Watershed Management Plan for the Region of the Great Bend of the Wabash River

May 10, 2011

A Project of the
Wabash River Enhancement Corporation
Sara Peel, Coordinator

Funded by:
Indiana Department of Environmental Management
Tippecanoe Partnership for Water Quality
Indiana American Water

This project has been funded wholly or in part by the United States Environmental Protection Agency under assistance agreement 305-9-54 to the Indiana Department of Environmental Management. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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ACRONYM LIST

ABE	Agricultural and Biological Engineering
ac	acre
AFS	American Fisheries Society
APC	Area Plan Commission
ASREC	Animal Science Research and Education Center
BFE	Base Flood Elevation
BMP	Best Management Practice
CAFO	Confined Animal Feeding Operation
CBBEL	Christopher B. Burke Engineering, Ltd.
CFO	Confined Feeding Operation
cfs	cubic feet per second
CR	County Road
CSO	Combined Sewer Overflow
CTIC	Conservation Technology Information Center
CWP	Center for Watershed Protection
D/S	downstream
E. coli	Escherichia coli
ERU	Equivalent Residential Unit
ESE	Environmental Science and Engineering
FCA	Fish Consumption Advisory
FEMA	Federal Emergency Management Agency
FIRMS	Flood Insurance Rate Maps
FNR	Fisheries and Natural Resources
GIS	Geographic Information Systems
HES	Highly Erodible Soil
HUC	Hydrologic Unit Code
IBI	Index of Biotic Integrity
IDDE	Illicit Discharge Detection and Elimination
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
ISDH	Indiana State Department of Health
IWF	Indiana Wildlife Federation
IWMA	Integrated Water Monitoring Assessment
lb	pound
lb/yr	pound per year
LEED	Leadership in Environment and Energy Design
LID	Low Impact Development
LLOW	Living Laboratory on the Wabash
L-THIA	Long-Term Hydrologic Impact Assessment
LUST	Leaking Underground Storage Tank
MCM	Minimum Control Measure

mg/L	milligram per liter
MGD	Million Gallons Per Day
mIBI	macroinvertebrate Index of Biotic Integrity
MS4	Municipal Separate Storm Sewer System
msl	mean sea level
NASS	National Agricultural Statistics Service
NICHES	Northern Indiana Citizens Helping Ecosystems Survive
NO3	Nitrate-nitrogen
NPDES	National Pollution Discharge Elimination System
NRCS	Natural Resources Conservation Service
NWI	National Wetland Inventory
PCB	Polychlorinated Biphenyls
PHES	Potentially Highly Erodible Soils
PTI	Pollution Tolerance Index
QHEI	Qualitative Habitat Evaluation Index
RC&D	Resource Conservation and Development
RM	River Mile
SRCER	Stream Reach Characterization Evaluation Report
SWCD	Soil and Water Conservation District
TCHD	Tippecanoe County Health Department
TCPWQ	Tippecanoe Partnership for Water Quality
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TP	Total Phosphorus
TSS	Total Suspended Solid
U/S	Upstream
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UZO	Unified Zoning Ordinance
WMP	Watershed Management Plan
WQI	Water Quality Index
WQS	Water Quality Standard
WREC	Wabash River Enhancement Corporation
WRHCC	Wabash River Heritage Corridor Commission
WWTP	Wastewater Treatment Plant

1.0 WATERSHED COMMUNITY INITIATIVE

A watershed is the land area that drains to a common point, such as a location on a river. All of the water that falls on a watershed will move across the landscape collecting in low spots and drainageways until it moves into the waterbody of choice. All activities that take place in a watershed can impact the water quality of the river that drains it. What we do on the land, such as constructing new buildings, fertilizing lawns, or growing crops, affects the water and the ecosystem that lives in it. A healthy watershed is vital for a healthy river, and a healthy river can enhance the community and helps maintain a healthy local economy. Watershed planning is especially important in that it will help communities and individuals determine how best to preserve water functions, prevent water quality impairment, and produce long-term economic, environmental, and political health.

The Wabash River watershed includes all the land that drains into the Wabash River. The river starts in Ohio and drains about 7,300 square miles by the time it passes through the current watershed project area which is highlighted by the southward bend of the Wabash River from its previously westward course (Figure 1). Our local watershed of interest includes the area that drains into the Wabash River from just downstream of Wildcat Creek to immediately upstream of Big Pine Creek. This watershed totals 478 square miles.

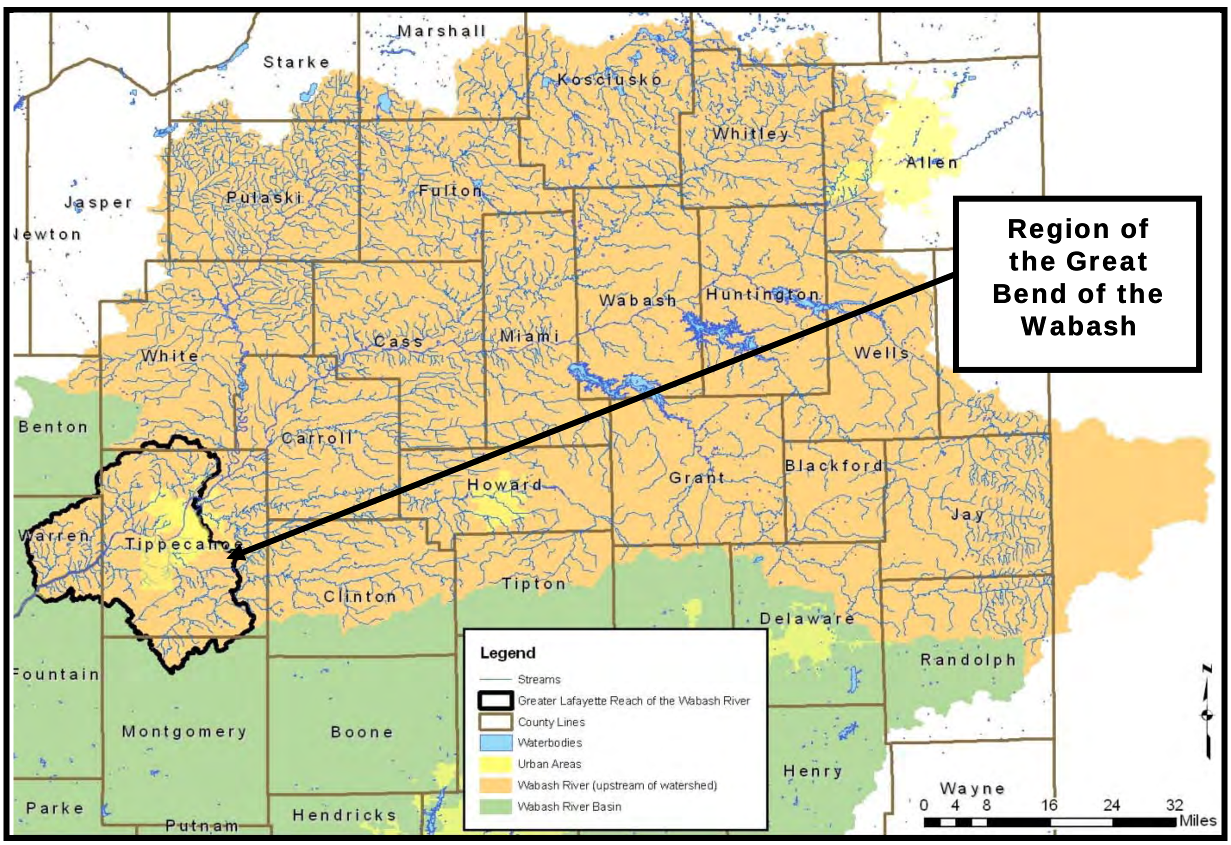

Figure 1. Wabash River watershed upstream of Attica, Indiana highlighting the Region of the Great Bend of the Wabash project area.
Data used to create this map are detailed in Appendix A.

By managing and improving this portion of the Wabash River watershed, we can do our part to improve water quality in the Wabash River. The following section details the history of the projects including funding details, project purposes, and stakeholder involvement as part of the Region of the Great Bend of the Wabash River Watershed Management Plan.

1.1 Project History

In 2006, the Wabash River Enhancement Corporation (WREC), Purdue University's Living Laboratory on the Wabash (LLOW) group, and community partners sponsored a community-wide visioning project known as River Vision (Caroffino et al., 2007). River Vision formed the basis for opinion gathering and completion of the first phase of Wabash River corridor management within the urban core of Lafayette and West Lafayette. Through this visioning effort, participants developed a vision for the Wabash River corridor (US 231 to I-65) within the cities of Lafayette and West Lafayette. Participants indicated that water quality improvement and the need for education about the river and all that it offers were two of the most unmet needs within the community. Based on these findings, WREC partnered with Purdue University's LLOW to identify potential water quality improvement opportunities. The partnership identified the need for a long-term plan encompassing Lafayette and West Lafayette and the area draining through the cities to the Wabash River.

In the fall of 2007, the Wabash River Enhancement Corporation and their partner, Purdue University's Living Laboratory on the Wabash (LLOW), submitted a Section 319 Non-point Source Program grant application to the Indiana Department of Environmental Management (IDEM) watershed planning section. The grant's purpose was fourfold:

1. To produce a watershed management plan for the Region of the Great Bend of the Wabash River (Figure 2);
2. To provide education and outreach to the watershed community and Greater Lafayette area;
3. To assess stakeholder opinions and provide educational opportunities; and
4. To monitor water quality within the Wabash River and its tributaries with hopes of showing a measurable improvement (change) in water quality during the implementation phase of the project.

Concurrent with grant submission, identification of watershed partners occurred. Many of these initial partners became part of the project steering committee. The grant application was approved in 2008.

In September 2008, WREC contracted with the Indiana Department of Environmental Management (IDEM) to complete the grant. WREC and project partners hired a watershed coordinator, whose work began in January 2009. This coordinator was responsible for guiding plan development, coordinating and facilitating committee meetings, planning and implementing water quality and watershed information gathering, and writing the watershed management plan with input and insight from the watershed partners and steering committee members. Purdue University was responsible for current water quality data collection and data analysis and assisted with guiding plan development.

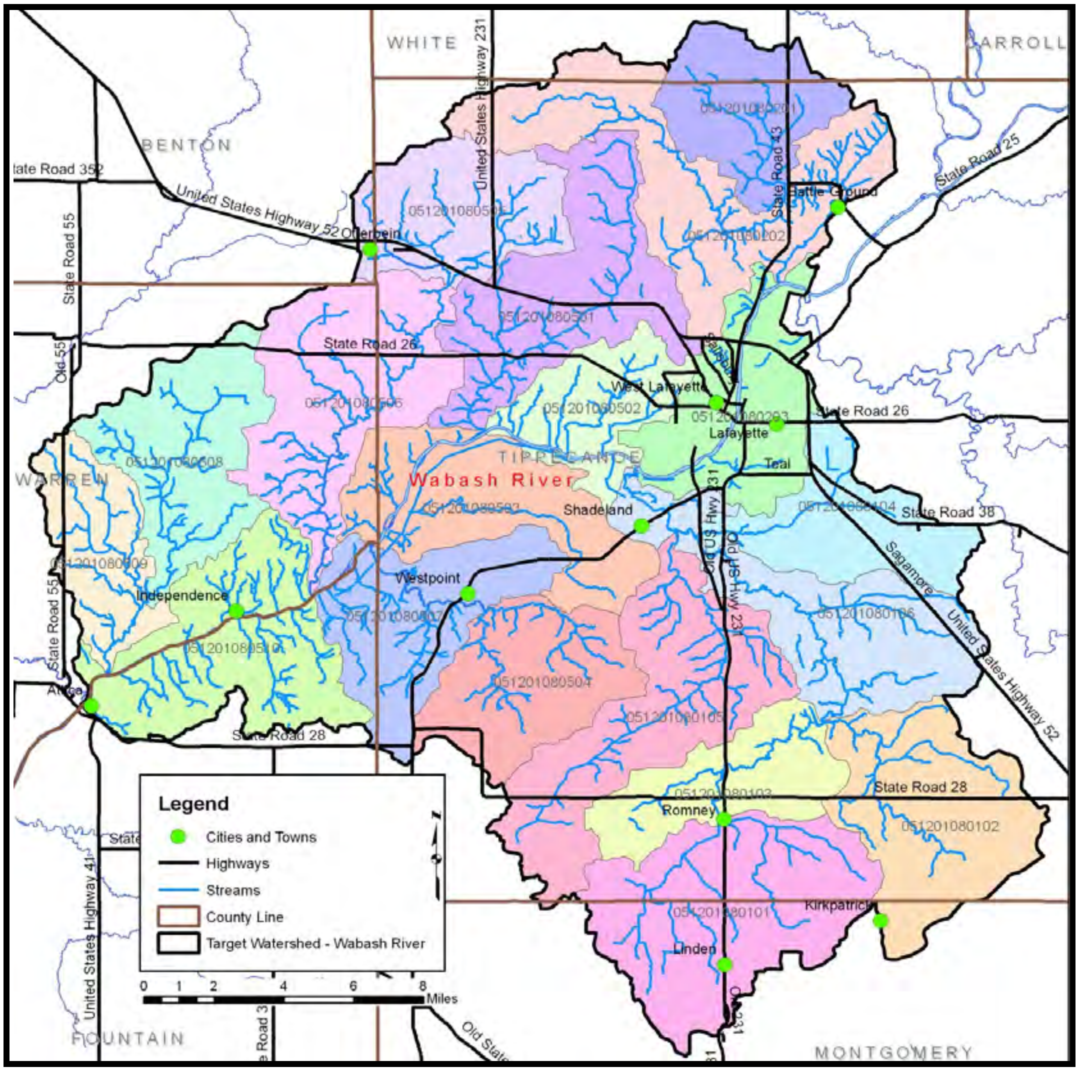

Figure 2. Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

Development of the Region of the Great Bend of the Wabash River watershed management plan (Great Bend WMP) was a community driven process and involved a diverse group of local citizens, experts, organizations, and community leaders. The following sections detail the committees created as part of this project, the work these committees completed, and the outcomes developed by the committees. Additionally, input from watershed stakeholders and the mechanisms in which this input was generated are also included in the following sections. All of these efforts were guided by the following mission and vision developed by public participants and committee members:

Mission: We are a community partnership to develop and implement a watershed management plan to improve and sustain water quality, natural resources, and economic benefits in the Great Bend Region of the Wabash River.

Vision: The Wabash River, Indiana's state river, merits stewardship equal to its importance.

The mission and vision are works in progress and may change as the project moves forward.

1.2 Stakeholder Involvement

Development of a watershed management plan requires input from interested citizens, local government leaders, and water resource professionals. These individuals are required to not only buy into the project and the process but must also become an integral part of identifying the solution(s) which will result in improved water quality. WREC involved stakeholders in the watershed management planning process through a series of committees, education and outreach events, and public meetings; via the social indicators surveys which targeted both urban and rural community members; and through educational material production.

1.2.1 Steering Committee

Individuals representing the cities, towns, and counties within the watershed; neighborhood associations; environmental groups; natural resource and engineering professionals; and industrial and educational entities comprised the steering committee. The steering committee met on roughly a quarterly basis from March 2009 through May 2011. Table 1 identifies the steering committee members and their affiliation.

Table 1. Region of the Great Bend of the Wabash River watershed steering committee members and their affiliation.

Steering Committee Member	Organization(s) Represented
Zach Beasley	Tippecanoe County Surveyor, MS4
Megan Benage	Tippecanoe County SWCD
K.D. Benson	Tippecanoe County resident
Laura Bowling	Purdue University Agronomy
Diane Damico	West Lafayette Go Greener Commission
Dan Dunten	Tippecanoe County SWCD/West Lafayette Parks & Recreation
Sallie Fahey	Area Plan Commission
Jane Frankenberger	Purdue University ABE
Phyllis and Michael Hunt	Centennial Neighborhood Association
Crystal Joshua	City of Lafayette, Stormwater Engineer
Steve Murray	Tippecanoe County Surveyor, MS4
Gus Nyberg	NICHES Land Trust
Joe Payne	West Lafayette Parks & Recreation Department
Linda Prokopy	Purdue University FNR
Chris Remley	Tippecanoe County SWCD
Art Remnet	New Chauncey Neighborhood Association
Joe Rund	Little Wea Conservancy District
Sara Christiansen	Indiana State Department of Agriculture
Don Staley	Purdue University Physical Facilities
Ron Turco	Purdue University Agronomy

1.2.2 Monitoring Committee

Water quality monitoring is a vital part of the watershed planning effort, providing information to better understand where pollutants originate and to determine priorities. The monitoring committee was responsible for sample site identification, historic water quality data identification, and data review and recommendation development. This committee met in the fall of 2008 to assist Purdue University in identifying sites where water was monitored for the next several years. Once sample collection began, this committee met on a roughly quarterly basis to review current and historic data, identify water quality targets, complete data analysis, and begin prioritization of concern areas. Table 2 identifies the monitoring committee members and their affiliation.

Table 2. Monitoring committee members and their affiliation.

Monitoring Committee Member	Organization(s) Represented
Melissa Baldwin	Area Plan Commission
Megan Benage	Tippecanoe County SWCD
Laura Bowling	Purdue University Agronomy
Jill Brown	Purdue University Agronomy
Indrajeet Chaubey	Purdue University ABE
Jane Frankenberger	Purdue University ABE
Reuben Goforth	Purdue University FNR
Megan Heller	Purdue University Agronomy
Crystal Joshua	City of Lafayette
Greg Michalski	Purdue University Civil Engineering
Steve Murray	Tippecanoe County Surveyor
Ron Noles	Tippecanoe County Health Department
Rae Schnapp	Hoosier Environmental Council
Julie Speelman	Hoosier Riverwatch Trainer, Warren Co. resident
Brad Talley	City of Lafayette
Ron Turco	Purdue University Agronomy

1.2.3 Education and Outreach Committee

The Education and Outreach committee developed the education program that coincided with and complemented development of the watershed management plan. This group determined the education priorities and goals, and developed and identified educational materials and programs to achieve the goals. Additionally, they determined opportunities to provide this message, identified individuals to carry the message, and completed educational program development and staffing. Table 3 identifies the education and outreach committee members and their affiliation.

Table 3. Education and outreach committee members and their affiliation.

Education Committee Member	Organization(s) Represented
Mary Cutler	Tippecanoe County Parks and Recreation
Dan Dunten	City of West Lafayette
Don Emmert	Tippecanoe County Partnership for Water Quality
Falon French	Hoosier Environmental Council
Lori Galloway	Fountain County SWCD
Crystal Joshua	City of Lafayette, TCPWQ
Deb Lane	Warren County SWCD
Rebecca Logsdon	Purdue University ABE
Alicia Malloy	Purdue University FNR
Lindsey Payne	Purdue University ESE
Linda Prokopy	Purdue University FNR
Art Remnet	New Chauncey Neighborhood Association
Dale Snipes	Tippecanoe County Surveyor's office, TCPWQ

1.2.4 Urban and Rural Committees

The urban and rural committees worked to identify critical areas within the watershed. These committees operated on two levels: the first completing the watershed inventory for their respective area and the second identifying specific BMPs and implementation areas for the implementation phase of the project. Individuals participating in the inventory portion walked, drove, or canoed portions of the watershed and recorded their observations. Once the inventory information was collected, these committees combined that information with public records and mapped data to identify locations where Best Management Practices (BMP) could be implemented and developed a targeted list of urban and rural BMPs to be implemented during future phases of this project. Table 4 and Table 5 identifies the urban and rural committee members and their affiliation.

Table 4. Urban committee members and their affiliation.

Urban Committee Member	Organization(s) Represented
John Burns	Tippecanoe County Area Plan Commission
Dennis Carson	City of Lafayette
Diane Damico	West Lafayette Go Greener Commission
Dan Dunten	Tippecanoe County SWCD
Sallie Fahey	Tippecanoe County Area Plan Commission
Michael Hunt	Historic Centennial Neighborhood Association
Crystal Joshua	City of Lafayette
Chandler Poole	City of West Lafayette
Don Staley	Purdue University Physical Facilities
John Thomas	Tippecanoe County Area Plan Commission

Table 5. Rural committee members and their affiliation.

Rural Committee Member	Organization(s) Represented
Linda Anderson	Tippecanoe County resident
Zach Beasley	Tippecanoe County Surveyor
Megan Benage	Tippecanoe County SWCD
Jill Brown	Purdue University Agronomy
Margy Deverell	Warren County resident, Banks of the Wabash
Linda Eastman	Area Plan Commission
Mark Eastman	Tippecanoe County NRCS
Reuben Goforth	Purdue University FNR
Megan Heller	Purdue University Agronomy
Allen Nail	Tippecanoe County Parks and Recreation
Gus Nyberg	NICHES Land Trust
Art Remnet	New Chauncey Neighborhood Association
Dean Zimmerman	Indiana Department of Natural Resources

1.2.5 Public Meetings

Public participation is necessary for the long-term success of any watershed planning and subsequent implementation effort. One component of public participation for this project was public meetings. A series of three public meetings occurred as part of this project. Each meeting was held twice – once within Lafayette or West Lafayette and once in an out-lying area. The purpose of the public meetings was to provide information on the overall planning effort and its progress; solicit stakeholder input, opinions, and participation; create opportunities for the public to recommend programs, policies, and projects to improve water quality; and build support for future phases of the project.

All three public meetings were advertised through local media efforts. Press releases were sent to each of the local newspapers in Attica, Williamsport, Lafayette/West Lafayette, and Purdue University. Additionally, information was posted on the WREC website (www.wabashriver.net), on WLFI TV-18's green event calendar, and on A Greener Indiana's event listing. Finally, e-mail invitations and event notices were sent to individuals listed in WREC's email and mailing lists and distributed through the cities' and towns' email systems.

The first public meeting was held on April 23, 2009 at the Holiday Inn City Centre in Lafayette. This meeting was repeated at the Warren County Education Center in the Williamsport Library on July 7, 2009. Approximately 140 individuals attended the April 23 meeting, which was concurrent with capstone class presentations from the 2009 Forestry and Natural Resources students at Purdue University. Attendees represented citizens, Purdue University and Ivy Tech State College, environmental groups, neighborhood associations, city and county employees, and local government agencies. An additional 12 individuals attended the July 7 meeting. Individuals represented area industry, natural resource agencies, and local individuals. During this meeting, WREC detailed the history of the project; described opportunities for individuals to volunteer as part of the project; and provided attendees with the opportunity to identify their concerns about the Wabash River, its tributaries, and its watershed and develop goals for the long-term vision of the River.

1.2.6 Educational Material Development

Education and outreach materials were developed throughout the planning process. The two key pieces were the project website and the informational brochure. The WREC website was updated to include a section which focused on the Region of the Great Bend of the Wabash River watershed management planning process. The website provided up-to-date information on the status of the project, meeting and event dates, and educational information. Additionally, the site served as a clearinghouse for committee meeting information and documentation and report and educational material draft and final pieces. The website can be found at www.wabashriver.net.

In the spring of 2009, the Wabash River Enhancement Corporation Watershed Management Project brochure was developed. The brochure highlights opportunities for individuals to get involved with the project, identifies community partners, and provides general information and fun facts about the watershed, watershed management planning, and the project. The brochure was distributed at all committee, public, and group meetings and at education events throughout the lifetime of the project.

1.2.7 Educational Events

WREC coordinated two field days, two workshops, four sampling blitzes; attended the Tippecanoe, Fountain, and Warren county fairs annually in 2009 and 2010; exhibited and assisted with planning of Wabash Riverfest in 2009 and 2010; and met with a variety of decision-making groups. Workshops and field days included the November 2009 Green Initiatives Tour, the May 2010 Rain Barrel and Rain Garden Workshop, the August 2010 Natural Areas Field Day and Pervious Pavement Demonstration. The first Wabash Sampling Blitz occurred in September 2009 in concert with World Water Monitoring Day. During this and each subsequent spring and fall blitz, nearly 200 volunteers sampled 210 stream sites collecting water quality samples, measuring temperature, and photographing conditions present at the time of sampling. For more information, visit at the Wabash River Enhancement Corporation website (www.wabashriver.net).

1.3 <u>Social Indicator Surveys</u>

WREC's ability to conduct effective education and outreach depends on: understanding how people feel about local water resources; how much they know about water quality concerns;

what practices they adopt on the land they manage; and what factors affect their land management decisions. Social indicator surveys provide one way to analyze these attitude, awareness, behavior, and constraint measures. The data obtained provide a snapshot of a given time, helping to direct outreach efforts and allowing for measurement of temporal change observed during future assessments. WREC education, urban, and rural committee members worked with a group of Purdue University social scientists to tailor an existing survey system that was originally developed for use in nonpoint source pollution projects by a regional team of researchers.

1.3.1 Survey Methods

In order to assess the significant differences between agricultural and urban populations, two distinct surveys were developed. While the general format of the survey remained the same, questions relating to specific practices and water quality concerns differed between the two versions. Recipients for the agricultural/rural survey were selected from a Farm Service Agency database of agricultural producers in Tippecanoe County. The 12-page agricultural survey was sent to 715 producers, garnering an overall response rate of 51%. Recipients for the urban survey were selected randomly from the census blocks within the boundaries of Greater Lafayette's MS4. In order to compensate for an anticipated low response rate from households in the 18-34 age range, we oversampled that demographic by 25%. The 12-page urban survey was sent to 1097 residents in the targeted area, garnering an overall response rate of 38%.

A standardized delivery and collection method was used for both surveys. In late Summer/Fall 2010, a five-wave mail survey was utilized to collect the data (Dillman, 2000). An advance notice letter was sent to potential respondents to inform them of the survey's purpose and to notify them that they would be receiving a paper survey in the next week. This letter also included instructions on how to complete the survey online. The paper survey was sent the following week and included verbiage similar to the original advance letter, instructions for completing the survey online, and a summary of the survey's purpose. A postcard reminder was sent two weeks later, followed by a replacement survey the following week. After two more weeks, a third replacement survey was sent to all non-respondents.

The survey covered the social indicators developed for use in 319-funded watershed projects. The indicators are grouped into four categories: awareness, attitudes, constraints, and behaviors. Sociodemographic information was also collected. Descriptive summaries for the respective surveys are included below. Detailed tables, including raw statistical data, are included in Appendix B.

1.3.2 Agricultural Survey Results

As detailed above, the agricultural survey was sent to 715 producers and resulted in a 51% return rate.

Water Quality for Recreational Use

Respondents were asked to rate the suitability of local water resources for a number of activities. "Scenic beauty/enjoyment" was the highest rated response category, while swimming and eating fish caught in the water received generally "poor" ratings. Water quality was generally thought to be "okay" for boating, fishing, and picnicking near the water. This suggests a prevalent "look but don't touch" attitude toward recreational use of the water.

Water Quality Attitudes

Respondents were asked to rank their level of agreement with a number of statements related to their attitudes toward water quality, including its importance to the community, the financial ramifications of management practices, and levels of personal responsibility. A 1-to-5 “strongly disagree” to “strongly agree” scale was used. In general, respondents felt that the community’s economic stability depended on good water quality, that using recommended management practices improves water quality, that personal actions affect water quality, and that it is important to protect water quality even if it slows economic development. Respondents were more ambivalent about their personal willingness to pay for improved water quality, neither agreeing nor disagreeing with the statements “I would be willing to pay more to improve water quality,” “taking action to improve water quality is too expensive for me,” and “investing in water quality protection puts the farmer at an economic disadvantage.” In summary, producers recognize that water quality is important for the community and that their actions can affect it, but they are less committed to paying for water quality improvements.

Water Impairments

Respondents were asked to rate the severity of numerous water impairments. Trash and debris, sedimentation, murkiness, and bacteria and viruses such as *E. coli*/coliform were seen as the most serious problems, with all four rated between slight and moderate problems. Flow alteration was seen as the problem of least severity. A significant lack of knowledge was reported for several impairments, with more than 30% of respondents indicating that they “don’t know” about the severity of nitrogen, phosphorous, oxygen in the water, and habitat alterations affecting local fish. These responses suggest that the most visible water quality problems are readily identified, while less is known about nutrient and aquatic habitat concerns.

Consequences of Poor Water Quality

Respondents were asked to rate the severity of several consequences to poor water quality. Contaminated fish was seen as the most serious issue, with loss of desirable fish species, reduced opportunities for water recreation, and reduced quality of water recreation activities also rated as slight-to-moderate problems. Contaminated drinking water, odor, and lower property values were identified only as slight problems or not problems at all. The responses suggest that the respondents view recreational concerns to be the most serious consequences of poor water quality.

Sources of Water Pollution

Respondents were asked to rate the severity of 18 different sources of water pollution. Discharge from sewage treatment plants, dumping/littering, and industrial discharge were seen as the most serious contributors to water pollution. Soil erosion from farm fields and streambanks was also seen as a slight-to-moderate problem. Excessive use of fertilizers and pesticides on lawns was viewed as a greater problem than excessive use of fertilizers for crop production. Waste materials from pets, droppings from waterfowl, and manure from farm animals were all viewed as non-issues or only slight problems. Stream channelization and removal of riparian vegetation were also seen as slight problems.

Practices to Improve Water Quality

Respondents were asked questions regarding specific land management practices to improve water quality. Of the 91 producers who reported having livestock, roughly one third (31%) reported that they currently use an approved grazing management, while 21% had never heard of the practice and 35% were only somewhat familiar with it. Of the 148 producers who reported owning a forest or woodlot, only 20% currently use an approved forest management plan. Just over 50% of agricultural producers reported that they currently follow university recommendations for fertilization rates and/or use integrated pest management. Around 40% of respondents reported that they establish permanent vegetation on retired ground, use cover crops, and/or take measures to improve wildlife habitat. Respondents were least familiar with using water and sediment control basins, restoring wetlands, restoring native plant communities, and using prescribed burning.

Conservation Program Participation
Respondents were asked if they participated in government conservation programs. Results are shown in Figure 3.

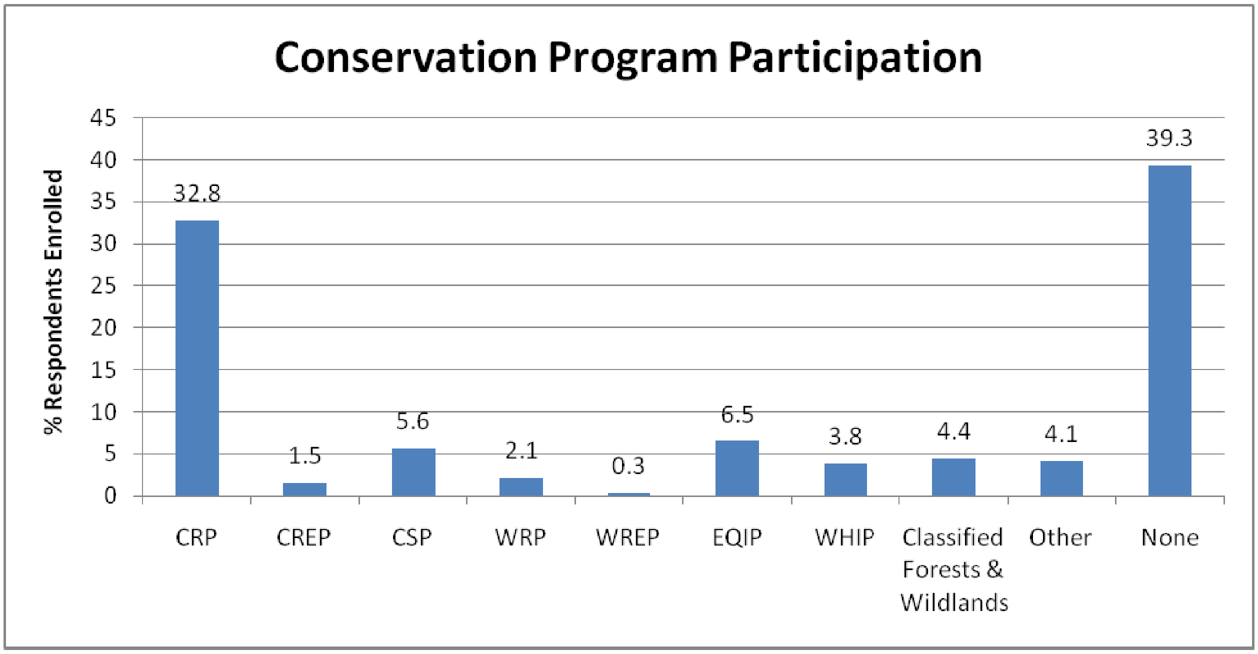

Figure 3. Conservation Program enrollment in the Region of the Great Bend of the Wabash River watershed.

Constraints for Specific Practices
Respondents were asked detailed questions about their adoption of specific conservation practices. Results from individual practices are included below:

Soil Tests
A majority (75%) of respondents produce row crops on their land (n=273). Nearly 90% of these producers reported that they currently use soil testing. Only 2% indicated that they would not be willing to try soil testing. Cost and “desire to keep things the way they are” were the highest ranking constraints preventing adoption of this practice.

Conservation Tillage
A majority (69%) of respondents who row crop reported that they use conservation tillage (n=261). An additional 14% indicated that they might be willing to try it, while 9.2% indicated that they would not be willing to go no-till. Lack of equipment and cost were the highest ranking constraints preventing adoption.

Grassed Waterways
Most (79%) respondents (n=221) indicated that they currently use grassed waterways. Of those indicating they do not use grassed waterway, 12% indicated that they might be willing to try installing them, while 6% said that they would not be willing to try grassed

waterways. Cost was the dominant constraint identified by the producers, with lack of equipment and time required also noted as concerns.

Conservation Buffers
Less than half (47%) of respondents (n=235) indicated that they currently use conservation buffers. Nearly one-tenth (9%) said that they had never heard of them. Almost one-third (30%) of respondents indicated that they might be willing to install conservation buffers, while 15% said they would not be willing. Cost was the primary constraint, followed by time required and lack of equipment.

General Constraints
Respondents were asked about the degree to which a number of constraints limited their ability to change their agricultural management practices. Personal expenses, lack of government funding, and inflexibility to change the practice were the top three constraints identified.

Information Sources
Respondents were asked about the extent to which they trust a number of conservation groups and related agencies. The three most trusted information sources were (in order) the Tippecanoe County SWCD, Purdue University, and the Natural Resources Conservation Service. These sources would thus be the best options for promotional and outreach materials. NICHES Land Trust, the EPA, and the Nature Conservancy garnered the least amount of trust, with all three scoring just about the slightly trusted mark. Respondents indicated that they slightly-to-moderately trusted the Wabash River Enhancement Corporation, though 36% reported that they were not familiar with the organization.

Septic Systems
Respondents were asked four questions related to septic systems. A majority of respondents (88%) indicated that they have a septic system (n=316). Most respondents with septic systems (72%) reported that they did not experience any problems with them in the last five years. Slow drains, sewage backup in the house, and bad smells were the three most common problems. Most respondents (89%) said that they have a finger system, while 5.4% said they did not and 5.7% said they did not know. Slow drains, toilet back up, sewage backup in house, bad smells, and wet spots in the lawn were the most commonly identified indicators of problems with the septic systems.

1.3.3 Urban Survey Results
As detailed above, the urban survey was sent to 1097 individuals and resulted in a 38% return rate.

Water Quality for Recreational Use
Respondents were asked to rate the suitability of local water resources for a number of activities. “Scenic beauty/enjoyment” was the highest rated response category, while swimming and eating fish caught in the water received generally “poor” ratings. Water quality was generally thought to be “okay” for boating, fishing, and picnicking near the water. These results are similar to those of the agriculture survey. Respondents were also asked to rank the same activities in terms of their importance. Scenic beauty/enjoyment ranked highest for 64%, followed by picnicking and family activities near water, fishing, and canoeing/kayaking/other boating.

Water Resources
Respondents were asked if they know where the water goes when it runs off their property. Almost one half of the respondents (44; n=359) indicated that they do not know where

water from their property goes. Respondents who answered "yes" listed the destination. A full list of responses can be found in Appendix B.

Water Quality Attitudes

Respondents were asked to rank their level of agreement with a number of statements related to their attitudes toward water quality, including its importance to the community, the financial ramifications of lawn care practices, and levels of personal responsibility. Respondents most strongly agreed with the statement "It is my personal responsibility to help protect water quality." They also agreed that the community's economic stability depended on good water quality, the way they care for their lawn influences water quality in rivers and streams, that it is important to protect water quality even if it slows economic development, and that quality of life depends on good water quality in local rivers and streams. Like their agricultural counterparts, urban respondents were more ambivalent about their personal willingness to pay for improved water quality, expressing a neutral feeling toward the statement "I would be willing to pay more to improve water quality."

Water Impairments

Respondents were asked to rate the severity of numerous water impairments. Pesticides, herbicides, fertilizers, and insecticides (collectively) were viewed as the most severe problem. Trash and debris, sedimentation, murkiness, bacteria and viruses such as *E. coli*/coliform, and habitat alteration harming local fish were seen as moderate or slight-to-moderate problems. Flow alteration was seen as the problem of least severity. A lack of knowledge was reported for most impairments, with more than 60% of respondents indicating that they "don't know" about the severity of nitrogen, phosphorous, oxygen in the water, and flow alteration. Additionally, 40% or more of respondents did not know about: bacteria or viruses; pesticides, herbicides, fertilizers, and insecticides; algae; not enough oxygen in the water; and habitat alteration harming local fish. This widespread ignorance about major water impairments suggests the need for extensive community education efforts in the urban areas.

Sources of Water Pollution

Respondents were asked to rate the severity of 18 different sources of water pollution. Industrial discharge, discharge from sewage treatment plants, dumping/littering, soil erosion from farm fields, and excessive use of fertilizers for crop production were seen as the most serious contributors to water pollution. Waste materials from pets and stream channelization were rated as the least severe problems. These results differ considerably from the agricultural survey, where water pollution associated with farm operations was viewed as a less severe problem.

Consequences of Poor Water Quality

Respondents were asked to rate the severity of several consequences to poor water quality. Contaminated fish was seen as the most serious issue, with loss of desirable fish species ranked a close second. Reduced quality of water recreation activities, reduced opportunities for water recreation, and reduced beauty of rivers and streams also rated as slight-to-moderate problems. Contaminated drinking water and lower property values were identified only as slight problems. The responses suggest that the respondents view recreational concerns to be the most serious consequences of poor water quality.

Practices to Improve Water Quality

Respondents were asked questions regarding specific household practices to improve water quality. More than half of the respondents (53%) indicated that they owned a pet. Roughly one-third (35%) of these pet owners had never heard of properly disposing of pet waste. An additional 20% were only somewhat familiar with the practice. Nearly two-thirds of respondents (62%) reported properly disposing of hazardous household wastes, while 7% know how to do so but do not. Less than one-third of respondents (27%) indicated some familiarity with proper household waste disposal, indicating an opportunity for outreach efforts.

Lawn/Grounds Management

Most respondents (81%) reported that they maintain the grounds around their residence (n=339). In general, this group of lawn managers reported no or low familiarity with several practices, including French drains, grass swales, dry wells or buried cisterns for stormwater storage, downspout disconnection, green/vegetated roofs, and using phosphorous-free fertilizer. A majority of respondents (60%) reported that they apply lawn chemicals at manufacturer guidelines and that they keep fertilizer off driveways and sidewalks, by far representing the highest rate of adoption of the listed practices. Significant education efforts are needed to increase knowledge of best practices for lawn care.

Constraints for Specific Practices

Respondents were asked detailed questions about their adoption of specific conservation practices. Results from individual practices are included below:

Rain Gardens

Most respondents (58%) reported that they have never heard of rain gardens (n=353), while another 33% said they were only somewhat familiar with them. Only 2% said that they have installed a rain garden. Although there was a high level of unfamiliarity, 61% of respondents said they might be willing to install a rain garden, but 21% said they were not willing to do so. Cost and “don’t know how to do it” were the highest ranking constraints preventing the use of rain gardens.

Rain Barrels

Respondents were more familiar with rain barrels than rain gardens, but the actual use rate was about the same (3%, n=349). Less than a third of respondents (29%) said they knew how to install a rain barrel but have not, while the majority (57%) said they were only somewhat familiar with rain barrels. Despite limited familiarity with rain barrels and their installation, 29% said they would be willing to use one, while 45% said they might be willing. Cost, “don’t know how to do it,” and the time required were the most severe constraints preventing rain barrel adoption.

Pervious pavement

Slightly more than half (52%) of respondents indicated that they had never heard of pervious pavement (n=347). Another 33% were only somewhat familiar with pervious pavement. Actual use of pervious pavement was very low with only 1.2% indicating use of this practice. Nearly 10% indicated that they were willing to install pervious pavement, while 46% said they might be willing. A large percentage (44%) said they would not install pervious pavement. Cost was a major constraint, with 46% reporting that the expense limited their ability to use pervious pavement “a lot.” Time required and “don’t know how to do it” were also cited as constraints.

