US Army Corps
of Engineers
Louisville District®

Wabash River Watershed
Section 729 Initial Watershed Assessment

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EXECUTIVE SUMMARY

The Wabash River begins as a drainage ditch near Fort Recovery, Ohio and meanders over 500 miles across Indiana, eventually forming the southern border with Illinois. The Wabash River is the second largest tributary to the Ohio River and is the longest segment of free flowing river east of the Mississippi River. The watershed has a total drainage of approximately 33,000 square miles and in 2010 had a population of around 4,366,000. Historically, the Wabash River served as a significant transportation corridor and helped facilitate the European settlement of the Midwest. Today, the Wabash River and its tributaries are no longer utilized for commercial navigation, but are still vital source of water supply and recreation in the region.

The Wabash River also serves as an important migration corridor for waterfowl and shorebirds and is home to nearly 400 rare species natural communities. This includes approximately 151 fish species and 75 mussel species. Although there have been losses in biodiversity, the Wabash River Watershed still has the foundations for substantial ecological rehabilitation. For example, the White River system, the largest tributary to the Wabash River, contains the last population of lake sturgeon (*Acipenser fulvescens*) in the Mississippi River basin and the main stem Wabash River maintains a commercial fishery for shovelnose sturgeon (*Scaphirhynchus platorynchus*)

Conversely, the Wabash River faces an array of challenges associated with flooding, drought, water quality and ecosystem integrity which must be addressed in a systems context that reflects the interdependency of water uses and competing interests of a diverse group of stakeholders. Moreover, there is broad interest in flood risk management, as well as the continued rehabilitation and preservation of the Wabash River. Numerous positive actions have been implemented by stakeholders in the watershed, and many others are planned. Still, it is evident that the development of a comprehensive watershed management plan would enhance collaboration and provide a mechanism for strategic improvements in the watershed.

The following report is an Initial Watershed Assessment (IWA) of the Wabash River Watershed. The IWA was prepared under the authority of Section 729 of the Water Resources Development Act of 1986 as amended. The IWA describes problems and opportunities identified through stakeholder outreach and a review of previous studies in the watershed.

This IWA details existing conditions within the Wabash River Watershed, identifies the largest problems that threaten the health of the watershed and discusses the scope and purpose of a future cost-shared watershed study. Moreover, the Illinois Department of Natural Resources (IDNR) and Indiana Chapter of The Nature Conservancy (TNC) were identified as a potential non-federal sponsors interested in cost sharing the Final Watershed Assessment.

The conclusion of the IWA recommends drafting a Watershed Assessment Management Plan (WAMP) to define the objectives of the Final Watershed Assessment. Given the scale of the watershed the IWA recommends that the Final Watershed Assessment focus on the Lower Wabash River Watershed, including the tributary watersheds of the Middle Wabash, Vermilion, Embarras and Little Wabash.

1. STUDY AUTHORITY, GUIDANCE, PROCESS AND FUNDING

1.1 Authority

This Initial Watershed Assessment (IWA) of the Wabash River Watershed is authorized by Section 729 of the Water Resources Development Act (WRDA) of 1986 as amended.

> (a) The Secretary, in coordination with the Secretary of the Interior and in consultation with appropriate Federal, State, and local agencies, is authorized to study the water resources needs of river watersheds and regions of the United States…
> (b) In carrying out the studies authorized under subsection (a) of this section, the Secretaries shall consult with State, interstate, and local governmental entities.

Section 729 of WRDA of 1986 has since been amended by Section 202 of WRDA 2000 to provide the Secretary discretionary authority to assess the water resources needs of river watersheds of the United States, including needs relating to ecosystem protection and restoration, flood damage reduction, navigation and ports, watershed protection, water supply and drought preparedness. It also establishes cost sharing provisions and defines cooperation and consultation requirements. The most recent amendment of Section 729 of WRDA of 1986 is contained in Section 2010 of WRDA 2007. This section includes priority river watersheds and modifies the non-federal cost sharing for assessments. The full authorization language for Section 729 of WRDA of 1986 and related amendments is located in Appendix A.

1.2 Guidance

This report was prepared in accordance with the legal procedures and technical requirements of US Army Corps of Engineers (USACE) Engineering Regulation ER1105-2-100 *Planning Guidance Notebook*, dated 22 April 2000. The primary source of guidance for conducting US Army Corps of Engineers (USACE) watershed assessments is Engineer Circular (EC) 1105-2-411, Watershed Plans. The purpose of EC 1105-2-411 is to provide guidance for conducting watershed planning. In the past, USACE has focused on problem solving and decision making for specific sites and projects. USACE has since recognized the need to undertake planning in a broader, integrated systems approach instead of focusing on single purpose projects.

Specifically, watershed planning is an approach for managing water resources within particular watersheds and addressing problems in a holistic manner that reflects the interdependency of water uses, competing demands and the desires of a wide range of stakeholders in addressing watershed problems and opportunities. The planning process should identify and characterize

systems of interest to the current and future needs of the watershed. Public involvement is essential to the success of watershed planning.

Additional guidance regarding watershed planning efforts was derived from USACE *Planning Guidance Letter # 61 – Application of Watershed Perspective to Corps of Engineers Civil Works Programs and Activities*, dated 27 January 1999.

1.3 Study Process

The watershed planning process requires the establishment of a collaborative partnership both within and outside of USACE. The USACE led watershed assessment process consists of two phases: Initial Watershed Assessment (IWA) and Final Watershed Assessment (FWA) and ultimately results in the creation of a watershed management plan. The process generally follows the USACE six-step Civil Works planning process and adheres to watershed principles. The following elements referenced in EC 1105-2-4111 are critical to facilitating an effective watershed planning process:

- Define the Study Area
- Identify Problems and Opportunities
- Inventory and Forecast Conditions
- Evaluation and Comparison of Alternative Approaches
- Strategy Selection

The IWA is conducted at 100 percent federal cost and limited to $100,000. It has the following purposes:

- Define the study area by identifying an appropriate watershed.
- Identify problems and opportunities within the watershed through stakeholder engagement.
- Identify a Non-Federal Sponsor for the second phase of watershed planning which will include development of a FWA
- Negotiate a cost-share agreement with the identified Non-Federal Sponsor.
- Define the scope and objective of the FWA.
- Prepare a WAMP (similar to a Project Management Plan that is developed for a traditional feasibility study).

The FWA results in a comprehensive Watershed Management Plan and is conducted in collaboration with multiple stakeholders throughout the watershed. The costs of the FWA are shared with a Non-Federal Sponsor. The following elements will be fully developed in the second phase of assessment based on stakeholder and Non-Federal Sponsor interest.

- Inventory and forecast conditions based on the stakeholder needs identified within the watershed.

- Evaluate and compare alternative approaches to address the identified needs within the watershed.
- Select a strategy or broad plan based on the shared vision of the stakeholders and partners that can be implemented to address significant identifiable watershed problems.

1.4 Funding

The Wabash River Initial Watershed Assessment is funded as part of the Ohio River Basin Comprehensive Study (ORBCS). The ORBCS is the overarching watershed study that identified five priority watersheds in the Ohio River Valley. The initial federal amount of $100,000 was received in Fiscal Year 2010 to initiate the IWA.

2. STUDY PURPOSE

The purpose of this IWA is to identify and document water resource related problems, needs, and opportunities in the Wabash River Watershed. The IWA will focus on defining the study area, describing existing conditions, and identifying the opportunities for addressing the watershed needs. The IWA will also describe the coordination efforts to date with other agencies and identify a potential Non-Federal Sponsor to share the cost of a FWA. The IWA will serve as a basis for establishing what would be addressed in detail during the cost-shared Final Watershed Assessment phase.

This IWA will serve as the basis for a comprehensive Final Watershed Assessment and development of a WAMP, which will provide strategic guidance to watershed restoration from a systems-wide perspective. The WAMP is analogous to a Project Management Plan (PMP) that is prepared for all USACE studies and projects. The WAMP will outline, in considerable detail, the tasks and costs associated with conducting a detailed FWA of the Wabash River Watershed.

3. LOCATION OF WATERSHED AND CONGRESSIONAL DISTRICTS

3.1 Location of Watershed

The Wabash River Watershed lies within the state of Indiana, extending into the western portion of Ohio and the eastern portion of Illinois, with a total drainage area of 32,910 square miles at the river's mouth. The headwaters of the Wabash River, the second largest tributary to the Ohio River, begin in western Ohio in Mercer County (approximately 15 miles east of the Indiana-Ohio state line). From Ohio, the Wabash River generally runs westerly through Indiana to near Covington, Indiana and then in a southerly direction through Indiana forming the boundary

between the states of Indiana and Illinois for a total distance of about 508 miles. Table 1 shows drainage areas for the major rivers within the Wabash River Watershed.

Table 1. Drainage Area of Major Rivers in the Wabash River Watershed

Wabash River Basin Drainage Area	
Tributary	**Drainage Area**
Flatrock River @ Mouth	542
Driftwood River @ Mouth	1165
Driftwood River Including Flatrock River	1707
East Fork White River Including Salt Creek	4688
East Fork White River Above West Fork White	5746
West Fork White River @ Mouth	11119
Wabash River Including Mississinewa River	2673
Wabash River Including Tippecanoe River	6350
Wabash River Including Vermillion River	9729
Wabash River Including Embarrass River	16188
Wabash River Including White River	27773
Wabash River Including Patoka River	28635
Wabash River Including Little Wabash River	32837
Wabash River @ Mouth	32910

3.2 Hydrologic Unit Codes (HUC)

A watershed is defined as an area of land that drains all surface water and rainfall to a common outlet. The term watershed is sometimes used interchangeably with drainage watershed and a larger watershed may contain many smaller watersheds. The United States Geological Survey (USGS) organizes watersheds into a hydrologic system that divides and subdivides the United States into successively smaller watersheds. These levels of subdivision, used for organization of hydrologic data, are called hydrologic units. Each hydrologic unit is identified by a unique hydrologic unit code (HUC) consisting of two to twelve digits based on the six levels of classification:

- 2-digit HUC first-level (region)
- 4-digit HUC second-level (subregion)
- 6-digit HUC third-level (accounting unit)
- 8-digit HUC fourth-level (cataloguing unit)
- 10-digit HUC fifth-level (watershed)
- 12-digit HUC sixth-level (subwatershed)

The Wabash River Watershed is a HUC 4 cataloging unit which is the defined study area for this IWA. The Wabash River Watershed is identified by the hydrologic unit four digit code 0512. The first two digits (HUC 2) together identify the water-resources region (Ohio River) and the first four digits (HUC 4) together identify the sub-region (Wabash River). The Wabash River Watershed contains 24 HUC 8 sub-watersheds, as seen on Figure 1.

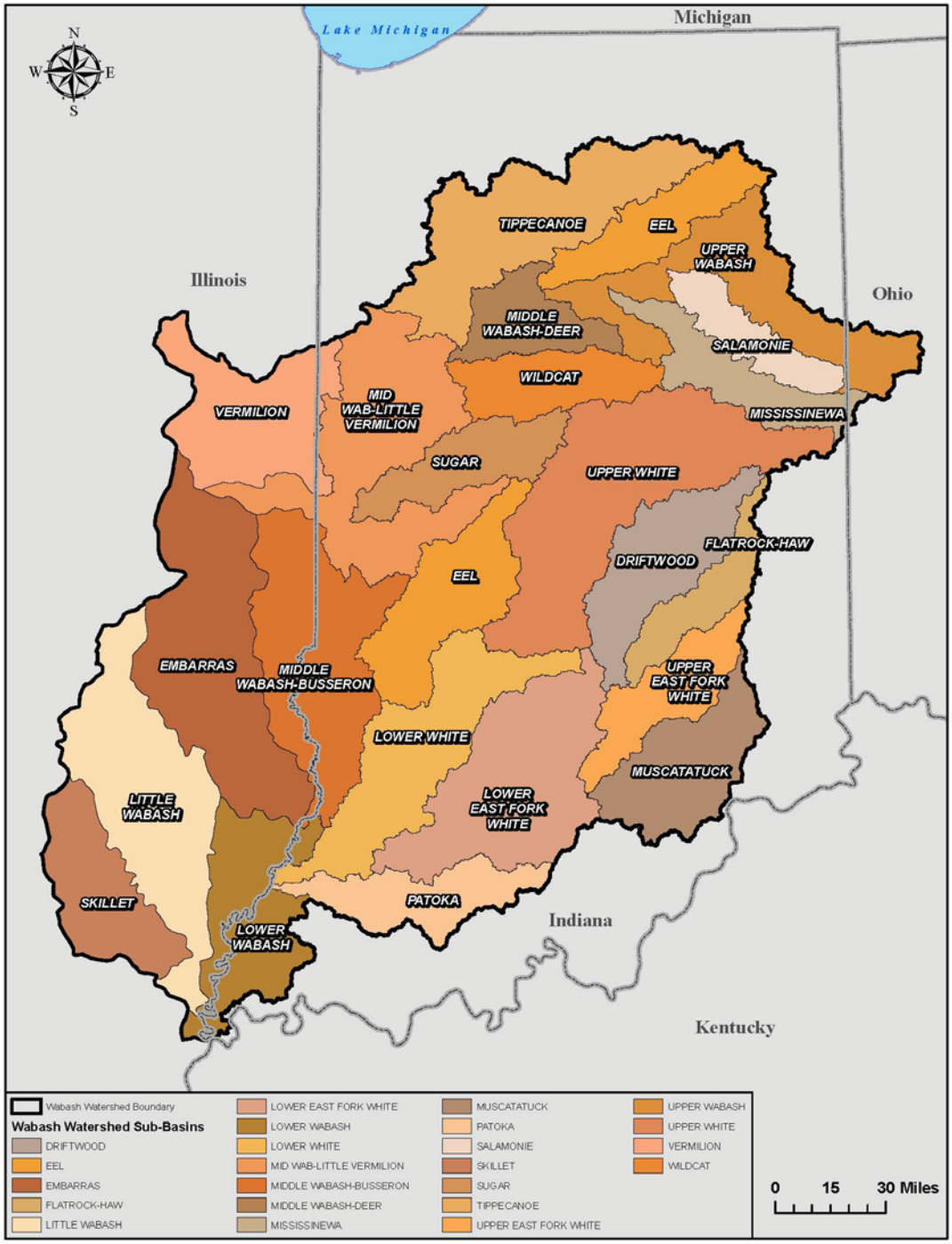

Figure 1. Map of HUC8 Sub-Watersheds

3.3 Congressional Districts

The study area lies within the geographic area of the following Congressional interests and Districts:

Table 2. Congressional Districts

Ohio	Indiana	Illinois
U.S. House of Representatives		
Jim Jordan (R-OH 4) Bob Latta (R-OH 5) John Boehner (R-OH 8)	Pete Visclosky (D-IN 1) Joe Donnelly (D-IN 2) Marlin Stutzman (D-IN 3) Todd Rokita (R-IN 4) Dan Burton (R-IN 5) Mike Pence (R-IN 6) Andre Carson (D-IN 7) Larry Bucshon (R-IN 8) Todd Young (R-IN 9)	John Shimkus (R-IL 19) Timothy Johnson (R-IL 15)
U.S. Senate		
Sherrod Brown (D-OH) Rob Portman (R-OH)	Daniel Coats (R-IN) Richard Lugar (R-IN)	Richard Durbin (D-IL) Mark Kirk (R-IL)

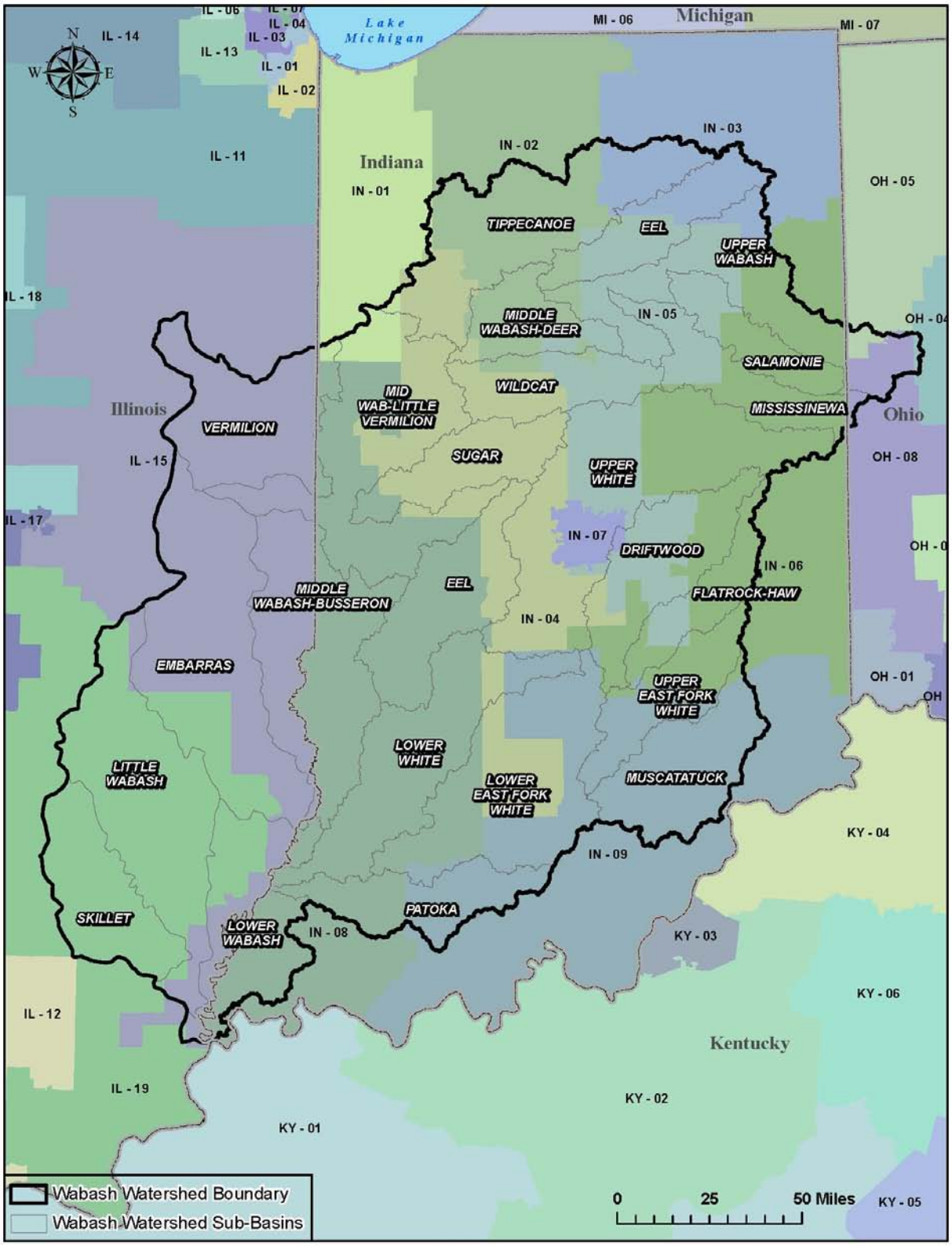

Figure 2. Map of Congressional Districts

4. REPORTS, PROJECTS, AND ACTIONS IN THE WATERSHED

4.1 Existing Reports

Numerous federal and non-federal studies and reports have been conducted in the Wabash River Watershed. A complete discussion of all such reports and actions is beyond the scope of this IWA. The following paragraphs will discuss pertinent reports and actions underway or completed by USACE, other federal agencies, and non-federal interests in the watershed related to flow regime, ecosystem integrity, water quality, and Wabash River projects and plans.

4.1.1 Reports Related to Flow Regime

Burke, D.B., R.P. Richards, T.T. Loftus and J.W. Kramer. 2004. *A New Flashiness Index: Characteristics and Applications to Midwestern Rivers and Streams.* Journal of the American Water Resources Association. JAWRA 40(2):503-522.
Flashiness reflects the frequency and rapidity of short term changes in stream flow, especially during runoff events, and is an important component of the hydrologic regime of a stream. Changes in land use and management may increase or decrease flashiness, which is often detrimental to aquatic life. Flashiness may be increased by activities such as increases in the amount of impervious surfaces in a basin, increases in the amount of drained agricultural land, and conversion of forests and wetlands to other uses. Large flood control reservoirs typically decrease flashiness through controlled releases of flood flows. The authors examined stream flow data from USGS gauging stations around the Midwestern United States.

Jackson, R.C., II. 1975. *Velocity-Bed-Form-Texture Patterns of Meander Bends in the Lower Wabash River of Illinois and Indiana*. Geological Society of America Bulletin 86:1522-1522.
This paper reported results of systematic monitoring of current velocity and two responses, bed forms and texture, around meander bends in the lower Wabash River. This paper described conditions that lead to formation of the new river channel.

