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Walnut Creek – Tippecanoe River Watershed

Watershed Management Plan

ARN: A305-6-7

Document Information

Prepared for	The Watershed Foundation, 301 N. Main St., North Webster, IN 46555
Project Name	Walnut Creek – Tippecanoe River Watershed Management Plan
Watershed Coordinator	Lyn Crighton, Executive Director, The Watershed Foundation
Watershed Sampling Contractor	Lilly Center for Lakes & Streams
Watershed Plan Compiler	Theresa Sailor
Date	July 2019

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Contents

Acronyms

CFO	Confined Feeding Operation
CFS	Cubic Feet per Second
CAFO	Concentrated Animal Feeding Operation
CQHEI	Citizen's Qualitative Habitat Evaluation Index
CSO	Combined Sewer Overflow
DNR	Department of Natural Resources
E. coli	Escherichia coli
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HUC	Hydrologic Unit Code
HSG	Hydrologic Soil Group
IDEM	Indiana Department of Environmental Management
LARE	Lake and River Enhancement
LCLS	Lilly Center for Lakes & Streams
LID	Low-Impact Development
MACOG	Michiana Area Council of Governments
MS4	Municipal Separate Storm Sewer System
NO3	Nitrates
NPDES	National Pollutant Discharge Elimination System
NPS	National Parks Service
NRCS	Natural Resources Conservation Services
NRI	National Rivers Inventory
PTI	Pollution Tolerance Index
STEPL	Spreadsheet Tool for Estimating Pollutant Load
SWCD	Soil and Water Conservation District
TKN	Total Kjeldahl Nitrogen
TP	Total Phosphorus
TMDL	Total Maximum Daily Load
TWF	The Watershed Foundation

USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish & Wildlife Service
WMP	Watershed Management Plan
PCB	Polychlorinated biphenyls

Watershed Management Plan 2019

Walnut Creek – Tippecanoe River Watershed
HUC 051201060203

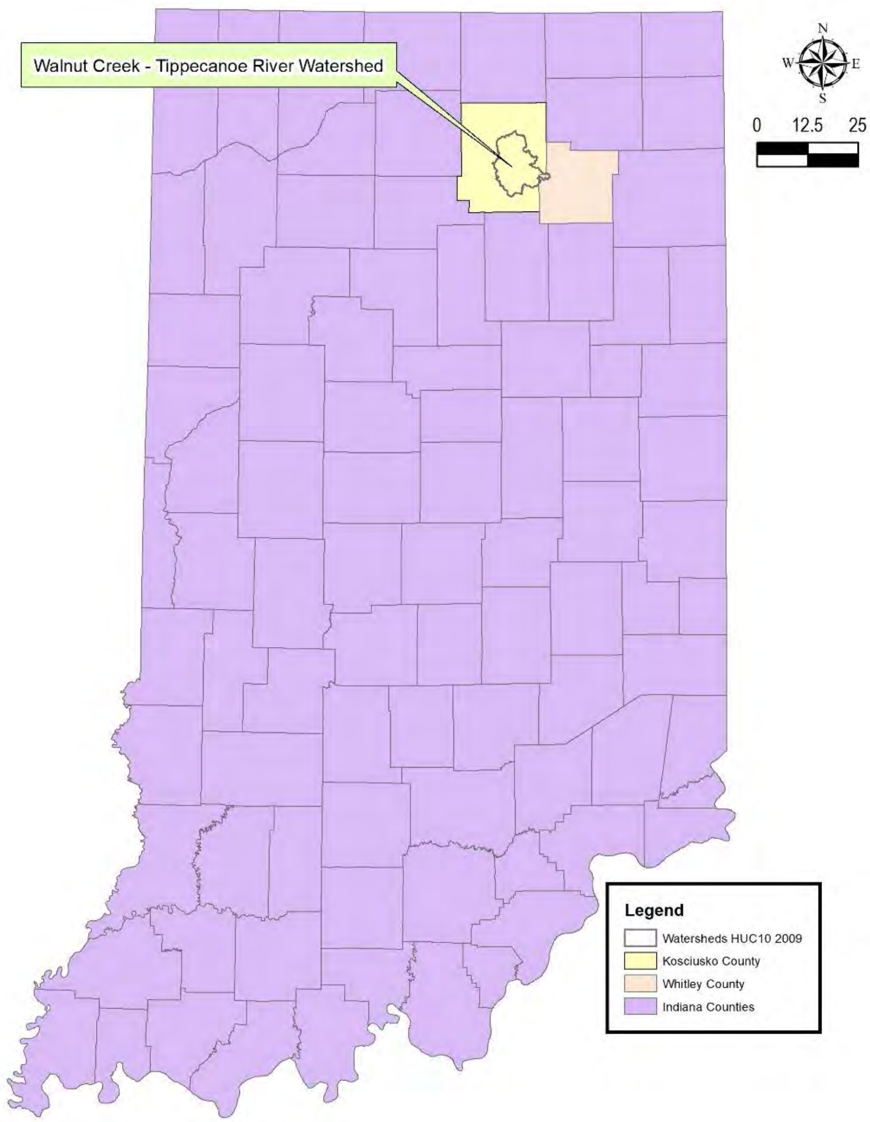


Figure 1 Location Walnut Creek - Tippecanoe River Watershed in Northern Indiana

The Walnut Creek – Tippecanoe River Watershed, Hydrologic Unit Code (HUC) 051201060203, is located predominately in Kosciusko County with 2% located in Whitley County to the east. The watershed is an area of land (78,406) that drains to the Tippecanoe River. Its general location in the State of Indiana is depicted in Figure 1.

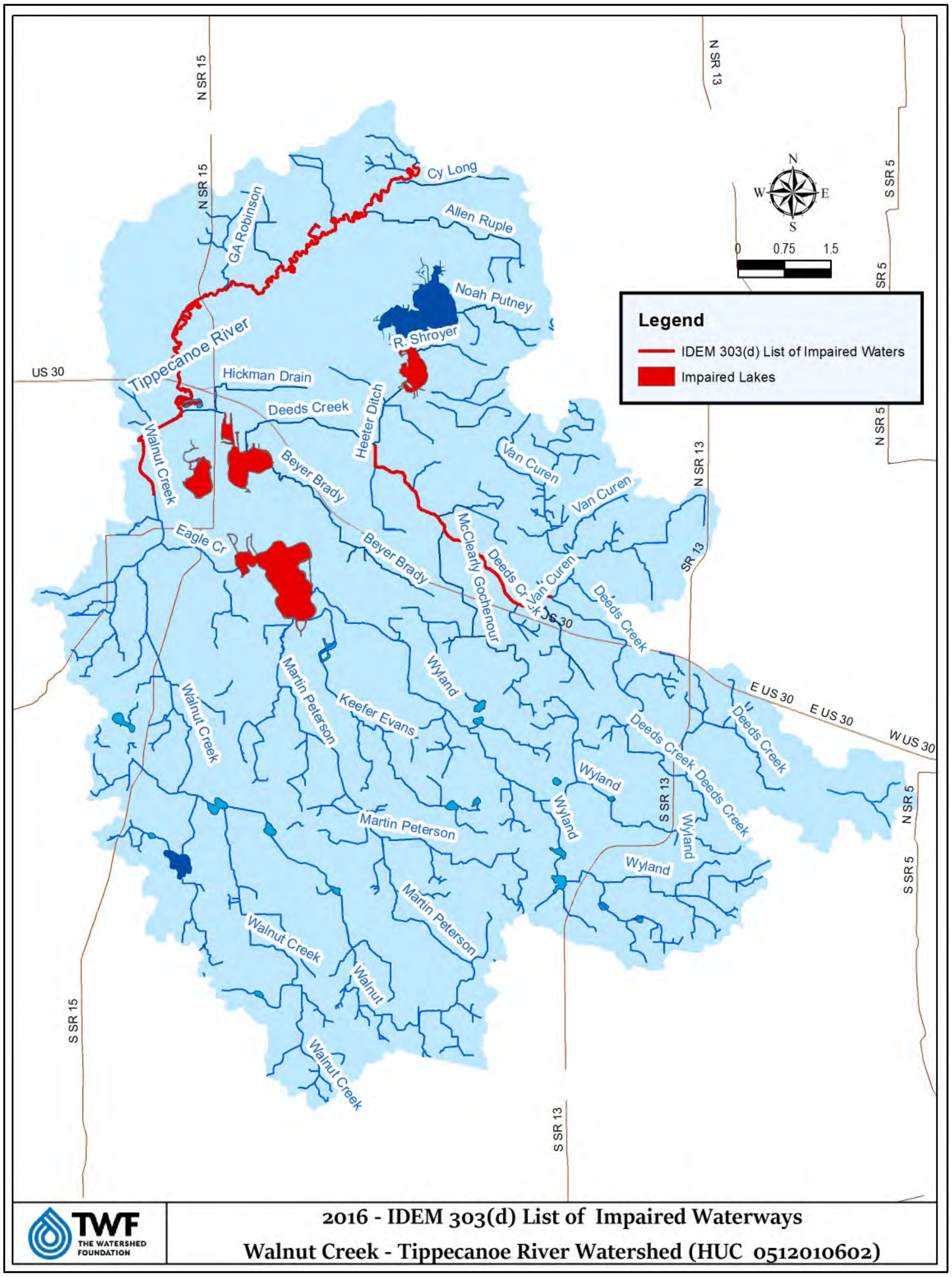


Figure 2 IDEM 2016 303(d) List of Impaired Streams & Lakes in the Walnut Creek – Tippecanoe River Watershed

The Watershed Management Plan (WMP) for the Walnut Creek – Tippecanoe River Watershed describes the issues present in the watershed and the management actions necessary to remediate them. The Indiana Department of Environmental Management (IDEM) currently lists multiple lakes and waterways in the 2016 303(d) list of impaired waters (Figure 2). This document builds on that information adding two years of additional water sampling, a desk-top survey, a partial field survey, and input from local stakeholders. This document represents only the first step of an on-going effort to evaluate & improve the watershed using a cyclical process of planning, implementation, evaluation, modification, and then repeating the process, ad infinitum, to achieve and maintain acceptable water quality within the watershed.

Clean Waters Partnership Watershed Community Initiative

Background on the Watershed Committee

At the request of the Indiana Department of Environmental Management (IDEM) in 2014, The Watershed Foundation (TWF), (formerly known as the Tippecanoe Watershed Foundation), approached several key water quality leaders and residents who work and/or live in the watershed to gage their interest in having the work of the TWF expand into the Walnut Creek – Tippecanoe River Watershed. TWF would adopt the adjacent watershed as an expansion of their organization combined with the support and guidance of a local steering committee of committed stakeholders. Stakeholders from government, business, education, and residential populations were initially approached through the local Kosciusko Chamber of Commerce Green Works Committee meeting in 2014 and at meetings of local lake associations. They were given the opportunity to weigh in and participate in the proposed project. The response was overwhelmingly positive.

In May of 2014, the Walnut Creek – Tippecanoe River Watershed Steering Committee was formed to protect and improve the waters of the Walnut Creek – Tippecanoe River Watershed. In August of that year, with the guidance and endorsement of the steering committee, the Foundation applied for a 319 non-point source grant through IDEM. In 2015, after being awarded funding to develop a watershed management plan (WMP), the steering committee adopted the name Clean Waters Partnership (CWP) as a tool for enlisting community support and commonality of purpose that could lead to enhancing public educational work and harnessing project funding. The CWP works under the leadership and administration of TWF, who was the recipient of the IDEM 319 grant supporting this work.

Importance of Water Quality to Stakeholders

Surface water is one of the most abundant and important geographic features in the Walnut Creek – Tippecanoe River Watershed. The many lakes, streams, and tributaries that make up the waterways in the watershed are an important contributor to the quality of life for local residences, bringing recreational and quality of place values that give residents an opportunity to live alongside wildlife, waterways, wetlands, and other natural areas and while still enjoying the benefits of urban living.

The lakes also provide an economic driver for the area's economy. In 2016, the Lilly Center for Lakes & Streams conducted research on the impact of lakes in Kosciusko County on annual business revenue (Bingham and Bosch). The study looked at business revenues in the county and determined that the area benefitted financially by an estimated additional $298,000,000 annually injected into the local economy due to lake related businesses and lake specific businesses. The research followed a 2013 study where researchers found increased lake property values contributed an additional $15,000,000 in property taxes to Kosciusko County (Bosch). The additional property taxes from lake property accounted for 37% of the entire property tax revenue. The study highlighted the importance of protecting water quality by directly connecting it to economic success of the community. The contribution of over one-third of property tax revenue and providing an influx of almost $300,000,000 revenue into the economy annually, this study established that the area's lake assets directly impact the economic health of residents, businesses, and local government (Bosch).

> 74% OF ALL RESPONDENTS OF THE SOCIAL INDICATOR SURVEY REPORTED USING LOCAL STREAMS, LAKES, OR PONDS FOR ONE OR MORE OF THE FOLLOWING: BOATING, PADDLING, SWIMMING, FISHING, OR HUNTING. 2018 Social Indicator Survey

Local leaders in Kosciusko County are sensitive to the importance of local waters. Water is abundant in the county and it is an important part of the local identity. The City of Warsaw is called "the City of Lakes" and takes great pride in the fact that it has three large lakes within its borders. Winona Lake is the centerpiece of the Town of Winona Lake. Local industry, especially the large orthopedic industry, needs a large workforce of skilled, educated employees and recognizes the importance of an area that provides opportunities where they can not only work but live and find quality recreational opportunities. Feedback from the watershed steering committee included value statements about the lakes and their importance to recruiting and retaining those employees. One member's goal statement for the watershed was to "become a public pro-active environmental community and increase the area's ability to draw a contemporary workforce by providing high visibility approach to environmental stewardship." Quality recreational opportunities and strong property values all contribute to the area being a community where people want to "live, work, and play", a tagline used by the City of Warsaw.

Steering Committee Members

There was clear willingness from the earliest discussions in 2014, when The Watershed Foundation approached local leaders to engage them in the prospect of starting a partnership to protect and improve water quality in the watershed. Local leaders included the Kosciusko Soil and Water Conservation District (SWCD), Lilly Center for Lakes & Streams (CL&S), City of Warsaw Utility, Kosciusko County Planning and Surveying Departments, Zimmer, and others. Community stakeholders were willing to provide support letters with many of them serving on the steering committee and providing matching funds. The Watershed Foundation was the lead organization and provided the overall administrative structure for both grant and watershed technical expertise. This structure allowed government, private industry, and local organizations to become collaborators with the ability to participate and contribute without the pressure and added commitment of providing those support services. TWF gathered diverse local stakeholders including industry, government, lake leaders, education leaders, agricultural leaders, and persons representative of each geographical area of the watershed to serve on the 22-member steering committee (Figure 3). These members, referred to as the Clean Waters Partnership (CWP), guided the development of the watershed plan. All steering committee meetings were open to the public.

Steering Committee Partner Organizations & Their Representatives		
Organization	**Representative Interest**	**Name**
Agricultural Community	Local Farmer	David Ransbottom
Lilly Center for Lakes & Streams	Education & Research	Nate Bosch
Center Lake Association	Lake Resident	Max Mauck
Chapman Lakes Foundation	Lake Resident	Peggy Wihebrink
Indiana American Water	Utility	Chris Harrison
Kosciusko County Council- District 4	County Government	Jon Garber
Kosciusko County Soil & Water District	Agricultural / Rural Land Use	Darci Zolman
Kosciusko County Surveyors Office	County Surveyor	Mike Kissinger
Kosciusko Emergency Management Agency	Emergency Management	Ed Rock
Kosciusko Area Planning	County Land Use	Matt Sandy
Kosciusko Chamber of Commerce	County Businesses	Rob Parker
Pierceton At-Large	Resident	Andrea Baker
Pike Lake Association	Lake Resident	Diane Quance
The Watershed Foundation	Executive Director	Lyn Crighton
The Watershed Foundation	Board of Directors	Chuck Brinkman
Warsaw Utilities Department	Stormwater Utility	Ryan Workman
Warsaw Utilities Department	Utility Manager	Brian Davison
Warsaw Parks Department	Parks Department	Larry Plummer
Warsaw Building & Engineering Department	Engineering	James Emans
Winona Lake Preservation Association	Lake Resident	Joy Lohse
Winona Lake Town Coordinator	Winona Lake Government	Craig Allebach
Zimmer Biomet	Orthopedic & Manufacturing	Kirk Swaidner

Figure 3 Steering Committee Members & Their Affiliations

Two subcommittees were also formed: Technical Advisory Committee, members listed in the Appendix, Table 3, and an Education and Outreach Committee, members listed in the Appendix, Table 3. Subcommittee meetings were open to the public and included additional members through invitation based on the topic being addressed. The Technical Committee often included additional local technical engineering and water resource personnel, Natural Resources Conservation District (NRCS), Department of Natural Resources (DNR), government advisors, and others. The Education Committee included local educators working on environmental education including TWF, Kosciusko County SWCD, Kosciusko Solid Waste Management District (known locally as the KC Recycling Depot), Lilly Center for Lakes and Streams (LCLS), City of Warsaw Stormwater Utility, and former school educators.

Generating Stakeholder Input

The committee collected public input regarding viewpoints on local concerns, expectations, and suggestions for improvement in the watershed. On March 23, 2016, the CWP held its first public open house at the Kosciusko Chamber of Commerce. The Partnership distributed 1,300 flyers at the Kosciusko Home and Garden Show on March 3-5, 2016 and posted the flyer at several local organizations and businesses. Local lake associations advertised the event. Additionally, TWF mailed over 500 personal invitations to the event. The Open House was an invitation for the public to come and learn about the partnership and give their input to project. All concerns listed at the Open House event are listed in Figure 4.

A watershed survey was posted on the TWF website where stakeholders could submit their concerns and input. TWF and the Clean Waters Partnership participated in the Northern Indiana Lakes Festival in June 2016, the Pierceton Heirloom Tomato Festival in August 2016, and Safety Day in September 2016. These events were used to provide public education, publicize the project, and create buy-in.

In 2017, a consultant was hired to conduct social indicator surveys to measure attitudes, behaviors, and knowledge of water quality issues. The project took place from December 2017 through March 2018. Two surveys were conducted. One was directed to the urban residential population. The second was designed to target large rural landowners who were likely engaged in agribusiness activities. Survey results are referenced in this management plan to demonstrate local concerns and values, interest in various land practices, and the understanding of different pollutants and pollution prevention practices. The Social Indicator Survey Report for the Walnut Creek Watershed is provided in the Appendix.

Watershed Stakeholder Concerns

Steering Committee Concerns

Beginning in 2015 and throughout the WMP process, the steering committee identified concerns and potential threats to water quality in the watershed. The steering committee also held public events to gather stakeholder concerns and worked to set goals based on stakeholder concerns, the watershed inventory, and the results from water quality testing. The following is a summarized review of stakeholder concerns.

THERE WERE 82 LARGE LAND OWNER RESPONDENTS TO THE SOCIAL INDICATOR SURVEY & 948 GENERAL PUBLIC RESPONDENTS. 2018 Social Indicator Survey

Nutrient Concerns

One of the biggest concerns in the watershed is nutrient loading. Of the 9 nine local lakes that are being monitored by the Indiana Clean Lakes program, 5 five are considered eutrophic to hyper-eutrophic. Little Chapman, Little Pike, Pike, and Center Lakes are all listed by IDEM for phosphorus impairments. Residents fight aquatic weeds and have initiated the creation of Lake and River Enhancement (LARE) funded aquatic vegetation management plans.

Bacteria Concerns

E. coli is also a concern for the watershed. Deeds Creek is listed as impaired for E. coli by IDEM. However, many streams have not been sampled for E. coli making it unclear if additional E. coli impairments are present. There is concern among stakeholders that E. coli levels may be an unseen bacteria problem. E. coli is an issue on public beaches. During 15 years of weekly sampling by the Kosciusko Health Department, Center Lake and Pike Lake had E. coli concentrations prompting beach closures 32% & 41% of the time, as cited in a 2014 study by the Lilly Center for Lakes & Streams, “Identifying causes of high E. coli concentrations at public beaches on Pike and Center lakes in Kosciusko County, Indiana” (Barber, Miles, et al. 2014).

65% OF GENERAL PUBLIC RESPONDENTS REPORTED THEY WERE CONCERNED ABOUT DROPPINGS FROM GEESE, DUCKS, AND OTHER WATERFOWL INDICATING THAT THEY BELIEVED IT TO BE A PROBLEM. 2018 Social Indicator Survey

60% INDICATED A CONCERN FOR EXCESSIVE AQUATIC PLANTS OR ALGAE. 2018 Social Indicator Survey

From 2010 -2013 the Lilly Center for Lakes & Streams studied blue-green algal toxins (microcystin) in Kosciusko County lakes. While concentrations of the toxin *microcystin* were generally low across lakes studied (including Pike, Center, Winona, Big and Little Chapman), detection was common (Bosch, Nathan, S., et al., 2014). With continued nutrient loading, the risk of increased frequency or population of algal blooms in the watershed may not only pose ecological threats, but significant human health threats if not addressed. (Bosch, Nathan, S., et al., 2014).

Sedimentation

Sedimentation is a concern in both the lakes and streams. Peterson and Wyland ditches, both entering Winona Lake, consistently have large sediment plumes and have had LARE-funded bank stabilization projects to repair erosion; however, streambank erosion can still be observed. Urban stormwater is also a contributor. In 2017, Winona Lake was pursuing a dredging project to remove sedimentation near the City of Warsaw outfall pipes on the northern part of the lake. The Chapman Lakes have pursued LARE-funded bank stabilization projects on four drains and sediment removal in several areas. Center Lake also has completed a LARE dredging project near the inflow from Lones Ditch.

Land Use Concerns

These lakes face the pressures of nutrient and sediment loading from their tributaries, as well as the added stress of urban impacts. The City of Warsaw MS4 district covers 10 square miles, 10% of which is water. The urban areas are heavily industrialized and include the heavily traveled US 30 highway. Proximity to heavy industrialization, transportation, and rapid growth leaves the lakes and streams vulnerable to pollution from a variety of sources, such as spills, industrial pollution, urban runoff, and hydrological modifications of stream flow due to stormwater inputs of large hard surfaces.

The primary rural concern is row crop agriculture, predominately corn and soybeans combined with highly erodible soils. The 2017 SWCD tilling transect study found that approximately 51% of county corn fields were no-till, but local SWCD staff estimate a likelihood of only 10-15% of the county's farms are using conservation measures to the fullest (2017 Transect Report Kosciusko County).

Additional agricultural pressures come from a significant number of animal operations in the watershed. Within the watershed are 13 IDEM permitted Confined Feeding Operations (CFO), eight of which are south of US 30 and near many of the inflows to the larger lakes. The need to spread manure presents an added challenge for farmers considering no-till who have traditionally knifed in manure as fertilizer.

Urban and Point Source Concerns

Urban areas are growing in the watershed, placing additional pressures on local waters. Stakeholders expressed concerns over growing development. According to the U.S. Census Bureau, the Town of Winona has experienced a 4.9% growth in the past seven years. Warsaw has experienced an 8.7% growth in the same period. The population of Pierceton has remained stable (Census). Construction in these municipalities, when not adequately stabilized, can lead to soil erosion and sedimentation of waterways. In 2015, reconstruction of East Market Street in Warsaw led to a significant sediment plume entering Winona Lake during a rain event Picture 1.

Wastewater treatment facilities are another potential concern for urban point source pollution. The public has not forgotten the potential legacy pollution from the previous Warsaw treatment plant's poor management discovered in 2002 that required years of remediation and monitoring of Walnut Creek's downstream ecosystem (Robinson, Felicia, 2002).

Pierceton's treatment plant was upgraded in 2017 but has had a history of IDEM citations for non-compliance. A new treatment facility serving the Barbee Chain of Lakes came online in 2017 adding a new point source to the watershed. Its effluent discharges to Van Curen Ditch which flows into Deeds Creek.

Picture 1 Sediment Laden Runoff into Winona Lake from a Warsaw Construction Project (Sailor,T., 2015)

Commercial and industrial discharges are of great concern. Numerous discharge complaints from outfalls have been reported by Winona Lake residents to the City of Warsaw. Several commercial and industrial businesses are located just north of Winona Lake and discharge stormwater or industrial non-contact cooling water. The most widely reported release in the last 10 years took place in 2015 due to a fire that released hazardous chemicals into the storm sewer system that drained directly to Winona Lake (Sabalow, Ryan, 2015).

Discharges are not new to Winona Lake. A Report on Winona Lake (Corvallis Environmental Research Laboratory and Environmental Monitoring & Support Laboratory, 1976) identified four outfalls with known industrial waste discharges including the Litchfield Creamery (milk), Indiana Briquetting Co. (oil), Gatke Corp. (oil), and Dalton Foundry (oil). Today, only Dalton Foundry remains. It is still a source of intermittent oil releases along with 300,000 – 1,000,000 gallons

Picture 2 Warsaw Chemical Fire 2015, Release of Toxic Chemicals into Winona Lake (Sailor, T. February 2015)

a day of warm water from state permitted non-contact cooling water. Dalton Foundry is one of many industrial and commercial business connections to the storm sewer that present a pollution concern.

The following figure lists stakeholder concerns raise during the plan process.

STAKEHOLDER CONCERNS	
Nutrient Loading	**Wildlife Habitat, Biotic Communities and Hydrology**
High levels of phosphorus in lakes and waterways	Improve health of the lakes
Urban runoff, i.e. yard waste nutrients entering storm drains and from lake residents	Develop a plan to manage wetlands
Urban ordinances currently do not allow native (tall) grasses	Promote urban wildlife habitat, swales, and rain gardens
Fertilizer runoff	Improve habitat, protect and improve open space
Fecal matter nutrient contamination (manure/septic)	Reduce the size and reoccurrence of algal blooms
Bacteria	Reduce flooding
Fecal matter contamination, waterfowl, pet, human, farm	Control/ Eliminate/ Educate Invasive species wildlife and plant community
Failed / failing septic systems education	Waterfowl management
Farm manure application management	Increase diversity and quantity of species in wildlife food web
Occurrence of blue-green algae (cyanobacteria)	Develop community awareness healthy soil = healthy water
Sedimentation	**Public Education & Engagement**
Sediment filling the bottom of the lakes reducing WQ for aquatic wildlife	Develop an increased level of appreciation of the lakes
Sedimentation in ditches & waterways	Non-lake resident education and how they are connected to the lake
Erosion from construction practices	Develop local understanding and buy-in to help stop pollution at its sources from owners and other sources
Waterway Maintenance	Engage community (decision makers, community, businesses) on being part of the solution
Bank stabilization lakes, & waterways	Preserve the local waters as community assets
Need for natural stone lake front sea walls	Develop a plan that identifies the education and outreach activities needed for implementation
Improve Infrastructure Maintenance	Engage diverse representation (businesses and geographical areas) to participate in the project
Combined sewer overflows	Increase local stewardship / connection to the water
Lack of sewer around large populated areas & lakes	Grow a program that gets people paddling / watercourse section for recreation
Possibility of septic limitations being ignored to allow building and growth	Develop informed and conscientious citizens regarding water pollution
Reduce Flooding	Mentor local youth in environmental conservation
Lack of green infrastructure that could filter out nutrients, such as curb cuts	Invite local populations to the watershed to *experience* specific ecosystems / natural resources
Chemicals Entering Waterways	Preserve Lake Economic Viability and Community Culture
Concerns about stormwater pollution, especially from state roads, i.e. SR 15 into Center Lake	Educate and engage local business (agriculture, poultry, ranching) on issues of local pollution and environmental stewardship.
Reduce chemicals entering waterways commercial, agriculture, & residential	Become a public pro-active environmental community and increase the area's ability to draw a contemporary workforce by providing high visibility approach to environmental stewardship
Concern that chemicals are leaching through groundwater into lakes TCE/sewage/medications	Promote downspout disconnection and drainage into rain gardens and yards not into lakes or storm drains
Concern of BOD/CODs in streams and lakes	Educate the public on the existence of endangered species.

Figure 4 List of Stakeholder Concerns

The Watershed Inventory

Waters of the Watershed

The Walnut Creek – Tippecanoe River watershed is part of the larger Wabash and Ohio River Basins. The Tippecanoe River combines with the Wabash at Lafayette, which joins the Ohio River on the SW corner of Indiana before meandering down to the Mississippi River and the Gulf of Mexico. The Mississippi River gathers sediment, nutrients, and other pollutants from its tributaries until reaching the Gulf of Mexico.

Although the process where nutrients and sediment wear away from the land and into receiving waters is a natural process that historically occurred slowly over time, in today's world the land is constantly being altered by an almost constant hum of harvesting and settlement activities that intensify pollutants and accelerate sediment loss downstream.

The Walnut Creek – Tippecanoe River Watershed is the second watershed from the headwaters of the Tippecanoe River sub-basin. It is 78,448 acres in over five subwatersheds. The watershed is dotted with glacial lakes that provide important recreational and economic opportunities for the area (Figure 5). That abundance of water including twenty-four lakes with a combined area of 1,882 acres adds to the importance and urgency for the conservation of local waters to protect human health, quality of life, and the protection of the biodiversity in the watershed.

The Walnut Creek – Tippecanoe River watershed lies predominately in Kosciusko County with just 2% to the east in Whitley County. The watershed is 122 square miles and includes the urban areas of Pierceton (1.2 square mile), the Town of Winona Lake (3.25 square miles), and its largest urban area, the City of Warsaw (12.9 square miles) (Figure 6).

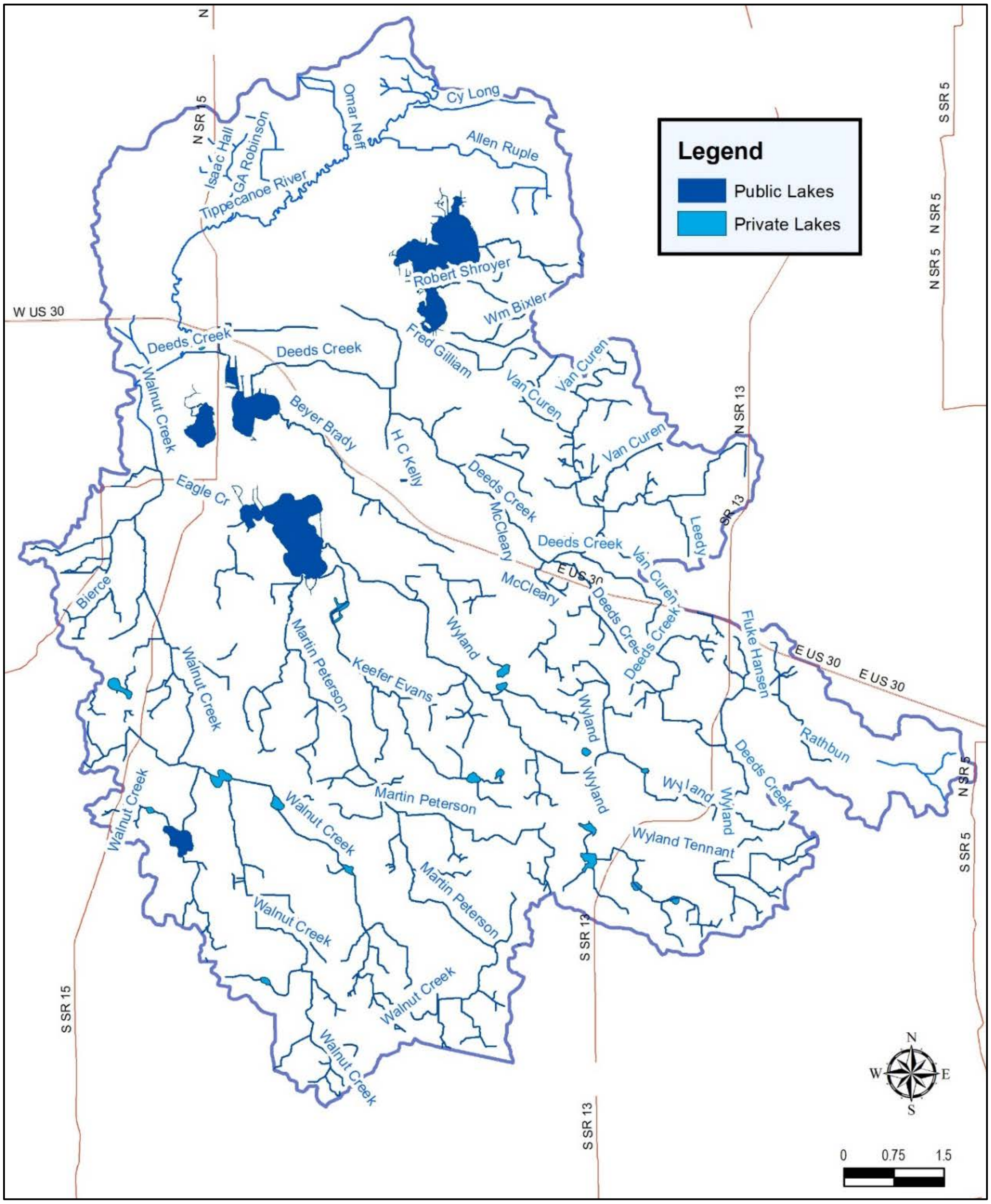


Figure 5 Labeled Waters in the Watershed

Urban Characteristics

There are two colleges: Grace College in Winona Lake and Ivy Tech Community College in Warsaw, Indiana. Although a significant amount of local employment in Warsaw is centered in the biomedical industry as the Orthopedic Capital of the World, the economy has diverse opportunities for employment. These include heavy manufacturing (foundry), light manufacturing including plastics, metalwork, product and chemical manufacturing, printing, watercraft production, construction, and health and medical services.

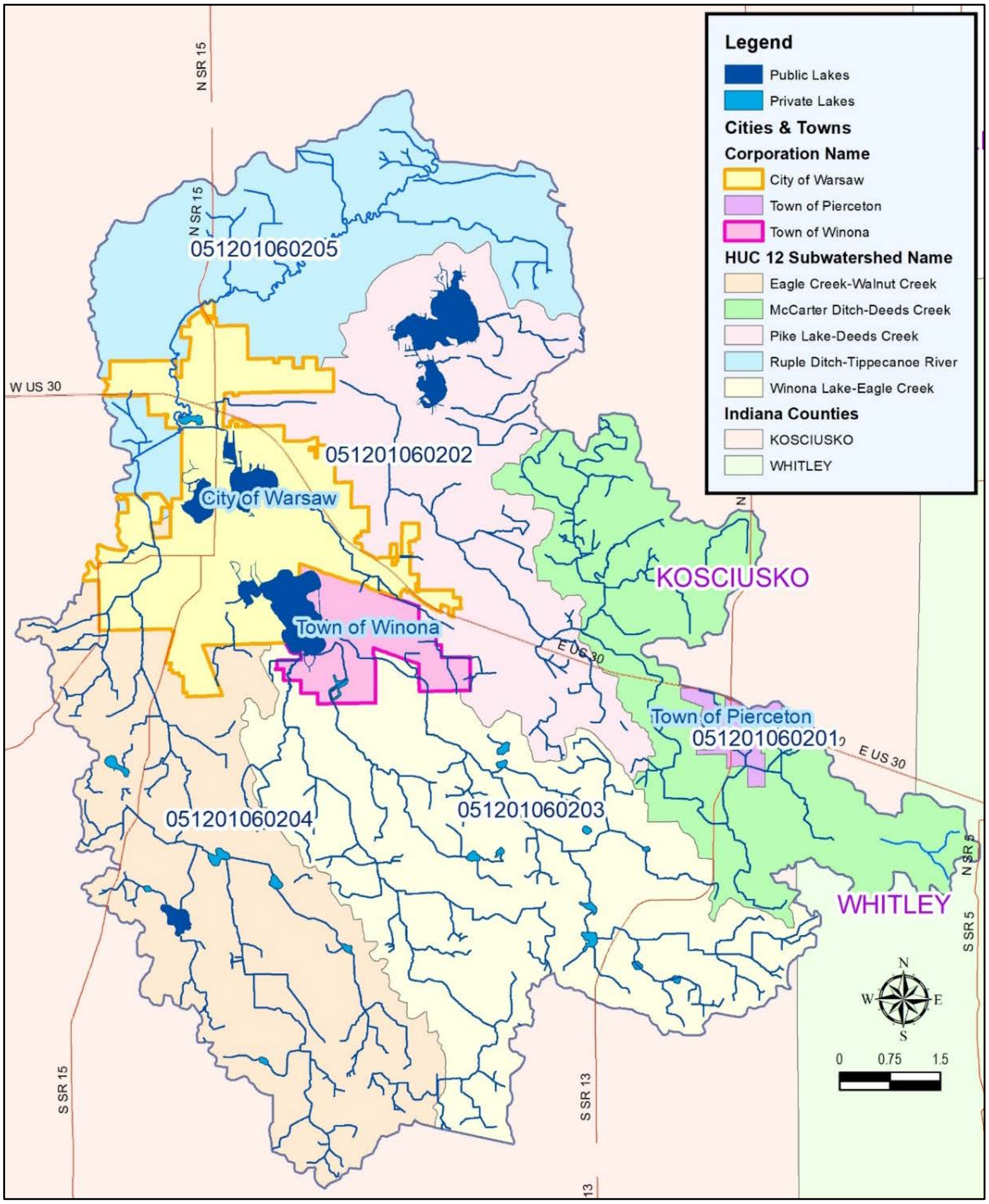


Figure 6 Watershed & Subwatersheds with Named Cities & Towns

Access to large volumes of water, 500,000 gallons a day or more, is important to more than a couple of the local industrial and manufacturing companies in Warsaw, who pump ground water for non-contact cooling water and discharge that water into the lakes and regulated drains in the community.

Agricultural Characteristics – Regulated Drains

A diverse agribusiness sector relies on water for both animal and crop production. There are over 250 miles of waterways (both open ditch and field tile (underground pipe)) in the watershed (Figure 7). Approximately 238 miles are regulated drains; 135 miles are open channel waterways and 115 miles are field tiles that provide drainage for wet soils that in turn

STAKEHOLDERS EXPRESSED CONCERNS REGARDING BACTERIAL CONTAMINATION FROM FARM ANIMAL MANURE ORIGINATING ON PROPERTIES WITH ANIMAL OPERATIONS OR IN THE LAND APPLICATION OF MANURE ONTO OR INTO CROPLANDS.

allow a significant portion

of the watershed to be classified as prime farmland (Map 13, Appendix). The readily accessible water, the cropland availability for manure land application, and the ability to maintain green pastures, all make the watershed a favorable location for both confined feeding and pastured animal production. The watershed is home to 14 permitted confined feeding operations (Map 21, Appendix) and a minimum of 14 hobby farms (found during the windshield survey).

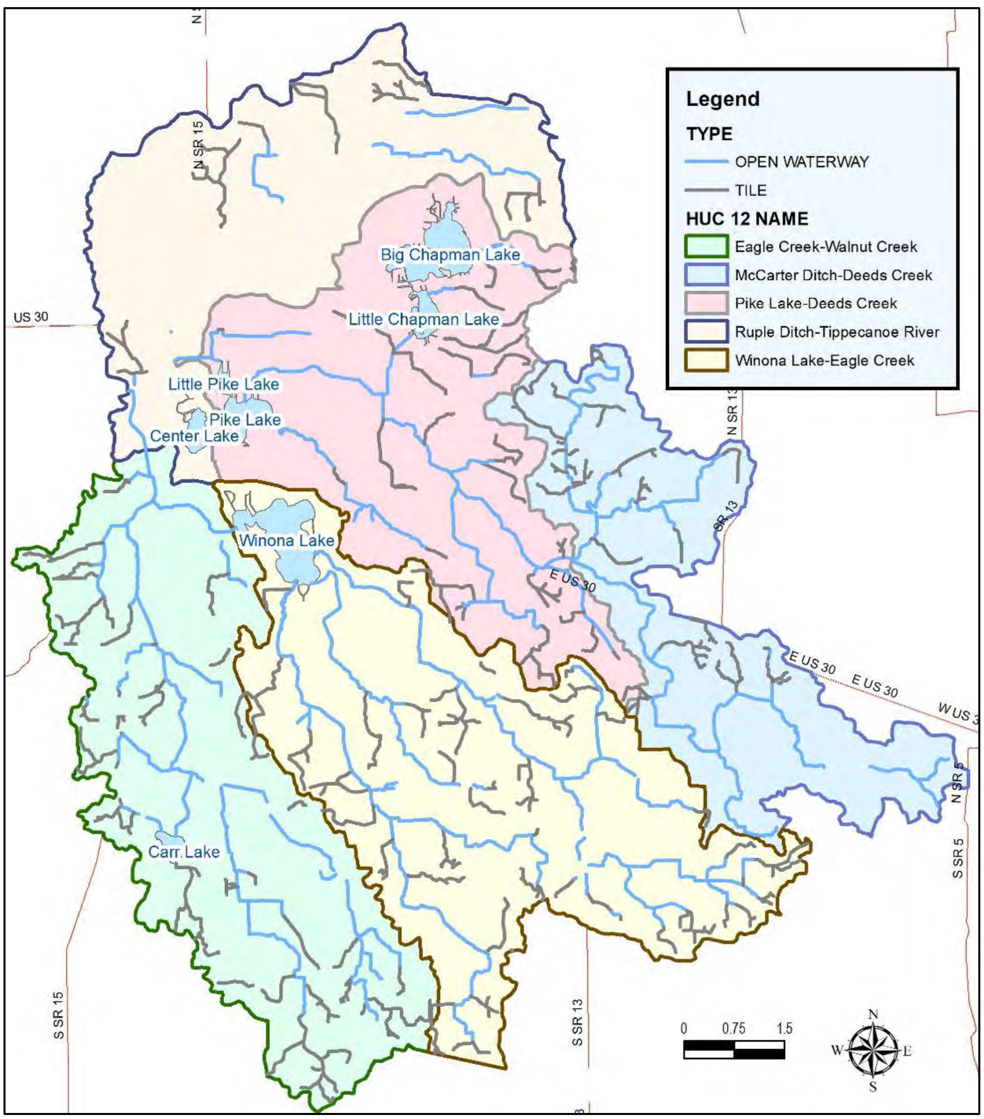


Figure 7 Regulated Drains in the Watershed

Local Economic Value of Water

Water and access to it has been, and remains to be, an important economic asset to the watershed. It contributes an important component in establishing and developing the industrial, recreational, real estate, service industries, and agribusiness sectors of the local economy. The watershed has significant groundwater and surface water resources. This watershed alone encompasses 24 natural freshwater lakes with a combined acreage of 1,882 acres. The 24 lakes (Map 20, Appendix) in this watershed, combined with an additional 66 natural freshwater lakes and over 200 manmade lakes and ponds in Kosciusko County, help to create a lake community culture in the area and the concurrent need for conservation and protection of those valuable assets. Figure 8 lists all waterways in each subwatershed, rivers, ditches and lakes.

STAKEHOLDERS EXPRESSED CONCERN OF SEDIMENTATION ENTER WATERWAYS AND FILLING THE BOTTOM OF LAKES AND REDUCING THE WQ FOR WILDLIFE.

These lakes provide recreational opportunities for both residents and tourists. There is fishing, kayaking, sailing, and paddle boarding opportunities. Many also allow motorized boating, pontoons, wakeboarding, and skiing. Even though not all the lakes provide public access or swimming, free public boating accesses as well as public swimming beaches are located at Winona, Center, and Pike Lakes. Public boat access is also available at Big Chapman and Carr Lakes. A complete listing of lake characteristics such as public access points, fish advisories, and other relevant public information can be found in the Tables 4 & 5 in the Appendix. In addition, Figure 8 lists the regulated drains, lakes, and rivers in each subwatershed. The Winona Lake – Eagle Creek and Eagle Creek – Walnut Creek subwatersheds have most smaller lakes in the watershed, whereas Pike – Lake Deeds Creek, McCarter Ditch – Pike Lake, and Ruple Ditch – Tippecanoe River subwatersheds all have extensive ditch systems. Map 3 and Map 4 in the Appendix shows a visual representation of the waterways and lakes within the subwatersheds. Map 3 includes named waterways and Map 4 includes named lakes and the subwatershed boundaries. This is important to note when looking at Map 17 in the Appendix, "Land Use and Waterways" which shows the concentration of agribusiness and urban development in relation to waterways in the watershed. Agribusiness is present in each subwatershed. Urban development is a concern for the large lakes located in the City of Warsaw and the Town of Winona, including Pike and Little Pike Lakes, Center Lake, and Winona Lake.

STAKEHOLDERS EXPRESSED CONCERNS REGARDING THE NUTRIENT ENTERING LAKES AND THE PRESENCE OF BLUE-GREEN ALGAE (CYANOBACTERIA).

STAKEHOLDERS EXPRESSED CONCERNS ABOUT STORMWATER POLLUTION AND RUNOFF AND DISCHARGES FROM REDIDENTIAL, COMMERCIAL, AND INDUSTRIAL PROPERTIES.

In addition to the lakes, there are 38 miles of creeks. Eagle and Deeds are too small to navigate; however, Walnut Creek could be navigable if it was cleaned out of logjams. The 12 miles of Tippecanoe River that passes through the watershed also provides recreational opportunities including fishing, canoeing, and kayaking. During 2014-2016 a group of organizations in a public/private partnership removed more than 280 logjams thereby clearing a 30-mile stretch of the Tippecanoe River starting at Oswego Lake and extending to SR 19. The entire stretch is an estimated 11 hours of paddling (Lilly Center for Lakes & Streams, 2016).

STAKEHOLDERS EXPRESSED THE DESIRE TO BECOME A PRO-ACTIVE ENVIRONMENTAL COMMUNITY AND INCREASE THE AREA'S ABILITY TO DRAW A CONTEMPORARY WORKFORCE BY PROVIDING HIGH VISIBILITY APPROACH TO ENVIRONMENTAL STEWARDSHIP.

HUC 10 Walnut Creek – Tippecanoe River Watershed Data within 0512010602					
Subwatershed Name,	Ruple Ditch-Tippecanoe River	Pike Lake-Deeds Creek	Winona Lake-Eagle Creek	McCarter Ditch-Deeds Creek	Eagle Creek-Walnut Creek
12-digit Hydrologic Unit	051201060205	051201060202	051201060203	051201060201	051201060204
Area (Acres)	13044	16254	20554	11352	17244
Rivers	Tippecanoe River	Big Chapman Lake	Winona Lake	Deeds Creek	Schultz Lake
Lakes	Center Lake	Little Chapman Lake	Lapsew Lake	Rathbun	Tibbits Lake
Creeks	Hidden Lake	Pike Lake	Tennant Lake	Fluke Hanson Ditch	Carr Lake
Ditches	Isaac Hall Tile Drain	Noah Putney Open Drain	Sellers Lake	Leedy Ditch	Price Lake
	GA Robinson Ditch	Robert Shroyer 8-14" Tile	Sherburn Lake	Van Curen Ditch	Fish Lake
	Omar Neff Ditch	Robert Shroyer Open Ditch	McPherson Lake	Elizabeth Schue Ditch	Muskellunge Lake
	CY Long Open Ditch	Deeds Creek-Heeter Arm Open Ditch	Stevens Lake	John Pyle Ditch	Goose Lake
	Rookstool Ditch	Fred Gilliam Tile	Reed Lake	Bierce Ditch	Walnut Creek
	ESSIG Tile Drain	Deeds Creek-Bareham Main 12-14" Tile	Wyland Lake	AJ Wiltrout Ditch	Eagle Creek
	Allen Ruple Open Ditch	Deeds Creek-McCarter Open Ditch	Sheely Lake	CW Scott Ditch	
		Beyer Brady Open Ditch	Lake John		
		McCleary Gochenour Open Ditch	Eagle Creek		
		Deeds Creek-Amanda Grove Arm Tile	Wyland Connell Arm Tile		
		Peter McClaine Tile	Wyland Tennant Workman Koontz Arm Tile		
		Peter McClaine Ditch	Wyland Tennant Workman Connell Tile		
		Deeds Creek O'Connell JJ tile	Wyland Tennant Davis Tile		
		Deeds Creek-Joseph Smith Arm 1 Tile	Wyland Tennant Stone Lizzie Open Ditch		
		Deeds Creek-Joseph Smith Open Ditch	Wyland Tennant Arm 2		
		Deeds Creek-Alfred Hall Tile	Wyland Open		
		Deeds Creek -Amos Stump Tile	Wyland Hoffman Open Ditch		
		Deeds Creek Open Ditch	Wyland Wertenberger Tile		
			Wyland Bouse Tile		
			Wyland Bergen Percy Tile		
			Keefer Evans O'Connel Tile		
			Walter Phillips Ditch		

Figure 8 Subwatersheds & Waterways in the Walnut Creek - Tippecanoe River Watershed

Infrastructure

Transportation Facilities

The watershed has 155 miles of roads. By census standards, Kosciusko County is not considered a major metropolitan hub with its approximately 78,000 population. Only its largest city Warsaw with a population of 13,500 met the census standards to be considered an "urbanized" area (over 10,000 people). However, Kosciusko County does provide ample opportunities for workers in this rural county and many adjacent counties. The employment opportunities attract workers who are willing to commute from for example, Wabash, Plymouth, Goshen, and Fort Wayne. The ease of access to arterial roads (U.S. Highway 30) and collector roads (S.R. 15, S.R. 13, S.R. 25) makes commuting an accessible option from greater distances. The arterial and collector roads have significant heavy truck traffic and can provide Warsaw industries easy accessibility to shipping options (Map 5, Appendix).

Other transportation assets include the Warsaw general aviation service airport. The 557-acre public use airport has over 15,000 flight operations a year leaving the airport. The airport manager states that in 2016, there were 51 aircraft based at this airport: 38 single-engine, 1 multi-engine, 7 jets, and 1 helicopter. UPS ships out once nightly on a chartered plane. There are both an East-West and a North-South railroad that travel directly through the City of Warsaw. Historically they were important shipping hubs for local industry. Now they simply travel through the City to other final destinations.

STAKEHOLDERS EXPRESSED CONCERNS FOR POTENTIAL SPILLS AND ACCIDENTS AS HEAVY INDUSTRIAL TRAFFIC UTILIZE THE TRANSPORTATION ACCESS THROUGH THE COUNTY.

Water Supply

Although Center Lake was the source of drinking water for the City of Warsaw until 1970, ground water is now the source of drinking water in Warsaw and throughout Kosciusko County. This supply is stored in deposits of glacial sand and gravel overlying Devonian bedrock formations of Antrim Shale (black shale, grey shale, and limestone) and Muscatatuck Group (limestone and dolomite) (Map 14, Appendix). The accessibility to groundwater in the sand and gravel layers in the northern and central area around Chapman Lake and the Tippecanoe River make that area susceptible to groundwater pollution.

The 1985 Soil Survey of Kosciusko County completed by the United States Department of Agriculture, Soil Conservation Service, in cooperation with Purdue University Agricultural Experiment Station estimated that the overall water supply was expected to meet future demand of municipal, recreational, agricultural, and industrial needs of the County. (Tharp, W. E., et al./ 1985).

Relief and Drainage

The terrain in Kosciusko County varies widely. It includes the nearly-level till plains and old lakebeds in the northwestern part of the county and the rolling, highly dissected moraines and alluvial bottom land in the southeastern part.

The highest elevation in the county is 1,025 feet above sea level. It is in an area north of Dewart Lake, in Turkey Creek Township, section 19. The lowest elevation is about 760 feet above sea level. It is in an area in Jackson Township where the Eel River flows into Wabash County. Most of the watershed has a 100-total foot variance in its elevation with a significant portion at or around the 850' elevation mark. The highs at 900' elevation are found toward the eastern part of the watershed and county. The lows at 800' elevation fall at the Tippecanoe River as it leaves the watershed and county. The receding and melting of the Wisconsin Glacier allowed for the formation of lakes dotting the landscape of Kosciusko County and the watershed. The relative fall is east to west. The 238 miles of ditches and waterways provide positive flow of water to reduce flooding and drain fertile but wet farmland. Map 8 in the Appendix shows the convergence of the waters in the watershed in the City of Warsaw and a substantial amount of flood risk in that area. By comparing the Floodplain Map (Map 8, Appendix) and the National Wetlands Inventory Map (Map 9, Appendix) the Flood map shows water where there is wetland and then beyond also as water. In reality, some of that property is developed. The Tippecanoe River is the outfall for the waters in the watershed; therefore, when it floods, the water in the Warsaw area does not have a place to go. Complicating that is the waters of the Tippecanoe River will back up into Walnut Creek and create flooding along Center Lake, Walnut Creek, and Eagle Creek.

The Continental Divide runs east and west through the top half of the county. Its relief combines with a moraine ridge that can be found just to the northwest of Warsaw extending northeast through Nappanee and up to the state line, splitting the county into three major drainage basins and three different receiving bodies, the Illinois River, the St. Joseph River and the Wabash River.

Relief has greatly affected the soils in Kosciusko County through its effect on natural drainage, runoff, erosion, plant cover, and soil temperature. Slopes range from nearly level to steep. Runoff is more rapid on steeper slopes with temporary ponding occurring in the lower areas.

Drainage is greatly affected by relief being excessively drained on ridgetops and very poorly drained in depressions. Drainage or lack of drainage affects soil aeration and the color of the soil. Well-drained soils allow for air and water to move freely through the soil. When the soil is well aerated, the iron and aluminum compounds in the soil are brightly colored and oxidized. An example of this is the well-drained Coloma soils. Opposite the Coloma are the poorly drained and poorly aerated Rensselaer soils that are dull and gray.

Soils

Factors of Soil Formation

Soils form through the physical and chemical weathering of geologic material. Soil characteristics are determined by its principal influences including; the physical and mineralogical composition of the parent material, or underlying bedrock in which the soils have formed; the climate conditions under which the soil material accumulated and existed since accumulation; the duration the soil has endured the climate; the use by both plant and animal life on and in the soil; and, the relief or contours of the land. Adequate examination of these interrelated influences in total are required for understanding the soil and its characteristics.

Some organic matter has accumulated in the surface layer of all the soils in the county. The content varies throughout the county. The darker soils generally have the highest organic content.

Time, usually a long time, is required in the process of soil formation to form distinct horizons. Differences in the length of time that the parent material has been in place are commonly reflected in the degree of profile development.

Parent Material

The underlying bedrock of the area is Devonian bedrock Map 5. The watershed uses groundwater from aquifers that lie in gravel and sand overlying Devonian bedrock. Above the Devonian bedrock lies a total of 150 to over 350 feet of unconsolidated glacial deposited material or parent material left over from the ice age. (Grove, Glenn E., 2008).

The following information on parent material and material types was excerpted from the 1985 USDA Natural Conservation Resources Service Soil Report for Kosciusko County (Tharp, W.E., et al., 1985). Parent material is the unconsolidated mass in which soils form. It determines the limits of the chemical and mineralogical composition of the soil. The parent materials in Kosciusko County were deposited by glaciers or by meltwater from the glaciers that originated in Canada, Michigan, Ohio, and Wisconsin. Some of these materials were reworked and redeposited by the subsequent actions of water and wind. The most recent glaciers, the Wisconsin Glacier, covered the county about 12,000 to 15,000 years ago. Although the parent materials are of common glacial origin, their properties vary greatly, sometimes within small areas, depending on how the materials were deposited. The dominant parent materials in Kosciusko County are glacial till, outwash deposits, lacustrine deposits, alluvium, and organic material.

Glacial till is unsorted glacial sediment material laid down directly by glaciers. It consists of a range of particles of different sizes that are mixed together. The small pebbles in glacial till have sharp corners, indicating that they have not been worn by water. The glacial till in Kosciusko County is calcareous (contains calcium carbonate), friable (easily crumbled) or firm fine sandy loam to clay loam mixtures. Miami soils are an example of soils that formed in glacial till. The Miami soils typically are medium textured and have well developed structure.

Outwash material was deposited by running water from melting glaciers. The size of the particles that make up outwash varies, depending on the velocity of the water that carried the material. When the water slowed down, the coarser particles were deposited. Finer particles, such as very fine sand, silt, and clay, were carried farther by the more slowly moving water. Outwash deposits generally occur as layers of similar-size particles, such as sandy loam, sand, gravel, and other coarse particles. Many Kosciusko soils are an example of soils that formed in outwash material.