Maintain Native Plant Communities

Nearly equal percentages indicated that they had never heard of maintaining native plant communities (39.5%) or were only somewhat familiar with the practice (40.5%; n=348). Nearly 11% currently maintain native plant communities, while 35% indicated that they would be willing to adopt the practice, and another 46% said they might be willing. Cost was the primary constraint, followed by time required and “don’t know how to do it.”

General Constraints

Respondents were asked about the degree to which a number of factors limited their ability to change their management practices. Out-of-pocket expense, effort for maintenance, access to equipment, and lack of available information were the highest rated constraints. “Not being able to see a demonstration of the practice” limited the ability to change “a lot” for 23% of respondents and “some” for 23% of respondents. Based on this input, funding assistance, equipment rentals, increased education, and demonstration areas will help alleviate constraints to desired practice adoption.

Information Sources

Respondents were asked about the extent to which they trust a number of conservation groups and related agencies. The three most trusted information sources were (in order) Purdue Extension, Indiana DNR, and the Tippecanoe County SWCD. These sources would thus be the best options for promotional and outreach materials. Lawn care companies and home improvement centers garnered the least amount of trust, with both response categories being only “slightly trusted” on average. Respondents indicated that they moderately trusted the Wabash River Enhancement Corporation, though 43% reported that they were not familiar with the organization (n=341).

1.3.4 Survey Summary

Measures of attitude toward water quality concerns are similar between urban and rural populations. Most Tippecanoe County residents believe that good water quality is important for the communities that they live in for both economic and quality-of-life reasons. Most individuals feel a degree of personal responsibility for the actions they take that affect local water resources, though they may be unwilling to pay for improvements. It’s clear that individuals frequently feel that they must compromise between desired environmental outcomes and their financial concerns.

In general, survey respondents readily identified visible water quality concerns such as littering and turbidity. Other problems, especially those related to nutrient loading and aquatic habitat alteration, are less understood. Urban residents in particular demonstrated a widespread lack of knowledge regarding many water impairments. Education and outreach efforts are needed across the board in order to effectively change management behaviors.

Rural respondents, particularly those who are agricultural producers, frequently identified financial factors as the primary constraint to adopting conservation practices. A detailed cross tabulation will be necessary to identify non-financial restraints for specific groups of non-practitioners. While urban residents also cited economic concerns, they also expressed little to no familiarity with many urban water conservation practices. Increasing the distribution of information about these practices, improving access to equipment, and using demonstration areas may convince many urban residents to adopt better management practices without having to provide financial incentives.

Purdue University and the Tippecanoe County Soil Water and Conservation District are two of the most trusted information sources for natural resource management concerns and would thus make excellent partners for outreach efforts. This survey indicates that WREC has a fairly low public profile; 43% of urban residents and 36% of rural residents were not familiar with the organization. WREC should take advantage of its partnerships with other well-known agencies in order to bolster its own name recognition and ability to achieve its goals.

1.4 Public Input

Throughout the planning process, project stakeholders, the steering committee, and the general public detailed concerns for the Wabash River, its tributaries, and its watershed. Public and committee meetings formed the primary mechanism for individual concerns to be recorded; however, concerns were also gathered at the county 4-H fairs and other education events. Committee chair names were posted to the project website to allow community members another route for detailing their concerns and opinions. All comments were documented and included as part of the concern documentation and prioritization process (Appendix C). Concerns voiced throughout the process are listed in Table 6. The order of concern listing does not reflect any prioritization by watershed stakeholders.

Table 6. Stakeholder concerns identified during public input sessions, January to August 2009.

Stakeholder Concerns (Revised 6 October 2009)
Agricultural best management practice methods should be utilized more within the watershed.
Urban best management practice methods should be utilized more within the watershed.
Individuals are unaware of implementation options; demonstration sites should be available for education and outreach opportunities and to include management practice implementation.
Green or low impact development (LID) practices and LEED certification possibilities are underutilized.
Too much physical waste is entering the river and its tributaries.
The public lacks knowledge about the river and its tributaries' water quality.
The public does not feel a sense of ownership for the river or its watershed.
Individuals use too much fertilizer and pesticide and are unaware of green options.
Too much medication and too high of pharmaceutical concentrations are entering the river.
Partnerships between existing organizations are under-utilized.
Private landowners are unaware of their obligations related to streams running through their property (snag clearing, who to contact for permit assistance, etc.)
Tile drainage negatively impacts water quality and water flow.
Combined sewer overflows (CSOs) within Lafayette and West Lafayette need to be corrected.
Too much untreated stormwater enters the Wabash River.
Water contact is unhealthy
There are too many locations where animals have access to watershed streams.
Too many locations where animals can access watershed streams
Sediment and erosion control are needed to improve water clarity and reduce sediment accumulation.
Septic systems are not efficient enough or maintained correctly and regulations relating to them are not enforced.
Buffers and transitional natural areas are needed along the Wabash River and its tributaries.
Nutrient and algae concentrations are too high within the Wabash River and its tributaries.
Industrial permit requirements are not enforced thus industrial inputs are too high.
Invasive and exotic species are present throughout the watershed and we do not have a plan to eliminate or reduce their presence or rate of spreading.
Natural areas are not contiguous limiting the corridors for wildlife population
Density and diversity of fish in the Wabash River is lower than historical levels.
The regional plan should be revised and/or re-evaluated to address development in the watershed.
Natural and wildlife areas should be created.

Stakeholder Concerns (Revised 6 October 2009)
There are not enough trails along the Wabash River.
Access to the Wabash River is limited by lack of parking, publicly-available boats, and boat ramps or access sites.
Development rates exceed infrastructural support and result in the conversion of natural areas into urban and agricultural land uses.
Fish consumption is unhealthy.
Road salts negatively impact stream biota.
Flooding occurs more frequently and in longer duration than historically resulting in unpredictable water levels.

2.0 WATERSHED INVENTORY I: WATERSHED DESCRIPTION

2.1 Watershed Location

As defined by McBeth (1899), the Region of the Great Bend of the Wabash River defines that area where the Wabash River turns south from the western route by which it traverses the width of the state. Figure 4 details McBeth's hand-drawn map of the region. As indicated by the red dots, the current project area includes a majority of the Region of the Great Bend of the Wabash River.

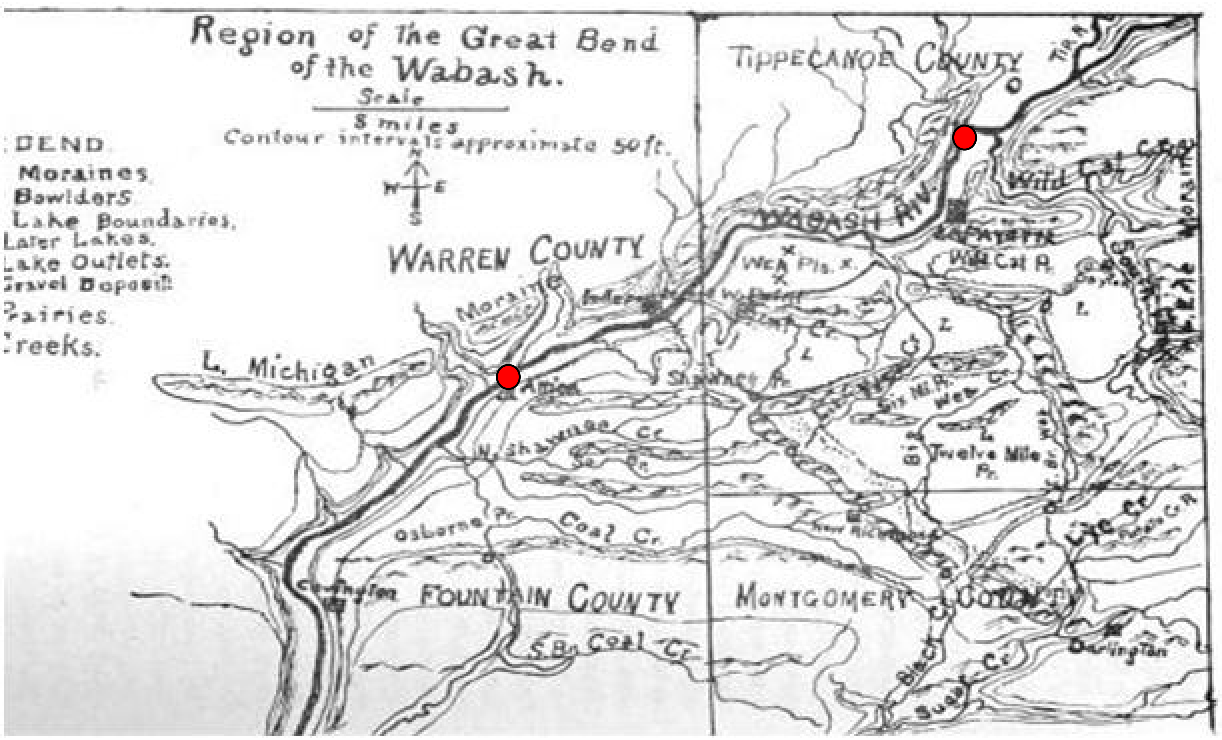

Figure 4. Region of the Great Bend of the Wabash River.
Source: McBeth, 1899.

The Region of the Great Bend of the Wabash River watershed is part of the Wabash River watershed and covers portions of Benton, Fountain, Montgomery, Tippecanoe, Warren, and White counties (Figure 5). The watershed extends along 29 miles of the mainstem of the Wabash River from downstream of the confluence with Wildcat Creek to upstream of the confluence with Big Pine Creek or from Battle Ground to Attica. The Region of the Great Bend of the Wabash River watershed covers 306,452 acres or 478 square miles and includes all of Lafayette, West Lafayette, Battle Ground, Shadeland, Otterbein and Linden and portions of Attica, Dayton, New Richmond, and Clarks Hill.

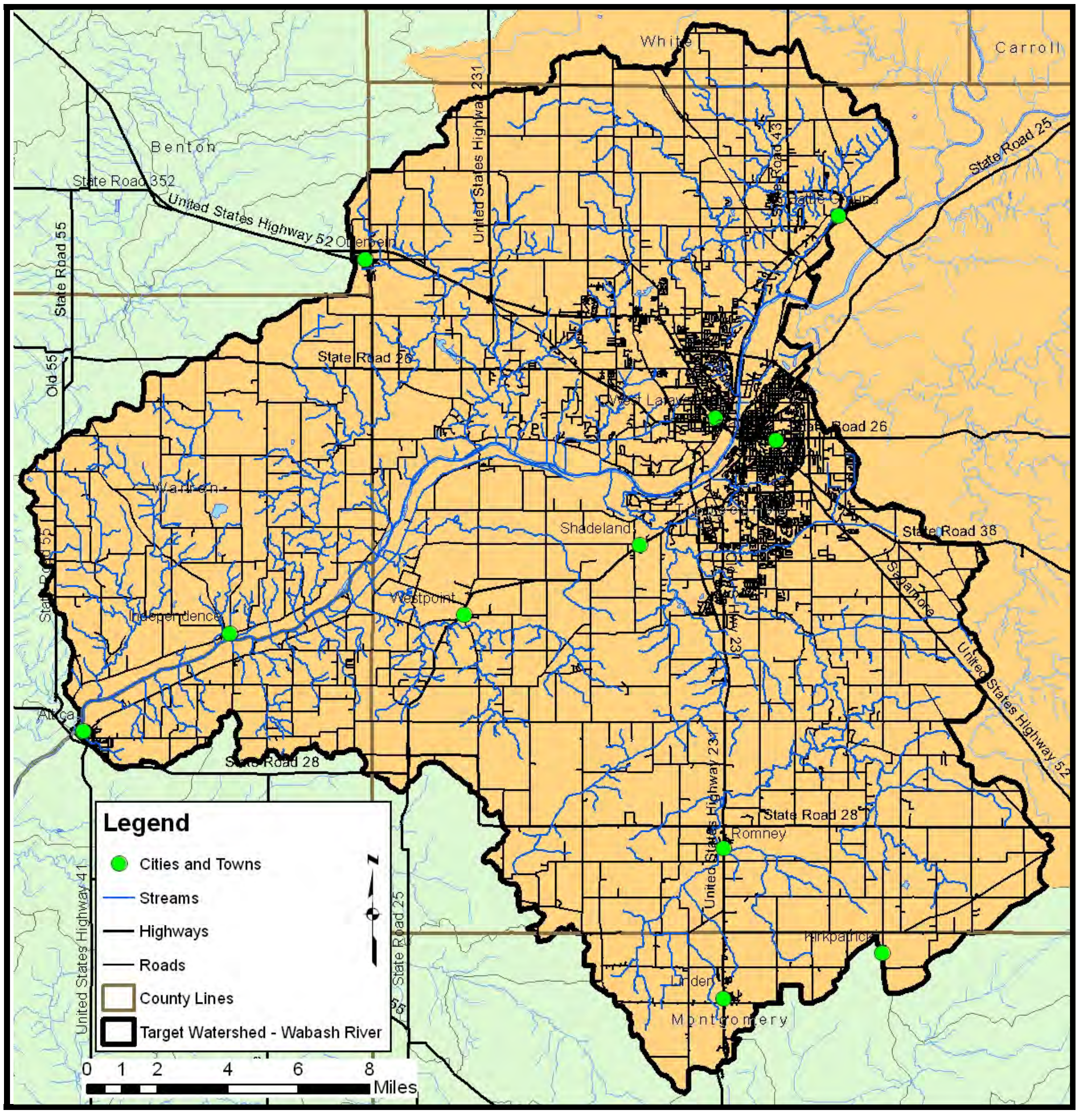

Figure 5. Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

2.2 <u>Subwatersheds</u>

2.2.1 10-digit Hydrologic Unit Code Watersheds

The Region of the Great Bend of the Wabash River watershed is composed of three 10-digit Hydrologic Unit Codes (HUC) including Wea Creek (HUC 0512010801), Burnett Creek-Wabash River (HUC 0512010802), and Kickapoo Creek-Wabash River (HUC 0512010805; Figure 6). The Region of the Great Bend of the Wabash River watershed is bordered to the north and west by the Big Pine Creek watershed, to the northeast by the Tippecanoe River, to the east by Wildcat Creek and Sugar Creek, and to the south by Sugar Creek.

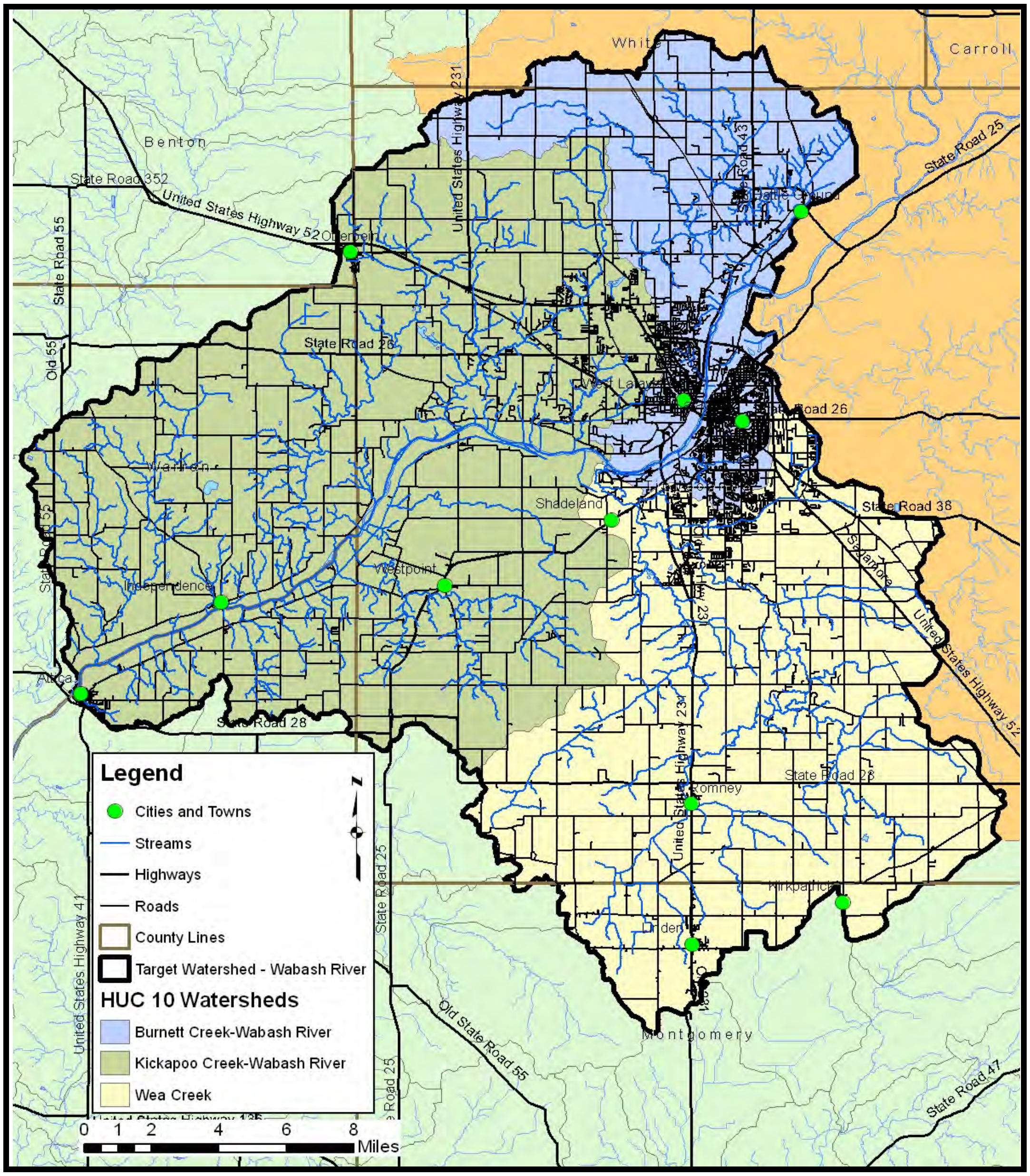

Figure 6. Region of the Great Bend of the Wabash River watershed highlighting the three 10-digit Hydrology Unit Code (HUC) watersheds.
Data used to create this map are detailed in Appendix A.

2.2.2 Region of the Great Bend of the Wabash River Tributary Watersheds

In total, nineteen 12-digit Hydrologic Unit Codes are contained within the Region of the Great Bend of the Wabash River watershed (Figure 7; Table 7). The subwatersheds range in size from just over 9,800 acres or 15 square miles to just over 23,000 acres or 36 square miles. Each of these drainages will be discussed in further detail under *Watershed Inventory II*.

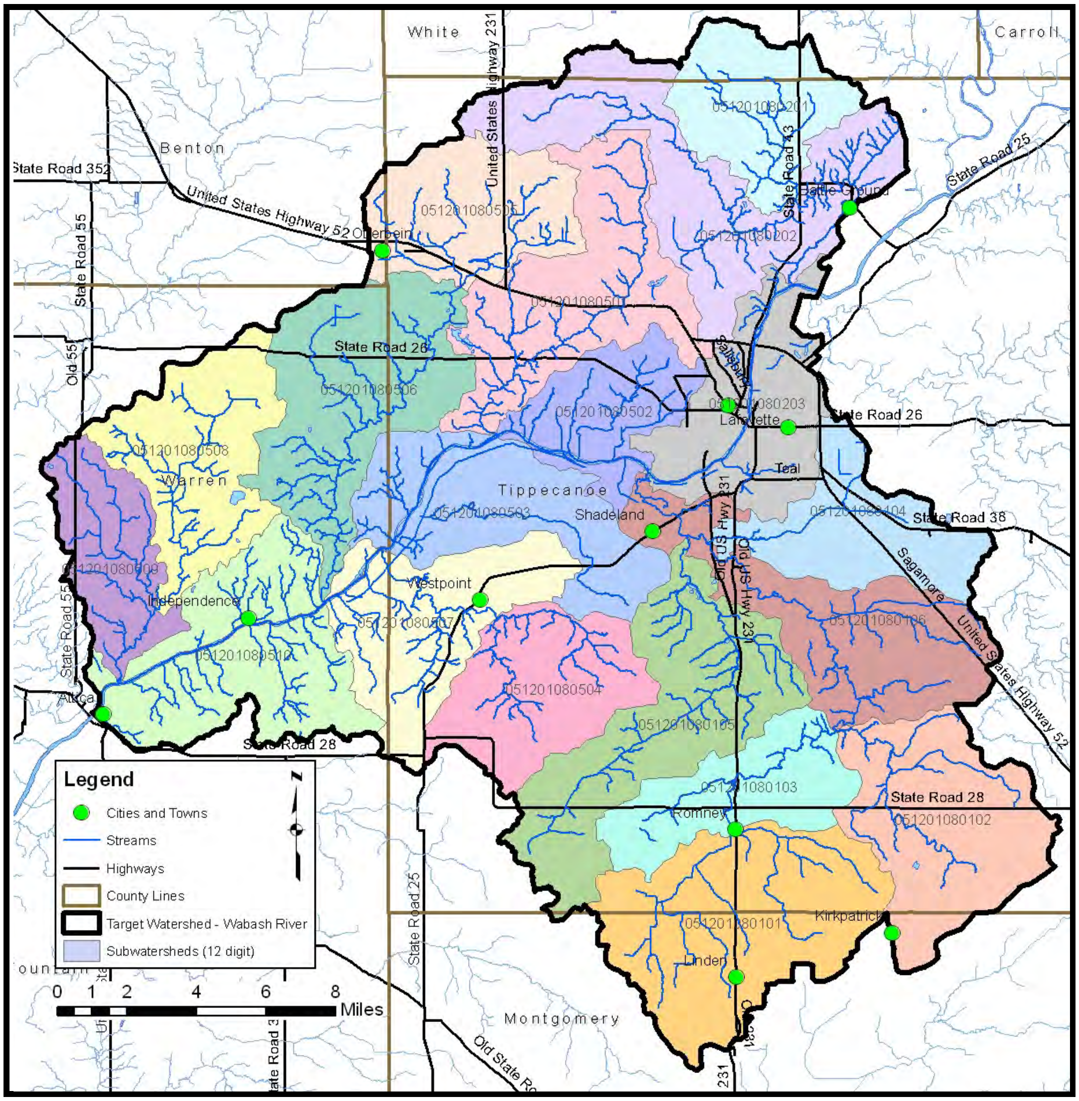

Figure 7. 12-digit Hydrologic Unit Codes in the Region of the Great Bend of the Wabash River. Data used to create this map are detailed in Appendix A.

Table 7. 12-digit Hydrologic Unit Code (HUC) watersheds in the Region of the Great Bend of the Wabash River watershed.

Name	HUC	Area (acres)	Area (sq mi.)	Counties
Romney Fraley Ditch	051201080101	23,386	36.5	M, T
East Branch Wea Creek	051201080102	18,365	28.7	M, T
Haywood Ditch-Wea Creek	051201080103	11,289	17.6	M, T
Elliot Ditch	051201080104	11,897	18.6	T
Little Wea Creek	051201080105	21,394	33.4	T
Kenny Ditch-Wea Creek	051201080106	18,219	28.4	T
North Fork Burnett Creek	051201080201	11,607	18.1	T, Wh
Headwaters Burnett Creek	051201080202	22,789	35.6	T, Wh
Cedar Hollow-Wabash River	051201080203	14,697	22.9	T
Indian Creek	051201080501	18,979	29.6	T
Jordan Creek-Wabash River	051201080502	10,010	15.6	T
Lost Creek-Wabash River	051201080503	16,852	26.3	T
Flint Run-Flint Creek	051201080504	13,977	21.8	T, Wa
Otterbein Ditch-Little Pine Creek	051201080505	13,186	20.6	B, T
Armstrong Creek-Little Pine Creek	051201080506	20,130	31.5	T, Wa
Flint Creek-Wabash River	051201080507	15,255	23.8	F, T, Wa
Headwaters Kickapoo Creek	051201080508	15,266	23.8	Wa
West Fork Kickapoo Creek	051201080509	9,814	15.3	Wa
Turkey Creek-Wabash River	051201080510	19,582	30.6	F, Wa

Note: B=Benton, F=Fountain, M=Montgomery, T=Tippecanoe, Wa=Warren, Wh=White

2.3 Climate

In general, Indiana has a temperate climate with warm summers and cool or cold winters. The Region of the Great Bend of the Wabash River watershed is no different. Climate in this watershed is characterized by four distinct seasons throughout the year. High temperatures measure approximately 85 ^{o}F in July and August, while low temperatures measure near freezing (31 ^{o}F) in January. The growing season typically extends from early April through late October with the season being slightly longer in the southern portion of the watershed, including Montgomery County, and slightly shorter in the northern portion of the watershed (White County). On average, 32 inches of precipitation occur within the watershed with precipitation as small, frequent rain events spread almost evenly throughout the year. Figure 8 details average precipitation in West Lafayette from 1971 to 2007. Meliora Environmental Design, 2009 note that more than 93% of rain events include less than one inch of rain with these events accounting for more than 70% of annual rainfall.

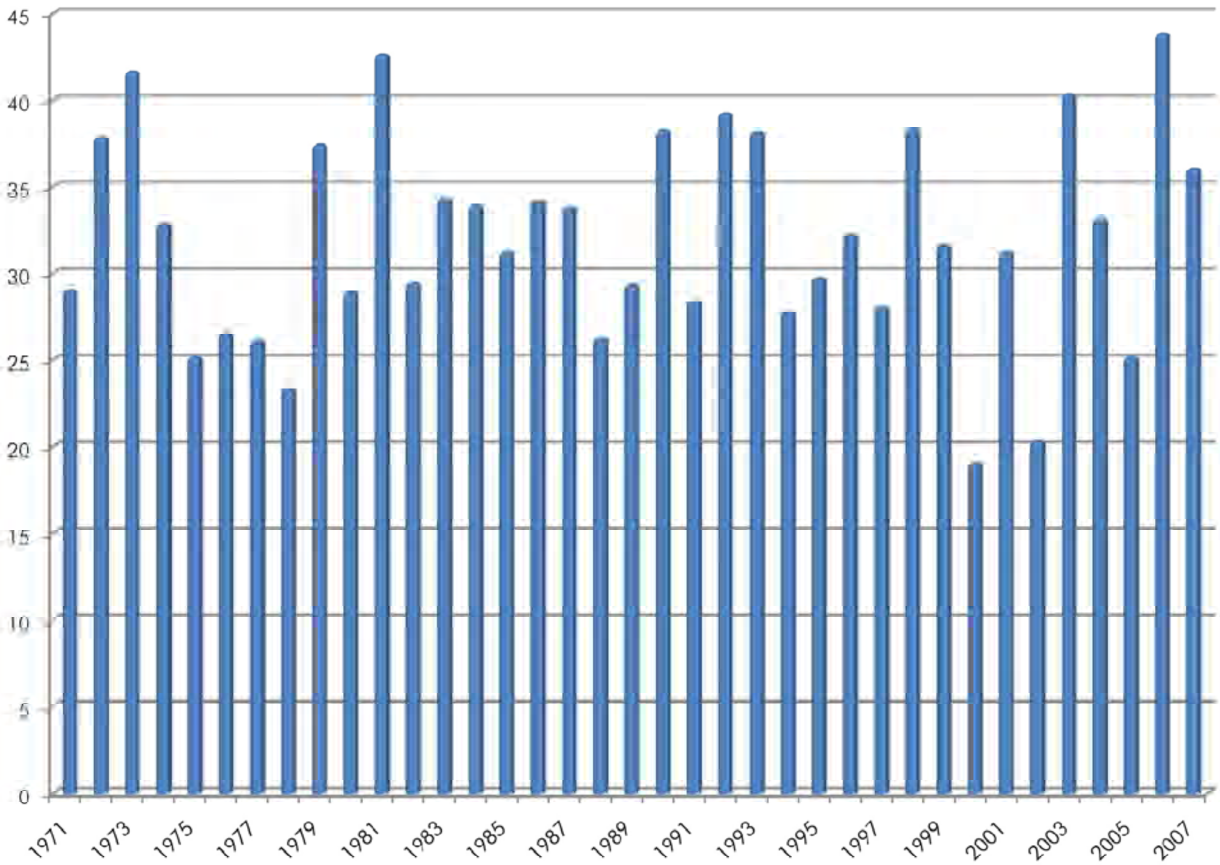

Figure 8. Average rainfall in inches per year from 1971 to 2007.

2.4 Geology and Topography

The geology and topography of the Region of the Great Bend of the Wabash River watershed in west-central Indiana is directly influenced by the advance and retreat of the Saginaw and Erie Lobes of the Wisconsinian glaciation (IDNR, 1980). Bedrock deposits are from the Devonian and Mississippian ages and generally consist of shale, siltstone, and limestone (Rosenshein, 1958). Unconsolidated drift deposits overlie the bedrock with deposits ranging from a few inches to 425 feet thick throughout the watershed. Glaciofluvial and waterlain till deposits cover nearly 75% of the watershed with dense clay and sand predominating. Within these locations, water stands on the clay soils resulting in slow percolation. Along the Wabash River and Wea Creek, alluvium predominates with outwash deposits covering much of the Wea Plains south and west of Lafayette (Figure 9). Water moves quickly through the outwash soils requiring the use of irrigation for crop growth. In the northern portion of the watershed, lake sand covers much of the headwaters of the Burnett Creek subwatershed. This lake plain is a remnant of the Kankakee Lake, which covered much of west-central Indiana during historic glaciation (McBeth, 1901).

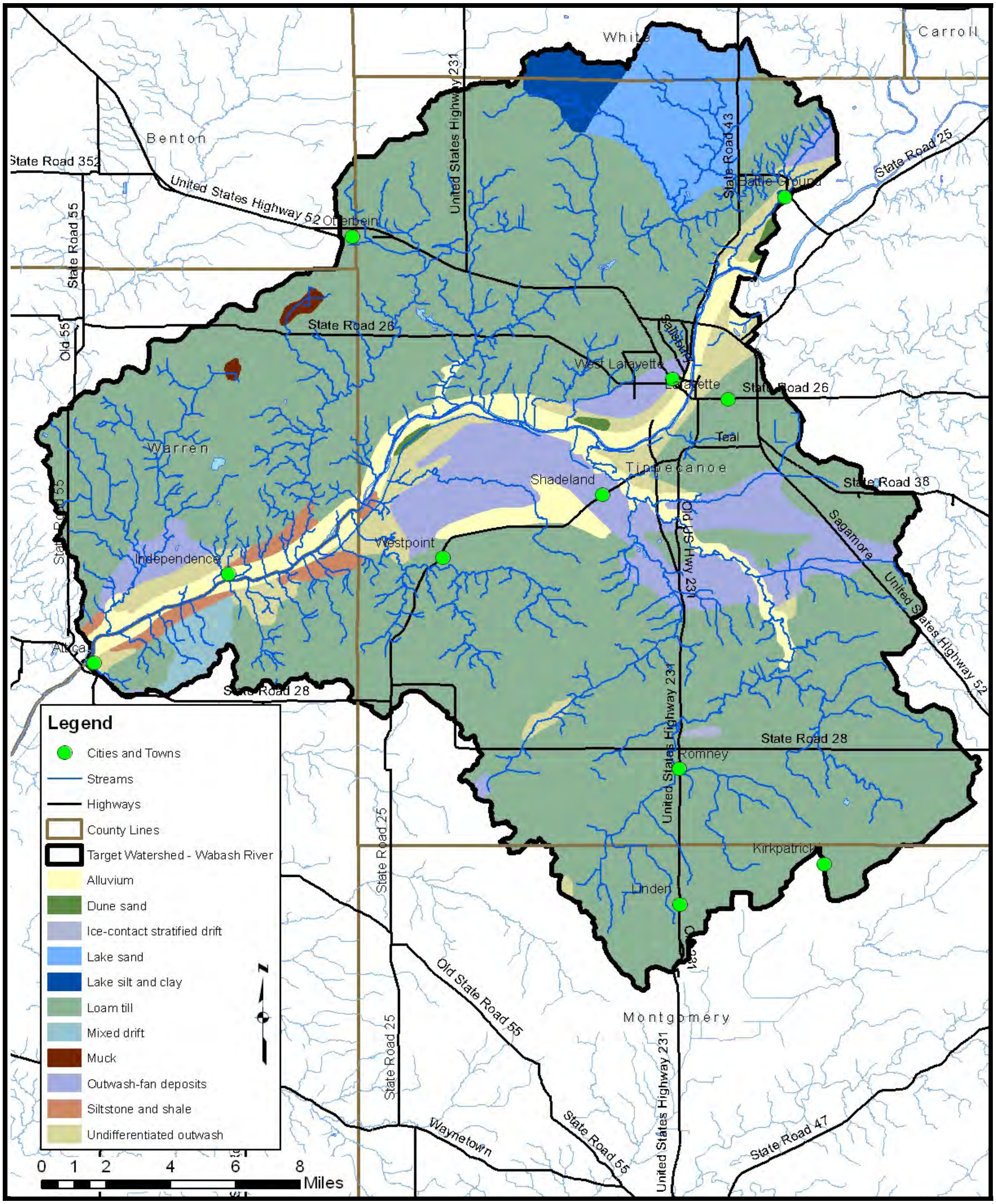

Figure 9. Surficial geology throughout the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

The topography, surficial geology, soil development, and bedrock geology in the Region of the Great Bend of the Wabash River were directly influenced by the advance and retreat of the Saginaw-Huron, Michigan, and Erie lobes of ice during the Wisconsinan glaciation (McBeth, 1899). The bedrock deposits of the watershed are from the Devonian and Mississipian ages. These rocks consist of dolomite and limestone overlain by shale (Clark, 1980). The unconsolidated deposits above the bedrock range from 150-200 feet thick in the watershed. The deepest unconsolidated unit is a dense, clay-loam till. In most of the watershed glaciofluvial deposits overlie the clay till. The glaciofluvial deposits consist of sand and gravel imbedded with clay (Clark, 1980). The highest point in the watershed is located at High Gap and measures 810 feet mean sea level (msl; Figure 10).

The topography of the Region of the Great Bend of the Wabash River watershed is relatively flat as is typical of the Tipton Till Plain region in which the watershed is located (Figure 11). The relatively flat topography is interrupted both by a series of parallel end moraines or hills and by the Wabash River. In Tippecanoe County, these end moraines are observable in the ridges present immediately north of the Wabash River and repeating near New Richmond and High Gap, the highest ridge in the watershed (Bruns and Steen, 2003). The Wabash River cuts through the flat plain flowing through a wide deposit of gravel (McBeth, 1899).

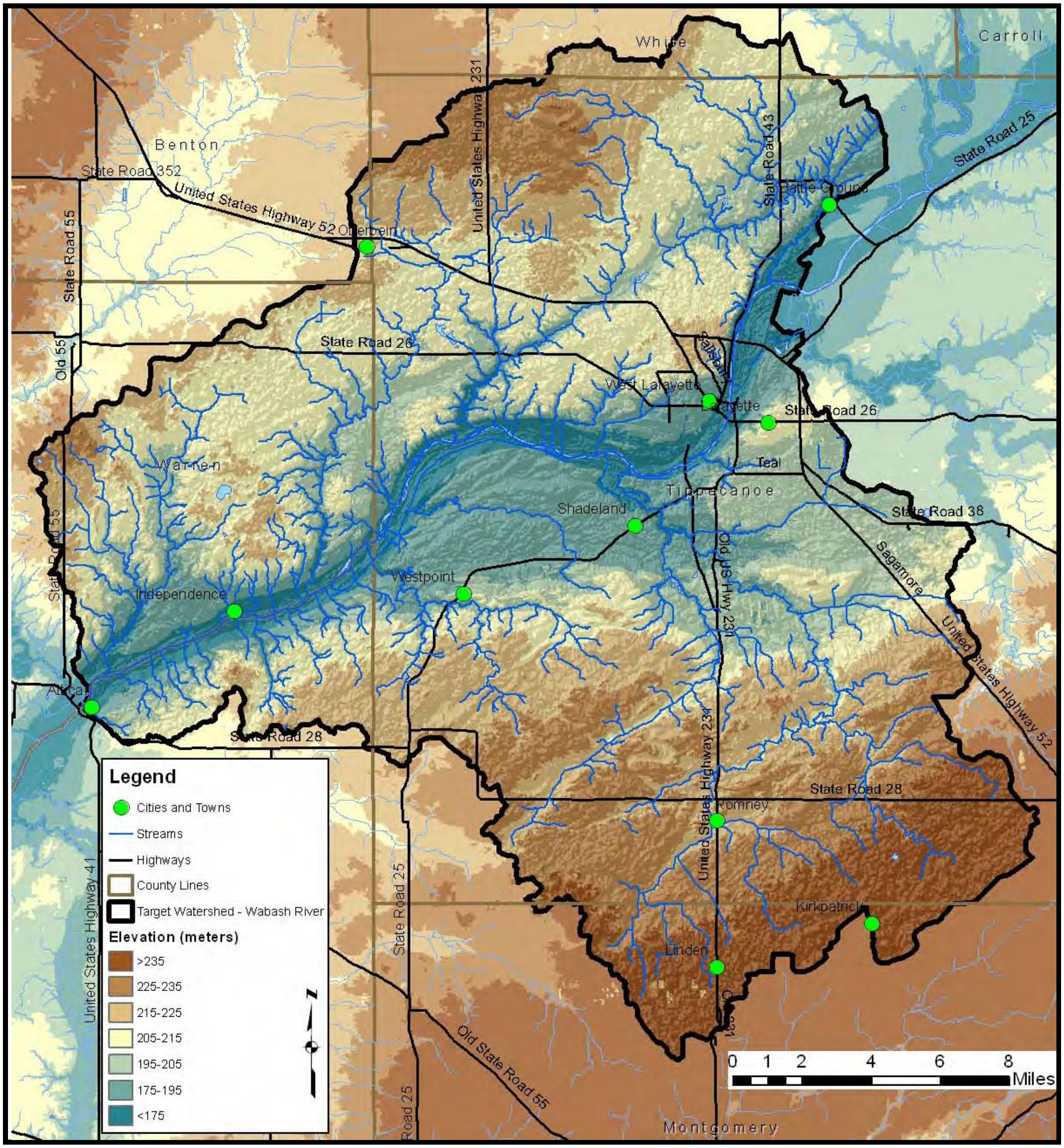

Figure 10. Surface elevation in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

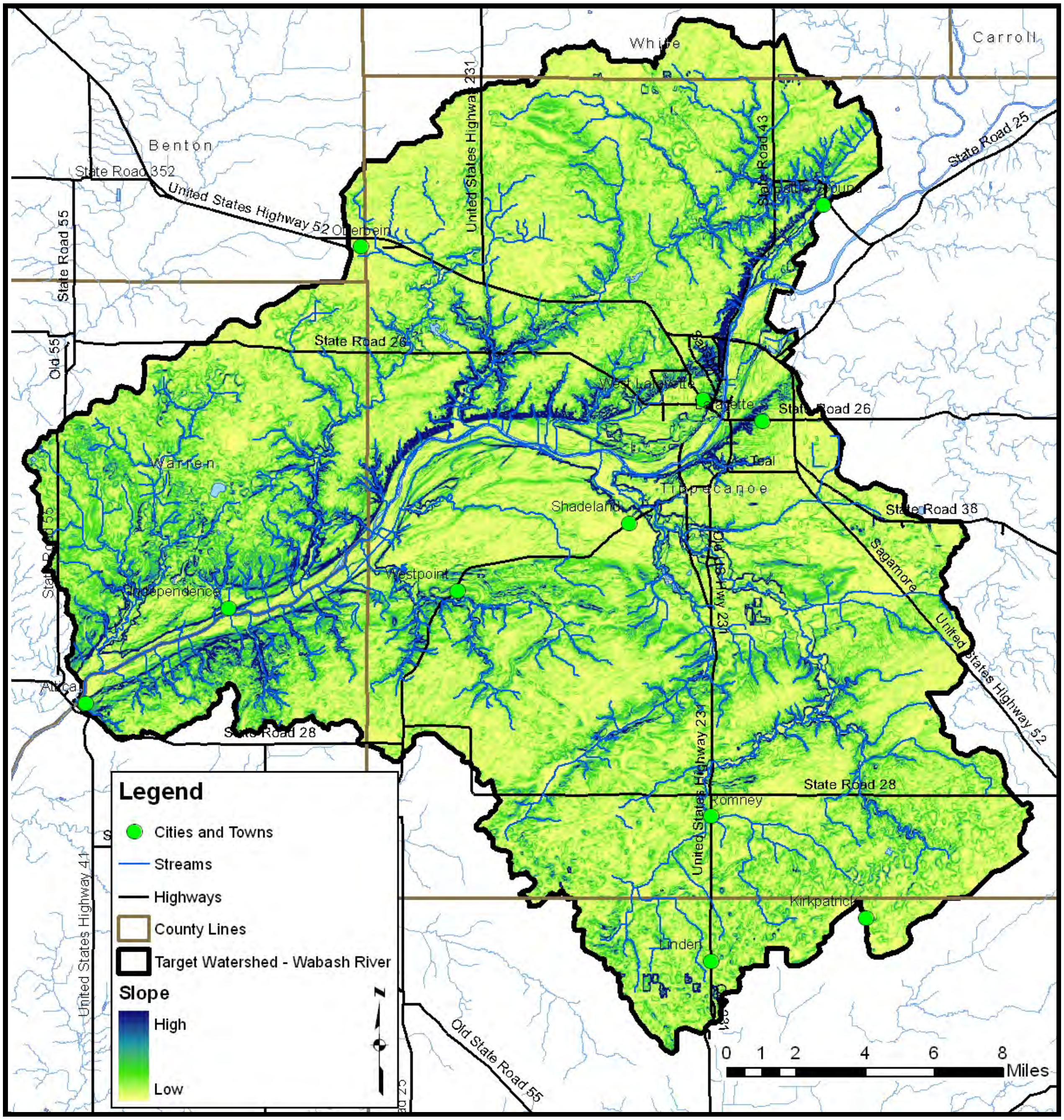

Figure 11. Surface slope of the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.5 Soil Characteristics

There are hundreds of different soil types located within the Region of the Great Bend of the Wabash River watershed. These soil types are delineated by their unique characteristics. The types are then arranged by relief, soil type, drainage pattern, and position within the landscape into soil associations. These associations provide the overall characteristics across the landscape. Soil associations are not used at the individual field level for decision making. Rather the individual soil types, which are mapped in subsequent sections, are used for field-by-field management decisions. Some specific soil characteristics of interest, including septic limitations and soil erodibility, for watershed and water quality management are detailed below.