Zucker, L.A. and L.C. Brown (Eds.). 1998. *Agricultural Drainage: Water Quality Impacts and Subsurface Drainage Studies in the Midwest.* Ohio State University Extension Bulletin 871. The Ohio State University.
The bulletin reviews the status and importance of drainage for agricultural production in the North Central Region; identifies the positive and negative effects of agricultural drainage and summarizes new drainage methods which work to increase productivity; enhance the positive effects of agricultural drainage and mitigate the adverse effects of agricultural drainage on the environment. More than half the natural wetlands in the United States have been lost to drainage practices with much of it related to agricultural drainage. Loss of wetlands is associated with declines in wildlife habitat and adverse effects on water quality. Wetland loss and the

corresponding loss of wetland functions that sustain healthy ecosystems are one of the most important environmental issues facing agriculture.

In the North Central Region, the Great Lakes and Corn Belt states (Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin) are some of the most highly drained states in the U.S. Illinois, Indiana and Ohio are ranked first, second and fourth, respectively among all states in land area that is artificially drained. Over eight million acres are drained in Indiana. Eighty-five percent of drained land in Indiana is cropland. Fifty percent of Indiana's cropland is artificially drained.

4.1.2 Reports on Ecosystem Integrity

Armitage, B.J. and E.T. Rankin. 2010. *An Assessment of Threats to the Biological Condition of the Wabash River Aquatic Ecosystem of Indiana.* Prepared for The Nature Conservancy, Indiana Chapter. 1505 N. Delaware Street, Suite 200. Indianapolis, IN 46202.
Armitage and Rankin reviewed fish assemblage, habitat, and water quality data collected in 1999 and from 2004 to 2006 in the Wabash River main stem. They grouped and analyzed the data by watersheds at the HUC 8 level.

The authors examined potential enhancement options for the Wabash River and identified three classes of actions. The first class concerns habitat loss and degradation on the main stem Wabash River. Major stressors in the main stem may be addressed by:

- Restoring bottomland forests which in turn resist bank erosion and provide habitat structure when recruited to the river; and
- Restoring oxbow and other wetland types.

The second class is related to the management of headwater streams throughout the Midwest, but especially when paired with agricultural drainage. They suggest rehabilitation of headwater stream systems addressing certain stressors. The third class discusses the increase in invasive species and impact to the river. They acknowledge that control over these species is limited.

Cummings, K.S., C.A. Mayer, and L.M. Page. 1988. *Survey of the Freshwater Mussels (Mollusca: Unionidae) of the Wabash River Drainage. Phase II: Upper and Middle Wabash River.* Prepared for Indiana Department of Natural Resources Division of Fish and Wildlife.
The Illinois Natural History Survey searched for freshwater mussels at 31 locations along the Wabash River from Huntington Reservoir to Francisville in Knox County. Two study sites were located in Tippecanoe County and a third was located in Carroll County southwest of Delphi near the Tippecanoe County line.

Weathered dead and sub-fossil specimens of the federally endangered fanshell mussel (*Cyprogenia stegaria*) were found at the Tippecanoe County sites. The abundance of shells on exposed bars suggests that this species was once very common. Sub-fossil shells of the federally endangered rough pigtoe pearly mussel (*Pleurobema plenum*) were found at the furthest downstream Tippecanoe County site. Weathered dead clubshell mussel (*Pleurobema clava*) shells and sub-fossil northern riffleshell mussel (*Epioblasma torulosa rangiana*) shells were found at the upstream site. Both of these species are federally endangered.

One live specimen of the federal candidate species rabbitsfoot mussel (Quadrula cylindrical) was found at Colliers Island downstream of the Granville Bridge in Tippecanoe County. Six live sheepnose mussels (Plethobasus cyphyus) were found upstream of Lafayette near the county line. Sub-fossil valves for the federal candidate species rayed bean mussels (Vilosa fabalis) were found in Tippecanoe County one-mile southeast of Battle Ground. Many of the species represented by only weathered or sub-fossil valves are believed extirpated from the Wabash River.

Fisher, B.E. 2006. *Current status of freshwater mussels (Order Unionoida) in the Wabash River Drainage of Indiana*. Proceedings of the Indiana Academy of Science. 115(2):103-109.
This study is the synthesis of data from prior studies of the distribution and population status of freshwater mussels in the Wabash River Watershed and tributaries. The following conclusions were drawn from the study:

- Reproductive populations for 30 species exist in the main stem Wabash River and its tributaries.
- Reproductive populations for 18 species historically found in the main stem Wabash River are now restricted to its tributaries.
- Nine species had populations that were always restricted to the tributaries; and
- 18 species have been extirpated from the entire Wabash River drainage.
- The federally endangered clubshell mussel (*Pleurobema clava*) is still found in the upper Wabash River and the Tippecanoe River. Another federally endangered species, fanshell mussel (*Cyprogenia stegaria*), is found in the Tippecanoe River below Lake Freeman and occasionally in the Wabash main stem.

Gammon, J.R. 1998. *The Wabash River Ecosystem*. Published by Cinergy Corporation, Plainfield, Indiana, Eli Lilly and Company, Indianapolis, Indiana, and DePauw University, Greencastle, Indiana. Distributed by Indiana University Press, Bloomington, Indiana.
This book is a summary of a long-term research program focused on the Wabash River Ecosystem beginning in 1968 and concluding in 1997. In general, most fish species populations improved over the course of the study with several species expanding their ranges into previously unoccupied areas. This fish population and community response is probably associated with the 50 percent reduction in biochemical oxygen demand (BOD) loading that occurred in the mid 1980's.

The fisheries resource of the Wabash River main stem is of global significance and is comprised of more than 150 species, including rare species such as shovelnose sturgeon (*Scaphirhynchus platorynchus*), paddlefish (*Polyodon spathula*), black redhorse (*Moxostoma duquesni*), spotted gar (*Lepisosteus oculatus*), and blue sucker (*Cycleptus elongatus*). Economically significant sport fish populations occur in the study area, including smallmouth bass (*Micropterus dolmieu*), largemouth bass (*Micropterus salmoides*), sauger (*Sander canadensis*), white bass (*Morone chrysops*), flathead catfish (*Pylodictis olivaris*), channel catfish (*Ictalurus punctatus*), and various sunfish species (*Lepomis spp.*). Reproductive success for nearly all of the fish species was extremely low following the prolonged elevated flows of 1993, although populations appeared to achieve modest rebounds near the conclusion of the study. Fish species that are intolerant to degraded water quality or habitat are most often found in the upper reaches of the main stem Wabash.

The condition of riparian forests is highly variable throughout the Wabash River corridor. In total, more than 27 km along the river banks were observed to have sparsely forested riparian zones consisting of one to two trees. The Wabash River between Delphi and Attica, Indiana accounted for 7.7 km of the riparian forests observed in this condition. The absence of riparian forests along the main stem apparently contributed to the presence of bare banks along nearly 29 of the 518 km comprising nearly three percent of the total length within the study area.

Stefanavage, T.C. 2009. *Summary of Harvest Estimates and License Sales for Indiana's Inland River Commercial Fisheries, 2007. Fish Management Report.* Fisheries Management Section, Indiana Department of Natural Resources, Division of Fish and Wildlife. 13 pp.
The Wabash River accounted for approximately half of the total inland river commercial harvest in Indiana for 2006. Inland commercial sales for 2007 were 335 licenses and 1,268 net tags. Reported total inland harvest for 2007 was 76,828 lbs down from the 2006 harvest of 94,218 lbs. Fluctuations in the total harvest from year to year are due to a number of variables.

The greatest influence appears to be major water level fluctuations. Inland catfish harvest for 2007 was 59,216 lbs (29,944 lbs channel catfish (*Ictalurus punctatus*), 22,160 lbs flathead catfish (*Pylodictis olivaris*), and 7,112 lbs blue catfish (*Ictalurus furcatus*). Catfish harvest comprised 77 percent of the total catch. The estimated monetary value of the 2007 inland commercial harvest was $216,042.

Wamsley, K. 2010. *Water over white stone*. The Nature Conservancy's Wabash River Initiative.
The Wabash River is the longest free-flowing river east of the Mississippi. Nearly 400 rare species inhabit the system, including 151 species of fish and 75 species of freshwater mussels. The middle reach of the Wabash River, which includes the area currently under study, contains nearly 120 species of plants and animals that are rare, threatened or endangered. The Nature Conservancy (TNC) has ranked the Tippecanoe River, a large tributary at the upstream end of the watershed, as the 8th most important freshwater system in North America for the conservation of imperiled species. Federally listed species, such as clubshell mussel (*Pleurobema clava*) and fanshell mussel (*Cyprogenia stegaria*), are known to occur in this river,

as are other rare species, including sheepnose mussel (*Plethobasus cyphyus*) , rayed bean mussel (*Vilosa fabalis*), rabbitsfoot mussel (*Quadrula cylindrical*), the Tippecanoe darter (*Etheostoma tippecanoe*), eastern sand darter (*Ammocrypta pellucid*), western sand darter (*Ammocrypta clara*), mimic shiner (*Notropis volucellus*), paddlefish (*Polyodon spathula*), and shovelnose sturgeon (*Scaphirhynchus platorynchus*).

4.1.3 Reports Related to Water Quality

Christensen, C.C. 1998. *Indiana fixed station statistical analysis 1997.* Indiana Department of Environmental Management, Office of Water Management, Assessment Branch, Surveys Section, Indianapolis, Indiana. IDEM 32/02/005/1998.
This report, produced by the Indiana Department of Environmental Management (IDEM), Office of Water Management, analyzed fixed station monitoring data from 1991 to 1997 throughout the State of Indiana, including Wabash River. Physical, chemical, bacteriological, and radiological parameters were collected monthly at fixed stations along the river, and trends in mean, median and standard deviation of those parameters were examined.

Holdeman, M.A.; Gibson, S.C.; Christensen, C.C. 1998. *Trend Analysis of Fixed Station Water Quality Monitoring Data in the Upper Wabash River Basin 1998.* Indiana Department of Environmental Management, Office of Water Management, Assessment Branch, Indianapolis, Indiana. 23p. IDEM 32/02/023/2003.
This report, produced by the Assessment Branch of the Indiana Department of Environmental Management (IDEM) Office of Water Management, analyzed data from 372 water samples collected at fixed station monitoring sites throughout the upper Wabash River basin in 1998. Samples were analyzed for nine recoverable metals and nutrient levels. Overall, 100 samples exceeded Chronic Aquatic Criteria standards for metals. Levels of lead and mercury exceeding the standards were found in the Wabash River and Wildcat Creek in Tippecanoe County. Upper basin nutrient analysis results showed increased median values for Phosphorus, Total Kjeldahl TKN, and Total Organic Carbon; while lower reaches of the basin had higher nitrate levels.

McDuffee R. 2002. *An Assessment of Pesticides in the Lower Wabash River Basin and Kankakee River Basin*. Indiana Department of Environmental Management, Office of Water Quality, Assessment Branch, Surveys Section, Indianapolis, Indiana. IDEM 032/02/028/2002.
The Wabash River at Lafayette drains 7,267 square miles. A total of 6,563 square miles (90 percent) of the drainage basin is planted in corn and soybeans. Annually, 2.4 million pounds of atrazine are applied to corn and 1.7 million pounds of glyphosate (Roundup©) are applied to soybeans in the Wabash River watershed above Lafayette.

Atrazine is suspected as an endocrine disrupter and has a potential to produce tumors in a long term setting. IDEM's Office of Drinking Water has recently implemented a Source Water Protection Program for human health and safety.

McFall, L.; Martin, S.; Christensen, C. 2000. ***1998. Upper Wabash River basin sampling sites and stream standard violations, report for the 305(b) Coordinator, compiled by Arthur C. Garceau.*** **Indiana Department of Environmental Management, Office of Water Management, Assessment Branch, Indianapolis, Indiana. 25p. IDEM 32/02/022/2000.**
This report produced by the IDEM Office of Water Management, summarized water quality sampling results, highlighting regulatory violations. Sampling programs acted upon in 1998 included watershed monitoring, fixed station, E. coli, and Total Maximum Daily Load (TMDL).

Results of the Watershed Monitoring probabilistic program did not observe any stream standard violations that pertain to aquatic life uses; however, other sampling programs did observe violations at specific sites.

Tetra Tech, Inc. 2006. ***Wabash River Nutrient and Pathogen TMDL Development.*** **Report for Illinois Environmental Protection Agency and Indiana Department of Environmental Management, Indianapolis.**
This report, a collective effort by the States of Indiana and Illinois, summarized comprehensive water quality results throughout the Wabash River, identified impairments, pollution sources, and needs for TMDL, and identified possible Implementation Plans.

4.1.4 Reports on Wabash River Projects and Plans

Christopher B. Burke Engineering, Ltd. 2007. ***Wildcat Creek Stahl Ditch – Kitty Run Watershed Management Plan.*** **Indianapolis, Indiana.**
The Wildcat Creek Stahl Ditch-Kitty Run watershed (HUC-14: 05120107010100 and 05120107020010) includes the City of Kokomo, Indiana, which discharges untreated stormwater to Wildcat Creek, as well as untreated combined sewage discharge from eighteen combined sewer overflows (CSOs). There is considerable development on the outskirts of the City, although 65 percent of the watershed remains in agricultural use.

Baseline characterizations of the watershed identified water quality problems related to elevated levels of toxicants (Polychlorinated Biphenyls and pesticides), bacteria, nutrients, total suspended solids, degraded habitats and stressed biological communities. Potential sources of these pollutants include point source National Pollutant Discharge Elimination System (NPDES) facilities, agricultural practices, and urban land uses (failing septic systems, pet and wildlife waste, industrial waste, erosion from construction sites and runoff from impervious surfaces).

Targeted management measures to improve water quality include:

- Addressing failing septic systems;
- Establishing streamside buffers;
- Implementing conservation tillage practices on highly erodible lands;
- Restoring areas with stream bank erosion;
- Developing parks and trails along waterways; and

- Complying with the requirements of the Phase II Municipal Separate Stormwater Sewer Systems (MS4) program.

Eco Logic, LLC. ***J. Frederick Hoffman Memorial Nature Area Ecological Assessment and Reforestation Plan*****. Prepared for: Tippecanoe County Parks Foundation.**
The Hoffman Memorial Nature Area is a 420-acre property that contains a large agricultural field in the central, upland area of the property, as well as two smaller agricultural areas adjacent to the Wabash. The goals of the reforestation plan are to increase habitat critical to many species of birds, manage and minimize the detrimental effects of invasive plant species, and control onsite erosion during the transition from open areas to forest communities.

A total of seventeen acres of floodplain forest will be established, as well as 127 acres of upland forest.

Tippecanoe County Soil & Water Conservation District. ***2005-2010 Long Range Plan.***
This Long-Range Plan is a roadmap for conserving soil and resources. The plan is intended to advance comprehensive conservation programs and innovative approaches to put "conservation on the ground". The plan includes measurable goals for the natural resources for Tippecanoe County related to:

- Stable Soils
- Healthy Forests and Riparian Buffers
- Clean Streams and Water Resources
- Productive Farms
- Sustainable Communities
- River Corridor Enhancement

US Army Corps of Engineers. 1938. ***Flood Control Plan Wabash River and Tributaries Basin Study.***
This report was prepared in response to the flooding in the basin that occurred as a part of the massive flooding in the Ohio River basin in 1937. The report discussed and/or recommended 70 levee or channel improvement projects and nine large reservoir projects. This report was revised in 1940 and updated in 1944. Follow up basin comprehensive studies were later conducted in 1963, 1968, and 1971. Of the original nine reservoir projects, a total of three were constructed at or near the originally proposed sites: CM Hardin, Monroe and Cagles Mill. Four other large multipurpose reservoir projects were constructed at other locations in the basin: Roush, Salamonie, Mississinewa and Patoka. Of the 70 originally proposed levee/channel projects: 36 were ultimately implemented under various types of construction authorizations; 13 were authorized for construction by Congress but never funded; and one is currently scheduled for construction under a recently executed cost sharing agreement. One additional levee at Mt. Carmel was added to the original project list and constructed.

U.S Army Corps of Engineers et al. 1971 ***Wabash River Basin Comprehensive Study*****.**
This Study, conducted by the Wabash River Coordinating Committee, was prepared at the field level and presents data for a comprehensive plan for the conservation, management, development and preservation of the basin.

U.S Army Corps of Engineers. 1977. ***Wabash River Comprehensive Navigation Study.***
This study looked at the possibility of constructing a series of locks and dams on the Wabash River for the purpose of establishing commercial navigation in the basin. The report concluded that the proposal was economically unjustified by a wide margin. A 1989 review of the findings arrived at the same conclusion.

U.S. Army Corps of Engineer. 1985. ***Special Report on Streambank Erosion Problem on the Wabash River at Grayville, Illinois***
The purpose of this study was to identify problems due to an oxbow cutoff on the Wabash River near Grayville, IL caused by Wabash River flood flows during April 1985. The objectives of this study were to determine the effects of the cutoff on public facilities and public health; define possible structural solutions to return the Wabash River to the previous channel; and identify any legislative authorities available to the Corps of Engineers applicable to this cutoff. The scope of this study was limited to a brief site inspection of the new cutoff, a review of existing information on the area relating to erosion, and a preliminary analysis of three possible alternatives. The primary problem identified was associated with the city's sewer out fall. During periods of normal or low flow, most flows of the Wabash River could bypass Grayville by way of the cutoff. The effluent from the city sewer system could eventually degrade the quality of the water in the oxbow due to the reduced flows.

U.S. Army Corps of Engineer. 1996. ***New Harmony, Indiana, Wabash River Streambank Erosion Feasibility Study*****.**
Section 101(b) (10) of WRDA of 1996 authorized construction of a project for streambank protection at New Harmony, Indiana, subject to completion of a final report. This study is the final report, which investigated the feasibility and the extent of Federal interest in providing a solution to the streambank erosion problem occurring along the Wabash River at New Harmony, Indiana. The authorized project consists of placing stone protection along the left bank of the Wabash River beginning at a point approximately 3100 feet upstream of the State Road 66/U.S. Route 460 bridge at New Harmony and continuing upstream for a distance of 4800 feet. The project is designed to prevent erosion-related damage to structures and facilities located along the Wabash River in the historic town of New Harmony.

U.S Army Corps of Engineers. 2001. ***White River Anderson Section 205***
A Detailed Project Report was completed in December, 2001. However, funding was not available to proceed into the Construction phase. The recommended plan consists of reconstructing approximately 3,260 linear feet of existing levee by adding earthen embankment to increase the cross sectional area and height. A realignment and extension of the levee at the upstream end will add approximately 1,500 feet to the line of protection. Approximately 417 linear feet of low concrete I-wall will be constructed immediately upstream of the 8th Street

bridge. The total length of the protection will be 5,180 feet. The plan also includes a flood warning system.

US Army Corps of Engineers. 2007. *Wabash River Analysis – Phase I Tippecanoe County, Indiana.* Planning Assistance to States Study Final Report.
The purpose of the Planning Assistance to States (PAS) study was to complete a Hydrologic and Hydraulic study of issues pertaining to the development of a conceptual master plan by the Wabash River Enhancement Corporation for Riverfront Development along the Wabash River in Lafayette-West Lafayette, Indiana. The results indicated that the HEC-RAS hydraulic model appears to accurately represent the Wabash River for predicting peak water surface elevations and inundation extents in the study area. This is beneficial for future planning related to the conceptual master plan.

U.S Army Corps of Engineers. 2010. *Section 905(B) (WRDA 1986) Analysis Grayville Dam, Illinois*
The 1985 high water created a cutoff that isolated a portion of the Wabash River channel, thus forming an oxbow lake where the river once flowed. In the ensuing 24 years, the cutoff has become part of the main channel of the Wabash and the former main channel has become an oxbow. A number of public concerns were identified during the course of the analysis including compromise of the city's sewage outfall, stagnation/siltation of the oxbow, reduced income of businesses caused by the change in course of the main stem, reduced recreational opportunities, ecosystem degradation caused by flooding of oil wells, destruction of the I-64 bridge and rest area complex and destruction of the Illinois Central Railroad bridge. This Analysis evaluated three alternatives: fully restoring the old channel, partially restoring the old channel and protecting the Waste Water Treatment Plant (WWTP) outfall pipe and no action. The Analysis recommends evaluation of measures protecting the WWTP outfall at Grayville, IL under Section 114 of the Continuing Authorities Program. No other Federal feasibility studies were recommended.

Wabash River Heritage Corridor Commission. 2004. *Wabash River Heritage Corridor Management Plan.* Lafayette, Indiana.
The plan identifies significant resources within the corridor, defines strategies that could be implemented to conserve and enhance those resources and identifies key resources, and tools that can be used by local governments and organizations to implement strategies.