Lacustrine material was deposited by still, or ponded, glacial meltwater. Because the coarser fragments dropped out of moving water as outwash, only the finer particles, such as very fine sand, silt, and clay, remained to settle out in still water. Lacustrine deposits are either silt based, or clay based. The soils in Kosciusko County that formed in these deposits are medium textured to fine textured. In Kosciusko County, the Toledo soils are an example of soils that formed in lacustrine material.

Alluvium is recently deposited material by floodwater along present streams. Like the Lacustrine, the size of the material depends on the flow of the water when it is deposited. Shoals and Saranac are examples of soils that formed in alluvium.

Organic material occurs as deposits of plant remains. After the glaciers withdrew from the survey area, water was left standing in depressions on outwash plains, lake plains, and till plains. Gradually the lakes filled with organic material from dead plants and trees that did not decompose that eventually developed into peat. In areas where the plant matter decomposed, muck formed instead. Houghton soils are an example of soils that formed in organic material.

Figure 9 shows the relative locations of soil groupings in the watershed.

The orange shaded area which is primarily located at the south end of each, McCarter Ditch – Deeds Creek, Winona Lake – Eagle Creek, and Eagle Creek – Walnut Creek subwatershed represents the *Blount-Glynwood-Morley* soils. These soils have different characteristics but are found together due to rolling elevations in these areas. The *Blount* soil is usually found in low areas, the *Glynwood* soil is found on slopes increasing 1- 4%, and the *Morley* soils are often on 6-12% slopes. Consistent with the soils, the elevations in these areas fluctuate from a gently rolling to a steeper grade. These soils are well-suited to corn, soybeans, and small grain. They are also often used for grazing, although overgrazing and grazing when the ground is wet are both a concern. Erosion is the biggest concern for this soil association. You can see this area on Map 10 (Appendix) as an area of highly erodible soils, HEL. Crop rotation that includes grasses, legumes, water and sediment control basins, terraces, diversions grassed waterways and grade stabilization structures help to control erosion and runoff. Over grazing, compaction on wet soils, and erosion can all be problematic and problem and should be managed with rotational grazing, cover crops, and no-till methods (Tharp, W.E., 1985).

The light purple shaded area falls in the McCarter Ditch – Deeds Creek and part of Deeds Creek-Pike Lake subwatershed. It represents the *Riddles-Crosier-Oshtemo* soils which are similar to the *Blount-Glynwood-Morley* soils, except they are generally wetter and slower draining. They are also an erosion concern this area is shaded on the map of HEL soils as well, (Map 10, Appendix). Tile drainage is often necessary to support deep rooted legumes. Crop rotation that includes grasses, legumes, water and sediment control basins, terraces, diversions grassed waterways and grade stabilization structures help to control erosion and runoff. Overgrazing and compaction on wet soils can be a concern. These soils are well-suited to corn, soybeans, and small grain (Tharp, W.E., 1985).

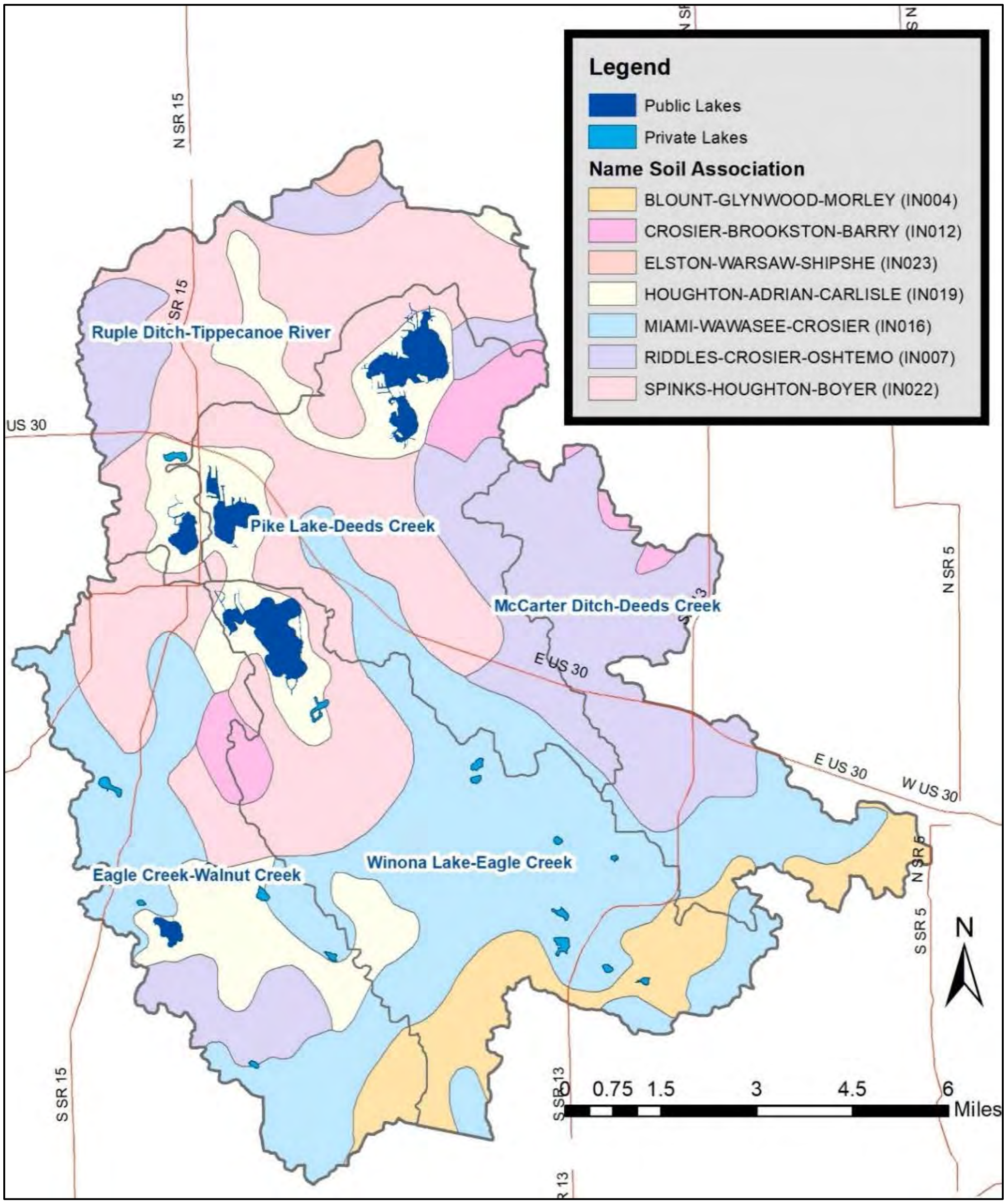


Figure 9 Watershed Soil Associations

The blue shaded area stretches through a large part of the Winona Lake – Eagle Creek and the Eagle Creek – Walnut Creek subwatershed. It represents ***the*** *Miami-Wawasee-Crosier soils* which are well suited to corn, soybeans, and small grain. Permeability is moderate, and it has a high capacity to store water. These soils can be worked (tilled) throughout a wide range of conditions. Erosion is the biggest concern. Crop rotation that includes grasses, legumes, water and sediment control basins, terraces, diversions grassed waterways and grade stabilization structures help to control erosion and runoff.

These soils need to be protected from overgrazing and grazing when the soil is wet to prevent compaction. Proper stocking rates and pasture rotation is important to protect again compaction (Tharp, W.E., 1985).

> 28% OF AGRIBUSINESS OWNERS CONSIDERED SOIL EROSION A LARGE PROBLEM IN THE WATERSHED. Social indicator study 2018

The yellow shaded area which is primarily the Eagle Creek – Walnut – Creek and part of the Winona Lake – Eagle Creek and Deeds Creek – Pike Lake subwatersheds represents ***Houghton-Adrian-Carlisle*** soils. These soils are very wet, mucky soils that have a high capacity for storing water and are generally slow to moderate draining. They have a high organic content close to the surface. The water table is near or above the surface during the winter and spring even when drained. If drained, these soils are well suited corn and soybeans; however, they offer management concerns for both the propensity to be wet and the fact that when they dry out, blowing soil can be a problem. When evaluating ditch maintenance, the high content of organic material can lead to ditch bank cave-ins. Conservation tillage, cover crops, wind breaks all help to control blowing soil. These soils are not well suited for trees (Tharp, W.E., 1985).

The red shaded area represents the *Spinks-Houghton-Boyer* soil grouping. It covers a majority of the middle to upper third of the watershed, including parts of all subwatersheds except McCarter Ditch – Deeds Creek. This soil association is a combination of outwash plain that would be found on knolls and ridges of moraines that were left by the melting glaciers and *Houghton muck* would be found in the lower areas. The muck soils in the low areas of Warsaw show this area has undisputedly been the “bowl” of the watershed where all water converges before leaving and entering the Tippecanoe River since the glaciers melted. The *Houghton* soil is not suited for trees. Undrained, the *Houghton* soil is poorly drained soil found in outwash plains and near lakes. If undrained, it is frequently ponded as it takes the runoff from nearby lakes and higher elevations. If left undrained, it is difficult to grow corn, soybeans, or legumes as the typical depth of the saturated soil is up to 60 inches.

Ruple Ditch – Tippecanoe River is higher elevation and soils in that area contain the sandy, moderately rapid and well-drained characteristics of the *Boyer soils.* This area is fairly well suited to corn, soybeans, and small grains. The *Boyer* soils have a low ability for water capacity and are prone to erosion which makes management a concern. The crops will respond well to irrigation. Conservation tillage and cover crops that leave all or most of the crop residue will help control erosion and increase the rate of water infiltration, reduce erosion, maintain organic content, and reduce evaporation rate. The *Boyer* soil is well suited to the no-till system. Crop rotation that includes grasses, legumes, water and sediment control basins, terraces, diversions grassed waterways and grade stabilization structures help to control erosion and runoff. (USDA)

The dark pink shaded area represents the *Crosier-Brookstone-Barry* soil grouping. This is a wet soil that can be found along drainageways. It is found in four of the five subwatersheds but only in very limited areas. If the soil is drained, it can be well-suited to corn, beans, and small grains. Legumes can also be grown. Permeability is moderately slow and when drained, the water table is at 1 to 3 feet during the winter and spring. The soil can be easily tilled; however, when the soil is tilled wet, clods form. Crop rotation that includes grasses, legumes, water and sediment control basins, terraces, diversions grassed waterways and grade stabilization structures help to control erosion and runoff. This soil is well suited for trees. (USDA)

The green shaded area is comprised *of Elston-Warsaw-Shipshe* soil grouping. This soil grouping is only found on the upper edge of the watershed in a small area of Ruple Ditch – Tippecanoe River subwatershed. These sand and gravel soils have moderately rapid permeability in the upper layer and very rapid in the underlying layers. Because of this, the storage capacity for water is very limited causing management concerns when planting corn, soybeans, and small grain. Without irrigation, it is more suited to deep rooting plants such as legumes and forage grasses. Rapid drainage also gives the soil poor filtering ability, such as is needed for septic systems. This soil is suited for no-till planting systems. Conservation tillage and cover crops that leave all or most of the crop residue will help hold water in the soil, maintain organic content, and reduce evaporation rate (USDA).

Soil Impact on Plant and Animal Life

Plants have been the principal organisms influencing the soils in Kosciusko County. Bacteria, fungi, and earthworms also have affected the formation of soils in the county.

The decomposition of plants and animals that would become humus is important to soil formation through the addition of organic material and nitrogen. The type of organic material added depends on the specific native plants that grew there. In addition, the plants and tree roots provided channels and pathways for the infiltration of water into the soils, as well as the organic matter from decayed roots. Soil bacteria breaks down the organic matter into nutrients and becomes an available food source for plants.

Deciduous trees formed the bulk of the native vegetation in Kosciusko County. Variations in soil type and drainage ability affected the type of vegetative cover that took root. A few areas of well-drained upland soils (Griswold and *Shipshe*) supported prairie grasses and others (*Miami, Morley,* and *Wawasee*) sugar maple, beech, and walnut trees. Some well drained upland soils, such as Griswold and *Shipshe* soils, formed under prairie grasses. The very well-draining soils (Coloma) grew black oak and scrub oak. The wet soils (*Barry,* Rensselaer, and Sebeka soils) supported maple, oak, and willow. Over time the areas of forest vegetation formed with less humus soil compared to the areas with prairie grass.

Prime Farmland

Kosciusko County has seen an increase in the loss of prime farmland as a recent trend, especially to industrial, commercial and urban development. This loss puts pressure on what are considered marginal lands. Marginal lands contain more erodible, droughty, less productive, and difficult to cultivate soils.

Approximately forty-six percent (46%) of the land in the Walnut Creek–Tippecanoe River Watershed is considered "Prime Farmland" by the USDA Natural Resource Conservation Service. Twenty-three percent (23%) of the watershed is considered prime farmland if drained, and the remaining thirty-one (31%) is considered not prime farmland. Map 13 in the Appendix delineates the areas of prime farmland in the watershed. The best farmland, noted as the darkest blue, is

STAKEHOLDERS ARE CONCERNED ABOUT THE LOSS OF PRIME FARMLAND IN THE WATERSHED. IT WAS THE #1 CONCERN OF AGRIBUSINESS OWNERS ON THE SOCIAL INDICATOR SURVEY.

primarily located in the McCarter Ditch – Deeds Creek subwatershed. The Winona Lake – Eagle Creek also has a significant amount of prime farmland, although it is primarily at the 70% prime rating. The arterial road, US 30, travels through the best farmland in the watershed incentivizing urban sprawl on this well-traveled road that connects to Fort Wayne, Indiana.

Hydric Soils & Wetlands

According to the Natural Resources Conservation Service, a hydric soil is a soil that formed under conditions of saturation long enough during the growing season to develop anaerobic conditions in the upper part. In the Walnut Creek – Tippecanoe River watershed hydric soils make up 26.1% (over 20,470 acres) of the watershed. Identifying locations where hydric soils (Map 9, Appendix) exist is important as one component to identifying wetland areas. It also is useful in determining land use suitability.

The National Wetland Inventory map (Map 16, Appendix) shows wetlands in the watershed. The National Wetland Inventory shows approximately 10,000 acres of wetlands (Table 4), which is less than half of the hydric soils in the watershed. Wetlands serve important environmental functions, such as water purification, flood protection, shoreline stabilization, groundwater recharge, and streamflow maintenance. Wetlands also provide habitat for fish and wildlife. In the Walnut Creek – Tippecanoe River Watershed, that habitat harbors endangered species such as the Blanding's turtle and the northern cricket frog. A full of list of endangered species in the watershed can be found in Appendix, Section E. The wetland soils absorb readily. Wetland plants and trees are adapted with deep roots to enable high water uptake and to

Stakeholders expressed concerns about wetlands and the desire to develop a plan to manage them.

hold hydric soils in place. Many wetlands also assist in recharging groundwater wells. Wetlands are complex dynamic systems with unique qualities. Removing or damaging a wetland can have significant effects to soil and water health, through increased erosion, nutrient pollution, or chemical pollution. It can also result in changes to the regional dynamics of flow patterns for water in the area.

When comparing Map 9 (Appendix) to Map 16 (Appendix), the reader can see that the National Wetland Inventory is significantly less populated than the map showing hydric soils. This loss of wetlands negatively affects wildlife whose lives depend upon this unique habitat. The wetlands' natural capacity is also lost.

Acres	Wetland Type
5145	Freshwater Forested/ShrubWetland
2567	Freshwater Emergent
1792	Freshwater Lake
488	Freshwater Pond
9992	**Total**

Figure 10 Breakdown of the Watershed's Acreage of Wetlands listed in NWI by Type

Septic System Suitability

The Natural Resources Conservation Service soil survey has identified soil types and their suitability for septic systems. The suitability of septic systems can be a limiting factor in development of an area, especially in a rural area with no access to wastewater treatment facilities. Ninety-four percent (94%) of the watershed soils are rated as "very limited" for septic system suitability, and 4.6% do not have any rating classification. Soil descriptors used to describe "very limited" soils include poor filtering, ponding, percolates slowly, has wetness, on slope, flooding, and severe wetness.

Much of the urban watershed is connected to municipal wastewater. There are two wastewater treatment facilities in the watershed. The City of Warsaw's Wastewater Treatment Plant serves Warsaw, Town of Winona, Leesburg, and a few larger customers that reside outside the corporate boundary, including the Zimmer Biomet Facility on the north side of Warsaw and a couple of mobile home / apartment communities which had experienced failed septic systems. It is also important to note that the Warsaw Wastewater Treatment Plant also has a trunk line to the north of Warsaw outside the watershed where Leesburg connects to the sanitary sewer. Although not everyone in the City of Warsaw is hooked up to the sanitary sewer service, all three of the large lakes in Warsaw (Winona, Pike, and Center) are sewered.

There are also 6 multi-family communities with septic systems. They include 3 campgrounds and 3 mobile home communities. All these facilities are adjacent to lakes which are used for recreational purposes. They are a concern for long-term protection of water quality and human health. There are not available sewer services in these locations at the present time.

There are additional concentrated populations in the watershed that are not currently connected to sewer. Those of larger concern are unsewered communities near lakes and waterways. The biggest unsewered micro population in this watershed are Chapman Lakes (including Big and Little Chapman Lakes). Septic systems that are placed on large homeowner lots, such as 1/3 acre or more, with adequate drainage and a minimum 50-foot distance between a leach field and a drinking water well typically pose no health hazard (State of Indiana DNR, 2018). It requires that same distance from the neighbor's leach field as well. Approximately 1/3-acre lot, depending on soils, is adequate to leave room for an additional septic system to be installed later, as septic systems are designed to last only 20-25 years and then they need to be replaced in a different area of the property.

This large lot size is not a typical size for homes around lakes where space is a premium. Additionally, a high-water table, closer to the surface than 40 inches, increases the risks and challenges to attaining a functioning septic system. Both Chapman and Little Chapman have a concentrated septic system community. These communities have a higher density of wastewater per acreage that is treated using septic systems and leach fields.

Poorly suited soils make the desire to bring industry and business to the area more difficult especially for the County. The difficulty in finding building sites with soils acceptable for commercial businesses has been an on-going problem and an important planning component as officials determine how to extend their sewer reach. Residential development, needing smaller systems, has other options such as a mound system, an engineered drain system that can be developed on many home sites that were unsuitable for a traditional leach field. Mound systems, however, are expensive and are typically not an option for high waste users like commercial and industrial.

Climate

Kosciusko County is cold in winter and hot in summer. It frequently snows in the winter, and according to the Kosciusko County Soils NRCS report generally has adequate winter precipitation for creating healthy spring soil moisture levels that minimize summer drought for most soils. The report further states that precipitation on an annual basis is adequate for crops that are grown in Kosciusko County's climate, both temperature and growing season.

USClimateData.com (yourweatherservice.com) listed the average highs and lows for the period beginning 1981 and ending 2010. The chart in Figure 11, lists December, January, and February average highs as 36º F, 32º F, and 36º F respectively. That is a noted increase over the USDA NRCS report citing the average winter high of 26º F during the period of 1951-1976. Respectively the lows reported during the 1981-2010 were December 22º F, January 17º F, and February 22º F. During the period of 1951-1976, winter recorded an average low of 17º F. Table 5

There were differences in rainfall data as well. The 1951-1976 data recorded average 35.5 inches of annual precipitation. During 1981-2010 the annual precipitation in the watershed averaged 38.9 inches of rainfall per year, which is typical for locales in Northern Indiana. It receives 1.5 -2.0 inches less per year than Central Indiana. Rainfall is adequate for healthy row crop farming. During the month of July, the most important rainfall month for growing corn, rainfall reaches 4.25 inches, the second highest month after May, for rainfall.

In winter the average temperature is 26 degrees F, and the average daily minimum temperature is 17 degrees. The lowest temperature on record, which occurred in Warsaw on January 16, 1972, is -25 degrees. In summer the average temperature is 70 degrees, and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which occurred on July 17, 1976, is 103 degrees. Tornadoes and severe thunderstorms occur occasionally. The storms are usually short and can cause scattered damage.

Average Temperatures and Precipitation in Warsaw Indiana												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average high in °F:	32	36	47	60	70	79	82	80	75	62	49	36
Average low in °F:	17	20	29	39	49	59	62	61	53	42	33	22
Average precipitation in inches:	2.28	1.69	2.24	3.54	4.61	4.21	4.25	4.29	3.07	3.39	2.68	2.6
USClimateData.com for Warsaw, Indiana (1981-2010 norms) Longitude: -85.8677, Latitude: 41.2634												

Figure 11 Historical Average Temperatures in Warsaw

The average seasonal snowfall is 26 inches. On the average, 14 days of the year have at least 1 inch of snow accumulation on the ground with the number of snow days varying from year to year. Humidity averages are 80% at dawn and 60% during mid-afternoon. The sun shines 70 percent of the possible time in summer and 40 percent in winter. The prevailing wind is from the southwest. Spring is the season with the highest average wind speed, 12mph.

Agribusiness

Agribusiness plays an important role in the diverse economy of the Walnut Creek – Tippecanoe River Watershed. According to the USDA Cropscape data for 2015, Figure 12, approximately 44% of the watershed is row crop farming and 16% of the land is used for grassland and pasture. Deciduous forest accounts for 16% and developed land another 16%. Together wetlands and open water make up 6% of the acreage.

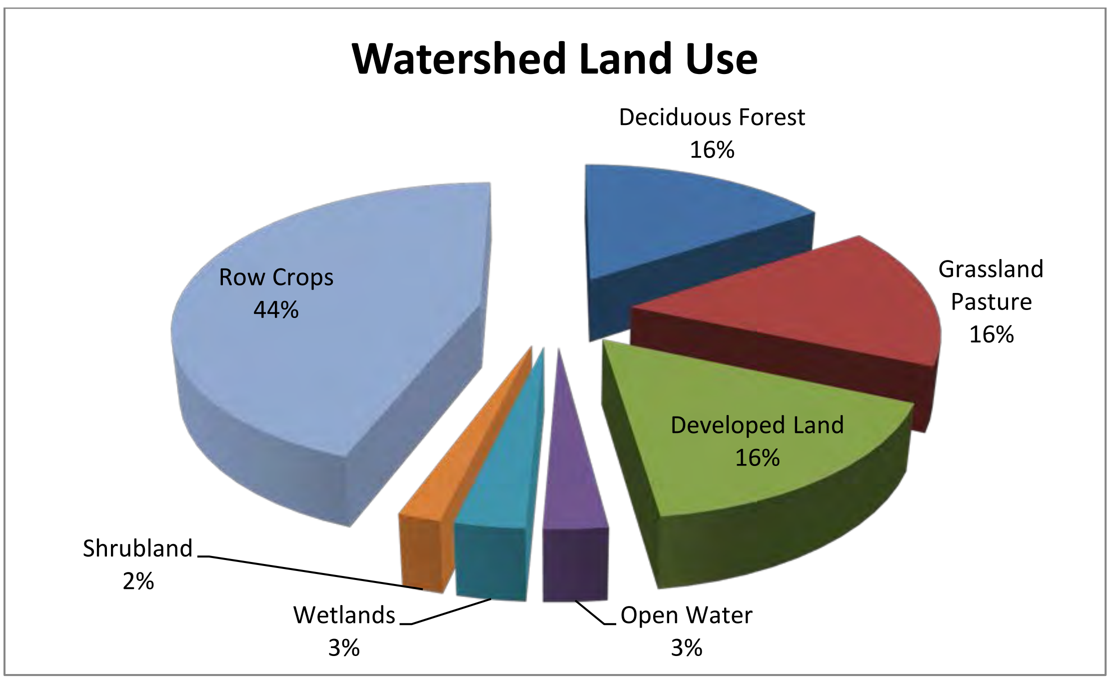


Figure 12 Walnut Creek - Tippecanoe River Watershed 2015 USDA Cropscape Data

Using Figure 13, the reader can see the visual representation of the same data. Figure 13 is a map that is formed from an Aerial of crops in 2016 also shows the breakdown of crops in the watershed. Corn and soybeans are the dominant crops,

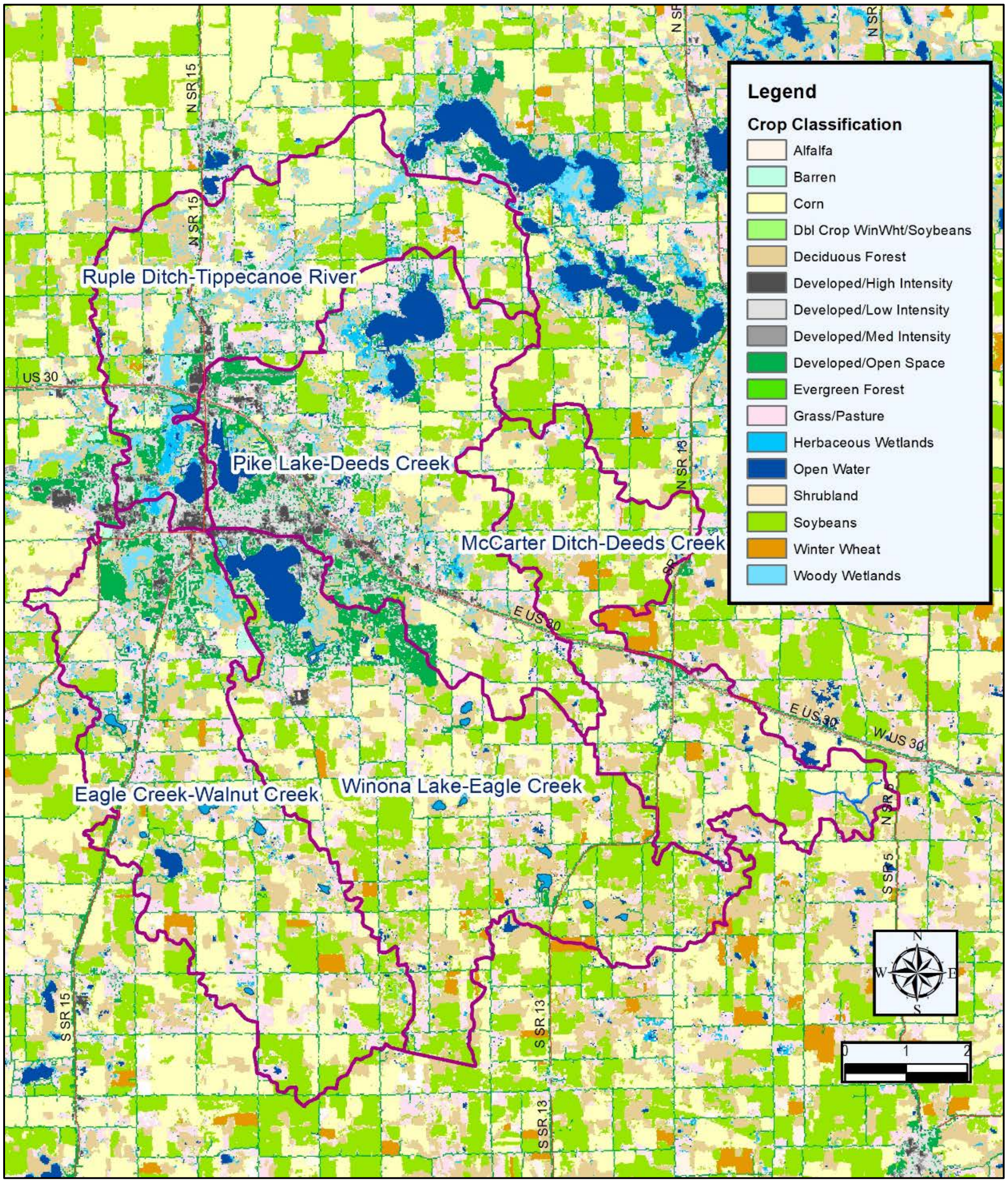


Figure 13 Walnut Creek - Tippecanoe River Watershed Crops & Vegetative Land Cover, National Agricultural Statistics Service, U.S.D.A, 2016

Land use can also be mapped using the USDA National Statistics Service (NASS0 database) to show relative development and corresponding agricultural concentrations. The reader can visually see the increased intensity of transportation assets (arterial roads) correlates directly to the loss of farmland on Map 8 in the Appendix. those areas being in the 15%-50% agricultural (yellow) or less (grey). There is also a decreased intensity of farmland in the McCarter Ditch – Pike Lake Subwatershed where much of the land is designated as prime farmland shown on Map 13 in the Appendix.

This map can also be used to make general assumptions of where BMPs might be more effective by volume in reducing pollutant loads. For example, where there are ditches in the areas of high percentages of cultivated farmland such as Van Curen ditch Leedy ditch, Wyland ditch, Deeds Creek, Rashburn, and Martin Peterson ditches found in the eastern and southeastern areas of the watershed, properties should be evaluated to determine potential land and water improvements with the possible introduction of BMPs. The subwatershed, Pike Lake – Deeds Creek, McCarter Ditch – Deeds Creek, and the Winona Lake – Eagle Creek are partially or wholly contained in the 51%-75% cultivated areas. Those subwatersheds directly drain to either Pike Lake or Winona Lake. In the Ruple Ditch area on the north side of the watershed, Allen Ruple ditch, Cy Long ditch, and Omar Neff ditches all drain to the Tippecanoe River. These waters are also in the 51-75% agricultural land use areas.

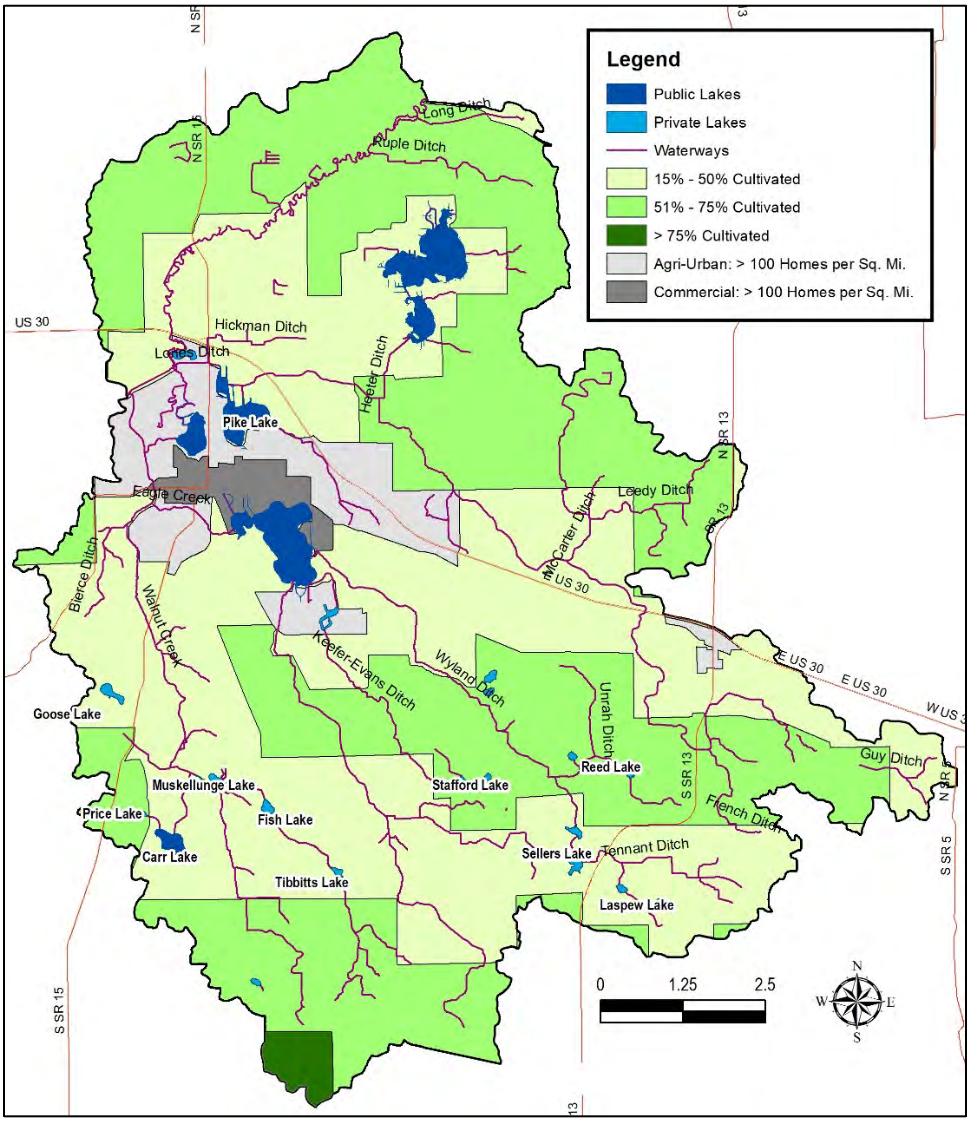


Figure 14 Walnut Creek - Tippecanoe River Watershed Land Use & Waterways

The Spreadsheet Tool for Estimating Pollutant Loads (STEPL) program (USEPA, 2018) was used to estimate land uses per acre in the watershed. The model uses current data from the USDA for input. The Walnut Creek – Tippecanoe River watershed has an estimated 12,712 acres of urban land use, 3,049 acres of pastureland, 12,071 acres of forested land, and 48,289 acres of cropland. Figure 15depicts percentages of land use in the watershed.

Urban land uses can be subdivided further into specific acreage for commercial, industrial, single family, and other uses. The following chart in Figure 16 breaks down those uses by approximate acres.

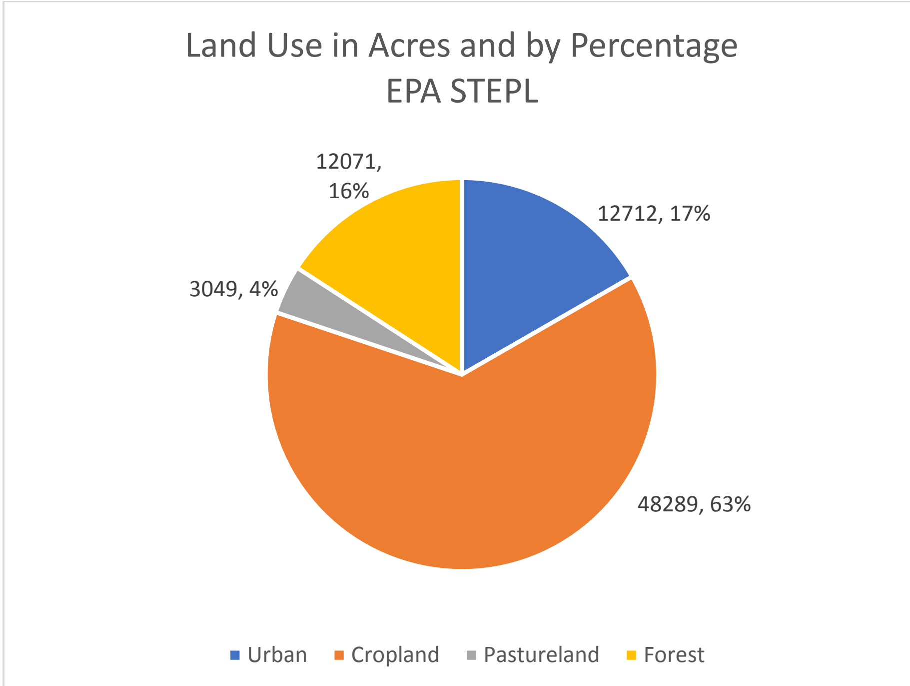


Figure 15 STEPL Land Use Data for the Walnut Creek - Tippecanoe River Watershed

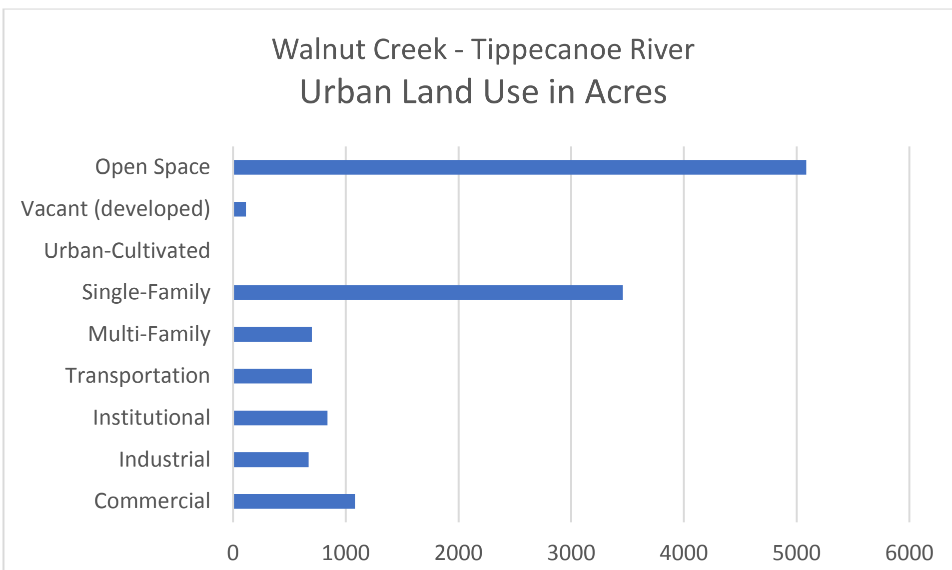


Figure 16 Urban Land Uses in the Walnut Creek - Tippecanoe River Watershed

Transect Data

Indiana State Department of Agriculture Spring Tillage Transect Results for the State of Indiana, Kosciusko County and Whitley County for the last 15 years are discussed in this section to explain row crop agricultural practices in Kosciusko County. The transect survey is designed to compile local data on various agricultural practices including tillage and crop residue management information that is collected at the local level and assimilated at the State and National level. According to Purdue University's Conservation Technology Information Center (CTIC), the survey has three goals: (1) to evaluate progress achieved in reaching county or statewide goals, (2) to provide information that can be used by individual soil and water conservation districts in establishing priorities for educational or other programs, and (3) to provide accurate data on tillage systems and crop residue cover for the annual National Crop Residue Management Survey which is compiled and distributed annually by the CTIC.

CTIC works with the USDA Natural Resource Conservation Service field offices and conservation districts who collectively work with local farm organizations, county extension agents, agribusiness and other parties to gather statistical data and roadside surveys to determine best estimates for the survey. The procedure is estimated at a 90% or more confidence in the accuracy of the numbers. The thoroughness and accuracy of the information makes its use in the watershed inventory process ideal for determining local agricultural practices.

Agriculture has had a significant impact on local soils in Kosciusko County. Both grain farming and the raising of livestock are the major agricultural enterprises, but most of the agricultural acreage in the county is row crop farmed. In the 20th Century, our understanding of land management and how agriculture affects the soils and local waterways has evolved and continues to do so. Now there is a common understanding among most row crop farmers that maintaining soil health is an important part of successful and profitable agricultural operation. The biggest shift in the conservation of soil occurred during the 1930s dust bowl era when dryland farming techniques greatly damaged millions of acres in the United States and Canada. It became an environmental catastrophe for many farmers and landowners. It was then that the issue of erosion became the single most important topic in the agricultural industry.

In the 1990s, farmers and extension agents began aggressively talking about no-till farming and many farmers decided to try it. Its adoption had mixed success. Instituting no-till farming as the only strategy for managing multiple factors generally proves less effective than combination strategies, such as no-till combined with living cover crops. When land owners did not see immediate increased yields and overall savings, (*note: changing any one BMP will be difficult to show clear success related to that change as many factors affect a crop on any given year including those that are not controllable, such as the weather)*, it became more difficult to market the BMP.

In Indiana, the number of acres planted into corn has remained relatively stable from 2000 to 2013 at approximately 5.5 million acres of corn per year except for 2015, when the number of acres planted in corn dropped to 4.6 million. By contrast, the number of acres planted in corn for Kosciusko County and the surrounding counties has generally edged up each year according to the transect reports. In Kosciusko County the production increased steadily from 91,000 bushels in 2000 to 124,000 bushels in 2015, except for 2007 where the acreage spiked at 169,000 bushels. According to the University of Illinois, Farmdoc, the price of corn in October in 2000 was $1.75 bushels with consistent growth to 2015 at $3.68 bushels. Four of those years the price exceeded that threshold with one year at $5+ bushels and another at $6+ bushels.

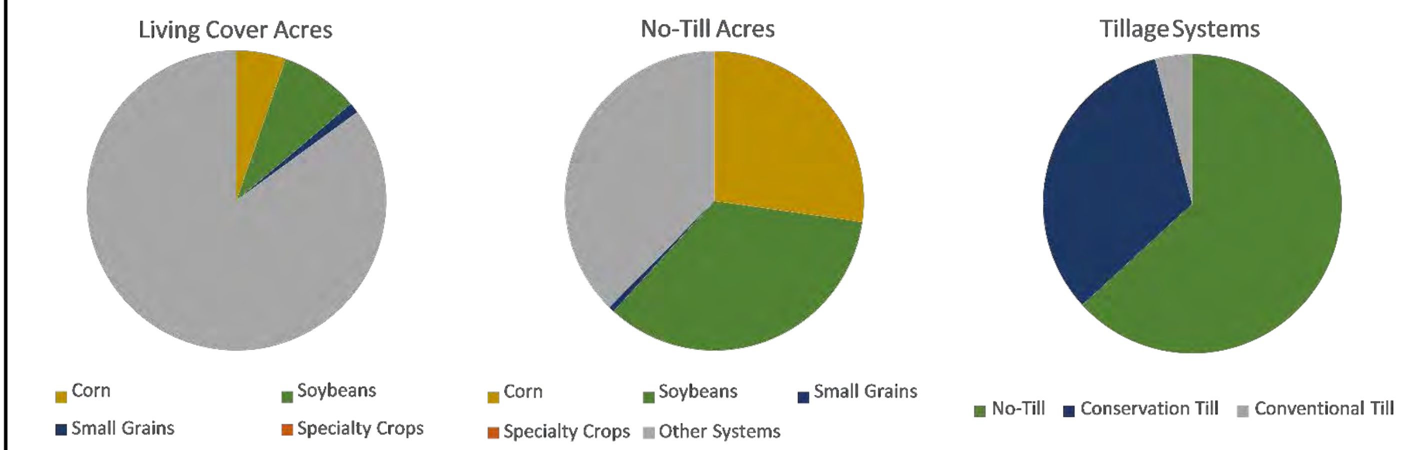
Soybean acres have remained relatively stable across the state at approximately 5 million acres from 2000-2016. There was a short spike in 2011 and 2013 of 5.4 million acres and then return down to the 5 million marks in 2015. During that same time, Kosciusko County production has fluctuated between approximately 60,000 bushels and 94,000 bushels, peaking in 2009 at 94,000 and then declining again to 67,000 in 2015. The trends are less patternistic in the soybean numbers compared to corn. The price of soybeans, according to Farmdoc, was at $4.49 in September in 2000 and at $8.81 bushels in 2015. Prior to 2000, the soybean price had been around $10 bushels for 7 years.

Wheat in October of 2000 was at $2.68 and then at $4.87 in 2015. Price gains across the 15 years were unpredictable and gains relatively small compared to soybeans and corn. Where wheat used to play a part of the crop rotation in the county many years ago, it had been almost eliminated from the crops being produced in 2016. A small number of farmers have begun to bring wheat back as a viable crop for improved soil health, drought resistance, and improved pest and weed management.

When yields of corn crops can average around 160 bushels per acre or more, soybeans can average around 50 bushels per acre, and wheat around 65 bushels per acre, farm economics becomes one of the most important factors in deciding on a crop rotation schedule. To be affective, education on the benefits of no-till, diversifying the crop rotation, cover crops, and other best management practices (BMPs) must present clear evidence of how it can protect and improve the bottom line.

Figure 17 and Figure 18 graph the 2017 fall cover crop data for Kosciusko and Whitley Counties respectively. The percentages of combined no-till and conservation tillage cover all but 3-5% of the corn and soybean acreage in Kosciusko County. Whitley County trails with 5-19%. There are significant gains to be made in living cover (cover crop) acreage, however. In Kosciusko County only 10 – 19% of corn and soybean acreage is protected by living cover. Whitley County is less at 6-11% living cover. The transect data does not address the topic of crop rotation.

KOSCIUSKO 2017 Fall Cover Crop and Tillage Transect



Crop	NASS CropScape Acres	Living Cover Percentage	Living Cover Acres	No-Till	No-Till Acres	Conservation Till	Conservation Till Acres	Conventional Till	Conventional Till Acres
Corn	107,065	10%	10,707	51%	54,603	45%	48,179	3%	3,212
Soybeans	89,860	19%	17,073	77%	69,192	18%	16,175	5%	4,493
Small Grains	3,198	70%	2,239	40%	1,279	20%	640	0%	-
Specialty Crops	287.5	25%	71.9	0%	-	0%	-	75%	215.6
Total	***200,411***	***15%***	***30,091***	***62%***	***125,075***	***32%***	***64,994***	***4%***	***7,921***

*No Till - Any direct seeding system, including site preparation, with minimal soil disturbance (includes strip & ridge till).
*Conservation Till - Any tillage system leaving 16% - 75% residue cover after planting, excluding no-till (includes mulch and reduced tillage).
*Conventional Till - Any tillage system leaving less than 15% residue cover after planting.
*Living Cover includes living cover crops and cereal grains planted into cash crops using direct seeding or broadcast methods.
*Data is limited to what is reported to ISDA by the individuals conducting windshield surveys and recording data

Figure 17 Kosciusko County 2017 Fall Cover Crop and Tillage Transect Data (Indiana State Department of Agriculture, 2017)

Tillage System Definitions:

No-till - any direct seeding system, including site preparation, with minimal soil disturbance (includes strip & ridge till)

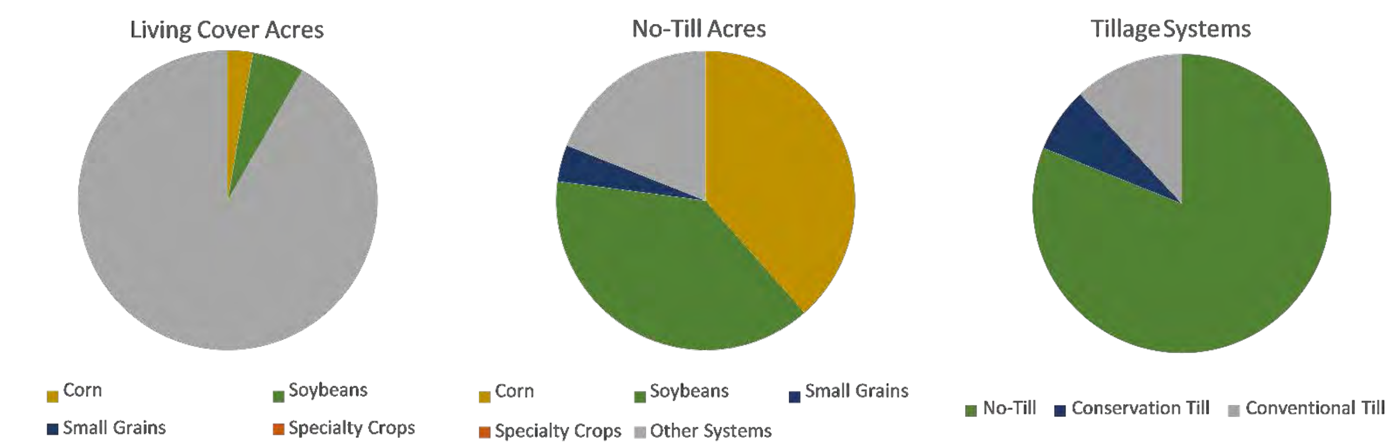
Mulch-till - any tillage system leaving 30-75% residue cover after planting, excluding no-till

Reduced-till - any tillage system leaving 16-30% residue cover after planting

Conventional-till - any tillage system leaving less than 15% residue cover after planting

Conservation Tillage - any system that leaves at least 30% residue cover after planting is considered to be conservation tillage

WHITLEY 2017 Fall Cover Crop and Tillage Transect



Crop	NASS CropScape Acres	Living Cover Percentage	Living Cover Acres	No-Till	No-Till Acres	Conservation Till	Conservation Till Acres	Conventional Till	Conventional Till Acres
Corn	60,826	6%	3,650	85%	51,702	11%	6,691	5%	3,041
Soybeans	68,249	11%	7,507	76%	51,869	4%	2,730	19%	12,967
Small Grains	5,313	0%	-	100%	5,313	0%	-	0%	-
Specialty Crops	11.8	0%	-	0%	-	0%	-	0%	-
Total	***134,400***	***8%***	***11,157***	***81%***	***108,885***	***7%***	***9,421***	***12%***	***16,009***

*No Till - Any direct seeding system, including site preparation, with minimal soil disturbance (includes strip & ridge till).
*Conservation Till - Any tillage system leaving 16% - 75% residue cover after planting, excluding no-till (includes mulch and reduced tillage).
*Conventional Till - Any tillage system leaving less than 15% residue cover after planting.
*Living Cover includes living cover crops and cereal grains planted into cash crops using direct seeding or broadcast methods.
*Data is limited to what is reported to ISDA by the individuals conducting windshield surveys and recording data

Figure 18 Whitley County 2017 Fall Cover Crop and Tillage Transect Data (Indiana State Department of Agriculture, 2017)

As stated in a 2013 Crops & Soils publication by the American Society of Agronomy (Ehmke, Tanner), “soil health is no longer about fertility, attributes such as organic matter, soil aggregation, tilth, porosity, and bulk density are considered key components to healthy soil.” The article focuses on what soil health really means in relation to crop production. Key aspects of soil heath include productivity, nutrient cycling to prevent nitrogen leaching, holding water for plant use, filtering contaminants, and withstanding erosion. Gary Steinhardt says that looking at soil health through those components is evolutionary for the industry (Ehmke, Tanner, 2013). Today’s concept of soil health is about organic matter and creating better soil aggregation. Organic matter, decomposing plant and animal material and the microbes are the glue that holds particles together. Those particles are better able to store water and allow air to move through the soil. “NRCS estimates that a 1% increase in organic matter equates to a .5-acre inch increase in available soil water capacity, or 13,577 gal/acre of water” (Ehmke, Tanner, 2013). Well aggregated soil also “allows for a more active root system that can achieve deeper penetration, says Mark Coyne (Ehmke, Tanner, 2013). He goes on to state that plants will be able to “make better use of available nutrients.”

The article acknowledges that because of the many factors in increasing organic material and evaluating crop outcomes, it is difficult to make a direct correlation between increasing organic content and an increased production. However, he reassures the reader will see that the increased organic matter and soil quality will correlate to a better crop response (Ehmke, Tanner, 2013).

Area Land Management and Planning

National Pollutant Discharge and Elimination System (NPDES)

In 1972 the National Pollutant Discharge and Elimination System (NPDES) was created by the Clean Water Act to regulate point source dischargers that discharge pollutants into waters of the United States. The NPDES system regulates potential areas of stormwater pollution, municipal separate storm sewer systems (MS4s), construction activities, and industrial activities.

Industrial NPDES Dischargers

There are several active point sources NPDES permitted dischargers in the watershed. This includes three (3) municipal wastewater facilities, one (1) municipal water facility, two (2) permitted private wastewater facilities, five (5) non-contact cooling water discharge facilities, and four (4) private wastewater facilities that serve mobile home communities. A list of NPDES dischargers in the watershed can be found in Table 6 in the Appendix.

Municipal Separate Storm Sewer Systems (MS4)

Starting in 2008, cities with a population of over 10,000 such as Warsaw, were required to obtain a permit for their separate storm sewer system, which included monitoring the storm sewer system and protecting waters of the state from pollutants that could enter through the storm sewer system. The stormwater conveyance system includes streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels and other stormwater conduits. The legislation, passed in 1972, was implemented in phases, focusing on the largest discharge communities first. Permitted MS4 communities are mapped in Figure 19.

The general NPDES permit requires MS4s to self-regulate stormwater discharges. The program is based on 6 Minimum Controls Measures (MCMs). The MCMs were determined by the EPA to be Best Management Practices (BMPs) for reducing stormwater pollution. The BMPs that Indiana MS4s are required to follow are the same BMPs that MS4s around the country are also required to follow. The general permits that each state has adopted to regulate the MS4 entities are individual to each state, making the expectations of a comprehensive program and the commitment to MS4 enforcement vary. In Indiana, there has even been substantial fluctuation in the adoption and adherence to the MS4 requirements among state enforcement actions and local governments.

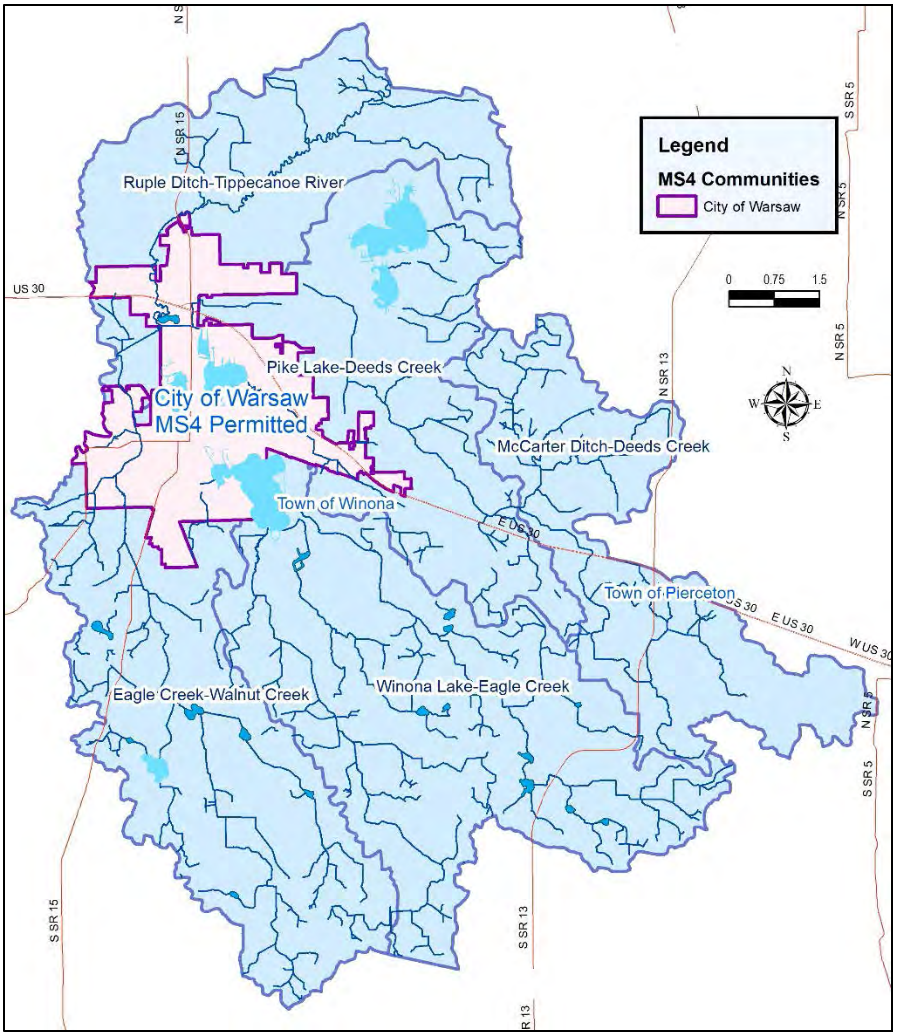


Figure 19 Walnut Creek - Tippecanoe River Watershed MS4 Communities

In each MCM category, MS4s must develop measurable goals, conduct stated activities in pursuit of meeting those goals, and demonstrate improvement over time related to water quality. Six minimum control measures require activities with measurable goals and demonstrated improvement in the community in each area. The 6 MCMs that are required as a part of an MS4 program are; Public Education and Outreach on Stormwater Impacts, Public Involvement/Participation, Illicit Discharge Detection and Elimination, Construction Site Runoff Control, Post-Construction Stormwater Management in New Development and Redevelopment, and Pollution Prevention/Good Housekeeping for Municipal Operations. In meeting the MCMs, the MS4 entity is required to:

• Implement the Stormwater Management Plan (SWMP) using appropriate stormwater management controls, or BMPs;

• Develop measurable goals for the SWMP;

• Evaluate the effectiveness of the SWMP; and

• Provide reports on program status.