2.5.1 Soil Associations

The watershed is covered by 18 soil associations with five associations individually accounting for 5% or more of the total watershed area. The Drummer-Toronto-Wingate soil association predominates covering nearly 42% of the watershed (Table 8). The Drummer-Toronto-Wingate association lies within till deposits and is somewhat poorly drained with slow permeability. This association possesses slopes of 0 to 6% and most are cropped in a corn-soybean rotation (USDA, 2009). This association covers much of the northern and southern portions of the watershed away from the Wabash River. The Fincastle-Brookston-Miami association covers nearly 16% of the watershed. This association covers much of the watershed north of the Wabash River within Tippecanoe County and lies within till deposits. The Fincastle-Brookston-Miami soil association is moderately well drained and relatively flat covering areas with slopes less than 6%. The Elston-Warsaw-Shipshe, Miami-Miamian-Xenia, and Sawmill-Lawson-Genesee soil associations are also relatively common in the watershed. The Elston-Warsaw-Shipshe association is the predominant soil association on glacial outwash deposits south of the Wabash River on the Wea Plains. The Sawmill-Lawson-Genesee soil association borders the Wabash River throughout the watershed, while the Miami-Miamian-Xenia association lies north of the Wabash River in Warren County (Figure 12).

Table 8. Soil associations in the Region of the Great Bend of the Wabash River watershed.

Soil Name	Area (acres)	Percent of Watershed
Drummer-Toronto-Wingate	127,381.3	41.6%
Fincastle-Brookston-Miamian	49,568.7	16.2%
Elston-Warsaw-Shipshe	27,332.0	8.9%
Miami-Miamian-Xenia	21,521.7	7.0%
Sawmill-Lawson-Genesee	16,680.2	5.4%
Warsaw-Lorenzo-Dakota	13,963.7	4.6%
Miami-Crosby-Treaty	12,341.8	4.0%
Miami-Strawn-Hennepin	12,257.9	4.0%
Rockfield-Fincastle-Camden	6,566.0	2.1%
Westland-Sleeth-Ockley	5,984.6	2.0%
Morley-Markham-Ashkum	2,759.7	0.9%
Russell-Hennepin-Xenia	2,473.0	0.8%
Blount-Glynwood-Morley	1,821.6	0.6%
Mahalasville-Starks-Camden	1,806.8	0.6%
Fincastle-Miami-Crosby	1,211.9	0.4%
Barce-Montmorenci-Drummer	1,203.9	0.4%
Martinsville-Ockley-Starks	1,131.9	0.4%
Martinsville-Whitaker-Rensselaer	446.5	0.1%
Total	**306,453.2**	**100%**

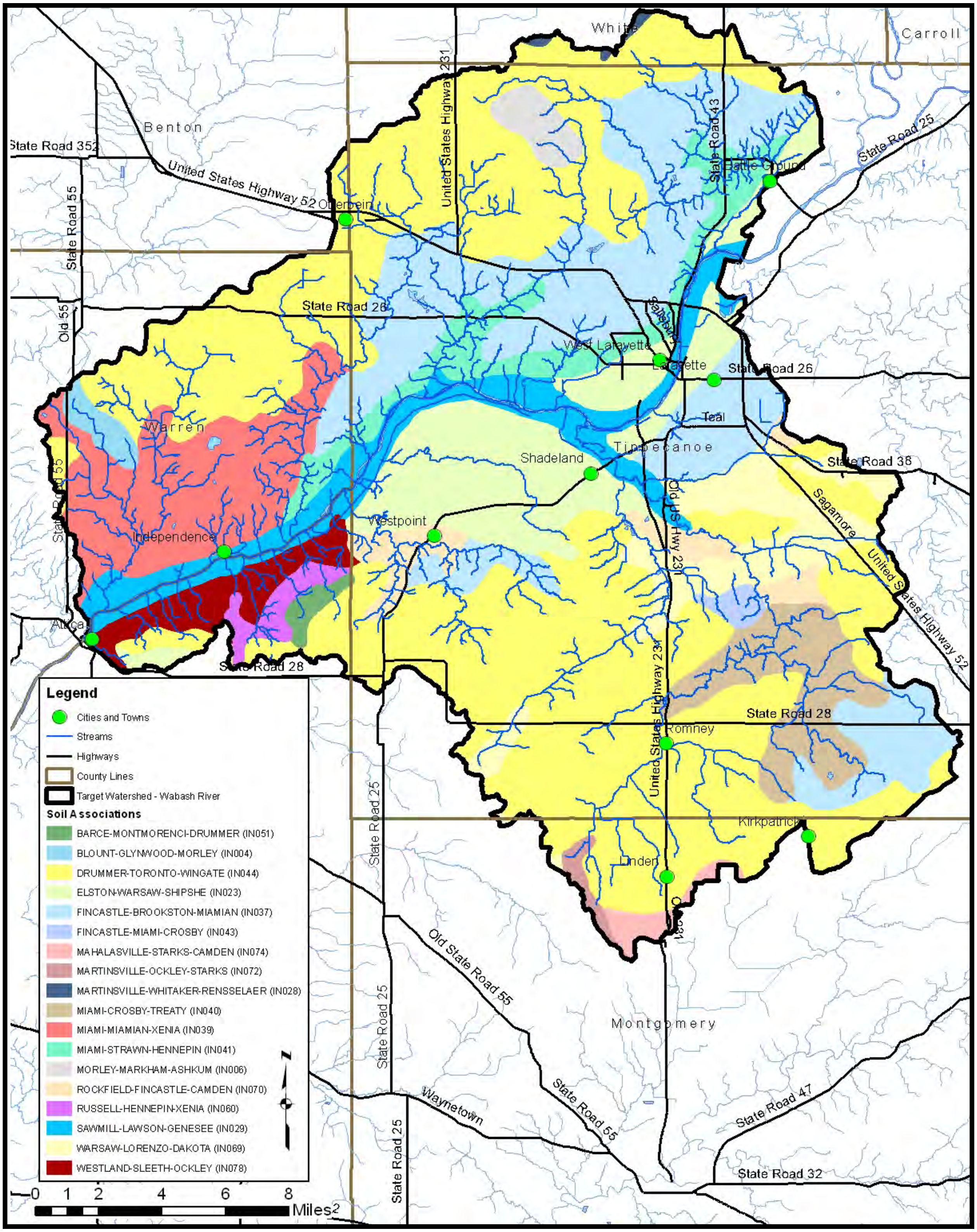

Figure 12. Soil associations in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.5.2 Soil Erodibility

Soils that move from the landscape to adjacent waterbodies result in degraded water quality, limited recreational use, and impaired aquatic habitat and health. Soils carry attached nutrients, pesticides, and herbicides. These can result in impaired water quality by increasing plant and algae growth or can kill aquatic life or damage water quality. The ability and/or likelihood for soils to move from the landscape to waterbodies are rated by the Natural Resources Conservation Service (NRCS). The NRCS uses soil texture and slope to classify soils into those that are considered highly erodible, potentially highly erodible, and non-erodible. The classification is based on an erodibility index which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss T value or tolerance value. The T value is the maximum annual rate of erosion that can occur for a particular soil type without causing a decline in long-term productivity. Potentially highly erodible soil determinations are based on the slope steepness and length in addition to the erodibility index value.

Watershed stakeholders are concerned about soil erosion. As detailed above, soils which have high erodibility index values are those that are located on steep slopes and are easily moved by wind, water, or land uses. Figure 13 details locations of highly erodible and potentially highly erodible soils within the Region of the Great Bend of the Wabash River watershed. In total, highly erodible soils cover 16% of the watershed or approximately 50,000 acres, while potentially highly erodible soils cover 10% of the watershed or approximately 32,200 acres. Highly erodible soils are found throughout the watershed, but are more concentrated within Tippecanoe County. Many are located adjacent to stream channels or along the north bank of the Wabash River. Potentially highly erodible soils are concentrated in Fountain, Montgomery, and Warren Counties and are also located in and around Lafayette and West Lafayette.

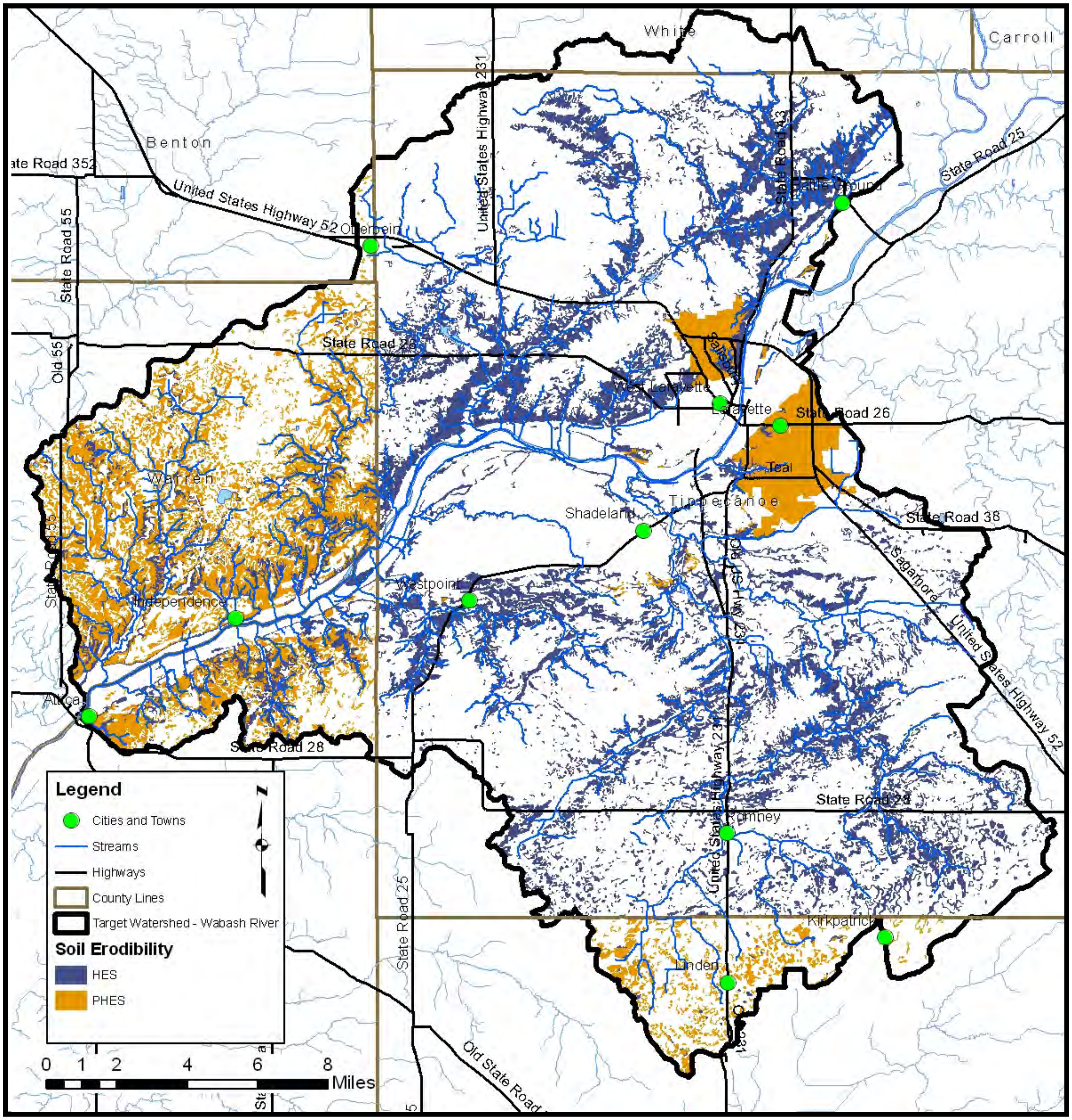

Figure 13. Highly erodible (HES) and potentially highly erodible soils (PHES) in the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

2.5.3 Hydric Soils

Hydric soils are those which remain saturated for a sufficient period of time thereby generating a series of chemical, biological, and physical processes. After undergoing these processes, the soils maintain the resultant characteristics even after draining or use modification occurs. Watershed stakeholders are concerned about the conversion of wetlands into agricultural and urban land uses. Approximately 80,900 acres (126 square miles) or 26% of the watershed are covered by hydric soils (Figure 14). A majority of hydric soils found in the watershed are located in the headwaters of Wea Creek (southern

Tippecanoe/northern Montgomery County) and within the Indian Creek and Burnett Creek watersheds in the northern portion of the watershed along the Tippecanoe County/White County boundary. As these soils are considered to have developed under wetland conditions, they are a good indicator of historic wetland locations and therefore will be revisited in the land use section.

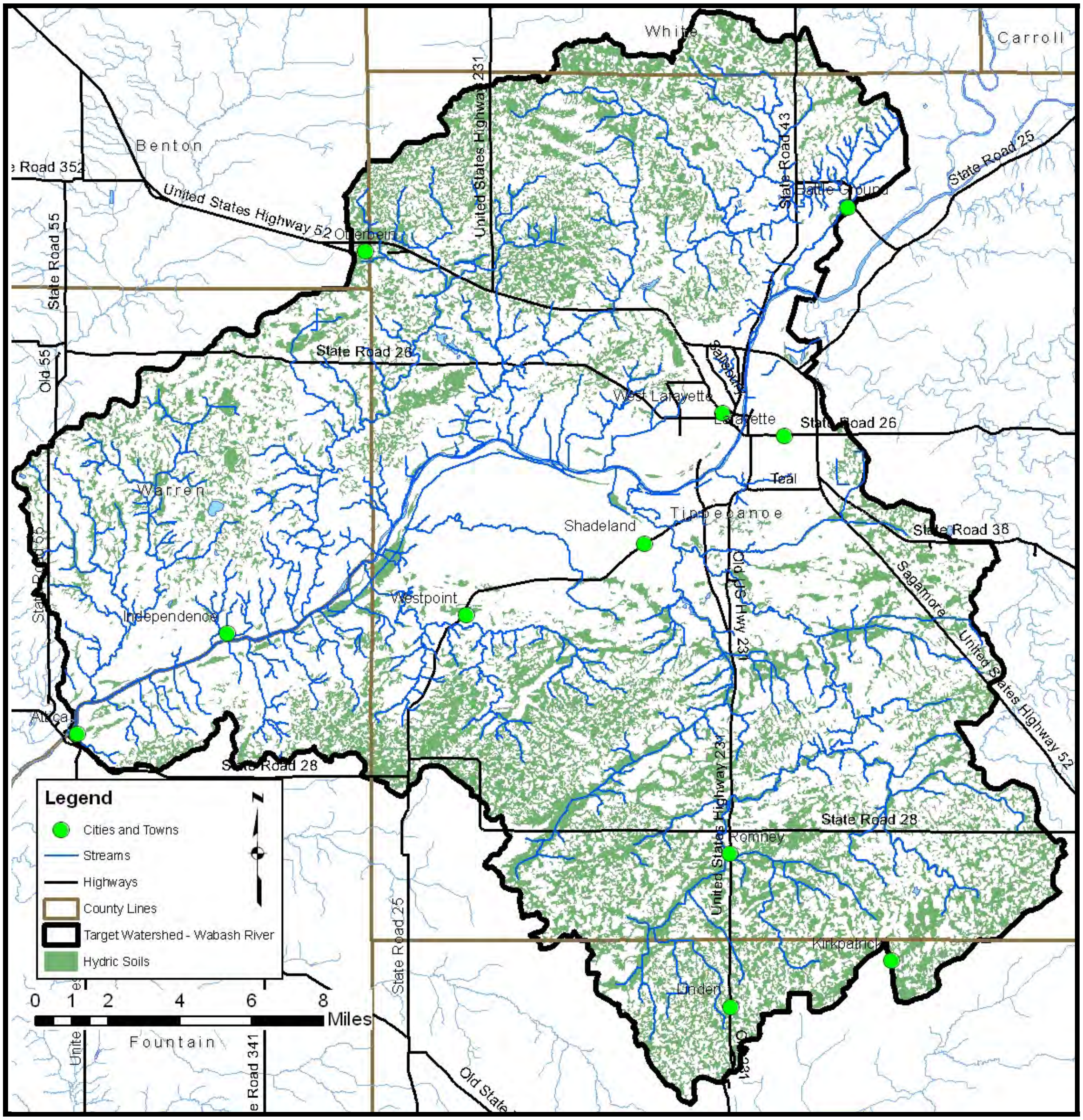

Figure 14. Hydric soils in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.5.4 Tile-Drained Soils

Soils drained by tile drains are relatively common in the Region of the Great Bend of the Wabash River watershed covering nearly 200 square miles (42%). A majority of tile-drained soils are located in the headwaters, specifically within Burnett Creek, Little Pine Creek, Indian Creek, and Wea Creek (Figure 15). Within Fountain and Warren Counties, tile-drained soils are limited to flat lands at the extreme headwaters of Kickapoo Creek and within the headwaters of a number of small, Wabash River tributaries. In these areas, materials applied to agricultural soils are directly transported to downstream waterbodies.

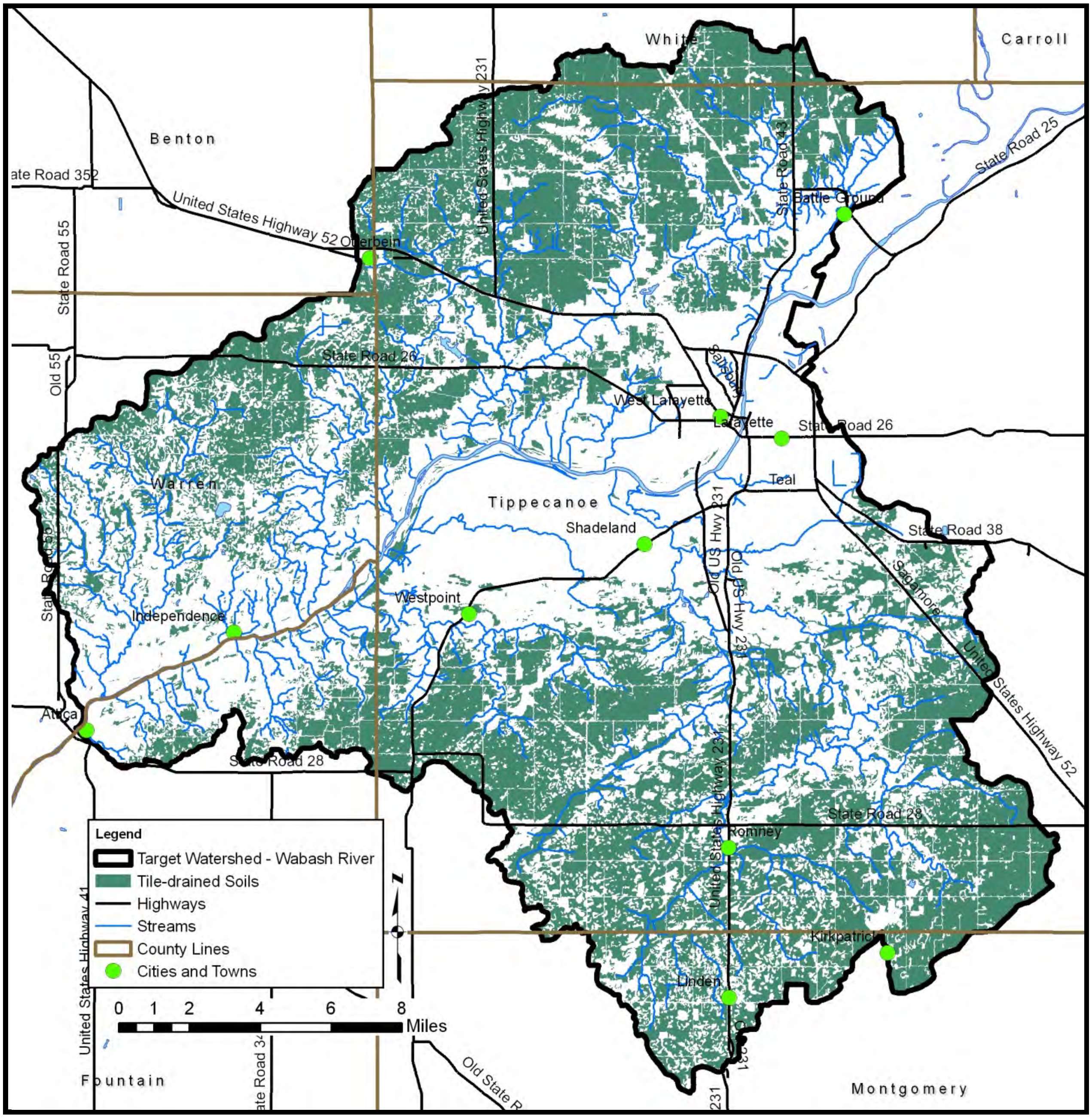

Figure 15. Tile-drained soils in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.6 Wastewater Treatment

2.6.1 Soil Septic Tank Suitability

Throughout Indiana, households depend upon septic tank absorption fields in order to treat wastewater. Seven soil characteristics, including position in the landscape, soil texture, slope, soil structure, soil consistency, depth to limiting layers, and depth to seasonal high water table, are utilized to determine suitability for on-site septic treatment. Septic tanks require soil characteristics that allow for gradual movement of wastewater from the surface into the groundwater. A variety of characteristics limit the ability for soils to adequately treat wastewater. High water tables, shallow soils, compact till, and coarse soils all limit soils abilities in their use as septic tank absorption fields. Specific system modifications are necessary to adequately address soil limitation; however, in some cases, soils are too poor for treatment and therefore prove inadequate for use in septic tank absorption fields.

Until 1990, residential homes located on 10 acres or more and occurring at least 1,000 feet from a neighboring residence were not required to comply with any septic system regulations. In 1990, a new septic code corrected this loophole. Current regulations address these issues and require that individual septic systems be examined for functionality. Additionally, newly constructed systems cannot be placed within the 100-year floodplain and systems installed at existing homes must be placed above the 100-year flood elevation. However, many residences grandfathered into this code throughout the state have not upgraded or installed fully functioning systems (Krenz and Lee, 2005). In these cases, septic effluent discharges into field tiles or open ditches and waterways and will likely continue to do so due to the high cost of repairing or modernizing systems ($4,000 to $15,000; ISDH, 2001). Lee et al. (2005) estimates that 76,650 gallons of untreated wastewater is expelled in the state of Indiana annually. The true impact of these systems on the water quality in the Region of the Great Bend of the Wabash River watershed cannot be determined without a complete survey of systems.

The Natural Resources Conservation Service (NRCS) ranks each soil series in terms of its limitations for use as a septic tank absorption field. Each soil series is placed in one of three categories: severely limited, moderately limited, and slightly limited. Some soils are also unranked. Severe limitations delineate areas whose soil properties present serious restrictions to the successful operation of a septic tank tile disposal field. Using soils with a severe limitation increases the probability of the system's failure and increases the costs of installation and maintenance. Areas designated as having moderate limitations have soil qualities which present some drawbacks to the successful operation of a septic system; correcting these restrictions will increase the system's installation and maintenance costs. Slight limitations delineate locations whose soil properties present no known complications to the successful operation of a septic tank tile disposal field. Use of soils that are rated moderately or severely limited generally require special design, planning, and/or maintenance to overcome limitations and ensure proper function.

Watershed stakeholders are concerned about the lack of maintenance associated with septic tanks, the use of soils that are not suited for septic treatment, and the presence of straight pipe systems within the watershed. These concerns are exacerbated by the fact that severely limited soils cover a majority of the watershed (Figure 16). In total, nearly 270,000 acres or 88% of the watershed is covered by soils that are considered severely limited for use in septic tank absorption fields. An additional 21,000 acres or 7% of the watershed soils rate as moderately limited. The remaining 14,000 acres are slightly limited, covered by water, or not rated. Many of the unrated soils are located within the cities of Lafayette and West Lafayette where wastewater treatment plants handle septic waste.

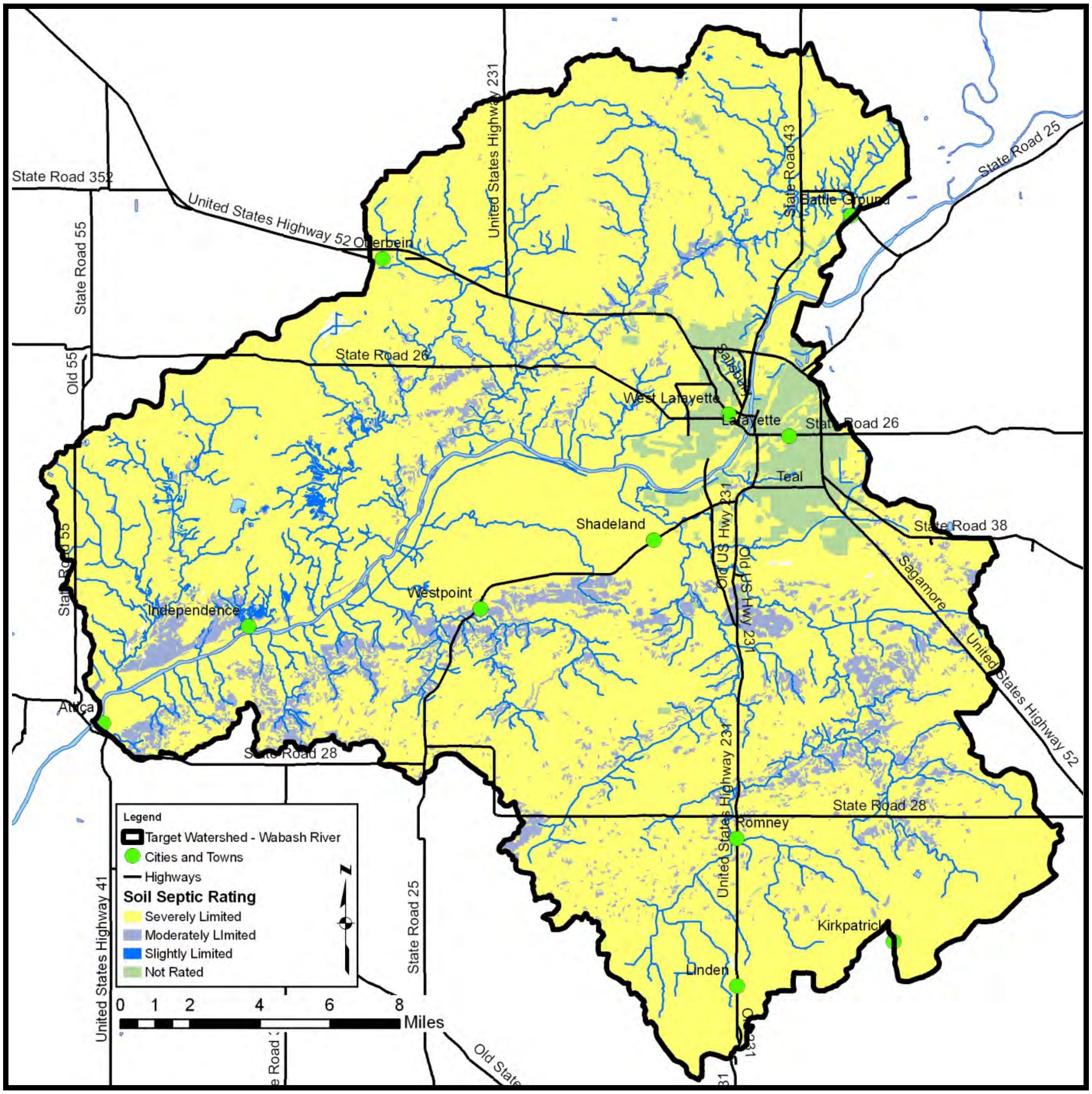

Figure 16. Suitability of soils for septic tank usage within the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

2.6.2 Wastewater Treatment and Solids Disposal

Several facilities which treat wastewater and are permitted to discharge the treated effluent are located within the watershed. These facilities are regulated by National Pollution Discharge Elimination System (NPDES) permits. These include several wastewater treatment plants ranging in size from small, local plants to large, publicly-owned facilities, industrial dischargers, commercial entities, and school facilities. In total, 25 NPDES-regulated facilities are located within the watershed (Figure 17). Table 9 details the NPDES facility name, activity, and permit number. More detailed information for each facility will be discussed on a subwatershed basis in subsequent sections.

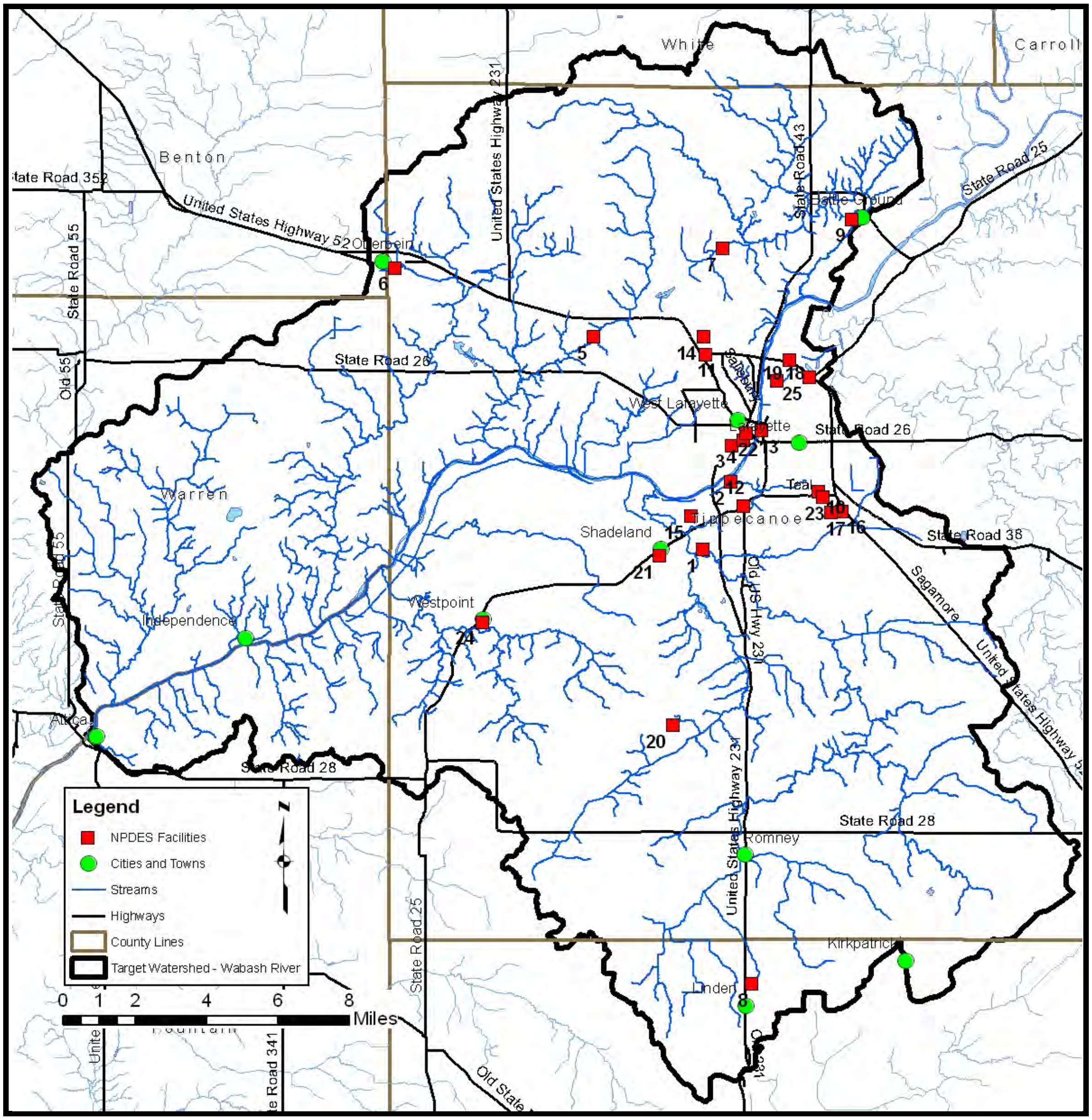

Figure 17. NPDES-regulated facilities in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

Table 9. NPDES-regulated facility information.

Map ID	NPDES ID	Facility Name	Activity Description
1	IN0038971	Royal Oak Estates MHP	Residential mobile home sites
2	IN0032468	Lafayette Water Pollution Control	Sewerage system
3	IN0003859	Purdue University Wade Physical Plant	Colleges, universities, and professional schools
4	IN0024821	West Lafayette WWTP	Sewerage system
5	IN0043273	American Suburban Utilities	Subdivision
6	IN00243990	Otterbein Municipal STP	Sewerage system
7	IN0038334	American Suburban Utilities	Residential care
8	IN0040274	Linden Municipal WWTP	Sewerage system
9	IN0020036	Battle Ground WWTP	Sewerage system
10	IN0001210	Alcoa Lafayette Operations	Secondary smelting and refining of nonferrous metals
11	ING080147	Amoco Service Station 10109	Gasoline service station
12	IN080096	Burger King	Gasoline service station
13	IN0003361	Cargill Incorporated	Soybean oil mills
14	IN0109690	CTS Corp Micro Electronics	Semiconductors and related devices
15	IN0002861	Eli Lilly & Co.	Medicinal chemicals and botanical products
16	IN0001481	Fairfield Manufacturing Company	Coating, engraving, and allied services
17	IN0029901	Ice Cream Specialties Inc.	Frozen bakery products
18	IN0060356	Lafayette Water Works	Water supply
19	IN0001074	Landis & Gyr	Electroplating, polishing, anodizing and coloring
20	IN0037206	Minonye Elementary School	Elementary and secondary schools
21	IN0047082	Shadeland MHP	Operators of residential mobile home sites
22	ING080155	Speedway 8534	Gasoline service station
23	ING080192	Speedway Service Station 7272	Gasoline service station
24	ING080163	Speedway Starvin Marvin	Gasoline service station
24	ING080175	Van's Wholesale	Gasoline service station
25	ING080202	Village Pantry 482	Gasoline service station

Source: USEPA EnviroFacts Warehouse, 2009.

2.6.3 Municipal Wastewater Treatment and Combined Sewer Overflows

Watershed stakeholders are concerned over the limitations of municipal wastewater treatment facilities specifically the intensity, density, and duration of combined sewer overflows within the watershed. Additionally, concerns about application of sludge from municipal wastewater treatment plants were also raised. In total, seven municipal wastewater treatment plants service areas of the Region of the Great Bend of the Wabash River watershed (Figure 18). Additionally, five of these wastewater treatment plants discharge to a tributary of the Wabash River within the watershed. The Lafayette and West Lafayette plants discharge directly to the Wabash River, while the Battle Ground plant discharges to Burnett Creek and the Otterbein plant discharges to Otterbein Ditch, which drains to Little Pine Creek and then to the Wabash River. Wastewater treatment plants service areas of Attica and Linden within the watershed; however, they discharge to the Wabash River and Sugar Creek then to the Wabash River, respectively, outside of the Region of the Great Bend of the Wabash River watershed. Sludge from municipal wastewater treatment plants is applied on 53.8 square miles throughout the watershed. Much of this application occurs within the Wea Creek basin (Figure 18).

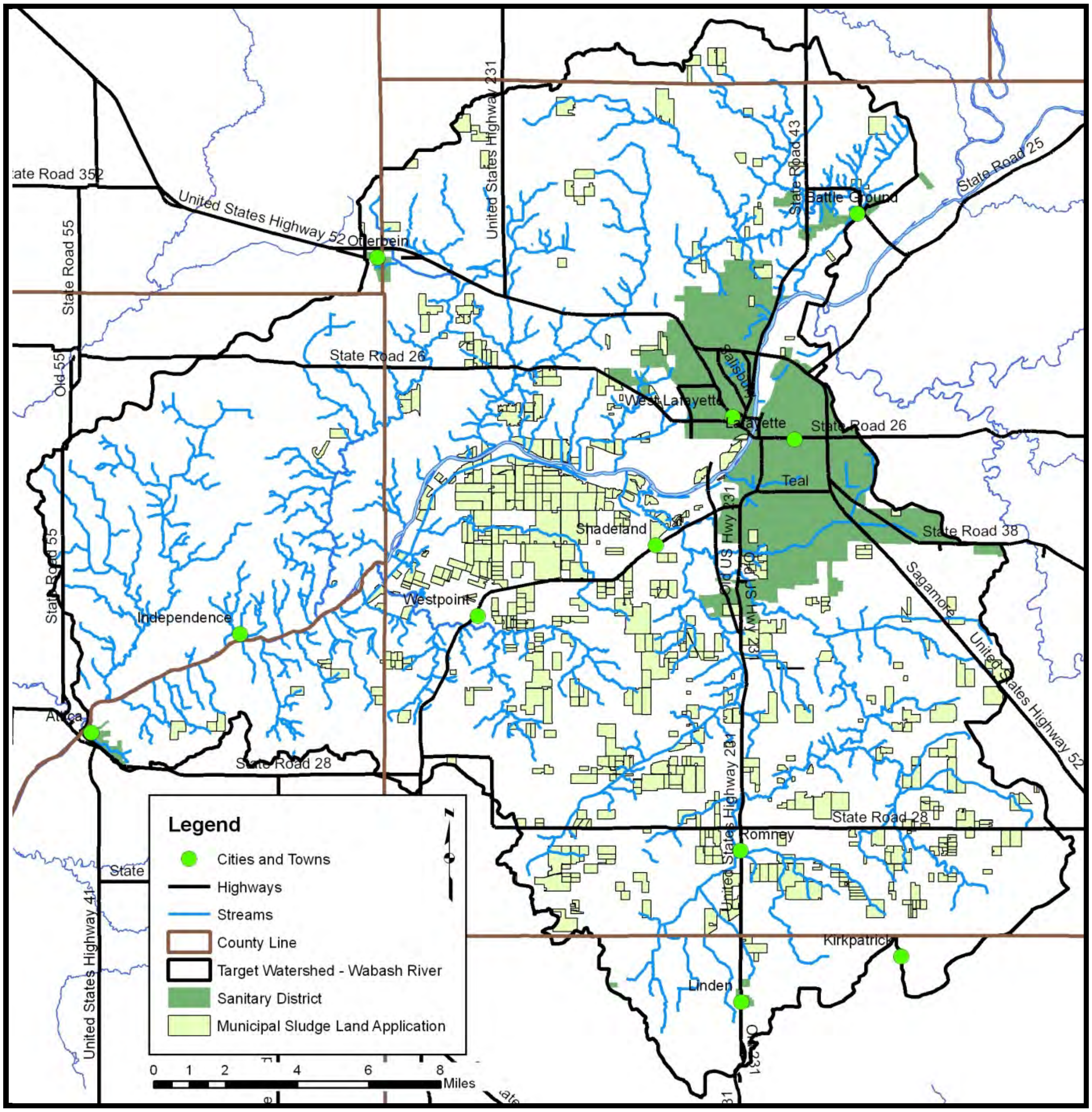

Figure 18. Wastewater treatment plant service areas and municipal sludge land application sites within the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

City of Lafayette

The City of Lafayette's wastewater treatment plant services 18,000 acres or 28.1 square miles. Lafayette maintains 436.4 miles of combined and sanitary sewers (Figure 18). Recent expansion of the wastewater treatment plant from an average annual capacity of 16 MGD (million gallons per day) to 26 MGD and a peak capacity of 28 MGD to 52 MGD during wet weather events occurred in 2004. The improvements included the following:

- New influent pump station;
- New fine screening, grit removal, and scum concentration facilities;
- Five new primary clarifiers;
- Two new aeration tanks;
- New process blowers;
- Four new final clarifiers and rehabilitation of the six existing clarifiers;
- New effluent pump station;
- New disinfection facilities and modified chlorine contact tank;
- Two new anaerobic sludge digester and rehabilitation of two existing digesters; and
- Standby power.