The plan identified the following actions related to natural resources:

- Stabilization of the riverbank.
- Re-establish riparian forests and wetlands along the river.
- Develop and implement setback programs to reduce surface runoff and non-point source pollution.
- Enforce existing regulations regarding point source pollution related to treatment plants and septic systems; explore the need for new regulations.
- Promote monitoring of water quality and public education about water quality.
- Preservation of large regional natural areas.

- Fish stocking and wildlife re-introduction in and along the Wabash River.

The plan identified 59 projects valued at over $13 million conducted between 1990 and 2000. In Tippecanoe County, 16 projects have been implemented, valued at $1.9 million. Projects include land acquisition, trail construction, reforestation, interpretive signage and other improvements.

Wallace, Roberts and Todd. 2010. *Master Plan for the Wabash River Greenway.*
The Wabash River Enhancement Corporation funded the development of a master plan for a greenway along the Wabash River. The greenway study area consisted of the 100-year Wabash River floodplain from Delphi in Carroll County through Lafayette and West Lafayette to Independence in Fountain / Warren County. This area was divided into six segments, and for each segment the master plan identified recreational opportunities such as driving and bicycle routes, camping and boating, as well as cultural features

Wildcat Creek Watershed Alliance, Inc. 2003. *Little Wildcat Creek Watershed Management Plan.* Prepared by Goode and Associates, Inc. for the Wildcat Creek Watershed Alliance. IDEM 319 Project ARN #00-199. July 2001-June 2003.
The Little Wildcat Creek Watershed is a HUC 14 watershed (HUC 05120107020020) within the Wildcat Creek Watershed. It drains 12,054 acres within Howard and Tipton County, Indiana. The dominant land use is agriculture with 76 percent of the watershed is in agricultural production, 16 percent is low density urban development.

The Howard County portion of the watershed is near the City of Kokomo and is rapidly urbanizing. Baseline characterizations of the watershed identified water quality problems related to elevated levels of oxygen consuming wastes, nutrients and bacteria. Potential sources of these pollutants include agricultural practices and urban land uses and development, as well as point sources from NPDES-permitted facilities. Both Gord Ditch and the East Fork of Little Wildcat Creek were listed on IDEM's 2002 303(d) list of impaired streams for *E. coli*.

Wildcat Creek Watershed Alliance. 2003. *Spring Creek-Lick Run Watershed Management Plan.* Prepared by Goode and Associates, Inc. for the Wildcat Creek Watershed Alliance. IDEM 319 Project ARN#00-199. July 2001–June 2003.
The Spring Creek-Lick Run Watershed is a HUC-14 watershed (HUC 05120107040100) within the Wildcat Creek Watershed that drains 10,842 acres within Clinton County, Indiana. 94 percent of the watershed is in agricultural production. Baseline characterizations of the watershed identified water quality problems related to elevated levels of nutrients, pesticides, sediment and bacteria. Potential sources of these pollutants include agricultural practices and urban land uses and development, as well as point sources from NPDES-permitted facilities. Heavilon Ditch and the South Fork of Wildcat Creek are both listed on IDEM's 303(d) list of impaired streams. Heavilon Ditch is listed for ammonia, dissolved oxygen, *E. coli* and organic enrichment, while South Fork Wildcat Creek is listed for cyanide and *E. coli*. A TMDL for Heavilon Ditch is under development.

4.2 Existing Projects

4.2.1 Lake Projects

A series of USACE lakes and reservoirs, as well as floodwalls and levees, protect many communities from devastating floods along many of the streams and rivers within this Wabash River Watershed. USACE lakes include Roush, Salamonie, and Mississinewa in the upper Wabash River Watershed while USACE lakes in the middle Wabash River Watershed include Cecil M. Harden, Cagles Mill, Monroe and Patoka. Both Cagles Mill and Monroe lakes reduce flows along the White River, as well as along the Wabash River (Figure 3). For the floods that occurred in June 2008, it is estimated that these seven lakes reduced flood damages downstream of the lakes by about $14,448,000 based on 2008 dollars.

The main project purpose of the USACE lake projects is flood control and each lake is a unit in the general comprehensive plan for flood control and allied purposes in the Wabash River and Ohio River basins. During the fall and winter months, when excessive rainfall is likely, the lakes are kept at a relatively low level referred to as winter pool. Should heavy rains occur, surface water runoff is stored in the lake until the swollen streams and rivers below the dam have receded and can handle the release of the stored water without damage to lives or property.

In addition, the lakes also operate for recreation and fish and wildlife activities and to provide a constant supply of water for downstream low flow augmentation. All seven lakes exist as a cooperative management effort between USACE and IDNR

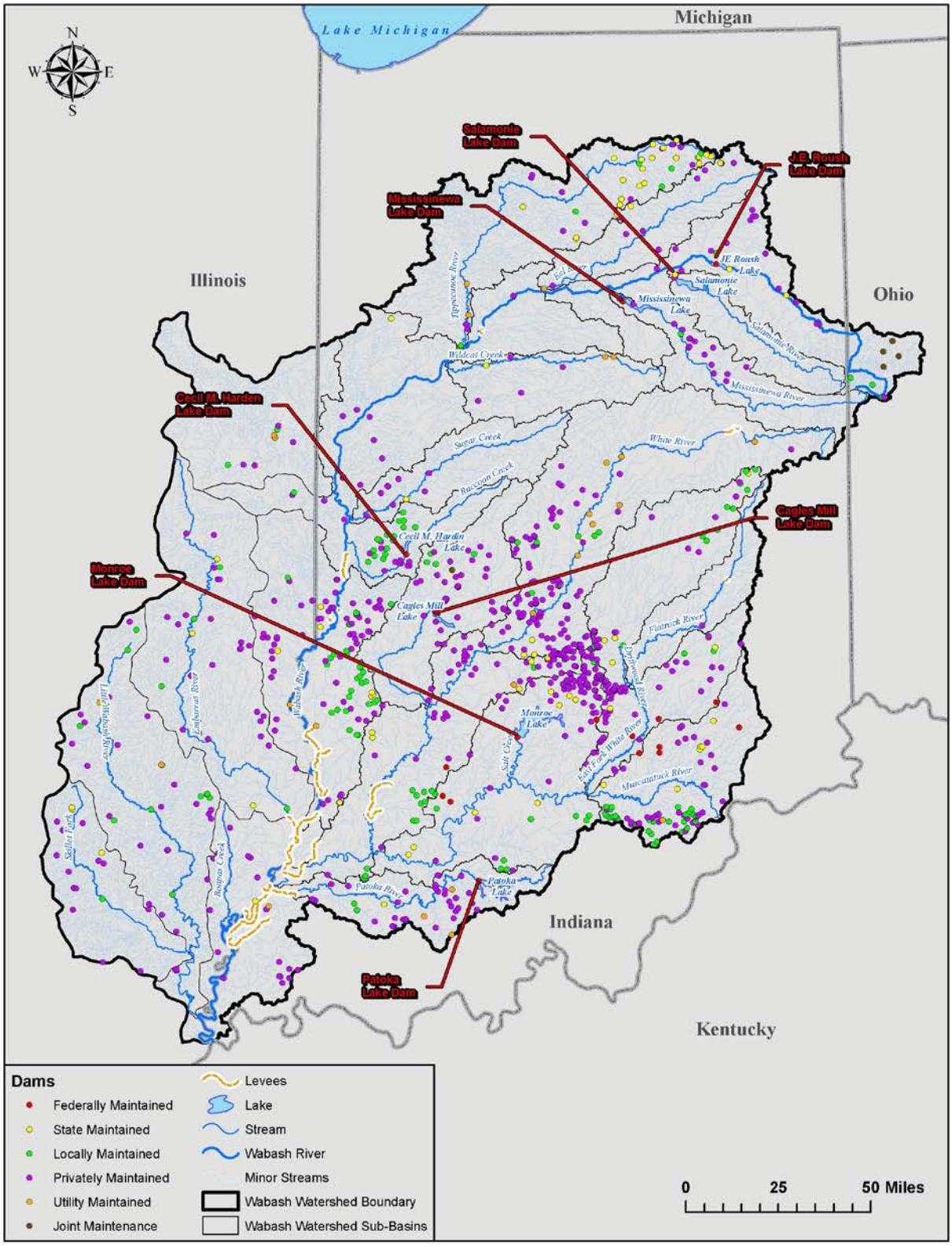

Figure 3. Map of Flood Protection Projects

J. Edward Roush Lake

Formerly known as Huntington Lake, J. Edward Roush Lake was authorized under the Flood Control Act (FCA) of 1958. The project area lies in Huntington and Wells counties, Indiana. The lake is located three miles southeast of Huntington, Indiana, 20 miles southwest of Fort Wayne, and is about a 100-mile drive from Indianapolis. The lake operates primarily as a unit with Salamonie and Mississinewa lakes to reduce flood stages in the upper Wabash River Watershed. The locations most directly benefited include the cities of Wabash, Peru, and Logansport, Indiana, and about 60,000 acres of agricultural land and related developments.

The dam is unique in the Louisville District, as it consists of rolled earth fill with a concrete center section containing the emergency spillway with three crest gates. The sluice gates and bypass are also located in the concrete center section. In addition, the project also has a USACE operated and maintained levee and pump plant at the town of Markle, approximately seven miles upstream from the dam. The levee and pump plant protect the town during periods of high river and lake levels. There is also a USACE operated and maintained levee protecting the Star of Hope Cemetery.

Salamonie Lake

Salamonie Lake was authorized under the FCA of 1958. The dam is about 15 miles east of Wabash, Indiana, on the Salamonie River, a tributary of the Wabash River. The lake ranks second in the Louisville District in total accumulative flood savings and for Fiscal Year 2010 fifth for average annual savings. The primary area benefiting from the flood control aspect of the project is along the Wabash River downstream from the dam to Logansport, Indiana, and about 40,000 acres of agricultural land and related development. The project also has a USACE operated and maintained levee and dike at the town of Lancaster. The levee and dike protects a cemetery during periods of high lake levels.

Mississinewa Lake

Mississinewa Lake was authorized under the FCA of 1958. The lake is located in Wabash, Miami, and Grant counties in north central Indiana, and is about an 85-mile drive from Indianapolis. The lake operates as a unit with J. Edward Roush and Salamonie Lakes to reduce flood stages in the upper Wabash River Watershed. Mississinewa Lake also operates with other lakes downstream to reduce flood stages along the lower Wabash River and the Ohio River. The locations most directly benefited include the cities of Peru and Logansport, Indiana and about 31,500 acres of agricultural land.

IDNR, under a lease agreement, operates four major recreation areas including Miami, Red Bridge, Pearson Mill, and Frances Slocum. The IDNR also manages natural resource and wildlife management programs under the same lease agreement. The total area leased to the IDNR covers 14,371.4 acres.

Construction began in April 1962, and the lake became operational in October 1967. Since its completion, Mississinewa Lake has prevented more than $305 million in flood damages, more than 10 times its original cost of $24.4 million.

Cecil M. Harden Lake.

The lake, formerly "Mansfield Lake," is located in west central Indiana, and lies predominantly in Parke County and extends into Putnam County. The dam is on Big Raccoon Creek 33 miles upstream of its juncture with the Wabash River, approximately 25 miles northeast of Terre Haute, Indiana. The lake serves as one unit of the comprehensive plan for the Ohio River Basin to reduce flood stages downstream from the dam, primarily in the Big Raccoon Creek and Lower Wabash River Watersheds.

USACE operates the dam and related facilities along with a small picnic area east of the dam site and a portion of the tailwater area. The majority of the land is leased to IDNR for recreation and fish and wildlife management. IDNR operates Raccoon State Recreation Area that provides camping, picnicking, swimming, boat launching, hiking, and playground facilities. They also maintain four other boat launching sites around the lake that include Mansfield, Walker, Hollandsburg and Portland Mills. Hunting areas and wildlife food plots are maintained by the IDNR near the Corps' operation area. The IDNR also handles 800 bank ties and 40 private group docks.

Cagles Mill Lake

Cagles Mill Lake was authorized under the Flood Control Act of 1938. USACE operates the project primarily for flood control in the Eel and White River Watershed and forms an integral unit of the comprehensive flood control plan for the Ohio and Mississippi rivers. The lake lies in Putnam and Owen counties in south-central Indiana, approximately midway between Indianapolis and Terre Haute. The area surrounding the lake is picturesque with rolling hills surrounded by streams and creeks. The dam is located on Mill Creek 2.8 miles above its mouth. Cagles Mill Lake bears the name of an old grist mill that was just downstream from the lake on Mill Creek. Lieber State Recreation Area, Cataract Falls SRA, and Cunot Boat Ramp are the lake’s primary recreation facilities and are operated by IDNR.

Monroe Lake

Monroe Lake was authorized under the Flood Control Act of 1938. Construction began in November 1960 and the project was completed in February 1965. The lake lies predominantly in Monroe County and extends into Brown, Jackson, and Lawrence counties in south central Indiana. The dam is on Salt Creek 25.9 miles upstream of its juncture with the East Fork of White River, approximately 20 miles south and east of Bloomington, Indiana. The three forks of Salt Creek which form Monroe Lake get their name from the many salt springs or "licks" along their course. This unique resource was utilized as early as 1822 when a well was dug near Salt Creek with the interest of converting the salt water into salt. Records show that it produced

about 800 bushels of this valuable pioneer commodity annually. In 1850 the first limestone quarry of the region was opened near Stinesville, leading to the development of what is still an important local industry.

Patoka Lake

Patoka Lake was authorized under the Flood Control Act of 1965. The dam is located 118.3 miles above the mouth of the Patoka River, a tributary of the Wabash River. The lake lies in Dubois, Crawford and Orange counties in southern Indiana. The dam is located approximately 118.3 miles above the mouth of the Patoka River, a tributary of the Wabash River, approximately 12 miles northeast of Jasper, Indiana. The lake lies in Dubois, Crawford, and Orange counties in southern Indiana. Patoka Lake is located within the purchase area of the Tell City Ranger District of the Hoosier National Forest is bordered by the forest on the east in Crawford and Orange Counties. The Hoosier National Forest is continuing to acquire private property within its exterior boundary throughout the lake area.

4.2.2 Local Flood Protection Projects

There are a series of federally constructed levees and floodwalls that protect various communities and agricultural areas from experiencing serious flooding problems. Table 3 lists the levee projects within the Wabash River Watershed.

Table 3. Wabash River Watershed Levees & Floodwalls

Wabash River Watershed Levees & Floodwalls	
Flood Protection Project	**Protected Area**
Levee Unit #5	Patoka River, Wabash River, Black River
Rochester & McCleary's Bluff	Wabash River
Mt. Carmel	Wabash River, Greathouse Creek
Brevoort	Wabash River, White River
England Pond	Wabash River
Vincennes	Wabash River
Niblack	Wabash River, Busseron Creek, Maria Creek
Gill Township	Wabash River, Busseron Creek, Turtle Creek
Island Levee	Wabash River, Turman Creek
West Terre Haute	Wabash River, Sugar Creek
Terre Haute (Conover)	Wabash River
Lyford Levee	Wabash River
Delphi	Wabash River, Deer Creek
Indianapolis	White River
Muncie	White River

Levee Unit 5, Indiana

Location*:* The project is in Gibson and Posey counties, Indiana, on the left bank of the Wabash River, 58 to 94.5 miles above the mouth.
Authorization*:* The project was authorized by the Flood Control Act approved 22 June 1936 and 24 July 1946. The project is located in Indiana Congressional District 8.
Project Features*:* The project consists of 41.9 miles of earth levee with appurtenant drainage structures. Top elevation of the protective works along the Wabash River varies from 383.5 to 404.6. The project affords protection for 44,000 acres of agricultural land and the small towns of Lyles, Skelton, and Griffin. The degree of protection afforded is for a flood flow equal to that expected about 7 times in each 100-year period, with a freeboard of one foot.

Rochester and Mccleary's Bluff, Illinois

Location*:* The project is in Wabash County, Illinois, on the right bank of the Wabash River, 80 to 89.0 miles above the mouth.
Authorization*:* The project was authorized by the Flood Control Act approved 24 July 1946. The project is located in Illinois Congressional District 8.
Project Features*:* The project consists of approximately 3.2 miles of levee setback, 5.4 miles of construction turnover, 0.5 mile of levee enlargement, a total of 9.1 miles of levee, and other necessary appurtenances. Top elevation of the protective works varies from 395.0 to 400.5. The project affords protection for 5,400 acres of farmland, of which approximately 4,670 acres are under cultivation. The degree of protection afforded is for a flood flow equal to that expected about 7 times in each 100-year period.

Mount Carmel, Illinois

Location*:* The project is in Wabash County, Illinois, on the right bank of the Wabash River, 93.6 to 95.6 miles above the mouth.
Authorization*:* The project was authorized by the Flood Control Act approved 23 October 1962. The project is located in Illinois Congressional District 19.
Project Features*:* The project consists of 15,700 feet of earth levee, 1,540 feet of concrete wall, 3 pumping plants, gravity outlets, and other necessary appurtenances. Top elevation of the protective works varies from 407.25 to 408.90. The project was assigned to local interests in October 1969.

Brevoort, Indiana

Location*:* The project is in Knox County, Indiana, on the left bank of the Wabash River, 104.5 to 127.5 miles above its mouth, and on the right bank of the White River, 6.3 to 22.2 miles above its mouth
Authorization*:* The project was authorized by the Flood Control Act approved 22 June 1936. The project is located in Indiana Congressional District 8.

Project Features*:* The project consists of the construction of 8.2 miles of earth levee, enlargement of 28.9 miles of existing earth levee, construction of 1 pumping plant, and other necessary appurtenances. The approximate lengths of the 4 sections are: Section I, 16.2 miles; Section II, 5 miles; Section III, 10.1 miles; Section IV, 4.6 miles; Section V, 1.2 miles. Top elevation of the levee varies from 412.0 to 426.0 feet mean sea level. The project affords protection to about 50,000 acres of agricultural land and the communities of Cathlinette, Zigville, St. Thomas, and Brevoort. Construction started in July 1938, completed in September 1947, and the project was assigned to local interests in January 1949.

England Pond Levee, Illinois

Location*:* The project is in Lawrence County, Illinois, on the right bank of the Wabash River, immediately north of St. Francisville, Illinois, about 7 miles southwest of Vincennes, Indiana.
Authorization*:* The project was authorized by the Flood Control Act approved 24 July 1946. The project is located in Illinois Congressional District 19.
Project Features*:* The project consists of approximately 6.0 miles of levee enlargement, 0.25 mile of railroad fill, and other necessary appurtenances. Top elevation of the protective works varies from 418.4 to 424.3. The project affords protection for approximately 4,950 acres of land lying in the Embarras and Wabash River's flood plain. Construction started in July 1970 and was completed in May 1972 and the project was assigned to local interests in January 1972.

Vincennes, Indiana

Location*:* The project is in Knox County, Indiana, on the left bank of the Wabash River, approximately 128 miles from its mouth
Authorization*:* The project was authorized under the general authorization for the Wabash River Basin contained in the Flood Control Act approved 24 July 1946. The project is located in Indiana Congressional District 8.
Project Features*:* The project consists of 3.9 miles of earth levee, 0.5 mile levee enlargement, 0.8 mile of concrete wall, 5 pumping plants, and other necessary appurtenances. The project, as constructed, provides protection for the City of Vincennes against Wabash River floods equal to or slightly greater than that provided by the adjoining downstream Brevoort Levee.

Niblack Levee, Indiana

Location*:* The project is in Knox and Sullivan counties, Indiana, on the left bank of the Wabash River, 134.8 to 151.8 miles above the mouth
Authorization*:* The project was authorized by the Flood Control Act approved 24 July 1946. The pumping plant was authorized by the Flood Control Act of 1968.
Project Features*:* The project consists of about 17 miles of earth levee having an average height of 14 feet with appurtenant drainage structures. Construction of Section 1 was started in March 1962 and was completed in April 1963; it was assigned to local interests in January 1963. Construction of Section 2 was started in May 1963, completed in April 1965, and it was assigned to local interests in January 1966.

Gill Township, Indiana

Location: In Sullivan County, Indiana, on the left bank of the Wabash River, 152 to 162 miles above its mouth
Authorization: The project was authorized under the Flood Control Act approved 22 June 1936. The project is located in Indiana Congressional District 8.
Project Features: The project consists of approximately 58,080 feet of levee enlargement, 10,032 feet of railroad enlargement, 2 pumping plants, and other necessary appurtenances. Top elevation of the protective works varies from 441.0 to 447.0. The project affords protection to approximately 12,000 acres and the small community of Riverton against Wabash River floods equal to the maximum on record, elevation 442.8 in March 1913, with a freeboard of three feet. Construction started in May 1939, completed in June 1946, and assigned to local interests in 1948.

