OWQ- WATERSHED ASSESSMENT & PLANNING BRANCH
IDEM/OWQ/WAPB/WS
VIRTUAL FILE CABINET INDEX FORM

Program: Watershed

Document Type: Report

*Document Date: 6/30/1990

*Security: Public

Project Name: Indiana 305(b) Report 1988-89

*Report Type 305B/Integrated

Fiscal Year: No Selection

HUC Code: 00000000 Statewide

Contract #:

County: No Selection

Cross Reference ID:

Comments: Indiana 1988-89 Integrated Report (305(b) Report and 303(d) List of Impaired Waterbodies)

Redaction Reference ID:

INDIANA
DEPARTMENT
OF
ENVIRONMENTAL
MANAGEMENT

OFFICE OF WATER MANAGEMENT
105 SOUTH MERIDIAN STREET
INDIANAPOLIS, IN 46206

INDIANA 305 (b) REPORT
1988 - 89

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EXECUTIVE SUMMARY

The 1988-89 305(b) Report is organized into four major sections, and Indiana's activities and concerns in each area are summarized or discussed as follows:

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

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

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

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

There are about 90,000 miles of rivers, streams, ditches and drainageways in Indiana. Of these, approximately 20,000 miles have sufficient all-weather flow and other physical characteristics necessary to support both the fishable and swimmable uses. Approximately 25% 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 100,000 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.

Different, more stringent criteria were used to determine the extent of support of designated uses in this report than in those prepared in previous years. Of the waters assessed, 60% 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 6% and the fishable goal was supported in 60%. 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 considerable monitoring for toxic substances in fish tissue and sediments. Over 2,500 stream miles and approximately 23,500 inland lake and reservoir acres were monitored in some way for toxics. Of the river and stream miles monitored, about 45% 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 about 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 1988, while the percentage served by advanced treatment facilities increased from 0% to 51% 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 $1.3 billion in federal construction grants money and has spent over $181 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 230 claims for more than $1,061,677,161 in tax exemptions for industrial wastewater treatment or control facilities in 1989. There were only 102 claims for $369,187,000 in 1978.

Indiana has a plentiful ground water resource serving 60% 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 man's activities, over 590 sites of ground water contamination have been documented. These problems affect over 1,720 individual wells and several hundred thousand people.

The substances most frequently detected as well water contaminants in the state are chlorinated volatile organic chemicals, petroleum products, heavy metals and nitrate. Monitoring wells at waste disposal sites most often indicate ground water pollution from inorganic chemicals like heavy metals. There is not a great deal of ground water data regarding pesticides in Indiana. However, concerns about the application of agricultural chemicals to farmlands and their potential effects on ground water has prompted the IDEM Ground Water Program to conduct several statewide studies during this reporting period. The data from these studies indicate that nonpoint sources are at least as significant as point sources in contributing to ground water pollution by these chemicals. Rural wells tend to have a higher incidence of detectable pesticides levels when compared to all wells statewide. However, less than half of those incidences constitute long-term health risks to well users. About 7-10% 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 material spills, leaking underground storage tanks and waste disposal activities. However, there are a wide variety of both contamination sources and their associated chemical pollutants which have been documented in Indiana's ground water.

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

In 1987, Indiana completed a comprehensive Ground Water Protection Strategy which addresses the problems documented in this report. Information needs and solutions to these problems are also discussed. 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 accomplishment 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 wastes 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 place heavier demands for a share of the water resource. There is now much greater concern for the preservation of some of Indiana's waterways in their natural state and to protect the waters and riparian habitat for fish, other aquatic life forms, and wildlife.

Although the population of Indiana and its demands on the water resource have increased greatly since the turn of the century, the extent of the water resource remains essentially the same. Of the estimated 90,000 total miles of water courses in Indiana, only about 20,000 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 more than 90 percent 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 100,000 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 1988-89.

II. SURFACE WATER QUALITY

Current Status and Designated Use Support

There are roughly 90,000 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 Stream Pollution Control Laws. Most of these drainageways do not even appear on detailed 1:24,000 scale United States Geological Survey (USGS) maps. Because of the way streams are formed in nature, the number of miles of temporary headwater streams is far larger than the miles of permanent streams.

There are probably no more than 10,000 miles of permanently flowing streams in Indiana which appear on a 1:500,000 scale USGS map. All of these are assumed to have enough depth and habitat the year around to be "fishable" and "swimmable". The remaining 80,000 stream miles could be assumed to be only intermittently flowing. Of this total, only about 20,000 miles of these "intermittent streams" appear on the more detailed 1:24,000 scale USGS maps. The remaining 60,000 miles of "intermittent" surface drainages probably hold water only periodically following heavy rainfalls and could not be "fishable."

Since 1979, the state has investigated over 250 "intermittent streams" appearing on 1:24,000 scale USGS maps to determine their existing and potential uses. About 50% of those examined have had adequate depth and habitat to be "fishable" and probably "swimmable" as well. This proportion of "fishable" headwater streams remained fairly constant throughout each physiographic region of the state. If only half of the 20,000 miles of the larger "intermittent streams" and none of the smaller temporary drainage ditches (60,000 miles) are capable of supporting these uses, there must be at least 70,000 miles of waterways in the state which cannot realistically be expected to meet the goals of the Clean Water Act during most of the year because of natural physical constraints. This leaves approximately 20,000 miles of surface waterways which could be assessed as to their degree of support of designated uses and Clean Water Act goals. Table 1 shows the total size of various types of waterbodies classified for various uses.

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 most waters in 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.*

CLASSIFIED USE	TOTAL SIZE CLASSIFIED FOR USE		
	RIVERS (MILES)	LAKES (ACRES)	LAKE MICHIGAN (SHORELINE MILES)
Aq. Fish & Wildlife	90,000 (20,000)*	106,203	43
Domestic water supply	**	32,000	43
Recreation	90,000 (20,000)*	106,203	43
Agriculture	90,000 (20,000)*	106,203	43
Industrial	90,000 (20,000)*	106,203	43
Navigation	--	--	43
Nondegradation	90,000 (20,000)*	106,203	43
Other (specify)	--	--	--
Unclassified	--	--	--

* *Although there are approximately 90,000 miles of watercourses and drainageways in Indiana which would technically fall under the jurisdiction of the water quality standards, only about 20,000 miles could reasonably be expected 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 all pollutants, criteria exceeded in $\leq$10% of measurements and mean of measurements is less than criteria. No fish consumption advisory exists.	For any one pollutant, criteria exceeded 11-25% and mean of measurements is less than criteria; <u>or</u> criteria exceeded $\leq$10% and mean is greater than criteria. A "general" fish consumption advisory exists	For any one pollutant, criteria exceeded >25% <u>or</u> criteria exceeded 11-15% and mean of measurements is greater than criteria. A complete ban on consumption of fish is recommended.
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 waterbody support of aquatic life and recreational uses separately. There are several 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. The state was in a transitional period in changing from fecal coliform as the bacteriological indicator to Escherichia coli.

3. Almost all field monitoring data were for E. coli but NPDES permits and the water quality standards in effect for most of this two year period were based on fecal coliform.

4. During this two year period most of the waters of the state were designated for partial body contact, but there is no appropriate E. coli criteria for this designation as all waters are designated for whole body contact in the new water quality standards (125/100 ml E. coli as a geometric mean and 235/100 ml E. coli as a maximum for whole body contact versus 1000/100 ml fecal coliform as a geometric mean and 2000/100 ml fecal coliform as a maximum for partial body contact).

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 problem. All NPDES permit holders that have disinfection requirements in their permits are required to meet limits to support whole body contact recreational uses. However, for most permit holders these limits are still in terms of fecal coliform bacteria, i.e., 200/100 ml as a monthly geometric mean and 400/100 ml as a weekly geometric mean. In 1988-89, there were 77 facilities that reported one or more violations of either the monthly average or weekly average permit limits. In many cases, a single sample exceeded the 400/100 ml limit but the monthly geometric mean was not exceeded. Many of these violations were at semi-public facilities. While some of the bacteriological problems result from these facilities, it is quite likely that many 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 contribution of each of these various sources to the problem.

In addition, two parameters for which the state has collected considerable data were not included in the determination of support or non-support of designated uses due to what appear to be unusual circumstances. These parameters will be discussed here, but they were not utilized in determining support of uses for waters of Indiana.

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 limit 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.

Mercury is the other parameter which presents a special situation. Although the chronic aquatic life criterion (0.012 ug/l) for mercury is also below the current detection limit (0.1 ug/l), this situation is different than that for arsenic. Whereas all arsenic samples in the Fixed Station Water Quality Monitoring Network data were found to be above the detection limit, most mercury samples were reported as less than 0.1 ug/l at all localities until the last quarter of 1988. At that time, rather high values for mercury suddenly began appearing in waters throughout the state. For instance, the five Lake Michigan stations showed less than values (with an occasional 0.1 ug/l) for all of 1986, 1987 and the first nine months of 1988. In October, November and December 1988, values at these stations were reported as high as 5.5 ug/l. During these same months, high values were reported for many other stations throughout the state. Similar results were found during the first two months of 1989, but values have now returned to mostly undetectable levels. It does not seem reasonable that mercury concentrations would suddenly increase by these relatively large amounts at most stations around the state at the same time, then drop back to undetectable values. However, these samples are prevalent enough in the data set that they would cause most waters of the state to be put in the partial or non-support category for aquatic life uses. These mercury results more reasonably fit a scenario of sample contamination (lab or field) problems. The state is currently trying to determine if this is the cause of these short-term high values. Furthermore, although considerable fish tissue sampling has been conducted on many lakes and streams throughout the State, no fish tissue samples have been found to exceed FDA Action Levels for mercury.

Tables 3 and 4 summarize the current status of use support in waterbodies of Indiana. There are roughly 20,000 miles of rivers and streams in Indiana which are potentially both "fishable" and "swimmable" during most of the year. About one-quarter of these miles were assessed for support of aquatic life uses. Of those miles assessed, 61% were judged to be fully supporting of aquatic life uses. Another 23% were partially supporting these uses, while 16% did not support these uses.

Only a little more than 10% of these 20,000 miles were assessed for attainment of whole body contact recreation uses. About 6% of the waters assessed fully supported this use designation, about 7% partially supported it, and 87% did not support this use due to frequent high E. coli

TABLE 3. *SUPPORT USES BY VARIOUS WATERBODY TYPES (EXCLUDING OHIO RIVER MAINSTEM)*

DEGREE OF USE SUPPORT	RIVERS AND STREAMS (MILES)						LAKES (ACRES)						LAKE MICHIGAN (SHORELINE MILES)					
	EVALUATED		MONITORED		TOTAL ASSESSED		EVALUATED		MONITORED		TOTAL ASSESSED		EVALUATED		MONITORED		TOTAL ASSESSED	
	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.	AQUATIC LIFE	REC.
Size fully supporting	1751	0	819	138	2570	138	63,494	97,372	33,878	0	97,372	97,372	--	--	--	43	--	43
Size threatened	272	0	144	0	416	0	0	0	*	--	--	--	--	--	--	--	--	--
Size partially supporting	207	2	936	151	1143	153	63	63	0	0	63	63	--	--	43	--	43	--
Size not supported	102	8	686	2005	788	2013	101	89	0	0	101	89	--	--	--	--	--	--
TOTAL	2,262	10	2,655	2,294	4,917	2,304	63,658	97,524	33,878	0	97,536	97,524	--	--	43	43	43	43

* All lakes are considered threatened to some extent by nonpoint urban and agricultural sources.

TABLE 4. *ATTAINMENT OF CLEAN WATER ACT GOALS*

GOAL ATTAINMENT	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKES MICHIGAN (SHORELINE MILES)	
	FISHABLE GOAL	SWIMMABLE GOAL	FISHABLE GOAL	SWIMMABLE GOAL	FISHABLE GOAL	SWIMMABLE GOAL
Size meeting	2,986	138	97,372	97,372	--	43
Size partially meeting	1,143	153	63	63	43	--
Size not meeting	788	2,013	101	89	--	--
Size not attainable*	77	--	--	--	--	--
TOTAL	**4,994**	**2,304**	**97,536**	**97,524**	**43**	**43**

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

concentrations. When separated into Clean Water Act goal categories, 60% of all stream miles assessed fully supported the "fishable" goal but only 6% were considered "swimmable". Only about 1% of the assessed miles have been officially designated as having uses less than "fishable" and "swimmable".

The quality of the rivers and streams assessed for this report appears to have decreased somewhat from the previous reporting period, especially with regard to support of recreational uses. However, for this assessment, all rivers and streams were considered to be designated for full body contact recreational use whereas in the past most of these waters were designated for partial body contact uses. Thus, for this assessment, bacteriological criteria were more stringent than those used in previous assessments. Also, the bacteriological indicator utilized in this assessment was *Escherichia coli* instead of the fecal coliform group which was utilized previously. Most NPDES permits still contain limits based on fecal coliform bacteria.

For this assessment, the quality of the waters was compared to recently adopted numerical water quality criteria for the most part, and these criteria were not in place for the last assessment. These new criteria have not yet been utilized to determine NPDES permit limits for many dischargers.

For these reasons, the State feels confident that the apparent decline in water quality is due to the differences in the criteria utilized in the assessment for this reporting period compared to those used previously.

Enough information was available to assess about 93% of the total acreage of the state's publicly owned inland lakes and reservoirs. All but about 0.2% of the lake and reservoir acreage assessed fully supported uses. The number of acres considered not meeting the "swimmable" goal was roughly equal to the number not meeting the "fishable" goal. No lakes in Indiana are designated for less than "swimmable" and "fishable" uses.

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. None of the lake has been designated for less than "fishable" and "swimmable" uses.

It has been estimated that in presettlement times there were approximately 5.6 million acres of wetlands in Indiana. These ranged from permanently flooded lakes and ponds to wet meadows and wooded areas with predominantly hydric soils. The majority of these wetlands have been drained to create farmland, but others have been drained or filled to permit construction of homes, businesses, industries, boat docks, parking lots, roads, railroads, parks, wastefills or just for landscaping purposes. It is now estimated that, other than the open water wetlands represented by lakes and reservoirs, Indiana only has a little over 100,000 acres of wetlands left. Most of these are marshes and shrub swamps, although bogs and wooded swamps are also present. These wetlands provide spawning areas for some fish, support many other kinds of wildlife, serve as sediment and nutrient traps, and aid in flood control. At this time no significant wetland areas are known to be adversely affected by point source wastewater discharges in Indiana.

From January 1988 to April 1990, the Indiana Department of Environmental Management has received approximately 275 Public Notices from the U.S. Army Corps of Engineers regarding applications for Section 404 dredge and fill permits. Approximately 25% involved proposals to place fill material in wetlands. Of the applications involving placement of fill in wetlands, more than 95% were denied Section 401 Water Quality Certification. No projects involving wetland fills were approved which did not adequately mitigate for lost wetland values. Of the approximately 275 public notices, about 40% involved proposed seawall construction. Public notices for seawalls increased dramatically in 1990 due to the Louisville District, Corps of Engineers rescinding nationwide permits and requiring individual permits for proposed seawalls on two large public water supply reservoirs in central Indiana. The increase in public notices is probably also due to a greater awareness by the public of the Section 401/404 permitting process.

Tables 5 and 6 summarize the causes and sources of non-support of uses in Indiana waterbodies, respectively. The five major pollutant categories contributing to non-support of uses, in descending order of importance, were E. coli bacteria, ammonia, other inorganics (primarily cyanide), 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 runoff from derelict coal mines. 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.

TABLE 5. *TOTAL SIZES OF WATERBODIES NOT FULLY SUPPORTING USES AFFECTED BY VARIOUS CAUSE CATEGORIES*

CAUSE CATEGORY	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKE MICHIGAN (SHORELINE MILES)	
	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT
Unknown toxicity	--	--	--	--	--	--
Pesticides	212	220	12	--	--	43
Priority organics	324	--	12	--	--	43
Non priority organics	--	--	--	--	--	--
Metals	71	93	--	45	--	--
Ammonia	147	716	22	100	--	--
Chlorine *	5	2	22	77	--	--
Other inorganics	407	355	--	--	--	--
Nutrients	--	--	122	12	--	--
pH	18	152	30	--	--	--
Siltation	--	15	--	--	--	--
Organic enrich./DO	180	130	59	63	--	--
Salinity	--	12	--	--	--	--
Thermal modification	--	--	--	--	--	--
Flow alterations	18	--	--	--	--	--
Other habitat alterations	--	--	--	--	--	--
Pathogens	1993	224	45	77	--	--
Radiation	--	--	--	--	--	--
Oil and grease	--	--	--	--	--	--
Suspended solids	19	155	--	--	--	--

* *Assumed to be moderately affecting use wherever it is used as a disinfectant (amount is unknown).*

** *Siltation is affecting most of our lakes and reservoirs to an undetermined extent.*

*** *Channelization has had moderate impact on many miles (amount is unknown).*

TABLE 6. *TOTAL SIZES OF WATERBODIES NOT FULLY SUPPORTING USES AFFECTED BY VARIOUS SOURCE CATEGORIES.*

CAUSE CATEGORY	RIVERS AND STREAMS (MILES)		LAKES (ACRES)		LAKE MICHIGAN (SHORELINE MILES)	
	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT	MAJOR IMPACT	MODERATE /MINOR IMPACT
Point Sources						
Industrial	280	73	--	--	--	43
Municipal/Semi-Public	646	1030	59	63	--	43
CSO	625	83	22	23	--	43
Storm Sewers	7	--	--	--	--	--
Nonpoint Sources						
Agriculture	1338	208	12	--	--	43
Silviculture	--	--	--	--	--	--
Construction	--	--	--	--	--	--
Urban runoff	142	27	35	22	--	--
Resource Extract	29	--	30	--	--	--
Land Disposal	42	--	--	--	--	--
Hydro/habitat mod.	--	--	--	40	--	--
Other	57	73	--	--	--	--
Aerial Deposition	--	--	--	--	--	43
Spills, unknown	--	--	--	--	--	--

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

In the last 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 effects on the aquatic environment and associated human health. These concerns have resulted in more time and money being spent on the collection, analysis and interpretation of data on toxic substances in Indiana waters. The following portion of this report focuses primarily on the studies Indiana has done in 1988-1989, 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, there has not been extensive monitoring of ambient surface waters for priority pollutants in Indiana. The revisions to Indiana's general water quality standards regulation (327 IAC 2-1) include numerical criteria for others. Indiana anticipates an increased need for surface water monitoring for the priority pollutants as a result of these revisions.

The total size of the various types of waterbodies monitored for toxics and determined to have elevated levels of toxics is shown on Table 7. Of the 815 total lake acres shown to have elevated levels of toxics, most are included only because contaminants in bottom sediments were found 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 lakes included on this list have been found to have tissue contaminant concentrations well below FDA action levels.

Nearly one-third of the 1,140 river and stream miles determined to have elevated levels of toxic substances were placed in this category, at least in part, due to fish consumption advisories. Most of the remainder of these miles are due to contaminants in sediment at medium to high levels of concern. In most instances, these rivers and streams supported diverse communities of aquatic organisms. These waterbodies are listed in Table 8 and are located on Figure 1.

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 the 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.

TABLE 7. *TOTAL SIZE OF WATERBODIES MONITORED AND AFFECTED BY TOXICS.*

WATERBODY	SIZE MONITORED FOR TOXICS	SIZE WITH ELEVATED TOXICS
Rivers (miles)	2,531	1,140
Lakes (acres)	23,500	815
Estuaries (miles)	--	--
Coastal waters (miles)	--	--
Freshwater wetlands (acres)	--	--
Tidal wetlands (acres)	--	--
Great Lakes (miles)	43	43

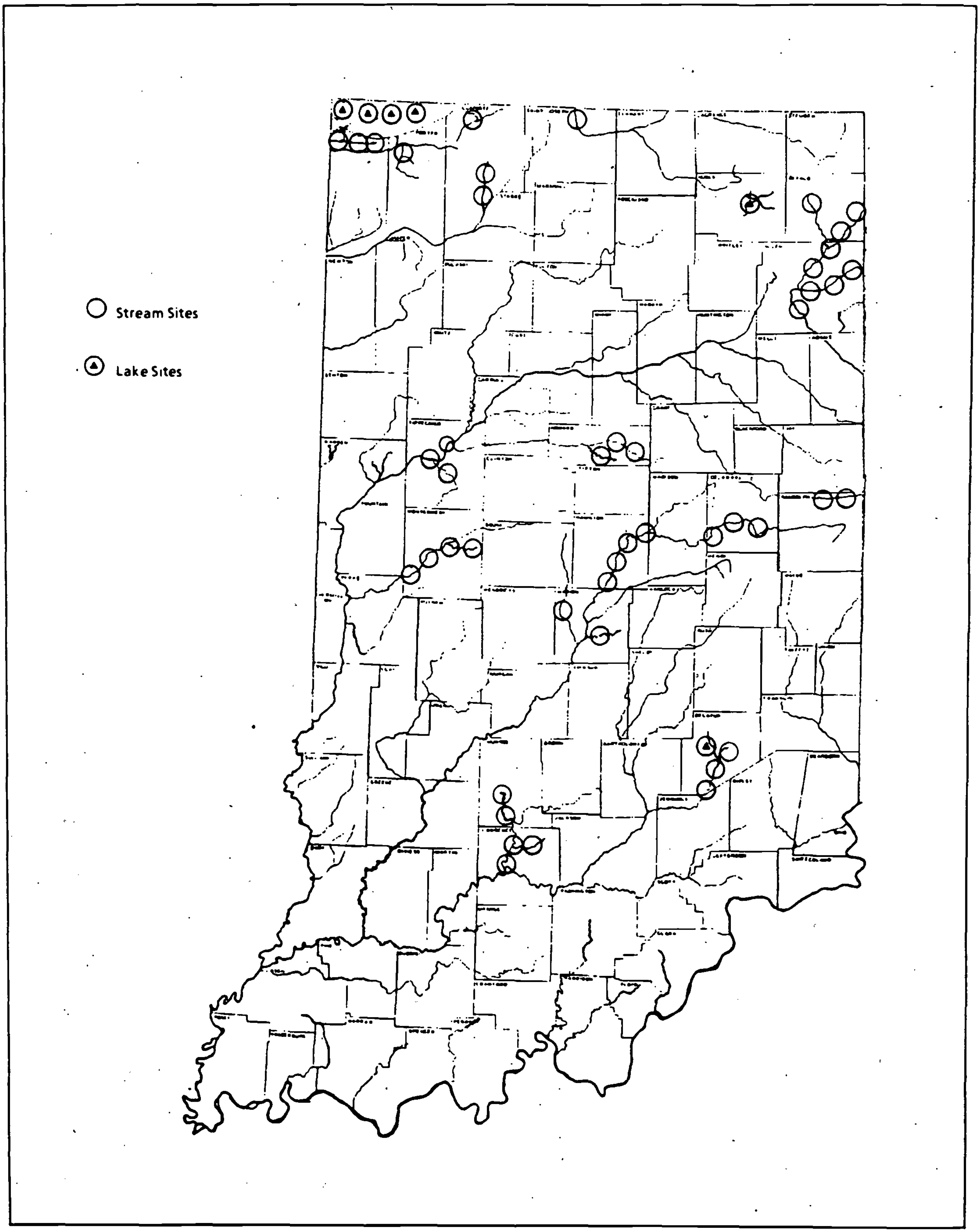
TABLE 8. *WATERBODIES WITH ELEVATED LEVELS OF TOXIC SUBSTANCES*

WATERBODY	COUNTY
LAKE MICHIGAN BASIN	
St. Joseph River	St. Joseph
Trail Creek	La Porte
Burns Ditch	Porter
Grand Calumet River	Lake
Indiana Harbor Canal	Lake
MAUMEE RIVER BASIN	
Maumee River	Allen
Harvester Ditch	Allen
Cedar Creek	DeKalb
Teutsch Ditch	DeKalb
KANKAKEE RIVER BASIN	
Travis Ditch	La Porte
WABASH RIVER BASIN	
Wea Creek	Tippecanoe
Sugar Creek	Montgomery
Little Mississinewa River	Randolph
Kokomo Creek	Howard
Wildcat Creek	Howard
Elliot Ditch	Tippecanoe
Mississinewa River	Randolph
Little Sugar Creek	Montgomery
WEST FORK OF WHITE RIVER BASIN	
West Fork White River	Deleware/Hamilton
Eagle Creek	Marion
Pleasant Run	Marion
Stoney Creek	Hamilton
EAST FORK OF WHITE RIVER BASIN	
Pleasant Run Creek	Monroe/Lawrence
Sand Creek	Decatur
Clear Creek	Monroe
East Fork Mainsteam	Lawrence

TABLE 8. ***WATERBODIES WITH ELEVATED LEVELS OF TOXIC SUBSTANCES (con't)***

WATERBODY	COUNTY
Muddy Fork of Sand Creek	Decatur
Salt Creek	Monroe/Lawrence
Boggs Creek	Lawrence
OHIO RIVER BASIN	
Cypress Creek	Warrick
LAKES	
Lake Michigan	Lake/Porter/La Porte
Cedar Lake - north basin	Lake
Decatur County Park Reservoir	Decatur
Henderson Lake	Noble

FIGURE 1. *ASSESSED SITES WITH ELEVATED LEVELS OF TOXIC SUBSTANCES*



A total of 75 fishkills were reported in 1988 and 1989 (Table 9), a decrease from the 1986-1987 period. Although many of the causes of fishkills were unknown (35%), livestock manure from feeding operations (17%), municipal sewage/sludge (12%), liquid fertilizer spills (9%), and other sources (10%) were responsible for most fishkills for which causes were determined (Figure 2). The causes grouped in the "other" category includes industrial chemicals, chlorine and thermal. Natural causes accounted for 10% of the reported kills.

In 16 (21%) of the 75 fishkills reported during 1988 and 1989, no counts or estimates of the number of fish killed were made, mainly due to late notification of the kill. In the 61 fishkills for which counts or estimates of the number of fish killed were made, a total of 454,222 fish were reported killed. Table 10 categorizes the reported 1988-89 fish kills as to size (number of fish killed) and the number of kills in each size category. Twelve fish kills were reported in Marion County during this period, six in Clinton County and five in Porter County. Four counties had three fishkills and nine had two reported kills.

Table 10. Size categories (number of fish killed) and number of fishkills reported per category in 1988-89.

Number of Fish Killed	Number of Fishkills Reported
Unknown	16
0-500	38
500-1000	8
1000-10000	10
10,000-100,000	3
more than 100,000	0
Total	75

Toxicity Testing Program

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. Fifty facilities were examined for acute and/or chronic toxicity in 1988-1989. Summaries of these test results are given in Table 11.

Thirty-eight (79%) of the 48 facilities tested showed no acute toxicity to daphnids or fish. Acute toxicity was found at 10 facilities with only 20 out of 134 tests showing acute toxicity. These 20 acute toxicity results were distributed as 11 daphnid LC_{50} tests for 9 facilities and 9 fish LC_{50}'s measured on 3 facilities. The acute toxicity range for daphnids was 6.5% to 70.7% effluent while fish acute toxicity ranged from 38.6% to 95% effluent. Daphnid acute toxicity was found at 19% of the facilities while fish acute toxicity was found at 6% of the facilities with 4% of the facilities indicating acute toxicity to both daphnids and fish.

TABLE 9. *FISH KILLS REPORTED IN 1988-89*

COUNTY	RECEIVING WATER	MATERIAL	NO. KILLED	MILES AFFECTED
Adams	Bracht Ditch	Liquid Fertilizer	100	U*
	Yellow Creek	Liquid Fertilizer	1,000	3
Allen	Little Wabash	Sewage	U	10
Boone	Prairie Creek	Sewage	200	0.1
	Fishback Creek	Animal Waste	U	3
Carrol	Bridge Creek	Animal Waste	25	1
	Bridge Creek	U	U	1.5
	Wabash River	U	U	0.25
Clinton	Gary Ditch	Liquid Fertilizer	400	1
	Reagan Run	Pesticides	81	0.5
	Prairie Creek	Ammonia	50	0.5
	Prairie Creek	Animal Waste	3,500	3
	Campbell's Creek and Pond	Pesticide	U	1 acre
	Prairie Creek	Animal Waste	250	7
Davies	Prairie Creek	U	253	1
	Haw Creek	Animal Waste	U	25
Dearborn	So. Hogan Creek	Animal Waste	36,737	2
	Tanners Creek	U	2,000	3
Decatur	Unnamed Ditch	Animal Waste	500	0.25
	Gas Creek	Sewage	280	0.5
Delaware	W.F. White River	Sewage	5,000	0.75
Elkhart	Stoney Creek	U	400	1.5
Gibson	Unnamed Ditch	U	200	0.25
Hamilton	Morse Reservoir	U	100	U
	Morse Reservoir	U	200	U
	Buck Creek	Sewage	1,100	0.5
	Six Mile Ditch	U	200	5
Henry	Montgomery Creek	Animal Waste	8,407	1

TABLE 9. FISH KILLS REPORTED IN 1988-89 (con't)

COUNTY	RECEIVING WATER	MATERIAL	NO. KILLED	MILES AFFECTED
Howard	Honey Creek	Animal Waste	9	U
Jackson	Gravel Pit	Sewage	U	0,5 sq. miles
	White Creek	U	U	2
Jennings	Vernon Fork	Sewage	845	0.5
Johnson	Young's Creek	U	174	0.25
Knox	Snapp Creek	U	300	U
Lake	Turkey Creek Ditch	Low D.O.	25	0.25
	Lake Holiday	Natural	500 (shad)	500 acres
	Little Calumet	U	1,000	U
Marion	Unnamed Ditch	U	U	U
	Eagle Creek Reservoir	Low D.O.	1,000	U
	White River	Sewage	20,000	1
	Buck Creek	U	100	1
	Buck Creek	U	12	U
	River Bay	U	150	U
	White River	U	50	U
	Williams Creek	Petroleum	U	U
	Bean Creek	Industrial Chemical	3,251	2.5
	White River	Natural	500 (shad)	4
	Lowman Creek	Natural	1,000	U
	Storm Retention Basin	Natural	100	0.5
Marshall	Pretty Cake	U	300	U
	Seltenright Ditch	U	25	0.25
	Yellow River	U	1,500	1
Miami	Unnamed Ditch	Fire Fighting Foam	263	0.25
Montgomery	Big Raccoon Creek	Pesticide	2,800	2
	Sugar Creek	Natural	20	U
	Little Sugar Creek	Animal Waste	U	1

TABLE 9. FISH KILLS REPORTED IN 1988-89 (con't)

COUNTY	RECEIVING WATER	MATERIAL	NO. KILLED	MILES AFFECTED
Morgan	White River	Thermal	1,000	0.25
	Pond	Fertilizer	U	1 acre
Newton	Morrison Ditch #2	Industrial Chemicals	2,000	0.75
Parke	Pond	Animal Waste	U	U
Pike	Patoka River	U	1,000	2
Porter	Burns Ditch	Individual Chemicals	5,100	U
	Flint Lake	U	150	U
	Pond	U	75	U
	Lake Michigan	Thermal	25	U
	Little Calumet River	Chlorine	35	1.5
Posey	Black River	Animal Waste	5,352	20
Pulaski	Mausley Ditch	Fertilizer	399	U
Shelly	Snail Creek	Liquid Fertilizer	31,175	U
Tipton	Cicero Creek	Sewage	300	0.25
Vermillion	Wabash River	Industrial Chemicals	300	1
Vigo	Prairie Creek	Animal Waste	U	2
Wabash	Charlie Creek	U	U	U
	Treaty Creek	Natural	200	0.75
Warren	Unnamed Ditch Fertilizer	Fertilizer	U	0.25

* *UNKNOWN*

FIGURE 2. *CAUSES OF 1988-89 FISHKILLS*

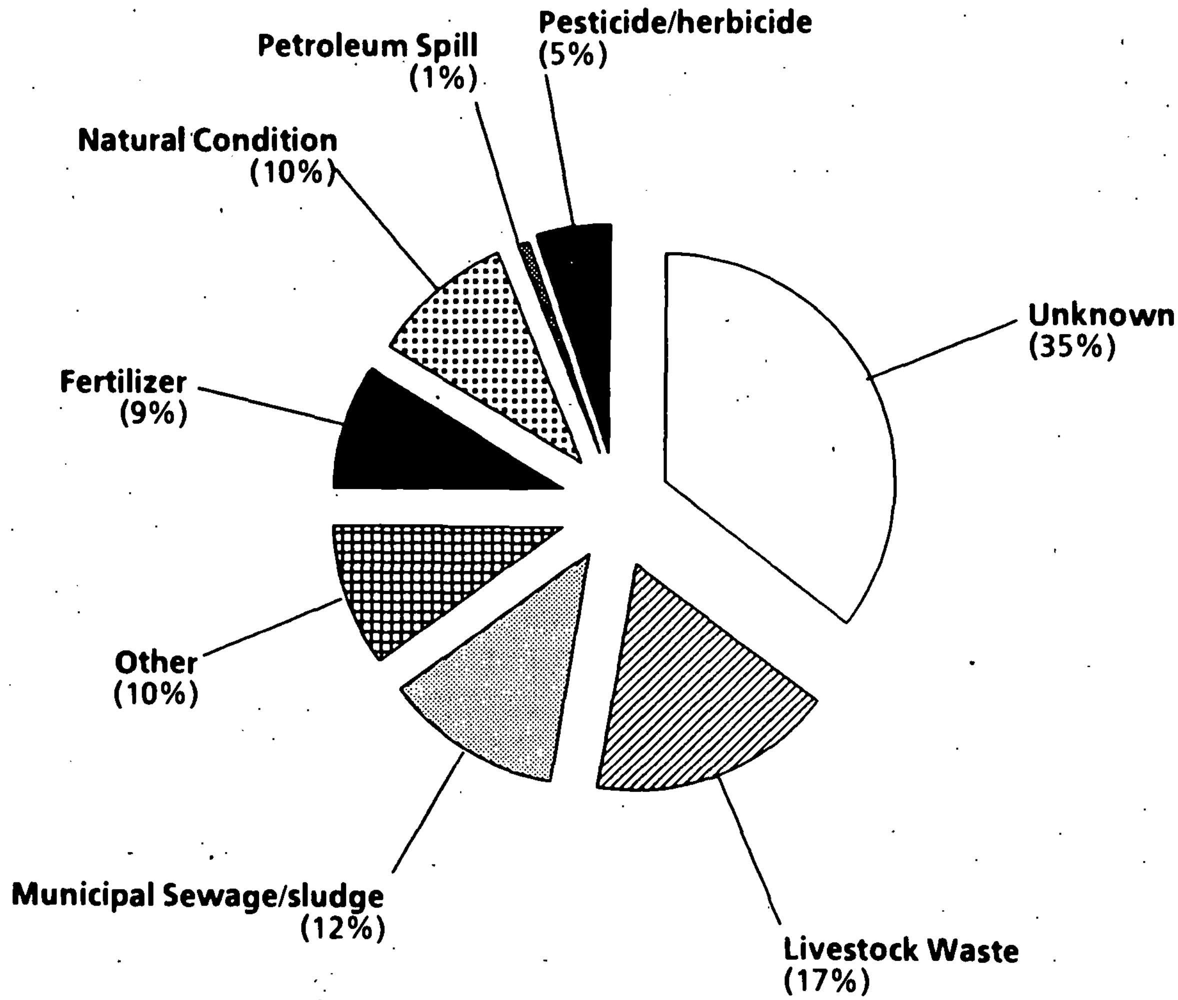


TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	ACUTE TOXICITY FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	CHRONIC TOXICITY FISH	CHRONIC TOXICITY ALGAE	MUTAGENICITY
LAKE MICHIGAN BASIN								
Amoco Oil Co	Lake Michigan	12/88*	No Toxicity	No Toxicity				
(Whiting)		12/88*	No Toxicity					
Bethlehem Steel Corp.	Burns Harbor	12/88*		No Toxicity	30%[3]	No Toxicity	No Toxicity	
(Chesterton)		1/89**	No Toxicity		No Toxicity	75%[1]	No Toxicity	
		2/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity	No Toxicity	
		6/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity		
		6/89	>31%					
		12/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity		
East Chicago Sanitary Dist	Grand Calumet River	6/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity	No Toxicity	
(E. Chicago)								
Inland Steel [012]	Indiana Harbor Canal	11/88**	No Toxicity	No Toxicity				
(E. Chicago) [014]		11/88**	No Toxicity	No Toxicity				
[018]		11/88**	No Toxicity	No Toxicity				
[012]		11/88**	No Toxicity					
[014]		11/88**	No Toxicity					
[018]		11/88**	70.7%					
[13]		1/89**	No Toxicity	No Toxicity	No Toxicity	50%[1]		
[15]		1/89**	No Toxicity		25%[3]	25%[1]		
[16]		1/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity		
[13]		1/89**	No Toxicity		No Toxicity			
[15]		1/89**	No Toxicity		No Toxicity			
[16]		1/89**	No Toxicity		No Toxicity			

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	ACUTE TOXICITY (LC_{50} = % EFFLUENT) FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	CHRONIC TOXICITY (NOEL = % EFFLUENT) FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) ALGAE	MUTAGENICITY
Michigan City POTW	Trail Creek	4/89*	14.6%	91.4%	0%[1]	60%[1]	10%[6]	
(Michigan City)								
Syndicate Stores Fixtures	Mather Ditch	2/89*	70.7%	38.6%	12.5%[1], 6.3%[3]	30%[1]	No Toxicity	
(Middlebury)		2/89*				60%[1]		
U.S. Steel Gary Works [010]	Grand Calumet River	6/88*	No Toxicity	No Toxicity	No Toxicity	No Toxicity		Negative
(Gary) [034]		6/88*			<100%	60%[1,5]		
Westville POTW	Crumpacker Arm	3/89	No Toxicity					
(Westville)								
MAUMEE RIVER BASIN								
Decatur POTW	St. Marys River	10/88	No Toxicity					
(Decatur)								
Ft. Wayne POTW	Maumee River	11/89	No Toxicity					
(Ft. Wayne)								
Phelps Dodge Magnet Wire	Harvester Ditch	2/87**			<30%[1]	30%[1,2]		
		3/89**			30%[1]	No Toxicity		
		4/89**	42.3%		10%[1]	No Toxicity		
KANKAKEE RIVER BASIN								
LaPorte POTW	Travis Ditch	1/89**	No Toxicity		75%[3]	50%[1], 75%[2]		
(LaPorte)		2/89**	No Toxicity		<10%[3]	50%[1]		
		3/89**	No Toxicity	No Toxicity		No Toxicity		

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	ACUTE TOXICITY FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	CHRONIC TOXICITY FISH	CHRONIC TOXICITY ALGAE	MUTAGENICITY
NIISCO Shaefer Gen. Sta.	Kankakee River	4/88	No Toxicity					
(Wheatfield)								
Roll Coater	Travis Ditch	2/88	50%					
(Kingsbury)		2/88	75%					
WABASH RIVER BASIN								
Churubusco POTW	Churubusco Branch	6/88	No Toxicity					
(Churubusco)								
Crawfordsville POTW	Sugar Creek	2/88*			50%[1]	30%[1], 60%[4], <3%[5]	60%[6]	Negative
(Crawfordsville)								
Dunkirk POTW	Dunkirk Drain	11/88	No Toxicity					
(Dunkirk)								
Eli Lilly Labs	Wabash River	8/88**			48%[3]	24%[1]		
(Lafayette)		10/88**			48%[1]	24%[1]		
		1/89**			24%[3]	12%[1]		
		2/89**			24%[3]	24%[1,2]		
		3/89**			24%	12%[1]		
		5/89**			24%[1,3]	24%[1]		
		7/89**				24%[1,2]		
Eli Lilly Labs	Wabash River	9/89*	No Toxicity	No Toxicity				
(Clinton)		9/89*	No Toxicity					

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	ACUTE TOXICITY FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	CHRONIC TOXICITY FISH	ALGAE	MUTAGENICITY
Grissom Air Force Base (Peru)	Pipe Creek	6/89	No Toxicity					
Hercules, Inc. (Terre Haute)	Spring Creek	2/89	8.4%					
Huntington POTW (Huntington)	Little River	2/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity	<6.3%[6]	
		3/89**	No Toxicity	No Toxicity	No Toxicity	45%[2]	<6.3%[6]	
		4/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity	45%[6]	
Inland Container Corp. (Newport)	Wabash River	8/89*	No Toxicity	No Toxicity				
		8/89*	No Toxicity					
Jasper POTW (Jasper)	Patoka River	2/89	No Toxicity					
Landis & Gyr Metering (Lafayette)	Wabash River	11/89**	No Toxicity	No Toxicity				
		11/89**	No Toxicity					
		12/89**	No Toxicity	No Toxicity				
		12/89**	No Toxicity					
Logansport POTW (Logansport)	Wabash River	4/88**	No Toxicity	No Toxicity	No Toxicity	No Toxicity	<6.25%[6]	
Pitman Moore Inc. (Terre Haute)	Wabash River	7/89*	No Toxicity	No Toxicity				
		7/89*	No Toxicity					

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC50 = % EFFLUENT) DAPHNID	ACUTE TOXICITY FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	CHRONIC TOXICITY FISH	CHRONIC TOXICITY ALGAE	MUTAGENICITY
Rochester POTW (Rochester)	Mill Creek	4/89	No Toxicity					
R R Donnelley & Sons (Warsaw)	Big Walnut Creek	4/88*	No Toxicity	No Toxicity	No Toxicity	No Toxicity	60%	Negative
United Technologies Auto (Columbia City)	Trib. To Cook Drain	6/88	6.5%					
		1/89**	No Toxicity					
Vincennes POTW (Vincennes)	Wabash River	11/88	No Toxicity					
Warsaw POTW (Warsaw)	Big Walnut Creek	4/88*	75.1%	No Toxicity				Negative
			72.9%					
W.F. WHITE RIVER BASIN								
HES, Roachdale Landfill (Indianapolis)		12/88	No Toxicity					
		12/88	No Toxicity					
Muncie POTW (Muncie)	W.F. White River	12/88**	No Toxicity	No Toxicity	No Toxicity	No Toxicity	25%[6]	
		1/89**	No Toxicity	No Toxicity	25%[3]	No Toxicity	50%[6]	
		2/89**		No Toxicity	50%[1,3]	No Toxicity	18% LC_{50}	
		9/89**			50%[3]		No Toxicity	
		10/89**			50%[1], <6%[3]			
		11/89**			<100%[3]			

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	FISH	ALGAE	MUTAGENICITY
Monroe Co. Sanitary Landfill (Bloomington)	Bean Blossom Creek	10/89	No Toxicity					
Speedway POTW (Speedway)	Eagle Creek	11/89**	No Toxicity					
		11/89	No Toxicity					
		11/89	No Toxicity					
E.F. WHITE RIVER BASIN								
GMC Central Foundry (Bedford)	Pleasant Run Creek	7/89	No Toxicity					
Keiffer Paper Mills (Brownstown)	E.F. White River	4/89	No Toxicity					
Newcastle POTW (New Castle)	Big Blue River	12/89	No Toxicity					
North Vernon POTW (North Vernon)	Vernon Fork	11/88	No Toxicity					
Randall Div. Textron (Morristown)	Big Blue River	6/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity		
		7/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity		
		8/89**	No Toxicity	No Toxicity	No Toxicity	No Toxicity		
Shelbyville POTW (Shelbyville)	Big Blue River	1/89	No Toxicity					

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	FISH	ALGAE	MUTAGENICITY
OHIO RIVER BASIN								
Brookville POTW (Brookville)	E.F. Whitewater River	5/89	No Toxicity					
Colgate Palmolive (Clarksville)	Ohio River	4/89	No Toxicity					
Genera Electric Plastics (Mt. Vernon)	Ohio River	1/88**		89 - 92%				
		2/88*		91%				
		3/88*		No Toxicity				
		4/88*		No Toxicity				
		5/88*		No Toxicity				
		6/88*		No Toxicity				
		7/88*		82%				
		8/88*		90%				
		9/88*		No Toxicity				
		10/88*		95%				
		11/88*		No Toxicity				
		12/88*		No Toxicity				
		1/89**		No Toxicity				
		2/89**		66.7%				
		6/89**		No Toxicity				
		9/89**		60%				
		11/89**		No Toxicity				
		12/89	No Toxicity					

TABLE 11. *ACUTE AND CHRONIC TOXICITY TESTS 1988-1989 (con't)*

DISCHARGER [OUTFALL]	RECEIVING WATER	TEST DATE	ACUTE TOXICITY (LC_{50} = % EFFLUENT) DAPHNID	ACUTE TOXICITY (LC_{50} = % EFFLUENT) FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) DAPHNID	CHRONIC TOXICITY (NOEL = % EFFLUENT) FISH	CHRONIC TOXICITY (NOEL = % EFFLUENT) ALGAE	MUTAGENICITY
Ind. Farm Bureau Co-Op (Mt. Vernon)	Ohio River	2/88*	No Toxicity No Toxicity	No Toxicity				Negative
Jeffersonville POTW (Jeffersonville)	Cane Run	10/88	No Toxicity					
New Albany POTW (New Albany)	Falling Run Creek	10/88	No Toxicity					
Sunman POTW (Sunman)	Br. Ripley Creek	6/89	No Toxicity					
South Dearborn RSD (Dearborn Co.)	Ohio River	10/89	No Toxicity					

1 = Survival, 2 = Growth, 3 = Reproduction, 4 = Hatchability, 5 = Teratogenicity, 6 = Inhibition
* EPA
** Consulting Company Discharger Test

Chronic toxicity tests were carried out on 15 facilities within Indiana. Four (27%) of these facilities showed no chronic toxicity on any end point while five (33%) of these facilities showed chronic toxicity on all end points measured. The remaining 40% of the facilities tested indicated various levels of toxicity and non-toxicity depending on the particular endpoint. Over 166 chronic end points were examined with 69% of these points showing No Observed Effect Levels (NOEL) greater than 100% effluent. The fathead minnow larval survival endpoint showed the most depressions (35%) followed by daphnid reproduction (27%), daphnid survival (23%) and minnow growth (10%).

The _Selenastrum_ algae growth test was performed on nine facilities during this time period. Three (33%) of the facilities showed no significant inhibition to algae growth at 100% effluent. Six (67%) of the facilities showed significant algae growth inhibition.

The U.S. EPA has conducted five Ames tests on Indiana effluents during this period. These tests measure potential for mutagenicity (the capacity of a substance to cause changes in chromosomes) associated with oral exposures such as using the water for drinking. As can be seen from Table 11 all tests for mutagenicity were negative.

Effluent toxicity tests are used to determine whether toxicity reduction measures are needed at a facility. Toxic testing as a method for determining compliance with water quality is presently required on 33 Indiana NPDES permits and is expected to increase in the future. The goal of the program is to eliminate all toxicity associated with wastewater discharges.

Fish Tissue Analysis

During 1987, 88, and 89, the State compiled data on contaminants in the tissue of 583 fish samples from 171 sites throughout Indiana. Samples from 1987 are included here because analyses had not been completed as of the last 305(b) writing. A list of parameters which were analyzed is shown in Table 12.

All of the fish samples collected from 28 lakes (Table 13) representing about 23,000 acres of surface waters in Indiana, contained "safe" levels of contaminants (i.e., did not exceed FDA Action Levels). No lakes in Indiana (except Lake Michigan, discussed below) are presently known to contain fish unsafe for human consumption. The consumption advisory for the Decatur County Park Reservoir near Greensburg is not based on tissue samples collected from this waterbody, but on fish samples collected both upstream and downstream of this reservoir that do contain contaminants.

Fish samples collected in 1987 and 1988 from Lake Michigan showed that large Coho salmon have residues of PCBs and certain pesticides but do not exceed the FDA Action Levels for those compounds. All samples of yellow perch and longnose suckers recently collected also contained "safe" levels of contaminants. A carp sample did exceed the FDA Action Level for total PCBs.

The remaining fish tissue samples for which data became available in 1988 and 1989 were from streams and rivers. Sites at which samples exceeded FDA Action Levels are shown in Figure 3 and listed in Table 14. Information

TABLE 12. *LIST OF POTENTIAL PARAMETERS FOR WHICH FISH FLESH SAMPLES WERE ANALYZED. (* MINIMUM SET OF ANALYTES)*

** % LIPIDS*

METALS

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

ACID EXTRACTABLE COMPOUNDS

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

PESTICIDES

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

PCBS

- * Total PCB

VOLATILE ORGANIC COMPOUNDS

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

BASE/NEUTRAL EXTRACTABLES

- Acenaphthylene
- Acenaphthene
- 4-Chloroaniline
- 2-Nitroaniline
- 3-Nitroaniline
- 4-Nitroaniline
- Anthracene
- Benzo(a)anthracene
- Dibenzo(a,h)anthracene
- 3,3'-Dichlorobenzidene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2,4-Trichlorobenzene
- Hexachlorobenzene
- Nitrobenzene
- Benzyl alcohol
- Chrysene
- n-Nitrosodiphenylamine
- n-nitroso-di-n-Propylamine
- Hexachloroethane
- Bis(2-chlorethyl)ether
- Bis(2-chloroisopropyl)ether
- 4-Bromophenyl-phenylethe
- 4-Chlorephenyl-phenylethe
- Fluoranthene
- Fluorene
- Benzo(beta)fluoranthene
- Benzo(kappa)fluoranthene
- Dibenzofuran
- Bis(2-chloroethoxy)methane
- Isophorone
- Naphthalene
- 2-Chloronaphthalene
- 2-Methylnaphthalene
- Hexachlorocyclopentadiene
- Bonzo(ghi)perylene
- Phenanthrene
- di-ni-Buthylphthalate
- Diethylphthalate
- Dimethylphthalate
- di-n-Octylphthalate
- Bis(2-ethylhexyl)phthalate
- Butylbenzylphthalate
- Pyrene
- Benzo(alpha)pyrene
- Indeno(1,2,3-c,d)pyrene
- 2,4-dinitrotoluene
- 2,6-dinitrotoluene
- Hexachlorobutadiene

TABLE 13. *LAKES MONITORED FOR TOXICS IN FISH AND SEDIMENTS IN 1987, 1988, AND 1989*

LAKE/RESERVOIR	ACREAGE	COUNTY
Bischoff Reservoir	200	Ripley
Carlson Pond		Porter
Cedar Lake	781	Lake
Cedarville Reservoir	245	Allen
Center Lake	120	Kosciusko
Henderson Lake	22	Noble
James Lake	282	Kosciusko
Jimmerson Lake	203	Steuben
Kokomo Reservoir #2	484	Howard
Lake James	1,034	Steuben
Lake Manitou	713	Fulton
Lake Maxinkuckee	1,864	Marshall
Lake Michigan +	154,000	
Lake of the Woods	416	Marshall
Lake Shipshewana	202	Lagrange
Lake Waubee	187	Kosciusko
Lake Wawasee	3,060	Kosciusko
Little Center Lake	10	Steuben
Long Lake	92	Steuben
Marquette Park Lagoon *	approx. 100	Lake
Marsh Lake	56	Steuben
Olin Lake	103	Lagrange
Oliver Lake	371	Lagrange
Oswego Lake	83	Kosciusko
Patoka Reservoir	9,032	Orange
Snow Lake	310	Steuben
Sylvan Lake	630	Noble
Tippecanoe Lake	768	Kosciusko
Turtle Creek Reservoir	1,500	Sullivan
Winona Lake*	562	Kosciusko

\+ *No sediment was collected from Lake Michigan.*

* *Sediment sample only.*

FIGURE 3. *RESULTS OF FISH TISSUE DATA FROM RIVERS AND STREAMS WHICH BECAME AVAILABLE IN 1987 - 1989.*

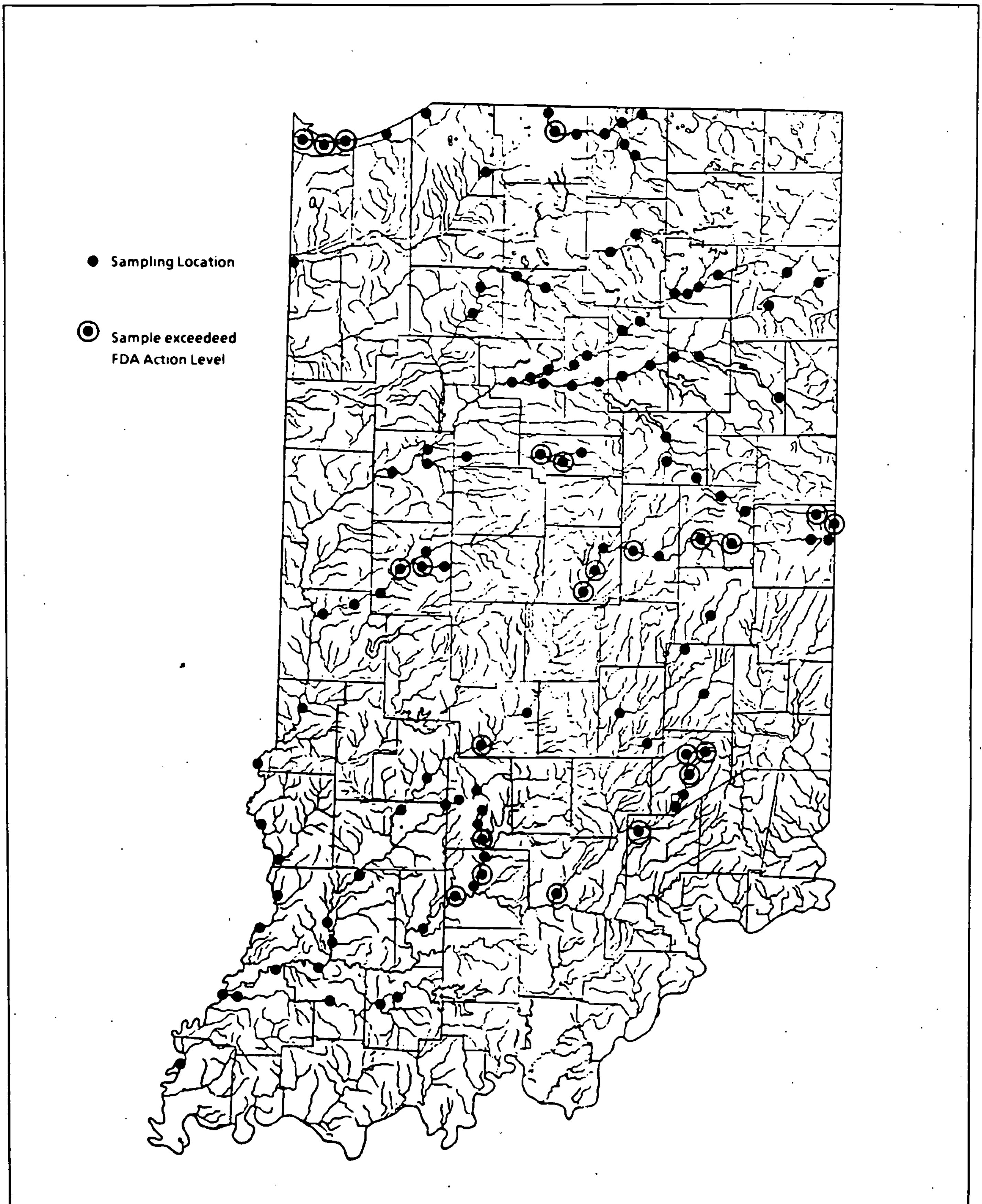


TABLE 14. *SUMMARY OF FISH TISSUE RESULTS RECEIVED IN 1987-89*

	YEAR SAMPLED	NUMBER OF SITES TESTED	NUMBER OF SAMPLES TESTED	PARAMETERS (and % of samples) EXCEEDING FDA ACTION LEVELS
Lakes	1987-89	28	122	None
Lake Michigan	1987-89	1	25	PCBs (4%)
Streams				
East Fork of White River Basin				
Big Blue River	1987	4	12	None
Muddy Fork of Sand Creek	1987	2	6	Dieldrin (50%)
Sand Creek	1987	4	13	Chlordane (8%) Dieldrin (15%)
Clear Creek	1987	4	7	PCBs (14%)
Pleasant Run	1987	2	4	PCBs (67%)
East Fork Mainstem	1987	4	18	PCBs (60%) Chlordane (63%)
	1989	1	3	PCBs (33%)
Flatrock River	1987	2	8	None
Salt Creek	1987	1	3	PCBs (100%)
Sugar Creek	1987	2	8	None
Wabash River Basin				
Eel River	1988	7	19	None
Kokomo Creek	1988	1	4	PCBs (25%)
Little Mississenewa River	1988	2	3	PCBs (100%)
Little Sugar Creek	1987	2	6	PCBs (67%)
	1989	1	3	data not available
Mississenewa River	1988	8	21	PCBs (10%)
Patoka River	1989	4	14	None
Sugar Creek	1987	2	6	PCBs (50%)
	1988	3	9	None
Tippecanoe River	1988	7	18	None
Wildcat Creek	1987	2	6	PCBs (50%)
	1988	3	10	PCBs (70%)
Wabash River	1987	6	21	None
	1989	19	65	None

TABLE 14. SUMMARY OF FISH TISSUE RESULTS RECEIVED IN 1987-89 (con't)

	YEAR SAMPLED	NUMBER OF SITES TESTED	NUMBER OF SAMPLES TESTED	PARAMETERS (and % of samples) EXCEEDING FDA ACTION LEVELS
West Fork of White River Basin				
Richland Creek	1987	2	4	None
Stoney Creek	1987	1	3	PCBs (100%)
Stout's Creek	1987	1	1	None
West Fork White River	1987	17	69	PCBs (7%) Chlordane (9%)
	1989	5	18	None
Maumee River Basin				
Maumee River	1988	1	3	None
St. Joseph River	1988	1	3	None
St. Mary's River	1988	1	3	None
Kankakee River Basin	1988	2	7	None
Lake Michigan Basin				
Trail Creek	1988	1	2	None
Burns Ditch	1988	1	3	None
Elkhart River	1988	2	6	None
Indiana Harbor Canal	1988	1	13	PCBs (33%)
	1987	1	1	PCBs (100%)
St. Joseph River	1988	16	18	PCBs (6%)
Grand Calumet River	1987	3	5	PCBs (60%)
TOTALS		171	583	

presented in this table is for concentrations of contaminants mainly in skin-on fish fillets. The FDA Action Levels are based on edible portions (i.e. fillets), and filleting whole fish samples has been shown to reduce the contaminant level by 20-50%.

The PCB contamination of fish is often correlated with identifies sources. Specific sources have been identified as contributary to PCB contamination in:

1) The Little Mississinewa River and Mississinewa River near Union City,

2) Elliott Ditch and Wea Creek near Lafayette,

3) Clear Creek, Salt Creek, Pleasant Run Creek, and the East Fork of the White River near Bloomington and Bedford,

4) Stoney Creek and the West Fork of the White River near Noblesville,

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

Lake Michigan fish have been exposed to PCBs from both point and non-point sources, many of which are in other states bordering the lake. PCB contaminated fish collected in the past from Burns Ditch and Trail Creek, which are direct tributaries to Lake Michigan, probably received their exposures to PCBs in the lake and simply migrated into the streams, since sediment sampling has failed to detect any significant PCB sources in the streams themselves. PCB levels in fish samples collected from these streams in 1988 did not exceed the FDA Action Level.

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 exceeded the FDA Action Level for total PCBs.

Starting in 1987, tissue analyses for semi-volatile and volatile compounds were done on some fish samples. A number of these compounds were detected in samples taken from Grand Calumet River and Indiana Harbor Canal. Those detected included: benzene, 2-Butanone, tetrachloroethylene, toluene, 2-Methyl napthalene, dibenzofuran, fluorene, fluoranthene, pyrene, acenaphthene, acenaphthylene, and phenanthrene. The significance of low levels of these contaminants in fish tissue to humans is not fully understood at this time.

To date, there are no known point sources which have contributed to PCB contamination in fish from the St. Joseph River near South Bend. Sediment testing in several tributaries of the river in 1985 indicated some evidence of contamination. Collections in 1988 revealed some PCBs in sediment upstream of Mishawaka. One carp sample exceeded the FDA Action Level for total PCBs and almost all fish samples had detectable amounts. Fish tissue samples from this stream also had concentrations of lead in the tissue which were considerably higher than were found in fish from other areas.

Chlordane and dieldrin, environmentally persistent pesticides banned from general agricultural use in 1980 and 1974, respectively, have also been common contaminants in fish (dieldrin contamination is now prevalent only in Lake Michigan fish). Extensive sampling of sediments, sludges, 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 each year in response to decreasing exposure from non-point sources such as farm field run-off. No concentrations of these pesticides in excess of FDA Action Levels were found in any 1988 or 1989 fish tissue samples (a few were found in 1987 samples).

The trend toward declining levels of PCBs, chlordane and dieldrin in fish collected at Indiana CORE Stations is shown in Table 15. There are 19 sites listed in the table which have been monitored for fish flesh contamination on a biennial basis. Only four of the sites had fish which exceeded one or more FDA Action Levels in 1987-89 compared with 5 sites exceeding such levels from 1985-1986 and 14 sites from 1979-84. The drop in chlordane and dieldrin concentration has been most dramatic. No samples exceeded the FDA Action Levels for chlordane or dieldrin at the CORE program stations for 1987-89.

Another trend toward declining levels of contaminants in the fish (carp) collected is shown in Figure 4. These graphs depict levels of PCBs and pesticides in two to four pound carp samples from sites which have had fish consumption advisories issued. The concentrations are normalized by comparing only levels in body fat, which is where the contaminants accumulate. Variables associated with different species, ages, and percent fat are thereby eliminated. At each of these sites, PCB, chlordane and dieldrin levels have declined steadily since 1981.

Fish Consumption Advisories

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 16 lists the Indiana waters affected by such advisories, the pollutants of concern in these waters, the fish species included, and the scope of the 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 individuals. Consumption of no fish is recommended in 251 miles.

In order to adequately inform the public as to the potential risks of consuming 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). Most of the pollutants of concern are concentrated in fat of the fish and studies have shown that skinning and filleting fish and removing any excess fat before cooking can substantially reduce (20 percent to 50 percent) contaminant levels in these fish. Cooking fish in such a way as to allow fats and oils to drip away from the fish (broiling, barbecuing, 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 15. *A SUMMARY OF TRENDS IN FISH TISSUE CONTAMINANT LEVELS AT INDIANA CORE STATIONS.*

SITE	NUMBER OF SAMPLES			% OF SAMPLES EXCEEDING FDA ACTION LEVELS: PCBs			Chlordane			Dieldrin		
	1987-89	1985-86	1979-84	1987-89	1985-86	1979-84	1987-89	1985-86	1979-84	1987-89	1985-86	1979-84
Lake Michigan at Michigan City	25	5	4	4	0	50	0	0	50	0	0	0
Wabash River above Lafayette	6	4	12	0	0	25	0	0	50	0	0	25
Wabash River below Lafayette	9	4	10	0	25	30	0	0	20	0	0	30
Wabash River near Terre Haute	6	3	10	0	0	20	0	0	30	0	0	40
Wabash River west of Fairbanks	7	4	12	0	0	0	0	0	42	0	0	42
Indpls. Waterway Canal at Indpls.	8	4	13	13	0	92	0	0	38	0	0	15
White River at Centerton	7	3	11	0	33	73	0	33	100	0	0	0
East Fork White River - Williams	9	4	14	33	75	79	0	0	50	0	0	21
White River at Petersburg	6	4	11	0	0	0	0	0	55	0	0	0
Kankakee River - Kingsbury Wildlife	4	3	12	0	0	0	0	0	0	0	0	0
Kankakee River at Shelby	3	3	12	0	0	0	0	0	8	0	0	0
Indiana Harbor Canal at East Chicago	4	2	4	50	100	75	0	0	25	0	0	0
Burns Ditch at Portage	4	3	8	0	67*	0	0	67*	0	0	33*	0
Trail Creek above Michigan City	2	3	7	0	33*	0	0	33*	14	0	0	0
St. Joseph River at Bristol	3	3	11	0	0	0	0	0	0	0	0	0
St. Joseph River at South Bend	3	3	12	0	67	58	0	0	25	0	0	0
St. Joseph River at Fort Wayne	3	3	12	0	0	0	0	0	0	0	0	0
Maumee River at Fort Wayne	3	3	12	0	0	17	0	0	0	0	0	0
St. Mary's River at Fort Wayne	3	3		0	0		0	0		0	0	
TOTAL SITES EXCEEDING ACTION LEVELS				4	5	10	0	1	11	0	0	6

* These numbers are excluded from the analysis because they were exceptionally large carp (8 - 18 pounds) and most likely are Lake Michigan migrants (see text).

FIGURE 4. *TRENDS IN TOTAL PCB, TOTAL CHLORDANE AND DIELDRIN CONCENTRATIONS IN CARP BODY FAT SAMPLES.*

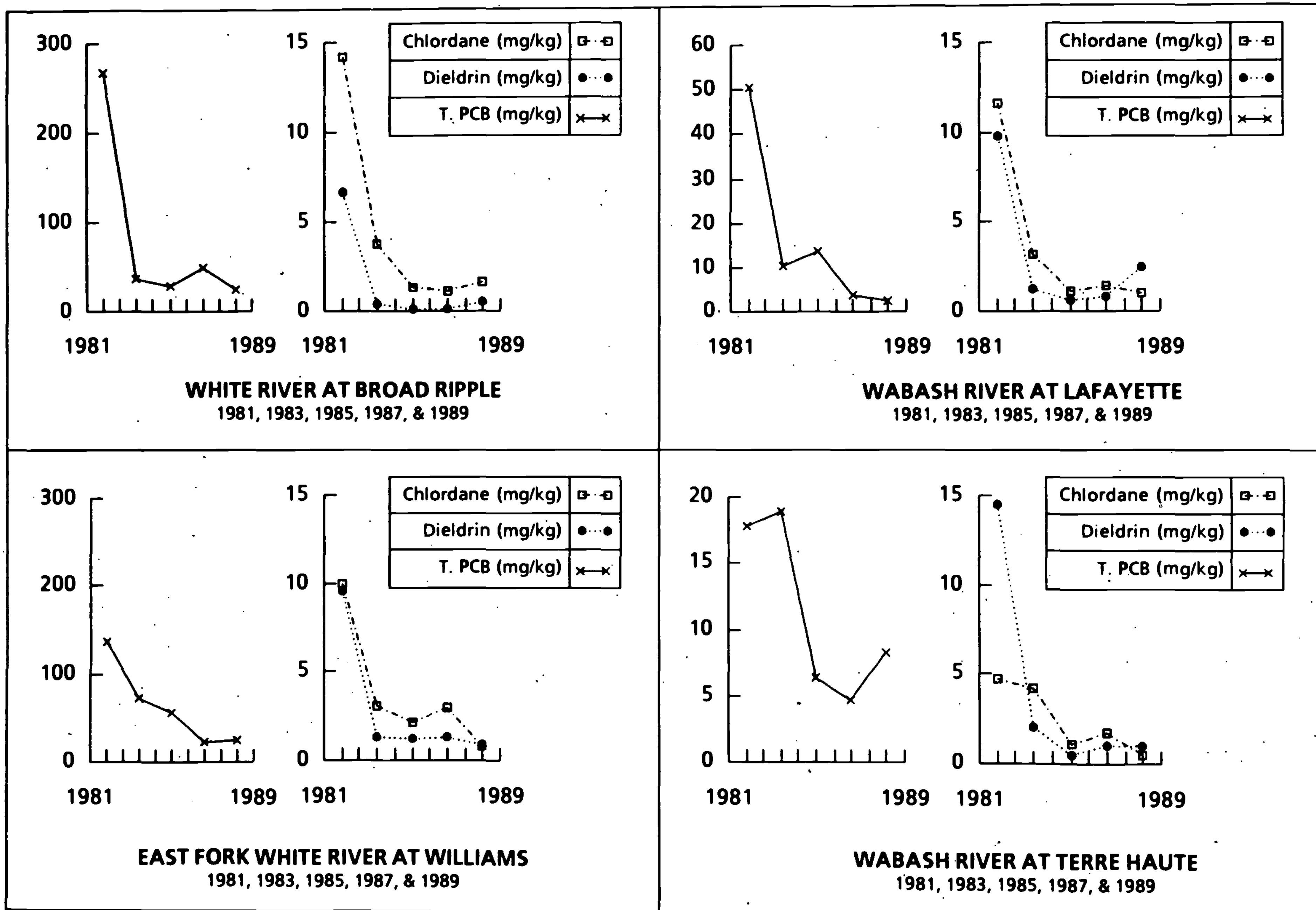


TABLE 16. *CURRENT INDIANA FISH CONSUMPTION ADVISORIES*

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 Co. 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 Co.	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 Co. south of I-74 to SR 32 Bridge.	PCBs	all	No fish should be eaten.
Little Sugar Creek in Montgomery Co.	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 Co. 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.

TABLE 16. ***CURRENT INDIANA FISH CONSUMPTION ADVISORIES** (con't)*

RIVER, STREAM OR LAKE	POLLUTANTS OF CONCERN	FISH SPECIES INVOLVED	SCOPE OF ADVISORY
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 is part of a Joint Fish Consumption Advisory.*

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

Sediment Contamination

Sediment monitoring is becoming increasingly important as a tool for detecting loadings of pollutants in streams and lakes. Many potential toxicants are easier to assess in sediments because they accumulate there at levels far greater than normally found in the water column. Also, sediments are 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 bioturbation processes. Remedial pollution projects may include the removal of contaminated sediments as a necessary step.

The state has compiled over 600 records of sediment samples taken from lakes, reservoirs and streams throughout Indiana. These include samples collected in 1988-1989 from 95 stream locations and 15 lakes and reservoirs. Chemical analyses for the priority pollutants listed in Table 17 were conducted on the sediment samples.

Since no criteria for sediment concentrations of pollutants have been promulgated by the state or U.S. EPA, the following strategy was adopted to aid in the interpretation of the analytical results. The maximum state sediment background concentration was determined from the analysis of sediment samples from 83 "non-contaminated" sites throughout Indiana (IDEM unpublished manuscript). Each of these sediment samples was obtained from a lake or from a small stream 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 non-point urban and agricultural run-off 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 18 presents the maximum background concentrations of constituents of Indiana stream and lake sediments determined by this study. Sediments containing less than two times the maximum background concentration of these constituents were classified as "uncontaminated."

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 priority pollutants measured. The criteria for grouping are presented in Table 19. If background concentrations of particular contaminants found were unknown the waterbody was placed into the "Unknown" category of concern.