Currently, the plant treats an average daily flow of 16.9 MGD including residential, commercial, and industrial sewage. Thirteen major and seven minor industrial contributors deliver wastewater to the wastewater treatment plant. Treatment occurs via primary and secondary clarification, followed by anaerobic digestion, and finally biosolid production. Approximately 10 million gallons of biosolids are produced annually. These solids are then spread as fertilizer on approximately 5,000 acres of agricultural land.

Historically, 13 permitted combined sewer overflows were located within the City of Lafayette's system. Two of those overflows were closed in 2001 and 2004 resulting in a total of 11 permitted CSOs (City of Lafayette, 2009). Overflows drain to the Wabash River reaching it as follows (Figure 19): six overflows drain to unnamed tributaries then to the Wabash River, three drain to Durkee's Run then to the Wabash River, and one drains to Elliot Ditch then to Wea Creek and then to the Wabash River (Greeley and Hanson, 2004). Over the past few years, multiple combined sewer overflows occurred (Table 10). Since data recording began, CSO occurrences dropped by approximately 25%.

This portion of the wastewater treatment system covers approximately 4,400 acres and is divided into 14 CSO service areas (Table 11). Each CSO service area consists of a trunk sewer that connects to interceptor lines through a diversion structure. During dry weather, flow through the trunk sewer is carried to the interceptor through throttle pipes. However, the capacity of the throttle pipes can be exceeded during storm events. This causes excess flows to be discharged over weirs located within each CSO diversion structure.

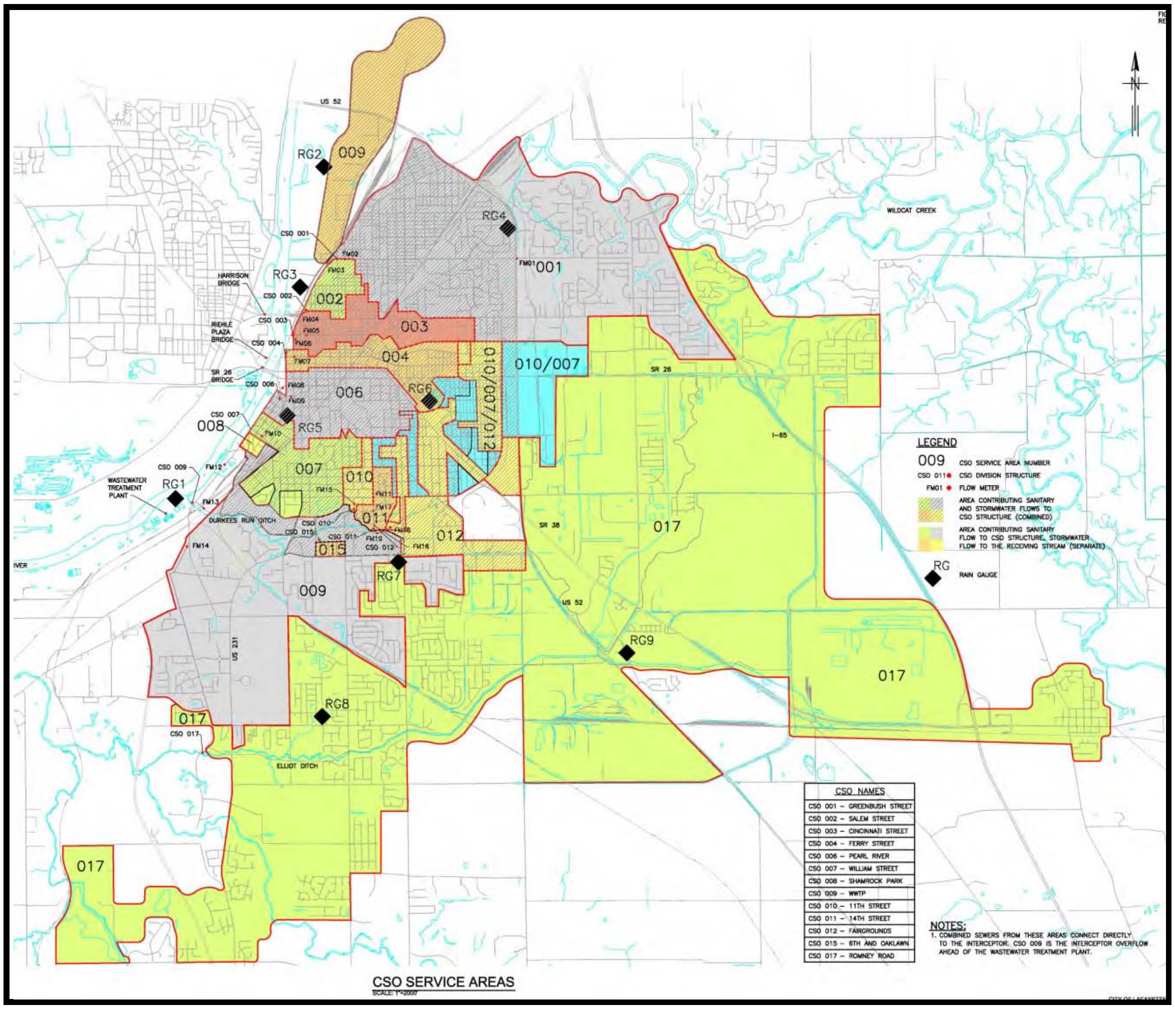

Figure 19. Areas flowing to a Combined Sewer within the City of Lafayette.
Source: Greeley and Hanson, 2004.

Table 10. Combined sewer overflow occurrences by month from 2002 to 2008.

Month	2002	2003	2004	2005	2006	2007	2008
January	7	1	8	14	7	7	3
February	13	5	2	9	4	3	8
March	11	5	11	5	9	7	7
April	18	6	5	6	9	8	6
May	16	15	12	4	11	5	9
June	11	7	11	7	8	9	12
July	5	15	12	7	9	6	9
August	7	4	10	5	9	5	3
September	4	6	2	9	7	3	8
October	6	4	8	4	6	7	3
November	4	5	10	6	7	5	4
December	5	9	5	4	9	9	7
Total # of Days	**107**	**82**	**96**	**80**	**95**	**74**	**79**

Source: City of Lafayette, 2009.

Table 11. Combined Sewer Overflow (CSO) service areas within the City of Lafayette's wastewater treatment system.

Service Area	Area/Combined Area (acres)	Customers	Status
001: Greenbush Street	2,260/1,050	Single-family; some industry	
002: Salem Street	100/100	Single-family; some industry	
003: Cincinnati Street	370/370	Single-family; some commercial	
004: Ferry Street	270/270	Single-family; industry	
006: Pearl River	410/410	Single-family; some industry; some commercial	
007:William Street	360/320	Single-family; some industry; some commercial	
008: Shamrock Park	16/16	Commercial	Closed 2001
009: WWTP	1,960/230	Open space, some commercial; some single-family	
010: 11th Street	69/68.5	Single-family	
007/010	950/160	Single-family	
011: 14th Street	73/73	Single-family; some open space	
012: Fairgrounds	680/680	Single-family; some commercial; some industry	
015: 6th and Oaklawn	20/20	Single-family	
017: Romney Road	10,540/680	Single family; some commercial; some open space	Closed 2004

Three of the 27 city-maintained lift stations, the Parking Lot lift station, Pearl River lift station, and Romney Road lift station, are located in the combined portion of the system. All three lift stations are undersized providing only 12 cubic feet per second (cfs), 3.8 cfs, and 16.5 cfs, respectively. In total, seven interceptors convey water from the CSO service areas to the wastewater treatment plant. These include:

- the West interceptor (Pearl River lift station to wastewater treatment plant),
- the Romney Road interceptor (Romney Road lift station to wastewater treatment plan),
- the Williams Street interceptor (Highland Park to West interceptor),
- Durkee's Run interceptor (Beck Lane/Summerfield Drive to Fairgounds CSO to West interceptor),
- Ferry Street interceptor (Ferry/26th to Parking Lot lift station),
- Cincinnati Street interceptor (St. Elizabeth's hospital south then west to Parking Lot lift station),
- Greenbush Street interceptor (Greenbush/20th to 9th Street south to Parking Lot lift station).

City of West Lafayette

The City of West Lafayette's wastewater treatment plant services 7,657 acres or almost 12 square miles. West Lafayette maintains 117.3 miles of combined and sanitary sewers (Figure 18). Since 1993, the City of West Lafayette has been working on upgrades for the wastewater treatment plant. These upgrades allow the plant to treat 9 MGD with a total treatment of 3.3 billion gallons of waste annually. The improvements included the following:

- Addition of ammonia-nitrogen removal and dechlorination;

- Completion of the foundation drain disconnect program in the BarBarry neighborhood;
- Construction of the North River Road lift station;
- Rehabilitation of the Happy Hollow interceptor;
- Construction of the wet weather treatment facility to reduce CSO impacts to the Wabash River; and
- Initiation and completion of the first two of four phases of the Western Interceptor project which will divert 6.5 MGD from the combined sewer system during wet weather events.

Historically, four permitted combined sewer overflows were located within the City of West Lafayette's system. One of those overflows was closed in 2001 resulting in a total of three permitted CSOs (City of West Lafayette, 2009). Currently, overflows drain to the Wabash River at three locations: Dehart Street, Quincey Street north, and Quincey Street south (City of West Lafayette, 2009). Based on data collected in 1999, as little as 0.8 inches of rain creates a combined sewer overflow event (Commonwealth Biomonitoring, 2000). Over the past few years, multiple combined sewer overflows occurred including a total of 92 occurrences in 2003 with more than 84 million gallons of combined stormwater and wastewater entering the Wabash River.

Towns of Battle Ground, Otterbein, Linden and Attica

The Town of Battle Ground operates a wastewater treatment plant which serves the town's 800 residents. In total, the plant treats 0.26 MGD of wastewater, which when cleaned, is discharged to Burnett Creek (USEPA, 2004). The service area is shown in Figure 18.

The Town of Otterbein operates a wastewater treatment plant which serves the town's 1,200 residents. In total, the plant treats 0.20 MGD of wastewater, which when cleaned, is discharged to Otterbein Ditch (USEPA, 2004). The service area is shown in Figure 18.

The Town of Linden operates a wastewater treatment plant which serves the town's 800 residents. In total, the plant treats 0.08 MGD of wastewater, which when cleaned, is discharged to Stoddard Ditch (USEPA, 2004). The service area is shown in Figure 18.

The Town of Attica operates a wastewater treatment plant which serves the town's 3,850 residents. In total, the plant treats 0.38 MGD of wastewater, which when cleaned, is discharged to the Wabash River downstream of the current watershed area (USEPA, 2004). Combined Sewer Overflows are a concern in the Attica treatment system; however, discharges occur downstream of the present watershed planning area. The service area is shown in Figure 18.

2.6.4 Unsewered Areas

Several unsewered areas were identified within the watershed (Figure 20). These entities generally consist of relatively concentrated housing units outside of the sanitary district boundaries discussed above. Additionally, school buildings are mapped as there is typically high density use at these facilities throughout the year. Locations of both entities were mapped using aerial photography and confirmed with on-the-ground observations.

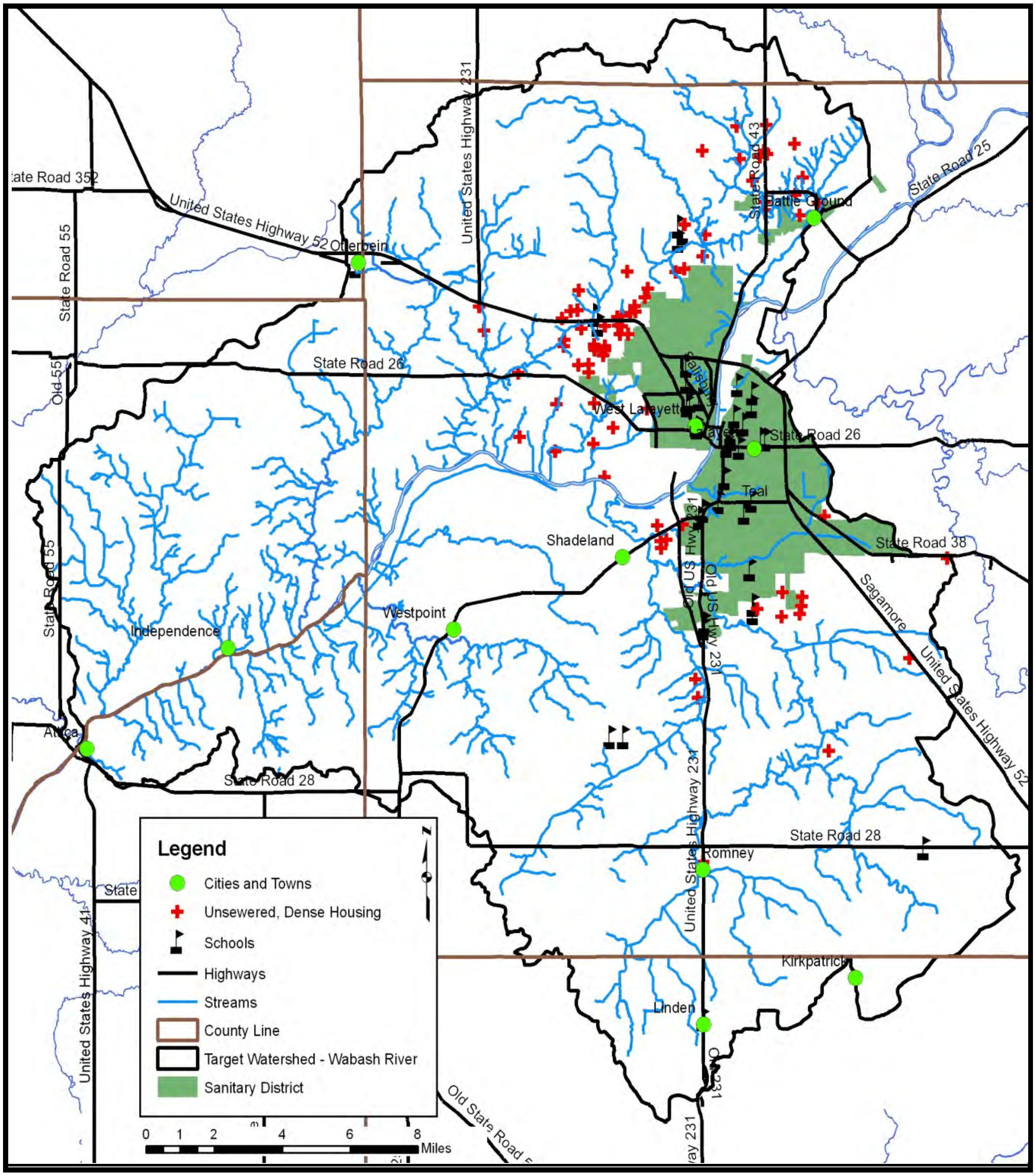

Figure 20. Unsewered areas in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.7 Hydrology

As part of his study, Gammon cataloged historic references to the Wabash River, assessed the fish community, and the overall river habitat. Each of these comments indicate the changing hydrology in the Wabash River. Some of the comments recorded by Gammon (1995) include:

- The Wabash River was clear and sparkled in the sunlight; Logansport, 1833 (McCord, 1970).

- The Wabash and its tributaries routinely rise above their banks and overflow into the low adjoining land; location unknown, undated.
- The Wabash River was low (July) and its rocky bed was exposed and dotted by small island. In 1845, Winter noted the effects of partially clearing the area stating that the islands were beginning to wash away under the influence of the greater volume of water; Logansport.
- Rolfe (1920) noted the continued change in water quality stating that the waters of the Wabash River were commonly brown and opaque with suspended sediments and that waters never cleared even in the lowest stages; Attica to Vermillion.
- Gerking (1945) identified "city sewage, cannery waste, mill waste, coal mine drainage, and dairy-products waste" as sources of water quality problems within the middle and lower Wabash River.
- Visher (1944) indicated four reasons for increased flooding within the Wabash River and its tributaries: abundant rainfall, concentration of rainfall, inadequate size and number of runoff channels, and changes produced by man.

Watershed streams, legal drains, floodplains, wetlands, storm drains, groundwater, subsurface conveyances, and manmade drainage channels all contribute to the watershed's hydrology. Each component moves water into, out of, or through the system. Their contributions will be covered in further detail in subsequent sections.

2.7.1 Watershed Streams

The Region of the Great Bend of the Wabash River watershed contains more than 1,900 miles of streams, legal drains, and tile drains (Figure 21-22). The major tributaries to the Wabash River within this watershed include Burnett Creek, Indian Creek, Little Pine Creek, Kickapoo Creek, Flint Creek, Wea Creek, Lost Creek, and Jordan Creek. Several minor tributaries also drain to the Wabash River within this watershed. The Wabash River and major tributaries are used for boating, fishing, and full-body contact recreation. Ponds and reservoirs located within the watershed are typically used for shoreline and small boat fishing, full-body contact recreation, and aesthetic enjoyment. Individuals are concerned about consuming fish from regional waterbodies and the possible health risks associated with full-body contact with many of the regional waterbodies, especially the Wabash River. No beaches are located within the watershed; rather access to the waterbodies is possible via public access sites along the Wabash River or public parks located adjacent to waterbodies such as the Tippecanoe Battlefield on Burnett Creek. Informal swimming areas may be located in the watershed; however, these sites were not identified by stakeholders.

In total, approximately 1,902 miles of streams, drains, and tiles exist within the Region of the Great Bend of the Wabash River. Of these, approximately 418 miles are legal drains while 997 miles are tiles. It should be noted that legal drains are maintained by the county surveyor's office; however, some of the legal drains within the watershed have neither a maintenance fund nor a maintenance schedule. Maintenance practices can include dredging with large construction equipment to maintain flow, debris removal, and vegetation management both within the legal drain and the riparian zone. As these waterbodies are subject to periodic cleaning, it is important to work with the county surveyor to establish priorities for these waterbodies in terms of water quality improvement and erosion control. Potential limitations were considered by the steering committee with regard to prioritizing specific projects and priorities for subwatersheds which contain high densities of legal drains. The remaining waters (487 miles) are streams which are not maintained and remain in their natural state.

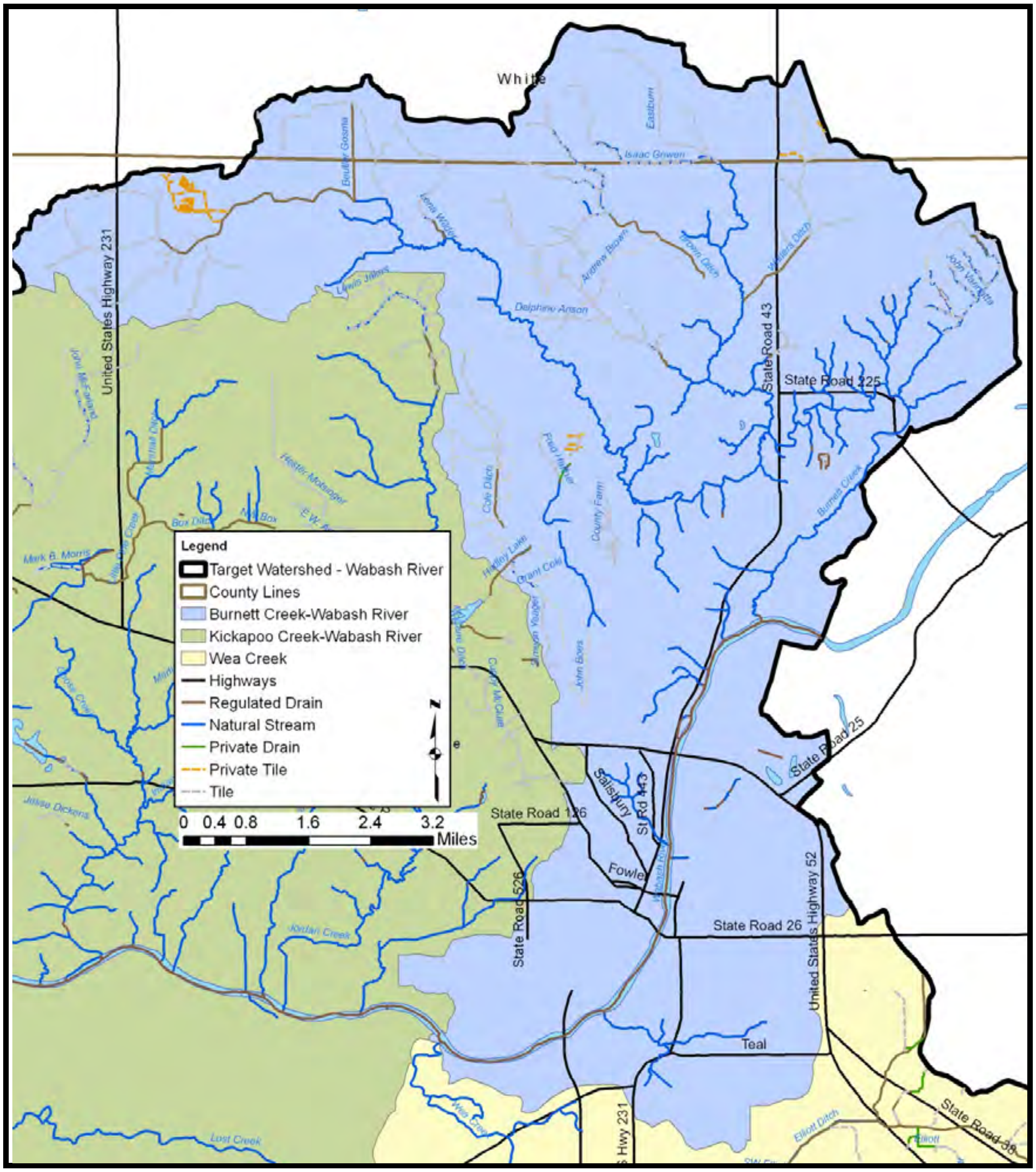

Figure 21. Streams, legal drains, and tile drains in the Burnett Creek-Wabash River subwatershed. Data used to create this map are detailed in Appendix A.

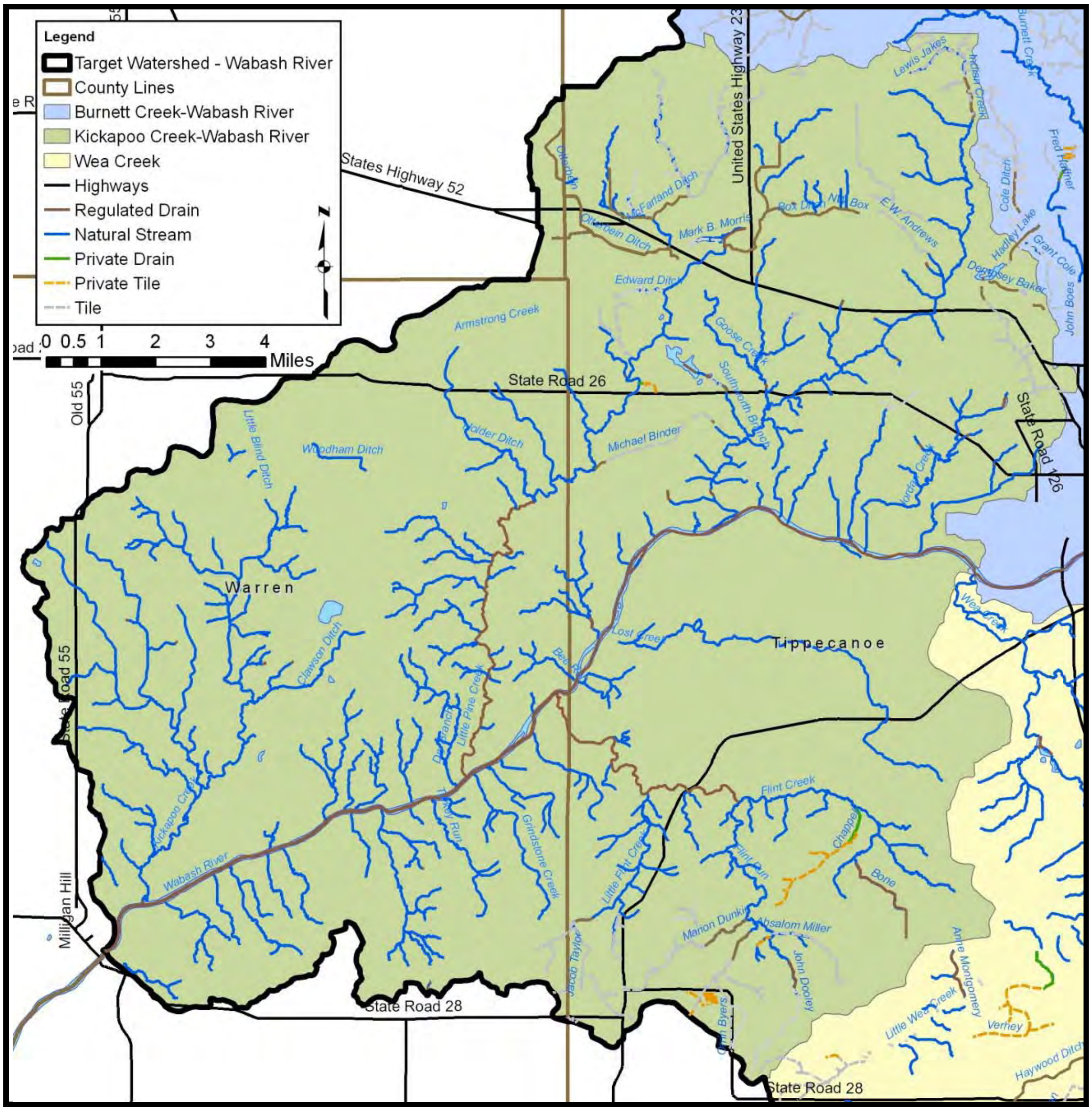

Figure 22. Streams, legal drains, and tile drains in the Kickapoo Creek-Wabash River subwatershed. Data used to create this map are detailed in Appendix A.

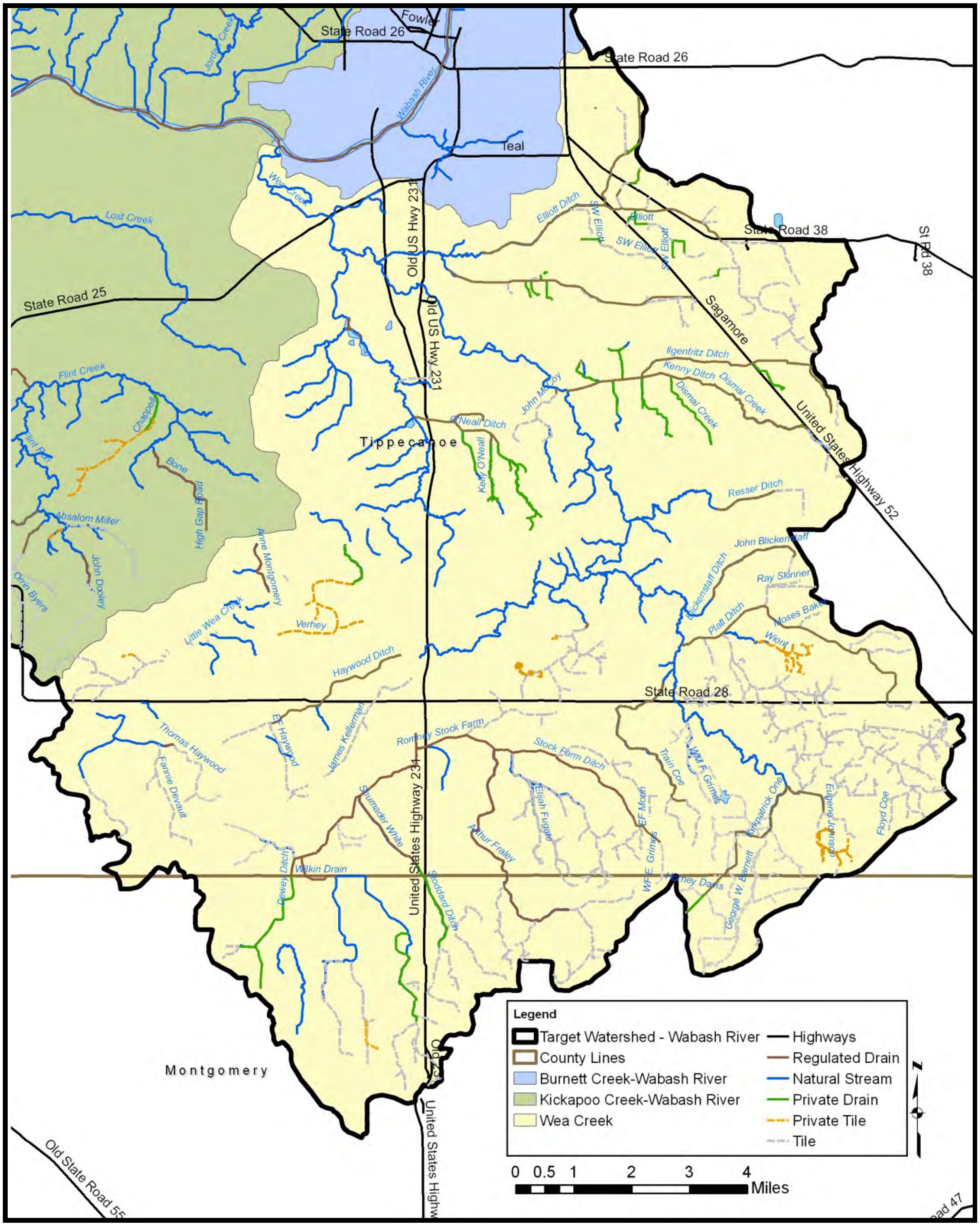

Figure 23. Streams, legal drains, and tile drains in the Wea Creek subwatershed.
Data used to create this map are detailed in Appendix A.

2.7.2 Outstanding Rivers

In addition to various stream type classifications discussed above, the state of Indiana also imposes two designations on streams throughout the state. These include the designation of outstanding rivers and impaired waterbodies. Outstanding rivers or streams are those that are of particular environmental or aesthetic interest and qualify under one or more of 22 categories (NRC, 2007). As such, the 2,000 river miles representing less than 9% of rivers in Indiana were listed by the IDNR Division of Outdoor Recreation. Conversely, the impaired waterbodies listing designates those waterbodies which do not meet state water quality standards. All waterbodies assessed by the IDEM are reviewed every two years to determine whether their water quality meets the state's requirements. Those waterbodies that do not contain sufficient water quality levels are included on the state's impaired waterbodies or 303(d) list. The most recent edition of this list was completed in 2008, with efforts to prepare the 2010 listing occurring concurrent with preparation of this plan.

Two streams in the Region of the Great Bend of the Wabash River watershed are designated as outstanding rivers (Figure 24). These include the entire length of the Wabash River and Little Pine Creek from the bridge southwest of Green Hill to the Little Pine's confluence with the Wabash River. Little Pine Creek was designated as an outstanding river as the state heritage program identified this waterbody as having outstanding ecological importance (NRC, 2007). The Wabash River is included as an outstanding river through legislation as part of the Wabash Heritage Corridor. This designation requires that these waterbodies be treated differently with regard to some state statutes and rules. Specifically, logjam removals and utility crossing requirements are more stringent within these waterbodies.

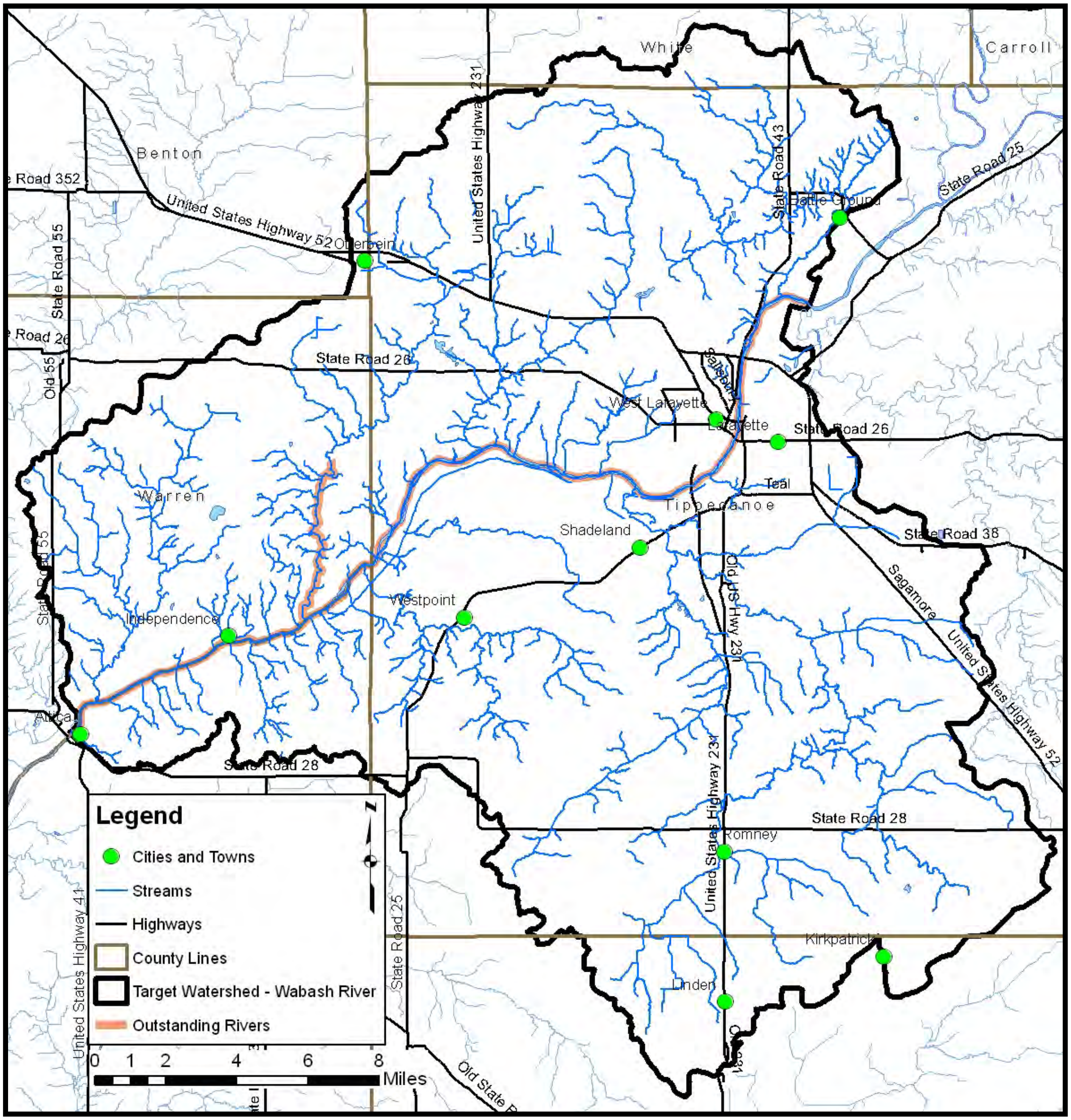

Figure 24. Outstanding river locations in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.7.3 Impaired Waterbodies (303(d) List)

The impaired waterbodies list is prepared biannually by the Indiana Department of Environmental Management. Waterbodies are included on the list if they do not meet the state's water quality standards. Waterbodies are relisted on the impaired waterbodies list once a Total Maximum Daily Load (TMDL) has been written for the waterbody or the waterbody again meets the state standards. Because a TMDL was written for the entire length of the Wabash River in Indiana and Illinois in 2007, the Wabash River is no longer listed on the 303(d) list; rather it remains on the list of impaired waterbodies to be reassessed following TMDL implementation. The TMDL and its impacts on water quality will be discussed in further detail in subsequent sections.

In total, 30 stream segments along seven waterbodies within the Region of the Great Bend of the Wabash River watershed were included on the draft 2010 list of impaired waterbodies or the 303(d) list. Table 12 details the listings in the Region of the Great Bend of the Wabash River, while Figure 25 details the segments and their locations within the watershed. Waterbodies are listed for *E. coli*, impaired biotic communities, nutrients, dissolved oxygen, mercury, and polycarbonate biphenyls (PCBs). Based on these listings, the following conclusions can be drawn:

- The *E. coli* water quality standard is routinely exceeded along Burnett Creek both upstream and downstream of Battle Ground, within the Wabash River, and one of its unnamed tributaries.
- High nutrient concentrations are typically present within the Wabash River.
- PCB and mercury levels are elevated in Wea Creek and its tributaries, Elliot Ditch, and the Wabash River.
- High nutrient and low dissolved oxygen concentrations are present within Flint Creek and its tributary Flint Run.
- Biological community impairments are present within Burnett Creek downstream of Battle Ground, Elliot Ditch, and the Wabash River. These listings are likely due to a fish consumption advisory; however, other issues cannot be ruled out at this time.

Table 12. Impaired waterbodies as listed on the 2010 draft list of impaired waterbodies in the Region of the Great Bend of the Wabash River watershed.

Assessment Unit Name	Cause of Impairment
Burnett Creek (upstream of Battle Ground)	*E. coli*
Burnett Creek (downstream of Battle Ground)	*E. coli*, Impaired biotic communities
Wabash River (upstream Greater Lafayette)	*E. coli*, Nutrients, Impaired biotic communities, Mercury in fish tissue, PCBs in fish tissue
Wabash River (Greater Lafayette to Tippecanoe County line)	*E. coli*, Nutrients, Mercury in fish tissue, PCBs in fish tissue
Wabash River (Tippecanoe County line to downstream Independence)	*E. coli*, Nutrients, PCBs in fish tissue
Wabash River (Attica)	*E. coli*, Nutrients, Mercury in fish tissue, PCBs in fish tissue
Unnamed Tributary to Wabash River	*E. coli*, Impaired biotic communities
Wea Creek	PCBs in fish tissue
Wea Creek (Elliot Ditch to mouth)	*E. coli*, Mercury in fish tissue, PCBs in fish tissue
Wea Creek tributaries	Mercury in fish tissue, PCBs in fish tissue
Elliot Ditch	Impaired biotic communities, PCBs in fish tissue
Flint Creek-Flint Run	Dissolved oxygen, nutrients
Flint Creek	Dissolved oxygen

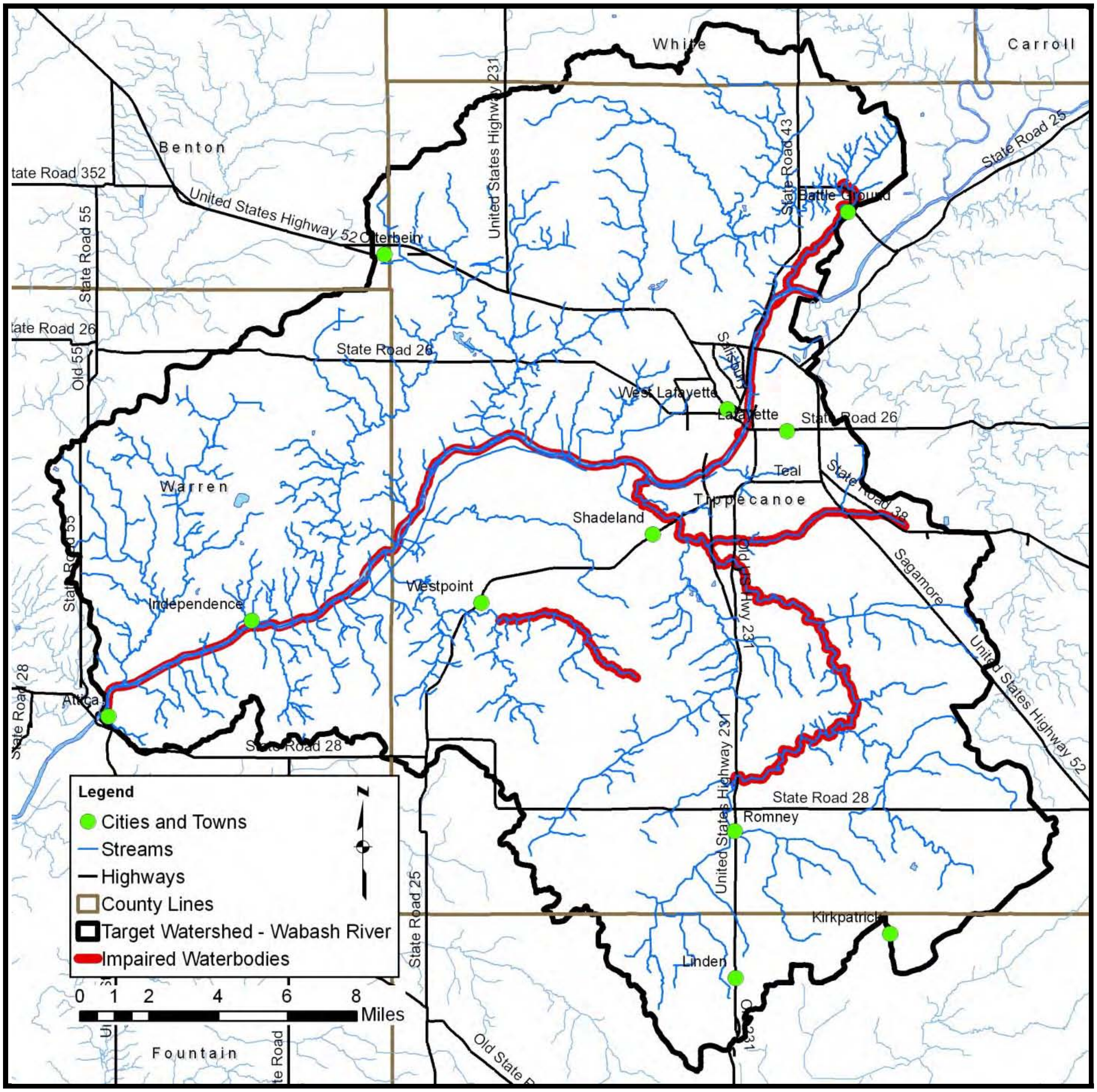

Figure 25. Impaired waterbody locations in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.7.4 Floodplains

Flooding is a common hazard that can affect a local area or an entire river basin. Increased imperviousness, encroachment on the floodplain, deforestation, stream obstruction, tiling, or failure of a flood control structure all are mechanisms by which flooding occurs. Impacts of flooding include property and inventory damage, utility damage and service disruption, bridge or road impasses, streambank erosion and riparian vegetation loss, water quality degradation, and channel or riparian area modification.