Island Levee, Indiana

Location*:* The project is in Sullivan County, Indiana, on the left bank of the Wabash River and the right bank of its tributary, Turman Creek, across the river from Hutsonville and York, Illinois, 169.4 to 179.0 miles above the mouth of the Wabash River.
Authorization*:* The project was authorized by the Flood Control Act approved 24 July 1946.
Project Features*:* The project consists of approximately 0.1 mile of new earth levee, 2.3 miles of levee enlargement, 6.6 miles of levee setback, 0.3 mile of construction turnover, a total of 9.3 miles of levee, and other appurtenances. Top elevation of the protective works varies from 448.5 to 454.0. The project affords protection to an area of 5,620 acres of the flood plain, 4,660 acres of which are under cultivation.

West Terre Haute, Indiana

Location*:* The project is in Vigo County, Indiana, on the right bank of the Wabash River, 212.0 to 214.6 miles above the mouth.
Authorization*:* The project was authorized under the general authorization for the Ohio River Basin contained in the Flood Control Act approved 28 June 1938.
Project Features*:* The project consists of 10,115 feet of earth levee, 845 feet of concrete wall, 2,045 feet of railroad fill slope blanket, 1,925 feet of raised street, 1 pumping plant, and other necessary appurtenances. Top elevation of the protective works varies from 476.3 to 480.0. The protected area contains about 440 acres. The project affords protection with three feet of freeboard to the City of West Terre Haute against a flood having a frequency of once each 100-year period.

Terre Haute, Indiana

Location*:* The project is in Terre Haute in Vigo County, Indiana, on the left bank of the Wabash River, 217.5 miles above the mouth.

Authorization*:* A local protection project for Terre Haute was authorized by the Flood Control Act approved 22 June 1936. The project is located in Indiana Congressional District 7.
Project Features*:* The project includes a sluice gate and a headwall with automatic flap gate on an existing culvert under the fill of U.S. Highway 41 near Terre. The project protects about 110 acres.

Lyford Levee, Indiana

Location*:* The project is in Parke County, Indiana, on the left bank of the Wabash River, 227.5 to 234.7 miles above the mouth
Authorization*:* The project was authorized by the Flood Control Act approved 22 June 1936. The project is located in Indiana Congressional District 7.
Project Features*:* The project consists of 2.6 miles of new earth levee and enlarging approximately 5.2 miles of existing earth levee. Top elevation of the protective works varies from 482.0 to 486.4. The project affords protection to about 3,500 acres of agricultural lands.

Delphi, Indiana

Location*:* The project is in Carroll County, Indiana, on the left bank of the Wabash River, 330 miles above its mouth.
Authorization: The project was authorized under the additional authorization for the Ohio River Basin contained in the Flood Control Act approved 24 July 1946. The project is located in Indiana Congressional District 5.
Project Features*:* The project consists of approximately 3,247 feet of earth levee, earth plugs, and gravity drainage outlets in waterway openings at two highway bridges, and sluice gate wells on four existing pipe drains and three gravity drainage structures. The protected area contains about 310 acres.

Indianapolis, Indiana

Location*:* The project is located in the city of Indianapolis on both banks of the White River in Marion County, Indiana. It extends from 232 to 250 miles above the confluence of the White and Wabash Rivers.
Authorization*:* The project was authorized by the Flood Control Acts of 22 June 1936 (Section 3, Public Law 738, 74th Congress) and 24 July 1946 (House Document 197, 80th Congress, 1st Session). The project is located in Indiana Congressional District 10.
Project Features*:* The federal project for Indianapolis comprises channel improvement of the White River from Washington Street to the Indianapolis Union Railway bridge and from the Northwestern Avenue to Broad Ripple Dam, a total distance of 7.1 miles; the channel improvement of Fall Creek from the mouth to 16th Street (1.2 miles); reconstruction or extension of 5 highway bridges; alteration of 1 railroad bridge; and attendant levees, walls, and drainage appurtenances. The authorized project affords protection to a considerable section of Indianapolis against the maximum probable flood on White River and Fall Creek. The protection grade is one foot above the project flow line which exceeds the 1913 flood stage.

Muncie, Indiana

Location*:* The project is in Delaware County, Indiana, on the West Fork of White River, 322 miles above the mouth of White River
Authorization*:* The project was authorized by the Flood Control Act approved 22 June 1936. The project is located in Indiana Congressional District 2.
Project Features*:* The project consists of approximately 19,020 feet of earth levee, 3,480 feet of concrete wall, 4,870 feet of levee enlargement, 1,150 feet of concrete wall improvement, 20,000 feet of channel improvement, 4 pumping plants, and other necessary appurtenances. Top elevation of the protective works varies from 925.5 to 953.9. The project affords protection to the City of Muncie against a flood equal to the maximum on record, elevation 939.7 in March 1913, with a freeboard of three feet.

4.2.3 Navigation Projects

Historically, the Wabash River provided a route north for early settlers and an important trade linkage to the Ohio River and points south. Flatboats were the primary mode of river transportation until the 1820's when they were replaced by the steamboat. The height of river navigation on the Wabash River occurred between 1832 and 1853 when Indiana constructed over 450 miles of canals with the assistance of federal land grants. The most extensive canal route was the Wabash and Erie Canal. At 468 miles, the canal connected the Maumee River at Fort Wayne with the Wabash River, then exited the Wabash at Terre Haute and continued south to Evansville by way of the Eel River. The canal eventually fell victim to advances in rail transportation and in 1876 the Wabash and Erie Canal was auctioned off by its trustees.

Following the Civil War, there was renewed interest in navigation on the Wabash River. In 1872 the first report recommending navigation improvement was published in the Annual Report of the Chief of Engineers. Subsequently, the federal government rebuilt the Grand Rapids Lock and Dam on the Wabash River near Mt. Carmel, Indiana. Additional improvements included: several dams and dikes to control bank erosion and river course; clearing and snagging; and dredging. Appropriations for navigation improvements ceased in 1902 and The Rivers and Harbors Act of 3 March 1925 authorized removal of Grand Rapids Lock and Dam.

Currently, commercial navigation on the Wabash is nonexistent, except for a few ferry boat crossings. In 1977 USACE conducted a comprehensive navigation study, which looked at the possibility of constructing a series of locks and dams on the Wabash River for the purpose of establishing commercial navigation in the watershed. The report concluded that the proposal was economically unjustified by a wide margin. A 1989 review of the findings arrived at the same conclusion.

5. EXISTING CONDITIONS

5.1 General Watershed Conditions

The Wabash River Watershed has a total area of approximately 33,000 square miles and lies mostly within the Till Plains Section of the Central Lowland Physiographic, with the southern edge of the basin in the Shawnee Hills Section of the Interior Low Plateaus Province and Ridge Province. The Wabash River is over 508 miles in length from its headwaters to its confluence with the Ohio River and has over 14 major tributaries contributing flow to the main river. The unregulated streams within the Wabash River Watershed show a wide variety of seasonal variation.

The terrain in the Wabash River Watershed varies considerably across the basin. The north is characterized by flat to gentle undulating hills, while the southern portion is comprised of more rugged knobs and hills. Portions of the watershed, especially along its major tributaries flow through flat country with poor natural drainage. Throughout the watershed, streambeds have relatively little slope and shallow streambanks. As a result, agriculture is prevalent in the floodplains and cultivation often encroaches on riparian buffers. The National Land Cover Data 2001 (NLCD 2001) datasets were utilized to identify variations in land cover throughout the Wabash River Watershed. Approximately 20 percent of the Wabash River Watershed is forested (Table 4). Cultivated crops represent the largest portion of the basin at 62 percent.

Table 4. Wabash River Watershed Land Cover

Wabash River Land Cover	Acres	Sq. Miles	% of Basin
Barren Land - Acres	13,386	21	0.06%
Cultivated Crops - Acres	13,030,581	20,360	61.68%
Deciduous Forest - Acres	4,058,987	6,342	19.21%
Developed - High Intensity - Acres	57,178	89	0.27%
Developed - Low Intensity - Acres	492,885	770	2.33%
Developed - Medium Intensity - Acres	137,063	214	0.65%
Developed - Open Spaces - Acres	1,301,002	2,033	6.16%
Emergent Herbaceous Wetlands - Acres	31,084	49	0.15%
Evergreen Forest - Acres	55,471	87	0.26%
Grassland/Herbaceous - Acres	236,825	370	1.12%
Mixed Forest - Acres	1,734	3	0.01%
Open Water - Acres	223,285	349	1.06%
Pasture/Hay - Acres	1,349,325	2,108	6.39%
Shrub/Scrub - Acres	35,133	55	0.17%
Woody Wetlands - Acres	100,770	157	0.48%
TOTAL	21,124,709	33,007	100%

In general, the majority of the Wabash River Watershed is devoted to agriculture with dispersed industrialization in locations such as Indianapolis, Anderson, Marion, Kokomo, Muncie and Terre Haute, Indiana and Danville and Champaign, Illinois. According to the U.S. Census, in 2010, the population of the watershed was approximately 4,366,000. These developed areas are highlighted as red in Figure 4 below and account for the majority of impervious surfaces (approximately 6.5 percent) in the study area.

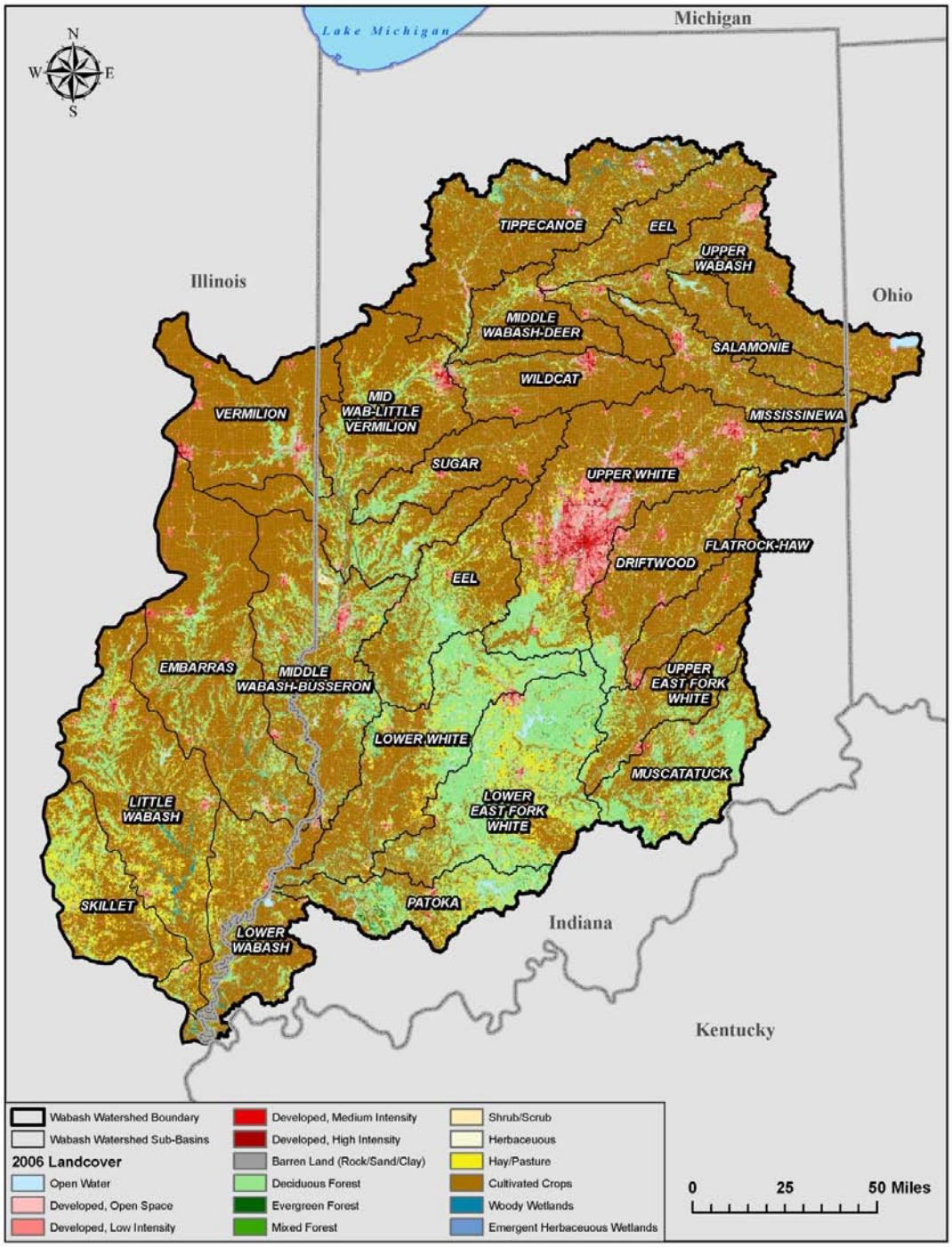

Figure 4. Map of Land Cover

5.2 Climate

The Wabash River Watershed has a temperate climate with relatively cold winters and hot, humid summers. The mean annual temperature for the Indianapolis area is 52.5 degrees F, with extremes ranging from 25 degrees below zero to greater than 100 degrees. The average monthly temperatures range from about 75 degrees F in July to about 26 degrees F in January (Figure 5).

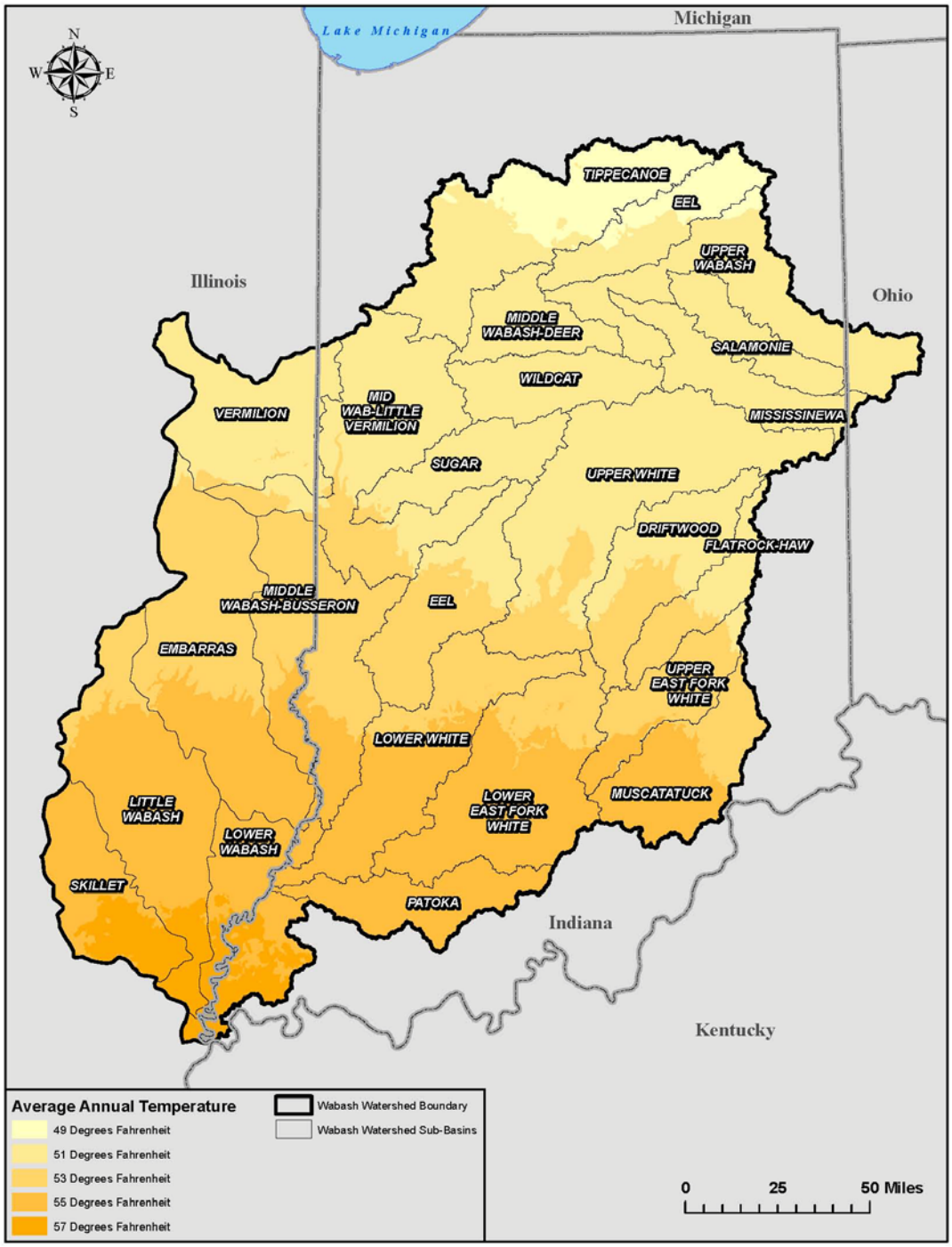

Figure 5. Map of Average Annual Temperature

Precipitation in the Wabash River Watershed is fairly well distributed throughout the year. For Indianapolis, the annual precipitation averages about 41.0 inches with a monthly average ranging from 2.41 inches in February to 4.42 inches in July (Figure 6).

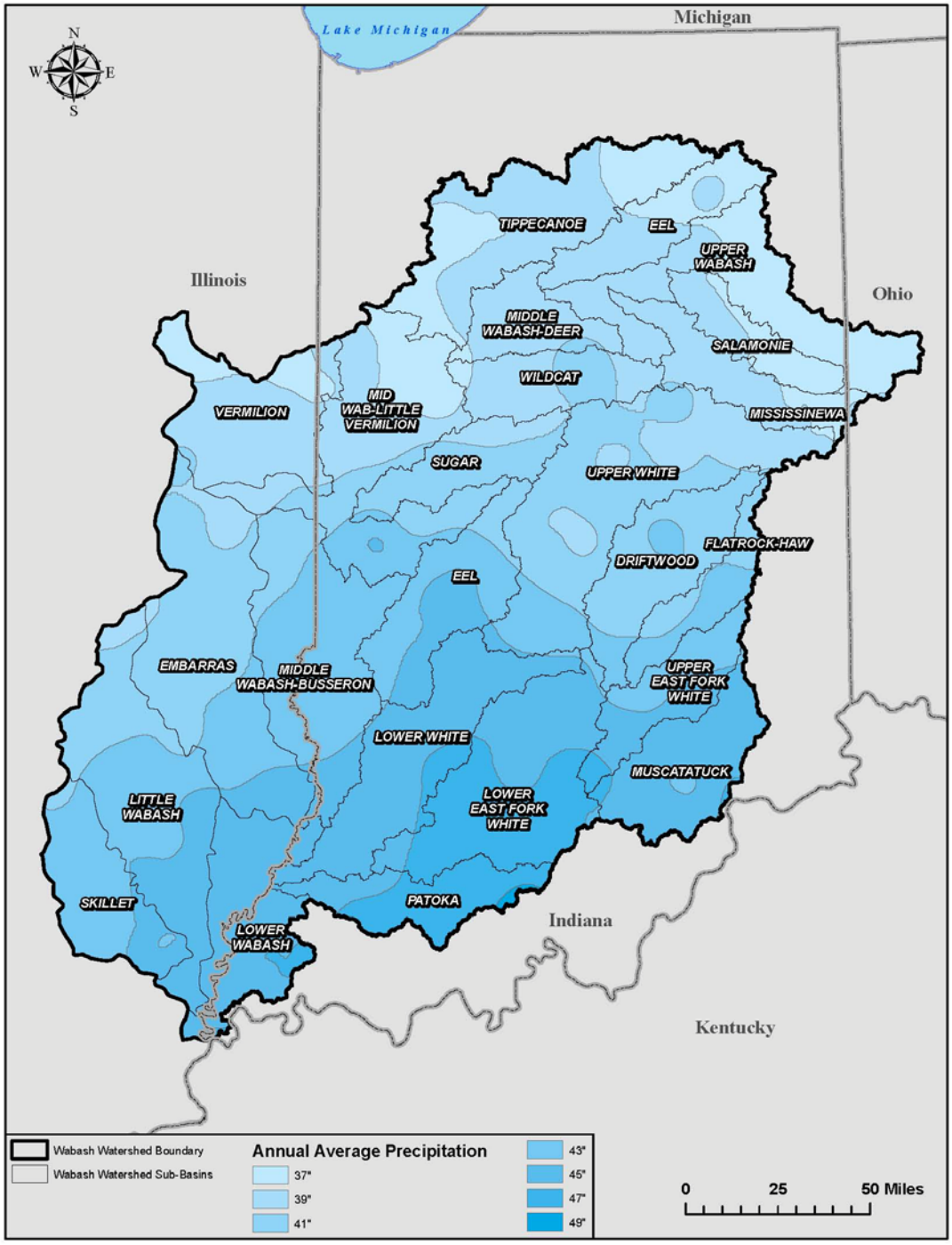

Figure 6. Map of Average Annual Precipitation

5.3 Physiography and Geology

5.3.1 Physiography

Overview

Most of the watershed lies in the Till Plains Section of the Central Lowland Physiographic Province, an area of broad rolling prairies underlain by thick glacial deposits and with little or no relief. The southern edge of the basin lies in the Shawnee Hills Section of the Interior Low Plateaus Province where the effects of glaciations are largely absent. It is a rugged section with bedrock exposures on steep hillsides and in narrow valleys.