TABLE 17. ***LIST OF PARAMETERS FOR WHICH AQUATIC SEDIMENT SAMPLES WERE ANALYZED IN 1988 - 89 BIENNIUM. % MOISTURE***

METALS

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

CYANIDE

PCBS

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

ACID EXTRACTABLE COMPOUNDS

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

PESTICIDES

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

VOLATILE ORGANIC COMPOUNDS

- Acetone
- Benzene
- Chlorobenzene
- Ethylbenzene
- 2-Butanone
- Carbon disulfide
- Chloroethane
- 1,1-Dichloroethane
- 1,2-Dichloroethane
- 1,1,1-Tichloroethane
- 1,1,2-Trichloroethane
- 1,1,2,2-Tetrachloroethane
- 1,1-Dichloroethylene
- 1,2-Dichloroethylene (total)
- Trichloroethylene
- Tetrachloroethylene
- 2-Chloroethyl vinyl ether
- 2-Hexanone
- Bromomethane
- Bromodichloromethane
- Dibromochloromethane
- Chloromethane
- Dichloromethane (Methylene chloride)
- Trichloromethane (Chloroform)
- Tetrachloromethane (Carbon tetrachloride)
- 4-methyl-2-Pentanone
- 1,2-Dichloropropane
- cis-1,3-Dichloropropylene
- trans-1,3-Dichloropropylene
- Styrene
- Toluene
- Vinyl acetate
- Vinyl chloride
- total Xylene

BASE/NEUTRAL EXTRACTABLES

- Acenaphthylene
- Acenaphthene
- 4-Chloroanile
- 2-Nitroaniline
- 3-Nitroaniline
- 4-Nitroaniline
- Anthracene
- Benzo(a)anthracene
- Dibenzo(a,h)anthracene
- 3,3'-Dichlorobenzidene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 1,2,4-Trichlorobenzene
- Hexachlorobenzene
- Nitrobenzene
- Benzyl alcohol
- Chrysene
- n-Nitrosodiphenylamine
- n-nitroso-di-n-Propylamine
- Hexachloroethane
- Bis(2-chlorethyl)ether
- Bis(2-chloroisopropyl)ether
- 4-Bromophenyl-phenylethe
- 4-Chlorephenyl-phenylethe
- Fluoranthene
- Fluorene
- Benzo(beta)fluoranthene
- Benzo(kappa)fluoranthene
- Dibenzofuran
- Bis(2-chloroethoxy)methane
- Isophorone
- Naphthalene
- 2-Chloronaphthalene
- 2-Methylnaphthalene
- Hexachlorocyclopentadiene
- Benzo(ghi)perylene
- Phenanthrene
- di-ni-Butylphthalate
- Diethylphthalate
- Dimethylphthalate
- di-n-Octylphthalate
- Bis(2-ethylhexyl)phthalate
- Butylbenzylphthalate
- Pyrene
- Benzo(alpha)pyrene
- Indeno(1,2,3-c,d)pyrene
- 2,4-dinitrotoluene
- 2,6-dinitrotoluene
- Hexachlorobutadiene
- 1,2-Diphenylhydrazine

* ***= MINIMUM PARAMETER COVERAGE FOR ALL SEDIMENT SAMPLES.***

TABLE 18. *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 19. *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.

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 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 receiving contaminants, to target waterbodies requiring additional sampling efforts, to identify sources of contaminants, and to confirm sites in which fish tissue analyses or toxicity tests indicate potential problems exist.

Along with sediment data, there is sometimes enough complementary information (fish tissue data, biosurveys, water chemistry, etc.) to document that contaminated sediments may have contributed to non-support of uses. Areas where this is true are listed in Table 20. Since use impairment is confirmed, the table represents sites in which sediment contamination is of highest concern.

Table 21 shows other waterbodies with sediment contaminants above background levels classified by degree of concern. No other information is currently available at these sites to indicate non-support of uses. Approximately 49% of the sites sampled in 1988-1989 were classified "Uncontaminated" and are not listed. A summary of all of the pollutants detected in sediments from Indiana streams and rivers in 1988 and 1989 samples is presented in Table 22 with the exception of the Grand Calumet River Indiana Harbor Ship Canal which will be discussed elsewhere in this report.

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 20. *AREAS WHERE SEDIMENT CONTAMINATION MAY BE CONTRIBUTING TO NON-SUPPORT OF USES (1988 - 89 DATA)*

WATERBODY	COUNTY	KNOWN CONTAMINANTS	ESTIMATED AREA (MILES)
Grand Calumet River	Lake	Cyanide Metals PCBs PAHs Other Organic Compounds	15
Indiana Harbor Canal	Lake	Cyanide Metals PCBs PAHs Other Organic Compounds	2
Kokomo Creek	Howard	PCBs	3
Little Mississinewa River	Randolph	PCBs Metals	10
Little Sugar Creek	Montgomery	PCBs	12
Mississinewa River	Randolph	PCBs	11
Sugar Creek	Montgomery/Parke	PCBs	9
Wildcat Creek	Howard/Carroll /Tippecanoe	PCBs	65

TABLE 21. *OTHER WATERBODIES WITH SEDIMENT CONTAMINANTS ABOVE BACKGROUND LEVELS.*

WATERBODY	COUNTY	SOURCE OF CONTAMINANTS (OTHER SOURCES POSSIBLE)	KNOWN CONTAMINANTS	DEGREE OF CONCERN
Tippecanoe River	Fulton/Pulaski	Unknown	PCB	Low
Mississinewa River	Randolph	Multiple	PCB Metals	Medium
Tippecanoe River	Kosciusko	Unknown	Pesticides	Medium
Eel River	Whitley	Unknown	Pesticides Cadmium	Low
Elkhart River	Elkhart	Unknown	PCB Cadmium	Low
Mississinewa River	Grant	Unknown	Pesticides Metals	Low
Mississinewa River	Delaware	Multiple	PCB	Low
Patoka River	Pike	Unknown	Aluminum	Low
St. Mary's River	Allen	Unknown	Zinc	Low
St. Joseph River	St. Joseph	Unknown	Pesticides Metals PCBs	Low
Trail Creek	Porter	Unknown	Pesticides Metals	Low
Wabash River	Cass/Gibson/Posey	Unknown	PCB	Low
Wabash River	Tippecanoe	Unknown	Pesticides PCB	Low
Wabash River	Miami/Wabash	Unknown	Pesticides	Low
Eel River	Cass/Wabash	Unknown	4-Methylphenol	Unknown
Eel River	Cass	Unknown	Chrysene Pyrene Benzo(a)pyrene Benzo(a)onthracene	Unknown
Mississinewa River	Randolph	Unknown	Fluoranthene	Unknown
Patoka River	Dubois	Unknown	Di-N-Bulphthalate Fluoranthene 2-Butanone	Unknown
St. Joseph River	St. Joseph	Unknown	Fluoranthene Phenanthrene	Unknown
Wabash River	Tippecanoe	Unknown	2-Butanone Methylene Chloride	Unknown
Wabash River	Vigo	Unknown	2-Butanone 4-Methylphenol	Unknown

TABLE 22. *METALS EXCEEDING 2X THE MAXIMUM STATE BACKGROUND AND ORGANIC POLLUTANTS DETECTED IN 1988-89 STREAM AND LAKE SEDIMENT SAMPLES*

PARAMETER	TOTAL NUMBER OF SAMPLES ANALYZED	% OF TOTAL NUMBER OF SAMPLES*	MG/KG DRY WEIGHT	
			Minimum	Maximum
***	61			
Bis (2 - Ethylhexyl) Phthalate	32	71 (23)	0.041	245.541
PCB - 1248	104	18 (19)	0.019	25.871
Cadmium	86	11 (10)	2.10	5.80
2-Butanone	32	27 (9)	0.010	196.043
Fluoranthene	33	24 (8)	0.021	49.710
Silver	86	9 (8)	1.10	4.00
Zinc	86	9 (8)	315.00	530.00
Copper	87	8 (7)	47.30	410.00
di-n-Butyl Phthalate	33	18 (6)	0.042	0.590
Toluene	32	16 (5)	0.001	0.746
Chloroform	32	15 (5)	0.003	0.010
Methylene Chloride	32	15 (5)	0.020	15.508
PCB - 1242	104	5 (5)	0.018	0.123
Pyrene	33	18 (6)	0.014	3.653
Phenanthrene	33	12 (4)	0.050	2.823
BHC (Beta)	84	5 (4)	0.034	0.060
Nickel	86	5 (4)	89.00	330.000
Selenium	86	3 (3)	1.30	2.40
4-Methylphenol (P-Cresol)	33	12 (4)	0.015	0.170
Benzo(a)Pyrene	33	7 (2)	0.026	0.420
Benzo (beta) Fluoranthene	33	7 (2)	0.061	0.740
Chrysene	33	7 (2)	0.037	0.360
Benzene	32	6 (2)	0.001	0.001
Chromium	86	2 (2)	110.00	170.00
Benzo(a)Anthracene	33	6 (2)	0.026	0.280
Benzo(ghi)Perylene	33	6 (2)	0.016	0.210
p,p' (4,4) (DDD)	84	2 (2)	0.029	0.030
Heptachlor	84	7 (6)	0.004	0.016
Antimony	86	2 (2)	1.10	6.70
1,2-Dichloroethane	32	3 (1)	7.768	7.768
Diethylphthalate	33	3 (1)	0.026	0.026
Dimethylphthalate	33	3 (1)	0.120	0.120
Tetrachoroethylene	32	3 (1)	2.068	2.068
Indeno(1,2,3-c,d)-Pyrene	33	3 (1)	0.250	0.250

TABLE 22. *METALS EXCEEDING 2X THE MAXIMUM BACKGROUND AND ORGANIC POLLUTANTS DETECTED IN 1988-89 STREAM AND LAKE SEDIMENT SAMPLES* (con't)

PARAMETER	TOTAL NUMBER OF SAMPLES ANALYZED	% OF TOTAL NUMBER OF SAMPLES*	MG/KG DRY WEIGHT	
			Minimum	Maximum
4-Methyl-2-Pentanone	33	3 (1)	1.132	1.132
Aluminum	36	3 (1)	19,800	19,800
Gamma Chlordane	62	2 (1)	0.061	0.061
o,p'(1,4)DDD	62	2 (1)	0.044	0.044
p,p'(4,4)DDE	84	2 (2)	0.012	0.014
PCB - 1254	104	2 (2)	0 054	0.383
PCB - 1260	104	1 (1)	0.029	0.029

These do not include the Grand Calumet River/Indiana Harbor Canal sediment results.

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. Table 23 shows the trophic classification of Indiana public lakes and reservoirs.

Approximately 220 of Indiana's lakes and reservoirs are greater than 50 acres in size. During the past two years, special effort has been made to resample water quality in these larger lakes, and this effort will continue through 1990, due in part, to a Lake Water Quality Assessment Grant from the U.S. Environmental Protection Agency. Work under this grant is being implemented through a contract with Indiana University's School of Public and Environmental Affairs.

A total of 115 lakes over 50 acres in size were monitored during 1988-1989. Of these, 110 were monitored as part of IDEM's Indiana Clean Lakes Program and 5 were monitored through the Indiana Department of Natural Resources (IDNR) Lake Enhancement Program. Monitoring consisted of the collection and analysis of a single set of water quality samples for 10 parameters. The sample sets were collected during July or August to facilitate comparison of results and to represent worst-case water quality conditions. Representative data for 93 of the lakes monitored are presented in Table 24.

Data for the water quality parameters were used to calculate the trophic state of each lake using the IDEM Trophic State Index (TSI) (Table 25). Index values can range from zero (oligotrophic) to 75 (hypereutropic). The TSI values for all 115 lakes monitored during 1988-89 along with TSI values determined for the same lakes during the mid-1970s are presented in Table 26. For 1988-89, TSI values ranged from a low of 11 (Celina Lake and Wall Lake) to a high of 57 (Mongo Reservoir). When compared with the mid-1970 TSIs, the lakes with the largest trophic gains were Westler (+28), Stone (+28) and Simonton (+25). The lakes showing the greatest TSI improvements were Loon (-37), Story (- 37). Golden (-33), Cedarville (-27) and Pigeon (-27).

Overall, 54% of the lakes gained eutrophy points, 43% lost eutrophy points and 3% did not change (Table 27). The mean eutrophy point change for all lakes was +0.27.

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. They are generally meso- oligotrophic

TABLE 23. *TROPHIC CLASSIFICATION OF INDIANA PUBLIC LAKES AND RESERVOIRS*

LAKES

CLASS	NUMBER	PERCENT	ACRES	PERCENT
One	72	17.3	15,949	39.8
Two	170	40.9	16,885	42.1
Three	55	13.2	4,896	12.2
Four	118	28.4	2,334	5.8
	415	**100**	**40,064**	**100**

IMPOUNDMENTS

CLASS	NUMBER	PERCENT	ACRES	PERCENT
One	50	31.2	46,936	70.9
Two	66	41.2	17,041	25.7
Three	44	27.5	2,162	3.2
	160	**100**	**66,139**	**100**

ALL WATERBODIES

CLASS	NUMBER	PERCENT	ACRES	PERCENT
One	122	21.2	62,885	59.2
Two	236	41.0	33,926	31 9
Three	99	17.2	7,058	6.6
Four	118	20.5	2,334	2.1
	575	**100**	**106,203**	**100**

TABLE 24. *WATER QUALITY DATA FOR LAKES MONITORED DURING JULY - AUGUST, 1989 UNDER INDIANA'S CLEAN LAKES PROGRAM. (Data for NO_3 and NH_3 are not as NO_3-N or NH_3-N)*

LAKE	COUNTY	N03 (mg/l)	NH3 (mg/l)	Org-N (mg/l)	SRP (mg/l)	Tot-P (mg/l)	pH	%DO Oxic	Secchi (ft)	1%Level (ft)
Adams	LaGrange	0.32	0.32	0.86	0 05	0 08	7 5	30	3.9	14.0
Appleman	LaGrange	0.43	1.09	1.11	0.39	0 39	7 8	71	8.2	14.5
Atwood	LaGrange	0.44	1.17	0.77	0.00	0 06	8 1	60	6.2	17.8
Ball	Steuben	2.79	0.71	1.57	0 01	0 18	7 9	79	4.6	8.0
Barton	Steuben	0.71	0.52	0.69	0.01	0 08	7 2	100	12.1	29.0
Beaver Creek	Dubois	2.12	0.69	1.49	0 02	0 03	7 0	88	7 9	15.5
Bear	Noble	13.95	1.02	2 02	0 11	0 16	7.9	27	3.0	8.0
Big Long	LaGrange	0.53	0.10	0.81	0.09	0 21	7.6	100	10.8	26.0
Big Otter	Steuben	0.77	0.56	1 25	0 05	0 12	7.7	75	6.6	10.0
Big Turkey	LaGrange	1.73	0.73	1.24	0.03	0.04	7.9	39	5.3	14.5
Blackman	LaGrange	0.40	0.49	1.23	0 01	0.03	6.9	86	8.2	20.5
Carr	Kosciusko	7.36	3.95	1.45	0 42	0 50	8.0	40	5.6	13.0
Cass	LaGrange	0.33	0.31	0 89	0 00	0 01	8.0	83	5.9	18.0
Cedar	LaGrange	0.73	0.61	0.51	0.01	0 02	7 2	86	5 9	25.5
Cedar	Lake	1.96	0.05	1.15	0 01	0 05	9 6	100	0 8	3.0
Celina	Perry	0.36	0.06	0 62	0 02	0 02	6 7	100	9 2	21.0
Center	Steuben	0.80	2.13	1 66	0 37	0 42	7.9	40	2.0	4.8
Clear	LaPorte	2.89	0.04	0 74	0 01	0 05	9.4	80	9.2	9.2 + + +
Clear	Steuben	0.65	0.03	1 18	0 02	0 09	6.8	100	7.6	29.0
Cook	Marshall	1.43	1.65	1.28	0.22	0 27	8.0	20	2.3	6.0
Crystal	Kosciusko	4.14	1.43	1.69	0.01	0 03	8.2	64	7.2	25.0
Diamond	Noble	1.99	0.29	2.00	0 03	0 04	7 4	40	5.6	16.8
Eagle	Noble	15.58	1.09	1.17	0.06	0 13	8 0	36	5.6	11.0
Engle	Noble	10.12	0.82	1 27	0 01	0 05	7 8	100	9.5	15.3
Fish nr Plato	LaGrange	2.05	0.38	1.31	0 08	0 09	7 6	100	3.9	13.0
Fish nr Scot	LaGrange	0.67	1.43	0 87	0 14	0 18	8 0	50	4.3	13.3
Fish	Steuben	0.49	0.99	2 02	0 26	0 33	6.6	29	3 6	6.5
Fox	Steuben	0.67	0.83	0 57	0 00	0 05	7 7	71	14 1	28.0
Gage	Steuben	0.73	0.38	0,95	0.00	0 03	7 5	100	18.7	46.0
George	Steuben	0.44	0.26	1 76	0.03	0 10	7 7	100	7 2	22.0
Golden	Steuben	1.42	1.78	1.05	0 12	0 16	7 8	75	3.9	8.5
Heaton	Elkhart	0.47	0.55	0.79	0 01	0 03	7 8	83	5 4	10.0
Hoffman	Kosciusko	4.92	1 14	1 31	0 01	0 06	7 9	70	4 6	20.0

TABLE 24. *WATER QUALITY DATA FOR LAKES MONITORED DURING JULY - AUGUST, 1989 UNDER INDIANA'S CLEAN LAKES PROGRAM (Data for NO3 and NH3 are not as NO3-N or NH3-N) (con't)*

LAKE	COUNTY	N03 (mg/l)	NH3 (mg/l)	Org-N (mg/l)	SRP (mg/l)	Tot-P (mg/l)	pH	%DO Oxic	Secchi (ft)	1%Level (ft)
Hog	Steuben	0.93	0.50	0.94	0.01	0.09	7.8	75	8.9	19.0
Hogback	Steuben	1.62	2.35	1.11	0.32	0.38	7.9	43	3.3	7.2
Hunter	Elkhart	0.45	0.16	0.90	0.00	0.07	8.1	88	9.5	22.0
Indian	DeKalb	0.83	0.61	1.06	0.03	0.10	6.9	29	3.9	11.0
James	Kosciusko	3.64	1.22	1.00	0.03	0.06	8.0	33	4.9	14.0
James	Steuben	0.58	0.42	0.89	0.02	0.10	7.3	96	8.5	21.0
Jimmerson	Steuben	0.51	0.73	0.81	0.01	0.09	7.9	69	9.2	21.0
Jones	Noble	13.54	2.52	1.83	0.51	0.72	7.8	67	2.6	7.0
Knapp	Noble	4.54	1.99	1.51	0.13	0.18	8.1	35	3.9	15.5
Lake of Woods	LaGrange	1.06	1.05	1.10	0.17	0.19	7.2	79	4.6	13.0
Lawrence	Marshall	2.83	1.12	1.28	0.12	0.16	6.9	50	6.9	14.0
Lake Pleasant	Steuben	0.49	0.36	1.03	0.01	0.08	7.1	71	6.6	19.0
Lincoln	Spencer	1.18	0.04	0.83	0.03	0.03	6.9	100	10.2	16.0
Lt. Chapman	Kosciusko	4.81	1.82	0.89	0.17	0.21	8.1	44	5.9	14.0
Lt. Turkey	LaGrange	1.06	1.91	1.50	0.02	0.06	7.5	67	3.3	10.0
Lt. Turkey	Steuben	5.88	1.87	0.98	0.03	0.10	7.5	50	6.6	10.0
Lower Fish	LaPorte	2.92	0.11	0.87	0.00	0.03	8.6	75	4.6	12.0
Long (Pleasant)	Steuben	1.42	2.18	1.38	0.18	0.22	7.9	22	2.3	5.0
Long (Clear)	Steuben	0.47	0.70	1.23	0.05	0.13	7.0	50	4.3	14.0
Long	Porter	1.11	0.10	1.10	0.04	0.07	7.7	50	4.3	8.0
Loomis	Porter	2.92	1.65	1.30	0.29	0.35	8.3	20	2.6	5.5
Loon	Steuben	0.55	0.12	1.26	0.00	0.05	7.7	80	8.2	15.5
Lower Long	Noble	9.00	0.78	0.74	0.18	0.15	7.9	67	8.9	19.0
McClish	Steuben	1.00	1.23	1.04	0.12	0.16	7.2	56	8.9	19.0
Messick	LaGrange	0.63	1.75	0.78	0.15	0.23	7.9	100	4.9	12.0
Mill Pond	Marshall	1.09	0.30	1.51	0.02	0.10	7.4	50	3.3	6.0
Mongo Res.	LaGrange	1.41	0.03	2.92	0.01	0.10	7.6	100	2.6	3.0
Myers	Marshall	2.21	0.69	0.94	0.13	0.15	7.6	56	9.8	19.0
N. Twin	LaGrange	0.68	0.53	0.41	0.00	0.08	7.9	91	7.9	30.0
Otter (West)	Steuben	0.78	1.76	1.35	0.06	0.09	8.0	50	2.6	7.5
Pigeon	LaGrange	1.27	1.87	0.97	0.01	0.04	7.2	100	3.9	7.5
Pigeon	Steuben	3.59	0.66	1.76	0.03	0.11	7.5	27	5.9	8.0
Pine	LaPorte	3.12	0.71	0.75	0.05	0.09	7.9	64	9.5	20.0

TABLE 24. *WATER QUALITY DATA FOR LAKES MONITORED DURING JULY - AUGUST, 1989 UNDER INDIANA'S CLEAN LAKES PROGRAM (Data for NO3 and NH3 are not as NO3-N or NH3-N) (con't)*

LAKE	COUNTY	N03 (mg/l)	NH3 (mg/l)	Org-N (mg/l)	SRP (mg/l)	Tot-P (mg/l)	pH	%DO Oxic	Secchi (ft)	1%Level (ft)
Pleasant	Steuben	0.31	0.30	0.66	0.02	0.08	8.1	75	10.8	24.0
Pretty	LaGrange	0.47	0.22	1.27	0.00	0.01	7.0	96	9.2	26.0
Pretty	Marshall	0.91	0.03	1.01	0.01	0.06	8.1	82	13.8	29.0
Round	Noble	1.69	0.20	1.64	0.01	0.06	7.7	22	4.9	13.5
Royer	LaGrange	1.14	1.76	1.55	0.16	0.19	8.1	100	2.6	8.0
Sand	Noble	0.42	0.97	0.49	0.15	0.20	8.1	87	8.2	12.5
Saugany	LaPorte	3.11	0.19	0.41	0.02	0.06	7.5	68	26.2	44.0
Silver	Steuben	0.42	0.59	1.58	0.00	0.04	7.7	64	10.5	20.5
Smalley	Noble	4.78	1.28	1.68	0.23	0.31	8.1	31	4.9	9.5
Snow	Steuben	0.76	0.41	1.12	0.08	0.15	7.7	84	8.2	15.0
Springs Valley	Orange	0.35	0.26	0.69	0.01	0.07	6.6	78	12.1	24.0
Steinbarger	Noble	16.68	2.15	1.62	0.20	0.26	7.0	60	5.6	14.5
Stone	LaPorte	3.10	0.24	0.78	0.00	0.07	8.1	100	13.8	23.0
Stone	LaGrange	0.26	0.01	0.63	0.00	0.02	7.5	88	10.5	25.0
Story	DeKalb	0.63	2.30	2.91	0.27	0.32	7.3	100	6.4	15.0
S. Twin	LaGrange	0.36	0.55	0.37	0.00	0.03	7.9	87	4.9	33.0
Sullivan	Sullivan	0.12	0.04	2.28	0.02	0.06	7.5	100	3.0	10.0
Tamarack (Rome)	Noble	6.45	2.07	1.12	0.20	0.29	7.2	60	4.9	10.0
Tippecanoe	Kosciusko	4.43	0.18	1.32	0.03	0.05	8.1	82	6.6	20.0
Upper Fish	LaPorte	4.52	1.16	0.82	0.00	0.05	7.7	71	7.5	12.5
Upper Long	Noble	3.26	0.53	1.18	0.13	0.15	8.0	40	6.4	18.0
Waldron	Noble	3.50	1.90	1.94	0.26	0.29	8.6	33	3.9	9.0
Wall	LaGrange	0.37	0.10	0.96	0.01	0.03	7.6	89	10.2	23.0
Walters	Steuben	0.44	1.09	1.84	0.18	0.23	6.8	29	4.9	7.0
West Boggs	Martin	5.56	1.81	1.44	0.15	0.18	7.8	25	2.1	8.0
Westler	LaGrange	0.97	2.84	0.99	0.17	0.24	7.7	42	3.9	10.0
Witmer	LaGrange	0.70	1.05	1.37	0.14	0.24	8.1	31	3.8	9.5

0.00 *= Less than detection limits.*

+ + + *= Sensor hit bottom before 1% level was reached.*

TABLE 25. *CALCULATION OF THE IDEM LAKE EUTHROPHICATION 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. 0.02 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. 0.02 to 0.99	4
E. 1.0 or more	5
III. Organic Nitrogen (ppm)	
A. At least 0.05	1
B. 0.6 to 0.B	2
C. 0.9 to 1.9	3
D. 2.0 or more	4
IV. Nitrate (ppm)	
A. At least 0.03	1
B. 0.4 to 0.B	2
C. 0.9 to 1.9	3
D. 2.0 or more	4
V. Ammonia (ppm)	
A. At least 0.03	1
B. 0.4 to 0.5	2
C. 0.6 to 0.9	3
D. 1.0 or more	4
Vi. Dissolved Oxygen	
Percent Saturation at 5 feet from surface	
A. 114% or less	0
B. 115% 50 119%	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 lease 0.1 ppm dissolved oxygen	
A. 2B% or less	4
B. 29% to 49%	3
C. 50% to 65%	2
D. 66% to 75%	1
E. 76% 100%	0
VIII. Light Penetration (Secchi Disk)	
A. Five feet or under	6

TABLE 25. *CALCULATION OF THE IDEM LAKE EUTHROPHICATION INDEX (con't)*

PARAMETER AND RANGE		EUTROPHY POINTS
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% to up	0
X.	Total Plankton per liter of water sampled:	
	One vertical tow from a depth of 5 feet	
A.	Less than 4,700/L	0
B	4,700/L - 9,500/L	1
C.	9,500/L - 19,000/L	2
D.	19,000/L - 28,000/L	3
E.	28,000/L - 57,000/L	4
F	57,000/L - 95,000/L	5
G.	More than 95,000/L	10
H.	Blue-green dominance	5 additional points
	One vertical ton from a depth of 5 feet that includes the beginning of the thermocline	
A.	Less than 9,500/L	0
B.	9,500/L - 19,000/L	1
C.	19,000/L - 47,000/L	2
D.	47,000/L - 95,000/L	3
E.	95,000/L - 190,000/L	4
F	190,000/L - 285,000/L	5
G.	285,000/L or more	10
H.	Blue-green dominance	5 additional points
I.	Population of 950,000/L or more	5 additional points

TABLE 26. *TROPHIC CLASSIFICATION OF LAKES MONITORED DURING 1988-89 COMPARED TO MID-1970S CLASSIFICATION*

LAKE	COUNTY	TROPHIC PTS (CLASS) 1988-89	TROPHIC PTS (CLASS) 1970s	POINT CHANGE
Adams	LaGrange	38 (II)	28 (II)	10
Appleman	LaGrange	44 (II)	30 (II)	14
Atwood	LaGrange	21 (I)	+	+
Ball	Steuben	24 (I)	34 (II)	-10
Barton	Steuben	14 (I)	32 (II)	-18
Bass	Starke	48 (II)	38 (II)	10
Beaver Creek	Dubois	21 (I)	+	+
Bear	Noble	43 (II)	46 (II)	-3
Big Chapman	Kosciusko	29 (II)	18 (I)	11
Big Long	LaGrange	19 (I)	33 (II)	-14
Big Otter	Steuben	41 (II)	52 (III)	-11
Big Turkey	LaGrange	30 (II)	+	+
Bischoff Res. + +	Ripley	55 (III)	53 (III)	2
Blackman	LaGrange	24 (I)	20 (I)	4
Bruce	Fulton	35 (II)	61 (III)	-26
Carr	Kosciusko	31 (II)	50 (II)	-19
Cass	LaGrange	28 (II)	+	+
Cedar	LaGrange	29 (II)	9 (I)	20
Cedar	Lake	56 (III)	70 (III)	-14
Cedarville + +	Allen	24 (II)	51 (III)	-27
Celina	Perry	11 (I)	10 (I)	1
Center	Steuben	34 (II)	+	+
Charles + +	Steuben	55 (III)	52 (III)	3
Clear	LaPorte	32 (II)	30 (II)	2
Clear	Steuben	19 (I)	25 (I)	-6
Cook	Marshall	42 (II)	40 (II)	1
Crystal	Kosciusko	27 (II)	10 (I)	17
Dallas	LaGrange	34 (II)	28 (II)	6
Dewart	Kosciusko	28 (II)	36 (II)	-8
Diamond	Noble	29 (II)	21 (I)	8
Eagle	Noble	25 (I)	+	+
Engle	Noble	26 (II)	26 (II)	0
Fish nr Plato	LaGrange	52 (III)	39 (II)	13
Fish nr Scot	LaGrange	37 (II)	+	+

TABLE 26. *TROPHIC CLASSIFICATION OF LAKES MONITORED DURING 1988-89 COMPARED TO MID-1970S CLASSIFICATION (con't)*

LAKE	COUNTY	TROPHIC PTS (CLASS) 1988-89	TROPHIC PTS (CLASS) 1970s	POINT CHANGE
Fish	Steuben	38 (II)	54 (III)	-16
Fox	Steuben	17 (I)	27 (II)	-10
Gage	Steuben	15 (I)	8 (I)	7
George	Steuben	16 (I)	9 (I)	7
Golden	Steuben	33 (II)	66 (III)	-33
Hamilton + + +	Steuben	28 (II)	31 (II)	-3
Heaton	Elkhart	14 (I)	10 (I)	4
Hoffman	Kosciusko	37 (II)	23 (I)	14
Hog	Steuben	19 (I)	+	+
Hogback	Steuben	35 (II)	58 (III)	-23
Hunter	Elkhart	16 (I)	20 (I)	-4
Huntingburg + +	DuBois	41 (II)	18 (I)	23
Indian	DeKalb	34 (II)	+	+
Indiana	Elkhart	22 (I)	11 (I)	11
James	Kosciusko	40 (II)	39 (II)	1
James	Steuben	15 (I)	22 (I)	-7
Jimmerson	Steuben	20 (I)	22 (I)	-2
Jones	Noble	38 (II)	+	+
Knapp	Noble	29 (II)	43 (II)	-14
Kokomo Res 2 + +	Howard	29 (II)	51 (III)	-22
Koontz + + +	Marshall	37 (II)	42 (II)	-5
Lake of Woods	LaGrange	29 (II)	18 (I)	11
Lawrence	Marshall	33 (II)	13 (I)	20
Lake Pleasant	STeuben	21 (I)	40 (II)	-19
Lincoln	Spencer	19 (I)	29 (II)	-10
Lt. Chapman	Kosciusko	25 (I)	25 (I)	0
Lt. Turkey	LaGrange	41 (II)	36 (II)	5
Lt. Turkey	Steuben	47 (II)	+	+
Lower Fish	LaPorte	26 (II)	8 (I)	18
Long (Pleasant)	Steuben	43 (II)	64 (III)	-21
Long (Clear)	Steuben	40 (II)	24 (I)	16
Long	Porter	36 (II)	33 (II)	3
Loomis	Porter	47 (II)	56 (III)	-9
Loon	Steuben	16 (I)	53 (IV)	-37

TABLE 26. *TROPHIC CLASSIFICATION OF LAKES MONITORED DURING 1988-89 COMPARED TO MID-1970S CLASSIFICATION (con't)*

LAKE	COUNTY	TROPHIC PTS (CLASS) 1988-89	TROPHIC PTS (CLASS) 1970s	POINT CHANGE
Loon	Whitley	36 (II)	46 (II)	-11
Lower Long	Noble	20 (I)	+	+
Mc Clish	Steuben	24 (I)	18 (I)	6
Messick	LaGrange	25 (I)	30 (II)	-5
Mill Pond	Marshall	32 (II)	58 (IV)	-26
Mongo Res.	LaGrange	57 (IV)	54 (III)	3
Myers	Marshall	36 (II)	21 (I)	15
N. Twin	LaGrange	16 (I)	13 (I)	3
Olin	LaGrange	29 (II)	10 (I)	19
Oliver	LaGrange	27 (II)	10 (I)	17
Otter (West)	Steuben	52 (III)	35 (II)	17
Pigeon	LaGrange	48 (II)	27 (II)	21
Pigeon	Steuben	30 (II)	57 (III)	-27
Pine	LaPorte	30 (II)	22 (I)	8
Pleasant	Steuben	15 (I)	20 (I)	-5
Pretty	LaGrange	14 (I)	25 (I)	-11
Pretty	Marshall	23 (I)	28 (II)	-5
Prides Creek + +	Pike	34 (II)	33 (II)	1
Round	Noble	24 (I)	24 (I)	0
Royer	LaGrange	44 (II)	26 (II)	18
Salinda + + +	Washington	41 (II)	47 (II)	-6
Sand	Noble	35 (II)	23 (I)	12
Saugany	LaPorte	14 (I)	1 (I)	13
Shipshewana + +	LaGrange	53 (III)	51 (III)	2
Shriner	Whitley	28 (II)	19 (I)	9
Silver + +	Kosciusko	53 (III)	51 (III)	2
Silver	Steuben	21 (I)	28 (II)	-7
Simonton	Elkhart	31 (II)	6 (I)	25
Smalley	Noble	54 (III)	34 (II)	20
Snow	Steuben	32 (II)	20 (I)	12
Springs Valley	Orange	21 (I)	20 (I)	1
Steinbarger	Noble	31 (II)	39 (II)	-8
Stone	LaPorte	34 (II)	6 (I)	28
Stone	LaGrange	23 (I)	2 (I)	21

TABLE 26. *TROPHIC CLASSIFICATION OF LAKES MONITORED DURING 1988-89 COMPARED TO MID-1970S CLASSIFICATION (con't)*

LAKE	COUNTY	*TROPHIC PTS (CLASS) 1988-89	TROPHIC PTS (CLASS) 1970s	POINT CHANGE
Story	DeKalb	23 (I)	60 (III)	-37
S. Twin	LaGrange	22 (I)	8 (I)	14
Sullivan	Sullivan	20 (I)	39 (II)	-19
Tamarack (Rome)	Noble	40 (II)	42 (II)	-2
Tippecanoe	Kosciusko	24 (I)	12 (I)	12
Upper Fish	Laporte	35 (II)	22 (I)	13
Upper Long	Noble	32 (II)	32 (II)	-1
Waldron	Noble	39/42 (II)*	43 (II)	-4/-1
Wall	LaGrange	11 (I)	13 (I)	-2
Walters	Steuben	33 (IV)	26 (IV)	7
West Boggs	Martin	41 (II)	45 (II)	-4
Westler	LaGrange	53 (III)	25 (I)	28
Witmer	LaGrange	32 (II)	27 (II)	5

* *1989 data / 1988 data*

\+ *No data available*

\+ + *Sampled by IDEM 1988*

\+ + + *Lake enhancement data*

or meso-trophic 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. Thirty-nine lakes (8,274 acres) monitored during 1988-89 are included in Class I. This represents 34% by number and 37% by area of all lakes monitored.

Class II lakes and reservoirs are moderately productive for Indiana waters. They include waterbodies that would generally be considered meso-eutrophic. 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. Sixty-five lakes (12,131 acres) monitored during 1988-89 are included in Class II. This represents 58% by number and 55% by area of all lakes monitored.

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 hypereutropic. 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. Only 10 lakes monitored during 1988-89 are in Class III. They represent 8% by number and 8% by area of all lakes monitored.

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 inaccessibility. Only one Class IV lake (53 acres) was monitored during 1988-89.

One-hundred and one of the 115 lakes sampled during 1988-89 were also sampled during the mid-1970's. Comparisons of trophic class changes between the mid-1970's and 1988-89 for those 101 lakes are presented in Figure 5 and

TABLE 27. *SUMMARY OF CHANGES IN TROPHIC CONDITIONS FOR LAKES SAMPLES IN 1988-89*

A. CHANGE IN TROPHIC INDEX NUMBERS

TROPHIC CLASS	NUMBER RE-SURVEYED	INDEX NO. INCREASED	INDEX NO. DECREASED	NO CHANGE
Class I	43	34 (79%)	7 (16%)	2 (5%)
Class II	40	15 (38%)	24 (60%)	1 (2%)
Class III	17	5 (29%)	12 (71%)	0
Class IV	1	1 (100%)	0	0
TOTAL	**101**	**54 (54%)**	**43 (43%)**	**3 (3%)**

B. SHIFTS IN TROPHIC CLASS

TROPHIC CLASS	TOTAL 1970's	TOTAL 1988-89	MOVED TO CLASS I	MOVED TO CLASS II	MOVED TO CLASS III	NO CHANGE
Class I	43	39	0	20	1	22
Class II	40	65	10	0	2	28
Class III	17	10	1	10	0	6
Class IV	1	1	0	0	0	1
TOTAL	**101**	**115**	**11**	**30**	**3**	**57**

C. TRENDS

TOTAL RE-SURVEYED	MOVED TO BETTER CLASS	MOVED TO WORSE CLASS	REMAINED IN CLASS
101	21 (21%)	24 (24%)	56 (55%)

FIGURE 5. *PERCENTAGE OF INDIANA LAKES IN VARIOUS TROPHIC CLASSES IN 1970's VS. 1988-89*

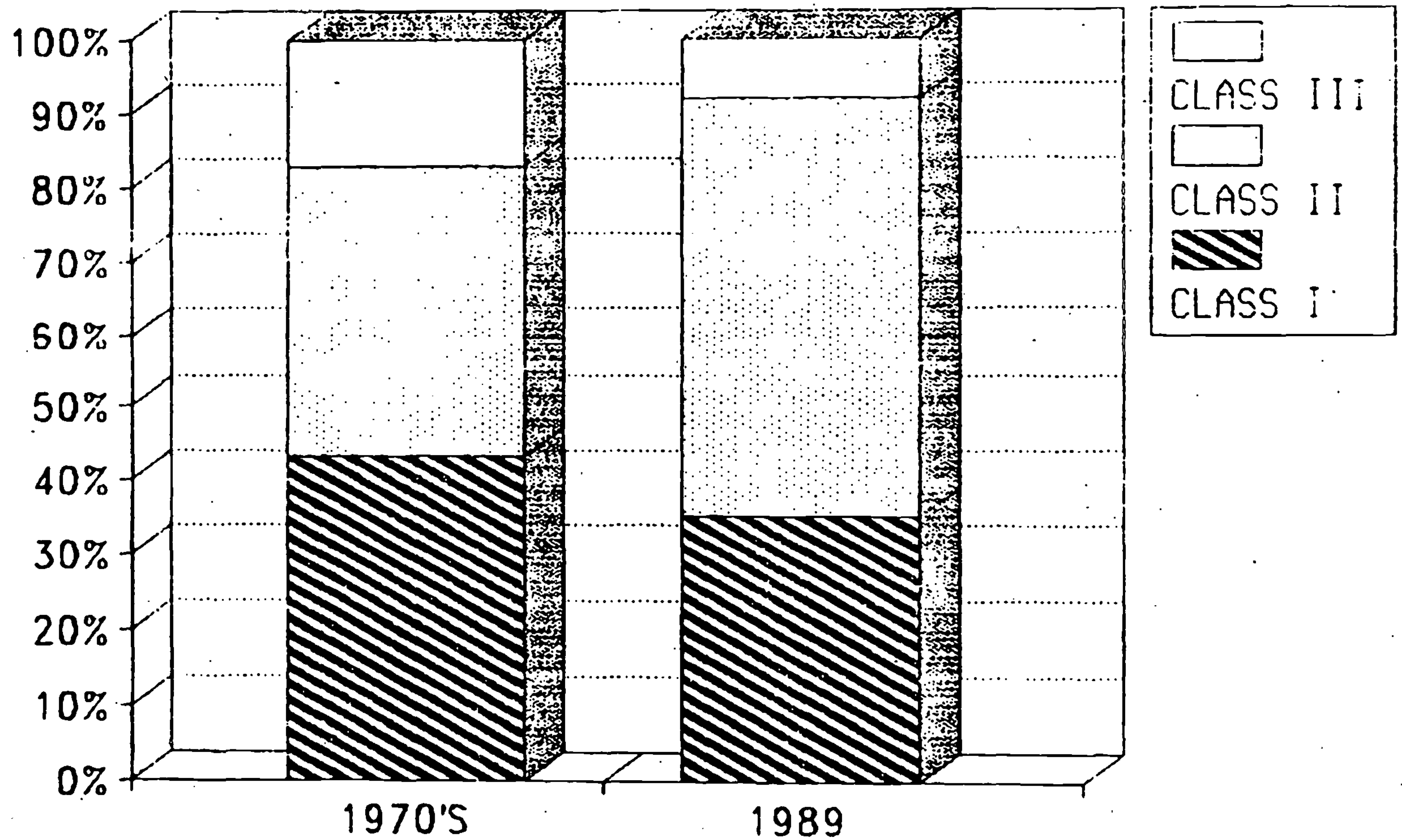


Table 27. During this period, the number of lakes in Class I and Class III declined while the number of lakes in Class II increased. Twenty Class I lakes moved down to Class II while 10 Class III lakes improved to Class II. This trend may reflect the success of water pollution abatement programs at our most eutrophic lakes but a failure to maintain water quality at our highest quality lakes.

Overall, 21% of the lakes surveyed in 1988-89 moved to a better class, 24% moved to a worse class, and 55% remained in their mid-1970s class (Figure 6 and Table 27). Appendix A shows the updated trophic classification and management group for each lake as well as other pertinent information.

Because of 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.

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.

Table 28 shows the maximum and minimum Secchi disk transparencies, the July-August average transparency and the relative ranking for each lake based on the July-August average for lakes having at least four Secchi Disk measurements. Average Secchi disk transparencies have little absolute meaning since transparency is not a linear function. For example, a lake with a Secchi disk depth of 10 feet is not twice as clear as a lake having a Secchi disk depth of 5 feet. However, as a relative comparative measure, the average Secchi disk transparency has value in rank ordering lakes from highest to lowest transparency.

Of the lakes included in the 1989 Volunteer Monitoring Program, Sweetwater and Cordry Lakes, private reservoirs in Brown County, had the highest average transparencies of 19.5 and 14.5 feet respectively. At the other end, Kokomo Reservoir and Cedar Lake had the lowest average transparencies, each averaging about 1 foot during July and August.

Table 29 shows 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. 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 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.

FIGURE 6. *CHANGES IN LAKE TROPHIC CLASS (FROM 1970'S TO 1988-1989)*

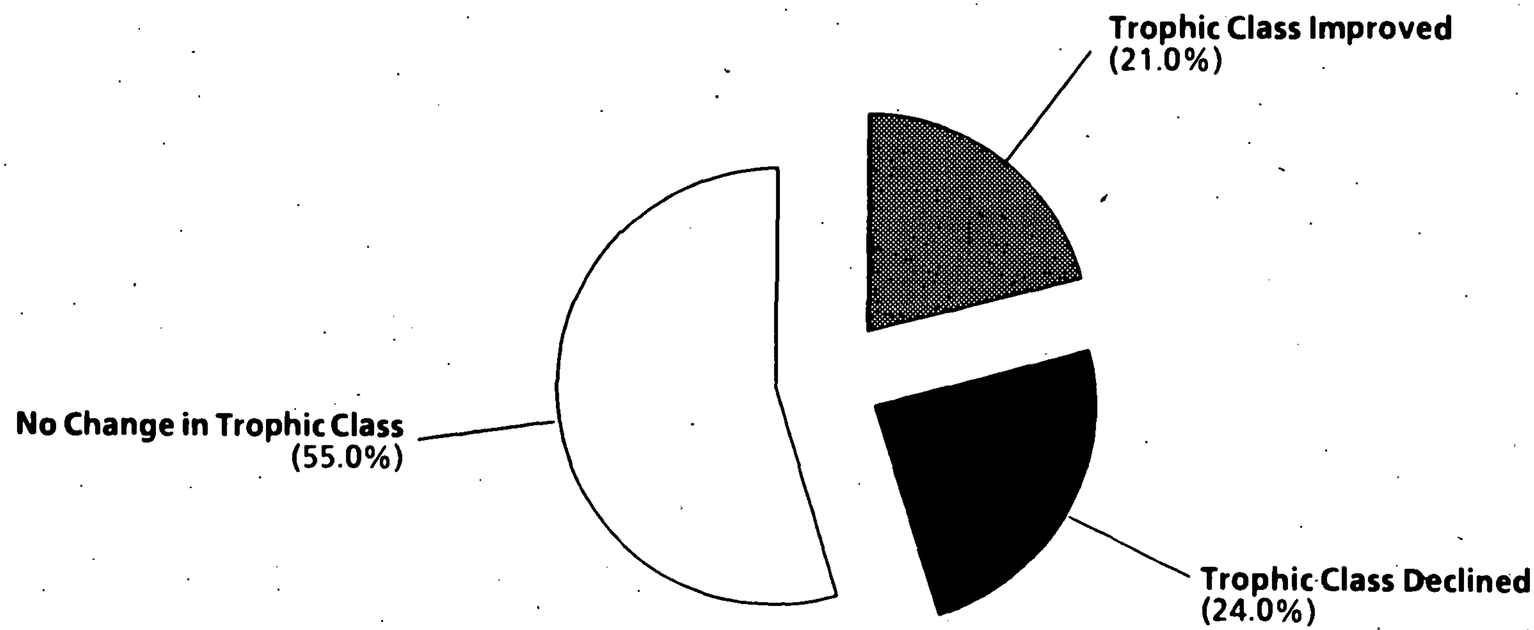


TABLE 28. *1989 SUMMARY RESULTS - VOLUNTEER SECCHI DISK MONITORING PROGRAM*

LAKE	COUNTY	YEARLY MAXIMUM (FEET)	YEARLY MINIMUM (FEET)	JUL-AUG AVERAGE (FEET)	STATE RANK
Barton	Steuben	17.00	13.00	13.00	3
Bass	Starke	6.50	3.00	4.92	18
Bear	Noble	3.75	3.50	3.54	31
Big Barbee	Kosciusko	4.00	2.50	3.00	35
Big Bass	Porter	5.00	1.00	2.20	38
Big Turkey	LaGrange	6.75	4.50	4.50	21
Cedar	Lake	1.25	1.00	1.06	41
Center	Kosciusko	9.00	5.50	6.88	14
Chapman	Kosciusko	19.75	6.25	8.69	11
Cordry	Brown	30.00	12.00	14.50	2
Crooked	Noble	12.00	7.25	9.13	10
Dewart	Kosciusko	16.00	8.50	12.25	4
Dixon	Marshall	6.50	1.50	3.95	26
Fish	LaGrange	12.50	4.00	4.63	20
Flint	Porter	12.25	7.50	12.25	5
Golden	Steuben	8.00	1.50	3.63	29
Hamilton	Steuben	13.00	3.25	3.81	27
Indiana	Elkhart	16.50	5.00	8.22	13
Irish	Kosciusko	6.00	3.00	3.25	34
Jimmerson	Steuben	13.00	8.50	10.25	7
Kokomo	Howard	2.00	1.00	1.00	42
Kuhn	Kosciusko	9.75	5.00	5.33	15
Kunkel	Wells	5.50	2.75	3.56	30
Lake on the Green	Lake	6.00	3.00	4.00	25
Little Barbee	Kosciusko	4.50	3.00	3.50	32
Little Long	Noble	8.50	3.00	4.69	19
Little Pike	Koscisuko	2.75	1.75	2.19	39
Long	Noble	10.75	4.50	10.13	8
Loon	Whitley	6.75	1.75	5.25	16
Nyona	Fulton	5.00	4.00	4.25	23
Patton Park	Morgan	5.50	4.00	4.00	24
Pile	Kosciusko	2.75	2.00	2.31	37
Round	Noble	6.00	3.00	5.25	17

TABLE 28. *1989 SUMMARY RESULTS - VOLUNTEER SECCHI DISK MONITORING PROGRAM (con't)*

LAKE	COUNTY	YEARLY MAXIMUM (FEET)	YEARLY MINIMUM (FEET)	JUL-AUG AVERAGE (FEET)	STATE RANK
Sand	Noble	11.00	9.25	10.50	6
Sawmill	Kosciusko	5.00	3.50	3.67	28
Sechrist	Kosciusko	13.00	6.50	8.50	12
Shipshewana	LaGrange	2.50	0.50	1.50	40
Springmill	Lawrence	5.00	3.00	4.44	22
Sweetwater	Brown	29.00	17.50	19.56	1
Sylvan	Noble	7.50	2.00	3.30	33
Wawasee	Kosciusko	13.75	6.50	9.63	9
Worster	St. Joseph	5.75	2.50	2.81	36

TABLE 29. *1989 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	100%	0%	0%	0%	4
Bass	Starke	0%	0%	83%	17%	6
Bear	Noble	0%	0%	100%	0%	7
Big Barbee	Kosciusko	0%	0%	50%	50%	4
Big Bass	Porter	0%	0%	20%	80%	15
Big Turkey	LaGrange	0%	17%	83%	0%	6
Cedar	Lake	0%	0%	0%	100%	9
Center	Kosciusko	0%	62%	38%	0%	8
Chapman	Kosciusko	25%	58%	17%	0%	12
Cordry	Brown	86%	14%	0%	0%	7
Crooked	Noble	0%	92%	8%	0%	13
Dewart	Kosciusko	33%	67%	0%	0%	18
Dixon	Marshall	0%	0%	75%	25%	12
Fish	LaGrange	0%	36%	64%	0%	11
Flint	Porter	0%	100%	0%	0%	5
Golden	Steuben	0%	9%	36%	55%	11
Hamilton	Steuben	0%	22%	78%	0%	9
Indiana	Elkhart	7%	81%	12%	0%	26
Irish	Kosciusko	0%	0%	50%	50%	4
Jimmerson	Steuben	0%	100%	0%	0%	5
Kokomo	Howard	0%	0%	0%	100%	6
Kuhn	Kosciusko	0%	25%	75%	0%	4
Kunkel	Wells	0%	0%	80%	20%	10
Lake on the Green	Lake	0%	0%	67%	33%	12
Little Barbee	Kosciusko	0%	0%	75%	25%	4
Little Long	Noble	0%	17%	66%	17%	6
Little Pike	Kosciusko	0%	0%	0%	100%	6
Long	Noble	0%	50%	50%	0%	6
Loon	Whitley	0%	15%	70%	15%	13
Nyona	Fulton	0%	0%	100%	0%	4
Patton Park	Morgan	0%	0%	100%	0%	10
Pike	Kosciusko	0%	0%	0%	100%	8
Round	Noble	0%	0%	83%	17%	6

TABLE 29. *1989 TRANSPARENCY CLASSIFICATION - VOLUNTEER SECCHI DISK MONITORING PROGRAM (con't)*

LAKE	COUNTY	VERY GOOD >13 ft.	GOOD 6.5 - 13 ft.	POOR 3 - 6.5 ft.	VERY POOR < = 3 ft.	TOTAL OBS.
Sand	Noble	0%	100%	0%	0%	5
Sawmill	Kosciusko	0%	0%	100%	0%	4
Sechrist	Kosciusko	0%	100%	0%	0%	4
Shipshewana	LaGrange	0%	0%	0%	100%	7
Springmill	Lawrence	0%	0%	90%	10%	10
Sweetwater	Brown	100%	0%	0%	0%	7
Sylvan	Noble	0%	12%	25%	63%	8
Wawasee	Kosciusko	5%	90%	5%	0%	19
Worster	St. Joseph	0%	0%	20%	80%	5

The excessive growth of weeds in a lake or reservoir can interfere with various designated uses. Aquatic weeds will occupy any 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 (DNR) 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 drought and warm temperatures during the summer of 1988 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 1988-89 numbered 235 as compared to 139 for 1986-87. A total of 3600 acres of water in 105 different lakes were treated, 1,510 acres during 1988 and 2090 acres during 1989 (Table 30). This is a 38% increase in acres treated compared to 1986-87. The 2,090 acres treated in 1989 represents 2% of the total surface area of Indiana's public lakes and reservoirs. The lakes with the most acres treated were Morse Reservoir, where 700 acres were treated for algae in 1989, and Shipshewana Lake where 272 acres were treated in 1988 primarily for macrophyte control. 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. A lake discharge policy 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 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.

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Story	DeKalb	1988	4	2 / M
Story	DeKalb	1989	6	2 / M
Heaton	Elkhart	1988	25	4 / C
Heaton	Elkhart	1989	25	4 / C
Heaton	Elkhart	1989	2	2 / M
Simonton	Elkhart	1988	20	4 / C
Simonton	Elkhart	1989	28	4 / C
Bruce	Fulton	1988	12	2 / M
Morese Reservoir	Hamilton	1989	700	- / M
Backwater	Kosciusko	1988	15	2 / F
Backwater	Kosciusko	1989	8	3 / F
Barbee	Kosciusko	1988	100	2 / FC
Barbee	Kosciusko	1989	124	2 / FC
Beaver Dam	Kosciusko	1988	45	1 / -
Beaver Dam	Kosciusko	1989	10	1 / M
Center	Kosciusko	1989	3	2 / C
Chapman	Kosciusko	1988	6	2 / M
Chapman	Kosciusko	1988	7.5	4 / C
Chapman	Kosciusko	1989	4	2 / M
Chapman	Kosciusko	1989	7 5	4 / C
Dewart	Kosciusko	1988	2	3 / C
Dewart	Kosciusko	1988	7	2 / M
Dewart	Kosciusko	1988	2	3 / C
Dewart	Kosciusko	1989	2.5	3 / C
Dewart	Kosciusko	1989	4	2 / M
James	Kosciusko	1989	1.5	1 / FC
Ridinger	Kosciusko	1988	1.5	1 / C
Ridinger	Kosciusko	1989	2	3 / C
Syracuse	Kosciusko	1988	1	2 / M
Syracuse	Kosciusko	1989	1	2 / M
Tippecanoe	Kosciusko	1988	9	3 / C
Tippecanoe	Kosciusko	1988	6	2 / M
Tippecanoe	Kosiusko	1989	9	4 / C
Tippecanoe	Kosciusko	1989	12	2 / M

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89 (con't)*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Waubee	Kosciukso	1988	2.5	2 / C
Waubee	Kosciusko	1989	2.5	2 / C
Wawasee	Kosciusko	1988	3	3 / M
Wawasee	Kosciusko	1989	15	2 / M
Webster	Kosciusko	1988	83	4 / FC
Webster	Kosciusko	1989	90	3 / FC
Adams	LaGrange	1988	6.5	3 / C
Adams	LaGrange	1988	2	3 / M
Adams	LaGrange	1989	6.5	3 / C
Adams	LaGrange	1989	2	3 / M
Adams	LaGrange	1989	2	3 / M
Atwood	LaGrange	1988	28	3 / -
Atwood	LaGrange	1989	28	4 / F
Big Long	LaGrange	1988	4	4 / M
Big Long	LaGrange	1989	3	3 / CM
Blackman	LaGrange	1989	1	3 / F
Case	LaGrange	1988	5	1 / -
Dallas	LaGrange	1989	15	4 / C
Fish	LaGrange	1988	5	4 / C
Hackenburg	LaGrange	1989	4	3 / C
Indian Chain of Lakes	LaGrange	1988	12	4 / C
Lake of the Woods	LaGrange	1988	1	4 / CM
Lake of the Woods	LaGrange	1988	7	2 / M
Messich	LaGrange	1989	1	2 / M
Messich	LaGrange	1989	1	4 / C
Oliver	LaGrange	1988	4	2 / M
Oliver	LaGrange	1988	1	3 / C
Oliver	LaGrange	1989	1	3 / C
Oliver	LaGrange	1989	8	2 / M
Pretty	LaGrange	1988	1	3 / CM
Pretty	LaGrange	1989	1	3 / MC
Shipshewana	LaGrange	1988	2	2 / M
Shipshewana	LaGrange	1988	250	3 / -
Shipshewana	LaGrange	1988	20	2 / F

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89 (con't)*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Westler	LaGrange	1988	1.72	2 / F
Westler	LaGrange	1989	4	2 / F
Westler	LaGrange	1989	5	3 / C
Witmer	LaGrange	1988	4	2 / M
Witmer	LaGrange	1988	6	2 / F
Witmer	LaGrange	1989	8	2 / F
Witmer	LaGrange	1989	2	3 / C
Fancher	Lake	1989	4	- / M
Hermits	Lake	1988	25	2 / F
Hermits	Lake	1989	25	2 / F
Lake Etton Co. Park	Lake	1989	11	3 / F
Lemon Lake Co. Park	Lake	1989	6.5	- / F
Oak Ridge Co. Park	Lake	1989	9	2 / F
Fish	LaPorte	1988	80	3 / C
Fish	LaPorte	1989	100	2 / C
Hidden Shores	LaPorte	1989	10	3 / C
Hudson	LaPorte	1988	5	2 / -
Hudson	LaPorte	1988	5	1 / -
Pine	LaPorte	1988	4	2 / F
Pine	LaPorte	1988	3	3 / -
Pine	LaPorte	1989	20	4 / C
Pine	LaPorte	1989	4	2 / F
Indianapolis Canal	Marion	1988	3	- / C
Cook	Marshall	1988	2	2 / M
Cook	Marshall	1988	7	3 / -
Cook	Marshall	1988	4	4 / C
Cook	Marshall	1989	4	3 / C
Cook	Marshall	1989	.4	3 / -
Dixon	Marshall	1988	2	2 / F
Holem	Marshall	1988	3	3 / C
Holem	Marshall	1989	3	3 / C
Koontz	Marshall	1988	26	4 / C
Koontz	Marshall	1989	26	4 / C
Kreighraum	Marshall	1989	1	1 / F
Lake of the Woods	Marhsall	1988	4	2 / M

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89 (con't)*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Lake of the Woods	Marshall	1989	4	2 / G
Latonka	Marshall	1988	30	2 / FC
Latonka	Marshall	1989	30	3 / FC
Lawrence	Marshall	1988	6	3 / C
Lawrence	Marshall	1989	6	4 / C
Marshall	Marshall	1989	2	2 / F
Maxinkuckee	Marshall	1988	4	3 / -
Maxinkuckee	Marshall	1989	4	3 / -
Maxinkuckee	Marshall	1989	5	2 / FC
Maxinkuckee	Marshall	1989	5	2 / FC
Meyers	Marshall	1988	8	5 / C
Meyers	Marshall	1989	8	4 / C
Mill Pond	Marshall	1988	2	3 / F
Mill Pond	Marshall	1989	2	3 / C
Pretty	Marshall	1988	4	2 / C
Pretty	Marshall	1989	3	3 / C
Lake Lemon	Monroe	1988	30	1 / -
Lake Lemon	Monroe	1989	50	1 / -
Waveland	Montgomery	1988	10	2 / F
Waveland	Montgomery	1989	10	2 / F
Bear	Noble	1989	3.5	3 / F
Big Lake	Noble	1989	2	2 / M
Cree Lake	Noble	1989	22.7	4 / C
Crooked	Noble/Whitley	1988	2	2 / M
Harper/Bouse	Noble	1988	6	4 / C
Harper/Bouse	Noble	1989	6	4 / C
High	Noble	1988	2	3 / C
High	Noble	1989	2	3 / C
Little Long	Noble	1988	6	2 / M
Loon	Noble	1988	20	2 / M
Loon	Noble/Whitley	1989	12	2 / M
Round	Noble	1989	1.5	3 / C
Skinner	Noble	1988	20	2 / M
Skinner	Noble	1989	5.5	3 / F
Skinner	Noble	1989	8	2 / M

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89 (con't)*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Sylvan	Noble	1988	29	4 / PF
Sylvan	Noble	1989	24	3 / F
Upper Long	Noble	1988	10	3 / C
Upper Long	Noble	1989	4	3 / C
Upper Long	Noble	1989	2	3 / M
Waldron	Noble	1988	3	2 / M
Waldron	Noble	1989	3	2 / M
Waldron	Noble	1989	2	3 / M
Loomis	Porter	1988	30	3 / C
Loomis	Porter	1988	7	2 / MC
Loomis/Spectacle	Porter	1989	15	3 / C
Glenn Flint	Putnam	1989	17.4	3 / -
Glenn Flint	Putnam	1989	18	3 / -
Bass	St. Joseph	1989	3.5	2 / C
Bass	St. Joseph	1989	3.5	2 / C
Pinhook	St. Joseph	1989	4	3 / -
Pinhook	St. Joseph	1989	3	2 / -
Pleasant	St. Joseph	1989	.5	2 / F
Pleasant	St. Joseph	1989	5	2 / F
Riddles	St. Joseph	1989	1.01	2 / F
Riddles	St. Joseph	1989	1.01	3 / F
Barton	Steuben	1988	2.5	3 / C
Barton	Steuben	1989	3	3 / M
Barton	Steuben	1989	2.5	3 / C
Big Long	Steuben	1988	20	3 / -
Big Turkey	Steuben	1988	80	3 / C
Big Turkey	Steuben/LaGrange	1989	80	3 / C
Big Otter	Steuben	1989	2	4 / C
Big Long	Steuben	1989	20	3 / F
Clear	Steuben	1988	.5	2 / -
Clear	Steuben	1989	1	3 / MC
Crooked	Steuben	1988	60	4 / M
Crooked	Steuben	1989	68	4 / M
Fish	Steuben	1988	300 ft.	1 / -
Hamilton	Steuben	1988	100	4 / C

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89 (con't)*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Jimmerson	Steuben	1988	12	4 / MC
Jimmerson	Steuben	1989	20	4 / MC
Lake Pretty	Steuben	1988	1	3 / C
Lake George	STeuben	1988	2.5	4 / M
Lake Pleasant	Steuben	1988	2	4 / MC
Lake James	Steuben	1988	.5	1/ -
Lake James	Steuben	1988	4	4 / C
Lake James	Steuben	1988	8	4 / C
Lake Pleasant	Steuben	1989	4	4 / M
Lake James	Steuben	1989	8	4 / C
Lake George	Steuben	1989	5	4 / M
Lake Hamilton	Steuben	1989	80	3 / C
Lake James	Steuben	1989	4	4 / C
Little Long	Steuben	1988	2	4 / MC
Little Long	Steuben	1989	4	4 / MC
Silver	Steuben	1988	2	4 / M
Silver	Steuben	1989	2	4 / M
Silver	Steuben	1989	1	2 / C
Snow	Steuben	1988	20	4 / C
Snow	Steuben	1988	23	4 / MC
Snow	Steuben	1988	1	3 / M
Snow	Steuben	1988	100 ft.	2 / -
Snow	Steuben	1988	.5	2 / -
Snow	Steuben	1989	3	3 / MC
Snow	Steuben	1989	22	4 / C
W. Otter	Steuben	1988	5	3 / C
W. Otter	Steuben	1989	15	3 / C
Wall	Steuben	1988	4	4 / M
Wall	Steuben	1989	13	1 / C
Boonville City Lake	Warrick	1988	4	2 / F
Boonville City Lake	Warrick	1989	2	2 / F
Scales	Warrick	1988	30	3 / C
Scales	Warrick	1989	51	4 / C
Big Cedar	Whitley	1988	1	1 / -
Big Cedar	Whitley	1989	1	3 / C

TABLE 30. *AQUATIC HERBICIDE PERMITS : 1988 - 89 (con't)*

LAKE	COUNTY	DATE	ACRES TREATED	MACROPHYTES/ALGAE*
Big Cedar	Whitley	1989	1	3 / C
Big	Whitley	1989	1	3 / F
Crooked	Whitley	1988	2	2 / M
Crooked	Whitley	1989	2	2 / M
Goose	Whitley	1988	8	2 / M
Goose	Whitley	1989	8	2 / M
Tri Lakes	Whitley	1988	34	2 / M
Tri Lakes	Whitley	1989	4	2 / M

*** MACROPHYTES**

- *1 = Watermilfoil (Myrophyllum sp.)*
- *2 = Elodea sp.*
- *3 = Pondweed (Potomogeton sp.)*
- *4 = Broad leafed*

ALGAE

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

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 environmental review and the 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 Non-point Source Assessment and Management Plans 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 non-point source contributions of nutrients and other contaminants to Indiana lakes and reservoirs. Non-point source problems and control programs are discussed at some length later in this report.

The state programs that have been in place for the last several years should have resulted in the improvement of some waterbodies and slowed the rate of degradation of a number of others. However, no lake or reservoir has been monitored on a regular basis to assess the effects of these programs.

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, totalling 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 aesthetic considerations.

There are two small public lakes with a total of 63 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.

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.

<u>Basin Information and Summaries</u>

Although U.S. EPA has requested the states to utilize the Waterbody System (WBS) in their 1990 305(b) reports, Indiana was unable to comply at this time. All waters of the state are currently being placed in segments to conform to the WBS format, and this task is nearly complete. Information in this 305(b) report will be transferred to the WBS format when the system becomes available.

Lake Michigan Basin

Lake Michigan is located in the northwest corner of the State. Indiana governs approximately 43 miles of shoreline and 241 square miles, about 1% of the total surface area of the lake.

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 7). The St. Joseph River and its tributaries will be referred to as the Lake Michigan Basin-Northeast in this report (Figure 8). 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 contiguous 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.

Analyses conducted on Lake Michigan water samples collected from the five water supply intakes as part of the Fixed Station Water Quality Monitoring Network during 1988-89 were reviewed. These data showed only occasional (less than 10%) violations of criteria for lead, cadmium and E. coli. A rather high percentage of samples from the Gary and East Chicago sampling points exceeded the chronic aquatic life criterion for copper (95% and 20%, respectively). However, there were no exceedances of this criterion at the other three sampling points on the lake. When all Lake Michigan samples are considered together, only 22% of the samples exceeded this criterion. This would indicate that the lake may be only partially supporting for aquatic life uses due to copper concentrations. There is also the possibility that these samples reflect copper contamination from the water intake systems at Gary and East Chicago as the Lake Michigan samples collected from the other intake locations did not show these copper levels.

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

FIGURE 7. *LAKE MICHIGAN BASIN - NORTHWEST*

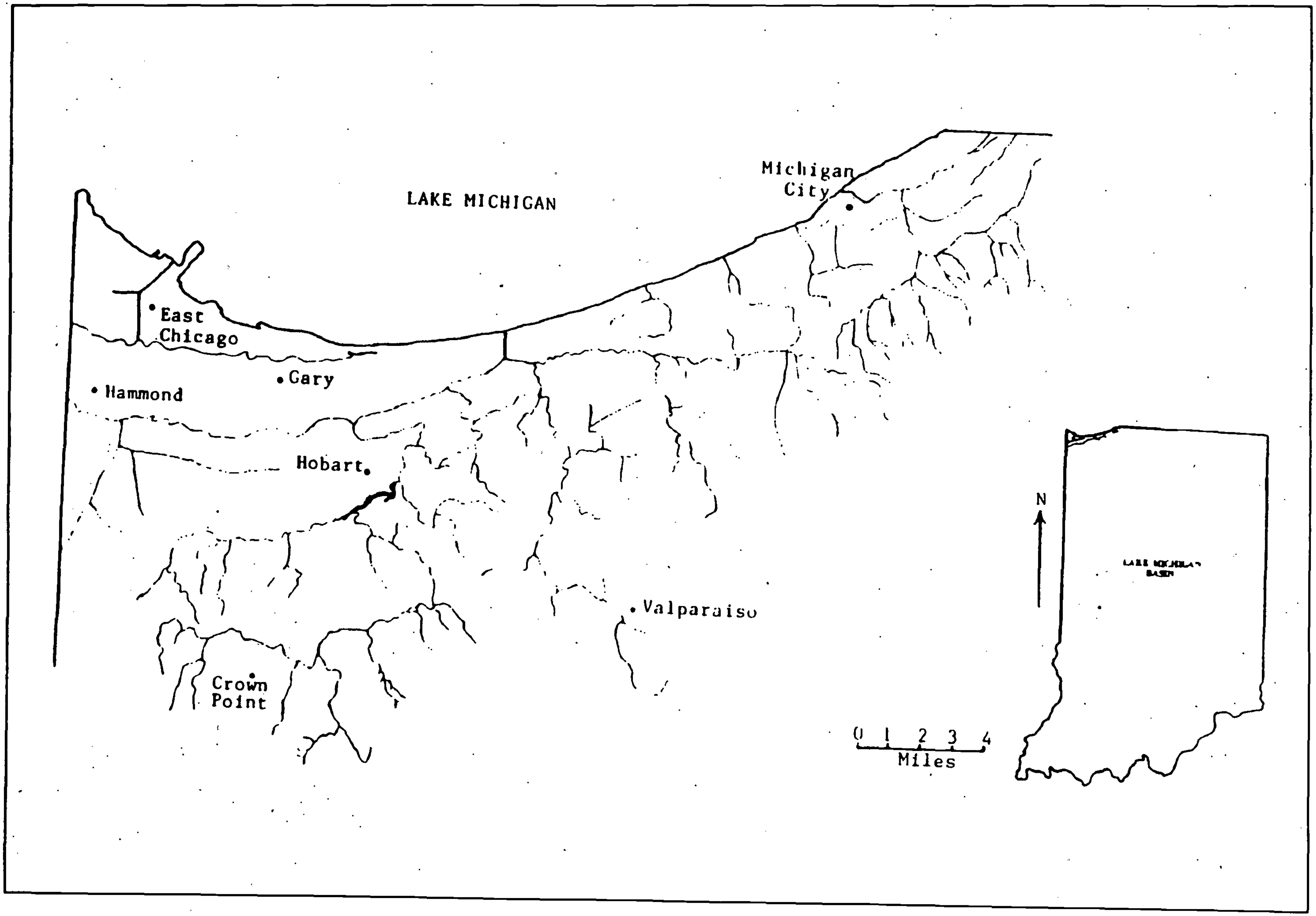
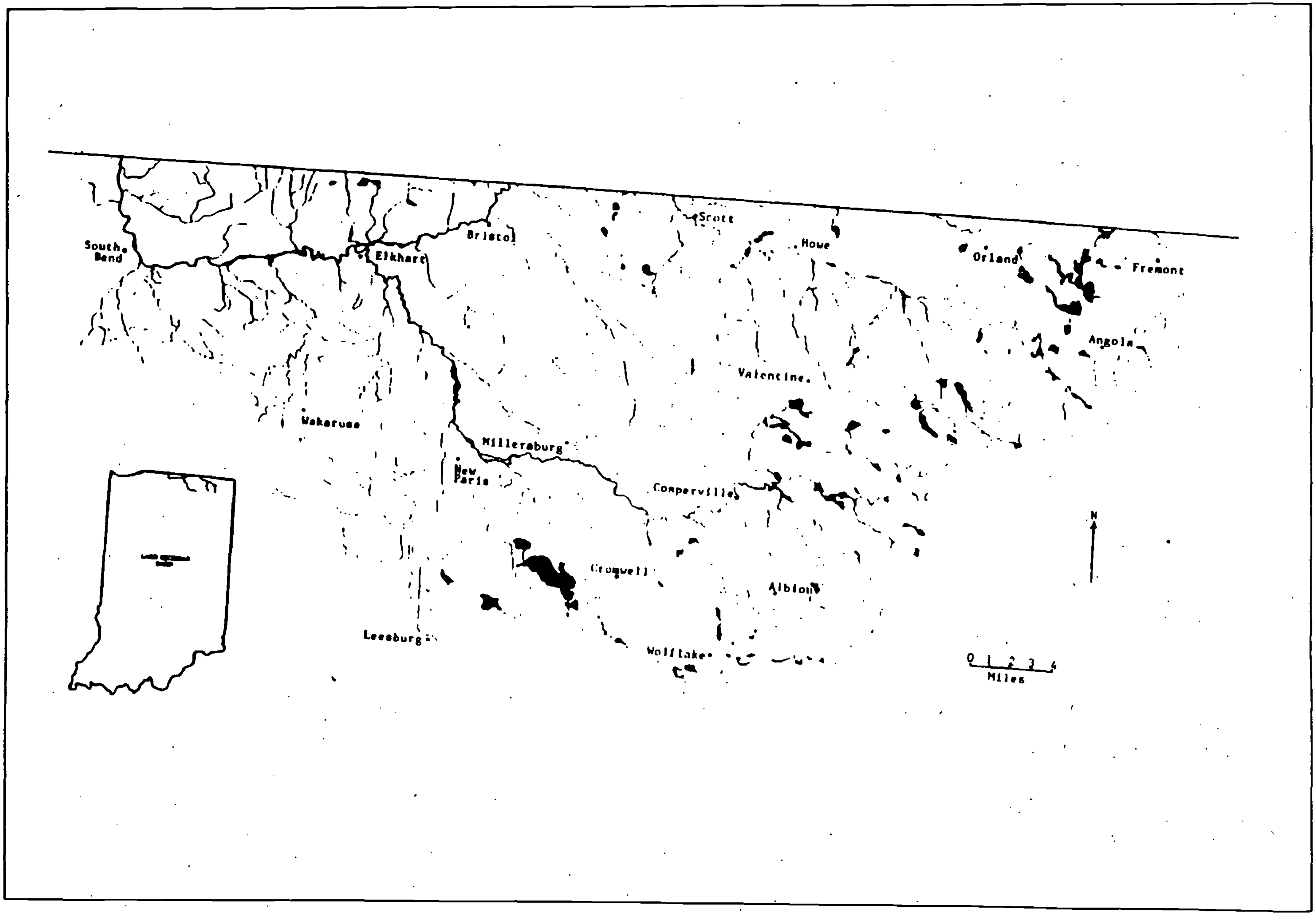


FIGURE 8. *LAKE MICHIGAN BASIN - NORTHEAST*



Levels in certain sizes and species of fish. A revised fish consumption advisory for fishermen and consumers of these fish is issued each spring. The most current advisory is shown in Table 16. Due to this consumption advisory and some high copper concentrations, Lake Michigan (43 shoreline miles) is determined to only partially support its designated aquatic life uses. Recreational uses 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 31. Additional information for certain stream reaches are also provided in this table.

