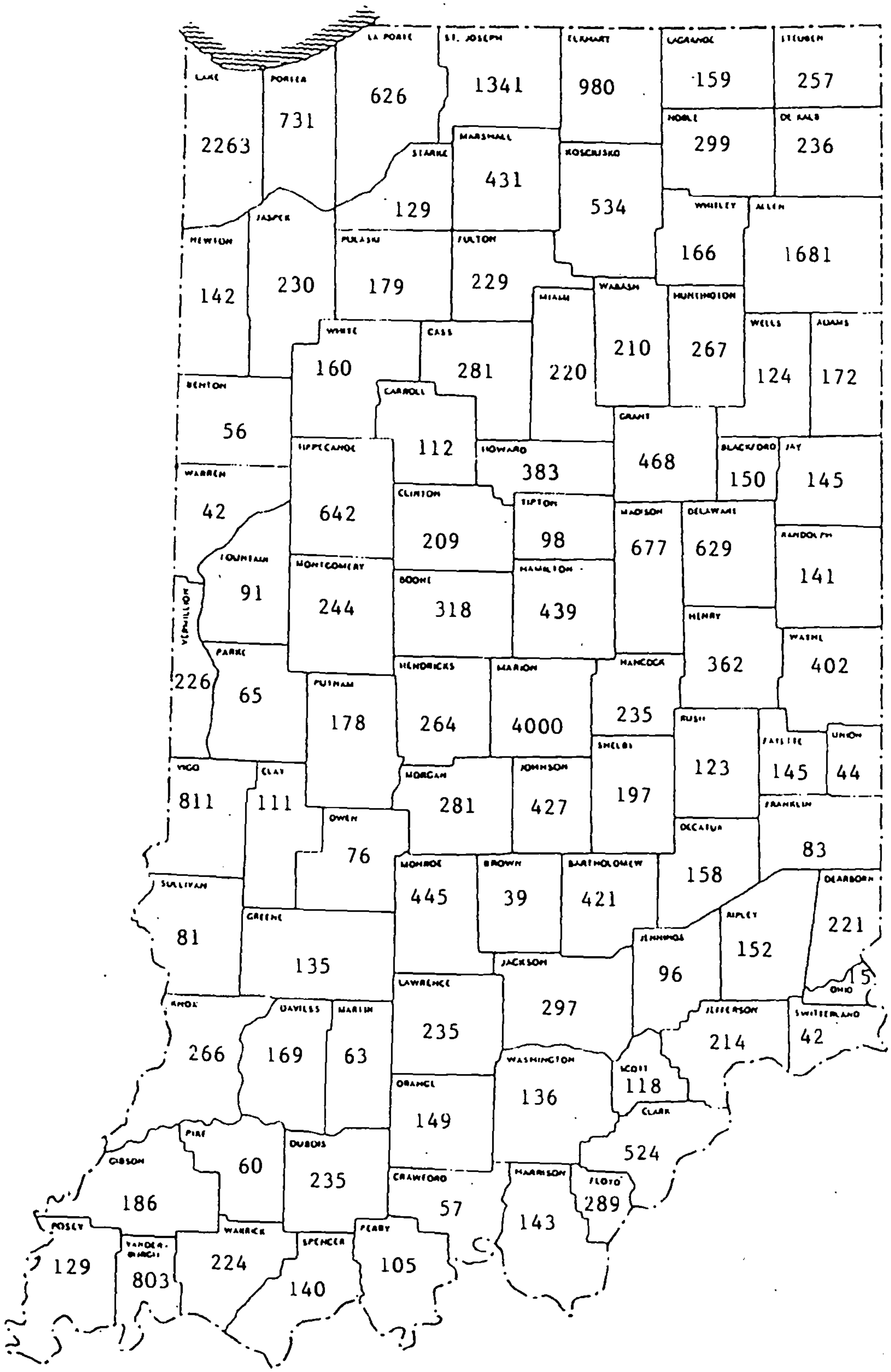
Over 90 percent of underground storage tanks contain petroleum products (Figure 36). Dissolved and undissolved gasoline is the substance most often detected in ground water due to leaks from underground storage tanks, although heating fuel and chlorinated solvents have also been found. The health risks 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-six sites in the State are on the U.S. EPA's Superfund National Priorities List and Forty- eight sites are on the list for State cleanup. See Figure 37 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. See Figure 38 for the distribution of these potential ground water pollution sites across the state.

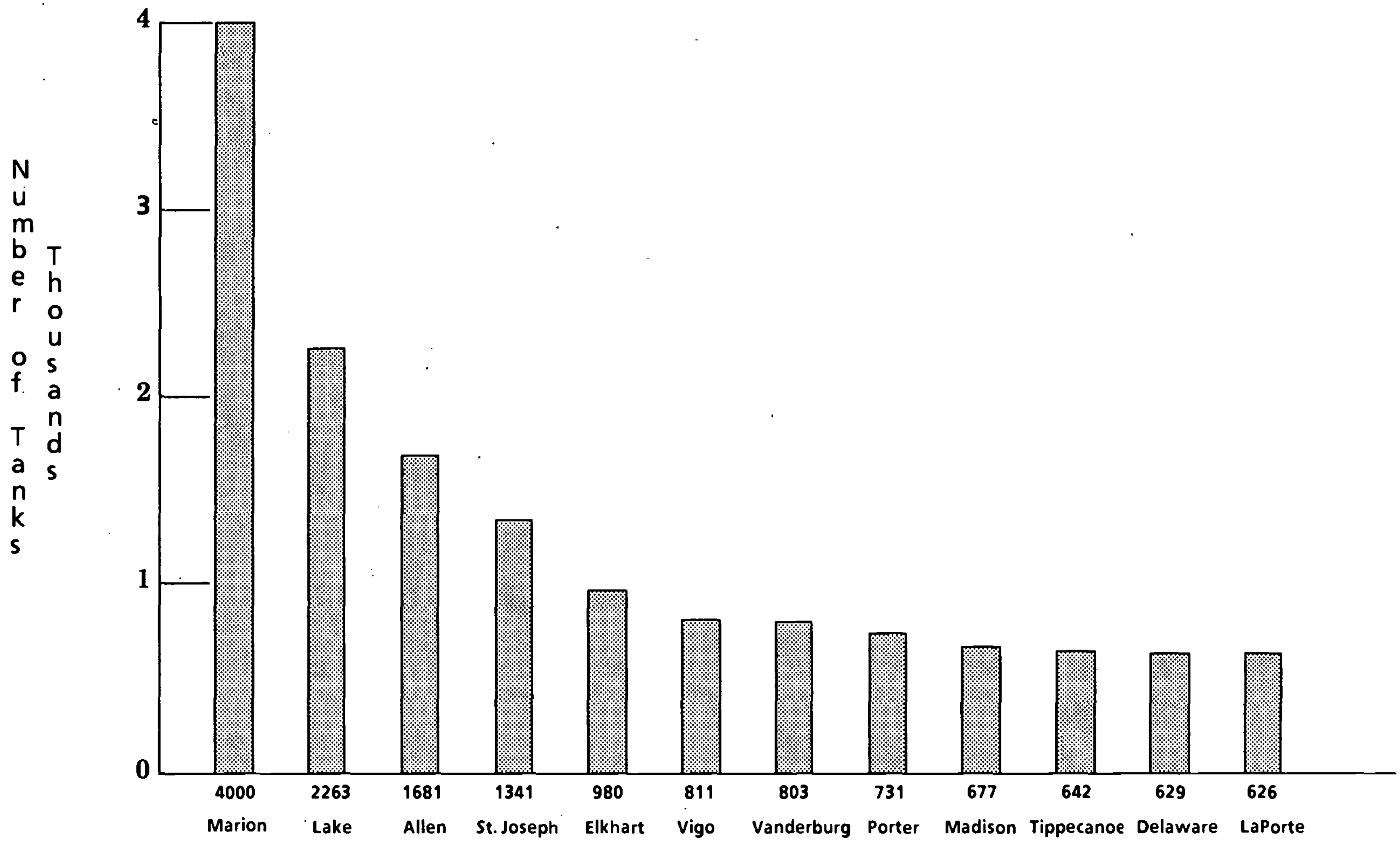
There are 5,058 operations in the state which generate treat, store, or dispose of hazardous waste. Figure 39 lists the number of facilities which generate, treat, store, or dispose of hazardous waste. Figure 40 list the counties with the greatest number of facilities. Figure 41 indicates the geographic 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 42 solid waste landfills in the state, most of

**FIGURE 34.** *Regulated Underground Storage Tanks Per County*



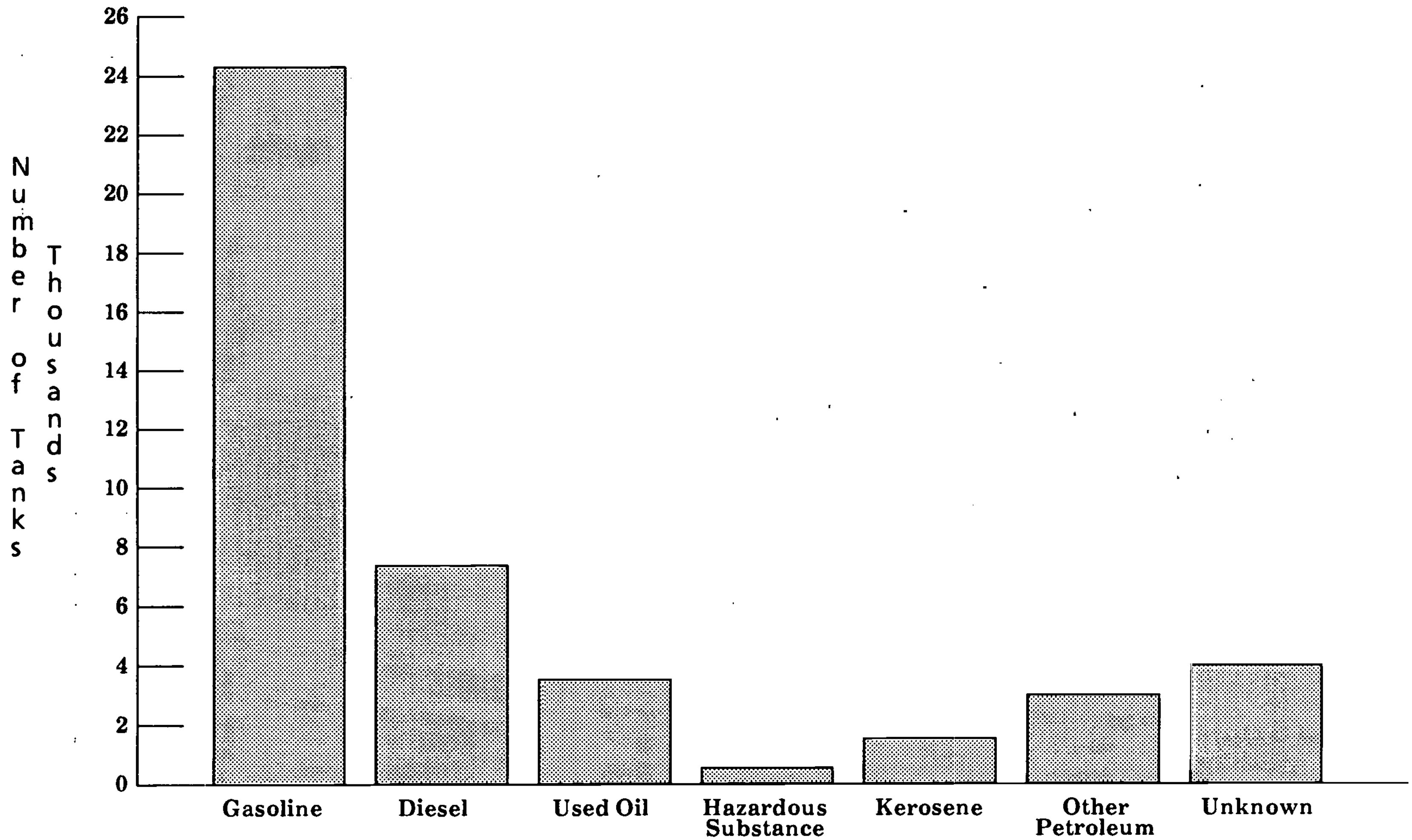

Source: IDEM Underground Storage Tank Section Data Base (1991)