In 2003, The City of Warsaw became the first and remains the only designated MS4 entity in the county. As an MS4, the City was required to develop ordinances to regulate illicit discharges and require construction site runoff control. In 2005, the City adopted Illicit Discharge and Connection to Stormwater System (Ord. No. 2005-01-01, 1-3-2005) and Chapter 47 – Siltation and Erosion (Ord. No. 2005-03-08, § 47-101, 4-4-2005. In 2006 the City adopted the Stormwater Quality Management for Post Construction Operation and Maintenance (Ord. No. 2006-07-06, 7-17-2006). The addition of the three new ordinances was completed in the first permit term of the new regulation. They were added to the City's Stormwater Technical Requirements that were adopted in 1996.

In 2013, the City's Mayor determined that the City was going to become fully compliant and resolved to begin the process of building a functioning Stormwater Department. The City hired a full-time coordinator to focus on MS4 management of stormwater infrastructure. In 2014, the City created a stormwater utility and adopted a stormwater fee. The Stormwater Department became a unique entity under the Utility Department. In a span of a little over 3 years, the Stormwater Department grew from 0 staff to 2 full-time persons. As staff was added, the Stormwater Department became better equipped to handle more responsibilities.

Regulation of Construction Activities

As a part of the Clean Water Act, construction activities of 1 acre or more are required to gain a permit and control soil and other pollutants during the construction operations beginning when vegetation is removed until vegetative cover at 70% has been established. In Indiana, this is called a Rule 5 permit. Construction activities under this Rule inside an MS4 area, such as Warsaw, are the responsibility of the MS4. Construction activities outside of any MS4 jurisdiction are the responsibility of the County SWCD, if so willing to evaluate and enforce, or the Indiana Department of Environmental Management, Stormwater Division. In all of Kosciusko County, except the City of Warsaw, the Kosciusko County SWCD regulates Rule 5.

Kosciusko County Comprehensive Plan

In 1990, Kosciusko County had a population of 65,000. It has experienced a 20 % growth in population and is now at 78,000 in 2016. Kosciusko County developed a comprehensive plan in 1996. Even in 1996, the community and elected officials knew that the County was growing at a steady pace that placed burden on infrastructure and land use. The plan recognized a need and "desire" to protect the natural features in the county. Specifically listed were nature, scenic quality, farmland, and wetlands. The plan describes those attributes as part of the character of Kosciusko County. The plan highlights the goals of protecting both industry and agriculture as important cohabitants. The plan also states that the value of the lakes and natural areas will continue to grow in importance as development increases.

The County plan presents the following objectives as guidelines for the future: *1. Growth management, 2. Preserved community character, Enhanced community identity, and 3. Improved communication, cooperation, and organization of local governments.*

The land use policies focused on concentrating development and grouping similar developments in a controlled approach, that included objectives to reduce sprawl, increase traffic flows, increase pedestrian and bicycle routes, and allow separation of residential areas from commercial and industrial areas. Sanitary sewers were a focus also as an important component in the county plan. They are clearly a limiting and concerning factor for the community. Multiple pages were used to plan how different areas could receive sewer and discussion on the priority of those efforts. The plan (Team) proposed restricting commercial development to land with suitable soils for adequate sanitary facilities or requiring the business to connect to public wastewater facilities. As an additional environmental concern, the plan recommended the County Health Department and the Commission develop an ordinance to "establish standards for waste disposal and materials storage, which will reduce air and water pollution, noise, and visual blight.

The plan outlines general policies for commercial, industrial and residential development. The plan recognizes that the environment is an important reason why people live in or have homes in Kosciusko County. Even though workers come from other counties to work in especially Warsaw, there is still a significant number of people who choose to live in Kosciusko County because of what it offers and then commute to Fort Wayne to work. The plan states, "the quality of the environment has attracted industry, jobs, and residents to Kosciusko County. Without question, growth and opportunity in Kosciusko is attributable to the vitality of its people. Natural characteristics and the physical environment have created attractive opportunities to develop and reside in the County. Kosciusko County Government officials recognize that there is an important relationship between the natural characteristics and economic opportunity in Kosciusko County, and the management of that relationship has become a critically important issue in land use regulation.

The Objectives that the plan focus on for the natural environment:

- *increase awareness of environmental issues*
- *increase energy efficiency and demand-sided alternatives*
- *provide incentives for participation in conservation programs*
- *guide land use in an environmentally sensitive manner*
- *increase awareness of recycling and alternative methods of waste disposal*
- *minimize the impact of new development*
- *coordinate governmental approaches to environmental quality*

The plan is 20 years old. Although there are no immediate plans for updating the County's Comprehensive Plan, the zoning ordinance for the County, Kosciusko County Zoning Ordinance Ord. #: 75-1, was updated September 6, 2016.

The County's zoning ordinance does reflect some of the objectives and proposed standards in the comprehensive plan. It has zoned areas to help minimize conflict between landowners by providing for separation among agribusiness, industrial, and residential. The ordinance also has an environmental district that protects areas that are unsuitable for development due to flooding, soil conditions, or other natural features. It also provides zoning to protect prime farmland. Kosciusko County is rich in prime farmland. Much of the soils and acreage that are unsuitable for septic systems are very suitable as farmland and much of the county and the watershed is classified as prime farmland by the USDA Natural Resource Conservation Service. The County Plan Commission recognizes that asset and has incorporated it into the zoning ordinance. Finally, the zoning ordinance has zone areas for livestock operations. Livestock grazing farms and also confined feeding operations (CFO) are a significant part of the local agribusiness economy and the ordinance has attempted to provide adequate buffer for those operations as well.

Protection of waterways, and specifically lakes in Kosciusko County, is important to residents and businesses in the county. That approach is reflected in the zoning ordinance. Language was added to prevent funnel developments whereby a multi-housing community/complex could be added to a lake with narrow frontage that would be the width of one or two houses. After a high-profile project and public outcry on Lake Wawasee, it was clear that high- density housing complexes funneling into a lakefront lot was not a balance between the planning objectives including *growth management* and *preserved community character*. The project threatened what the comprehensive plan called the *"natural characteristics and the physical environment (that) have created attractive opportunities to develop and reside in the County."*

The 1996 comprehensive plan recommended an ordinance prohibiting unprotected outside storage areas and requiring business and industrial operations to protect waters from chemicals and oils and other pollution. The following language was added to the zoning ordinance," all *solid waste whether generated from supplies, equipment, parts, packaging, or operation or maintenance of the facility, including old parts and equipment, shall be removed from the site in a timely manner consistent with industry standards. All hazardous waste generated by the operation and maintenance of the* *facility, Kosciusko County Zoning Ordinance - 51 -including but not limited to lubricating materials, shall be handled in a manner consistent with all local, state and federal rules and regulation."* Additionally, as a part of their commitment to pollution prevention the County instituted a stormwater protection and erosion control ordinance in 2006 to require stormwater planning as a part of development and to require protections on bare earth construction sites.

City of Warsaw Comprehensive Plan

The City of Warsaw adopted a long-term comprehensive plan in 2015. The comprehensive plan was approved after a several months of exploration and review with opportunities for public input and discussion. Seven planning principle objectives were adopted as the driving focus of the plan:

1. Quality of life for residents
2. Opportunity for business and industry to thrive
3. City services
4. Transportation systems
5. Natural environment
6. Community aesthetics
7. Housing opportunities

The planning principles that will be used to guide the City in the implementation of the planning principle objectives fit into five separate categories:

1. Manage Community Growth and Form
2. Foster Effective and Safe Transportation
3. Stimulate Economic Growth
4. Nurture Environmental Quality
5. Inspire Community Character

Manage Community Growth and Form – Benefit

The comprehensive plan is important as the City continues to expand. Plan documents can have a tendency to be forgotten or ignored on a day-to-day running of City business, especially when outside pressures that may involve business opportunities provide temptation to disregard requirements to satisfy a developer or business. The plan provides the public with: 1) a view of how developments are (or should be) evaluated before final approval, 2) an avenue to advocate for and promote good steward policies and infrastructure changes that support the community principals mutually agreed upon in the comprehensive plan document.

In urban areas land use and stormwater protections are the two most important areas in protecting water quality and wildlife habitat. The plan does recognize the connection between land use and water quality in some sections and the

URBAN STAKEHOLDER CONCERNS

EROSION FROM CONSTRUCTION PRACTICES

NUTRIENTS FROM GRASS CLIPPINGS AND LEAVES ENTERING THE STORM DRAINS

URBAN ORDINANCES DO NOT ALLOW TALLER NATIVE GRASSES & FORBES

DESIRE FOR GREEN INFRASTRUCTURE

CONCERNS FOR ROAD POLLUTANTS AND POSSIBLE SPILLS ENTERING WATERS FROM STORM SEWERS THAT DISCHARGE DIRECTLY TO WATERBODIES.

protection of environmentally sensitive areas with some degree of specificity. In addition, it recognizes the objective to reduce costs to provide and maintain city infrastructure. Although green infrastructure is not mentioned in the comprehensive plan as a viable alternative for stormwater protection, green infrastructure can be considerably more cost effective in stormwater controls than conventional stormwater piping to waterways. As the City has not used green infrastructure in the past, it may require additional education and assistance in developing that area of expertise. Adoption of green infrastructure would also require ordinance changes that do not currently allow those types of infrastructure components. Changes may include taller native grasses and forbs on a lawn, depressed tree lawns and parking islands with curb cuts to allow for stormwater infiltration and requiring large paved areas to be broken up with green space to capture and clean stormwater and reduce the heat island effect. Additionally, many cities have developed a range of mixed-use areas that hold and infiltrate stormwater during rain events and provide recreational opportunities during dry weather.

There are three areas in the plan that relate directly to water quality, land development, fostering effective and safe transportation, and nurturing environmental quality.

The plan states the need to *minimize land use conflicts* by: increasing the quality of development; providing residents, organizations, businesses, and industries with predictability and property value security; protecting environmentally sensitive areas; intensify commercial district to maximize commercial vitality; reducing costs to provide and maintain City infrastructure; reducing energy consumption; and improving surface water quality. The land use section also recognized the need to identify and show areas that should be conserved and remain undevelopable although the path to selecting those areas was not made clear. It also suggested the use of undevelopable land such as floodways, floodplains, and large wetlands as passive recreation, trails, and open space.

In providing *effective and safe transportation,* the plan promotes the adoption of a" Complete Streets" ordinance to promote full and safe utilization of street rights-of-way for all uses and their needs". Although the complete street concept does not address stormwater, it has been included in many progressive communities with their implementation of a complete streets program. Typically, the change from conventional streets to a complete street will require a construction project as the East Market project in Warsaw did in 2015. Road construction projects give Cities an opportunity to concurrently change stormwater design, especially when there is storm system failure that requires replacement, also as on East Market. The projects become opportunities to change design with little or no additional cost. Often the pipe size reduction seen in a green streets project can provide savings both in upfront costs, and in long term lifetime costs. The American Planning Association promotes integrating green stormwater management into the complete street reconstruction and provides information on how to effectively merge the two.

The last significant principal is *Nurture Environmental Quality* by protecting environmental features; protecting ground water and surface water quality; providing recreational amenities; enhancing natural systems; and promoting environmental sustainability. This principal clearly is aimed at water quality. It is an opportunity for proponents of water quality to actively participate in city government and assist in the development and implementation of these ordinances. The following, environmentally significant language was copied from the City's 2015 Comprehensive Plan as it is considered noteworthy for the watershed management plan steward.

Objective 4.1: Require private development stay clear of wetlands, floodplains, and land designated as "conservation" in the Land Classification Plan.

Objective 4.2: Offer incentives for conservation and preservation of environmentally sensitive areas.

Objective 4.3: Maintain a city-wide storm water management and erosion control ordinance. Recognize and promote low impact development (LID) and best management practices.

Objective 4.4: Encourage development practices that reduce the city's footprint on the environment (e.g. redevelopment, higher densities, and conservation subdivisions).

Objective 4.5: Maintain a Department of Natural Resources approved Parks Master Plan and revise said document on a 5-year cycle to qualify for State grant funding.

Objective 4.6: Promote the utilization of solar panels (and other appropriate technologies as they evolve).

Objective 4.7: Require the use of native plant material when landscaping is required for new developments.

Objective 4.8: Fully phase out the use of septic systems and private wells in the City and lobby for no further use of the technology outside the City's jurisdiction, especially along near inlet streams. Also, require new development to connect to the municipal sanitary sewer and water system.

Objective 4.9: Seek donation of undevelopable land for conservation or passive recreation, especially in the south and west sides of Warsaw where significant undevelopable acreage exists.

Objective 4.12: Inventory and monitor environmental features that are unique, large in size, irreplaceable, or contain a rich diversity of plants and wildlife. Consider incentives that encourage the permanent protection of these environmental features.

Warsaw and Winona Lake Greenway Trails

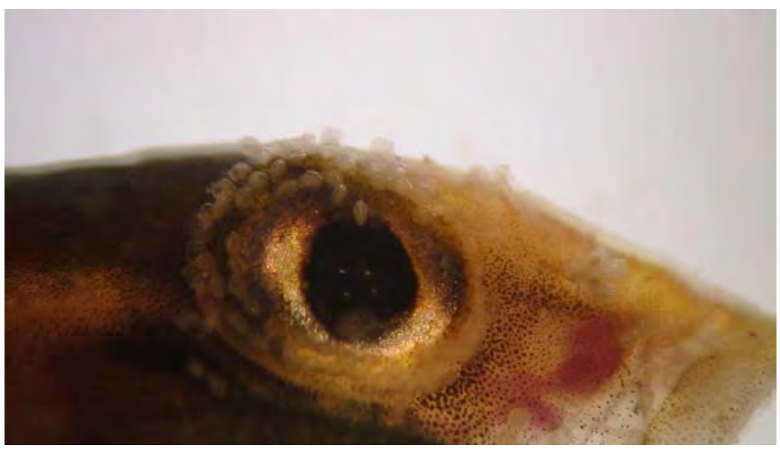
Warsaw and Winona Lake have worked to develop a network of bicycle and walking trails. To date there are 180 miles of Kosciusko County bikeways, 5.67 miles of greenways, 2.87 miles of bike lanes, 3.03 miles of side paths, 2.68 miles of signed routes, and 9.70 miles of mountain bike trails. As of 2016, through the work of the Clean Waters Partnership, there is now a 1.2-mile interactive environmental interpretative trail also.

Flora and Fauna

Kosciusko County is home to a large variety of flora and fauna due to the variety of terrains that cover the county's total 554 square miles. When the first settlers arrived in the 1830s, they wrote accounts of the abundant wildlife and vegetation, all necessary to sustain the flood of pioneers to the newly established county. The federal government has recognized 5 species of mussels, 2 species of reptiles and 2 species of bats as either endangered or threatened, all of which make their home in Kosciusko County. The mussels are white catspaw (Epioblasma obliquate perobliqua), northern riffleshell (Epioblasma torulosa rangiana), clubshell (Pieurobema clava), rabbitsfoot (Quadrula cylindrica cylindrica), and rayed bean (Villosa fabalis). The listed reptiles are the copperbelly water snake (Nerodia erythrogaster neglecta) and the eastern massasauga (Sistrurus catenatus). The two mammals recognized are the Indiana bat (Myotis sodalis) and the northern long-eared bat (Myotis septentrionallis).

Picture 3 "Clubshell (Pleurobema clava)." (USFWS, n.d.)

The state of Indiana has an expanded list of state endangered, threatened, and rare species for Kosciusko County. It includes 11 mollusk species, 17 butterflies and moths, 3 fish, 5 amphibians, 5 reptiles, 16 birds. and 4 mammals, along with 51 vascular plants. Required habitats range from dry upland forest to shrub swamp, and sedge meadows to open streams.



Picture 4 "Riffleshell mussels on host fish." www.biosci.ohio-state.edu

Of these species, the state's mussels have suffered some of the largest losses. A quarter of the 77 species historically recorded in the state are now extinct or no longer reproducing, including 19% of remaining mussels listed as endangered, threatened or rare. As mussels are filter feeders, taking in and expelling out water in order to obtain oxygen and nutrients, they have an increased sensitivity to water pollutants. Their numbers have been affected by numerous other factors, including but not limited to waterflow modifications, dams, increased sediments in waterways, and the additional competition of invasive species. In addition, some species, like the clubshell, require a "host" fish for the larvae, or "glochidia" stage, to attach to until they reach adulthood. Their preferred habitats include medium to large streams and rivers, along with numerous lakes located in the Walnut Creek-Tippecanoe Watershed.

Picture 5 "Copperbelly Water Snake," (Farcus, Jillian, 2014)

Picture 6 "Blanding's turtle," (Hall, Carol, n.d.)

The federal government has listed the copperbelly water snake and the eastern massasauga rattlesnake as threatened. Indiana has also included three additional reptile species in Kosciusko County, the spotted turtle, Blanding's turtle and the Kirtland snake. The copperbelly and the eastern massasauga rattlesnake require similar habitats, preferring shallow wetlands and the use of adjacent uplands for part of the year. However, the Kirtland snake prefers to use crayfish burrows, living burrowed in wet meadows, muddy ponds, and sluggish streams.

Picture 7 “Frog Friday: Northern Cricket Frog,” (Commonwealth of Virginia, 2015)

*Picture 8 “Blue-spotted Salamander,” (*State of Connecticut, n.d.)

Approximately ⅓ of all aquatic and semi-aquatic turtle species across the United States are in need of some level of conservation assistance. Of the two turtles that Indiana has listed for Kosciusko County, both fall into the aquatic/semi-aquatic category. The spotted turtle is the smallest, measuring 3.5 to 5 inches in diameter. This turtle is mostly aquatic, preferring to eat underwater and use water as an escape mechanism from predators. It prefers clean, shallow, slow-moving bodies of water that have soft muddy bottoms with some vegetation, as seen in shallow ponds, wet meadows and prairies, as well as small woodland streams and ditches. However, as important as water is to the Spotted turtle, it also requires access to dry land, such as open fields. It is especially common to find these turtles moving on land during mating season and nesting times. It is during these movements that they are the most vulnerable, especially when crossing roadways, unless protective buffer zones are established around their wetlands.

The Blanding’s turtle is a larger (7 to 9 inch) semi-aquatic species that can be easily mistaken for a box turtle due to its domed upper shell and hinged bottom shell. For survival, this species requires multiple habitat components, including access to permanent wetlands, as well as a selection of smaller and or temporary wet areas, like small pools and ponds, used as a seasonal feeding ground and refuge for both adults and juveniles. Besides a water requirement, these turtles require a significant amount of dry open ground to use for moving as they will migrate between wetlands, in addition to open, well drained soils for nesting. It is this complex environment that makes the protection of this turtle challenging as well as its own biology as they do not reach maturity until 14 or 15 years old.

The importance of amphibians in the environment cannot be overstated. While small and often overlooked, they are thought to be the biological indicators of our environmental health. Indiana has listed five amphibians: the northern cricket frog, the northern leopard frog, the blue-spotted salamander, the four-toed salamander and the common mudpuppy, all of which live in the Walnut Creek-Tippecanoe River Watershed. Both of the frogs prefer similar habitats: wetlands, streams, and ponds. The small four-toed salamander and the blue-spotted salamander prefer vernal ponds and damp woodland environments. The common mudpuppy, as it spends its entire life underwater as a bottom dweller, is found in permanent lakes, streams and rivers and is particularly susceptible to the effects of pollution and increased sediments.

While preservation of wetlands is imperative to all these species, it is impractical and unrealistic not to consider the concurrent human use of these required habitats. Both humans and wildlife are attracted to these shared habitats, i.e. ponds and lakes, for similar reasons: water, fish, and accessibility to wildlife. To preserve this shared habitat and to prevent the unnecessary loss of species, precautions need to be established. Communities should monitor their local wetland habitats and create guidelines in order to provide maximum protection for these rarer species.

Picture 9 "Common Mudpuppy," (State of Connecticut, n.d.)

Considerations should be given to creating and promoting "shoreline zones," encouraging natural edgings with shallow and gradual sloping access into the water, encouraging reduced use/elimination of lawn and gardening chemicals, using native plants and involving the community to increase support and awareness of rare/endangered local species. By monitoring and guiding current and future developments in these important habitat communities, these wetland habitats will be maximized for both humans and species alike.

Of the three different fish species on the state list, only one falls into the Walnut Creek-Tippecanoe River Watershed. The gilt darter, once found in several of the larger rivers throughout Indiana, now has one of the most restricted ranges. It is only found in the upper Tippecanoe River, trapped upstream of Lake Schaffer due to constructed dams.

The Indiana bat and the northern long-eared bat are the two protected mammals in the watershed basin. Both species prefer a summer habitat of stream corridors with access to woods. Both bat species migrate out of the area during the winter months.

Figures 1-4 in the Appendix contains the complete list of animals, insects and plants that are of a federal and or state concern that reside in Kosciusko County.

Preliminary Conclusions

This watershed represents a diverse collection of stakeholders which will require a coordinated effort among the stakeholders to implement BMPs throughout multiple industries, including residential to make a lasting and significant impact in the watershed. There are significant watershed and wildlife resources that need to be protected, including lakes, rivers, ditches, wetlands, natural areas, and even endangered species. Even after the conclusions and recommendations, there will remain an on-going struggle to balance agribusiness, urban expansion, and the protection of natural resources. Finding BMPs that benefit people, business (including agribusiness), as well as the environment, and increasing public education and buy-in will be important to success. Lakes and streams are acknowledged to be an important part of the culture and draw to the area but are not actively protected through the regulatory and enforcement process. It is important to understand how much or how little citizens connect the protection of those resources with their own quality of life and the economy and standard that Kosciusko County provides to the area.

There are some clear areas where gains can be made in agriculture including in the planting of cover crops which are underutilized in the watershed. Conservation tillage numbers are high but there is still room for improvement in implementing no-till practices. Soils with high erosion protentional are also a concern in the watershed. Properties in those areas should be evaluated for effectiveness of current BMPS that retain those soils on the land and keep them from contributing to water degradation. There are many animal operations and the land application of manure/biosolids also remains a pollution concern. Although specific known sites of biosolid / manure application are not available, the resulting bacteria contamination from fecal matter found in the waters of the watershed is clearly above the target threshold of 235 CFU/100mL

There is still one large unsewered area next to a large lake area, Big and Little Chapman Lakes. Adding a sewer system or connecting that area to an existing sewer system will be an important step in protecting the lakes from human waste bacteria and nutrient leaching of septic systems around the lake.

Protecting human health is very important in the watershed as the lakes are being used for recreation. Evaluating and reducing the risk of possible hazards such as bacteria, cyanobacteria, and nutrient pollution (phosphorus & nitrates) through BMPs and pollution prevention should be high priority in the watershed.

Urban area stormwater pollution should be an area of increased public education and implementation of urban BMPs, such as green infrastructure or Low Impact Construction (LID). As a designated MS4 community, population alone will dictate that stormwater will contribute significant pollutants into local waters without the installation of BMPs to remediate them. That impact can be remediated with education (equating to residents reducing their contribution of pollution entering the storm drains) and the addition of green infrastructure, or another stormwater BMP.

The Watershed Inventory Part II Watershed Level

Overview of Data and Data Sources

The watershed inventory involves collecting data through a "windshield survey," on-the-ground observation, and a "desktop survey" which is research examining pollution records, community planning documents, animal inventories, soil types and other relevant information in the watershed to help provide a complete picture of the watershed. Evaluating the watershed for its current water quality and determining the sources or potential sources of degradation is important in determining the needs of the watershed. The overview will introduce the data collected and look at it on a watershed level. Later, the data will be analyzed on a subwatershed basis.

Description of Chemical Sampling Methodology

A Quality Assurance Project Plan (QAPP), found in the Appendix, for the Walnut Creek-Tippecanoe River Watershed was submitted to IDEM for review and was approved in January of 2016. Complete site descriptions can be found on Table 10 also in the Appendix. A baseline of water quality in the watershed using the sites 1-10 was determined through four different monitoring activities, including: regular stream sampling, storm event sampling (four occurrences), one occurrence of a biological assessment, and one occurrence of a habitat assessment.

The bi-weekly sampling sites (1-10) were chosen (based on the main tributaries that flow through the watershed) to be sampled bi-weekly through the two-year sampling window. Bi-weekly sampling began on 27 January 2016 and ended on 13 December 2017. Two years' worth of sampling netted 55 individual sampling events. With each sampling event, the stream flow cross section was measured, and the velocity was calculated in cubic meters per second. With the large amount of data calculated, the stream flow was simply averaged as well as the pollutant concentration measured in mg/L to calculate loads for each site. Water quality target loads for each site location were calculated using the average flow for that site and the highest target concentration amount for that specific parameter.

"High Source" and "Outfall" sites were not sampled as rigorously and not calculated for total pollutant loads. They acted more as a comparison barometer to the biweekly sampling data collected at sites 1-10 on the same day.

"High source" identification sampling, areas where samples tested high for a parameter of concern and required follow-up, was done at seven sites (sites 11-17) which were sampled six times each. Storm event sampling was conducted on sites 1-10 on four occasions and at 3 sites of stormwater outfalls numbered 18-20 on six occasions. Stormwater outfalls were evaluated using the same testing parameters and flow was noted using size of pipe and percentage of pipe full, i.e. 50% full. (Note: There was a fourth stormwater site; however, the sampling team tested the wrong pipe, one that ended up being a culvert from a usually dry vegetated swale instead of the urban highway outfall on the other side of the ditch. The swale was dry 3 out of six samplings. Results from the swale were not used.)

Sampling parameters collected included: stream flow, dissolved oxygen, conductivity, pH, water temperature, E. coli, total suspended solids, chloride, fluoride, sulfate, silica, total phosphorus, soluble reactive phosphorus, total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, and nitrite. Stream flow, dissolved oxygen, conductivity, pH, and water temperature were measured in situ with field equipment. E. coli samples were transported to the Kosciusko County Health Department for lab analysis. Total suspended solids, chloride, fluoride, sulfate, silica, total phosphorus, soluble reactive phosphorus, total nitrogen, total Kjeldahl nitrogen, ammonia, nitrate, and nitrite samples were transported to the National Center for Water Quality Research at Heidelberg University for lab analysis. Complete sampling data can be found in the Appendix.

Sampling was consistent every two weeks. There was minimal interruption in obtaining results, < 10% to include lab closure, sensor failure, dangerous storms, or other interruption. High water sampling protocols were used on site# 4 (3 times), site #3 (6 times), site# 8 (3 times), site #10 (7 times), and site #9 (17 times). High water protocol was conducted by using measurements from predetermined landmarks at each specific site that would allow extrapolation of the flow.

Figure 20 Maps the sampling points in the watershed while Table 1 shows a description of each sampling point.

Sampling Site Location Descriptions				
Site #	Waterway	Sampling Site Type	**Influences:** Rural Residential (R), Agricultural (A), Urban (U), Lake (L), Wastewater Plant (WWTP)	Location Description
1	Deeds Creek	Bi-weekly	A	Deeds Creek near E 100 N
2	Heeter Ditch	Bi-weekly	A, L	Heeter Ditch off of 175 N
3	Lones Ditch	Bi-weekly	A, U	Lones Ditch W of SR 15
4	Wyland Ditch	Bi-weekly	A, R, U	Wyland Ditch east of Winona Lake, E of Park Ave, Winona Lake
5	Keefer Evans Ditch	Bi-weekly	A, L, R, U	Keefer Evans Ditch south of Winona Lake, 2002 Eastwood Rd, Winona Lake
6	Martin Peterson Ditch	Bi-weekly	A, R	Martin Peterson south of Winona Lake, 741 E Lakewood Ave, Warsaw
7	Eagle Creek	Bi-weekly	A, L, R, U	Eagle Creek west of Winona Lake, 1109 Country Club Rd, Warsaw
8	Walnut Creek before Eagle Creek	Bi-weekly	A,R,U,	Walnut Creek south of Eagle Creek, 429 West Creek Dr, Warsaw
9	Walnut Creek before Tippecanoe River	Bi-weekly	U, A, R, L	Walnut Creek south of Tippecanoe River, at the intersection of Lake St, Warsaw
10	Tippecanoe River	Bi-weekly	U, A, R, L	Tippecanoe River east of WWTP outfall, east of Fox Farm Road
11	Deeds Creek	High Source	A	Deeds Creek at SR 30 east of Pike Lake
12	Van Curen Ditch	High Source	A	Van Curen Ditch at Old Rd 30
13	Leedy Ditch	High Source	A	Leedy Ditch at 600 E
14	Deeds Creek	High Source	A	Deeds Creek, SR 30 3426 SR 30 E
15	Deeds Creek	High Source	A, R	Pierceton Rd east of 600 E
16	Deeds Creek	High Source	A, WWTP	350 S and 725 E, W of Pierceton WWTP
17	Deeds Creek	High Source	A	8506 E Ryerson Rd, E of Pierceton WWTP
18	Outfall into Kelly Park Pond	Stormwater Outfall	U	Kelly Park, 130 Fawley St (STO-60-010)
19	Outfall into Winona Lake	Stormwater Outfall	U	2400 Winona Ave. (STO-047-039)
20	Outfall into Pike Lake	Stormwater Outfall	U	Warsaw Cemetery, 421 N Maple Street (STO-028-003)

Table 1 Sampling Site Location Descriptions

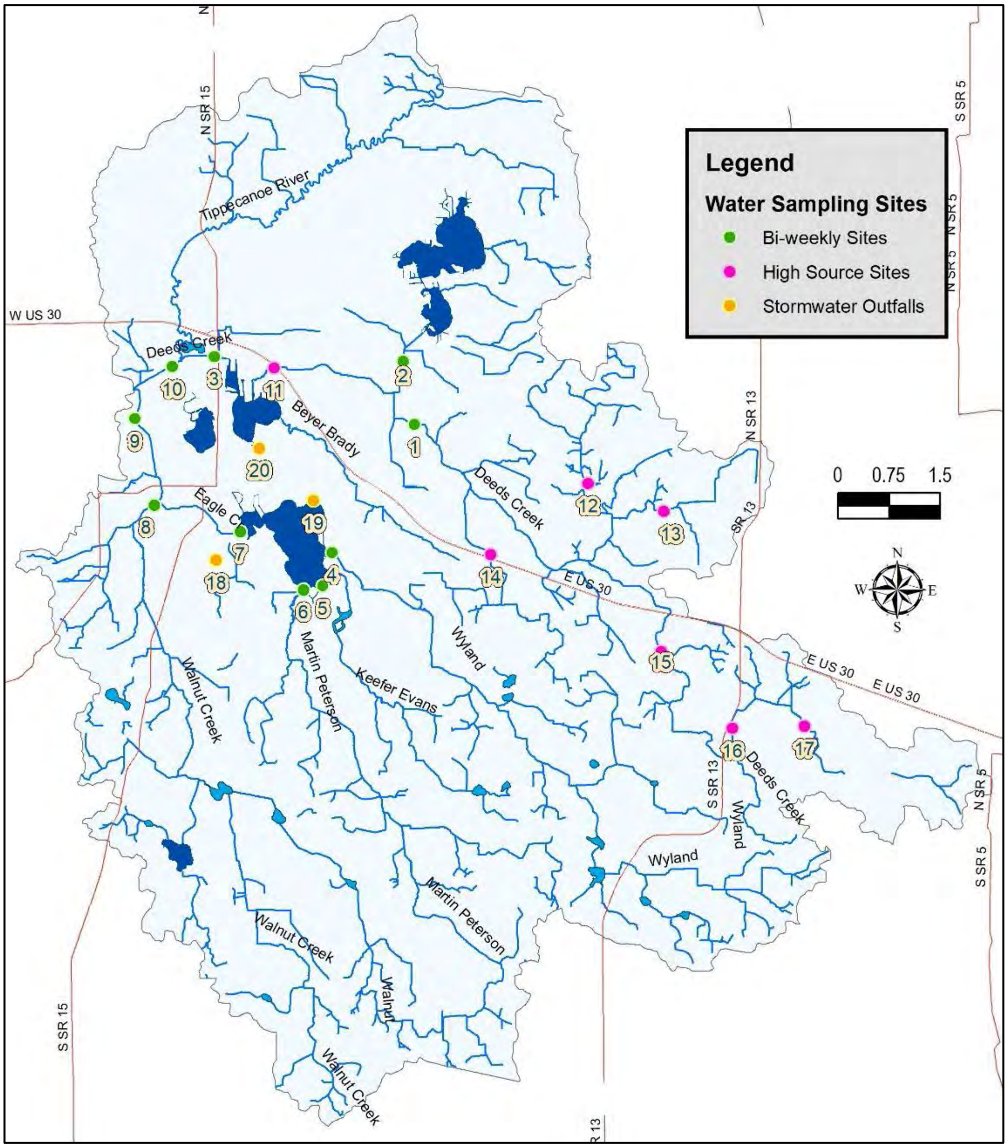


Figure 20 Walnut Creek - Tippecanoe River Sampling Points

Clean Waters Partnership Selected Chemical Targets and Watershed Overview

On November 30, 2016, the Technical Committee (list of the Technical Committee members can be found in Appendix A, Table 2) met to evaluate 10 months of data, determine target water quality recommendations for the watershed, and generate consensus on where to conduct source identification sampling. Attendees included Lyn Crighton, Chelsea Cottingham, Stephen Becker, Ryan Workman, Brian Davison, Dr. Nate Bosch, David Ransbottom, Jim Moyer, Sam St. Clair, Ed Rock, Kirk Swaidner, and Theresa Sailor.

The committee was presented with the data from 10 months of sampling, an explanation of the testing procedures, parameters, and results with a breakdown of averages, high points, and recommendations for targets.

of certain parameters. Additionally, the committee selected locations for to investigate areas that tested for high concentrations of pollutants, or “high source” sites. High source sampling occurred at an additional seven sites;

site numbers 11-17. Sites were selected on long waterway runs that had heavy nutrient and / or sediment loads to help narrow areas of highest loading.

The committee also developed a consensus of recommended water quality targets that was later adopted by the steering committee (Table 2)

To derive at those target values, the technical committee evaluated Indiana water quality standards listed in Indiana Administrative Code (327 IAC-2-1-6), Federal EPA recommended standards, and standards broadly recognized as necessary for maintaining high water quality that would sustain diverse biota.

Indiana water quality standards are evaluated using three components: designated uses, numeric criteria for certain parameters, and the anti-degradation rule to protect waterways from further degradation, as well as protections for unique or high-quality waters. Indiana has not developed targets in all parameters, including values for nutrients that can degrade waterways, other than those that also pose human health concerns. Minimum surface water quality standards are listed in Indiana Administrative Code 327 IAC 2-1-6. Sec. 6 (a) (1) Sec. 6. (a) The following are minimum surface water quality conditions:

(1) All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following: (A) Will settle to form putrescent or otherwise objectionable deposits. (B) Are in amounts enough to be unsightly or deleterious. (C) Produce: (i) color; (ii) visible oil sheen; (iii) odor; or (iv) other conditions; in such degree as to create a nuisance. (D) Are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to: (i) create a nuisance; (ii) be unsightly; or (iii) otherwise impair the designated uses.

For determining viable parameters and targets, the watershed committee did not adopt a tiered target system based on designated use. The committee adopted the more stringent targets assuming full-recreational and healthy biota standards in every waterway.

The steering committee chose to focus on dissolved oxygen (DO), pH, Escherichia coli (E. coli), total suspended solids (TSS), total phosphorus (TP), and nitrates (NO3). The parameters were chosen based on their importance to aquatic or human health and the committee's ability to reduce or change that pollutant in the watershed. Table 2 shows each water quality parameter selected by the technical committee to develop water quality targets for, the source of the selected target value, and relevant background information for each.

2016 Watershed Management Plan Water Quality Target Recommendations by the Technical Committee			
Water Quality Parameter	Identified Watershed Target	Source of Target	Background Information
Dissolved Oxygen (DO)	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code (327 IAC-2-1-6)	Dissolved Oxygen as measured in mg/L should fit in the 4-12 mg/L parameter; however, the technical committee advises that DO % saturation is determined using temperature and nutrient factors affecting oxygen supply, thus the saturation percentage of dissolved oxygen is key for understanding the available oxygen for aquatic life. 60% - 105% Dissolved Oxygen Saturation is required for the most diverse biota.
pH	Minimum 6 and maximum 9	Indiana Administrative Code (327 IAC-2-1-6)	USGS states importance to aquatic life: The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For example, in addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. In the case of heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble. (Source: A Citizen's Guide to Understanding and Monitoring Lakes and Streams).
Escherichia coli (E. coli)	Max: 235 CFU/100mL in a single sample	Indiana Administrative Code (327 IAC-2-1-6)	Measurement used to identify potential presence of fecal bacterial that statistically could result in increased human health risks.
Total Suspended Solids (TSS)	25.0 mg/L	US EPA Recommendation for Excellent Fisheries	Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. Suspended solids are present in all waters both point source and non-point source discharges. As levels of TSS increase, a waterbody begins to lose its ability to support a diversity of aquatic life. TSS will absorb heat from sunlight, which increases water temperature and decreases levels of dissolved oxygen. Photosynthesis decreases, since less light penetrates the water then less oxygen is produced by plants and algae and there is a there further drop in dissolved oxygen. TSS can destroy fish habitat as SS can settle to the bottom, blanket a river bed, and smother eggs of fish and aquatic insects, and suffocate newly-hatched insect larvae. In adult fish TSS can clog gills, reduce growth rates, and lower resistance to disease. Water with TSS of less than 20 mg/L appears clear. Water with TSS between 40 and 80 mg/l tends to appear cloudy, and water with concentrations over 150 mg/l usually appears dirty. (michigan.gov)
Total Phosphorus (TP)	.076 mg/L	US EPA Recommended Target	Phosphorus is a nutrient for plants and is released in decomposing plant life. Along with natural sources such as leaves that fall into a water stream, it can be unnaturally introduced by stormwater that is contaminated with grass clippings or leaves, agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent. The addition of unnatural sources speeds up eutrophication of rivers and lakes and grows unwanted algae including toxic variants. Soil erosion from unvegetated, partially vegetated, or cultivated lands can be a major contributor of phosphorus to streams. Bank erosion during floods also can transport significant phosphorous from the river banks and adjacent land into a stream.
Nitrates (NO3) nitrogen	1.5 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodds, W.K. et al., 1998, Table 1, pg. 1459, and in EPA-822-B-00-002 [PDF], p 27.)	Excess nitrogen (a plant nutrient) can cause overstimulation of growth of aquatic plants and algae, use up dissolved oxygen as they decompose, and block light to deeper waters. Lake and reservoir eutrophication can occur, which produces unsightly scums of algae on the water surface, can occasionally result in fish kills, and can even "kill" a lake by depriving it of oxygen. The respiration efficiency of fish and aquatic invertebrates can occur, leading to a decrease in animal and plant diversity, and affects our use of the water for fishing, swimming, and boating. Although nitrogen is abundant naturally in the environment, it is also introduced through sewage and fertilizers. Chemical fertilizers or animal manure is commonly applied to crops to add nutrients. Heavy rains can generate runoff containing these materials into nearby streams and lakes. Wastewater-treatment facilities that do not specifically remove nitrogen can also lead to excess levels of nitrogen in surface or groundwater. Source: usgs.gov

Table 2 Clean Waters Partnership Water Quality Targets

Dissolved Oxygen

Dissolved oxygen (D.O.) is an important parameter used in determining the health of a streams and lakes. It is measured in mg/L or as a percentage of oxygen saturation in the water. Since different species of aquatic life require different levels of oxygen, the target for a diverse biota is generally cited between the range of 4 mg/L and 12 mg/L. Saturation percentage was also identified and the saturation of 60% - 105% dissolved oxygen was selected to promote a diverse biota. Oxygen levels fluctuate on a daily and seasonal cycle as concentrations are inversely dependent on water temperature.

Coldwater fish such as trout and salmon are affected most by low dissolved oxygen levels. The mean DO level for adult salmonids is 6.5 mg/L, and the minimum is 4 mg/L. (Fondriest Environmental, Inc., n.d.) These fish will avoid areas where dissolved oxygen is less than 5 mg/L and will begin to die if exposed to DO levels less than 3 mg/L for more than a couple days. (Fondriest Environmental, Inc., n.d.) For salmon and trout eggs, dissolved oxygen levels below 11 mg/L will delay their hatching, and below 8 mg/L will impair their growth and lower their survival rates. (Fondriest Environmental, Inc., n.d.) When dissolved oxygen falls below 6 mg/L (which is considered normal for most other fish), the vast majority of trout and salmon eggs will die if dissolved oxygen levels are not above 5 mg/L with 5.5 mg/L being the lowest for optimum conditions. (Fondriest Environmental, Inc., n.d.) Although they can survive at lower levels of dissolved oxygen, they will avoid areas below 3 mg/L. (Fondriest Environmental, Inc., n.d.)

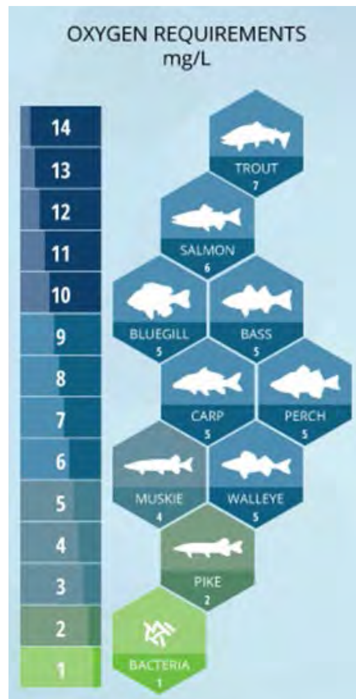


Figure 21 Minimum Dissolved Oxygen Requirements of Freshwater Fish (Fondriest Environmental, Inc., n.d.)

Bluegill, Largemouth Bass, White Perch, and Yellow Perch are considered warm-water fish and can withstand lower oxygen levels and are more successful in eutrophic lakes where the water tends to become warmer in the summer. (Fondriest Environmental, Inc., n.d.)

pH

pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. A pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units." Each number represents a 10-fold change in the acidity/basicness of the water. Water with a pH of five is ten times more acidic than water having a pH of six (USGS).

The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For example, in addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. In the case of heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble (USGS).

pH will also tend to increase during the day when plants are using carbon dioxide during photosynthesis and then reduce during the night when algae respire and give off carbon dioxide, making carbonic acid which lowers the pH. In lakes, especially, where there is a high nutrient concentration, the pH can rise as high as 10 as nutrients feed algal growth.

E. coli

Fecal coliform bacteria are found in intestines and feces of humans, waterfowl, and animals. In unpolluted waters, the bacteria are rare or absent. Many coliform bacteria are harmless and certain types are actually an important part of a healthy human intestinal tract. However, others are pathogenic for humans, meaning they can cause illness, either diarrhea or illness outside of the intestinal tract. The types of fecal coliform that can cause diarrhea can be transmitted through contaminated water or food, or through contact with infected animals or persons.

The test for fecal coliform is done through testing of Escherichia coli (E. coli), one of the most common subgroups of fecal coliform. The incubated and the number of coliform units are counted to determine a concentration of fecal coliform in the water. The U.S. EPA has determined that an E. coli colony count above 235 colonies per 100mL indicates that 8 people in 1,000 who come into contact with the water may become sick with E. Coli or some other pathogen from fecal contamination. As the concentration of E. coli goes up, so does the chance that someone will get sick. Pathogens can enter the body through contact with a person's eyes, nose, mouth, or open cuts or sores. A person's susceptibility is influenced also by a person's age and/ or their health. The presence of E. Coli indicates there is fecal matter in the water. With the presence of fecal matter confirmed, there could also be various other pathogens, in addition to E. Coli. Beyond fecal coliform bacteria, the fecal matter may contain other pathogens, disease producing bacteria, viruses, or even parasites that live in the digestive tracts of humans or animals. These can cause ear infections, Hepatitis A, Salmonella, Rotavirus, Norovirus, Enterovirus, Cryptosporidium, Campylobacter, and Giardia.

Fecal matter can enter water through a variety of channels. Bird, wild animal, or pet waste can travel in stormwater runoff during heavy rains or even travel off buildings and parking lots into in gutters or storm sewers which are often piped directly to the water. Rainfall runoff allows waste from pets, farm animals and wildlife to flow over land and into storm drains or waterways. Septic system failures of homes or businesses can cause sewage to come up out of the ground. Also, septic systems that are near the water table, especially those beside lakes or rivers, can mix with the groundwater and contaminate the adjacent waterway, or nearby drinking well, with fecal matter. Old septic systems, usually installed before 1972 when the federal Clean Water Act was enacted, could be legally piped directly into a lake or ditch. Occasionally, in urban areas, a plumber will accidentally install a home's plumbing to the storm sewer instead of the sanitary sewer.

Nitrates

Nitrogen (NO3) is also an essential nutrient for plant and animal life. Although some plants can access some atmospheric nitrogen, in the natural environment, plants predominately receive their nitrogen needs from the nitrogen in the soil from decomposing organic material. Row crops are more difficult to manage as disruption of the root can damage the nutrient cycle and cause the release of nitrogen from the soil and into water runoff. Tillage is damaging to the careful balance that the soil maintains in holding nitrogen for plant use. The combination of tilling and the use of annual only crops that die off in the winter can upset that balance and allow the nitrogen to flush out of the soil in a rainfall.

This loss of nutrients has been offset by the addition of manure and other waste bio solids and anhydrous ammonia. These all are short term additions to the farm field to provide nitrogen for plant growth when adequate nitrogen has not been retained in the soil. Cover crops have become an important tool in the ability for farmers to essentially grow their own fertilizer.

Excess nitrogen has some of the same concerns as excess phosphorus. Both are nutrients that when introduced in an unhealthy level can lead to a reoccurring cycle of aquatic plant overproduction and decomposition. That can lead to reduced oxygen, warmer temperatures, less sunlight penetrating the water due to plants and sediments, and overproduction of algae all contribute to a degrading environment for aquatic life.

High nitrogen loads also pose a threat for human and animal health. Drinking water with high nitrogen levels can restrict oxygen transport in the blood. The condition, called "blue baby syndrome," can affect young human babies as well as animal juveniles.

Total Phosphorus

Phosphorus and nitrogen are both nutrients that feed plant growth. When they are released into a lake system, they are removed from the water by the plants and become part of the food chain. Many of the plants grow, or in the case of algae, will grow rapidly, then die and fall to the bottom to decompose. When the plants decompose, the phosphorus is released to again become a part of the cycle. When phosphorus is introduced into a lake system in large quantities, such as in urban areas where storm sewers carry many square miles of leaves and grass clippings to a lake, the result can be large quantities of material that decays in the bottom. This not only reduces the oxygen level but begins to fill in the bottom of the lake. Then, in a matter of 100 years, with six inches of material added to the bottom of the lake a year, the result is the lake becomes fifty (50) feet shallower, has less oxygen, fewer fish and living species, and more plant growth. The process is called eutrophication. It is the natural process that occurs when a lake gradually builds its organic material and slowly becomes a wetland. In a natural setting, without a concentrated infusion of nutrients, it would take thousands of years. Other contributors to large amounts of nutrients would include erosion on waterways, erosion of construction sites and farm fields, and the over application of fertilizers. Total phosphorus (TP) is the term that represents all phosphorus that is present in a sample in all its forms.

Total Suspended Solids

The limiting of Total Suspended solids (TSS) is important because fish and other aquatic life need to breathe. Gills don't come with filters to filter out sediment from the water as they are trying to remove the oxygen with every breath. Sediment fills their gills and makes it difficult for them, not unlike smoke makes it difficult for humans to remove oxygen from air. Total suspended solids also create other problems for fish. They can reduce growth rates and smother eggs of fish and insects, including smothering newly hatched insect larvae. These pollutants can also damage the balance of a water body in other ways. Suspended solids darken water and allow more heat from the sun to be absorbed. Heated water results in a lower ability to retain oxygen making it difficult for some fish to survive. Sediments also bring a host of elements (nutrients) like phosphorus with them which act as plant fertilizer for aquatic algae. Algae readily eats the nutrients, multiplies and then dies on its short life cycle. As it decays on the bottom, the decomposition process steals more oxygen from the system.

Overview of Chemical Sampling of Sites #1-10

Dissolved Oxygen Sites #1-10

Many sites had dissolved oxygen results that were within the water quality standards set by the committee of 4-12 mg/L. However, three sites were a concern, testing low (under 4 mg/L). Site #2 (Heeter Ditch) tested under 4 mg/L in seventeen (17) percent of the samples, site #8 (Walnut Creek before Eagle Creek) tested under 4 mg/L in eleven (11) percent of the samples, and site #9 (Walnut Creek south of the Tippecanoe River) tested below the threshold in nine (9) percent of the samples.

Site # 1 (Deeds Creek) tested under the threshold of 60% dissolved oxygen saturation for twenty-two (22) percent of the samples and site #8 (Walnut Creek before Eagle Creek) tested below the threshold twenty-six (26) percent of the time. Site # 7 (Eagle Creek) tested above 105% oxygen saturation forty (40) percent of the time as did site #6 (Martin Peterson Ditch) eleven (11) percent of the time and Walnut Creek before the Tippecanoe River forty-three (43) percent of the time.

The sampling data for the dissolved oxygen is included in the subsequent subwatershed sections only for the sites that did not meet the watershed's target results. Waters not meeting the threshold for dissolved oxygen typically remained at the low end of the criterion in the summer months. In summer months, the warmer water is less able to hold oxygen and there is a natural decline at all sampling sites. The additional loss in oxygen saturation could be due to nutrient loads and organic waste that are acting as a food source for bacteria. Dips coinciding with rain events indicate nutrients entering the waterways during rain events that in turn increase the biological demand and reducing the oxygen available in the water for fish and other aquatic life.

pH Sites #1-10

After two years of data, the results from pH testing on all sites tested within the watershed's target parameters of 6-9. Sampling results for pH can be found in the Appendix along with a complete listing of all other sampling results.

E. coli Sites #1-10

Walnut Creek before Eagle Creek (site #8), Peterson Ditch (site #6), Wyland Ditch (site #4), and Deeds Creek (site #1) all exceeded the upper testing limit of 2914 cfu/mL at the Health Department. Although Heeter Ditch (site #2) and Walnut Creek (site #9) before the Tippecanoe River did not reach the upper testing limit, these two sites also exceeded the target threshold of 235 cfu/mL. All the exceedances correlated with rain events indicating that fecal matter is being flushed into the waterway at, during, or immediately after rain events. These high concentrations indicate significant waste material is entering the water on a regular basis in these waterways.

A summarized table of the sampling results can be found in Table 3. For each sampling site, E. coli, nitrates, total phosphorus, and suspended solids are listed with the average reading, highest reading, lowest reading, and % of instances exceeding water quality targets.

Nitrates Sites #1-10

Nitrate concentration is a problem for the entire watershed. Tippecanoe River before Fox Farm Road (site #10) exceeded the high nitrate target one time. Every other site exceeded the target at least twice. Although still exceeding the target maximum a few times throughout the year, Heeter Ditch (site #2), Walnut Creek before the Tippecanoe River (site #9), and Eagle Creek (site #7) had relatively stable numbers that were generally below the 1.5 mg/L threshold. That cannot be said for the other sites. Deeds Creek (site#1) tested over 9 mg/L one time, and several times over 4 mg/L. Deeds Creek (site #1), Wyland Ditch (site#4), Peterson Ditch (site #6), Walnut Creek before Eagle Creek (site #8), and Keefer – Evans (site #5) Ditch all exceed the threshold numerous times. Sampling results followed a seasonal pattern. Nitrate concentrations were higher in winter and spring when more cropland was bare. Alternately, nitrate concentrations during the growing season were stable and usually met the target threshold even during heavy rain events.

A summarized table of sampling values from the watershed can be found in Table 3. For each sampling site, E. coli, nitrates, total phosphorus, and suspended solids are listed with the average reading, highest reading, lowest reading, and percentage of instances exceeding water quality targets.

Total Phosphorus Sites #1-10

The total phosphorus (TP) highest peaks matched the TSS highest peaks. Additional high results were found throughout the growing season and peaks that were at or above 100 mg/L in TSS correlated to elevated TP concentrations. Walnut Creek before the Tippecanoe River, Walnut Creek before Eagle Creek, and Deeds Creek maintained elevated levels in most samples.

A summarized table of sampling values from the watershed can be found in Table 3. For each sampling site, E. coli, nitrates, total phosphorus, and suspended solids are listed with the average reading, highest reading, lowest reading, and % of instances exceeding water quality targets.

Total Suspended Solids Sites #1-10

Deeds Creek (site# 1) and Peterson ditch (site# 6) exceeded 25 mg/mL (target 35 mg/L) each three times. Additionally, Wyland ditch (site# 4) and Keefer – Evans ditch (site#4) exceed the 25 mg/L once. These were all after large rain events. The timing corresponded with spring plowing season (April), winter rains when many fields are exposed, and end of June/ beginning of July. Most sites meet the water quality target.

A summarized table of the sampling results can be found in Table 3. For each sampling site, E. coli, nitrates, total phosphorus, and suspended solids are listed with the average reading, highest reading, lowest reading, and % of instances exceeding water quality targets.

Summary of Sampling Data at All Sites																	
		E. coli				Nitrates (NO3)				Total Phosphorus				Suspended Solids			
Site #	Waterbody	Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
1	Deeds Creek	650	>2419	36	62%	3.21	9.38	0.36	87%	0.118	0.606	0.015	46%	23	254	0	22%
2	Heeter Ditch	319	>2419	1	30%	0.67	2.40	0.09	9%	0.044	0.111	0.012	8%	11	48	0	7%
3	Lones Ditch	38	727	1	6%	1.23	3.37	0.00	39%	0.039	0.154	0.007	4%	8	32	0	2%
4	Wyland Ditch	354	>2419	28	42%	1.95	5.61	0.48	54%	0.072	0.544	0.014	22%	14	292	0	6%
5	Keefer Evans	223	1986	9	26%	0.96	3.86	0.09	24%	0.056	0.376	0.016	11%	11	162	0	4%
6	Peterson Ditch	723	>2419	21	54%	1.86	5.92	0.34	54%	0.090	0.738	0.013	25%	24	337	0	9%
7	Eagle Creek	24	345	0	19%	0.51	1.91	0.00	2%	0.033	0.064	0.014	0%	5	17	0	0%
8	Walnut Creek Before Eagle Creek	298	>2419	1	33%	1.62	4.97	0.09	44%	0.085	0.201	0.018	52%	6	20	0	0%
9	Walnut Creek before Tippecanoe River	172	1732	13	26%	0.78	2.37	0.07	11%	0.069	0.151	0.030	39%	7	33	0	0%
10	Tippecanoe River East of Fox Farm	115	1119	13	11%	0.64	1.55	0.09	2%	0.032	0.072	0.012	0%	5	16	0	0%
11	Deeds Creek	457	980	106	75%	1.51	1.87	1.34	25%	0.062	0.136	0.032	25%	11	31	1	25%
12	Van Curen Ditch	783	>2419	30	75%	1.35	2.10	0.93	25%	0.070	0.120	0.017	100%	6	6	2	0%
13	Leedy Ditch	1117	>2419	435	100%	2.58	3.25	1.98	100%	0.136	0.189	0.043	75%	17	36	6	25%
14	Deeds Creek	1096	>2419	236	100%	4.51	6.25	2.92	100%	0.050	0.088	0.020	25%	4	7	0	0%
15	Deeds Creek	807	>2419	210	75%	3.60	4.11	3.20	100%	0.170	0.198	0.096	100%	11	27	0	25%
16	Deeds Creek	1416	>2419	225	75%	5.71	7.66	3.93	100%	0.540	0.906	0.289	100%	10	26	2	0%
17	Deeds Creek	1864	>2419	200	75%	3.47	5.29	1.29	75%	0.140	0.167	0.115	100%	30	50	7	50%
18	Outfall into Kelly Park Pond	922	>2419	816	80%	0.50	1.10	0.12	100%	0.170	0.238	0.129	100%	30	75	12	33%
19	Outfall into Winona Lake	130	>2419	23	33%	0.30	0.74	0.00	83%	0.160	0.356	0.049	100%	237	679	3	50%
20	Outfall into Pike Lake	739	>2419	179	0.4	0.65	1.12	0.26	100%	0.430	0.712	0.091	100%	223	788	4	33%

* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.