Upper Wabash

The upper portion of the Wabash River basin lies within two physiographic areas; the Northern Moraine and Lake Region and the Tipton Till Plain. Except for occasional bedrock exposures and recent stream deposits, most physiographic features in the upper Wabash River Watershed were formed by glaciers during the Pleistocene epoch. Local relief ranges from 100 to 150 feet.

The Northern Moraine and Lake Region is characterized by moraines, outwash, and lake (lacustrine) plains. As glaciers advanced and retreated, the leading edge of ice would accumulate existing surficial materials and deposit them as moraines primarily consisting of gravels. Sand deposited by glacial meltwaters can be found in valley trains, outwash plains, and lake-sand deposits within the Tippecanoe River valley. Prevailing westerly winds have rearranged the sand into dunes in White and Pulaski counties.

South of the Eel River is the Tipton Till Plain. The surface of the till plain surface is nearly flat to gently undulating, poorly drained, and featureless. It is underlain by ground moraine and ablation tills. Surface relief is generally less than 10 feet per 1,000 feet. Relief across the moraines is low, generally less than 50 feet, although relief is slightly greater in several areas. The recessional moraines are one to six miles wide. Stratigraphy in the till plain area tends to be more horizontally continuous and less complex than in morainal deposits, except where thin till covers morainal deposits.

Middle Wabash

Topographic relief within the Middle Wabash River Watershed is approximately 530 feet. Altitudes range from a low of nearly 440 feet above sea level to a high of 970 feet above sea level.

The valley of the Wabash River is a dominant physiographic feature within the basin. In places the valley is two to three miles wide. Large expanses of floodplain lowlands are present at the

confluences of major tributaries, such as the Vermillion River and Big Raccoon Creek. Prominent terrace surfaces can also be seen in many areas along the course of the river valley.

The surface physiography of the Middle Wabash River Watershed is dominated by the Tipton Till Plain. The Tipton Till Plain surface is generally featureless, flat to gently-rolling plain, which is interrupted in places by low relief end moraines. Some ice-disintegration features, including disintegration ridges and prairie mounds, can also be seen within the Tipton Till Plain.

There are several large areas of human-disturbed land in the basin, particularly in the southern part in Vermillion, Vigo, Clay and Parke counties. Most of the disturbed land in those counties results from surface mining of coal and tailings disposal.

Lower Wabash

The lower section Wabash River valley is primarily within the Wabash Lowland physiographic unit. The Wabash Lowland is a broad, flat glacial drainage channel that includes winding channels, a wide flood plain, and adjacent terrace levels. The valley floor ranges from 3 to 10 miles in width. Local relief on the valley floor is typically less than 50 feet, except for isolated hills (Fidlar, 1948).

The physiography is controlled by bedrock, although pre-Wisconsinan glacial deposits and Wisconsinan loess are present at land surface. The overall subdued topography is controlled dominantly by the underlying fine-grained, clastic Pennsylvanian bedrock.

5.3.2 Geology

Overview

The bedrock consists of Pennsylvanian-age rocks in the Illinois part of the watershed and in southwestern Indiana. To the east of the Pennsylvanian beds, outcrops of Mississippian, Devonian, Silurian and Ordovican rocks appear across Indiana. Much of east-central Indiana is underlain by rocks of Silurian age; while Ordovician rocks occur in the southeastern part of the state.

Upper Wabash

Bedrock in the upper section of the Wabash River Watershed is composed of Paleozoic limestones, dolomites, sandstones and shales. Bedrock structure is dominated by the Cincinnati Arch, which plunges northwest across this basin. The plunge of the axis is steepest in the northwestern part of the Upper Wabash River Watershed. Bedrock dips southwest in the part of the Upper Wabash River Watershed that includes Benton, Carroll, Clinton, Tippecanoe and White counties. Although Paleozoic bedrock crops out at numerous locations in the Upper

Wabash River Watershed, it is covered by drift in most places. Most bedrock exposures are near the Wabash River or its southern tributaries.

Where present, the Rockford Limestone is overlain by silts and shales of the Borden Group. The Borden Group is generally less than 50 feet thick in Benton, Clinton, Tippecanoe and White counties.

The youngest rocks in the upper portion of the Wabash River basin were deposited during the early Pennsylvanian Period. The rocks are medium- to coarse-grained sandstones in alluvial-channel deposits containing carbonaceous shale lenses (S.J. Keller, Indiana Geological Survey, oral communication, 1990). These isolated subcrops of Pennsylvanian rock are generally less than 30 feet thick.

Middle Wabash

The middle section of the Wabash River Watershed lies on the eastern and northeastern margin of the structural Illinois Basin and on the southwestern limb of the Kankakee Arch. Bedrock units strike generally northwest, dipping gently into the interior of the Illinois Basin. Subcrops of rock units at the bedrock surface are progressively younger westward.

Clastic rocks of the basal Pennsylvanian Raccoon Creek Group overlie Mississippian carbonate rocks in the south-central part of the basin and overlie Borden Group rocks in the northern part of the basin (Gray et al. 1987). The Raccoon Creek Group is dominated by shales and sandstones, but also includes coals and minor limestones (Shaver et al. 1986).

Clastic rocks of the Carbondale and McLeansboro Groups overlie the Raccoon Creek Group. The Carbondale Group, which is dominated by shales and sandstones and which contains four economically significant coals, consists of the Linton, Petersburg and Dugger Formations (Shaver et al. 1986).

Lower Wabash

Pennsylvanian rocks are at the bedrock surface throughout the lower section of the Wabash River basin and are more than 1,000 feet thick. A lithologic sequence of sandstone, shaly sandstone, shale, thin limestone, coal and underclay comprise the Raccoon Creek, Carbondale and McLeansboro Groups of Pennsylvanian age (Cable et al. 1971).
Pennsylvanian bedrock exposed at the land surface or bedrock surface in the basin belong to the Linton, Petersburg, and Dugger Formations of the Carbondale Group and to the Shelburn, Patoka, Bond and Mattoon Formations of the McLeansboro Group. These Pennsylvanian rocks unconformably overlie older Mississippian rocks (Shaver et al. 1986).

The Raccoon Creek Group ranges in thickness from 100 to 1,000 feet and is composed of 95 percent shale and sandstone, plus minor amounts of clay, coal and limestone.

The Carbondale Group ranges in thickness from 260 to 470 feet and averages 300 feet. The group, which is thickest in central Posey County, is composed primarily of variable shales and sandstones and includes some laterally extensive limestone and coal beds.

The McLeansboro Group attains its maximum thickness of 770 feet in northern Posey County. The group is made up of 90 percent shale and sandstone plus minor amounts of siltstone, limestone, clay, and coal.

The Bond and Mattoon Formations are present only in the far western part of the lower Wabash River Watershed. The formations are primarily shale, siltstone, and sandstone.

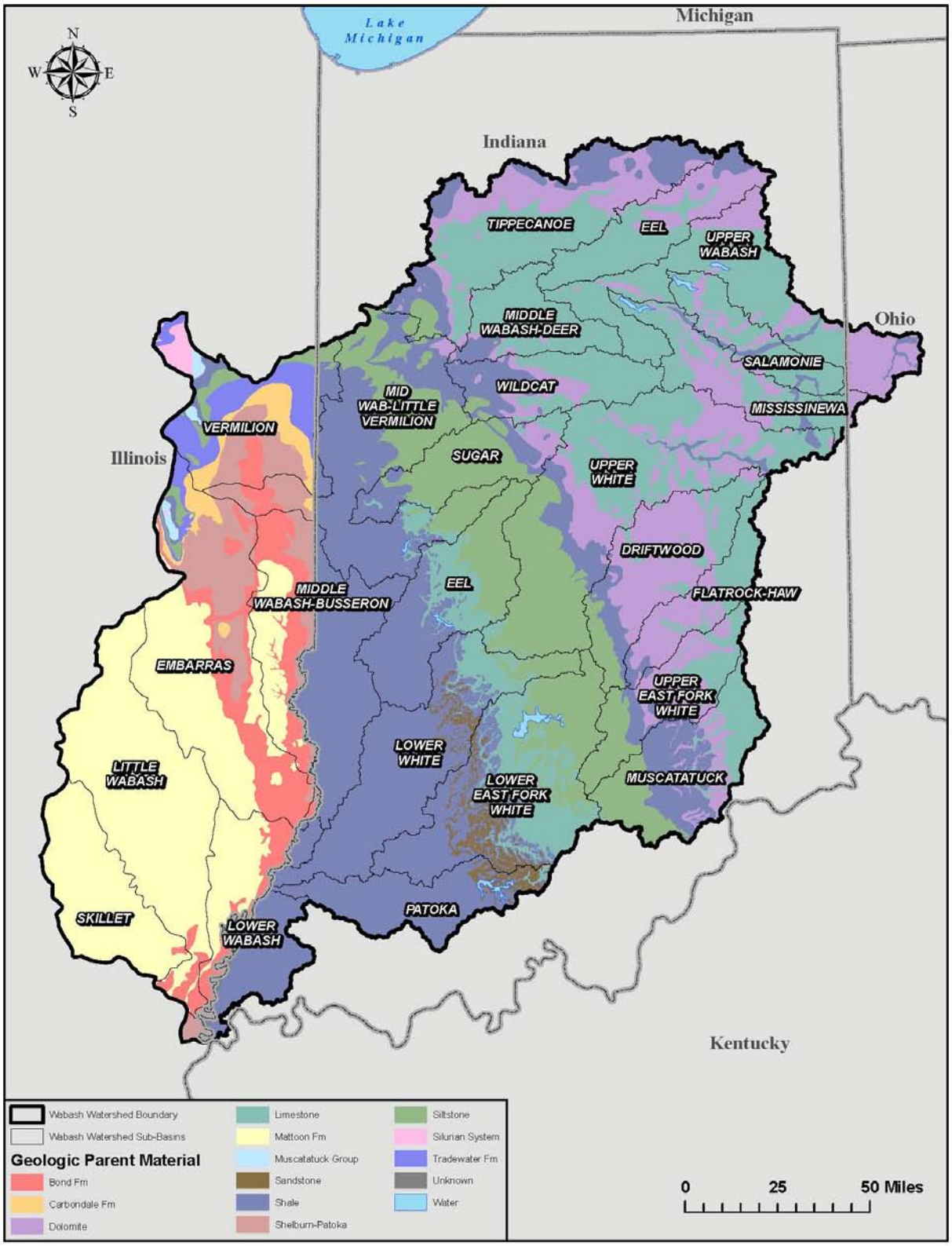

Figure 7. Map of Geologic Parent Material

5.4 Hydrology and Water Quality

5.4.1 Hydrologic Conditions

The Wabash River is over 508 miles in length from its headwaters to its confluence with the Ohio River, with a total drainage area of 32,910 square miles and over 14 major tributaries contributing flow to the main river. The largest of the tributaries to the Wabash River is the White River, with a total drainage area of 11,119 square miles. The unregulated streams within the Wabash River basin show a wide variety of seasonal variation, with the highest flows generally occurring from December through May, although it is possible for major floods to occur at any time of the year. For the Wabash River Watershed, major floods have occurred in March 1913, January 1937 and May 1943, with later floods occurring in January 2005, June 2008, and April 2011. The discharges for these streams are often negligible in the late summer and early fall with low flows generally expected during this period.

As mentioned previously, for the Wabash River Watershed, a series of USACE lakes protect many communities from devastating floods along many of the streams and rivers within the watershed. Reduced flows downstream of these lakes correspond to reduced flood damages for all highwater events that have occurred since construction and operation of these lakes. The average annual flood control benefits for these seven lakes since their beginning of operation is over $33 million based upon 2008 computations.

As for the discharges, both for streams with natural flows as well as for modified by our Corps lakes, by a Memorandum of Understanding dated May 6, 1976, the Natural Resources Conservation Service (NRCS), USGS, USACE (Louisville, Detroit, and Chicago Districts) and the Indiana Department of Natural Resources (IDNR) mutually agreed to coordinate discharge-frequency values for use in water resources investigations and planning activities in the State of Indiana. As part of this coordination effort, IDNR developed the publication “Coordinated Discharges of Selected Streams in Indiana”. Starting with the November 1996 publication, yearly updates to this manual have been issued without having to reprint the entire book. This publication is subdivided into 28 separate sub-basin areas with each area listing coordinated discharge-drainage area-frequency curves for many of the streams within that basin. For the smaller streams in each of the 28 sub-basins, ungaged streams are grouped together by county showing this discharge frequency relationship. For the States of Illinois and Ohio within the Wabash River Watershed, only streams from previous hydrologic studies performed by USACE have available information.

5.4.2 Hydraulic Conditions

Historical records for both stream flow and highwater data have generally been made available since the early 1900’s. The hydraulic conditions of the Wabash River Watershed have been modified due to the development within the basin, construction of USACE lakes, and flood

protection projects adjacent to the streams and rivers to protect the various communities. All of these hydraulic conditions do affect the stream flows and highwater data. While development within the watershed tends to increase the flows along the various streams, the USACE lakes have the opposite effect in tending to reduce discharges during flooding events. All studies that have been performed to date and will be conducted in the future should take into account these changing conditions.

Most of the flood control projects along the Wabash River Watershed include both urban and rural agricultural levees. For the local protection projects protecting urbanized areas, these flood control projects have provided over $850 million of average annual flood control benefits based upon 2008 computations. For the agricultural levees, which provide a lesser level of protection, over $16 million of average annual benefits have been derived. Levees and floodwalls provide much of the protection for the Wabash River Watershed, but there are instances where channel modifications do provide flood protection. For the Wabash River and White River, channel modifications do not exist along the various communities within their reaches. However, for some of the smaller streams within this basin, channel enlargements have been designed by the USACE for various communities such as Pipe Creek at Alexandria, Indiana.

Numerous hydraulic studies within the Wabash River basin have been performed by the Louisville District USACE throughout the years. These studies include Floodplain Information Studies (FPIS), Flood Insurance Studies (FIS), Section 22 Studies, Planning Assistance to the States (PAS) Studies, Reconnaissance, Feasibility, and Plans & Specs. Most of these hydraulic studies utilized programs developed by USACE Hydrologic Engineering Center (HEC) for development of the frequency profiles. In addition to these frequency profiles for the various streams and studies, historic profiles for many of the streams and rivers within the basin are also available. These profiles often include not only the flood of record but many other historic floods as well. The Hydrology and Hydraulic Design Section in USACE Louisville District has this information for analysis and review. Table 5 lists various hydraulic studies with available models for the Wabash River Watershed. It should be noted that other studies performed by other agencies or firms may be available. These can be located by checking with other state and federal agencies such as Illinois DNR and FEMA.

Table 5. Available Hydraulic Studies

Available Hydraulic Studies in the Wabash River Watershed	
Study	**Type of Study**
Allen County	FIS
Wabash River @ Wabash	FPIS
Wabash River @ Peru	FPIS
Wabash River @ Logansport	FPIS
Wabash River @ Delphi	Section 22
Kosciusko County	FIS
Tippecanoe River @ Winamac	Section 22
Wabash River @ Lafayette	PAS
Wildcat Creek @ Lafayette	PAS
Sugar Creek @ Crawfordsville	FPIS
Wabash River @ Vincennes	PAS
Charleston, IL	FPIS
Knox County	FIS
Henry County	FIS
Shelby County	FPIS
Flatrock Creek @ Rushville	P&S
Bartholomew County	FIS
Vernon Fork @ Vernon	Section 22
Scott County	Section 22
Brown County	FIS
East Fork White River @ Shoals	Section 22
Lick Creek @ Paoli	Section 22
French Lick Cr @ French Lick	Section 22
Buck Creek @ Muncie	FPIS
White River @ Anderson	P&S
Noblesville	FIS
Tipton	Section 22
Marion County	FIS
Johnson County	FIS
Monroe County	FPIS
Big Walnut Cr @ Greencastle	Section 22
Bonpas Creek, IL	FIS
Little Wabash River @ Carmi	FIS

5.4.3 Water Quality

The Wabash River has been continually degraded since settlement times, primarily from agricultural development and increased human population impacts. These historical trends appeared to reverse in 1984, when a sudden and substantial improvement in the middle Wabash River fishery was identified, continuing to the present time (Gammon, 1994, 1998). Gammon (1994) suggested these changes were due to gradual, but cumulative point source reductions in biological oxygen demand loadings to the river.

Several negative impacts of agricultural activities remain including siltation, rapid drainage due to tilling of fields, and fertilizer and pesticide inputs. These are common problems in similar agricultural regions. There are also two industrial facilities and three wastewater treatment plants with NPDES permits in the Wabash River Watershed that contribute to sediment and nutrient loading. Industrial effluents were historically a major source of degradation, but recently appear to have relatively low impact. Other current impacts to the Wabash River Watershed include non-point urban pollution from numerous adjacent communities (Gammon, 1998).

The Wabash River and its tributaries exhibit generally moderate water quality. Phosphorus is above desirable limits and nitrogen is high. Temperature, dissolved oxygen, and biochemical oxygen demand levels appear to be acceptable for lotic (flowing water) conditions although oxygen concentration has occasionally been reduced below the standards of Indiana and Illinois. Fecal coliform bacteria densities are such that the very few aquatic vascular plants are able to persist in the main stream of the Wabash River. A diverse phytoplankton community is supported along with minor occurrence of periphytic algae. Rotifers, copepods, and cladocerans are the dominant members of the zooplankton community. Benthic macroinvertebrate studies, which can be used to determine water quality, have been performed on pools of the Wabash River. These surveys revealed a fauna dominated by oligochaetes, dipterans, and mollusks. Riffle areas with suitable substrate harbored mainly caddisflies and mayflies. Similar to water chemistry measurements, the macroinvertebrate community surveys indicate moderate water quality.

Integrated Water Quality Monitoring and Assessment Reports are the new reporting method used by the U.S. Environmental Protection Agency (EPA) which combines the 303(d) impaired stream listing and 305(b) overall assessment of a state's waters. Ohio, Indiana and Illinois have all produced a Draft Integrated Water Quality Monitoring and Assessment Report in 2010. A review of 2010 state water quality reports indicated that approximately 7300 miles of streams in the Wabash River basin are considered impaired. The Upper White and Tippecanoe and Wildcat Watersheds are the three HUC4s in the Wabash Watershed with the highest totals of impaired streams. The NRCS initiated the Mississippi River Basin Healthy Watersheds Initiative (MRBI) to work with conservation partners and agricultural producers in the 13-state area to address nutrient loading and minimize agricultural runoff. In 2010, 41 focus area watersheds were identified as priorities; six are located in the Wabash River Watershed (Figure 8).