Figure 35. *Counties with Largest Number of Underground Storage Tanks*



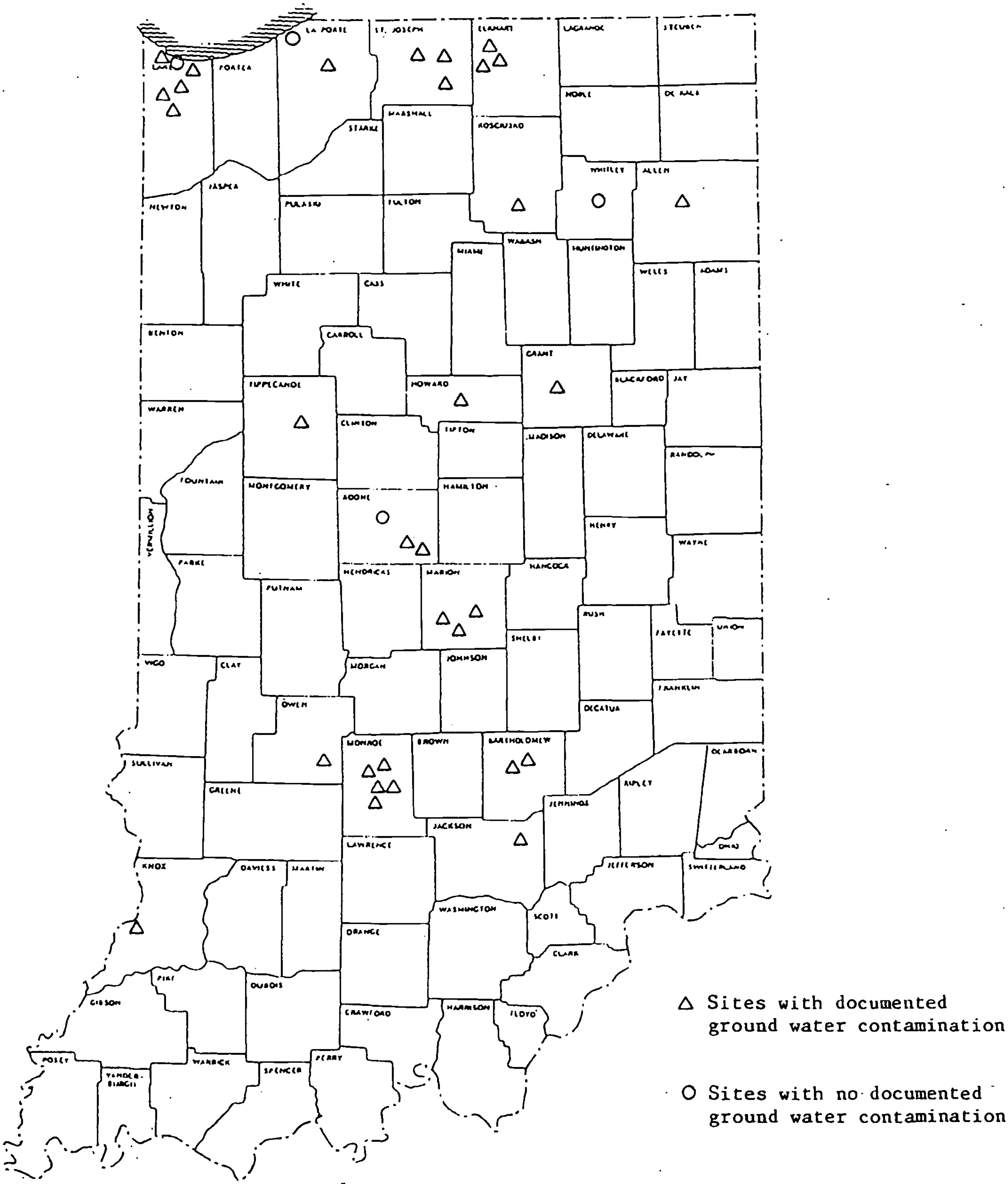

Source: IDEM Underground Stroage Tank Section Data Base (1991)

Figure 36. *Registered Underground Storage Tanks*



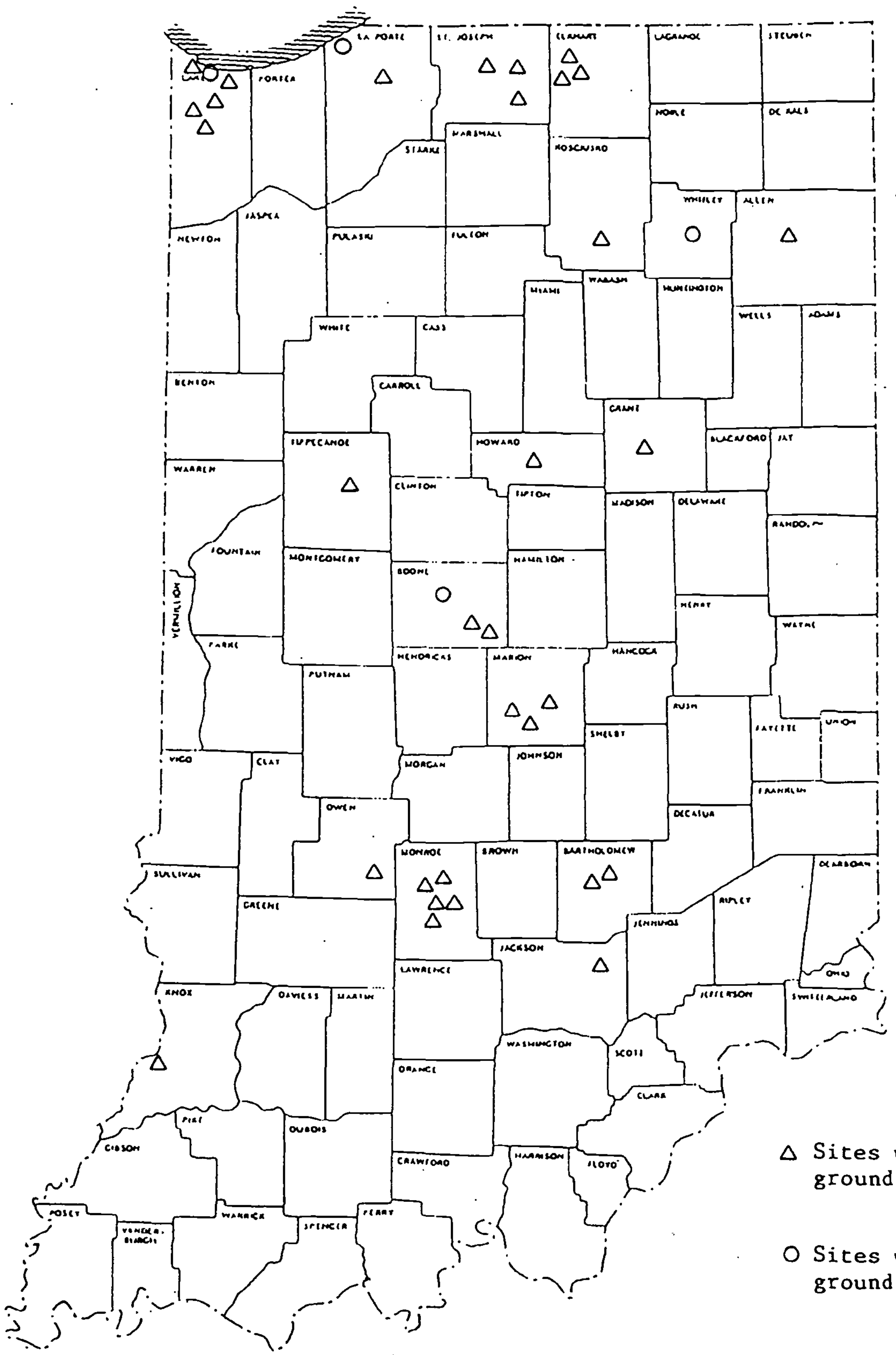

Source: IDEM Underground Storage Tank Section Data Base (1991)

**FIGURE 37.** *Superfund Sites - State Cleanup Sites*




Source: IDEM Site Management Section

**FIGURE 38.** *Superfund National Priorities List Sites*




△ Sites with documented ground water contamination

○ Sites with no documented ground water contamination

Source: IDEM Site Management Section

**FIGURE 39.** *Hazardous Waste Facilities Per County Regulated Facilities Which Generate, Treat, Store or Dispose Hazardous Waste*