Table 3 Summary of Sampling Data at All Sites

High Source Sampling (sites #13-20)

The technical committee identified seven additional sites to conduct sampling in the Pike Lake – Deeds Creek & McCarter Ditch – Deeds Creek subwatersheds upstream of site #1. Site #1 was the site with the highest incidence and frequency of water quality target exceedance in the watershed. It also is connected to the most extensive ditch system. The additional sampling was to be used to eliminate "fingers" from the system and better identify where the pollutants were concentrated. The seven sites were called "high source" and numbered #11-17.

Each site was sampled four times. None of the seven sites showed high levels of sediment. All seven individual sites, however, showed high levels of at least two of the three other parameters (E. coli, nitrates, or phosphorus). Six of the seven sites would be considered as having very high levels (averaging more than double the target value) of at least two of the three parameters (sites #13-17). Five of the sampling sites exceeded the water quality targets on all three parameters, E. coli, nitrates, and total phosphorus.

For each sampling site, E. coli, nitrates, total phosphorus, and total suspended solids are listed with the average reading, highest reading, lowest reading, and % of instances exceeding water quality targets.

Urban Stormwater Outfall Sampling (sites #18-20)

There were four outfalls identified in the QAAP to be sampled. Data for three of the outfalls will be discussed here. One of the sampling sites, a dry ditch, was thrown out. Three of the four parameters, E. coli, total phosphorus, and total suspended solids exceeded the target limit in stormwater runoff. The stormwater tested did not exceed the target for nitrates.

Site #17, Pike Lake, exceeded the target limit in average E. coli, TP, and TSS. Average TP was over five times the target limit.

Site #18, Winona Lake, exceeded the target limits for both TP and TSS. Average TP was two times higher than the target limit.

Site #19, Kelly Park, exceeded the target limits in average TP and TSS. Average TP was over twice the target limit.

For each sampling site, E. coli, nitrates, total phosphorus, and suspended solids are listed with the average reading, highest reading, lowest reading, and % of instances exceeding water quality targets.

Biological and Habitat surveys

There was limited biological and habitat data gathered for the watershed plan. Biological and habitat data can be an important component in determining the health of water quality and its ability to support a diverse aquatic community. In the case of the Walnut Creek – Tippecanoe River Watershed, the QAPP sampling strategy proposed and utilized did not include repeat biological or habitat sampling. The sampling was done on just one date per site, with a double sample collected on that date (sample A & sample B) using the Hoosier Riverwatch Biological Monitoring and Citizen's Qualitative Habitat Evaluation Index (CQHEI) guidelines. The data collected can be used as an indicator and may become the start of a data set if it is followed by additional testing over the next several years, but, is inadequate to use in forming any conclusions or develop trending in the watershed.

Biological and habitat data can be an important component in determining the health of water quality and its ability to support a diverse aquatic community. A biological assessment was conducted utilizing bottom (benthos) dwelling macroinvertebrates (organisms that lack backbones and can be seen by the naked eye). These benthic macroinvertebrates are an important part of the food chain acting as middlemen between plants and fish. Some shred plants and leaves and other organic matter that enters the water, while others feed on algae and bacteria. In a healthy ecosystem, they are abundant and provide an important food source for fish. There are many species of macroinvertebrates. Each has a different sensitivity or tolerance toward pollution. The presence or absence of certain macroinvertebrate species is used as an indicator of the level of pollution present or previously present in a waterbody.

Some organisms such as mayflies, stoneflies, and caddisflies are more susceptible to the effects of physical or chemical changes in a stream than other organisms; whereas, some organisms such as midges and worms are pollution tolerant. This provides the opportunity to sort macroinvertebrates into pollution tolerance groups and quantify the diversity of macroinvertebrates in a river to determine overall river health using a Pollution Tolerance Index (PTI). The resulting PTI converts to a level of river health based on what is currently able to live there (IDEM, 2017)

The Citizens Qualitative Habitat Evaluation Index (CQHEI) is designed to be a quantitative measurement of a stretch of waterway. The maximum score for the CQHEI is 114 points. The score provides a measurement of the stream habitat and riparian health that relates the physical factors present that affect fish and other aquatic life, such as macroinvertebrates. The stream or ditch evaluation is done by characterizing a 200-lineal foot section. Score greater than 60 "have been found to be generally conducive to the existence of warm water fauna." Ohio also uses the CQHEI and provides additional guidance in determining Scores related to habitat value using the following scale.

> **0-49** Moderate to extensive man-made modifications to stream. These waterbodies would generally be classified as "Modified Warm Water Habitats." Channelized, treeless ditches with little depth and poor flow rate could score as low as 30 or 40. Silt and muck included in the same stream could result in scores as low as 20.
>
> **50-60** Streams in this range generally can attain "Warm Water Habitat" (WWH) biological communities. Depending on which features (flow, depth) are lacking the biological communities may continue to fall short of the WWH classification.
>
> **61-69** Streams scoring at this range have enough positive habitat features available to attain "Warm Water Habitat" (WWH). This would include good depth, flow, substrate, and forest canopy over stream.
>
> **70-100** Streams scoring in this range are capable of supporting "Exceptional Warm Water Habitat" biological communities. This would include variable depth, good flow, riffles and pools, good substrates, and good riparian quality.

As noted previously, the biological and habitat data (using Hoosier Riverwatch Biological Monitoring and CQHEI guidelines) was limited to one sampling event. Additional sampling will be important in determining an accurate baseline of biological and habitat health in the watershed. In keeping with the intent of supporting healthy biota standards, biological and habitat data should maintain a minimum rating of "good" in biological monitoring and work to achieve and maintain a combined score of 60 when rating sites for habitat characteristics.

Overview of Biological Monitoring and Habitat (CQHEI) for Sites #1-10

The biological monitoring and collection of the CQHEI data was completed in July of 2016. Rainfall data for the month of July indicates no significant (<.05") rainfall per day until the 24 hours before the CQHEI that was done for the Walnut Creek before the Tippecanoe River. The subwatersheds that carry the water into that sampling site received .10-.14" rain in that preceding period. That could have impacted the sediment and turbidity in the stream by a maximum of 5 points, but it should have no other bearing on the results.

Biological monitoring is more sensitive to rainfall events. Prior to the July 14 monitoring, there was a significant rain event for some of the subwatersheds that likely affected monitoring results at certain sites. The southern area of the watershed from the southern boundary of Winona Lake and down to the bottom of the watershed received between .22'' - .72" of rain. That is a significant rain event that would likely negatively impact the results of the monitoring activity at Site #6 (Peterson Ditch), site #8 (Walnut Creek before Eagle Creek), and then possibly site #9 (Walnut Creek before the Tippecanoe River) as an indirect result. The Walnut Creek – Eagle Creek subwatershed and parts of the Winona Lake-Eagle Creek subwatershed, had received two consecutive days of rain, with the Walnut Creek – Eagle Creek subwatershed (Eagle Creek tributaries) receiving the most, .73" recorded on July 13 and .72" recorded the morning of July 14. This could have affected the monitoring site #9 as the water flowed north, even though the northern part of the subwatershed was only receiving closer to .10" (Figure 22).

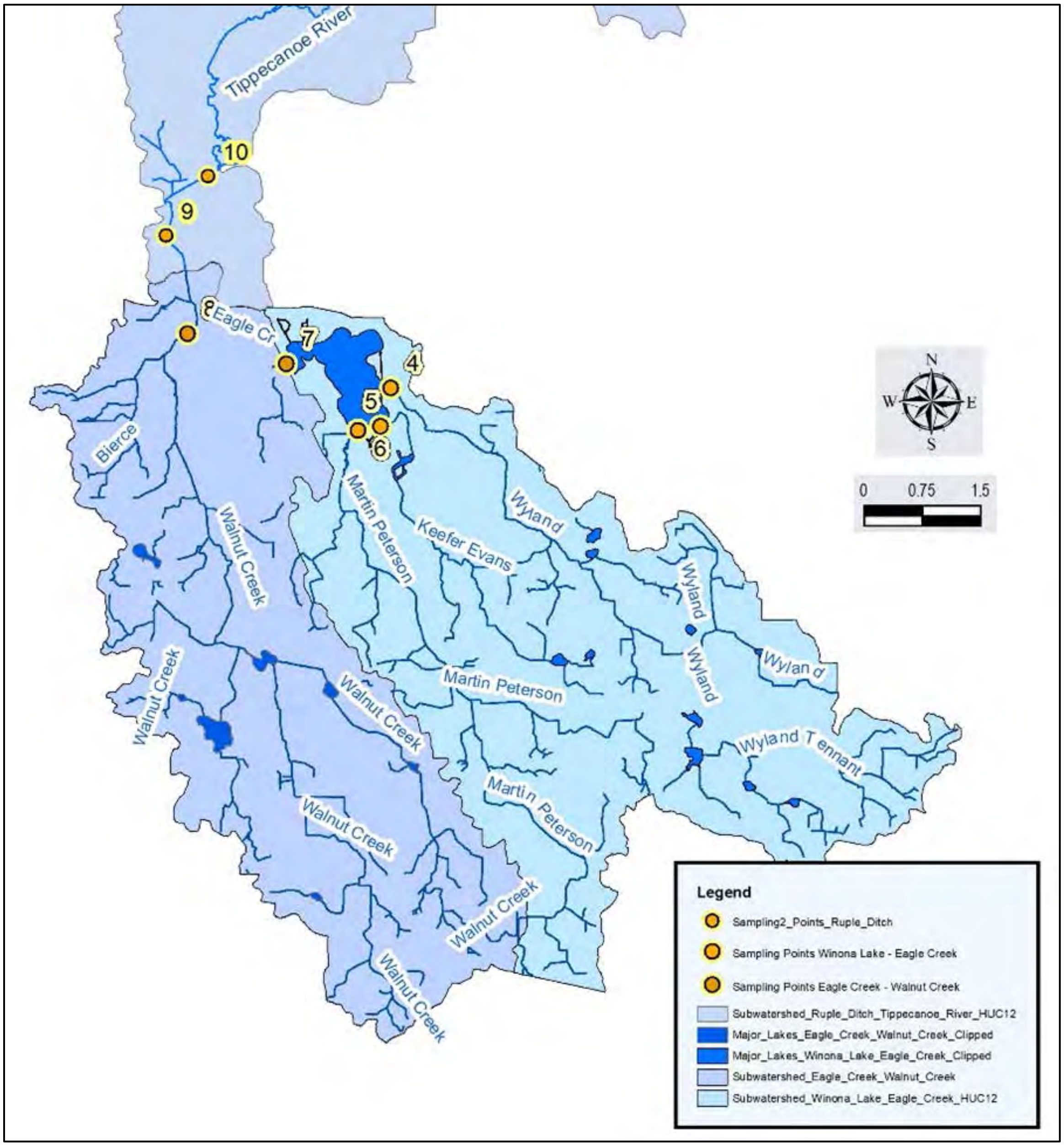


Figure 22 Map of Sampling Sites Potentially Affected by Rain Events

The areas of the Pike Lake – Deeds Creek Subwatershed (not pictured) received much less, data showing a possible rain of .10’ recorded on the morning of July 14, with accumulated rain for the previous 24 hours. This would be a much smaller influx of rainwater, even accounting for the stormwater being released from the City of Warsaw. The urban watershed accounting for rain entering Lones Ditch is a small stormwater area, which under summer, high heat circumstances would send an only a limited amount of the .10” rainfall to the ditch.

Site # 10 (Tippecanoe River near Fox Farm Rd) should ***not*** have been significantly affected by the additional rain. The Ruple Ditch – Tippecanoe River subwatershed did not receive significant rain. Therefore, it would be influenced only by the amount coming from site #3 (Lones Ditch) in the Pike Lake – Deeds Creek subwatershed which should not have significantly changed the biological data being collected (Figure 22).

The Hoosier Riverwatch data and the Citizens Qualitative Habitat Evaluation Index Data for the Walnut Creek – Tippecanoe River Watershed are below (Table 4).

Hoosier Riverwatch & Citizens Qualitative Habitat Evaluation Index Data															
Site #	Site Description	Sample #	2016 Date	Pollution Tollerance Index Rating (PTI) Score (23+ Excellent, 10 or less Poor)		Presence of Group 1 - Pollution Intollerant Organisms	2016 Date	Qualitative Habitat Evaluation Index (CQHEI)	Waterway Substrate (0-25)	Fish Cover Present (2-18)	Stream Shape and Human Alteration (0-20)	Stream Forests, Wetlands, Riparian, Erosion (0-19)	Water Depth & Velocity (0-15)	Riffles Runs (0-15)
1	Deeds Creek	A	7/6	20	Good	Yes	7/6	52.5	15	10	12	9.5	6	0
1	Deeds Creek	B	7/6	15	Fair	No								
2	Heeter Ditch	A	7/14	22	Good	Yes	7/6	29.5	0	8	9	4.5	8	0
2	Heeter Ditch	B	7/14	20	Good	Yes								
3	Lones Ditch	A	7/14	10	Poor	No	7/6	51.5	5	16	9	13.5	8	0
3	Lones Ditch	B	7/14	10	Poor	No								
4	Wyland Ditch	A	7/6	21	Good	Yes	7/6	55	16	8	9	3	6	13
4	Wyland Ditch	B	7/6	19	Good	Yes								
5	Keefer-Evans Ditch	A	7/6	26	Excellent	Yes	7/6	54.5	5	10	18	13.5	8	0
5	Keefer-Evans Ditch	B	7/6	20	Good	Yes								
6	Martin Peterson Ditch	A	7/6	4	Poor	No	7/6	48.5	15	10	9	8.5	6	0
6	Martin Peterson Ditch	B	7/6	4	Poor	No								
7	Eagle Creek	A	7/6	15	Fair	Yes	7/6	44.5	15	6	6	9.5	8	0
7	Eagle Creek	B	7/6	9	Poor	No								
8	Walnut Creek before Eagle Creek	A	7/14	11	Fair	Yes	7/6	66.5	16	10	15	10.5	9	6
8	Walnut Creek before Eagle Creek	B	7/14	9	Poor	No								
9	Walnut Creek before Tippy River	A	7/14	21	Good	Yes	7/6	57.5	10	12	12	13.5	10	0
9	Walnut Creek before Tippy River	B	7/14	20	Good	Yes								
10	Tippy River at Fox Farm Rd	A	7/14	25	Excellent	Yes	7/6	63.5	16	14	9	16.5	8	0
10	Tippy River at Fox Farm Rd	B	7/14	21	Good	Yes								
Denotes an area that received .18-.72 inches of rain in the 24 hours prior to monitoring. Results may not be typical. Macroinvertabrates that may normally have been found at that site could have been flushed by the heavy rain event.														

Table 4 Hoosier Riverwatch & Citizens Qualitative Habitat Evaluation Index Data

The data for macroinvertebrate sampling of the ten sites produced mixed results. Sites #3 (Pike Lake - Deeds Creek subwatershed), sites 6 & 7 (Winona Lake – Eagle Creek subwatershed), and 8 (Walnut Creek – Eagle Creek subwatershed) scored either fair or poor in the Pollution Tolerance Index (PTI). It needs to be notes that site #8 was one of the sites that could have been disturbed due to heavy rainfall so that result could be an inaccurate representation of the site.

The Citizens Qualitative Habitat Evaluation Index (CQHEI) data was less positive. Site #2 (Pike Lake – Deeds Creek subwatershed) and #6, #7 (Winona Lake – Eagle Creek subwatershed) all scored in the lowest tier for rating the quality of habitat available for biological organisms. Its score is characterizing moderate to extensive man-made modifications to the waterway.

Site #2, Heeter Ditch (Pike Lake – Deeds Creek subwatershed), received the worst rating at 29.5. Indeed, it is a shallow, channelized, treeless ditch with some silting, making it too warm, shallow, and silted to provide habitat for most aquatic life.

Site #6, Martin Peterson Ditch, is channelized for approximately 1,700 feet before entering Winona Lake.

Site # 7 Eagle Creek, exiting Winona Lake, is channelized with concrete seawalls has minimal shade and has unpredictable flow because of the dam at the exit of Winona Lake. Both sites had a CQHEI score in the forties indicating a habitat less likely to support a diverse community aquatic community.

Sites #1,3,4,5 & 9 score slightly better in the fifties. This score is indicative of sites that still fall short of meeting the requirements of an adequate Warm Water Habitat (WWH) that has adequate depth, flow, substrate, and forest canopy. No sites met the requirements of the highest classification of 70-100. Streams scoring in this range can support "Exceptional Warm Water Habitat" biological communities. This would include variable depth, good flow, riffles and pools, good substrates, and good riparian quality.

Current State of the Watershed – Observations of Land Use & Present Conditions and Gathering of Watershed Knowledge & Opinions on Water and Land Use Practices

In addition, there were other sources of data actively gathered to determine the State of the Watershed in form a "windshield survey", on-the-ground inventory of what is in the watershed along with consultation with professionals and a public survey which tested people's knowledge and opinions on water and land use practices. The driving portion of the windshield survey is were properties are identified which need land use Best Management Practices (BMPs) to protect water quality.

Field Observations

The windshield survey was conducted in February of 2017. It included the Eagle Creek - Walnut Creek, Winona Lake – Eagle Creek, McCarter Ditch – Deeds Creek, and the Deeds Creek – Pike Lake, and part of Ruple Ditch – Tippecanoe River subwatersheds. In a drive by survey, parcels were noted for land use practices including filter strips, fall tillage, conservation tillage, no till, animal operations, fallow land, pastureland, cover crops, and hay crops, as well as the presence of farm animals. All locally mapped tributaries in the field survey area were also visually surveyed from the road. Additionally, the windshield survey section also contains field data through a Snapshot Monitoring Day event in September 2017. Field observations and the large landowner recommendations were made by TWF's watershed conservationist in 2018. This data is later used to identify possible projects in the action register.

Snapshot Monitoring Day

On September 27, 2017 and September 20, 2018, The Watershed Foundation with the assistance of the Kosciusko County Soil & Water District organized a "Snapshot Monitoring Day". Snapshot Monitoring Day is a blitz of sampling in the Walnut Creek – Tippecanoe River Watershed and the Grassy Creek – Tippecanoe River Watershed. The sampling included 30 sites in the Walnut Creek Watershed using Hoosier Riverwatch training, sampling, and analysis methods for attaining chemical information pertaining to water quality.

Tests were conducted for dissolved oxygen, E. coli, turbidity, pH, temperature, nitrate, nitrite, and orthophosphate using Hoosier Riverwatch methods outlined in the Volunteer Stream Monitoring Training Manual (IDEM, 2017). In addition, the sites were evaluated in preparation for the sampling event for depth of channel silting in 2017. A total of twenty sites were evaluated for channel silting.

The Results for 2017 Snapshot Monitoring Day sampling are included in Table 5.

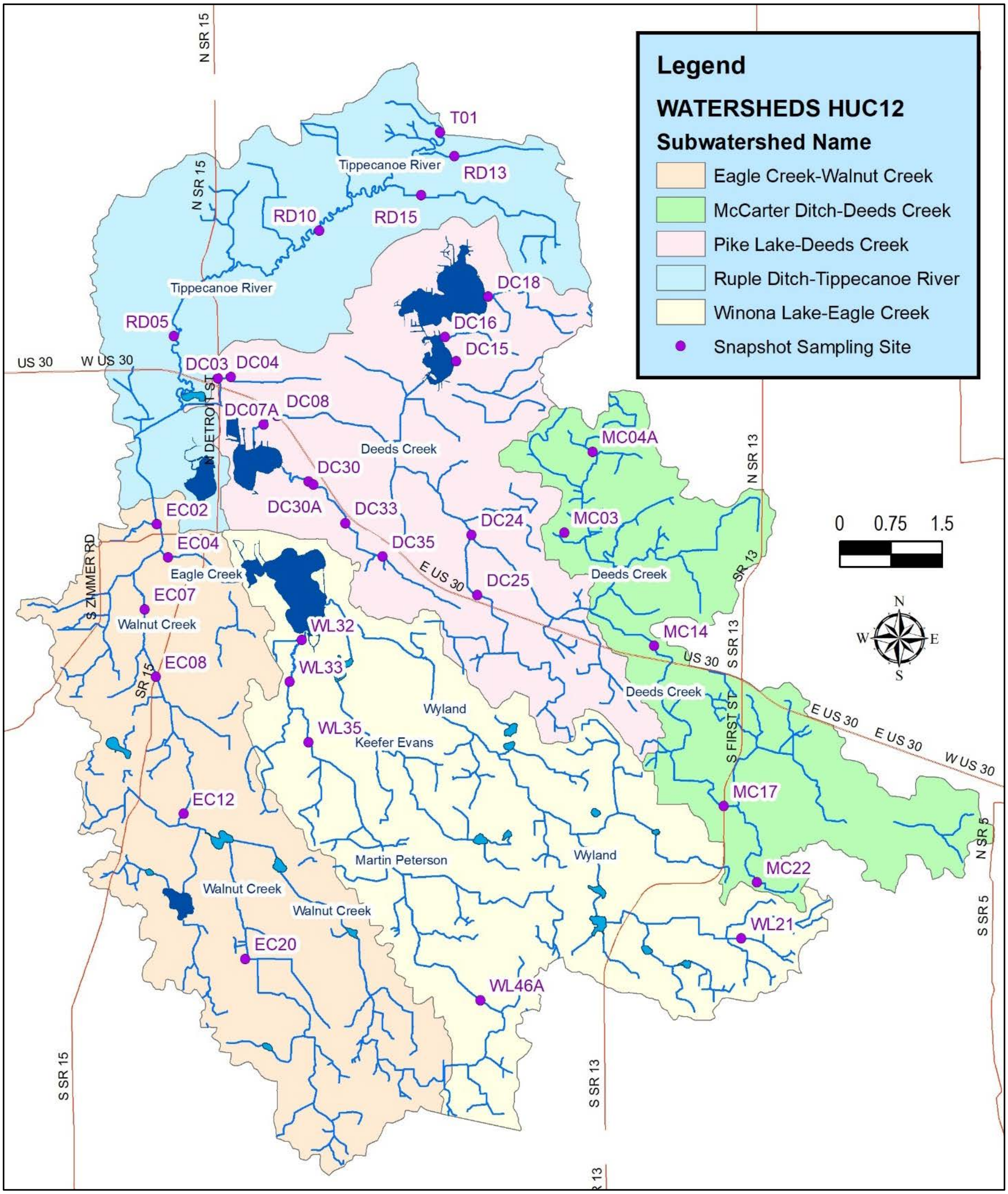


Figure 23 Snapshot Monitoring Day Sampling Sites

Snapshot Water Monitoring Day Results - September 27, 2017									
Field Survey Done for each site prior to sampling to check channel silting, highlighted is point of concern									
Site #	Temp (˚F)	Turbidity (cm)	Dissolved Oxygen (mg/L)	Nitrite (mg/L)	Nitrate (ml/L)	Ortho-phosphate (mg/L)	pH	E.coli (CFU/ 100mL	Silting of Channel (inches)
DC03	60	60	5	0	0	0	7	0	2
DC04	60	16	2.5	0	0.15	0.8	7.5	900	24
DC07A	68	60	4	0.15	2	0	6.5	0	uk
DC08	70	24	8	0	0.5	0.2	7	350	0
DC 15	no flow								uk
DC 16	70	56	10	0	0.5	0.1	8.5	0	uk
DC 18	68	60	6	0	0.5	0.1	7.5	600	5+
DC24	68	60	8	0.5	0.5	0.1	8	200	0
DC25	67	60	6	0	0.5	0.2	8	250	uk
DC30	68	60	5	0	0.5	0.1	7.5	0	0
DC30A	66	60	4	0	0.5	0.1	7.5	300	4
DC33	62	60	7	0.5	0	0.1	8	100	uk
DC35	72	47.2	7	0	0	0	7.5	0	8
EC02	71	59	4	0	0	0.3	7.5	0	6
EC07	68	60	7	0	0.5	0.3	7.5	100	0
EC08	71	60	6	0	0.5	0.6	7	300	2
EC12	69	65	5	0	2	0.4	7	450	uk
EC20	64	65	5.5	0	0.1	0.2	7.5	800	uk
EC4A	71	120	5	0	0.5	0.4	6.5	50	uk
MC03	67	60	5.5	0	0.5	0.2	8.5	200	2
MC04A	65	60	11	0.15	10	0.3	8	200	uk
MC14	Did not get sampled in 2017								0
MC17	Did not get sampled in 2017								6
MC22	62	27.5 cm	4.5	0	0	0.3	8	750	6
RD05	71	59 cm	6	0	0	0	7	0	0
RD10	72	60 cm	11	0	0	0	7	0	0
RD13	65	15 cm	3	0	0	0.3	7.5	0	3
RD15	no flow								N/A
WL21	60	8 cm	5	0	0	0.4	7	300	uk
WL32	65	60 cm	8	0	0	0	7.5	250	uk
WL33	64	60 cm	6	0	0	0.05	7	300	0
WL35	63	65 cm	8.5	0	0.5	0.1	7	100	12
WL46A	58	32 cm	5	0	2	0.2	7.5	500	uk
T01	76.5	60	7	0	0	0	7.5	0	uk
Key: Ruple Ditch - RD, McCarter Ditch - MC, Winona Lake - WL, Deeds Creek - DC, Eagle Creek - EC									

Table 5 Snapshot Monitoring Day Results 2017

Turbidity

Turbidity, or cloudiness, in water is caused by a variety of suspended materials. The material can be both organic (plankton, sewage) and inorganic (silt, clay). The suspended material will scatter and absorb light passing through the water. The light scattered back to the observer can be affected so that the water will have a color dependent upon the type and amount of suspended matter. The cloudiness and color can be observed also if a sample of water in a transparent container is held between the observer's eye and a light source. (Annis, 2019)

Turbidity relates to the effect that suspended particles have on water clarity. Using the handheld field turbidity tube, turbidity readings are based on the number of centimeters of water that a person can see though (0-120 cm), therefore, a low number result (low clarity) can indicate erosion and sedimentation problems. Rainfall and runoff can increase the suspended solid load in a river and make the river appear cloudy or muddy. High biological productivity related to increases in nutrients and temperature can result in increases of diatoms and other algae that contribute to turbidity. (Annis, 2019)

Elevated turbidity can cause an increase in temperature since suspended particles absorb heat. Reduction of light penetrating the water column due to turbidity can decrease the rate of photosynthesis. This, in turn, can decrease the amount of dissolved oxygen in the water. As suspended particles settle, they can impair the habitat needed for fish spawning and aquatic macroinvertebrates. They can also clog the gills of fish and the breathing apparatus of invertebrates. Particles serve as places of attachment for harmful microorganisms and toxic materials. (Annis, 2019)

Although turbidity was not a parameter used in the biweekly sampling data, it was included in snapshot monitoring day data as a parameter that could be reviewed and evaluated over time using citizen volunteers. Sampling points which had water clarity that was degraded to less than 30 cm in the turbidity tube was flagged as a point of concern to watch in the above chart, equating it to “silting” and “cloudiness” on the CQEHI. It should be noted that water taken for the turbidity test was in the main flow upstream of any disturbance. All subwatershed except the Eagle Creek – Walnut Creek Subwatershed had at least one sampling point that with turbidity that was less than 30 cm. Twenty-three (23%) of the sites had turbidity that was flagged as less than 30 cm.

Dissolved Oxygen

Only two sampling points, one in the Deeds Creek – Pike Lake Subwatershed (DC04) and one in the Ruple Ditch – Tippecanoe River Subwatershed (RD13), failed to meet the dissolved oxygen target parameters of 4 mg/L – 12 mg/L. In both cases the D.O. was low (DC04 – 2.5, RD13 – 3.0).

Nitrate

Both nitrite and nitrate sampling were conducted. Only nitrate sampling results will be discussed in this report for consistency with the bi-weekly sampling. One sampling point in each subwatershed except for Ruple Ditch – Tippecanoe River Subwatershed tested high for nitrates over the 1.5 mg/L target threshold set by the committee. One site (MC04A) in the McCarter Ditch – Deeds Creek tested at 10 mg/L. Thirteen (13%) percent of the sites exceeded the 1.5 mg/L target threshold.

Orthophosphate

Orthophosphates, also known as “reactive phosphates,” are a main constituent in fertilizers used for agriculture and residential purposes. Orthophosphates found in natural water provide a good estimation of the amount of phosphorus available for algae and plant growth. This is the form of phosphorus that is most readily utilized by biota. Orthophosphates can be carried into streams and lakes through run-off. (Northeast Ohio Regional Sewer District)

Phosphorus is recycled so rapidly through biota, dissolved reactive phosphate concentrations as low as 0.005 mg/L are enough to maintain eutrophication in natural waterways. (Northeast Ohio Regional Sewer District).

Orthophosphate was not a parameter tested in the bi-weekly sampling; therefore, the committee did not set target limits. For this report all data readings that were above the .005 mg/L were highlighted as possible data of concern. TWF plans to continue the Snapshot Monitoring Day in successive years to collect additional data. Seventy-seven (77%) percent of the sites measured above .005 mg/L for orthophosphate.

pH
None of the sampling sites had pH values that were outside the target parameters.

E. coli
Ruple Ditch – Tippecanoe River Subwatershed was the only subwatershed that did not have elevated levels above the target threshold of 235 CFU/100mL. Forty (40%) percent of the sites sampled had E. coli levels above the target.

Channel Silting
Silting of the channel was also noted in the evaluation of the site. The CQHEI evaluates the channel bottom for silting and smothering. For the purposes of this document, in excess of two (2) inches of silting is considered at risk for potentially smothering macroinvertebrates living on the bottom. Of the twenty (20) that were evaluated for smothering, nine (9) had over 2 inches of silting at the bottom or forty-five (45%) percent. All subwatersheds had at least one sampling site represented in the sampling.

Social Indicator Surveys
A social indicator study was done in the watershed during late 2017 and early 2018 to develop a baseline of constituent's knowledge and willingness to change behaviors. There were two target audiences, large landowners and urban constituents.

The large landowners were sent a letter followed up with a postcard with an invitation to complete a survey on-line or a paper survey that would be in the Kosciusko Soil & Water Conservation District office. 478 landowners were identified as owning 20 acres or more and sent the letter and postcard. Of those receiving the survey, there were 82 responses.

The general public survey was done using multiple methods, including mail correspondence sent to random households in the watershed. There were two different sets of addresses used for postcard mailings of 1000 each. There were also two social media blitzes done by the Clean Waters Partnership partners to get responses. The two social media blitzes corresponded to giveaways. One was in December of 2017 and offered free Mudlove bracelets to persons completing the survey. Another was done in February and offered a coupon for a reduced-price local car wash with opportunities to win a free month or three months of unlimited car washes. That incentive received the most responses totaling 676. In all there were 924 general public respondents.

Desktop Survey
Data was generated through Geographical Information System (GIS) mapping. GIS layers were used from Indianamap.org which has the most recent layers from the Indiana Department of Environmental Management, Indiana Department of Natural Resources, United States Department of Agriculture (USDA), United States Geological Survey (USGS). Additionally, local layers were obtained from the City of Warsaw and Kosciusko County. A complete listing of GIS data sources is listed in the appendix. Tributaries evaluated in the field and the desktop surveys included all locally mapped tributaries per the Kosciusko County Surveyors Office.

303 (d) List
The IDEM Office of Water Quality is required to develop a list of impaired waters in the State, Indiana's 303(d) List of Impaired Waters, as part of the state's Integrated Water Monitoring and Assessment Report. This report is submitted to the U.S. EPA every two years in accordance with Sections 305(b) and 303(d) of the Clean Water Act (CWA). CWA Section 305(b) requires states to make water quality assessments and provide water quality reports to the U.S. EPA, and CWA Section 303(d) requires states to identify waters through their Section 305(b) water quality assessments, that do not or are

not expected to meet applicable state water quality standards with federal technology based standards alone (IDEM, 2016). Figure 24 shows the 2016 303(d) list of Impaired Waters in the watershed.

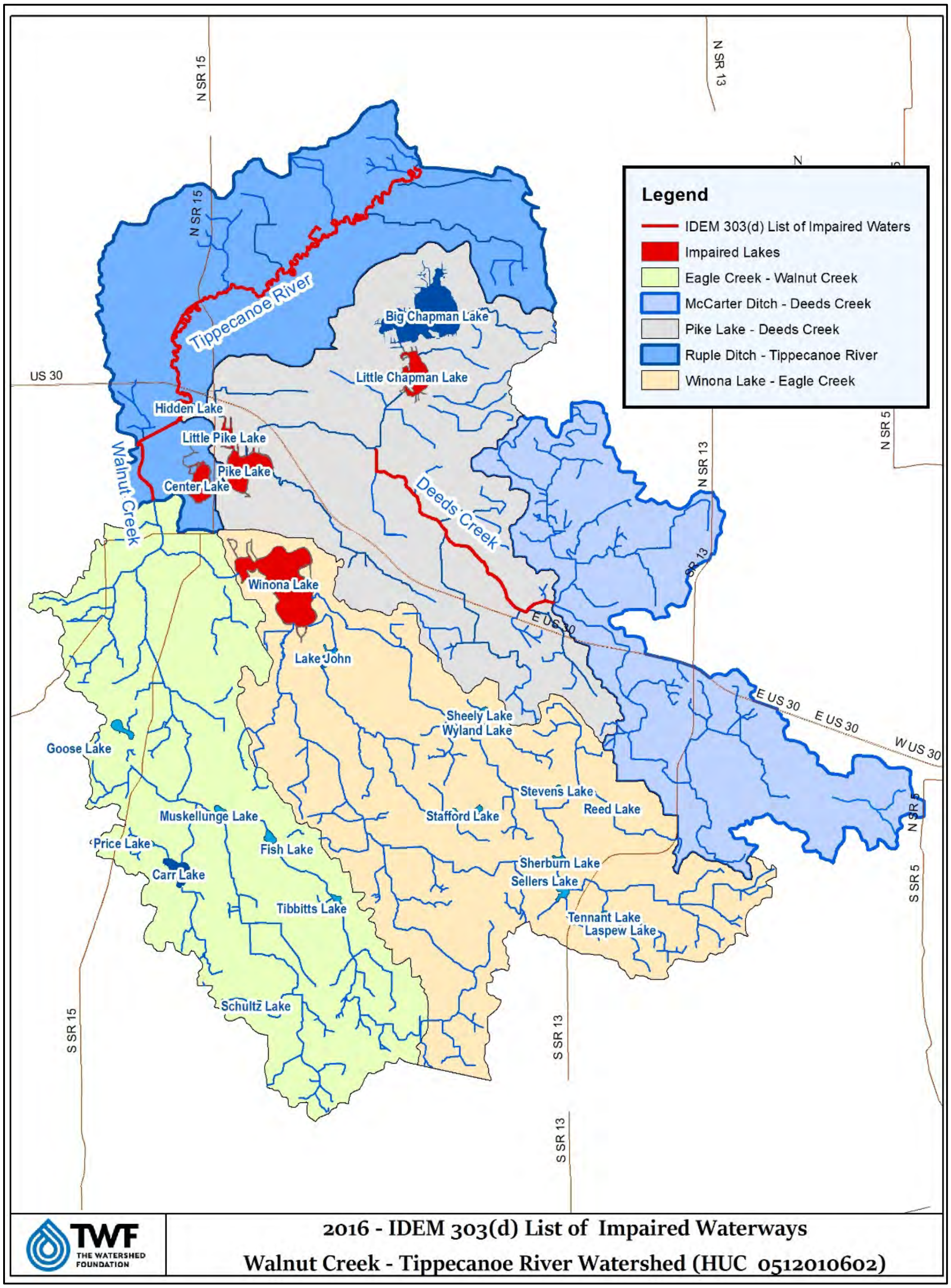


Figure 24 IDEM 2016 303(d) List of Impaired Waters

Impaired waters include the Tippecanoe River (Polychlorinated biphenyls (PCBs), Total Mercury, E. coli), Center Lake (Phosphorus), Little Chapman (Phosphorus), Pike Lake (Phosphorus and PCBs), Little Pike (Phosphorus), Winona Lake

(PCBs), Deeds Creek (E. coli), and Walnut Creek (PCBs). Tables 4 & 5 in the Appendix list the Impairments by waterway.

Indiana Clean Lakes Program

The Indiana Clean Lakes Program was established by the Indiana Department of Environmental Management and administered by the Indiana University's O'Neill School of Public and Environmental Affairs to sample 70-80 randomly distributed public lakes each year in the months of July and August for multiple water quality parameters to determine the Lake's overall health as well as its tropic state.

The Volunteer Lake Monitoring is a complement of the statewide program that increases the opportunities to gain data on lakes by training and utilizing volunteer citizen scientists to collect data on the lakes where they live and recreate. (Indiana University, 2018). Citizen scientists state-wide provide a cost-effective means for the State to track and trend the health of lakes across the state as a part of the statewide monitoring program (Indiana University, 2018). The program is adapted to provide options both for the needs of the lake community and the volunteer's time commitment (Indiana University, 2018).

Volunteers may monitor for multiple parameters, such as secchi disk transparency, temperature, dissolved oxygen, total phosphorus, chlorophyll α, invasive species, and algal blooms. The data gathered is used to determine the tropic state of the lake as a numerical value that can be monitored as an indicator to overall lake health.

The trophic state of a lake refers to its overall level of nutrition or biological productivity. This system was developed by Richard Vollenweider in the 1970's and is often used as guidelines for evaluating concentrations of water quality parameters in lakes (IDEM and Indiana University, 2018). Trophic categories include oligotrophic, mesotrophic, eutrophic, and hypereutrophic. Lake conditions typically associated with these trophic states are:

- Oligotrophic - lack of plant nutrients keep productivity low; lake contains oxygen at all depths, has clear water, deeper lakes can support trout.
- Mesotrophic - moderate plant productivity, hypolimnion may lack oxygen in summer, moderately clear water, warm water fisheries only, bass and perch may dominate these lakes.
- Eutrophic - contains excess nutrients, blue-green algae dominate during summer, algae scums are probable at times, hypolimnion lacks oxygen in summer, poor transparency, and rooted macrophyte problems may be evident.
- Hypereutrophic - algal scums dominate in summer, few macrophytes, no oxygen in hypolimnion, fish kills possible in summer and under winter ice.

Indiana uses a Trophic State Index (TSI) to evaluate water quality data. Pike Lake, Winona Lake, Center Lake, Big Chapman and Little Chapman all have regularly sampled data in the summer months as a part of the Indiana Clean Lakes Program. Table A TSI condenses water quality data into a single, numerical index. Points are assigned for various water quality concentrations. The index total, or TSI, is the sum of the individual eutrophic points for a lake. According to the Indiana Clean Lakes Program, "Interpreting Lake Data" document, "The most widely used and accepted TSI in the U.S. is one developed by Bob Carlson called the Carlson TSI. Carlson analyzed summertime total phosphorus, chlorophyll a, and Secchi disk transparency data for numerous lakes and found statistically significant relationships among the three parameters (IDEM and Indiana University, 2018). He developed mathematical equations for these relationships for the Carlson TSI that correlates the numeric index into a eutrophic classification (Figure 25). Using this index, a TSI value can be generated by one of three measurements: Secchi disk transparency, chlorophyll a or total phosphorus" (IDEM and Indiana University, 2018).

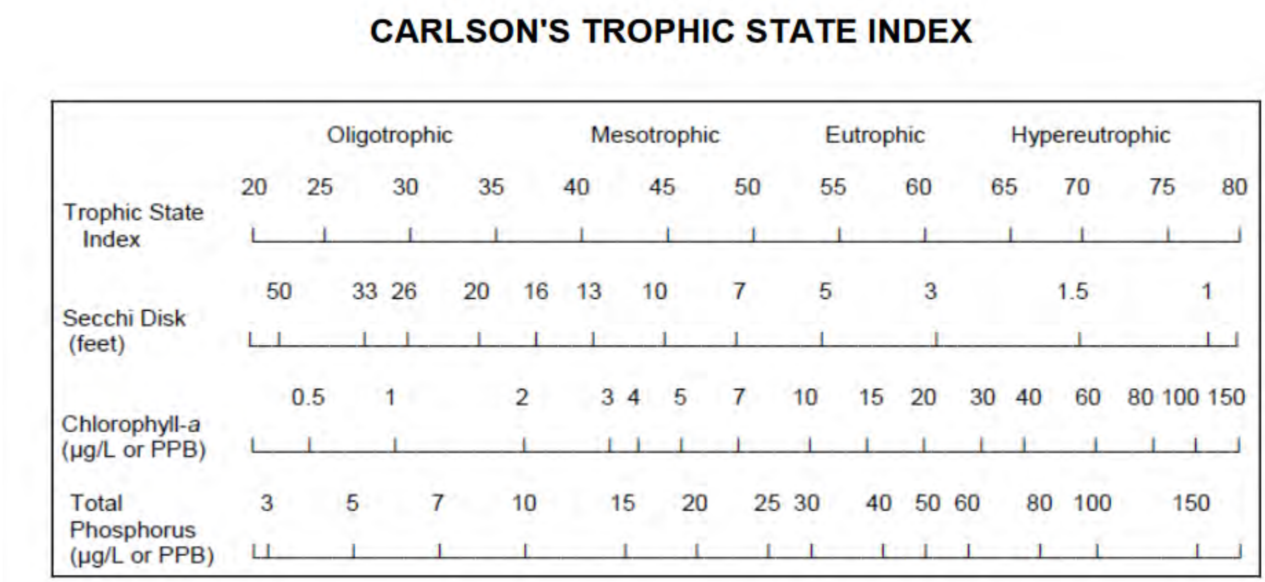


Figure 25 Carlson's Trophic State Index (IDEM and Indiana University, 2018)

The data for the largest lakes in the watershed, Pike, Little Pike, Winona, Center, Big Chapman, and Little Chapman are lakes that have been monitored during the last eight years. Table 6 below includes Clean Lakes Program Data, when available, from 2011-2017 (IDEM and Indiana University). They are computed using the Secchi disk method. There is also a column to acknowledge the trend of the data, improving (I), stable (S), fluctuating (F), degrading (D) or unknown (U). The final column shows the current eutrophic status based on the test results, oligotrophic (O), mesotrophic (M), eutrophic (E), hypereutrophic (H). Table 6 TSI Values for Larger Lakes in the Walnut Creek - Tippecanoe Watershed from the Indiana Clean Lakes Program

Table 6 TSI Values for Larger Lakes in the Walnut Creek - Tippecanoe Watershed from the Indiana Clean Lakes Program (IDEM and Indiana University 2011-2018)

Looking at the lake data of the five lakes in the watershed, the lake that stands out as potentially being the biggest concern for its high eutrophic index in the mid-sixties would be Pike Lake. Pike Lake is currently not being regularly sampled through the Clean Lakes Program. Figure 26 graphs the trends of the Trophic Indices for Pike, Center, Winona, Big Chapman, and Little Chapman.

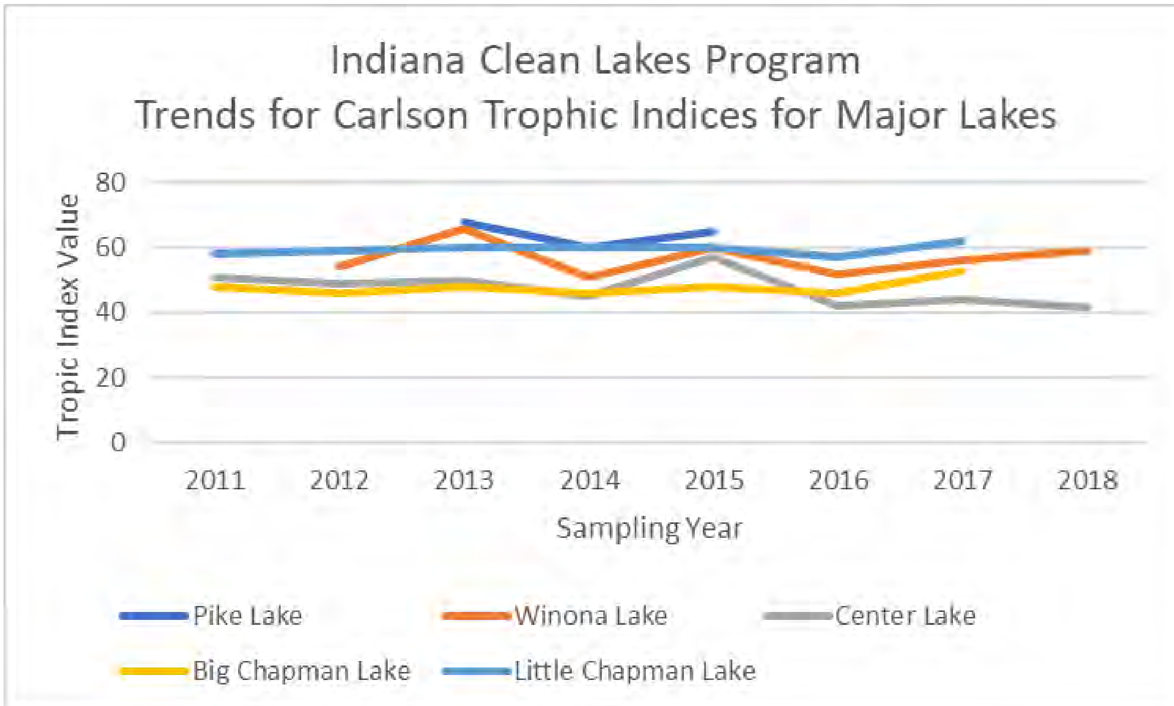


Figure 26 Trends for Carlson Trophic Indices for Major Lakes in the Watershed - Indiana Lakes Program

Watershed Inventory Part II – Subwatershed Data

There are five HUC 12 subwatersheds in the Walnut Creek – Tippecanoe River Watershed. This section will look at some of the unique properties in each subwatershed. It will also include related maps and figures detailing areas of importance, such as waterways, lakes, major roads, urban centers, land use, and potential sources of pollution, in each subwatershed.

Figure 27 below shows the acres of land in each subwatershed and its percentage of whole watershed. The Winona Lake – Eagle Creek Subwatershed is the largest at 20,554 acres. McCarter Ditch – Deeds Creek is the smallest at almost one-half that size, 11,352 acres. Ruple Ditch – Tippecanoe River is the next smallest at 13,044 acres. Pike Lake – Deeds Creek and Eagle Creek – Walnut Creek subwatersheds are average in the watershed at 16, 254 acres and 17,244 acres respectively.

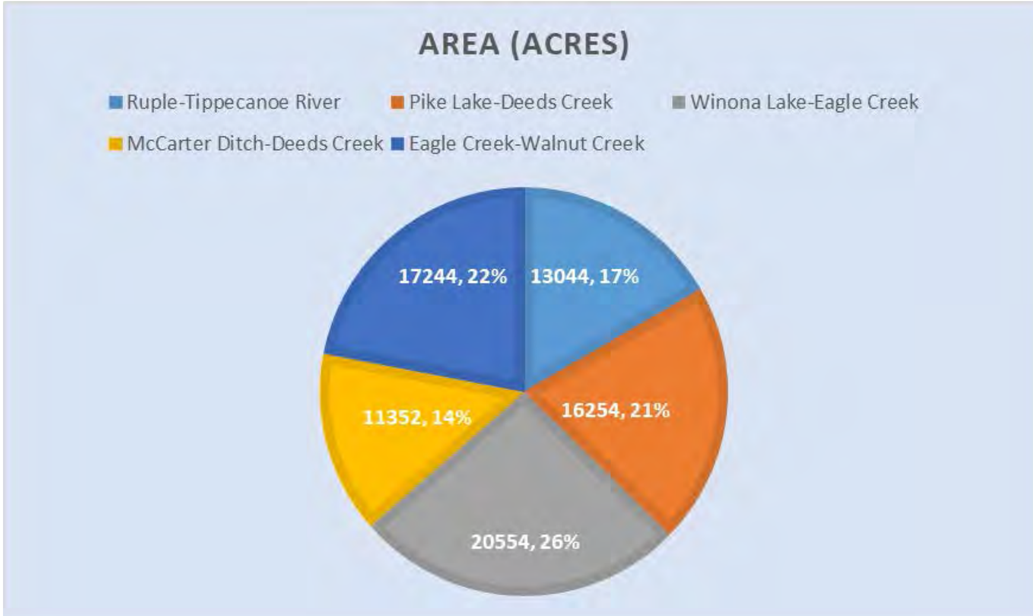


Figure 27 Subwatershed breakdown of the Walnut Creek - Tippecanoe River Watershed

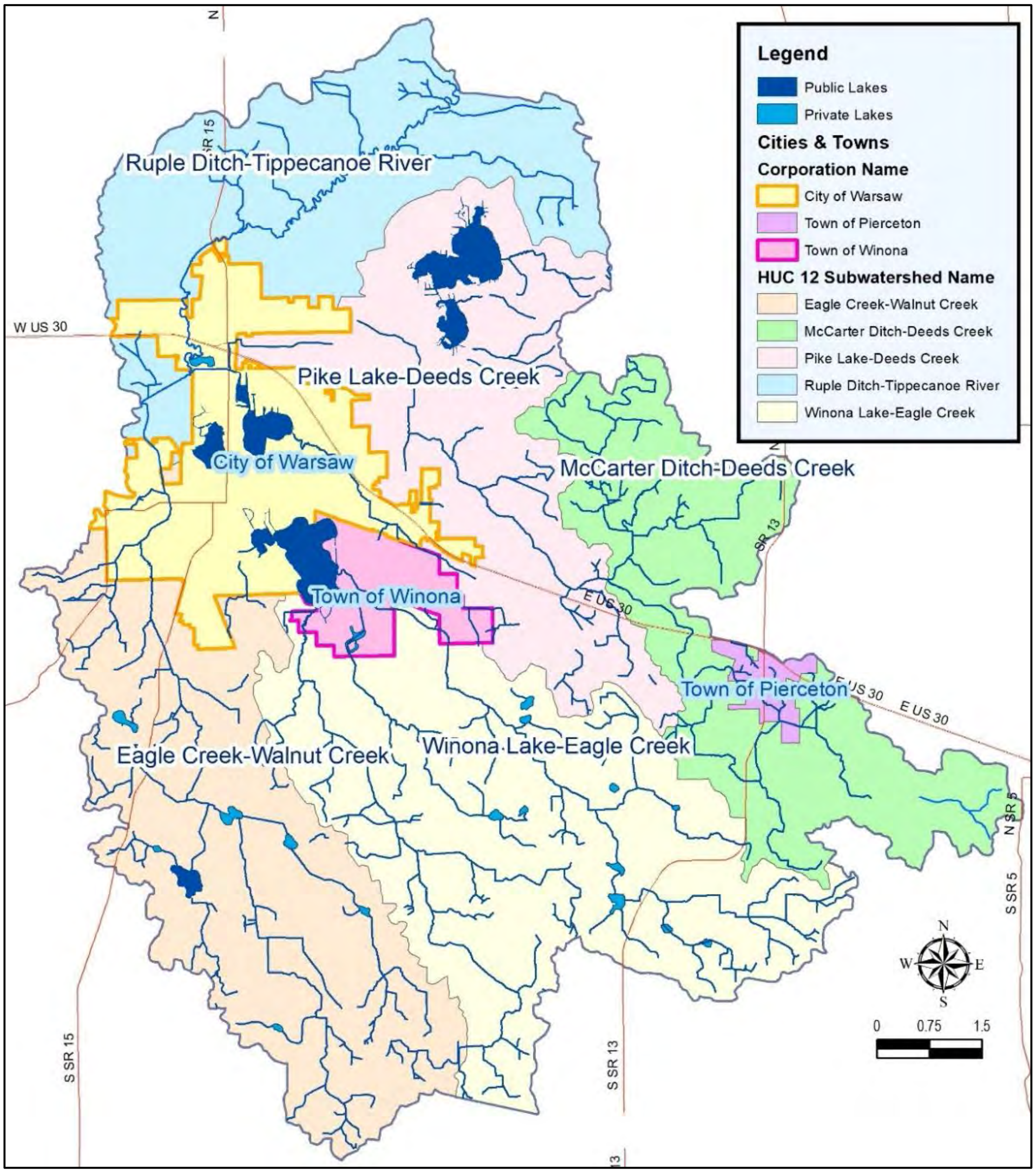


Figure 28 Subwatersheds and Urban Centers of the Walnut Creek - Tippecanoe River Watershed

Ruple Ditch – Tippecanoe River Subwatershed

The Ruple Ditch – Tippecanoe River subwatershed has an area of 13,044 acres. This subwatershed contains the Tippecanoe River and at its farthest southwestern corner receives all the water from the entire watershed. Its position as the receiving body makes it a critically important area to maintain conservation practices especially in areas that are or will become intensively developed, such as commercial industrial or multi-unit residential. It had remained largely undeveloped with exception of agricultural and rural residential subdivision communities before the addition of sanitary sewer in 2009. Wet hydric soils that are typical in the watershed had been a natural impediment to concentrated urban development.

As the Ruple Ditch area has become more connected to sewer services, development has followed. Most or all of that development has been done using conventional civil engineering practices with stormwater piping and waterway releases, large impervious surfaces, and minimal green space. The result is negative pressure on aquatic ecosystems through pollutant releases (thermal discharges, increase in sediment and nutrients, untreated discharges containing petroleum and heavy metals, salts, and other chemicals) and destruction of habitat (less groundwater recharge, destruction of plant diversity, planting of non-native and non-supportive grasses / bushes such as turf grasses, burning bushes, exotic species. All these changes cumulatively place pressure on natural resources and deplete diversity of species trying to live there.

Waterways

The Tippecanoe River runs through the Ruple Ditch subwatershed. The river serpentines for nearly 13 miles through the Ruple Ditch -Tippecanoe River subwatershed. There are an additional 20 miles of ditches and one large public lake, Center Lake, and one private lake, Hidden Lake. There are 33 total miles of waterways in Ruple Ditch – Tippecanoe River Subwatershed. Thirteen (13) miles of that belong to the Tippecanoe River. Eight (8) miles are open regulated ditches. Twelve (12) miles of the waterways are tiled ditches.

Impaired Waters

There are four waters in Ruple Ditch – Tippecanoe River that are listed on the 2016 IDEM 303(d) List of Impaired Waters, the Tippecanoe River, Walnut Creek, and Center Lake. Figure 29 shows the locations of those waterways.