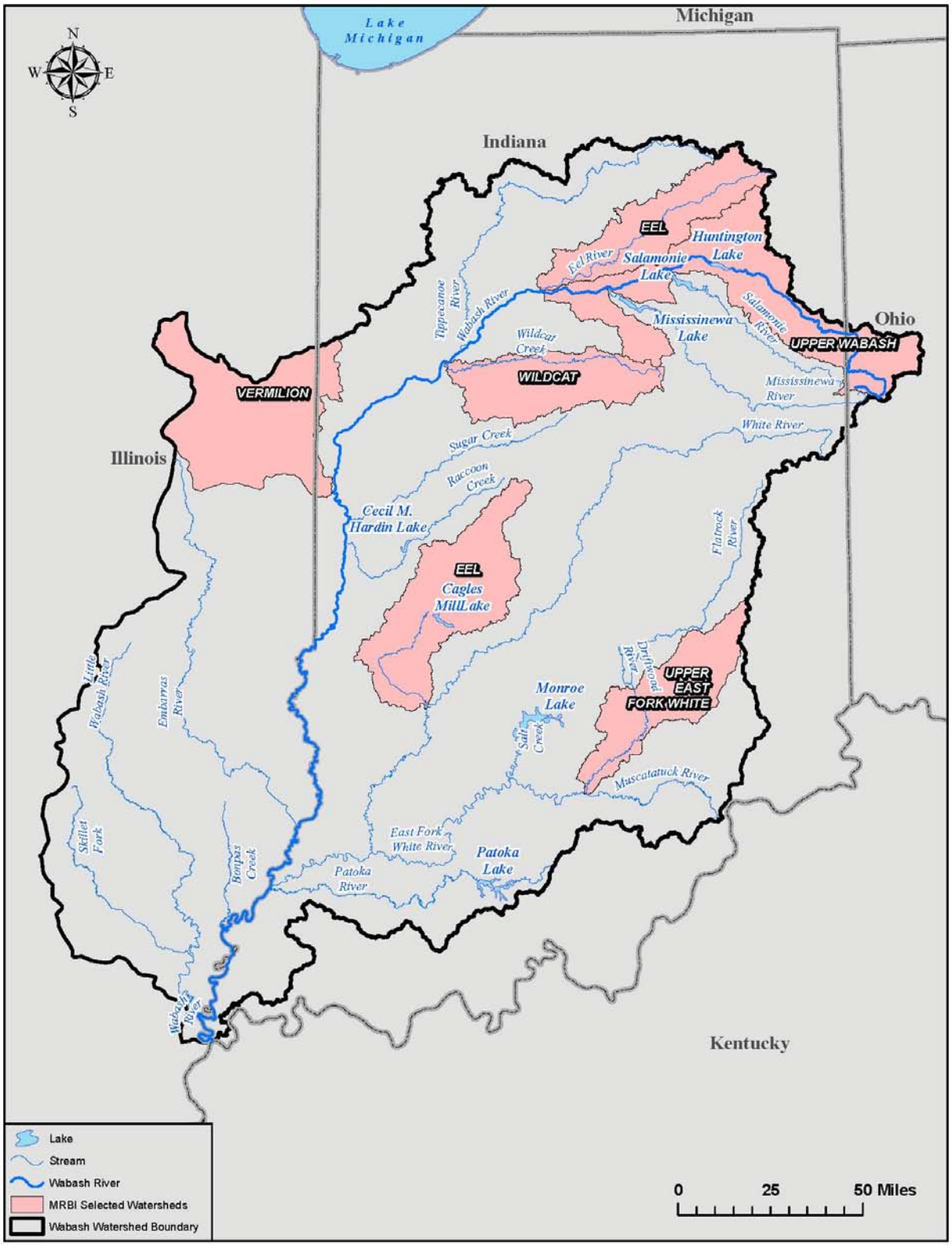

Figure 8. Map of MRBI Priority Watersheds

5.5 Natural Resources

5.5.1 Terrestrial Fauna

A variety of large and small mammals occurs within the study area. At least 249 species of birds, 66 reptiles and amphibians, and 42 mammals presently occur in the Wabash River Watershed, including one federally threatened and three federally endangered species. Because of the variety of habitats, more reptile and amphibian species have been recorded from the Lower Wabash River Valley than from any other geographic province in Indiana.

Of the original habitats available in the valley, native prairies have been virtually eliminated and the expansive oak-hickory forest has been greatly reduced. Vegetation in the rest of the watershed has been greatly affected by urbanization, industrialization, and agricultural practices. Presently, over 80 percent of the landscape in the lower Wabash River Watershed is agricultural. Cropland and old fields provide habitat for some adaptable prairie and generalist species. Remnant forest exists along some stretches of the riverbanks and in areas too steep or wet to farm. Some small wetlands and floodplain forests remain relatively intact. Because of this habitat degradation and fragmentation, most present-day animals are species that have adapted readily to the agricultural landscape, while wetland and forest-interior species have been especially decimated.

Thousands of ducks and geese migrate along or across the Wabash River every year. The lower end of the river combined with the Hovey Lake State Wildlife Area is an important waterfowl wintering area, especially for mallards.

5.5.2 Aquatic Fauna

The lower Wabash River provides habitat for the fish which primarily prefer large pools. Smaller headwater and tributary streams support generally smaller fish adapted for faster flowing and higher gradient streams. In tributaries of the Wabash River that have been fragmented by impoundments, a shift in piscivore abundance and composition was observed by Cameron (2006), with smallmouth bass (*Micropterus dolomieu*) and redfin pickerel(*Esox americanus*) replaced by largemouth bass (*Micropterus salmoides*) and white bass (*Morone chysops*). Fish assemblages in the Wabash River main stem are typical of most Midwestern systems. In addition to numerous aquatic macroinvertebrates, spotfin (Cyprinella spiloptera), emerald (*Notropis atherinoides*), and river shiners (*Notropis blennius*), gizzard shad (*Dorosoma cepedianum*), and numerous minnow and sunfish species make up the forage base for larger species that includes, but is not limited to, channel catfish (*Ictalurus punctatus*), flathead catfish (*Pylodictis olivaris*) freshwater drum (*Aplodinotus grunniens*), gar (*Lepisosteus spp.),* redhorse (*Moxostoma spp*.), common carp (*Cyprinus carpio*), river carpsucker (*Carpoides carpio*), and black basses (*Micropterus spp*.).

Thirteen of the approximately 151 fish species are recent, including three alien species. Better municipal and industrial waste treatment has improved water quality, but excessive agricultural runoff remains detrimental to many fishes. In addition to water quality issues, invasive species, particularly bighead carp (*Hypophthalmichthys nobilis*) and silver carp (*Hypophthalmichthys molitrix*), threaten many native fish species. These fast growing and aggressive fish out-compete native fish for food sources and continue to multiply rapidly since they have very few natural enemies outside of their home ranges.

Although there have been losses in biodiversity, the Wabash River watershed still has the foundations for substantial ecological rehabilitation. For example, the White River system, the largest tributary to the Wabash River, contains the last population of lake sturgeon (*Acipenser fulvescens*) in the Mississippi River basin (Drauch et al. 2008) and the main stem Wabash River maintains a commercial fishery for shovelnose sturgeon (*Scaphirhynchus platorynchus*). Other sensitive species, such as blue sucker (*Cycleptus elongates*) and other sucker species, maintain viable populations along large reaches of these rivers (Armitage and Rankin, 2010).

From a historical perspective, the Wabash River contained a rich mollusk population, both in species and numbers. During the early 20th century, the some reaches of the Wabash River were notable for commercial mussel harvesting operations. Commercial operations have continued into contemporary times but are severely depressed at present. This depression is most certainly due to depletion of numbers resultant from adverse habitat and water quality conditions.

Unionid mussel diversity has been reduced 55 percent in the Wabash River main stem and 24 percent in the watershed including all tributaries. Although numerous mussel species have been extirpated or are rare, at least 30 species still maintain reproducing populations in the Wabash River (Fisher 2006).

5.5.3 Threatened and Endangered Species

Threatened and endangered species are found within the Wabash River as well as in terrestrial habitat adjacent to the rivers.

Table 6. Federal and State Listed Species in the Wabash River Watershed

Common Name	Scientific Name	Fed	IN	IL	OH	Distribution
Mammals						
Gray Bat	*Myotis grisescens*	E	E	E	N	Clark, Crawford, and Spencer counties, IN
Indiana Bat	*Myotis sodalis*	E	E	E	E	Potential habitat statewide in IN, IL, and OH
Birds						
Least Turn	*Sternula antillarum*	E	E	E	N	Gibson and Spencer counties, IN Wabash County, IL

Common Name	Scientific Name	Fed	IN	IL	OH	Distribution
Reptiles						
Copperbelly water snake	*Nerodia eythogaster*	T	E	N	E	Kosciusko County, IN
Eastern massasauga	*Sistrurus c. catenatus*	C	E	E	E	Allen, Carroll, Kosciuscko, Marshall, Noble, Pulaski, and Tippecanoe counties, IN
Mussels						
Clubshell	*Pleurobema clava*	E	E	E	E	Carroll, Fulton, Kosciusko, Marshall, Pulaski, Starke, Tippecanoe, and White counties, IN Vermillion County, IL
Fanshell	*Cyprogenia stegaria*	E	E	E	E	Carroll, Daviess, Dubois, Martin, Pike, Tippecanoe, Wabash, and White counties, IN White County, IL
Fat Pocketbook	*Potamilus capax*	E	E	E	N	Daviess, Gibson, Knox, Pike, and Posey counties, IN Gallatin, Lawrence, Wabash, and White counties, IL
Northern riffleshell	*Epioblasma torulosa rangiana*	E	E	E	E	Pulaksi County, IN
Rabbitsfoot	*Quadrula cylindrica cylindrica*	C	E	E	E	Carroll, Cass, Fulton, Miami, Pulaski, Spencer, Starke Tippecanoe, and White counties, IN Clark, Crawford, Jasper, Lawrence, Vermillion, Wabash, and White counties, IL
Rayed bean	*Villosa fabalis*	PE	SC	N	E	Allen, Carroll, Dekalb, Fulton, Johnson, Kosciusko, Marshall, Pulaski, Starke, Tippecanoe, and White counties, IN Auglaize, Darke, and Mercer counties, OH
Rough pigtoe	*Pleurobema plenum*	E	E	N	N	Martin County, IN
Sheepnose	*Plethobasus cyphyus*	PE	E	E	E	Carroll, Cass, Clark, Fulton, Jefferson, Knox, Marshall, Martin, Pulaski, Spencer, Starke, Tippecanoe, Vanderburgh, Warrick, and White counties, IN
Snuffbox	*Epioblasma triquetra*	C	E	E	E	Carroll, Hancock, Huntington, Johnson, Shelby, Tippecanoe, and White counties, IN Coles, Cumberland, and Douglas counties, IL

Common Name	Scientific Name	Fed	IN	IL	OH	Distribution
Plants						
Eastern praire fringed orchid	*Plantathera leucophaea*	T	E	E	E	White County, IN Clay, Coles, Crawford, Cumberland, Douglas, Edgar, Effingham, Fayette, Ford, Iroquios, Jasper, Lawrence, Livingston, Marion, Moultrie, Richland, Shelby, Vermilion, and Wabash counties, IL
Short's bladderpod	*Lesquerella globosa*	C	E	N	N	Posey County, IN
Mead's milkweed	*Asclepias meadii*	T	N	E	N	Vermillion County, IL

E-Endangered, T-Threatened, C-Candidate, SC- Special Concern, Proposed as Endangered, N-None

5.5.4 Mineral Resources

The extraction of mineral resources is concentrated in the southwestern portion of the basin where bituminous coal and petroleum are predominant. However, mining activities can be found throughout the basin in reduced quantities (Figure 9). The principal mineral resources of the watershed are coal, petroleum, natural gas, sand, gravel, clay, shale, stone and gypsum. Mineral producers ship coal, petroleum, dimension stone and gypsum to markets outside the basin. Often, the majority of sand, gravel, clay, shale, and crushed stone is sold and used in close proximity to the source of production.

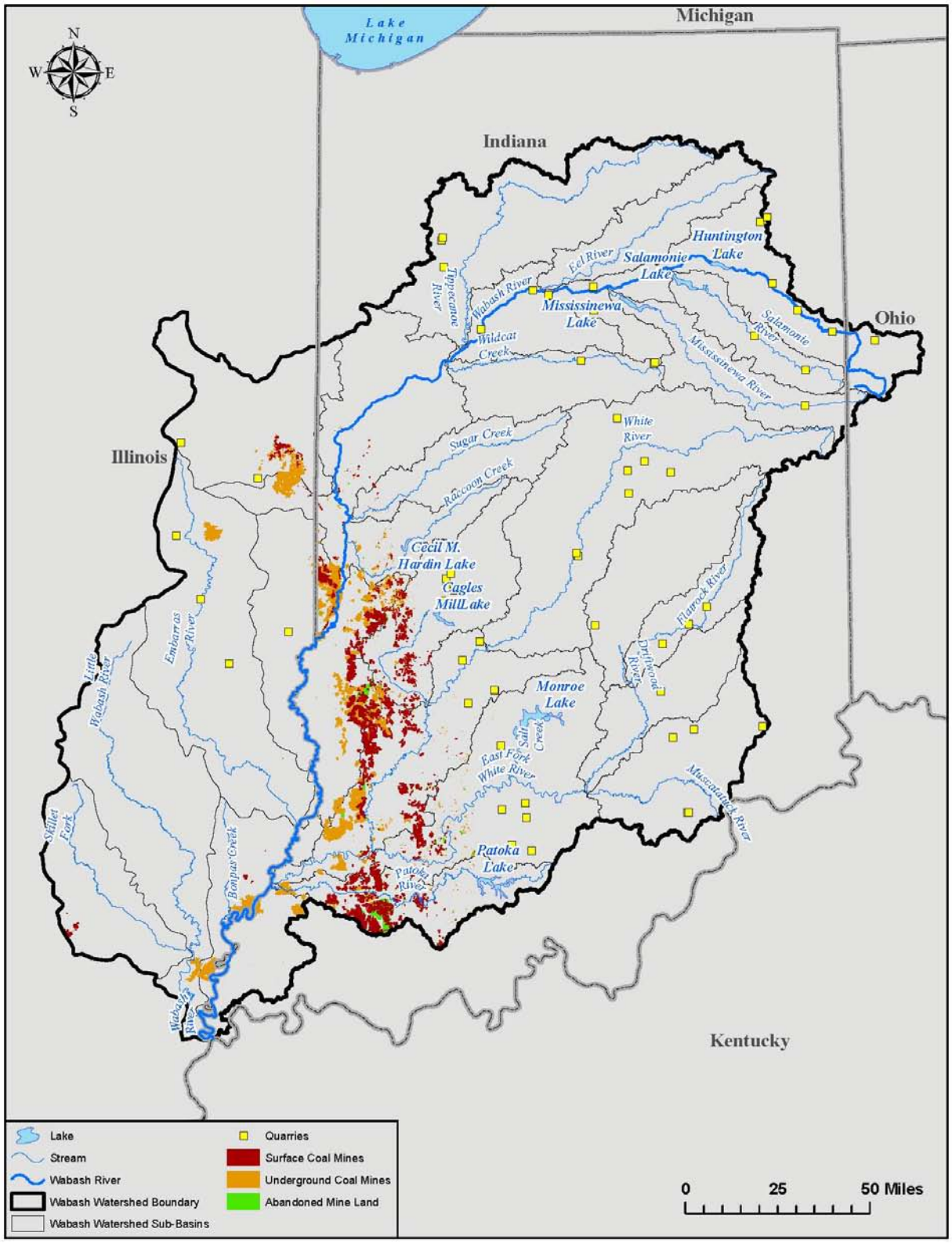

Figure 9. Map of Mines and Quarries

5.5.5 Groundwater

Devonian and Silurian limestones, dolomites and sandstones yield large quantities of water to wells in the northeastern part of the basin. Buried bedrock valleys and present river valleys contain thick deposits of glacial materials, which are capable of supplying water to large municipal and industrial users.

Large supplies of groundwater are available in most parts of the Wabash River Watershed. There are two primary sources of water: glacial and bedrock aquifers. Except for some of the older bedrock aquifers in the northern part of the basin, the glacial aquifers are the most important. For the most part, the ground-water development potential in glacial sediments is proportional to the volume and permeability of the sand and gravel deposits. Those deposits having the largest potential occur primarily in buried valleys, in outwash and along major rivers. The amount of water in the bedrock aquifers is related to rock porosity and the development of solution channels along joints and bedding plains. Drainage to deep valleys may have caused a lowering of the water table during preglacial time resulting in a deeper and more intense degree of weathering, thus accounting for the presence of the most productive bedrock aquifer in the vicinity of the Teays-Mahomet valley and major buried valleys.

The total or maximum yield of an aquifer to wells is related primarily to its area extent, saturated thickness, and permeability; whereas, the sustained yield (the amount of water that can be pumped continuously) is related primarily to recharge and potential recharge to the aquifer.

Recharge to ground water occurs either from direct precipitation on the intake area or downward percolation of stream runoff. The former occurs when the soil occupying an intake area reaches field capacity and precipitation percolates to the water table. The latter occurs by induced infiltration of surface water when the water table is below the water surface of the stream and the aquifer is hydraulically connected to the stream.

The quantity of direct recharge from precipitation is dependent primarily upon intensity, duration, and type of precipitation; slope of the land; soil characteristics; and surface cover. Some of the above factors are favorable to recharge of ground water in the Wabash River Watershed. For example, the precipitation is generally plentiful and well distributed throughout the year. Also, the land surface is of low relief; thus, the rate of overland runoff is held back and precipitation has greater opportunity to infiltrate the soil. In addition, the outwash-plain and valley-train deposits are highly permeable intake areas along and adjacent to bedrock outcrops. The upland areas of the basin, however, have low infiltration because they are covered by glacial till which is relatively impermeable.

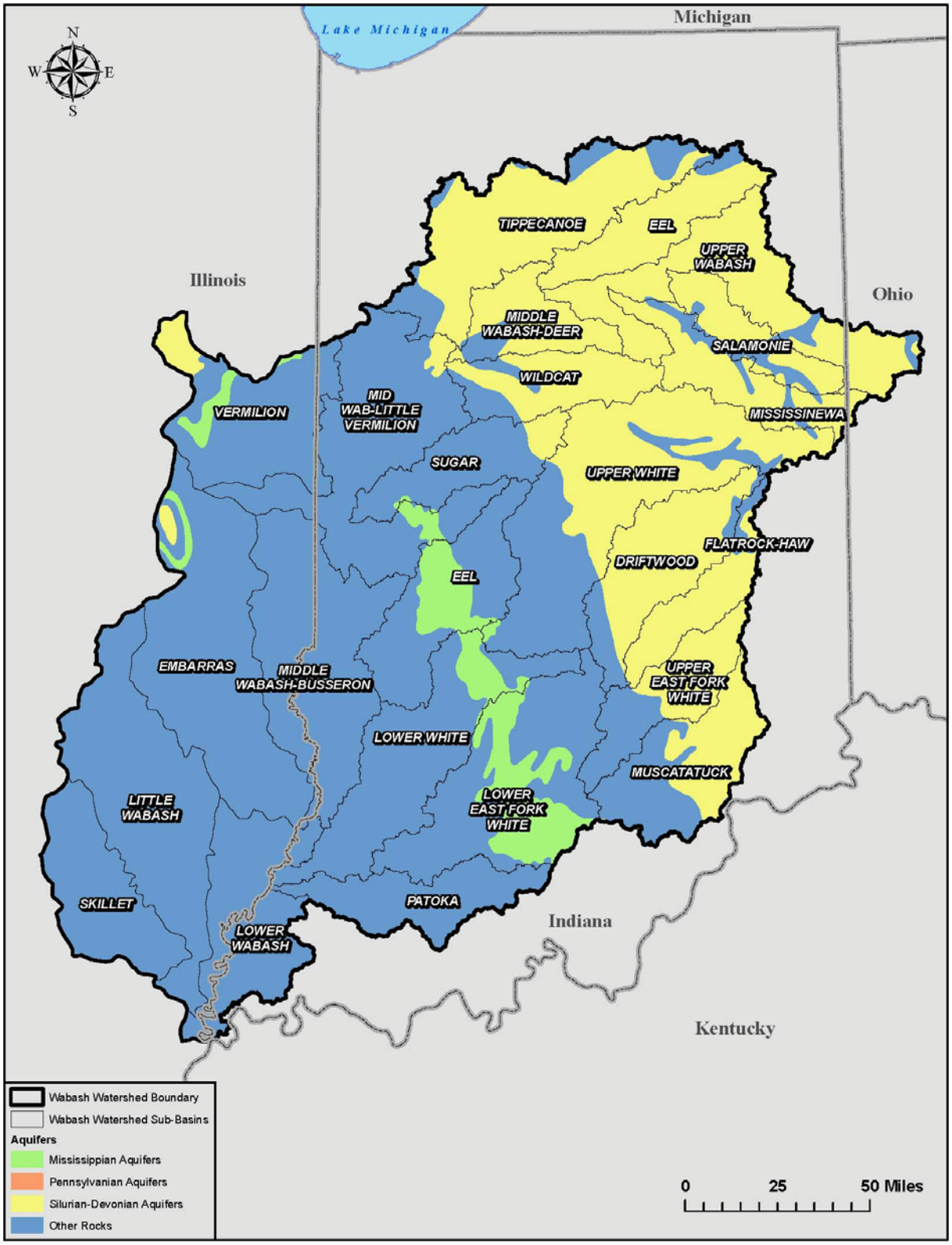

Figure 10. Map of Aquifer Types

5.5.6 Wetlands

The U.S. Department of the Interior, National Wetlands Inventory (NWI) maps were reviewed to determine the presence of wetlands within the Wabash River Watershed. The NWI maps indicated approximately 200 square miles or 0.6 percent of the watershed as wetland and nearly 350 square miles as open water in the watershed. Wetland systems in the Wabash River Watershed include palustrine (swamp-like), lacustrine (lake-like) and riverine (associated with surface water) with water regimes ranging from temporarily flooded to permanently flooded. The largest wetland types within the watershed fall under the classification of palustrine, forested wetland with a temporary water regime and palustrine, forested, wetland with a seasonal water regime. Other important types include palustrine, emergent, temporary water regime, and palustrine, emergent, seasonal water regime wetlands. Riverine and small areas of other wetland types also occur. Wetlands adjacent to the tributaries in the watershed include small forested, scrub-shrub, or emergent wetlands in the floodplains, to riverine systems associated with the larger tributaries. A generalized map from the NWI is shown below in Figure 3 and indicates that the distribution of wetlands across the watershed is relatively uniform except for the northern portion of the basin in Illinois.