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 this waterway. Inadequately treated sewage, combined sewer overflows (CSOs), industrial discharges and chemical spills have contributed to its poor condition and resulted in fish kills at different times. In 1986 and 1987, four fish kills occurred due to low dissolved oxygen, high temperature, and/or ammonia. However, no fishkills were reported in 1988 or 1989. Significant modifications to the Michigan City wastewater treatment plant (POTW) were recently completed to prevent the plant from discharging raw and/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 POTW to handle larger volumes of wastewater which has reduced the frequency of bypassing. The Michigan City POTW 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 violations in the lower reaches of the creek occurred 11% of the time during 1988 and 1989 compared to 1986-87 when violations occurred 40% of the time according to the Fixed Water Quality Monitoring Network data. The E. coli bacteria criteria were violated often enough during 1988-89 that the designated recreational uses were not supported, and isolated violations of un-ionized 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.

TABLE 31. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, 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	FS (Aquatic Life)	Evaluated		10	Combined sewer overflow to Coffee Creek has been eliminated.
Coffee Creek	Chesterton	PS (Aquatic Life)	Evaluated	Urban run-off	2	
Upper Salt Creek	Valparaiso	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	4	Valparaiso STP - now produces a good effluent.
Lower Salt Creek	McCool Portage	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	4	Neighborhood Utilities now connected to Portage. This eliminated constant bypassing of sewage into Salt Creek.
Dunes Creek	Tremont	FS (Aquatic Life) (Threatened)	Evaluated	Channelization E. coli	5	County Health Dept., National Lake Shore, and IDEM have tested Dunes Creek for fecal coliform elevated levels of E. coli, about 1,000 col/100 ml have been found, but no source can be identified Further testing for E. coli is warranted.
Kintzele Ditch and its tributaries	Michigan City	FS (Aquatic Life) (Threatened)	Evaluated	Channelization	5	
Upper Trail Creek and its tributaries	Michigan City	PS (Aquatic Life) (Threatened)	Evaluated	Agricultural Run-off Cyanide E. coli	42	a) The Anderson Company has had many violations of their NPDES Permit Evidence of sludge deposit in tributary. The Anderson Company has directed all process water to the Michigan City sewers This has eliminated this pollution source b) Storm water and combine sewer overflows may have degraded stream
Lower Trail Creek	Michigan City	NS (Aquatic Life) (Recreational)		D.O. E. coli Lead PCBs Chlordane	3	a) Michigan City STP - Much improvement in the water quality with the construction of the new wastewater treatment facility. b) Fish Consumption Advisory for carp
Galena River and its tributaries	Heston Lalimere	FS (Aquatic Life)	Evaluated		13	

TABLE 31. ***WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST (con't)***

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Burns Ditch	Lake Station Portage	PS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	Dieldrin PCBs Chlordane E. coli Lead Cyanide	8	a) Portage STP - Well operated facility. The addition of new sludge dewatering facilities have helped treatment. Discharge usually extremely good quality. b) Town of Burns Harbor - Apparently many failed septic systems. c) Burns Harbor Waterway - Connected to City of Portage. POTW Discharge eliminated. d) National Steel - Violations of NPDES permit have occurred. Lab QC/QA unsatisfactory. Civil penalties administrated. e) Enamel Plate Products - All chemical cleaning waste pump to National Steel for treatment. This pipeline has ruptured several times and caused degradation. e) Fish Consumption Advisory for carp
L. Calumet River	Gary	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	7	a) Bethlehem Steel-Compliance with permit majority of time. Only violations are for temperature (regularly) b) Black Oak areas sometimes discharges raw sewage. Action initiated c) City of Gary - Raw sewage bypassing from 15th and Clay Lift Station occurred in 1989. Poor maintenance is the reason
L. Calumet River	Porter Chesterton	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	6	a) Multiple sources. b) Porter POTW now tied into Chesterton - no problems. c) Chesterton POTW expansion is complete and ammonia removal functioning well. Effluent quality is substantially improved.

TABLE 31. ***WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST** (con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Little Calumet River	Hammond	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	Cyanide Ammonia D.O. E. coli	10	a) Multiple sources. b) Combined sewers and storm water cause degradation.
Deep River	Hobart	PS (Aquatic Life)	Evaluated	Run-off Hobart POTW Poor Habitat	4	City of Hobart - Construction of lift station which pumps all sewage to Gary is complete and operating. Severe inflow & infiltration into sewer system still exists. This impacts Gary sewers which can impact L.C. R. or G.C.R
Deep River	Lake Station	FS (Aquatic Life) (Threatened)	Evaluated		4	Infrequent lift station overflows from small subdivision impair river.
Turkey Creek	Hobart	PS (Aquatic Life)	Evaluated	Runoff Channelization	8	Community Utilities - Bypassing of raw sewage causes obvious degradation.
Indiana Harbor Canal	Whiting E.Chicago	NS (Aquatic Life) (Recreational)	Monitored (b)(c)	Cyanide PCBs D O Ammonia Lead E. coli	4	a) Multiple sources. b) Fish Consumption Advisory for all species of fish. c) LTV, Inland, are major contributors. Slag ground water from Inland Steel reaching canal
Lake George Branch of Indiana Harbor Canal	E Chicago	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	Cyanide Oil & Grease E. coli PCBs D.O	1	a) Multiple sources. b) Fish Consumption Advisory. c) Oil leachate from Amoco Oil and E.C.I property Amoco has installed ground cover system to held reduce leachate problems.

TABLE 31. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST (con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
E. Branch Grand Calumet River	Gary, E. Chicago	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	Oil & Grease E. coli Lead Cyanide Ammonia PCBs	10	a) E. Chicago STP - New facility operating well. Combined sewer overflows still degradate stream. b) Gary STP - The facility has been poorly managed and opereated. The state and EPA have been trying to correct problems in Gary for many years with little success. Sewer system is in a state of disrepair as is the treatment facility. Combined sewage discharge during wet and dry weather cause obvious degration. c) U.S. Steel - Oily discharges from thier facility cause degradation. Years of neglect have caused many sediment contamination problems d) U.S.S. Lead - Lead battery casing and covering site. Facility is abandoned Possible source of lead to the river. e) Dupont - Compliance with NPDES permit, but ground water leachate being evaluated
W Branch Grand Calumet River	Hammond E. Chicago	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli D.O PCBs Lead Cyanide Ammonia CSO's Lead	3	The Hammond Sanitary District- has caused severe degradation of the river Dissolved oxygen levels of zeo are not uncommon. All combined sewage discharge need to be eliminated.
Plum Creek	Dyer	NS (Aquatic Life)	Evaluated	Run-off CSO's Amonia	4	
Hart Ditch	Munster, Highland	NS (Aquatic Life)	Evaluated	Run-off CSO's Unknowns	2	Munster and Highland now discharge to Hammond POTW.
Dyer Ditch	Dyer	NS (Aquatic Life)	Evaluated	Ammonia	2	Dyer STP - Ammonia treatment is needed. Sewage bypassed during wet-weather
Kaiser Ditch	Lincoln Village	NS (Aquatic Life)	Evaluated	E. coli D.O.	1	Lincoln utilties now connected to Merrillville POTW, but source pollution remains.

TABLE 31. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENTS, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHWEST (con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Beaver Dam Ditch	Crown Point	NS (Aquatic Life)	Evaluated	Crown Point POTW Poor Habitat Ammonia	7	

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

2 *b = biological, c = chemical.*

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 to 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 POTW. 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.

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 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 and Munster were major problems in this reach. Dissolved oxygen values below 4.0 mg/l occurred more than 50% of the time from 1984 to 1985 at the fixed water quality station at Hohman Avenue (LCR-13). The 1986-1987 data show fewer dissolved oxygen violations (23%), and still fewer in 1988-89 (18%) based on 1988-89 monitoring data. However, criteria for cyanide and ammonia were exceeded often enough that this portion of the Little Calumet River is considered to not support the aquatic life designation. Violations of the bacteriological standard for whole body contact recreation occurred approximately 90% of the time in 1988-1989.

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. Results from surveys are showing that nitrification is taking place during the treatment process. No adverse effects from the plant discharge have been noted in nearby Brown Ditch and the plant is meeting its NPDES permit limits.

During 1988 and 1989 the Dyer sewage treatment plant was experiencing some bypassing to Plum Creek (Hart Ditch). The facility has since hired a consulting company to evaluate the situation. 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. Once Dyer's operational problems have been corrected, the quality of water in Plum Creek and the Little Calumet River should be improved.

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 and Salt Creek are designated by Regulation 327 IAC 2-1 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 should have helped to alleviate many problems. Control of combined sewer overflows was also required. During 1988, no NPDES violations occurred at the facility. In 1988- 89, almost no violations of water quality standards were reported at the fixed water quality monitoring stations located on Salt Creek. However, bacteriological standards were exceeded often enough that the stream does not support the recreational use designation.

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. Crown Point's only problem currently is the need for ammonia removal. The City plans to install fine air diffusers to treat ammonia. The plan is to achieve the ammonia limits through the use of more efficient oxygen transfer from fine bubbles. Also regionalization of the Hobart wastewater treatment plant with Gary has been completed, and the elimination of this discharge to Deep River is expected to further improve water quality in this stream.

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 temperatures 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 Steels' thermal violations were relatively minor and are being addressed through modification of the permit.

Midwest Steel also discharges wastewater to Burns Ditch. While inspection reports from the previous two year period indicated that Midwest Steel was meeting its NPDES permit limits, this facility has had six violations during 1988 and 1989. The most significant violations have been of the monthly average value for iron. Mechanical problems have been primarily responsible for these violations. An improved plant maintenance schedule has recently proved beneficial in eliminating violations.

Macroinvertebrate samples collected in 1988 were very similar to those collected in 1986. All the organisms were facultative for tolerance to low dissolved oxygen, 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.

Burns Ditch is included in the fish consumption advisory for Lake Michigan and its tributaries (Table 16).

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. Steel Corporation (USX) 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 entire state. The Grand Calumet River-Indiana Harbor Ship Canal 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 1988-89 were examined. Of the six metals (cadmium, copper, lead, nickel, silver, and zinc) for which data were available, only lead was found to violate water quality standards. Lead values exceeded the chronic aquatic life criterion from 28% to 78% of the time at these stations. Cyanide was also prevalent in these waters, and violations of the criterion for this substance were found at each of the monitoring stations ranging from 28% to 71% of the time. Frequent exceedances of the dissolved oxygen and un-ionized ammonia criteria were found at the monitoring station on the West Branch of the Grand Calumet River (71% and 39%, respectively), and the dissolved oxygen criterion was also frequently violated in the IHC (5% to 35% of the time at various stations). The un-ionized ammonia criterion was exceeded 42% of the time at the most upstream station on the East Branch of the Grand Calumet River. The _E. coli_ bacteriological criterion was exceeded frequently at each of the monitoring stations (27% to 73% of the time). Thus, concentrations of cyanide, lead, ammonia, and _E. coli_ appeared to be of concern throughout much of the GCR/IHC system, and dissolved oxygen was a problem in the West Branch and Indiana Harbor Ship Canal during this monitoring period. Problems have existed in these waters for many years. However, some past pollutant problems have been resolved, and the concentrations of many of these substances have been reduced even though criteria violations still occur.

As a result of these water quality problems and the designation of this area as a Class A Area of Concern (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. A special section reporting on the results of this sampling follows the basin reports section (page 170).

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.

Additionally, as a result of the designation of this area as a Great Lakes AOC, a Remedial Action Plan (RAP) needed to be developed to address the water quality/aquatic habitat/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 and/or restored. IDEM established a Remedial Action Plan Work Group, and a draft plan was completed in January 1988. The RAP is still undergoing review and revision. The final RAP will be submitted to the Great Lakes Water Quality Board of the IJC.

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 before. A final ruling has yet to be determined. It's outcome will be dependant on the conclusions given by IDEM enforcement staff based on a sediment sampling study as well as other factors.

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 1989 showed no violations of interim NPDES permit limits, but samples often contained levels of dissolved solids, cyanide and several metals which will probably exceed final limits which will go into effect soon. Dissolved oxygen levels also were a concern.

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.

Industrial discharges from U.S. Steel, (USX) Inland Steel, LTV Steel DuPont, Vulcan Material, Material Handling and American Steel affect 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, etc.

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

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. However, the presence of many "facultative" organisms (especially odonates, certain midges and snails) and a few intolerant species indicated that severe oxygen depletions do not occur frequently. Stresses associated with toxic chemicals were indicated by most samples.

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 16) and the consumption of any species of fish from these waterways is not advised.

In summary, 169 stream miles were assessed for support of aquatic life uses in the Lake Michigan Basin-Northwest. Of these assessed waters, 58 miles (34%) fully supported their designated uses, 62 miles (37%) only partially supported designated uses, and 49 miles (29%) did not support designated uses. Of the 58 miles that fully supported their designated uses, 14 miles

(24%) are considered threatened. Only 60 of these miles were assessed for recreational uses and none supported this use. In addition all 43 shoreline miles (241 square miles) of Lake Michigan are considered to only partially support designated aquatic life uses but does support recreational uses.

Lake Michigan Basin - Northeast

In the Lake Michigan Basin - Northeast, approximately 295 miles were monitored and/or evaluated to determine support of use designations. Table 32 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. 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 (SJR-87), Mishawaka (SJR-64), and South Bend (SJR-51) 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 not supporting the aquatic life use because of a fish consumption advisory on carp due to high PCB and lead levels in tissue of this species. The source of these pollutants are not known. Due to the frequency of high E. coli levels, the the designated recreational use is not supported throughout the river.

No CORE station macroinvertebrate samples were collected from the Bristol and South Bend stations in 1988. The Hester Dendy samplers were lost due to high water or vandalism.

The Pigeon River in Steuben and LaGrange counties, located in northeastern Indiana enters the St. Joseph River after flowing into 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 does not support whole body contact recreational uses due to E. coli bacteria levels. The Angola POTW is operating poorly, has problems with combined sewers and has a sludge storage problem. It has been referred for enforcement action.

TABLE 32. ***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 SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Mud Creek and its tributaries	Helmer	FS (Aquatic Life)	Evaluated		5.5	
Unnamed Tributary from Loon Lake to Crooked Lake	Crooked Lake	FS (Aquatic Life)	Evaluated		1.5	
Fawn River	Howe	FS (Aquatic Life)	Evaluated		4.5	
Fawn River	Scott	FS (Aquatic Life)	Evaluated		4.0	
Fawn River	Orland	FS (Aquatic Life)	Evaluated		8.5	
Little Elkhart Creek	Wolcottville	FS (Aquatic Life)	Evaluated		3.0	New Regional POTW in the works.
North Branch Elkhart River	Wolcottville	FS (Aquatic Life)	Evaluated		7.0	
North Branch Elkhart River	Millersburg	FS (Aquatic Life)	Evaluated		4.5	Only periodic problems
Middle Branch Elkhart River	Rome City	FS (Aquatic Life)	Evaluated		2.5	
Croft Ditch	Albion	FS (Aquatic Life) (Threatened)	Evaluated		7.0	Albion POTW.
Carroll Creek	Wolf Lake	FS (Aquatic Life)	Evaluated		3.0	Poor condition.
Forker Creek	Burr Oak	FS (Aquatic Life)			3.0	
Elkhart River	Ligonier New Paris	FS (Aquatic Life)	Evaluated		19.5	
Elkhart River	Goshen Elkhart	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	CSO's E. coli	18.0	
Upper Turkey Creek and Tributaries	Millersburg	FS (Aquatic Life)	Evaluated		9.0	
Turkey Creek	Syracuse	FS (Aquatic Life) (Threatened)	Evaluated	TSS Sewage	2.0	Facility upgraded. Still problems with sludge.
Turkey Creek	Helmer Stroh Elmira	FS (Aquatic Life)	Evaluated		14.0	
Lower Turkey Creek	Milford New Paris	FS (Aquatic Life)	Evaluated	Algae Problems	15.5	
Coppes Ditch	Leesburg Milford	FS (Aquatic Life)	Evaluated		6.5	No POTW - Septic failures

TABLE 32. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHEAST (con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Little Elkhart River	Bristol Middlesburg	FS (Aquatic Life)	Evaluated		10.5	
Baugo Creek	Wakarusa Jamestown	FS (Aquatic Life)	Evaluated		11.0	
Christiana Creek	Elkhart	FS (Aquatic Life)	Evaluated		4.5	
Cobus Creek	Elkhart	FS (Aquatic Life)	Evaluated		5.5	
Gast Ditch	Elkhart	FS	Evaluated		2.0	
St. Joseph River	South Bend Mishawaka Elkhart Bristol	NS (Aquatic Life) (Recreational)	Monitored (b)(c)	Lead PCBs Chlordane E. coli	34.0	Fish Consumption Advisory.
Judy Creek	South Bend	FS (Aquatic Life)	Monitored (b)(c)		7.0	
Crooked Creek	Nevada Mills	FS (Aquatic Life)	Evaluated		3.0	
Eaton Creek and its tributaries	Fremont	FS (Aquatic Life)	Evaluated		5.5	POTW near capacity - new lagoons, algal problems.
Follette Creek	Jamestown	FS (Aquatic Life)	Evaluated		0.5	
Crooked Creek	Jamestown	FS (Aquatic Life)	Evaluated		1.5	
Pigeon River	Mongo Howe	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	17.0	
Pigeon River	Angola	FS (Aquatic Life)	Evaluated	CSO Sludge	9.0	POTW functions poorly
Pigeon Creek	Pleasant Lake Angola	PS (Aquatic Life)	Evaluated		4.0	See Mud Creek.
Pigeon River	Flint	FS (Aquatic Life)	Evaluated		12.0	
Upper Fly Creek	LaGrange	FS (Aquatic Life)	Evaluated		6.0	
Lower Fly Creek	LaGrange	FS (Aquatic Life) (Threatened)	Evaluated	LaGrange POTW Ammonia	4.5	LaGrange POTW trickling filter plant incapable of meeting ammonia nitrogen limits. Agreed Order filed with complaint in Marion Circuit Court 8/13/87. LaGrange POTW awarded $2.1 million in FY87 for advanced treatment and ammonia removal. Completion of these projects is targeted for late 1989.

TABLE 32. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE LAKE MICHIGAN BASIN - NORTHEAST (con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Kohler Ditch	Leesburg	NS (Aquatic Life)	Evaluated	Septic Overflows	0.5	Raw sewage from septic systems.
South Branch Elkhart River	Albion Kimmel	NS (Aquatic Life)	Evaluated	Low D.O.	7.0	
Henderson Lake Ditch	Kendallville	NS (Aquatic Life)	Evaluated		3.5	Kendallville POTW. New construction operating well.
Mud Creek and tributary to Angola STP	Angola	NS (Aquatic Life)	Evaluated	Angola POTW CSO's	3.0	
Berlin Court Ditch	Nappanee	NS (Aquatic Life)	Evaluated	Runoff.	4.5	

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

2 *b = biological, c = chemical.*

Several other smaller streams assessed do not fully support aquatic life uses due almost entirely to problems at POTWs. Portions of Henderson Lake Ditch and Berlin Court Ditch are impaired by periodic poor treatment and/or bypassing at POTWs in Kendallville and Nappanee, respectively. In several of these situations corrective action is underway. In Kendallville, new plant construction is completed and the plant is operating exceptionally well. The water quality in Henderson Lake Ditch has improved greatly. The Nappanee facility is operating well but has had occasional metals violations. Kohler Ditch near Leesburg has received some raw sewage from inadequate individual septic tank disposal systems.

The South Branch of the Elkhart River does not fully support aquatic life uses in its lower reaches due to natural conditions. This portion of the river flows through extensive wetland areas and is very sluggish and slow moving. Although no point sources have been shown to contribute to the problem, dissolved oxygen levels often fall below the established criteria. Fish community diversity does appear to be low in this reach as a result.

In summary, 295 miles of streams were assessed as to support of aquatic life uses in the Lake Michigan Basin - Northeast. Of these assessed waters, 238 miles (81%) fully supported aquatic life uses, 4 miles (1%) partially supported these uses, and 53 miles (18%) did not support these uses. Of the 266 miles which were fully supporting, 14 (5%) are considered threatened. Only 59 of these miles were assessed as to the extent they were meeting whole body contact recreational uses, and none of these miles supported this use.

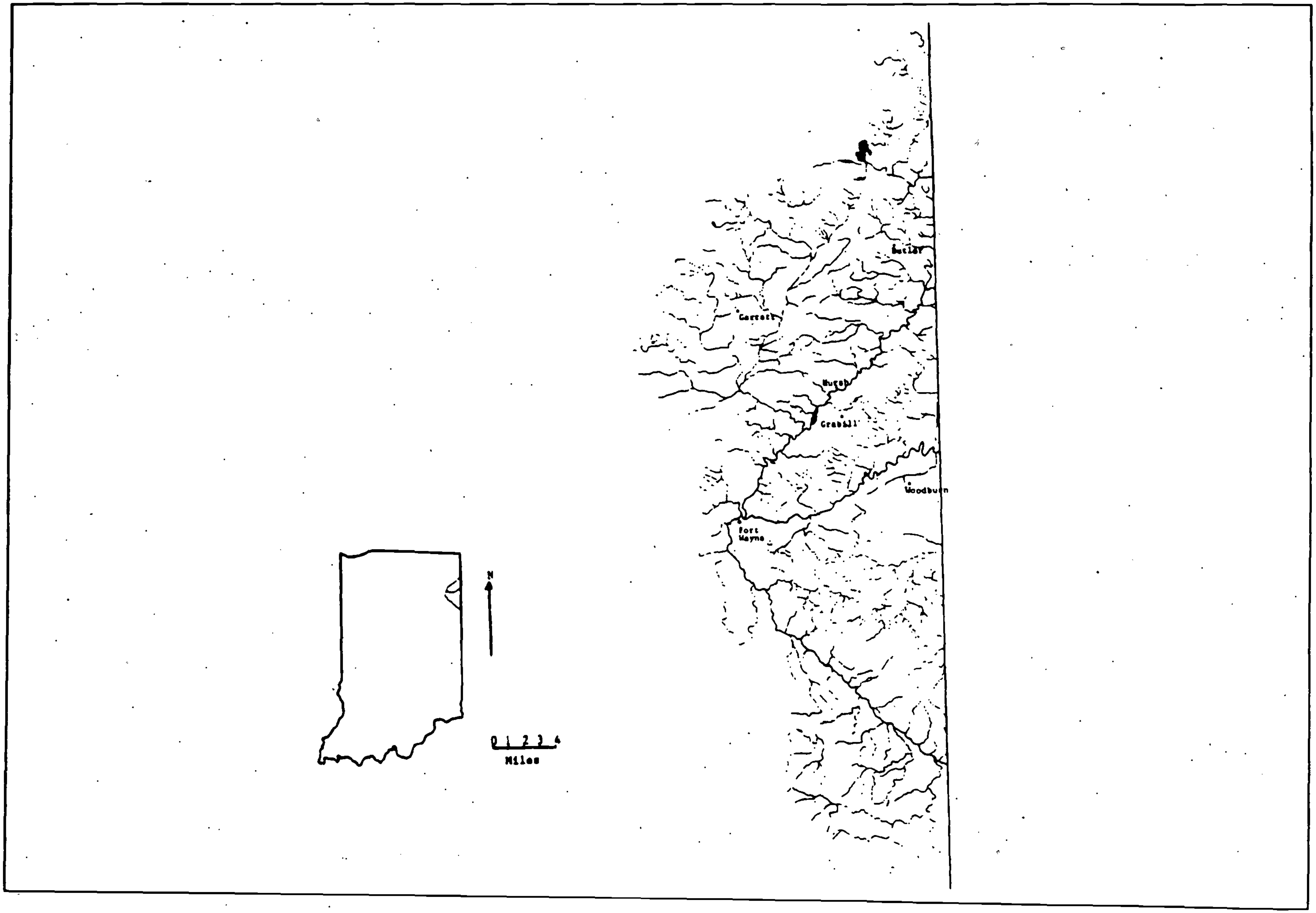
Maumee River Basin

The Maumee River Basin is located in the northeastern portion of Indiana and drains portions of Adams, Allen, DeKalb, Noble, and Wells counties (Figure 9). The drainage area in Indiana is approximately 1,216 square miles with the land use approximately 80% agriculture, 10% urban, and the balance forested and 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 a 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 comprises 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 traverses across the northern portion toward Toledo and empties into Lake Erie. The $Q_{7,10}$, as estimated at New Haven in Allen County is 70 cfs. The St. Mary's River originates near New Bremen, Ohio and flows northwest to Fort Wayne. Approximately 39 river miles are within Indiana ($Q_{7,10}$ is 9.3 cfs at Decatur). The St. Joseph River originates near

FIGURE 9. *MAUMEE RIVER BASIN*



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 33. Additional comments are also given for certain reaches.

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 POTW 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 CSOs 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. They have been having trouble meeting ammonia limits, as more stringent ammonia limitations 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.

Currently, there are three fixed water quality stations for monitoring the St. Mary's River (STM-37, STM-11, and STM-0.2). Station STM-0.2 was added in 1986 to monitor water quality after the impact of CSOs and industry in the Fort Wayne area and is a CORE station.

Violations of the cyanide criteria in the upper river (STM-37) and the un-ionized ammonia criteria in the Fort Wayne area (STM-11 and STM-0.2) were found infrequently, but often enough during the two-year period to place the St. Mary's River in the partial support category for aquatic life. *E. coli* violations at these stations occurred often enough that the river was considered to not support its designated recreational use. Comparison with historical data from the St. Mary's River fixed water quality monitoring stations indicate that there have been no significant changes in overall water quality over the last several years, although levels of copper and lead appear to have decreased over the past two years.

There was a fish kill in Yellow Creek in Adams County in April, 1988. Yellow Creek is a tributary of the St. Mary's River with its confluence just upstream of Decatur. The fish kill was attributed to a liquid nitrogen fertilizer spill.

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 packer), several industries involved in electroplating (B&B Custom Plating in Hoagland, and Fort Wayne Wire and Die, Inc.), and five minor municipal discharges. None have had any documented recent problems in terms of impacting water quality of the St. Mary's River.

TABLE 33. ***WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE MAUMEE RIVER BASIN***

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
St. Mary's River	State line to near Fort Wayne	NS (Recreational) PS (Aquatic Life)	Monitored (b)(c)	Nonpoint Cyanide E. coli	28	CSO separations in Decatur. New aeration system to handle more flow. More stringent ammonia standards.
St. Mary's River	Fort Wayne	NS (Recreational) PS (Aquatic Life)	Monitored (b)(c)	E. coli Ammonia	11	
Yellow Creek	Monroe	FS (Aquatic Life)	Evaluated		3	
St. Joseph River	State line to Allen County Line	FS (Aquatic Life)	Evaluated		18	
St. Joseph River	Allen County line to mouth	NS (Recreational) NS (Aquatic Life)	Monitored (b)(c)	E. coli Cyanide Ammonia	20	
Willow Creek	Huntertown	FS (Aquatic Life)	Evaluated		1	G.C.I. Inc. is connected to the Fort Wayne sewer line and has removed discharge from Willow Creek.
Cedar Creek	Waterloo	FS (Aquatic Life) (Threatened)	Evaluated	Metals	1	Kitchen Equip. has lowered discharge volume since 1988 and no permit violations have occurred
Cedar Creek	Waterloo to Auburn	FS (Aquatic Life)	Evaluated		6	
Cedar Creek	Auburn	PS (Aquatic Life) (Recreational)	Monitored (b)(c)	Suspended Solids D.O. E. coli	2	Expansion of Auburn POTW completed. Problem with sludge running off into Cedar Creek. Ammonia removal system installed.
Cedar Creek	River Mile 13.7 to mouth	FS (Aquatic Life) (Threatened)	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 Oil and Grease Phenol Chlorine Ammonia	1	

***TABLE 33. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE MAUMEE RIVER BASIN** (con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Big Run Creek	Butler	FS (Aquatic Life)	Evaluated		7	
Hilkey Ditch	Auburn	FS	Evaluated		1.5	This is a limited use stream.
Hindman Ditch	St. Joe	FS	Evaluated		0.5	This is a limited use stream.
Bear Creek	St. Joe	FS (Aquatic Life)	Evaluated		1	
Haifley Ditch	Grabill	FS (Aquatic Life)	Evaluated		1	
Witmer Ditch	Grabill	FS (Aquatic Life)	Evaluated		1	
Maumee River	Fort Wayne to State line	NS (Aquatic Life) (Recreational)	Monitored (b)(c)	PCBs E. coli Ammonia Cyanide Siltation	25	Fish Consumption Advisory, CSO problems.
Harvester Ditch	Fort Wayne	FS (Aquatic Life)	Evaluated		1	
Flatrock Creek	Adams County	FS (Aquatic Life)	Evaluated		15	
Blue Creek	Adams County	FS (Aquatic Life)	Evaluated		25	

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

Fish and macroinvertebrates were sampled for the first time in 1986 at station STM-0.2, near the mouth of the St. Mary's River. Both fish and macroinvertebrate diversity was low, but no stress due to toxics or low dissolved oxygen was indicated by the species composition. No macroinvertebrate samples were obtained in 1988, because the samplers were lost, but fish tissue samples collected contained no contaminants in concentrations at or above FDA Action Levels. Concentrations of toxics in sediments were not high enough to be of concern. The St. Mary's River is probably most adversely affected by heavy silt loads from non-point sources in the basin. Most macroinvertebrates found in 1986 were "silt tolerant," and most substrate areas of the stream are covered with layers of silt of various depths.

The St. Joseph River drains an area of largely agricultural usage and contains no major metropolitan areas except Fort Wayne at its mouth. It is dammed north of Fort Wayne in Allen County forming Cedarville Reservoir, a shallow, eutrophic, water supply impoundment.

Cedar Creek is an important tributary of the St. Joseph River entering just below Cedarville Reservoir. Unfortunately, in portions upstream of the area designated as a State Resource Water, some water quality problems exist. The Auburn sewage treatment facility experienced some NPDES permit violations for ammonia, cadmium and copper in 1988. Throughout 1989, however, the plant effluent and operations were excellent. In 1987, the City began a program to remove storm water from its collection system.

A number of industrial dischargers are also found in the Cedar Creek watershed. Kitchen Quip Corporation in Waterloo has had a number of NPDES permit limit violations in the past. However, they have worked to eliminate these violations and have reduced their plating waste. Their treatment system currently appears to be operating satisfactorily.

G.C.I., Inc., formerly Gridcraft Corporation, in Huntertown has also had a history of wastewater problems. A Consent Decree was signed in October 1984, requiring G.C.I., among other things, to dredge Willow Creek for 200 feet downstream from the point of discharge to remove the contaminated sediment. They were also required to connect to the Huntertown sewer system which is sending its wastewater to the Fort Wayne municipal wastewater treatment plant. Connection with the Huntertown/Fort Wayne interceptor was completed in 1989. The elimination of this discharge and removal of the contaminated stream sediment should improve water quality in Willow Creek and Cedar Creek.

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 (STJ-0.5). This station is part of the CORE program and is also near a water supply intake point. Chemical data from this station indicates good water quality with almost no violations of established standards.

Macroinvertebrate samples were not obtained at this station in 1988 because the samplers were lost in high water. However, biological data collected in 1986 indicated good water quality at this station. Sediment sampling at station STJ-0.5 in 1986 revealed that no toxic organics were present in concentrations of concern. Analysis of fish tissue samples indicated that no contaminants exceeded FDA Action Levels.

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 St. Joseph River is designated for whole-body contact recreation. Values for E. coli, during the recreational season, exceeded the State standard 36% of the time. This would indicate that this portion of the St. Joseph River is not supporting its designated recreational use.

The IDNR also conducted fish population studies in Spy Run at Vevay Park and Franke Parke in 1989. These studies 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. Sediment sampling in 1986 in Spy Run in Fort Wayne showed elevated levels of polyaromatic hydrocarbons (PAH's) of unknown origin.

Universal Tool and Stamping, which discharges to Teutsch Ditch near Butler has had a history of NPDES permit limit violations including ammonia, BOD_5, cyanide, zinc, hexavalent chromium and total chromium. However, recent upgrading of equipment at this facility has resulted in improvement in the effluent. A November 1987 toxicity bioassay revealed no toxicity, and only one permit violation (for zinc) occurred in 1988-89.

There are two industries upstream of Universal Tool and Stamping that also discharge into Teutsch Ditch near Butler, Bohn Aluminum and Brass Company and DeKalb Plastics. Bohn Aluminum and Brass Company has had problems meeting discharge limits for oil and grease, suspended solids, and total residual chlorine.

Beatrice (County Line) Cheese in Auburn discharges to Hilkey Ditch in south-central DeKalb County. Hilkey Ditch, which is a small "limited use" stream for 1.5 miles downstream of the Beatrice discharge, eventually flows into the St. Joseph River. Beatrice Foods has recently installed a new treatment facility and has its own analytical laboratory with well trained personnel. The operation of this facility's wastewater treatment plant is much improved.

Another industry with a history of water quality problems in the St. Joseph River basin is Ralph Sechler and Sons, Inc., St. Joe. This is a vegetable pickling firm that discharges seasonally. The receiving stream is Hindman Ditch which connects to Bear Creek, a tributary of the St. Joseph River. Hindman Ditch is a small "limited use" stream, and Sechler supplies most, if not all, of the flow during portions of the year. In 1983-84 the wastewater treatment facility was expanded and aeration capacity increased. Recently, there have been no reports of problems at this facility and no water quality problems have been noted in Bear Creek.

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 of 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 which have caused serious water quality problems. However, the effluent from the wastewater treatment plant is of good quality and does not appear to be causing significant degradation of the Maumee River.

Fixed water quality station M-129 is located in New Haven at the Linden Road bridge over the Maumee River, six miles downstream from the Fort Wayne sewage treatment facility. In 1986, this station was designated a CORE station and the upstream station (M-135) was dropped from the Fixed Station Water Quality Monitoring Network. Chemical data from the two stations were similar and biological information had usually been collected in the stream reach between these two stations. The other fixed water quality monitoring station on the Maumee River (M-114) is located at the State Road 101 bridge north of Woodburn which is 22 miles downstream of the Fort Wayne sewage treatment plant.

Chemical data from the two Maumee River stations indicate that, while there were very few violations of most chemical parameters examined, water quality standards for cyanide were exceeded about 28% of the time over the two year period. This would place the river in non-support of aquatic life uses. Violations of the E. coli standards also indicate non-support of the whole body contact designated use.

Biological sampling in the Maumee River has included fish and macroinvertebrates. Macroinvertebrate samples collected in the Maumee River in 1988 indicated relatively low population densities, but no indication of low dissolved oxygen or toxics stress. A limited fish consumption advisory for carp was issued for the Maumee River in 1990, although PCB levels in whole fish samples collected in 1988 did not exceed FDA Action Levels. The advisory is based on past sampling, and is less restrictive than the one previously in effect. The source of the PCB contamination is thought to be an old landfill along the bank which may be leaching substances into the river. This is currently under investigation. Results from sediment samples collected by the Corps 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 sediments.

The metropolitan Fort Wayne area includes a number of industries that discharge to Harvester Ditch, a tributary to the Maumee River. These industries would include ITT-Aerospace/Optical Division, REA Magnet Wire, and Phelps Dodge Magnet Wire. ITT-Aerospace/Optical Division now sends its process water to the Fort Wayne POTW and discharges only non=contact cooling water, cooling tower overflow and boiler blow down to Harvester Ditch. A recent inspection indicated some problems with oil and grease and TSS in the discharge. REA Magnet Wire also now sends its process water to Fort Wayne and discharges only non-contact cooling water. No recent problems have been found at this facility or at Phelps Dodge Magnet Wire.

Also included in this watershed segment is Flatrock Creek. It flows into Indiana from Ohio and through southeastern Allen County. It flows northwest to a point just north of Monroeville and then northeast back into Ohio before its confluence with the Maumee River. The only point discharger in the Flatrock Creek drainage basin is the Monroeville POTW. A recent assessment of Flatrock Creek concluded that water quality of the segment was satisfactory. The Monroeville POTW 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. As the important point sources in the basin are already discharging phosphorus at levels considerably under their allowed limits, agricultural runoff has been identified as Indiana's primary concern and focal point. 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.

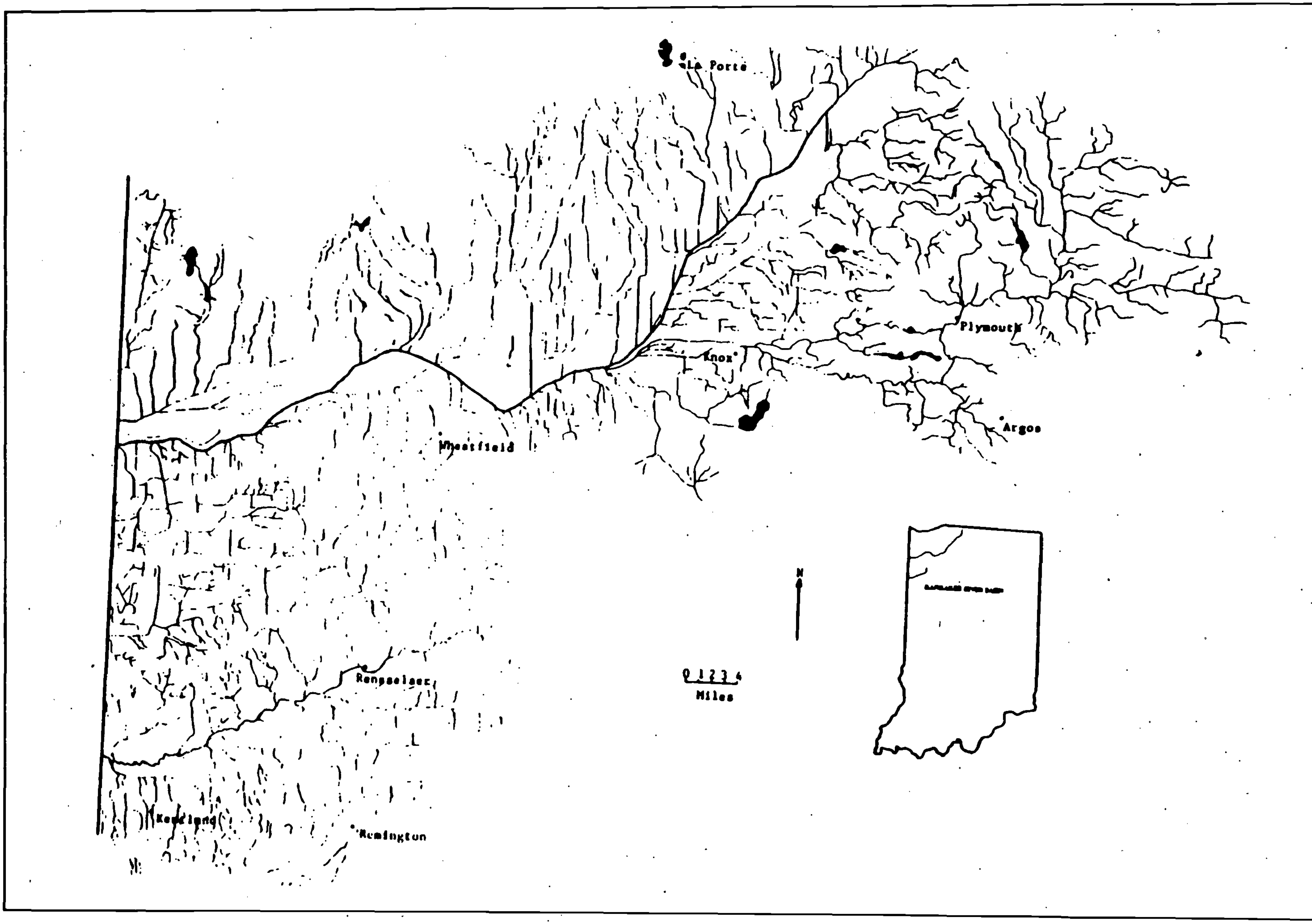
By establishing 1982 as the base year and using available cropping and soils information, the ANSWERS computer model was used to determine sediment and phosphorus loads from Adams, Allen and DeKalb counties. Increased application of conservation tillage practices in these three counties has resulted 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.

In summary, 187 miles of waterways were assessed in the Maumee River Basin. Of these total miles, 94 miles (50%) support the aquatic life designated use, another 44 miles (24%) partially support the aquatic life designated use, and 49 miles (26%) did not support the aquatic life designated use. Of the 89 miles assessed for recreational use 98% (74 miles) did not meet the whole body contact recreational criteria, and no waters assessed were fully supporting of this use.

Kankakee River Basin

The Kankakee River Basin (Figure 10) drains about 3,000 square miles of northern Indiana before flowing westward into Illinois. Major tributaries in Indiana include the Iroquois and Yellow rivers. The largest cities in the watershed are LaPorte and Plymouth, and most of the area is extensively farmed. There are relatively few industrial or municipal discharges in the basin, and even at low summer flows only about 3% of the flow in the Kankakee River, where it leaves Indiana, is treated wastewater.

FIGURE 10. *KANKAKEE RIVER BASIN*



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 the melting ice made the basin lower than surrounding areas. Sand was deposited in this low area by the melting glacier, and much of this lowland became a gigantic marsh. Beginning in the mid-1800s, ditches were dug throughout the basin to improve drainage for farming. Today most of the streams in the basin have been dredged and straightened. The basin is still flood-prone, but nearly all of it is farmed. Most of the streamflow is made up of groundwater, providing a relatively constant discharge of cool water throughout the year.

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

Water quality monitoring in the basin during 1988 and 1989 included:

(1) Monthly chemical and bacteriological sampling at two fixed stations (KR-68 and KR-118).

(2) Biological sampling and fish tissue analysis at two CORE stations (KR-68 and KR-118).

(3) Effluent toxicity testing at the Schaeffer Generating Station, LaPorte POTW and Roll Coater in Kingsbury.

(4) Fish population studies conducted by the Indiana Department of Natural Resources (IDNR) on the Iroquois River and Yellow River.

(5) Compliance Sampling Inspections (CSI's) at ten facilities.

Those waterbodies assessed, the status of designated use support, probable causes of non-support, and miles affected are shown in Table 34. Additional comments concerning certain reaches are also given in this table.

Tissue analysis of fish collected at the two CORE stations revealed that metals, PCBs, and pesticides in fish from the Kankakee River remain among the lowest in the state and are well below the concentrations affecting human health. No stream uses are impaired in the Kankakee Basin due to toxics in fish.

TABLE 34. ***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 SUPPORT[1]	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Cedar Creek	Lake Dalecarlia Lowell	FS (Aquatic Life)	Monitored (c)		5	a) Lowell has constructed ammonia removal facilities and has eliminated bypassing at the POTW. No permit violations. b) Lake Dalecarlia is constructing sewers to connect to the Lowell POTW.
Carpenter Creek	Remington	FS (Aquatic Life)	Monitored (b)		5	Remington POTW has installed new pumps and electronics at the lift station but construction at this facility still in progress. Remington is currently meeting its permit limits and past ammonia problems have now been eliminated.
Cobb Creek	Hebron	PS (Aquatic Life)	Evaluated	D. O. Ammonia	5	Hebron has had bypass problems during 1988 and the violations were addressed during a 7/89 compliance conference. Most of the issues are now being addressed in that the community has received an FmHA grant.
Travis Ditch	Kingsbury LaPorte	PS (Aquatic Life)	Monitored (b) (c)	D. O. Ammonia Metals Dissolved Solids	10	a)LaPorte POTW has had problems complying with NPDES permit limits partially due to equipment failures causing ammonia violations. Construction has not been completed but a dechlorination facility will also be built. b) Roll coater has had high TDS values due to high levels of sulfates. There are also elevated levels of metals in the stream. Various problems in eliminating toxicity from their effluent occurred during 1988 - 1989.

TABLE 34. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE KANKAKEE RIVER BASIN* (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Crumpacker Arm/Forbes Ditch/Crooked Creek	Westville	FS (Aquatic Life)	Evaluated		5	a) Westville POTW now meeting all limits. b) Improvements to the Westville Correctional Center Sewage Treatment Plant have also helped these streams.
Montgomery Ditch	Kentland	PS (Aquatic Life)	Evaluated	Ammonia	3	Major construction of a new facility at Kentland is continuing with completion expected for 1990. It's current effluent has been good but occasionally contains an oil from Viscare Corp.
Yellow River	Plymouth Knox	PS (Aquatic Life)	Monitored (b) (c)	D.O. Ammonia Cyanide	25	a) Plymouth Fertilizer has hired consultants for a new treatment system. The enforcement action should be resolved soon. An increased effort by the Plymouth POTW pretreatment program to discover the sources of cyanide violations is needed. b) Knox sewage treatment plant was issued a noncompliance notice to correct effluent violations in 7/89. Enforcement staff is monitoring the facility.
Neispodziany Ditch	New Carlisle	PS (Aquatic Life)	Evaluated	D.O. Ammonia	2	New Carlisle STP - Judicial action filed 6/30/88 Town is now on a schedule to correct deficiencies and to meet discharge limits.
Hunter Ditch	Goodland	PS (Aquatic Life)	Evaluated	D.O. Ammonia	2	Goodland had a Consent Decree finalized 4/88 to correct water quality violations. The community received 2.2 million dollars in grants during 1989. A judicial order against this community will soon be revised.

TABLE 34. ***WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE KANKAKEE RIVER BASIN*** (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Deardurff Ditch/ Beaver Creek	Morocco	FS (Aquatic Life)	Evaluated		3	
Upper Kankakee River	Crumstown/ English Lake	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	40	
Iroquois River	Rensselaer	FS (Aquatic Life)	Monitored (b)		20	Rensselaer POTW is under a judicial order to comply with the final effluent limits by 10/90. Construction for plant improvements began 3/89 and should be operational by 1990. IDNR survey of this river indicated diverse fish community.
Yellow River	Bremen	FS (Aquatic Life)	Monitored (b)		25	Bremen equipment and unlined surface ponds are to be corrected; the facility will stop discharging unpermitted wastewater to the ground IDNR survey of this river indicated diverse fish community.
Lower Kankakee River		PS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	E. coli Lead	40	
Sugar Creek	Earl Park	FS (Aquatic Life)	Evaluated		10	
Wolf Creek	Wheatfield	FS (Aquatic Life)	Evaluated		10	
Hoffman Ditch	Lakeville	FS	Evaluated		10	Limited use stream.
Eagle Creek	Starke County	FS (Aquatic Life)	Evaluated		20	
Slocum Ditch/Reeves Ditch	Wanatah	FS (Aquatic Life)	Evaluated		20	
Potato Creek	North Liberty	FS (Aquatic Life)	Evaluated		5	
Mill Creek	Union Mills	FS (Aquatic Life)	Evaluated		10	
West Creek	Lake County	FS (Aquatic Life)	Evaluated		20	
Slough Creek	Jasper County	FS (Aquatic Life)	Evaluated		10	
Beaver Lake Ditch	Newton County	FS (Aquatic Life)	Evaluated		10	
Singleton Ditch	Lake County	FS (Aquatic Life)	Evaluated		10	
Brown Ditch	Schneider	FS (Aquatic Life)	Evaluated		5	
Knight Ditch	Newton County	FS (Aquatic Life)	Evaluated		10	
Pitner Ditch	LaPorte County	FS (Aquatic Life)	Evaluated		10	
Little Kankakee River	LaPorte County	FS (Aquatic Life)	Evaluated		10	
Craigmile Ditch	Starke County	FS (Aquatic Life)	Evaluated		10	

TABLE 34. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE KANKAKEE RIVER BASIN* (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT[1]	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Kline-Rouch Ditch	St. Joseph County	FS (Aquatic Life)	Evaluated		5	
Myers Ditch/Wolf Creek	Argos	FS (Aquatic Life)	Evaluated		5	
Robbins Ditch	Starke County	FS (Aquatic Life)	Evaluated		10	
Curtis Creek	Jasper County	FS (Aquatic Life)	Evaluated		5	
Ryan Ditch/Oliver Ditch	Jasper County	FS (Aquatic Life)	Evaluated		15	
Pine Creek	North Judson	FS (Aquatic Life)	Evaluated		5	
Yellow Bank Creek	LaPaz	FS (Aquatic Life)	Evaluated		5	
Pine Creek	North Judson	FS (Aquatic Life)	Evaluated		5	
Wolf Creek/Sandy Hook Ditch	Lake Eliza	FS (Aquatic Life)	Evaluated		10	
Geiger Ditch	Porter County	FS (Aquatic Life)	Evaluated		5	
Lateral 5 Ditch	St. Joseph County	FS (Aquatic Life)	Evaluated		5	
Evers Ditch	DeMotte	FS (Aquatic Life)	Evaluated		5	
Benkie Ditch	Kouts	FS (Aquatic Life)	Evaluated		5	
Kent Ditch	Kentland	FS (Aquatic Life)	Evaluated		3	
Fish Creek	LaPorte County	FS (Aquatic Life)	Evaluated		5	

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*

Approximately 50 miles of streams in the basin are partially impaired by toxics. Bioassays of effluents from the LaPorte POTW and Roll Coater, Inc., at Kingsbury, have demonstrated toxicity due possibly to metals, surfactants and dissolved solids (sulfates). Both discharges are to Travis Ditch in LaPorte County. Sediments in Travis Ditch were found to contain metals concentrations considerably above background levels. In addition, water samples from the water quality monitoring station on the lower Kankakee River (KR-68) were found to contain lead concentrations which exceeded the chronic aquatic life criterion about 12% of the time.

Partial impairment of the aquatic life use still occurs in streams below the POTW's at Hebron, Plymouth, Knox, LaPorte, and New Carlisle. Partial impairment also occurs because of sewage pollution in Hunter Ditch below Goodland. Goodland does not presently have a POTW. However, Goodland has a consent decree to correct water quality violations and has received a $2.2 million grant for treatment plant construction. At Kentland, construction of new sewers and a new treatment plant have resulted in a few effluent violations related to construction activities. Construction is expected to be completed in May 1990. Bypassing problems at Hebron are now being addressed through a FmHA grant.

Bacteriological sampling at the two fixed stations on the Kankakee River helps estimate the quality of water for recreational uses. All streams in the basin are now designated for whole-body contact. Data from these stations indicate that the river currently does not support this recreational use. The limited amount of data available makes it impossible to determine whether violations of the standard were caused by point sources, CSO's, or runoff from animal feedlots.

Lowell now has ammonia removal facilities in place and has eliminated bypassing problems. Improved operations and monitoring has occurred in Lake Dalecarlia and construction has begun to connect this town to the Lowell POTW. As a result of these activities, low dissolved oxygen and high ammonia levels in Cedar Creek have been eliminated.

Improved water quality at several locations in the basin should occur when additional wastewater treatment facilities are in operation at Rensselaer, English Lake, Remington, LaPorte, and Plymouth. Construction on these projects should be completed in 1990 or 1991. Until all new construction is completed, the Plymouth facility needs an increased effort by their pretreatment program to discover and eliminate sources of cyanide causing current effluent violations. However, new sanitary sewers in Plymouth eliminated eight bypass points which should improve water quality in the Yellow River. In recent years, several fish kills in the Yellow River were attributable to the Plymouth POTW. During 1988-89, only one fish kill occurred in the Yellow River, and it was not attributable to this facility. Equipment failure problems at the LaPorte POTW have resulted in ammonia and copper violations in Travis Ditch. Hopefully, these will be corrected once the construction is completed. New pumps and electronics now in place at the Remington POTW have eliminated some problems (ammonia) and the plant is currently meeting its permit limits although other construction is still in progress.

Enhanced water quality is expected in the basin due to equipment and operation changes at the Westville, Lowell, and Knox POTWs. Each of these discharges benefitted from the state's Operator Assistance Program, which provided technical expertise to solve equipment malfunctions or provide operator training. Recent changes in the treatment process at Capitol Products in Kentland have apparently helped reduce ammonia problems in that company's discharge. Also, new staff at the Schneider POTW have apparently been able to operate and maintain this plant so as to eliminate the past problems which have occurred in Brown Ditch. Roll Coater in Kingsbury has been a continuing problem, but they are now under a state imposed compliance schedule to correct metals limits violations by 1992. Effluent toxicity has also been a problem at this facility and may be due to very high dissolved solids (sulfates) in the effluent. Possible alternative treatment methods are being investigated.

The Indiana Department of Natural Resources conducted fish community studies on the Iroquois River in Jasper and Newton counties and the Yellow River in Starke and Marshall counties in 1989. The Department reports indicated that both the Iroquois River and Yellow River supported diverse recreational fish communities.

In summary, 463 stream miles were assessed in the Kankakee River Basin in 1988 and 1989. No waters assessed (80 miles) fully supported the whole-body contact recreational use designation. With regard to aquatic life uses, 376 miles (81%) fully support and 87 miles (19%) partially supported their designated aquatic life use. Sewage related pollution accounted for the large majority of stream miles not fully supporting their designated areas.

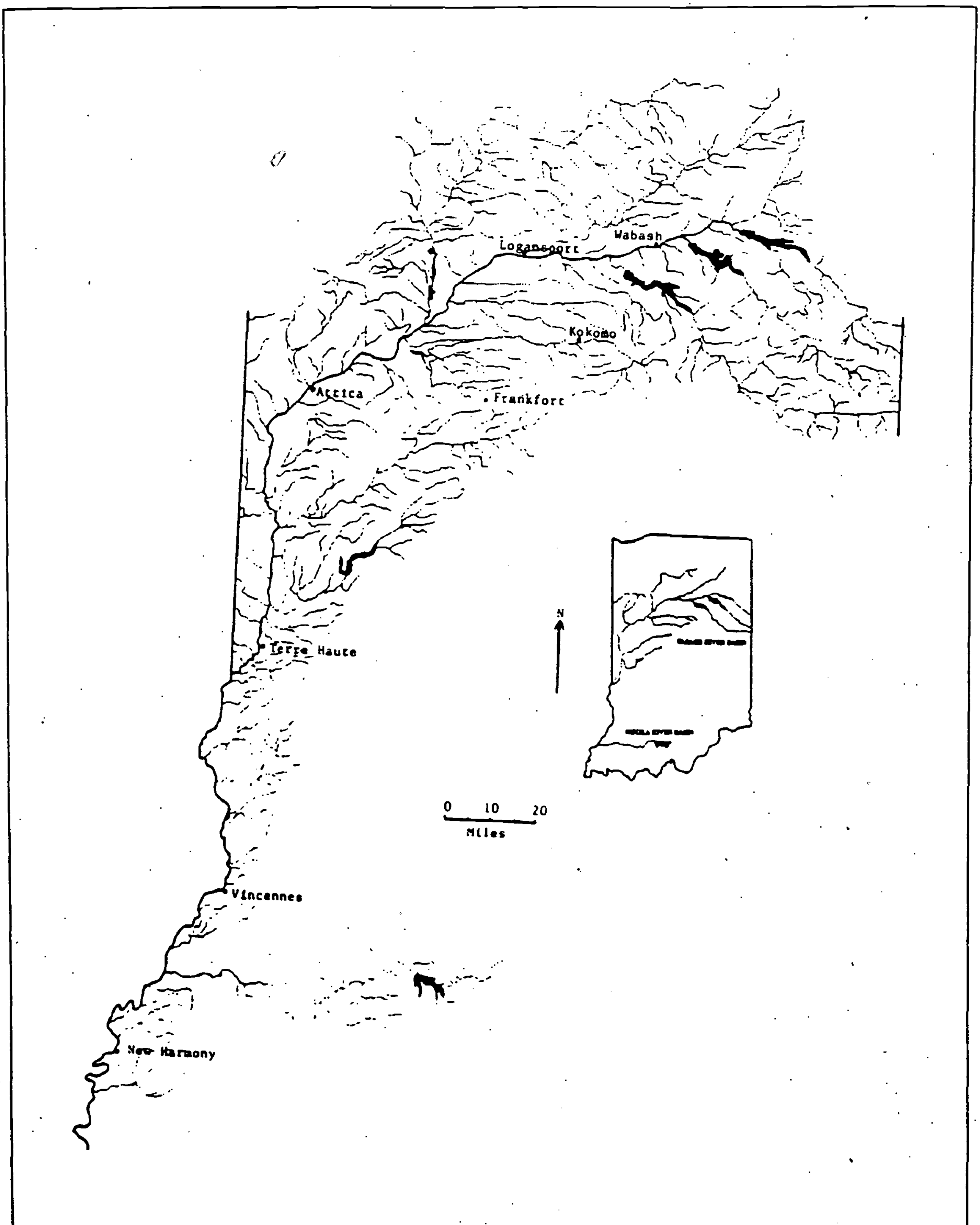
Wabash River Basin

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 11). The portion of the river system addressed in this section excludes the White River Basin, and is therefore limited to about 21,000 square miles.

There is one large Corps of Engineers (C.O.E.) impoundment on the 450-mile river 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 State Resource Waters.

FIGURE 11. *WABASH RIVER BASIN (INCLUDING PATOKA RIVER BASIN)*



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 35) are in the Wabash River Basin.

Limited use streams are those watercourses which because of their shallow depths, lack of flow, and/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 36. Surface water intakes for public water supplies are located on the waters shown in Table 37.

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 1988 and 1989 included:

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

2. Fish tissue and sediment sampling at six CORE stations. Macroinvertebrate sampling is conducted at these stations, but only Bluffton was collected in 1988 because the samplers at the other stations were lost in high water.

3. IDNR fish population studies at several sites.

4. Compliance Sampling Inspection records.

5. Special fish tissue and sediment sampling studies at several sites on the Little Mississinewa/Mississinewa Rivers, Eel River, Patoka River, Tippecanoe River and Wabash River.

A total of 1,625 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 38. 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 in addition to the CORE station 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.

TABLE 35. *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 36. *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 its confluence with Ell Creek.
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 37. *PUBLIC WATER SUPPLY SURFACE WATER INTAKES IN WABASH RIVER BASIN*

WABASH RIVER BASIN	
Logansport	Eel River
Kokmo	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)

TABLE 38. *WATER 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 SUPPORT[1]	METHOD OF ASSESSMENT[2]	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Wabash River	Geneva	NS (Recreational) (Aquatic Life)	Monitored (b) (c)	E. coli Cyanide	16	
Wabash River	Markle	NS (Recreational) PS (Aquatic Life)	Monitored (b) (c)	E. coli Ammonia	3	
Wabash River	Huntington	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	TSS E. coli	6	Huntington POTW usually meets limits occasional TSS violations.
Wabash River	Andrews	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli Cyanide	16	Some infrequent bypassing at Andrews.
Wabash River	Wabash Peru	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli	28	1) IDEM enforcement action against City of Wabash and Container Corporation of America resulted in improved effluent. 2) Peru Plant runs well but needs mechanical upgrades.
Wabash River	Georgetown	NS (Recreational) PS (Aquatic Life)	Monitored (b) (c)	E. coli Ammonia	27	Georgetown Plant operating well now
Wabash River	Upstream Lafayette	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli	30	IDEM enforcement action against City of Wabash and Container Corporation of America resulted in improved effluent
Wabash River	Lafayette Terre Haute Darwin	NS (Recreational) PS (Aquatic Life)	Monitored (b) (c)	E. coli Ammonia	73	
Wabash River	Darwin to Mouth	NS (Recreational) PS (Aquatic Life)	Monitored (b) (c)	E. coli Ammonia	185	
Salamonie River	Portland	NS (Recreational) (Aquatic Life)	Monitored (b) (c)	E. coli Cyanide	23	
Salamonie River	Upstream Lancaster to Mouth	FS (Aquatic Life) PS (Recreational)	Monitored (b) (c)	E. coli	54	

TABLE 38. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN 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 Mississinewa River	Union City	NS (Aquatic Life)	Monitored (b) (c)	PCBs Chlordane Metals	7	1) Partially state-funded clean-up of PCB contamination in Union City sewage treatment plant. 2) Westinghouse site now being scored for CERCLA 3) IDEM enforcement action on Sheller-Globe resulting in establishment of interim limits and a compliance schedule.
Mississinewa River	Union City to Ridgeville	NS (Aquatic Life)	Monitored (b) (c)	PCBs Chlordane	9	Fish Consumption Advisory - No fish should be eaten.
Mississinewa River	Ridgeville to Marion	PS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli Cyanide	60	1) Ridgeville POTW meeting limits. QA/QC program has improved. 2) Albany POTW needs extensive repair due to expansion at plant.
Mississinewa River	Marion	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli	36	
Mississinewa River	Jalapa to Mouth	PS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli	37	
Eel River	Headwaters near Churusubso	FS (Aquatic Life)	Evaluated		5	
Eel River	Near headwaters to upstream South Whitley	FS (Aquatic Life)	Evaluated		20	
Eel River	South Whitley	FS (Aquatic Life)	Evaluated		2	
Eel River	2 mi D/S South Whitley to Roann	FS (Aquatic Life)	Monitored (b) (c)		24	
Eel River	Roann to Mouth	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli TSS	41	Roann POTW to address poor QA/QC and lab methods.
Williamson Ditch	Upstream Palestine Lake	FS (Aquatic Life) (Threatened)	Evaluated	Metals	2	
Tippencanoe River	Headwater to Rochester	FS (Aquatic Life)	Evaluated		53	
Tippecanoe River	Rochester	NS (Recreational) PS (Aquatic Life)	Monitored (b) (c)	E. coli Ammonia Cadmium	5	Construction completed at Rochester POTW. Permit limits now being met.

TABLE 38. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN 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
Tippecanoe River	Downstream Rochester to Mouth	NS (Recreational) PS (Aquatic Life)	Monitored (b) (c)	E. coli Ammonia	102	
Wildcat Creek	Headwater to Kokomo	FS (Recreational) NS (Aquatic Life)	Monitored (b) (c)	Cyanide	16	
Kokomo Creek	Kokomo	NS (Aquatic Life)	Monitored (b)	PCBs	2	Fish Consumption Advisory for all species.
Wildcat Creek	Below Kokomo to Mouth	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli Cyanide Ammonia PCBs	65	Fish Consumption Advisory for all species.
South Fork Wildcat Creek	Entire Length	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli Cyanide	41	
Elliott Ditch and Wea Creek	Lafayette	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	PCBs E. coli	27	Negotiations between IDEM and ALCOA to remove PCB contaminated sediments from Elliott Ditch are continuing.
Big Pine Creek	Pine Village	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	77	
Vermillion River	Cayuga	PS (Aquatic Life)	Monitored (b) (c)	E. coli Cyanide	8	
Sugar Creek	Above Crawfordsville	FS (Aquatic Life)	Monitored (b) (c)		35	
Sugar Creek	Near Crawfordsville	NS (Aquatic Life)	Monitored (b) (c)	PCBs	7	Fish Consumption Advisory for all species due to PCBs
Sugar Creek	Downstream Crawfordsville to Mouth	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	30	
Little Sugar Creek	Near Crawfordsville	Ns (Aquatic Life)	Monitored (b) (c)	PCBs	10	Fish Consumption Advisory for all species due to PCBs.
Big Raccoon Creek	Entire Length (except for 1 mile)	FS (Aquatic Life)	Evaluated		82	Based on DePauw University fish population study.
Big Raccoon Creek	Coxville	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	1	
Otter Creek (Upper)	Vigo and Clay counties	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	11	
Otter Creek (Lower)	Vigo County	FS (Aquatic Life)	Evaluated		9	

TABLE 38. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN 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
Philipps Ditch	Walton	PS (Aquatic Life)	Evaluated	Metals	2	Occasional overflows from Wm. H. PFarrer Company
Coal Creek	Vigo County	PS (Aquatic Life)	Evaluated	Acid Mine Drainage, Silt	7	
Blue River	Columbia City	FS (Aquatic Life) (Threatened)	Evaluated	BOD	3	Plant expansion is forthcoming; bypassing occurs.
Flack Ditch	Laketon	FS (Aquatic Life) (Threatened)	Evaluated		1	Plant operations improved. Violations less frequent than in past.
Brouilletts Creek	Vigo & Vermillion Counties	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	2	
Honey Creek & Tributary	Terre Haute	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	25	Indiana Department of Natural Resources (IDNR) Division of Reclamation has spent $3.5 million reclaiming Victory Mine area.
Honey Creek	Terre Haute	PS (Aquatic Life)	Evaluated	Acid Mine Drainage	2	IDNR has spent $250,000 reclaiming 23 acres of gob
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	NS (Recreational) FS (Aquatic Life)	Monitored (b) (c)	E. coli	86	City of Jasper is under an Agreed Order to rehabilitate its sewage treatment system which includes a sewer ban. Jasper has also been warned of pretreatment limit and interim discharge limit violation. On-going construction and sewer line projects.

TABLE 38. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN 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
South Fork of Patoka River and Tributaries	Pike, Warrick and Gibson Counties	FS (Aquatic Life) (Threatened)	Evaluated	Acid Mine Drainage	40	1) Oakland City POTW expansion not completed. Plant meeting limits. 2) IDNR is spending $2.9 million to reclaim the Blackfoot area; Burial of gob and slurry and draining of acid lakes began in 1986 and is 93% complete.
South Fork Smalls Creek	Bruceville	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	8	IDNR is spending $2.1 million to reclaim 56 acres of gob and 20 acres of slurry and acid water; 90% complete.
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 Lagoons	21	1) Criminal prosecution of president and chairman of board for C&M Plating (Roanoke) by IDEM 2) Clean-up of metals-laden lagoons at Roanoke POTW scheduled.
Humbert Ditch	Fowler	FS (Aquatic Life)	Evaluated		1	
Round Prairie Creek	Windfall	FS (Aquatic Life)	Evaluated			
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) (Threatened)	Evaluated		5	
Danner Ditch	Etna Green	FS (Aquatic Life)	Evaluated		5	
Little Pipe Creek	Converse	PS (Aquatic Life)	Evaluated		2	
Grant Creek	La Fontaine	FS (Aquatic Life)	Evaluated		3	
Burnetts Creek	Burnettsville	FS (Aquatic Life)	Evaluated		5	

TABLE 38. WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN 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
Rock Creek	West Lebanon	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 Raccoon Creek	Russellville	FS (Aquatic Life)	Evaluated		16	
West Fork Busseron Creek	Farmersburg	FS (Aquatic Life)	Evaluated		7	Sludge storage problem at Farmersburg POTW.
Bond Ditch	Oaktown	FS (Aquatic Life)	Evaluated		3	
Lost Creek	Francisco	FS (Aquatic Life)	Evaluated		2	
Trimble Creek (Mentone)	Kralis Bros. Poultry (Mentone)	NS (Aquatic Life) (Recreational)	Evaluated	BOD TSS Ammonia E. coli	4	
Yellow Creek	Provimi Veal	FS (Aquatic Life)	Evaluated		1	

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.

Fish tissue samples collected from Elliott Ditch and Wea Creek in Tippecanoe County exceeded FDA Action Levels for PCBs. These areas are also included in the 1990 fish consumption advisory (Table 16). This is considered a 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 discharge low levels of PCBs to Elliott Ditch.

ALOCA 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 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 9 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 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, and then through parts of four Indiana counties until it is dammed to form the 900-acre Huntington Reservoir. Data from fixed water quality monitoring stations at Markle (WB- 420) and Geneva (WB-452) show that the portion of the river upstream of the reservoir does not support its designated recreational use due to E. coli bacteria levels. This portion of the river ranges from partial to non-support of the aquatic life use due to elevated ammonia and cyanide levels. Huntington Reservoir is impacted to some extent by non-point 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 were 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 Wabash River near Andrews and Peru did not support the recreational use, but aquatic life uses ranged from partial to full support. From Georgetown downstream to its mouth, E. coli levels prevented the mainstem Wabash River from meeting its recreational use designation and occasional high ammonia and cyanide levels indicated it would only partial support the aquatic life use. The (City of) Wabash POTW has had only occasional violations of fecal coliform and total suspended solids limits, and the POTWs at Clinton and Terre Haute are currently meeting their permit limits. The several industries which discharge to the Terre Haute reach of the Wabash River currently appear to be meeting their permit limits. The source of the occasional ammonia and cyanide problems are not apparent and may be the result of combined sewer overflows (CSO's) and non-point runoff as may the E. coli violations.

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 ones occurred in this reach of the river in the late 1970s. 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 in this area, 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 has 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. However, dissolved oxygen levels below 4.0 mg/l were still found on a few occasions. Studies done in recent years by Dr. James Gammon of DePauw University indicate that the fish community has 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 POTW 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 an unprecedented arrest of the firm's president and the chairman of the board. C & M Plating is presently not operating. C & M was to construct a wastewater treatment plant but requested time to remove sludge stored on their property which contained heavy metals. They are still in the process of obtaining permits for this operation. All enforcement actions against C & M Plating are still pending.

The Salamonie River in its upper reaches does not support recreational or aquatic life uses due to high E. coli and cyanide levels. Again the sources of these contaminants are not clear as, for the most part, the Portland POTW operates well although there have been CSO problems in the past. The portion of the river from Lancaster to its mouth partially supports its recreational uses and fully supports the aquatic life use.

The Indiana Department of Natural Resources (IDNR) studied the fish communities in the following tributaries of the Salamonie Reservoir in 1988: 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 9 miles of the Mississinewa River from near Union City downstream to Ridgeville do not support the aquatic life use due to PCBs and chlordane in fish tissue. An advisory against consuming any fish from the Little Mississinewa River and carp and catfish from this portion of the Mississinewa River is currently in effect. The PCBs apparently came from a Westinghouse facility which discharged to the Union City POTW which, in turn, discharged to the Little Mississinewa River, 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 POTW. In the course of the clean up, additional PCB contaminated areas were found. At this time, A.O. Smith exercised an option in the purchase contract that required Westinghouse to repurchase the site if contamination was found. Westinghouse then did additional cleaning in 1989, but there is a question as to its effectiveness. Additional sampling is now being done, and the site is currently being scored for CERCLA. The Union City POTW has been cleaned and PCBs are no longer being discharged from this facility.

The reach of Mississinewa River from Ridgeville to Marion partially supports the aquatic life use due to cyanide and does not support recreational uses due to E. coli. A bioassessment of the Mississinewa River downstream of Albany showed that the macroinvertebrate population was impaired by poorly treated effluent from the Albany POTW. The macroinvertebrate community was depressed for at least one mile downstream.

Although the Marion POTW complies with its permit limitations in most instances, the Mississinewa River in this reach does not support recreational uses. High E. coli bacteria levels probably resulting from combined sewer overflows appear to be causing this problem. The river does fully support aquatic life uses in this reach. Studies of the benthic life of the Mississinewa River downstream of Marion revealed a diverse macroinvertebrate community. The stream in both the Marion and Gas City areas supported several species of mayfly and caddis fly larvae. High E. coli levels in the reach of the river near Jalapa occur frequently enough that this segment of the river only partially supports recreational uses. However, this segment of the river fully supports aquatic life.

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 revealed 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 POTW which discharges to the Blue River, a tributary of the Eel River, meets its NPDES permit limits, but dry weather bypassing has occurred. This problem should be corrected with plant expansion which is scheduled to be completed in August 1990.

In the past, several problems occurred at the Laketon Refining Corporation which discharges to Flack Ditch, a tributary to the Eel River. Permit violations have 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 collected 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, a substantial improvement from the last reporting period.

The Wm.H Pfarrer Company has had a negative impact on Phillips Ditch near Walton. There have been chronic metal problems at the facility. A request was made by the company to discharge to the Walton city sewer but the request was denied. Plans are currently underway to move the company to Peru, Indiana where discharge to the municipal sewer system after pretreatment has been approved.