Floodplains are lands adjacent to streams, rivers, and other waterbodies that provide temporary storage for water. These systems act as nurseries for wildlife, offer green space for humans and wildlife, improve water quality, and buffer the waterbody from adjacent land uses. The Federal Emergency Management Agency (FEMA) developed Flood Insurance Rate Maps (FIRMs) for most of the country including all of the Region of the Great Bend of the Wabash River watershed. These maps allow local and regional governments to assess the risk of flooding in specific areas and create risk assessment levels by which insurance agencies can determine insurance rates for developed properties. Tippecanoe County is currently updating their floodplain maps; new maps will be included herein once they are complete. Nonetheless, the current FIRM data for the Region of the Great Bend of the Wabash River watershed are detailed in Figure 26.

Regional stakeholders are concerned about impacts to floodplains from development, lack of landowner maintenance, and soil erosion and deposition within the floodplain. Approximately 7.5% (23,105 acres) of the Region of the Great Bend of the Wabash River watershed lies within the 100-year floodplain. This 100-year floodplain is composed of three regions:

- Zone A is the area inundated during a 100-year flood event for which no base flood elevations (BFE) have been established. Zone A covers 67% of the floodplain for 15,600 acres. This includes the urban portion of the Wabash River running through Lafayette and West Lafayette and a portion of Burnett and Wea creeks.
- Zone AE is the area inundated during a 100-year flood event for which BFEs have been determined. The chance of flooding in Zone AE is the same as the chance of flooding in Zone A; however, floodplain boundaries in Zone A are approximated, while those in Zone AE are based on detailed hydraulic models which allows Zone AE floodplains to be more accurate. Zone AE covers 6925 acres or 30% of the floodplain
- Zone X includes areas outside the 100-year and 500-year floodplains which have a 1% chance of flooding to a depth of one foot of water. No BFEs are available for these areas and no flood insurance is required. Nearly 580 acres or less than 3% of the floodplain is located within Zone X.

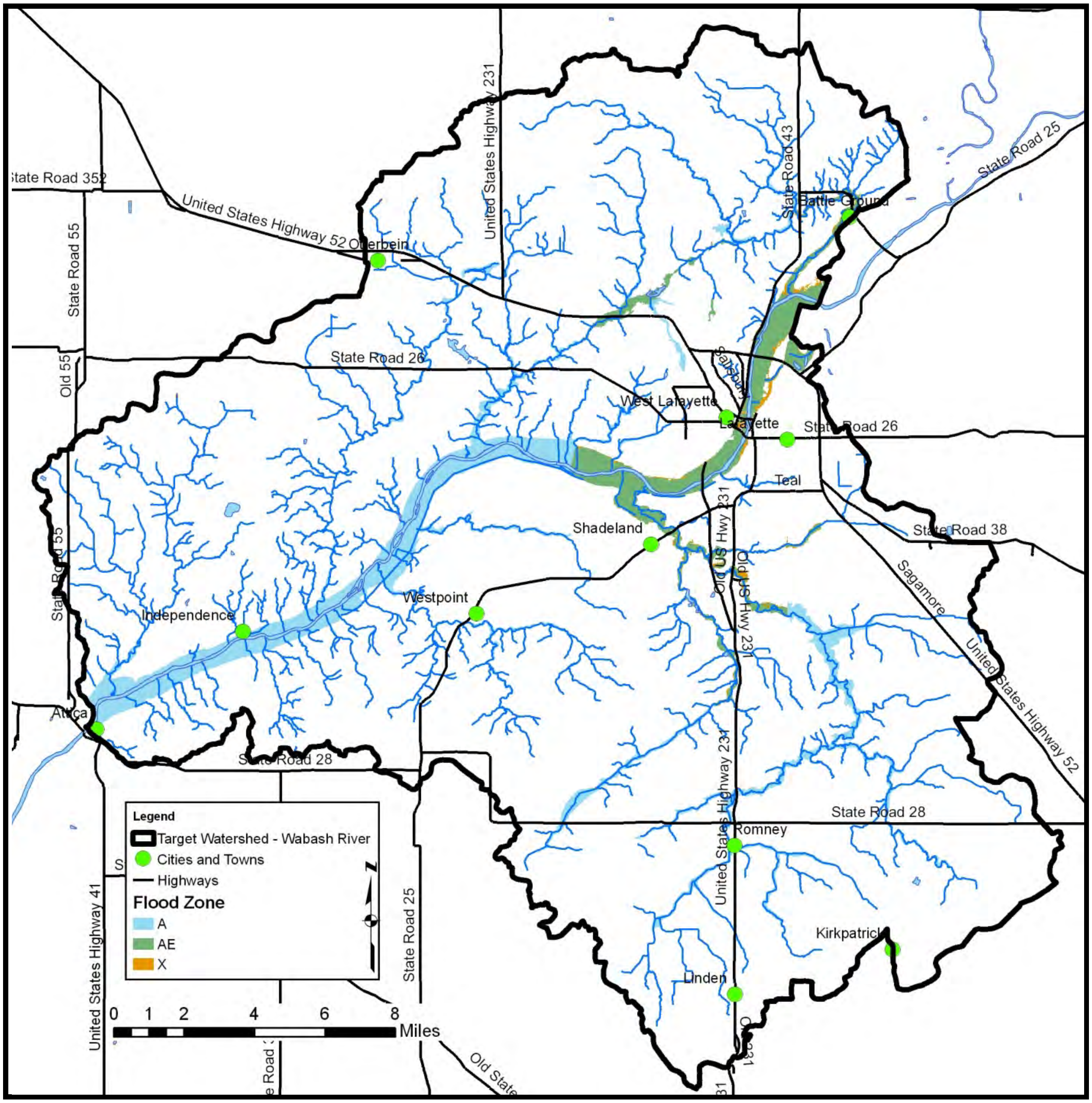

Figure 26. Floodplain locations within the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

A majority of land within the floodplain is classified as agricultural land use (51% or approximately 11,675 acres). (Land use classifications will be discussed in further detail in subsequent sections.) An additional 41% of the land in the floodplain is in forested or wetland land uses, while open water and urban land uses each account for 4% of the floodplain land use. Tippecanoe County's floodplain ordinance limits use of the floodplain and provides maximums as to the amount of modification or structural repairs that can be made to structures within the floodplain. Since 1965, West Lafayette, Lafayette, Battle Ground, Dayton, Clarks Hill, Shadeland and unincorporated Tippecanoe County have limited construction of new walled structures within the floodplain. The Unified Zoning Ordinance (UZO) requires a 25 foot no-building setback from the floodplain boundary with all structures within the next 75-feet to be built 2 or more feet above the regulatory flood elevation. All homes built prior to 1965 which are located within the floodplain zone are rated as non-conforming structures. This limits improvements and repairs which can occur on structures within the floodplain.

2.7.5 Wetlands

Approximately 25% of Indiana was covered by wetlands prior to European settlement (IDEM, 2007). Overall, 85% of wetlands have been lost resulting in Indiana ranking fourth in the nation in terms of percentage of wetland loss. Wetlands provide numerous valuable functions that are necessary for the health of a watershed and waterbodies. Wetlands play critical roles in protecting water quality, moderating water quantity, and providing habitat. Wetland vegetation adjacent to waterways stabilizes shorelines and streambanks, prevents erosion, and limits sediment transport to waterbodies. Additionally, wetlands have the capacity to increase stormwater detention capacity, increase stormwater attenuation, and moderate low water levels or flow volumes by allowing groundwater to slowly seep back into waterbodies. These benefits help to reduce flooding and erosion. Wetlands also serve as high quality natural areas providing breeding grounds for a variety of wildlife. They are typically diverse ecosystems which can provide recreational opportunities such as fishing, hiking, boating, and bird watching. It should be noted that wetlands are regulated through the IDEM and the U.S. Army Corps of Engineers. Any modification to wetlands requires permits from these agencies.

The Region of the Great Bend of the Wabash River watershed contains approximately 10,520 acres (16.4 square miles) of wetlands. In total, wetlands cover 3% of the watershed. When hydric soil coverage is used as an estimate of historic wetland coverage, it becomes apparent that nearly 90% of wetlands have been modified or lost over time. This represents nearly 110 square miles of wetland loss within the Region of the Great Bend of the Wabash River watershed. Figure 27 details the current (pink) and historic (green) distribution of wetlands throughout the watershed. Wetlands displayed in Figure 27 result from compilation efforts by the U.S. Fish and Wildlife Service as part of the National Wetland Inventory (NWI). The NWI was not intended to map specific wetland boundaries that would compare exactly with boundaries derived from ground surveys. As such, NWI boundaries are not exact and should be considered to be estimates of wetland coverage. Specific areas of wetland preservation and loss will be discussed in more detail in subsequent sections.

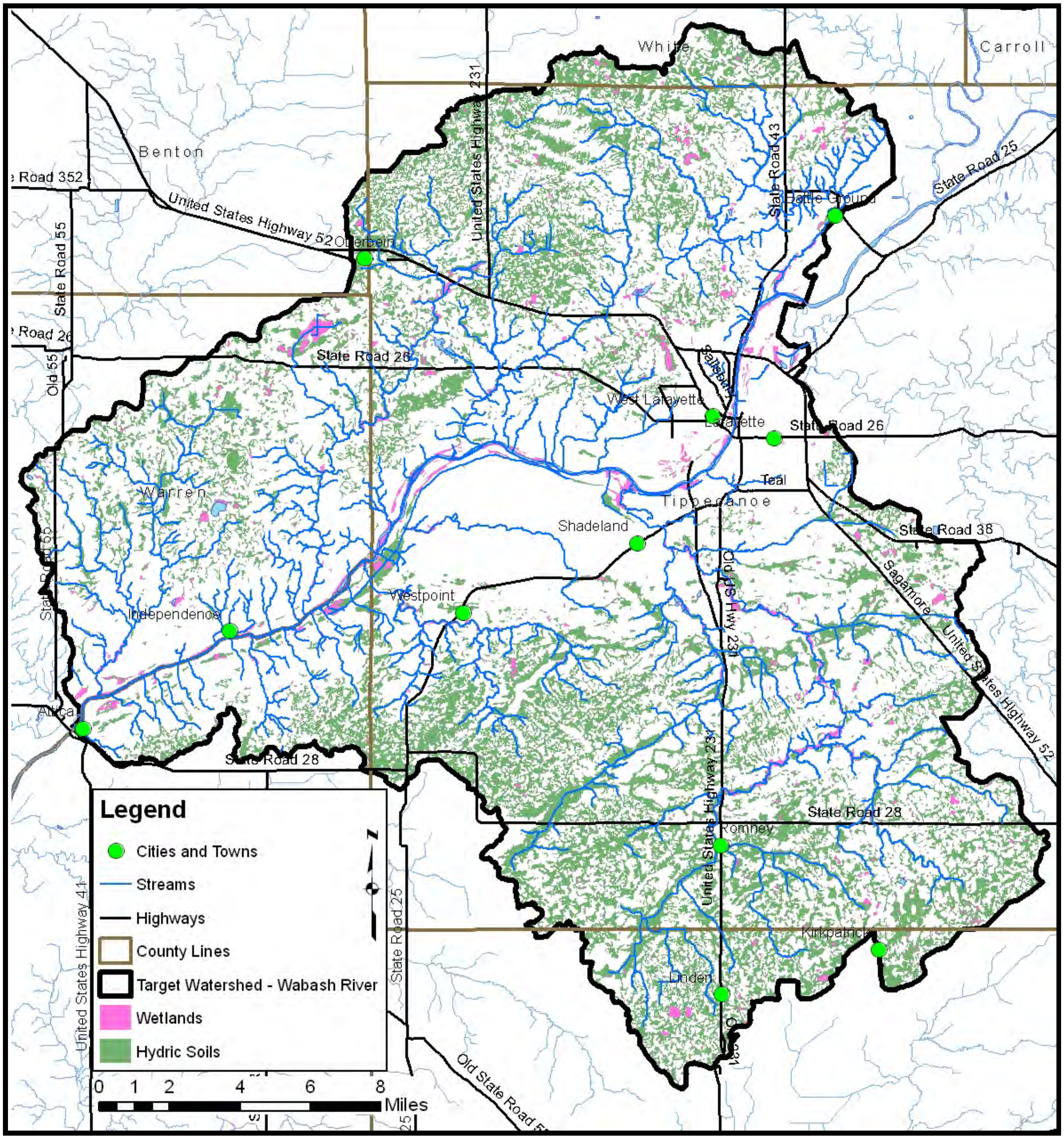

Figure 27. Wetlands and hydric soils located in the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

2.7.6 Stormwater and Storm Drains

Under natural conditions, the majority of precipitation is allowed to infiltrate the soil and recharge groundwater resources. The volume of infiltration and groundwater recharge diminishes as development increases. To handle the large volume of precipitation falling in urban areas, stormwater systems have been constructed. Storm drain systems are present in most urban areas throughout the watershed. In total, more than 800 miles of storm drain pipe are present within the watershed. The Tippecanoe County Stormwater Ordinance prohibits direct or indirect discharge of anything that is not stormwater into the stormwater system. Furthermore, the ordinance requires that dischargers of stormwater install best management practices as possible to reduce pollutant concentrations in stormwater. The stormwater ordinance also requires that developers file a stormwater drainage permit and design their structure(s) to result in no increase in combined on and off-site flows, in volume for the outlet of the project site, or flow or velocity for the total basin in which the project site exists.

2.7.7 Wellfields/Groundwater

In general, municipal water supply is taken from the Lafayette (Teays) Bedrock Valley System, associated with the Wabash River which traverses north-central Indiana. Additionally, the Silurian-Devonian aquifer (carbonate-rock), and other surficial sand and gravel aquifers may be utilized in Tippecanoe County by rural wells. Recharge of local aquifers occurs in the same manner as do many of the other aquifers in the state, namely by the downward percolation of local rainfall through the soil horizon and underlying formations. However, localized significant rainstorms can produce relatively quick response to recharge especially if adjacent areas did not receive the rainfall. Care must be taken to ensure the quality of the water from alluvial and surficial aquifer source waters. Table 13 lists wellhead protection areas within the Region of the Great Bend of the Wabash River watershed. Potential pollution from construction, sewage outfall, illegal dumping, agriculture, and storm water runoff must be avoided or controlled due to the recharge of these aquifers from runoff and river water.

Table 13. Wellhead protection areas within the Region of the Great Bend of the Wabash River watershed.

ID Number	System Name	City
5254007	Linden Water Department	Linden
5279001	American Suburban Utilities, Inc.	West Lafayette
5279002	Battle Ground Water District	Battle Ground
5279004	Candlelight Development Corp.	West Lafayette
5279013	Lafayette Water Works	Lafayette
5279015	Purdue Univ. Water Works	West Lafayette
5279016	Royal Oaks Estates	Lafayette
5279017	Shadeland Trailer Park	Lafayette
5279019	Indiana American Water - Westwood	West Lafayette
5279020	Indiana-American Water - West Lafayette	West Lafayette
5279030	Lafayette A-Ok Campground	Lafayette

2.8 Natural History

Geology, climate, geographic location, and soils all factor into shaping the native flora and fauna which occurs in a particular area. Categorization of these floral and faunal communities has been completed by a number of ecologists since the earliest efforts by Coulter in 1886. Since this time, Petty and Jackson (1966) identified regional communities; Homoya et al. (1985) classified Indiana into natural regions, while Omernik and Gallant (1988) categorized Indiana into ecoregions. In 1886, Professor John Coulter placed the Region of the Great Bend of the Wabash River watershed into the prairie region. The prairie region was characterized by sparse trees and shrubs most commonly including black walnut, buroak, white ash, shagbark hickory, wild cherry, sugar maple, beech, pawpaw, buckeye, sassafras, redbud, mulberry, crabapple, and dogwood. DeHart (1909) details the presence of wildflowers and prairie grass intermingled with trees especially in the bottom lands adjacent to the Wabash River and its tributaries. Descriptions from that time period detail the presence of kingfishers, bluejays, blackbirds, cranes, and heron waiting patiently for schools of fish including salmon, bass, redhorse, and pike within the river. DeHart (1909) lamented the loss of forests throughout the region as more settlers arrived. He described Indiana as becoming a "treeless state" where native timber stands were removed for farming purposes. He wrote "with more timber our streams would again flow with more water; our climate would be better, crops would be better and prosperity would be insured to those that come after us." He further noted issues with forest removal sighting the Wabash River drainage as one of the most concerning areas in the state creating vast nude areas along the Wabash River bluffs.

2.8.1 Natural and Ecoregion Descriptions

According to Homoya et al.'s (1985) classification, the Region of the Great Bend of the Wabash River watershed lies within two natural regions: the Tipton till plain and the grand prairie natural regions (Figure 28). Much of the watershed is contained in the central till plain natural region; however, the northern portion of the watershed from approximately five miles north of the Wabash River to the watershed boundary lies within the grand prairie natural region. The Tipton till plain is characterized by a mix of poorly drained soils which support a variety of oaks, maples, ash, elm, and sycamore and better drained soils home to hickory, tulip tree, white ash, sugar maple, and beech (Jackson, 1997). Within the till plain, depressions are often wet and mesic forests contain highly diverse communities. Jackson (1997) details the grand prairie natural region as a place of wide open skies, far horizons, hundreds of plant species, and fire. Native Americans called this part of the Midwest "mas-ko-tia" or the place of fire and dry prairie vegetation offered excellent fuel for fall fires which raced across the flat areas of the prairie.

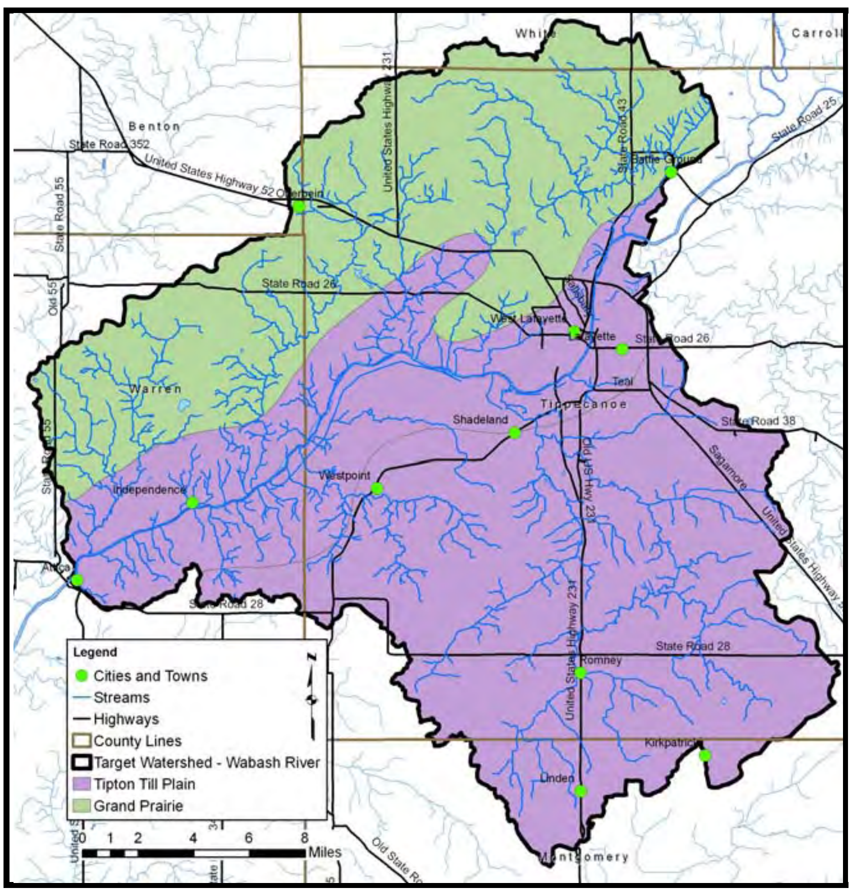

Figure 28. Natural regions in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

Similarly, the watershed lies within two ecoregions: the central corn belt plains and the eastern corn belt plains (Figure 29). The dividing line between the two ecoregions is similarly located with the dividing line between the two previously discussed natural regions. However, the ecoregion division lies slightly farther north generally following the northern watershed boundary with the central corn belt plains covering areas approximately four miles south of this boundary. Omernik and Gallant (1988) describe the central corn belt plains as being primarily prairie communities which may or may not have been converted to farm land. Soils are also generally dark and fertile with soybeans, corn, sheep, cattle, poultry, and hog production being the norm. Conversely, the eastern corn belt plains are primarily composed of gently rolling hills where tree cover occurs naturally. Additionally, soils are rich and well-drained and soybeans, corn, and livestock production is common (Omernik and Gallant, 1988).

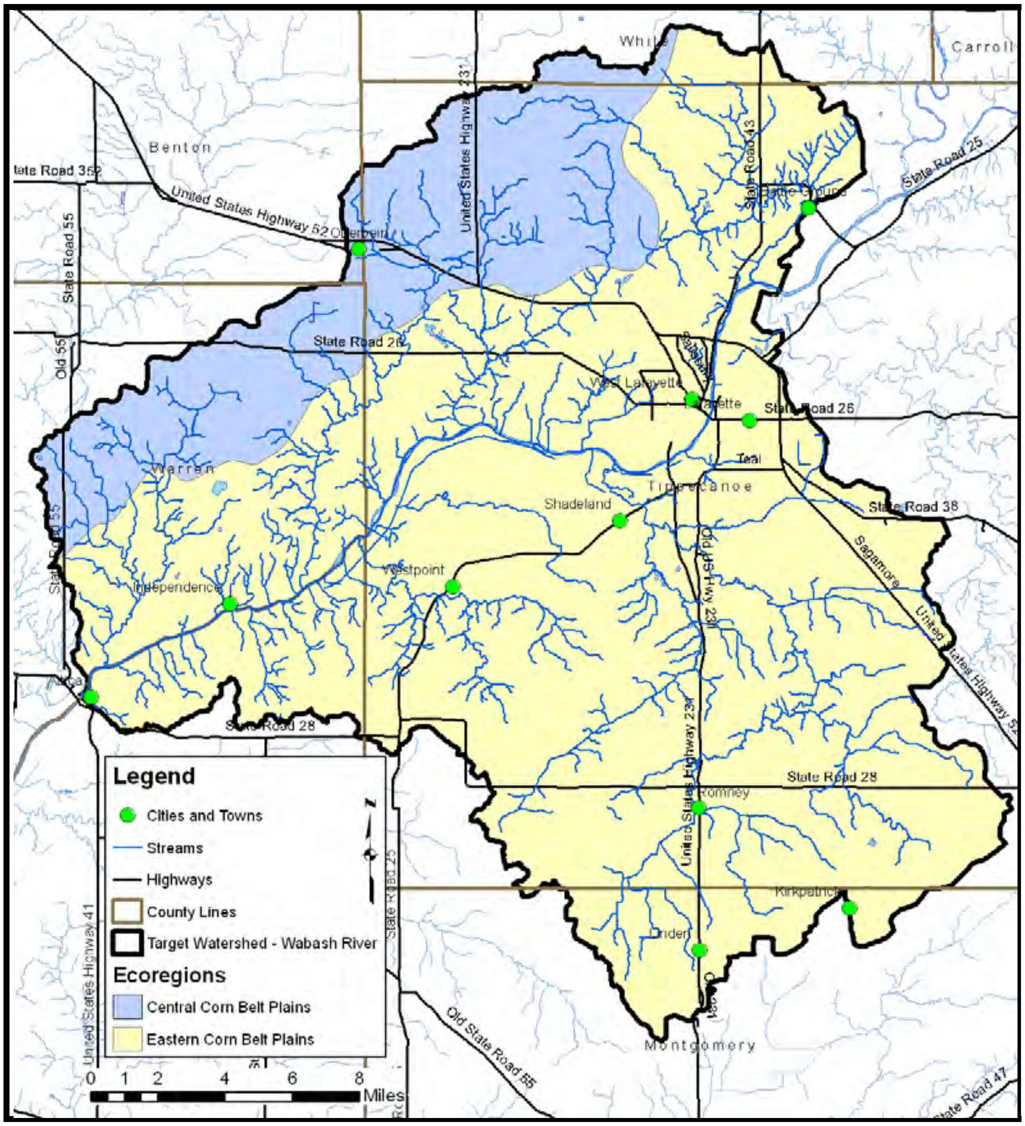

Figure 29. Level III eco-regions in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.8.2 Wildlife Populations

Individuals are concerned about lack of knowledge of local wildlife populations and the impact that changing land uses could have on these populations. Additionally, pathogen inputs from wildlife are also a concern. These will be quantified in subsequent sections. With these concerns in mind, wildlife density can be estimated from a variety of sources. The Indiana Department of Natural Resources (IDNR) is tasked with managing wildlife populations throughout the state. In order to complete this task, the IDNR must have an idea of the population density within specific areas, counties, or regions. Much of the Region of the Great Bend of the Wabash River watershed lies within the northwest region as defined by the IDNR. The most recent survey of wildlife populations occurred in 2005. Those densities are shown in Table 14 with deer and squirrel being the most common wildlife present within the region. It should be noted that these numbers could both underestimate and overestimate populations within the watershed. Densities are recorded based on animal observations per 1000 hours of overall observation. If observations areas are not equally spread throughout the region, over or underestimates of the populations could occur. Likewise, animals are not likely equally distributed throughout the region; therefore, the regional density may again over or underestimate the true density of the animal in question. Nonetheless, these estimates provide the best guess at wildlife densities.

Table 14. Wildlife density estimates for the Region of the Great Bend of the Wabash River watershed.

Animal	2005 Population Observation (per 1000 hrs of observation)
Coyote	21
Squirrel	650
Opossum	12
Rabbit	42
Raccoon	43
Fox	8
Turkey	158
Geese	487
Duck	219
Deer	947

Source: Plowman, 2006.

2.8.3 Endangered Species

The Indiana Natural Heritage Data Center, part of the Indiana Department of Natural Resources, Division of Nature Preserves, maintains a database documenting the presence of endangered, threatened, or rare species; high quality natural communities; and natural areas in Indiana. The database originated as a tool to document the presence of special species and significant natural areas and to assist with management of said species and areas where high quality ecosystems are present. The database is populated using individual observations which serve as historical documentation or as sightings occur; no systematic surveys occur to maintain the database.

The state of Indiana uses the following definitions to list species:

- *Endangered*: Any species whose prospects for survival or recruitment with the state are in immediate jeopardy and are in danger of disappearing from the state. This includes all species classified as endangered by the federal government which occur in Indiana. Plants currently known to occur on five or fewer sites in the state are considered endangered.

- *Threatened*: Any species likely to become endangered within the foreseeable future. This includes all species classified as threatened by the federal government which occur in Indiana. Plants currently known to occur on six to ten sites in the state are considered threatened.
- *Rare*: Plants and insects currently known to occur on eleven to twenty sites.

Appendix D details the database results for the Region of the Great Bend of the Wabash River watershed. Additionally, county-based listings for those counties which occur within this watershed are also included in Appendix D.

In total, 225 observations of special species and/or high quality natural communities occurred within the Region of the Great Bend of the Wabash River watershed (Figure 30). Of these observations, nine federally listed species have historically been observed in the watershed. These listings include seven mussel species, one mammal, and one bird including the following federally threatened species: eastern fanshell pearly mussel, clubshell, scaleshell, ring pink, rough pigtoe, tubercled blossom, white wartyback, Indiana bat, and bald eagle. The local community prioritizes preservation of habitat for these species and especially identifies with the bald eagle. Individuals are concerned that not enough effort is being made to maintain habitat for these species.

On a state listing basis, 44 species which are listed in the Natural Heritage Database as state endangered have been observed within the Region of the Great Bend of the Wabash River including:

- Mussels: rough pigtoe, white wartyback, eastern fanshell pearlymussel, clubshell, pyramid pigtoe, tubercled blossom, sheepnose, snuffbox, and rabbitsfoot;
- Reptiles: eastern massasauga, Blanding's turtle, and smooth green snake;
- Fish: channel darter;
- Insects - regal fritillary, rove beetle, and earwig scorpionfly;
- Birds: cerulean warbler, henslow sparrow, king rail, loggerhead shrike, peregrine falcon, Canada burnet, bald eagle, barn owl, black-crowned night-heron, least bittern, short-eared owl, upland sandpiper, and American bittern;
- Mammals: evening bat, Indiana bat, and Franklin's ground squirrel; and
- Vascular plants: Hill's thistle, kitten tails, longsolid, pitcher's stitchwort, plains muhlenbergia, shaggy false-gromwell, cyperus-like sedge, heavy sedge, least grape-fern, Louisiana broomrape, narrow-leaf puccoon, sword bogmat, and wild hyacinth.

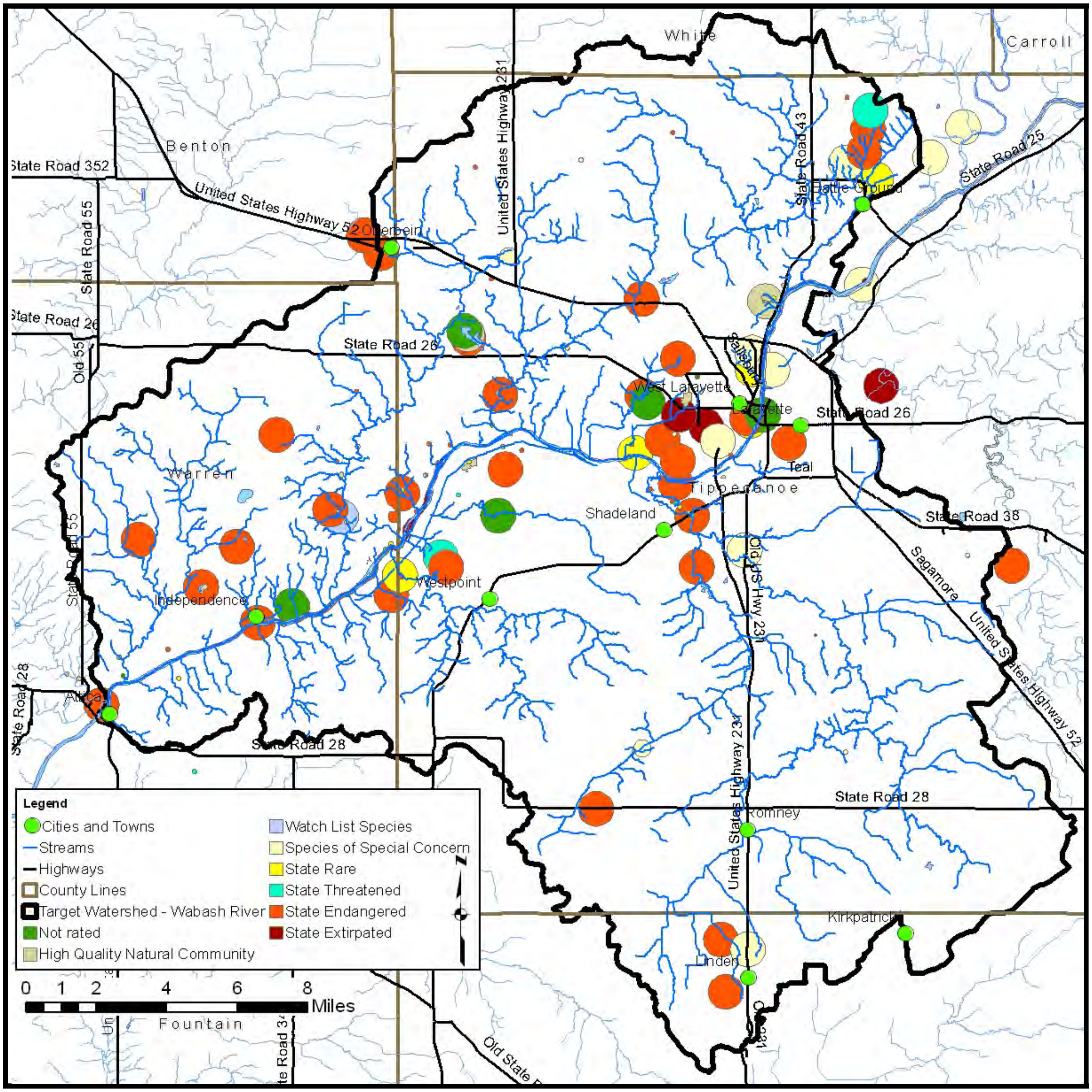

Figure 30. Locations of special species and high quality natural areas observed in the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix D.
Note: Polygons reflect locational uncertainty associated with reported observations. A small circle indicates that there is less uncertainty of where the observation is mapped in relation to its real world location. A large circle reflects more uncertainty. Fish and mussels locations are mapped as linear polygon typically following river and stream stretches based on observational records along that stretch of the stream (R. Hellmich, personal communication March 3, 2009).

An EPA study of Elliot Ditch found 5 species of federally endangered mussels, two of which, ring pink and fanshell, are not included on the IDNR list of known species in the county. They also encountered the federally endangered bluebreast darter (*Etheostoma camurum*) in Elliot Ditch, which is not included on the IDNR list (USEPA, 2008).

Finally, five species are listed in the Heritage Database as state extirpated. These include two mussels, ring pink and scaleshell, and four vascular plant species, few-flowered scurf-pea, small enchanter's nightshade, long-leaved panic grass, and bog bluegrass. This listing indicates that these species no longer occur within Indiana.

Habitat preferences for the state and federally listed species vary. For instance, the mussel and fish species prefer slow flowing, relatively clear water but can exist in waters of slightly poorer water quality. All of the fish and mussel observations included in the Heritage Database occurred within the Wabash River, which offers high mussel diversity. Additional observations occurred within Elliot Ditch during a USEPA assessment, which suggests that Elliot Ditch and Wea Creek also provide mussel habitat. Mussels feed by filtering water and are sensitive to impurities in the water or increases in water temperature. They also require specific fish species in order for reproduction cycles to occur. Warm water temperatures, high turbidity, and loss of habitat can all impact fish and mussel diversity. Deforestation or forest fragmentation likely affect the bald eagle, peregrine falcon, and evening and Indiana bat species. These species require large hunting areas where dense forests are present and small stream corridors with well developed riparian forests. The elimination of these habitats could result in the loss of roost and hunting habitat thus eliminating these species. Other listed species, including Franklin's ground squirrel, eastern massasauga, smooth green snake, and several bird and vascular plant species rely on prairie habitat. Many live on the border between forested and prairie habitats hunting in one habitat and nesting in the other. The conversion of prairies and forests to agricultural and urban land uses could have resulted in the decline in these populations. Other plant and bird species are found in wetland habitats. Again, the fragmentation and loss of wetland habitat likely impacted the diversity and density of these listed species.

2.8.4 Exotic and Invasive Species

Exotic and invasive species are prevalent throughout the state of Indiana. Their presence throughout the watershed and their potential impacts on high quality natural communities and regional species are of concern to stakeholders. Individuals are especially concerned about the prevalence of garlic mustard and honeysuckle species, reproducing populations of grass carp, and the long-term impacts of zebra mussels and Asian carp on the Wabash River. Many species impact portions of the Region of the Great Bend of the Wabash River watershed. Exotic species are defined as non-native species, while invasive species are those species whose introduction can cause environmental or economic harm and/or harm to human health. Thousands of dollars are spent annually controlling exotic and/or invasive species populations within both publicly-owned natural areas and on privately-owned land. While this section is current as of the plan's publication, the threat of exotic and invasive species is continuously evolving. Therefore, new species or treatment methods may be available since the publication of the plan. Table 15 lists exotic species observed within the counties which comprise the watershed. Additionally, specific areas where species have been observed or those species that are of special concern within the watershed are noted in Appendix E.

Table 15. Observed exotic and/or invasive species by county within the Region of the Great Bend of the Wabash River watershed.

Species	Benton	Fountain	Mont.	Tippe.	Warren	White
Plant Species						
Asian bush honeysuckle	X	X	X	X	X	X
Autumn olive	X	X	X	X	X	X
Bicolor lespedeza		X				
Black locust		X		X	X	
Buckthorn			X	X		
Canada thistle	X	X	X	X	X	X
Chinese lespedeza		X	X			
Chinese yam				X		
Common reed	X	X		X	X	X
Creeping Charlie	X	X	X	X	X	X
Creeping Jenny	X	X	X	X	X	X
Crown vetch	X	X	X	X	X	X
Dame's rocket	X	X	X	X	X	X
Garlic mustard	X	X	X	X	X	X
Japanese hedge parsley			X	X		
Japanese honeysuckle	X	X	X	X	X	X
Japanese knotweed	X	X		X		
Mulitflora rose	X	X	X	X	X	X
Norway maple	X	X	X	X		X
Oriental bittersweet						X
Periwinkle	X	X	X	X	X	X
Privet		X	X	X	X	X
Purple loosestrife						X
Purple winter creeper	X	X	X	X	X	X
Reed canary grass	X	X	X	X	X	X
Russian olive				X		
Siberian elm	X	X	X	X	X	X
Smooth brome	X	X	X	X	X	X
Spotted knapweed		X		X		
Star-of-Bethlehem	X	X	X	X	X	X
Sweet clover	X	X	X	X	X	X
Tall fescue	X	X	X	X	X	X
Tree of heaven	X	X	X	X	X	X
White mulberry	X	X	X	X	X	X
Winged burning bush				X		
Fish and Mussel Species						
Silver carp		X		X	X	
Bighead carp		X		X	X	
Grass carp		X		X	X	
Common carp		X		X	X	
Zebra mussel		X		X	X	

Source: Bledsoe, 2009; Fisher et al., 1998.

2.8.5 Recreational Resources and Significant Natural Areas

A variety of recreational opportunities and natural areas exist within the Region of the Great Bend of the Wabash River watershed. Recreational opportunities include parks, nature preserves, fair grounds, recreational facilities, golf courses, and school and university-owned properties (Figure 31).