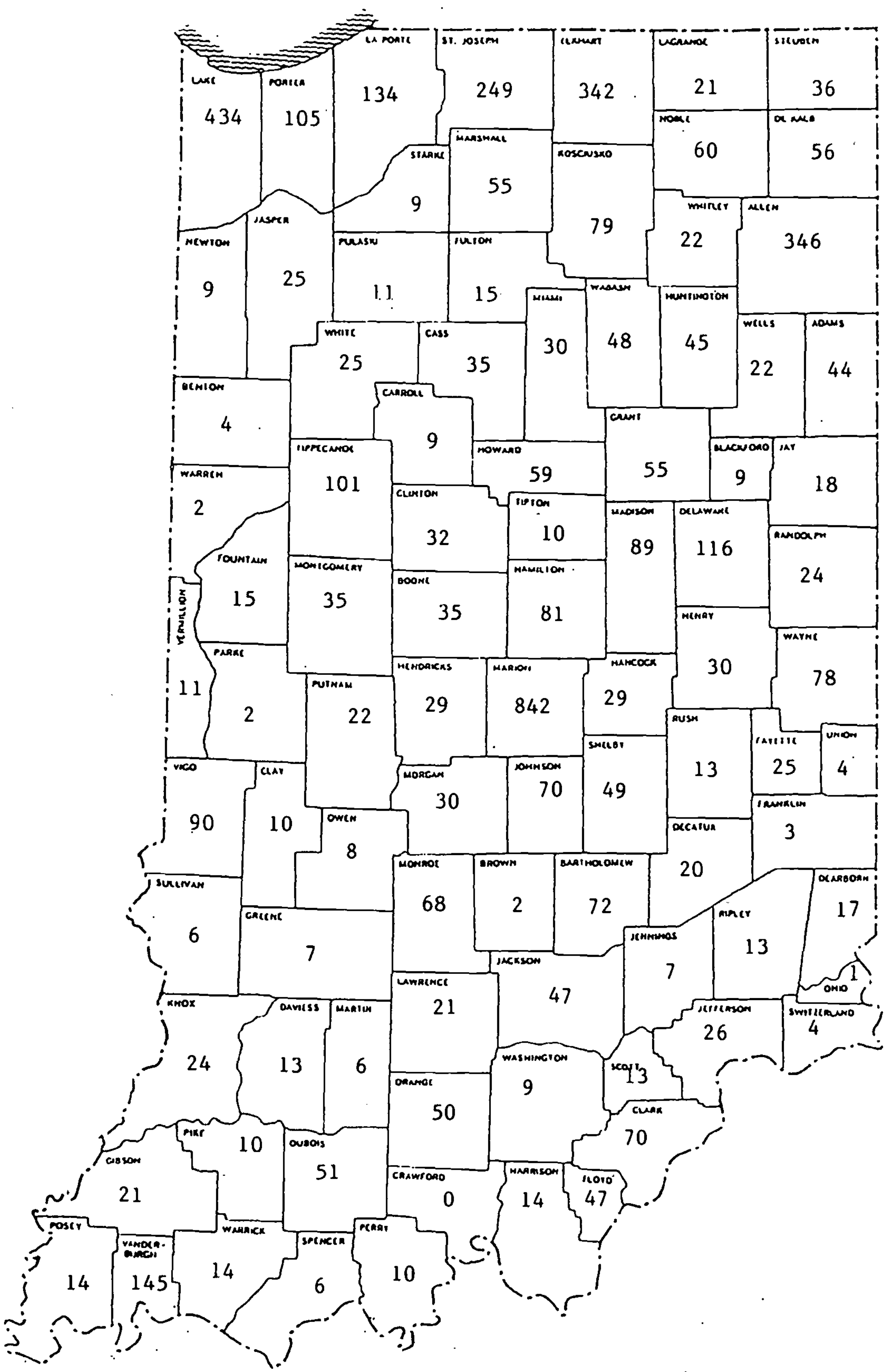
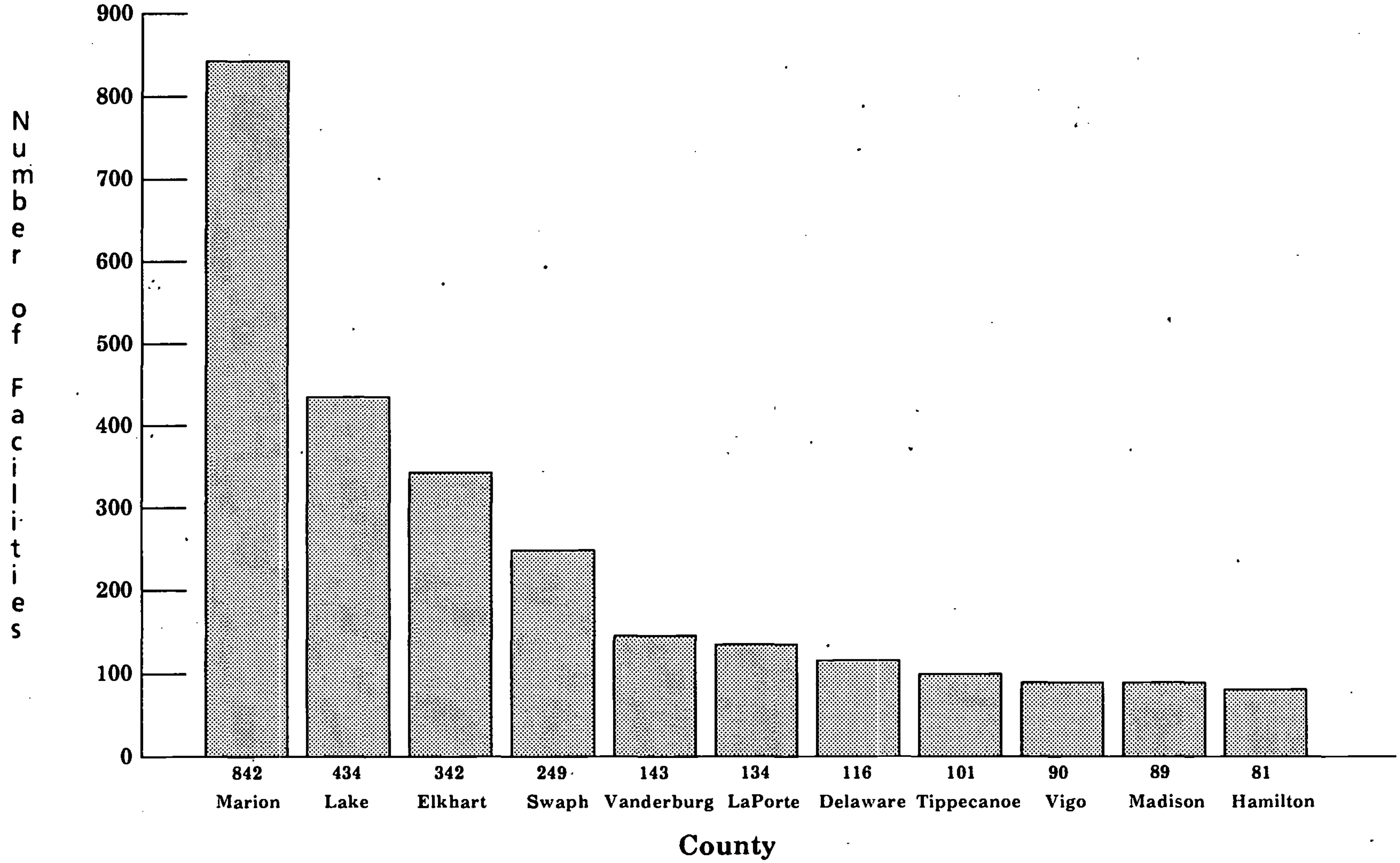
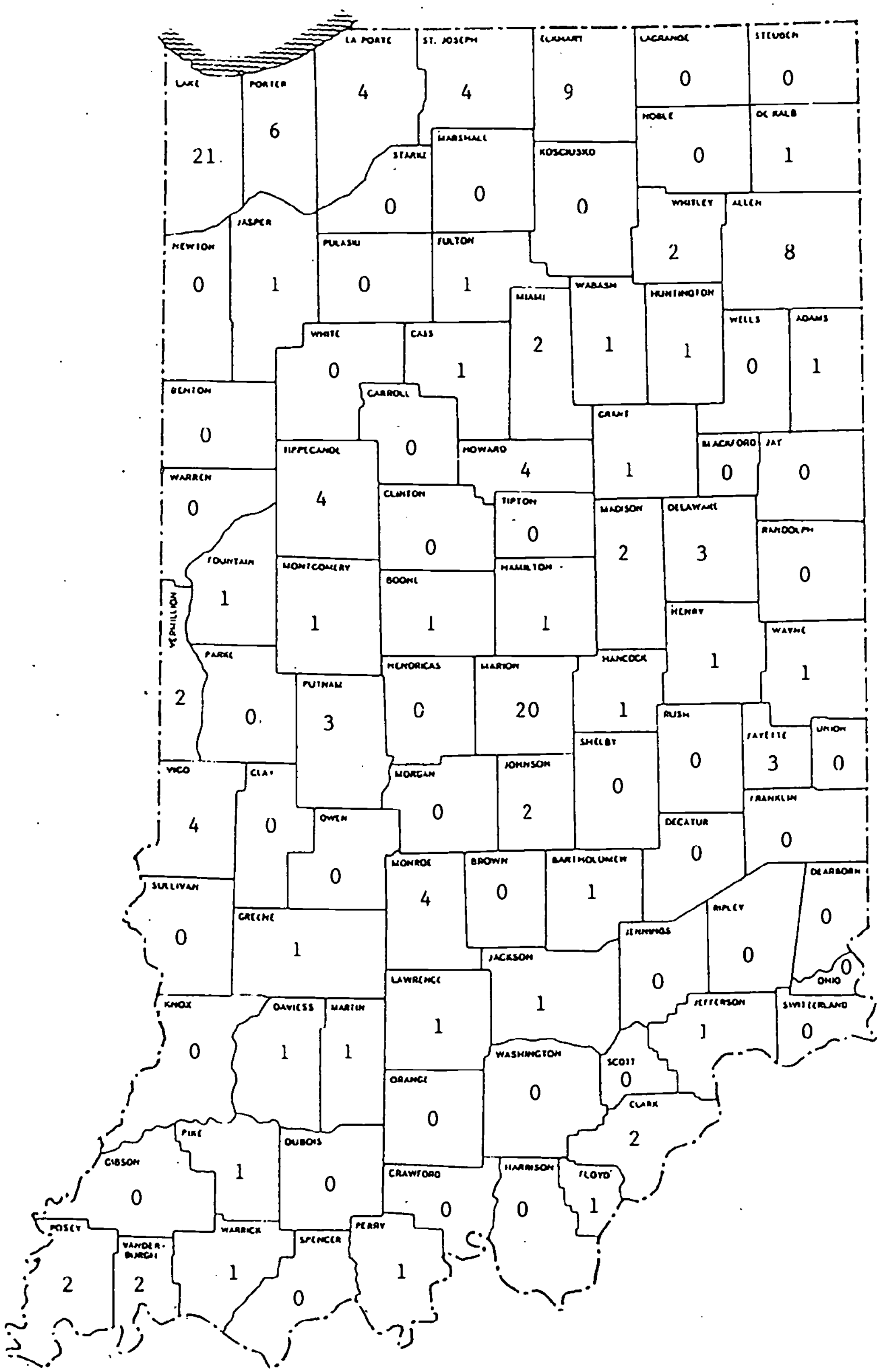


Figure 40. *Counties with Greatest Number of Hazardous Waste Treatment Storage and Disposal Sites*




Source: IDEM Hazardous Waste Management Branch Data Base (1991)

**FIGURE 41.** *Permitted Hazardous Waste Treatment, Storage and Disposal Facilities*




Source: IDEM Hazardous Waste Management Branch Data Base (1991) them currently inactive, has also contributed to the ground water contamination documented through monitoring by IDEM staff.

## Substances Contaminating Ground Water

At last 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 67 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.

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 0.05 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 0.05 mg/1 involve concentrations in the range from 0.05 to 2.0 mg/1.