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) soil survey information was reviewed for the watershed. There is variation in soils across the entire watershed. Similar to the NWI maps, the distribution of hydric soils is reasonably uniform across the watershed. The dominant hydric soils mapped by the NRCS were Pewamo and Brookston, followed by Crosby. All three soils are listed in *Hydric Soils of the United States, U.S. Department of Agriculture, Revised October 1990*.

Bottomland forested wetlands remain a high priority within the U.S. Fish and Wildlife Service for protection and restoration. Palustrine, forested wetlands suffered the greatest net losses of any wetland type between the mid-1950's and the mid- 1970s (Tiner, 1984). Consequently, the North American Waterfowl Management Plan has targeted bottomland hardwood forests through its joint venture and other programs for protection. A notable example of focused protection and restoration is the Healthy Rivers Initiative in Indiana. In the summer of 2010 Indiana announced the conservation initiative with a goal to protect 43,000 acres located in the floodplain of the Wabash River and Sugar Creek in west-central Indiana and another 26,000 acres of the Muscatatuck River bottomlands in southeast Indiana. This one initiative has the potential to permanently protect a large percentage of existing wetlands in the Wabash River Watershed.

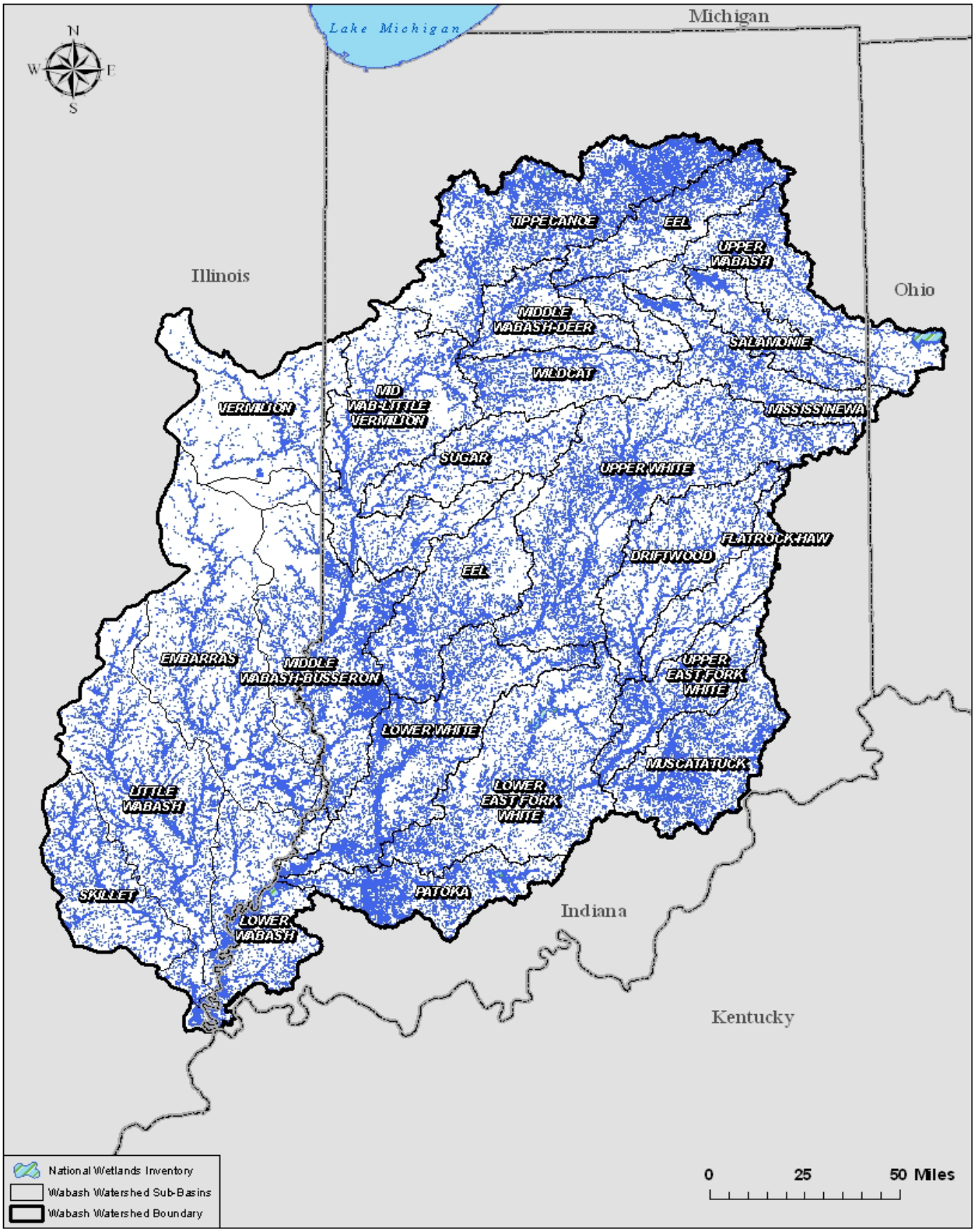

Figure 11. National Wetland Inventory Map of Wetlands in the Wabash River Watershed

5.6 Historic Storms and Floods

Numerous historic floods have occurred within the Wabash River Watershed during recorded times. Near the mouth of the Wabash River, the January 1937 flood was the worst flood to occur as long as records have been kept. This flood of record near the lower end of the Wabash River was due to backwater of the Ohio River. This flood easily surpassed all other floods along the Ohio River and lower portion of the Wabash River and was caused by heavy rainfall during the month of January which totaled over 19 inches within the Ohio River basin at many locations and about 15 inches for the Evansville area. During an eleven day period beginning on January 14th, over 12 inches of rainfall were recorded plus several inches of snowfall. This heavy rainfall caused the river to crest at a stage 5 feet greater than any other historical flood.

For the central portions of the States of Illinois, Indiana, and Ohio, the March 1913 flood proved to be the largest on record with many flood control projects designed and built based upon that historic event.

More recent flood events occurred in June 2008 when rainfall amounts from about two inches to more than 10 inches fell in south-central Indiana and Illinois over a three day period. This heavy rainfall resulted in severe flooding on many streams within the White River Watershed during June 7 through June 9. USGS. stream gages at nine locations recorded new record peak stream flows for their respective periods of record. Recurrence intervals were estimated to be greater than 1 percent chance (100-year) at many locations. Flooding was particularly severe for the communities of Columbus, Edinburgh, Franklin, Seymour, Martinsville, and Newberry to name a few. Some of the streams affected by this historic rainfall included Blue River, Canary Ditch, Clifty Creek, East Fork White River, Eel River, Flatrock River, Haw Creek, White River, and Youngs Creek which affected the communities listed above. Because of this historic flooding, various federal and state agencies performed a study to document the meteorological and hydrological conditions leading to the flood, compile flood-peak gage heights, stream flows, and recurrence intervals at USGS stream gages as well as determine estimates for stream flows and recurrence intervals at selected ungaged areas.

The very latest flood event occurred from heavy rainfall which fell during most of April 2011 and the beginning of May 2011 over southern Illinois and Indiana including the Wabash River, White River, and Patoka River basins. This rainfall totaled over 17.1 inches at Seymour between April 1 and May 5 and was indicative of the lower White River and Lower Wabash River basins throughout this area producing near record flooding at Mt. Carmel along the Wabash River and at Jasper along the Patoka River. Both Monroe Lake and Patoka Lake recorded their highest recorded pools with inflows to the lakes reaching their respective spillways.

Along the upper and middle Wabash River, other more recent events included the July 2003 and January 2005 floods.

5.6.1 Highwater Marks

Highwater marks are available for all of the historic floods mentioned in paragraph 4 of Section 5.6 for many of the streams and rivers within the Wabash River Watershed. These highwater marks are available in the Louisville District's Hydrology & Hydraulic Design Section. In addition, for the June 2008 flood, the USGS publication *Flood of June 7-9, in Central and Southern Indiana*, lists many other highwater mark elevations and profiles for the streams listed in the previous section.

5.7 Recreation and Scenic Resources

According to The National Land Cover Data 2001 (NLCD 2001), nearly 4.5 percent of the Wabash River Watershed is classified as public land. At approximately 1,500 square miles, the largest continuous track of public land is the Hoosier National Forest located in the south-central portion of the watershed. All seven USACE lakes exist as a cooperative management effort between the Corps of Engineers and the Indiana Department of Natural Resources. In addition to flood control, the lakes are utilized for fishing, boating, swimming and other water related activities. Land adjacent to the lakes provides the public with green space, picnic areas, trails, campgrounds, and playgrounds. The Wabash River and its many tributaries provide numerous recreational and educational opportunities (Figure 11).

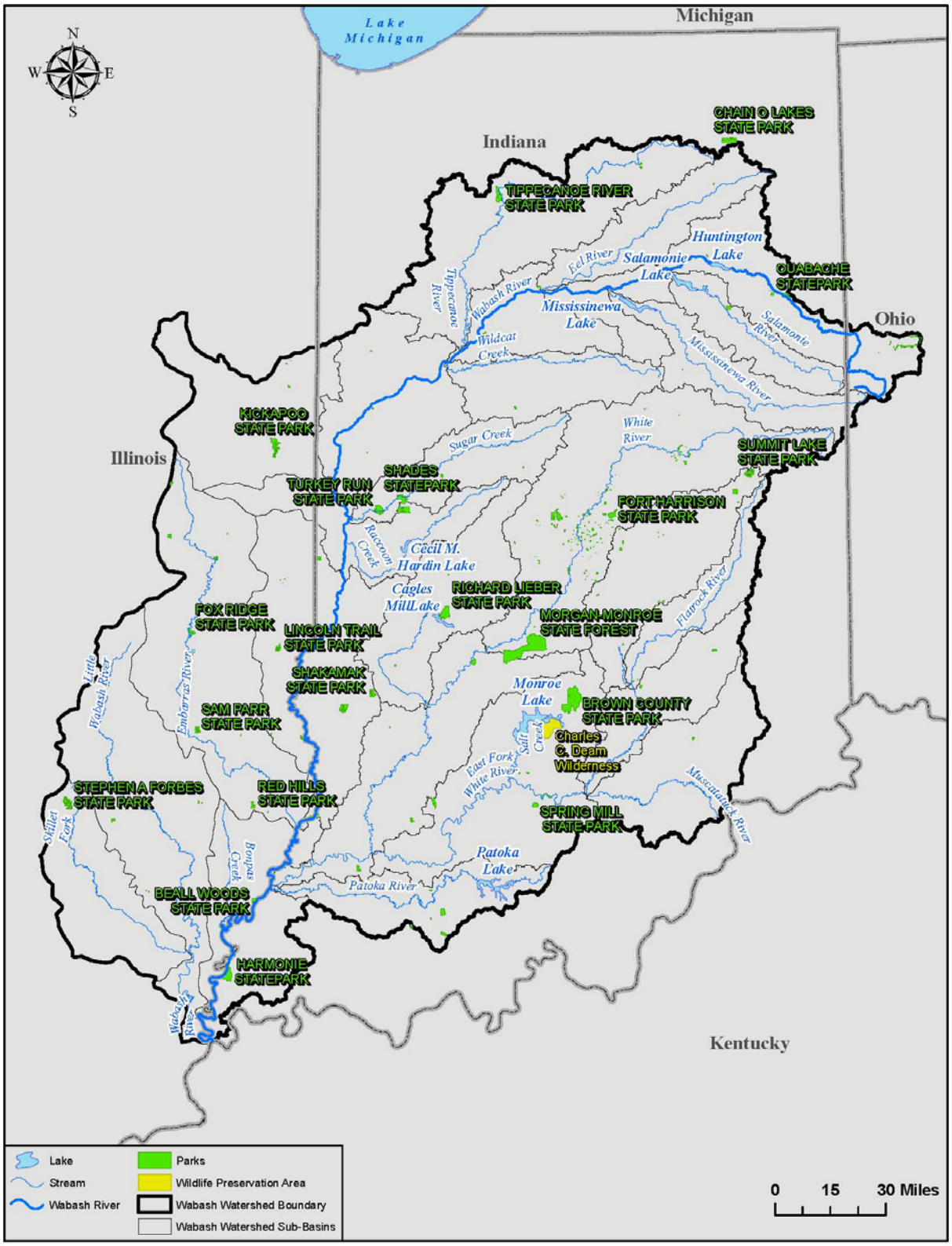

Figure 12. Map of State Parks and Wildlife Preservation Areas

5.8 Cultural Resources

Steeped in history, the Wabash River is closely connected to Native American culture. Starting over 12,000 years ago, indigenous people occupied the Wabash Valley for thousands of years. Native Americans living along the river in historical times included groups known today as Miami, Wea, Piankashaw, and later Potawatomi. European contact, spurred by the market for furs, resulted in the Wabash becoming the primary fur trade route between the Great Lakes and the Gulf of Mexico. The ensuing battles for control of the Wabash may be its most famous period. Many of those who participated in these conflicts would become celebrated names in the nation's history: George Rogers Clark, Little Turtle, Tecumseh, The Prophet, Anthony Wayne, Jean Baptiste Richardville and William Henry Harrison.

A hundred years later, the Wabash River provided water for the Wabash and Erie Canal, stimulating growth in cities along the canal through increased travel and commerce. The river also served communities along its banks as steamboats traveled from the Ohio to the mouth of the Tippecanoe River loaded with corn, wheat, flour, flax, pork, sugar beets, apples, potatoes, and whiskey. The demise of the canal and steamboats was the result of the onset of rail transportation and the storied Wabash Cannonball took its place in American lore. Transportation of merchandise was not the only enterprise the Wabash River supported. The abundance of fresh water mussels in the river would lead to a thriving button industry and later support the Japanese pearl industry. Eventually, over-harvesting would lead to the disappearance of some of the many freshwater mussel species in the Wabash River. Others were reduced in numbers. More recently, protection of this valuable resource has enabled populations to recover somewhat throughout the main stem and its tributaries.

6. PROBLEMS AND OPPORTUNITIES

This Initial Watershed Assessment of the Wabash River Watershed offers a preliminary identification of problems and opportunities in watershed. This was accomplished through a review of existing reports and stakeholder outreach. Specifically, stakeholder input was derived by compiling information from current reports and surveys in the watershed, as well as meetings in Ohio, Indiana and Illinois. Consistently water quality, water supply and flood risk management were identified as major concerns in the watershed. The following sections detail the input obtained through the stakeholder outreach process.

6.1 Ohio River Basin Comprehensive Reconnaissance Study

The first source for stakeholder concerns and outreach information was gathered from the Ohio River Basin Comprehensive Reconnaissance Study (ORBCS). The ORBCS identified problems and opportunities regarding water resources development and management for the entire Ohio River Basin, as well as for each of the 15 sub-watersheds within the basin. Multiple stakeholder meetings and a website dedicated to outreach were used to compile concerns of interested

parties. All four Corps Districts involved (Pittsburgh, Huntington, Louisville, and Nashville) and a majority of non-federal stakeholders agreed on the top five issues throughout the basin, including

- Water quality degradation from runoff by land use conversions and combined sewer overflows;
- Water quality affects on threatened and endangered species (especially mussels) in the Ohio River and its tributaries;
- Sufficiency of water supplies in view of projected population increases & potential climate changes;
- Repair and rehabilitation of aging infrastructure in the basin (dams, levees, floodwalls, locks and dams); and
- Need for additional flood protection in many major cities and smaller communities.

6.2 Wabash River Heritage Corridor Commission - Wabash River Corridor Management Plan

The Wabash River Corridor Management Plan was developed throughout 1992 and early 1993 by means of regional public planning meetings conducted by IDNR and the National Park Service Rivers, Trails and Conservation Assistance Program, and meetings of the Wabash River Heritage Corridor Commission (WRHCC). The plan recognized the Corridor as a 510-mile, 19-county corridor greenway (a conservation corridor) with cultural and natural resources rivaling those of any in the country. The purpose of creating the plan was to develop a united vision for the future of the Corridor that would serve as a guide for the corridor communities and WHRCC.

The vision identified through the planning process was to have:

- A river which is attractive and easily usable for fishing, canoeing, and boating;
- A corridor in which to hike, bike, ride, and drive to enjoy diverse cultural and natural resources; and
- A greenway cooperatively managed for its maximum benefits, primarily in private ownership yet with ample public use areas and trail connections between those areas where feasible.

As a part of the public process, the following goals were defined for the Commission:

- To promote the improvement of the natural environment of the corridor.
- To promote the improvement of recreational opportunities in the corridor.
- To increase public awareness of the corridor as a whole.
- To encourage that recreational areas and trails are acquired and developed in the corridor without the use of eminent domain.
- To promote the development of a better environmental ethic in the citizens and communities of the corridor.

- To promote better cooperation between all of the groups and individuals with an interest in the corridor.

6.3 Wabash and Ohio Rivers Coordinating Council - Wabash River Strategic Plan

The Wabash and Ohio Rivers Coordinating Council (WORCC) was established in 2010 and is focused on coordinating policies and programs that work with residents and communities to increase awareness of and address the environmental and economic issues of the Wabash and Ohio Rivers watersheds in Illinois. The USACE Louisville district utilized WORCC to initiate dialog and contacts with stakeholders active in the watershed. WORCC also submitted a letter of support for the continuation of the Section 729 study (Appendix D).

WORCC is currently developing a strategic plan to guide the Council's actions and restoration efforts in the Wabash River Watershed.

In support of this effort, the council partnered with the Illinois Institute for Rural Affairs to survey residents on their priorities for the watershed. A survey was distributed to 2,500 residents throughout the Illinois portion of the Wabash Watershed and it was posted online. The survey was intended for all residents in Champaign, Clark, Clay, Coles, Crawford, Cumberland, Edgar, Edwards, Effingham, Ford, Hamilton, Jasper, Lawrence, Richland, Vermillion, Wabash, Wayne, and White counties. Approximately 250 surveys were returned.

Results from the survey indicate that clean, healthy rivers are a high priority for Wabash River Watershed residents:

- 98 percent gave the highest ranking to drinking water as a use of water
- 57 percent think restoring wetlands is effective method for preventing flooding
- 48 percent consider watershed restoration and conservation projects to be of "high" importance.
- 48 percent place a "high" level of importance on preserving natural resources in the Wabash River Watershed
- 43 percent think the state of Illinois should make easement programs like the Conservation Reserve Enhancement Program (CREP) or Wetland Reserve Enhancement Program (WREP) more available in the area.

In addition to the survey, WORCC identified key stakeholders organized by eight topics: business, industry and agriculture; habitat; human resources; hydrology; recreation; research and monitoring; and water quality. Through a series of meetings with these stakeholders, a broad set of goals, objectives and actions were developed. The goal and objectives related to each typology is captured below.

<u>Business, Industry and Agricultural: Promote economic development in the Wabash River Watershed.</u>

- Objective: Assist the private sector in developing business opportunities focused on agri-tourism, eco-toursim, and recreation.
- Objective: Develop and promote business opportunities and technologies that utilize river basin resources.
- Objective: Study strategic business opportunities along the river.
- Objective: Involve stakeholders, landowners, business, industry and agriculture in planning for natural resources use, including water usage.
- Objective: Restore infrastructure in the region.
- Objective: Study land use changes in order to develop an initiative explaining the impacts of land use decisions on natural resources

Habitat: Improve habitat in the basin to revitalize the natural ecosystem.

- Objective: Improve aquatic habitat in the basin.
- Objective: Improve riparian habitat in the basin.
- Objective: Protect existing wetlands and restore new wetlands throughout the watershed.
- Objective: Restore and protect upland forests and grasslands.
- Objective: Reduce sedimentation in the Wabash River and tributaries.

Human Resources: Work with local stakeholders to educate the public on watershed problems and plan water usage.

- Objective: Study and summarize conflicts of law and usage regarding water allocation in the basin and establish a conflict resolution process for the watershed.
- Objective: Protect the public water supply
- Objective: Improve local understanding of the watershed.
- Objective: Provide technical assistance to landowners wishing to protect natural resources in the watershed and restore natural habitats.

Hydrology: Improve monitoring and mapping of precipitation and stream heights and reduce flood risk throughout the region.