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 concentrations of metals and PCBs were considerably lower. In a 1986 bioassay, the LC50 concentration was 44 percent. Recent inspections have shown improved operations, and a recent toxicity test showed that toxicity is still 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 receives the discharge from Kralis Brothers Poultry near Mentone. This operation in the past has had numerous permit violations for BOD, TSS, and fecal coliform. Recently this facility has been violating its ammonia limits and approximately four miles of this stream downstream of the discharge is considered not to support the aquatic life use.

Provimi Veal, which discharges into Yellow Creek, another Tippecanoe River tributary, violated its permit limits for fecal coliform bacteria and BOD regularly in the past. A new aeration wastewater treatment facility with dissolved air floatation for primary treatment was put into operation in February 1988. All the units are operational and there has been marked improvement in treatment with no compliance problems since then.

The Tippecanoe River mainstream is fully supportive of aquatic life uses from its upper reaches to Rochester. Downstream of Rochester, levels of *E. coli*, cadmium, and ammonia are high enough that the Tippecanoe River in this reach does not support recreational uses and only partially supports the aquatic life use. This city has received construction grant money to expand its wastewater treatment plant and add ammonia removal, and all construction is now completed. There were problems with a clarifier tank which had risen in the ground due to groundwater, but now two tanks are operational and all NPDES limits are being met. Downstream of the Rochester area to its mouth, the Tippecanoe River does not support recreational uses and only partially supports the aquatic life use due to occasional high ammonia levels.

Due to frequent high cyanide levels, Wildcat Creek is not considered to support the aquatic life use above Kokomo, but this reach fully supports recreational uses. 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, ammonia, and cyanide are partial causes of this non-support. Wildcat Creek is also under a complete fish consumption advisory for all species due to high PCBs in fish tissue. Approximately two miles of Kokomo Creek near Kokomo do not support aquatic life uses due to a complete fish consumption advisory for PCBs.

Little Sugar Creek and about seven miles of Sugar Creek near Crawfordsville do not support the aquatic life use because of a fish consumption advisory for all species because of PCB concentrations in fish tissue which exceed FDA Action Levels. The source of the PCB contamination is the Mallory Landfill site which is currently being cleaned up. Recent fish tissues samples from these streams show reduced PCB concentrations, but they are still above FDA Action Levels.

Other than for these seven miles, Sugar Creek both 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 has been impacted by acid mine drainage and organic loading from the Jasper and Oakland City POTWs, but aquatic life uses are supported. Frequent high E. coli levels in the Patoka River prohibit this stream from meeting its recreational use designation. New POTW construction was begun in February of 1987 at Oakland City. However, some of the improvements were improperly constructed and the contractor must either rebuild or replace some structures. The Oakland City facility is not meeting its permit limits due to solids handling problems.

The Jasper POTW occasionally exceeds its limits for fecal coliform, cyanide, copper, lead, cadmium and chromium. A sewer line rehabilitation project that is currently underway should reduce the hydraulic overloading at the plant which is thought to be part of the problem.

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, 1,625 miles were assessed in this basin as to support of the aquatic life use. Of these miles, 822 (51%) fully supported, 545 (34%) partially supported, and 258 (16%) did not support this use. Only 1,096 of these miles were assessed as to support of recreational uses. Of these miles 16 (1%) fully supported, 99 (9%) partially supported, and 981 (90%) did not support the whole body contact recreational use.

The 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 39 shows the waters assessed in this basin, the status of their support of designated uses, the probable causes of impairment, and the miles affected. 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. In addition to these discharges, combined sewer overflows (CSO's) and urban non-point 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, and this portion of the advisory has been lifted.

In the reach of the river from the Delaware County 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. Periodic ammonia concentrations which exceeded standards were also found in the portion of the river below Noblesville to Indianapolis. High E. coli concentrations were found often enough throughout this entire reach that whole body contact recreational uses were not supported.

FIGURE 12. *WEST FORK OF WHITE RIVER BASIN*

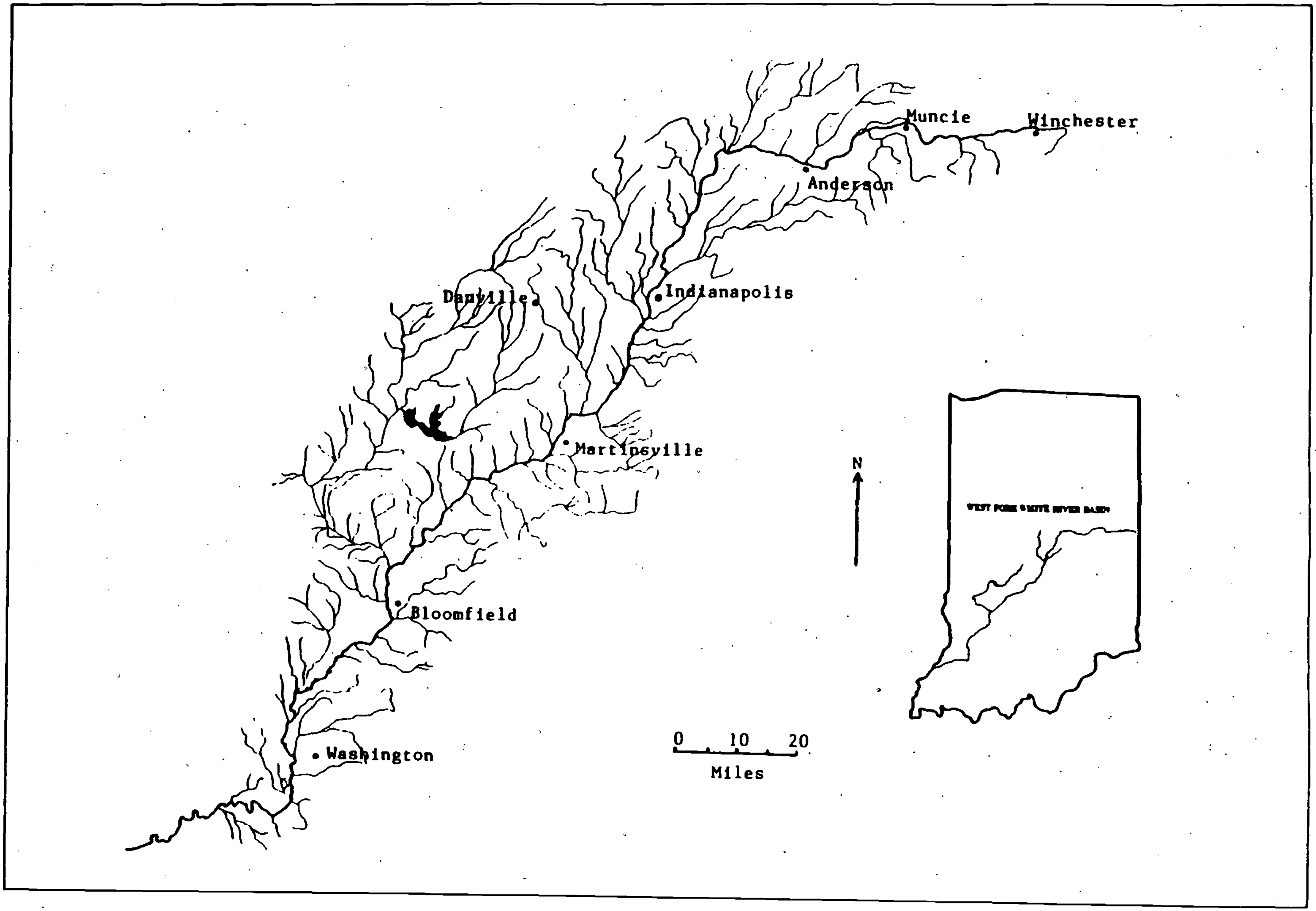


TABLE 39. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
WF White River	Winchester to Delaware County Line	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	25	
WF White River	Delaware County	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli CSO's PCBs Chlordane	31	1) Muncie has had sludge handling problems, but effluent quality has improved dramatically. 2) Fish Consumption Advisory for carp.
WF White River	Delaware County Line to Noblesville	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli Cyanide	40	
WF White River	Noblesville to North Marion County Line	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	PCB Chlordane E. coli Cyanide Ammonia	20	1) Noblesville POTW has occasional violations. 2) Fish Consumption Advisory - limited consumption of all species.
WF White River	No. Marion County to Martinsville	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli Cyanide	58	COSs and bypassing at Indianapolis.
W F White River	Martinsville to confluence of the West Fork of White River and the East Fork of White River near Petersburg	PS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli Cyanide Ammonia	142	
White River (Main Stream)	Petersburg to Wabash River	FS (Aquatic Life) (Recreational)	Monitored (b) (c)		48	
Lilly Creek	Orestes	FS (Aquatic Life) NS (Recreational)	Evaluated	E. coli	1	
Duck Creek	Elwood	NS (Aquatic Life) (Recreational)	Monitored (c)	Bypassing, E. coli Ammonia Low D.O.	3	POTW bypasses during rains. Need new sewers. Has new holding tank.
Duck Creek (lower 8 miles)	Strawtown	FS (Aquatic Life) (Threatened)	Monitored (c)		8	Periodic bypassing from Elwood POTW threatens this reach of stream.
Fall Creek (Headwaters through Geist Reservoir)	Pendleton	FS (Aquatic Life)	Evaluated		17	
Fall Creek (The last seven miles before joining WF White River)	Indianapolis	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	CSO Spills Metals E. coli	5	

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Fall Creek	Immediately Downstream Geist Reservoir	FS (Aquatic Life)	Evaluated		6	
Eagle Creek	Indianapolis	NS (Aquatic Life) (Recreational)	Monitored (b) (c)	E. coli Metals Ammonia Nonpoint Cyanide	4	1) Speedway POTW has ammonia removal project under way and also new pretreatment requirement. 2) Several industrial discharges to this stream.
Eagle Creek	Zionsville - Headwater to Eagle Creek Reservoir	PS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli Cyanide	25	
East Fork of White Lick Creek for 3 miles downstream of Indianapolis	Indianapolis	PS (Aquatic Life)	Evaluated	Urban, Industrial, and Agricultural Nonpoint. Effects of past municipal and industrial discharges and spills. (Metals)	3	
Julia Creek	Indianapolis	NS (Aquatic Life)	Evaluated	Heavy Metals	1	
White Lick Creek	Brownsburg	PS (Aquatic Life) (Recreational)	Evaluated	Ammonia Low D O High BOD E coli	2	Brownsburg POTW has occasional violations but is performing better recently.
White Lick Creek	Plainfield	FS (Aquatic Life)	Evaluated		2	Expansion and modification of this POTW are completed. Plant meets permit limits
White Lick Creek	Mooresville to Confluence with WF White River	FS (Aquatic Life)	Evaluated		7	
West Fork White Lick Creek	Danville	FS (Aquatic Life) (Threatened)	Evaluated	Nonpoint	2	Problems at Danville POTW as well as nonpoint runoff threaten 2 miles of this stream. New plant improvements at Danville POTW increased capacity and treatment level.
West Fork White Lick Creek	Pittsboro	FS (Aquatic Life)	Evaluated		5	
Wilson Ditch and Stoney Creek	Noblesville	NS (Aquatic Life)	Monitored (b) (c)	PCB Chlordane	1	Complete Fish Consumption Advisory.
Pleasant Run	Indianapolis	NS (Aquatic Life)	Evaluated	Nonpoint Unknown factors CSO Chlordane	9	

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Richland Creek	Whitehall, Monroe County to confluence with White River in Greene County	FS (Aquatic Life)	Monitored (b) (c)		19	Neals Landfill has been capped and measures to prevent runoff applied. Additional monitoring is occurring.
Stouts Creek	Bloomington	FS (Aquatic Life)	Monitored (b) (c)	PCBs	2	Bennets Landfill has been capped and measures to prevent runoff applied. Additional monitoring is occurring.
Beehunter Ditch	Linton	PS (Aquatic Life)	Monitored (b) (c)	Ammonia Low D.O. Bypassing BOD TSS	4	POTW has occasional violations. Construction of ammonia removal facilities has begun.
Indiana Creek	Bicknell	NS (Aquatic Life)	Evaluated	Acid Mine Drainage	4	
Hawkins Creek	Washington	NS (Aquatic Life) (Recreational)	Evaluated	Low D.O. Ammonia High BOD E. coli CSO	4	Washington has a serious CSO problem also which is only being partially addressed.
Pipe Creek	Alexandria	FS (Aquatic Life) (Threatened)	Evaluated	Unknown Factors	20	Effluent from several POTWs, nonpoint runoff, currently unkown factors periodically threaten this stream
Jacks Defeat Creek	Elletsville	FS (Aquatic Life)	Evaluated		6	
Bean Blossom Creek	Bloomington to confluence with WF White River.	FS (Aquatic Life) (Threatened)	Monitored (b) (c)		12	Low concentrations of PCBs found in fish tissue.
Lattas Creek	Switz City	FS (Aquatic Life)	Evaluated		12	
Mill Creek	Stilesvillle to Cataract Lake	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	E. coli	17	
Four Mile Creek	Lyons	FS (Aquatic Life)	Evaluated		4	
Black Creek	Sandborn	FS (Aquatic Life)	Evaluated		5	
Vertrees Ditch	Elnora	FS (Aquatic Life)	Evaluated		3	
Kane Ditch	Odon	FS (Aquatic Life)	Evaluated		4	

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
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	
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.	8	
Cabin Creek	Farmland	FS (Aquatic Life)	Monitored (c)		10	
Cicero Creek	Cicero	FS (Aquatic Life) (Threatened)	Evaluated		7	Occasional problems at the Sheridan and Cicero POTWs as well as nonpoint runoff threaten this stream
Little Cicero Creek	Cicero	FS (Aquatic Life)	Evaluated		16	
Cool Creek	Westfield	FS (Aquatic Life)	Evaluated		11	
Williams Creek	Indianapolis	FS (Aquatic Life)	Evaluated		6	
Little Eagle Creek	Indianapolis	FS (Aquatic Life) (Threatened)	Evaluated		5	Urban, nonpoint runoff 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 (b) (c)	E. coli	10	
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	

TABLE 39. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE WEST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Plass Ditch	Decker	FS (Aquatic Life)	Evaluated		5	

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.

In the past, there have been several fish kills in this reach of the river, mainly in the areas downstream of Muncie and Indianapolis. During this reporting period, four fish kills were reported in this reach of the West Fork of White River. One occurred in Delaware County due to a sewage bypass, one occurred in Indianapolis as a result of a malfunction at a lift station, one occurred near a power plant on the White River below Indianapolis as a result of high temperatures in the summer of 1988, and one occurred below the Broad Ripple Dam in Marion County (cause unknown).

Although analysis of the data from this reach of the West Fork of White River indicates non-support of aquatic life uses, the major municipal discharges in this reach have made significant improvements to their facilities and generally produce high quality effluents. Recent renovations have occurred at the Muncie POTW, including improved sludge handling facilities. The quality of their effluent has improved dramatically as a result of new pretreatment requirements, and recent bioassays show no acute or chronic toxicity. Muncie is also attempting to address their CSO problems.

The City of Indianapolis has recently completed over $60,000,000 in additional advanced waste treatment and ammonia removal facilities at their two POTW's. Although there are still some intermittent problems with some of the new equipment, the quality of their effluents has improved since these renovations. Fish and other aquatic life communities in the West Fork of White River below Indianapolis continue to show improvement in both numbers and diversity. Many of the problems in this reach of the river may be more attributable to past conditions or to CSO's and non-point sources 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 partially supports the designated aquatic life use. Occasional high ammonia and cyanide concentrations are the main problems. High E. coli concentrations in this reach prevent attainment of the whole body contact designated use. Again, the sources of these pollutants 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 is of generally good quality and supports both aquatic life and recreational designated uses. There are two electrical generating stations located at Petersburg just downstream of the confluence of the East and West Forks. Recently issued NPDES permits for these generating stations contain more stringent thermal effluent limitations, including the requirement to reduce power generation if necessary to meet water quality standards. 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 White River have been assessed. Nearly all the tributaries receive agricultural non-point runoff which results in some degree of siltation, nutrient enrichment, and exposure to pesticides. The streams of the lower part of the West Fork White River Basin are more severely channelized for drainage than the streams of the upper basin, however, nearly all 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 as a result of a complete fish consumption advisory on these streams (Table 16). The fish are heavily contaminated with PCBs which have come from the Firestone Industrial Products facility which has a discharge to Wilson Ditch. The PCBs appear to come from roof and surface drains which become part of their discharge and not from actual manufacturing processes. 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 have had problems with PCBs in fish in the past. 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, and contained PCB contaminated wastes. A two mile reach of Stouts Creek, also in Monroe County, also had fish and sediment which contained high levels of PCBs which 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 done. A leachate collection and treatment system has been installed at Neal's landfill and sediments were dredged from Conards 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 fish tissue samples collected from Richland Creek and Stout's Creek show 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 this past violation and to insure that future violations do not occur.

Two years ago several streams in the West Fork White River Basin did not fully support their designated uses due to poor POTW operation, CSO's, and POTW bypassing due to overloaded plants. Many of the problems with the POTW's have been corrected.

The Elwood POTW in Madison County has had some new construction and is generally working well with no permit violations. However, this facility, which discharges into Duck Creek, has serious bypassing problems which effect Duck Creek during rains and the town also needs a new or renovated sewer system.

White Lick Creek in Hendricks County downstream of Brownsburg and Plainfield has improved, in part, because of the renovations of both the Brownsburg and Plainfield POTW's. The Brownsburg facility has increased it's capacity and treatment level, however, there are occasional ammonia violations. The Plainfield and Mooresville POTWs are running well with no problems.

Avon utilities which also discharges to White Lick Creek has had problems meeting permit limits in the past. The State currently has an enforcement action ongoing with this facility. Recent inspections show that the facility is operating much better now.

The East Fork of White Lick Creek in Marion County had a problem due to periodic bypassing from a lift station, metals contamination from Quemetco Corporation and industrial effluent from Avon railroad yards. Both of those facilities have improved the quality of their effluent significantly and the 1988-89 inspections proved satisfactory. Urban, industrial and agricultural non-point runoff still affect the East Fork of White Lick Creek periodically. Eagle Creek in the Indianapolis area receives the discharge from the Speedway POTW and several industries. This facility has made improvements but still is having problems with bypassing and in meeting ammonia limits. Some pretreatment problems with an industrial discharge to their POTW have recently been resolved and this may help improve effluent quality. Industrial dischargers to this stream still experience occasional problems with ammonia and metals, but these facilities have improved their treatment processes and now generally meet their permit limits. However, this reach of Eagle Creek does not currently support its aquatic life or recreational use designation.

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 POTW which discharges into Beehunter Ditch currently is constructing an ammonia removal system which should address the occasional ammonia violations there.

Indian Creek near Bicknell in Knox County does not support aquatic life uses for about four miles due to acid drainage from abandoned mine land. This stream is already impacted by acid mine drainage before it receives the discharge from the Bicknell POTW.

Red Gold Canning near Orestes in Madison County has added two new ponds to hold discharges to its treatment system, making a total of five lagoons. This company formerly discharged to Lilly Creek and several fish kills had occurred there in the past due to organic oxygen demanding waste. There were no fish kill reports in this stream reach during the past two years. The Town of Orestes, however, does have an unpermitted discharge and fecal coliform levels are a concern. The Madison County Health Department is conducting an investigation of the problem.

In summary, 815 miles of streams were assessed in the West Fork of White River Basin for support of designated aquatic life uses. Of this total, 456 (56%) of the miles fully supported this use, 176 (22%) of the miles partially supported this use, and 183 (22%) of the miles did not support this use. Only 430 miles were assessed as to support of the whole body contact recreational use. Of these miles 48 (11%) fully supported this use, 2 (less than 1%) partially support this use, and 382 (89%) did not support this use.

Chlordane and PCBs in fish tissue and occasional to frequent high levels of cyanide, ammonia, and *E. coli* seemed to be the major problems. The exact sources of these pollutants are hard to determine, but they are probably spread across point, nonpoint and CSO problems.

East Fork of White River Basin

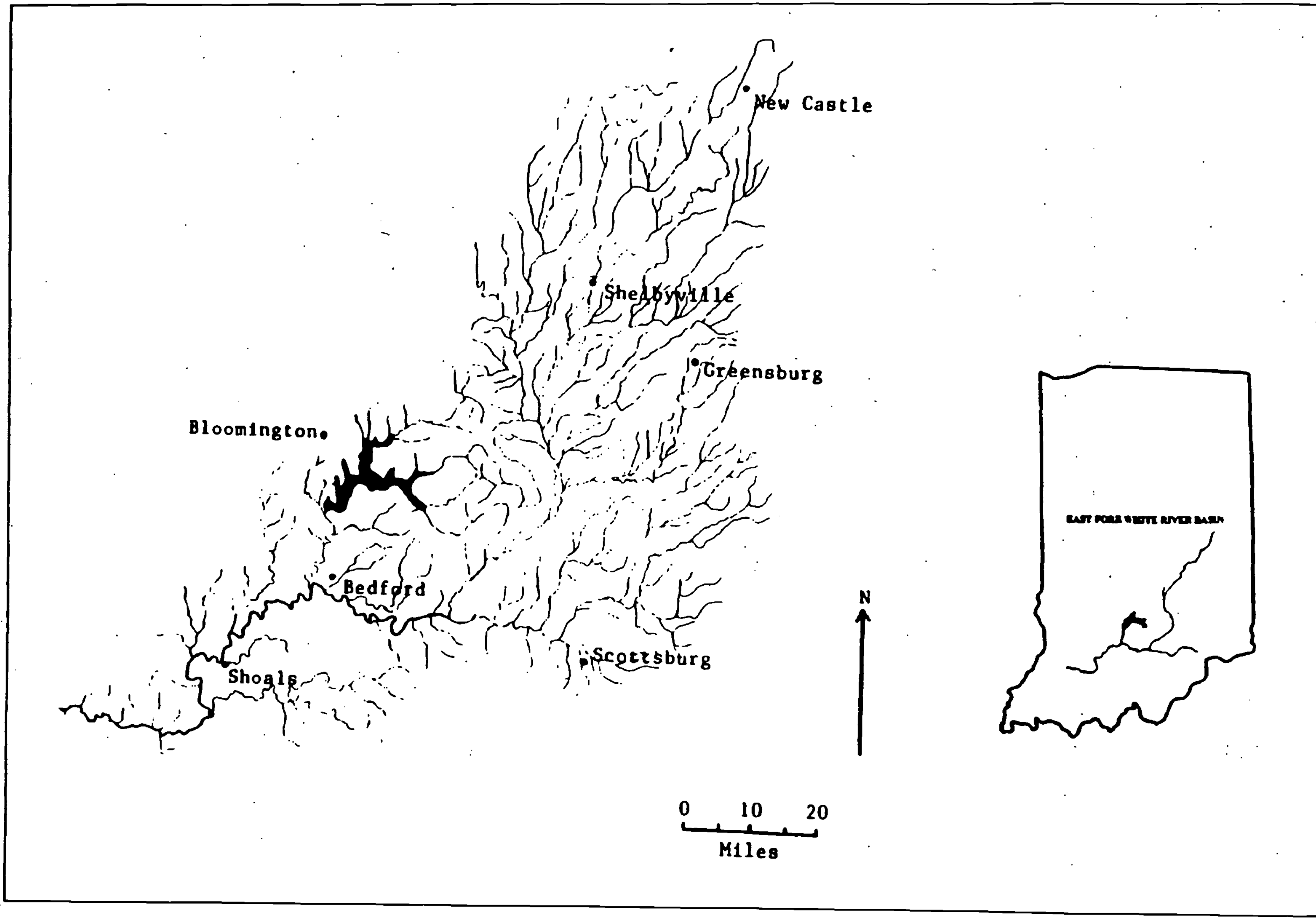
The East Fork of White River drains about 5,600 square miles of southern Indiana (Figure 13). Roughly 15,000 miles of streams and ditches are included in the basin. Sugar Creek, Big Blue River, Driftwood River, Flatrock River, the Muscatatuck River, and Salt Creek are the river's major tributaries. The 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 caves and sinkholes in 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 White River Basin have been minimal.

The East Fork of 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 to be justified, as the state records for sucker and smallmouth bass were 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. The shells of certain mussels are used in the cultured pearl industry and are commercially valuable.

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.

FIGURE 13. *EAST FORK OF WHITE RIVER BASIN*



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 1988 and 1989 included:

1. Monthly or quarterly chemical and bacteriological sampling at ten fixed stations (EW-1, EW-79, EW- 94, EW-168, EW-239, BL-0.7, BL-64, SLT-12, MU-20, and SGR-1).

2. Biological sampling and fish tissue and sediment analysis at one CORE station (EW-79).

3. Compliance Sampling Inspections (CSI's) at discharges to Leary Ditch, Big Blue River, Youngs Creek, Hutton Creek, Pleasant Run Creek, Salt Creek and the Muscatatuck River.

4. Intensive stream surveys at Bailey's Branch, Salt Creek, Pleasant Run Creek and tributaries to the East Fork of White River downstream of the General Motors Corporation foundary to determine whether PCBs were in sediments.

Those waters assessed, the status of designated use support, the method of assessment, probable causes of non-support, and miles affected are shown in Table 40. 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 White River indicated a potentially serious PCB and pesticide contamination problem in the streams. As a result, fish consumption advisories were issued for certain reaches of these streams.

More recent sampling of these and other streams in the basin disclosed that tissue concentrations of contaminants were much reduced and that the consumption advisories could be removed entirely or substantially reduced for many miles of stream.

TABLE 40. *WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES 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	NS	Evaluated	D.O, Ammonia Minimum conditions	4	a) Some hydraulic overloading and bypassing; equipment problems. b) Limited use stream.
Big Blue River	New Castle	PS (Recreational) NS (Aquatic Life)	Monitored (b)(c)	E. coli Cyanide Metals	10	a) Allegeny-Ludlum Steel (New Castle) received a new permit with lower metals limits. New treatment sytems. b) Avesta, Inc, (New Castle) has ceased discharge and is connected to the POTW.
Big Blue River	Carthage Shelbyville Edinburg Knightstown	PS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	Chlordane E. coli BOD	60	a) New construction is underway to improve ammonia removal. b) Knightstown is required to complete sewer hook-up to unsewered area presently discharging to Big Blue River.
Clear Creek/Salt Creek/East Fork White River from Bedford to Williams	Bloomington Bedford Williams	NS (Aquatic Life) PS (Recreational)	Monitored (b)(c)	PCBs Chlordane D.O. E. coli	40	a) Westinghouse began implementing Consent Decree to hydrovaccum PCB contaminated sediments from Clear Creek and Salt Creek. b) Permit limits placed on Bloomington POTW and GM Central Foundry for PCBs. c) Fish Consumption Advisory.
Pleasant Run	Bedford	NS (Aquatic Life)	Monitored (b)(c)	Chlordane PCBs Heptachlor Metals	4	a) Drainage from adjacent railroad property, causing degradation. b) Fish Consumption Advisory. c) Central Foundry PCBs.
Gas Creek/Sand Creek/Muddy Fork	Greensburg	NS (Aquatic Life)	Monitored (b)(c)	Chlordane Dieldrin D.O., Ammonia Metals	15	a) Construction finished and sanitary sewer installed. b) Fish Consumption Advisory.
Sand Creek	Below Greensburg	PS (Aquatic Life)	Monitored (b)(c)	Chlordane Dieldrin	15	Fish Consumption Advisory.

TABLE 40. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Muscatatuck River	Austin Scottsburg	NS (Recreational) FS (Aquatic Life)	Monitored (c)	<u>E. coli</u>	25	Construction at Scottsburg started June 88 includes sanitary sewer service to eliminate infiltration inflow problems. Expansion will also reduce hydraulic overloadings. Construction is due for completion in 1990. They are now meeting limits.
Lick Creek	Paoli	PS (Aquatic Life)	Evaluated	TSS D.O. Ammonia	5	City rehabilitating storms sewers. POTW expansions completed.
Underground Lost River	Orleans	PS (Aquatic Life)	Evaluated	D.O. Ammonia	5	
Rock Lick Branch	Mitchell	PS (Aquatic Life)	Evaluated	TSS D.O. Ammonia	4	Plant and lab expansion is not yet complete.
E.F. White River (Lawrence County Line to mouth)	Shoals Petersburg	FS (Aquatic Life) NS (Recreational)	Monitored (b) (c)	<u>E. coli</u>	75	
E. F. White River (Williams to Lawrence County Line)	Williams	PS (Aquatic Life) NS (Recreational)	Monitored (b)(c)	PCBs <u>E. coli</u> Chlordane	5	Fish Consumption Advisory for carp.
E.F. White River	Seymour Brownstown Medora	NS (Aquatic Life) FS (Recreational)	Monitored (b) (c)	PCBs D.O.	74	a) New million gallon sludge lagoon to be installed at Brownstown b) Brownstown meeting permit limits but occasional metals violation occur. c) Medora under construction. d) Fish Consumption Advisory.
E.F. White River	Columbus	NS (Recreational) (Aquatic Life)	Monitored (b) (c)	<u>E. coli</u> Cyanide	71	
Leary Ditch/Little Sugar Creek	Greenfield	PS (Aquatic Life)	Monitored(b) (c)	Ammonia	4	
Underground Carters Creek	Campbellsburg	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	Construction of new Campbellsburg POTW pending, two new lagoons added.
Millstone Creek	Westport	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	Westport has new, expanded plant.

TABLE 40. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Pee Dee Ditch	Wilkinson	PS (Aquatic Life)	Evaluated	Ammonia D.O.	2	Now connected to Shirley POTW.
Brock Bezor Ditch	Spiceland	PS (Aquatic Life)	Evaluated	Ammonia D.O.	2	
Hominy Ditch	Crothersville	PS (Aquatic Life)	Evaluated	TSS D.O. Fertilizer Runoff	1	New facilities completed.
Brewer Ditch	Whiteland	PS	Evaluated	Ammonia	3	a) Expansion completed. b) Limited use stream.
North Fork of Salt Creek	Nashville	PS (Aquatic Life)	Evaluated	Ammonia D.O.	3	Expansion completed.
Heddy Run	Seymour	PS (Aquatic Life)	Evaluated	Metals Pesticides Phenols Cyanide	1	All discharges go into Seymour POTW.
Sugar Creek	Edinburg	NS (Recreational)	Monitored (b)	E. coli	5	
Slate Creek	Alfordsville	PS (Aquatic Life)	Evaluated	Abandoned Mine Drainage (pH, Metals)	7	
Little Blue River	Mays, Shelbyville	FS (Aquatic Life) (Threatened)	Evaluated		25	Metals.
Brandywine Creek	Greenfield	FS (Aquatic Life) (Threatened)	Evaluated		25	
Clifty Creek	Hartsville	FS (Aquatic Life) (Threatened)	Evaluated	BOD TSS NH_3-N	10	
Boggs Creek	Martin County	FS (Aquatic Life) (Threatened)	Evaluated		15	Metals, Cyanide, Non-Prority Pollutants. The Crane Naval Weapons Storage Depot is on a compliance schedule to meet ammonia, cyanide, copper, and pH Limits.
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	Additional lagoon installed.

TABLE 40. WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT, AND MILES AFFECTED IN THE EAST FORK OF WHITE RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Sulphur Creek	Martin County	FS (Aquatic Life)	Evaluated		10	
South Fork Salt Creek	Freetown	FS (Aquatic Life)	Evaluated	NH_3-N	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		10	Pesticides and low D.O. levels. In 1987, Franklin completed a $1.5 million expansion of its POTW. Still ongoing equipment problems.
Cooks Creek/Little Sand Creek	Elizabethtown	FS (Aquatic Life)	Evaluated		5	
Flatrock River	Columbus, Rushville	FS (Aquatic Life) (Threatened)	Monitored (b) (c)		40	Pesticides.
Grassy Creek	New Whiteland	FS (Aquatic Life)	Evaluated		3	
Conns Creek	Waldron	FS (Aquatic Life)	Evaluated		3	
Little Flatrock River	Milroy	FS (Aquatic Life)	Evaluated		7	NP
South Fork Otter Creek	Holton	FS (Aquatic Life)	Evaluated		10	
Haw Creek	Hope	FS (Aquatic Life) (Threatened)	Evaluated		10	Pesticides.
Sugar Creek	New Palestine to Edinburgh	FS (Aquatic Life) (Threatened)	Evaluated		25	Pesticides.
Driftwood River	Edinburg Columbus	PS (Aquatic Life)	Evaluated	Chlordane	15	
Sand Creek	Brewersburg	FS (Aquatic Life)	Evaluated		10	

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 current (1990) fish consumption advisory (Table 16) still 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 White River from Bedford downstream to the Lawrence County line is also included. The pollutant of concern in these segments are PCBs.

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 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 White River Below Bedford. However, fish tissue in these streams still exceed FDA Action Levels for PCB's.

The pesticides chlordane and dieldrin are no longer used in the U.S. but are highly persistent in the environment. No point source dischargers of these pesticides have been identified, and nonpoint runoff from previously contaminated upland sites is probably responsible for their presence in streams.

Approximately 10 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 are believed to have originated primarily from two steel mills in New Castle. Previous effluent toxicity tests at Allegheny Ludlum Steel and Avesta, Inc. confirmed the potentially toxic effect of these discharges on aquatic life. During the last two years Allegheny 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, Inc., did contribute metals to the Big Blue River but no longer discharges. They are now connected to the New Castle sewer system.

High Total Suspended Solids and Low Dissolved Oxygen levels have occasionally impaired the Muscatatuck River. Some improvements such as rebuilt sand filters at the North Vernon STP and the completion of a new POTW at Crothersville have helped to reduce those violations. The Scottsburg STP also along the Muscatatuck, now regularly meets its permit limits, and plant improvements are to be completed in 1990.

Improvements in water quality should be evident soon due to improved wastewater treatment at several other sites. Construction at the Campbellsburg POTW is still pending, but they have added two new lagoons. The treatment plant at Wilkinson has connected to the Shirley POTW and Greensburg and Paoli have recently completed expansion of their sewage treatment facilities. At Greensburg additional sanitary sewers are also being installed.

The expansion of the wastewater treatment plant at Nashville is complete but sludge handling is still a problem there. Construction of a new plant has also been completed at Westport. Improvements at Mitchell, Franklin, Brownstown and Scottsburg are due for completion during late 1990. Mitchell has done some lagoon expansion during its construction period and the improvements have assisted in the facility meeting its permit limits more consistently than in 1987 when it was plagued with low dissolved oxygen and high ammonia concentrations. Sewage related problems at the Loogootee POTW are less severe than in the past due to updates in procedures and equipment at the facility, but there is still some hydraulic overloading.

There are also seven miles of Slate Creek in Daviess County which were partially impaired by drainage from 2.0 acres of unreclaimed barren mine spoil. However, twenty acres of abandoned mine lands in this county were reclaimed in 1986 under IDNR's Abandoned Mine Lands program and this should improve the future condition of Slate Creek.

Bacteriological sampling at the ten fixed stations in the basin provides an estimate of how safe the waters are for swimming (recreational use). All streams in this basin are now designated for whole body contact. The Big Blue River near New Castle partially supports this use. Downstream, the Big Blue River near Carthage, Shelbyville, Edinburg and Knightstown does not support this recreational use due to frequent high levels of E. coli bacteria.

The Muscatatuck River is also non-supportive of recreational uses. The East Fork of the White River near Columbus does not support this use, but the river near Seymour, Brownstown, and Medora is fully supportive. The river is partially supportive near Bedford down to Williams. From Williams downstream it becomes non-supportive for recreation.

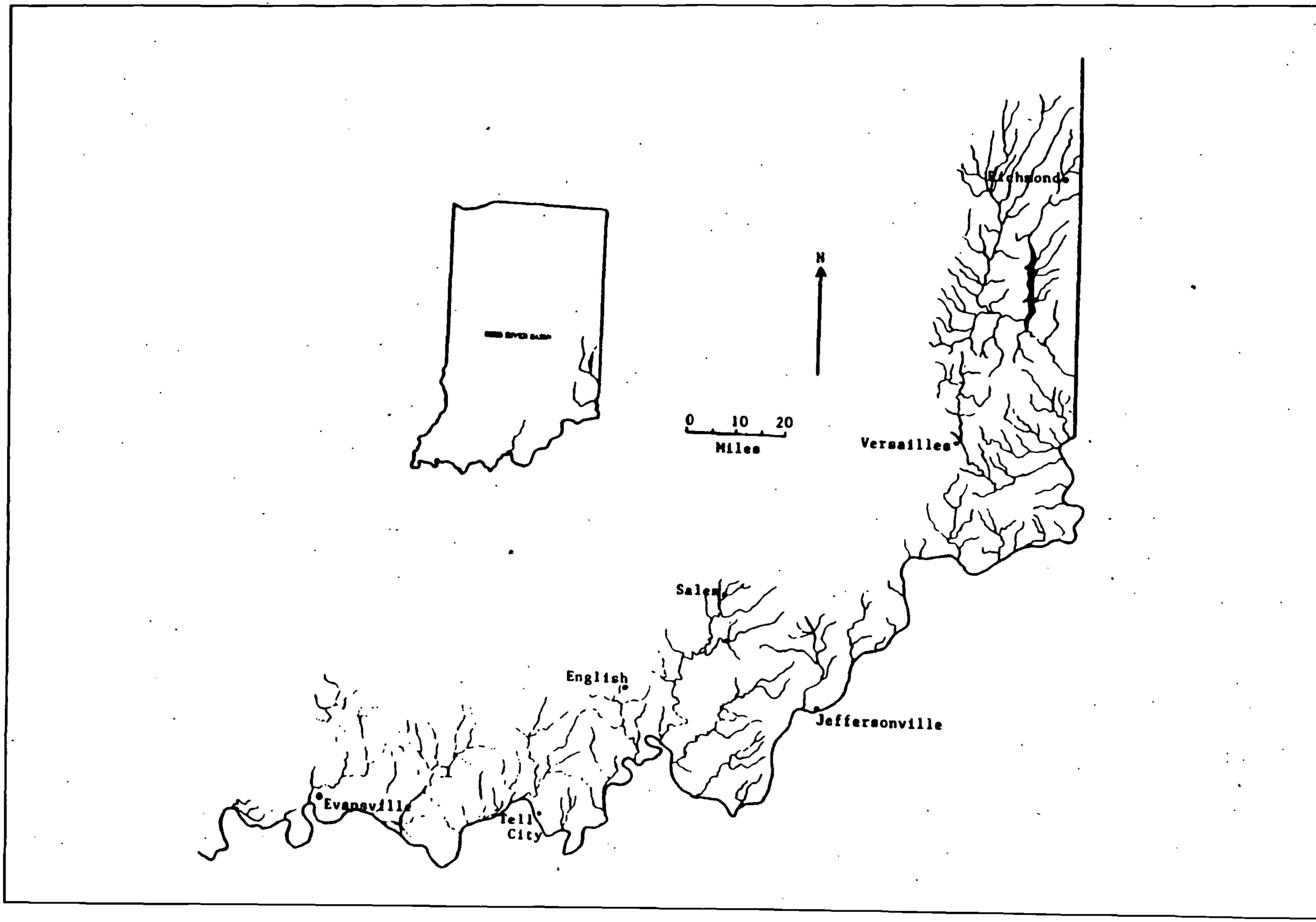
There was one fish kill in this basin during 1988-1989 and it was located in Daviess County. During 1986-87 there were four confirmed fish kills and six others reported.

In summary, 763 miles of streams were assessed as to meeting aquatic life uses in the East Fork of White River Basin in 1988 and 1989. Of these, 407 miles (53%) fully supported designated uses, 133 miles (17%) were partially supporting, and 223 miles (29%) did not support designated uses. Accumulation of high levels of PCBs and pesticides in fish accounted for most (87%) of the stream miles not meeting or only partially meeting the designated uses. In terms of recreational uses, 365 miles were assessed. Only 74 miles (20%) of those assessed fully supported, 50 miles (14%) partially supported this designated use, and 241 (66%) did not support it.

The Ohio River Basin

The Ohio River and its Indiana tributaries (excluding the Wabash River) drain approximately 5,800 square miles in Indiana (Figure 14). 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

FIGURE 14. *OHIO RIVER BASIN*



in the basin is agriculture, 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 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 Department of Environmental Management (DEM) personnel conduct compliance sampling inspections and other water quality monitoring activities on Indiana facilities and water bodies that discharge to the Ohio River.

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 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 both to increased leisure time and 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 and/or hazardous wastes.

Although most of Indiana's dischargers do not appear to be causing problems in the Ohio River, some actions have occurred recently which should further enhance water quality. At the South Dearborn POTW, most recent surveys show permit limits are being met. In the past the effluent here always looked poor and very rarely met limits for Total Suspended Solids. This had been an ongoing problem due to high organic loadings.

The Madison facility has had a solids removal problem due to old, poorly operating equipment. This is currently being addressed by new equipment purchases and reconstruction of some plant components. Cannelton and Troy are now sending their wastewaters to the Tell City POTW thus eliminating these discharges. New or upgraded POTW's have been completed at Charlestown and Clarksville. Some problems still exist at the Rockport and Mount Vernon POTW's mainly due to operational and maintenance problems.

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 1988-89 ORSANCO 305(b) report. Therefore, this report will not address these waters.

Several Indiana streams tributary to the Ohio River have been assessed. Table 41 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.

Most Indiana streams in the Ohio River Basin 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 impacts many of the streams especially 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 POTWs 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 construction at the Dale POTW and it discharges an effluent that is basically raw sewage. All three POTWs are being investigated by the IDEM enforcement branch.

Cane Run in Clark County does not currently support its designated uses. Cane Run received discharges from both the Clarksville POTW and the Jeffersonville POTW until recently. Cane Run was grossly polluted with organics and a significant sludge bank had formed in the Ohio River at the mouth of this stream. 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 currently underway to formally protect this area. A new POTW which discharges directly to the Ohio River has been completed at Clarksville (October 1987), and the Clarksville North and South POTW's are no longer in use. The new Clarksville facility is currently experiencing more noncompliance than is normal for a new facility. Jeffersonville, which still discharges to Cane Run, currently has POTW improvements to correct a continuing solids problem under review by the state.

TABLE 41. ***INDIANA TRIBUTARY WATERS ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN***

WATERBODY	NEAREST TOWN(S)	STATUS OF DESIGNATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
W. F. Whitewater River	Connersville	FS (Aquatic Life)	Monitored (b,c)		40	The Connersville POTW has continued to operate within its permit.
E.F. Whitewater River	Richmond	NS (Recreational) PS (Aquatic Life)	Monitored (b,c)	E. coli Cyanide	48	Richmond's POTW experiences difficulties during wet weather.
Whitewater River	Brookville	NS (Recreational) FS (Aquatic Life)	Monitored (b,c)		16	
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	
Pipe Creek	Brookville	FS (Aquatic Life)	Evaluated		10	
Big Cedar Creek	Cedar Gove	FS (Aquatic Life)	Evaluated		4	
Village Creek	Alquina	FS (Aquatic Life)	Evaluated		6	
Richland Creek	Cedar Grove	FS	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.
Coles Creek	Tennyson	FS (Aquatic Life)	Evaluated		5	

TABLE 41. INDIANA TRIBUTARY WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN (con't)

WATERBODY	NEAREST TOWN(S)	STATUS OF DESINGATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
West Fork Pigeon Creek	Fort Branch	FS (Aquatic Life)	Evaluated	E. coli	5	New POTW began operation Spring 1990.
Stollsburg Ditch	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	
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 POTW.
Deer Creek	Cannelton	FS (Aquatic Life)	Evaluated		5	Cannelton wastewater now goes to Tell City POTW.
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 to begin construction of new POTW in June 1990.
Muddy Fork	Sellersburg	FS (Aquatic Life)	Evaluated		10	
Little Indian Creek	Lanesville	FS (Aquatic Life)	Evaluated		8	Lanesville has a new POTW under construction. The plant is 80 - 90% completed.
Big Indian Creek	Corydon	FS (Aquatic Life) (Threatened)	Monitored (b,c)		10	Corydon POTW has problems with ammonia limits at times. Part of the problem may be a poultry processing plant discharge to the POTW.
Blue River	Fredericksburg	NS (Recreational) FS (Aquatic Life)	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 POTW.
Georgetown Creek	Georgetown	FS (Aquatic Life)	Evaluated		2	
Harvey Branch	Oldenburg	NS (Aquatic Life) (Recreation)	Monitored (b,c)	Municipal (POTW) Low D.O. Ammonia E. coli Organics	2	Severe hydraulic overloads.

TABLE 41. INDIANA TRIBUTARY WATER ASSESSED, STATUS OF DESIGNATED USE SUPPORT, PROBABLE CAUSES OF IMPAIRMENT AND MILES AFFECTED IN THE OHIO RIVER BASIN. *(con't)*

WATERBODY	NEAREST TOWN(S)	STATUS OF DESINGATED USE SUPPORT1	METHOD OF ASSESSMENT2	PROBABLE CAUSE OF IMPAIRMENT	MILES AFFECTED	COMMENTS
Tributary of Laughrey Creek	Osgood	PS (Aquatic Life)	Evaluated	Municipal (POTW) organics	2	
Otter Creek	Boonville	NS (Aquatic Life)	Evaluated	Acid Mine	8	
Cypress Creek	Boonville	NS (Aquatic Life) (Recreation)	Monitored (b,c)	CSO's Nonpoint Acid Mine drainage Chlordane E. coli	10	Bonnville POTW has been upgraded.
Pigeon Creek	Evansville Haubstadt	PS (Aquatic Life)		Municipal (POTW) organics Habitat alteration Nonpoint	30	Haubstadt has completed construction of POTW improvements, but still has occassional sludge probelms. Haubstadt discharges to a limited use stream.
Tirbutary of Ripley Creek	Sunman	NS (Aquatic Life)	Evaluated	Municipal (POTW) organics Low D.O.	2	Large volumes of algae present on treatment lagoons.
Little Pigeon Creek	Dale	NS (Aquatic Life) (Recreation)	Monitored (b,c)	Municipal (POTW) organics Low D.O. Ammonia E. coli	5	Dale has received initial awards totaling $1,775,562 for new sewage treatment facilities. Construction may begin in June 1990
Oil Creek	Perry County	PS (Aquatic Life)	Evaluated	Institutional treatment plant Organic unkowns	7	
Cane Run	Clarksville Jeffersonville	NS (Aquatic Life) (Recreation)	Evaluated	Municipal (POTW) organics Low D.O. Ammonia, E. coli	1	The City of Clarksville POTW 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 POTW still has sludge and solids problems. Plant upgrading is being planned.

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

Pigeon Creek and its tributaries in Vanderburgh and Warrick counties receive effluent from POTW's in Elberfield, Haubstadt, Chandler, Fort Branch and Francisco, some of which is inadequately treated. 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 POTW effluents cause Pigeon Creek to only partially support its designated uses for about 30 miles.

Approximately 10 miles of Cypress Creek near Boonville in Warrick County does not support designated uses. The Boonville POTW was a problem before it was upgraded but now runs well and is meeting its permit limits. However, CSO's, acid mine drainage and agricultural nonpoint runoff contribute to the degradation of Cypress Creek. Elevated PCB and chlordane levels have been found in the sludge drying beds of the Boonville POTW and in the sediments of Cypress Creek. Those sediments will be excavated and taken to a hazardous waste landfill. Newburgh has a new facility, but often exceeds limits for Total Suspended Solids.

The Branchville Training Center wastewater treatment plant owned and operated by the Department of Corrections exceeds BOD limits occasionally. This facility is located on the headwaters of Oil Creek.

Silver Creek near Sellersburg, Big Indian Creek near Corydon, and the Middle Fork of Blue River near Salem all fully support their designated uses but are threatened due to POTW problems at these towns. The Sellersburg POTW has new construction completed and it is in compliance with its permit limits. Coplay Cement Company in Sellersburg also discharges to Silver creek and it is having problems with its treatment facility. When Coplay Cement Company gets the treatment problems alleviated as proposed, conditions in Silver Creek should improve. The Corydon POTW is consistently found to be slightly over their limits for ammonia in the final effluent but upstream and downstream inspections showed no signs of stream degradation. IDEM is currently negotiating with a poultry processing plant to improve its pretreatment program. The POTW at Salem has recently been upgraded but, due to filtering problems, this facility was exceeding its limits for BOD_5. Corrections have now been made and the plant is currently in compliance.

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, and 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 and/or endangered animal species. This is the only stream system in Indiana in which the hellbender salamander (<u>Cryptobranchus alleganiensis</u>) is found, and it appears that there is a rather large, reproducing population there. Spotted darters (<u>Etheostoma maculatum</u>), variegate darters (<u>E. variatum</u>), rosefin shiners (<u>Notropics ardens</u>), and the cottonmouth water moccasin (<u>Agkistrodon piscivorous</u>) are other unique species which have been found in the Blue River and its environs.

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. A habitat evaluation of the stream at English in 1981 during extreme low flow revealed no visible degradation from the town although there are probably some localized high fecal coliform concentrations from septic tanks. 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 a remnant population of the endangered Ohio River muskellunge. The Town of English is reportedly eligible for funding for a wastewater treatment facility. It has no facility now.

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.

In summary, 600 miles of Indiana tributaries to the Ohio River were assessed in this report. Of these miles, 484 (81%) fully support the aquatic life use, but 38 of these 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.

Grand Calumet River/Indiana Harbor Canal Studies

The Grand Calumet River (GCR)/Indiana Harbor Canal (IHC) is located in Lake County Indiana and empties into Lake Michigan within the boundaries of Indiana. The river consists of an east and west branch, with the two branches meeting to form the Indiana Harbor Canal. The east portion originates in Gary, Indiana at the outlet of the Marquette Park Lagoons just upstream of the outfalls of the USX Steel Corporation mill. It flows west and empties into Lake Michigan via the IHC. The west branch flows both east and west with the dividing line occurring near the Indianapolis Boulevard Bridge. The lake level also influences the flow of water down the Harbor Ship Canal. When the lake level is high or water is piled up in the southern part of the lake due to north winds or seiches, flow out the canal into the lake may be inhibited. At other times, municipal waste treatment effluent can account for all of the flow in the west branch. The western flow into Illinois reaches the Illinois River Basin. Effluents from industries and municipalities account for 93% of the flow in the east branch.

The Grand Calumet River Basin drainage area is small, but includes some of the most industrialized and populated areas in the state. Point source dischargers include steel mills, refineries, foundries, chemical manufacturers, municipal sewage treatment plants, combined sewer overflows

(CSO's) and landfills. Nonpoint sources of pollutants to this system include, but are not limited to, urban runoff, atmospheric deposition from nearby industries, and seepage from former and present day waste disposal facilities. In his book "The Rivers of Indiana" (1985) Richard Simon described the Grand Calumet River:

> "Its bed contaminated by the foul discharge of the state's heaviest concentration of commerce, industry, and pollution, this dirty, slimy, workhorse, needs a bar of lava soap and a thorough scrubbing, not only on Saturday but on every night of the week. It is burdened, abused, contaminated: it surface is oily and scummy. It is polluted, offensive and unable to support fish life. No swimmers dare use its waters. It is an ecologists nightmare."

In addition to the highly industrialized nature of this basin the Grand Calumet River channel is surrounded by a variety of riverine and palustrine wetland areas. These areas feature dominant vegetation of cattails and giant reed grass. The river and canal shoreline vegetation also includes numerous patches of the emergent arrowhead plant. In-channel submerged species include curly pondweed, sago pondweed and waterweed. Within the west branch submerged vegetation can become so thick that it is almost impossible to move a boat through.

The entire area is frequented by a number of animal species including migratory and nonmigratory waterfowl. Species observed include great blue heron, green heron, black crowned night heron, various duck species, coots and gallinules. Red-tailed hawks have also been seen around the river with regularity (unpublished observations). Muskrats and snapping turtles are common inhabitants of all areas along the Grand Calumet River. However, the resident fish community of the river and canal is very limited consisting primarily of pollution tolerant species such as carp, goldfish, and golden shiner (IDEM fish collection records). Because of continued sludge deposition from poorly operated treatment facilities and illegal discharges most instream habitat for fish reproduction has been covered. It is speculated, at this time, that most carp probably enter the GCR from Lake Michigan and that any reproduction occurring for the other species is due to the surrounding riverine wetlands and vegetation providing some spawning cover. Historically the river's channel has been greatly altered.

The GCR/IHC has been designated as a Class "A" Area of Concern (AOC) by the International Joint Commission (IJC). Water quality standards for dissolved oxygen, chlorides, ammonia, and E. coli bacteria are regularly exceeded. River sediment quality is very poor. It is highly contaminated with cyanide, heavy metals, polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs) as well as other organic toxics. Currently there is a fish consumption advisory against consuming any fish from the GCR/IHC.

In 1987, IDEM biologists sampled the aquatic macroinvertebrate populations in the GCR/IHC using Hester-Dendy artificial substrate samplers. Macroinvertebrate populations were sampled at six locations within Indiana. Results indicated that there was evidence of moderate organic pollution at every site, and most of the sites were probably stressed by toxic compounds as well. Samples collected near Bridge Street contained the most depressed macroinvertebrate community, but metals and PCBs were probably not the cause of depressed conditions at most sites. The affect of polynuclear aromatic hydrocarbons (PAHs) and cyanide on the aquatic community should be investigated further. Nutrient inputs into the GCR/IHC were relatively low and, despite their polluted appearance, the Lake George Canal and Indianapolis Boulevard stations had surprisingly good macroinvertebrate communities relative to other locations in the GCR/IHC. Macroinvertebrate sampling in 1988 from the IHC at the Dickey Road Bridge showed a single *Baetis* sp. larva and one species of bryozoa along with the usual dominant pollution tolerant macroinvertebrate fauna (oligochaeta, diptera, gastropoda). Baetid mayflies and bryozoans are commonly found in less polluted waterways.

A limnological study was conducted on the Marquette Park Lagoon basins in 1986. The results indicated the lagoon that is farthest to the east and the middle lagoon have good water quality with low total phosphorus and total nitrogen concentrations. Plankton counts were low to moderate with green algae species dominant in the middle lagoon. During the summer, all three lagoon basins are choked with large amounts of submerged aquatic macrophytes. The farthest west lagoon had moderately high average nutrient concentrations.

The west basin is clearly impacted by nonpoint runoff from industrial areas. This lagoon had a secchi disk reading of only 18 inches compared to about six feet in the other two basins. The bluegreen algae *Microcystis* sp. and *Phormidium* sp. were present in large numbers here although green algae were dominant.

Monitoring the presence and fate of toxic substances in the Grand Calumet River and Indiana Harbor Canal will be mandated by the Northwest Indiana area of Concern Remedial Action Plan (RAP). The RAP is a component of the comprehensive Northwest Indiana Environmental Action Plan. Some of the objectives of this plan are:

1. To more fully determine the types of contaminants in surface sediments, fish tissue and other biological matrices.

2. To determine the degree of contamination.

3. To determine where contamination occurs.

4. To determine whether contamination is still occurring, and if so, where it is originating.

5. To estimate deposition or sedimentation rates.

6. To examine the possibility of contaminant uptake by aquatic vegetations and its affect on contaminant remobilization.

In July 1988, a survey was conducted on the Grand Calumet River/Indiana Harbor Canal (GCR/IHC) to attempt to quantify the presence of toxic substances in these waters. Both effluent and ambient water column samples were collected. Although the emphasis was on toxic substances, other parameters were also monitored at the outfalls and in the river system. Approximately 180 different parameters were analyzed, although not all parameters were measured at each outfall or river station.

Outfall locations are distributed throughout the river system but most outfalls are located upstream on the East Branch of the Grand Calumet and along the Indiana Harbor Canal. Table 42 lists the 36 outfalls along with the respective outfall locations. Outfall locations are presented on Figure 15.

Eleven water quality survey sampling locations were distributed throughout the river system (three on the West Branch, two on the Indiana Harbor Canal and six on the East Branch). Table 43 lists the 11 water quality survey sampling locations and descriptions. The locations of these sampling stations are presented on Figure 16.

All outfalls and water quality sampling locations are shown schematically on Figure 17. Because of the large number of outfalls and long list of potential sampling parameters, not all outfalls were sampled for the organic priority pollutants. In general, the intent was to perform as many applicable analyses on all process water outfalls as the available laboratory contracts would allow. These outfalls were assumed to account for the presence of organic priority pollutants discharged to the GCR/IHC System. All noncontact cooling waters were sampled for all parameters except the organic priority pollutants. Table 44 describes all the types of discharges associated with each outfall.

Of the approximately 145 organic parameters which were sampled during this survey, only 35 were found in either effluents or ambient water at levels above the detection limit (Table 45). Of these, only 1,2-dichloroethane was found at levels which exceeded Indiana's water quality standards in either effluent or ambient water samples. There was one sample taken from the West Branch of the Grand Calumet River near Hohman Avenue that contained 40,500 ug/l of the substance. Although this substance was found at detectable levels at several ambient water sampling stations, this was the only sample that was near or above the applicable standard (2,430 ug/l).

Acetone was also found at fairly high levels in some ambient water samples (up to 22,700 ug/l) but not above detection levels in effluent samples. This is thought to be a sample contamination problem as the sampler used to collect ambient water samples was cleaned and rinsed with acetone between sampling stations. Individual samplers were used for each effluent sample and acetone was not found in these samples.

Metals and cyanide found in detectable levels in both effluent and ambient water are shown in Table 46. Although found in detectable amounts, ambient water concentrations of antimony, nickel and zinc did not exceed water quality standards at any station. Copper concentrations were found in four samples from the West Branch of the Grand Calumet River at levels exceeding the

TABLE 42. *POINT SOURCE DISCHARGERS IN GCR/IHC SYSTEM*

DISCHARGE NUMBER [1]	NAME	STATION CODE [2]	OUTFALL NUMBER	RECEIVING STREAM [3]	GRAND CAL. RIVER MILE
1	U. S. Steel	GW002	002	EBGC	13.5
2	U.S. Steel	GW005	005	EBGC	13.4
3	U.S. Steel	GW007	007	EBGC	13.3
4	U.S. Steel	GW010	010	EBGC	13.1
5	U.S. Steel	GW015	015	EBGC	12.9
6	U.S. Steel	GW018	018	EBGC	12.4
7	U. S. Steel	GW019	019	EBGC	12.3
8	U.S. Steel	GW020	020	EBGC	12.2
9	U.S. Steel	GW030	030	EBGC	11.6
10	U.S. Steel	GW032	032	EBGC	11.5
11	U.S. Steel	GW033	033	EBGC	11.3
12	U.S. Steel	GW-34	034	EBGC	9.2
13	Gary STP	GSTP001	001	EBGC	8.8
14	Industrial Disposal	MH001	001	EBGC	8.3
15	AMG Resources (Vulcan)	VM001	001	EBGC	6.8
16	DuPont	DP002	002	EBGC	4.9
17	DuPont	DP003	003	EBGC	4.9
18	Harbison-Walker	HW001,HW002	001,002	EBGC	4.8
19	E. Chicago STP	ECSTP001	001	WBGC	4.6(W)
20	Hammond STP	HSTP001	001	WBGC	5.5(W)
21	Federal Cement	FC001	001	WBGC	7.4(W)
22	American Steel	AS001	001	IHC	1.7
23	Inland Steel	IS001	001	IHC	1.5
24	Inland Steel	IS002	002	IHC	1.3
25	Inland Steel	IS007	007	IHC	0.7
26	Inland Steel	IS008	008	IHC	0.5
27	Inland Steel	IS011	011	IHC	-0.3
28	Inland Steel	IS012	012	IHC	-0.4
29	Inland Steel	IS014	014	IHC	-0.4
30	Inland Steel	IS015	015	IHC	-0.4
31	Inland Steel	IS018	018	IHC	-0.5
32	LTV Steel	JL001	001(101)	IHC	2.1

TABLE 42. *POINT SOURCE DISCHARGES IN GCR/IHC SYSTEM (con't)*

DISCHARGE NUMBER 1	NAME	STATION CODE 2	OUTFALL NUMBER	RECEIVING STREAM 3	GRAND CAL. RIVER MILE
33	LTV Steel	JL002	002	IHC	1.3
34	LTV Steel	JL009	009	IHC	0.6
35	LTV Steel	JL010	010	IHC	0.5
36	LTV Steel	JL011	011	IHC	-0.8

1 *Refers to numbers on Figure 15.*

2 *Code numbers refer to individual outfall numbers shown on Figure 17*

3 *EBGC = East Branch Grand Calumet*
WBGC - West Branch Grand Calumet
IHC - Indiana Harbor Canal

FIGURE 15. *LOCATION OF POINT SOURCE DISCHARGES IN GCR/IHC SYSTEM.*

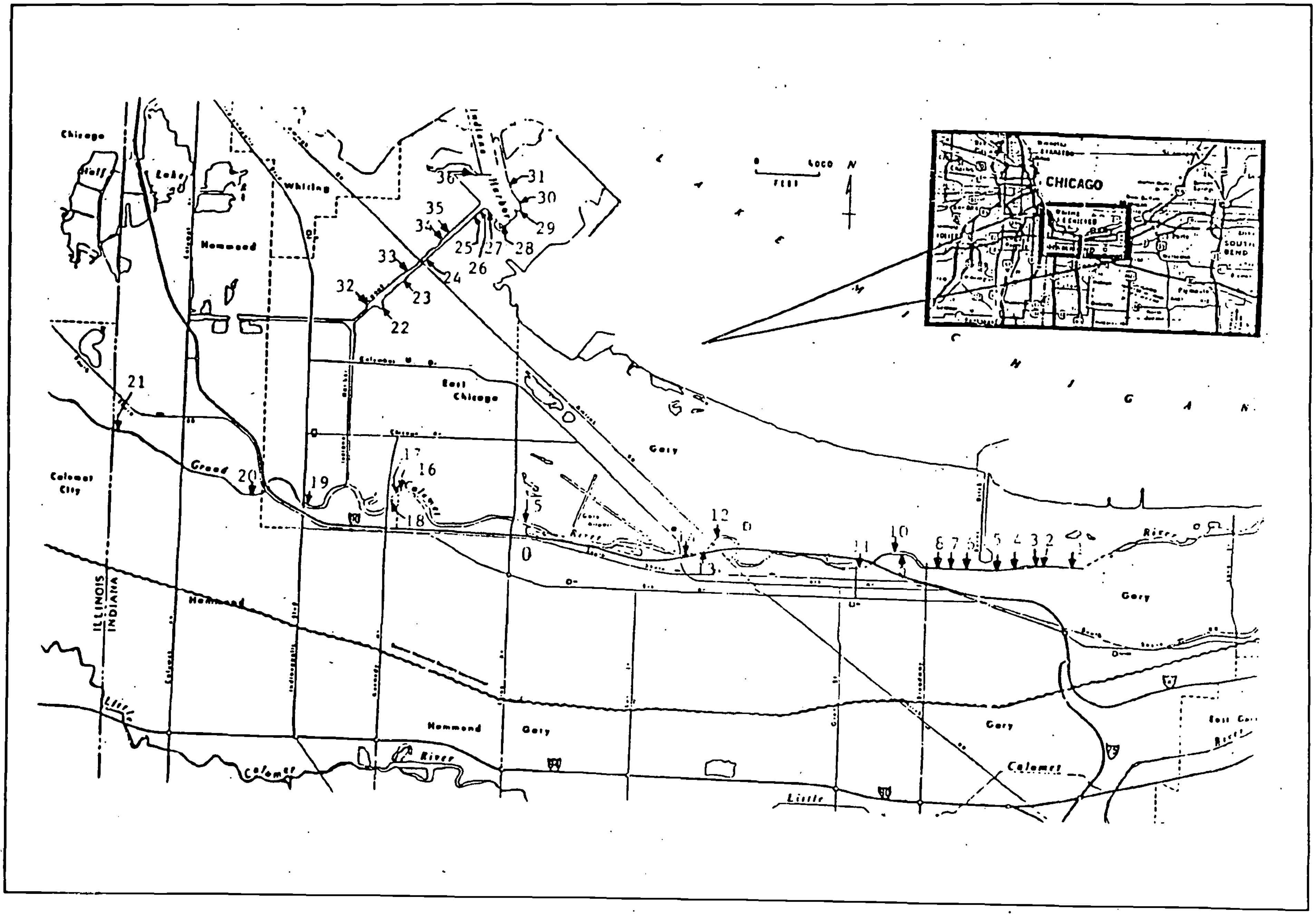


TABLE 43. *WATER QUALITY SURVEY SAMPLING LOCATIONS (JULY 1988)*

STATION NUMBER [1]	LOCATION NAME	STREAM [2]	GRAND CALUMET RIVER MILE
1	Headwaters at Culvert from Marquette Park Lagoons	EBGC	13.8
2	Broadway Bridge	EBGC	12.1
3	Buchanan Street	EBGC	11.0
4	Bridge Street	EBGC	10.0
5	Cline Avenue	EBGC	6.5
6	Kennedy Avenue	EBGC	4.7
7	Indianapolis Blvd.	WBGC	4.6 (W)
8	Columbia Avenue	WBGC	6.1 (W)
9	Hohman Avenue	WBGC	6.9 (W)
10	Chicago Avenue	IHC	3.2
11	Dickey Road	IHC	1.4

1 *Refers to numbers on Figure 16.*

2 *EBGC = East Branch Grand Calumet*
WBGC - West Branch Grand Calumet
IHC - Indiana Harbor Canal

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FIGURE 16. *WATER QUALITY SURVEY SAMPLING LOCATIONS FOR JULY 1988 GCR/IHC SURVEY*

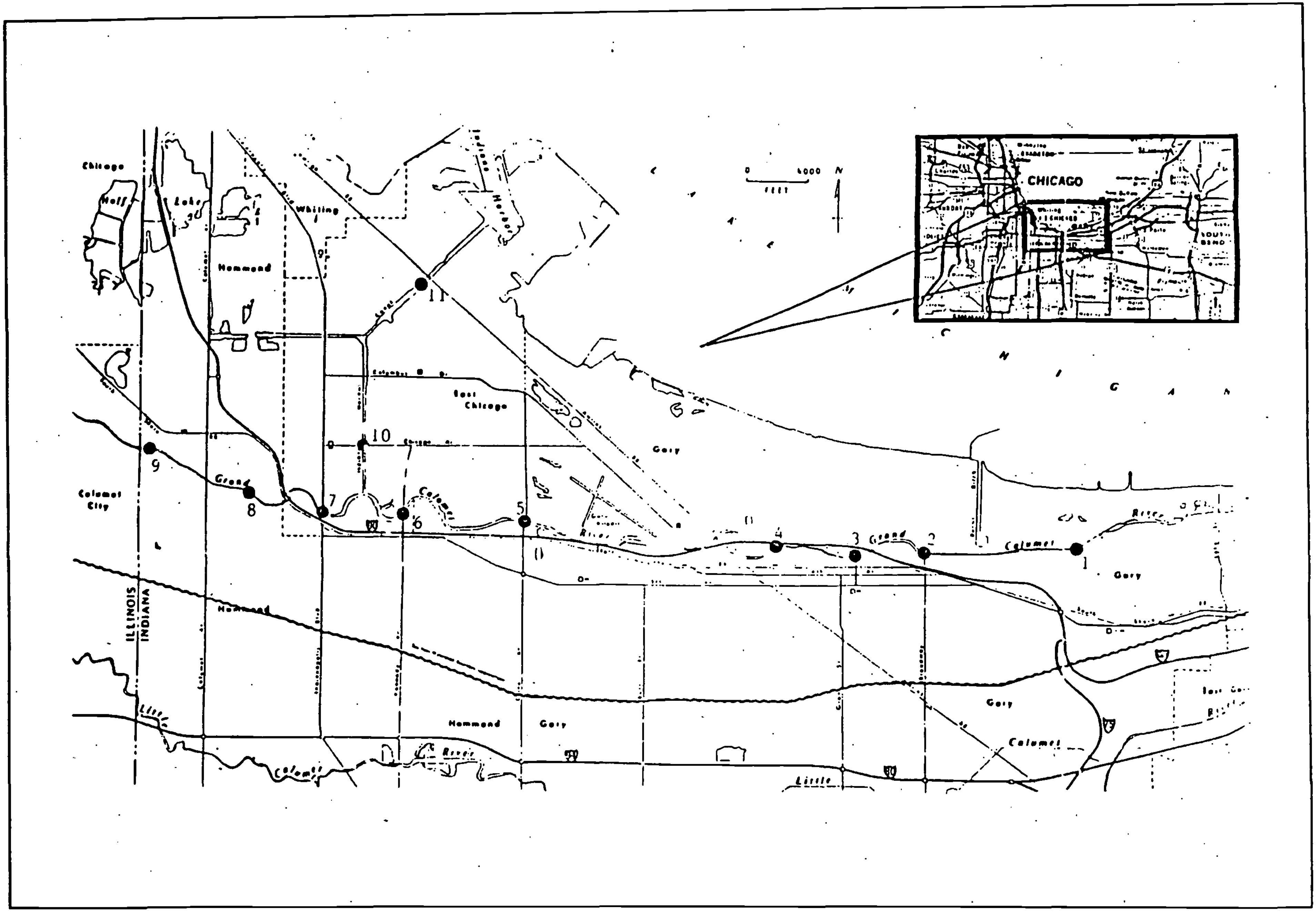


FIGURE 17. *SCHEMATIC DIAGRAM OF SOURCE DISCHARGE AND RIVER SAMPLING LOCATIONS ON GCR/IHC SYSTEM IN JULY 1988*

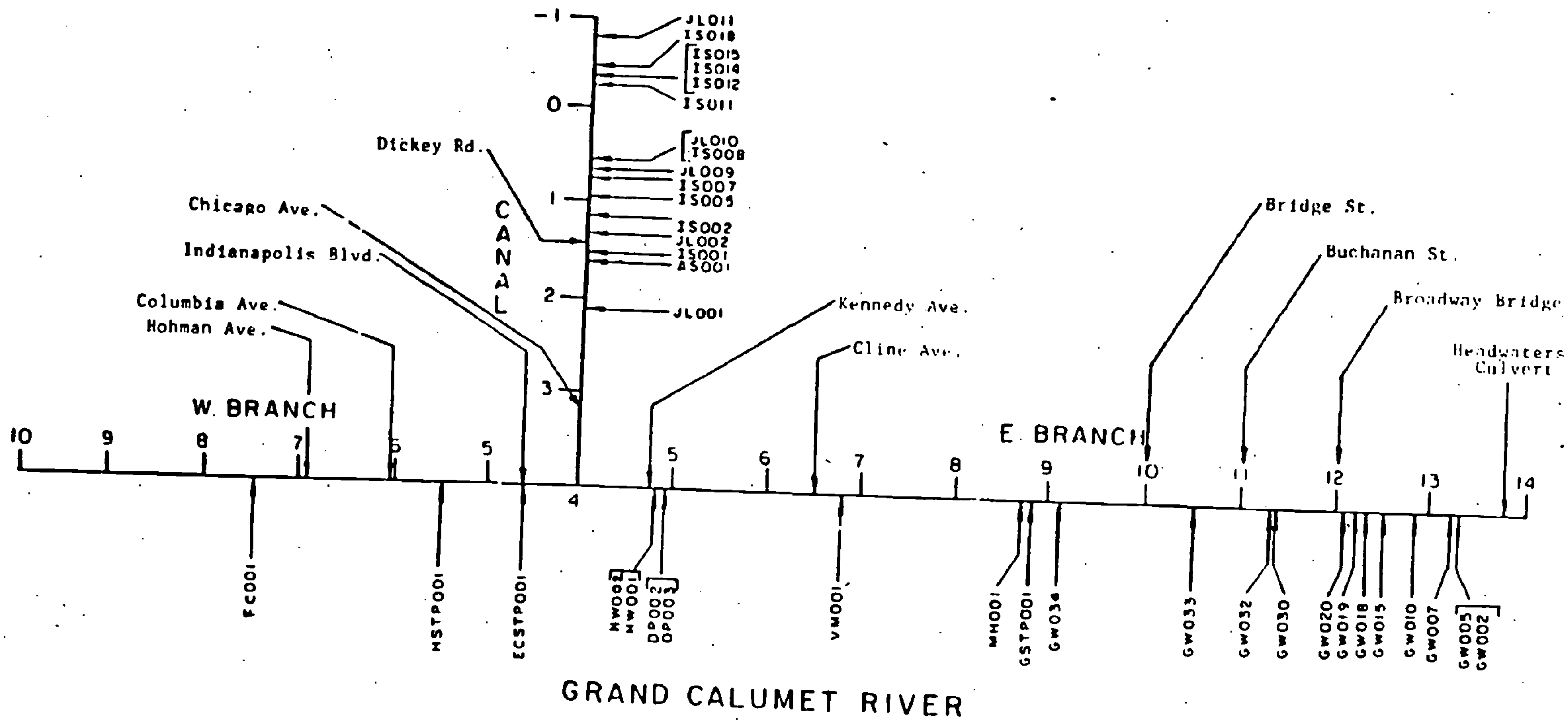


TABLE 44. *DESCRIPTION OF DISCHARGES TO GRAND CALUMET SYSTEM*

FACILITY	OUTFALL	DESCRIPTION
U.S. Steel	002	Tube operation recycle blow down, non-contact water from coke plant
U.S. Steel	005	Non-contact cooling water from coke plant
U.S. Steel	007	Non-contact water from coke plant, miscellaneous
U.S. Steel	010	Non-contact water from coke plant
U.S. Steel	015	Non-contact water from #3 sinter plant
U.S. Steel	018	Non-contact water from energy division
U.S. Steel	020	Non-contact water from #1 basic oxygen process shop (BOP)
U. S. Steel	030	Primary bar plate mills and BOP shops
U.S. Steel	032	Non-contact water from bar mills
U.S. Steel	033	Non-contact cooling water from atmospheric gas plant and miscellaneous finishing operations
U.S. Steel	034	Process water from terminal treatment plant and 84 inches hot strip mill recycle system blow down, non-contact cooling from miscellaneous finishing operations
Industrial Disposal	001	Seepage and runoff water
AMG Resources (Vulcan Materials)	001	Press and air compressor non-contact cooling water, water softener regeneration water, boiler blow down water, storm runoff water
E. I. DuPont	002	Process and non-contact cooling from chemical production
E.I. DuPont	003	Process and non-contact cooling from chemical production
Harbison-Walker	001	Non-contact cooling water from air compressors and welding equipment
Harbison-Walker	002	Non-contact cooling water from refractory press
U.S.S. Lead	001	Non-contact cooling water from blast furnace and casting mold
American steel	001	Process and cooling waters from foundry
LTV Steel	001	Process and cooling from flat roll operations
LTV Steel	002	Cooling water from cold rolling and finishing
LTV Steel	009	Power house and sinter plant cooling water
LTV Steel	010	Power house and blast furnace cooling water
LTV Steel	011	Process and cooling water from steel plant operations
Inland Steel	001	Process and cooling water from electric furnace steel shop and bar mill
Inland Steel	002	Process water, cooling water, and non-contact water from numerous operations
Inland Steel	007	Non-contact cooling from blast furnaces
Inland Steel	008	Non-contact condenser cooling water from power house
Inland Steel	011	Non-contact cooling from blast furnaces, non contact from sinter plant and power house
Inland Steel	012	Blast furnaces blow down, cooling water from coke plant and treated sanitary water
Inland Steel	014	Process water from numerous operations
Inland Steel	015	Non-contact water from open hearth furnace and small amount of treated sanitary water

TABLE 44. *DESCRIPTION OF DISCHARGES TO GRAND CALUMET SYSTEM (con't)*

FACILITY	OUTFALL	DESCRIPTION
Inland Steel	018	Grit water from basin oxygen furnaces, contact and non-contact basic oxygen furnace, power house cooling water
East Chicago STP	001	Municipal POTW water
Hammond STP	001	Municipal POTW water
Gary STP	001	Municipal POTW water
Federal Cement	001	Sanitary and non-contact cooling water

TABLE 45. *ORGANIC POLLUTANTS FOUND IN DETECTABLE AMOUNTS IN EFFLUENTS AND/OR AMBIENT WATER DURING JULY 1988 GCR/IHC SURVEY*

SUBSTANCE	EFFLUENT			AMBIENT WATER		
	NO. SAMPLES	NO. DETECTIONS (%)	CONC. RANGE (UG/L)	NO. SAMPLES	NO. DETECTIONS (%)	CONC. RANGE (UG/L)
Acetone	62	0	<5	20	7 (35)	<10 - 22,700
Acrolein	62	0	<10	20	1 (5)	<10 - 20
Acrylonitrile	62	0	<10	20	1 (5)	<10 - 110
Benzene	62	3 (5)	<1 - 61	20	3 (15)	<1 - 12
Benzylbutyl phthalate	11	2 (18)	<10 - 15	12	4 (33)	<10 - 17
Bis (2-ethylhexyl) phthalate	11	1 (9)	<10 - 13	12	6 (50)	<10 - 37
Bromodichloromethane	62	0	<1	20	2 (10)	<1 - 8
Bromoform	62	0	<5	20	4 (20)	<5 - 15
Bromomethane	62	0	<5	20	5 (25)	<5 - 38
Carbon Tetrachloride	62	0	<5	20	3 (15)	<5 - 8
Chlorobenzene	62	0	<5	20	3 (15)	<5 - 14
Chloroethane	62	0	<5	20	3 (15)	<5 - 23
Chloroform	62	5 (8)	<5 - 13	20	3 (15)	<5 - 14
Chloromethane	62	0	<5	20	2 (10)	<5 - 19
Chrysene	62	1 (2)	<10 - 12	12	1 (8)	<10 - 12
1,1-dichloroethane	62	0	<5	20	2 (10)	<5 - 10
1,2-dichloroethane	62	3 (5)	<5 - 1400	20	15 (75)	<5 - 40,500
1,1-dichloroethene	62	0	<5	20	2 (10)	<5 - 10
t-1,2-dichloroethene	62	0	<5	20	4 (20)	<5 - 9
1,2-dichloropropane	62	0	<5	20	4 (20)	<5 - 15
t-1,3-dichloropropene	62	0	<5	20	3 (15)	<5 - 9
Di-n-butyl phthalate	62	4 (7)	<10 - 48	20	3 (15)	<10 - 32
Ethylbenzene	62	0	<5	20	7 (35)	<5 - 24
Fluorotrichloromethane	62	0	<5	20	1 (5)	<5 - 6
Methylene chloride	62	2 (3)	<5 - 10	20	5 (25)	<5 - 26
Pyrene	11	0	<10	12	2 (17)	<10 - 17
1,1,2,2-tetrachloroethane	62	0	<1	20	4 (20)	<1 - 13
Tetrachloroethane	62	3 (5)	<5 - 12	20	4 (20)	<5 - 13

TABLE 45. *ORGANIC POLLUTANTS FOUND IN DETECTABLE AMOUNTS IN EFFLUENTS AND/OR AMBIENT WATER DURING JULY 1988 GCR/IHR SURVEY* (con't)

SUBSTANCE	EFFLUENT			AMBIENT WATER		
	NO. SAMPLES	NO. DETECTIONS (%)	CONC. RANGE (UG/L)	NO. SAMPLES	NO. DETECTIONS (%)	CONC. RANGE (UG/L)
Toluene	62	0	<5	20	12 (60)	<5 - 114
1,1,1-trichloroethane	62	2 (3)	<5 - 43	20	4 (20)	<5 - 10
1,1,2-trichloroethane	62	1 (2)	<5 - 13	20	2 (10)	<5 - 15
Trichloroethene	62	0	<5	20	3 (15)	<5 - 12
Vinyl acetate	62	0	<10	20	1 (5)	<10 - 21
Vinyl chloride	62	0	<10	20	2 (10)	<10 - 30
Xylenes (total)	62	0	<1	20	6 (30)	<1 - 44

TABLE 46. ***METALS AND CYANIDE FOUND IN DETECTABLE AMOUNTS IN EFFLUENT AND/OR AMBIENT WATER IN GCR/IHC DURING JULY 1988 SURVEY***

SUBSTANCE	EFFLUENT			AMBIENT WATER		
	NO. SAMPLES	NO. DETECTIONS (%)	CONC. RANGE (UG/L)	NO. SAMPLES	NO. DETECTIONS (%)	CONC. RANGE (UG/L)
Antimony	42	1 (2)	<60 - 95	15	5 (33)	<60 - 165
Arsenic	42	0	<10	15	1 (6)	<10 - 13
Barium	42	1 (2)	<50 - 552	15	0	<10
Chromium (total)	42	5 (12)	< 10 - 32	15	0	<10
Copper	42	1 (2)	<25 - 96	15	4 (27)	<25 - 112
Lead	42	1 (2)	<10 - 11	15	3 (20)	<10 - 14
Nickel	42	3 (7)	<10 - 34	15	0	<10
Zinc	42	9 (21)	<20 - 357	15	12 (80)	<20 - 83
Cyanide	42	17 (40)	< 5 - 175	15	6 (40)	< 5 - 19

standards. One value for lead from a West Branch sample, and one value for arsenic also were above the criteria for these substances. However, the detection limits for copper (25 ug/l) and arsenic (10 ug/l) were above the standard for these substances in all parts of the GCR/IHC system, and that for lead (10 ug/l) was above the criterion except in the West Branch where the hardness was higher (criteria vary with hardness). Thus, the standard for these metals could have been exceeded elsewhere and not been detected.