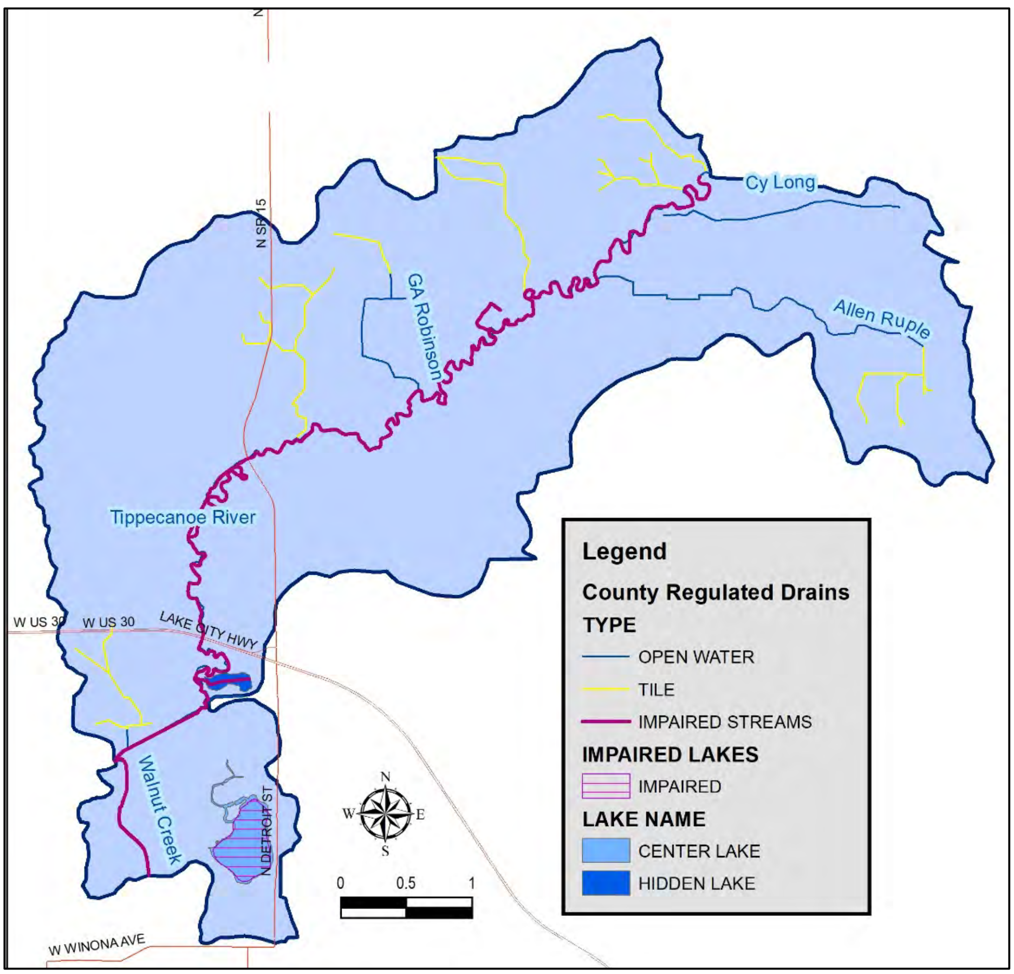


Figure 29 Regulated & Impaired Waterways Ruple Ditch - Tippecanoe River Subwatershed, IDEM 2016

Pollution in the Tippecanoe River includes legacy pollution of Polychlorinated biphenyl (PCBs) and Mercury. The Tippecanoe River is also impaired for E. coli. Walnut Creek is also impaired for PCBs. Center Lake is impaired for Mercury and Phosphorus.

Tippecanoe River

The Tippecanoe River stretch in the Ruple - Tippecanoe River subwatershed is considered an Outstanding River in Indiana, as listed by the Natural Resource Commission (NRC) in 1997 (map found in Appendix). The NRC identifies rivers and streams which have an environmental or aesthetic interest. It is in this section of the Tippecanoe River that water quality and its undisturbed habitat supports the endangered clubshell mussel and the Blanding's Turtle. These waters and natural areas are of prime importance for protection of endangered species, protection of undisturbed habitat, and are an area of potential of recreational use.

This stretch of the river has also become an important recreational treasure for paddling and fishing, especially with the removal of the low head dam in 2018 south of Fox Farm Road and local log jam removal project. The local paddling club is continuing to keep it cleared for paddling so that the public can enjoy it as a natural treasure.

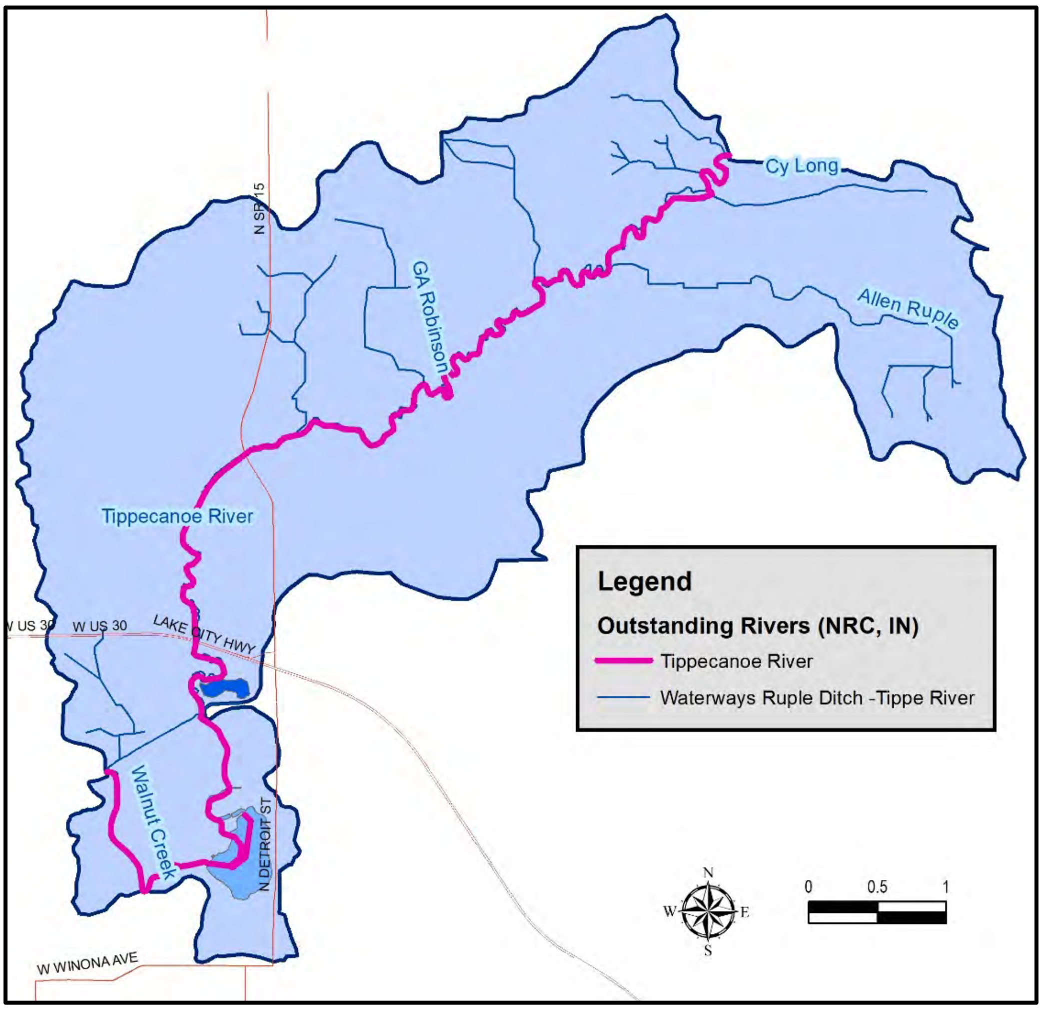


Figure 30 Outstanding Rivers in the Ruple Ditch - Tippecanoe River Subwatershed

Center Lake

Center Lake is 129 acres and one of the three (3) large lakes (Center, Pike, & Winona) in the City of Warsaw. It is a public access lake that has fishing that includes bluegill, red ear, crappie, and largemouth bass. The lake was the source of drinking water for the City until the 1990s. A dam structure owned by the City of Warsaw was built in 1960 on the west side of the lake. The DNR rated the dam as in poor condition at its inspection in 2015. It is used to hold the lake level in the summer, but it also serves to keep backflow from entering the lake from Walnut Creek that originates from the Tippecanoe River during high water events. That isolation protects the lake from additional unwanted sediment and nutrients. In periods of flooding, which happens multiple days and sometimes weeks throughout the early spring and summer, water in the Tippecanoe River floods into the DNR owned wetlands on the west side of the lake and the Walnut Creek tributary that flows back into the lake under Minor Drive. When the flooding is more severe, the flooding will cut off part of Minor Drive forcing residents to use an alley to get to their homes. Although, residents have not experienced a tragedy due to the flooding, it certainly adds risk to both residents, public safety professionals, and property.

The lake also has a control structure on the north end of the lake where a manmade ditch connects the lake to the Tippecanoe River. Although the documentation for the purpose of the ditch has not been found, the prevailing theory is that the ditch was built to maintain the lake level when Center Lake was being used as a municipal drinking water source. The structure was a modern addition by the Center Lake Association to isolate the lake from the backwater of the Tippecanoe River. The structure has one gate that can be opened or closed because residents wanted the option to open the gate if the lake was ever low. However, the gate has only been opened once or twice in the last 10 years. The permanent closure or construction of a permanent barrier blocking the ditch would not be unreasonable. The City of Warsaw has been willing to assist as a partner on maintenance items for this structure.

In a 1998 report Indiana DNR recommended that an engineered dike be constructed on the east side of the preserve as flood protection for the residential communities that are on the northeast corner of the lake. Currently there are no immediate plans to construct the dike. The owner of the strip of property on the edge of the DNR property is deceased and its future ownership is in question. Additionally, construction costs, ownership, liability and maintenance of a dike are all questions of concern.

Center Lake is 90% developed on all sides. On the south side, there has been significant Park acreage historically, but that could be changing as Warsaw looks to add high income housing in the downtown area. Currently Center Lake has a public beach and two (2) public boat ramps. Its large connected park system on the south side of the lake not only provides conservation acreage, but also provides a large venue for concerts, festivals, and other large outdoor public events that is not present anywhere else in Warsaw. The east side of the lake hosts some industrial businesses, it also is home to restaurants and a service industry who market the view of the lake. The western side of the lake is home to two different residential communities. Center Lake plays an important role providing quality of life opportunities for residents and in attracting visitors to the City.

The west and southwest side, specifically, is comprised of many homes that were built 100 years ago or more. The elevation on that stretch of land is twenty feet above the lake level in places supporting many of the earliest built homes against flooding. By contract, the homes built on the northwest corner of the lake and some to the north were built partially through filling and / or dredging to develop waterfront property. These homes were built in the last 30 years when sewers were available and lakefront property was becoming less available.

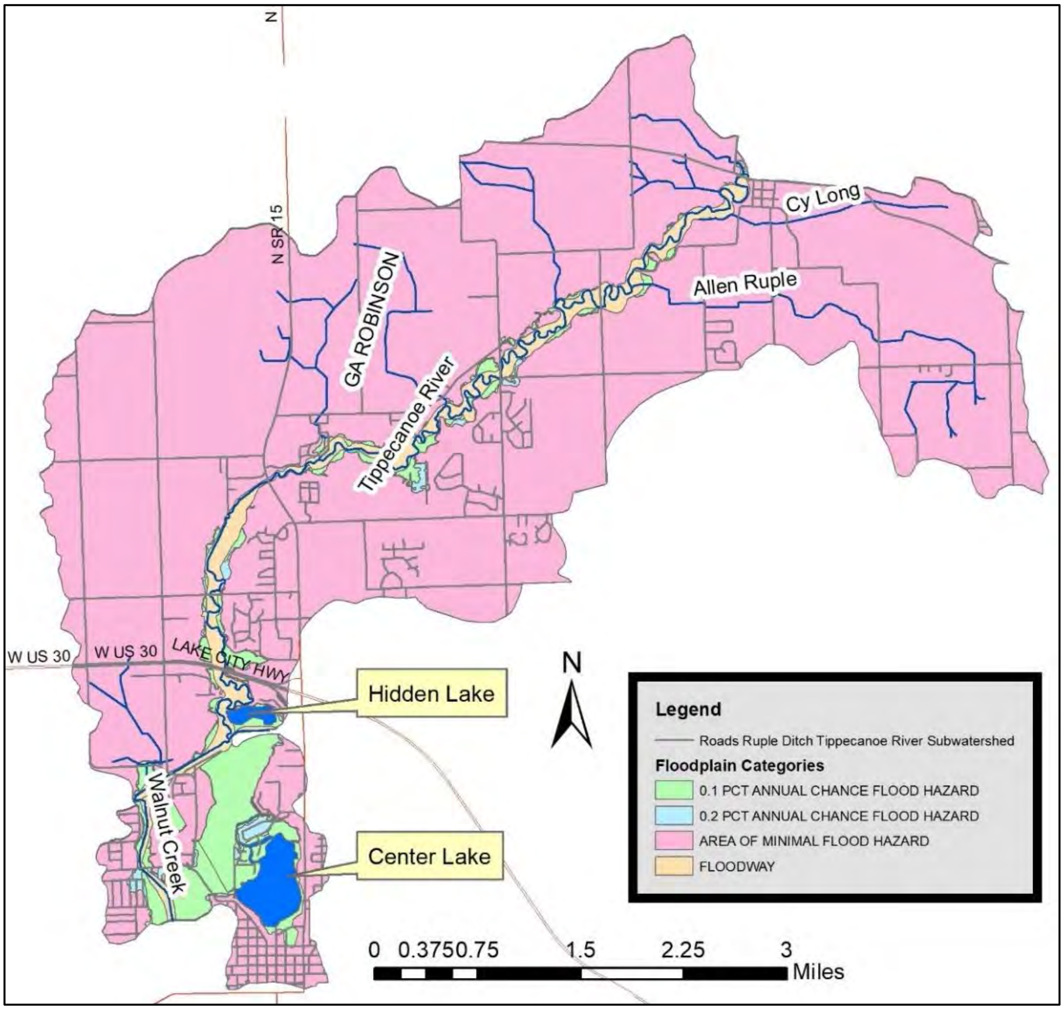


Figure 31 Ruple Ditch - Tippecanoe River Subwatershed FIRM Map (2018)

Lake Water Quality

Center Lake has a Trophic State Index (TSI) that has shown a mixture of TSI results over the last eight years. It appeared that the TSI score was rising but has lowered and stabilized in the last three years. Coincidently, at the same time the City of Warsaw cleaned out a large 36" storm sewer in 2015 that was discharging into the lake during most heavy rains and is now rarely discharging into the lake. It is unclear what benefit if any the cleanout has had on the lake, but the TSI index has lowered since that maintenance occurred. Center Lake should continue to be monitored for signs of a changing eutrophic index. A trophic index increase in 10 points represents a doubling in algal biomass. This would be a dramatic increase in nutrients that not only would change the functioning of the lake but alter the habitat significantly, as well as alter the aquatic species that it can support. *Hidden Lake has not been assessed by IDEM.*

Indiana Clean Lakes Program - Trends for Carlson Trophic Indices for Center Lake										
Waterbody	2011	2012	2013	2014	2015	2016	2017	2018	Trend - Stable (S), Fluctuating (F), Degrading (D), Unknown (U)	Trophic Status - Oligotrophic (O), Mesotrophic (M), Eutrophic (E), Hypereutrophic (H)
Center Lake	51	49	50	45	57	42	44	41	S	M

Figure 32 Indiana Clean Lakes Data - Center Lake

Erosion on the Lakes

Field inventory indicated that Center Lake has over 600 feet of shoreline erosion located on the south end of the lake in public areas. Hidden Lake is unknown.

Lake Associations

Center Lake has a lake association, Center Lake Conservation Association, which works to maintain the lake. As an Association that is led by resident volunteers, it is able to work to maintain weeds but needs the backing of larger networks to look toward long-term protection of the lake.

Hidden Lake has no association. There are only a couple of owners of the property around the private lake.

Agribusiness in the Ruple Ditch – Tippecanoe River Subwatershed

Agriculture plays an important role in the Ruple Ditch – Tippecanoe River Subwatershed; however, it does not dominate the area. Commercial, industrial, and residential have reduced the available land for agriculture. As the City of Warsaw expands north and the availability of sewer has increased, so has the development in the area. The whole north corridor along SR15 has been developed in the last fifteen years. In the last five years, the development of an industrial tech park has begun north of SR30 on the west side of the subwatershed.

The 2016 USDA land use Figure 34 shows significant land use is still being used for agriculture purposes. That is backed up with the 2018 modeling on the EPA's Spreadsheet Tool for Estimating Pollutant Load (STEPL) Figure 33 which shows that 60% of the acres in the Ruple Ditch – Tippecanoe River Subwatershed are cropland. This is the highest percentage of cropland in all the subwatersheds. Ruple Ditch, however, still has the smallest number of cropland acres as it is the smallest subwatershed.

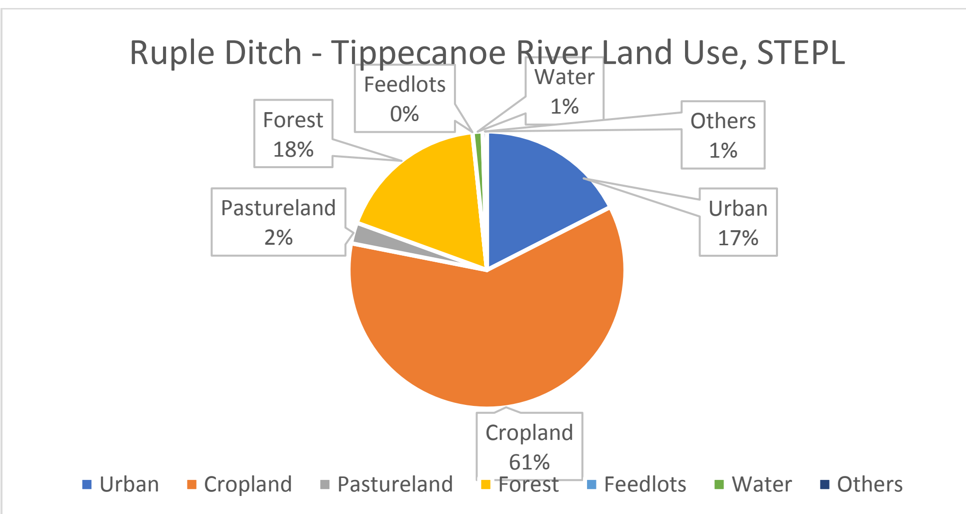


Figure 33 Ruple Ditch - Tippecanoe River Land Use Data, 2018 STEPL

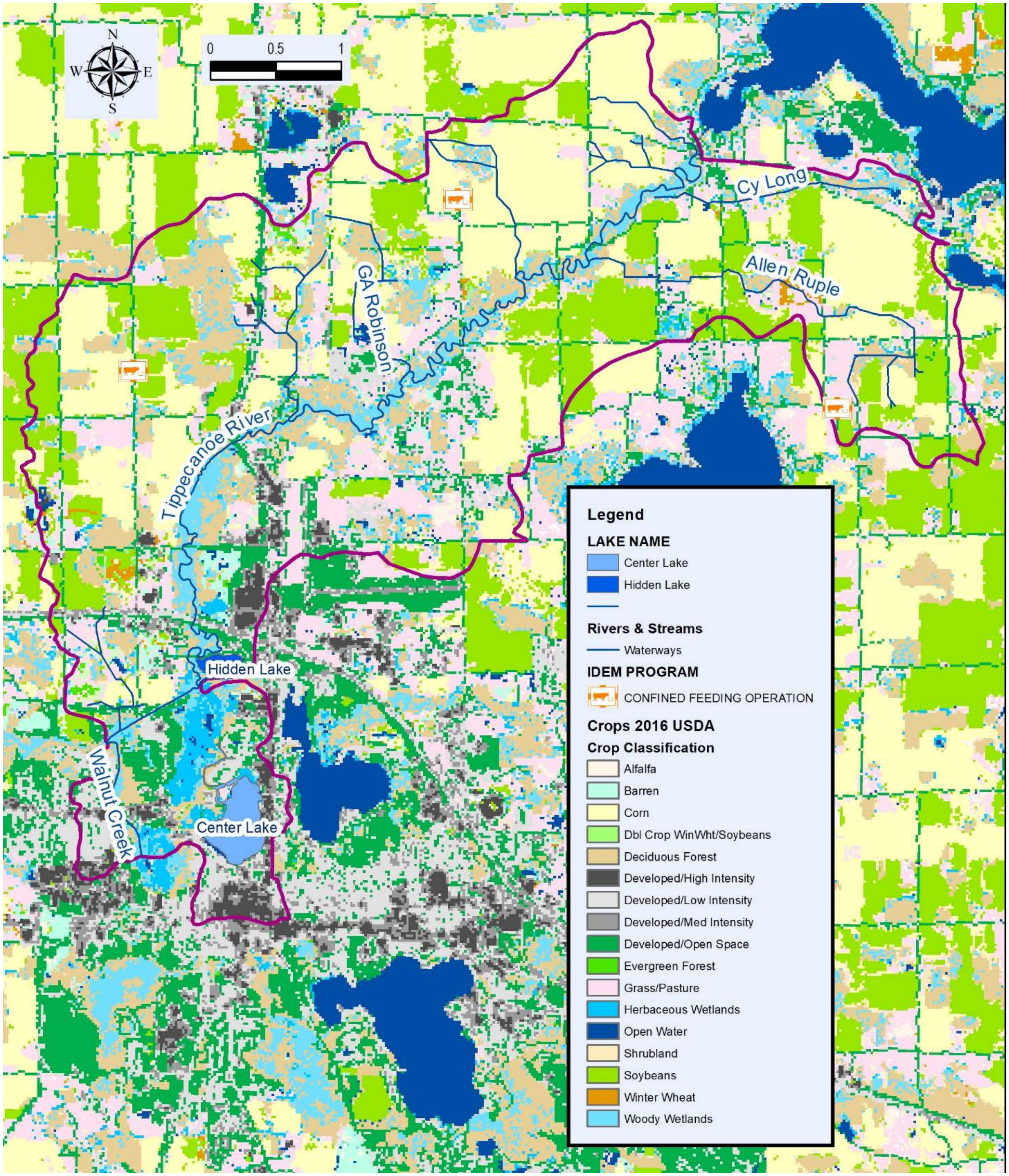


Figure 34 Ruple Ditch - Tippecanoe River Subwatershed, 2016 USDA Land Use Map

Large animal operations are also present in the subwatershed. According to 2018 data from IDEM, there are three permitted CFO facilities. There is also one additional non-CFO pastured animal operation that was noted in the field survey. Figure 35 depicts the locations of CFO and non-CFO animal operations.

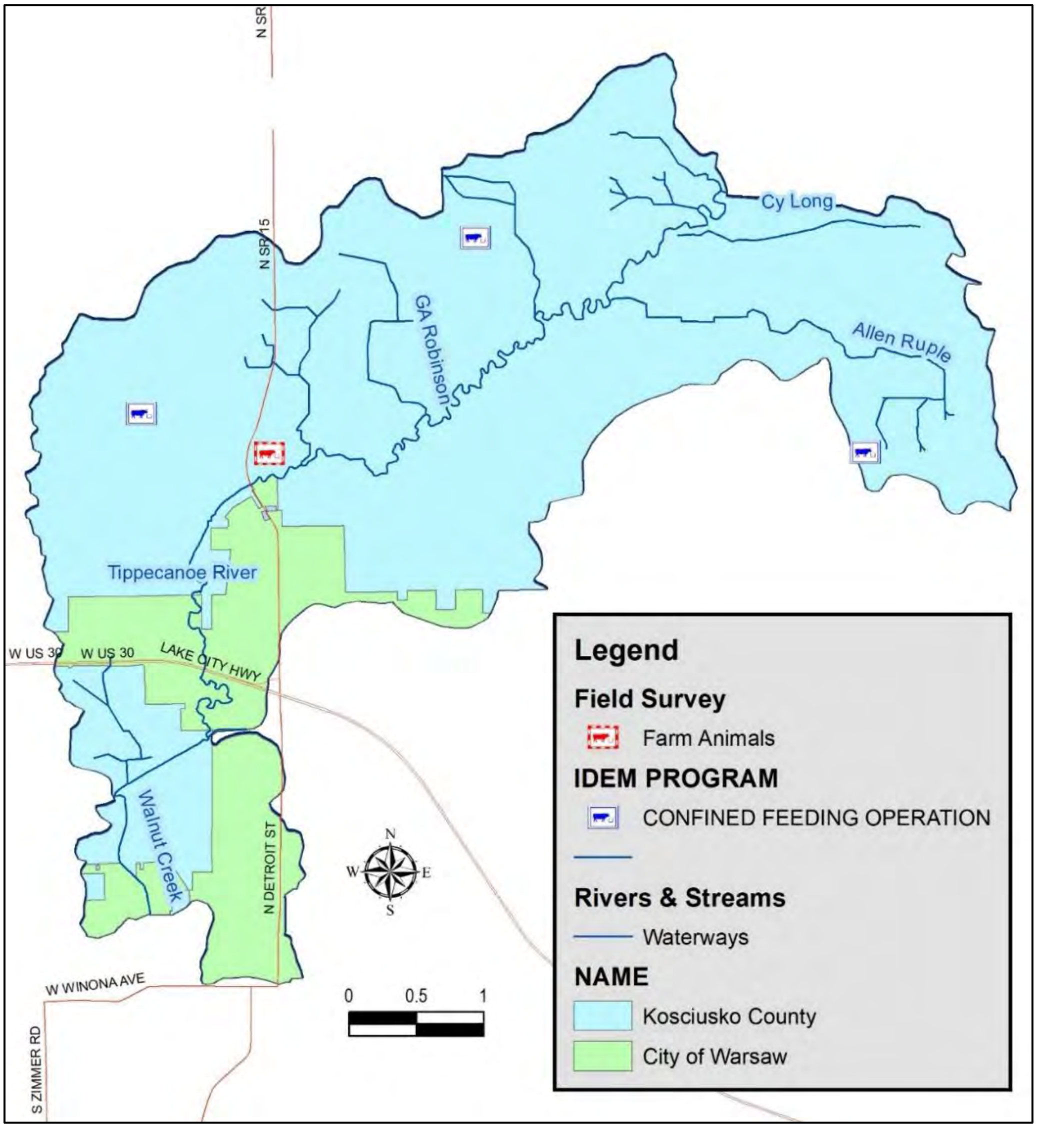


Figure 35 Field Survey (2017) and IDEM CFOs (2018) - Ruple Ditch - Tippecanoe River Subwatershed

Additionally, during the Field & Desktop Surveys, there was over six (6) miles of waterways identified in need of buffer strips to protect waters from pollutants. Buffer strips are an important barrier to protecting waters from soil erosion, grass clipping, plant waste, and other pollutants. Figure 36 depicts waters in need of buffer strips.

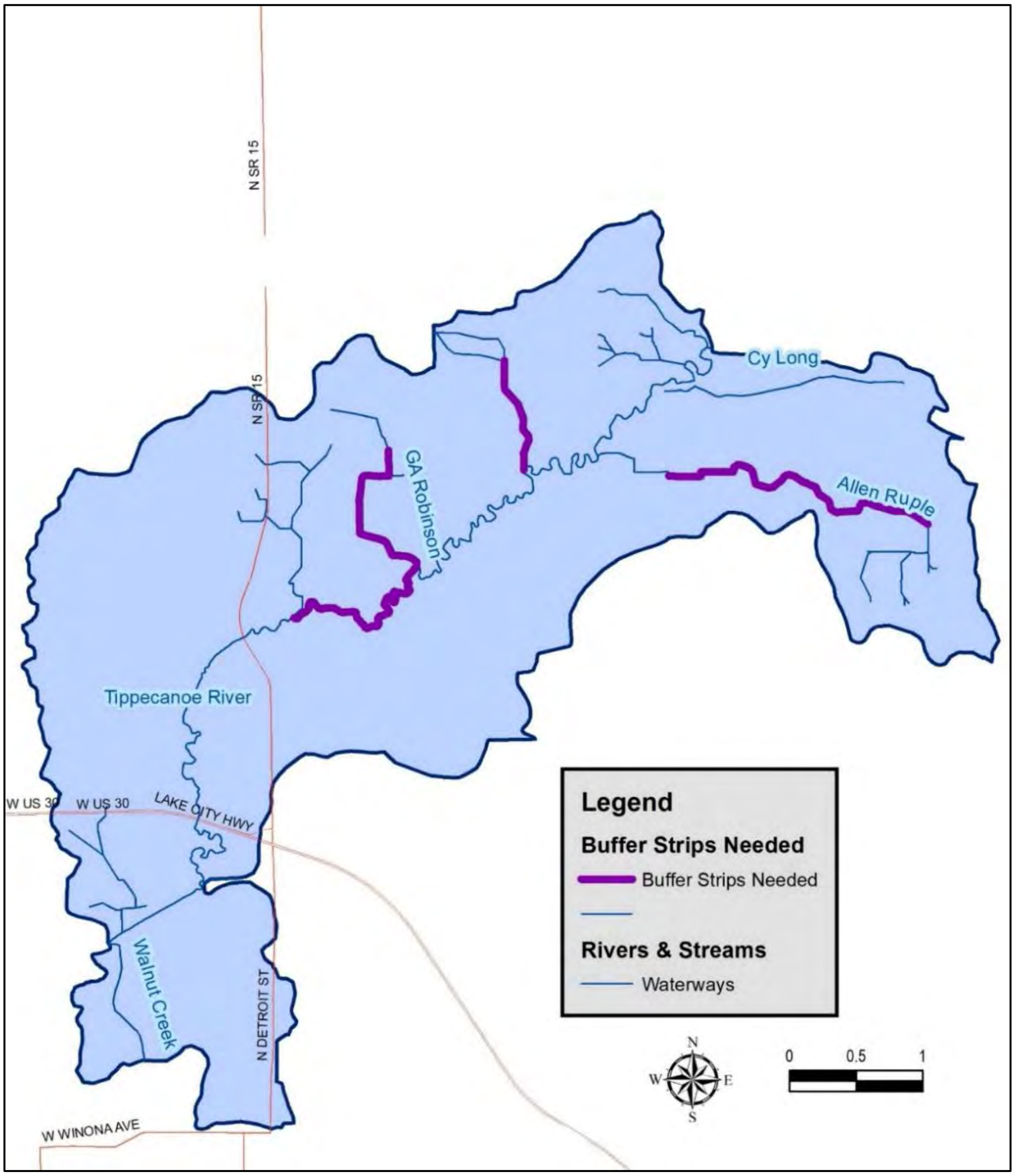


Figure 36 Ruple Ditch - Tippecanoe River Subwatershed Buffer Strips Needed 2017

Urban Development Influences

The addition of municipal sanitary sewer north of US 30 to Leesburg in July 2009, has allowed an explosion of development in the Ruple Ditch – Tippecanoe River subwatershed. In 2011, SR 15 was widened to accommodate industry and commercial development. Consistent with Warsaw's long-term master plan for development, it has undergone rapid growth with the addition of shopping, commercial, and industry along SR 15, industry development along the SR 30 corridor and residential development on both on the east and west sides of SR 15. The City of Warsaw has also added a new Industrial Technology Park to encourage new and relocating businesses to Warsaw. Figure 4 depicts the breakdown of urban land use by type and acres.

Stormwater Pollution

Stormwater pollution prevention is a real concern for the Ruple Ditch – Tippecanoe River Subwatershed. Besides being the receiving water for the watershed, the Tippecanoe River is also directly tied to stormwater runoff from agriculture, rural subdivision development, commercial development, and development in the City of Warsaw stormwater which includes residential subdivision, commercial, and industrial.

Walnut Creek is also a direct recipient of stormwater discharge taking residential, commercial, and industrial discharges.

As new business and expanded business comes to the Warsaw area, the housing industry continues to boom just to keep up. Warsaw employment opportunities have vastly outpaced the housing market. The working population is estimated at 20,000 while the resident population is under 14,000. The master plan states that Warsaw will continue to promote development in the Ruple Ditch – Tippecanoe Creek and the Pike Lake – Deeds Creek subwatersheds. This plan will allow business to take maximum advantage of US 30 and SR 15. This development will in turn will result in additional urbanization and stress on natural resources as well as the continued loss of wildlife habitat and/or agricultural opportunities.

Human activities create stresses on the environment. Concentrated development in urban areas increases those stresses, especially when conventional engineering practices that utilize piping of stormwater to the nearest waterway are implemented. Even with the inclusion of a sediment basin, when low flows can release into the ditch, creek, or river, they carry their highest pollutants of any rain event with them, called the “first flush”. Stormwater flowing from urban areas without filtration is now considered the greatest threat to surface waters in the United States. To exasperate this concern, the Ruple Ditch – Tippecanoe River subwatershed is already home to industry and commercial businesses and currently has a couple of sites that are conducting environmental remediation.

STAKEHOLDER EXPRESSED CONCERN FOR CHEMICALS AND POLLUTION ENTERING CENTER LAKE FROM STORM SEWERS, ESPECIALLY FROM SR 15 WHICH DISCHARGES DIRECTLY TO THE LAKE.

The residents of Center lake are also concerned with stormwater, especially due to the lake’s location next to SR 15. The lake receives the untreated stormwater that runs into the storm drains on SR 15. This is a concern for the normal pollutants on a public highway that would include heavy metals from brake dust, petroleum products, and other vehicular pollution. The State road also has salt, sediment, road applications that flake or roll off such as paint and bituminous asphalt. It is also vulnerable to spills and ruptures that could be released in an accident situation. Any one of these scenarios could be catastrophic for aquatic life.

Center Lake and Walnut Creek receive stormwater coming from the eastern middle of Warsaw. Stormwater travels through a 30-inch trunkline sewer on the north and then west side of the lake where it is released through a large pump station into the backwater area of Walnut Creek off Minor Drive, west of the west dam on Center Lake. This system is also supported by a pump station in Central Park that is activated only in high flows when the capacity of the 30 inch is exhausted, and it discharges directly into Center Lake. The trunkline pipe has been recently been cleaned and refurbished and is currently keeping most stormwater from that trunkline out of the lake.

Industrial and Commercial Business in Ruple Ditch – Tippecanoe River Subwatershed

Industrial and commercial influences are a factor for potential pollutants. Legacy pollution has left Center Lake impaired for Mercury. The Tippecanoe River is also impaired for Mercury and PCBs due to legacy pollution. The desktop survey revealed multiple sites of concern from IDEM Land Quality Mapping of potential sites of pollutants, including fifty-one (51) Underground Storage Tanks, fifteen (15) Leaking Underground Storage Tanks, two (2) Brownfields, three (3) Brownfields Designated as Cleanup Sites, one (1) Brownfield in the Voluntary Cleanup Program, and eight (8) Industrial Hazardous Waste Program (Generator or Managers). Figure 36 maps those sites.

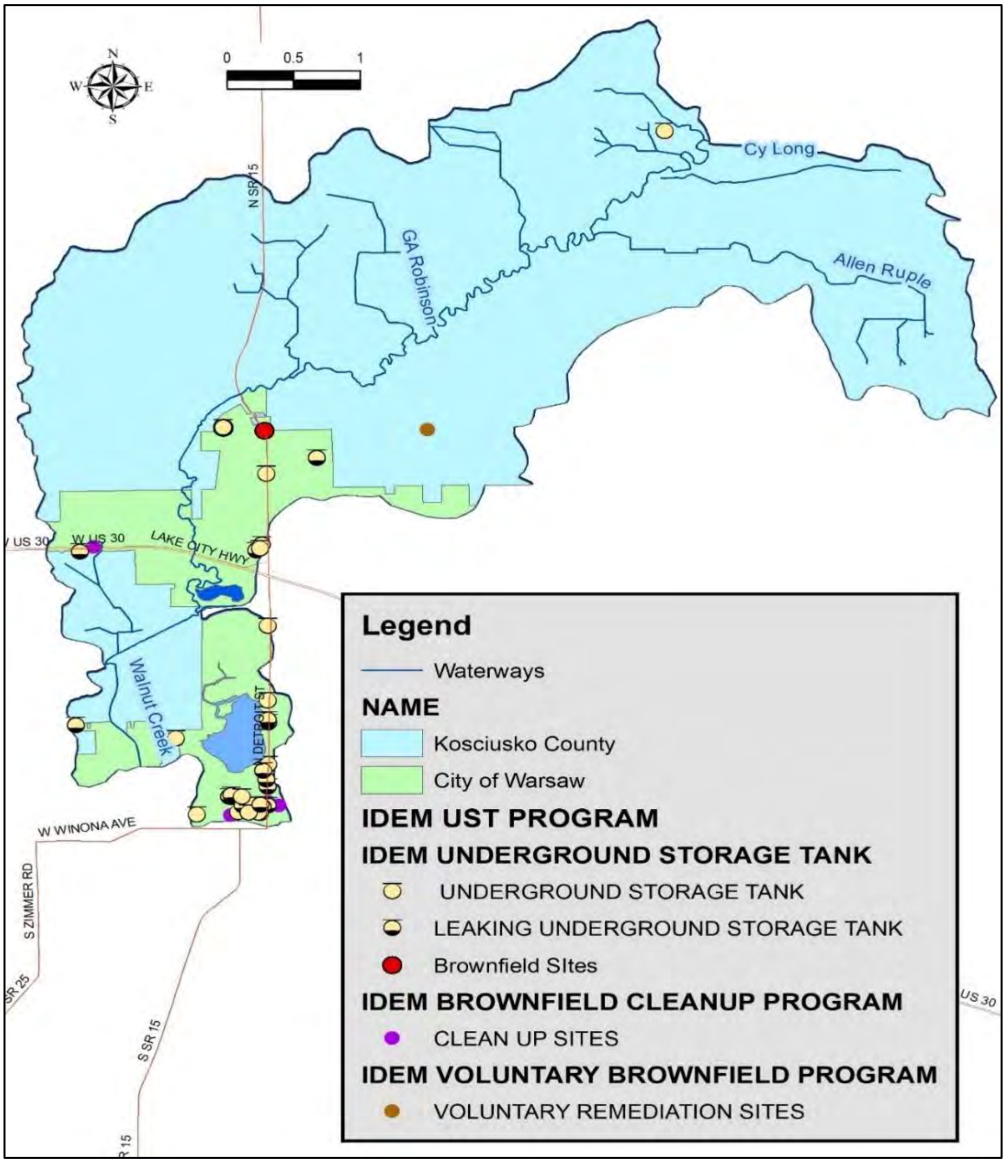


Figure 37 Source of Potential Urbanized Pollution Ruple Ditch – Tippecanoe River Subwatershed, Source IDEM 2019

The National Pollutant Discharge System

In 1972 the National Pollutant Discharge and Elimination System (NPDES) was created by the Clean Water Act regulate point source discharges that discharge pollutants into waters of the United States. The NPDES system regulates potential areas of stormwater pollution, municipal separate storm sewer systems (MS4s), construction activities, and industrial activities.

Industrial NPDES Dischargers

According to the 2018 data from IDEM Office of Water Quality, there are several active point source permitted dischargers in the watershed. This includes three (3) municipal wastewater facilities, one (1) municipal water facility, two (2) permitted private wastewater facilities, and three (3) non-contact cooling water discharge facilities.

Ruple Ditch – Tippecanoe River Sampling Data

The Ruple Ditch – Tippecanoe River Subwatershed had two sampling points (Figure 37). Site # 10 was located on the Tippecanoe River just upstream (east) of the Warsaw Wastewater Treatment Plant outfall which is also east of Fox Farm

Road. This site encompasses all the water from the Ruple Ditch – Tippecanoe River Subwatershed and all the water coming from the McCarter Ditch – Deeds Creek and the Pike Lake – Deeds Creek Subwatersheds. The latter two subwatershed influences would be partially filtered as they traveled through Pike Lake.

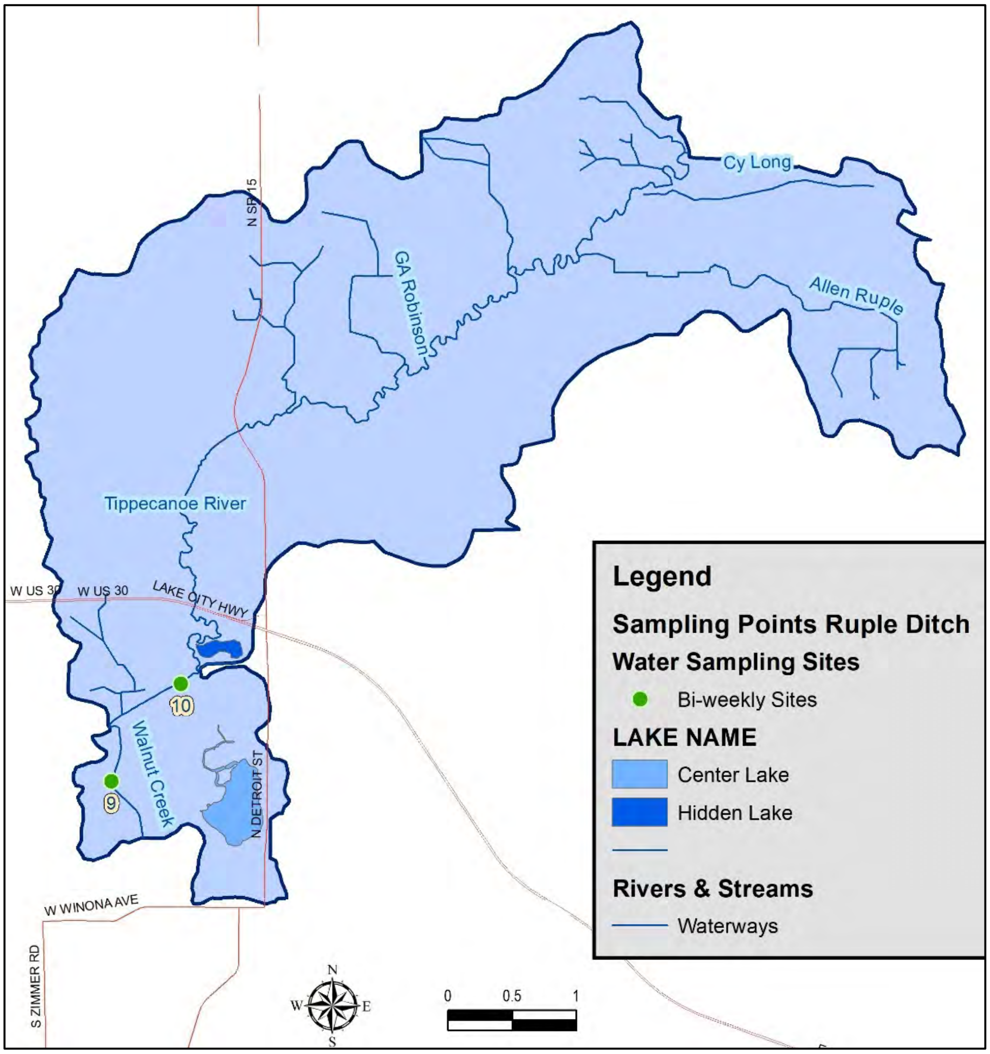


Figure 38 Ruple Ditch - Tippecanoe River Subwatershed Water Sampling Sites

The second sampling point in this subwatershed (site #9) is located on Walnut Creek just before the Tippecanoe River. Site #9 receives all water from both the Walnut Creek – Eagle Creek and the Winona Lake – Eagle Creek Subwatersheds.

Tables are included in this section for the parameters including E. coli, nitrates (NO3), total phosphorus, and suspended sediments. Both dissolved oxygen and pH results fell within the target parameters. The complete data can be found in the appendix.

E. coli Sampling in the Ruple Ditch - Tippecanoe River Subwatershed					
Site #	Waterbody	E. coli			
		Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL
9	Walnut Creek before Tippecanoe River	172	1732	13	26%
10	Tippecanoe River East of Fox Farm Road	115	1119	13	11%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.					

Table 7 E. coli Results - Ruple Ditch - Tippecanoe River Subwatershed

Walnut Creek – Site #9

Walnut Creek south of the Tippecanoe River (Site #9) E. coli results revealed a spike in E. coli on fourteen (14) separate sampling dates over the 235 cfu/100mL target threshold, resulting a twenty-six (26) percent of sampling events exceeding the target threshold (Table 7).

Nitrates spiked six (6) times above the target of 1.5 mg/L, total phosphorus tested above its target threshold of .076 mg/L twenty-one (21) times or thirty-nine (39) percent of the time, and suspended solids tested above its threshold of 25 mg/L just one (1) time (Table 8). Phosphorus and E. coli are both parameters of concern with high testing values for the Walnut Creek Waterway. The frequency of the high results indicate that the E. coli and Phosphorus are being continuously introduced to the Creek and not limited to rain events (Table 8).

Sampling Data in the Ruple Ditch - Tippecanoe River Subwatershed												
Site #	Nitrates (NO3)				Total Phosphorus				Suspended Solids			
	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
9	0.78	2.37	0.07	11%	0.069	0.151	0.030	39%	7	33	0	0%
10	0.64	1.55	0.09	2%	0.032	0.072	0.012	0%	5	16	0	0%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.												

Table 8 Nitrate, Phosphorus, and Suspended Solids Results for the Ruple Ditch - Tippecanoe River Subwatershed

Tippecanoe River – Site #10

The Tippecanoe River east of Fox Farm Road (Site #10) E. coli results revealed a spike in E. coli over the 235 cfu/100mL just six (6) times over the two years of bi-weekly sampling resulting in just two (2) percent exceeding the target threshold (Table 7).

Total phosphorus and suspended solids both remained under the threshold amounts of .076 mg/L and 25mg/L respectively. Nitrates did exceed the target threshold. (Table 8).

Summary

When looking at the sampling values gathered, the results exceed thresholds primarily in phosphorus and E. coli. Nitrates are also a concern for Walnut Creek (Site #9). It is important to note, however, that these are large waterways. These two sampling points in the Ruple Ditch – Tippecanoe River Subwatershed are at the waters with the largest flow volume. Walnut Creek (Site #9) flows an average of 3 cubic meters per second (cms) and the Tippecanoe River (Site #10) flows at six (6) cms. By comparison, the next two waters with the highest flow rates are at a rate of one (1) cms, Wyland Ditch (Site #4) and Lones Ditch (Site #3). The remaining six (6) biweekly sampling sites are under one (1) cms flow volume.

These sampling points are also measuring the pollutants as the water flows from the watershed which is at the upper part of the Wabash River Basin. There is only one HUC 10 watershed above this watershed, Grassy Creek – Tippecanoe River Watershed. Therefore, any exceedances of the target thresholds are a concern for both water quality in the watershed as well as downstream.

Pike Lake – Deeds Creek Subwatershed

The Pike Lake – Deeds Creek Subwatershed has 16,254 acres. Urban land uses cover approximately 2,375 acres. This subwatershed has a large portion of both the City of Warsaw and The Town of Winona. The subwatershed is centrally located in the middle of the watershed. There is only a small portion that is exposed to a neighboring watershed, otherwise, it is surrounded by the other Walnut Creek – Tippecanoe River subwatersheds. Its position in the middle where elevations allow water to flow through it on its way to the Tippecanoe River. Elevations in Figure 38 show the land is higher in the McCarter Ditch – Deeds Creek subwatershed area and falls as it moves to the Pike Lake – Deeds Creek Subwatershed.

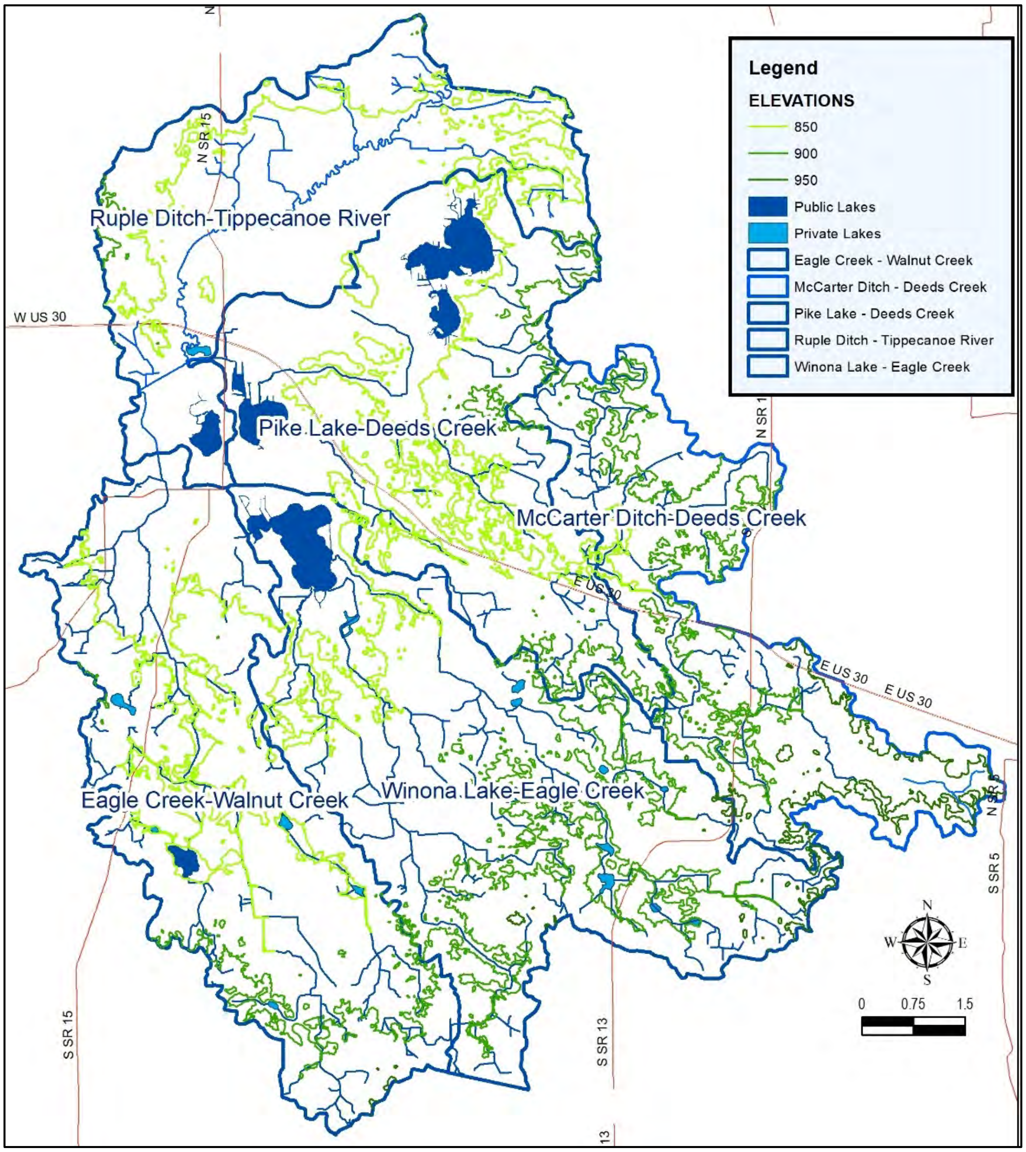


Figure 39 Elevations in the Walnut Creek - Tippecanoe River Watershed

There are significant institutional, commercial, industrial, and transportation assets with over seven miles of US 30 highway. Urban commercial and industrial development are concentrated also the US30 corridor. It is a heavily travelled road from that is a connector across the State of Indiana from Chicago area to Fort Wayne. The USDA Land Use Map (Figure 40) shows the increased urban “high intensity” development along that corridor.

The subwatershed also has substantial water and natural assets. Pike Lake – Deeds Creek has approximately seventeen (17) percent urban acreage, or 4,347 acres, which is the highest percentage and total urban acres of any of the subwatersheds. The subwatershed has significant agricultural and forest assets as well. Cropland, pastureland and forest make up almost three quarters of the subwatershed. Cropland is the predominate use of land at 61% of the subwatershed (STEPL, 2018) (Figure 39).

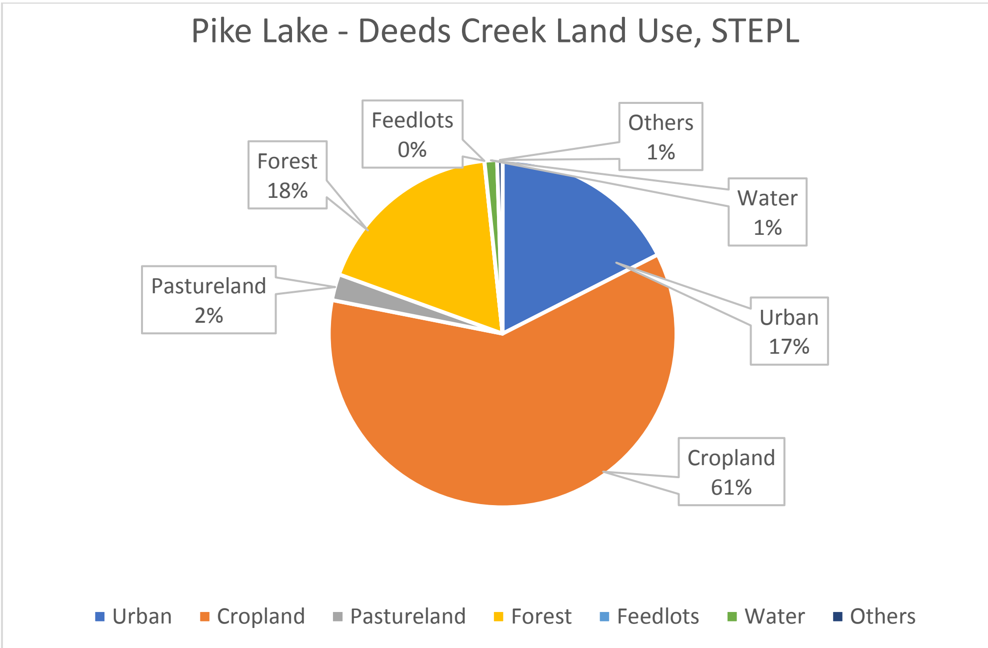


Figure 39 Pike Lake Deeds Creek Subwatershed Land Use, STEPL

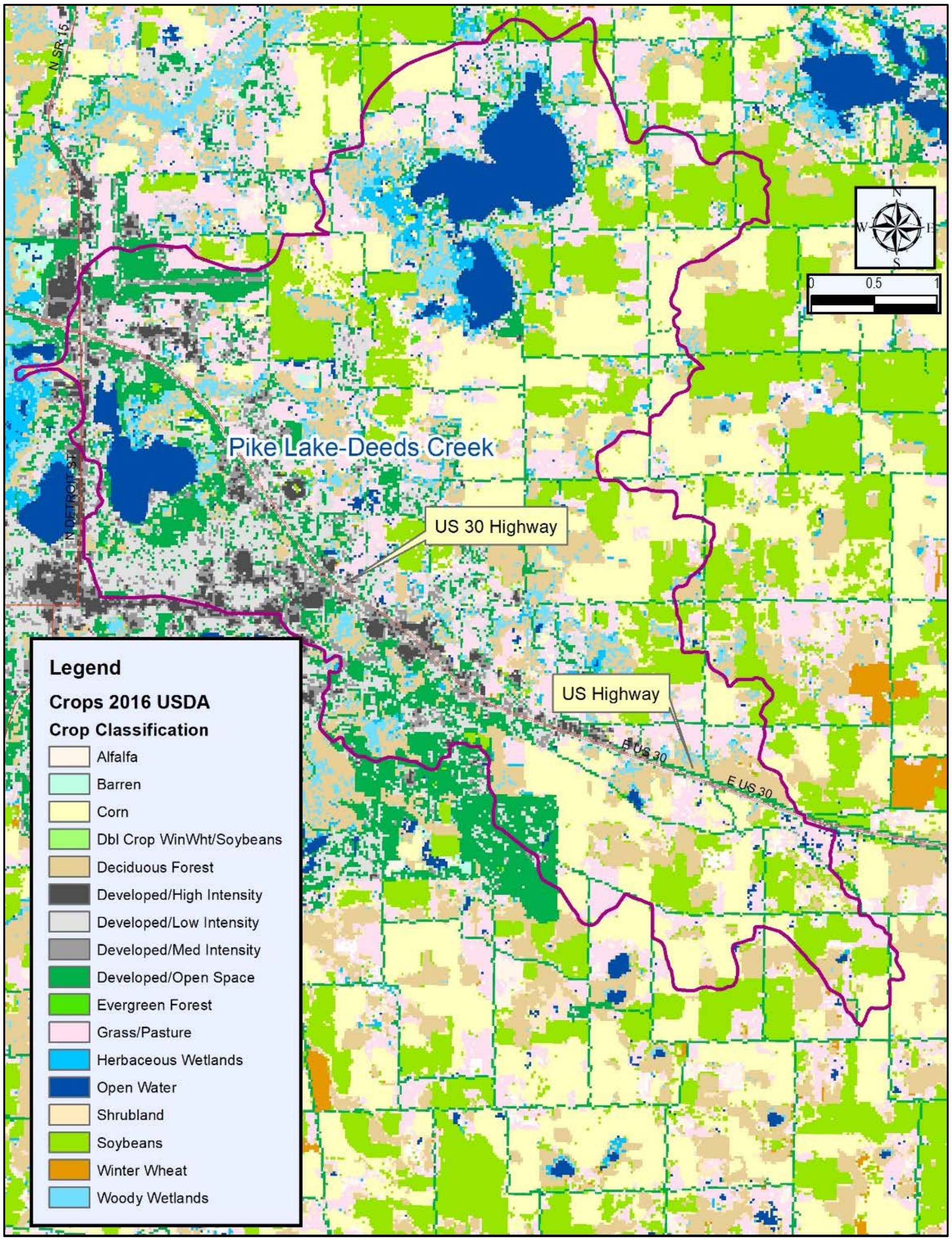


Figure 40 Land Use Pike Lake - Deeds Creek (USDA, 2014)

Waterways

This subwatershed contains two (5) streams, Deeds Creek and the Beyer Brady Ditch both that flow to Pike Lake, Hickman Drain that drains to Deeds Creek in a short stretch (Deeds Creek in this stretch is locally known as Lones Ditch) that connects Pike Lake to the Tippecanoe River, McCleary Gochenour Ditch that flows into Deeds Creek in the southern portion of the subwatershed, and two smaller open ditches that are noteworthy flowing to Chapman Lakes, Robert Shroyer and Noah Putney (Figure 41). The ditches and streams make up approximately twenty-four (24) miles total of open waterways and twenty-two miles (22) of tiled waterways.