TABLE 67. *CHEMICAL CONTAMINANTS DETECTED IN INDIANA GROUND WATER*

| Chemcial Type<br>Chemical Name | Percent Freq. Per Chemical Type | Maximum Concen-tration Recorded | Concentration and Source of "Standard" Used for Registry | Abbrev. /Other Name |
|---|---|---|---|---|
| **1. Halogenated Voliatile Organics (577)[a]** | | | | |
| Trichloroethylene | 21.3% | 992,000 ppb | 5 ppb MCL | TCE |
| 1,1,1-Trichloroethane | 16.3% | 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% | 1,700 ppb | -- | 1,1-DCA |
| 1,2-Dichloroethene | 7.5% | 44,000 ppb | 5 ppb MCL | 1,2-DCA |
| 1,1-Dichloroethylene | 5.7% | 1,800 ppb | 7 ppb MCL | 1,1-DCE |
| Methylene chloride | 5.7% | 227,000 ppb | 5 ppb MCL* | $MeCl_2$ |
| Chloroform | 4.3% | 1,301 ppb | 10 RfD | -- |
| t-1,2-Dichloroethylene | 6.4% | 3,200 ppb | 100 ppb MCL | t-DCE |
| Vinyl Chloride | 5.4% | 40,000 ppb | 2 ppb MCL | VC |
| Carbon tetrachloride | 2.3% | 6,860 ppb | 5 ppb MCL | CC14 |
| Bromodichloromethane | 1.6% | 2,000 ppb | 20 Rfd | -- |
| Trichlorofluoromethane | 1.4% | 340 ppb | -- | TCF |
| 1,1,2-Trichloroethane | 0.9% | 2,000 ppb | 5 ppb MCL* | -- |
| Dibromochloromethane | 0.9% | 26.0 ppb | -- | DCM |
| 1,1,2,2-Tetrachloroethane | 0.7% | 120 ppb | -- | -- |
| Bromoform | 0.7% | 1.42 ppb | 20 RfD | -- |
| Chlorobenzene | 0.3% | 9.0 ppb | -- | -- |
| 1,2 Dichloropropane | 0.2% | 0.34 ppb | 5 ppb MCL | -- |
| **2. Aromatic Volatile Organics (287)a** | | | | |
| Toluene | 28.6% | free product | 1,000 ppb MCL | -- |
| Benzene | 26.8% | free product | 5 ppb MCL | -- |
| Xylenes (o,p & m) | 25.1% | 26,000 ppb | 10,000 ppb MCL | -- |
| Ethylbenzene | 19.5% | 600 ppb | 700 ppb MCL | -- |
| **3. Nonhalogenated Volatile Organics (32)[a]** | | | | |
| Acetone | 37.5% | 150,000 ppb | -- | -- |
| Methyl ethyl ketone | 34.4% | 3,800 ppb | 200 ppb HA | MEK |
| Methyl isobutyl ketone | 21.9% | 780,000 ppb | -- | MIBK |
| Methyl tertiary butylether | 6.3% | 5,400 ppb | 40 ppb HA | MTBE |
| **4. Petroleum (18)[a]** | | | | |
| Gasoline | 42.9% | free product | free product | -- |
| Oil and Grease | 35.7% | 1,700 ppm | free product | -- |
| Crude Oil | 7.1% | free product | free product | -- |
| Heating Oil | 7.1% | free product | free product | -- |
| Diesel Fuel | 7.1% | 7.6 ppm | free product | -- |

TABLE 67. *Chemical Contaminants Detected in Indiana Ground water (cont.)*

| Chemcial Type Chemical Name | Percent Freq. Per Chemical Type | Maximum Concen-tration Recorded | Concentration and Source of "Standard" Used for Registry | Abbrev. /Other Name |
|---|---|---|---|---|
| **5. Base/Neutral Fraction (50)[a]** | | | | |
| BIS (2-Ethylhexyl) Phthalate | 22.0% | 3,800 ppb | 6 ppb MCL* | |
| Naphthalene | 10.0% | 140 ppb | 20 ppb HA | |
| Di-N-Butylphthalate | 8.0% | 99 ppb | -- | |
| 1,2,4-Trichlorobenzene | 6.0% | 66 ppb | 70 ppb MCL* | |
| Diethylphthalate | 6.0% | 420 ppb | 5 ppm HA | |
| 1,3-Dichlorobenzene | 4.0% | 74 ppb | 600 ppb HA | |
| Dimethylphthalate | 4.0% | 850 ppb | -- | |
| Pyrene | 4.0% | 62 ppb | .03 RfD | |
| Butylbenzylphthalate | 4.0% | 3.7 ppb | 100 ppb PMCL | |
| Styrene | 4.0% | 220 ppb | 100 ppb MCL | |
| 1,4-Dichlorobenzene | 2.0% | 14 ppb | 75 ppb MCL | |
| 1,2-Dichlorobenzene | 2.0% | 6,000 ppb | 600 ppb HA | |
| N-Nitro-N-Dipropylamine | 2.0% | 240 ppb | -- | |
| Acenaphthalene | 2.0% | 1 ppb | -- | |
| Acemaphthene | 2.0% | 100 ppb | -- | |
| Fluorene | 2.0% | 38 ppb | -- | |
| N-Nitrosodiphenylamine | 2.0% | 240 ppb | -- | |
| Phenanthrene | 2.0% | 81 ppb | -- | |
| Anthracene | 2.0% | 58 ppb | 0.3 RfD | |
| Fluoranthene | 2.0% | 40 ppb | -- | |
| Benzo (A) Anthracene | 2.0% | 30 ppb | 0.1 ppb PMCL | |
| Chrysene | 2.0% | 26 ppb | 0.2 ppb PMCL | |
| Benzo (A) Pyrene | 2.0% | 12 ppb | 0.2 ppb PMCL | |
| Tetrahydrofuran | 2.0% | 1,620 ppb | -- | |
| **6. Pesticides (144)[a]** | | | | |
| Atrazine | 18.8% | 49 ppb | 3.0 ppb MCL | Aatrex |
| Metolachlor | 8.3% | 150 ppb | 100 ppb HA | Dual |
| Alchlor | 7.6% | 150 ppb | 2.0 ppb MCL | Lasso |
| Dicamba | 6.9% | 230 ppb | 200 ppb HA | Banvel |
| Ethylene dibromide | 4.9% | 0.85 ppb | .05 ppb MCL | EDB |
| Chlordane | 4.9% | 92 ppb | 2.0 ppb MCL | -- |
| 2,4-D | 3.5% | 12 ppb | 70 ppb MCL | -- |
| Dacthal | 3.5% | 0.51 ppb | 4,000 ppb HA | DCPA |
| Lindane | 2.8% | 1.2 ppb | 0.2 ppb MCL | g-BHC |
| Metribuzin | 2.8% | 8.2 ppb | 200 ppb HA | Sencor, Lexone |
| Trifluralin | 2.8% | 0.4 ppb | 5 ppb HA | Treflan |
| Dibromochloropropane | 2.1% | 0.1 ppb | 0.2 ppb MCL | DBCP |

TABLE 67. *Chemical Contaminants Detected in Indiana Ground water (cont.)*

| Chemcial Type Chemical Name | Percent Freq. Per Chemical Type | Maximum Concen-tration Recorded | Concentration and Source of "Standard" Used for Registry | Abbrev. /Other Name |
|---|---|---|---|---|
| Aldrin | 2.1% | 0.1 ppb | .00003 RfD | |
| Endrin | 2.1% | 0.26 ppb | 2.0 ppb MCL* | -- |
| Heptachlor | 2.1% | 0.8 ppb | 0.4 ppb MCL | -- |
| DDT | 2.1% | 0.25 ppb | -- | -- |
| Endosulfan sulfate | 2.1% | 1.37 ppb | -- | -- |
| Cyanazine | 2.1% | 0.96 ppb | 1 ppb HA | Bladex |
| Diazion | 2.1% | 0.65 ppb | 0.6 ppb HA | -- |
| Simazine | 2.1% | 25 ppb | 4.0 ppb MCL* | Simazine |
| Heptachlor epoxide | 1.4% | 0.22 ppb | 0.2 ppb MCL | -- |
| DDE | .14% | 0.24 ppb | -- | 00 |
| Terbufos | 1.4% | 12 ppb | 0.9 ppb HA | Counter |
| Permethrin | 1.4% | 0.5 ppm | -- | -- |
| Bromacil | 1.4% | 0.37 ppb | 90 ppb HA | -- |
| Methiocarb | 0.7% | 0.2 ppb | -- | -- |
| Bentazon | 0.7% | 1.16 ppb | 20 ppb HA | -- |
| Chlorpyrifos | 0.7% | 0.17 ppb | 20 ppb HA | Lorsban, Dursban |
| Dieldrin | 0.7% | 0.22 ppb | 0.00005 RfD | -- |
| a-BHC | 0.7% | 0.4 ppb | -- | -- |
| b-BHC | 0.7% | 0.8% | -- | -- |
| 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 |
| Dinoseb | 0.7% | 0.12 ppb | 7 ppb MCL* | -- |
| **7. Other Organic Chemicals (26)[a]** | | | | |
| PCB's (1016, 1242, 1248, 1260) | 42.3% | 1,100,000 ppb | 0.5 ppb MCL | -- |
| Phenol (Total) | 34.6% | 36,000 ppb | 4 ppm HA | -- |
| Cyanide | 11.5% | 420 ppb | 200 ppb MCL* | -- |
| Picoline | 7.7% | 1,100 ppb | -- | -- |
| Pyridine | 3.8% | 1,100 ppb | -- | -- |
| **8. Metals (296)[a]** | | | | |
| Iron | 26.0% | 5,200 ppm | 0.3 ppm SMCL | Fe |
| Manganese | 19.3% | 130 ppm | .05 ppm SMCL | Mn |
| Arsenic* | 11.5% | 50 ppm | .05 ppm MCL | As |
| Leas* | 8.1% | 2 ppm | 0.015 ppm AL | Pb |
| Sodium | 7.4% | 12,000 ppm | -- | Na |
| Chromium* | 7.1% | 66 ppm | 0.1 ppm MCL | Cr |

TABLE 67. *Chemical Contaminants Detected in Indiana Ground water (cont.)*

| Chemcial Type<br>Chemical Name | Percent Freq. Per Chemical Type | Maximum Concen-tration Recorded | Concentration and Source of "Standard" Used for Registry | Abbrev. /Other Name |
|---|---|---|---|---|
| Barium* | 7.1% | 18,350 ppm | 2.0 ppm MCL | Ba |
| Zinc | 3.4% | 211 ppm | 5 ppm SMCL | Zn |
| Nickel | 2.7% | 7.1 ppm | 0.1 ppm MCL* | Ni |
| Cadmium* | 2.7% | 10 ppm | 0.005 ppm MCL | Cd |
| Copper | 2.4% | 15 ppm | 1.3 ppm AL | Cu |
| Silver | 1.0% | 50 ppb | 0.1 ppm HA | Ag |
| Selenium* | 1.0% | 0.2 ppm | 0.05 ppm MCL | Se |
| Mercury* | 0.3% | 6.8 ppb | 0.002 ppm MCL | Hg |
| * Heavy Metals | | | | |
| **9. Other Inorganics (261)[a]** | | | | |
| Nitrate | 65.1% | 1,190 ppm | 10 ppm MCL | $NO_3$ |
| Chlorides | 14.6% | 22,000 ppm | 250 ppm SMCL | -- |
| Sulfates | 8.4% | 2,000 ppm | 400/500 ppm PMCL | -- |
| Fluorides | 5.7% | 5.0 ppm | 4 ppm MCL | -- |
| Ammonia | 5.4% | 174 ppm | 30 ppm HA | $NH_3$ |
| Nitrite | 0.4% | 0.1 ppb | 1 ppm MCL | $NO_2$ |
| Sulfides | 0.4% | 41 ppm | -- | -- |

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- trichloromethane (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 (aesthetic 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

**TABLE 68.** *Number of Sites With Specific Volatile Organic Chemicals*

| CHEMICAL | TYPE | NUMBER OF SITES |
|---|---|---|
| Trichloroethylene | H | 123 |
| 1,1,1-Trichloroethane | H | 94 |
| Toluene | A | 82 |
| Benzene | A | 77 |
| Xylenes (o,p & m) | A | 72 |
| Tetrachloroethylene | H | 60 |
| Ethylbenzene | A | 56 |
| 1,1-Dichloroethane | H | 47 |
| 1,2-Dichloroethane | H | 43 |
| t-1,2-Dichloroethylene | H | 37 |
| 1,1-Dichloroethylene | H | 33 |
| Methylene chloride | H | 33 |
| Vinyl chloride | H | 31 |
| Chloroform | H | 25 |
| Carbon tetrachloride | H | 13 |
| Acetone | NH | 12 |
| Methyl ethyl ketone | NH | 11 |
| Bromodichloromethane | H | 9 |
| Trichlorofluoromethane | H | 8 |
| Methyl isobutyl ketone | NH | 7 |
| 1,1,2-Trichloroethane | H | 5 |
| Dibromochloromethane | H | 5 |
| 1,1,2,2,-Tetrachloroethane | H | 4 |
| Bromoform | H | 4 |
| Chlorobenzene | H | 2 |
| Methyl tertiary butylether | NH | 2 |
| 1,2-Dichloropane | H | 1 |

***Note: H = Halogenated, A = Aromatic, NH = Non-Halogenated***

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.