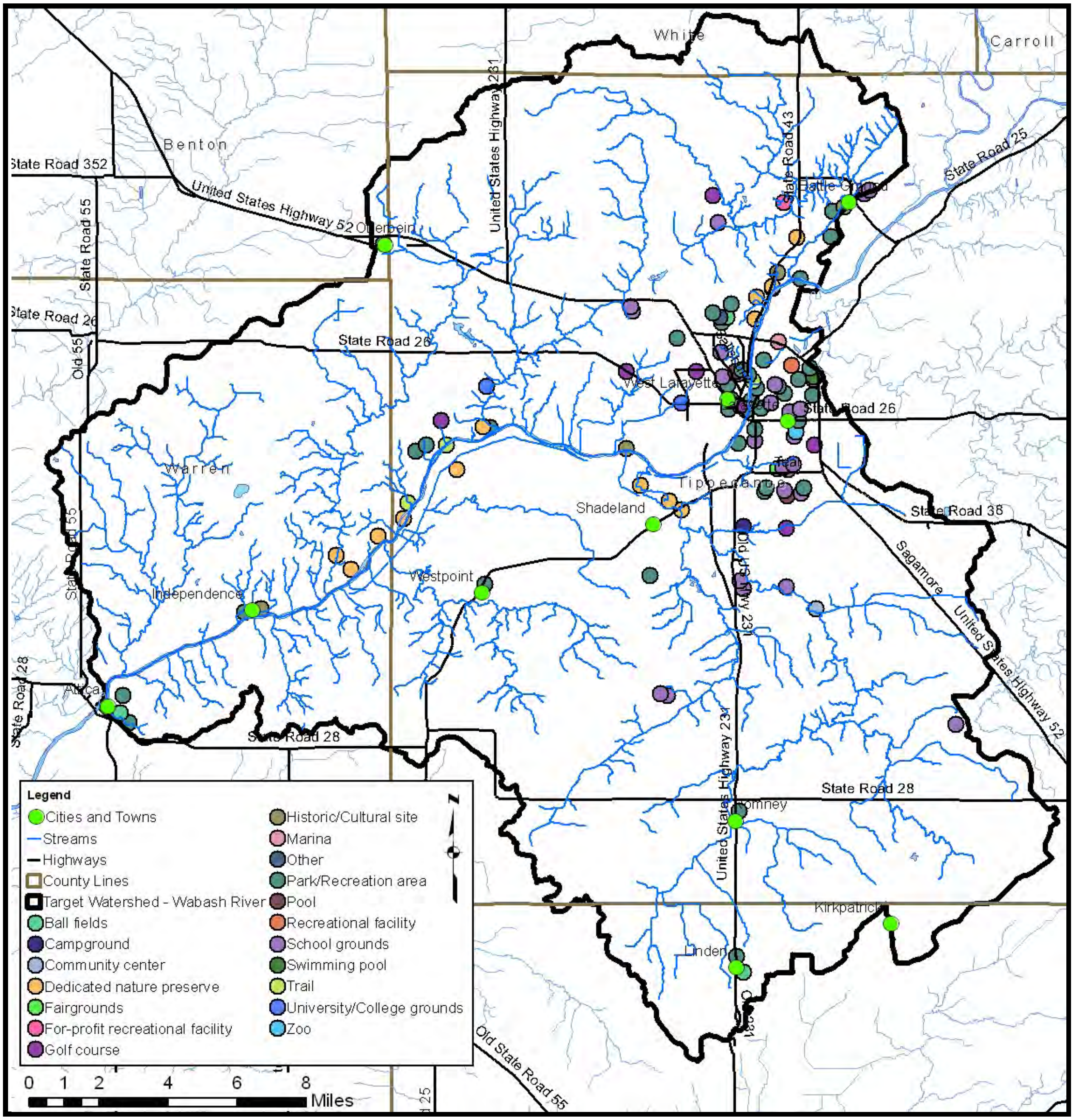

Figure 31. Recreational opportunities and natural areas in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

The cities of Lafayette, West Lafayette, and Attica all maintain multiple park-based facilities. In the cases of Lafayette and West Lafayette, maintenance and upkeep of these facilities occurs through each city's park department. Properties throughout the watershed are also owned and maintained by Tippecanoe County through the Tippecanoe Parks Department, the state of Indiana, The Nature Conservancy, and NICHES Land Trust. Purdue University also maintains significant portions of the watershed as both privately-maintained and publicly-usable facilities. Additionally, many festivals and events occur as part of the cultural and ecological experience within the Region of the Great Bend of the Wabash River watershed.

2.9 Land Use

Water quality is greatly influenced by land use both past and present. Different land uses contribute different contaminants to surface waters. As water flows across agricultural lands it can pick up pesticides, fertilizers, nutrients, sediment, pathogens, and manure, to name a few. However, when water flows across parking lots or from roof tops it not only picks up motor oil, grease, transmission fluid, sediment, and nutrients, but it reaches a waterbody faster than water flowing over natural or agricultural land. Hard or impervious surfaces present in parking lots or on rooftops create a barrier between surface and groundwater. This barrier limits the infiltration of surface water into the groundwater system resulting in increased rates of transport from the point of impact on the land to the nearest waterbody. A review of the historic land types present in the watershed will provide an idea of the types of restoration that could occur within the watershed and also a basis for the past uses of the land.

2.9.1 Historic Land Use

The Region of the Great Bend of the Wabash River watershed is replete with historical significance. When the area was settled, three main tribes of Indians remained - the Potawatomi, the Shawnee, and the Miami. The Potawatomi's covered much of the northeastern portion of the watershed, while the Wea, a branch of the Miami, covered the central portion of the watershed and the Shawnee occupied southern portions of the watershed. French records indicate that settlement of the watershed occurred as early at 1719 in the form of Post Ouiatenon, which was to later become Fort Ouiatenon (DeHart, 1909). Another historically significant location within the watershed includes the Battle Field and Prophet's Rock near Battle Ground. A major skirmish occurred at this site between William Henry Harrison and the remaining Indians formerly led by Tecumseh and the Prophet. The battle occurred on the banks of Burnett Creek and was one of the bloodiest battles recorded in Indian history.

During its early days, the watershed was described as being resplendent with large trees and prairies as far as the eye could see. Coulter (1886) described the region as part of the prairie region. Black and white walnut; black, white, and bur oak; white ash; pignut, bitternut, shagbark, and scale bark hickory; wild cherry, sugar maple; and beech were the most common trees (DeHart, 1909). Willow, dogwood, hazelnut, crabapple, plum, pawpaw, buckeye, sassafras, redbud, and mulberry were also prevalent. Coulter (1886) described the low water mark of the Wabash River as being 504 feet above sea level and detailed the numerous clear, cold streams and springs which carried water to the Wabash River.

The first permanent settlement occurred within the watershed in Tippecanoe County in the 1820s. Peter Weaver is recognized as the first settler, creating a homestead on the southern end of the Wea Plains. Several others followed and by 1826 Tippecanoe County was incorporated. Platting of several watershed towns soon followed with Lafayette platted in 1825, Romney in 1831, West Point in 1833, Granville in 1834, Montmorenci in 1838, Clark's Hill in 1850, Chauncey (now West Lafayette) in 1855, and Battle Ground platted in 1858. Purdue University was founded in 1869 on a tract of 100 acres near Chauncey. The campus was subsequently enlarged to include 241 acres by 1909. Additionally, the agricultural experimental station was established in 1887 and included 190 acres north and west of

Purdue University's main campus. The Tippecanoe County courthouse was erected between 1881 and 1884 with development of the current downtown area occurring over the next several years. Industry soon moved into the watershed with the Lafayette Box-Board and Paper Company being one of the largest enterprises of its day (1902) in the area. By 1905, eighty factories operated within Lafayette and by 1909, the city was home to 23,000 individuals, contained 4.2 miles of asphalt and 2.5 miles of brick streets, 1.4 miles of sanitary sewers, 13 hotels, 34 churches, and 2 public parks (DeHart, 1909). Over the past 100 years, development within Lafayette, Tippecanoe County, and the Region of the Great Bend of the Wabash River watershed continued.

2.9.2 Current Land Use

In 2001, agricultural land uses dominated the Region of the Great Bend of the Wabash River watershed (Figure 32; Table 16). In total 75% of the watershed is covered by agricultural row crop or pasture. Forested lands and wetlands account for 14.4% of the watershed land use, while urban land uses, including urban open space and low, medium, and high intensity developed areas, account for 11.6% of the watershed. Definitions for each land cover type are included in Appendix F.

Table 16. Detailed land use in the Region of the Great Bend of the Wabash River watershed. Source: USGS, 2001.

Classification	Area (acres)	Percent of Watershed
Cultivated Crops	206,103.9	67.3%
Deciduous Forest	37,445.2	12.2%
Pasture/Hay	20,799.3	6.8%
Open Space (urban)	16,641.1	5.4%
Low Intensity Developed	12,442.6	4.1%
Medium Intensity Developed	3,881.1	1.3%
Grassland/Herbaceous	3,255.5	1.1%
High Intensity Developed	2,373.4	0.8%
Open Water	2,328.3	0.8%
Woody Wetland	889.4	0.3%
Barren Land	229.6	0.1%
Evergreen Forest	44.7	<0.1%
Emergent/Herbaceous Wetland	15.3	<0.1%
Shrub/Scrub Wetland	3.9	<0.1%
Total	**306,453.2**	100%

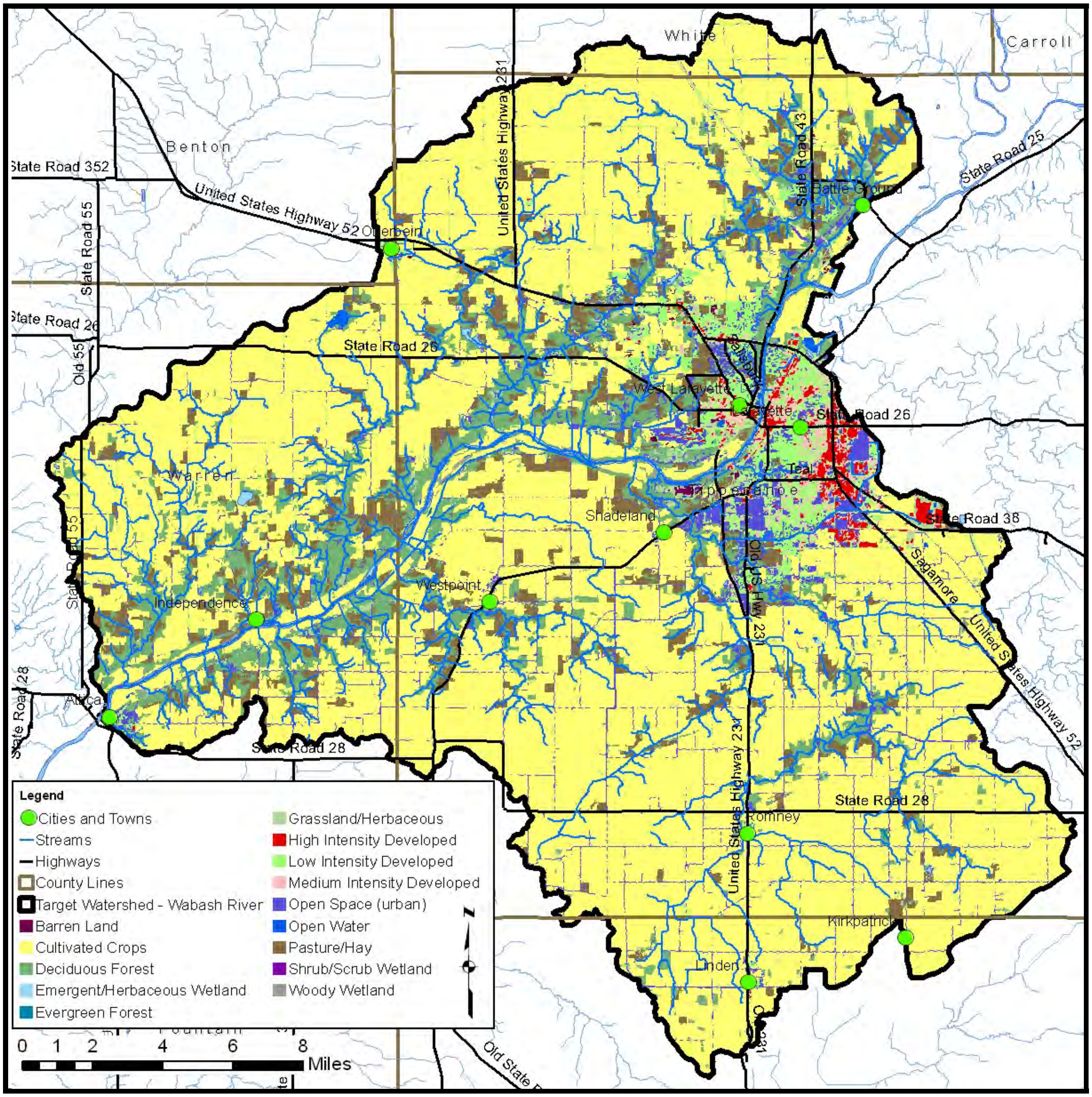

Figure 32. Land use in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.9.3 Agricultural Land Use

Individuals are concerned about the impact of agricultural practices on water quality. Specifically, the volume of exposed soil entering adjacent waterbodies, the prevalence of tiled fields and thus the transport of chemicals into waterbodies, the use of agricultural chemicals, and the volume of manure applied via small animal farms and through confined animal feeding operations are concerning to local residents. Each of these issues will be discussed in further detail below. These concerns are especially important as according to the 2001 land classification effort, nearly 75% of the watershed is used for agricultural purposes. According to USDA data from 2004, cultivated areas cover approximately 95% of the watershed with a majority of cultivation occurring in densities of 75% or greater (Table 17; Figure 33).

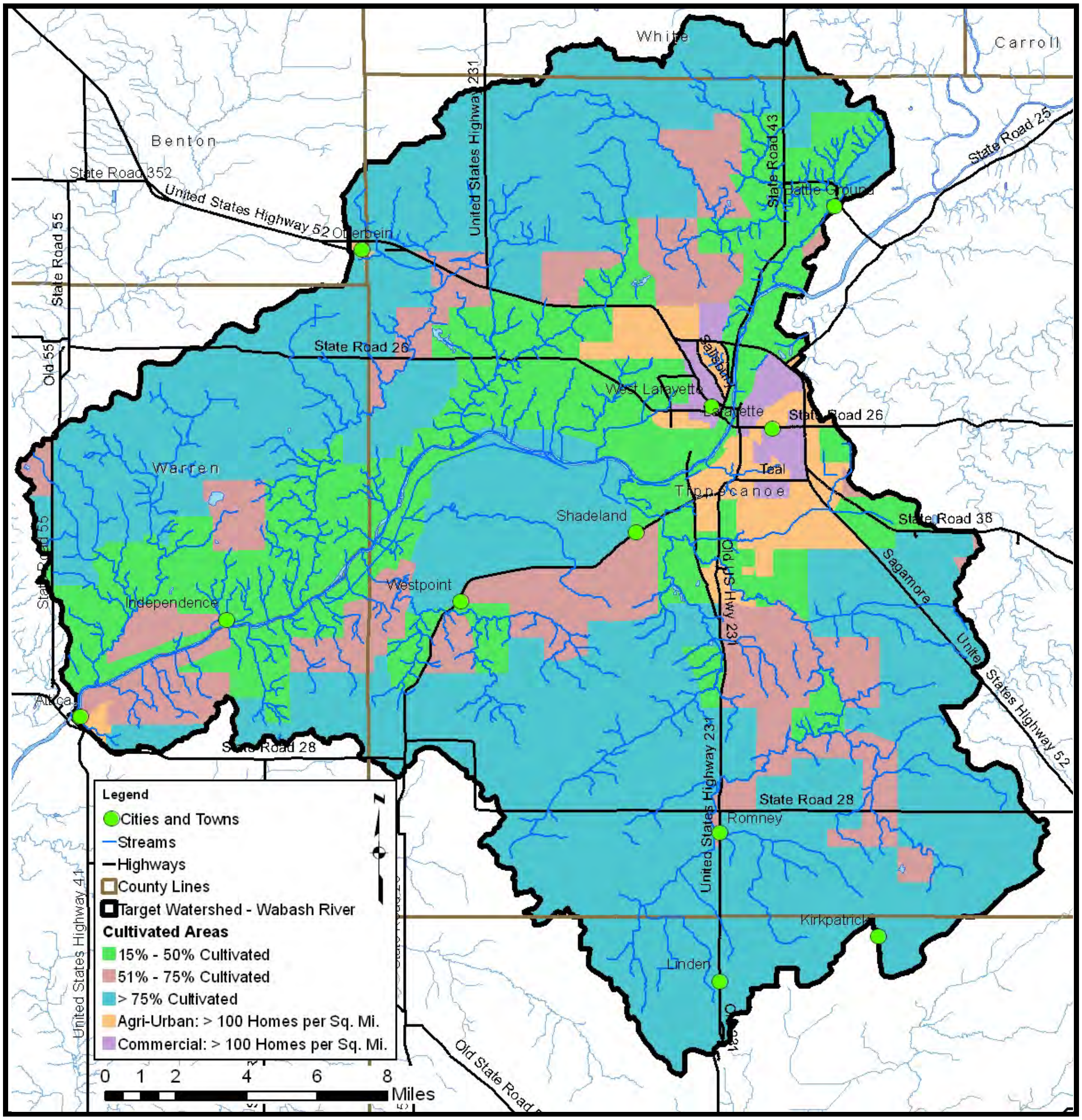

Figure 33. Cultivation density and type (2004) within the Region of the Great Bend of the Wabash River watershed.

Data used to create this map are detailed in Appendix A.

Table 17. Cultivation density and type within the Region of the Great Bend of the Wabash River watershed.

Cultivation Type and Density	Area (acres)	Percent of Watershed
15% - 50% Cultivated	69,977.6	22.8%
51% - 75% Cultivated	44,454.7	14.5%
> 75% Cultivated	175,259.1	57.2%
Agri-Urban: > 100 Homes per Sq. Mi.	12,152.8	4.0%
Commercial: > 100 Homes per Sq. Mi.	4,609.0	1.5%
Total	**306,453.2**	**100.0%**

Of the areas that are cultivated, corn and soybean production dominates crop production (Table 18; Figure 34). In total, corn production accounted for 32% of land cover in 2006, while soybeans accounted for 28% of land cover. Non-agricultural uses, such as woodland and urban areas, covered an additional 28% of the watershed. Grasses and clover, small grains, alfalfa, winter wheat, and other crops covered the remaining crop production lands.

Table 18. Crop type in the Region of the Great Bend of the Wabash River based on aerial photograph interpretation.

Crop	Total Acreage	Percent of Watershed
Corn	96,706.8	31.6%
Soybeans	87,046.9	28.4%
Non-agricultural grass	55,620.6	18.1%
Woodland	29,272.4	9.6%
Developed	14,809.2	4.8%
Grass/Clover	5,531.6	1.8%
Other small grains	5,059.5	1.7%
Alfalfa	3,929.3	1.3%
Water	2,768.3	0.9%
Winter wheat	2,292.7	0.7%
Fallow	2,045.8	0.7%
Winter wheat-soybeans	743.1	0.2%
Other crop	538.5	0.2%
Wetlands	87.6	<0.1%
Unknown	0.8	<0.1%
Total	**306,453.2**	**100.0%**

Source: NASS, 2006.

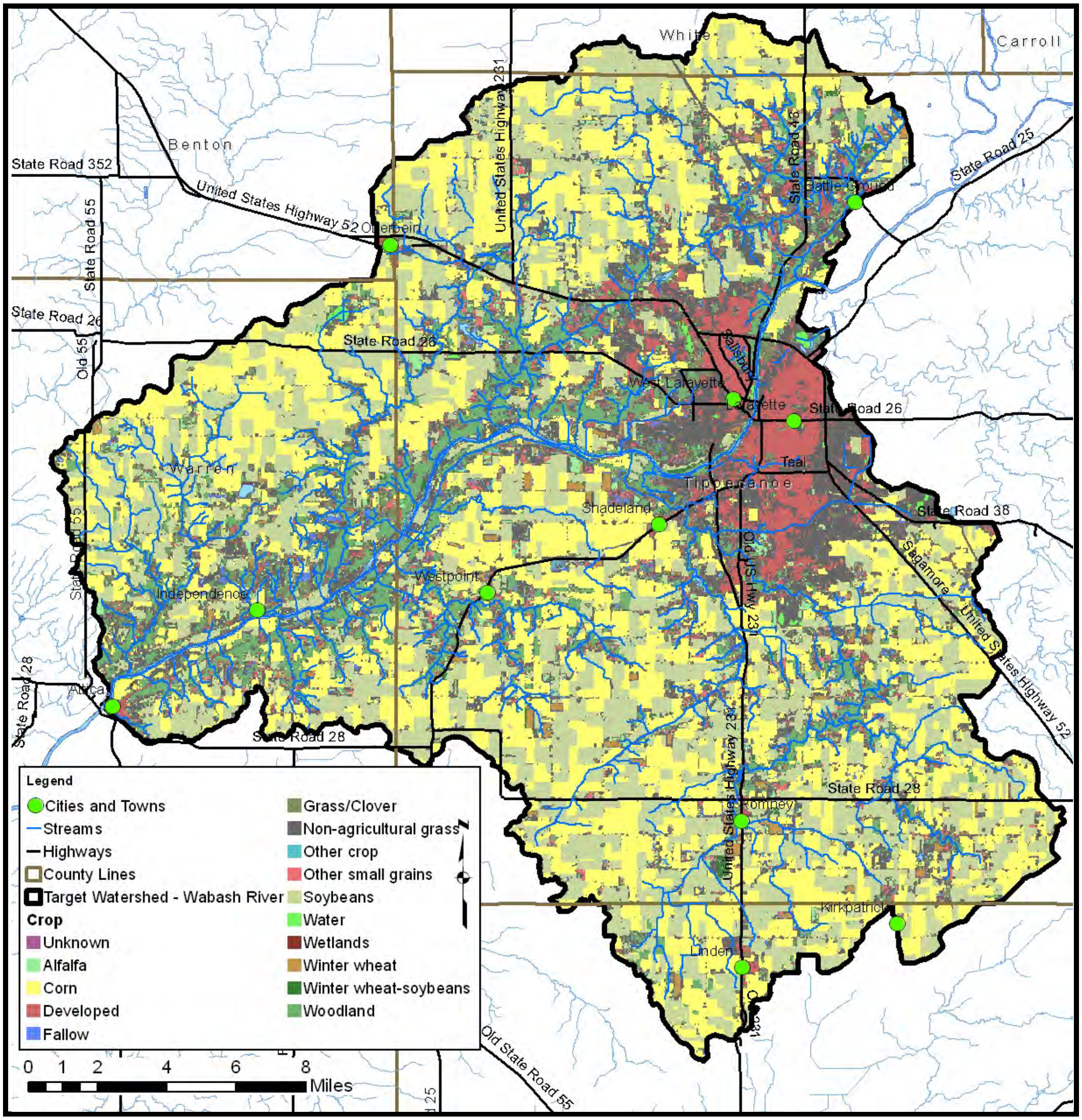

Figure 34. Crop type (2006) in the Region of the Great Bend of the Wabash River. Data used to create this map are detailed in Appendix A.

According to the 2007 Census of Agriculture, Tippecanoe County ranks in the top 20 statewide for corn and soybean production, while Warren County ranks 13th for corn and 16th for grain production and Fountain County ranks in the 30s for corn, soybean, and wheat production. Most farms within the watershed undergo a corn-soybean rotation with some including a corn-soybean-wheat rotation. According to the 2007 survey, conservation tillage practices within the three main counties which comprise the Region of the Great Bend of the Wabash River are on par or a little below the median for the state of Indiana (Table 19).

Table 19. Tillage practices in the Region of the Great Bend of the Wabash River watershed.

Crop	Conventional Tillage	Reduced Till	Mulch Till	No Till	No Till Acreage	Total Acreage
Corn						
Fountain	45%	15%	6%	34%	35,466	103,770
Tippecanoe	41%	33%	6%	20%	21,711	108,557
Warren	18%	45%	32%	5%	4,654	102,003
Soybeans						
Fountain	2%	4%	15%	79%	66,115	83,191
Tippecanoe	4%	12%	13%	70%	54,116	77,124
Warren	1%	4%	36%	60%	39,948	66,321

Source: ISDA, 2007.

Agricultural Chemical Usage

Agricultural herbicides, pesticides, and fertilizers are commonly applied to row crops in Indiana. These chemicals can be carried into adjacent waterbodies through surface runoff and via tile drainage. This is especially an issue if a storm occurs prior to the chemicals being broken down and used by the crops.

Data for chemical usage on an individual county or watershed level are not currently collected. Rather, data is collected for the state as a whole in two forms. First, the National Agricultural Statistics Survey (NASS) collects information on chemical usage, number of applications per year, type of chemical applied, number of applications per year, and the application rate. These data were last collected in 2006 (NASS, 2006). Additionally, NASS collects farmland data for the number of acres in agricultural production by type (i.e. corn, soybeans, grains) every five years. These data were last collected in 2007 (NASS, 2007). The acreage of cropland in the watershed was estimated (Table 20) using 2005 cropland cover data.

These data indicate that corn and soybeans are the two primary crops grown in Fountain, Tippecanoe, and Warren counties. Fertilizers are more typically applied to corn than to soybeans. This occurs due to soybeans acting as nitrogen fixers, which means that they pull the nitrogen that they need from the atmosphere then convert it into a form which they can use. Corn does not fix nitrogen; therefore nitrogen needs to be applied. Nitrogen is typically applied twice in Indiana – once at or before planting and a second time when corn reaches approximately one foot in height (NASS, 2007) Agricultural data indicate that corn receives 98% of the nitrogen applied in the state and 87% of the phosphorus (Table 20). For these reasons, nutrient calculations were only completed for corn as applications to soybeans are likely negligible. Based on these data, it is estimated that 14.2 million pounds of nitrogen and 7.1 million pounds of phosphorus are applied annually within the Region of the Great Bend of the Wabash River watershed.

Table 20. Agricultural chemical usage for corn in the Region of the Great Bend of the Wabash River watershed.

Nutrient	Acres of Corn	% of Area Applied	Applications (#/year)	Rate/Application (lb/acre)	Total Applied/ Year (Mil Lb)
Nitrogen	96,660	100	2.2	67	14.2
Phosphorus	96,660	93	1.4	56	7.1

Source: NASS, 2005.

Herbicides and pesticides are also used on crops grown in Indiana. The Office of the Indiana State Chemist indicates that the two predominant active ingredients applied are atrazine and glyphosate. Atrazine is applied as a corn herbicide, while glyphosate is a soybean herbicide. NASS indicates that in 2005, an average of 6,864 pounds of atrazine was applied per acre of corn and 2,950 pounds of glyphosate were applied per acre of soybeans (NASS, 2006). This suggests that nearly 600 million pounds of atrazine and 285 million pounds are applied to cropland in the Region of the Great Bend of the Wabash River watershed (Table 21).

Table 21. Herbicide usage in the Region of the Great Bend of the Wabash River watershed.

Crop	Acres	Application Rate (lb/ac)	Total Applied (million lbs)	Total Applied (tons)
Soybeans	87,047	6,864	597.5	298,500
Corn	96,660	2,950	285.2	142,573

Source: NASS, 2005.

Confined Feeding Operations and Hobby Farms

A mixture of small, unregulated and larger, regulated livestock operations (confined feeding operations) are located within the Region of the Great Bend of the Wabash River watershed. Small farms are those which house less than 300 animals, while larger farms that house large numbers of animals for longer than 45 days per year are regulated by the IDEM. These regulations are based on the number and type of animals present. IDEM requires permit applications which document animal housing, manure storage and disposal, and nutrient management plans for farms which maintain 300 or more cows, 600 or more hogs, or 30,000 or more fowl. These facilities are considered confined feeding operations (CFO). There are 19 active confined feeding operations and 420 small, unregulated farms located in the watershed (Figure 35). Nearly 105,000 animals are located on small and regulated farms throughout the watershed. None of the CFOs are large enough to be classified as a concentrated animal feeding operation (CAFO).

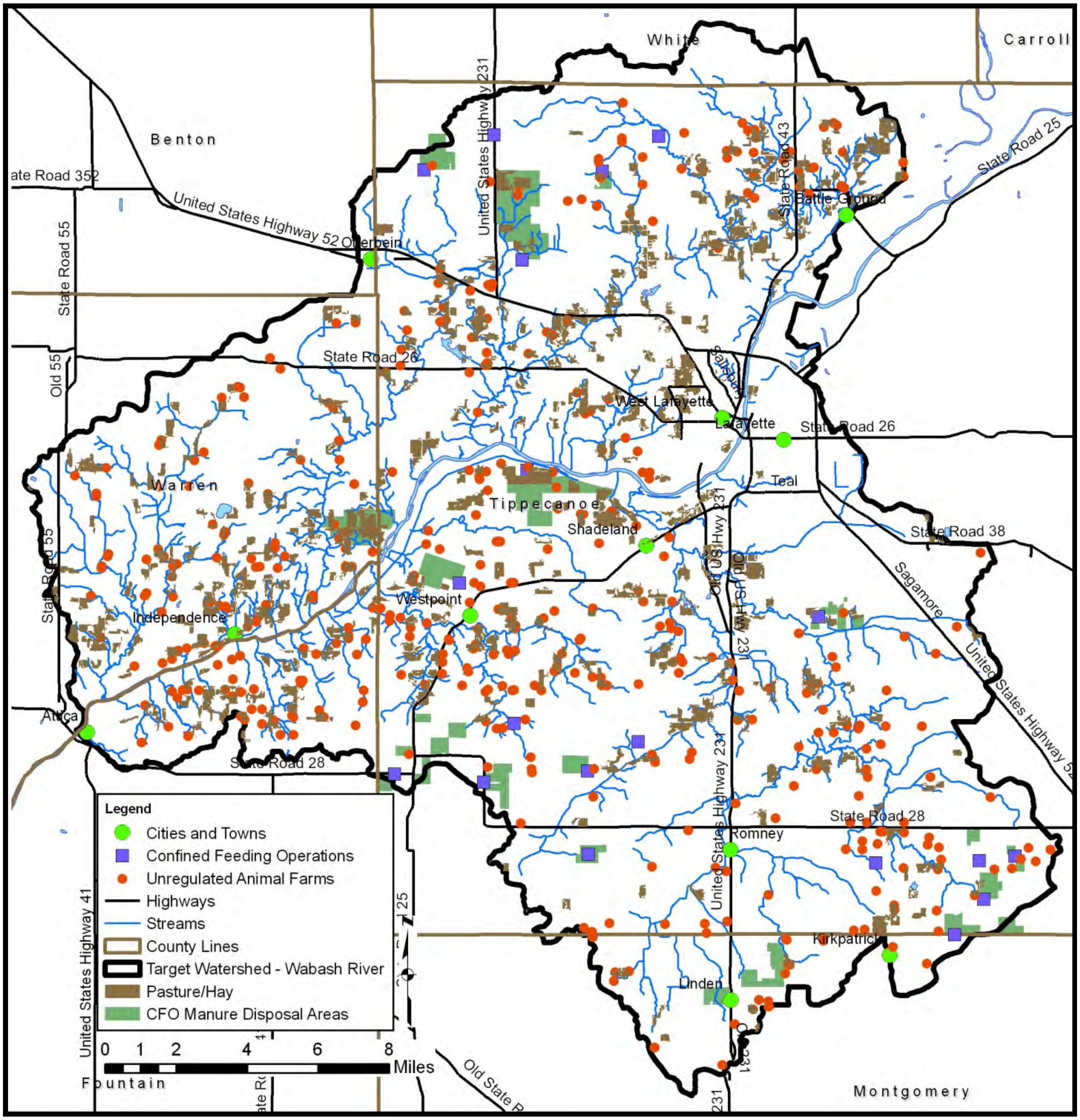

Figure 35. Confined feeding operation and unregulated animal farm locations within the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.9.4 Natural Land Use

Natural land uses including forest, wetlands, and open water cover 14% of the watershed. Individuals are concerned that too much forested land is being lost within the watershed and would like to see reforestation prioritized. Approximately 35,000 acres or 10% of the watershed are covered by trees. Forest cover occurs adjacent to waterbodies throughout the watershed; however, these tracts are not contiguous (Figure 36). However, large lengths of the watershed streams no longer contain intact riparian buffers. Specific areas of concern will be discussed in further detail in subsequent sections.

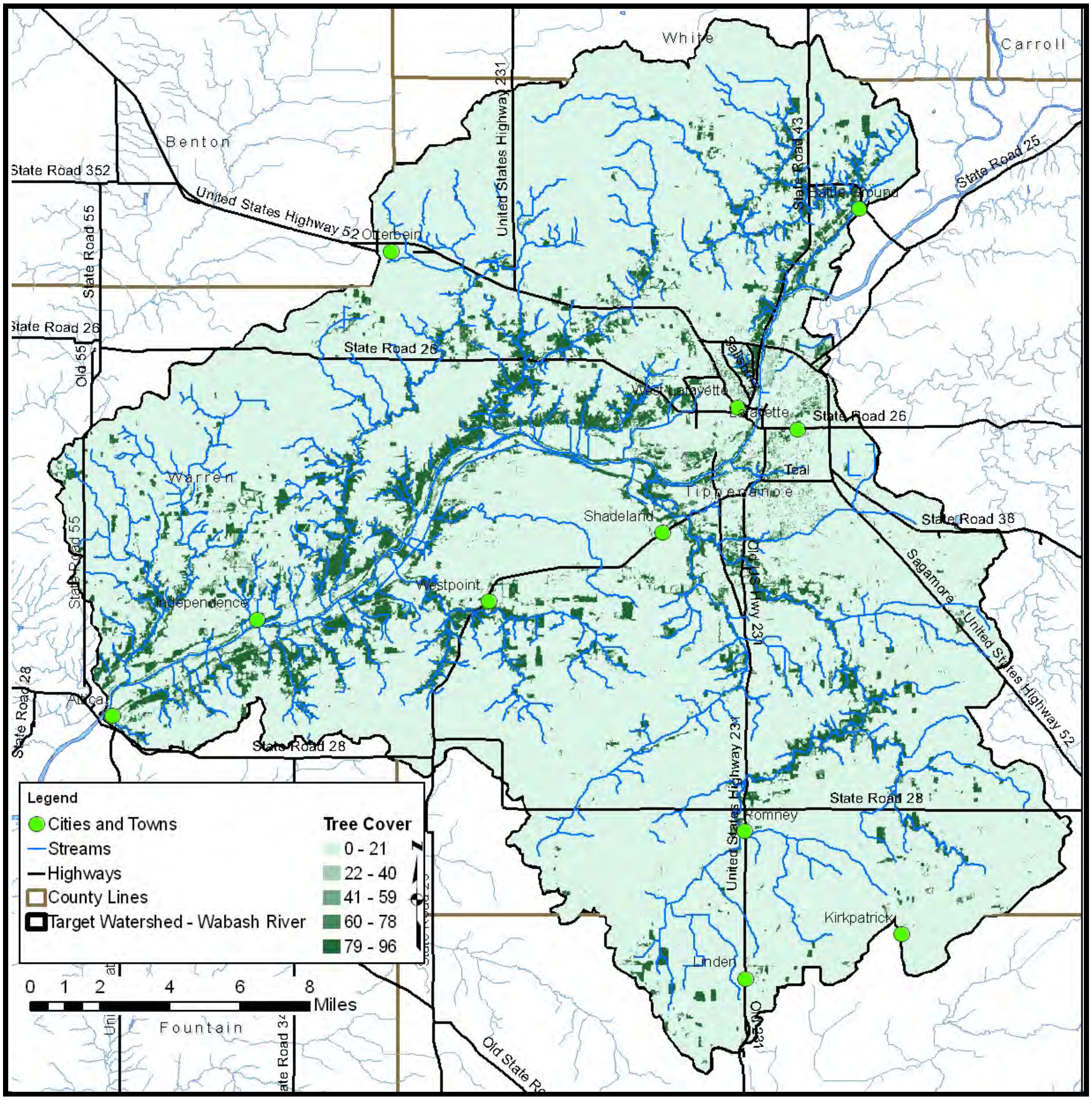

Figure 36. Percent forest cover in the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

2.9.5 Urban Land Use

Urban land uses cover an additional 12% of the watershed (Figure 37). These land uses include low, medium, and high density residential and commercial development and urban grasslands. Many urban land use issues are of concern to stakeholders including: the prevalence of impervious surfaces, which contribute to both the increasingly flashy nature of the Wabash River and sediment transportation to watershed waterbodies; continued urban development and conversion of lands from agricultural to urban uses without restoration of forested and wetland land uses; use of septic systems in areas which are unsuited for high-density residential development and where sewer systems are not yet present; the presence of chemical inputs from previous industrial development and uses; and individual residential landowner's choices with regards to fertilizer, herbicide, and pesticide use, use of phosphorus-free fertilizers, and pet waste removal.

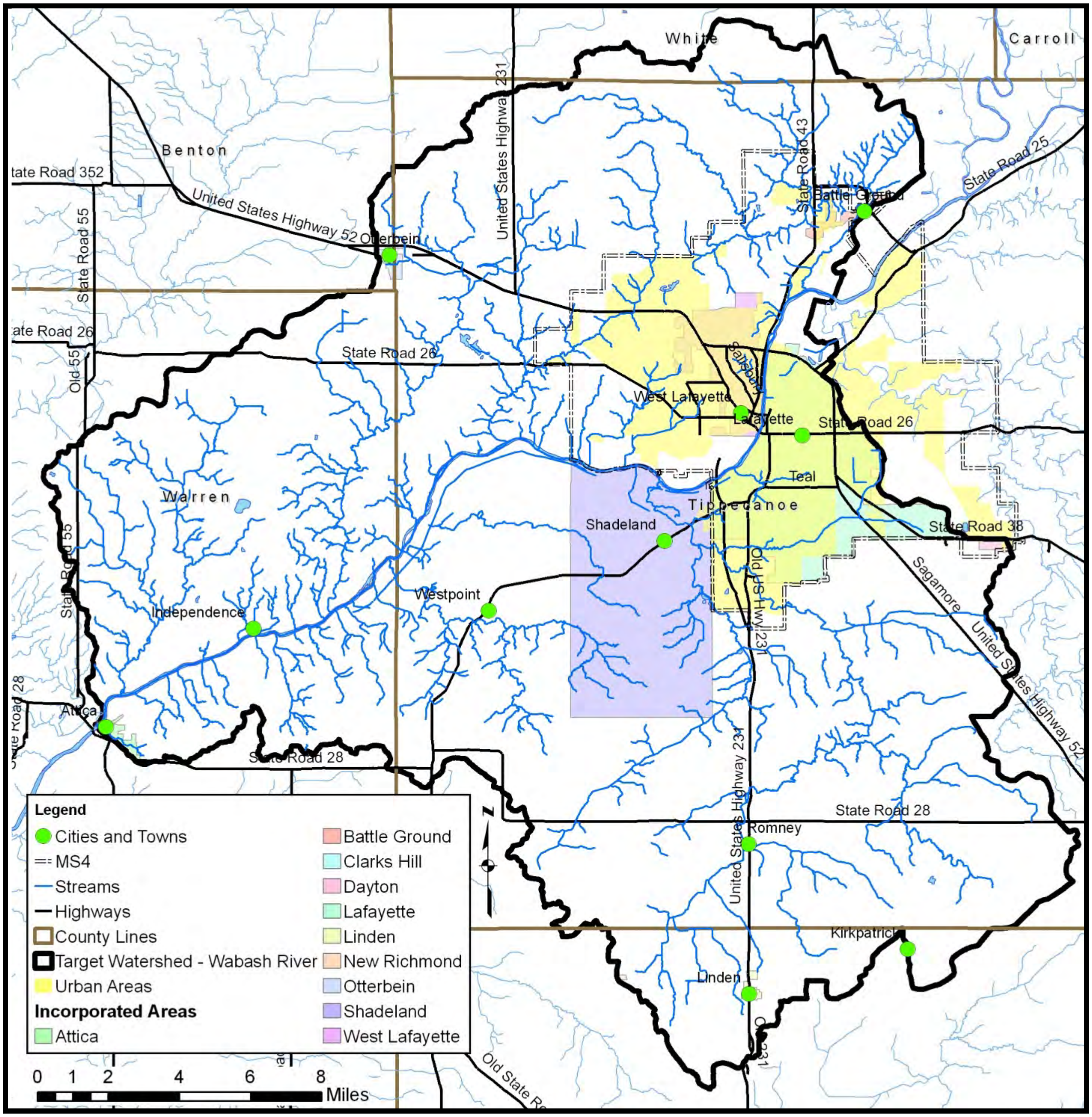

Figure 37. Urban boundaries and incorporated areas within the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

A majority of the urban land is located within the cities of Lafayette and West Lafayette; however, Battle Ground, Otterbein, Linden, New Richmond, Dayton, Romney, Shadeland, Clark's Hill, Attica, and other small towns throughout the watershed also contribute to urban development within the watershed. Incorporated city boundaries and urban areas are displayed in Figure 37 as is the boundary for the municipal separate storm sewer system (MS4). The MS4 boundary is designated by IDEM and includes seven entities: Tippecanoe

County, Purdue University, Ivy Tech-Lafayette, Lafayette, West Lafayette, Battle Ground, and Dayton. The seven entities formed a partnership, the Tippecanoe Partnership for Water Quality (TCPWQ) to work on stormwater issues within the MS4. Details on the MS4 and their efforts will be included in the *Planning Efforts in the Watershed* section.