There are also four (4) lakes, Pike and Little Pike Lakes and Big and Little Chapman Lakes. The lakes together comprise eight hundred sixty-seven (867) acres in the subwatershed or five (5) percent of the total acreage in the watershed.

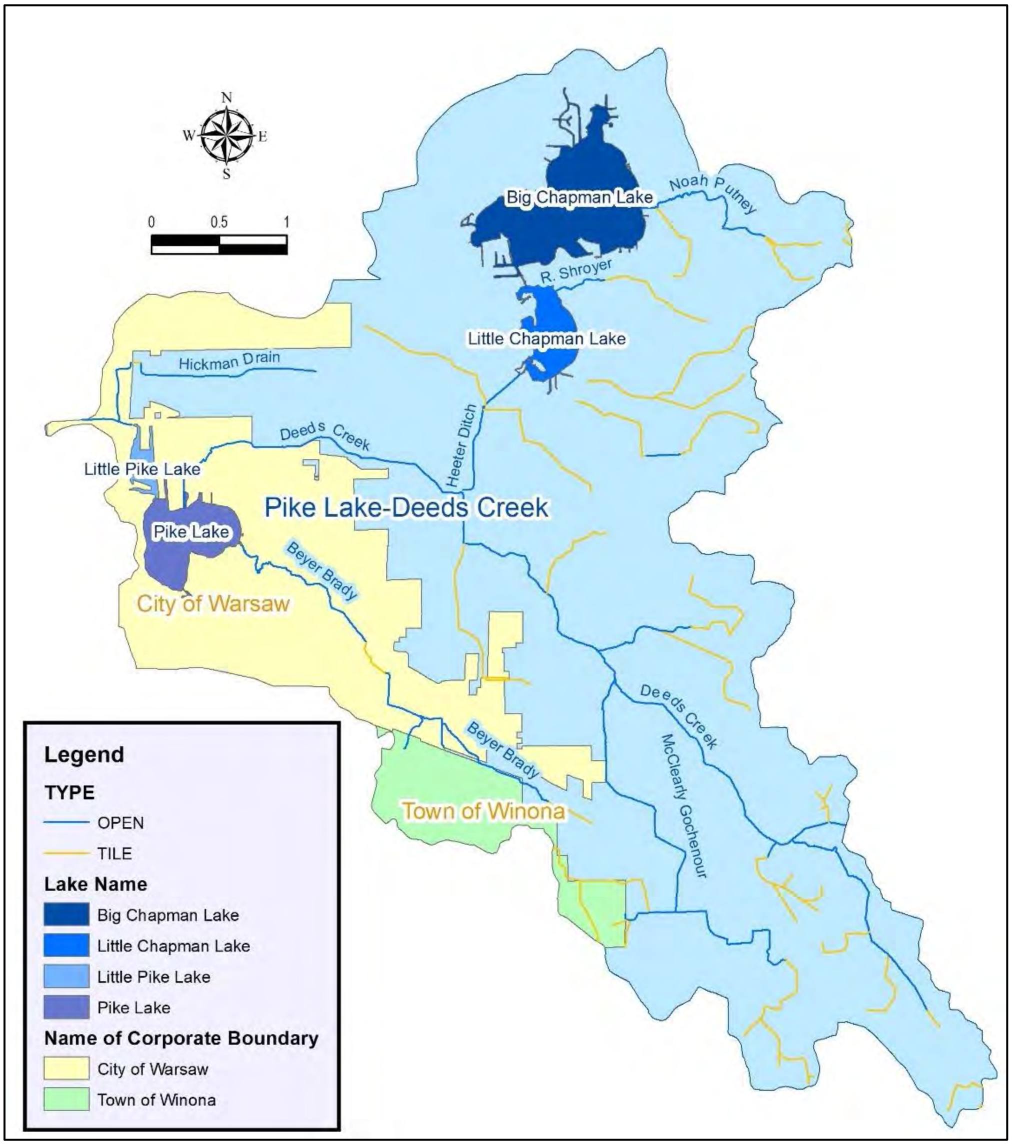


Figure 36 Waterways in the Pike Lake - Deeds Creek Subwatershed

Impaired Waters

Deeds Creek is listed on the 2016 IDEM 303(d) List of Impaired Waters for the Pike Lake – Deeds Creek Subwatershed. The map in Figure 42 shows the stretch of Deeds Creek that is listed as impaired for E. coli. The approximate length is 4.5 miles.

Stakeholders are concerned that E. coli levels may be an unseen bacteria problem. E. coli is an issue on public beaches. Deeds Creek is listed as impaired for E. coli. However, many streams have not been sampled for E. coli making it unclear if additional E. coli impairments are present

Pike Lake is listed as impaired for Phosphorus and PCBs. PCBs are legacy pollution from industrial activity in the area.

Stakeholders are concerned about nutrient loading in the lakes. Little Chapman, Little Pike, Pike, and Center Lakes are all listed by IDEM for phosphorus impairments. Residents fight aquatic weeds and have initiated the creation of Lake and River Enhancement (LARE) funded aquatic vegetation management plans.

Phosphorus has been an ongoing concern for Pike and Little Pike Lake (also impaired). Little Chapman Lake is impaired for phosphorus as well.

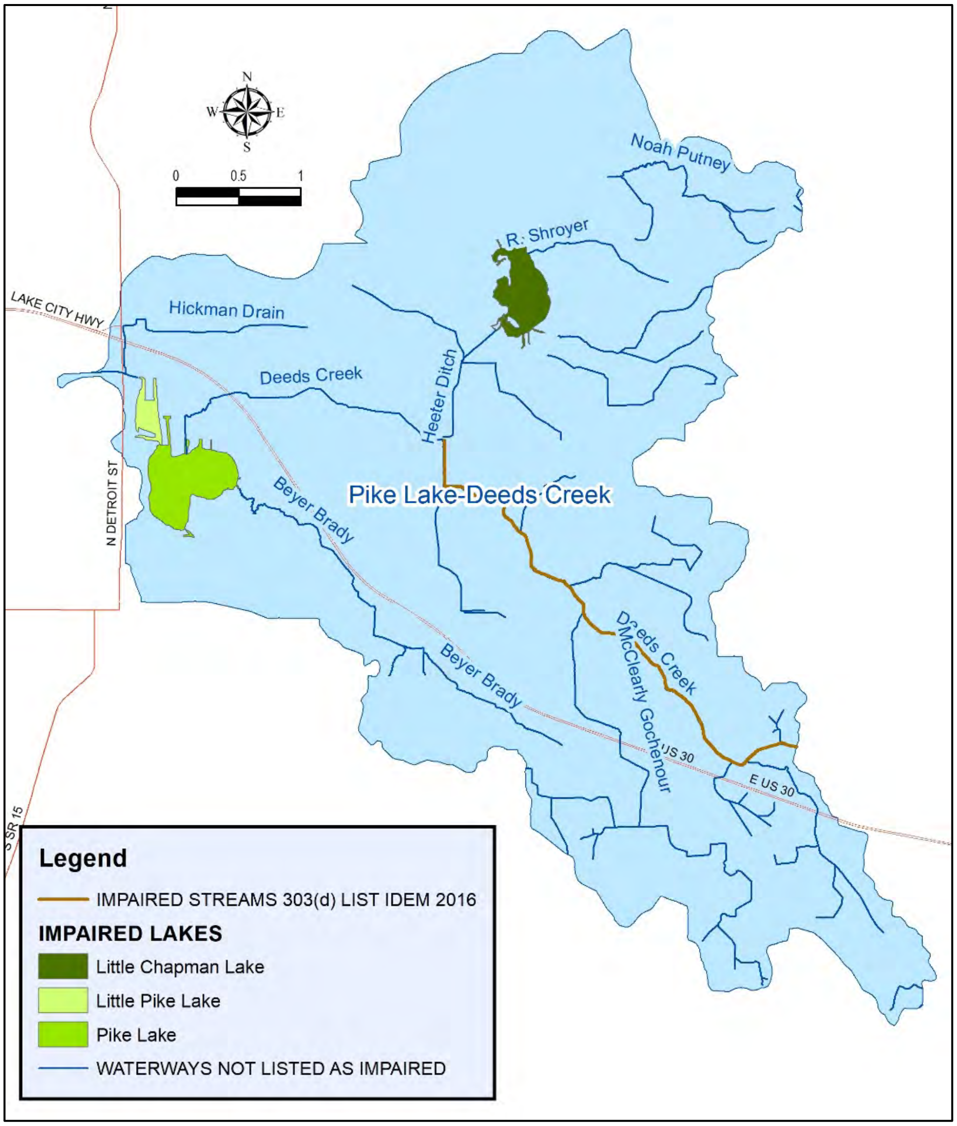


Figure 37 Impaired Waters IDEM 303(d) List of Impaired Waters 2018

Endangered Species

According to the 2007 Strategic Lakes Management Plan Kosciusko County conducted by JF New and Case & Associates for the Chapman Lakes Foundation, the Big Chapman Lake Nature Preserve area on the west side of Little Chapman (Figure 43) supports four different high quality habitat communities: marl beach, marsh, sedge meadow, and shrub swamp wetlands (New & Associates, 2007). These provide habitat for three state endangered animal species, the northern harrier

(Circus cyaneus), the Virginia rail (Rallus limicola), and the Blanding's turtle (Emydoidea blandingii). In addition, Circumneutral bogs, marsh wetlands, and sedge meadow wetlands have been documented within the Little Chapman Lake Nature Preserve. This wetland community is home to the marsh wren (Cistothorus palustris), least bittern (Ixobrychus exilis), black-and-white warbler (Mniotilta varia), black-crowned night-heron (Nycticorax nycticorax), king rail (Rallus elegans), Virginia rail (Rallus limicola), and the golden-winged warbler (Verivora chrysoptera). These birds are all listed as state endangered species or species of special concern. The state endangered Blanding's turtle and the state rare green-keeled cotton-grass (Eriophorus viridicarinatum) were also observed within the Preserve.

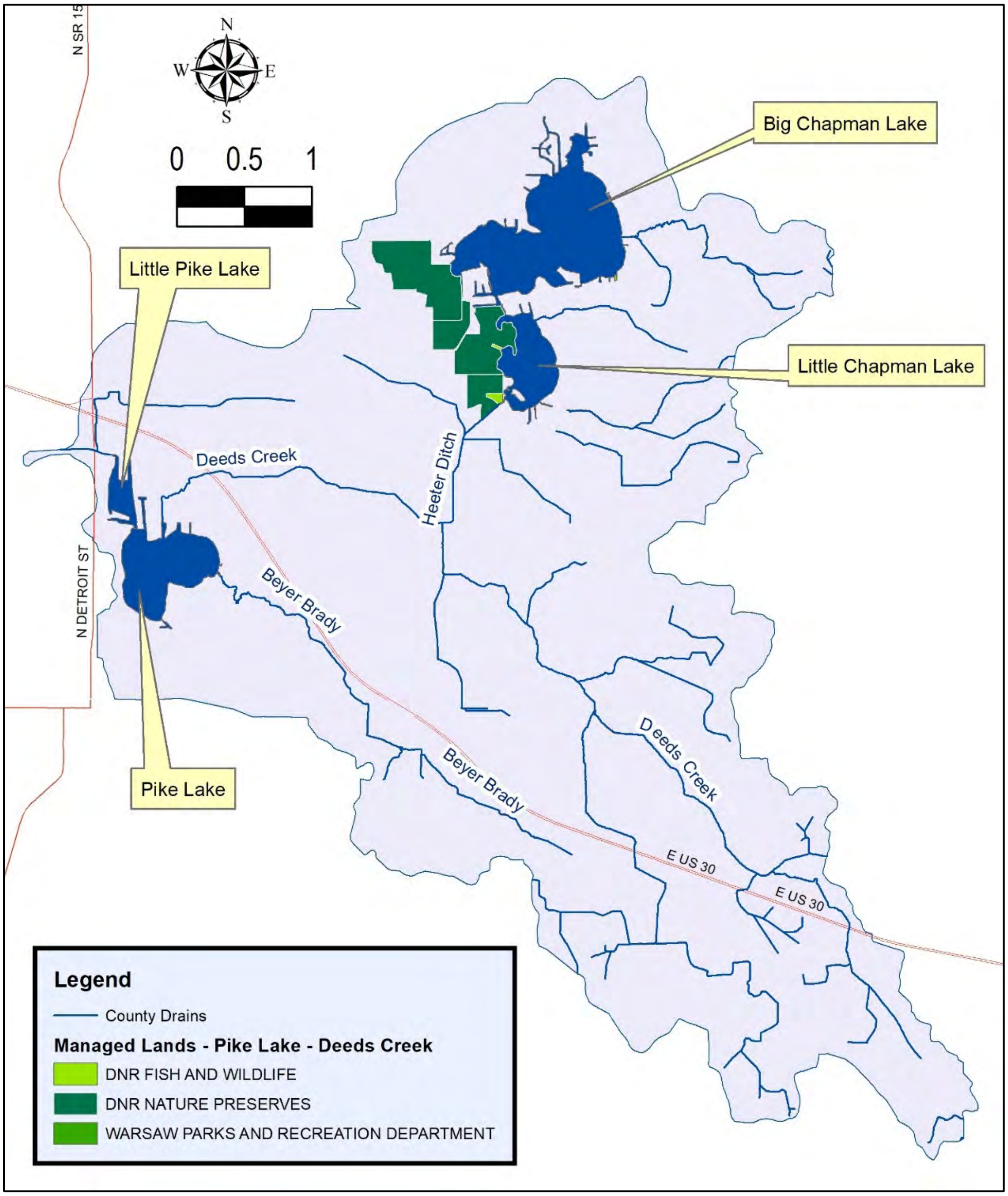


Figure 38 Managed Lands of the Pike Lake - Deeds Creek Subdivision IDNR, 2019

Streams & Ditches in the Deeds Creek - Pike Lake Subwatershed

Deeds Creek is the prominent stream that runs the length of the McCarter Ditch-Deeds Creek Subwatershed (11 miles in McCarter Ditch – Deeds Creek) along with nine (9) miles of Van Curen Ditch that joins Deeds Creek in the McCarter Ditch - Deeds Creek Subwatershed before flowing into the Pike Lake – Deeds Creek Subwatershed. In the Pike Lake – Deeds Creek Subwatershed, Deeds Creek flows for 11 more miles of open waterway combining with four (4) miles of the McCleary Gochenour Ditch until reaching Pike Lake, its receiving body.

Deeds Creek plays an important drainage role in the subwatershed. This subwatershed has a high groundwater table. The land is dotted with wetlands and ponds (Figure 44). As most of the McCarter Ditch – Deeds Creek Subwatershed is considered prime farmland (Map 13, Appendix), Deeds Creek is important for adequate drainage for crop production. The number if tiles miles, twenty-two (22) miles, is almost as many as the open waters, twenty-four (24) miles. Working with a diverse coalition of stakeholders will be important to both meet local water quality standards and meet the needs of the local stakeholders.

Pike Lake - Deeds Creek Watershed													
Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory 2016	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Deeds Creek	None Designated									No	E. coli	11	uk
Beyer Brady Ditch	N/A									No	None Listed	4	uk
Hickman Ditch	N/A									No	None Listed	2	uk
McCleary Gochenour Ditch	N/A									No	None Listed	4	uk
Robert Shroyer	N/A									No	None Listed	0.5	uk
Noah Putney	N/A									No	None Listed	1	uk
Big Chapman Lake	Chapman Lake Public Access off of Chapman Lake Drive	Yes	No	Yes	Yes	Yes	None	Yes	No	No	None Listed	413	39
Little Chapman Lake	No Public Access	No	N/A	N/A	N/A	Yes	Yes	N/A	N/A	No	Phosphorus	200	31
Pike Lake	Pike Lake Park & Campground	Yes	Yes	Yes	Yes	Yes	None	Yes	No	Yes	Phosphorus, PCBs, Largemouth Bass 13+"	212	34
Pike Lake	Beyer Park	Yes	No	No	No	N/A	N/A	Yes	No	Yes			34
Pike Lake	Lucerne Park	Yes	No	No	No	Yes	None	Yes	No	Yes			34
Little Pike Lake	Access thru Pike Lake	No	No	No	No	Yes	None	N/A	No	No	Phosphorus	42	9

Table 9 Waters of the Pike Lake - Deeds Creek Subwatershed

This is an important subwatershed for the public using water for recreational and quality of life attributes. Big Chapman, Little Chapman, Pike Lake and Little Pike Lake are all accessible to the public. Big Chapman provides access for both Big and Little Chapman. Pike Lake provides public access to Little Pike. In total there are eight hundred sixty-seven acres of recreational lake waters that residents and visitors call home or use for recreational purposes (Table 9).

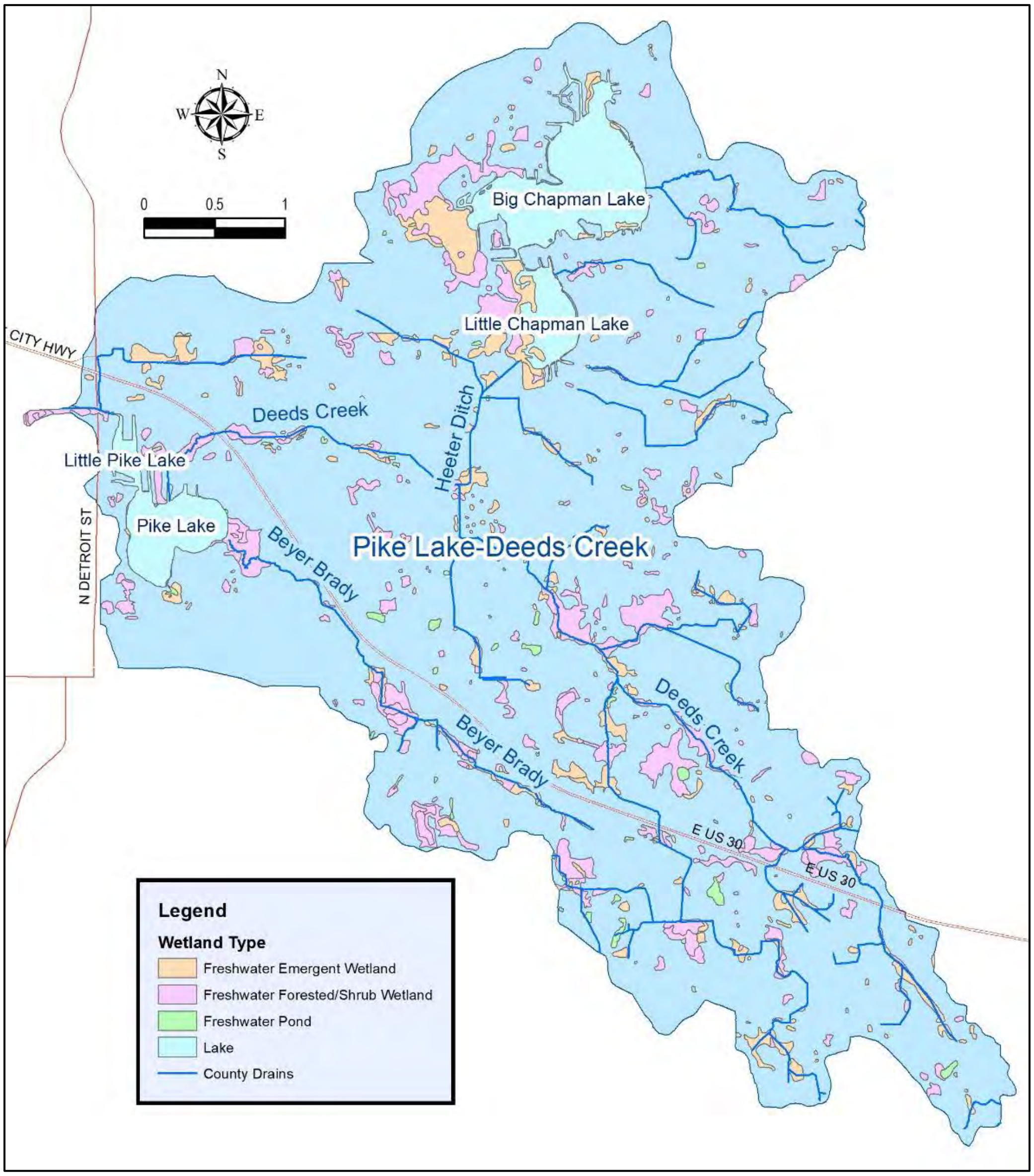


Figure 39 Wetlands Inventory (USFWS, 2014)

Lakes

There are four (4) lakes in the Pike Lake – Deeds Creek Subwatershed, Pike and Little Pike Lakes and Big and Little Chapman Lakes. These are public lakes and are important assets in the community.

Pike and Little Pike Lakes

Pike Lake has a history of high nutrient levels. It is listed on the 303 (d) list as impaired for phosphorus. It also has legacy pollution and is listed for PCB contamination. Pike Lake's TSI from the Clean Lakes Program Data has resulted in mixed numbers being Eutrophic or Hypereutrophic, showing some variability in its rating. This is a public lake that is used for swimming, fishing, and boating. Being classified at a eutrophic status is a concern for the high level of nutrients. Testing above eutrophic into the range of hypereutrophic puts the ecosystem at risk for becoming susceptible for developing toxic blue-green algae or other bacterial organisms that are not healthy for humans or other animals.

Indiana Clean Lakes Program - Trends for Carlson Trophic Indices for Center Lake										
Waterbody	2011	2012	2013	2014	2015	2016	2017	2018	Trend - Stable (S), Fluctuating (F), Degrading (D), Unknown (U)	Trophic Status - Oligotrophic (O), Mesotrophic (M), Eutrophic (E), Hypereutrophic (H)
Pike Lake			68	60	65				U	E-H
Yellow shaded areas have no data for that year.										

Figure 40 Pike Lake Data from the Indiana Clean Lakes Program

Pike Lake and Little Pike Lake have undergone many human-altered hydrological changes in the last 150 years. The 1879 map is the oldest map that is readily available. It is a record of the area that would be as close to hydrology as to when it was formed. This is important because there is a significant difference in the life and management of natural lakes that have undergone few human hydrological changes compared to those that have. Lakes that have had significant changes will tend to need care and management suggestive of a man-made lake or pond. These glacial formed lakes were formed under pressure (compaction) of tens of thousands of pounds. Disturbed areas are no longer compacted to the level that they once were and are more susceptible to erosion processes.

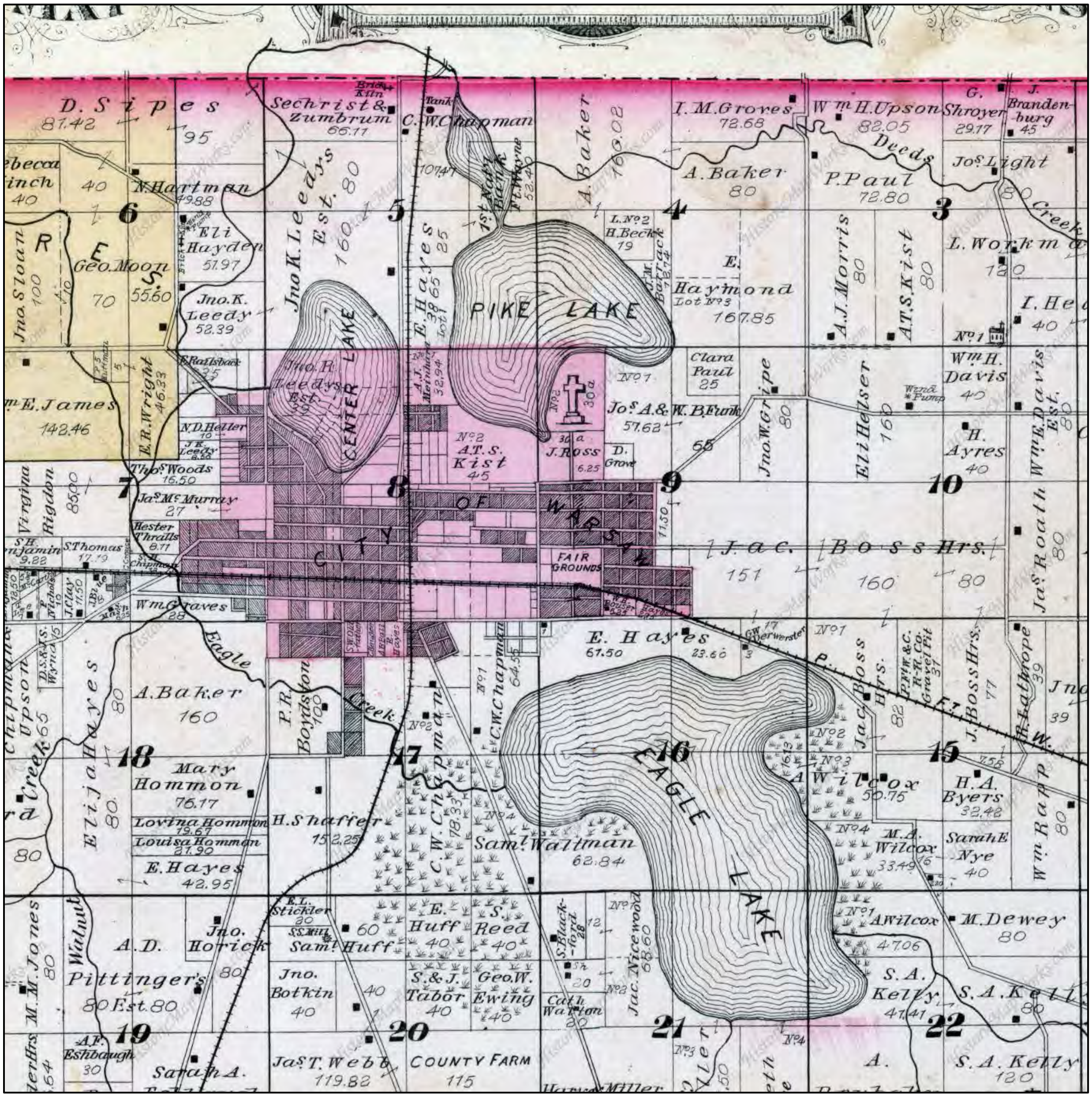


Figure 41 1879 Washington Township Map with Lines of Hydrology

When comparing the 1879 historic map (Figure 46) to the 2018 map (Figure 47), Pike Lake and Little Pike compared to 1879 share few common traits. The main flow of Deeds Creek now enters Pike Lake not Little Pike as it once did. Pike Lake now acts as a settling basin for material entering from Deeds Creek and all other water entering the Lake. It also retains sediment and nutrients from the erosion processes happening in the lake through shoreline erosion and erosion from disturbed areas.

The combination of hydrological modifications and the high nutrient and sediment load entering the lakes has sped up the eutrophic process. Recent construction on the lakes, specifically Little Pike Lake, where the water table is high and the soils are highly erodible, has most likely been a contributor as well.

Figure 42 Hydrology of Pike Lake & Deeds Creek 2018

Pike Lake needs active resource management to prevent further degradation of water quality by reducing nutrients and sediment coming into the lake. The City of Warsaw has begun working on shoreline restoration and that is a start to reducing erosion on the shoreline, but reducing sediment and nutrient transport into the lake through Deeds Creek, Beyer Brady, and urban stormwater sources is imperative, especially given that Pike lake receives nutrients and sediment from two subwatersheds, Pike Lake - Deeds Creek and also and McCarter Ditch – Deeds Creek subwatersheds.

Lake Associations

Pike Lake Association is the lake organization that works to provide upkeep in the form of weed management for Pike Lake. In general, this association struggles to find resources and fund basic weed control. It does not appear to have had technical expertise in recent years to help guide the efforts of the Association, reducing its effectiveness on changing long term outcomes which would be done with a comprehensive a management plan that goes beyond weed management. Additionally, it does not have the resources to fund management studies or lake improvement projects.

Urban Development Influences

Pike and Little Pike Lakes are located within the City of Warsaw. Pike Lake has two tributaries, Beyer Ditch and Deeds Creek. The lakes also have twenty-nine public- owned stormwater outfalls around the lakes that drain roads and parking lots. Additionally, there are four public-owned outfalls. Deeds Creek and its tributaries extend to the farthest eastern corner of the Walnut Creek watershed and beyond into the Grassy Creek watershed where Deeds Creek is now the receiving body for the sewer system recently built to serve the Barbee Chain of Lakes.

Two of the Walnut Creek subwatersheds flow into and through the lake, McCarter Ditch and the Pike Lake -Deeds Creek subwatersheds. The outfall at the Little Pike Lake dam drains water into Lones Ditch (local name for Deeds Creek where it exits Pike Lake) where it travels to the Tippecanoe River. The dam is used to control the water level in Pike and Little

Pike Lakes for recreational use. There is no active control of the dam. It is a court set elevation set through the use of planks that are placed at the dam structure in April and removed in November.

Pike Lake and Little Pike Lake are home to predominately year-round residences. They are surrounded by fully developed parcels. Additional development would require local approval of flood fringe development which could occur and has been approved in recent years. The Lakes have public access through two municipal parks, a campground, beach area, and a boat ramp.

Although these lakes are prone to flooding (Figure 48), they play an important part of flood prevention as half of Pike Lake's east side is a wetland. The flooding that occurs is a problem for residents of Warsaw living around the lake, but it is not a problem that can be solved in isolation by the local community of Warsaw without the inclusion of the hydrological influences coming from the Tippecanoe - Grassy Creek Watershed.

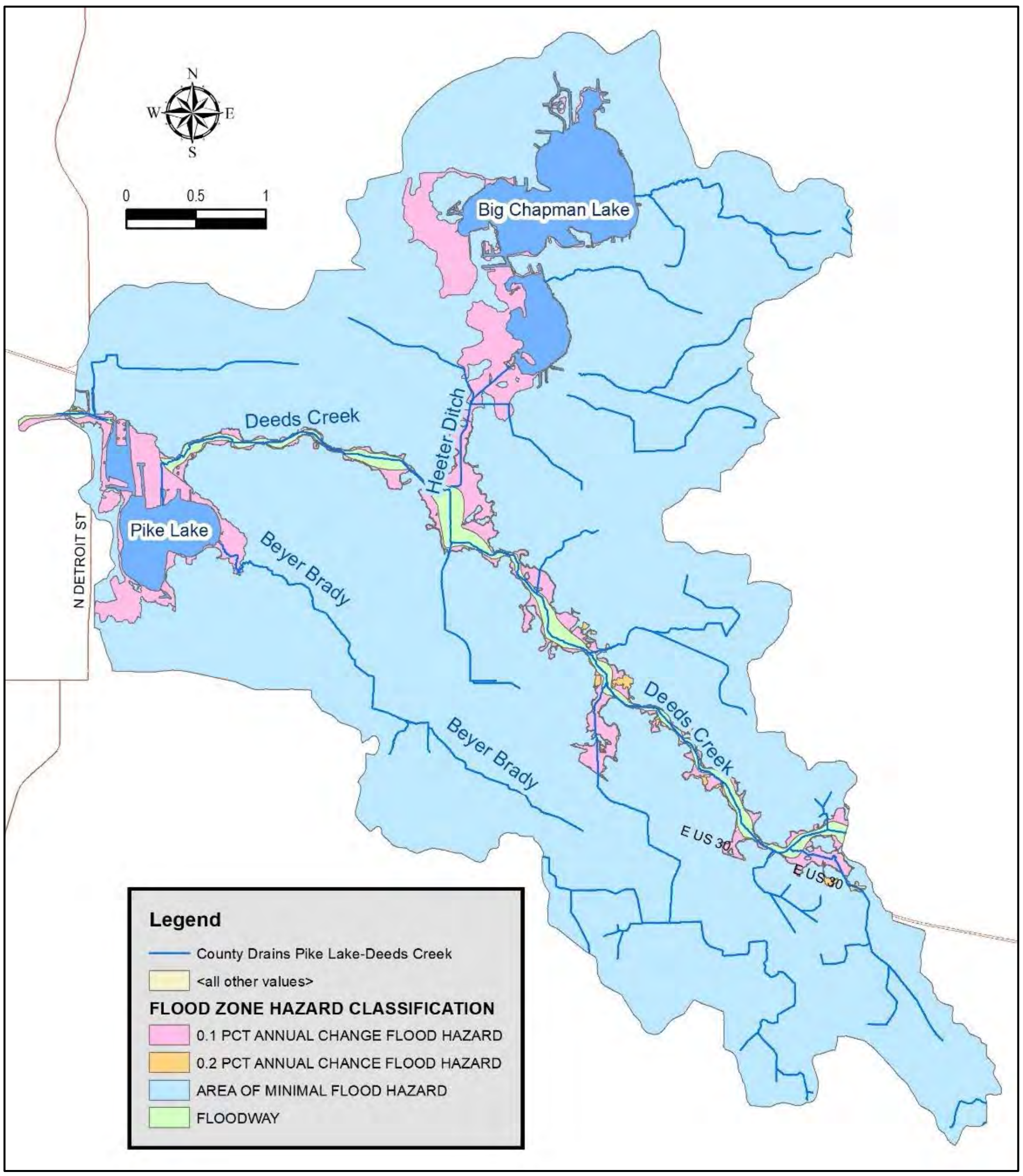


Figure 43 FIRM 2019 Map Pike Lake - Deeds Creek Subwatershed

Erosion & Buffer Strips

Shoreline erosion is a real concern for Pike Lake. There is significant erosion on the south end of the lake on public properties. The City of Warsaw Parks and Stormwater Departments have begun a regular program of shoreline restoration. Erosion has cost the City over 10 feet of property on the southwest side of the lake. There is an estimated 4,500 lineal feet of shoreline that needs stabilization on municipal-owned properties (Example, Picture 10).

According to the Indiana Department of Natural Resources Division of Fish and Wildlife document entitled "Lakeshore Protection in Indiana," concrete seawalls degrade habitat and contribute to sustained energy from wave action that increases erosion. Concrete seawalls are the predominate shoreline effect on Pike Lake for residential properties. Public owned properties are predominately natural or grass with significant erosion. However, the City of Warsaw began working in 2015 on a long-term plan to restore those public-owned natural or grassed shorelines with native buffers to abate erosion.

Invasive Plants & Animals

Eurasian Watermilfoil was the dominate plant in Pike Lake in Lare Reports dating back to 2005. It continues to be the dominate plant in the lake today.

Stakeholders are concerned about the increasing number of invasive and overgrowth of weeds in the lake reducing its value for recreational use. Residents have even reported that there were too many weeds to swim across the lake.

Picture 10 Beyer Brady Ditch at Pike Lake, Shoreline Erosion, 2016 Pictometry Kosciusko County Government (2016 Pictometry)

Big & Little Chapman Lakes

Big Chapman and Little Chapman Lakes are located approximately 5 miles northeast of Warsaw. Little Chapman is listed on the 2016 IDEM 303(d) list as being impaired for phosphorus.

Big Chapman has a TPI rating of 42 and Little Chapman has a TPI rating of 50. Both have generally held steady in recent years.

Indiana Clean Lakes Program - Trends for Carlson Trophic Indices for Center Lake										
Waterbody	2011	2012	2013	2014	2015	2016	2017	2018	Trend - Stable (S), Fluctuating (F), Degrading (D), Unknown (U)	Trophic Status - Oligotrophic (O), Mesotrophic (M), Eutrophic (E), Hypereutrophic (H)
Big Chapman Lake	48	46	48	46	48	46	53		S	M
Little Chapman Lake	58	59	60	60	60	57	62		S	E
Yellow shaded areas have no data for that year.										

Invasive plants and animals

According to a 2016 report conducted by Aquatic Control, the primary invasive species in Chapman and Little Chapman is Eurasian watermilfoil (Myriophyllum spicatum). Invasive curly-leaf pondweed (Potamogeton crispus) and spiny naiad (Najas marina) have also been documented, but rarely reach the level of Eurasian watermilfoil. Native eel grass (Vallisneria americana) is also abundant in the lakes and can reach nuisance levels.

Lake Associations

Chapman Lakes has an active lake association, the Chapman Lakes Conservation Association, which predominately operates weed control functions and other smaller maintenance items along with fireworks and other functions. Contrasting the Association, the Chapman Lakes Foundation operates to provide funding and steering of larger and more long-range projects to protect and improve lake quality. According to their website, their mission is stated to "Prolong the life of the lakes for the enjoyment by current and future generations and to develop an ever-changing plan that plots the path for maintaining and improving the health of the Chapman Lakes for long-term recreational enjoyment; increasing property values; improving environmental stewardship; and inspiring action by focusing on communication, collaboration, and education."

Chapman Lakes Urban Development Influences

Chapman Lakes are home to over 725 homes, a mobile home community and a campground. The homes on Chapman Lakes comprise of over 75% of year-round resident occupants. Chapman Lakes are spring fed with no inflow from major streams. There are, however, five regulated drains that enter the lakes which encompasses 4,500 acres of the watershed, or about seven square miles. Big Chapman is large enough for skiing and power boating. It is about three times the size of Little Chapman Lake. Big Chapman flows into Little Chapman, which outlets into Heeter Ditch.

The Chapman Lakes are considered among the best in Indiana for fishing. Adjacent wetlands and less human alteration have helped protect the water quality of these lakes. Big Chapman Lake has 48,241 feet of shoreline; Little Chapman Lake has 27,374 feet of shoreline (including wetland areas).

More than 260 acres of wetlands, primarily on the west side of Little Chapman are vital to maintaining the water quality of the lakes. Little Chapman Lake has a dam that remains at a fixed elevation (by court decree) that maintains the lake level for residents. The dam and levee also serve to protect the wetlands by maintaining a healthy and consistent water level for the wetlands. The five regulated drains entering the lake are island Park Drain, Crooked Creek (Noah Putney Drain), Arrowhead Park Drain (Robert Shroyer Drain), Highland Park Drain (Little Chapman located in the center from north to south and on the east side of the lake), and Lozier's Drains (includes two drains both Gillam and Bixler on the south end of Little Chapman next to the campground). According to the Chapman Lakes Study done in 2001, these drains," during low flow conditions, contributed little nutrient or sediment loading to the lakes, although some sites did exhibit elevated concentrations or total phosphorus and Escherichia coli (E. coli) bacteria. During storm flow, Lozier's and Crooked Creek added the largest amounts of pollutants to the lakes. Suspended solid loading and E. coli loading were greatest from Crooked Creek, while ortho-phosphorus loading was most pronounced from Lozier's Creek. Crooked Creek delivered the most sediment, total phosphorus, and bacteria per acre of watershed. At base flow conditions, the Highlands Park inlet also contributed substantial amounts of the pollutants despite having a relatively small watershed."

In the last five years, the Chapman Lakes Foundation has worked with local partners and the LARE program to improve Crooked Creek and the Highland Park Drain. Crooked Creek projects were separated into Phase I and Phase II. Phase I was completed in 2016. It included repairs of placing stone toe protection along a total of 247 linear feet bank, improving existing stone cribs and lifts in numerous areas along 236 linear feet of bank and placing riffle-grade control along 60 linear feet of the channel. Crooked Creek had been identified in previous engineering studies as contributing significant sediment and nutrient loads into the lake. The Foundation will be applying for LARE funding for Phase II.

Using the information from the Indiana Clean Lakes Program, Big Chapman Lake is best classified as a mesotrophic lake in that it supports only moderate rooted plant growth and has moderately clear water. Residents report fishing a variety a fish species including bluegill and bass. Engineering reports indicate a diverse mix of native pondweeds, eel grass, and emergent vegetation grows in patches throughout the lake. In 2001, JF New conducted a study of the lakes and noted that although Big Chapman Lake generally has better water quality than most other Indiana lakes, there is a concern that the "phosphorus concentrations appear to be increasing since the mid-1990's, while the percentage of the water column containing oxygen appears to have been decreasing. Secchi disk transparency of Big Chapman Lake is holding steady or slightly decreasing. In general, trophic state indices and water quality parameters indicate that although water quality in Big Chapman Lake is good, concern for worsening conditions is warranted. Phosphorus modeling of Big Chapman Lake and its watershed suggests that 22% of the phosphorus in the lake originates from internal sources."

The same phosphorus modeling was done for Little Chapman Lake and indicated that 37% of the phosphorus loading was originating from internal sources. Bluegill and gizzard shad have historically composed most of the fish biomass. The lake quality tends to be worse that Big Chapman Lake as it scores 10 points higher on the Carlson Trophic State Index rating.

Little Chapman Lake is influenced by a larger watershed than Big Chapman Lake and flushes its water approximately three times per year. With sediment concerns for the water inflow sources into Little Chapman and the increased number of flow sources, Little Chapman acts as a basin for the sediment and nutrients coming into the lake. Big Chapman has a smaller watershed, larger body of water and a lower flow of water entering the lake. Due to the smaller inflow, Big Chapman flushes its water only once per year.

Identified Future Lake Quality Projects

Big Chapman Lake has some of the best lake water quality in the state. It is important to protect this lake. The Chapman Lake Foundation has worked hard on projects to improve and protect the two lakes. They have proven to be dedicated and resourceful stewards through planning and resource management of the lakes and surrounding areas. Table 10 lists recommended water quality improvement projects to benefit Big and Little Chapman Lakes. Projects were identified in the Lozier Highland Engineering Study done in 2006 by JF New and the project(s) were delineated in a 2014 report by S& L Engineering for application for LARE program for Phase I of the streambank restoration and riffle-grade control project of Crooked Creek. Phase I was completed in 2016. S & L Environmental Group submitted the report and application for funding for LARE application for Phase II. Additional projects that have been identified previously in the 2006 Lozier Highland Study by JF New are listed below (New, 2006).

Site	Drain	Issue/Source of Impairment	Potential Project(s)
A	Highland Park	Stream flows through old pond structure; Severe erosion occurs along length of streambed and banks	Stream Restoration
B	Highland Park	Rill and gully erosion are forming throughout row crop agricultural field; Water flow unchecked across property and would benefit from on-site retention	1. CRP Enrollment (bare ground) and Wetland Restoration (woodlot); 2. Grassed Waterway and WASCOB* Installation; 3. Sediment Basin Installation
C	Highland Park	Grassed waterway is overgrown with woody material; Waterway needs to be mowed and properly maintained to provide optimal function	Grassed Waterway Maintenance
D	Lozier (Bixler)	Stream is eroding streambank and is disconnected from its floodplain; Best benefit achieved by improving on-site retention; Secondary benefit from restoring streambank	Stream Restoration (Check Dams)/Wetland Enhancement/Pond Installation
E	Lozier (Bixler)	Field drainage flows around existing concrete structure previously installed by the NRCS; Structure needs to be replaced or repaired to correct erosion issues	Structure Replacement/Repair
F	Lozier (Bixler)	Minor rill and gully erosion are occurring within the field; Improve on-site retention or reduce sediment loading	CRP Enrollment
G	Lozier (Bixler)	Minor rill and gully erosion are occurring within the field; Improve on-site retention or reduce sediment loading	Grassed Waterway Installation
H	Lozier (Gilliam)	Erosion is occurring within field at tile outlet and at outlet of pipe under road; Correct erosion issues and improve on-site retention	Structure Replacement/Repair; WASCOB and Tile Installation; Rock Outfall at Road
I	Lozier (Gilliam)	Minor rill and gully erosion are occurring within the field; Improve on-site retention or reduce sediment loading	Grassed Waterway Installation
J	Lozier (Gilliam)	Drain flows along gravel road; Little or no filtration of roadside or open field sediment loading	Roadside Drain or Infiltration Trench Installation
K	Lozier (Gilliam)	Degraded, partially farmed wetland; Increase on site retention and water filtration	Wetland Restoration
L	Lozier (Gilliam)	Degraded, partially farmed wetland; Increase on site retention and water filtration	Wetland Enhancement

Table 10 Little Chapman Lake Projects Identified in 2006 Engineering Study by JF New (New, 2006)

Picture 11 Chapman Lakes Natural Shoreline 8/26/2016 (Sailor, 2016)

Picture 12 Little Chapman Lake Natural Shoreline, DNR Owned Wetland 8/26/2016 (Sailor, 2016)

Urban Development Influences

The Pike Lake - Deeds Creek subwatershed has two NPDES wastewater permitted facilities according to the 2018 update from the IDEM Office of Water Quality (Figure 48). Dalton Industries resides in the Pike Lake – Deeds Creek Subwatershed and pipes its non-contact cooling water through the municipal storm sewer system to Winona Lake located in the Winona Lake – Eagle Creek Subwatershed. Applied Thermal Technologies discharges into Hickman Ditch which drains to Lones Ditch. Although the Pike Lake has legacy pollution from PCBs, its primary pollutant load from inside the subwatershed would be from commercial and residential stormwater and pollutants from agriculture activities both inside the subwatershed and from the McCarter Ditch Subwatershed. It should be noted that Dalton does discharge pollutants into the air, including mercury, under permit from IDEM's Air Quality Monitoring Program. Although no lakes in this subwatershed are listed as impaired for mercury, there are lakes in the watershed that are.

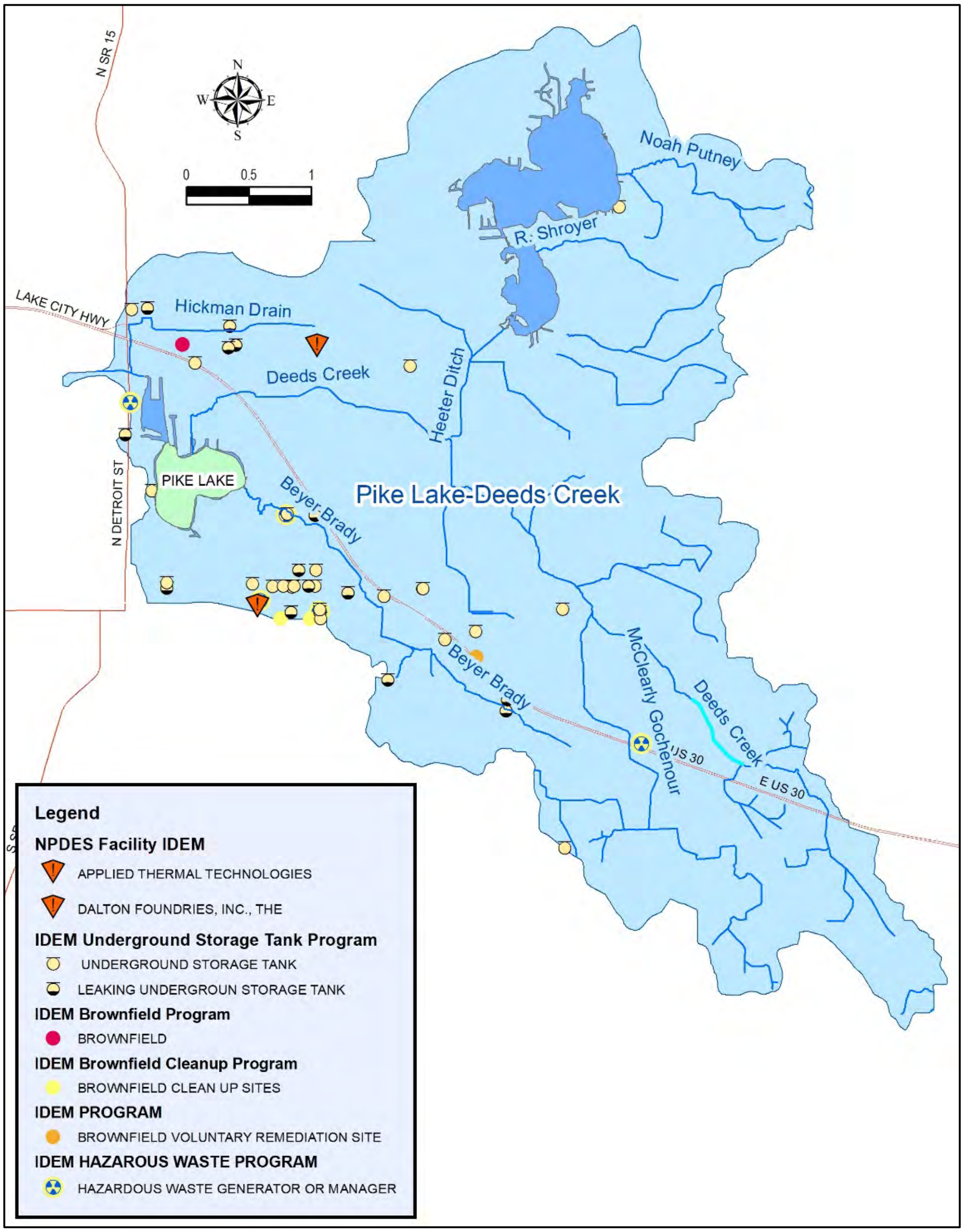


Figure 44 Potential Sites of Industrial and Commercial Pollutants Pike Lake - Deeds Creek Subwatershed

In this subwatershed there is also one (1) brownfield and fifty-six (56) underground storage tanks of which thirty-two (32) are leaking. Forty-six (46) of the underground storage tanks are in the City of Warsaw.

There is also three (3) IDEM Clean-up sites, one (1) Voluntary Remediation site, and one (1) Hazardous Waste Generator.

The properties within the City of Warsaw and Winona Lake are sewered, including all the properties on Pike and Little Pike Lake. Big Chapman and Little Chapman, however, are not sewered. They are the last remaining larger "community" that is unsewered in the watershed.

Agribusiness in Pike Lake - Deeds Creek Subwatershed

A significant portion of the watershed is agricultural, including sixty-one (61) percent of the subwatershed as cropland, eighteen (18) percent forest, and two (2) percent pasture (Figure 39).

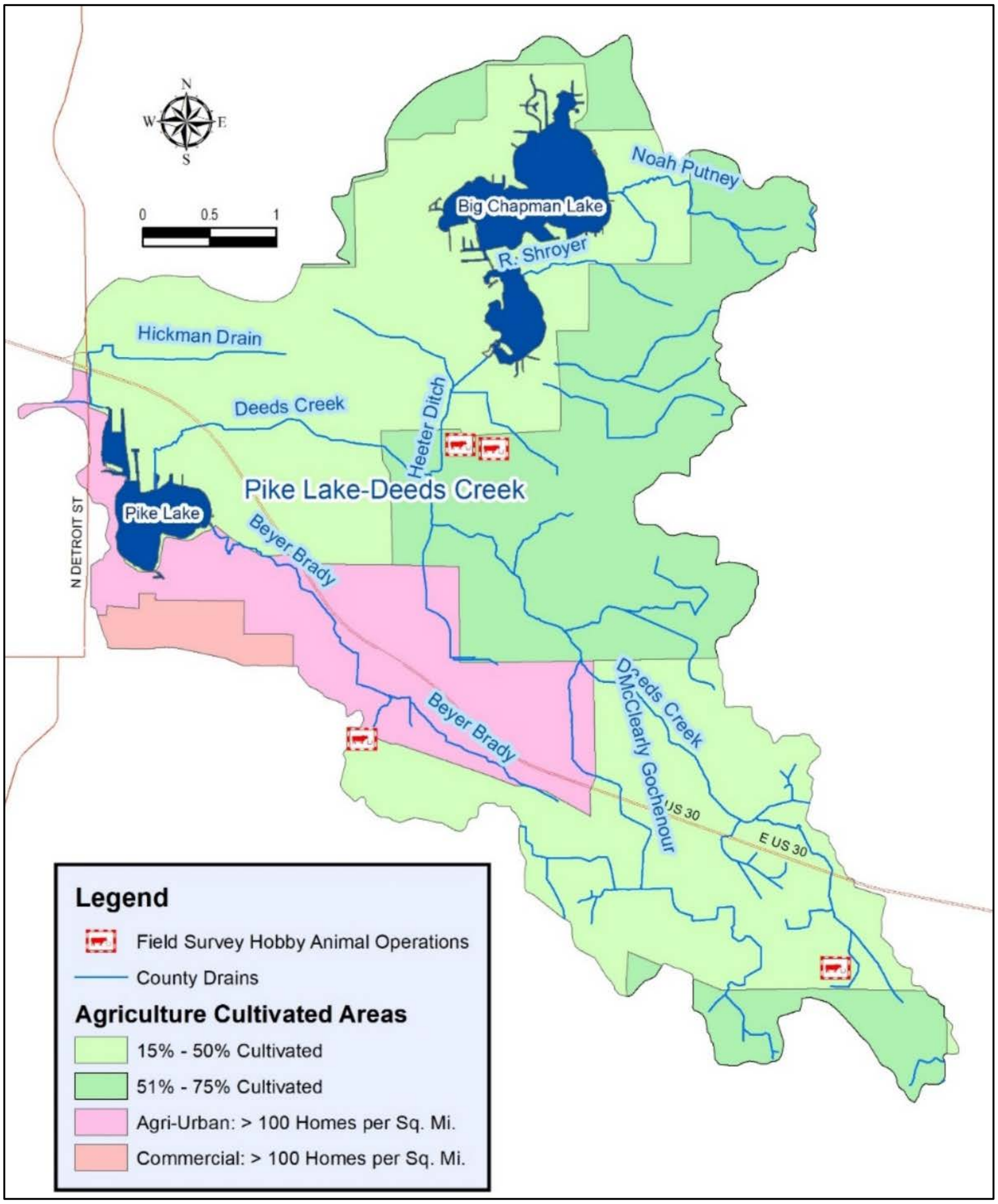


Figure 45 Agribusiness in Pike Lake - Deeds Creek Subwatershed

There is currently no IDEM permitted confined feeding operations, either designated confined feeding operations (CFO) or confined animal feeding operations (CAFO). The Field Survey did find four (4) "hobby" farms with pastured animal operations, however (Figure 50). These "hobby" farms should not be considered small without investigation. They may have livestock counts that are significant but less than the total number of animals required to be classified as "permitted."

The Field & Desktop Surveys also identified areas where ditches and streams needed buffer strips. There was over seven (7) miles identified. Locations are noted on Figure 51.