# Part III. Geographic Areas Of Concern

## Areas Vulnerable to Ground Water Contamination

There are some areas of the state where the geologic setting makes the ground water more vulnerable to contamination then others. In this approach, vulnerability is considered as the relative ease for downward migration of a pollutant from a release at the surface. This is dependent in part on the permeability and thickness of the material overlying the ground water, which can be inferred from geologic maps. There are two conditions that can be considered to represent relatively high vulnerability to contamination: permeable deposits of mostly sand and gravel (and to a lesser extent, silt), and unconsolidated material less than 50 feet thick. These areas are shown in Figure 42.

Highly vulnerable areas of permeable geologic materials include: alluvium; valley-train and outwash plain sediments; muck, peat and marl paludal; eskers, kames, and kame complexes; eolian sand and slit; beach and shoreline deposits; sandy lacustrine sediments; and valley-train sand and gravel overlain by thin lacustrine or alluvial deposits.

**FIGURE 42.** *Areas Susceptible to Ground Water Contamination*

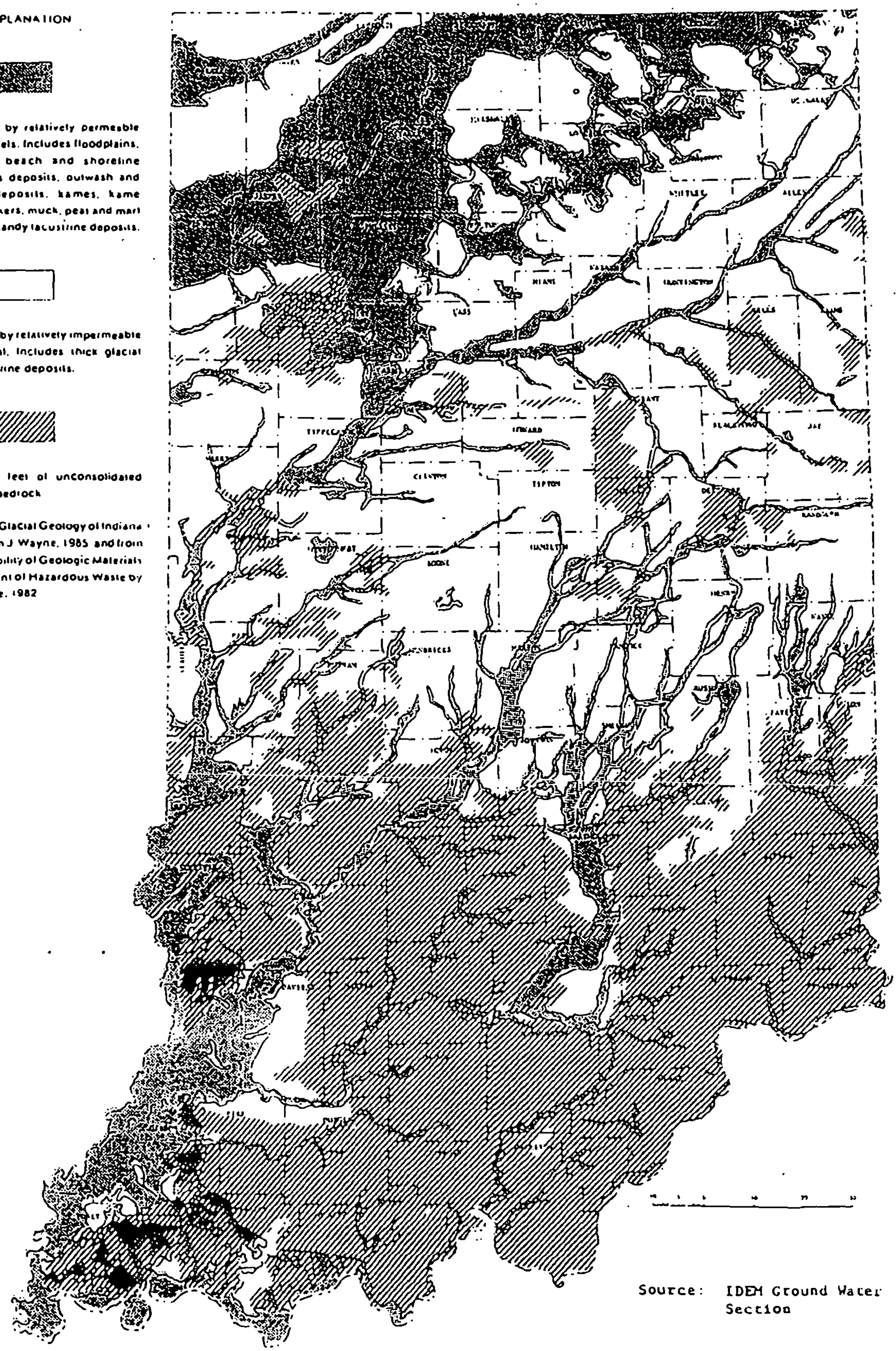
EXPLANATION

Areas covered by relatively permeable sands and gravels. Includes floodplains, dune sands, beach and shoreline deposits, loess deposits, outwash and valley-train deposits, kames, kame complexes, eskers, muck, peat and marl deposits, and sandy lacustrine deposits.

Areas covered by relatively impermeable clayey material. Includes thick glacial tills and lacustrine deposits.

Less than 50 feet of unconsolidated material over bedrock

Modified from Glacial Geology of Indiana map by William J Wayne, 1985 and from Relative Suitability of Geologic Materials for Confinement of Hazardous Waste by Hill and Hartke, 1982



Source: IDEM Ground Water Section

Where the unconsolidated deposits are of a shallow depth, conditions of high vulnerability to ground water contamination also exist. This is because there is relatively less material to slow contaminant migration into bedrock and bedrock aquifers, or into ground water in the non-bedrock material. Since the smallest contour interval on maps of the thickness of unconsolidated deposits statewide is 50 feet, areas with less than 50 feet of this material have been considered highly vulnerable for the approach shown in Figure 42.

An area of the state whose bedrock conditions are uniquely vulnerable to contamination of ground water is that with karst or sinkhole topography. The limestone bedrock appears close to the surface and typically contains sinkholes, caves, solution channels, and cave streams. Surface contaminants can rapidly enter and move in this ground water environment. The area of karst topography in Indiana is shown in Figure 43.

A soil survey report is available for every county in Indiana. The information available in these references is very detailed, compared to statewide geologic and ground water data. Knowledge of soil permeability, parent material, drainage, limitations on use, depth to water table, and other factors can be obtained from a soil survey. For site specific planning to identify conditions were the ground water is vulnerable to contamination, the soil surveys and assistance from soil scientists can be very useful. By contrast, the areas vulnerable to contamination based only on geologic information should be interpreted on a boarder scale and not for site specific decisions.

### Priority Sites for Wellhead Protection in Indiana

The federal Safe Drinking Water Act Amendments of 1986 established a program for protection of wellhead areas of public water supply systems from contamination. States prepare program plans describing the delineation and management of wellhead protection zones, and may receive federal financial assistance for these efforts. Protection of public water supply wellfields is also a prime initiative in the Indiana Ground Water Strategy and the Indiana Ground Water Protection Act.

The IDEM Ground Water Section identified priority sites in Indiana for Wellhead Protection (WHP), to be used for phasing in the delineation and management of WHP zones during program implementation. The criteria used in selecting the sites includes vulnerability to contamination, threats of contamination, and population served. The selection process involved the evaluation of local geologic conditions through review of over 1,500 well records for wellfields of 436 public water supply systems. Based on geologic conditions alone, 218 systems in the state were rated highly vulnerable to contamination, as shown in Figure 44.