Impervious Surfaces

Impervious surfaces are hard surfaces which limit surface water from infiltrating into the land surface to become groundwater thereby creating high overland flow rates. Hard surfaces include concrete, asphalt, compacted soils, rooftops, and buildings or structures. In developed areas like Lafayette and West Lafayette, land which was once permeable has been covered by hard, impervious surfaces. This results in rain which once absorbed into the surface running off of rooftops and over pavement to enter the Wabash River with not only higher velocity but also higher quantities of pollutants. Figure 38 displays the impervious surface cover density within the Region of the Great Bend of the Wabash River.

Overall, much of the watershed is covered by low levels of impervious surfaces; however, high impervious densities are present in Lafayette and West Lafayette with lower densities occurring within smaller towns and along roads throughout the watershed. Estimates indicate that nearly 3,000 acres (<1%) of the watershed are 75% or more covered by hard surfaces, while 21,665 acres (7%) of the watershed are 10% or more covered by hard surfaces. Elvidge et al. (2004) indicated that streams in watersheds with greater than 10% impervious surfaces clearly exhibited degradation. The Center for Watershed Protection (CWP) identified similar impacts from impervious surface density on water quality. The CWP study indicates that stream ecology degradation begins with only 10% impervious cover in a watershed. Higher impervious surface coverage results in further impairments including water quality problems, increased bacteria concentrations, higher levels of toxic chemicals, high temperatures, and lower dissolved oxygen concentrations (CWP, 2003). Area of high impervious surface density (>10%) within the watershed should be considered as a factor during implementation.

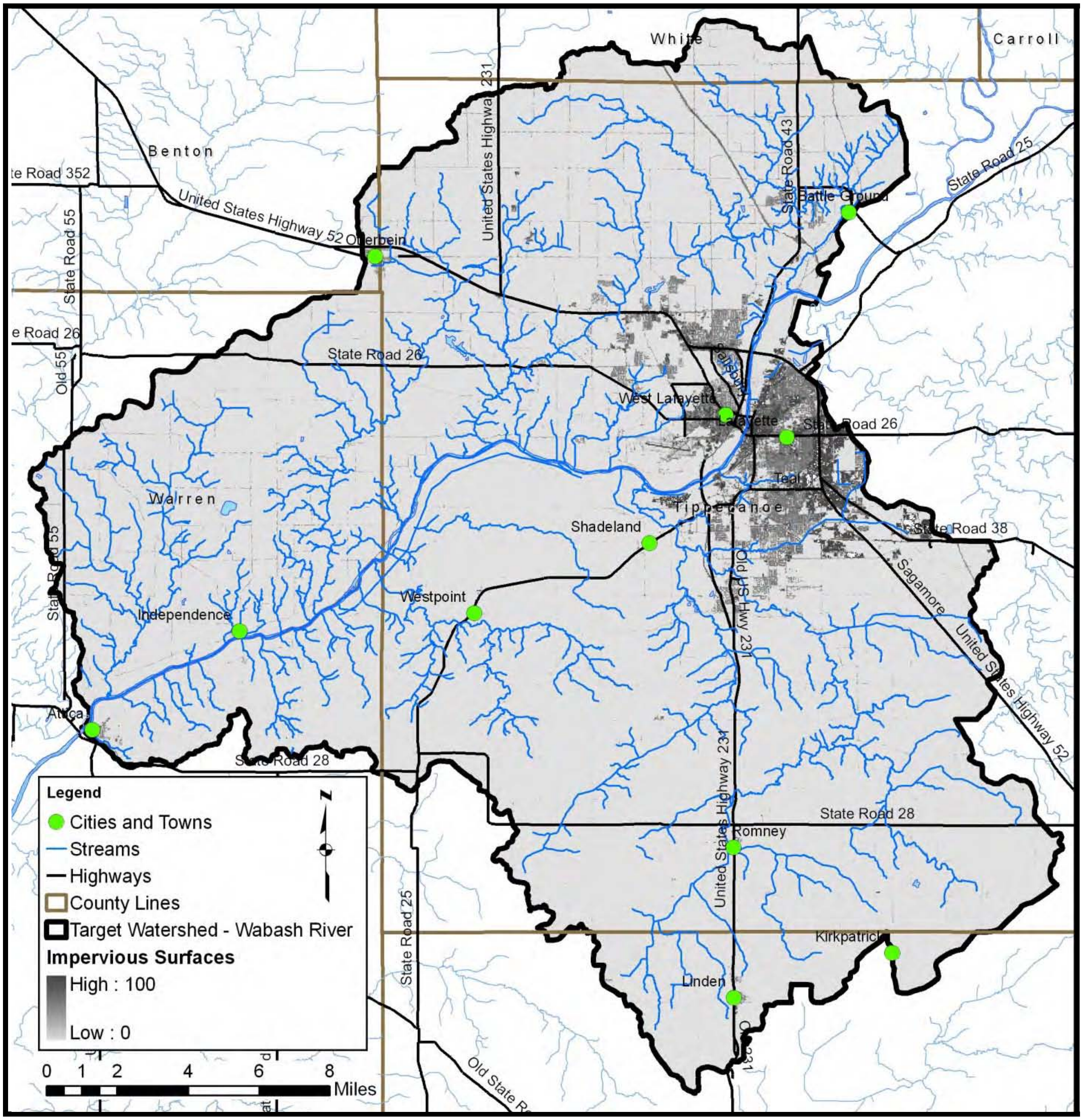

Figure 38. Impervious surface density within the Region of the Great Bend of the Wabash River watershed. Data used to create this map are detailed in Appendix A.

Remediation Sites

Remediation sites including industrial waste, leaking underground storage tanks (LUST), open dumps, brownfields, and one superfund site are present throughout the Region of the Great Bend of the Wabash River watershed (Figure 39). Most of these sites are located within the urban areas around Lafayette, West Lafayette, and Attica. These facilities are representative of the industrial history of the region. In total, 43 industrial waste sites, 129 LUST facilities, three open dumps, and 12 brownfields are present within the watershed.

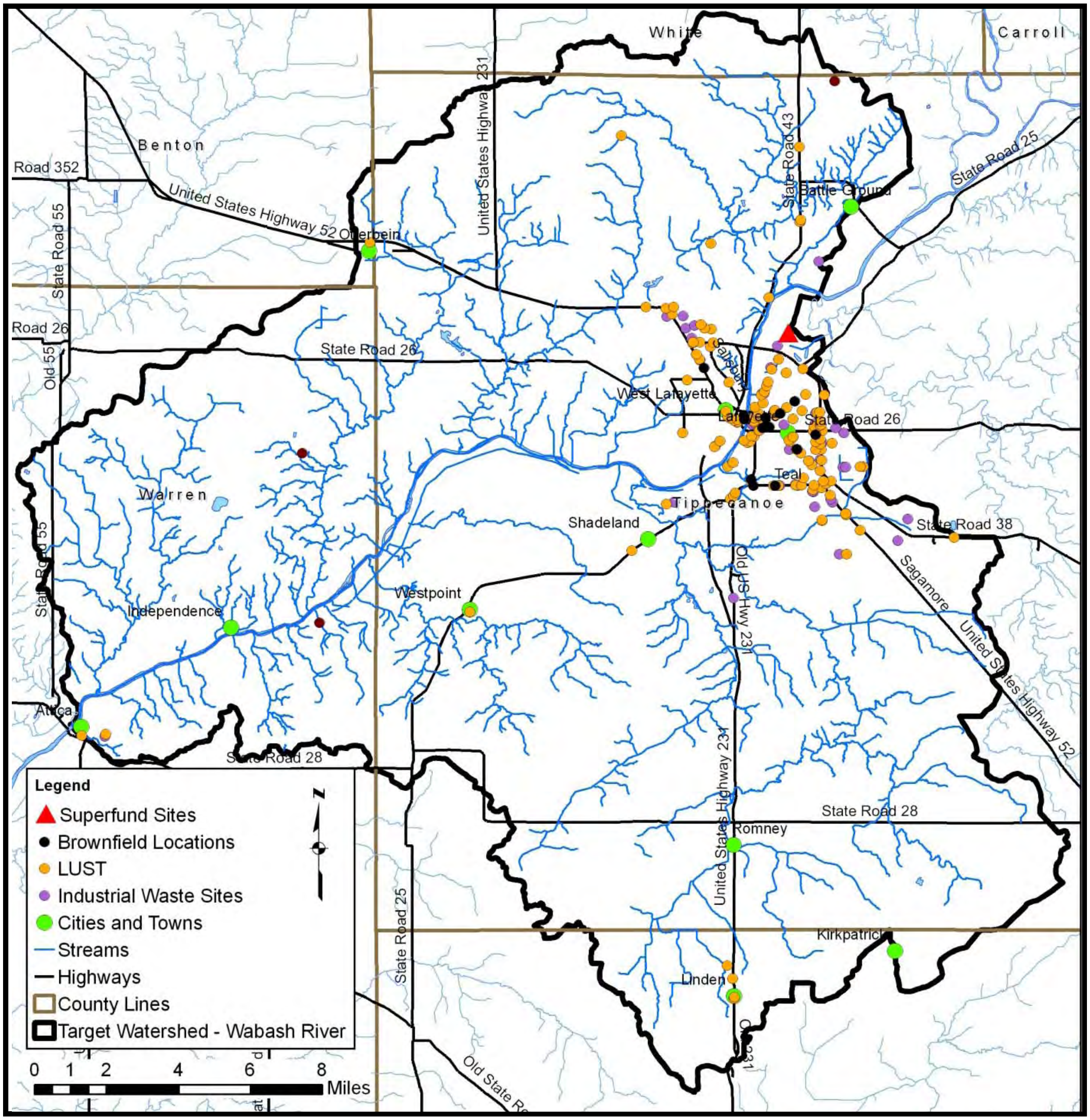

Figure 39. Industrial remediation and waste sites within the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

One superfund site (red triangle), the Tippecanoe Sanitary Landfill, is present in the watershed. Superfund sites are those sites which contain hazardous substances that may endanger public health or the environment and that the USEPA is providing money for clean up. Since 1971, the landfill served as the primary landfill for all non-hazardous waste from Purdue University, Tippecanoe County, the City of West Lafayette, and the City of Lafayette. In 1978, renewal of the landfill operating permit was denied due to poor operating practices included sporadic cover, unsatisfactory cover material, poor geologic conditions, and possible acceptance of hazardous materials (IDEM, 2005). The landfill operated using poor practices including accepting industrial sludge containing polychlorinated biphenyls (PCBs). The landfill closed in October 1989. The Tippecanoe Sanitary Landfill signed a Consent

Decree in 1997 whereby the site clean-up was specified. This clean-up included: covering the sanitary landfill, fencing the disposal area, extracting landfill leachate, creating a groundwater remediation program, and monitoring and maintaining the site. Remediation of the site began in June 2000 with all physical activities completed by November 2002. Maintenance and monitoring is on-going (IDEM, 2005).

2.9.6 Development Trends

Development pressures are strong within the Region of the Great Bend of the Wabash River. This is especially true along the southern and eastern portions of Lafayette, the western and northern edges of West Lafayette, and adjacent to Shadeland, Battle Ground, Attica, Otterbein, and the U.S. 52 and U.S. 231 corridors. Figure 40 displays changes in land use from 1992 to 2006. In total, 1,212 acres of agricultural ground, natural areas, and bare ground were converted to urban uses during the time period. In the period since 2006, it is likely that further conversion has occurred. A majority of the converted land (902 acres or 74%) was mapped as agricultural land in 1992. Forested (18%), open water and wetland areas (5%), and grassland (2%) account for the remaining converted land.

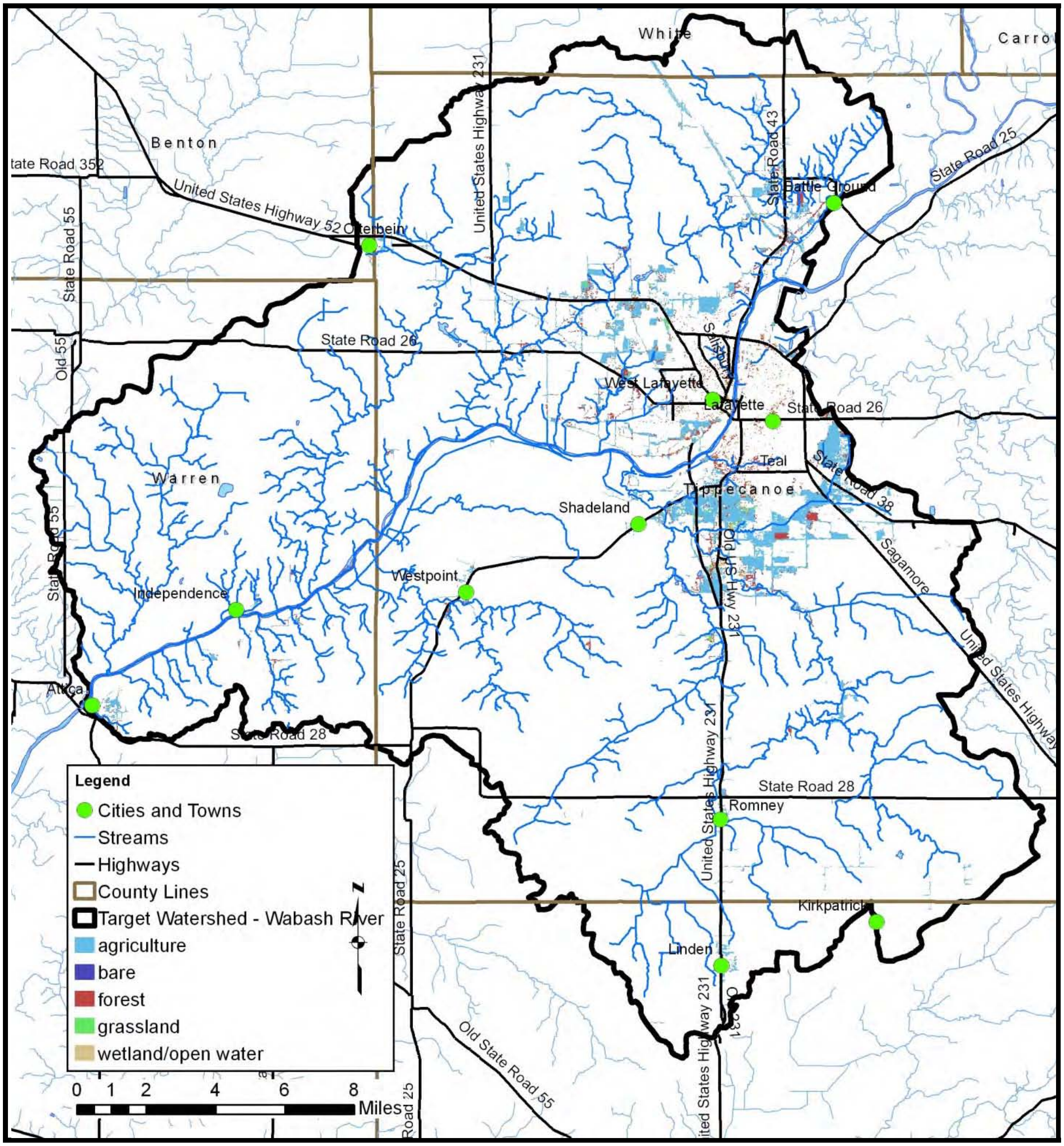

Figure 40. Land converted to urban uses (1992 to 2006) within the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

2.10 Population Trends

As the land use discussion details above, the Region of the Great Bend of the Wabash River watershed supports an amalgam of sparsely and densely populated areas. Tracking population changes within a watershed is a bit difficult as watershed boundaries rarely align with the boundaries (township, census tract, county) used to report populations. Reported data can be used to estimate current and projected populations, track population growth over the past century, and assist in identifying high and low density populations within the vicinity of the watershed. Stakeholders are concerned about the impacts of continued development to satisfy the growing population.

The Region of the Great Bend of the Wabash River watershed lies within six counties. It drains nearly 70% of Tippecanoe County, 21% of Warren County, 7% of Fountain County, 5% of Montgomery County and less than 2% of Benton and White counties. Population trends for these counties derived from the most recently completed census (2000) are shown in Table 22, while Table 23 displays estimated populations for the portion of the county located within the watershed. These data indicate considerable growth in Tippecanoe County over both the past century (325% growth) and over the previous decade (14%). Over the century, growth and loss are equally spread over the counties with three showing increasing populations over time and three detailing declining populations. In the most recent decade, increases in population were identified in all counties except Benton.

Table 22. County demographics for counties within the Region of the Great Bend of the Wabash River watershed.

County	Area (acres)	Population (2000)	Population Growth		Pop. Density (#/sq. mile)
			(1890-2000)	(1990-2000)	
Benton	259,953	9,421	-20.9%	-0.2%	23.19
Fountain	254,465	17,954	-8.2%	0.8%	45.16
Montgomery	323,248	37,629	34.3%	9.3%	74.50
Tippecanoe	321,810	148,955	324.6%	14.1%	296.23
Warren	234,303	8,419	-23.1%	3.0%	23.00
White	325,372	25,267	61.2%	8.6%	49.70

Table 23. Estimated watershed demographics for the Region of the Great Bend of the Wabash River watershed.

County	Area of County in Watershed	Percent of County in Watershed	Population
Benton	1,090	0.4%	40
Fountain	16,112	6.3%	1,137
Montgomery	14,387	4.5%	1,675
Tippecanoe	221,385	68.8%	102,472
Warren	48,604	20.7%	1,746
White	4,872	1.5%	378
		Total Estimated Population	**107,448**

The majority (90%) of the Region of the Great Bend of the Wabash River watershed supports less than 10% of the population at a density less than 700 people per square mile. The average population density for the watershed is 3,270 people per square mile (Figure 41). The majority of the population lives in a density of 10,500 to 23,250 people per square mile. The higher population densities are present within the vicinity of Lafayette and West Lafayette with other high density areas occurring around Attica and Battle Ground.

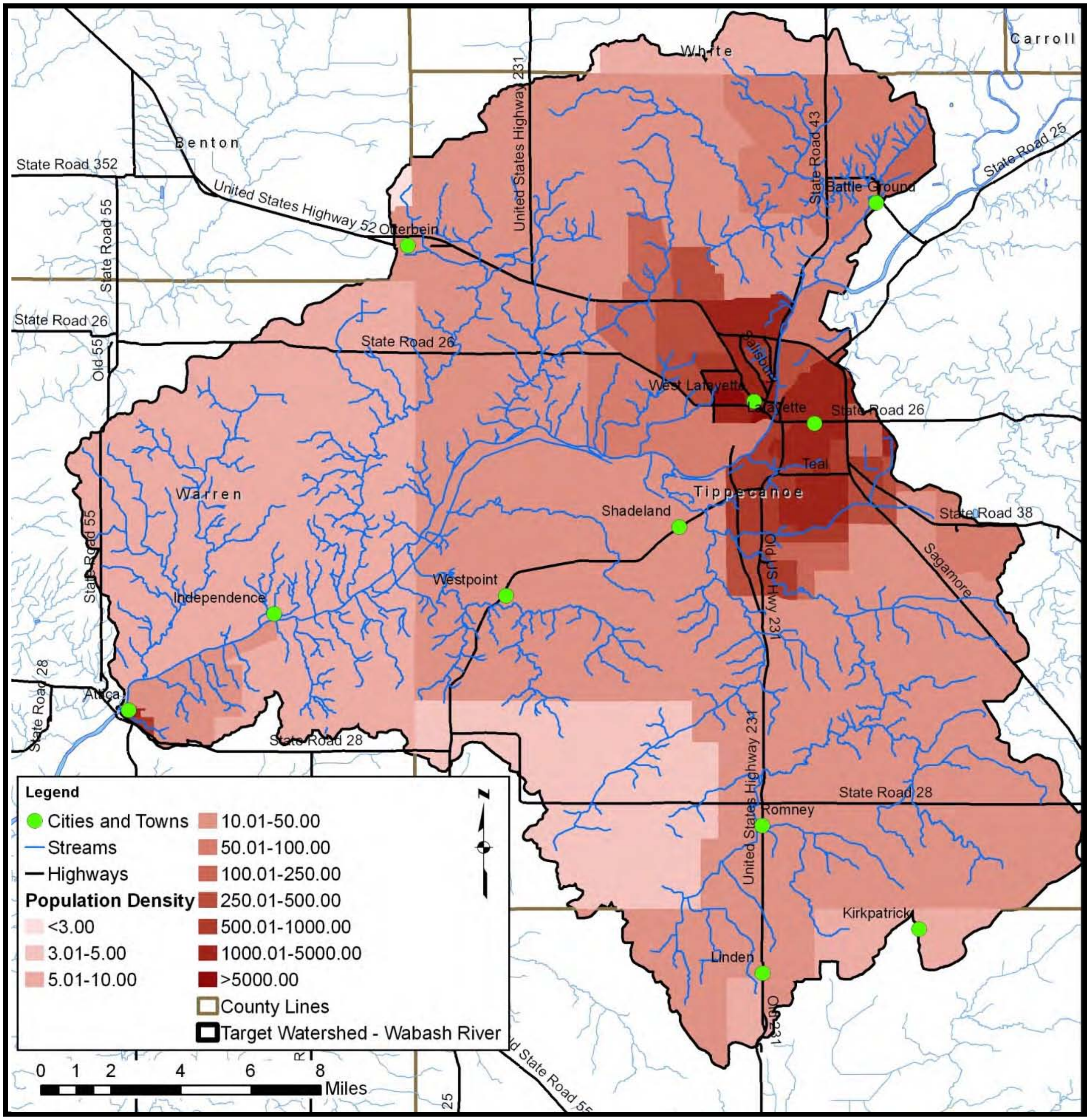

Figure 41. Population density (#/square kilometer) within the Region of the Great Bend of the Wabash River watershed.
Data used to create this map are detailed in Appendix A.

2.11 Planning Efforts in the Watershed

Many planning efforts have occurred at many scales within the Region of the Great Bend of the Wabash River watershed. The earliest identified plan was completed by the U.S. Army Corps of Engineers in the 1970s. This effort focused on resources present within the corridor of the Wabash River along its entire length. More recent planning efforts include those by the Wabash River Heritage Corridor Commission (WRHCC) along the length of the Wabash River and the U.S. Army Corps of Engineers Reconnaissance Study of the Wabash River within Tippecanoe County. Additionally, Tippecanoe County maintains a county-based master plan as do several of the cities. More focused planning and outreach has occurred in targeted areas as well including the Purdue University campus, the urban corridor along the Wabash River within Lafayette and West Lafayette, green corridor planning along the Wabash River throughout Tippecanoe County, and the Tippecanoe County Partnership for Water Quality, the regional Municipal Separate Storm Sewer System.

2.11.1 Wabash River Heritage Corridor Commission

In 1990, the Indiana Department of Natural Resources (IDNR) created the Wabash River Heritage Corridor Fund to provide assistance with conservation and recreational development projects along the Wabash River. In 1991, the Wabash River Heritage Corridor Commission (WRHCC) was created by House Enrolled Act 1382. The WRHCC protects and enhances the natural, cultural, historical and recreational resources of the Wabash River within the nineteen counties through which the river runs. This includes Tippecanoe, Fountain, and Warren counties, which are part of the current planning project. Since 1990, approximately 60 projects received funding totaling more than $13 million through the corridor fund (WRHCC, 2004). Additional efforts by the WRHCC include maintenance of a visible presence within the corridor counties, provision of interaction along the length of the corridor, and promotion of the Wabash River and its historical and recreational opportunities.

In 2004, the WRHCC updated its master plan via a series of public meetings along the Wabash River corridor. The master plan focused on eight main areas including land use, natural resources, historic resources, recreational resources, corridor connection and linkages, scenic by-way linkages, thematic connections, and tourism. As portions of the watershed are contained within the Wabash River Heritage Corridor, it is important that the goals, strategies, and actions developed as part of this plan be in line with those developed as part of the WRHCC master plan. The master plan identified the following action items:

- Maintain and enhance the natural diversity of the corridor.
- Restore natural landscapes of the Wabash River Heritage Corridor.
- Ensure that mineral extraction is environmentally sensitive.
- Stabilize the riverbank.
- Re-establish riparian forests and wetlands along the Wabash River.
- Develop and implement set-back programs to reduce surface runoff and non-point source pollution.
- Enforce existing regulations regarding point source pollution related to wastewater treatment plants and septic systems and explore the need for new regulations.
- Promote monitoring of water quality and public education about water quality.
- Preserve large regional natural areas.
- Fish stocking and wildlife reintroduction in and along the Wabash River.
- Conduct a historic resource inventory of the corridor resource and nominate eligible properties for National Register designation within the corridor.
- Develop a prioritized list of historic and cultural resources that are threatened for focused preservation effort by county.
- Identify long-term funding opportunities for historic preservation along the corridor.
- Acquire and develop more recreational areas and opportunities.
- Promote and enhance hunting and fishing opportunities.
- Promote and enhance birding opportunities in the corridor.
- Promote and enhance bicycling opportunities in the corridor.
- Develop trail connections along the river linking corridor communities.
- Increase access to the Wabash River for recreational use, boating, fishing, and enjoyment of the river. Increase overnight facilities access.
- Establish designation of scenic by-way along the river.
- Install directional or identification signs for scenic by-ways along the river.

- Create an image to connect and interpret significant resources.
- Develop a Wabash River Heritage Corridor Center that would introduce and interpret the significance of the Wabash River and the Heritage Corridor and serve as a central repository or records center for Wabash studies.
- Develop a Wabash River and Heritage Corridor education curriculum for teacher training opportunities.
- Create corridor identification.
- Promote and market corridor resources and events.
- Develop and coordinate corridor events as part of the Heritage Corridor identity.
- Provide information to promote local and corridor recreational resources and facilities.
- Develop a natural resources guide specific to the Wabash River Heritage Corridor that will be site specific including river and public access information.

Stakeholders identified many of the action items detailed by the WRHCC for improvement of the Region of the Great Bend of the Wabash River watershed. Based on information from WRHCC commissioners, little advancement toward meeting these goals have occurred since 2004 in the counties located within the watershed including Tippecanoe, Warren, and Fountain counties.

2.11.2Tippecanoe County Area Plan

The Tippecanoe Area Plan Commission (APC) completed the County Master Plan in 1981 (TCAPC, 1981). Multiple updates to the plan occurred since that time. In 1981, the plan was composed to provide the following:

- An essential statement of policy devised to facilitate public participation in the planning process.
- A statement of policy encouraging interaction with public officials.
- A policy guide to provide stability and consistency in light of changing conditions.
- A guide to legislative bodies throughout the county in light of adopting land use controls by which changes can be based.

The plan was intended to serve as a guidance document by which development and changes within the county could occur. The key planning pieces contained within the County Master Plan which are relevant to the watershed management plan include the land use, transportation, and floodplain plans. The key highlights of each of these individual plans are described below.

- Land use: In 1981, residential land use occurred mainly within Lafayette and West Lafayette with sporadic residential development east of town in Fairfield Township, south of town in Wea Township, and north of town in Wabash Township. Future development plans identified residential expansion from the southern urban boundary to Wea Creek, from the eastern urban boundary beyond the I-65/SR 26 east intersection, extend across the Wea Plains from Little Wea Creek to West Point, expand into Dayton and Clarks Hill, expand outward from Battle Ground, and in smaller areas throughout the county. These expansions were identified as possible without inhibiting agricultural production on the most productive lands in the county.

- Transportation: An updated 2030 transportation plan for Tippecanoe County was adopted in 2007 (APC, 2007). The goal of the updated plan was to develop a coordinated transportation system which includes rail, vehicle, pedestrian, mass transit, and bike access. The plan addressed the following current and future roadway plans and issues: Hoosier Heartland Corridor (SR 25) from Lafayette to Logansport, US 231 around the west side of Purdue University, SR 26 and US 52 within urban areas, and continued access and development of City Bus and bicycle and pedestrian facilities. Specific reviews of the Hoosier Heartland and US 231 redevelopment should be part of this planning process as should any development or redevelopment of other roads within the watershed.

- Floodplain: Flooding is covered as part of the multihazard management plan which was updated in 2006 (APC, 2006). The multihazard management plan is included as a portion of the County Master Plan. Flooding is noted as a significant concern within Tippecanoe County having occurred three times in the period of July 2003 through February 2005. In total, 14 flood events were recorded within the county from May 1943 through February 2005. These events resulted in more than $67 million in property damage and more than $58 million in crop damage. Flooding is typically limited to riverine flooding but has also historically been associated with flash, overland, lake, and urban flooding. Lake flooding is associated with Hadley Lake, while urban flooding is likely due to inadequate drainage and too high of densities of impervious surfaces.

As the county master plan was largely composed in 1981 with partial updates occurring since that time, it is not surprising that the plan can no longer address natural land use, soil erosion, or development concerns. Stakeholder concerns regarding development, soil erosion and deposition, and the impact of these on waterbodies need to be incorporated into future updates of the land use planning portion of the master plan at a minimum.

2.11.3 Tippecanoe County SWCD Master Plan

The Tippecanoe County Soil and Water Conservation District (SWCD) was created in 1940 and was tasked with coordinating the conservation of soil, water, and related natural resources within Tippecanoe County (Tippecanoe SWCD, 2010). The SWCD's vision of natural resources for Tippecanoe County is: stable soils, healthy forests and riparian buffers, clean streams and water resources, productive farms, and sustainable communities. As part of their planning process, the SWCD identified the following areas of concern:

- Accelerated erosion on areas under construction resulting in downstream silting of drainageways, bottomlands, and streams.
- Increased surface water management problems and flooding due to runoff from impervious surfaces.
- Improper soil use in construction of buildings, streets, and other structure that fail due to soil limitation that were not addressed.
- Limited riparian buffers resulting in the loss of natural topography.
- Negative impacts from water pollution on drinking water, household needs, recreation, fishing, transportation, and commerce.
- Rapid urban growth demands more space for housing developments and shopping centers at the direct expense of family farms and traditional framing mechanisms.

As the action items identified by the SWCD apply to a majority of the watershed, these practices and intent should be considered when developing priority action items for watershed improvement. Additionally, as these action items mesh with stakeholder concerns with regards to limited watershed buffers, livestock access to streams, and loss of wildlife habitat, efforts should be made to combine implementation efforts as possible. The following actions were identified by the SWCD to be completed by 2014:

- No till practices shall be increased by 2,500 acres in the Upper Wabash and Wildcat Creek watersheds.
- Cover crops shall be increased by 2,500 acres in Tippecanoe County by 2014.
- The SWCD will educate 20 landowners in high manure application areas on best management practices for manure application by 2014.

- The SWCD will increase streambank stabilization awareness/education through 10 partnering opportunities by 2014.
- 125 acres of buffers will be installed in the Wea Creek and Wildcat Creek watersheds by 2014.
- The SWCD will educate 150 landowners about the benefits and installation of two-stage ditches by 2014.
- The SWCD will provide 10 educational and/or outreach opportunities on the environmentally wise use of lawn fertilizers and pesticides by 2014.
- The SWCD will educate 750 landowners about beneficial native plants and the negative impact of invasive plants on the environment by 2014.
- 350 acres of wildlife habitat will be installed in Tippecanoe County by 2014.
- The SWCD will work to reduce stormwater runoff by facilitating programs to establish 250 best management practices by 2014.

2.11.4Vision 20/20 Plan

The Vision 2020 Plan focused energy and efforts throughout Greater Lafayette and Tippecanoe County on areas of need (Benson et al., 2002). A variety of round table and planning groups were created as part of the visioning process. Additionally, many of the action items recommended have since been implemented. Specifically, the environmental and land use action items are most relevant for the current watershed planning process. These recommendations include:

- Upgrading and fully implementing a solid waste management plan for Tippecanoe County.
- Adequate funding and staffing of the Wildcat Creek Solid Waste Management District to enable coordination and implementation of the solid waste management plan noted above.
- Development of marketing strategies to encourage all entities and organizations to use recycled materials.
- Establishment of watershed groups to identify problems and promote solutions and develop/implement public education strategies for surface and groundwater quality improvement.
- Development of a public education strategy for education homeowners with private wells.
- Support and implementation of a wellhead protection plan for each community water supply system.
- Identify and remediate Brownfield and other chemically-contaminated sites to reduce threats to local groundwater and streams.
- Provide adequate funding and staffing for county and city offices to coordinate and implement the NPDES Phase II stormwater program.
- Prevent soil erosion by wind and water in urban and rural settings by promoting the use of best management practices.
- Lobby for aesthetics to be added as a purpose of zoning in the state enabling acts.
- Implement state and federal programs to protect farmland and natural areas.
- Designate River Road from I-65 to Black Rock as a scenic by-way and protect North River Road as a model entrance to the Greater Lafayette urban area.
- Conduct constant updating of the Tippecanoe County Comprehensive Plan.
- Revise the county land use plan so that it adequately serves to protect watersheds, preserve natural areas, and maintain and enhance the rural landscape and agricultural resources.
- Preserve and restore a variety of natural areas to protect the diversity of native wildlife and plant species and create opportunities for human enjoyment of the natural environment.

- Develop a comprehensive plan for parks, recreation, leisure, historic and cultural sites and other interesting places along the Wabash River corridor.
- Enhance, improve, integrate, and maintain recreational, green spaces, and natural areas through the creation of linkages between the Wabash River and other sites both existing and future.
- Plan for development of new commercial and residential areas contiguous to established areas zoned for similar usage at the edges of the cities or within redevelopment areas.

The Vision 20/20 planning effort provided a solid foundation that suggests that many historic stakeholder concerns are still relevant today. Specifically, stakeholder concerns regarding development pressures, soil erosion, conversion of agricultural to urban land uses, and the need for recreational access were all identified as part of the Vision 20/20 plan.

2.11.5River Vision

Over 100 community members and interested stakeholders participated in River Vision on November 4, 2006. The goal of River Vision was to develop a list of values, ideas, and visions for the future of the Wabash River within Greater Lafayette's urban corridor from US 231 to Interstate 65. The goal of the visioning session was not consensus but rather to gather community input and provide information which would be used as a basis for the Wabash River corridor master planning process slated to start in 2007. Major areas of interest among community groups were environmental and recreational with participants social, cultural, wildlife, economic, heritage, education, community and connectivity, and aesthetics of secondary importance. Recommendations developed as part of River Vision are as follows:

- Utilize environmentally sensitive design to enhance existing natural areas south of the cities' wastewater treatment plants to create wildlife habitat and increase flood storage.
- Create low-impact trails along the Wabash River connecting downtown Lafayette and West Lafayette with Fort Ouiantenon.
- Correct Combined Sewer Overflow issues and reduce odor problems at the wastewater treatment plants.
- Physically connect downtown Lafayette to the river through the Wabash Avenue Neighborhood and McAlister Park.
- Expand existing trails along the river.
- Provide water-based recreation and provide a canoe livery, boat storage location, aquatic center, and swimming beach along the river.
- Create permanent cultural activities location that could support museum, educational facilities, and community artists.
- Enhance Shamrock Park and connect it and the Wabash Avenue Neighborhood to downtown Lafayette.
- Enhance views of the river from bridges.
- Restore and expand Mascouten Park.
- Provide parking and picnic areas near Davis Ferry Park.
- Connect Davis Ferry Park to Prophetstown State Park via a trail.
- Create a recreational destination where the Tippecanoe River and Wabash River combine.
- Create an access point where the Wabash River and Wildcat Creek combine.

2.11.6 County-wide Corridor Master Plan (WREC)

The Wabash River Enhancement Corporation and their consultant, Wallace Roberts & Todd, completed a County-wide Corridor Master Plan in 2011 (Wallace, Roberts & Todd, 2011). The project sought to capitalize on past accomplishments, current activities, and new opportunities to define the Wabash River's place in the community and identify the river as the region's most valued resource. The planning project occurred in two phases with the Central Corridor Planning Project beginning in May 2007 and the Wabash River Greenway Planning Project beginning in May 2009.

The Central Corridor Plan was developed with input from the WREC board of directors, community members, and stakeholders from Lafayette and West Lafayette with the following goals:

- Connect the cities to the river and create a healthy balance.
- Cultivate healthy ecosystems.
- Engage the whole community.
- Connect the cities to each other.
- Focus on creating a sustainable community of choice.

The plan recognizes three distinct zones within the urban or central corridor. The Northern Reach is largely parkland and includes opportunities for ecological, education and recreational enhancements as well as neighborhood development investments. The Central Reach represents the civic core of Lafayette and West Lafayette and present opportunities to enhance riverfront and community connectivity. The Southern Reach includes WREC and city-owned properties, the Wabash Avenue Neighborhood, and parkland allowing for educational, recreational, and ecological enhancement as well as cultural interpretation. Figure 42 details projects identified within the Central Corridor as part of the County-wide Corridor Master Plan. Appendix G details these projects more completely.

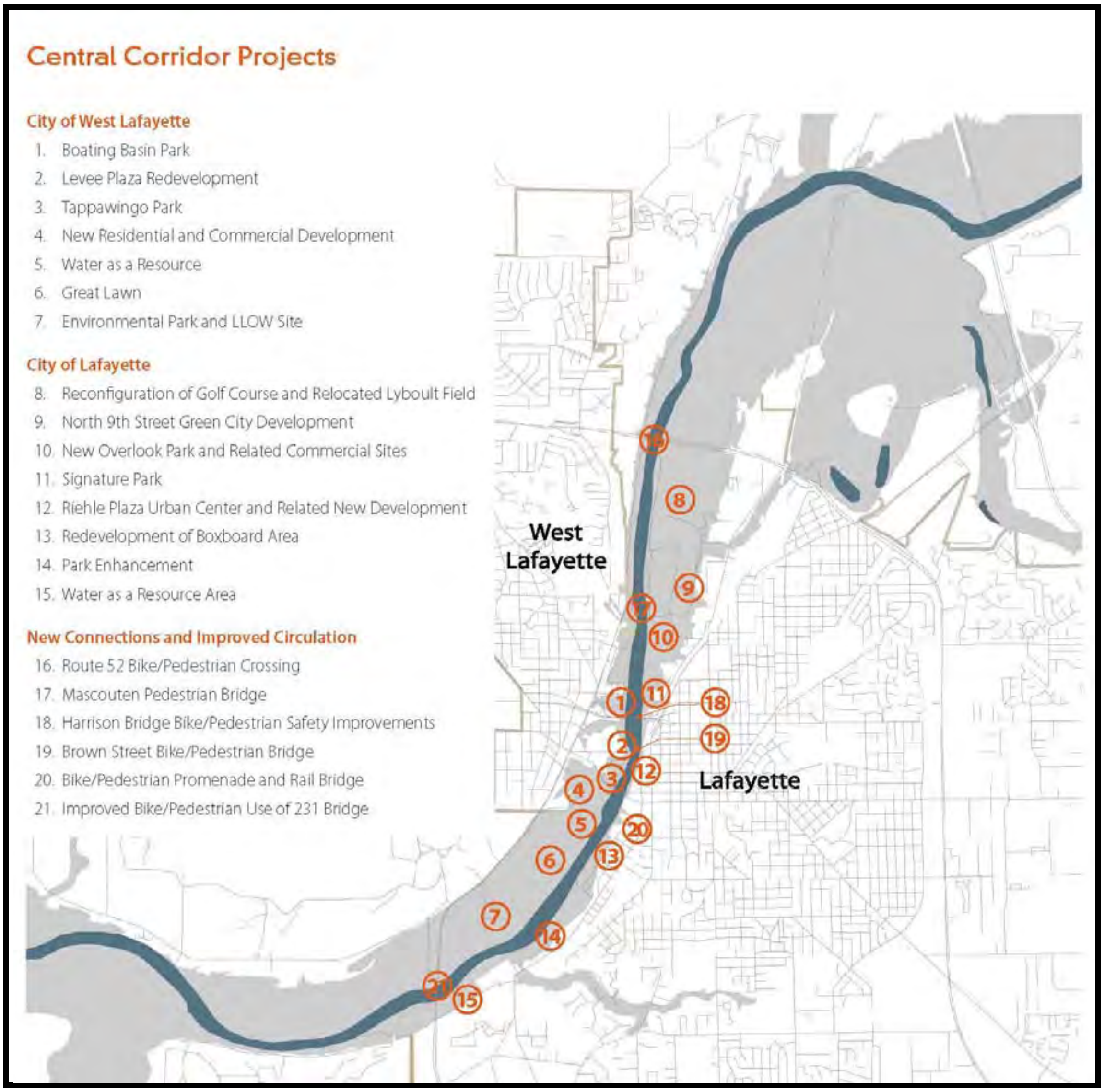

Figure 42. Projects identified within the Central Corridor as part of the County-wide Corridor Master Plan.