The standard for cyanide was exceeded in six ambient samples, although only one (19 ug/l) was substantially above the 5.2 ug/l standard (others ranged from 6 to 8 ug/l). Five of these samples were from the East Branch of the Grand Calumet River and one was from the Indiana Harbor Ship Canal. Effluents from several dischargers contained rather high cyanide concentrations (USX - 20 ug/l; Industrial Disposal - 27 ug/l; Gary POTW - 175 ug/l; Inland Steel - 72 ug/l; East Chicago POTW - 37 ug/l, and Federal Cement - 13 ug/l). However, effluents did not contain high concentration of metals for the most part.

It is interesting that only 11 of the 35 organic compounds found above detection levels in ambient water samples were found in the effluent samples (Table 45). This may indicate that nonpoint sources may be important contributors of organic compounds to this river system. Also, combined sewer overflows or bypasses were not sampled in this survey, and they may be other sources of these substances.

Surficial bottom sediment composite grab samples as well as water column sediment trap samples were collected for contaminant analysis in 1986 and 1987. Additionally, surficial bottom sediment grab composite samples were collected in conjunction with vegetation collected for chemical contamination assessment (1988). All samples were analyzed for 35 volatile organic compounds, 15 phenolic compounds, 23 metals, cyanide, 54 base/neutral extractable organic compounds, 29 persistent chlorinated pesticides and PCBs (Table 45). There were a total of 42 sediment samples collected in this time period in the GCR/IHC and Marquette Park Lagoons composed of 13 suspended sediment and 29 surficial bottom sediment samples.

Each class of chemicals measured (volatiles, phenolics, base/neutrals, metals and metalloids, and chlorinated hydrocarbons) contributed to the sediment contamination problem at one or more sites. There appeared to be ongoing sediment contamination for some elements and compounds at some of the sites. Sediments in the suspended sediment traps, which presumably represent the newest, most mobile sediments in the river, generally had higher metals and volatile organics concentrations than the older previously deposited surficial sediments from ponar grabs. For example, where sediment trap and surficial sediment samples differed by a factor of 2 or more, 20 out of 24 "volatiles" measurements and 65 out of 71 "metals" measurements were higher in the suspended sediments than in the surficial sediment samples (except in Lake George Canal samples which are discussed below). Phenolics seemed to be of roughly equal concentrations in both types of samples. Total PCBs (Webb-McCall quantitation) and base/neutrals, on the other hand, generally had higher concentrations in surficial sediment samples (16 out of 19 measurements differing by a factor of 2). This suggests that PCB and base/neutrals input contamination may be decreasing.

Generally, all sampling sites had one or more metals present in the sediment at greater than 10X statewide background levels. Statewide background values used for assessment are listed in Table 18. Zinc was present at greater than 10X background at all sampling sites, and Indianapolis Boulevard (West Branch GCR) had 7 of 23 inorganic elements at these elevated levels. Metalloids that generally fall into this level of concern for the GCR/IHC include antimony, cadmium, copper, silver and zinc. Other elements that generally range from 2-10X the background concentration include arsenic, beryllium, chromium, iron, lead, mercury, nickel, selenium and thallium. The highest metal concentration was 200X background for antimony at Hohman Avenue (West Branch GCR). Antimony occurred at seven of ten sites at a level of 10-20X background in 1986. Metalloids in concentrations of 30-80X the background level included copper in Lake George Canal (IHC) and selenium and silver at Indianapolis Boulevard, Indiana Harbor Canal and Lake George Canal. Highest mercury values occurred at Hohman Avenue and Kennedy Avenue (East Branch GCR). Highest arsenic, copper, and lead levels occurred at the Kennedy Avenue station. Elevated levels of cyanide also occurred at all GCR/IHC sites sampled with levels being greater than 10X background.

Polychlorinated biphenyls were found in virtually every sediment sample collected from the GCR/IHC system. Concentrations are high enough at all locations to warrant a high level of concern (range 0.238-41.17 ppm dry weight for PCB-1248). PCB-1248 was the most commonly detected aroclor. The highest value recorded (41.2 ppm dry weight) was at Bridge Street (East Branch GCR).

The pesticides aldrin, isomers of benzene hexachoride (BHC), chlordane, DDT, heptachlor, heptachlor epoxide and endosulfan-I have all been detected in the sediments of the GCR/IHC. BHC levels exceeded 2X background concentration in the Hohman Avenue and Indiana Harbor Canal surficial sediments collected in 1988 (0.240 ppm and 0.111 ppm dry weight, respectively). Previous surficial sediment collections showed similar levels (0.027-0.310 ppm dry weight). Sediment trap collections from 1987 showed a BHC concentration range of 0.080-0.540 ppm dry weight.

Only one isomer of chlordane was detected in surficial sediment collections from 1988 (alpha-chlordane). This one detection (from Lake George Canal) was greater than 10X the established background concentration for total chlordane. Suspended sediment trap samples collected in 1987 showed concentrations of total chlordane greater than 0.058 ppm at two locations, Lake George Canal and Kennedy Avenue.

Isomers of DDT were detected in suspended sediments at five out of eight locations (range 0.026-0.142 ppm dry weight). Concentrations in surficial sediments were higher (0.050-2,156 ppm dry weight) with detections occurring at eight out of nine locations.

Heptachlor epoxide was found in surficial sediments at five out of nine sampling locations. There were no detections in suspended sediments. Generally, heptachlor epoxide values ranged from 0.056-0.359 ppm dry weight. Heptachlor was detected in one 1987 sample from the Virginia Street location at 0.431 ppm dry weight. Endosulfan-I was detected in only one bottom sediment sample (Cline Avenue, East Branch GCR) at 0.250 ppm dry weight.

Six different phenolics have been detected in sediments from the Grand Calumet River/Indiana Harbor Canal. These include phenol, 4-methylphenol, 2,4-dimethylphenol, 2,4-dichlorophenol, 4-chloro-3-methylphenol and pentachlorophenol. Pentachlorophenol had the highest concentration (141.7 ppm dry weight) at Kennedy Avenue. The most widely distributed compound was 4-methylphenol with a range of 0.14-130.00 ppm dry weight. Only one suspended sediment sample had a detectable amount of 4-methylphenol (2.1 ppm dry weight at Indianapolis Boulevard). All 1988 GCR/IHC surficial sediment samples contained 4-methylphenol in quantifiable amounts.

The most widely distributed base/neutral extractable semivolatile compounds in the GCR/IHC sediments were naphthalene, methylnaphthalene, chrysene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, fluoranthene, phenanthrene, benzo(a)pyrene and Bis(2-ethylhexyl) phthalate. These were detected at all sampling locations. Other base/neutral semivolatile compounds detected include 1,2-dichlorobenzene, 3,3'-dichlorobenzidene, 4-chlorophenylphenylether, 2-chloronaphthalene, diethylphthalate, di-n-octylphthalate, di-n-butylphthalate, butylbenzylphthlate, acenaphthylene, acenaphthene, 2-methylnaphthalene, benzo(ghi)perylene, pyrene and indeno (1,2,3-c,d) pyrene. Samples from the Bridge Street station generally contained the highest concentrations of these compounds.

The most widely distributed volatile organic compounds were benzene and methylene chloride. However, methylene chloride detections may be due to laboratory contamination as this compound is consistently found in the laboratory control blanks. Other volatile organic compounds detected in 1988 sediment samples include ethylbenzene, 2-butanone, carbon disulfide, toluene, xylene, 4-methyl-2-pentanone and 2-chloroethylvinylether. Generally, volatile organic compound concentrations in surficial sediments were highest at Bridge Street and in the Lake George Canal.

Some of the contaminants are so widespread that it is impossible to determine a source. Examples of these are zinc, copper, cyanide, benzene and PCBs. Other contaminants, however, were found at much higher concentrations at particular sites, making a determination of their source more likely. For example, most of the PAH compounds in the base/neutral group appear to originate in the Bridge Street area. Volatile organic concentrations (especially xylene, toluene and ethylbenzene) were much higher in Lake George Canal samples than anywhere else. Most metals concentrations were higher at the downstream sites (mouth of the West Branch, Indiana Harbor Canal at Dickey Road and Lake George Canal) than farther upstream. Phenolics seemed to center around Kennedy Avenue. Four of the five detectable levels of phenolics in the basin were at this site.

Microscopically GCR/IHC suspended sediments appeared to be composed of amorphous clumps of vegetative matter inviting speculation that wetland plants which had bioaccumulated certain pollutants during their growing season, could be contributing to the sediment pollutant load during the decomposition and deposition process. An evaluation of sediment concentrations versus vegetation concentrations showed that vegetation concentrations seemed too low to account for the high values in suspended sediments. However, some Saggitaria sp. samples collected at Kennedy Avenue in 1988 had metals and PCB concentrations which seemed to match suspended sediment concentrations very well. Saggitaria sp. is a minor component of the Grand Calumet wetlands (less than 10% of the aquatic macrophyte biomass) so it seems unlikely that Saggitaria alone could account for the high concentrations in the traps. However, the possibility of plants contributing to the sediment load of certain pollutants is possible and should be evaluated further.

The following average sedimentation rates were calculated from test tube traps set in 1986 and converted to dry weight from the % solids data submitted to us by the State Board of Health Environmental laboratory:

Bridge Street	62 mg/cm^2/day
Cline Avenue	42 mg/cm^2/day
Kennedy Avenue	58 mg/cm^2/day
Indianapolis Boulevard	16 mg/cm^2/day
Lake George Canal	2.5 mg/cm^2/day
Indiana Harbor Canal	29 mg/cm^2/day

However, daily sedimentation rates can vary greatly since contributions to flow by discharges can fluctuate daily. Traps were left in place for six to eight weeks.

Fish and crayfish were collected from the Grand Calumet River and Indiana Harbor Canal (GCR/IHC) to monitor for biocontamination. Fish tissue samples have also been collected from the Marquette Park Lagoons in Gary at the headwaters of the river. The locations for collections were: (1) Indiana Harbor Canal, near Dickey Street Bridge; (2) GCR near Bridge Street Bridge; (3) GCR near Cline Avenue Bridge; (4) GCR near Kennedy Avenue Bridge; (5) GCR near Indianapolis Boulevard Bridge; and (6) Marquette Park Lagoons. Crayfish were also collected at the first four locations.

Because of the movements of fish species, differences in uptake rates and variability within and between species, it is difficult to interpret associations of organic compounds and metals concentrations in fish tissue with sediment concentrations at each location. However, results of fish tissue monitoring for contaminants of concern show an unusually large number of compounds detected in the GCR/IHC area compared to other fish tissue sampling locations in the state. Compounds detected and their concentration ranges are listed in Table 47.

Generally, the only compounds for which Food and Drug Administration (FDA) Action Levels were exceeded were Total PCB and Total Chlordane. Although most of the compounds listed in Table 45 have no FDA Action Level by which to compare tissue concentrations, the GCR/IHC is the only location in the state where many of these compounds have been detected. Highest Total PCB values occurred in fish taken from near Bridge Street, IHC near Dickey Road and at the beginning of the IHC. Total PCBs averaged 5 ppm in carp samples from the GCR/IHC. Total PCBs were found in fish samples from Marquette Park lagoons, but these ranged from 0.320 to 1.100 ppm in whole fish samples. Fillet sample concentrations would likely be much lower. Fish tissue containing the highest total chlordane levels came from near Kennedy Avenue.

TABLE 47. *COMPOUNDS EXCEEDING FDA ACTION LEVELS FOR CONSUMPTION OR OF CONCERN DETECTED IN FISH TISSUE FROM THE GRAND CALUMET RIVER/INDIANA HARBOR CANAL*

COMPOUND	% DETECTIONS	RANGE (ppm)
Total PCBS	89	1.421 - 12.504
Total Chlordane	9	0.020 - 0.538
Total DDT	73	0.022 - 3.342
Total BHC	27	0.002 - 0.040
Cadmium	19	0.01 - 0.10
Chromium	65	0.38 - 1.70
Copper	67	0.82 - 4.90
Arsenic	33	0.02 - 0.20
Lead	68	0.25 - 8.90
Mercury	83	0.03 - 0.22
Manganese	71	0.80 - 17.30
Selenium	7	2.00
Zinc	100	28.80 - 130.00
4-Methylphenol	7	0.510
Acenaphthylene	33	0.031 - 0.360
Acenaphthene	73	0.140 - 4.300
Fluoranthene	53	0.130 - 0.490
Fluorene	60	0.069 - 0.870
Benzo (k) Fluoranthene	7	0.240
Dibenzofuran	80	0.090 - 1.700
Naphthalene	60	0.020 - 1.500
2-Methylnaphthalene	80	0.033 - 5.200
Phenanthrene	53	0.089 - 0.720
di-n-Butylphthalate #	40	0 120 - 0.230
Bis(2-ethylhexyl)phthalate #	27	0.130 - 0.740
Pyrene	27	0.051 - 0.290
Benzene	86	0.050 - 0.120
Ethylbenzene	21	0.012 - 0.064
2-Butanone #	86	0.039 - 0.190
Carbon Disulfide	50	0.001 - 0.012
1,1,1-Trichloroethane #	64	0.003 - 0.014

TABLE 47. *COMPOUNDS EXCEEDING FDA ACTION LEVELS FOR CONSUMPTION OR OF CONCERN DETECTED IN FISH TISSUE FROM THE GRAND CALUMET RIVER/HARBOR CANAL (con't)*

COMPOUND	% DETECTIONS	RANGE (ppm)
Trichloroethylene	7	0.003
Tetrachloroethylene	57	0.006 - 0.094
Bromodichloromethane #	36	0.005 - 0.008
Methylene Chloride #	100	0.038 - 1.300
Chloroform #	100	0.002 - 0.049
Toluene #	100	0.007 - 0.170
Total Xylene	100	0.007 - 0.250

\# Compound also Detected in Associated Laboratory Blanks

Highest metals concentrations in fish tissue tended to occur around Bridge Street (the most upstream station for fish collections in the river). Metals detected include lead, chromium, cadmium, copper, arsenic, mercury, manganese and zinc. There were no detections of silver, thallium, vanadium or nickel in any fish tissue samples collected from the GCR/IHC. Tissue concentrations of these metals do not appear to be abnormally elevated. Fish samples were analyzed as whole fish.

Results of crayfish tissue analysis showed detections of total PCBs averaging 0.868 ppm (whole basis) for the six samples analyzed with a range of 0.40-1.200 ppm. The crayfish samples containing the highest total PCB levels came from near Cline Avenue and near Kennedy Avenue. Metals detected in crayfish include arsenic, chromium, copper, lead and zinc. Crayfish tissue concentrations of lead appeared to be at elevated levels (7.4 mg/kg average) when compared with samples from a control site (2.2 mg/kg average).

Crayfish did not accumulate any pesticides or acid extractable organic compounds. However, there were numerous detections of base neutral extractable and volatile organic compounds including fluoranthene, fluorene, di-n-butylphthalate, diethylphthalate, BIS(2-ethylhexyl)phthalate, acenaphthalene, acenaphthene, chrysene, benzo(a)anthracene, naphthalene, 2-methylnaphthalene, phenanthrene, pyrene, benzo(a)pyrene, benzene, chlorobenzene, ethylbenzene, 2-butanone, carbon disulfide, tetrachloroethylene, dichloromethane and xylene.

It would appear that there is a definite chronic affect of the water and/or sediment on the fish community that exists within the Grand Calumet River and Indiana Harbor Canal. Clearly, the species present are relatively tolerant to extreme water and sediment pollution and poor instream habitat, and there is a high incidence of physical anomalies (external tumors, lesions, fin rot, etc.). Further studies are needed to determine the cumulative effect of the contaminants on the animal populations that visit as well as inhabit the GCR/IHC.

III. WATER POLLUTION CONTROL PROGRAM

Point Source Control Program

The point source control program in Indiana primarily involves discharges from municipal or industrial wastewater treatment facilities. In order to meet the goals of the Clean Water Act, federal, state, and local governments, as well as industry, have spent considerable monies to improve the degree of wastewater treatment they provide and, in turn, the water quality of Indiana's lakes, rivers and streams. The concentrations of polluting materials in these discharges are regulated by the National Pollutant Discharge Elimination System (NPDES) permit program. All facilities which discharge to Indiana waters must apply for and receive a 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 48 depicts the changes in the degree of wastewater treatment provided by municipal facilities in Indiana in the period from 1972 to 1989. 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 1989, 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 semipublic 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.

Table 48. Changes in degree of wastewater treatment provided by municipal facilities to the population of Indiana in the period 1972-1989.

	1972	1982	1985	1988	1989
Population size	5,195,000	5,490,000	5,500,000	5,510,000	5,556,000
No municipal treatment	40%	40%	38%	38%	37%
Primary treatment	6%	0.4%	0.04%	0%	0%
Secondary treatment	54%	41%	17%	11%	10%
Advanced treatment	0%	18%	45%	51%	53%

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 over 1.3 billion dollars in federal construction grants money and has spent over

181 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 1988 and 1989 is shown in Table 49.

Industrial Facilities

By July 1, 1977, industrial dischargers were required to meet Best Practicable Control Technology Currently Available (BPT) or achieve water quality standards, whichever was more stringent. Nearly all Indiana industries met BPT by this time. For those which did not comply, enforcement action was initiated and eventually resolved to achieve compliance. However, there was a concern that toxic pollutants, which are the primary focus of Best Available Technology Economically Achievable (BAT), were not sufficiently addressed. Many permittees now have installed treatment that can meet BAT, primarily because of an overriding site-specific water quality issue. Applicants for permit reissuance are required to specifically identify toxic substances which are or may be discharged to the waters of the state from their facility. The permit reissuance process involves the detailed review of these applications, and toxic pollutants are limited to safe levels. If there is a question as to the presence of a particular substance in sufficient quantities to be of concern, a monitoring requirement is established in the permit. A final permit limit is based on these additional monitoring data.

Although the total amount of money expended by industry for wastewater treatment has not been reported, it has been considerable. Data from claims for tax exemptions for wastewater treatment equipment provide some idea of these expenditures. The number of claims and total amounts claimed for each year from 1978-1989 by Indiana industries are shown in Table 50. This amount has nearly tripled in this time period.

Table 50. The number of tax exemption claims and the total dollars claimed by Indiana industries for wastewater treatment facilities from 1978 to 1989.

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

TABLE 49. *STATE AND FEDERAL GRANTS AWARDED IN FISCAL YEARS 1988 - 89*

APPLICANT	INITIAL AWARD ELIGIBLE PROJECT	INITIAL AWARD FEDERAL AMT.	INITIAL AWARD STATE AMT.	EXPECTED COMPLETION DATE	NEED ADDRESSED
Shirley	1,718,500	1,227,555	1,343,700	July 1990	A C X N
White Oak CD	2,066,025	1,454,975	413,205	April 1990	B
Greensburg	2,356,000	1,346,640	471,200	Sept. 1990	N
Orleans	1,982,800	1,147,700	396,560	March 1991	A N
Medora	1,577,600	859,430	315,520	March 1990	A C X
Ferdinand	1,365,500	885,205	273,100	April 1990	A
Kentland	3,024,375	1,577,225	604,875	April 1990	X
Little Racoon RSD	5,160,000	3,869,980	1,032,000	Sept. 1990	B
Jasper	12,960,200	8,092,910	2,592,040	Sept. 1990	X
Remington	1,993,950	1,230,120	398,790	March 1990	A N
W. Wayne RSD	6,390,500	4,549,205	1,278,100	Sept. 1990	X N
Frankton	1,827,800	1,044,370	365,560	Sept. 1990	C X
Rensselaer	4,230,500	2,673,435	846,100	Aug. 1990	C X
Sharpsville	2,015,100	1,306,539	403,020	Aug. 1990	B
West Lebanon	3,164,400	2,344,480	632,880	April 1991	B
Dupont	633,100	462,745	126,620	Oct. 1990	A
Amo	2,136,000	1,174,800	427,200	Oct. 1990	B
Coatsville	1,327,300	730,015	265,460	July 1990	B
Churabusco	1,662,300	914,265	332,460	July 1990	A
Wilkinson	2,084,200	1,146,310	416,840	June 1990	B
Mentone	2,874,900	1,971,315	574,980	Aug. 1990	B
South Bend	18,339,100	10,086,505	3,667,820	Sept. 1990	A
Van. Buren	1,543,900	1,045,096	308,780	Feb. 1990	A N
Sellersburg	9,933,200	5,463,260	1,986,640	June 1990	A X N
Greentown	2,494,400	1,371,920	498,880	Jan. 1990	A F X N
Rossville	2,212,800	1,217,040	442,560	Dec. 1990	X
Campbellsburg	982,100	540,155	196,420	Aug. 1991	A C N
West Terre Haute	9,591,500	5,275,325	1,918,300	June 1992	B
Georgetown	6,159,200	4,051,620	1,231,840	May 1992	B
Fountain City	2,581,020	1,419,500	516,204	Dec. 1990	B
Arcadia	2,183,700	1,201,035	436,740	Feb. 1991	A F N
Berne	1,825,500	1,004,025	365,100	?	N
New Point	1,441,400	792,770	288,280	Jan. 1990	B

TABLE 49. *STATE AND FEDERAL GRANTS AWARDED IN FISCAL YEARS 1988 - 89 (con't)*

APPLICANT	INITIAL AWARD ELIGIBLE PROJECT	INITIAL AWARD FEDERAL AMT.	INITIAL AWARD STATE AMT.	EXPECTED COMPLETION DATE	NEED ADDRESSED
Goodland	4,013,900	2,207,645	802,780	Oct. 1991	B
Anderson	7,723,300	4,247,815	1,544;660	July 1991	N
Hope	2,072,100	1,139,665	414,420	Oct. 1991	C N
Bainbridge	1,787,210	982,965	357,442	Oct. 1990	B
Etna Green	1,504,600	827,530	300,920	June 1990	B
Lapaz	3,672,300	2,019,765	734,460	April 1990	B
South Henry Co.	8,111,000	4,461,050	1,622,200	?	B
Decatur	2,418,800	1,330,340	483,760	June 1991	D N
Adams Lake RSD	2,320,200	1,276,100	464,040	Oct. 1991	B
Lake Eliza CD	2,870,900	1,578,995	574,180	Dec. 1991	B
Claypool	869,000	477,950	173,800	April 1991	B
Silver Lake	3,022,600	1,662,430	604,520	March 1991	B
New Carlisle	507,500	279,125	101,500	?	D
Evansville	20,622,000	11,342,100	4,124,400	June 1992	A

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

In the past, industrial wastewaters have caused water quality problems even though they were discharged to a municipal sewage treatment facility. These wastes would often "upset" the various treatment processes at the municipal sewage treatment facility to the extent that little or no wastewater treatment would occur. Also, some of these pollutants can pass through a wastewater treatment facility and remain at levels that are still toxic to the aquatic life in the receiving stream. Toxic substances can also accumulate in the municipal sludge at levels which make disposal much more expensive.

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 or more and have an adequate industrial base are required to work directly with the industries which need pretreatment to develop their own plans for control of these discharges. In general, the state works with the smaller municipalities and their associated industries to develop their pretreatment programs.

Indiana has identified 45 municipalities that need to have direct control of their industrial users (IUs). Approximately 450 IUs are controlled by these 45 municipalities, and their pretreatment programs are audited annually by the state. Also, there are approximately 50 IUs that discharge into smaller municipal sewage plants that are controlled directly by the state.

Compliance and Enforcement

In order to assure compliance with NPDES permit limits for substance in the dischargers' effluent, a variety of data are reviewed. These data would include such things as self-monitoring data submitted on monthly monitoring report forms, 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 permit 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.

In Indiana, compliance with NPDES permit requirements is tracked with the assistance of computers. Tracking is performed monthly for each permittee identified on the state compliance monitoring priority list. The 1988-1989 methods used to determine compliance rates were based upon U.S. EPA's use of the number and percentage of major facilities in Significant Noncompliance (SNC). This information is generated quarterly and predicates compliance on permitted effluent discharges within 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. This Quarterly Compliance Report highlights the status of each permittee and provides a plan for returning noncomplying facilities to compliance. The 1989 compliance rate for major dischargers has increased to about 96% for municipalities and industries, and to 100% for federal facilities.

Minor dischargers experience a somewhat lower compliance rate due to 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, the Municipal Compliance Strategy (MCS) has been implemented to achieve maximum municipal compliance by July 1988. This was a requirement of the 1981 amendments to the Clean Water Act and subsequent National Municipal Compliance Strategy. The MCS plan is designed not only to help municipalities achieve and maintain compliance with their permit limits but also to provide information and guidance to allow the municipality to plan for future expansion, replacement, and operational and maintenance costs independent of outside financial assistance. The MCS policy dictated that communities forecasted to be unable to meet the congressionally mandated deadline would have to be put under a judicial order (J.O.) containing a compliance schedule. State and federal grants to such communities would not, in fact, be issued unless and until J.O.'s were in place for those communities. During 1986-87, final list of communities was developed which were targeted as needing J.O.'s. That list of communities was the National Municipal Policy (NMP) list. That list was later subdivided to differentiate between communities with treatment plants (NMP communities) and those without treatment plants (Indiana Municipal Policy or IMP communities) but needing facilities to correct water quality violations.

Enforcement staff worked diligently during 1987-1988 to get the 69 identified NMP/IMP communities on enforcement schedules through J.O.'s. Over time, it became evident (or was determined by EPA) that IMP communities would not have to be under a J.O. schedule after all, but could be dealt with through the administrative process in Agreed Orders (A.O.'s). Presently, 14 or the 24 IMP facilities have had J.O.'s filed. Most of these facilities are delinquent in meeting their J.O. schedule, and in some cases fines will be requested. Two of the remaining 10 IMP facilities have had notices of violation filed and notices of violation are currently being requested for two others.

Of the 45 identified NMP facilities, all but four permittees have had J.O.'s filed in court. All four of these cases are presently in various stages of being finalized.

Indiana has met 91% of its goal for getting its NMP permittees under J.O. but only 58% of its IMP permittee goals. It should be noted that all but one facility has had action started to get the community under an A.O. Delays in establishing workable schedules within the grants process also slowed down the order issuance process for these facilities. It is anticipated that the remaining 4 NMP facilities will be under a J.O. (assuming no further protracted litigation) by the end of the fiscal year. The remaining IMP facilities should be under an A.O. by the end of the calendar year.

Nonpc ·:ce Control Program

1987, in cooperation with other agencies and organizations, IDEM formed a State Nonpoint Source (NPS) Task Force to begin the process of developing a comprehensive NPS program. In accordance with §319 of the Clean Water Act, a Nonpoint Source Water Pollution Assessment Report and a draft NPS Water Pollution Management Program were submitted by the task force in August 1988. After a public review period, revisions were made to the latter document which was then submitted to the U.S. EPA in final in June 1989. EPA formally approved the Assessment Report in September 1989 and the Management Program in January, 1990.

The Assessment Report contains information about surface and groundwaters that are affected by NPS pollution. It is not considered to be complete, since it is based on only the limited data that were already available at the time of its preparation. It is anticipated that future biological and chemical sampling programs for surface waters and chemical analyses of wells will provide additional data in the next few years that will allow for development of a much more comprehensive assessment. The Management Program established categorical methods and processes for alleviation of the various NPS problems; this includes existing as well as proposed solutions.

A number of state and/or federally funded programs are currently in place which have helped curtail NPS problems in Indiana. Some of the most widely recognized are implemented by the U.S. Department of Agriculture (USDA) through the Soil Conservation Service (SCS) and the Agricultural Conservation and Stabilization Service (ASCS). These agencies, working cooperatively with soil and water conservation districts (SWCDs), provide technical and cost-sharing assistance to individual landowners to resolve soil erosion and animal waste problems which often affect water quality. In addition, these federal activities are supplemented by similar programs implemented by the State Soil Conservation Board and the Indiana Department of Natural Resources' (IDNR) Division of Soil Conservation. The latter group has burgeoned with the addition of approximately 50 new employees since 1987, made possible by a three million dollar annual budget. As a result, the state "T by 2000" program is underway and focuses not only on agricultural erosion, but also addresses urban soil and water problems related to construction and development. A "Lake Enhancement" program to address lake sedimentation and associated nutrient introduction has been implemented by the division, as well, and provides grants to local groups to fund lake evaluations and renovation projects. The program's $300,000 annual budget is now to be supplemented by a boat tax expected to generate about $1 million per year.

The USDA is placing greater emphasis on water quality and is sponsoring activities designed specifically to address the issue. In 1989, ASCS allocated $57,400 to the LaGrange SWCD to be used for a special water quality project that would reduce sediment and nutrient inputs to six glacial lakes. Other districts have applied for 1990 ASCS funds for similar projects. The SCS is coordinating the development of a special hydrologic unit project on the upper Tippecanoe River that was selected as one of 37 projects to be funded nationwide. The IDEM, IDNR and local entities are cooperating in the implementation of the effort.

The state's 1971 Confined Feeding Control Law has been instrumental in limiting NPS pollution from animal feedlot waste. Anticipation of the rapid evolution of high-volume animal production facilities prompted the enactment of the law to regulate waste disposal, since the waste is generally land applied and poses a potential threat to surface and ground water if it is improperly handled. Although the sheer number of facilities has outstripped IDEM's present ability to inspect all of them regularly, the law has proved to be a useful regulatory tool.

The IDNR's Division of Reclamation, in its administration of the 1977 Federal Surface Mining Control and Reclamation Act, regulates not only point source discharges from mine areas, but also nonpoint sources--both from active sites and abandoned mine lands. Mine operators are required to utilize accepted management practices for erosion and sedimentation control during active mining as well as during reclamation. Acid drainage from abandoned mine lands is being addressed by IDNR's reclamation program, but limited federal funding will not be sufficient to eliminate all of the state's acid drainage problems, particularly since correction of safety hazards is a higher priority.

Combined sewer overflows (CSOs) share characteristics of both point sources and nonpoint sources. Indiana has explored different methods for evaluating CSOs to determine their effect on water quality, and IDEM is currently pursuing a CSO strategy based on Region V's "NPDES Permit Strategy for Combined Sewer Systems". At the present time all municipalities are being required to minimize CSOs through more effective operation and maintenance. If water quality standards violations attributable to overflows are discovered in the future, remedial action (including sewer separation or treatment plant expansion) will be required to eliminate the problems. Toxic CSO constituents are addressed indirectly and limited, in part, by industrial pretreatment programs and sewer use ordinances.

Indiana's developing groundwater protection program has been significantly enhanced by the production of an overall strategy and implementation plan which provides the guidance necessary to link NPS program elements to the protection of groundwater. A number of NPS categories have been identified in the strategy as potential groundwater problem sources and have been targeted for further investigation. The state is committed to the development of water quality standards for groundwater as soon as possible.

Since pesticide usage has long been recognized as a source of surface and groundwater pollutants, different programs have been in place for a number of years to prevent problems from occurring. Use of pesticides is regulated by the Indiana Pesticide Use and Application Law and the Indiana Pesticide Registration Act, as administered by the Office of the State Chemist and the Indiana Pesticide Review Board. The State Chemist is responsible for the licensing of the state's 20,000 applicators and, through the Cooperative Extension Service, has provided training to both commercial and private (farm) applicators. The overall program reduces indiscriminate use of the 30 million pounds of pesticides applies annually in Indiana, and controls the usage of particularly hazardous substances. A rule is currently being considered by the Office of the State Chemist which would regulate bulk storage and containment of pesticides, thereby reducing the possibility of water contamination from spills or poor handling practices.

Even prescribed usage of agricultural pesticides can result in passage of the chemicals into surface or groundwaters. A study performed by the U.S. Geological Survey in 1989 revealed significant levels of four commonly used herbicides in streams at 16 locations in Indiana. Highest values were obtained after spring applications, but detectable levels were observed in early spring indicating residual amounts remaining from 1988 usage.

Indiana's Phosphate detergent Law, which was enacted in 1971, has been helpful in reducing not only point source, but nonpoint source phosphorus discharges to surface waters as well. Decreased phosphorus contributions to inadequate septic systems and combined sewers have resulted in decreased NPS phosphorus discharges from those systems. While such decreases may appear insignificant for each household involved, the reduced overall mass loadings to downstream lakes and reservoirs can be substantial.

Of all the nonpoint source pollution control efforts undertaken in Indiana, the general reduction of phosphorus discharges into lake watersheds has been one with the most readily identifiable benefits. In particular, the phosphorus load reduction in Indiana's portion of the Lake Erie Basin has been the singular endeavor that has provided overwhelming evidence of its success in a relatively short period of time. Six northeastern Indiana counties, along with counties in Ohio and Michigan, have participated in the Tri-State Tillage project funded through the Great Lakes National Program Office under Section 108 of the Clean Water Act. The project has been a cooperative effort among federal, state and local agencies to accelerate the rate of adoption of conservation tillage in the target area. These unconventional tillage practices allow crop residues to be retained on the land surface, protecting soil from the erosive forces of wind and rain. By preventing soil particles from being transported off the land, and allowing more water to percolate into the ground, phosphorus is also prevented from being carried to adjacent streams and then to downstream lakes. By promoting conservation tillage, then, the phosphorus load to Lake Erie's western basin has been substantially reduced. This effort, in conjunction with reductions by industrial and municipal point source dischargers, has played an important rule in Lake Erie's renewed vitality.

In accordance with Annex 3 of the Great Lakes Water Quality Agreement of 1978, Indiana developed a Phosphorus Reduction Plan for the state's portion of the Lake Erie drainage basin. The principal element of the NPS portion of the plan has been to monitor implementation of conservation tillage in three counties to assure that adoption of the practice increases at predicted rates. Existing data indicate that Indiana has already exceeded its phosphorus load reduction goal.

Another nutrient, nitrogen, is applied extensively in different forms as an agricultural fertilizer. Its production, storage and use present widespread potential for nitrate contamination of human and livestock drinking water supplies. Researchers in Indiana are beginning to discover that the magnitude of the problem could be much greater than had previously been realized. A need exists to more thoroughly examine both the cycling of nitrogen following its application and the overall potential for problems to occur throughout the state. It is hoped that an extensive fertilizer management education and research program can be established to prevent future problems from occurring. Promulgation of a new rule is being pursued by the Office of the State Chemist that will regulate bulk storage and containment of fertilizers, thereby diminishing the potential for spills that can contaminate surface and groundwaters.

Evidence has been mounting over the last decade which indicates that atmospheric deposition is a significant source of a variety of pollutants in surface waters. Most of the data have resulted from studies on the Great Lakes or in the northeastern states; little research has been conducted in Indiana which would link water pollution with atmospheric transport. "Acid rain", the best known of the problems, is not a great concern in the state because of the pH buffering capabilities of most of its surface waters. There is evidence, though, of potential for some localized problems which could warrant further investigation. Indiana is now involved in a number of air monitoring efforts, resulting principally from concerns about Great Lakes pollution, which will provide data concerning the relationship between air and water pollution.

On-site sewage disposal systems for individual residences and commercial buildings are widely used throughout Indiana. Unfortunately, though, over 70% of the state's soils are incapable of allowing proper functioning of conventional septic tank/absorption field systems. Many areas are unsuitable because of either slow or rapid permeability, creviced bedrock, or karst geology--areas where surface and groundwater protection is most needed. Despite the frequency of problems arising from inadequate systems, new home construction in areas not served by municipal sewage collection and treatment facilities necessitates the continued use of individual systems. Most of the problems related to malfunctions are very localized, resulting only in "ponding" on the property, but they can be very significant if groups of homes all produce discharges to streams--or more importantly--to lakes.

Septic tank system design and location, which is regulated by local health departments, is too often dictated by economic and social pressures rather than site capabilities. In many cases, land which is not suitable for sewage disposal systems is selected for residential or commercial development. In such situations, wastewater treatment is generally a lesser concern whose neglect leads to the potential for problems.

The State Board of Health is attempting to improve the ability of local health departments to assess and regulate on-site sewage disposal. Some communities have such widespread problems that they are being required by IDEM to construct centralized sewage collection and treatment systems. A source of funding is being sought to provide for further research on and development of septic system technology appropriate to Indiana soils.

Approximately 475 municipal sewage treatment plants, industries and other generators utilize land application to dispose of sludges, waste products and wastewater in a manner subject to state regulations. The wastes typically are high in organic and nutrient content, making them suitable for use as a soil conditioner and a fertilizer on agricultural lands, when appropriately applied. However, the wastes may contain other constituents, such as heavy metals or chlorinated organic compounds, which can limit application rates. Land application of the wastes, while beneficial, can pose a threat to surface and groundwater if it is not carefully regulated and implemented.

Urban runoff (in addition to CSOs), is known to transport pollutants into surface waters, but little has been done to evaluate the effects of this runoff on water quality. While Section 402 of the Water Pollution Control Act will begin to address storm sewer discharges from industries and large municipalities, it will be several years before results of studies will enable the state to determine the overall extent of the problem.

Production and harvesting of timber in Indiana have not been known to cause serious NPS problems. The greatest pollution potential arises when trees are removed, exposing land to the erosive effects of rainfall, but proper management can limit erosion to acceptable levels. When problems do occur, the impact is generally localized and subsides as the affected areas become revegetated. Although there are no regulatory programs for forestry activities in Indiana, the Department of Natural Resources, the U.S. Forest Service and the Purdue University Cooperative Extension Service are all actively involved in education and technology transfer efforts to assure the use of management practices necessary to protect water quality.

Stream channelization, dredging, dam construction, streambank modification, channel relocation, urban development, and road and bridge construction are all activities that typically involve earthmoving and/or excavation work, and removal and destruction of vegetative cover, which can cause locally severe erosion and sedimentation problems. Construction activities within or adjacent to the state's rivers and streams often involve disturbance of the channel bed and banks. Activities such as channel dredging, clearing and snagging, channel relocation or modification and equipment movement within the stream result in the disturbance of stream bed materials and sediments. Much of this material becomes suspended in the water can can move downstream, carrying contaminants with it. There have been numerous cases of siltation and sedimentation problems in the state's rivers and streams as a result of upstream construction activities. However, it is difficult to assess the amount of material which is dislodged as a result of channel work, and to determine the extent of the overall problem. There are only limited data on the annual number of instream construction projects and the amount of sedimentation which results from them. Many projects which are not under contract to state or federal entities are not monitored for compliance during construction. Few projects are reviewed after construction is completed. Minimal data exist in Indiana which document the impacts of sediment to downstream water quality and aquatic habitat.

Various state and federal agencies have endeavored to control pollution from erosion. Indiana Department of Transportation contractors are required to prevent sediments from entering streams. Standard specifications and special provisions address sod, seed, mulched seed, agricultural limestone, pesticides and fertilizers used to reestablish vegetative cover. All federal aid projects must conform to requirements of the Natural Environmental Policy Act, which involves a systematic assessment of all environmental impacts including water quality. Projects are reviewed by a number of state and federal agencies for potential environmental effects and mitigation measures.

Pursuant to Indiana Code 13-2-33, the Indiana Department of Natural Resources must approve any construction, excavation, or filling within the floodway of any river or stream in the state. As a condition of the approval, the Department of Natural Resources generally requires that disturbed areas be protected from erosion during construction and be suitably revegetated or provided with permanent protection upon completion. In addition, the issue of soil erosion and sedimentation is being addressed by the state through the "T by 2000" program which provides technical and financial assistance for "lake enhancement" of public lakes and erosion control structural measures on private land where resulting sedimentation is detrimental to the public good.

During 1989 the Highway Extension Research Project for Indiana Counties and cities (HERPICC) brought together representatives from several disciplines to form a work group. That group developed a model ordinance designed to be adopted by local government entities to control erosion resulting from construction projects. The ordinance has been well received by several local planning agencies and is being widely promoted by IDNR's Division of Soil Conservation and IDEM.

Regulatory controls over road construction projects which are not under contract to state or federal entities are minimal or nonexistent, although portions of such projects located within the floodways of the state's rivers and streams would require approval in accordance with IC 13-2-22. As a part of the IDNR permitting process, erosion control measures implemented on the remaining portions would be included at the discretion of the contractor performing the work.

IDEM, IDNR, U.S. EPA, and the U.S. Fish and Wildlife Service all review stream-related construction projects subject to the Corps of Engineers' Section 404 permitting process. The agencies suggest ways in which the projects can be improved to limit erosion and sedimentation. A Section 404 permit cannot be issued unless Section 401 Water Quality Certification or a waiver thereof is received from the IDEM.

Landfills can represent NPS pollution contributions in a number of different ways. Soils disturbed by the landfill activity can be washed into surrounding waterways. Runoff contaminated by contact with waste materials can flow off-site. Leachate within a landfill can reach the surface either through openings in the cover material or through subsurface formations, and can also affect groundwater.

Through the hazardous waste program, there are regulatory controls over run-on to disposal sites, as well as the runoff. The run-on must be diverted and the runoff must be collected from the active areas of the landfill. Double liners are required for subsurface control, and inspection of closed hazardous waste disposal areas is required to monitor integrity of the cover.

The state's solid waste regulation, which became effective in February 1989 requires that run-on be diverted from landfills, but does not require that runoff be collected or controlled. The regulation, therefore, does not specifically provide for control of siltation and of runoff contaminated by contact with waste, although most of the recently proposed landfills in more heavily populated areas do provide for a sedimentation pond. The regulation also states that leachate shall not flow "into a stream, lake, river or other surface water, or an aquifer without adequate control measures on operation".

While the regulation does not require that all landfills collect runoff, it does require that "sedimentation and/or erosion control systems shall be provided and maintained wherever necessary to minimize erosion and the sedimentation of surface water". The regulation also prohibits the surface movement of leachate more than 50 feet outside of the solid waste boundary.

A state law enacted in 1987 requires that the soil and water conservation districts (SWCDs) conduct inspections of landfills twice per year for compliance with state requirements concerning erosion. This has helped to coordinate the erosion control experience of the SWCDs with the regulatory programs of the IDEM.

In addition to concerns about surface water runoff, solid waste landfills pose a possible threat to groundwater. The degree of threat posed and the control measures necessary for sanitary landfills and for landfills dedicated to particular types of wastes are a matter of controversy and no clear consensus appears to exist. The design of current sanitary landfills is primarily based on restricting infiltration into the waste and then relying on clay barriers to limit flow and attenuate pollutant movement from the site. Increased consideration is now being given, in many cases, to designs which allow for collection of at least a portion of the leachate generated at the site.

With the exception of sludge lagoons, which are not specifically addressed by the current solid waste regulations, the various program areas either adequately control NPS contributions from operating landfills or are in the process of modifying regulatory controls to increase control over NPS problems. It is likely that, through changes in either the state or federal solid waste regulations, solid waste landfills will be required to install runoff collection basins with a discharge that would be regulated by the National Pollutant Discharge Elimination System (NPDES) program.

There are about 95 solid waste disposal landfills in Indiana which were once permitted by the state but are now closed. In addition, there are dozens of older sites, some of them once open dumps, which were closed prior to the permitting of landfills in 1969. Only very few of the closed sites have monitoring wells. Some of these facilities accepted hazardous waste or special wastes which are not allowed at permitted landfills now. Therefore, closed waste disposal sites present a potentially significant but unquantified threat to water quality.

Abandoned waste disposal sites have caused or are suspected of causing ground and surface water contamination in many locations in the state, affecting public health, public water supplies, private wells, and the natural environment. Many other sites not identified yet as sources of contamination pose a threat of future problems.

The Comprehensive Environmental Response Compensation and Liability Act of 1980 (CERCLA) and it 1986 reauthorization and amendments (SARA), is designed to address liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive or abandoned hazardous waste disposal sites. The law provides authority and funding for government to conduct necessary corrective actions in the absence of responsible parties to perform the work. Sites addressed under the program can be expected to be dealt with in a comprehensive manner over the long term with adequate attention to potential and actual water contamination. The primary deficiencies in the program are the inability of the state to adequately address sites that do not technically quality for federal attention, and the inordinate amount of time it takes to complete a project.

Cleanup of sites which do not quality for the Superfund program become the responsibility of the state, without federal assistance. These sites may be addressed through several mechanisms, such as state enforcement action, voluntary cleanup by responsible parties, or state-funded cleanup utilizing the Hazardous Substances Emergency Trust Fund.

Under the authority of the Environmental Management Act, IDEM can regulate some closed landfills, although some past owners have escaped any post-closure responsibility through bankruptcy. State enforcement actions can utilize the Indiana Environmental Management Act (IC 13-7) which contains provisions regarding identification and liability of responsible parties. The threat of potential Superfund liability often encourages responsible parties to work toward satisfactory settlements with the state, but much greater effectiveness can be accomplished with this more explicit statutory authority.

The cleanup of abandoned waste disposal sites is an extremely high manpower- and resource-intensive activity. The number of sites known to need attention surpasses the availability of staff and trust fund money to deal with them all expediently. Since the number of sites that can be addressed is directly related to the availability of resources, recent legislation calls for a prioritization to be established by rule, so that sites posing the greatest risk to the public are addressed first.

ral hundred chemicals and generic wastes are termed hazardous by EPA du their characteristics of toxicity, corrosivity, ignitability or reacti . In Indiana there are about 1,800 facilities, each of which generates over 1,000 kilograms or more of hazardous waste per month. Annually, nearly 4 million tons of hazardous waste are generated within the state. There are about 350 facilities where some 12 million tons per year of hazardous waste are treated, stored or disposed (TSD). The potential for NPS surface or groundwater contamination from this many generators and TSD sites is significant.

Indiana has obtained authorization to operate its own hazardous waste management program. Under the authority of the Environmental Management Act, IDEM has adopted regulations for hazardous waste management (329 IAC 2) which are modeled after U.S. EPA rules. EPA is in the process of revising the regulations and it is expected that Indiana will follow the federal lead and modify state regulations to reflect the federal revisions.

Indiana has about 40 hazardous waste management facilities, under interim permit status, that have surface impoundments where wastes are treated, stored, or disposed. These facilities tend to be clustered near major industrial centers located statewide. Groundwater monitoring near these impoundments has shown that the majority are causing localized groundwater pollution. The state needs to be able to assure that these problems are adequately addressed in order to protect water quality.

All hazardous waste TSD facilities which obtained interim permitted operating status have been required since 1981 to have specific groundwater monitoring systems in place. Some 30% of these facilities are not in compliance. The inadequacies which have been identified in some existing monitoring programs were related to hydrogeologic studies, well siting and construction, and sampling. The TSD facilities seeking final permitted status from IDEM will be required to operate adequate groundwater monitoring programs in order to obtain permit approval.

Industry can conduct a closure process for waste impoundments which involves IDEM approval of cleanup, monitoring and assurance of financial responsibility. In the absence of the closure procedure, though, IDEM still needs to be able to order specific corrective actions for closed impoundments at operating facilities. Facilities that treat, store or dispose of hazardous waste are required to correct pollution problems from waste impoundments closed prior to 1976 in order to receive final permitted status. This provision is currently not part of Indiana's regulations, so future action will be necessary to modify state hazardous waste regulations accordingly.

The accidental or intentional unpermitted discharge of any undesirable substance into public waters constitutes a potential hazard not only to aquatic life and the general vitality of surface and groundwaters, but also to organisms dependent on the systems as drinking water sources. Hundreds of such "spills" are reported to IDEM each year, and, while many are relatively inconsequential, a great number are capable of causing severe degradation.

During 1988-89, approximately 3,050 incidents were reported. These involved a variety of materials including petroleum products, agricultural pesticides and fertilizers, sewage, manure from animal production facilities, and miscellaneous chemicals. Impacts to public waters can vary from being negligible to disastrous, depending on the pollutant involved, its quantity, and the waterbody's uses. A frequently used subjective indicator of pollution severity in surface waters is the "fish kill" which can result not only from toxicity of a spilled substance, but also from asphyxiation brought on by the introduction of oxygen-depleting discharges.

The Indiana Spill Control Regulation (327 IAC 2-6) requires the responsibility party to immediately notify the Office of Environmental Response, IDEM, of all spills of oil, hazardous, and/or objectionable substances that enter or threaten to enter waters of the State. The regulation further requires the spiller to promptly contain and clean up the spilled material. The Office of Environmental Response may provide technical assistance in the containment and recovery of the offending substance. This process provides a mechanism whereby most incidents are resolved before severe damage is incurred. Unfortunately, on many occasions, remedial action cannot be initiated quickly enough to prevent damage from occurring, particularly if the incident is not discovered until the damage is already evident, such as with a fish kill.

Indiana's Wetland Protection Programs

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. Two studies by the Indiana Department of Natural Resources Division of Fish and Wildlife indicate that over 80% 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 State laws and regulations.

The Indiana Lake Classification System and Management Plan was adopted by the Indiana Stream Pollution Control Board in 1980 as part of its statewide water quality management plan. This plan was updated by the IDEM in 1986. The protection of all wetland areas contiguous to each lake or reservoir and their tributary streams is part of the generic restoration and management plan for each of the seven lake management groups.

In view of the above, the IDEM is reluctant to approve any wetland fill unless extensive mitigation is provided. Therefore, there is essentially no net loss of wetlands as a result of programs administered by IDEM.

The number of U.S. Army Corps of Engineers Public Notices on applications for Section 404 permits for placement of fill in Indiana's wetlands is steadily increasing. This probably is more a result of an increased awareness of the Section 401/404 permitting program than an increase in the desire to fill wetlands. To handle the increased workload, additional staff will be hired by the IDEM to review the COE public notices. Additionally, 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 Monitoring 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 representative 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 1988-1989, 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 51 and shown in Figures 18 and 19.

Physical, chemical, and bacteriological analyses are run on samples from all 106 of the stations. Forty-one (41) stations are monitored for phytoplankton with emphasis on interstate waters and stations selected to bracket POTW discharges. Radiological analyses are conducted at 23 stations. A list of the parameters for which analysis are run is given in Table 52.

TABLE 51. *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 51. ***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 State Park	39 56 46/87 03 33	S R 234 Bridge, above Shades State Park

TABLE 51. *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

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

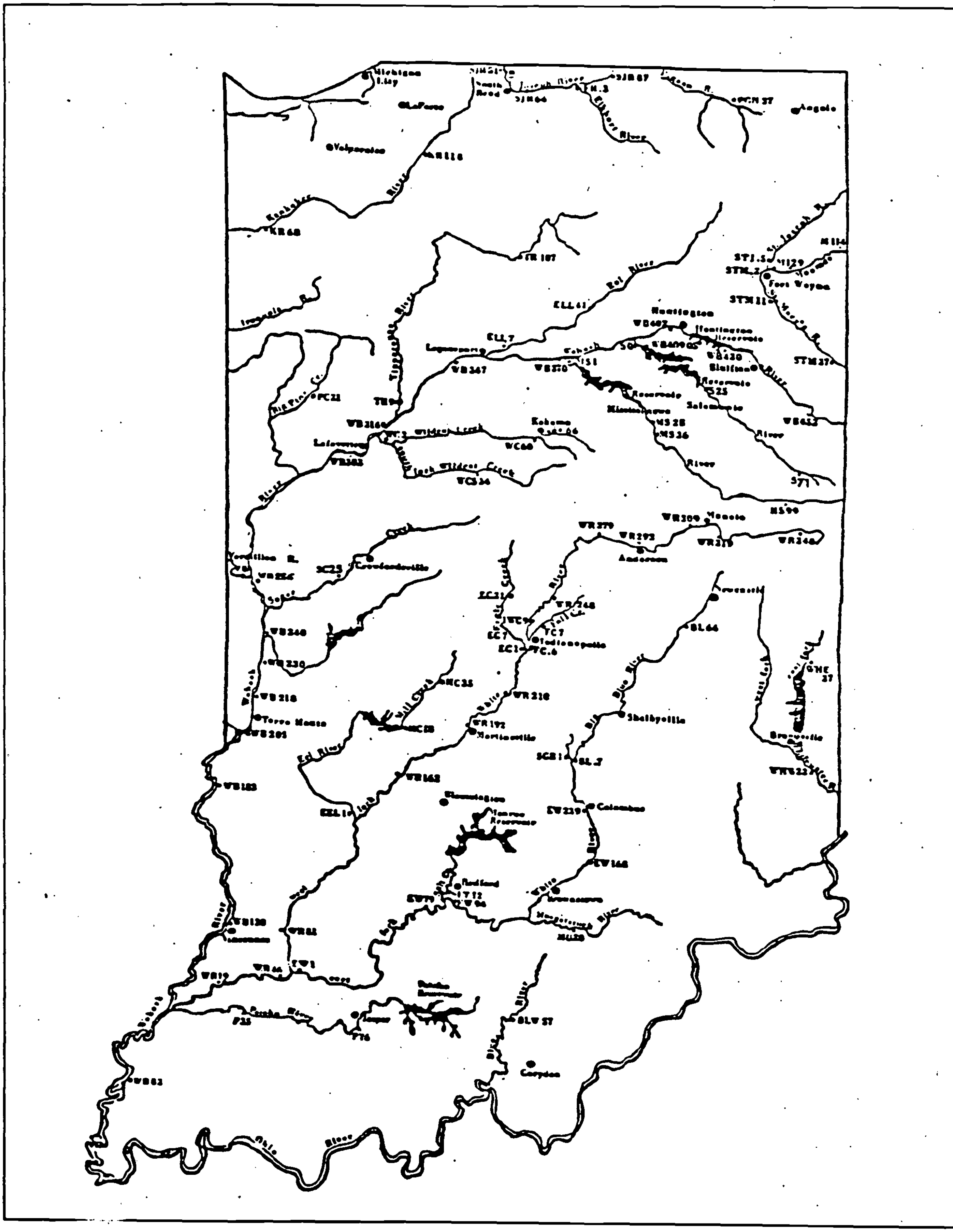


FIGURE 19. *LOCATIONS OF INDIANA'S FIXED STATION WATER QUALITY MONITORING NETWORK STATE IN NORTHWEST INDIANA*

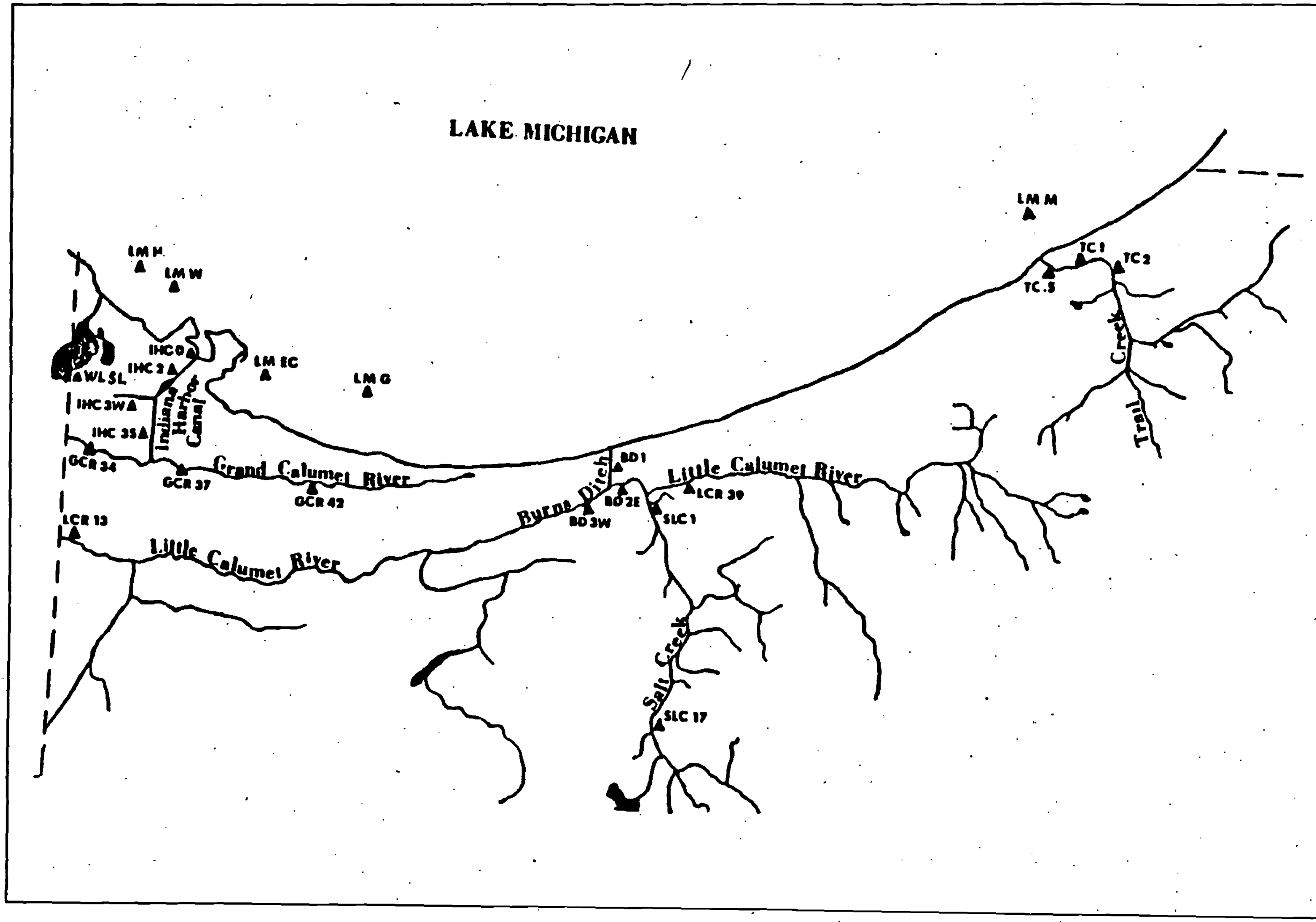


TABLE 52. *A. ANALYSES CONDUCTED AT INDIANA'S FIXED WATER QUALITY MONITORING STATIONS. (NOT ALL PARAMETERS ARE SAMPLED AND ANALYZED AT EACH STATION)*
B. SAMPLING FOR THESE PARAMETERS DONE ONCE EVERY THREE MONTHS

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-Bromophenylphenylether
- 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 inspections, 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 (5 fish each, if possible) are collected at each station. Skin-on, scaleless fish samples are submitted to the laboratory for analysis. A list of the parameters for which fish samples are analyzed is shown in Table 12. Sediment samples collected are analyzed for 150 pollutants (Table 17).

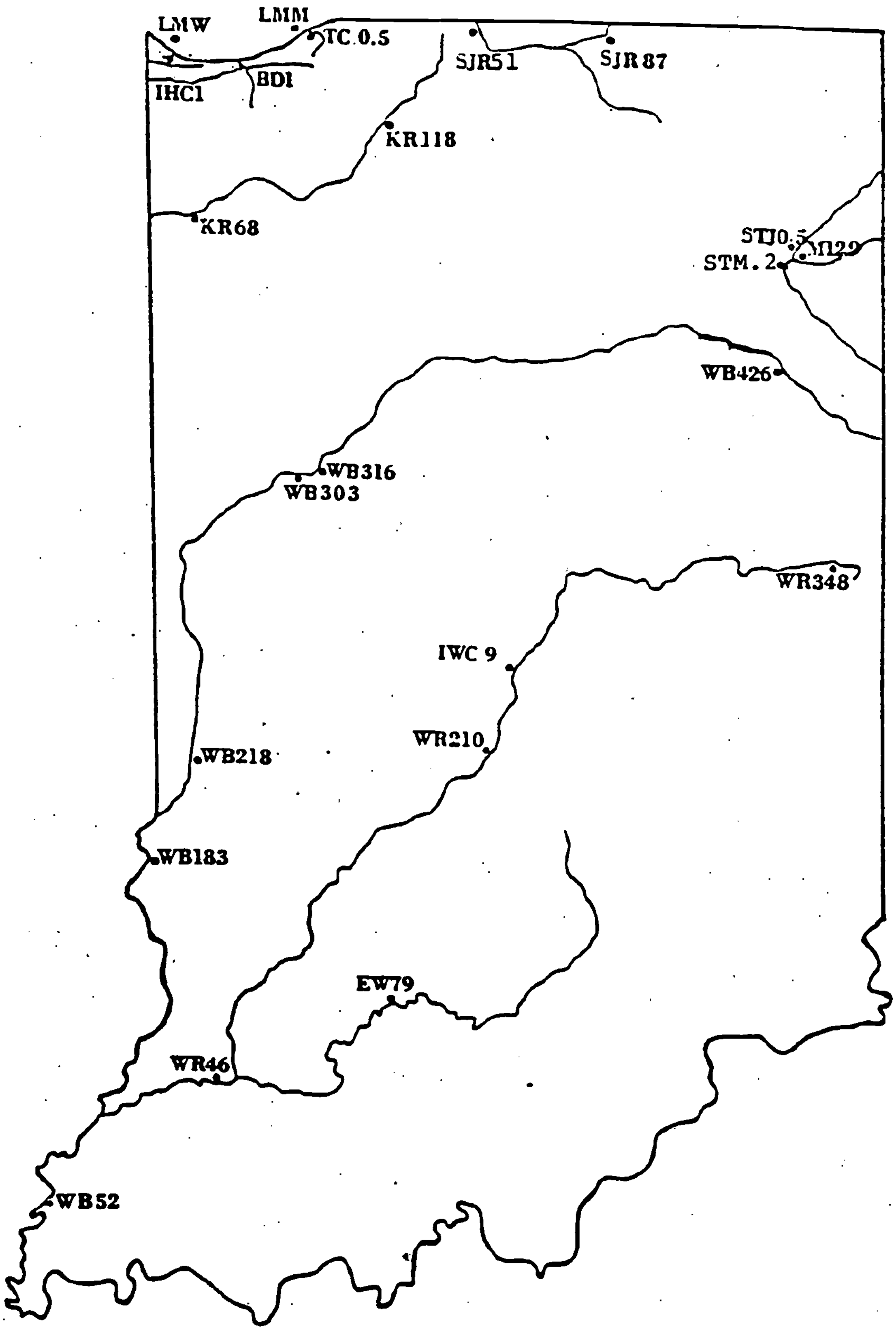
In addition to the more routine monitoring, special studies of fish, turtles, crayfish, aquatic vegetation, sediment and in some cases, water were conducted to monitor for toxic substances. Studies were conducted on segments of 25 waterbodies and 16 lakes (Table 13 and 14).

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. 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). Fifty NPDES discharge facilities were examined for acute and chronic toxicity in 1988-1989.

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

FIGURE 20. *LOCATION OF INDIANA'S CORE MONITORING STATIONS*



in the State's water quality standards revisions adopted in 1989. When it is uncertain if toxic substances are present in a discharge, when site specific conditions are suspected to possibly increase or modify the toxic effects of a discharge, or when more than one toxicant may create additive or antagonistic effects, the permit may include a toxicity testing requirement.