FIGURE 43. *Areas of Exposed Karst Geology*

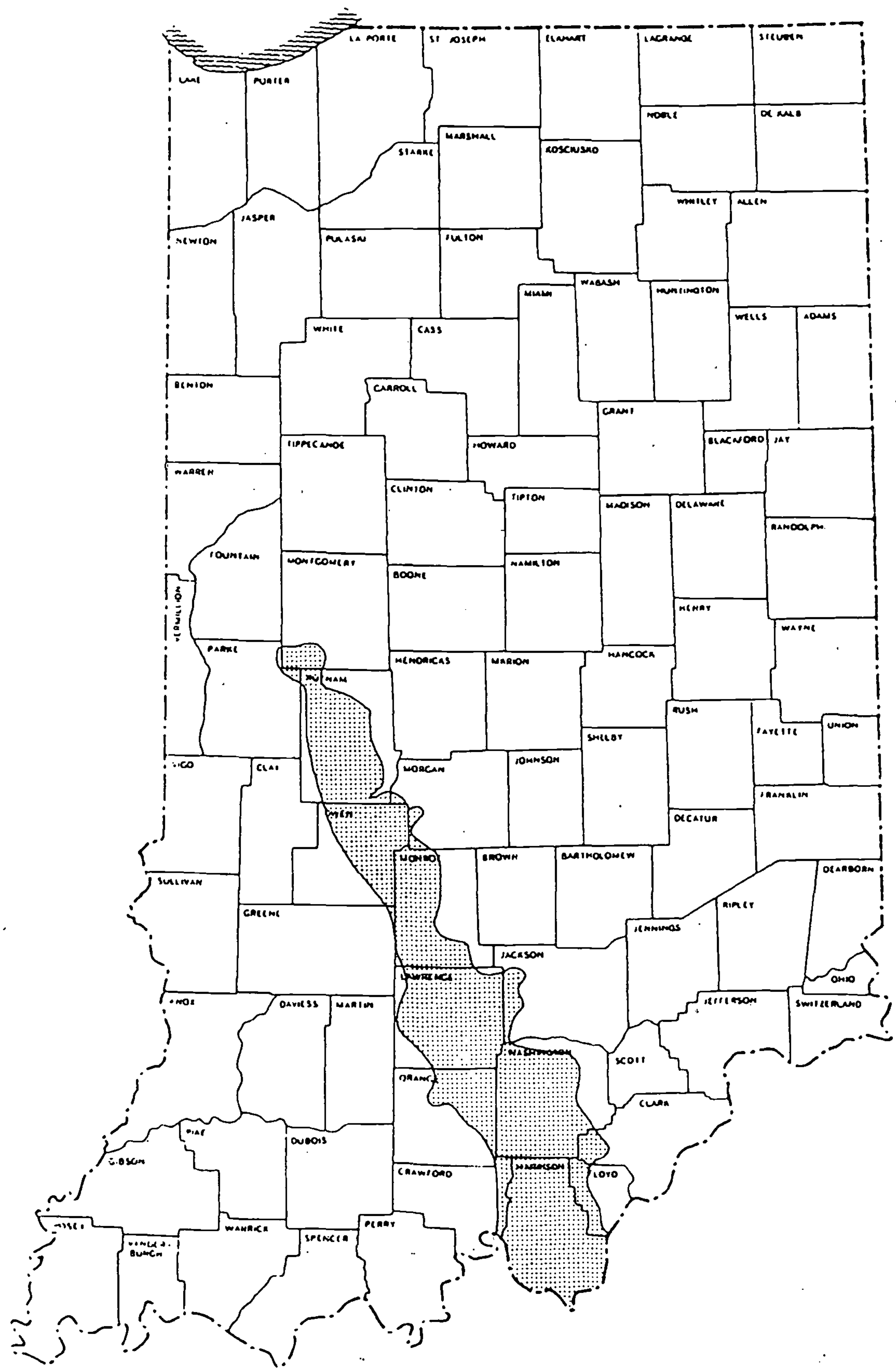
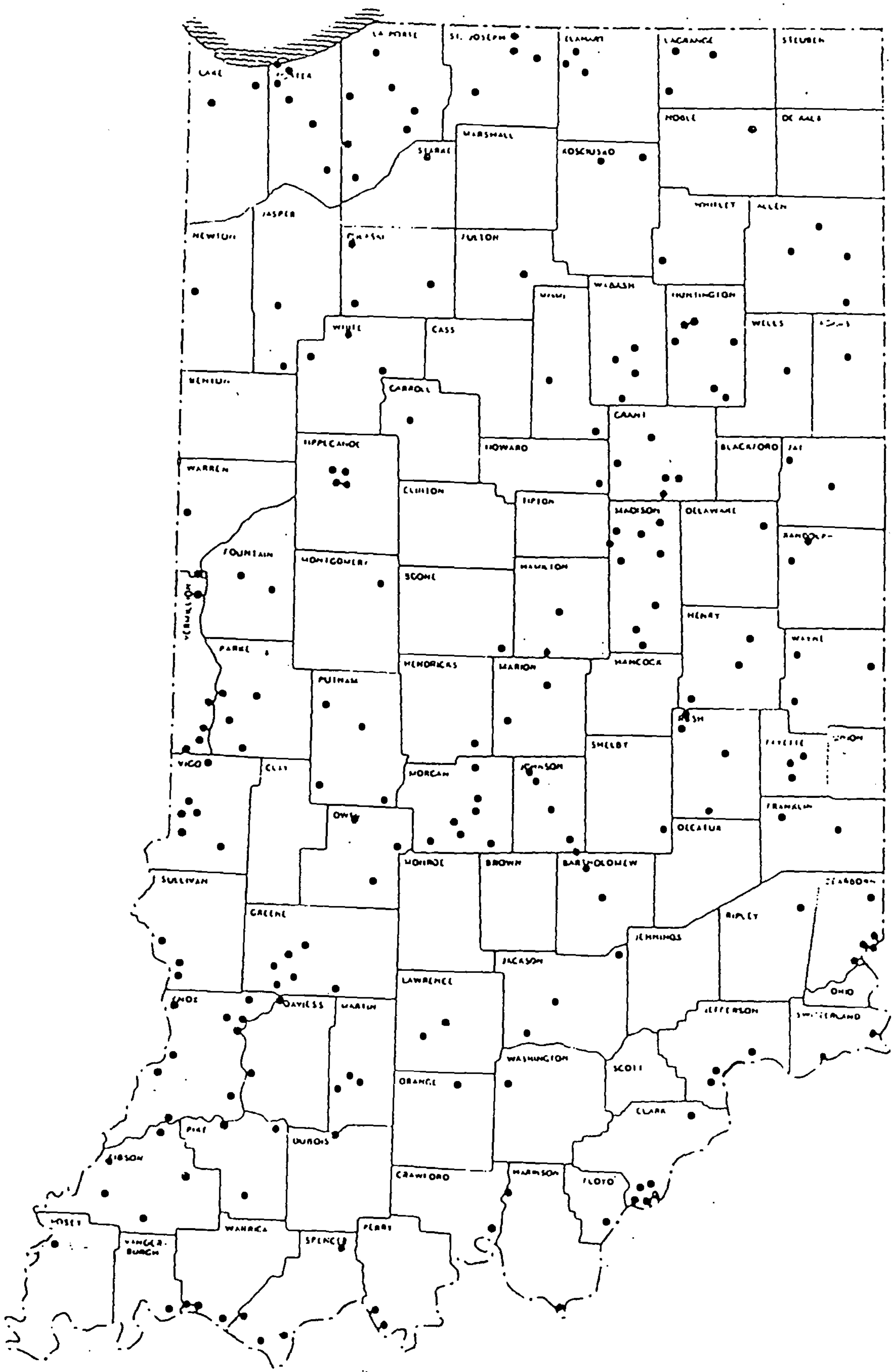


**FIGURE 44.** *Wellfields Vulnerable to Contamination*



**Potential Sole Source Aquifers in Indiana**

The Federal Safe Drinking Water Act established a program for formal designation and protection by EPA of sole source aquifers in the U.S. Formal designation by EPA of a sole source aquifer means that all federally financially assisted projects above the aquifer receive an evaluation for their potential to cause significant pollution. Adverse impacts that could result must be corrected in order for the federal funding to be allowed.

The IDEM Ground Water Section has prepared a statewide inventory of potential sole source aquifers. Conceptually, hydrogeologic environments were sought where one aquifer is thought to exist that serves nearly all (50 percent or more) of the water needs of nearby residents. Notably, the areas identified possess natural boundaries for use in prioritizing parts of the state for ground water protection and management activities. The incorporation of the sole source aquifer concept can be useful for ground water activities in the state needing higher status from a more regional basis. The inventory can provide a starting point for positioning the EPA for formal designation of some of Indiana's sole source aquifers.

Three, generic, geologic environments were examined for sole source aquifer potential. They include thick, glacial, valley train and sluiceway deposits, sand and gravel filled river valleys, and sandstones formed from ancient shorelines. In central and southern Indiana, there are several sand and gravel filled valleys following some of the state's major surface water drainage, including the Wabash River, East Fork White River, West Fort White River, the Ohio River, and the Whitewater River. In southwestern Indiana, some Pennsylvanian system sandstones, limestones and coals yield the only water available to private well users in the upland areas. This is in contrast to the other potential sole source aquifer environments where public water systems supply the majority of the residents with private wells comprising only a small portion of the water use. See Figure 45 for the location of Indiana's potential sole source aquifers and Table 69 for a summary of their use. The precise boundaries and hydrologic features of these aquifers will require detailed descriptions from a technical perspective. From a policy viewpoint, the inventory intends only to suggest that aquifer environments which satisfy the federal "sole source" criteria do exist in Indiana.

The St. Joseph River Valley and Tributary System Aquifer was designated a sole source aquifer in June, 1988 under Section 1424 (e) of the Safe Drinking Water Act of 1974. This section of the Act prohibits Federal financial assistance to any project that may contaminate a single source aquifer through its recharge zone. The St. Joseph River Valley aquifer is a glacio-fluvial body of outwash valley train which is underlain by shale and limestone not used as potable aquifers. Maximum daily use of water for the 211,000 people served by the 10 public supplies in this aquifer is 75 MGD and

FIGURE 45. *Potential Sole Source Aquifers in Indiana*

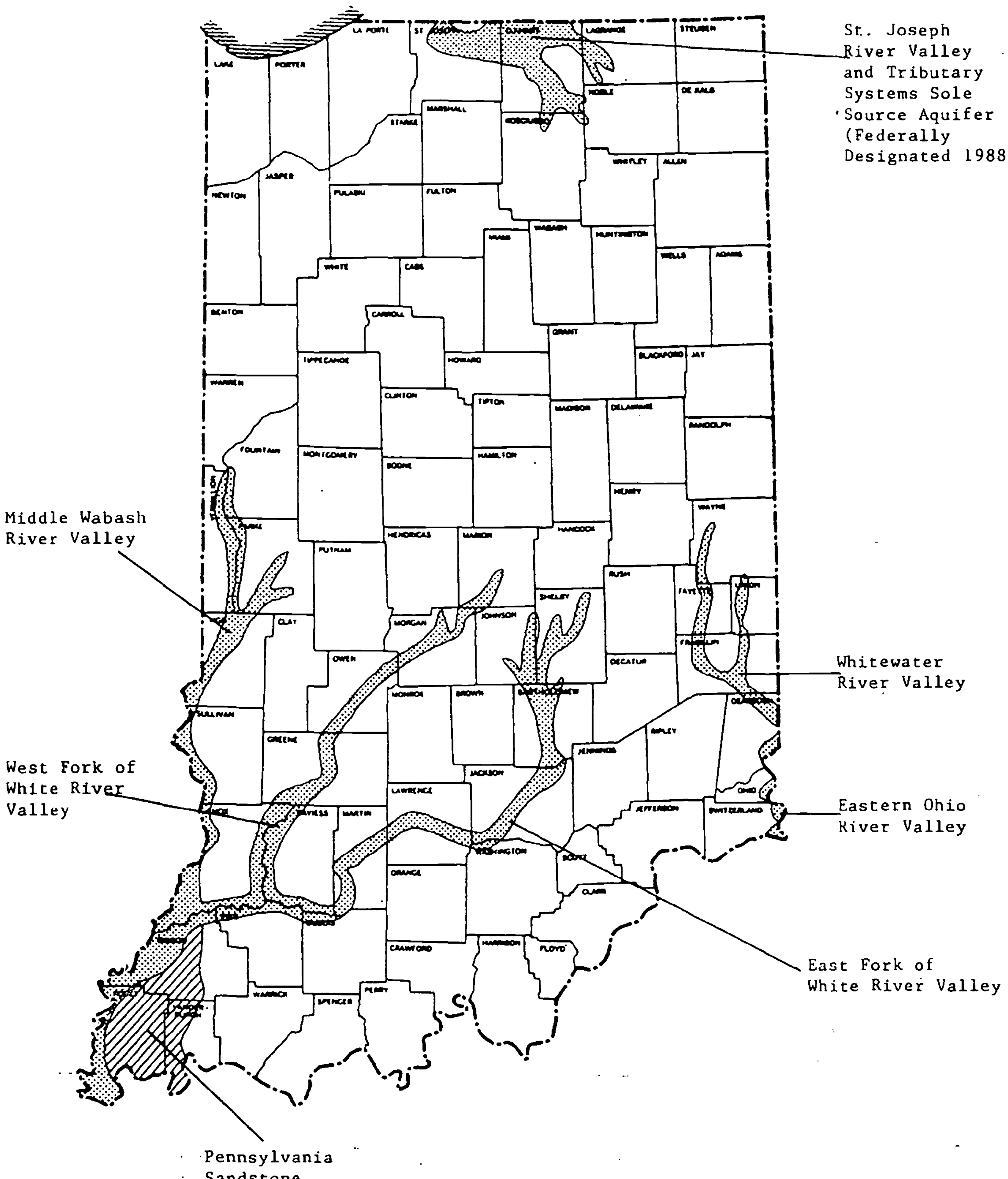


**TABLE 69.** *Ground Water Use in Indiana's Potential Sole Source Aquifers*

| AQUIFER NAME | NUMBER OF PUBLIC WATER SUPPLIES | POPULATION SERVED | MAXIMUM DAILY GROUND WATER USE (MGD) |
|---|---|---|---|
| 1. East Fork White River Valley | 12 | 84,487 | 25.936 |
| 2. West Fork White River Valley | 17 | 79,012 | 16.501 |
| 3. Whitewater River Valley | 10 | 33,008 | 9.961 |
| 4. Wabash River Valley | 17 | 31,271 | 6.127 |
| 5. Eastern Ohio River Valley | 7 | 41,062 | 7.434 |
| 6. Pennsylvanian Sandstone | 0 | 3,000 | 0.200 |
| TOTAL | 63 | 271,840 | 64.959 |

***Note:***
***MGD = Million Gallons Per Day***

***(Source: Data on Indiana Public Water Supplies, Bulletin No PWS-3, Indiana State Department of Health Public Water Division, revised 1984)***

up to 10,000 people may depend on private wells. The seasonal average flow of the river at Elkhart is 2,000 MGD and the once in 30 years low flow is 270 MGD. Average supply of surface water is 25 times present demand, but the piping, impoundment, and treatment plant infrastructure to use this does not exist. Therefore, the St. Joseph River Valley aquifer is the sole water source in use at this time.