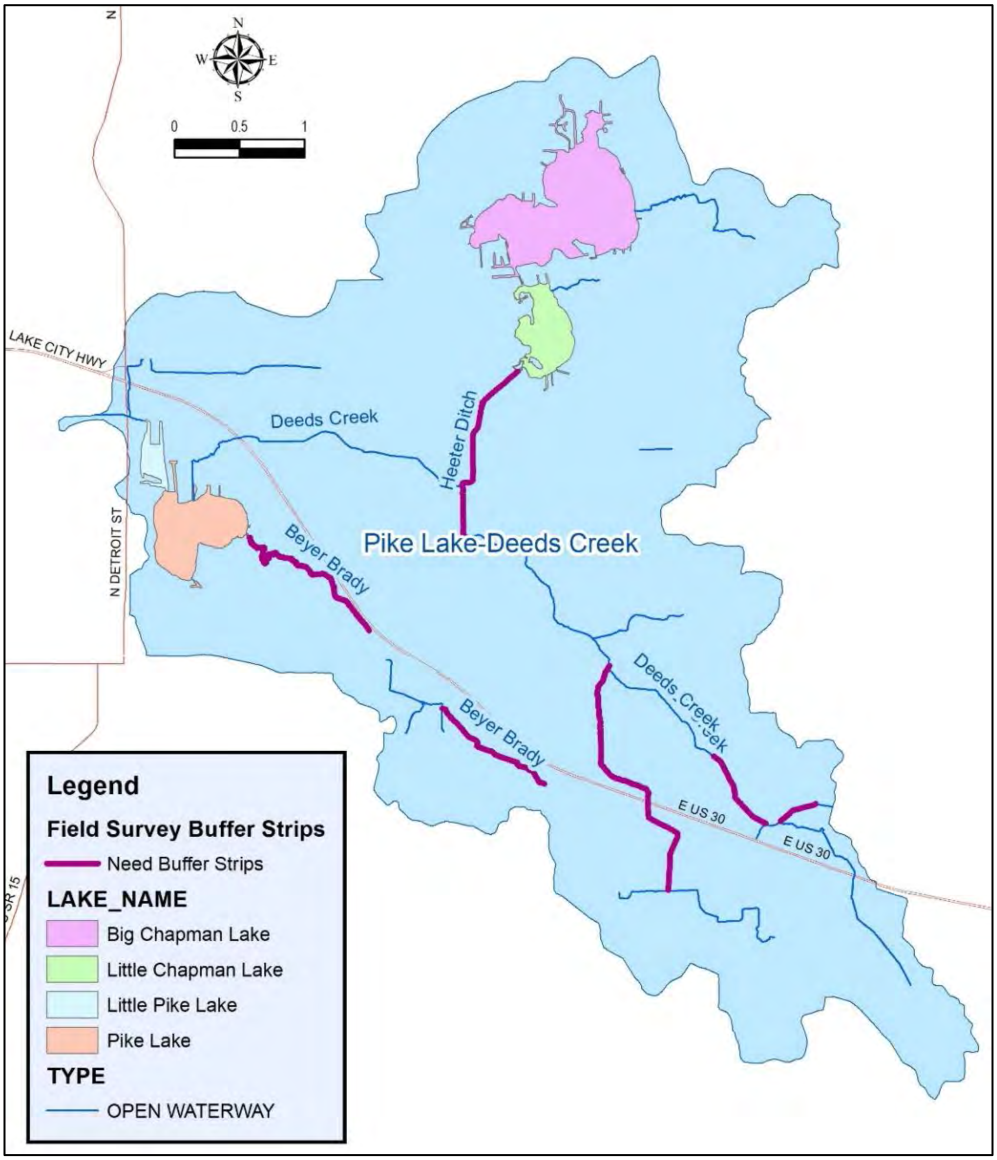


Figure 46 Open Waters and Areas Needing Buffers 2017 Pike Lake - Deeds Creek Subwatershed

Areas needing buffer strips were not limited to farm or rural properties. The Beyer Brady Ditch which is in the City of Warsaw also had a significant stretch where property lawns were being trimmed next to the water's edge and allowing fertilizer, grass clippings, animal waste (example; goose or dog) to enter the water.

Pike Lake – Deeds Creek Sampling Data

There were three bi-weekly sampling points in the Pike Lake – Deeds Creek subwatershed. Deeds Creek (Site #1), Heeter Ditch (Site #2), and Lones Ditch (Site #3). Complete sampling sites and descriptions are in Table 11. There are two (2) high source sites, Deeds Creek (Site #11) and Deeds Creek (Site #14). There is one stormwater outfall site, Outfall into Pike Lake (Site #20). Sampling sites are listed in Table 11 and mapped in Figure 52.

Site #	Waterway	Sampling Site Type	**Influences:** Rural Residential (R), Agricultural (A), Urban (U), Lake (L), Wastewater Plant (WWTP)	Location Description
1	Deeds Creek	Bi-weekly	A	Deeds Creek near E 100 N
2	Heeter Ditch	Bi-weekly	A, L	Heeter Ditch off of 175 N
3	Lones Ditch	Bi-weekly	A, U	Lones Ditch W of SR 15
11	Deeds Creek	High Source	A	Deeds Creek at SR 30 east of Pike Lake
14	Deeds Creek	High Source	A	Deeds Creek, SR 30 3426 SR 30 E
20	Outfall into Pike Lake	Stormwater Outfall	U	Warsaw Cemetery, 421 N Maple Street (STO-028-003)

Table 11 Sampling Sites Pike Lake - Deeds Creek Subwatershed

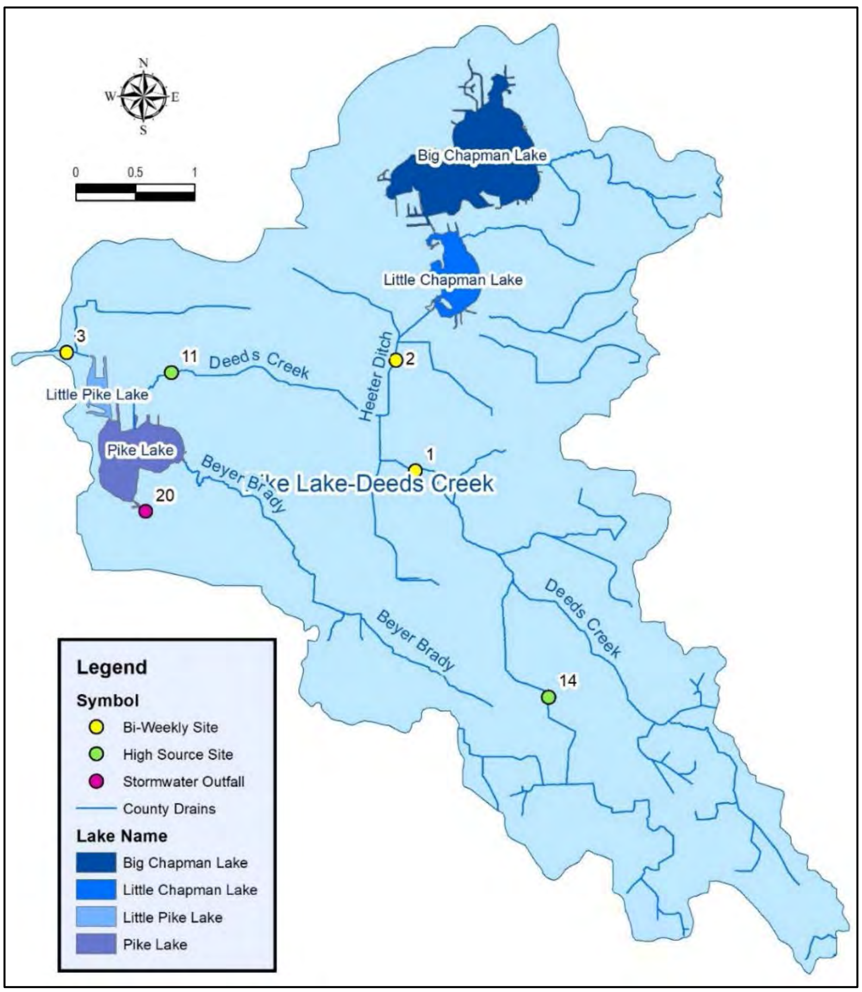


Figure 47 Sampling Sites in Pike Lake - Deeds Creek Subwatershed

Bi-weekly sites were sampled fifty-five (55) times in a two-year period (2016-2017). High Source Sites (HSS) were sampled during the 2017 period four (4) times. HSS were identified after the first year of sampling. They were used to identify locations of possible sources of pollution in the watershed based on high pollutant readings in the regular bi-weekly sampling results from the first year. Stormwater outfalls were sampled a total of six (6) times during rain events (2016-2017).

E. coli Sampling in the Pike Lake - Deeds Creek Subwatershed					
Site #	Waterbody	**E. coli**			
		Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL
1	Deeds Creek	650	>2419	36	62%
2	Heeter Ditch	319	>2419	1	30%
3	Lones Ditch	38	727	1	6%
11	Deeds Creek	457	980	106	75%
14	Deeds Creek	1096	>2419	236	100%
20	Outfall into Pike Lake	739	>2419	179	80%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.					

Table 12 E. coli Sampling in the Pike Lake - Deeds Creek Subwatershed

Sampling Data in the Pike Lake - Deeds Creek Subwatershed												
	Nitrates (NO3)				**Total Phosphorus**				**Suspended Solids**			
Site #	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
1	3.21	9.38	0.36	87%	0.118	0.606	0.015	46%	23	254	0	22%
2	0.67	2.40	0.09	9%	0.044	0.111	0.012	8%	11	48	0	7%
3	1.23	3.37	0.00	39%	0.039	0.154	0.007	4%	8	32	0	2%
11	1.51	1.87	1.34	25%	0.062	0.136	0.032	25%	11	31	1	25%
14	4.51	6.25	2.92	100%	0.050	0.088	0.020	25%	4	7	0	0%
20	0.65	1.12	0.26	100%	0.430	0.712	0.091	100%	223	788	4	33%

* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.

Table 13 Nitrates, Total Phosphorus, & Suspended Solids in the Pike Lake - Deeds Creek Subwatershed

The sampling results for the Pike Lake – Deeds Creek Subwatershed sites are summarized in Table 12 & Table 13.

Site #1

Site #1 is Deeds Creek is the convergence of all water coming from the McCarter Ditch Subwatershed, and Deeds Creek in the Pike Lake – Deeds Creek Subwatershed up to this point. It is just downstream from the Heeter Ditch tributary. Both dissolved oxygen and pH results fell within the target parameters for this site. The Citizen's Qualitative Habitat Evaluation Index (CQHEI) for this site was a fifty-three (53) which generally indicates the stream can attain "Warm Water Habitat" (WWH) biological communities, depending on which features (flow, depth) are lacking the biological communities may continue to fall short of the WWH classification.

Sixty-two (62) percent of the samples taken at Site #1 were over the target threshold of 235 CFU/mL for **E. coli**. This site had the highest percentage of bi-weekly samples exceeding the target. The average reading was 650 CFU/100 mL which is well above the target threshold.

Site #1 exceeded the **nitrate** threshold of 1.5 ml/L 87% of the samples taken with an average reading is 3.21 mg/L. The highest reading at this site was 9.38 mg/L which is over six times the threshold. This was this highest nitrate reading in the watershed with the highest percentage of exceedances in nitrates for bi-weekly sampling points.

Total Phosphorus also exceeded the target threshold. It exceeded the .076 mg/L target forty-six (46) percent with a high of .606 mg/L, almost eight (8) times the target threshold. The average reading was .118 mg/L which was also above the target.

Suspended Solids at Site #2 were elevated above the target threshold of 25 mg/L twenty-two (22) percent of the time with an average reading of 23 mg/L.

Site #2

Site #2 is Heeter Ditch in the flowline from Chapman Lakes to Deeds Creek. Site #2 (Heeter Ditch) tested under 4 mg/L in seventeen (17) percent of the samples. Site #2, Heeter Ditch (Pike Lake – Deeds Creek subwatershed), received the lowest rating of all the sampling points in the Citizen's Qualitative Habitat Evaluation Index (CQEHI) rating at 29.5.

Streams generally classified this low have had extensive man-made modifications and like the description of a typical stream scoring this low, Heeter Ditch is a shallow, channelized, treeless ditch with some silting, making it too warm, shallow, and silted to provide habitat for most aquatic life. Its score is characterizing moderate to extensive man-made modifications to the waterway. Using Hoosier Riverwatch's methods of finding and counting macroinvertebrates, the site's Pollution Tolerance Rating was considered "good."

Site #2 exceeded the 235 cfu/mL **E. coli** target threshold thirty (30) percent of the time and had its average reading at 319 cfu/100 mL.

The **nitrate** testing yielded an average of .67mg/L, only exceeding the 1.5mg/L target threshold nine (9) percent of the samples taken. **Total Phosphorus** exceeded the target threshold of .076mg/L eight (8) percent of the samples taken with an average sample reading of .044mg/L. **Suspended Solids** exceeded the target of 25mg/L seven (7) percent of the samples with an average of 11mg/L.

Site #3

Site #3 Lones Ditch is the stretch of Deeds Creek between Little Pike Lake and the Tippecanoe River. The sampling point is downstream from the exit of Little Pike Lake. Lones Ditch received a "poor" PTI rating. Its **CQHEI** was a fifty-one, generally indicating the stream can attain "Warm Water Habitat" (WWH) biological communities. Its PTI was rated as "poor". The CQHEI noted a lack of riffles and runs with a score of 0 and a low score of 5 out of 25 for the waterway substrate.

Site #3 had an average **E. coli** reading of just 38cfu/100mL, exceeding the target threshold just six (6) percent of the time. Site #3 exceeded the **nitrate** threshold thirty-nine (39) percent of the time with an average reading of 1.23mg/L. The highest nitrate reading was 3.37mg/L. **Total Phosphorus** exceeded the target threshold of .076mg/L four (4) percent of the samples with an average reading of .039mg/L. **Suspended Solids** two (2) percent of the samples with an average of 8 mg/L.

Site #11

Site #11 is a High Sampling Site (HSS). It is located on Deeds Creek before Deeds Creek enters Pike Lake. Seventy-five (75) percent of the **E. coli** samples taken on this HSS were higher than the target threshold. The average was 457cfu/100mL.

Site #11 exceeded the **nitrate** target threshold twenty-five (25) percent of the samples with an average reading of 1.51mg/L. The high reading was 1.87mg/L. The site exceeded the **total phosphorus** threshold twenty-five (25) percent of the samples with an average reading of .062mg/L. The site exceeded the **suspended solids** threshold twenty-five (25) percent of the samples with an average reading of 11mg/L.

Site #14

Site #14 is a High Sampling Site (HSS). It is located on the McClearly Gochenour Ditch before it joins the main tributary of Deeds Creek., All four HSS samples taken at this site tested above the target for **E. Coli** with an average of 1096 cfu/100mL.

Site #14 exceeded the **nitrate** target threshold one hundred (100) percent of the samples with an average reading of 4.51mg/L. The high reading was 6.25mg/L. The site exceeded the **total phosphorus** threshold twenty-five (25) percent of the samples with an average reading of .050mg/L. The site exceeded the **suspended solids** threshold zero times with an average reading of 5mg/L.

Site #20

Site #20 is a stormwater outfall that flows to a tributary of Pike Lake. The tributary is a small pond just south of Pike Lake. There is a short channel that connects the pond to the lake. Eighty (80) percent of the samples taken for **E. coli** tested above the threshold for E. coli, averaging 739 cfu/100mL.

Site #20 did not exceed the **nitrate** target threshold. The site had an average reading of .65mg/L. The site exceeded the **total phosphorus** threshold one hundred (100) percent of the samples with an average reading of .430mg/L. The site exceeded the **suspended solids** threshold thirty-five (33) percent of the samples with an average reading of 223 mg/L and the highest reading being 788mg/L.

Summary

Pike Lake – Deeds Creek Subwatershed has a mix of pollutants from both the agriculture sector and urban influences, especially Deeds Creek. Although the urban area cannot be ignored for its part in adding pollutants, the agriculture influence is substantially larger based on contributing acres and miles of waterway. Pollutants are seen in the consistently high sample readings for nitrates and phosphorus and to a lesser extent suspended solid in bi-weekly and HSS samples. Deeds Creek had the highest nitrates in the watershed. The CQHEI noted all three of the streams sampled, Deeds, Lones, and Heeter lacked features that would improve habitat and health of the waters.

E. coli is also a persistent problem in the Pike Lake – Deeds Creek Subwatershed for all sample locations, urban and agriculture.

There are over seven miles of waterways that need buffer strips divided between urban and agriculture. Reducing the miles in urban areas would be relatively easy with public education as the buffer need not be as wide and the education centers more on landscaping practices.

The health of Pike Lake is a real concern with over forty miles of streams entering the lake. The pollutant concentrations entering the lake through Deeds Creek at .118mg/L total phosphorus and exiting the lake through its only exiting tributary (Lones Ditch, Site #2) at .044mg/L total phosphorus is a concern for the on-going health of a viable urban lake that is used for recreational purposes.

McCarter Ditch – Deeds Creek Subwatershed

McCarter Ditch – Deeds Creek Subwatershed is the smallest subwatershed with only 11352 acres. It is overwhelmingly agriculture with seventy-four (74) percent cropland, six (6) percent pastureland, and thirteen (13) percent forest. The subwatershed has just seven (7) percent urban land use which includes the Town of Pierceton.

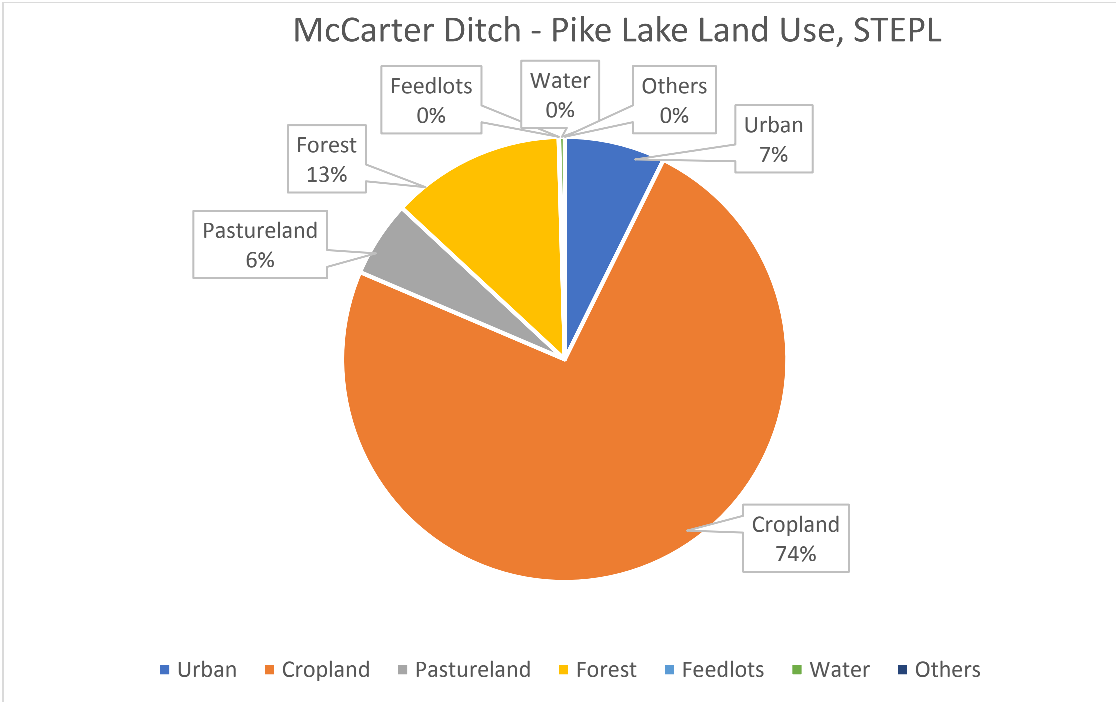


Figure 48 Land Use McCarter Ditch - Deeds Creed Subwatershed, STEPL 2018

Waterways

The McCarter Ditch – Deeds Creek Subwatershed has three waterways. Deeds Creek, Van Curen Ditch (also flows into Deeds Creek), and Guy Ditch (Figure 54).

McCarter Ditch - Deeds Creek													
Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Deeds Creek	No Public Access									No	E.Coli	11	uk
Van Curen Ditch	No Public Access									No	E.Coli	9.4	uk
Guy Ditch	No Public Access									No	E. coli	2.5	uk

Table 14 Waterways in the McCarter Ditch - Deeds Creek Subwatershed

Guy Ditch is an open waterway that is approximately two and one-half (2 ½) miles long. It is at the southeast corner of the subwatershed in Whitley County. It is an isolated waterway that does not connect to other waters in the subwatershed.

Van Curen Ditch has over nine (9) miles of open waterway and ten (10) miles of tiled waterway. Van Curen Ditch discharges into Deeds Creek before leaving the subwatershed.

Deeds Creek has eleven (11) miles of open waterway and an additional seven (7) miles of tiled waterway. All the water in the Deeds Creek subwatershed flows into Deeds Creek except Guy Ditch before leaving the subwatershed.

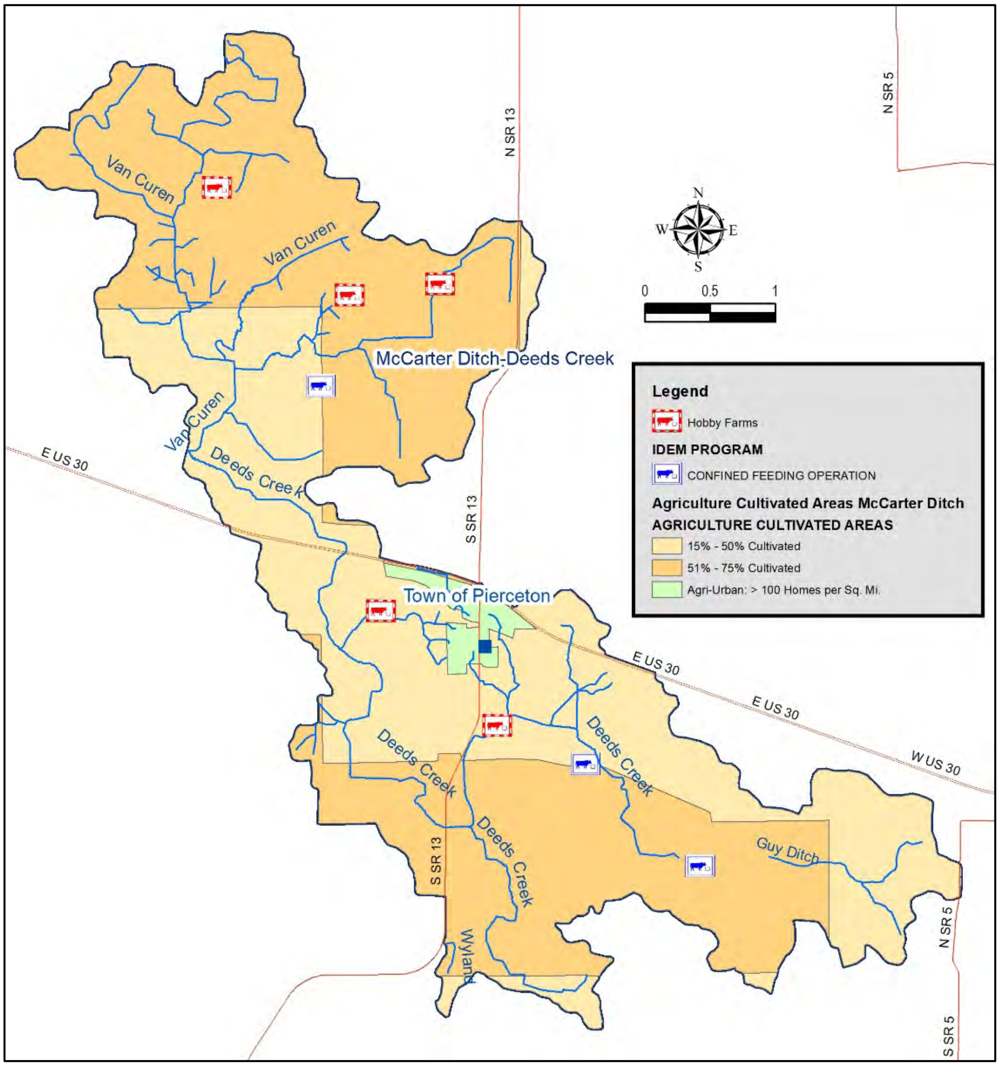


Figure 49 Land Use & Field Survey McCarter Ditch - Deeds Creek Subwatershed

Agribusiness

Agribusiness is important in McCarter Ditch – Deeds Creek Subdivision. Animal operations total three (3) CFOs and an additional five (5) other pasture operations identified during the field survey and labeled “hobby” in Figure 54, but may or may not be business operations. These farms are not large enough to be “permitted” by IDEM but may still be large animal operations that could use additional Best Management Practices (BMPs) to protect water quality.

The field survey also yielded six (6) miles of waterways in need of buffers. These waterways are mapped in Figure 55.

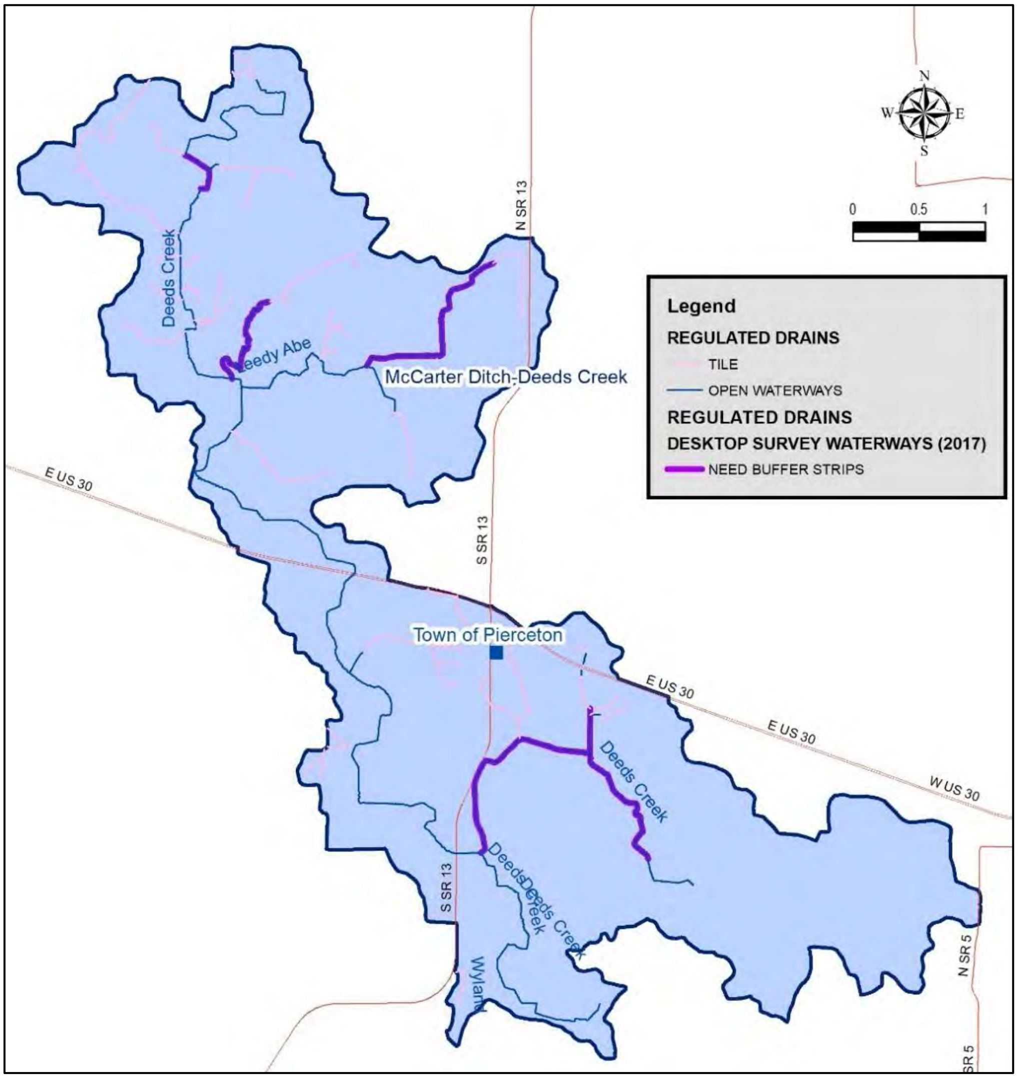


Figure 50 Waterways in Need of Buffer Strips in the McCarter Ditch - Deeds Creek Subwatershed

Urban Development Influences

The Town of Pierceton is in the McCarter Ditch – Deeds Creek Subwatershed (Map 12). It has a population of approximately 1,000 people as counted in the 2014 census. The Town has a municipal water and wastewater plants, and a stormwater system all that all drain to Deed's Creek. There is an NPDES drinking water permit for the water plant (back flushing of the screens) and the wastewater treatment facility. There are some sites that are industrial, commercial, and small retail shopping. The manufacturing in Pierceton is significant enough to require a pre-treatment program for wastewater users. The largest manufacturers are located off US 30 where they have ready access to Warsaw and Fort Wayne markets. Given the location to the highway and the available undeveloped property in the area, it is reasonable to expect that the number of manufacturing operations within the area will increase, especially if there is the opportunity for wastewater treatment access. There are small retail and small commercial locations in the Town itself. The Town has a stormwater system that drains to Deeds Creek.

Through the desktop survey, sites were identified (Figure 56) that could be sources of pollutants in the watershed. The subwatershed has two (2) leaking underground storage tanks, one (1) brownfield, one (1) NPDES sanitary sewer discharge point, and one (1) NPDES discharge for the Town of Pierceton Water Plant. IDEM permitted NPDES facilities are listed in Table 15.

Walnut Creek - Tippecanoe River Watershed NPDES Facilities						
Facility Name	**Description**	**Permit Status**	**Discharge Water Body**	**Outfall Type / Ownership**	**Specific Type**	**Subwatershed**
Pierceton Water Department	Municipal or Water District	Effective / Non-Compliant 2017	Tributary to Deeds Creek	Direct Discharge	Water (Filter Flushing)	McCarter Ditch - Deeds Creek
Pierceton WWTP	Municipal or Water District	Effective / Non-Compliant 2013. 2015. 2016, 2017	Deeds Creek	Direct Discharge	Wastewater	McCarter Ditch - Deeds Creek
Information compiled for the Walnut Creek - Tippecanoe River Watershed Desktop Survey 2017 Non-compliance listed for last 4 years. May not be all-inclusive.						

Table 15 NPDES Facilities McCarter Ditch - Deeds Creek Subwatershed

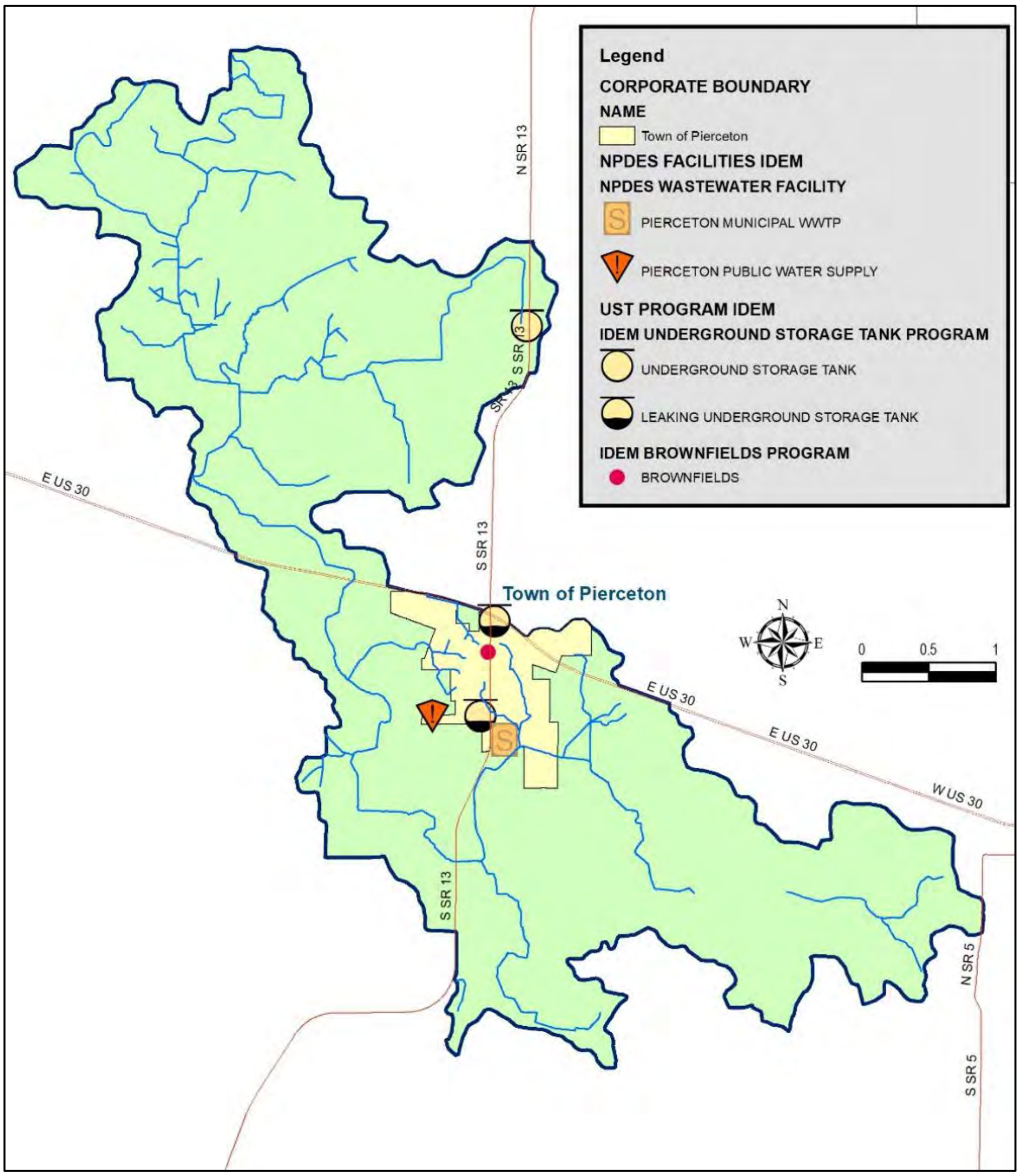


Figure 51 Potential Industrial & Commercial Pollution Sites McCarter Ditch - Deeds Creek Subwatershed

Indiana Department of Environmental Management records indicate that the Town has struggled with NPDES permit compliance. Table 15 lists the NPDES permitted sites by type and location. This noncompliance is a concern for the watershed as the receiving body is Deeds Creek and ultimately Pike Lake. Records indicate as recently as February 23, 2017, IDEM conducted an inspection of Pierceton's Wastewater Treatment facility and found multiple notable violations. The most concerning of these stated on the report, "The Effluent Appearance Portion generated an unsatisfactory rating. At the time of the inspection, the effluent contained some visible pin floc and solids. This is a violation of Part I. A. 2 of the permit which prohibits the discharge from all point sources specified within this permit from causing the receiving waters to contain substances, materials, floating debris, oil, or scum: (1) that will settle to form putrescent or otherwise objectionable deposits; (2) that are in amounts sufficient to be unsightly or deleterious; or (3) which are in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such a degree as to create a nuisance, be unsightly, or otherwise impair the designated uses." In total, the inspector rated the plant operations as marginal, maintenance as unsatisfactory, the laboratory as unsatisfactory, and a pre-treatment program as unsatisfactory. This event was not been the first time that the wastewater treatment plant had been cited for compliance issues. As of 2017, the wastewater treatment facility was under reconstruction

Sampling Data

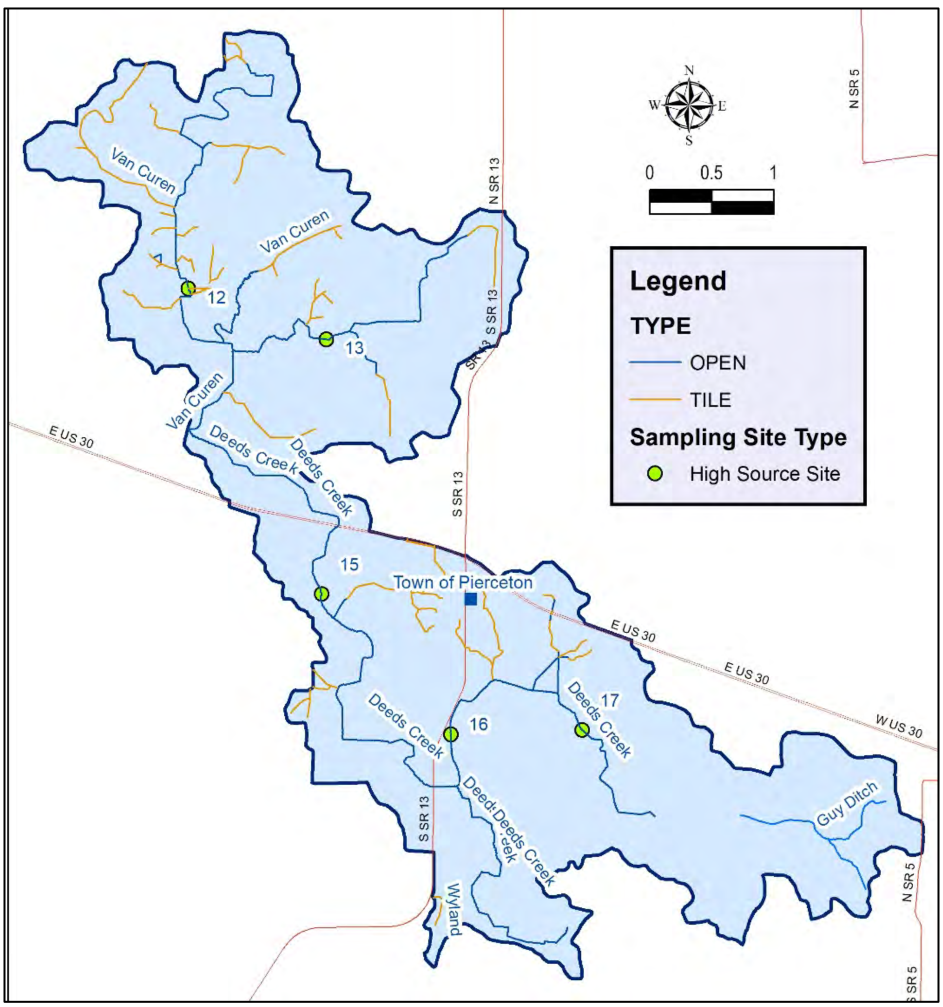


Figure 52 Waterways (Open & Tiled) & Sampling Sites McCarter Ditch – Deeds Creek Subwatershed

There were no bi-weekly sampling sites selected in this subwatershed for the first year of monitoring, and biological or habitat assessments were conducted. However, after the first year of sampling Deeds Creek was identified as a source of high pollution levels so Sites #12, 13, 15, 16, and 17 were selected for additional testing and labeled High Source Sites (HSS). Each site was then sampled four (4) times each during the second year.

E. coli Sampling in the McCarter Ditch - Deeds Creek Subwatershed					
		E. coli			
Site #	Waterbody	Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL
12	Van Curen Ditch	783	>2419	30	75%
13	Van Curen Ditch	1117	>2419	435	100%
15	Deeds Creek	807	>2419	210	75%
16	Deeds Creek	1416	>2419	225	75%
17	Deeds Creek	1864	>2419	200	75%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.					

Table 16 E. coli Sampling in the McCarter Ditch - Deeds Creek Subwatershed

Sampling Data in the Ruple Ditch - Tippecanoe River Subwatershed												
	Nitrates (NO3)				**Total Phosphorus**				**Suspended Solids**			
Site #	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
12	1.35	2.10	0.93	25%	0.070	0.120	0.017	75%	6	6	2	0%
13	2.58	3.25	1.98	100%	0.136	0.189	0.043	75%	17	36	6	25%
15	3.60	4.11	3.20	100%	0.170	0.198	0.096	100%	11	27	0	25%
16	5.71	7.66	3.93	100%	0.540	0.906	0.289	100%	10	26	2	0%
17	3.47	5.29	1.29	75%	0.140	0.167	0.115	100%	30	50	7	50%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.												

Table 17 Sampling Data in the McCarter Ditch - Deeds Creek Subwatershed

Site #12

Site #12 is a High Sampling Site (HSS). It is located on the Van Curen Ditch. The Van Curen Ditches flow to the main tributary of Deeds Creek before flowing into the Pike Lake - Deeds Creek Subwatershed. Seventy-five (75) percent of the HSS samples taken at this site tested above the target for **E. Coli** with an average of 789cfu/100mL.

Site #12 exceeded the **nitrate** target twenty-five (25) percent of the samples with an average reading of 1.35mg/L. The site exceeded the **total phosphorus** threshold seventy-five (75) percent of the samples with an average reading of .070mg/L. The site exceeded the **suspended solids** threshold zero times with an average reading of 6mg/L.

Site #13

Site #13 is a High Sampling Site (HSS). It is located on the Van Curen Ditch. The Van Curen Ditches flow to the main tributary of Deeds Creek before flowing into the Pike Lake - Deeds Creek Subwatershed. One hundred (100) percent of the HSS samples taken at this site tested above the target for **E. Coli** with an average of 1117cfu/100mL.

Site #13 exceeded the **nitrate** target one hundred (100) percent of the samples with an average reading of 2.58mg/L. The site exceeded the **total phosphorus** threshold seventy-five (75) percent of the samples with an average reading of .136mg/L. The site exceeded the **suspended solids** threshold twenty-five (25) percent with an average reading of 17mg/L.

Site #15

Site #15 is a High Sampling Site (HSS). It is located on Deeds Creek (Figure 57). Seventy-five (75) percent of the HSS samples taken at this site tested above the target for **E. Coli** with an average of 807cfu/100mL.

Site #15 exceeded the **nitrate** target one hundred (100) percent of the samples with an average reading of 3.60mg/L. The site exceeded the **total phosphorus** threshold one hundred (100) percent of the samples with an average reading of .170mg/L. The site exceeded the **suspended solids** threshold twenty-five (25) percent with an average reading of 11mg/L.

Site #16

Site #16 is a High Sampling Site (HSS). It is located on Deeds Creek (Figure 57). Seventy-five (75) percent of the HSS samples taken at this site tested above the target for **E. Coli** with an average of 1416 cfu/100mL.

Site #16 exceeded the **nitrate** target one hundred (100) percent of the samples with an average reading of 5.71mg/L. The site exceeded the **total phosphorus** threshold one hundred (100) percent of the samples with an average reading of .540mg/L. The results at this site did not exceed the **suspended solids** threshold.

Site #17

Site #17 is a High Sampling Site (HSS). It is located on Deeds Creek (Figure 57). Seventy-five (75) percent of the HSS samples taken at this site tested above the target for **E. Coli** with an average of 1864 cfu/100mL.

Site #17 exceeded the **nitrate** target seventy-five (75) percent of the samples with an average reading of 3.47mg/L. The site exceeded the **total phosphorus** threshold one hundred (100) percent of the samples with an average reading of .140mg/L. The site exceeded the **suspended solids** threshold fifty (50) percent with an average reading of 30mg/L.

Winona Lake – Eagle Creek Subwatershed

The Winona Lake – Eagle Creek subwatershed (Map 13) has 20,554 acres. It is the largest subwatershed in the watershed. It is divided into approximately sixty-five (65) percent cropland, three (3) percent pastureland, fifteen (15) percent forest, and thirteen (13) percent urban (Figure 58). Although, Cropland at sixty-five (65) percent is not the largest percentage in all the subwatersheds, the acreage is the largest acreage of cropland at 13,380 acres, making it important to include in any pollutant reduction strategy.

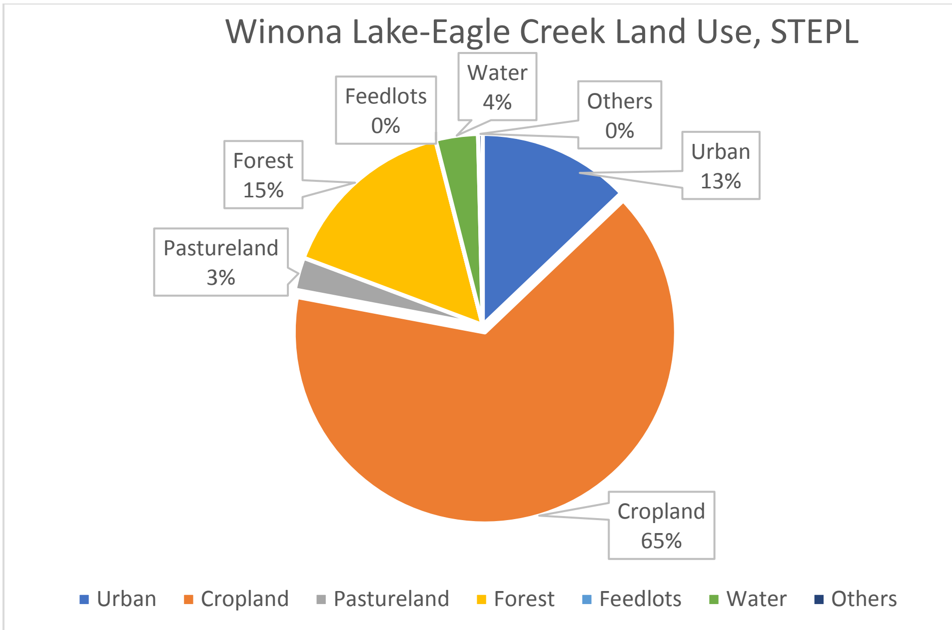


Figure 53 Land Use Winona Lake - Eagle Creek Subwatershed, STEPL 2018

Waterways

There are seventy-five (75) miles of regulated drains in the subwatershed. Winona Lake – Eagle Creek Subwatershed is mapped in Figure 59. There is thirty-nine (39) open miles of streams and thirty-five (35) miles of tiled waterways. The regulated drains are comprised of 3 main trunk lines Wyland Ditch (also known as Cherry Creek), Keefer – Evans Ditch, and the Martin Peterson ditch. All the waterways in the Winona Lake – Eagle Creek Subwatershed drain into Winona Lake. In addition, there are eleven (11) lakes in the subwatershed. Only one (1), however, has public access, Winona Lake.

Impaired Waters

There is one lake listed on the 2016 IDEM 303(d) List of Impaired Waters, Winona Lake. It is polluted with PCBs and Mercury, both legacy industrial pollutions. Mercury, however, is still a by-product from local industrial activity. Dalton Corporation still discharges Mercury through IDEM permitted air discharges. Air pollution becomes water pollution when the air particles combine with rainfall.

Streams

There are three streams in the subwatershed, Wyland Ditch, Keefer – Evans Ditch, and Martin Peterson Ditch. Wyland Ditch has 19 miles of open water, Keefer – Evans Ditch has six (6) miles of open waterway, and Martin Peterson Ditch has fifteen (15) miles of open water. Waterways are mapped in Figure 59. Waterways play a significant role in draining agricultural land. Wyland Ditch and Martin Peterson Ditch both drain extensive acreage in the subwatershed. Keefer – Evans plays a more isolated role in the middle of the subwatershed.

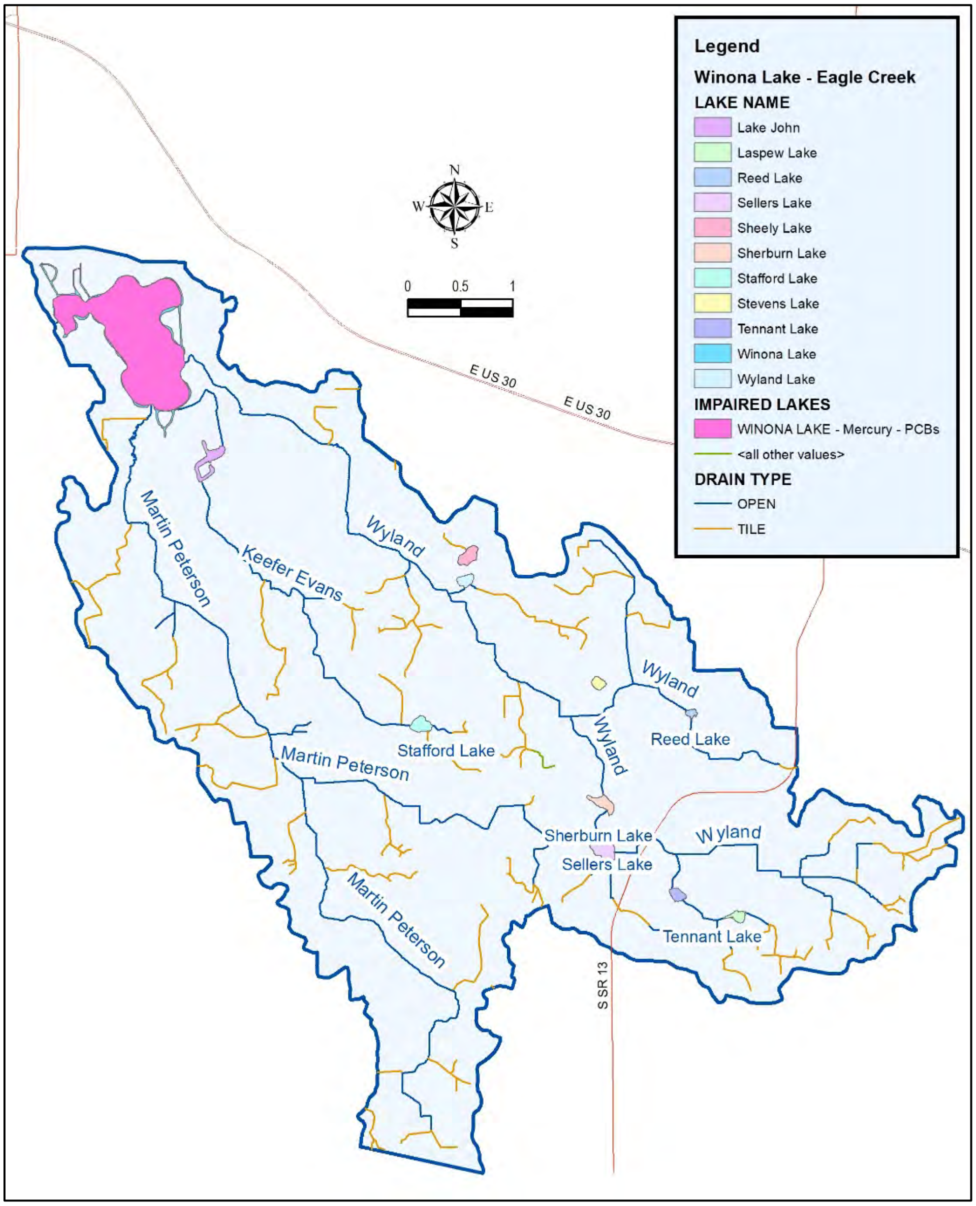


Figure 54 Waters & Impaired Waters in the Winona Lake - Eagle Creek Subwatershed

Lakes

Winona Lake is by far the largest of the lakes (Figure 58) in the subwatershed. It measures approximately 20 times the size, in acres, as the next largest lake. It is also the only public lake in the subwatershed. It lies at the confluence of the subwatershed. Only three of the lakes have data from the Indiana Clean Lakes Program.

Winona lake is 90% developed with mostly concrete seawalls that are not absorbent of wave energy in the lake, as well as mowed turf grass at the water edge where shallow root systems are unable to prevent erosion and withstand wave action. Winona Lake has seawalls that are a mix of wooded riparian buffer, stone, and concrete seawall. Concrete seawall makes up approximately 60 % of the armored seawall. Approximately 30% of the properties have stone at the water's edge with the remaining a mix of eroded shoreline and wooded riparian buffer. The approximately 7,000 lineal feet of eroded shoreline on Winona Lake will continue to worsen without at least a change in management practices and may also need to be fortified with engineered and permit solutions to stop the loss of property into the lake.

Winona Lake - Eagle Creek Subwatershed													
Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Wyland Ditch	N/A										None Listed	19	uk
Keefer - Evans Ditch	N/A										None Listed	6	uk
Martin Peterson Ditch	N/A										None Listed	15	uk
Winona Lake	Kiwanis Park Warsaw	Yes	No	Yes	Yes	Yes	None	Yes	No	Yes	Pcbs, Total Mercury, Common Carp 26+", White Bass 16+"	571	79
Winona Lake	Winona Lakes Limitless Park	Yes	Yes	Yes	Yes	Yes	None	Yes	No	Yes			79
Winona Lake	Kosciusko County Fairgrounds	Yes	No	Yes	No	Yes	None	Yes	Yes	Yes			79
Laspew Lake	No Public Access										None Listed	8.4	uk
Tennant Lake											None Listed	8.8	8
Sellers Lake											None Listed	26.6	21
Sherburn Lake											None Listed	14	uk
McPherson Lake											None Listed	6.7	uk
Stevens Lake											None Listed	7.6	uk
Reed Lake											None Listed	4.1	4
Wyland Lake											None Listed	9.1	38
Sheely Lake											None Listed	14.4	uk
Lake John											None Listed	23	uk

Table 18 Waterways in the Winona Lake - Eagle Creek Subwatershed

Data for Winona Lake from the Indiana Clean Lakes Program shows that Winona Lake Tropic Indices have remained relatively stable with a slight trend upward in the 2016-2018 years. Additional recording will tell whether it is a trend or normal fluctuation. Data in included in Table 19 & Figure 60.

Indiana Clean Lakes Program - Trends for Carlson Trophic Indices for Center Lake										
Waterbody	2011	2012	2013	2014	2015	2016	2017	2018	Trend - Stable (S), Fluctuating (F), Degrading (D), Unknown (U)	Trophic Status - Oligotrophic (O), Mesotrophic (M), Eutrophic (E), Hypereutrophic (H)
Winona Lake		54	66	51	60	52	56	59	S	E
Yellow shaded areas have no data for that year.										

Table 19 Indiana Clean Lakes Program Results for Winona Lake

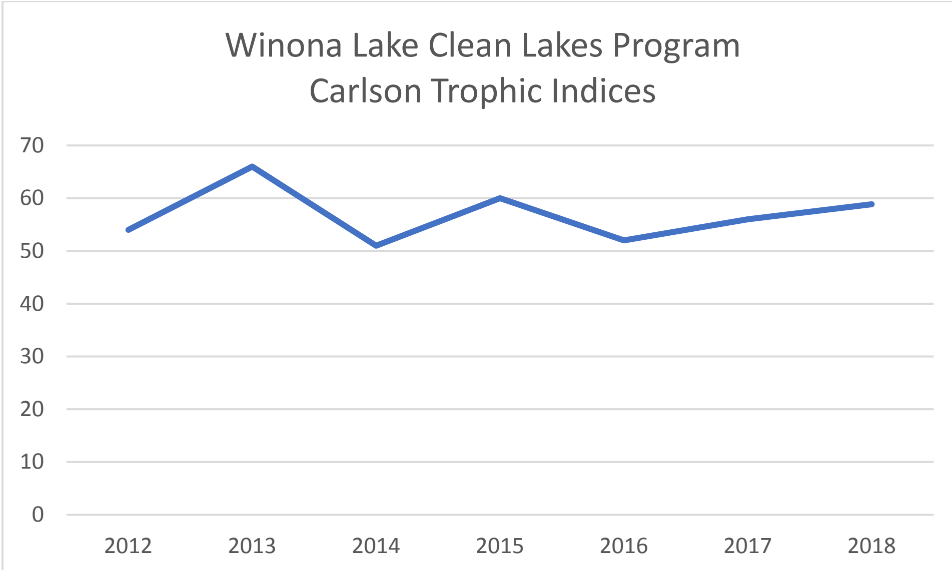


Figure 55 Winona Lake Clean Lakes Program Data Trends

Winona Lake Preservation Association

Winona Lake has a lake association of residents and businesses along the Winona Lake, Winona Lake Preservation Association. The Association is generally well funded and made up of people who truly care about the lake and "lake living.". They are successful in providing aquatic weed control, supporting studies to become informed of water quality problems and potential solutions, but they have not been as successful in completing many projects that reduce pollutants coming into the lake, as it is difficult to coordinate projects that must occur with other landowner partners. The National Resource Conservation Service (NRCS) and the Kosciusko Soil & Water Association (SWCD) has been partners but additional assistance in the way of coordination, management, and implementation of project-based solutions would increase the success in completing projects that make changes to improve water quality. This support would enable them to begin reducing the sedimentation and pollutants coming into the lake one project at a time.

Several management and engineering studies have been done for Winona Lake most notably a 1999 study for stabilization of Peterson Ditch done by Steve Gough from Little River Research & Design, a 2000 Wyland Ditch -Winona Lake Feasibility Study done by JF New, and a 2013 Engineering Feasibility Study of Wyland Ditch by Davey Resource Group to examine possible project sites to provide stabilization and reduce the sedimentation from Wyland Ditch, Cherry Creek.