The Wabash River Greenway developed as the second phase of Corridor Planning along the Wabash River. The Wabash River Greenway will be tailored to fit specific circumstances present in Tippecanoe County. The Wabash River Greenway should 1) develop as economic, social, and environmental conditions allow; 2) encompass the 100 year floodplain and coincide with the floodplain zoning district of the Unified Zoning Ordinance; and 3) comprise private, public, and nonprofit land ownership. The Greenway is divided into three sections: A mostly-urbanized central section and north and south sections that are primarily rural-suburban. The Wabash River Greenway identifies travel routes through the greenway via roadways, pathways, and waterways (Figure 43 to Figure 45) that will increase access to the Wabash River and connectivity with and along the river. Additionally, the greenway is divided into six sections which highlight recreational opportunities, historic features, natural areas, and trail-related amenities. Each section includes travel routes (Appendix G).

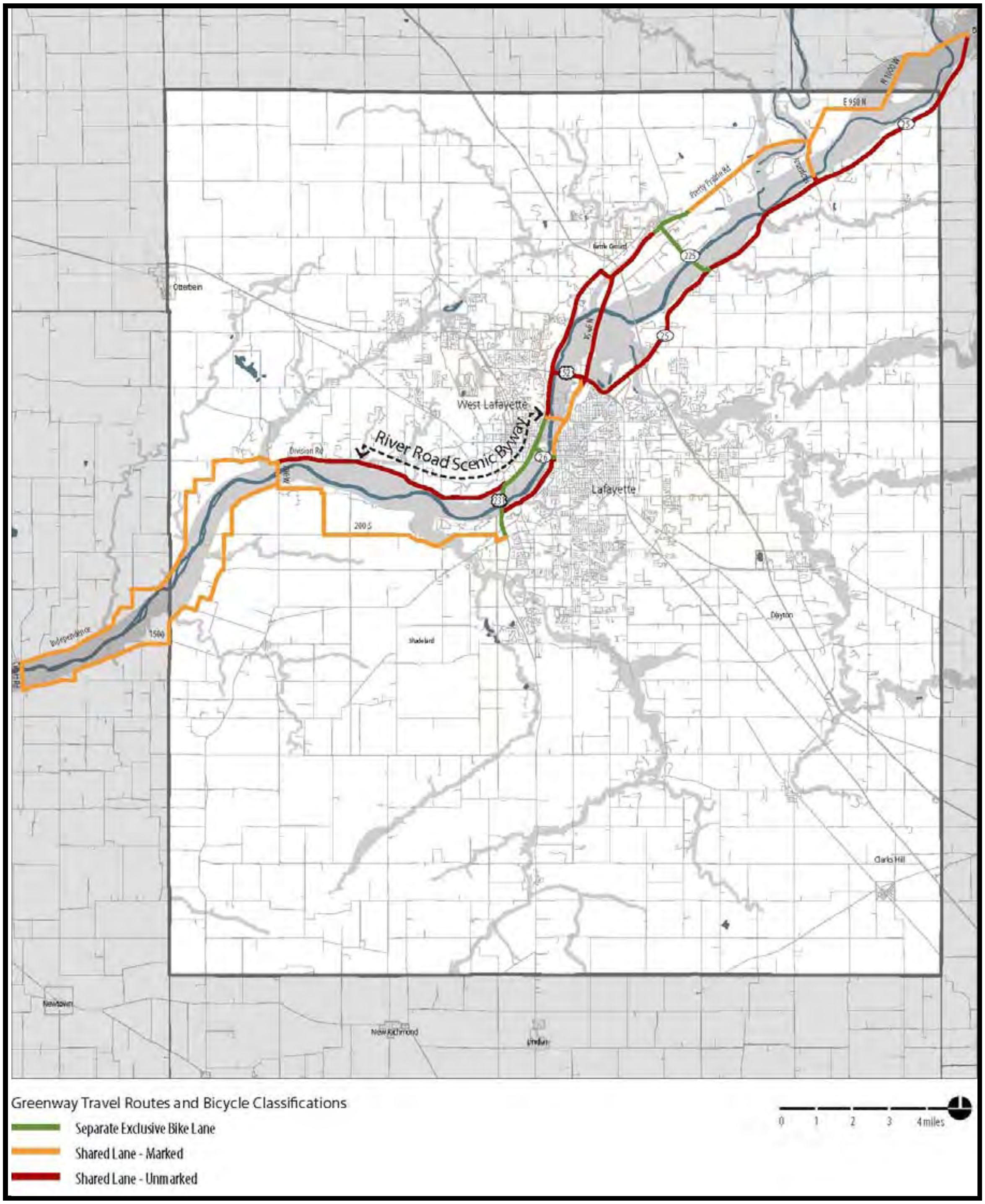

Figure 43. Wabash River Greenway travel routes and bicycle classifications.

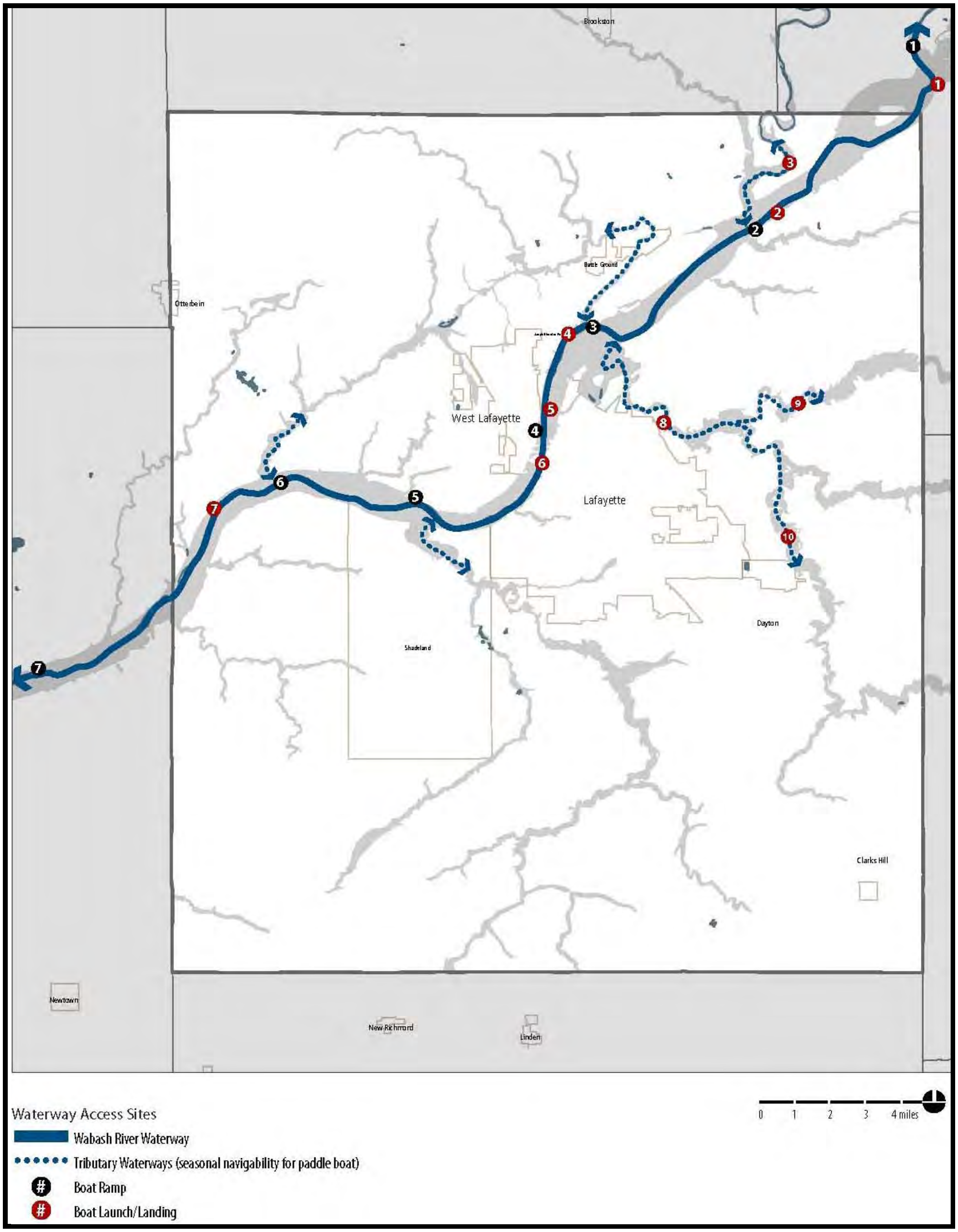

Figure 44. Waterway access sites in the Wabash River Greenway.

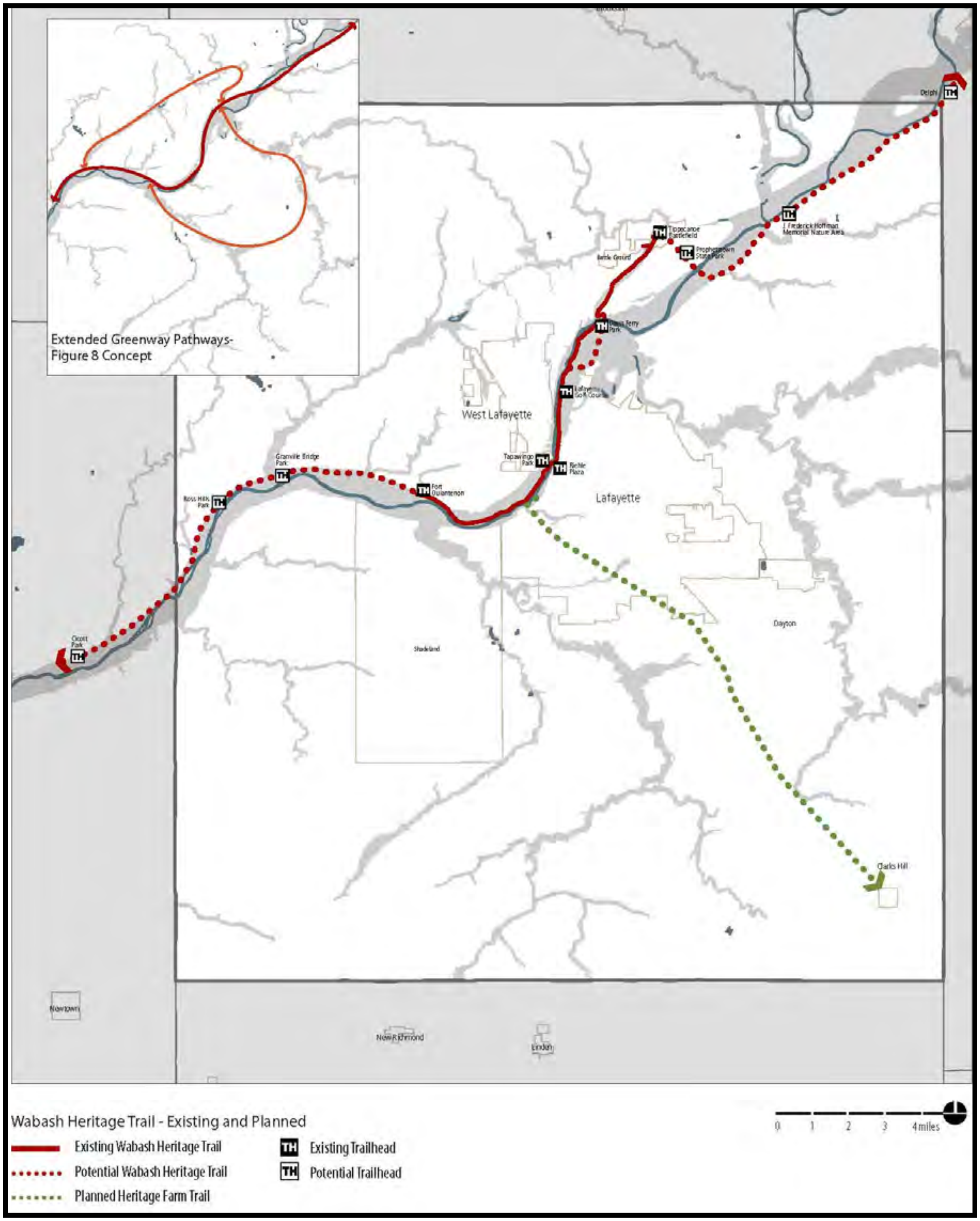

Figure 45. Existing and future trails within the Wabash River Greenway.

2.11.7 Wabash River Reconnaissance Study (Corps)

The U.S. Army Corps of Engineers (Corps) completed a 905(b) (WRDA 86) analysis of the Wabash River in Tippecanoe County (Corps, 2011). The purpose of the study is to determine if there is Corps interest in providing flood damage reduction and ecosystem restoration solutions to identified water resource problems within the 29 miles of the Wabash River in Tippecanoe County. Public concerns identified as part of the study include water quality, bank erosion, flooding and flow flashiness, wildlife habitat, historic and cultural resource preservation, recreation, economic development, and property rights. Potential projects identified as part of this plan include:

- Stabilization of 35,000 linear feet (6.5 miles) of streambank;
- Enhancement of 37 acres of riparian vegetation;
- Stabilizations of Happy Hollow Park.

2.11.8 Tippecanoe County Partnership for Water Quality Plan

Tippecanoe County, Purdue University, Ivy Tech State College, and the Cities of Battle Ground, Dayton, Lafayette, and West Lafayette signed a joint agreement to collectively manage stormwater issues within the state designated Municipal Separate Storm Sewer System (MS4; Figure 46). This partnership is known as the Tippecanoe Partnership for Water Quality (TCPWQ). Collectively, TCPWQ submitted a notice of intent to accept responsibility for the management of the MS4 and the six designated minimal control measures (MCMs) which include: public education and outreach, public participation/involvement, illicit discharge detection and elimination (IDDE), construction site run-off control, post-construction run-off control, and municipal operations pollution prevention and good housekeeping.

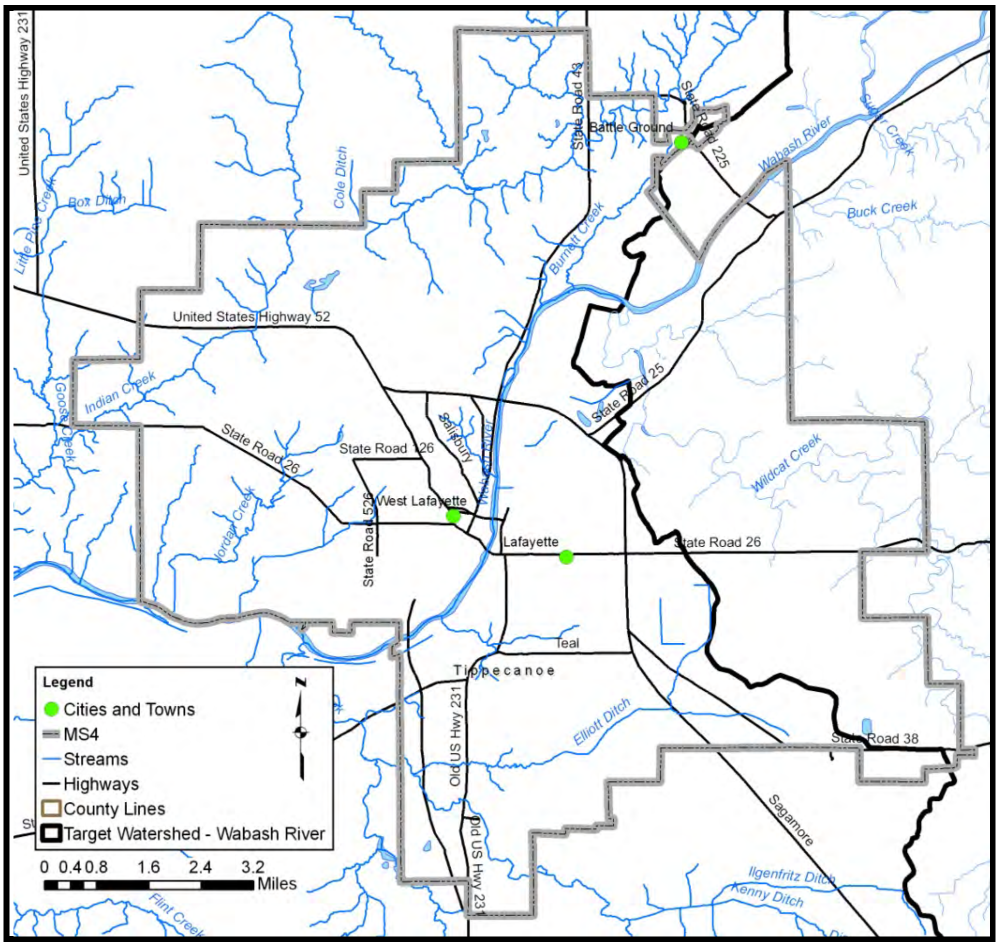

Figure 46. Tippecanoe County Partnership for Water Quality (MS4) jurisdiction. Data used to create this map are detailed in Appendix A.

In May 2004, the Baseline Characterization Report (or Part B) was submitted to IDEM as part of the MS4 permitting process (CBBEL, 2004). The report characterizes the land use and stormwater runoff, identifies sensitive areas and structural and non-structural best management practices, and specifies priority implementation areas within the MS4. Based on the fact that agricultural land uses dominate the MS4 area (60%), the implementation of agricultural best management practices focused on sediment and nutrient transport reduction are encouraged. The recommended best management practices include conservation tillage, nutrient and pesticide management, buffer strips, and wetland restoration. The implementation of these items will assist in addressing stakeholder concerns relating to sediment erosion and transport and high nutrient concentrations. To address the next highest land use, urban land uses which account for 13% of the MS4 region, the baseline characterization report recommends adoption of a comprehensive stormwater ordinance and identifies urban best management practices for each MCM.

2.11.9City of West Lafayette Stormwater Improvement Projects

As part of the Tippecanoe Partnership for Water Quality, the City of West Lafayette works collectively to meet the identified minimum control measures (MCMs) with other TCPWQ members. Additionally, they've identified the potential need to implement a stormwater fee to complete several capital projects necessary to reduce stormwater impacts on the Wabash River from the City of West Lafayette. These projects include:

- Improve Blackberry Pond embankment, potentially modify the detention basin and armor Indian Creek as part of the Blackbird Pond Stormwater Improvement Project.
- Improve stormwater drainage to Celery Bog, upgrade the wetland outfall structure, and reduce erosion to the north drain to Celery Bog.
- Install additional stormwater drains, sewer piping, and manufactured water quality structures to filter stormwater from North River Road near downtown West Lafayette.
- Reduce erosion of Happy Hollow Park ravines, improve park and neighborhood drainage, and install rain gardens at the top of the Happy Hollow drainage.
- Upgrade the Manchester Street Ditch and improve channel and stormwater infrastructure within Cumberland Park to reduce flooding within Cole Ditch.
- Improve the detention pond and drainage system in Purdue Research Park.
- Implement rain gardens and rain barrels within residential areas of The Island.
- Install under drains to remove water from saturated soils and create infiltration basins to filter water and reduce flooding in University Farms.

2.11.10City of Lafayette Stormwater Improvement Projects

To meet their NPDES permit requirements, avoid fines, and complete drainage improvements, the City of Lafayette established a stormwater utility. In 2010, residential property owners will be assessed a $4/monthly or $48 annual fee. This fee pays for runoff from one equivalent residential unit (ERU) or 3,200 square feet. Non-residential developed property owners pay annual stormwater fees based on their calculated impervious surface with a minimum $5/month fee (DLZ, 2010).

As part of their stormwater program, the City of Lafayette developed a stormwater infrastructure rehabilitation and expansion program (Figure 47). The following projects were identified as part of the program:

- Construction of a new storm sewer including stormwater detention ponds and rain gardens along the length of Valley Street.
- Erosion control and streambank armoring, stream realignment, and high-flow bypass channel construction along Elliot Ditch near Poland Hill Road.
- Construct a new storm sewer along South 30th Street from Teal Road to the industrial park near Beck Lane.
- Install rain gardens and rain barrels at targeted locations within the City of Lafayette.

- Improve stormwater filtration of drainage near Beck Lane and South 18th Street before it enters the pond in Armstrong Park with wetland plantings and regarding to create a stormwater pond upstream of the Armstrong Park pond.
- Redirect combined stormwater to detention ponds along South 18th Street near Jefferson High School to treat runoff into Durkee's Run while constructing 1,200 feet of new storm sewer.
- Dredge silt from existing Vinton Woods detention ponds, improve piping between the ponds, and correct the outlet structure near the northern edge of the northern pond.
- Construct a new storm sewer along Orchard Drive to drain stormwater more quickly and prevent stormwater and sanitary sewer backups during storm events.
- Repair and replace storm sewer outfalls throughout the City of Lafayette.

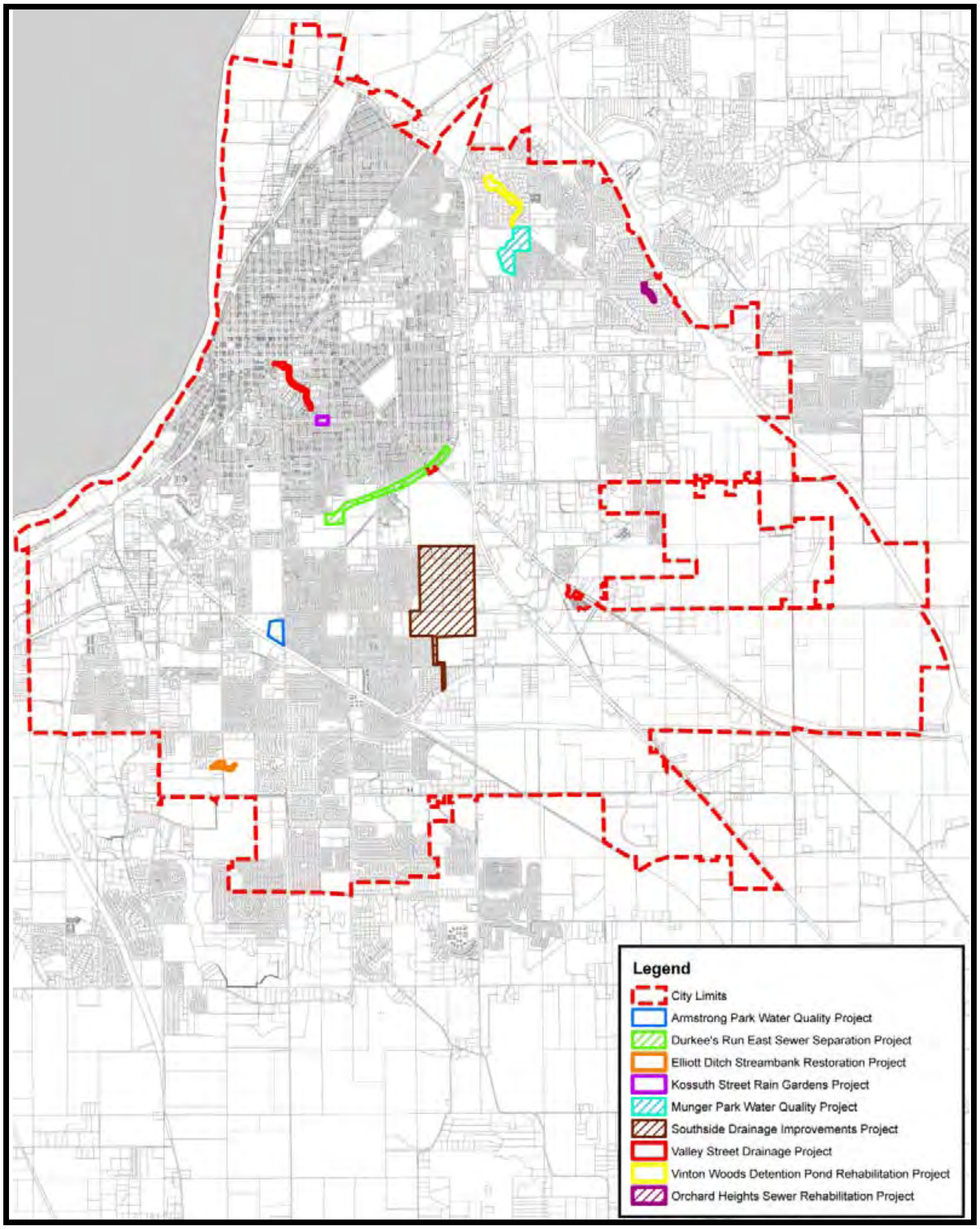

Figure 47. Stormwater project identified in the City of Lafayette.

2.11.11 Purdue University Master Plan and Stormwater Plan

Purdue University recently completed a new master plan (Sasaki, 2009) for all of the university-owned property (Figure 48). The master plan focuses on mechanisms to redirect the campus focus inward, limit campus sprawl, and to utilize campus space following re-routing of U.S. 231 and re-designation of State Street from State Road 26 to a locally-maintained roadway. Many of the items contained within the strategic plan focus on specific campus development or redevelopment options. However, a few specific items contained within the Purdue University Master Plan that should be considered as part of the current planning process include: reforestation of the Western Lands, or land located west of campus currently in forested, pasture, and row crop agricultural land use; internal development rather than campus sprawl to the north and west; and regional recreational and wildlife corridor connections. All of these items mesh with concerns identified by stakeholders.

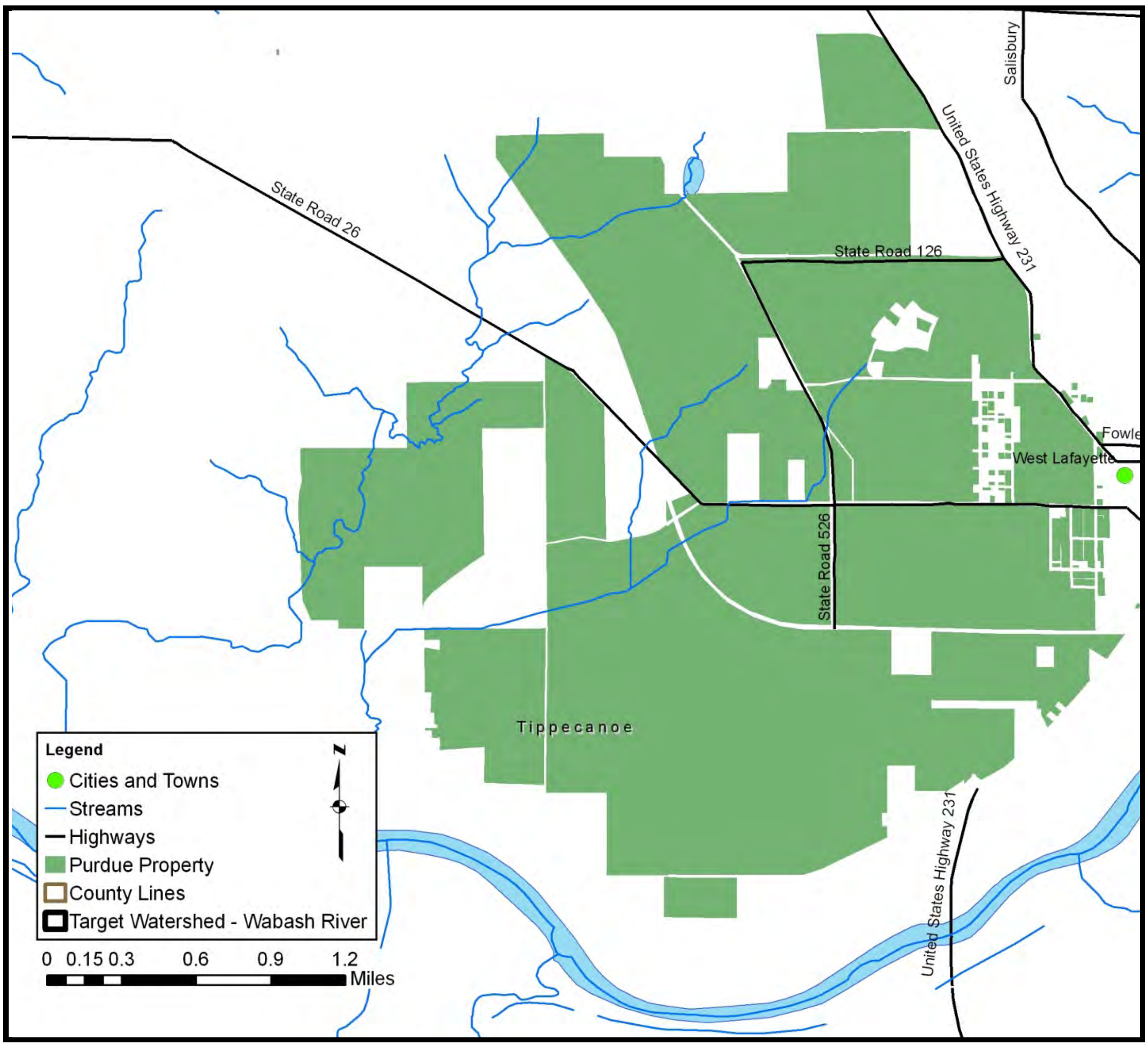

Figure 48. Purdue University Master Plan jurisdiction.
Data used to create this map are detailed in Appendix A.

Purdue University identified the need for a comprehensive stormwater management plan and completed this plan in 2010. Stormwater exits the campus in three manners. Nearly 584 acres of campus, including a small portion of the City of West Lafayette, drains into the campus stormwater system discharging into Harrison Pond, a former gravel pit near the southern edge of campus. Approximately 124 acres flow to the City of West Lafayette's sewer system entering in the portion of the system that receives combined sewer overflows. Water falling on the western portion of campus (267 acres) drains to Jordon Creek an intermittent tributary to the Wabash River. The key elements of this data are that the Jordan Creek (26%) and CSO (12%) drainage areas are the parts of campus (38%) which directly impact the Wabash River. The Jordan Creek watershed is only 14% impervious but, the CSO drainage area is 72% impervious. Consequently, recommended stormwater management strategies are significantly different in each area. For instance, the density of the CSO area suggests interception and treatment of roof runoff would have the greatest impact. The rest of campus (62%) drains into Harrison Pond which does not drain, overland, into the Wabash River. Rather, drainage to Harrison Pond reaches the Wabash River as groundwater.

The recently finished campus master plan calls for additional development around the edges of campus and redevelopment within the existing campus structure. With this in mind, it is necessary to address impervious surfaces which cover 46% of campus and their associated stormwater concerns as development and redevelopment occurs. The new master plan focuses development and redevelopment within the existing development footprint of the university in order to preserve the edges, particularly the highly pervious land west of campus which contains the university's well fields. Since the areas identified for future development on campus exclude the Jordan Creek and the airport watersheds, the future development areas actually average about 62% impervious. This area drains to Harrison Pond and the West Lafayette combined sewers.

As part of stormwater plan development, the following occurred:

- Review of existing stormwater conditions on campus including identification of problem and opportunity areas.
- Evaluation of historic rainfall on and around campus.
- Analysis of runoff and pollutant loads within the three runoff areas.
- Identification of opportunities for stormwater improvements.
- Evaluation of constraints created by the campus landscape and existing infrastructure.
- Development of a prioritized project list including cost concepts.

Findings suggest that addressing small, frequent storm events will provide the most effective treatment of stormwater on Purdue's campus. Over 93% of storm events at Purdue result in less than one inch of precipitation (Meliora Environmental Design, 2009). Additionally, addressing streets and sidewalks, which collectively comprise the majority of impervious area on campus, and parking lots, which will be included in campus development and redevelopment plans, offer opportunities to reduce Purdue's stormwater impact on the Wabash River. Recommendations are as follows:

- Design for small, frequent rainfall events.
- Create a sustainable approach which is a systems approach.
- Create a resilient stormwater system by decentralizing infrastructure.
- Manage stormwater where it falls.
- Review all future projects for stormwater opportunities.

The following list of potential projects was generated as part of this analysis. They are listed below by drainage. These projects should be considered as potential and their listing herein does not suggest an endorsement or schedule for their completion. Some practices are already in progress of installation.

Outlets to Harrison Pond.

- Incorporate stormwater capture techniques into the Mackey Arena Redevelopment Project including bioswale and tree trench use in parking lots for Mackey Arena and Ross-Ade Stadium; infiltration bed construction under practice fields; and capture of roof runoff from Mollenkopf Athletic Center.
- Install an infiltration bed under the band practice field, install tree trenches along Third Street and a cistern to capture chiller discharge from field irrigation well houses.
- Downspout disconnection and rain garden and tree trench installation at Hilltop Apartments.
- Bioswale, cistern, and rain garden installation at the Recreational Sports Center.
- Tree trench, bioswale, rain garden, and pervious pavement installation at the Agricultural Mall.
- Rain garden installation at the Rush Crossing.
- Depression of the road island and installation of rain gardens and formal plantings at State and Grant streets.
- Rain garden and storm water infiltration at the Mathematical Sciences Building.
- Construct wetland treatment areas adjacent to Harrison Pond.
- Bioswale or vegetative filter and permanent water treatment unit at the coal storage area for Wade Power Plant.

Outlets to Jordan Creek and drains to Wabash River.

- Conversion of non-essential greens and fairways to different vegetated cover types; creation of native buffer along open water courses, seeps, and wetlands; and establishment of pretreatment for wash-down and parking lots with wetland treatment prior to runoff discharging to the Jordan Creek; and streambank restoration of Jordan Creek.
- Incorporate a stormwater streetscape such as tree trenches, bump-out, pervious pavement, and infiltration beds at Tower Acres.
- Rain garden and tree trench installation in Tower Acres parking lot.
- Install native planting along stream channels and drainage ditches along Stadium Drive at Pickett Park.
- Restore pool riffle sequences, the streambank of Jordan Creek, and floodplain areas in Pickett Park.
- Infiltration trench and tree trench installation at intramural fields.

Outlets to West Lafayette combined sewer overflow and drains to Wabash River.

- Rain garden installation at Windsor Halls parking lot.
- Tree trench, bioswale, rain garden, and pervious pavement installation at the Agricultural Mall.
- Depression of the road island and installation of rain gardens and formal plantings at State and Grant streets.
- Tree trench, porous sidewalk, and porous pavement installation within The Island.
- Rain garden installation within the Armstrong Hall bump-out along Stadium Avenue.
- Tree trench, flow-through planter box, and cistern installation at Stadium Mall.

Additionally, the stormwater plan creates the following policies:

- All development or redevelopment projects disturbing over 1,000 square feet should capture all stormwater runoff and manage a one inch rain on site.
- Campus improvements to landscaping or hardscape disturbing over 1,000 square feet should meet the same requirements.

- Where runoff cannot be captured on-site, stormwater should be addressed to improve the quality of runoff before it reaches surface waters.
- Opportunities to reduce impervious surface coverage or change land coverage from hardscape or lawns to plantings or infiltration areas are encouraged.
- When stormwater management cannot be addressed on site, mitigation of this stormwater impact should occur in another area of campus which drains to the same surface waterbody.

2.11.12 City of West Lafayette Strategic Plan

In 2010, the City of West Lafayette completed an update to their strategic plan. As part of this effort, the following economic development projects were identified:

- Create a Village/Levee Master Plan focusing on mixed-use development and redevelopment of the Village and Levee districts of West Lafayette.
- Continue and enhance the marketing campaign to recruit retail to West Lafayette.
- Consider alternative grocery store models to Trader Joe's.
- Promote mixed-use office development that could accommodate medical uses.
- Consider a retail incentive package.
- Create an economic development focused Corridor Master Plan for Sagamore West.
- Develop a multi-cultural retail incubator.
- Develop an annual Capital Improvements Plan.
- Continue to implement pedestrian and bike improvements throughout the city.
- Deploy procedures for neighborhoods requesting traffic calming.
- Continue to implement the wayfinding program.
- Feature the Morton Community Center and Library within the Village/Levee Master Plan.
- Continue sustainable practices when planning and implementing city projects.
- Conduct a joint development effort to maximize land use options in the island.
- Create an Art in Public Places site map and implementation strategy.
- Continue to support the efforts of the City Parks Department and Wabash River Enhancement Corporation to enhance the public amenities along the Wabash River.
- Continue creative partnerships with school systems.
- Develop improvements to gateways to the community.
- Partner with West Lafayette Community Schools Corporation for creative redevelopment of the Burtsfield Site.
- Continue pursuit of fiber to the home/fiber of the premise throughout West Lafayette.
- Create a Council of Neighborhood Presidents.
- Implement an incentive program for landlords.
- Create a short-term task force between Purdue, students, and the city to evaluate off-campus housing information and procedures.
- Explore incentives for converting rental housing to owner occupancy.
- Develop infill housing concept plans on key sites in the city.
- Join the International Town and Gown Association.
- Host State of the City summit annually.
- Create a city Facebook and Twitter account.
- Consider ongoing online meetings in the future.
- Develop a volunteer recognition program.

Many of these action items do not fall within the purview of the watershed management plan; however, all of the above actions should be considered during development of the plan.

2.11.13 City of West Lafayette Combined Sewer Overflow Long-term Control Plan

In 1993, the City of West Lafayette began a nine-part, 20-year plan to reduce combined sewer overflows and comply with federal regulations related to the Clean Water Act. Over the last 10 years, a number of major improvements have been made, including:

- An $18 million upgrade to the wastewater treatment plant that included ammonia removal and de-chlorination.
- Completion of the $2.2 million foundation drain disconnect program in the BarBarry neighborhood (1999).
- Construction of the $2.3 million North River Road lift station (1999).
- The $1.9 million rehabilitation of the Happy Hollow interceptor (2001).
- Construction of the $5.9 million wet weather treatment facility to significantly reduce CSO impacts on the Wabash River (2003).

The city is moving forward on the final components of the 20-year plan. The western sanitary interceptor will remove a portion of sanitary flows out of the combined storm and sanitary system, reducing the number of CSOs and the strength of the wastewater in a CSO overflow event. It will also result in the elimination of three lift stations.

2.11.14 City of Lafayette Combined Sewer Overflow Long-term Control Plan

The City of Lafayette's wastewater treatment plant services 18,000 acres or 28.1 square miles. Lafayette maintains 436.4 miles of combined and sanitary sewers (Figure 18). Recent expansion of the wastewater treatment plant from an average annual capacity of 16 MGD (million gallons per day) to 26 MGD and a peak capacity of 28 MGD to 52 MGD during wet weather events occurred in 2004. The improvements included the following:

- New influent pump station;
- New fine screening, grit removal, and scum concentration facilities;
- Five new primary clarifiers;
- Two new aeration tanks;
- New process blowers;
- Four new final clarifiers and rehabilitation of the six existing clarifiers;
- New effluent pump station;
- New disinfection facilities and modified chlorine contact tank;
- Two new anaerobic sludge digester and rehabilitation of two existing digesters; and
- Standby power.

Plans were enacted in 2004 to implement nine minimum controls as detailed in the CSO operational plan; modify the collection system and CSOs to eliminate six lift stations and one CSO discharge; and expand the wastewater treatment plant. Since the plan was enacted, reconstruction on the south side of the city occurred resulting in the creation of a new interceptor, new lift station, and new force mains; removal of the Romney Road lift station; and closure of CSO outfall 017. Additionally, reduction in storm water flow to the Shamrock Park CSO outfall occurred resulting in the permanent closure of CSO outfall 008; while smaller pumping station elimination efforts focused on South 18th Street sewer, Twyckenham Boulevard extension, and Rome Drive.

Additional progress is on-going to remediate some of the CSO issues. Slyder (2009) details recent updates to the Lafayette system which included digging a 2,300-foot long, 10-foot diameter tunnel under 2nd Street. The completed tunnel holds up to 1.2 million gallons of combined sewage and stormwater and connects to the Pearl River lift station at 1st and Walnut streets. This project eliminates 30 percent of the city's overflow volume and cost approximately $27 million to complete.

The following improvements (Figure 49) are planned as part of Phase I and Phase II of the City of Lafayette's CSO Long-term Control Plan:

- Eliminate the parking lot lift station.
- Separate the sewer in the Earl Avenue area.
- Install a 48-inch parallel interceptor along Durkee's Run.
- Extend the storage and conveyance tunnel from North Street to the Cincinnati Street CSO.
- Install a 36-inch throttle pipe at CSO 010 and a 24-ince throttle pipe at CSO 015.
- Install a 96-inch conveyance sewer along the railroad corridor.
- Install at 5.9 MG combined stormwater storage facility near CSO 001 resulting in closure of CSO 002.
- Expand wet-weather storage at the Pearl River Lift Station for wet weather control.
- Install a 5.3 MG combined sewer overflow storage facility at CSO 006.
- Install a 72-inch conveyance sewer from CSO 007 to CSO 006 storage facility.
- Install a 119 MGD high-rate treatment facility near CSO 009.
- Install a 60-infh force main from the Pearl River Lift Station to the wastewater treatment plant.
- Implement a post-construction water quality monitoring program following completion of phase I (elimination of parking lot lift station) and phase II (all other practices).