Currently there are 45 discharges in Indiana with a toxicity testing requirement, and that number is expected to increase next year. The State also requires toxicity reduction evaluations (TREs) in the cases where toxicity requirements are not met. A TRE is used to determine what measures are necessary to control effluent toxicity. This could include bench scale treatability studies, spill control procedures or process modifications in which the identification of specific toxicants is not necessary.

Biological Monitoring Program

Biological monitoring involves sampling for fish, aquatic invertebrates, plankton, bacteria, and conducting bioassay work. Some of these programs were discussed in the Toxic Monitoring Programs Section and will not be discussed further here.

In addition to those fish collected and analyzed for toxic substances, data as to number and kinds of all fish observed are recorded during sampling. This provides qualitative information as to the composition of the fish community at these stations. These data can be compared to data obtained in previous years or from other studies to give some indication of how the fish community is reacting to changes in water quality.

Monitoring for aquatic macroinvertebrates also is done at the CORE program stations. Approximately 4-6 weeks before the fish and sediment sampling occurs, three Hester-Dendy macroinvertebrate samplers are set at each station to be sampled that year. At the time of the fish sampling, these samplers are retrieved, and the organisms collected, preserved, and identified to the lowest taxon possible and counted. Differences in kinds and/or number of organisms between samples set upstream and downstream of major discharge areas indicate the nature of water quality problems in these areas. These data can be compared to data obtained in previous years or from other studies to give some indication of how the macroinvertebrate community is reacting to changes in water quality.

Routine monitoring of E. coli bacteria is done at all fixed water quality monitoring stations. Very high numbers of these organisms usually indicate inadequate sewage treatment, feedlot contamination, or areas where combined sewer overflows (CSOs) may be causing problems upstream. Bacteriological samples are also collected as part of surveys or inspections at wastewater treatment facilities.

Primary productivity studies are also part of the biological monitoring program. These are not done on a routine basis, but are used to provide information for full scale river and stream models and wasteload allocations when needed and in conjunction with special lake studies. These studies provide information on the rates of algal photosynthesis and respiration in the river, lake, or stream.

When necessary Habitat and Use Attainability Studies are conducted to determine the existing and/or potential uses that various stream reaches will support. During the study, a checklist which includes detailed information regarding the physical, chemical, and biological nature of the stream, as well as a description of the riparian land use, is completed. This information is used to prepare a habitat evaluation report which describes the existing and potential uses of the stream.

Some streams are 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. Waters which provide unusual aquatic habitat, which are an integral feature of an area of exceptional natural beauty or character, or support unique assemblages of aquatic organisms may be classified for "Exceptional Use."

If a habitat evaluation study indicates that the use designation for a particular stream or stream reach should be changed, the report is presented to the Water Pollution Control Board to support a recommended change in the official stream use designation. The report will also be made part of the official record of the public hearing that is held to consider changing the official use designation in the water quality standards. In 1988-1989, Habitat and Use Attainability Studies were conducted on seven streams. However, many of these were re-checks of streams previously designated for "Limited Use," and no new stream reaches are currently being proposed for this designation. At present, 34 streams reaches (77 stream miles) are designated for "Limited Use" and 11 are designated for "Exceptional Use" (181 stream miles).

IV. GROUND WATER QUALITY IN INDIANA

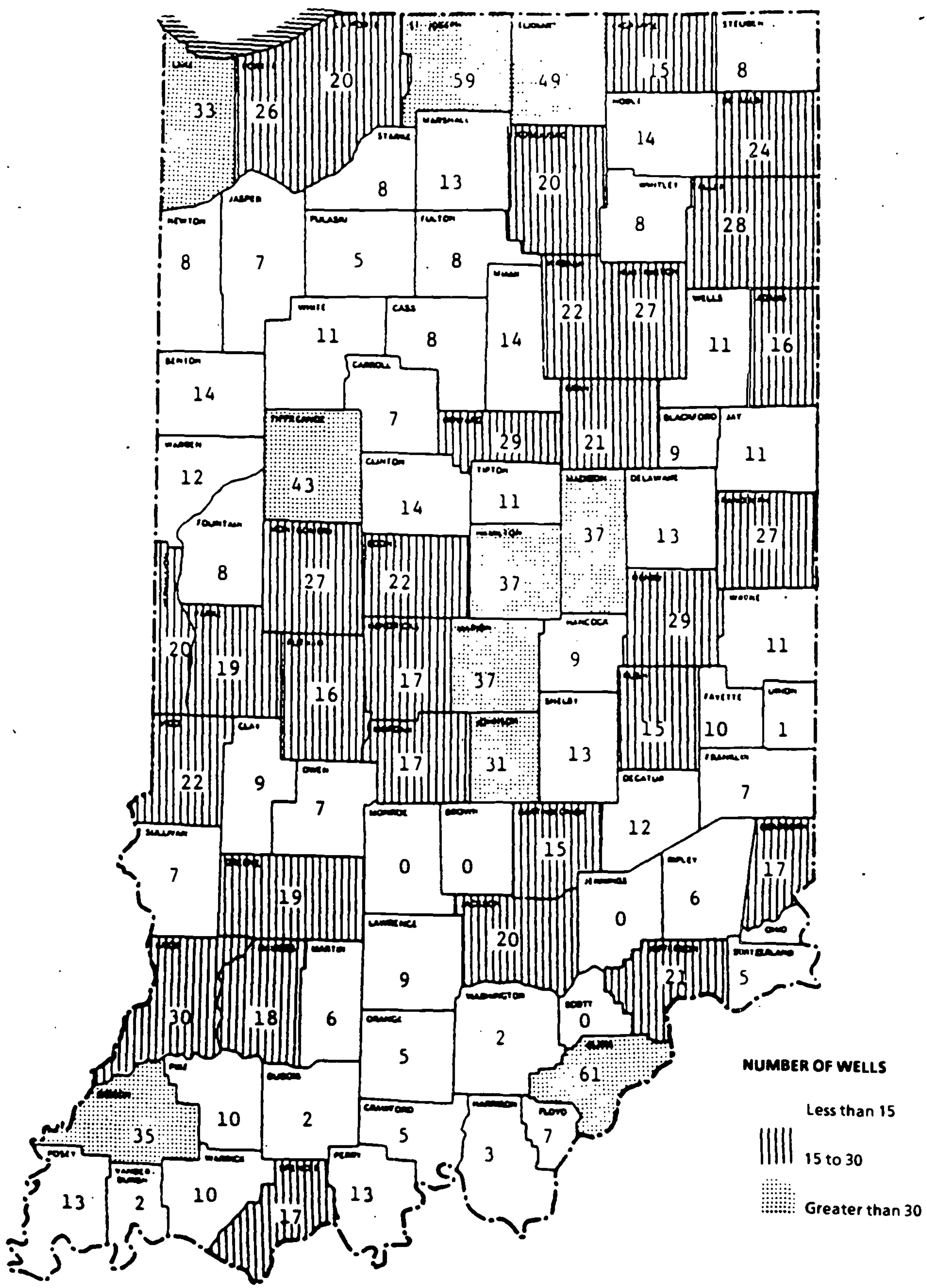
Part I. The Ground Water Resource

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 there ranges from 400 to 2,000 gpm. The major bedrock aquifers include the Pennsylvania 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 important bedrock aquifers can vary from 20 to 600 gpm.

The ambient ground water quality throughout Indiana is variable and dependent on the aquifer system, geologic setting, and depth of the formation. On a general basis, 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 over the 0.3 ppm aesthetic threshold for 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 northeastern Indiana, and 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. Even small concentrations can be objectionable to domestic water users.

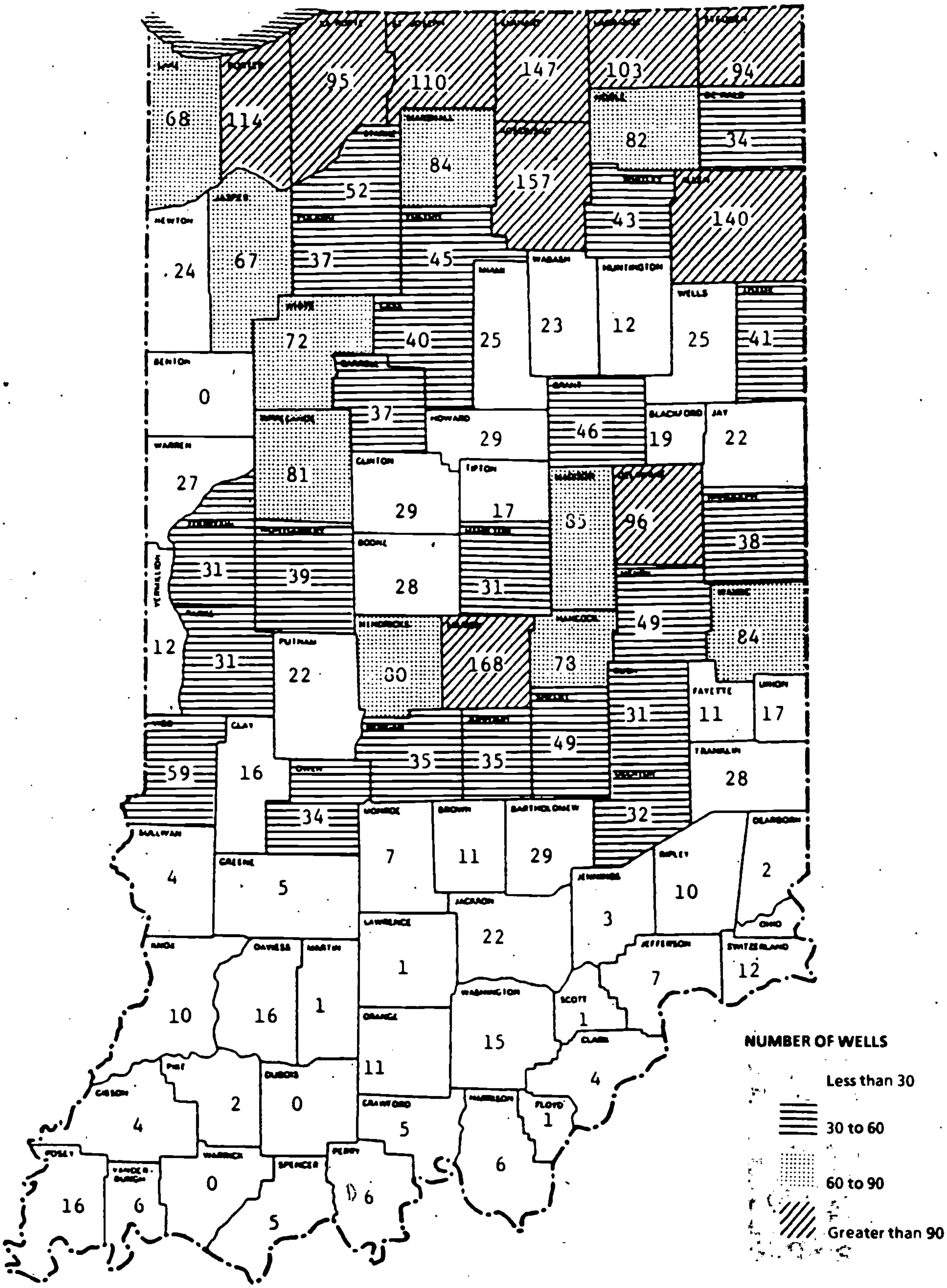
Nearly 60 percent of the State's population uses ground water for drinking water purposes. There are approximately 4,100 public water systems utilizing some 6,200 water wells, that are directly dependent on ground water for their supplies. About half of the population served by public water supplies uses ground water. There are over 425 community water systems with about 1,800 wells, some 500 mobile home parks and at least 3,000 non-community water systems in Indiana dependent upon water wells. (Non-community systems service a transient or nonresidential 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 21 and 22. Approximately a half-million homes have private wells for their water supply and their number may increase by as much as 44 percent by the year 2000. The 1980 census data for private wells per county is shown in Figure 23. 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.

FIGURE 21. *COMMUNITY WATER SUPPLY WELLS (PER COUNTY)*



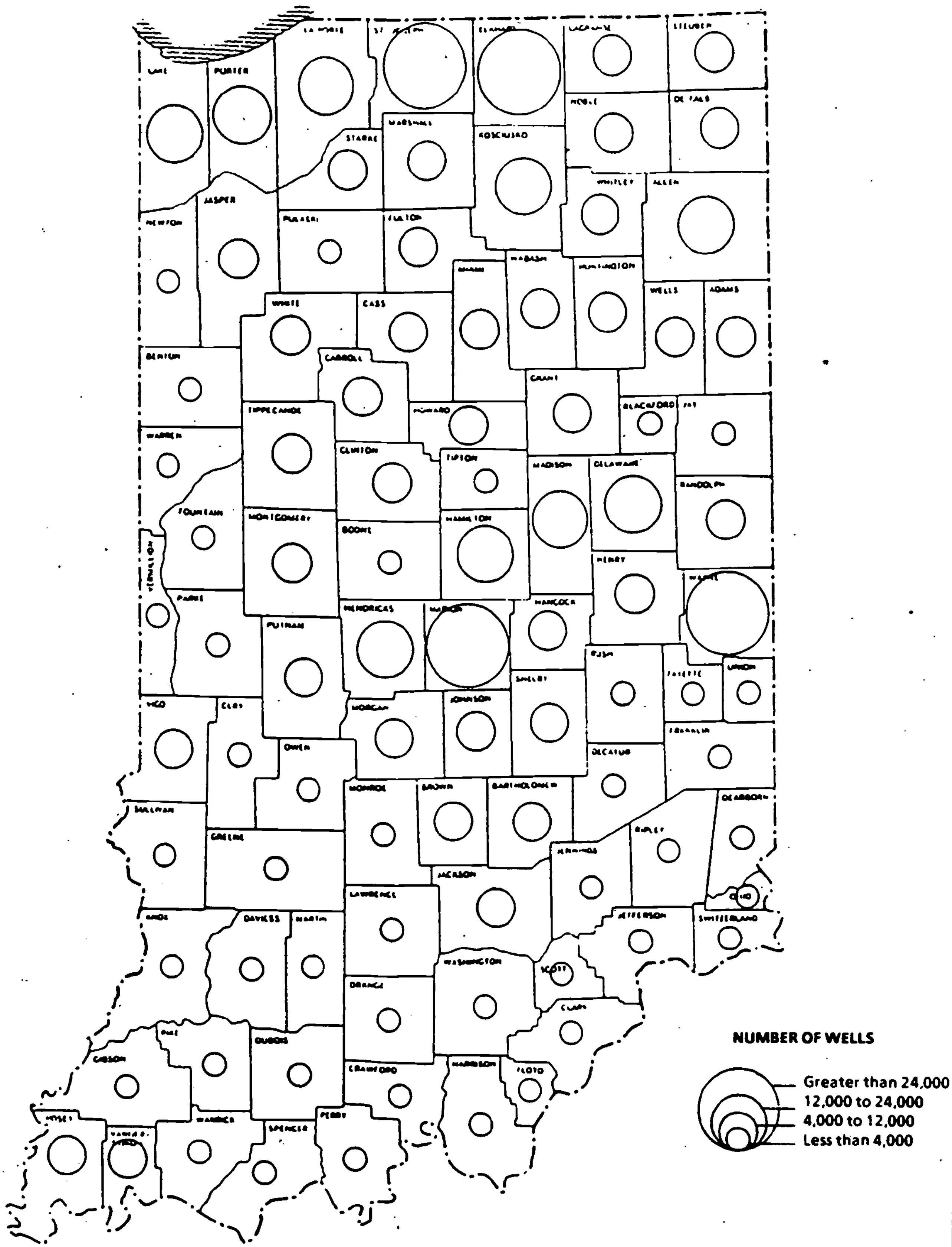
SOURCE: **DATA ON INDIANA PUBLIC WATER SUPPLIES**, Bulletin No PWS 3 Indiana State Board of Health, Public Water Supply Division, Revised 1984.

FIGURE 22. *NON-COMMUNITY WATER SUPPLY WELLS (PER COUNTY)*



Information Obtained From a Survey of Non-Community Water Supplies in the State of Indiana, Hunger et al, 1986 Indiana Univerity.

FIGURE 23. *PRIVATE WATER SUPPLY WELLS (PER COUNTY)*



Information taken from 1989 Census on Population and Housing for Indiana, U.S. Dept. of Commerce, listing number of drilled are dug well per county.

Indiana's Ground Water Programs

Indiana's primary ground water management and protection efforts reside within four 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, 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 Board of Health's ground water function is administration of regulations for on-site 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 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 powers 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 a 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 relationship 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 of the Department of Environmental Management, Department of Natural Resources, State Board of Health, State Chemist's 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

The priority recommendations of the Strategy and agency responsibilities are as follows:

> 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.

Indiana Ground Water Protection Act of 1989

The 1989 Indiana General Assembly passed comprehensive legislation concerning ground water protection in Indiana. It structured and formalized 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 authorized 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 Governor must make the appointments before January 1, 1990. 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 (ISBH),
> State Chemist Office (ISCO), and
> State Fire Marshal (SFM)

One [illegible]entative from the business community, the environmental community, the a[illegible]ltural community, labor, and local government are also to be appoin[illegible].

The agency heads shall invite participation by the Governor's Office and U.S. Environmental Protection Agency. The 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 required 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 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, with initial rules to be adopted before July 1, 1990. These standards are to apply to activities regulated by the five state agencies represented on the Task Force (IDEM, IDNR, ISBH, ISCO, SFM). The standards are to be used 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 effluents 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 wells/wellfields, with initial rules to be adopted by January 1, 1991. 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, ISBH, ISCO and SFM) 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 non-hazardous waste and waste water. The initial rules are to be adopted before January 1, 1991. The requirements of the rules must apply to activities regulated by the five state agencies.

Status of Ground Water Strategy Implementation (1988-1989)

Inter-Agency

Ground Water Task Force: The ad-hoc Task Force was expanded in 1988 to include about 60 government and non-government members. Work groups were active on the following issues: quality standards, complaint response, research, education, aquifer mapping and agricultural chemicals. Legislation in 1989 required the Governor to appoint a ten-member Task Force by January 1990, to include five state agency heads and five non-government appointees.

Safe Drinking Water Act Primacy: IDEM received its start-up grant in late 1989 to take over 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: The Indiana Ground Water Protection Act (IGWPA) requires initial rules for wellfield protection zones for community water supplies by January 1991. IDEM helped conduct four wellhead protection program development workshops in 1989. Two regional planning agencies were funded to prepare local pilot projects for wellfield protection in 1988-89. A development plan for wellhead protection in Indiana was prepared by IDEM for EPA, and federal grant assistance is set for 1990.

Aquifer Mapping: The U.S. Geological Survey has completed half of the Indiana Ground Water Atlas as a cooperative project with IDNR and IDEM. Mapping could be completed by the end of 1990 with publication in 1992. IDNR has published the St. Joseph River Basin and Whitewater Basin Water Resource studies with detailed aquifer maps. Three other study areas have been completed by IDNR, with reports forthcoming: Kankakee River Basin, Lake Michigan Basin, and Maumee River Basin. Work is underway on the West Fork of White River Basin.

Public Education-Information-Participation: The IGWPA establishes a ground water quality information clearinghouse at IDEM. The Indiana Cooperative Extension Service is hosting ground water quality seminars in nearly every county in the period 1988-90 and has prepared a series of ground water information bulletins. Ground water displays by IDEM, IDNR, and other agencies were set at the 1988-89 Indiana State Fair. State personnel have presented dozens of lectures, classes and slideshows on ground water protection during 1988-89.

Ground Water Quality Standards: The IGWPA requires a draft rule by July 1990. For about a year, a work group under the Task Force has been preparing a standards proposal. Public workshops are planned to provide the necessary input to complete the draft rule. The standards shall apply to activities governed by all state agencies.

<u>Indiana Department of Environmental Management</u>

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. Nearly 50 projects are currently being managed along with 10 emergency cleanups in the past year.

Nonpoint Source Pollution: IDEM coordinated completion of a Nonpoint Source Water Pollution Management Program plan in 1989 which addresses ground water concerns. IDEM is conducting the state's first multi-phase study of agricultural chemicals in ground water during 1987-89. 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 authorized IDEM to continue its program for investigating contamination of public and private water supply wells. A "Guidebook for Ground Water Protection" has been completed, with input from the Ground Water Task Force. It was distributed statewide in 1989 to aid a variety of local officials in the screening, referral and response to ground water complaints.

In addition, IDEM has responsibility for the Safe Drinking Water Act primacy, wellfield protection, and ground water quality standards. Also, the IGWPA requires IDEM to promulgate rules for waste water pits, ponds, and lagoons by January 1991.

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, modelled upon the state program.

See State Priorities summary for these agency priorities for the IDNR: aquifer mapping, plus oil and gas underground injection control.

Indiana State Board of Health

Local Environmental Health Programs: ISBH 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 ISBH to assist local health agencies in this regard. The most common local initiative identified is adoption of a well ordinance.

Office of State Chemist

Spill Containment and Control: Draft rules have been introduced that require specific spill prevention, containment and control structures, as well as practices for bulk storage of fertilizers and pesticides.

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 details from 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 in excess of a final Maximum Contaminant Level (from the public water supply regulations) or an EPA published Lifetime Health Advisory limit. For public water supply wells, all detections of organic chemicals are also recorded. 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 590 sites of ground water contamination recorded. Their location is displayed in Figure 24. Information sources for these case histories appear in Table 53. 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 1989, with the majority after 1977. Figure 25 shows a trend of increased detections of contamination over the past six years. However, any program effort to deal with ground water contamination and keep records of contamination incidents has only been active for the past six years.

For all of the case histories, about 45 percent or 1,720 of the over 3,870 wells at 590 sites sampled were shown to be contaminated. About 20 percent of the sites involved monitoring wells, but nearly 84 percent included drinking water wells. For drinking water wells in the registry, 31 percent are at public water supply systems and 53 percent are private residential supplies. Figure 26 describes the types of wells affected by ground water pollution. Figure 27 shows the location of 480 sites where drinking water supply wells were contaminated, which typically involves shallow wells 50 to 80 feet deep, within 500 to 1,000 feet of the pollution source.

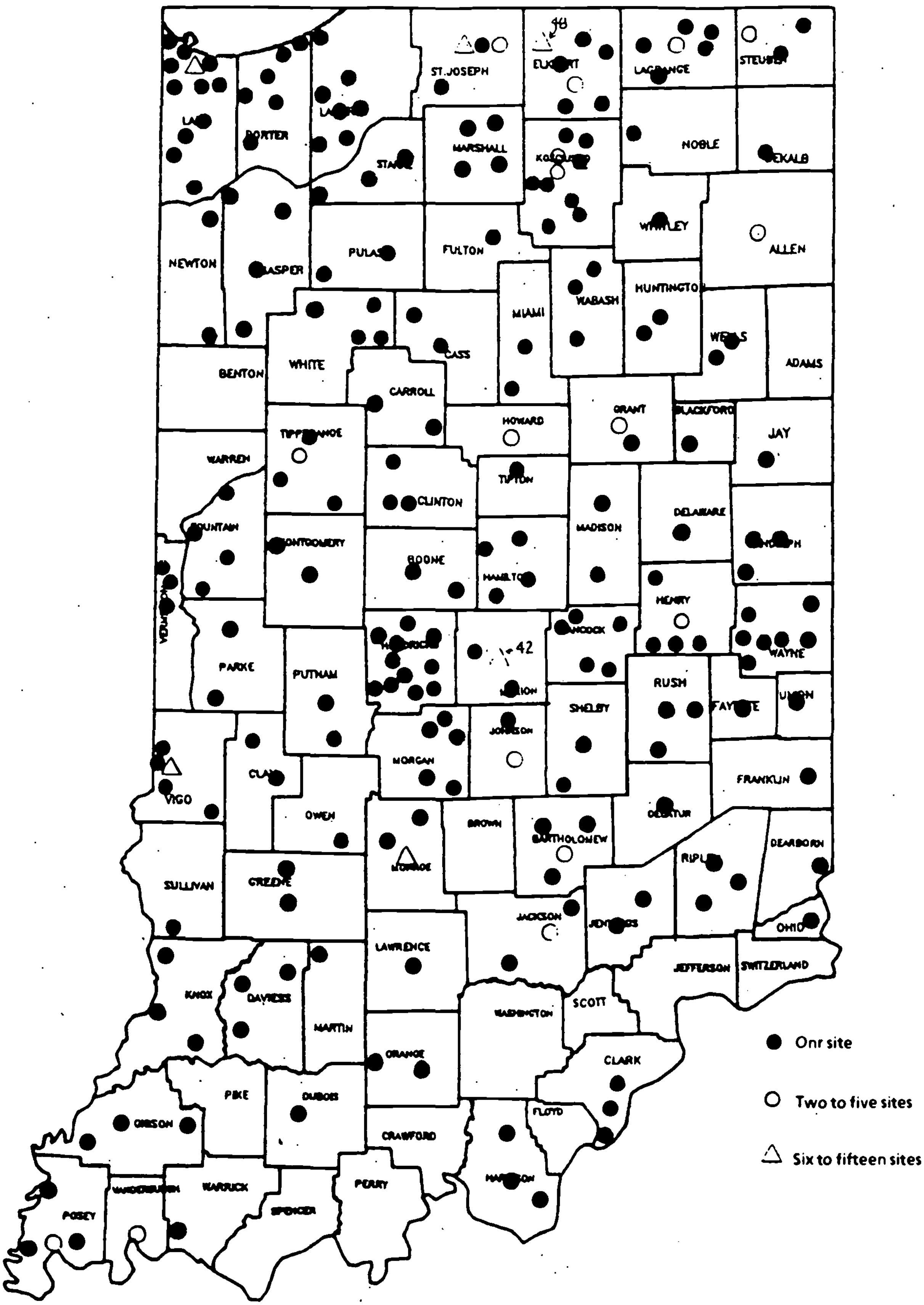
Investigations into drinking water well contamination were initiated because of complaints of taste or odor in the water for about 44 percent of the cases in the registry. Similarly, concerns over pollution sources resulted in problems being documented in nearly 28 percent of the cases. But at over 43 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 54 for a summary of ground water monitoring actions which documented contamination and Table 55 for a summary of remedial actions.

Public Water Supply Monitoring

Volatile Organic Chemicals

From 1981-1986, the U.S. EPA - Region 5 Drinking Water Section conducted a water quality survey of community water systems in Indiana utilizing ground water as a source of supply. Samples of untreated well water and finished water ready for the customer were analyzed for the presence of 26 synthetic volatile organic chemicals. Each of the over 400 systems in the state using ground water was sampled. During this time, at least one of these chemicals was detected in about 140 of the 1,700 wells surveyed. For 20 wells, the concentration reported constituted an excess life time cancer risk that would now be above an enforceable drinking water standard. As a result, 16 wells were abandoned and treatment and blending of the water were required for other systems.

FIGURE 24. *DOCUMENTED SITES OF GROUND WATER CONTAMINATION*



SOURCE: IDEM Ground Water Section, Contamination Site Registry (1989) for Time Period 1956 - 1989.

TABLE 53. *CASE HISTORY INFORMATION SOURCE*

SOURCE OF INFORMATION	NUMBER OF CASES	PERCENT OF CASES
Ground Water Section - DEM	177	30.2%
Public Water Supply Section - DEM	129	22.0%
County Health Departments	75	12.8%
CERCLA (Superfund Cleanup Program) - DEM	48	8.0%
Other Sources	47	7.2%
Department of Natural Resources	33	5.6%
Underground Storage Tank Section - DEM	30	5.1%
RCRA (Hazardous Waste Management Program) - DEM	22	3.7%
CERCLIS (Superfund Site Investigation Program) - DEM	19	3.2%

SOURCE: IDEM Ground Water Section Contamination Registry (1989) for Time Period 1956 - 1989).

FIGURE 25. *DOCUMENTED GROUND WATER CONTAMINATION*
Number of Cases per Year

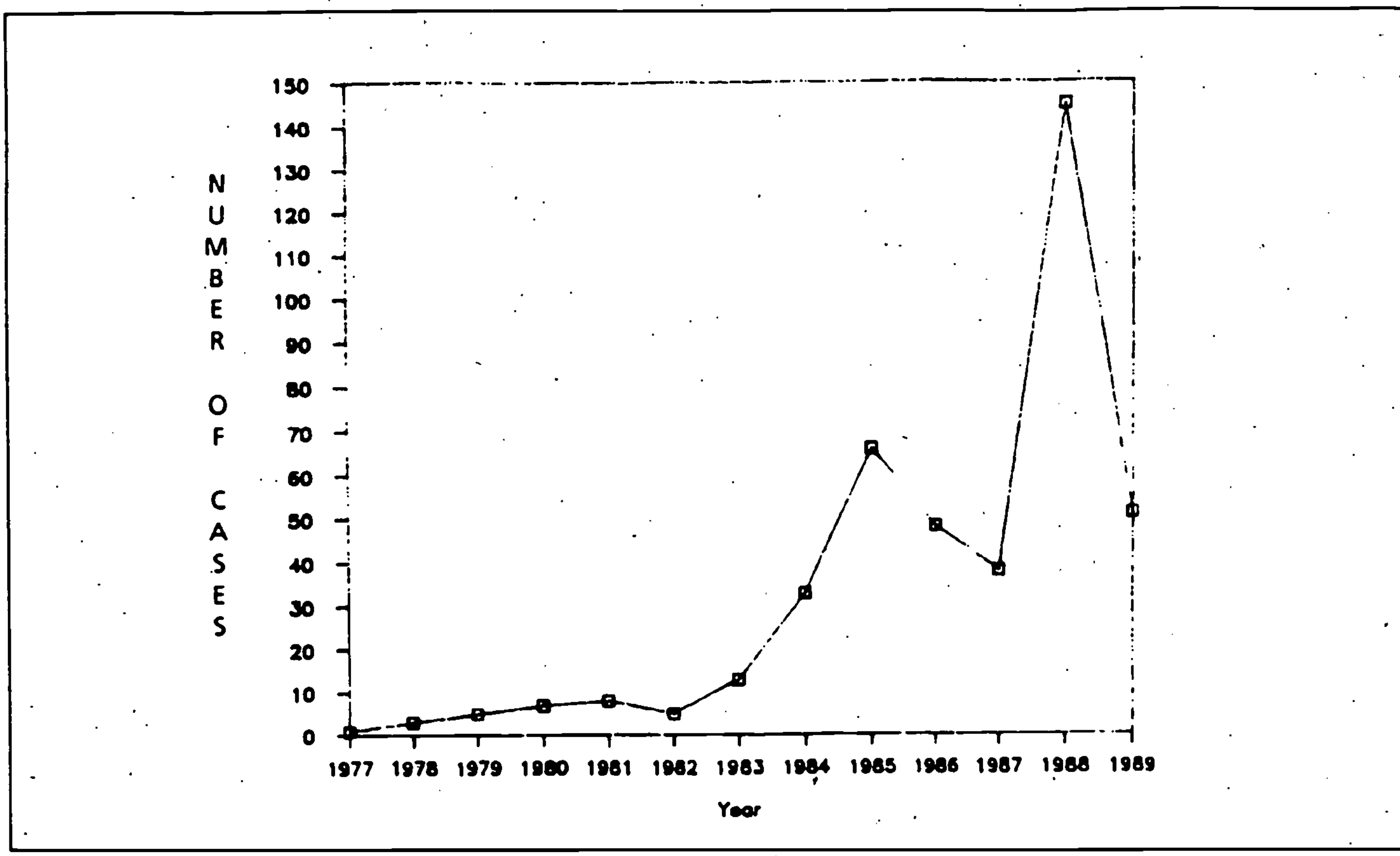
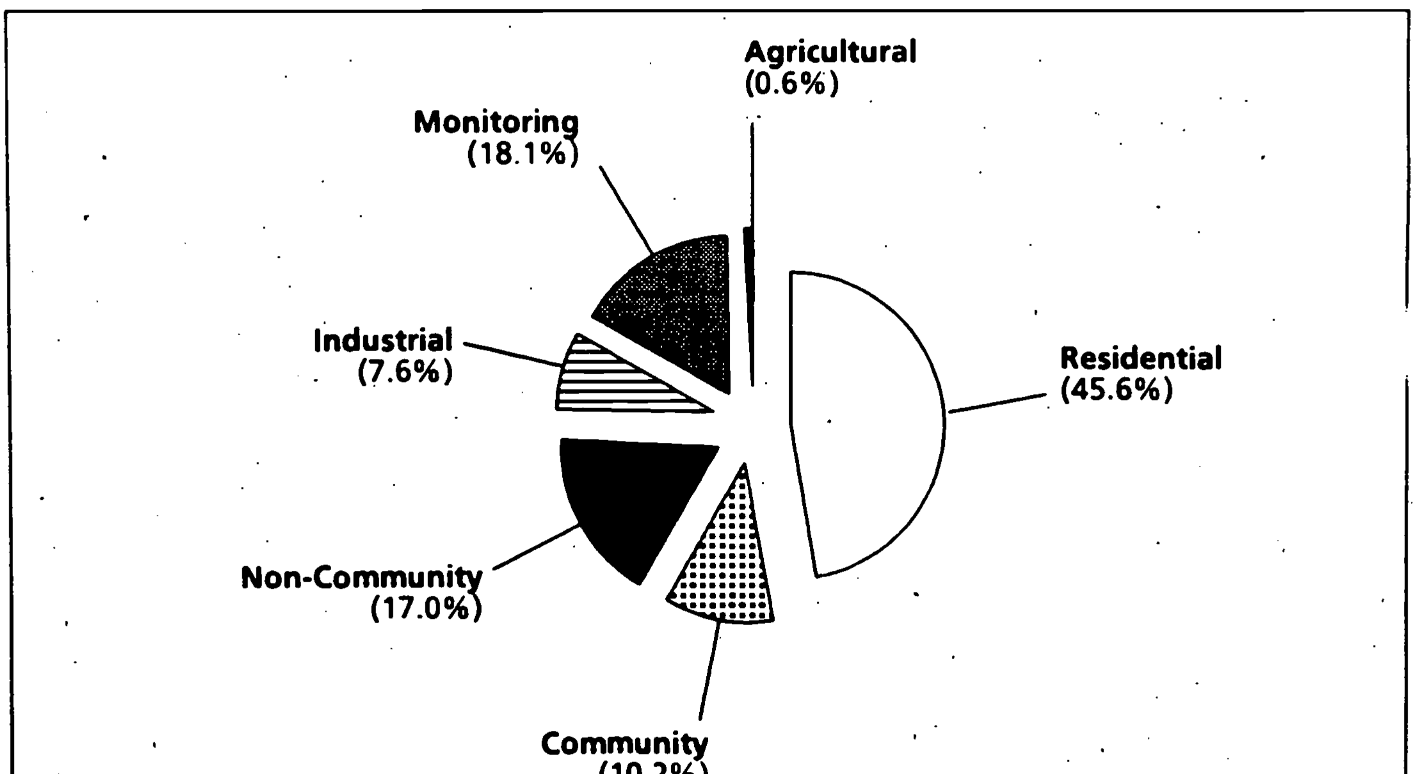
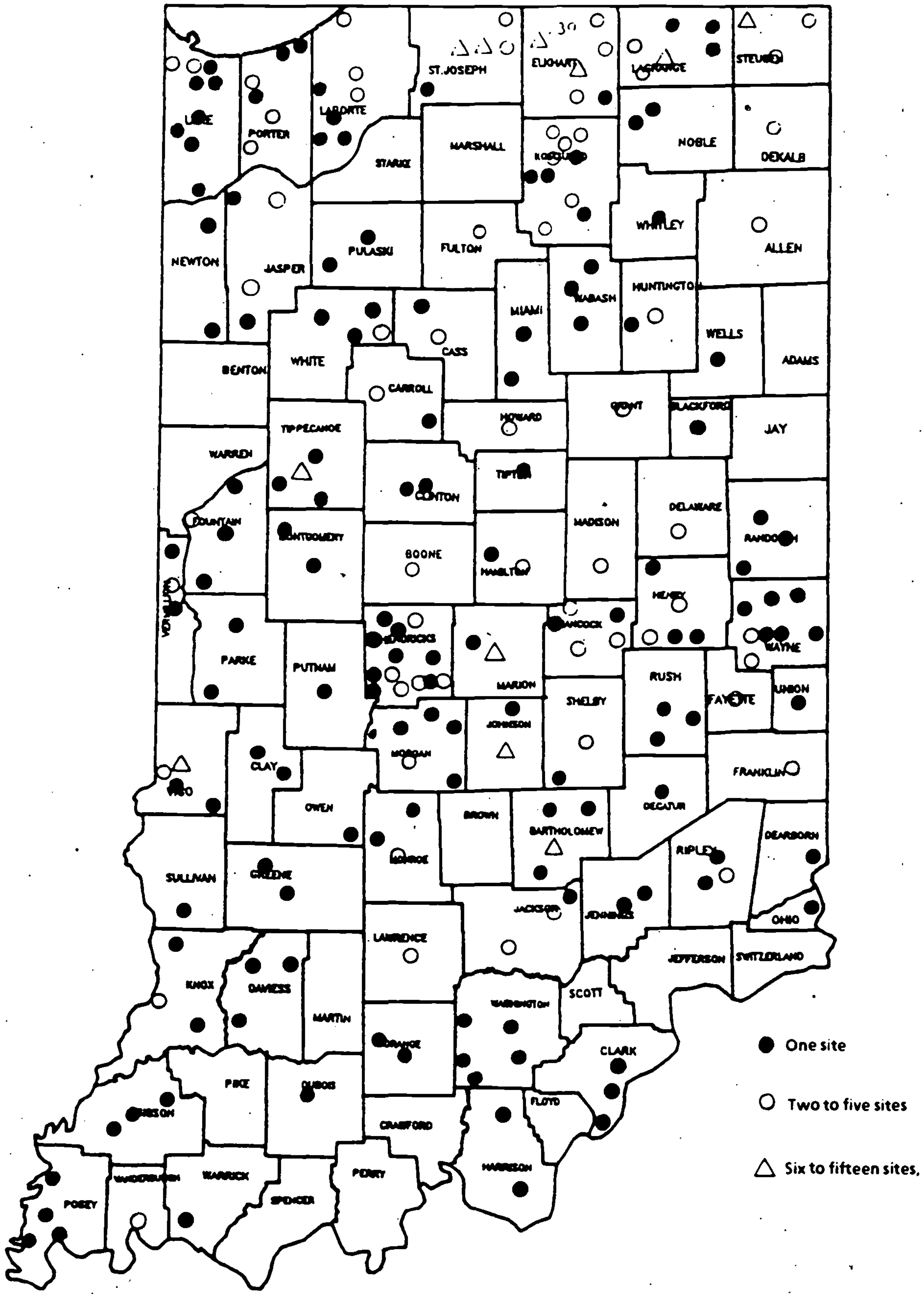


FIGURE 26. *DOCUMENTED GROUND WATER CONTAMINATION*
Types of Wells Affected



SOURCE: IDEM Ground Water Section, Contamination Site Registry (1989) for Time Period 1956 - 1989.

FIGURE 27. *SITES OF DOCUMENTED DRINKING WATER WELL CONTAMINATION*



SOURCE: IDEM Ground Water Section, Contamination Site Registry (1989) for Time Period 1956 - 1989.

TABLE 54. *GROUND WATER MONITORING ACTIONS WHICH DOCUMENTED CONTAMINATION*

ALL GROUND WATER CONTAMINATION (590 SITES)			DRINKING WATER CONTAMINATION ONLY (480 SITES)		
ACTION	**NUMBER OF CASES**	**PERCENT OF TOTAL**	**ACTION**	**NUMBER OF CASES**	**PERCENT OF TOTAL**
Water Sample Analysis	218	36.9%	Water Sample Analysis	197	43.7%
Investigation of Known Pollution Source	133	22.5%	Complaint Response for Objectional Odor of Water	106	23.5%
Compliant Response for Objectional Odor of Water	118	20.0%	Compliant Response for Objectional Taste of Water	91	20.2%
Required Ground Water Monitoring	117	19.8%	Investigation of Known Pollution Source	69	15.3%
Compliant Response for Objectional Taste of Water	101	17.1%	Investigation of Suspected Pollution Source	56	12.4%
Investigation of Suspected Pollution Source	70	11.9%	Complaint Response for Health Concern With Water	36	8.0%
Complaint Response for Health Concern With Water	39	6.6%	Required Ground Water Monitoring	21	4.7%
Complaint Response for Color of Water	14	2.3%	Complaint Response for Color of Water	11	2.4%
Complaint Response for Sediment in Water	4	0 7%	Complaint Response for Sediment in Water	4	1.0%

(Percent total will exceed 100 due to multiple sources for some cases.)

SOURCE: IDEM Ground Water Section Contamination Registry (1989) for Time Period 1956 - 1989).

TABLE 55. *REMEDIAL ACTIONS FOR DRINKING WATER WELL CONTAMINATION*

ACTION	NUMBER OF CASES	PERCENT OF TOTAL
No Other Remedial Action/Health Advisory	87	19.3%
Long Term Monitoring	84	18.6%
Bottled Water	71	15.7%
Point of Entry/Point of Use Water Treatment	61	13.5%
Public Water Cnnection	45	10.0%
Well Abandonment	34	7.5%
New Well	31	6.9%
Miscellaneous	31	6.9%
Contaminated Soil Removal	27	6.0%
Well Disinfection	11	2.4%
Pump and Decontaminate Ground Water	11	2.4%
Contaminant Recovery Well	8	1.8%
Well Repair	7	1.6%

(Percent total will exceed 100 due to multiple sources for some cases.)

SOURCE: IDEM Ground Water Section Contamination Registry (1989) for Time Period 1956 - 1989).

In 1988, enforceable 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 did their monitoring in 1988 and systems with 3,300 to 10,000 customers had 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 is shown in Figure 28.

For community systems serving over 10,000 customers, 55 using well water were sampled and 20 (36 percent) had detectable VOCs and in 80 (45 percent) of 177 individual wells. The total population served by these systems with VOCs is nearly 1.4 million. At eight of the supplies, the finished water had detectable VOCs, but the MCL or proposed MCL was exceeded at only two of these.

At the community systems serving 3,300 to 10,000 customers, 73 using well water performed the monitoring and 13 (18 percent) had detectable VOCs in 17 (38 percent) of 45 separate wells. The supplies with VOCs serve over 81,500 customers. The finished water at two of the systems had detectable VOCs and the proposed MCL was exceeded at one of those.

The top two most frequently reported VOCs in raw well water for the 128 systems monitored in 1988-1989 were trichloroethylene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA). Other contaminants in the top five for both sizes of community systems include tetrachloroethylene (TCE), 1,1-dichloroethylene (DCA). 1,2- dichloroethylene, and total xylenes. The MCLs currently in place include only TCE and TCA. Overall, 17 of the 59 VOC compounds analyzed in the monitoring were reported detected in any of the samples, including total trihalomethanes. In the finished water 10 different VOCs were reported for all the systems sampled; there are MCLs for three of these ten. The MCL or proposed MCL was exceeded in the finished water for only four of these ten VOCs, for TCE, TCA, PCE, and CIS-1,2-dichloroethylene.

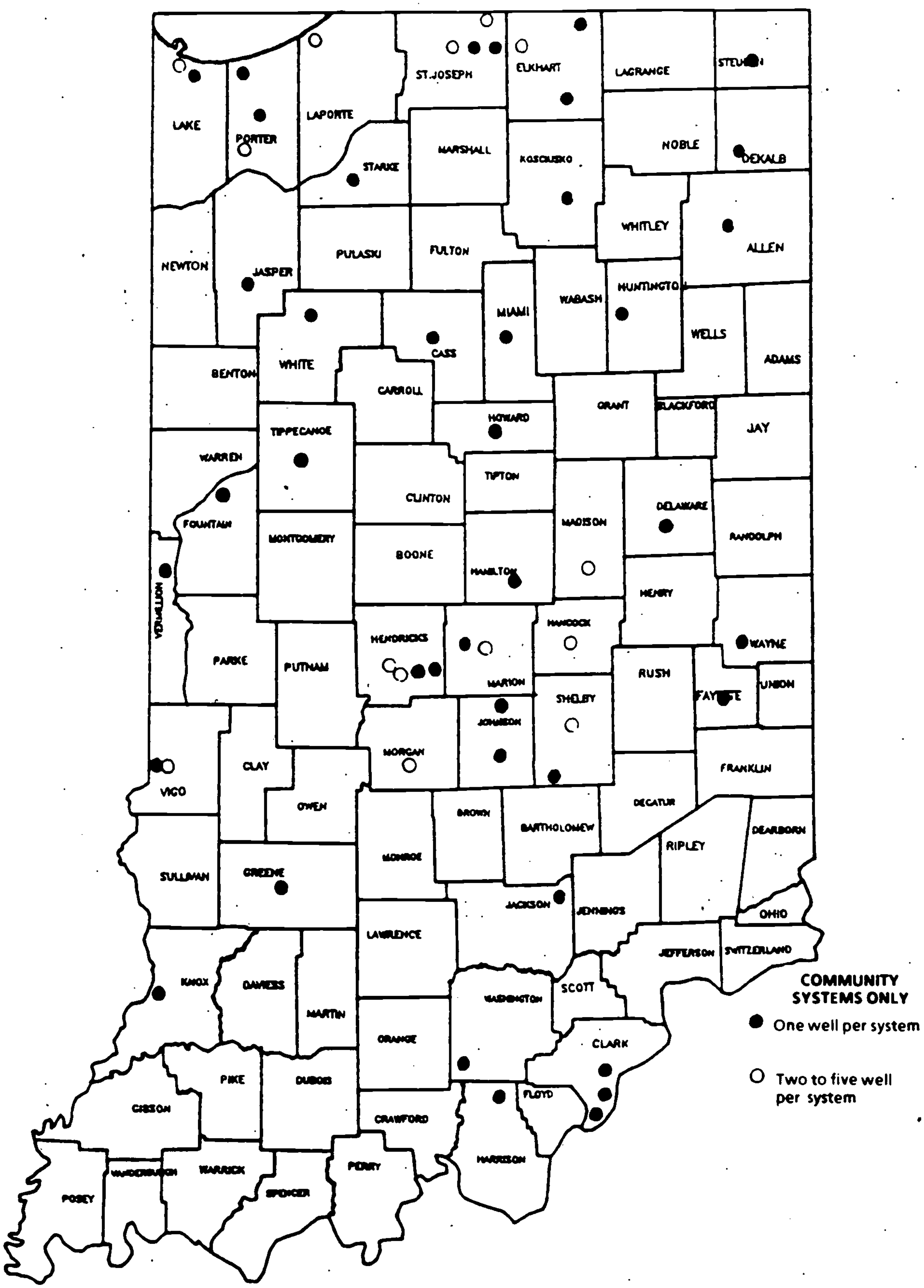
Inorganic Chemicals

Community Water Supplies in Indiana which use 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 five years, only seven systems, serving about 9,500 people, 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 nonpoint source 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 have not been reported to the State.

FIGURE 28. *PUBLIC WATER SUPPLY WELLS (WITH DETECTABLE ORGANIC CHEMICALS)*



SOURCE: IDEM Ground Water Section, Contamination Site Registry (1989) for 1981 - 89 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 pollute ground water in Indiana, as evidenced in Table 56. 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 absorption 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.

In 1989, there were about 2,012 hazardous materials spills reported to the IDEM Office of Environmental Emergency Response. The largest number occurred in heavily industrialized areas such as Marion County (331 spills) and Lake County (156 spills). The statewide distribution of these events is shown in Figures 29 and 30. 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. Such materials are more frequently spilled at industrial, commercial, or agricultural sites when they impact ground water. The circumstances which cause these events most often are equipment failure and employee error (Figure 31). This reinforces the need for spill prevention and containment engineering and employee safety training as a means of protecting ground water and the environment. The types of materials spilled and the sources of these materials for 1989 are shown in Figures 32 and 33, respectively.

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. In the period from January 1989 to December 1989, 377 sites were reported to have leaking underground storage tanks, although documented ground water pollution was not always present.

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). Between May 1986 and January 1989, some 34,757 tanks had been reported. The statewide distribution is shown in Figure 34. If the statewide reporting averages about 50 percent, then there could be up to 65,000 underground storage tank systems in Indiana subject to regulation. Figure 35 shows the Indiana counties with the largest number of regulated underground storage tanks.

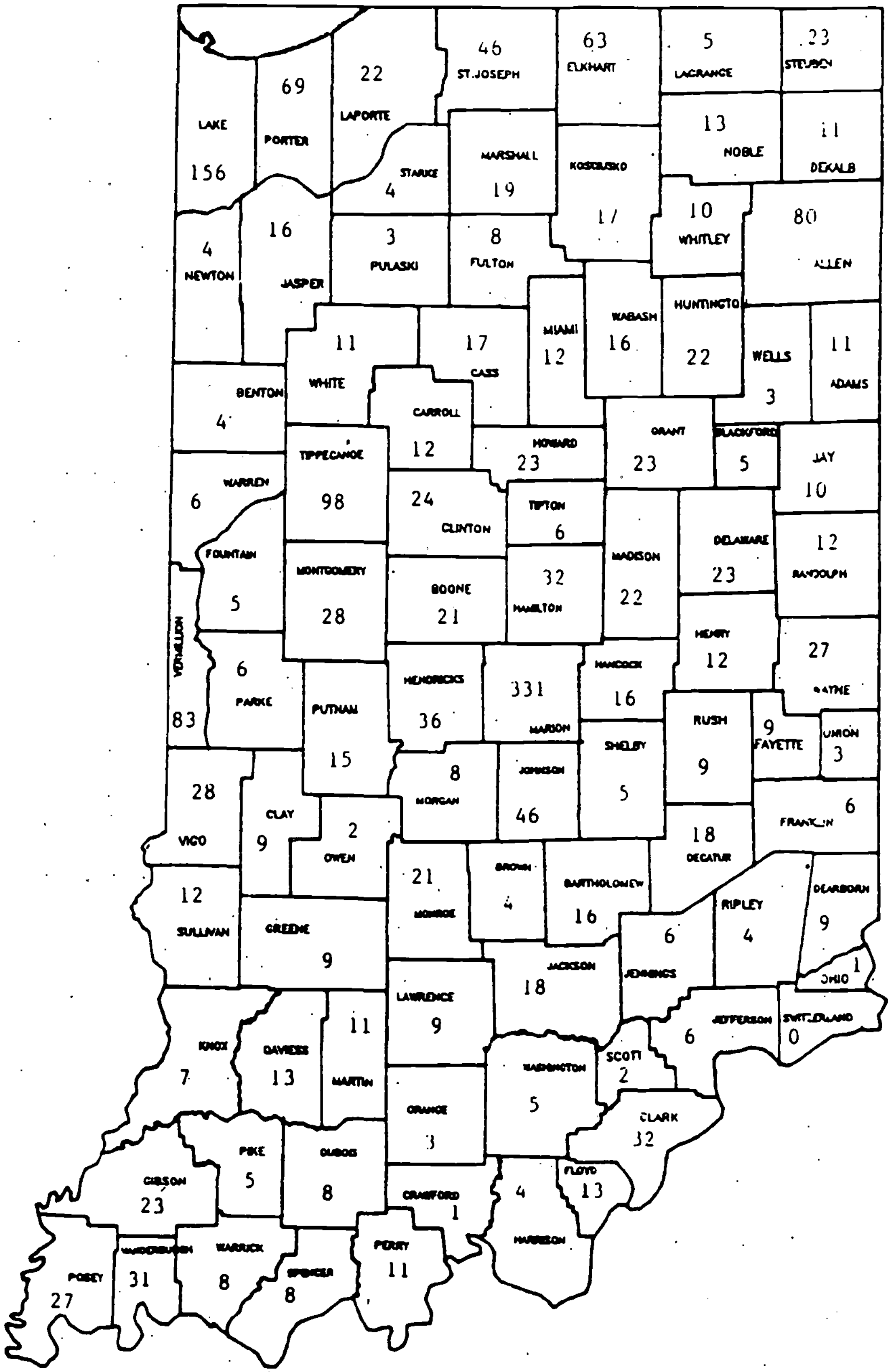
TABLE 56. *SOURCE OF GROUND WATER CONTAMINATION*

ALL GROUND WATER CONTAMINATION (590 SITES)		DRINKING WATER CONTAMINATION ONLY (480 SITES)	
TYPE OF CONTAMINANT SOURCE	**PERCENT OF CASES**	**TYPE OF CONTAMINANT SOURCE**	**PERCENT OF CASES**
Unknown/Not Confirmed	28.3%	Unknown/Not Confirmed	32.8%
Underground Storage Tanks	17.3%	Underground Storage Tanks	13.3%
Hazardous Material Spills	13.2%	Hazardous Material Spills	12.4%
Hazardous Waste Disposal	9.3%	Hazardous Waste Disposal	8.2%
Solid Waste Disposal Facility	7.1%	Pesticide Application	6.0%
Pesticide Application	5.1%	Solid Waste Disposal Facility	5.5%
Above Ground Storage Tank	4.6%	Improperly Abandoned Hole/Well (Associated with oil and gas)	5.1%
Improperly Abandoned Hole/Well (All associated with oil & gas)	4.2%	Above Ground Storage Tanks	4.0%
Pit, Pond or Lagoon	3.9%	Septic System	3.5%
Septic System	3.1%	Pit, Pond or Lagoon	2.9%
Salt Storage/Handling Facility	1.7%	Pesticide Storage/Disposal	2.0%
Wastewater Disposal Into a Dry Well	1.5%	Salt Storage Handling Facility	1.8%
Liquid Transport Pipeline	1.5%	Oil and Gas Recovery Well	1.6%
Pesticide Storage/ Disposal	1.5%	Wastewater Disposal into a Dry Well	1.6%
Oil and Gas Recovery Well	1.4%	Liquid Transport Pipeline	1.1%
Injection Well (For brine disposal)	0.7%	Injection Well (For brine disposal)	0.9%

(Percent totals will exceed 100 due to multiple sources for some cases.)

SOURCE: IDEM Ground Water Section Contamination Registry (1989) for Time Period 1956 - 1989).

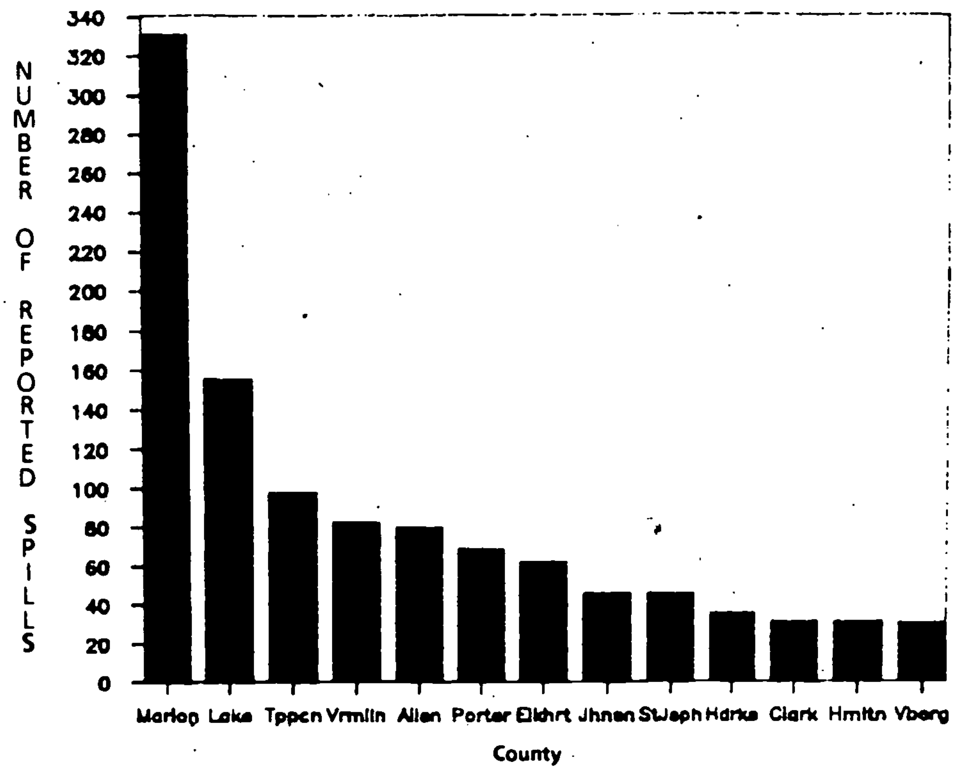
FIGURE 29. *REPORTED HAZARDOUS MATERIALS SPILLS (PER COUNTY)*
Januray 1, 1989 - December 31, 1989



SOURCE: IDEM Emergency Response Branch Data Base (1989).

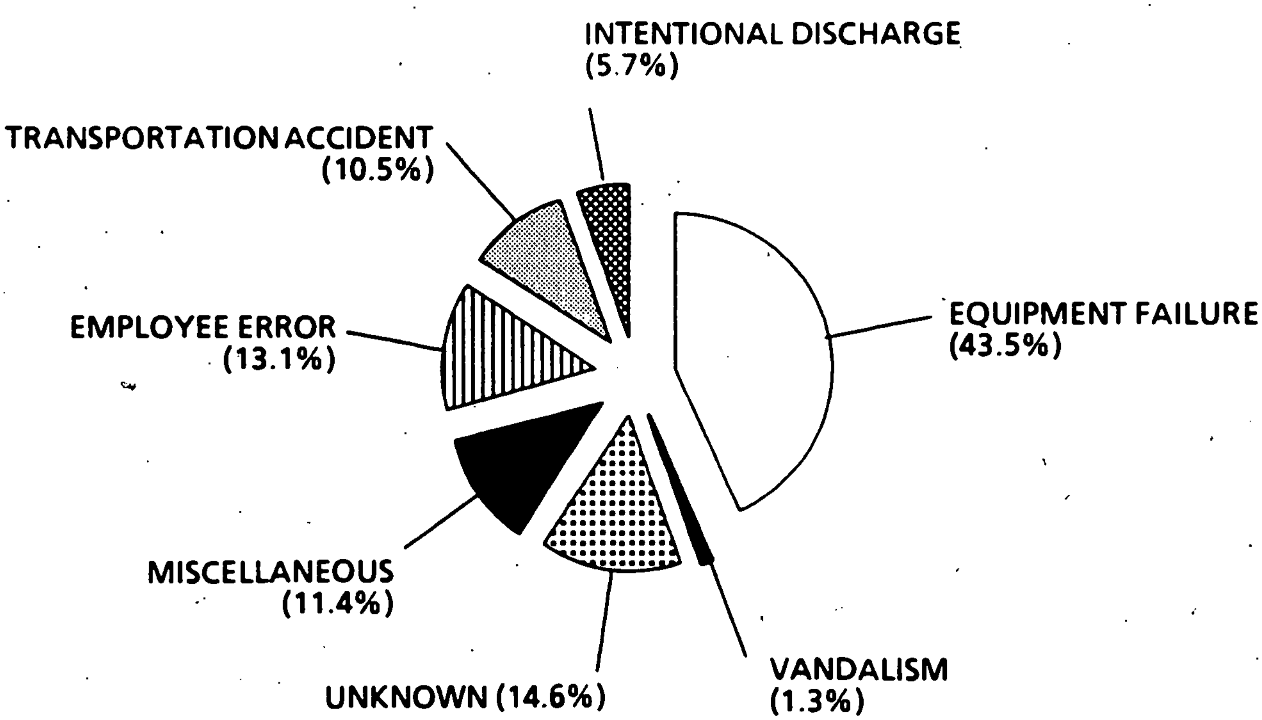
FIGURE 30. *REPORTED HAZARDOUS MATERIAL SPILLS 1989*

Counties with greatest number of spills



SOURCE: IDEM Emergency Response Branch Data Base (1989).

FIGURE 31. *CIRCUMSTANCES OF MATERIALS SPILLED*



SOURCE: IDEM Ground Water Section, Contamination Site Registry (1989) for Time Period 1956 - 1989.

FIGURE 32. *TYPES OF MATERIALS SPILLED (1989)*

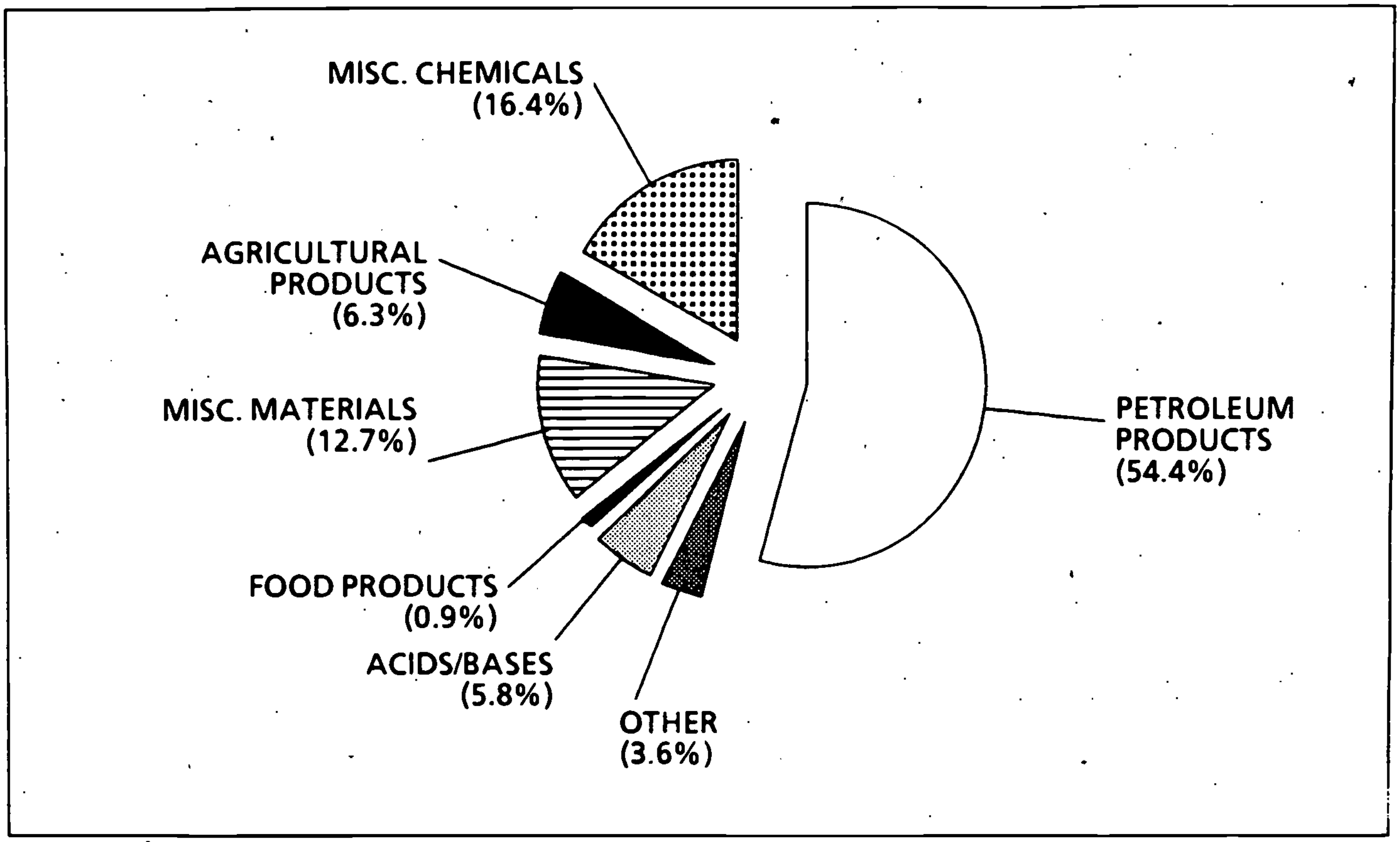
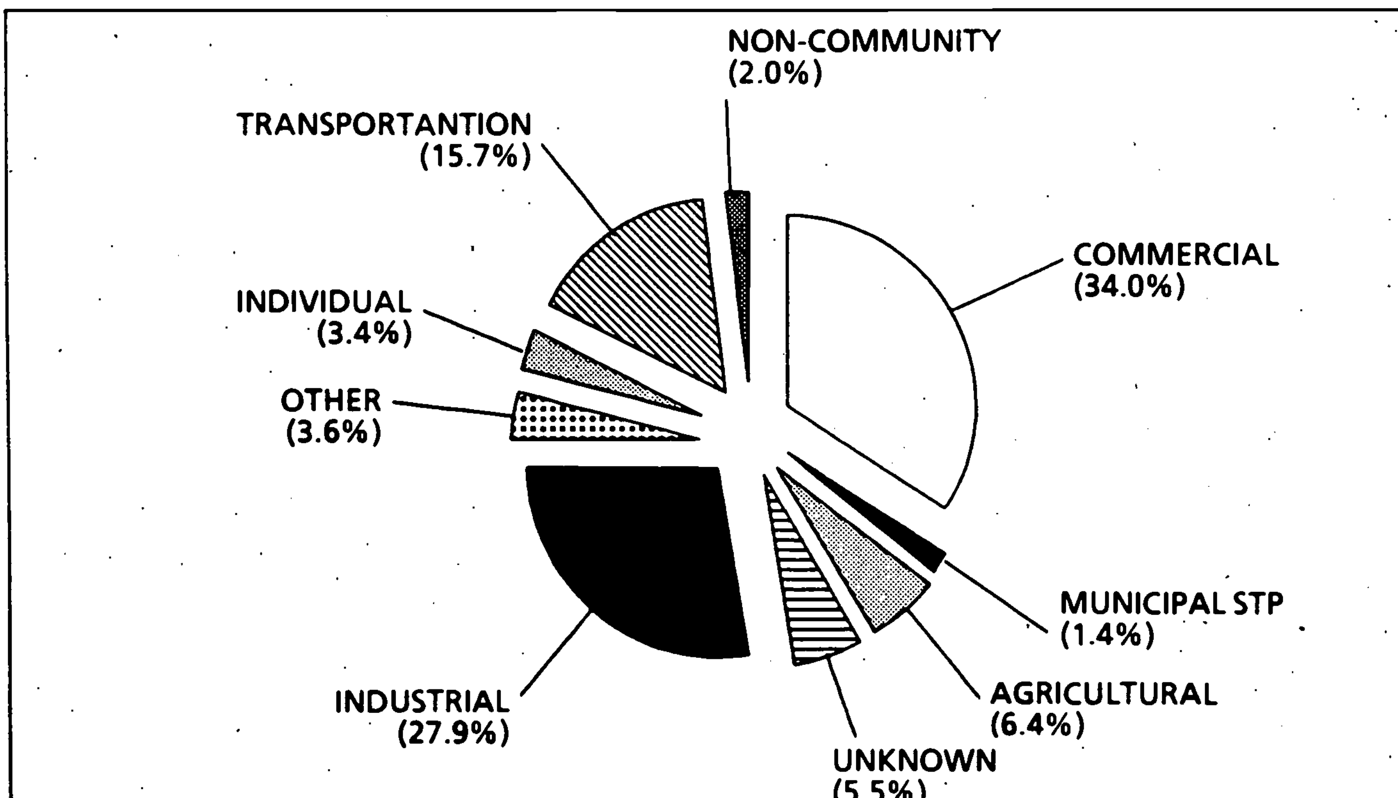
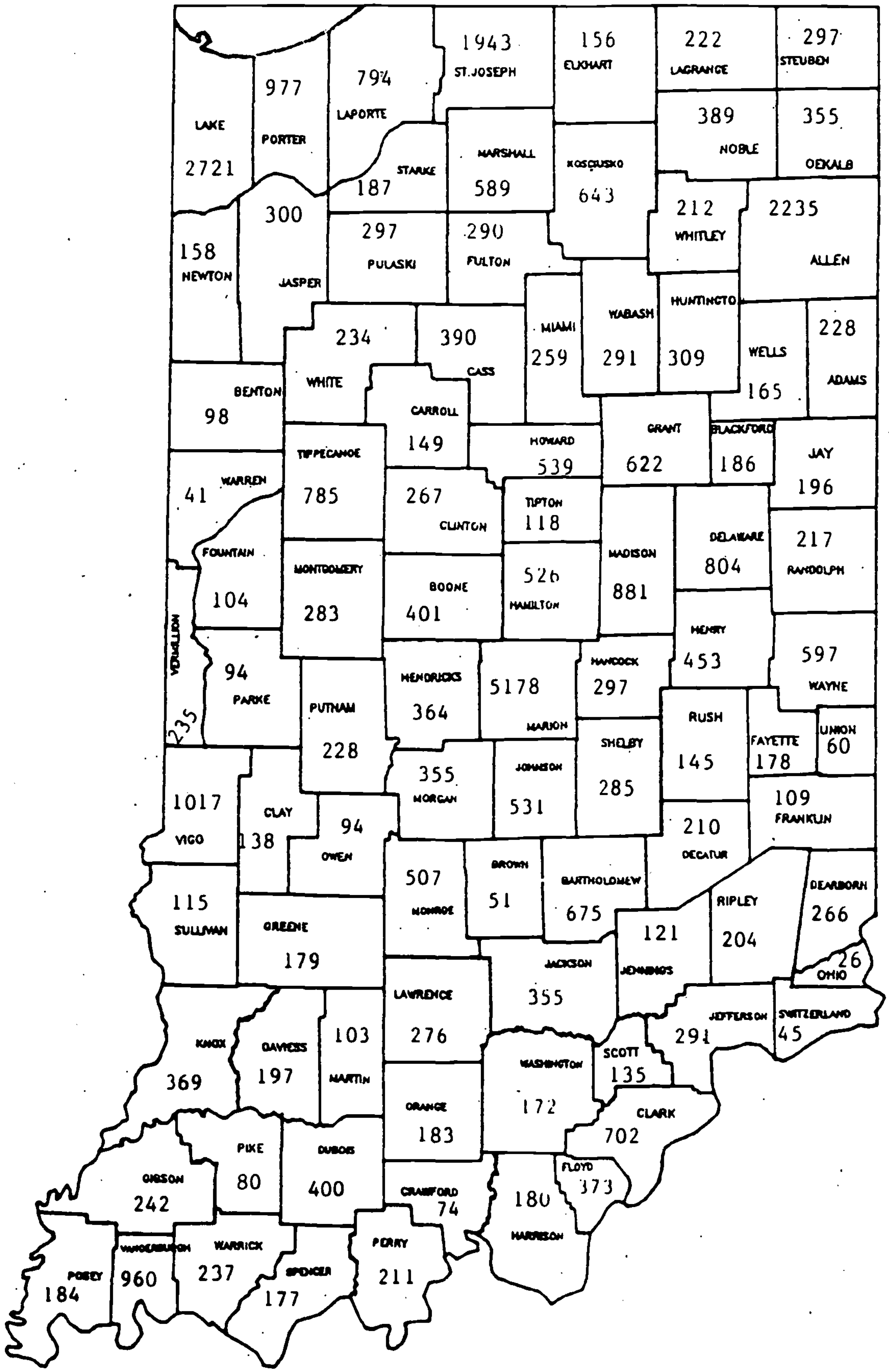


FIGURE 33. *SOURCES OF MATERIALS SPILLED (1989)*



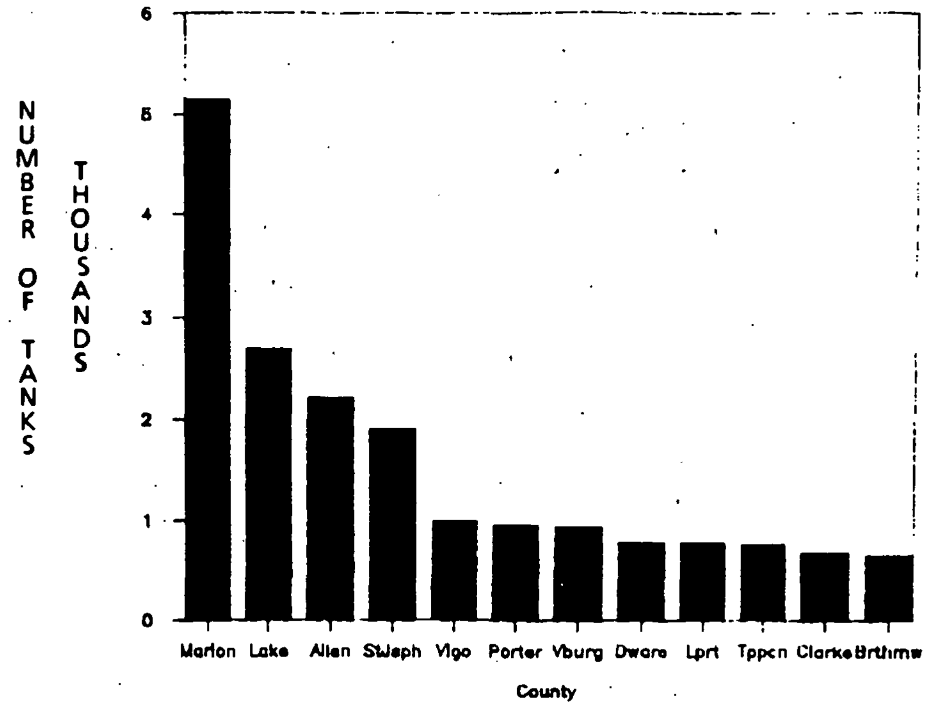
SOURCE: IDEM Emergency Response Branch Data Base (1989)

FIGURE 34. *REGULATED UNDERGROUND STORAGE TANKS (PER COUNTY)*



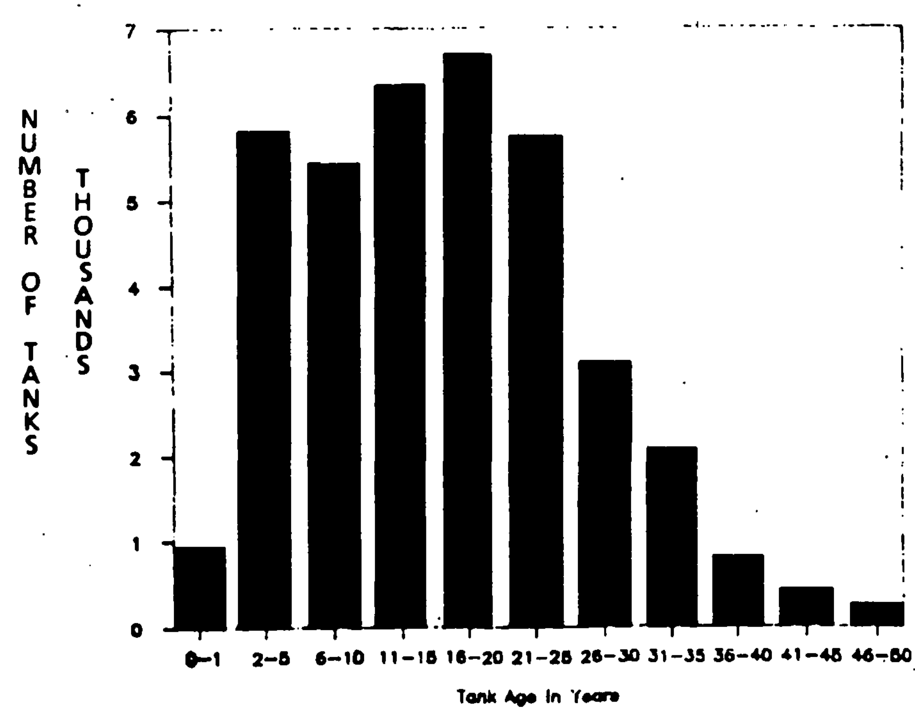
SOURCE: IDEM Underground Storage Tank Section Data Base (1989)

FIGURE 35. *REGULATED UNDERGROUND STORAGE TANKS*
Counties with largest number



SOURCE: IDEM Under Ground Storage Tank Section Data Base (1989).