- Objective: Create and maintain stream gage stations throughout the watershed for accurate monitoring of stream heights and flood risk.
- Objective: Improve and expand the use of mapping and forecasting technology within the region.
- Objective: Reduce flood damages in the region.

Recreation: Increase recreation in the Wabash River Watershed.

- Objective: Increase public access to public and private land for recreational opportunities.
- Objective: Develop, promote and maintain walking, biking and paddling trails in the watershed.
- Objective: Promote existing recreational opportunities and events in the watershed.

Research and Monitoring Goal: Support and expand research within the Wabash River Watershed.

- Objective: Review existing data within the watershed.
- Objective: Make data more available to the public for widespread use.
- Objective: Expand research in the watershed.

Water Quality Goal: Improve water quality in the Wabash River and its tributaries.

- Objective: Ensure there is an adequate water supply to meet human and habitat needs.
- Objective: Eliminate pollution from oil and gas wells.
- Objective: Ensure groundwater is safe to drink and expand the public understanding of groundwater issues.
- Objective: Improve the water quality of lakes and streams.

6.4 The Nature Conservancy, Indiana Chapter - Wabash River Initiative

The Indiana Chapter of The Nature Conservancy (TNC) has identified the following ecological processes that sustain rare, threatened, and endangered species in the study area:

- Hydrologic fluctuations within natural bounds
- High water quality from headwaters and groundwater
- Clean river substrates for habitat
- Channel formation connectivity (riffle, run, pool)
- Connectivity to backwaters and floodplain

TNC identified the following stressors that threaten the continued existence of these species in the watershed:

- Increased flooding due to loss of upstream wetlands and agricultural drainage
- Nutrient and toxin loading from agriculture and urban activities
- Increased sedimentation from agricultural, drainage ditch, bank erosion and urban activities
- Loss of connectivity due to dams on tributaries, levees and agriculture limit access to natural floodplain communities (the Huntington dam is the only main-stem dam)

TNC goals for the Wabash River ecosystem that are relevant to this study include:

- Restore forested floodplains and reconnecting adjacent oxbows and backwaters
- Reforest 20,000 acres in the Wabash River floodplain by 2016
- Acquire and restore floodplain lands
- Identify the 20 worst tributary watersheds in the Wabash River Watershed by 2012
- Establish ten new projects to improve water quality the worst watersheds by 2015
- Participate in the Wabash Watershed Consortium
- Data collection and analysis of conservation efforts on the Wabash River

- Demonstrate the effectiveness of 15 drainage projects to reduce pollutants by 2014

6.5 Additional Stakeholder Concerns

Ohio

Grand Lake St. Marys is Ohio's largest inland lake (12,700 acres) and is located in the far eastern edge of the study area. The lake was constructed in the 1841 to store water for the Miami-Erie Canal. Currently, it is a popular recreation lake and supplies drinking water for the city of Celina, Ohio. The lake also has become increasingly enriched by phosphates and nitrates from anthropogenic and natural sources resulting in a marked decline of the lake's water quality. Ohio Environmental Protection Agency (OEPA) and multiple state and local partners have actively worked to improve the condition of streams that feed the lake

In 2007 OEPA participated in a national study of water quality conditions by collecting one day of sampling data in Grand Lake St. Marys and 19 other Ohio lakes. The analysis indicated microcystins levels in Grand Lake St. Marys were elevated compared to the other Ohio lakes. Subsequent sampling was conducted in 2009 and 2010 and indicated an ongoing problem with blue-green algae and associated toxins.

The Louisville District attended a June 2011 meeting with the OEPA, at their Columbus offices. The meeting focused on design concepts for the restoration of Grand Lake St. Marys. The meeting with OEPA was an informational meeting for Ohio state agencies and provided an opportunity to discuss the Wabash Initial Watershed Assessment.

Indiana

In June 2011, the Louisville District also met with INDNR in Indianapolis, Indiana. As mentioned in Section 5.5.6, the Healthy Rivers Initiative is a major focus for the agency. The conservation initiative has a goal to protect 43,000 acres located in the floodplain of the Wabash River and Sugar Creek in west-central Indiana and another 26,000 acres of the Muscatatuck River bottomlands in southeast Indiana

Through its Nonpoint Source Grant Program, IDEM has completed multiple watershed management plans in the Wabash River Watershed. These plans are written by locally-led watershed groups and have a primary focus on non-point source pollution and water quality monitoring. Any effort to develop a watershed management plan for the Wabash River Watershed should utilize existing efforts and data generated from these watershed plans.

Illinois

In 2011 the Illinois State Water Survey (ISWS) partnered with the Indiana Department of Natural Resources to begin the Discovery process for the Middle Wabash-Busseron and Lower Wabash Watersheds. Discovery is the first step in the FEMA Risk Mapping, Assessment, and Planning (Risk MAP) program. Through a series of six meetings in Illinois and Indiana, information was collected from the community that pertained to flood hazard mapping, flood risk, mitigation planning, and communication needs. Once available, it will be essential to incorporate information generated through the Discovery process into any future Watershed Management Plan for the Wabash River Watershed.

7. FORECAST OF WATERSHED CONDITIONS

There are many ongoing activities throughout the watershed led by stakeholder agencies and organizations that aim at improving current conditions. However, all these ongoing efforts may not be enough to sustain success as continued growth in the region is expected to put even more stress on the watershed. As a result, the watershed will continue to face water quantity and water quality challenges. Continued water impairments will likely result in suppression and reduction of aquatic and terrestrial biodiversity. In the absence of system-wide planning, the current condition is likely to worsen in the future. However, with a comprehensive watershed management plan in place, Wabash River can be managed in a sustainable manner.

The land uses of the Wabash River Watershed are a mixture of agriculture, forest and urban uses. This mixture has led to water quality deterioration through sedimentation and nutrient/bacterial loading from agricultural and livestock practices and increased impervious cover and stormwater management issues from urban sprawl. The increasing price of commodity crops and continuation of low density suburban development indicate that these problems will continue into the future. Furthermore, urban stormwater runoff and combined sewer overflow issues remain largely unabated in many watersheds. Future reductions in federal spending (national deficit reduction) for abatement programs promises continued water resources impacts.

Of additional concern are the future effects of anticipated climate change on the land and water resources of the watershed and its population. Current climate model predictions indicate that climatic changes in this region may include higher temperatures in summer and winter with measurably less annual rainfall, but more intensive rainfall events when they do occur.

Specifically, the 2009 *Global Climate Change Impacts in the US* report by the U.S. Global Change Research Program indicates average temperatures in the Midwest have risen in recent decades. This increase in temperature has extended the growing season by approximately one week in the study area due to earlier dates for the last spring frost. Furthermore, the report predicts heat waves in the study area that are more frequent, severe, and sustained. Higher summer temperatures would generate greater rates of evaporation at Corps reservoirs and greater water supply needs for irrigation and potable water from those same shrinking resources. Higher

summer temperatures raise the threat of reduced recreation usage on the waterways and reservoirs and higher temperatures throughout the year increase the threat of migration northward of warm-weather invasive terrestrial and aquatic species. The onslaught of both floral and faunal invasive species could wreak havoc on watershed and reservoir ecosystems and endanger potential ecosystem restoration projects.

Decreases in annual precipitation could endanger aquatic ecosystems and threaten groundwater supplies and conservation pools at reservoirs. The potential threat to aquatic ecosystems from sustained drought conditions would be increased for all watersheds in the basin. Increased intensity of rainfall events would raise the risks of flash flooding (and associated loss of life risks) in the sub-watersheds and increase the frequency of channel-modifying, bank full flows – flows that lead to bank instability, armoring and channel instability. Riparian resources throughout the basin could be threatened by these larger flows and their effects on the stream channel environment.

8. FEDERAL AND NON-FEDERAL INTEREST, NON-FEDERAL SPONSORSHIP

8.1 Interest

Based on meetings and initial coordination with multiple federal, state agencies and local organizations involved in various activities throughout the Wabash River Watershed, there is a significant interest to participate in a collaborative Watershed Assessment that would result in a comprehensive Watershed Management Plan.

8.2 Non-Federal Sponsorship

The Illinois Department of Natural Resources (IDNR) and The Indiana Chapter of The Nature Conservancy are the potential Non-Federal Sponsors for the cost shared phase of the Watershed Assessment and expressed their interests via Letters of Intent (Aug. 29, 2011 – IDNR, August 11, 2011 – TNC).

Specifically, IDNR has expressed interest in watershed planning in the lower Wabash River watershed, including the tributary watersheds of the Vermilion, Embarras and Little Wabash. In addition, TNC expressed interest in planning assistance for the Middle and Lower Wabash River Watershed including the Vermilion River.

9. SCOPE AND OBJECTIVE OF FINAL WATERSHED ASSESSMENT

As defined in EC 1005-2-411, the specific goals and objectives of a USACE led Watershed Assessment, resulting in a Watershed Management Plan, are:

- To address problems, needs, and opportunities within a watershed or regional context;
- To achieve integrated water resources management (IWRM);
- To develop general, non-project specific, holistic plans or strategies to address watershed needs;
- Where applicable, to recommend programs and the initiation of site-specific project implementation studies.

10. MILESTONES FOR WATERSHED STUDY

The next step in planning for a detailed Section 729 Watershed Assessment is to prepare and negotiate with a Non-Federal Sponsor a Cost Share Agreement and Watershed Assessment Management Plan (WAMP). The primary purposes of the WAMP are outlined below:

- Working together with a Non-Federal Sponsor, develop a detailed scope of work for the Watershed Assessment.
- Develop a detailed schedule, including appropriate milestones, for the Watershed Assessment.
- Develop a detailed Work Breakdown Structure for the Watershed Assessment.
- Develop a detailed cost-estimate for the Watershed Assessment.
- Determine what Work-In-Kind efforts, done by the Non-Federal Sponsor, would be applicable to their 25 percent share of the Watershed Assessment.
- Develop WAMP associated plans such as Quality Control Plans, Communication Plans, Risk Management Plans, Safety Plans, Closeout Plans, and Acquisition Strategies as required by USACE Guidance.
- Develop a Review Plan for the FWA in collaboration with the appropriate Planning Center of Expertise
- Develop, negotiate and execute a detailed watershed assessment cost-sharing agreement with the Non-Federal Sponsor.

11. POTENTIAL ISSUES AFFECTING INITIATION OF WATERSHED ASSESSMENT

Continuation of this study into the cost-shared phase is contingent upon an executed Section 729 Assessment Agreement. Issues that could impact the initiation of the cost-shared Final

Watershed Assessment phase include sponsor's capability and willingness to sign the agreement and availability of federal funding.

12. RECOMMENDATIONS

Based upon this Initial Watershed Assessment and strong sponsor and stakeholder support, I recommend that a Watershed Assessment Management Plan be developed and negotiated with the Non-Federal Sponsors. Further, I recommend that if the Watershed Assessment Management Plan and associated cost-sharing agreement is successfully negotiated that USACE Louisville District participate in a comprehensive watershed assessment of the Lower Wabash River Watershed, including the tributary watersheds of the Middle Wabash, Vermilion, Embarras and Little Wabash,

27 JAN 12
DATE

Luke T. Leonard
Colonel, Corps of Engineers
Commanding

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APPENDIX A – Authority

WATER RESOURCES DEVELOPMENT ACT OF 1986: PUBLIC LAW 99-662

SEC. 729. STUDY OF WATER RESOURCES NEEDS OF RIVER BASINS AND REGIONS.

(a) The Secretary, in coordination with the Secretary of the Interior and
In consultation with appropriate federal, state, and local agencies, is authorized to study the water resources needs of river basins and regions of the United States. The Secretaries shall report the results of such study to Congress not later than October 1, 1988.
(b) In carrying out the studies authorized under subsection (a) of this section, the Secretaries shall consult with State, interstate, and local governmental entities.
(c) There is authorized to be appropriated $5,000,000 for fiscal years beginning after September 30, 1986, to carry out this section.

WATER RESOURCES DEVELOPMENT ACT OF 2000: PUBLIC LAW 106–541

SEC. 202. WATERSHED AND RIVER BASIN ASSESSMENTS.
Section 729 of the Water Resources Development Act of 1986 is amended to read as follows:

‘‘SEC. 729. WATERSHED AND RIVER BASIN ASSESSMENTS.

‘‘(a) IN GENERAL.—The Secretary may assess the water resources needs of river basins and watersheds of the United States, including needs relating to—
‘‘(1) ecosystem protection and restoration;
‘‘(2) flood damage reduction;
‘‘(3) navigation and ports;
‘‘(4) watershed protection;
‘‘(5) water supply; and
‘‘(6) drought preparedness.
‘‘(b) COOPERATION.—An assessment under subsection (a) shall be carried out in cooperation and coordination with—
‘‘(1) the Secretary of the Interior;
‘‘(2) the Secretary of Agriculture;
‘‘(3) the Secretary of Commerce;
‘‘(4) the Administrator of the Environmental Protection Agency; and
‘‘(5) the heads of other appropriate agencies.
‘‘(c) CONSULTATION.—In carrying out an assessment under subsection (a), the Secretary shall consult with Federal, tribal, State, interstate, and local governmental entities.
‘‘(d) PRIORITY RIVER BASINS AND WATERSHEDS.—In selecting river basins and watersheds for assessment under this section, the Secretary shall give priority to—
‘‘(1) the Delaware River basin;
‘‘(2) the Kentucky River basin;
‘‘(3) the Potomac River basin;

‘‘(4) the Susquehanna River basin; and

‘‘(5) the Willamette River basin.

‘‘(e) ACCEPTANCE OF CONTRIBUTIONS.—In carrying out an assessment under subsection (a), the Secretary may accept contributions, in cash or in kind, from Federal, tribal, State, interstate, and local governmental entities to the extent that the Secretary determines that the contributions will facilitate completion of the assessment.

‘‘(f) COST-SHARING REQUIREMENTS.—

‘‘(1) NON-FEDERAL SHARE.—The non-Federal share of the costs of an assessment carried out under this section shall be 50 percent.

‘‘(2) CREDIT.—

‘‘(A) IN GENERAL.—Subject to subparagraph (B), the Secretary may credit toward the non-Federal share of an assessment under this section the cost of services, materials, supplies, or other in-kind contributions provided by the non-Federal interests for the assessment.

‘‘(B) MAXIMUM AMOUNT OF CREDIT.—The credit under subparagraph (A) may not exceed an amount equal to 25 percent of the costs of the assessment.

‘‘(g) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section $15,000,000.’’.

<u>WATER RESOURCES DEVELOPMENT ACT OF 2007: PUBLIC LAW: 110-114</u>

SEC. 2010. WATERSHED AND RIVER BASIN ASSESSMENTS.

Section 729 of the Water Resources Development Act of 1986 is amended.

(1) in subsection (d)--

(A) by striking `and' at the end of paragraph (4);

(B) by striking the period at the end of paragraph (5) and inserting a semicolon; and

(C) by adding at the end the following:

(6) Tuscarawas River Basin, Ohio;

(7) Sauk River Basin, Snohomish and Skagit Counties, Washington;

(8) Niagara River Basin, New York;

(9) Genesee River Basin, New York; and

(10) White River Basin, Arkansas and Missouri.';

(2) by striking paragraph (1) of subsection (f) and inserting the following:

(1) NON-FEDERAL SHARE- The non-Federal share of the costs of an assessment carried out under this section on or after December 11, 2000, shall be 25 percent.'; and

(3) by striking subsection (g).

APPENDIX B – Illinois Department of Natural Resources Letter of Intent

Illinois Department of
Natural Resources

One Natural Resources Way Springfield, Illinois 62702-1271
http://dnr.state.il.us

Pat Quinn, Governor
Marc Miller, Director

August 29, 2011

Ms. Sharon Bond
Chief, Planning Branch
U.S. Army Engineer District, Louisville
P.O. Box 59
Louisville, KY 40201-0059

Re: U.S. Army Corps of Engineers' Section 729, Watershed Assessment, WRDA 1986.

Dear Ms. Bond:

On behalf of the State of Illinois, The Department of Natural Resources (Department) is writing to request watershed planning assistance for the lower Wabash River watershed, including the tributary watersheds of the Vermilion, Embarras and Little Wabash.

The Department understands that the provisions of Section 729 of the Water Resources Development Act of 1986, as amended, provide authority for the Corps of Engineers to assess the water resource needs of river basins and watersheds of the United States, including needs relating to ecosystem protection, and restoration; flood damage reduction; navigation and ports; watershed protection; water supply; and drought preparedness.

The Department would like to discuss the availability of information, required schedule, and level of effort required in order to negotiate a cost-sharing agreement to initiate a watershed assessment.

Please contact Rick Mollahan, Natural Resources Manager, Division of Fisheries, at (217)785-8264 or Rick.Mollahan@illinois.gov to arrange a further discussion of this request.

Sincerely,

Marc Miller, Director

CC: Olivia Dorothy, Lt. Governor's Office
John Rogner
Jim Herkert
Mitch Cohen
Debbie Bruce
Bob Appleman
Rick Mollahan
Louisville District Corps of Engineers
ATTN: Mr. Brandon Brummett, PM-P (Outreach Coordinator)
P.O. Box 59
Louisville, KY 40201-0059

APPENDIX C – The Nature Conservancy Letter of Intent

The Nature Conservancy
Protecting nature. Preserving life.™

The Nature Conservancy in Indiana
Efroymson Conservation Center
620 East Ohio Street
Indianapolis, IN 46202-3811

tel [317] 951-8818
fax [317] 917-2478
nature.org/indiana

August 11, 2011

Ms. Amy Babey
Acting Chief, Planning Branch
U.S. Army Engineer District, Louisville
P.O. Box 59
Louisville, Kentucky 40201-0059

Dear Ms. Babey:

This is in reference to the Corps of Engineers' Section 729 Watershed Assessment. We understand that the provisions of Section 729 of the Water Resources Development Act of 1986, as amended, provides authority for the Corps to assess the water resources needs of river basins and watersheds of the United States, including needs relating to ecosystem protection and restoration; flood damage reduction; navigation and ports; watershed protection; water supply; and drought preparedness. The Indiana Chapter of The Nature Conservancy requests watershed planning assistance for the Middle and Lower Wabash River Watershed including the Vermillion River. This watershed takes in portions of the states of Illinois and Indiana.

We would like to discuss the availability of information, required schedule, and level of effort required in order to negotiate a cost-sharing agreement relating to this second phase of the Section 729 Watershed Assessment process.

We understand that in the event that future cost-share arrangement is included in the project, the cost-share for the watershed assessment is 75% Federal and 25% non-Federal with the non-Federal share as cash or work-in-kind. No commitment to obligating these cost share dollars is requested or being made by either party with this letter.

Please contact Larry Clemens in our Indianapolis office (317) 951-8818 to arrange a further discussion of this request.

Sincerely,

Mary McConnell
State Director, Indiana Chapter of The Nature Conservancy

cc: Louisville District Corps of Engineers
ATTN: Mr. Brandon R. Brummett; PM-P (Outreach Coordinator)
P.O. Box 59
Louisville, Kentucky 40201-0059

APPENDIX D – Wabash and Ohio Rivers Coordinating Council Letter of Support

OFFICE OF THE LIEUTENANT GOVERNOR

SHEILA SIMON – LIEUTENANT GOVERNOR

August 31, 2011

Ms. Sharon Bond
Chief, Planning Branch
U.S. Army Engineer District, Louisville
P.O. Box 59
Louisville, KY 40201-0059

Re: U.S. Army Corps of Engineers' Section 729, Watershed Assessment, WRDA 1986.

Dear Ms. Bond:

On behalf of the Wabash and Ohio Rivers Coordinating Council, I am writing to express support for the Illinois Department of Natural Resources' watershed planning assistance request for the lower Wabash River watershed. The Council is very interested in completing a watershed assessment on the Wabash River, as authorized by Section 729 of the Water Resources Development Act of 1986.

The Council would like to assess the lower Wabash River and the tributary watersheds of the Vermilion, Embarras and Little Wabash Rivers. The Council has tentatively identified the need to assess flood risk management, ecosystem restoration, water quality and quantity monitoring and sedimentation in the region. Through the watershed assessment, the Council will be able to expand on its goal to restore and protect the ecologic and economic vitality of the basin.

Thank you for considering this funding request. If you have any questions, please contact Olivia Dorothy, Senior Policy Advisor on the Environment, at 217-558-3095 or Olivia.Dorothy@illinois.gov.

Sincerely,

Sheila Simon
Lt. Governor

cc: Louisville District Corps of Engineers
ATTN: Mr. Brandon Brummett, PM-P (Outreach Coordinator)
P.O. Box 59
Louisville, KY 40201-0059

214 STATE HOUSE SPRINGFIELD, ILLINOIS 62706