# 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

In the 1988-89 305(b) Report the state expressed some concern about how combined sewer overflows (CSOs) and storm water runoff may be impacting surface water and how to best deal with these problems. Since that time, the state has worked on these concerns and has developed strategies to effectively handle these problems.

The U.S. EPA approved Indiana's CSO strategy 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 based on the approved strategy. The strategy is aimed at idenifying 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 any water quality impacts caused by the CSO events. If there are water quality impacts, the municipalities are expected to determine the cause and correct it.

On September 30, 1992, a new regulation will become effective. This regulation is 327 IAC, Article 15 and is identified as the NPDES General

Permit Rule Program. Rules 5 and 6 in Article 15 are the storm water general permits-by-rule. When Article 15 becomes effective, all point source dischargers of storm water will be 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 have 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. Sometimes it is not clear who is then responsible or accountable for the operation and maintenance of these facilities. The state needs to develop a strategy to allow for these facilities to be inspected and monitored on a regular basis and also to assure that responsible parties will be available to operate and maintain them as long as they are in use.

**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. Other than FDA Action Levels, which are available for relatively few toxic pollutants, little guidance is available to aid the state in interpreting these fish tissue data as to potential health effects. Health effects criteria for substances in fish tissue need to be 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 Initiative (GLWQI)**

Although the state has been involved in the process of developing the GLWQI, there are still concerns about the impacts that this guidance may have on the state. Although many of the criteria developed in the GLWQI do not appear to be substantially different than those Indiana already has in place, there is still concern expressed about these criteria and even more so about some of the implementation procedures in the guidance. It would appear that U.S. EPA and the states will still need to work closely together to present and explain this guidance once it is published for public comment. Perhaps

EPA should consider holding public meetings in each Great Lakes state to explain their GLWQI guidance.

## Biocriteria

The state is trying to acquire the data necessary to develop numeric biocriteria based on both fish and macroinvertebrate community data to compliment existing narrative biocriteria. However, due to severe personnel shortages, this process has fallen behind schedule. The state is still planning to develop these databases and, subsequently, numeric biocriteria, but the process may take longer than originally planned. These constraints need to be understood by EPA.

## Data Analysis and Report Writing

The state needs to develop a strategy which will place more emphasis on data review, analysis, interpretation and reporting. Due to lack of adequate time and personnel, most staff time has been spent in the gathering of data and not processing and reporting. A reduction in field and inspection activities may be necessary, unless additional staff can be acquired. The state and EPA need to discuss and agree on the time and priority given to each of these activities.

## 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 building departments 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 efforts are also gaining importance in the cleanup efforts. 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 rules taking effect on October 1, 1992, providing for permit requirements for stormwater runoff from construction and industrial activities.

## Ground Water Protection

The principal objective of Indiana's Ground Water Program 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 a 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 an improved public participation, education and awareness program. 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 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 commitment the agency can make to the 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.