FIGURE 36. *AGE OF UNDERGROUND STORAGE TANKS*



About two-thirds of the existing buried storage tanks in the State are over ten years old and of bare steel construction (Figure 36). Most of these older tank systems do not have the corrosion protection or leak detection features required of new installations. Over 90 percent of these tanks contain petroleum products (Figure 37). 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

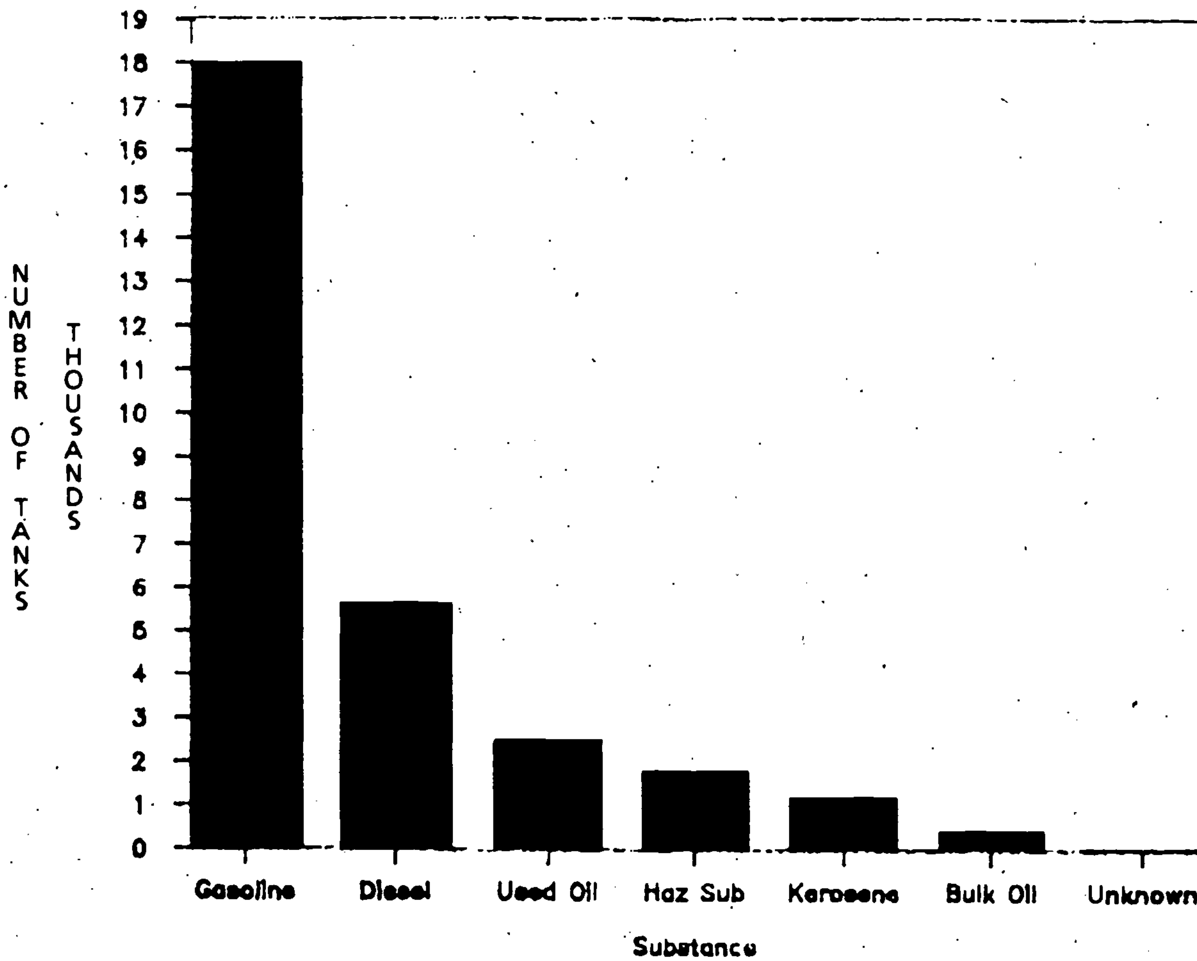
Activities related to the disposal of solid and hazardous wastes have contributed to the pollution of ground water at over 50 sites in Indiana. At 30 of the 38 sites in the State on the U.S. EPA's Superfund National Priorities List, contamination of the ground water has been documented. See Figure 38 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 1,400 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. Figure 39 shows the distribution of these potential ground water pollution sites across the State. Figure 40 shows the counties with the greatest number of abandoned waste disposal sites.

There are over 4,641 operations in the State which generate hazardous wastes, including 2,552 facilities that are small quantity generators and over 177 facilities which, treat, store or dispose of these wastes. Figure 41 lists the number of facilities in each county which generate, treat, store or dispose of hazardous waste. Figure 42 lists the counties with the greatest number of treatment, storage and disposal facilities, and Figure 43 indicates the geographic location and number of treatment, storage and disposal facilities. Two million tons of hazardous waste are managed in the State each year. Stringent regulation 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 and operation of the waste management units at these sites are likely to have resulted in the ground water pollution recorded. Similarly, deficiencies in the siting or management of 42 solid waste landfills in the State, most of them currently inactive, have also contributed to the ground water contamination documented through monitoring by IDEM staff.

Substances Contaminating Ground Water

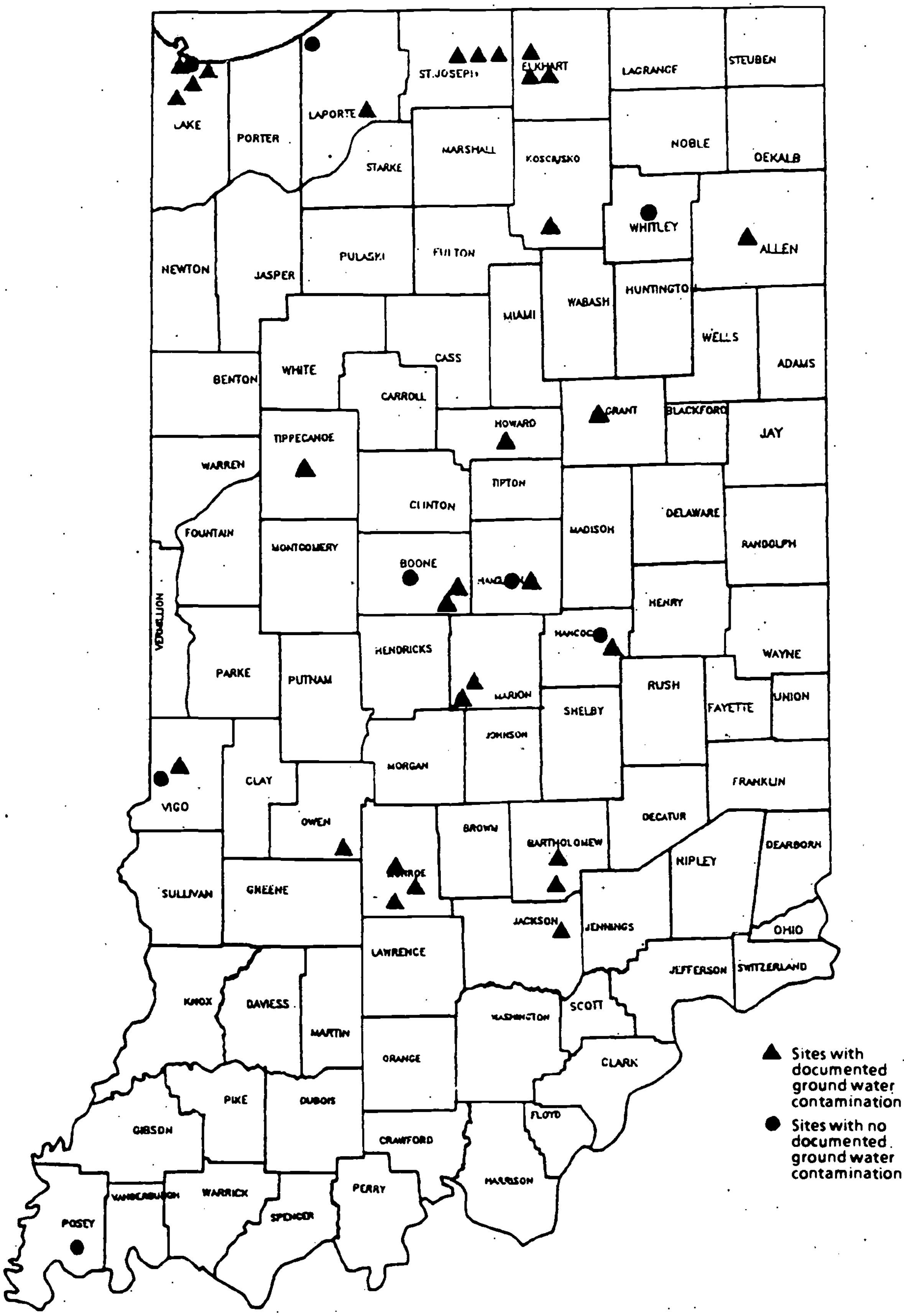
At least 80 different chemicals have been detected through analysis of water samples from public or private water wells, or monitoring wells, at the sites of ground water contamination in the registry for Indiana (Table 57). In summarizing the information from available State agency records, several

FIGURE 37. *REGISTERED UNDERGROUND STORAGE TANKS*
Substance stored



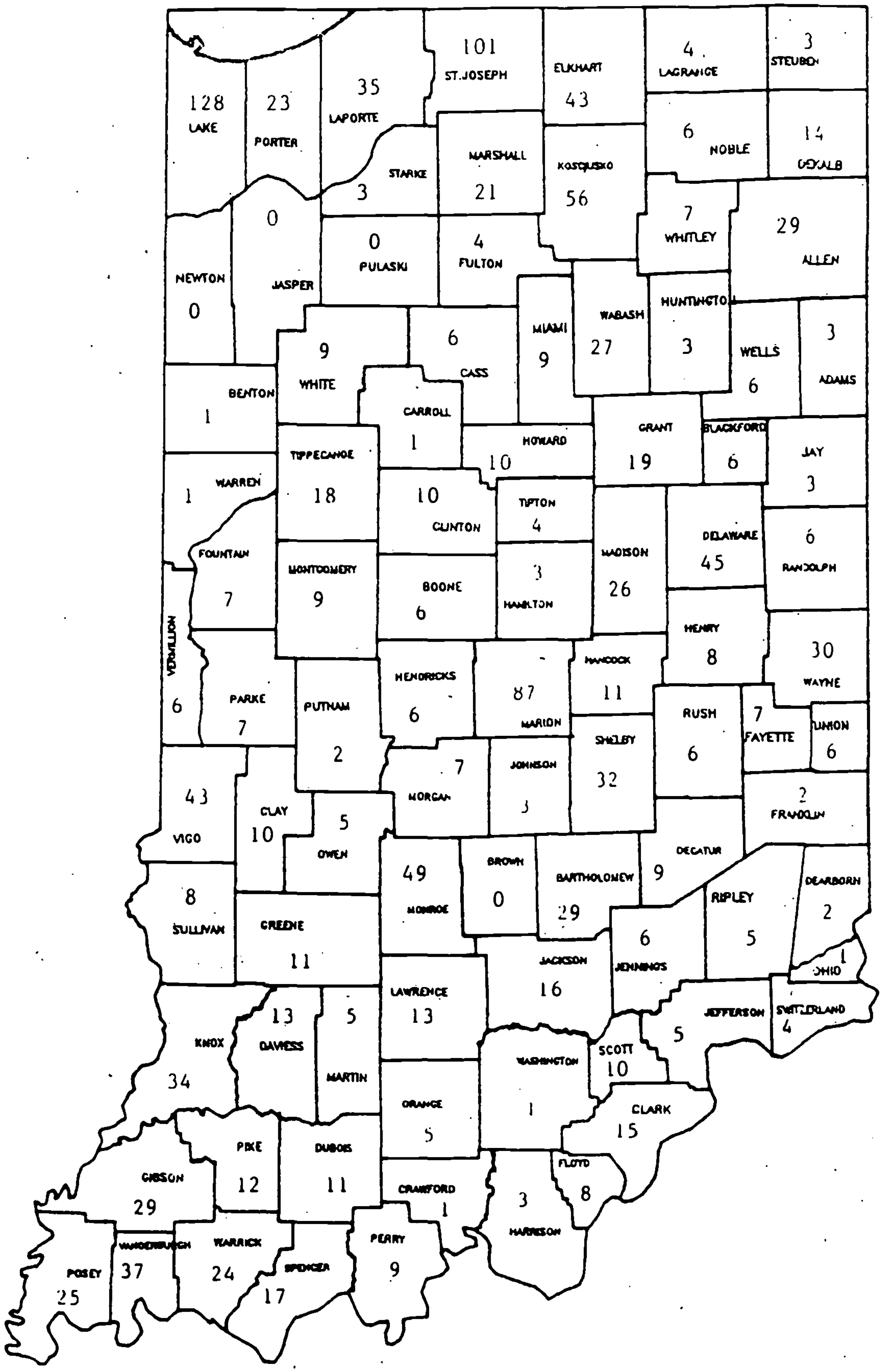
SOURCE: IDEM Underground Storage Tank Section Data Base (1989).

FIGURE 38. *SUPERFUND NATIONAL PRIORITIES LIST SITES*



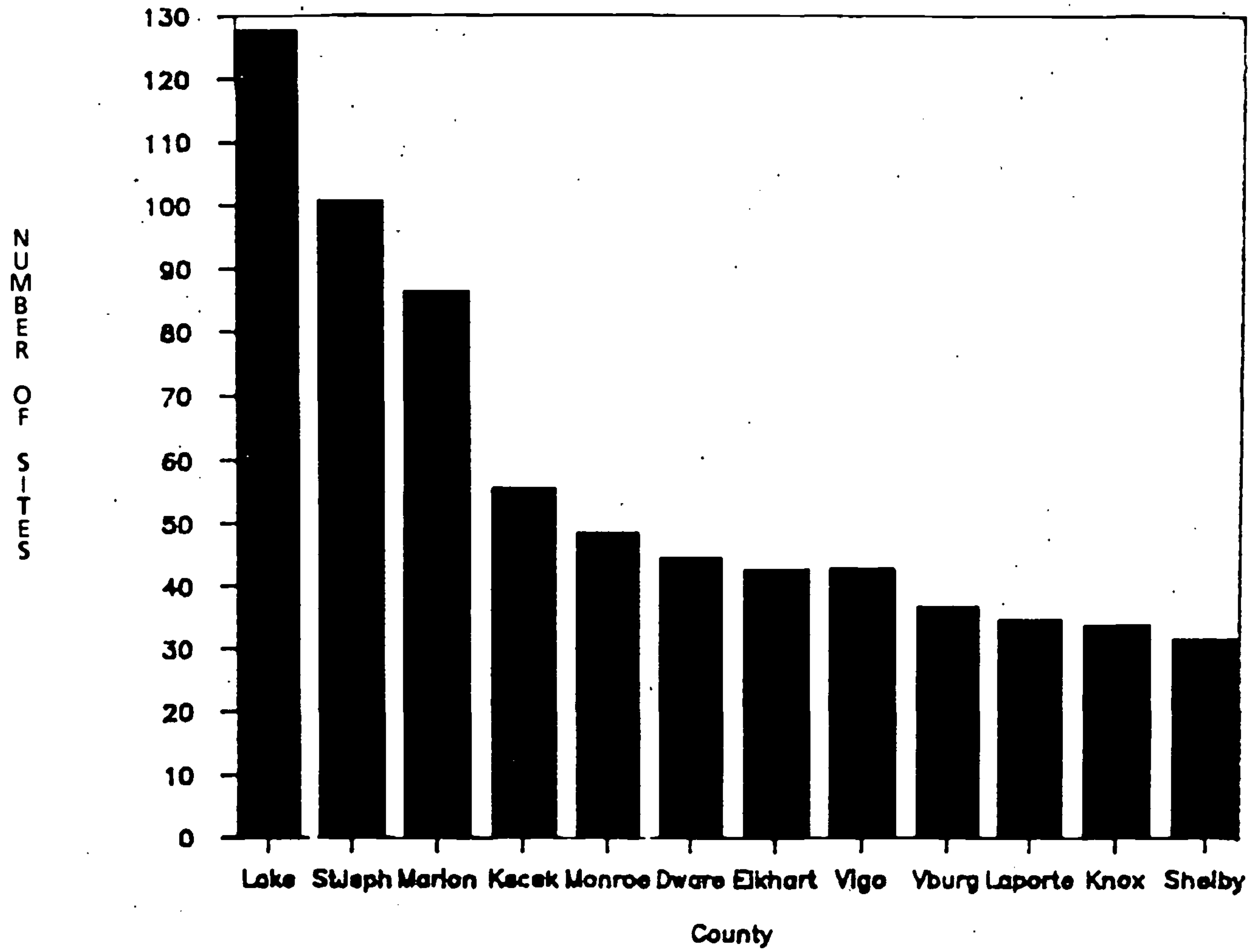
SOURCE: IDEM Site Management Section 1989

FIGURE 39. *ABANDONED WASTE DISPOSAL SITES DISTRIBUTION (PER COUNTY)*



SOURCE: IDEM Site Investigation Section CERCLIS List (1989)

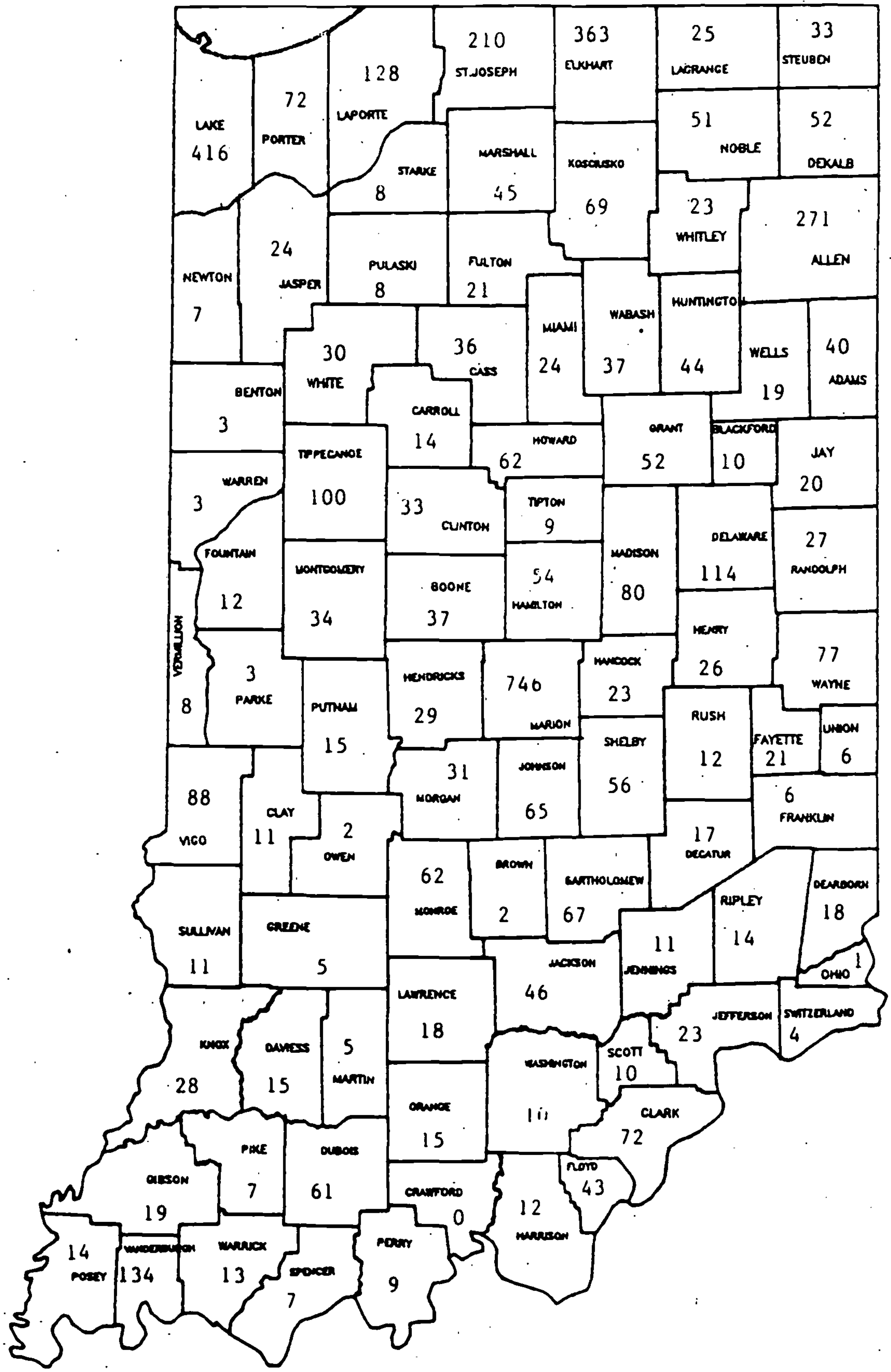
FIGURE 40. *ABAND WASTE DISPOSAL SITES*
Counti: greatest number



SOURCE: IDEM Site Investigation Section CERCLIS List (1989)

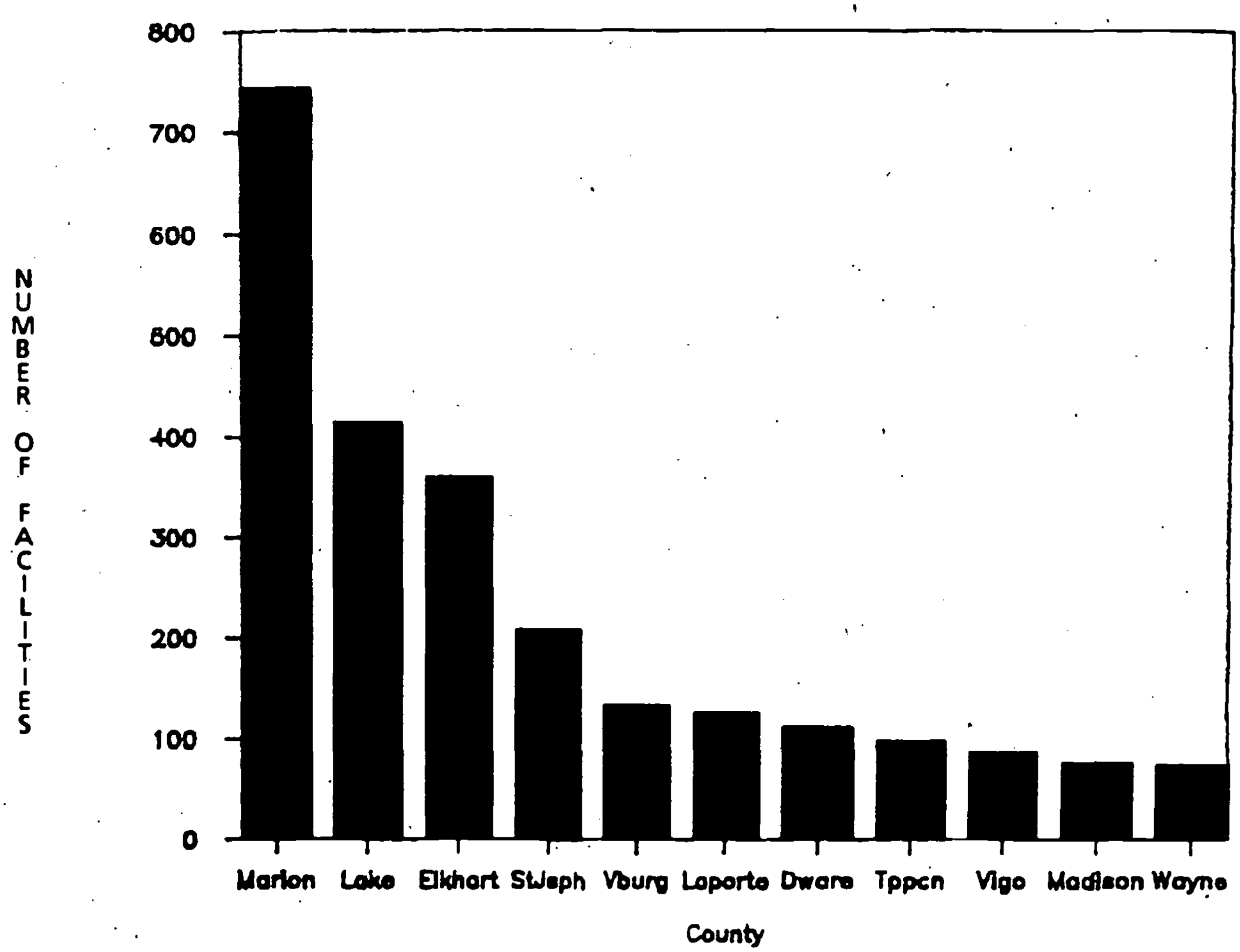
FIGURE 41. *HAZARDOUS WASTE FACILITIES (PER COUNTY)*

Regulated facilities which generate, treat, store or dispose hazardous waste



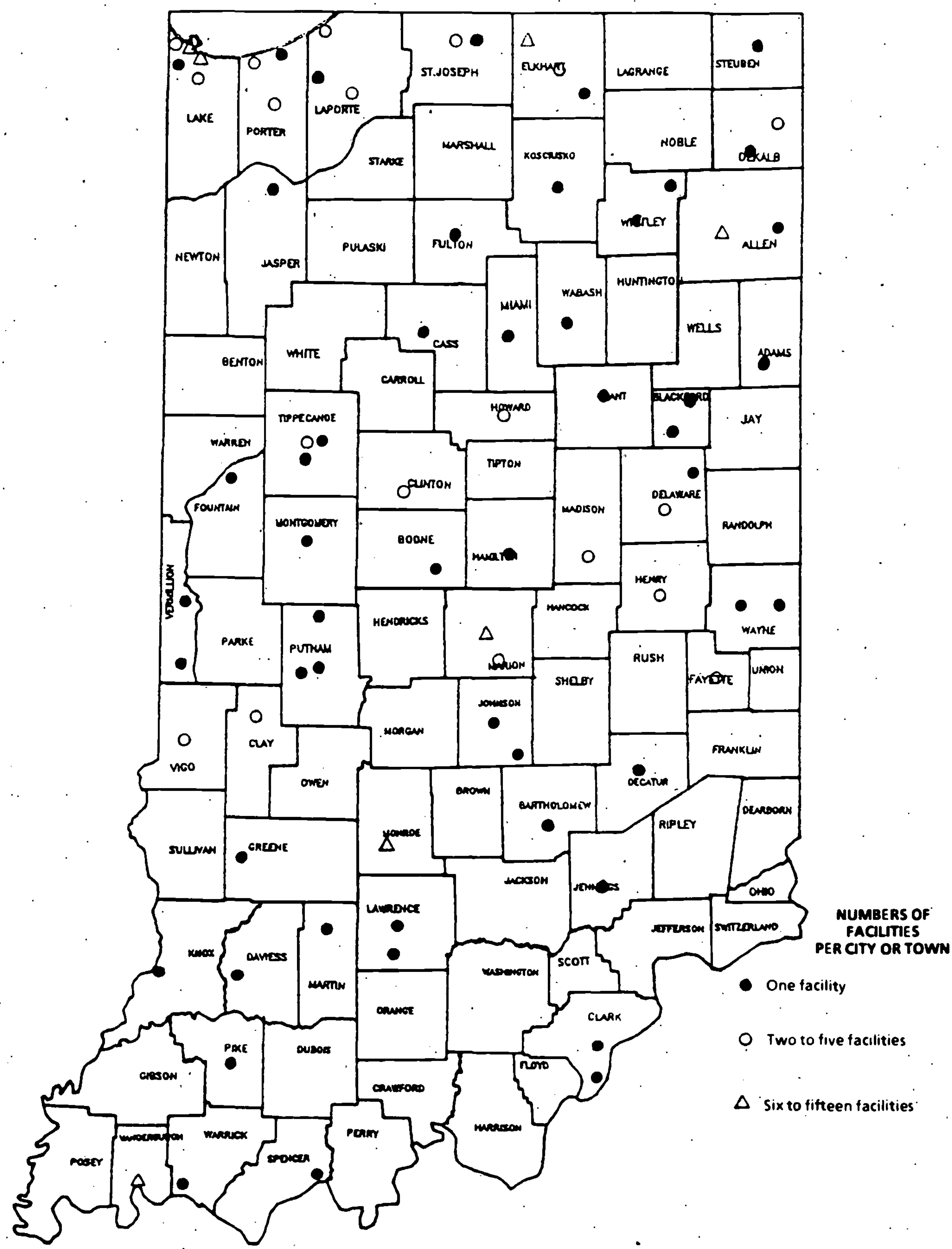
SOURCE: IDEM Hazardous Waste Management Branch Data Base (1989), including small quantity generators.

FIGURE 42. *REGULATED HAZARDOUS WASTE FACILITIES*
Counties with greatest number



SOURCE: IDEM Hazardous Waste Management Branch Data Base (1989)

FIGURE 43. *PERMITTED HAZARDOUS WASTE*
Treatment, storage and disposal facilities



SOURCE: IDEM Hazardous Waste Management Branch Data Base (1989)

TABLE 57. *CHEMICAL CONTAMINANTS DETECTED IN INDIANA GROUND WATER*

CHEMICAL TYPE CHEMCIAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBR./ TRADE NAME
1. Halogenated Volatile Organics				
Trichloroethylene	24%	9800 ppb	5 ppb MCL	TCE
Tetrachloroethylene	12%	9400 ppb	5 ppb PMCL	PCE
1,1,1-Trichloroethane	10%	9000 ppb	5 ppb DL	111-TCA
1,2-Dichloroethane	10%	4100 ppb	5 ppb MCL	12-DCA
1,1-Dichloroethane	8.5%	1700 ppb	5 ppb DL	11-DCA
t-1,2-Dichloroethylene	7%	2000 ppb	70 ppb PMCL	t-DCE
Chloroform	6%	250 ppb	.6 ppb HA	—
Methylene Chloride	5.5%	4400 ppb	5 ppb HA	$MeC1_2$
Vinyl Chloride	4.5%	4000 ppb	2 ppb MCL	—
Carbon Tetrachloride	2%	12,000 ppb	5 ppb MCL	$CC1_4$
1,1,2,2-Tetrachloroethylene	1.5%	100 ppb	5 ppb DL	—
1,1,2-Trichloroethane	1%	2000 ppb	5 ppb LD	—
Tetrahydrofuran	.5%	1620 ppb	5 ppb DL	THF
Trichlorofluoromethane	.5%	230 ppb	5 ppb DL	TCF
2. Aromatic Volatile Organics				
Benzene	33%	10,000 ppb	5 ppb MCL	
Toluene	30%	28,000 ppb	5 ppb DL	
Xylenes (o,p&m)	20%	2400 ppb	5 ppb DL	
Ethylbenzene	17%	150 ppb	30 ppb PMCL	
3. Non Halogenated Volatile Organics				
Methyl ethyl Ketone	46%	3800 ppb	200 ppb HA	MEK
Methyl isobutyl Ketone	26%	780 ppb	5 ppb DL	MIBK
Acetone	20%	360 ppb	5 ppb DL	—
Methyl tertiary butylether	6%	5400 ppb	200 ppb HA	MTBE

TABLE 57. *CHEMICAL CONTAMINANTS DETECTED IN INDIANA GROUND WATER (con't)*

CHEMICAL TYPE CHEMCIAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBR./ TRADE NAME
4. Petroleum				
Crude Oil	42%	free product	free product	—
Gasoline	30%	free product	free product	—
Heating Oil	15%	free product	free product	—
Diesel Fuel	9%	free product	free product	—
Naptha	3%	free product	free product	—
5. Pesticides				
Ethylene Dibromide	9%	.98 ppb	.02 ppb (DL)	EDB
Dibromochloropropane	8%	.89 ppb	.02 ppb (DL)	DBCP
Dicamba	8%	230 ppb	.05 ppb (DL)	Banvel
Alachlor	7%	150 ppb	.20 ppb (DL)	Lasso
Carbofuran	6%	12 ppb	12.0 ppb (DL)	Furadan
Cyanazine	6%	3 ppb	.70 ppb (DL)	Bladex
Chlorpyrifos	6%	.17 ppb	.10 ppb (DL)	Dursban
Metolachlor	5%	2.4 ppb	.10 ppb (DL)	Dual
Chlordane	5%	92 ppb	.50 ppb (DL)	Belt
Atrazine	4%	68 ppb	.10 ppb (DL)	Aatrex
Aldrin	4%	.1 ppb	.05 ppb (DL)	
Lindane (g-BHC)	3 %	.6 ppb	.05 ppb (DL)	
Endrin	3%	.13 ppb	.05 ppb (DL)	
Heptachlor	3%	.07 ppb	.05 ppb (DL)	
Heptachlor Epoxide	3%	.22 ppb	.05 ppb (DL)	
4,4-DDT	3%	.25 ppb	.10 ppb (DL)	
4,4,-DDE	3%	.24 ppb	.10 ppb (DL)	
Dieldrin	2%	.22 ppb	.10 ppb (DL)	
Simazine	2%	5.2 ppb	.20 ppb (DL)	Princep

TABLE 57. *CHEMICAL CONTAMINANTS DETECTED IN INDIANA GROUND WATER (con't)*

CHEMICAL TYPE CHEMCIAL NAME	PERCENT FREQUENCY PER CHEMICAL TYPE	MAXIMUM CONCENTRATION RECORDED	CONCENTRATION AND SOURCE OF "STANDARD" USED FOR REGISTRY	ABBR./ TRADE NAME
2,4-D	2%	9 ppb	.50 ppb (DL)	Princep
Metribuzin	2%	1.4 ppb	.06 ppb (DL)	Lexone
Terbufos	2%	12 ppb	.35 ppb (DL)	Counter
Diazinon	2%	65 ppb	.20 ppb (DL)	Counter
Trifluralin	2%	.25 ppb	.10 ppb (DL)	Treflan
Linuron	1%	18 ppb	2.0 ppb (DL)	Lorox
6. Other Organic Chemcials				
PCB's (arochlor 1248, 1245)	24%	1100 ppb	.5 ppb PMCL	
Cyanide	19%	420 ppb	200 ppb HA	
Phenol (Total)	19%	150 ppm	5 ppm DL	
Picoline	9.5%	1100 ppb	5 ppb DL	
Pyridine	5%	1100 ppb	5 ppb DL	
Napthalene	5%	36 ppb	5 ppb DL	

PMCL = Proposed Maximum Contaminant Level
MCL = Final MCL
DL = Detection Limit
HA = Lifetime Health Advisory (Draft or Final)

categories of contaminants were documented. A statistical cross tabulation between sources and contaminants was not performed, but their frequency of detection is presented in Table 58. The substances which have been documented to contaminate ground water at the most sites in Indiana are nitrates, aromatic, non-halogenated, and halogenated volatile organic chemicals, primarily solvents and dissolved petroleum products. 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. (Additional discussion of nitrates in ground water occurs in the section on nonpoint source pollution.) In general, it is expected that about two percent of the public water supply wells and from seven to ten percent of the private water supply wells in the State, if tested, would exceed the 10 mg/l level for nitrate. The highest concentration for nitrate documented is 1,190 mg/l, and the median range of nitrate levels recorded is about 14-16 mg/l for those reported above 10 mg/l.

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 microbiological capacity for conversion to nitrate is exceeded. Concentrations of ammonia in excess of 0.05 mg/l are considered to be elevated above natural conditions. The registry includes a maximum value of nearly 175 mg/l from a spill vent. The majority of the nonpoint source monitoring records for ammonia above 0.05 mg/l involve concentrations in the range from 0.05 to 2.0 mg/l, however.

Volatile Organic Compounds

Halogenated, non-halogenated, and aromatic volatile organic chemical compounds (VOCs) are the most common ground water contaminants, present at about 300 sites (Table 59). The most frequently detected chlorinated (halogenated) VOCs are trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA). Nearly 20 other halogenated chemicals have also been documented. This group 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.

TABLE 58. *SUBSTANCES CONTAMINATING GROUND WATER*

ALL GROUND WATER (590 SITES)			DRINKING WATER ONLY (480 SITES)		
TYPE OF CONTAMINANT	NUMBER OF CASES	PERCENT OF TOTAL	TYPE OF CONTAMINANT	NUMBER OF CASES	PERCENT OF TOTAL
Nitrates	172	29.5%	Nitrates	150	33.3%
Aromatic/non-halogenated volatile organic chemicals	151	25.6%	Halogenated volatile organic chemcals	118	26.2%
Halogenated volatile organic chemcals	144	24.4%	Aromatic/non-halogenated volatile organic chemicals	112	24.8%
Heavy metals	96	16.3%	Heavy metals	60	13.3%
	62	10.5%	Chlorides/salts	38	8.4%
Other metals/inorganics	57	9.7%	Other metals/inorganics	34	7.5%
Chlorides/salts	46	7.8%	Pesticides	33	7.3%
All other organic chemicals *	43	7.3%	Petroleum/petroleum products	32	7.1%
Pesticides	38	6.4%	All other organic chemicals *	27	6.0%
Unknown/other	26	4.4%	Unknown/other	24	5.3%
Coliform bacteria (in aquifer)	20	3.4%	Coliform bacteria (in aquifer)	19	4.2%
Cyanide	4	0.7%	Cyanide	2	0.4%

(Percent total will exceed 100 due to multiple contaminants for some cases.)

* phenols, semi-volatile extractable compuinds

SOURCE: IDEM Ground Water Section Contamination Registry (1989) for Time Period 1956 - 1989).

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. Of 65 sites contaminated with petroleum or petroleum products, 35 involved underground storage tanks leaking motor fuel, heating oil or petroleum based solvents. Another five sites involved spills from above ground storage tanks. Other sites involve 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. Fire and explosion hazards in addition to drinking water risks result from ground water pollution involving these fuels and solvents.

Metals and Inorganics

Inorganic parameters typically analyzed for in 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. At 25 sites, arsenic, lead or chromium exceeded drinking water supply standards, and iron and manganese were greatly elevated, at least forty sites which involve drinking water wells only, have high levels of arsenic, barium, manganese, iron, fluoride or sulfate, and could be affected, in part, by natural water quality conditions associated with heavily mineralized waters from some bedrock aquifers. In over fifty cases, drinking water wells were contaminated with heavy metals such as lead, chromium, or cadmium due to leaching from waste disposal landfills and lagoons.

Chlorides and Salts

Concentrations of chlorides in excess of the secondary public drinking water standard of 250 parts per million can produce objectionable taste in drinking water, particularly at levels of about 500 parts per million or greater. All 46 cases of public or private water wells impacted by chlorides resulted from impacts due to man's activities. Elevated levels of sodium, in excess of 150 parts per million, are typically found in conjunction with elevated chlorides. The majority of the problems resulted from leaching of road deicing salt from uncovered storage piles. The other contaminated sites are associated with crude oil exploration and production activities involving brine disposal pits, brine disposal wells, and improperly abandoned testholes.

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 construction because properly constructed wells should be sanitary. Although thousands of bacteria samples are analyzed

TABLE 59. *NUMBER OF SITES WITH SPECIFIC VOLATILE ORGANIC CHEMICALS*

CHEMICAL	TYPE	NUMBER OF SITES
Trichloroethylene	H	79
1,1,1 Trichloroethane	H	62
Benzene	A	61
Toluene	A	59
Xylenes	A	46
Tetrachloroethylene	H	40
Ethylbenzene	A	39
1,2-Dichloroethane	H	34
1,1-Dichloroethane	H	33
1,1-Dichloroethylene	H	25
Methylene Chloride	H	22
Trans-1,2-Dichloroethylene	H	21
Chloroform	H	18
Vinyl Chloride	H	15
Methyl Ethyl Ketone	NH	11
Acetone	NH	10
Methyl Isobutyl Ketone	NH	7
Carbon Tetrachloride	H	7
Bromodichloromethane	H	6
1,1,2,2-Tetrachloroethane	H	5
1,1,2-Trichloroethane	H	5
Trichlorofluoromethane	H	4
Dibomochloromethane	H	3
Picoline	NH	2
Pyridine	NH	1
Bromoform	H	1
Chlorobenzene	H	1
Methyl Tetiary Butyl Ether	H	1
Tetrahydrofuran	H	1

NOTE: H = Halogenated, A = Aromatic, NH = Non-Halogenated
SOURCE: IDEM Ground Water Section Contamination Registry (1989) for Time Period 1956 - 1989).

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 semi-volatile compounds such as napthalene, styrene and phthalate esters, phenols and polychlorinated biphenyls (PCBs). Pesticides are discussed in the following section on nonpoint source pollution.

III. Ground Water Pollution from Agricultural Chemicals

The pollution of ground water with agricultural chemicals from nonpoint sources is an issue that has received considerable attention in Indiana in recent years. About 70 percent of the land use in the state is agricultural and Indiana is a leading producer nationally of both field crop and animal agricultural products. Previously, very little data existed on fertilizers and pesticides in ground water in Indiana. (Pesticides include chemicals to control weeds, insects, fungi, worms, etc., while fertilizers primarily include nitrogen and phosphorous, for purposes of this report.) Concerns over widespread application of agricultural chemicals onto farmland with regard to the potential effect on ground water quality have lead to several studies in Indiana during 1987-89.

In the previous Indiana Water Quality Management 305(b) Report for 1986-87 and in greater detail in the Indiana Nonpoint Source Assessment Report of 1989, both prepared by IDEM, the available data on nitrates and pesticides in ground water was presented. Nitrate was reported to be a frequently encountered nonpoint source contaminant in rural wells. However, most of the older pesticide data was very limited. Filling this data gap was dependent upon findings from the Indiana Pesticide Survey which was previewed in the Nonpoint Assessment. Therefore, the issue of agricultural chemicals nonpoint source pollution of Indiana's ground water has been addressed by reporting the results of the Indiana Pesticide Survey here in this report.

The National Pesticide Survey by EPA was another project in 1988-89 to address the agricultural chemicals nonpoint source issue. Approximately 12 public water supply and 40 private water supply wells were sampled in Indiana as part of this EPA project. The results have not been formally released yet, so they are not reported here. All the other information from the Indiana Nonpoint Source Assessment has not been repeated here either. No other new data source on agricultural chemicals in Indiana ground water was developed in 1988-89 that was not already described in the Nonpoint Source Assessment.

Indiana Pesticide Survey

The Indiana Pesticide Survey is a multi-phase study to assess the occurrence of agricultural chemicals in drinking water supply wells statewide. The project is being conducted by the Ground Water Section of the IDEM with grant support from the United States Environmental Protection Agency, Region V.

Three phases of the project were completed between August 1987 and November 1988, in which 276 ground water quality samples were collected from 207 public water supply wells. A fourth phase, which is currently being conducted, involves the collection of ground water quality samples from private drinking water supplies in selected geologically vulnerable aquifers of the rural areas of the State.

By the end of 1990, over 500 ground water quality samples will have been collected from 160 private water wells in five geologically diverse aquifers systems. This study is funded to continue through 1991.

The purpose of the Indiana Pesticide Survey is to determine which pesticides can be detected, their frequency and range of detection and geographic location; and to compare these findings with potential adverse health risk thresholds. Moreover, the frequency, location, and concentration of nitrate, ammonia, phosphorus and other nutrient indicators are also being assessed, along with a suite of volatile organic chemicals that may be associated with the non-active ingredients of pesticide formulation.

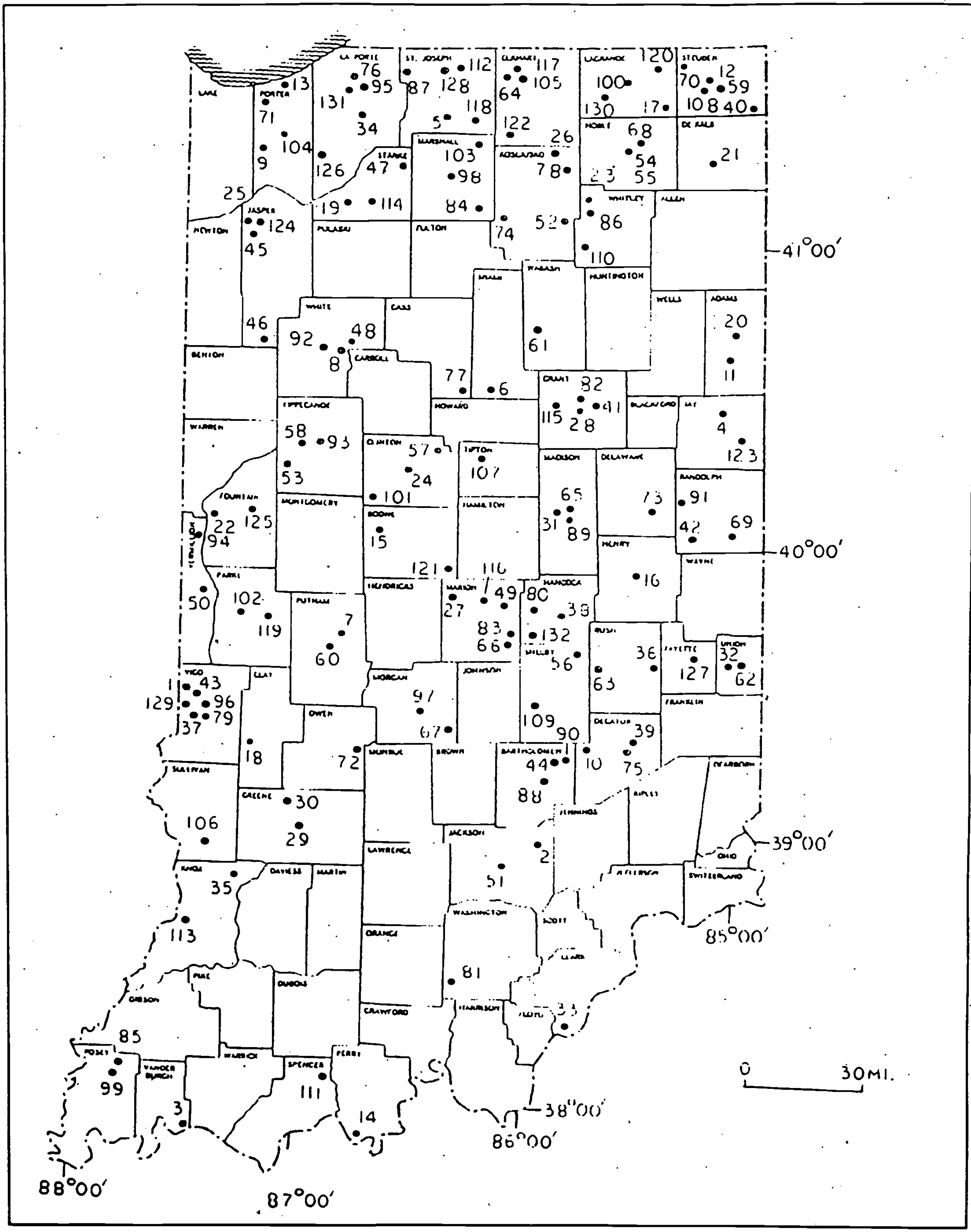
Indiana Pesticide Survey - Phase 1

Phase 1 of the Indiana Pesticide Survey was completed in fall 1987, and included the collection of untreated ground water at 132 sites (Figure 49). The project was based on a weighted random sample of 2.6 percent of the public water supplies in the state, to include 102 non-community systems and 20 community systems. The sites were randomly selected using a computer file and random number generator, while the ratio of community to non-community systems was intended to resemble the numbers of each in the state. Community systems serve over 25 persons year round, whereas non-community systems supply over 25 persons at least 60 days a year.

Ground water collected in Phase 1 was analyzed for 78 pesticides, in addition to nitrate as total nitrogen and ammonia as total nitrogen. Analysis was provided by USEPA regional contract laboratories.

Positive detections of pesticides occurred at five (4.0 percent) of the sites. Atrazine was detected at one location, while 1,2-dibromoethane (EDB) was found in four of the water wells sampled. The five water wells indicating positive detections of pesticides were resampled in spring 1988. At the time, only one of the four water wells was found to contain EDB. Moreover, the water from this same well also contained a positive concentration of 1,2- dibromo-3-chloropropane (DBCP). Atrazine was not

FIGURE 44. *MAP SHOWING SAMPLE LOCATIONS FOR INDIANA PESTICIDE SURVEY PHASE 1*



detected in the spring 1988 sampling event. Concentrations of EDB ranged from 0.05 ug/l to 0.24 ug/l. The 0.24 ug/l value was from the water sample collected in spring 1988, showing an increase from 0.09 ug/l in fall 1987. The fall 1987 sample containing atrazine was analyzed to show 0.45 ug/l.

Nitrite as total nitrogen was detected above 0.1 mg/l in 56 of the 132 ground water quality samples. These values ranged from 0.11 mg/l to 14.50 mg/l. The median concentration of nitrate as total nitrogen equaled 0.85 mg/l, while 46 percent of the water wells indicating detectable concentrations had levels greater than 1.0 mg/l. Four water wells, or seven percent of those showing detectable concentrations had values greater than 10 mg/l, the maximum contaminant level applied to public water supplies. (National Interim Primary Drinking Water Regulations, USEPA, 40 CFR 141).

Ammonia as total nitrogen was detected above 0.05 mg/l in 59 of the 132 ground water quality samples, while these values ranged from 0.06 mg/l to 6.89 mg/l. The median concentration of ammonia as total nitrogen equaled 0.39 mg/l, whereas 16 percent of the samples containing detectable concentrations had values greater than 1.0 mg/l. Two water wells had an extremely high level of ammonia with values of 4.42 mg/l and 6.89 mg/l, respectively.

Indiana Pesticide Survey - Phase 2

Phase 2 of the Indiana Pesticide survey relied on a non-random site selection process aimed at sampling the ground water at 50 community supply wells in the state. The non-random process was utilized in order to assess the impact of nonpoint source pollution from agricultural chemicals on public water wells at greatest risk due to their location and geologic vulnerability.

Site Selection Methods

Two approaches were combined to delineate and rate the vulnerability (lack of low permeability geologic material) of public water supply well fields, the "well log method" and the "map method". The vulnerability ratings required the acquisition and organization of an extensive amount of data from a variety of sources.

First, the existence of public water supply wells was obtained from a 1984 bulletin published by the Indiana State Board of Health which lists the owner-operators, source of supply and population served ("Data on Indiana Public Water Supplies, Bulletin PWS-311, 1984). A list was compiled of 436 public water supply well fields, which consisted of over 1800 drinking water wells. Secondly, the available driller's records (well logs) for the 1800 water wells were obtained from the Indiana Department of Natural Resources, the Indiana State Board of Health, individual drillers, and from public water supply systems. The exact geographic location of these wells was then plotted on 7 1/2 minute topographic maps in order to determine if a well field was situated in a rural, agricultural type environment.

Following this procedure, all well field locations were transferred to 1° x 2° regional geologic maps (map method) which depict the surficial geology as dictated by its depositional environment. In this approach, vulnerability is considered to be the relative ease for an agricultural chemical to move into the ground water from a release at the surface. This is dependant in part on the permeability and thickness of the material overlying and containing the ground water. Therefore, two conditions were considered to represent relatively high vulnerability to contamination: permeable deposits of mostly sand and gravel and unconsolidated material less than 50 feet thick.

Of the well fields considered to be vulnerable to contamination from agricultural chemicals as delineated by the "map method", the "well log" method was then employed to further define information on well depth, static water level, and the vertical sequence and thickness of the geologic material. The remaining public water supply well fields were then assigned a vulnerability rating based on the most vulnerable well.

Vulnerability ratings were high, medium, or low based on the reported presence and thickness of clay layers below the top 20 feet of surface deposits. The vulnerability rating criteria were:

High - Zero to 5 feet
Medium - 5 to 20 feet
Low - over 20 feet

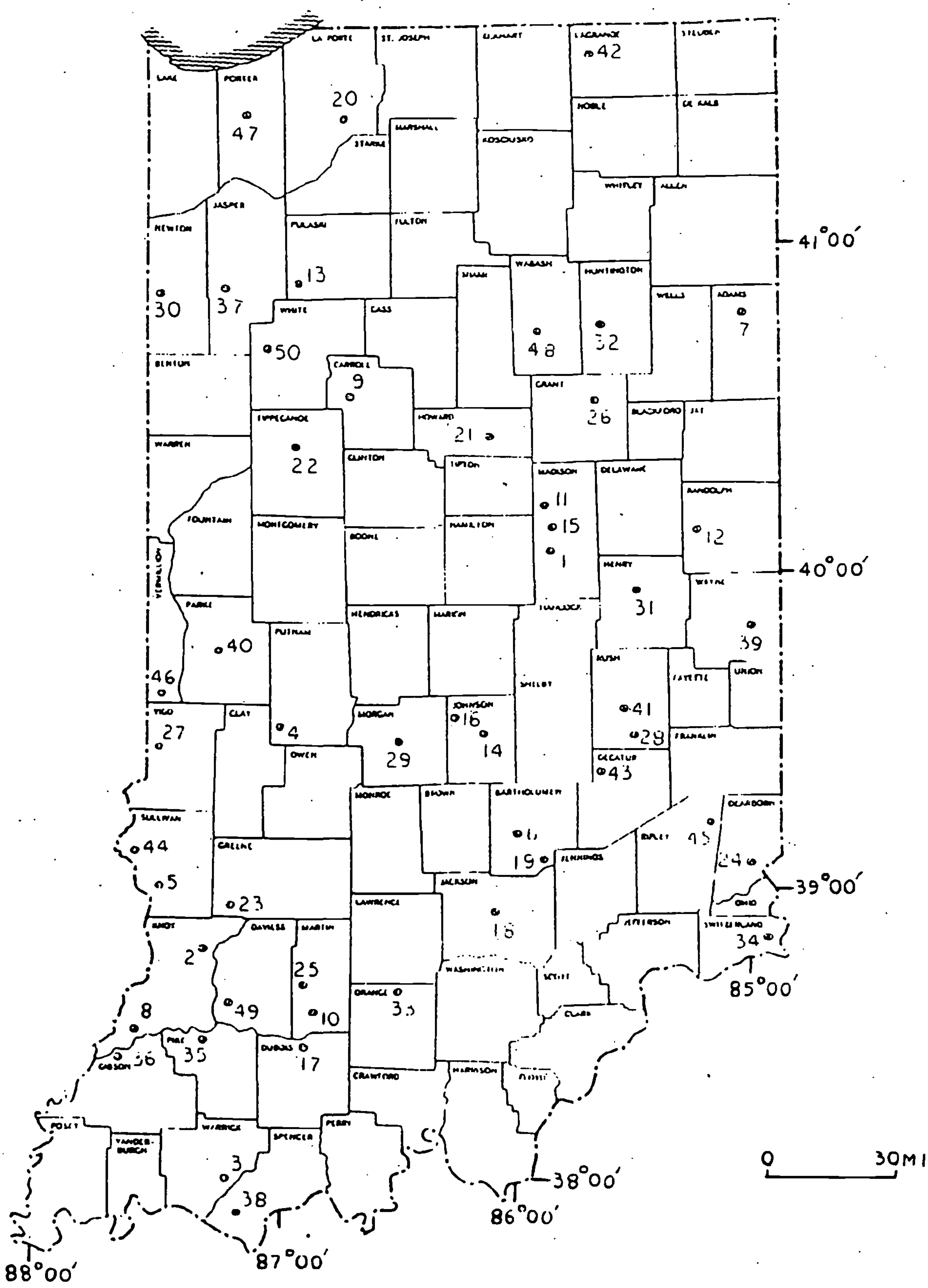
This rating scale used the following assumptions regarding the relative vulnerability of well fields due to the presence or lack of confining layers in the stratigraphic sequence: (a) Less than 5 feet of continuous clay is insignificant as a confining layer or as a factor in retarding the downward migration of agricultural chemicals. (b) Continuous clay layers of greater thickness (5 to 20 feet or over 20 feet) are relatively more significant as confining zones or for retarding the downward migration of contaminants. In summary, vulnerability was considered roughly equivalent to aquifer confinement as a suitable factor in rating priority sites for Phase 2 activities. This, in conjunction with pre-surveillance of the well fields based on their topographic map location to assure a lack of point source, contamination potential was used to produce a list of 50 sample sites selected for Phase 2 of the Indiana Pesticide Survey (Figure 45).

Sample Results

Phase 2 samples were analyzed for 78 pesticides by USEPA regional and contract laboratories, with nitrate as total N, ammonia as N and 26 volatile organic chemicals analyzed at the Indiana State Board of Health Environmental Laboratory.

Of the 50 sample sites, pesticides were detected in four water wells (8 percent of the total). Two different pesticides were found, including EDB with a concentration range of 0.04 ug/l to 0.85 ug/l, and DBCP with a range of 0.04 ug/l to 0.11 ug/l. Three of these water wells were completed in unconsolidated material, while one was completed in bedrock. Resampling of

FIGURE 45. *MAP SHOWING SAMPLE LOCATIONS FOR INDIANA PESTICIDE SURVEY PHASE 2*



these water wells in June 1988 as part of Phase 3 of the Indiana Pesticide Survey indicate that EDB and DBCP were not detected in three of wells. Nevertheless, one of the wells was confirmed to contain EPB at a reduced concentration of 0.04 ug/l as compared to 0.08 ug/l during the March 1988 sampling event.

Nitrate as total nitrogen was detected above 0.10 mg/l in 25 of the 50 wells sampled, with a range of 0.21 mg/l to 6.75 mg/l. The median value of nitrate equaled 1.42 mg/l, while 56 percent of the water wells with detectable concentrations had a value of 1.0 mg/l or greater. Ammonia as total nitrogen was detected above 0.05 mg/l in 23 of the 50 water wells, whereas, the concentrations ranged from 0.06 mg/l to 0.63 mg/l. The median concentrations of ammonia in the water wells having detectable amounts were 0.28 mg/l.

Indiana Pesticide Survey - Phase 3

Phase 3 of the Indiana Pesticide Survey was a continuation of Phase 2, with the addition of 14 public water supply well fields (Figure 46). The site selection for the additional public wells was identical to that in Phase 2. Moreover, 21 non-community supply wells (mostly schools) were selected similarly, from a list of sites reported to contain over 5.0 mg/l nitrate as total nitrogen in the 1985 "Indiana Non-Community Water Supply Survey" (Indiana University School of Public and Environmental Affairs).

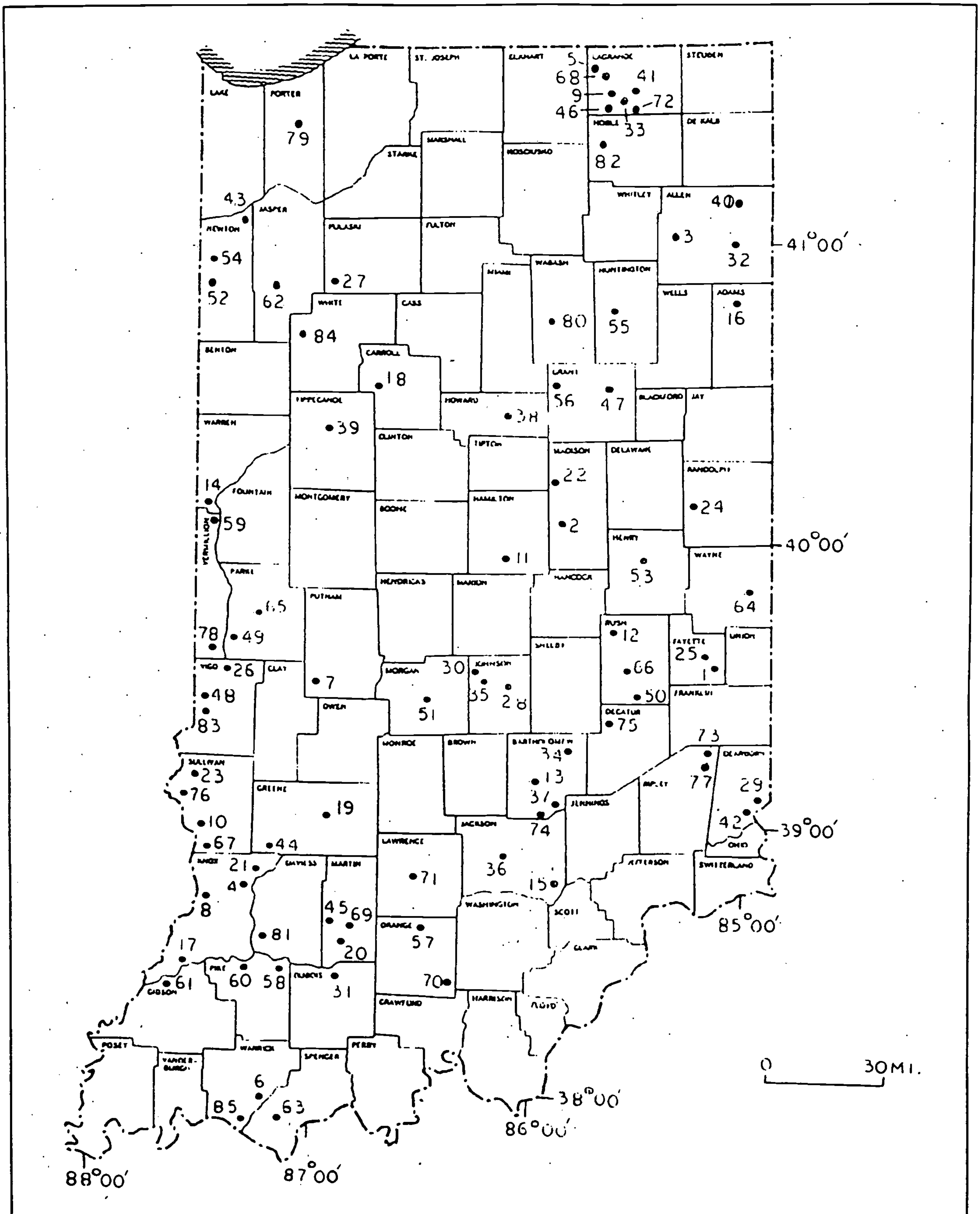
In essence, Phase 3 began an examination of ground water quality throughout a portion of the growing season since these samples were collected in June 1988, with confirmation samples being collected in September 1988. Moreover, 1988 was considered to be a drought year with spring and summer precipitation average being well below normal in certain parts of the state.

Phase 3 samples were analyzed for 78 pesticides by USEPA regional and contract laboratories. The Indiana State Board of Health Environmental Laboratory provided analysis for four pesticides, 26 volatile organic chemicals, and six nutrient parameters.

In Phase 3, pesticides were detected in the ground water at three of the 85 sample sites. As previously mentioned, EDB was detected at 0.04 ug/l as a confirmation sample for that site from Phase 2. Detectable concentrations of diazinon were found in the second water well, while a suite of pesticides was found in the third (alachlor at 1.8 ug/l, linuron at 18.0 ug/l, and simazine at 5.2 ug/l). A second sample collected from this water well indicates the forementioned pesticides to not be present in September 1988. Nevertheless, the water at that time was found to contain trifluralin at 0.25 ug/l, metribuzin at 1.4 ug/l, and atrazine at 49.0 ug/l.

Nitrate as total nitrogen was detected above 0.1 mg/l in 56 of the 85 wells which were sampled, while these value ranged from 0.1 mg/l to 18.0 mg/l. The median value of nitrate equalled 2.3 mg/l, whereas 68 percent of the water wells with detectable concentrations had values of 1.0 mg/l or greater. Six water wells, or eleven percent of those showing detectable concentrations, had values greater than 10.0 mg/l nitrate as total nitrogen.

FIGURE 46. *MAP SHOWING SAMPLE LOCATIONS FOR INDIANA PESTICIDE SURVEY PHASE 3*



All six of these wells were completed in unconsolidated material, and generally were very shallow, less than 30 feet in depth. Ammonia as total nitrogen was detected above 0.1 mg/l in 30 of the 85 ground water quality samples, while these values ranged from 0.1 mg/l to 1.5 mg/l. The median concentration of ammonia equaled 0.3 mg/l, and 4 percent (2 wells) had concentrations greater than 1.0 mg/l. Phosphorus as total P was also analyzed in Phase 3 of the Survey, and was detected above 0.03 mg/l in 27 of the 85 samples collected. The median value of phosphorus equaled 0.04 mg/l, while this parameter had a range of 0.03 mg/l to 0.57 mg/l.

Summary - Indiana Pesticide Survey Phases 1 Through 3

Phases 1-3 of the Indiana Pesticide Survey focused on public water supply wells in Indiana, particularly those which are susceptible to ground water contamination due to the geologic material into which the wells where drilled. In all, 276 ground water quality samples were collected in three seasons at 207 different public well fields. Forty-seven of these sites included the collection of ground water quality samples before and after the planting season.

Positive detections of pesticides were reported at eleven (5 percent) of the sample locations while three of these sites showed positive concentrations upon analysis of confirmation samples. Nine difference pesticides were found, including EDB at nine locations. DBCP was detected in the water at four sites, whereas atrazine was detected at two locations, and diazinon was found to be in the water at one sample site. One water well contained a variety of pesticides including alachlor, linuron, simazine, trifluralin, metribuzin and the forementioned atrazine. Detectable concentrations of pesticides ranged from 0.04 ug/l to 49.0 ug/l. EDB and DBCP, by far the most prevalent pesticides, had concentration ranges of 0.04 ug/l to 0.85 ug/l and 0.04 ug/l to 0.11 ug/l, respectively. The highest concentration of pesticide in well water was 49.0 ug/l atrazine. Two sites showed a detectable concentration of the same pesticide upon the collection of a confirmation sample. At that time the concentration of EDB decreased from 0.8 ug/l to 0.04 ug/l in one well, while the EDB concentration increased from 0.09 ug/l to 0.24 ug/l in the other.

Indiana Pesticide Survey - Phase 4

Phase 4 of the Indiana Pesticide Survey focuses on private water supply wells located in vulnerable geologic environments and rural locations. Site selection involves a non-random method intended to assess nonpoint source pollution effects from agricultural chemicals, and to avoid point source effects. Through 1989, two study areas had been completed, the Topeka Aquifer and the Lower Kankakee Aquifer. Multiple sample rounds at selected water wells throughout a growing season were used to account for temporal variations in the ground water quality. Phase 4 began in spring 1989 and continued through fall 1989. In this phase, 144 ground water quality samples were collected from 48 private water wells. Three sample rounds were performed to include analysis of the ground water quality prior to planting of crops (April - May), after application of fertilizers and pesticides (June - July) and before harvest (September).

Selection of specific water wells to examine utilized a pre- survey questionnaire delivered to all home owners in the two study areas. The form requested information on the private wells and the homeowner's evaluation of their well water quality. Written consent to participate in the studies was also requested. Windshield surveys of the sample sites were then conducted to plot locations on topographic and county plat maps.

Sample locations that could be affected by point sources of pesticides or fertilizers were eliminated from the studies. These include cesspools, manure pits, privies, failing septic tanks, livestock pens and agricultural chemicals storage-mixing-loading sites. Separation distances from organic nitrogen sources used for this screening were 100 feet, and for bulk agricultural chemicals, 500 feet.

Phase 4 private water supply well samples, plus those private water well samples collected as part of the Water Management Basin Studies (next section) were analyzed by Indiana Department of Environmental Management Contract Laboratories and the Indiana State Board of Health Environmental Laboratory. Forty-four pesticides were analyzed, including those in current and past use in Indiana, along with over sixty volatile organic chemicals, over twenty inorganic and general chemical parameters, six nutrients and bacteria. Several pesticide active ingredients were included among the volatile organic chemical analytes as well.

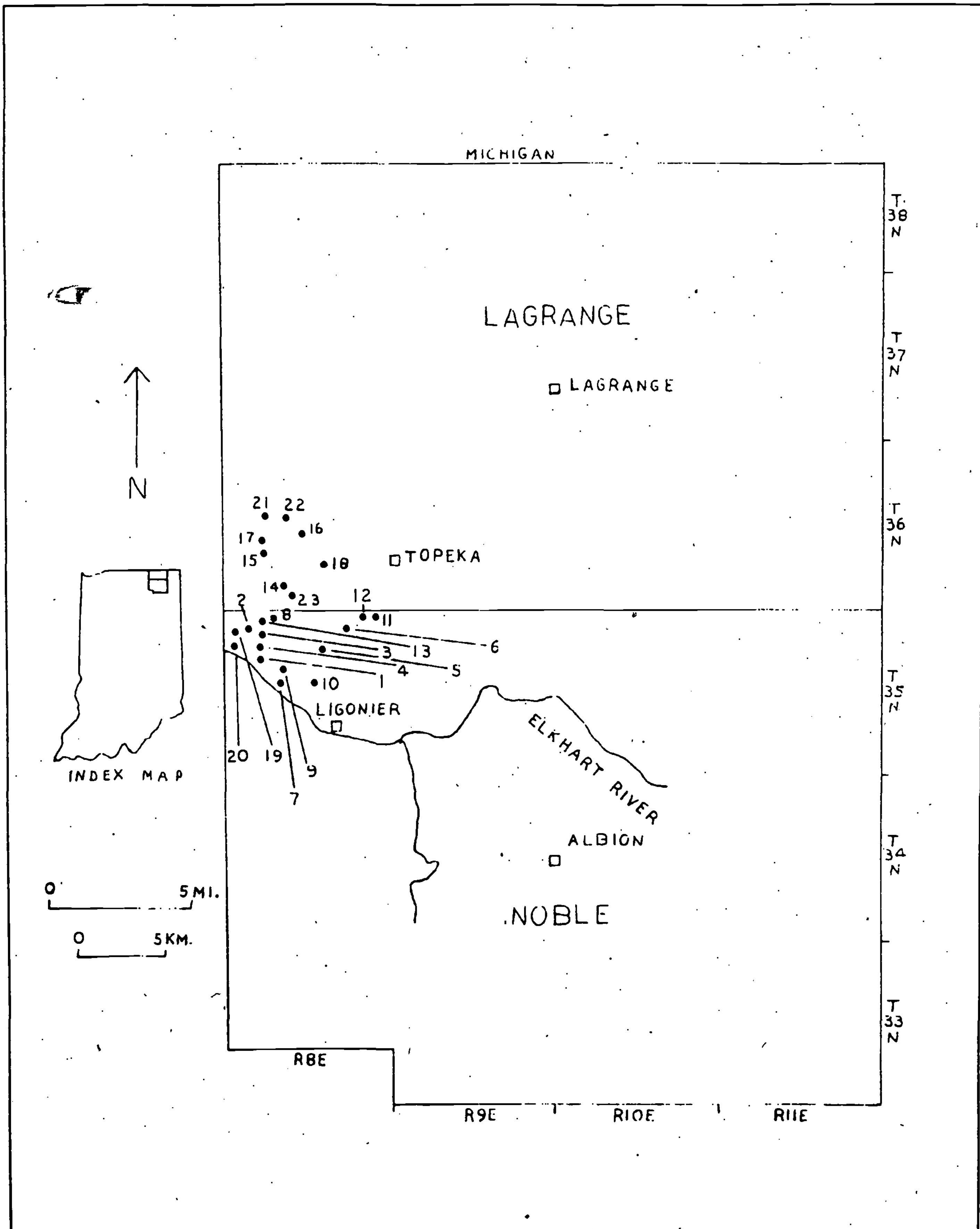
A description of the Study areas and the findings for each of them follows.

Topeka Aquifer Study Area

The Topeka Aquifer is gravel outwash over shale bedrock and is part of the St. Joseph River Basin Aquifer System. The study area is located in LaGrange County north of the Town of Ligonier (Figure 47). It is a region heavily populated by people of the Amish and Mennonite culture, typified by small family farms and extensive dependence on livestock and animal-based agriculture. The shallow aquifer beneath the sandy soils is the main water source for residential, farm, and irrigation wells of various depths. Spray irrigation for crop watering and application of liquid animal manure slurries can be found on some of the large farms in the area. Corn, soybeans, wheat, and hay are the main field crops raised in the area. Herbicides, insecticides, commercial fertilizers and animal manures are used throughout the area as part of the routine agricultural practices.

The study area was selected because of its geological potential for agricultural chemicals to enter the ground water and because of a past history of nitrate contamination in local wells. The local topography is characterized by generally level to gentle sloping terrain. Ground water flow velocity tends to be very slow and generally influenced by limited surface drainage that trends toward the Little Elkhart River. Field applied chemicals leached beyond the root zone could be expected to persist in the aquifer. More importantly, past sampling efforts in this region through the Indiana Pesticide Survey, Indiana Non-Community Water Supply Survey and IDEM Ground Water Section investigations have indicated a high percentage of wells may exceed the 10 parts per million nitrate standard. The cause of this contamination was thought to be nonpoint source in origin.

FIGURE 47. ***MAP SHOWING SAMPLE LOCATIONS FOR INDIANA PESTICIDE SURVEY PHASE 4 (TOPEKA AQUIFER)***



During May 1989 through September 1989, 23 private water supply wells were sampled. In all, eight of the 25 water wells were found to contain pesticides at one time or another, the majority of these being detected in the ground water during the May sampling event. None of the water wells indicated positive concentrations of pesticides for two consecutive sampling events, although one well did exhibit the presence of pesticide during the May and September collection of samples.

Fifteen different pesticides were reported, with values ranging from 0.06 ug/l to 12.0 ug/l. A suite of organochlorine pesticides was detected in three water wells, whereas 2,4-D was also found in three wells.

Nitrate as total nitrogen was detected at least once in all 23 of the water wells, with values ranging from 0.34 mg/l to 46.93 mg/l. Concentrations of nitrate in the ground water generally became higher as the growing season progressed. Eight water wells exceeded the nitrate standard of 10 mg/l, while 4 or these wells exceeded that standard during all three sampling events. Interestingly enough, two water wells containing nitrate above the standard also were found to contain positive concentrations of pesticides.

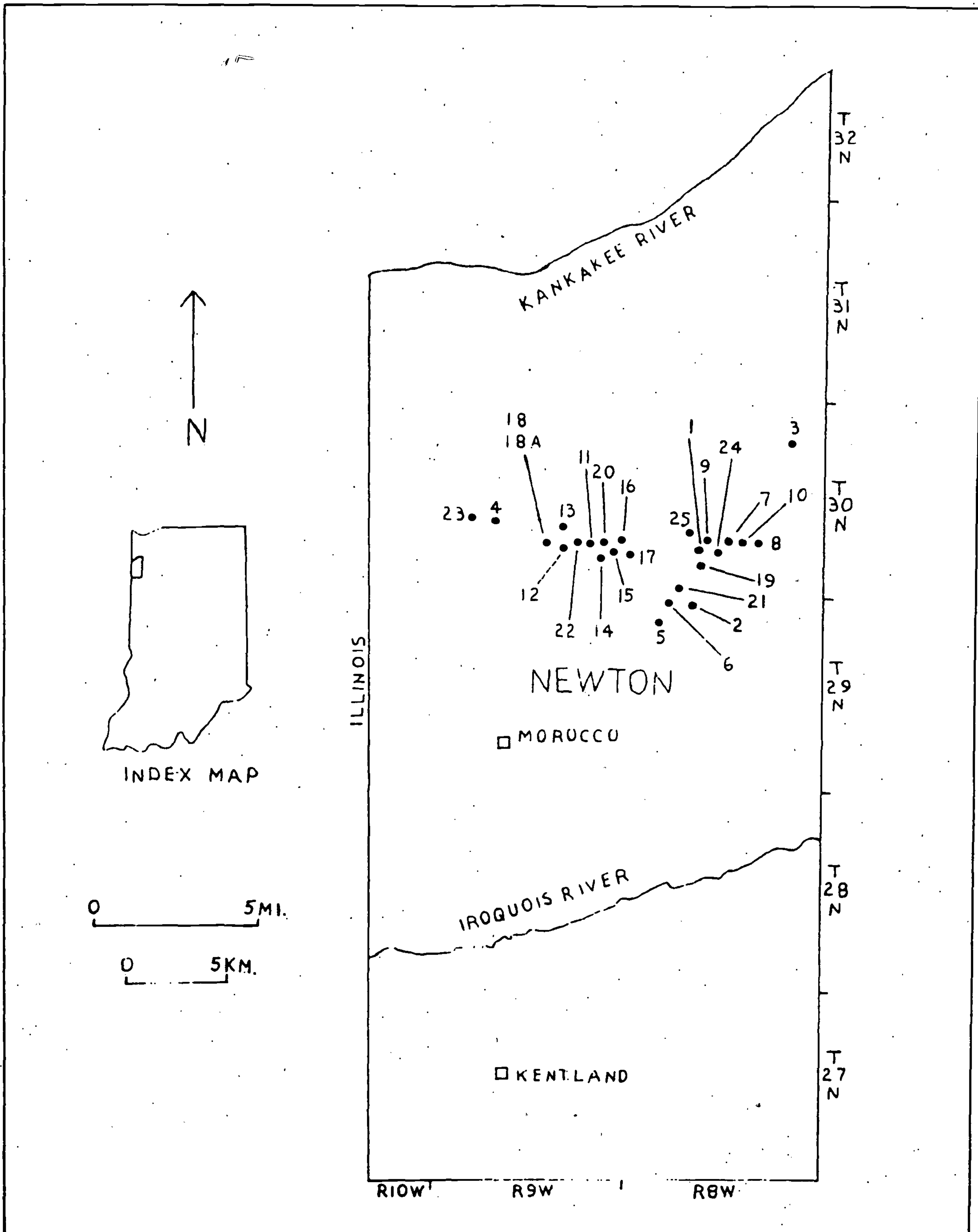
Lower Kankakee Aquifer Study Area

The Kankakee Aquifer System is a broad glacial outwash aquifer extending from the Indiana - Illinois state line northeastward to near LaPorte. The Lower Kankakee Aquifer study area includes a sand and gravel water table aquifer above a carbonate bedrock aquifer. It is located in Newton County near the towns of Fair Oaks and Enos, and along the south edge of the Prudential Insurance Company's Fair Oaks Farm (Figure 48). This is the region of the former Great Kankakee Swamp of northwest Indiana, which was drained in settlement times to provide for farming. In the study area, extensive drainage ditches provide seasonal lowering of the water table in the sandy soils to allow for cultivation. The topography is flat and ground water flow velocity and direction are likely to be almost stagnant, although some localized influence on ground water flow from the drainage systems and a regional trend toward the Kankakee River may exist.

The study area was selected for several reasons. There are potential hydrogeological conditions where field applied chemicals leached beyond the root zone could tend to persist in the aquifer near the farm fields. There is widespread use of center pivot spray irrigation over large areas to raise corn, soybeans and other row crops. The water table and underlying carbonate aquifers have been shown to be interconnected. A combination of bedrock and unconsolidated aquifer wells can be found in the study area,so potential impacts on wells in both aquifers could be examined through the sampling. Finally, data from earlier phases of the Indiana Pesticide Survey, and other well water quality analyses had indicated the presence of elevated nitrate levels and detectable pesticides could be found in this area.

Similar to the Topeka Aquifer Study, 25 private water wells completed in the Lower Kankakee Aquifer were sampled. The sampling period extended from April 1989 through September 1989.

FIGURE 48. *MAP SHOWING SAMPLE LOCATIONS FOR INDIANA PESTICIDE SURVEY PHASE 4 (KANKAKEE AQUIFER)*



Upon combining data from the three sampling periods, it was determined that pesticides were detected in three of the 25 water wells. This included a suite of organochlorine pesticides detected in one water well during April 1989. Moreover, dicamba was found above its detection limit in two water wells. In all, a total of eight different pesticides were detected with concentrations in well water ranging from 0.08 ug/l to 5.0 ug/l. Of particular interest was one well site, ID No. 8 (Figure 48) in which pesticides were detected in all three sampling events. During the April 1989 sampling period, this water well was found to contain a variety of organochlorine pesticides, indicating a range of concentrations from 0.08 ug/l to 0.80 ug/l. In July 1989 and September 1989 these pesticides were not detected. Nevertheless, the water was found to contain 1.37 ug/l endosulfan sulfate in July and 0.29 ug/l of endosulfan sulfate in September.

Nitrate as total nitrogen was detected at least one time in all of the water wells studied, with values ranging from 0.1 ug/l to 84.0 ug/l. As occurred in the Topeka Aquifer, nitrate concentrations generally increased as the growing season progressed. Four water wells exceeded the nitrate standard, while only one well exceeded that standard consistently.

Water Management Basin Studies

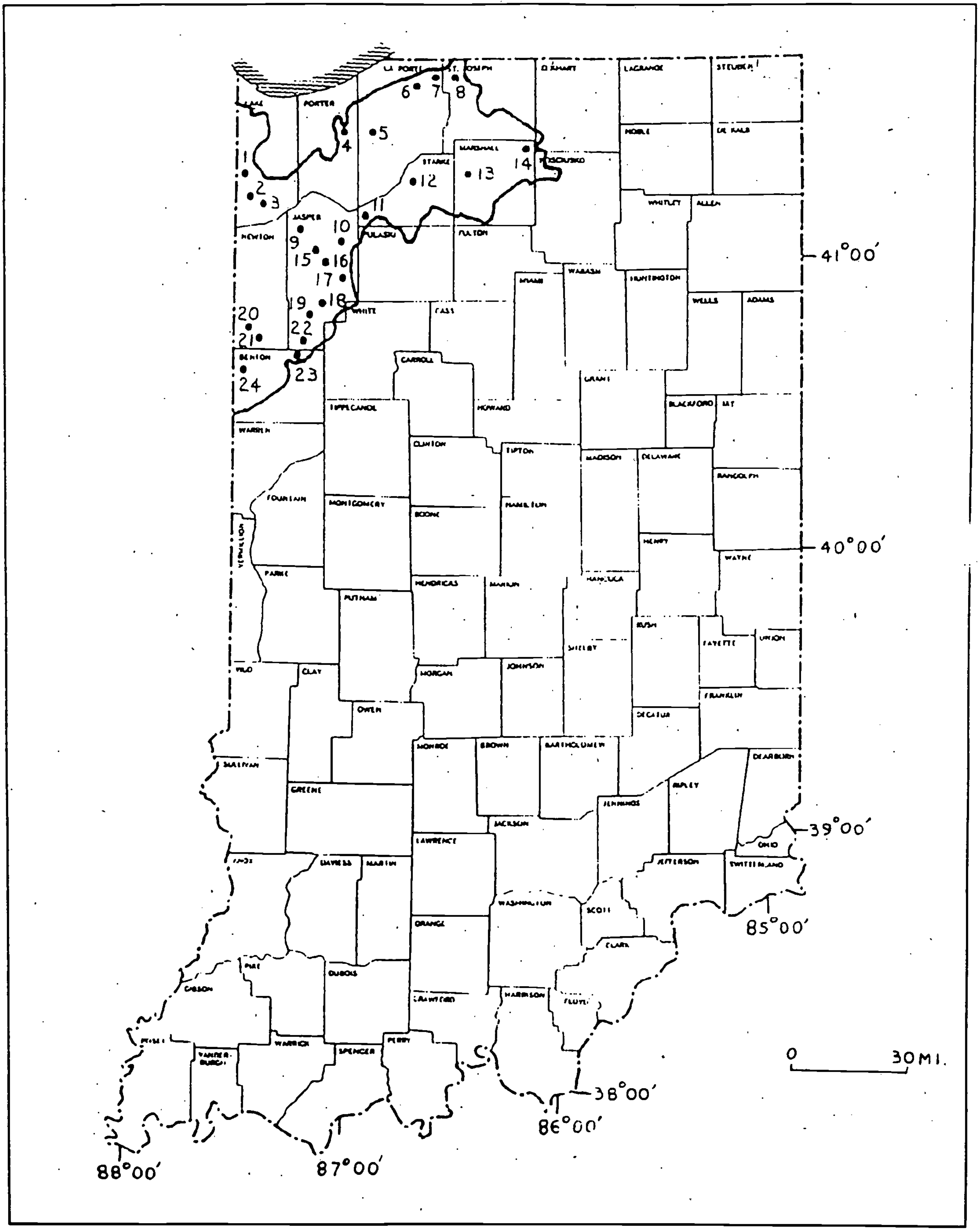
An ongoing project conducted by the Indiana Department of Natural Resources includes the assessment of water resource availability throughout Indiana's twelve major water management basins. In a cooperative effort with the Department of Natural Resources, the Indiana Department of Environmental Management Ground Water Section investigated the effects of nonpoint source pollution from agricultural chemicals in three of the 12 basins: the Kankakee River Basin, Maumee River Basin and West Fork White River Basin, during 1986-89.

The Indiana Department of Natural Resources randomly selected a set of private wells in each study area from a population of those wells with a completed drilling record which had been field verified. From this sample set, the Ground Water Section identified and field located wells in vulnerable geologic environments and rural locations to be studied as part of the Indiana Pesticide Survey. Indiana Department of Natural Resources' concurrent resource assessment included aquifer mapping and collection of ambient ground water quality samples not affected by point sources of pollution, with analysis by IDNR for major anions and cations and physical parameters. The Pesticide Survey work intends to provide a simple, broad overview of nonpoint source effects on ground water over the entire management basin area.

Kankakee River Basin

The headwaters of the Kankakee River Basin begin in St. Joseph County, and extend in a southwesterly direction before leaving the state on the boundary between Lake County and Newton County (Figure 49). The area is floored by a huge glacial outwash plain bounded by moraines in the north and the south. Shales underlie the unconsolidated deposits in the northern part of the basin while limestone and dolomite dominate the bottom portion.

FIGURE 49. *MAP SHOWING SAMPLE LOCATIONS WITHIN KANKAKEE RIVER BASIN*



In summer 1986, ground water quality samples were collected from 24 private water wells within the basin, including 16 water wells completed in unconsolidated material and 8 water wells completed in the bedrock. The average depth of these wells completed in unconsolidated deposits equaled 67 feet, while bedrock water wells averaged 186 feet in depth.

Water from these wells was analyzed for only ten pesticides and 26 volatile organic chemicals, unlike other study areas in Phase 4. No detectable concentrations of volatile organic chemicals were observed, although one water well contained 2.8 ug/l alachlor. This water well, a 219 feet bedrock well, was resampled in the fall 1986 as a confirmatory measure. At that time the well was found to contain 1.1 ug/l of alachlor.

MAUMEE RIVER BASIN

The boundaries of the surface water drainage basin of the Maumee River defines the area of the water resource assessment study conducted by the Indiana Department of Natural Resources. Similar to the Kankakee River Basin, a cooperative investigation of nonpoint source pollution from agricultural chemicals was performed by the Indiana Department of Environmental Management Ground Water Section.

The study area extends from Cedar Lake in the north to Berne in the south, and from the Indiana-Ohio border to near Ft. Wayne. It includes DeKalb County, with portions of Steuben, Allen, Noble, Wells, and Adams Counties (Figure 50).

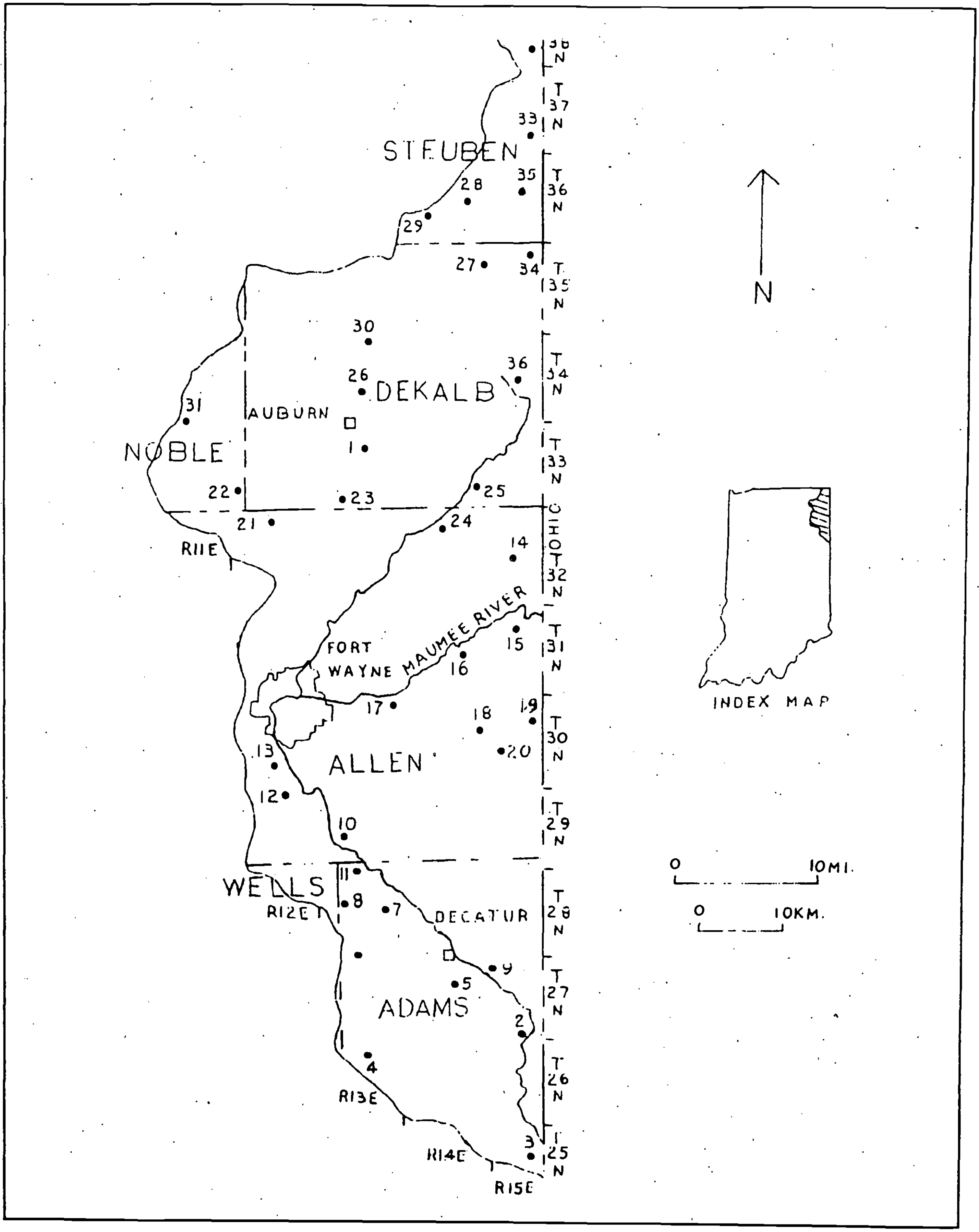
The geology of the Maumee River Basin consists mainly of thick till and morainal deposits, with a few scattered outwash, alluvium, dune and lacustrine deposits. The bedrock consists of carbonates in the south progressing to shales in the north. The majority of water wells are completed in the unconsolidated deposits.

There are several reasons for including the Maumee River Basin in the private water well study phase of the Survey. The longest use of no-till, minimum till agricultural practices in Indiana has occurred in this region. Because such an approach to farming relies more heavily on chemical control of weeds and insects, the potential for ground water contamination could be relatively higher.

In fall 1988, ground water quality samples were collected from 36 water wells within the Maumee River Basin. The sample locations consisted of 23 water wells completed in the bedrock and 13 in unconsolidated deposits. The average depth of the unconsolidated water wells was 81 feet and the bedrock water wells had an average depth of 122 feet.

Nitrate as total nitrogen was observed above its detection limit in 10 of the 36 water wells. Values ranged from 0.01 mg/l to 0.07 mg/l, with a median value of 0.03 ug/l. Ammonia as total nitrogen was detected in 32 of the water wells sampled. These values ranged from 0.2 mg/l to 0.9 mg/l, while the median concentration equaled 0.4 mg/l. Phosphorus as total P was observed in 7 of the 36 sample location sites, with values ranging from 0.04 mg/l to 0.09 mg/l. The median value of phosphorus equalled 0.05 mg/l.

FIGURE 50. *MAP SHOWING SAMPLE LOCATIONS WITHIN MAUMEE RIVER BASIN*



Pesticides were detected in three water wells. Specifically, the pesticide dicamba was detected with values ranging from 10.6 ug/l to 44.2 ug/l. The three affected water wells were all completed in unconsolidated deposits at depths of 42 feet, 190 feet and 260 feet. Two of these three water wells also contained the largest concentration of phosphorus found in the study area. In January 1989, the three water wells were resampled and analyzed for dicamba. At that time, no detectable concentrations were observed in any of the water wells.

WEST FORK WHITE RIVER BASIN

The West Fork White River Basin extends from Pike County northward to Tipton County, with an east-west limit from Vigo to Randolph County (Figure 51). Pesticide Survey study locations were in Clay, Delaware, Greene, Hamilton, Hancock, Hendricks, Johnson, Madison, Monroe, Owen, Putnam and Randolph Counties.

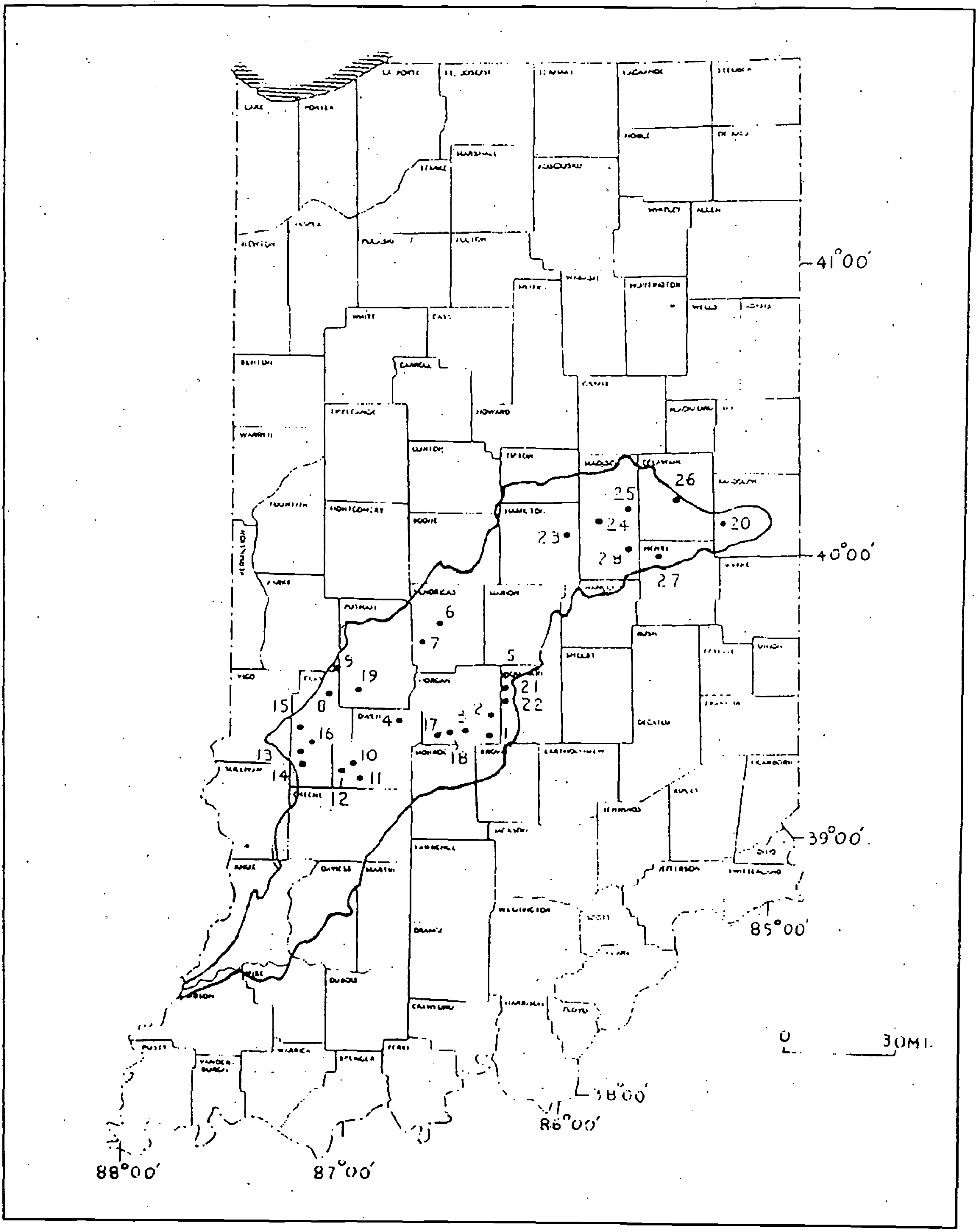
From its headwaters in east central Indiana to the confluence with the Wabash River, the West Fork White River Basin encompasses a variety of geologic environments. The upper portion of the basin is underlain by unconsolidated material consisting of glacial till and morainal deposits while major stream channels and flood plains are composed of alluvium and valley-train deposits.

The bottom portion of the basin is composed of thin deposits of glacial till. As in the upper half of the basin, stream channels and flood plains consists of alluvium, with minor amounts of valley-train deposits. Lacustrine deposits, some of large areal extent, are present, while a thin blanket of loess atop glacial till bounds the river basin in southwestern Indiana. The bedrock underlying the basin consists of limestones, dolomite and argillaceous dolomite in the upper half, whereas, siltstones, shales and sandstone dominate the bottom half.

Ground water quality samples were collected from 28 water wells in the West Fork White River Basin from August 1989 through February 1990. Fifteen of the water wells were completed in bedrock, having an average depth of 106 feet, whereas, the thirteen water wells completed in unconsolidated material had an average depth of 58 feet.

No pesticides or volatile organic chemicals were detected in the water at the time of sample collection. Nitrate as total nitrogen was detected in 14 water wells, with values ranging from 0.1 mg/l to 12.0 mg/l. The median value of nitrate was found to be 2.6 mg/l. Ammonia as total nitrogen was observed in 13 of the 28 water wells. The values ranged from 0.1 mg/l to 2.3 mg/l, and the median concentration equalled 0.3 mg/l. Phosphorus as total P was found above its detection limit in 12 water wells. It had a range of 0.03 mg/l to 0.31 mg/l with a median concentration of 0.05 mg/l.

FIGURE 51. *MAP SHOWING SAMPLE LOCATIONS WITHIN WEST FORK WHITE RIVER BASIN*



Summary of Pesticides Detected in Water Supply Wells

In addition to the 514 ground water quality samples collected at 343 public well fields and private water wells in studies conducted as part of the Indiana Pesticide Survey, nearly another 300 samples have been collected by the Ground Water Section as part of its complaint response program. As in the Survey, these ground water quality samples were also analyzed for pesticides in the effort to determine if the water posed a health risk to the consumer. These two data sets were combined for this summary. Figure 52 indicates the 46 locations in Indiana where pesticides have been found in detectable concentrations in water supply wells.

Since 1984, 23 different pesticides have been detected with concentrations ranging from 0.1 micrograms per liter to 230.0 micrograms per liter. The majority of the water wells with detectable concentrations of pesticides are completed in unconsolidated material. In all, 30 of the 46 sites are private water wells, 8 are community water wells, and 8 are non-community water wells.

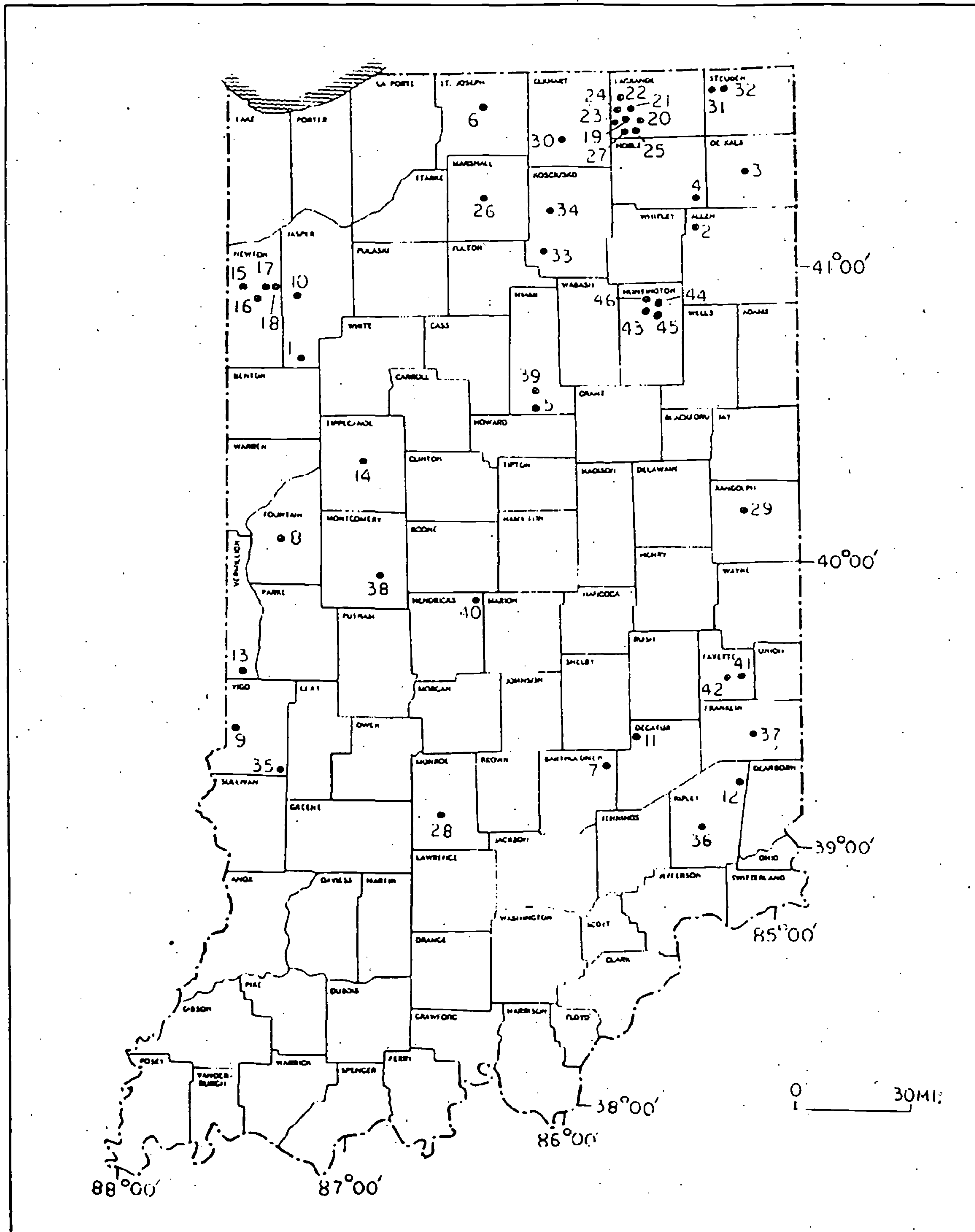
Nineteen of the contaminated water wells were related to a non-point source, while 16 water wells were attributed to a point source of pollution. Four became contaminated as a result of pesticide misuse, whereas the remainder were contaminated due to a variety of reasons such as spills, backsiphonage, or poor housekeeping.

Nine pesticides were detected much more frequently than others and include in descending order; atrazine in 12 wells, alachlor in 9 wells, dicamba, metolachlor and EDB each in 8 wells, 2,4-D in 5 wells, and DBCP, lindane and trifluralin each in 4 wells. In summary, for the combined total of pesticide detections in the 46 water wells, 57 were below a drinking water standard (EPA Maximum Contaminant Level or Lifetime Health Advisory Limit), while 45 equalled or exceeded the standard. Nevertheless, confirmation samples indicate that upon resampling a particular contaminated water well, the majority of the pesticides were then either not detectable or fell below the drinking water standard.

The available data on pesticides in ground water in Indiana, through 1989, indicates nonpoint source pollution is at least as significant as point sources. Survey findings suggest that private wells in rural locations are far more likely to have pesticide contamination than public wells in similar settings. Likewise, rural wells will tend to have a higher proportion of pesticide detections than all wells statewide. Although pesticides can be found in well water samples in the state, less than half of these incidents may constitute a long-term health risk to the well users. Also, pesticides in a certain well may not be consistently documented as present over some time period.

About half of the chemicals which have been detected are pesticide active ingredients which are no longer in use due to bans and restrictions, but the remainder are in widespread use statewide today. No single chemical appears so often due to nonpoint source origins, based on this data, that its use

FIGURE 52. *MAP SHOWING LOCATIONS WHERE PESTICIDES HAVE BEEN DETECTED IN WATER SUPPLY WELLS*



ought to be considered for restriction. Similarly, the evidence is lacking that any non- active ingredients of pesticide formulations are occurring frequently in the state's ground water.

By comparison, nonpoint source introduction of field-applied nutrients, primarily nitrate-nitrogen but to some degree ammonia nitrogen appear as common private well contaminants in some rural environments. This suggests that improved nutrient management in agriculture could be important in reducing nitrate and ammonia levels in some aquifers.

In conclusion, efforts to monitor Indiana's ground water for the presence of agricultural chemicals could continue to provide a sound, scientific basis for decision-making. The data can form a basis for statewide pesticide management planning and to target areas where best management practices for use of fertilizers and nutrients on farmland are most needed. Overall, ground water resource protection and land use are interrelated aspects of nonpoint source pollution management. Evidence in Indiana presently suggests where localized concerns can be addressed, a statewide problem can be prevented.

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 than 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 53.

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 silt; beach and shoreline deposits; sandy lacustrine sediments; and valley-train sand and gravel overlain by thin lacustrine or alluvial deposits.

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 53.

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 54.

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 where 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 broader 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

FIGURE 53. *AREAS SUSCEPTIBLE TO GROUND WATER CONTAMINATION*

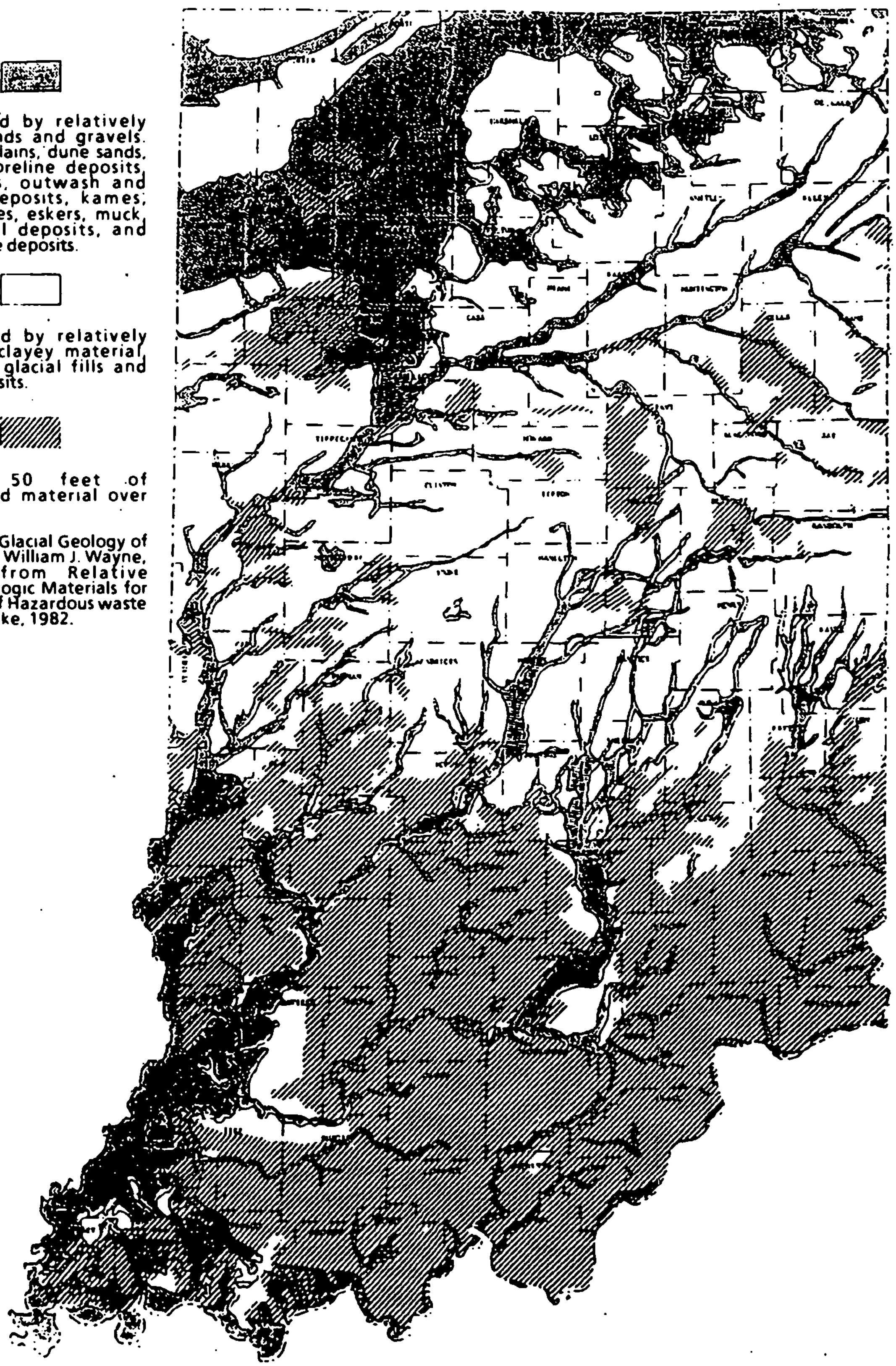
EXPLANATION

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, peal and marl deposits, and sandy lacustrine deposits.

Areas covered by relatively impermeable clayey material, includes thick glacial fills 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 Geologic Materials for Confinement of Hazardous waste by Hill and Hartke, 1982.



SOURCE: IDEM Ground Water Section

FIGURE 54. *AREAS OF EXPOSED KARST GEOLOGY*

SOURCE: IDEM Ground Water Section

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, extent 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 55.

Potential 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 than from a more regional basis. The inventory can provide a starting point for petitioning 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 drainages, including the Wabash River, East Fork White River, West Fork 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 56 for the location of Indiana's potential sole source aquifers and Table 60 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.

FIGURE 55. *WELLFIELDS VULNERABLE TO CONTAMINATION*

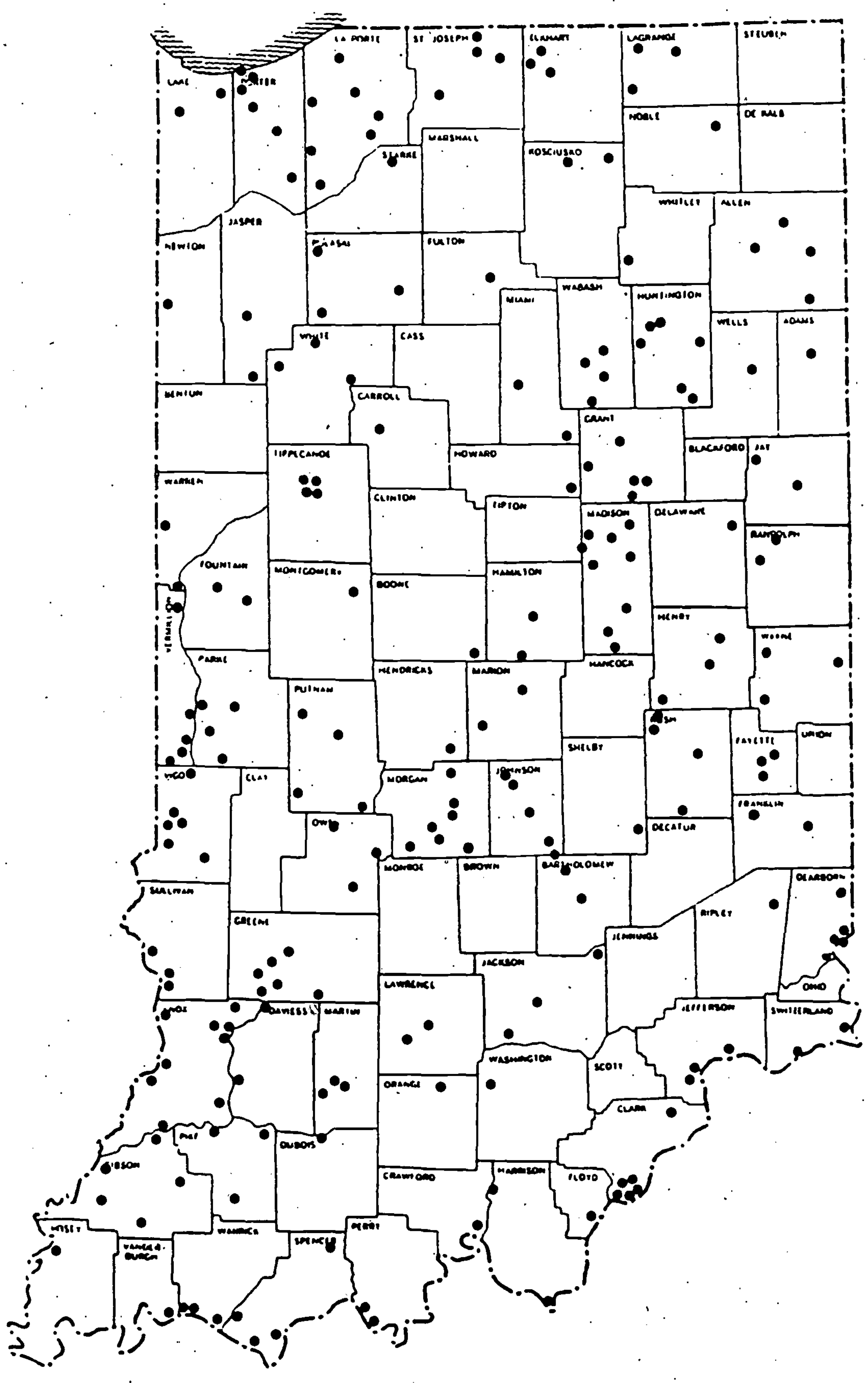


FIGURE 56. · *OURCE AQUIFERS IN INDIANA*

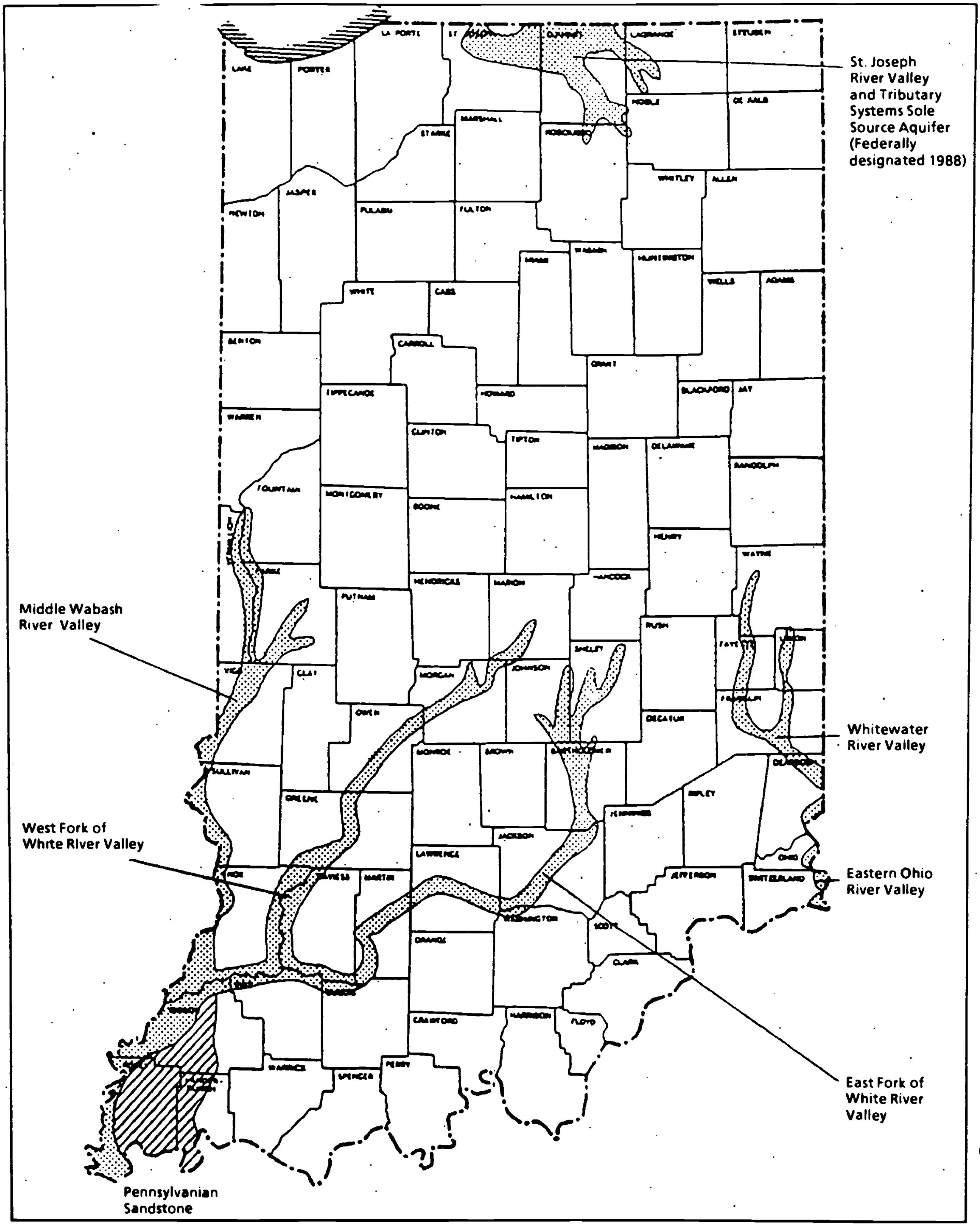


TABLE 60. *GROUND WATER USE IN INDIANA'S POTENTIAL SOLE SOURCE AQUIFERS*

AQUIFER NAME	NUMBER OF PUBLIC WATER SUPPLIES	POPULATION SERVED	POPULATION SERVED
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	.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 Board of Health Public Water Supply division, revised 1984.

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 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

An agency task force was formed to determine how to best assess the effects of combined sewer overflows (CSOs) on the receiving waters and determine when to require corrective actions. U.S. EPA should have comments back on the State Strategy soon. The strategy proposed sampling points for each community. The data should show if the CSOs are significant and, if so, communities can backtrack to the particular overflow that is the source of most problems. If this would happen to be an industry, additional pretreatment could be recommended. The goal is to find the sources causing problems in the CSOs and correct them.

A concern still exists regarding storm water runoff from both residential and rural areas. The runoff sometimes carries contaminants in high enough concentrations to adversely affect water quality. In the past, there had been some confusion concerning the extent to which stormwater should be regulated as a point source.

Although there may be hundreds of storm sewer outfalls in some major Indiana cities, the Water Quality Act of 1987 required EPA to develop regulations for industrial stormwater discharges and for municipal storm sewer systems serving more than 250,000 residents within two years. Within four years, regulations were required for municipal systems serving a population of between 100,000 and 250,000 people. At this point, it appears that this requirement may affect decisions for some of the larger communities regarding the justification for sewer separation projects since treatment may be required for storm water in any event. The DEM is still uncertain how municipal and industrial storm sewers will be regulated. The preference would be to use a general permit for all towns and industries. Currently an informal application is being accepted. Indiana hopes to have a more concrete idea on the storm water permitting process once regulations forecast for late 1990 are in place.

Criteria for Contaminants in Fish Tissue and Sediment

Increased monitoring of fish tissue and sediments for toxic and bioconcentrating materials has occurred in Indiana over the last several years and a considerable amount of data has been collected. 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 and sediment data as to health effects and potential environmental impacts. U.S. EPA should consider taking the lead in developing sediment criteria and health effects criteria for substances in fish tissue for which FDA Action Levels do not exist.

Ammonia Criteria

Indiana accomplished a major revision of its water quality standards during this reporting period. The general water quality standards for most of Indiana's waters were revised to include numerical criteria for many toxic substances, to designate all waters under this rule for full body contact (recreation) and to provide bacteriological criteria for these waters based on *E. coli* as the indicator organism instead of fecal coliform. Revisions of the water quality standards governing Lake Michigan, the Grand Calumet River/ Indiana Harbor Ship Canal, and the Salmonid streams were successfully put under one rule. The standards have been officially adopted and approved by U.S. EPA. However, Indiana's existing ammonia criteria were not changed in this revision due to concerns about the validity of the EPA criteria and the economic impacts of implementation. EPA has agreed to investigate these aspects and provide information to the states on their concerns soon. This should greatly enhance the ability of the State to adopt revisions to the ammonia standards in the future.

Ground Water Standards

The Water Pollution Control Board is attempting to promulgate a rule establishing ground water quality standards. These standards are to be used to select targets for ground water clean ups, establish minimum compliance levels for ground water quality monitoring at regulated facilities and to establish concentration limits for contaminants in ambient ground water. IDEM has received grants from U.S. EPA for several programs designed to address a number of issues and to serve as a common reference for state agencies, businesses and citizens. While many programs within the ground water protection agenda have been proposed to be completed by 1991, U.S. EPA will be needed during the initial phase-in period to assist with local government, industry and other state agency implementation of ground water protection measures.

Laboratory Requirements

With the increased emphasis on toxics control and the use of more stringent water quality standards there will be an increased demand for laboratory services. Increased surface water monitoring for toxics, investigations of ground water contamination, more sediment and fish tissue monitoring, and/or increased effort to monitor drinking water wells, all will require additional laboratory capabilities. Currently DEM is using more contract laboratories because the State Board of Health laboratory cannot handle the increased sample load. The State and EPA need to be aware of the potential problem of laboratory support for the toxic programs both from a monetary and personnel perspective. Also, DEM needs to enhance the capabilities of its biological laboratory and increase laboratory staff to better handle its biomonitoring requirements.

Nonpoint Source Pollution

The control of nonpoint source (NPS) pollution still poses a concern for the State. Since 1987, Indiana has developed several programs which are attempting to alleviate various NPS problems. In addition, several federal programs are being supplemented by state activities to provide technical and cost sharing assistance to individual landowners to resolve soil erosion and animal waste problems which often affect water quality. It is hoped that in the future, Indiana can develop educational and possibly regulatory programs in areas such as fertilizer storage and management to prevent problems from occurring. At present, the ability to control NPS pollution through enforcement actions is extremely limited.

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
BARTHOLOMEW CO.								
Grouse Ridge	Two	20	25.0	10.0	0.10	4.0	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 (1986)	One	133	30.0	14.2	0.04	17.0	20	V
CARROL CO.								
Freeman (1986)	Two	1,547	44.0	16.0	0.067	1.5	31	III
CLARK CO.								
Bowen	One	7	22.0	6.0	0.05			V
Deam (1986)	One	195	33.0	12.0	0.03	14.0	2	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	One	19	24.0	8.9	0.03	8.0	10	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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM OEPTH (ft)	MEAN OEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI OISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
DAVIESS CO.								
Dogwood (1986)	Two	1,300	40.0	18.0	0.07	9.5	26	III
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	Two	1,216	30.0	15.0	0.05	5.5	36	III
DUBOIS CO.								
Beaver Creek (1989)	One	205	15.0	11.5	0.03	7.9	21	VII A
Ferdinand (Ferdinand State Forest)	Three	42	23.0	10.5	0.04	5.0	55	IV B
Ferdinand 1	One	16	17.0	10.0	0.03	--	20	VII A
Holland 1	Two	17	12.0	10.0	--	0.6	27	VII A
Holland 2	Two	20	14.0	10.0	--	7.0	25	VII A
Huntingburg City (1989)	Two	102	30.0	12 0	0.03	5.0	41	V
ELKHART CO.								
Fish	Three	34	30.0	10.0	0.11	6.5	35	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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
FRANKLIN CO.								
Brookville Res.	1979 (Dam)	5,260	120.0	25.0	0.02	4.0	23	I
Brookville Res.	1985 (Dam)	--	--	--	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
Bruce (1989)	Two	245	18.0	14.0	0.12	2.5	35	IV B
Fletcher	Two	45	60.0	15.0	0.14	6.8	45	VII B
King (1976) Estimate (Low)	Two	18	35.0	10.0	--	5.0	35	IV B
King (1985)	Three	00	--	--	0.046	2.0	56	VII A
Lake 16	Two	27	30.0	8.1	0.10	6.0	32	VII A
Manitou (1987)	Two	713	35.0	8.0	0.28	3.8	41	III
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	Three	56	16.0	11.0	0.07	2.5	61	IV B
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
HAMILTON CO.								
Morse Res. (1975)	Two	1,375	40.0	15.4	0.10	4.5	31	III
Morse Res. (1985)	Two	1,375	40.0	15.4	0.036	4.0	22	III
HOWARD CO.								
Kokomo Res. 2 (1988)	Two	484	22.0	7.0	0.117	2.5	29	VII A
HUNTINGTON CO.								
Salamonie Res. (1975 Dam)	One	2,800	60.0	16.6	0.04	2.5	21	I
Salamonie Res. (1985 Dam)	Two	2,800	60.0	16.6	0.03	4.3	18	I
Huntington Res. (1985 Dam)	Three	900	36.0	17.0	0.21	0.5	50	III

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
JACKSON CO.								
Cypress	Two	200	20.0	5.0	0.10	2.5	49	IV A
Starve Hollow	Two	145	17.0	6.8	0.03	9.0 (Atypical)	58	VII A
JENNING CO.								
Brush Creek Res.	Three	167	32.0	10.0	0.07	4.0	55	VII B
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	Three	30	15.0	5.0	0.12	1.5	55	IV A
KOSCIUSKO CO.								
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	Two	304	49.0	18.6	0.05	5.0	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	Two	40	60.0	9.2	0.35	7.5	43	VII C
Caldwell	Two	45	42.0	17.8	0.12	6.0	46	VII B
Carr (1989)	Two	79	35.0	17.0	0.05	5.6	31	VII B
Center (1987)	Two	120	42.0	17.0	0.035	8.5	5	VII B
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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
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
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	Two	182	35.0	12.8	0.05	7.0	45	VII C
James (1989)	Two	282	63.0	26.9	0.06	4.9	40	IV B
Kuhn	Two	137	27.0	9.4	0.01	9.8	15	V
Little Barbee	Three	74	26.0	13.0	0.08	5.0	56	VII B
Little Chapman (1989)	One	177	30.0	11.2	0.21	5.9	25	VII A
Little Pike	Two	25	30.0	5.6	0.09	2.5	31	VII A
Loon	Three	40	30.0	16.8	0.05	2.5	52	IV B
Mc Clures	Two	32	30.0	12.8	0.05	2.5	51	VII B
Muskelonge	Two	32	21.0	9.4	0.14	1.8	40	VII C
North Little	Three	12	26.0	10.0	0.12	2.5	52	VI B
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	Three	12	40.0	20.0	0.10	8.0	50	IV B
Ridinger	Two	136	42.0	21.0	0.05	3.5	58	VII B
Sawmill	Two	36	26.0	10.3	0.01	5.5	33	VII A
Sechrist	One	105	26.0	23.7	0.02	9.0	24	VI A
Shock	Two	37	59.0	32.7	0.23	9.0	28	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	Two	18	34.0	25.0	0.19	9.0	36	VI A
Stanton	Two	32	30.0	15.0	0.01	12.0	20	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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Wabee (1897)	One	187	51.0	25.4	0.035	8.5	13	IV D/ 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	Two	774	45.0	7.0	0.06	3.0	37	VII A
Winona (1987)	Two	562	80.0	29.0	0.03	6.5	40	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	One	36	40.0	10.0	0.03	8.0	11	V
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	Four	20	31.0	17.5	0.03	6.0	9	V
Cotton	Three	31	25.0	30.0	0.11	3.5	66	IV D
Dallas	Two	283	96.0	35.2	0.633 / 0.05	9.0 / 6.5	28	II C
Emma	Two	42	34.0	16.7	0.04	4.0	44	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	Two	42	38.0	12.1	0.07	6.5	29	VII A
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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Martin	One	26	56.0	34.2	0.33 / 0.04	10.5 / 6.0 / 5.5	35	II C
Meteer	One	18	18.0	8.3	0.03	12.5	17	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
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	One	30	58.0	20.7	0.03	8.0	19	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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
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
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	Two	432	42.0	11.7	0.02	5.5	23	VII A
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
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. (1985)	Two	--	--	--	0 45	3.0	35	III
Geist Res. (1973)	Two	1,800	220	12.0	0.14 / 0.06	2.5	37	III
Geist Res. (1985)	Two	--	--	--	0.12	3.0	42	III
MARSHALL CO.								
Cook (1989)	Two	93	64.0	17.7	0.27	2.3	41	VII B

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Dixon	Two	33	48.0	14.5	0.26	7.0	30	VII B
Eddy	Two	16	49.0	25.0	0.09	5.0	42	VI A
Flat	Two	26	24.0	8.1	0.16	6.0	35	VII A
Gilbert	Three	37	41.0	13.2	0.43	1.0	75	IV B
Holem	One	30	74.0	0.8	0.03	8.5	23	VII A
Hawks (Lost)	Three	40	9.0	4.0	0.10	5.0	65	IV B
Koontz	Two	346	31.0	9.2	0.05	3.5	42	VII C
Kreighbaum	Two	20	28.0	20.0	0.07	11.0	32	VII A
Lake of the Woods (1987)	Two	416	48.0	16.0	0.04	2.5	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
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	Three	16	58.0	15	0.06	4.5	51	IV B
MARTIN CO.								
Trinity Springs	Three	10	7.0	2.0	0.18	2.0	60	IV A
West Boggs Creek (1989)	Two	622	30.0	12.5	0.18	2.1	41	VII B
MIAMI CO.								
Mississinewa Res. Dam 1975	One	3,180	45.0	17.5	0.02 / 0.03	6.5	20 16	I
Mississinewa Res. Dam 1985	One	--	--	--	0.081	5.0	24	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.	Two	130	30.0	10.0	0.30	7.5	40	VII C
Lemon (1986)	One	1,650	28.0	10.0	0.056	2.0	18	III
Monroe Res. Dam 1976	One	10,750	38.0	15.0 - 20.0	0.03	12.0	25	I

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
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
MONTGOMERY CO.								
Waveland (1978)	Two	360	27.0	10.0	0.03	5.0	20	VII A
NEWTON CO.								
J. C. Murphy	Three	1,515	8.0	5.0	0.045	1.5	47 (Atypical)	III
NOBLE CO.								
Bartley	Two	34	34.0	12.6	0.07	7.2	35	VII A
Baugher	Three	32	36.0	12.2	0.08	3.0	54	IV B
Bear (1989)	Two	136	59.0	22.3	0.16	3.0	46	VI B
Big	Two	228	70.0	24.7	0.17	3.0	38	VI B
Bixler	Two	120	43.0	17.4	0.09	8.0	38	VII B
Bowen	Two	30	36.0	15.0	0.04	7.0	41	VII B
Crane	Two	28	26.0	12.9	0.04	9.0	45	VII B
Cree	Two	58	26.0	15.7	0.07	5.3	39	VII B
Crooked (1987)	One	206	108.0	43.0	0.065	10.0	12	II B
Diamond (1989)	Two	105	81.0	14.0	0.04	5.6	29	VII A
Dock	Two	16	40.0	16.6	0.05	7.0	38	VII B
Duely	Four	21	19.0	8.6	0.09	5.0	42	IV 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

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Gilbert	Two	28	36.0	17.5	0.03	7.0	28	VII B
Gordy	Two	31	35.0	21.9	0.11	7.5	43	VII B
Hall	One	10	35.0	18.0	0.03	8.0	16	V
Harper	Three	11	25.0	14.5	0.03	5.1	60	VII B
Henderson	Three	22	35.0	15.0	1.00	1.0	73	IV B
High	Three	123	25.0	10.1	0.07	4.0	53	VII B
Hindman	Four	13	20.0	10.8	0.42	7.0	52	IV B
Horseshoe	Two	18	28.0	13.9	0.40	6.5	40	VII C
Indian (Village)	Four	12	22.0	13.3	0.06	5.1	59	IV B
Jones (1989)	Two	115	25	8.3	0.72	2.6	38	VII C
Knapp (1989)	Two	88	59.0	25.0	0.18	3.9	29	VII A
Latta	Two	42	38.0	21.4	0.05	5.0	36	VI A
Little Long	Two	71	32 0	24.6	0.04	5.0	32	VI A
Long (Chain of Lakes)	Two	40	32.0	15.8	0.04	7.0	33	VII B
Lower Long 1989	One	66	55	23.6	0.15	8.9	20	VI A
Millers	Two	28	34.0	14.6	0.05	8.0	35	VII B
Moss	Four	9	19.0	8.9	0.24	8.0	51	IV B
Muncie	Two	47	37.0	12.3	0.09	3.0	46	VII C
Norman	Three	14	46.0	20.0	0.18	11.0	39	VI A
Pleasant	Two	20	67.0	27.0 / 22.5	0.21	8.0	29	VI A
Port Mitchell	Two	15	31.0	12.0	0.19	8.0	30	VII A
Rider	Four	5	15.0	6.0	0.07	7.5	55	IV B
Rivir (Chain of Lakes)	Two	24	32.0	15.8	0.07	6.0	38	VII B
Round (1989)	One	99	66.0	21.6	0.06	4.9	24	VI A
Sacarider	Two	33	60.0	22.4	0.25	9.0	35	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	Three	125	32.0	14.0	0.04	4.0	45	VII C
Smalley (1989)	Three	69	49.0	22.0	0.31	4.9	54	IV D
Sparta	Two	31	10.0	5.5	0.04	6.0	40	VII C
Stienbarger (1989)	Two	73	39.0	21.8	0.26	5.6	31	VI A

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Sylvan (1987)	Three	575	36.0	14.0	0.25	2.5	62	IV C
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	Three	49	27.0	13.3	0.08	4.0	55	IV B
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	
PARKE CO.								
Raccoon (1986) (Cecil Harden)	One	2,060	60.0	15.0	0.07	4.5	27	III
Rockville	Three	100	30.0	15.0	0.31	5.0	47	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	One	149	25.0	15.0	0.03	9.0	20	VI A
Saddle	Two	41	20.0	15.0	0.03	6.0	36	VI A
Tipsaw	One	131	15.0	15.0	0.03	8.0	19	VI A
PIKE CO.								
West Lake	Two	15	25.0	10.0	0.03	7.0	7	V
Prides Creek	Two	90	20.0	10.0	0.80	4.0	33	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	Three	45	35.0	15.0	0.08	3.8	42	VII B

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
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	Three	35	24.0	10.0	0.06	2.0	50	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	Two	21	48.0	35.0	0.11	7.0	31	II C
POSEY CO.								
Hovey	Four	242	51.0	4.0	0.06	0.7 / 1.5	60	IV 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
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	Three	93	10.0	5.0	0.10	4.0	59	IV 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 (1985)	Two	--	--	--	0.13	2.0	30 (Atypical)	--
ST. JOSEPH CO.								
Bass	One	88	37.0	10.0	0.01	10.7	17	V
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	Two	29	39.0	18.0	0.11	3.4	29	VII B
Potato Creek Res. (Worster Lake)	Two	300	--	15.0	0.03	6.5	25	VII A
Quarry	Two	43	64.0	15.0	0.04	6.0	30	VI A
Riddles	Two	77	20.0	8.3	0.02	4.0	30	VII A
Sously	Three	40	19.0	4.0	0.04	4.0	50	IV A

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
South Clear	Three	51	15.0	2.0	0.08	5.0	50	IV A
SCOTT CO.								
Hardy	One	705	40.0	12.0	0.02	5.0	19	VII A
Scottburg Res.	Three	83	16.0	4.0	0.11	1.0	63	IV 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	One	28	40.0	13.2	0.05	9.0	23	VII A
Langenbaum	Three	48	19.0	5.4	0.03	7.0	41	VII C
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	Two	11	26.0	15.0	Illogical Results	10.0	27	VII A
Bell	Two	38	24.0	13.4	0.05	10.0	24	VII A
Big Bower	Three (Atypical)	25	22.0	11.2	0.16 / 0.09	3.0 / 3.0	66	IV B
Big Otter (1989)	Two	69	38.0	25.8	0.12	6.6	41	IV D
Big Turkey	Two	450	65.0	16.2	0.07	5.0	44	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.) (1986)	One	828	77.0	12.0	0.03	6.0	17	VII A
Deep	Four	12	28.0	10.0	0.06	5.0	51	IV A
Failing	One	23	35.0	8.0	0.01	15.0	20	V

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
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 (1989)	Two	119	31	15.2	0.16	3.9	33	VII B
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. 1986)	Two	802	70.0	20.0	0.04	4.0	31	VI C
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 (1989)	Two	146	26	10.1	0.38	3.3	35	VII A
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
Johnson	Four	17	39.0	15.0	0.045	5.0	30	VI A
Lake Anne (Unique)	One	17	31.0	16.5	0.10	9.0	38	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	Three	34	37.0	21.8	0.28	5.5	58	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) (1989)	Two	92	33.0	16.7	0.22	2.3	43	VII B
Long B (Clear) (1989)	Two	154	36.0	11.9	0.13	4.3	40	VII C

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
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	One	16	25.0	14.0	0.03	10.0	22	VII A
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 (1989)	Two	61	38.0	15.2	0.11	5.9	30	VII B
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	Two	30	25.0	11.3	0.03	8.0	23	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
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	Two	30	40.0	23.0	0.02	6.0	21	VI A
Lake 29 (Acid)		–	--	--	0.10	--	--	--
Lake Sullivan (1989)	One	507	25.0	10.0	0.06	3.0	20	VII A

LAKE NAME	TROPHIC CLASS	SIZE (acres)	MAXIMUM DEPTH (ft)	MEAN DEPTH	TOTAL PHOSPHORUS (mg/l)	SECCHI DISC (ft)	EUTROPHICATION INDEX	LAKE MANAGEMENT GROUP
Merom Gravel Pits	One	55	50.0	6.0	0.03	10.0	5	V
Shakamak	Two	56	26.0	10.9	0.13	6.5	38	VII C
Turtle Creek Res.	Three	1,550	25.0	10.0	0.60	2.0	50	III
UNION CO.								
Whitewater Lake	Two	199	46.0	15.0	0.06	8.5	29	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
Green Valley	Two	50	--	--	0.04	5.0	36	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
WABASH CO.								
Hominy Ridge	Three	11	20.0	8.0	0.32	2.5	59	IV A
Long (at Laketon)	Two	48	39.0	16.0	0.04	7.0	30	VII B
Lukens	Two	46	41.0	22.0	0.09	10.0	30	VI A
Round (at Laketon)	Two	48	25.0	11.2	0.03	2.0	43	VII B
Twin Lakes	Two	81	16.0	10.6	0.05	4.5	50	IV B
WARRICK CO.								
Scales	Two	66	20.0	7.0	0.04	15.0	50	VII C
WASHINGTON CO.								
Elk Creek	Two	47	32.0	12.5	0.04	17.0	13	V
John Hay	Two		40.0	15.0	0.03	8.0	13	VI A
Salinda (1989)	Two	70	20.0	15.0	0.13	3.2	41	VII B
WAYNE CO.								
Middle Fork Res.	One	277	30.0	15.0	0.03	8.0	18	V
WELLS CO.								
Kunkel	Three	25	19.0	6.0	0.06	1.5	59	IV A
Moser	Three	26	12.0	6.0	0.19	3.0	55	IV A
WHITE CO.								
Shaffer Dam (1986)	Two	1,291	30.0	10.0	0.08	3.5	23	III

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WHITLEY CO.								
Blue	Two	239	49.0	21.0	0.15	10.5	35	VI A
Cedar (Tri-Lake)	One	131	75.0	30.0	0.04	21.0	8	II A
Dollar	Four	10	59.0	15.0	0.10	18.0	29	V
Goose	Three	84	69.0	25.9	0.04	3.5	61	IV D
Little Crooked	Two	15	50.0	20.0	0.04	9.0	32	VI A
Loon (1989)	Two	222	96.0	25.8	0.05	9.5	35	VI A
New	One	50	44.0	17.6	0.03	12.0	7	II A
Old	Two	32	42.0	19.4	0.15	9.5	48	VII B
Round (Tri-Lake)	Three	125	63.0	25.0	0.06	10.0	30	VI A
Scott	Two	18	22.0	5.0	0.05	5.0	23	VII A
Shriner (Tri-Lake) 1988	Two	111	61.0	45.0	0.23	7.5	28	II C
Troy-Cedar	Three	93	88.0	27.3	0.08	4.5	60	IV D