# 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 | One | 7 | 27.0 | 10.0 | 0.03 | 5.0 | 7 | V |
| Crooked Creek | One | 13 | 27.0 | 10.0 | 0.03 | 5.0 | 7 | V |
| Ogle | One | 20 | 24.0 | 12.5 | 0.03 | 5.0 | 8 | V |
| Strahl | One | 6 | 23.0 | 9.0 | 0.05 | 5.0 | 10 | V |
| Yellowood (1990) | One | 133 | 30.0 | 14.2 | 0.03 | 11.5 | 11 | 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 | Three | 15 | 15.0 | 6.0 | 0.52 | 1.0 | 67 | IV B |
| **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 (1975) | Three | 23 | 14.0 | 6.0 | 0.23 | 2.5 | 60 | IV A |
| 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 (1990) | Two | 34 | 30.0 | 10.0 | 0.13 | 5.9 | 40 | VII A |
| Heaton (1989) | One | 87 | 22.0 | 7.4 | 0.03 | 5.4 | 14 | V |
| Hunter (1989) | One | 99 | 29.0 | 11.3 | 0.07 | 9.5 | 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 | VII A |
| Manitou (1991) | Two | 713 | 35.0 | 8.0 | 0.33 | 4.3 | 33 | 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 | Two | 200 | 20.0 | 5.0 | 0.10 | 2.5 | 49 | IV 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 (1989) | Two | 308 | 91.0 | 25.0 (Atypical) | 0.08 | 3.9 | 38 | VI A |
| Appleman (1989) | Two | 52 | 26.0 | 11.3 | 0.39 | 8.2 | 44 | VII C |
| Atwood (1989) | One | 170 | 33.0 | 18.0 | 0.06 | 6.2 | 21 | II B |
| Big Long (1989) | One | 388 | 82.0 | 40.0 | 0.21 | 10.8 | 19 | II B |
| Big Turkey (1989) | Two | 450 | 65.0 | 25.0 | 0.04 | 5.3 | 30 | VI A |
| Blackman (1989) | One | 67 | 60.0 | 18.1 | 0.03 | 8.2 | 24 | VI A |
| Brokesha (1990) | One | 36 | 40.0 | 10.0 | 0.03 | 9.2 | 20 | VII A |
| Cass (1989) | Two | 120 | 30.0 | 20.0 | 0.01 | 5.9 | 28 | VI A |
| Cedar (1989) | Two | 120 | 30.0 | 8.5 | 0.02 | 5.9 | 29 | 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 | Two | 283 | 96.0 | 35.2 | 0.633 / 0.05 | 9.0 / 6.5 | 28 | II C |
| Emma (1990) | Two | 42 | 34.0 | 16.7 | 0.05 | 3.3 | 32 | VII B |
| Eve | Two | 31 | 42.0 | 21.6 | 0.03 | 8.0 | 18 | VI A |
| Fish (Near Plato) (1989) | Three | 100 | 78.0 | 40.5 | 0.09 | 3.9 | 52 | IV D |
| Fish (Near Scott) (1989) | Two | 139 | 57.0 | 18.4 | 0.18 | 4.3 | 37 | VII B |
| Green (Rawles) | Four | 62 | 10.0 | 5.0 | Ill.Res. | 5.0 | 51 | V |
| Hackenberg (1990) | Three | 42 | 38.0 | 12.1 | 0.18 | 4.9 | 56 | III B |
| Hayward | Two | 6 | 20.0 | 15.0 | Ill.Res. | 6.0 | 43 | VII B |
| Lake of the Woods (1989) | Two | 136 | 84.0 | 40.2 | 0.19 | 4.6 | 29 | II C |
| Little Turkey (1989) | Two | 135 | 30.0 | 11.5 | 0.06 | 3.3 | 41 | VII B |
| Martin (1990) | Two | 26 | 56.0 | 34.2 | 0.02 | 11.8 | 34 | II C |
| Meteer (1991) | One | 18 | 18.0 | 8.3 | 0.03 | 11.2 | 6 | V |
| Messick (1989) | One | 68 | 55.0 / 54.0 | 21.3 | 0.23 | 4.9 | 25 | VI A |
| Mongo Res. (1989) | Four | 24 | 15.0 | 5.0 | 0.1 | 2.6 | 57 | IV A |
| Nasby Mill Pond | Two | 35 | 15.0 | 10.0 | 0.05 | 2.5 | 41 | IV B |
| Nauvoo | Three | 38 | 40.0 | 25.0 | 0.05 | 3.0 | 50 | VI A |
| North Twin (1989) | One | 135 | 30.0 | 15.7 | 0.08 | 7.9 | 16 | 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 (1989) | Two | 103 | 82.0 | 38.0 | 0.01 / 0.03 | 9.0 / 7.0 | 29 | II C |
| Oliver (1989) | Two | 362 | 91.0 | 40.0 | 0.01 / 0.03 | 12.0 / 10.0 | 27 | II C |
| Pigeon (North) (1989) | Two | 61 | 35.0 | 19.0 | .04 | 3.9 | 48 | VII B |
| Pretty (1989) | One | 184 | 84.0 | 25.7 | 0.1 | 9.2 | 14 | VI A |
| Rainbow | Two | 16 | 40.0 | 15.6 | 0.03 | 2.64 | 31 | VII B |
| Royer (1989) | Two | 69 | 59.0 / 56.0 | 23.6 | 0.19 | 2.6 | 44 | IV D |
| Shipshewana (1987) | Three | 202 | 14.0 | 6.7 | 0.18 | 1.5 | 53 | IV A |
| South Twin (1989) | One | 116 | 52.0 | 31.0 | 0.03 | 4.9 | 22 | II B |
| Spectacle Pond | Three | 6 | 20.0 | 7.5 | Ill. Res. | 8.0 | 52 | IV A |
| Star Mill Pond | Four | 38 | 10.0 | 10.0 | 0.03 | 4.0 | 43 | VII C |
| Still (1991) | Two | 30 | 58.0 | 20.7 | 0.05 | 10.5 | 26 | VI A |
| Stone (1989) | One | 116 | 58.0 | 14.7 | 0.02 | 10.5 | 23 | V |
| Wall (1989) | One | 141 | 34.0 | 11.0 | 0.03 | 10.2 | 11 | V |
| Weir | Four | 6 | 19.0 | 12.0 | 0.03 | 9.0 | 10 | V |
| Westler (1989) | Three | 88 | 38.0 | 20.1 | 0.24 | 3.9 | 53 | IV B |
| Witmer (1989) | Two | 204 | 54.0 | 34.5 | 0.24 | 3.4 | 32 | 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 (1990) | One | 346 | 31.0 | 9.2 | 0.05 | 5.3 | 17 | V |
| 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 (1987) | One | 1,864 | 88.0 | 24.5 | 0.034 | 8.0 | 13 | 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<br>16 | I |
| Mississinewa Res. (Dam) (1991) | One | -- | -- | -- | 0.05 | 5.3 | 25 | I |
| **MONROE CO.** | | | | | | | | |
| Cherry | One | 4 | 30.0 | 12.0 | 0.01 | 8.0 | 15 | V |
| Bryants Creek Lake | One | 9 | 23.0 | 10.0 | 0.02 | 6.0 | 15 | 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 (1989) | Two | 136 | 59.0 | 22.3 | 0.16 | 3.0 | 46 | VI B |
| Big (1990) | Three | 228 | 70.0 | 24.7 | 0.06 | 6.2 | 58 | IV D |
| Bixler (1990) | One | 117 | 43.0 | 17.4 | 0.15 | 5.9 | 24 | 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 (1990) | Two | 58 | 26.0 | 15.7 | 0.04 | 5.6 | 36 | VII B |
| Crooked (1987) | One | 206 | 108.0 | 43.0 | 0.065 | 10.0 | 12 | II B |
| Deer (1990) | Two | 36 | -- | -- | 0.05 | 3.0 | 44 | |
| Diamond (1990) | Three | 105 | 81.0 | 14.0 | 0.25 | 3.9 | 56 | IV B |
| Dock (1991) | Two | 16 | 40.0 | 16.6 | 0.33 | 3.9 | 35 | VII B |
| Duely (1991) | One | 21 | 19.0 | 8.6 | 0.08 | 4.6 | 25 | VII A |
| Eagle (1989) | One | 81 | 49.0 | 13.0 | 0.13 | 5.6 | 25 | VIIA |
| Engle (1989) | Two | 48 | 29.0 | 14.0 | 0.05 | 9.5 | 26 | VII A |
| Gilbert (1991) | One | 28 | 36.0 | 17.5 | 0.06 | 11.5 | 13 | VI A |
| Gordy (1991) | Two | 31 | 35.0 | 21.9 | 0.11 | 9.5 | 35 | VII B or VI A |
| Hall (1991) | One | 10 | 35.0 | 18.0 | 0.06 | 4.6 | 23 | VI A |
| Harper (1991) | Two | 11 | 25.0 | 14.5 | 0.08 | 7.5 | 29 | VII B |
| Henderson (1990) | Two | 22 | 35.0 | 15.0 | 0.09 | 1.6 | 28 | VI A |
| High (1990) | Three | 123 | 25.0 | 10.1 | 0.27 | 2.0 | 63 | IV B |
| Hindman (1991) | Two | 13 | 20.0 | 10.8 | 0.05 | 9.2 | 26 | 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 (1991) | One | 9 | 19.0 | 8.9 | 0.06 | 7.2 | 13 | V |
| 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 (1991) | One | 5 | 15.0 | 6.0 | 0.05 | 8.5 | 14 | V |
| Rivir (Chain of Lakes) (1991) | Two | 24 | 32.0 | 15.8 | 0.48 | 4.6 | 32 | VII B |
| Round (1989) | One | 99 | 66.0 | 21.6 | 0.06 | 4.9 | 24 | VI A |
| Sacarider (1990) | Two | 33 | 60.0 | 22.4 | 0.04 | 5.6 | 45 | VI A |
| Sand (Chain of Lakes) (1989) | Two | 47 | 51.0 | 27.0 | 0.2 | 8.2 | 33 | VI A |
| Shockopee | Two | 21 | 26.0 | 13.3 | 0.94 | 5.0 | 30 | VII A |
| Skinner (1990) | Three | 125 | 32.0 | 14.0 | 0.09 | 3.6 | 70 | VII C |
| Smalley (1989) | Three | 69 | 49.0 | 22.0 | 0.31 | 4.9 | 54 | IV D |
| Sparta (1991) | One | 31 | 10.0 | 5.5 | 0.06 | 7.5 | 10 | V |
| Stienbarger (1989) | Two | 73 | 39.0 | 21.8 | 0.26 | 5.6 | 31 | VI A |
| Sylvan (1991) | Two | 575 | 36.0 | 14.0 | 0.21 | 2.6 | 40 | VII B |
| Tamarak (1989) | Two | 50 | 37.0 | 17.6 | 0.29 | 4.9 | 40 | VII B |
| Upper Long (1989) | Two | 86 | 54.0 | 22.1 | 0.15 | 6.4 | 32 | VI A |
| Waldron (1989) | Two | 216 | 45.0 | 14.4 | 0.29 | 3.9 | 39 / 42 | VII C |
| Wible (1990) | Two | 49 | 27.0 | 13.3 | 0.34 | 2.3 | 37 | VII C |
| 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 | Two | 9 | 20.0 | 9.0 | 0.03 | 7.0 | 24 | 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 (1989) | One | 87 | 66.0 | 40.5 | 0.18 | 4.6 | 24 | II C |
| Barton (1989) | One | 94 | 44.0 | 14.3 | 0.08 | 12.1 | 14 | V |
| Bass | Two | 61 | 20.0 | 7.4 | 0.06 | 11.0 | 34/31 | |
| Beaver Dam (1990) | One | 11 | 26.0 | 15.0 | 0.03 | 6.9 | 17 | VI A |
| Bell (1990) | One | 38 | 24.0 | 13.4 | 0.03 | 12.1 | 24 | 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 |
|---|---|---|---|---|---|---|---|---|
| Big Bower (1990) | Two (Atypical) | 25 | 22.0 | 11.2 | 0.00 | 4.3 | 27 | VII A |
| Big Otter (1989) | Two | 69 | 38.0 | 25.8 | 0.12 | 6.6 | 41 | IV D |
| 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 | Four | 20 | 57.0 | 15.0 | Illogical Results | 5.0 | 30 | VI A |
| Center (1989) | Two | 46 | 19.0 | 8.5 | 0.53 | 1.5 | 34 | VII A |
| Charles (1988) | Three | 150 | 10.0 | 5.0 | 0.38 | 0.5 | 55 | IV C |
| Cheesboro | Two | 27 | 16.0 | 10.0 | 0.05 | 5.0 | 40 | VII C |
| Clear (1989) | One | 800 | 107.0 | 31.2 | 0.09 | 7.6 | 19 | 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 | Four | 12 | 28.0 | 10.0 | 0.06 | 5.0 | 51 | IV A |
| Failing (1991) | Two | 23 | 35.0 | 8.0 | 0.09 | 11.5 | 30 | VII A |
| Fish (1989) | Two | 59 | 34.0 | 12.7 | 0.33 | 3.6 | 38 | IV B |
| Fox (1989) | One | 142 | 55.0 | 22.2 | 0.05 | 14.1 | 17 | VI A |
| Gage (1989) | One | 332 | 70.0 | 30.6 | 0.03 | 18.7 | 15 | II B |
| George (1989) | One | 488 | 71.0 | 25.0 | 0.10 | 7.2 | 16 | II B |
| Golden (1990) | Two | 119 | 31 | 15.2 | 0.12 | 4.3 | 49 | IV D |
| Gooseneck | One | 25 | 28.0 | 20.0 | 0.03 | 7.0 | 15 | VI A |
| Grass | Four | 20 | 25.0 | 10.0 | 0.03 | 5.0 | 24 | VII A |
| Gravel | One | 12 | 89.0 | 10.0 | 0.05 | 5.0 | 19 | VII A |
| Gravel Pit | One | 28 | 29.0 | 15.0 | 0.03 | 9.0 | 12 | VI A |
| Green | One | 24 | 27.0 | 10.0 | 0.02 | 9.5 | 15 | VII A |
| Hamilton (E. Bas. 1991) | Two | 802 | 70.0 | 20.0 | 0.12 | 4.3 | 26 | |
| Handy | Four | 16 | 41.0 | 18.1 | 0.04 | 10.0 | 35 | VI A |
| Henry | Four | 20 | 25.0 | 15.0 | 0.32 | 5.0 | 38 | VII B |
| Hog (1989) | One | 48 | 26 | 11.8 | 0.09 | 8.9 | 19 | VII A |
| Hogback (1990) | Three | 146 | 26 | 10.1 | 0.29 | 3.3 | 53 | IV B |
| Howard | Four | 27 | 12.0 | 4.8 | Illogical Result | 5.0 | 64 | IV A |
| James (1989) | One | 1,034 | 86.0 | 35.5 | 0.1 | 8.5 | 15 | II B |
| Jimmerson (1989) | One | 346 | 56.0 | 36.0 | 0.09 | 9.2 | 20 | 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) | Three | 34 | 37.0 | 21.8 | 2.09 | 6.9 | 63 | IV D |
| Little Turkey (1989) | Two | 58 | 30.0 | 13.4 | 0.1 | 6.6 | 47 | VII B |
| Lime | Four | 30 | 29.0 | 11.0 | 0.03 | 10.0 | 10 | V |
| Lime-Kiln | Two | 25 | 22.0 | 10.0 | 0.04 | 5.0 | 42 | VII C |
| Long A (Near Pleasant) (1990) | Two | 92 | 33.0 | 16.7 | 0.18 | 3.3 | 48 | VII B |
| Long B (Clear) (1989) | Two | 154 | 36.0 | 11.9 | 0.13 | 4.3 | 40 | VII C |
| Loon (1989) | One | 138 | 18.0 | 4.6 | 0.05 | 8.2 | 16 | V |
| Marsh (1988) | Three | 56 | 38.0 / 35.0 | 20.0 | 0.60/0.50/0.39 | 6.0 / 5.5 / 4.5 | 67 / 65 / 54 | IV B |
| McClish (1989) | One | 35 | 57.0 | 34.6 | 0.16 | 8.9 | 24 | II C |
| Meserve (1990) | One | 16 | 25.0 | 14.0 | 0.18 | 12.8 | 14 | V |
| Middle Center | Three | 15 | 20.0 | 5.0 | 0.50 | 5.0 | 62 | IV A |
| Mirror | Four | 9 | 60.0 | 13.3 | 0.03 | 10.0 | 25 / 12 | VII A |
| Mud B | Four | 16 | 40.0 | 18.0 | 0.05 | 5.0 | 59 | VII B |
| Mud C | Four | 20 | 32.0 | 6.0 | 0.25 | 5.0 | 48 | VII C |
| Perch | Four | 12 | 36.0 | 18.0 | 0.04 | 5.0 | 30 | VII B |
| Pigeon (1990) | Two | 61 | 38.0 | 15.2 | 0.16 | 2.3 | 26 | VI A |
| Pleasant (1989) | One | 53 | 44.0 | 30.0 | 0.08 | 10.8 | 15 | II A |
| Round A | Two | 30 | 60.0 | 35.0 | 0.06 | 6.0 | 25 | II C |
| 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 (1989) | One | 238 | 38.0 | 10.7 | 0.04 | 10.5 | 21 | VII A |
| Snow (1989) | Two | 421 | 84.0 | 30.0 | 0.15 | 8.2 | 32 | II C |
| Stayner | Four | 5 | 10.0 | 7.0 | 0.03 | 7.0 | 51 | VII A |
| Tamarak | Two | 47 | 14.0 | 5.0 | 0.04 | 7.0 | 30 | VII A |
| Walters (1989) | Four | 53 | 29.0 | 10.4 | 0.23 | 4.9 | 33 | VII C |
| Warner | Four | 17 | 25.0 | 15.0 | 0.04 | 7.0 | 30 | VII A |
| West Otter (1989) | Three | 118 | 31.0 | 16.6 | 0.09 | 2.6 | 52 | VII 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 |
|---|---|---|---|---|---|---|---|---|
| **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 | Two | 50 | 40.0 | 15.0 | 0.14 | 10.0 | 50 | VII B |
| 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 |