The 1999 study included a short list of actionable areas to focus on in Peterson Ditch generally with planting of woody species and other bank stabilization activities. The Wyland Ditch report from 2013 provided comparative information and data on all three ditches, Wyland, Keefer-Evans, and Peterson and then recommended a project list with specific pollution reduction goals, noting that not all projects may be feasible, depending on landowner participation.

The 2013 study concluded that "approximately equal amounts of non-point source pollution (mostly sediment and nutrients) originates from the Peterson Ditch and the Wyland Ditch watersheds." The study further concluded that Peterson Ditch had unstable streambanks that undergoing significant erosion. The Keefer – Evans Ditch was the origination of the largest nutrient influx. Lawn fertilizer from "urban riparian areas" were determined to be the cause.

The study developed a recommended project list to reduce sediment entering Winona Lake from Wyland Ditch.

Project 1 - Streambank Stabilization at Winona Lake Park – Completed Summer 2018

Project 2 - Wyland Ditch Floodplain Reconnection

Project 3 - Streambank Stabilization and Vegetative Buffer at Stonehenge Golf and Country Club

Project 4 - Wetland Creation at the Camdon Property near Pierceton

Project 5 - Wetland Creation at a field of hydric soils in the middle of the Wyland watershed

Sellers Lake

Sellers Lake is a private lake in the subwatershed. In 2005 and 2006 it rated near the hypereutrophic index level. There is no additional data for that lake. It is a lake of concern that also has a concentrated multi-family septic system adjacent to the lake, the Sellers Lake Mobile Home Community.

Agribusiness

Agriculture is an important part of the Winona Lake – Eagle Creek Subwatershed. The field & desktop surveys of the subwatershed found seven (7) non-permitted "hobby" farms or animal operations. There is also four (4) IDEM Permitted Confined Feeding Operations. All are mapped in Figure 61.

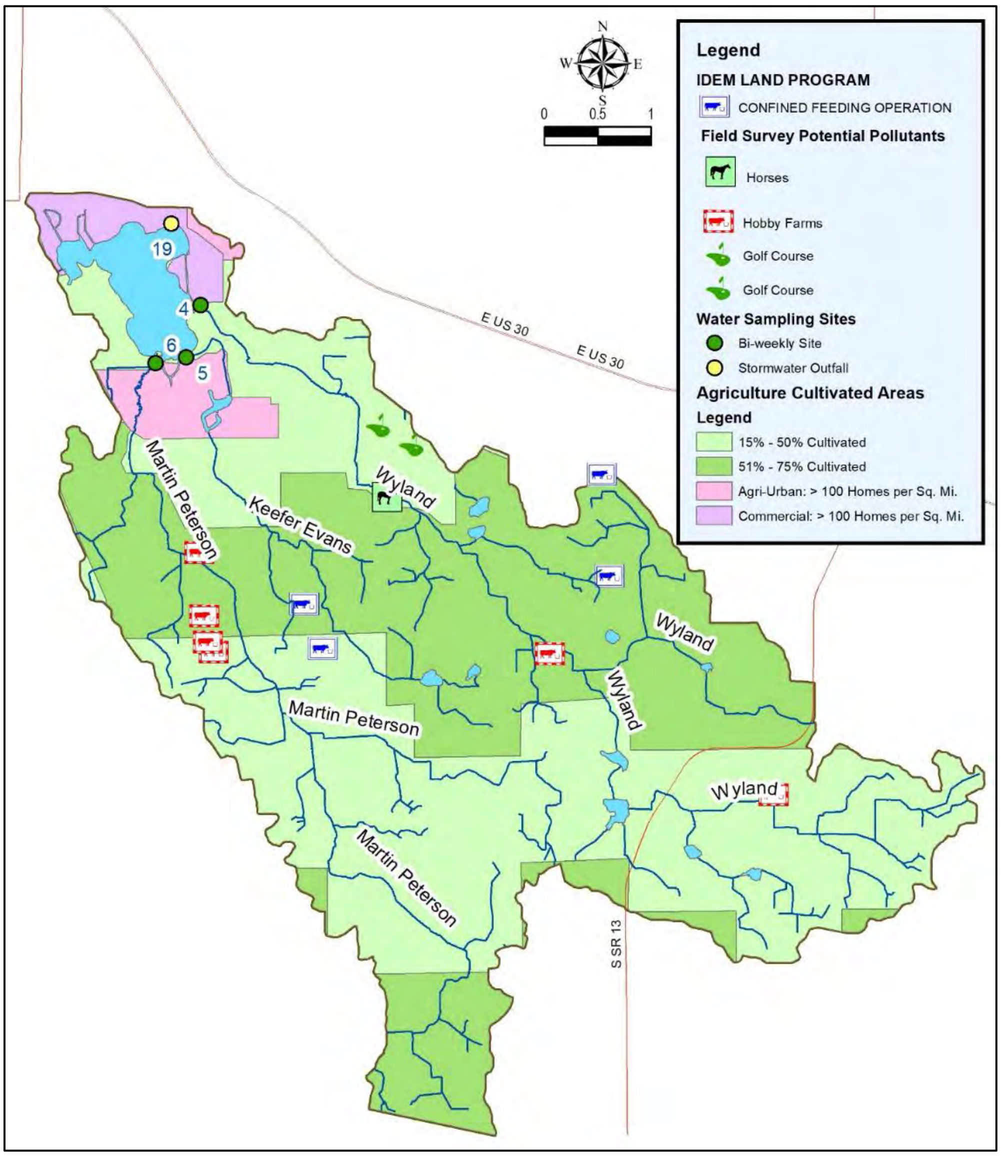


Figure 56 Agribusiness in Winona Lake - Eagle Creek Subwatershed

There were also areas identified where waterways need buffered. Approximately twelve (12) miles were identified as needing buffer strips (Figure 62). Buffering waters are particularly important in this subwatershed due to an abundance of highly erodible soils Figure 63. Erodible soils allow soil to be easily removed from unvegetated land or land that has a shallow root cover, such as "turf" grass. Bluegrass and other often "preferred" lawn grasses that require frequent mowing have a shallow root system, 3" or less. Shallow roots are less able to withstand unvegetated patches and open areas show as stream or ditch banks. The protection that roots provide only goes down 3 inches leaving the rest exposed to easy erosion.

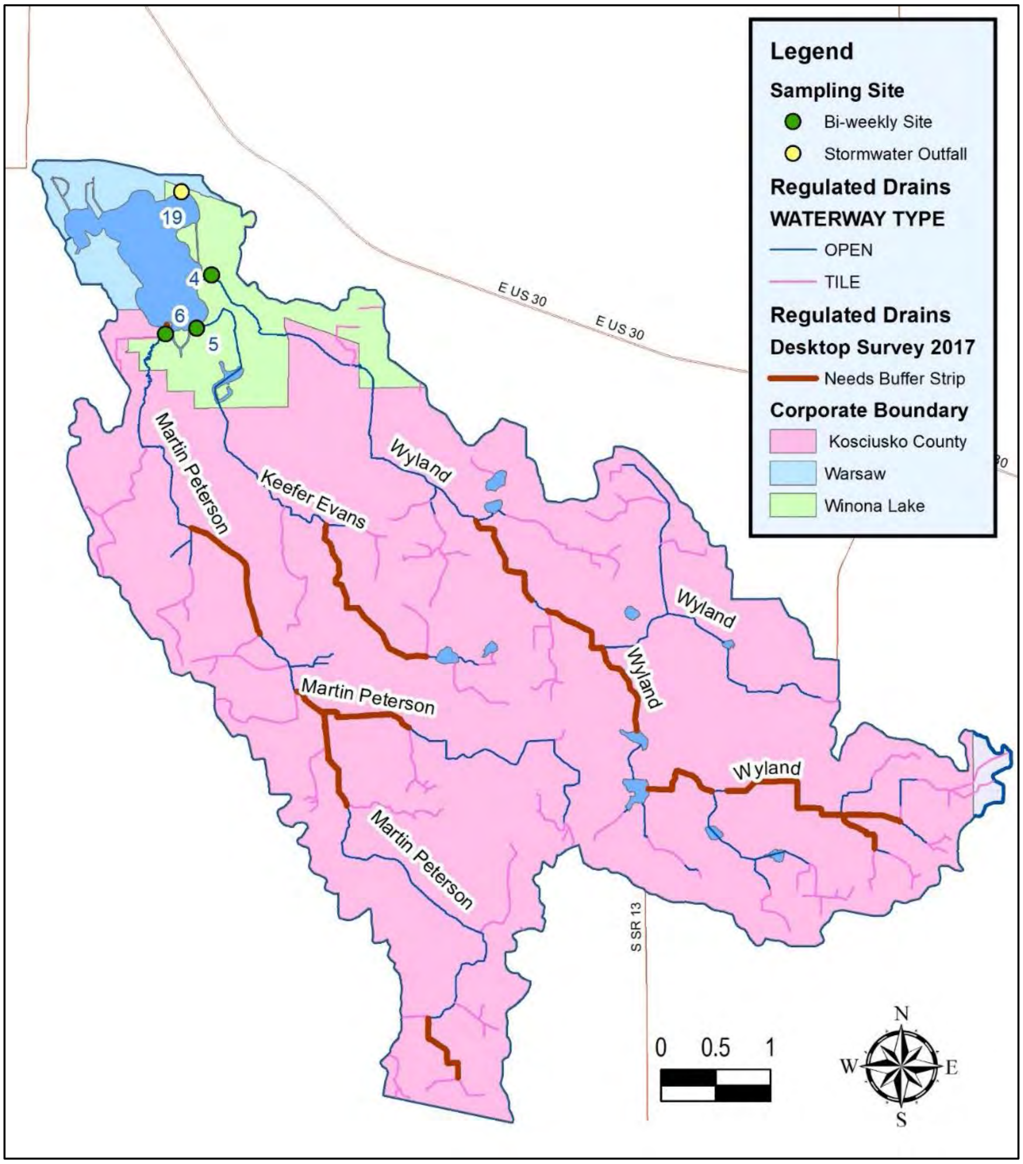


Figure 57 Waterways Needing Buffers Winona Lake - Eagle Creek Subwatershed

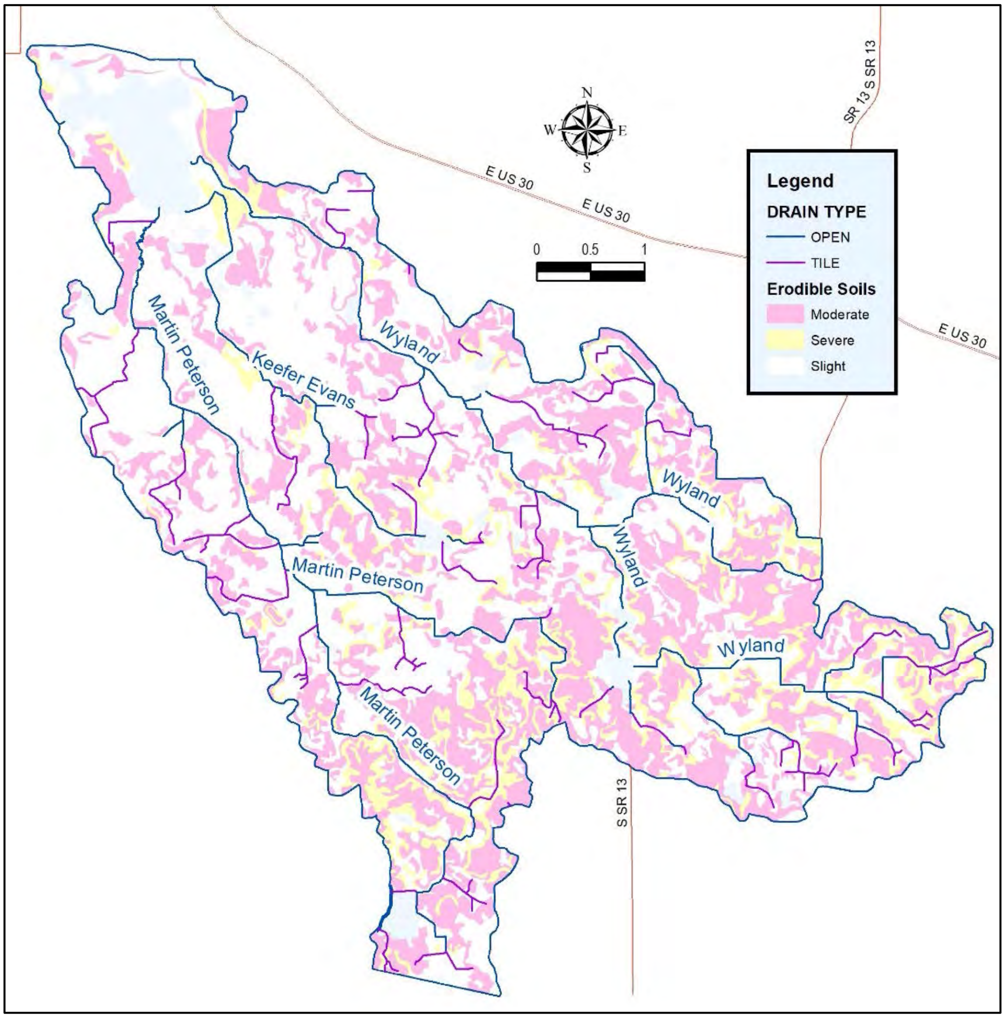


Figure 58 Erodible Soils Winona Lake - Eagle Creek Subwatershed

Industrial and Commercial Influences in the Winona Lake – Eagle Creek Subwatershed

Figure 64 illustrates the industrial and commercial influences in the Winona Lake – Eagle Creek subwatershed. Winona Lake has a history of receiving stormwater flows including from Warsaw (north and west of Winona), Town of Winona Lake (east of Winona), and many of the residents and businesses on the lake direct pipe their stormwater from roofs and foundation drains via their sump pumps into the lake. From the industrial side, Winona Lake has also been the receiving body of industrial discharges historically. In 1976, an EPA Region V Report, Working Paper No. 348, titled “Report on Winona Lake” reported four (4) storm sewers that discharge urban runoff and the discharges of infrequent and unquantified dairy wastes. The report also noted the Kosciusko County Fairgrounds as another source of nutrients from animal waste leaving the property through the sewer pipe. It is unclear currently if that problem is still present. The City of Warsaw provides wastewater treatment for restrooms at the fairgrounds. Septic settling tanks with an overflow to the lake may remain for the draining in the livestock areas. By 1976, Winona Lake residents and businesses were connected to Warsaw’s Wastewater Treatment Facility so septic systems were no longer a concern for the lake.

Since the 1976 report, there are additional industrial manufacturers that have contributed to pollution at Winona Lake, including toxins such as mercury that are still an airborne by product of manufacturing in the area and still settle into the lake, and (dumping done by local industrial and commercial businesses including those currently participating in voluntary remediation.) (Pollutants that have come from spills and leaks of industrial consumers, sediment from construction sites, spills and pollutants in parking lots and on streets, residential yard waste, and thermal pollution such as industrial NPDES permitted non-contact cooling water and runoff of parking lots, streets, and roofs in the summer time.) All these have been transported through the storm sewer system.

The only NPDES industrial facilities permitted for discharging in this subwatershed is Dalton Corp. (It is not pictured on the map because Dalton's physical address is in Pike Lake – Deeds Creek Subwatershed, however, Dalton discharges into Warsaw's stormwater sewer system that then discharges into Winona Lake. It has been and is a source of pollution into Winona Lake. It uses between 500,000 to 1,000,000 gallons of water a day that are released into the lake as non-contact cooling water. The water cools hydraulic lines that are filled with oil, some of which are vegetable and some of which are petroleum. When the closed system has a leak, the non-contact cooling water becomes contaminated with oil. The non-contact cooling water is also a source of thermal pollution. Dalton was granted a waiver by IDEM to release very warm water, winter temperature 90° F April – November and 80° F December - March, into Winona Lake. The current permit term expires in 2021. Dalton also releases mercury vapor and is permitted under IDEM's Air Quality Section.

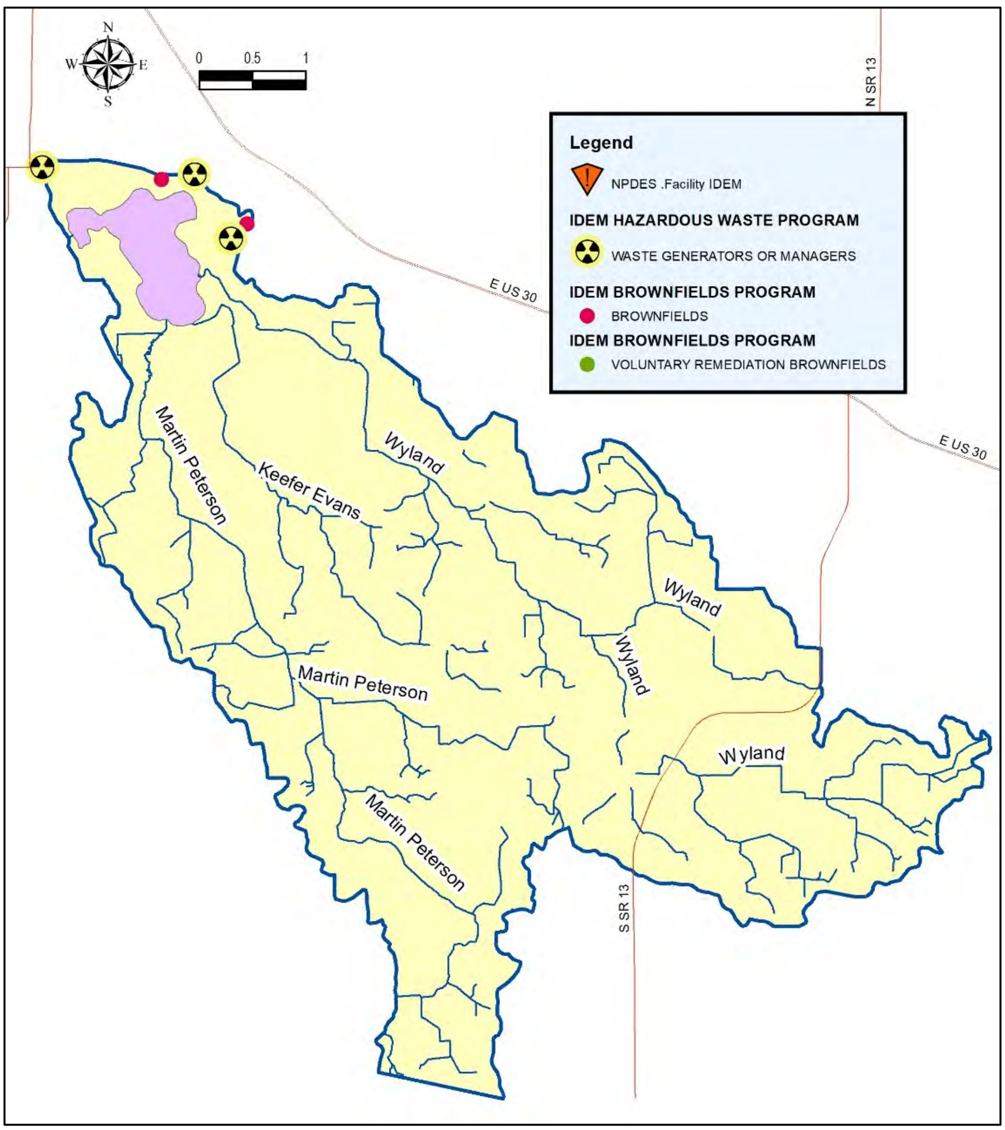


Figure 59 Potential Sources of Industrial Pollution Winona Lake - Eagle Creek Subwatershed

Sampling Data

There are three sampling sites in the Winona Lake -Eagle Creek Subwatershed. The Wyland Ditch (also known as Cherry Creek) site samples water coming from Wyland Ditch just before it enters Winona Lake. There is approximately 35 miles of Wyland Ditch. Keefer Evans Ditch (9 miles) and Martin Peterson Ditch (29 miles) are also both sampled just before they flow into Winona Lake.

E. coli Sampling in the Winona Lake - Eagle Creek Subwatershed					
		E. coli			
Site #	Waterbody	Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL
4	Wyland Ditch	354	>2419	28	42%
5	Keefer Evans	223	1986	9	26%
6	Peterson Ditch	723	>2419	21	54%
19	Outfall into Winona Lake	130	>2419	23	33%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.					

Table 20 E. coli Results in the Winona Lake - Eagle Creek Subwatershed

Sampling Data in the Winona Lake - Eagle Creek Subwatershed												
	Nitrates (NO3)				Total Phosphorus				Suspended Solids			
Site #	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
4	1.95	5.61	0.48	54%	0.072	0.544	0.014	22%	14	292	0	6%
5	0.96	3.86	0.09	24%	0.056	0.376	0.016	11%	11	162	0	4%
6	1.86	5.92	0.34	54%	0.090	0.738	0.013	25%	24	337	0	9%
19	0.30	0.74	0.00	83%	0.160	0.356	0.049	100%	237	679	3	50%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.												

Table 21 Nitrates, Total Phosphorus, Suspended Solids in the Winona Lake - Eagle Creek Subwatershed

Site #	Waterway	Sampling Site Type	**Influences:** Rural Residential (R), Agricultural (A), Urban (U), Lake (L), Wastewater Plant (WWTP)	Location Description
4	Wyland Ditch	Bi-weekly	A, R, U	Wyland Ditch east of Winona Lake, E of Park Ave, Winona Lake
5	Keefer Evans Ditch	Bi-weekly	A, L, R, U	Keefer Evans Ditch south of Winona Lake, 2002 Eastwood Rd, Winona Lake
6	Martin Peterson Ditch	Bi-weekly	A, R	Martin Peterson south of Winona Lake, 741 E Lakewood Ave, Warsaw
19	Outfall into Winona Lake	Stormwater Outfall	U	2400 Winona Ave. (STO-047-039)

Site #4

Site #4 is Wyland Ditch upstream of Winona Lake. Both dissolved oxygen and pH results fell within the target parameters for this site. The Citizen's Qualitative Habitat Evaluation Index (CQHEI) for this site was a fifty-five (55) which generally indicates the stream can attain "Warm Water Habitat" (WWH) biological communities, depending on which features (flow, depth) are lacking the biological communities may continue to fall short of the WWH classification.

Forty-two (42) percent of the samples taken at Site #4 were over the target threshold of 235 CFU/mL for **E. coli**. The average reading was 354 cfu/100 mL.

Site #4 exceeded the **nitrate** threshold of 1.5 ml/L fifty-four (54) percent of the samples taken with an average reading is 1.95 mg/L. The highest reading at this site was 5.61 mg/L.

Total Phosphorus also exceeded the target threshold. It exceeded the .076 mg/L target twenty-two (22) percent with a high of .511 mg/L.

Suspended Solids at Site #4 were elevated above the target threshold of 25 mg/L six (6) percent of the time with an average reading of 14 mg/L.

Site #5

Site #5 is Keefer – Evans Ditch upstream of Winona Lake. The Citizen's Qualitative Habitat Evaluation Index (CQHEI) for this site was a fifty-five (55) which generally indicates the stream can attain "Warm Water Habitat" (WWH) biological communities, depending on which features (flow, depth) are lacking the biological communities may continue to fall short of the WWH classification. Using Hoosier Riverwatch's methods of finding and counting macroinvertebrates, the site's Pollution Tolerance Rating was considered "good" to "excellent"

Site #5 exceeded the 235 cfu/mL **E. coli** target threshold twenty-six (26) percent of the time and had its average reading at 223 cfu/100 mL.

The **nitrate** testing yielded an average of 1.95 mg/L, only exceeding the 1.5 mg/L target threshold fifty-four (54) percent of the samples taken. **Total Phosphorus** exceeded the target threshold of .076 mg/L twenty-two (22) percent of the samples taken with an average sample reading of .072 mg/L. **Suspended Solids** exceeded the target of 25 mg/L six (6) percent of the samples with an average of 14 mg/L.

Site #6

Site #6, Peterson Ditch, downstream of Winona Lake. This site had a "poor" PTI rating. Its **CQHEI** was a forty-nine (49) generally indicating the stream can attain "Warm Water Habitat" (WWH) biological communities. The CQHEI noted a lack of riffles and runs with a score of 0 and generally scored poorly in all the other categories.

Site #6 had an average **E. coli** reading of 723 cfu/100mL, exceeding the target threshold fifty-four (54) percent of the time. Site #6 exceeded the **nitrate** threshold fifty-four (54) percent of the time with an average reading of 1.86mg/L. The highest nitrate reading was 5.92 mg/L. **Total Phosphorus** exceeded the target threshold of .076 mg/L twenty-five (25) percent of the samples with an average reading of .090 mg/L. **Suspended Solids** exceeded the target threshold nine (9) percent of the samples with an average of 24 mg/L.

Site #19

Site #19 is a 36" stormwater outfall that flows to Winona Lake. Thirty-three (33) percent of the samples taken for **E. coli** tested above the threshold for E. coli, averaging 130 cfu/100mL. The highest readings exceeded the testing limit of 2,419 cfu/100mL.

Site #19 did not exceed the **nitrate** target threshold. The site exceeded the **total phosphorus** threshold eighty-three (83) percent of the samples with an average reading of .16 mg/L and the highest reading of .356. The site exceeded the **suspended solids** threshold -fifty (50) percent of the samples with an average reading of 237 mg/L and the highest reading being 679 mg/L.

Overview

The Winona Lake – Eagle Creek Subwatershed

Eagle Creek – Walnut Creek Subwatershed

The subwatershed is 17,244 acres. It is the second largest next to Winona Lake – Eagle Creek Subwatershed. This part of the watershed contains the southern portion of Warsaw that extends south on SR 15 to a portion of 900 S. As the other subwatersheds in the Walnut Creek – Tippecanoe River Watershed, this subwatershed is heavily agriculture. Sixty-two (62) percent of the subwatershed is cropland, five (5) percent is pastureland, and sixteen (16) percent is forest. It is the second largest in cropland acres with 10,637 acres, the largest pasture acreage at 926 acres, and largest acreage of feedlots at 7 acres. This subwatershed also has a significant urban area at 2,602 acres, second only to Winona Lake – Eagle Creek at 2,647 acres. Figure 65 graphs the land use in the subwatershed.

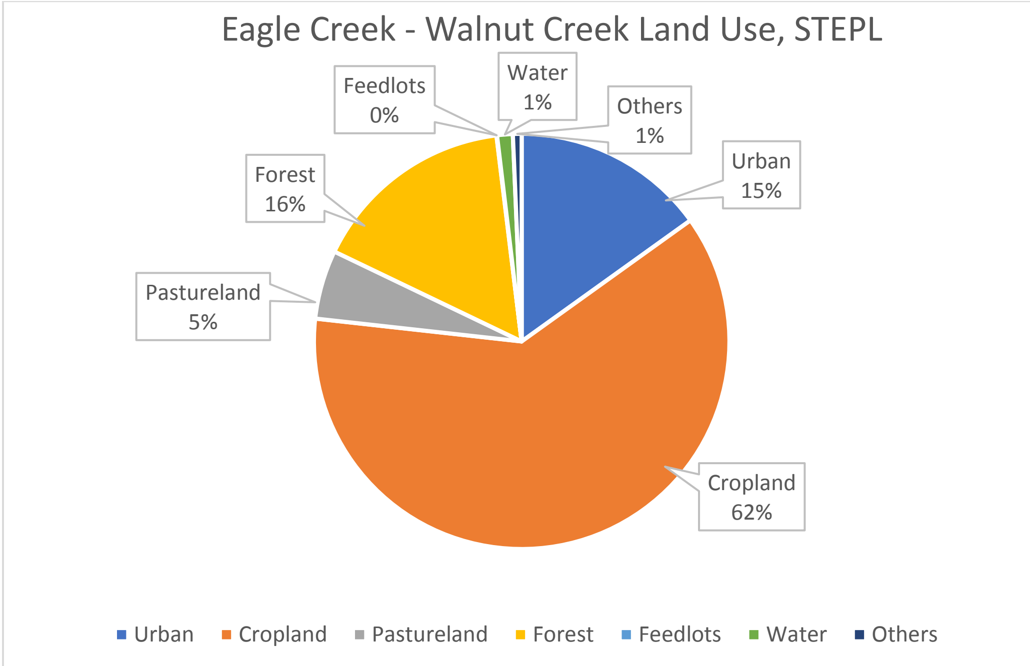


Figure 60 Land Use Eagle Creek - Walnut Creek Subwatershed

Waterways

There are two (2) main streams in the Eagle Creek- Walnut Creek Subwatershed, Eagle and Walnut Creeks (Figure 65). The subwatershed is also home to seven (7) small lakes, six (6) of them private. There are seven (7) lakes of note in this subwatershed; six (6) of them are private lakes with no public access. Table 22 list the major waters in the subwatershed.

Eagle Creek - Walnut Creek Subwatershed													
Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Eagle Creek	No Official Public Access Point, paddlers can access at Country Club Road or Logan Street										None Listed	1.5	uk
Walnut Creek	No Public Access										None Listed	27	uk
Schultz Lake	No Public Access										None Listed	7.2	uk
Tibbitts Lake											None Listed	9.4	uk
Carr Lake	East on CR 400S at SR 15 then south on Kinsey Rd. S, 1.1 mi	Yes	No	Yes	Yes	Yes	None	Yes	No	No	None Listed	80.1	35
Price Lake	No Public Access										None Listed	5.4	uk
Fish Lake											None Listed	17.3	uk
Muskellunge Lake											None Listed	31	21
Goose Lake											None Listed	27.7	53

Table 22 Waterways in the Eagle Creek - Walnut Creek Subwatershed

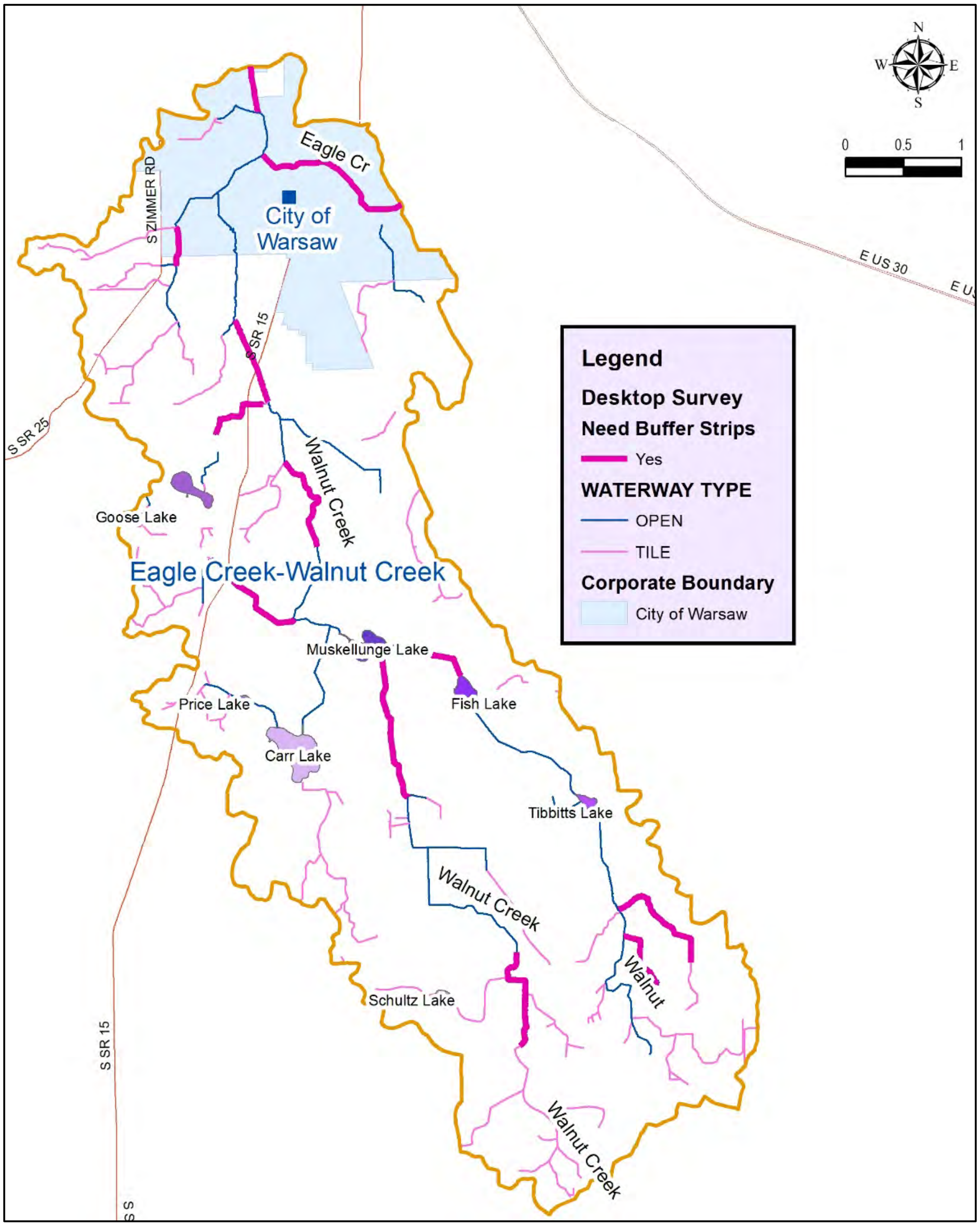


Figure 61 Waterways & Waters Needing Buffers in the Eagle Creek -Walnut Creek Subwatershed

Streams

There are approximately 29 miles of open streams & ditches in the Eagle Creek – Walnut Creek Subwatershed. Eagle Creek has 1.5 miles of open waterways and Walnut Creek has 27 miles. There is an additional 30 miles of tiles ditches. During the Desktop and Field surveys, six (6) miles of streams/ditches were identified as needing buffer strips (see Figure 65). Both tiled and open waters are important to the subwatershed for drainage of agricultural property, especially where it is concentrated in the southern part of the subwatershed.

None of the waters in this subwatershed are identified on the 2016 Indiana 303(d) List of Impaired Waters. That is not a definitive list, however, it could be that the waters in this subwatershed have not been evaluated. The northern most stretch of Walnut Creek before it joins the Ruple Ditch – Tippecanoe River Subwatershed has been an area of concern in the past when municipal dumping occurred in the early 2000s. In the northern portion of Walnut Creek is also where the combined sewer outfall (CSO) is for the City of Warsaw. Additionally, the desktop and field surveys identified ten (10) miles of buffer strips needed in this subwatershed (Figure 65).

Lakes

The Eagle Creek – Walnut Creek Subwatershed has seven (7) lakes that are sprinkled through the subwatershed, most of them are attached to Walnut Creek. All are private except Carr Lake.

Carr Lake

Carr Lake is the only lake that has a public lake in this subwatershed. It has a public access concrete boat ramp and offers fishing and paddling. The Indiana Clean Lakes Program calculates its TSI in the eutrophic category. The lake itself is not very large, 80 acres, making it vulnerable to degradation with smaller amount of pollutants. The Desktop and Field surveys identified almost two (2) miles of shoreline erosion in and around this lake.

There is a handful of single-family homes on the lake and most have evidence of shoreline erosion identified on the Desktop and Field Surveys. Carr Lake has two concentrated population septic systems, a campground and a mobile home community along with the single-family residences. Failing septic systems could pose potential pollution risk to the lake.

Carr Lake has a two channels/ditches feeding into it that have been human altered to become straight channels, opening them up for additional erosion concerns, of which there is erosion evidence. This is an agricultural area including row crop farming with inadequate buffers potentially adding sedimentation and nutrients to these lakes, as well. Carr Lake also has adjacent cattle grazing operation.

Muskellunge Lake

There is no previously collected data for Muskellunge other than a size of thirty–one (31) acres and a maximum depth of twenty-one (21) feet (Table 22). The Desktop and Field surveys indicated evidence of almost one (1) mile of shoreline erosion on the lake and ditch line erosion on the ditches that connect and transport water into the lake. Muskellunge also has a campground with a septic system that could be a source of pollution for the lake. Muskellunge is located on Walnut Creek. Water flows from Fish Lake then into Walnut Creek and then to Muskellunge Lake. From Muskellunge, it travels on to the City of Warsaw. The Creek shows evidence of human altering by straightening both entering and exiting Muskellunge Lake.

Goose Lake

Goose Lake is a private lake. It is approximately 28 acres and has a maximum depth of 53 feet. It is residentially platted with approximately eighty (80) percent being developed. It sits outside the current sanitary sewer system availability. It shows no obvious erosion areas in the desktop survey. Goose Lake lies to the west and just south of Warsaw. It connects to Walnut Creek through field tile before becoming open ditch and joining the trunkline of Walnut Creek and entering Warsaw.

Fish Lake

Fish Lake is a private lake with a single owner. A sign states that it is a protected conservation area. It is approximately 17 acres with an undocumented depth. The lake does not have obvious shoreline erosion. Most of the lake is surrounded with wetland. The adjacent property to the north is a confined feeding operation with pasture area. The manure stockpile and pasture area drain to a small pond that is directly connected by culvert to Fish Lake. Fish Lake is on Walnut Creek. Water flows from Walnut Creek then to Fish Lake and then on to Muskellunge Lake. The Creek shows evidence of human altering by straightening both entering and exiting Fish Lake.

Schultz, Tibbitts, and Price Lakes

Schultz (7.2 acres), Tibbitts (9.4 acres), and Price (5.4 acres) are the remaining lakes in this subwatershed. Schultz Lake is and its surrounding property are owned by the same owners. The lake is surrounded by a wetland. Schultz Lake is connected to Walnut Creek through field tile at the southern end of the subwatershed.

Tibbitts Lake has a single owner. There is one "hobby" farm of horses adjacent that drains to the lake. The shores of Tibbitts lake are divided among four (4) owners. Wetlands border fifty (50) percent of the shoreline. Walnut Creek flows through Tibbitts Lake and then on to Fish Lake. The Creek shows evidence of human altering by straightening both entering and exiting the lake.

Price Lake has a single owner. It is surrounded by wetland. It is connected by open straightened channel to Carr Lake as a part of Walnut Creek.

Agribusiness

Even as Warsaw housing continues to expand to the south, agribusiness is still an important part of the subwatershed (Figure 67). In this subwatershed, there are three confined feeding operations and significant row crop farming, especially in the southern half of the subwatershed. The field survey revealed an additional six large animal operations where animals were pastured. These included horses and cattle (Figure 67 & Table 23).

Walnut Creek - Tippecanoe River Animal Production Sites						
	Waterbody Drains to	Municipality	Regulatory ID or Alternate ID	IDEM Sub-program	layerName	Notes
Eagle Creek - Walnut Creek		Claypool	1446	CFOG	Confined Feeding Operations	
Eagle Creek - Walnut Creek	**Fish Lake**	Warsaw	262	CFOG	Confined Feeding Operations	Cattle, Pasture, Drains to Fish Lake
Eagle Creek - Walnut Creek		Claypool	1000	CFOG	Confined Feeding Operations	
Eagle Creek - Walnut Creek	**Tibbitts Lake**	Warsaw	N/A	N/A		Horses, Drains to Tibbitts Lake
Eagle Creek - Walnut Creek	**Walnut Creek**	Claypool	N/A	N/A		Cattle, drains to Walnut Creek
Eagle Creek - Walnut Creek	**Walnut Creek (tiled)**	Claypool				Cattle, drains to ditch and Walnut Creek Tile
Eagle Creek - Walnut Creek	**Walnut Creek**	Claypool	N/A	n/A		Farmette, Lg Animals
Eagle Creek - Walnut Creek		Claypool				Cattle, Non-CFO,Pasture, Drains to Carr Lake
Eagle Creek - Walnut Creek	**Walnut Creek**	Claypool				Fenced Lg Animals, Non-CFO

Table 23 Eagle Creek - Walnut Creek Animal Production Sites

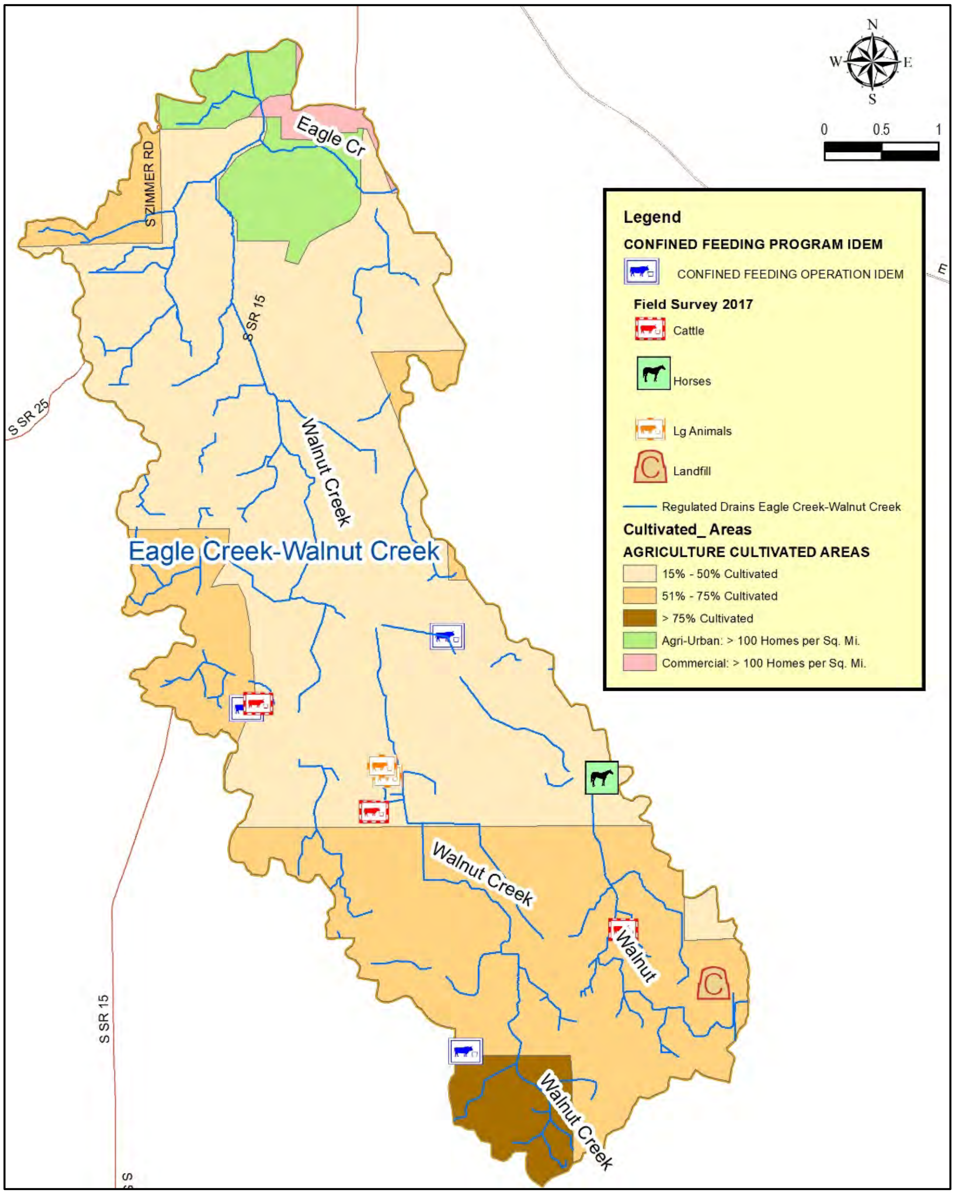


Figure 62 Agribusiness Eagle Creek - Walnut Creek Subwatershed

Urban Development Influences

This subwatershed includes a significant industrial area of Warsaw, including the City of Warsaw Street Department which straddles Walnut Creek and is adjacent to a wetland area at its north property boundary. The Street Department storage area on the west side of Walnut Creek is also the former City dump. The site was closed many years ago and was covered with soil, not clay capped, as that was customary at the time. The Street Department operations and offices are located on the east side of Walnut Creek. It has stormwater pipes that predominately are hooked to sanitary sewer; however, there are parking storm sewer pipes on the east side and additional storm sewer pipes in the northern-most shop that are still hooked onto the storm sewer that drains to the wetland. The City of Warsaw's Wastewater Treatment Plant #1 was also located at this address. It was the site of illegal sewage dumping and "treatment" by City workers in the early 2000s. Now the plant has been converted into combined sewage sewer overflow storage and a pump station to pump sewage to Plant #2 located in the Ruple Ditch – Tippecanoe River Subwatershed. The one remaining combined sewer overflow for the City remains here just south of Center Street and flows into Walnut Creek.

Additional historical dumping and pollution is are present in this subwatershed as it has a history of industrial use. Currently many industrial and commercial businesses operate in this subwatershed in the Warsaw Corporate boundary, including small businesses that are less likely to be aware of the environmental impacts of their businesses. The City of Warsaw operates Plant 1 of the Wastewater Treatment Facility. The combined sewer overflow discharge point is also beside that location. There are also two (2) brownfields in this subwatershed and one (1) voluntary remediation site. There are no underground storage tanks listed on IDEMS inventory.

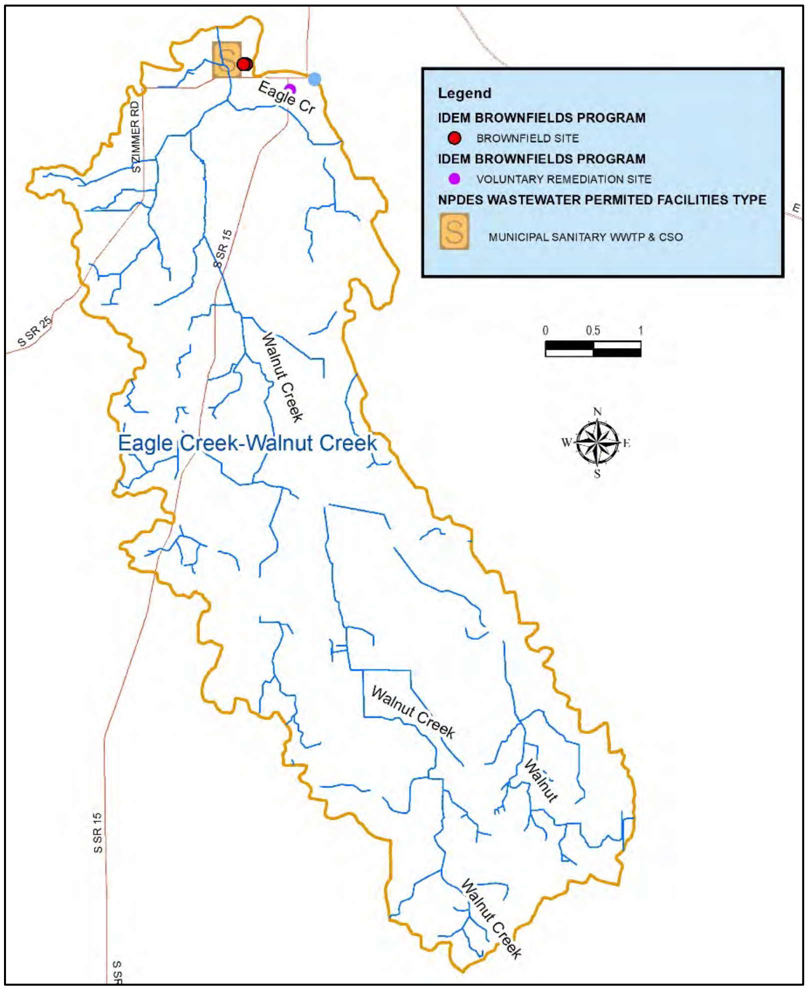


Figure 63 Sites of Potential Commercial & industrial Pollution in the Eagle Creek - Walnut Creek Subwatershed

1.1.48 Eagle Creek - Walnut Creek Sampling Data

There are two (2) bi-weekly sampling sites in this subwatershed (Sites #7 & 8) and one stormwater outfall (Site #18). One sampling site is Eagle Creek downstream of Winona Lake (Site#7). This site is a man-made channel with little vegetation where the water leaves the dam at Winona Lake. Its pollution tolerance rating was a fair /poor. In addition, its habitat CQHEI was a 45, mostly for lack of cover, human alteration, and lack of a buffer or riparian boundary.

The second site, (Site #8) is on Walnut Creek before merging with Eagle Creek. Site #8 tested low for dissolved oxygen. Site #8 also received a fair/poor PTI. Its habitat score was higher at a 66. It would benefit from the addition of riffles and runs as well as fish cover.

Site #	Waterway	Sampling Site Type	**Influences:** Rural Residential (R), Agricultural (A), Urban (U), Lake (L), Wastewater Plant (WWTP)	Location Description
7	Eagle Creek	Bi-weekly	A, L, R, U	Eagle Creek west of Winona Lake, 1109 Country Club Rd, Warsaw
8	Walnut Creek before Eagle Creek	Bi-weekly	A,R,U,	Walnut Creek south of Eagle Creek, 429 West Creek Dr, Warsaw
18	Outfall into Kelly Park Pond	Stormwater Outfall	U	Kelly Park, 130 Fawley St (STO-60-010)

Table 24 Sampling Site Descriptions Eagle Creek - Walnut Creek Subwatershed

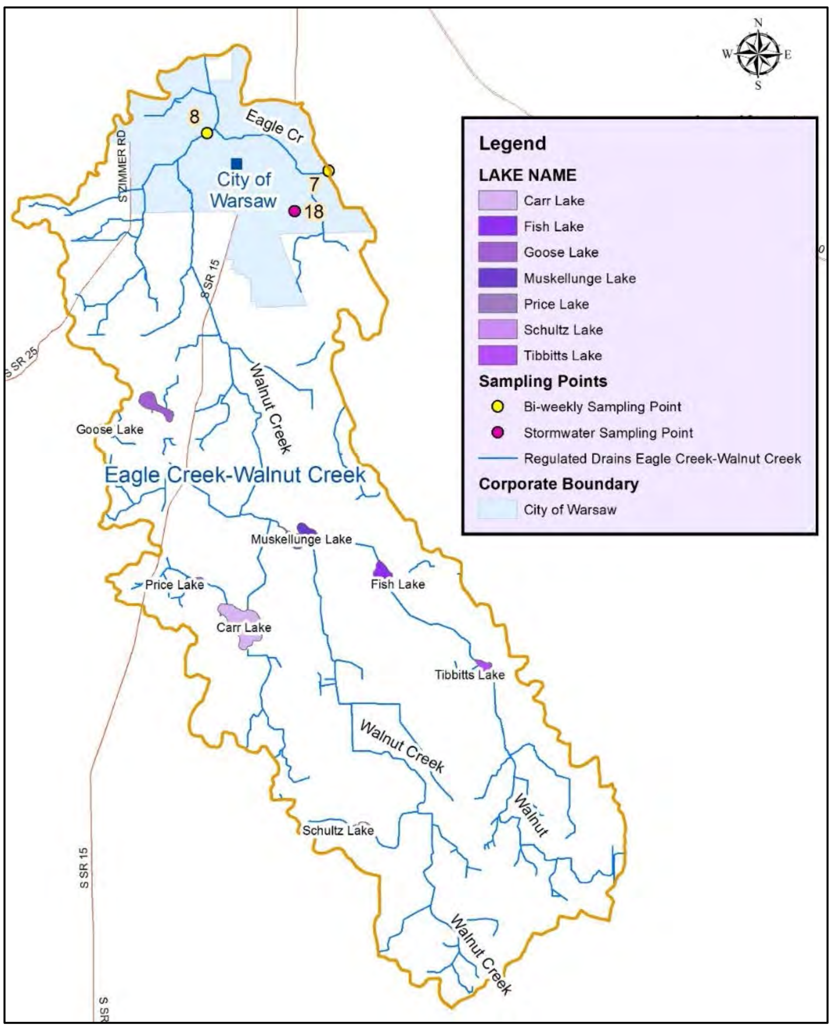


Figure 64 Sampling Sites Eagle Creek - Walnut Creek Subwatershed

This subwatershed had two (2) biweekly sampling sites and one stormwater outfall sampling site. All three sites exceeded E. coli target thresholds during the sampling (Table 27). Site #7 (Eagle Creek downstream from Winona Lake) exceeded the threshold nineteen (19) percent of the time. Walnut Creek upstream of Eagle Creek exceeded the threshold thirty-three (33) percent of the samples taken. This site had an overall average that was over the threshold of 235 cfu/mL. Site #18 (outfall to Kelly Park Pond) was significantly higher at eighty (80) percent of the samples over the threshold.

The results for nitrates, phosphorus, and suspended solids look similar to the E. coli results. Site #7 (Eagle Creek) came very close to meeting the target threshold standards at only two (2) percent above the nitrate target of 1.5 mg/mL and phosphorus and suspended solids meet their targets.

E. coli Sampling in the Eagle Creek - Walnut Creek Subwatershed					
		E. coli			
Site #	Waterbody	Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL
7	Eagle Creek	24	345	0	19%
8	Walnut Creek Before Eagle Creek	298	>2419	1	33%
18	Outfall into Kelly Park Pond	922	>2419	816	80%

* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.

Table 25 E. coli Summary Data Eagle Creek - Walnut Creek Subwatershed

Sampling Data in the Eagle Creek - Walnut Creek Subwatershed												
	Nitrates (NO3)				**Total Phosphorus**				**Suspended Solids**			
Site #	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
7	0.51	1.91	0.00	2%	0.033	0.064	0.014	0%	5	17	0	0%
8	1.62	4.97	0.09	44%	0.085	0.201	0.018	52%	6	20	0	0%
18	0.50	1.10	0.12	100%	0.170	0.238	0.129	100%	30	75	12	33%

* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.

Table 26 Nitrates, Total Phosphorus, Suspended Solids Sampling Data Eagle Creek - Walnut Creek Subwatershed

Site #8 (Walnut Creek upstream of Eagle Creek) exceeded the target threshold for nitrates forty-four (44) percent of the samples and fifty-two (52) percent of the sample for phosphorus exceeding .076 mg/mL. Site #8 did not exceed the threshold for suspended solids.

Site #18 exceeded the threshold for nitrates and phosphorus in one hundred (100) percent of the samples taken. It also exceeded the suspended solids threshold of 25 mg/mL in twenty-five (25) percent of the time.

Summary

The Eagle Creek – Walnut Creek Subwatershed is a true mix of agriculture and urban. Just as the southern portion is heavily agriculture with both livestock and row crop farming, the northern tip is industrial with brownfields and an industrial IDEM regulated voluntary cleanup. Like most of the waters in the watershed, there has been significant human alteration through channeling, streambank erosion, lack of buffering, and the development of pollutants due to land uses.

The lakes along Walnut Creek in the Eagle Creek – Walnut Creek Subwatershed play an important pollution prevention role. Water that travels through the lakes enter a natural filter where sediments and phosphorus can be filter out of the water so that water leaving the lake is often cleaner than the water entering. This can be seen in the sampling data at Eagle Creek (Site # 7). Pollutant loads exiting Winona Lake are much smaller than any single waterway entering Winona lake.

The Watershed Inventory Part Three

Evaluating the watershed for its current water quality and determining the sources or potential sources of degradation are significant in developing a plan to effectively reduce pollutant loads to achievable benchmarks established by the CWP. Part three of the inventory process relates the data to the stakeholder concerns, and then identifies problems and possible causes. The pollutant loads are quantified, and reductions calculated when necessary. The CWP short-term and long-term goals are listed with a relevant action register to successfully achieve goals and regularly evaluate the plan and activities for effectiveness.

The Social Indicator Survey

A social indicator study was conducted in the watershed in late-2017 and early-2018 to develop a baseline of stakeholders' knowledge and willingness to change behaviors. There were two target audiences: agricultural landowners with 20+ acres and urban/suburban (non-agricultural) residents.

During the 2018 State of the City address, Warsaw's Mayor Thallemer stated, "30-40% of our local workforce travels into our county on a daily basis from the surrounding region." https://www.warsaw.in.gov/DocumentCenter/View/1881/2018-State-of-the-City-Script-PDF?bidId .

Agricultural landowners were contacted through a letter using their *address of record* with the Kosciusko County Assessor's office and invited to complete a survey online or at the Kosciusko SWCD office. The letter was also followed up with a postcard. All four hundred seventy-eight (478) of the 20+ acre landowners in the watershed received the notification. There were 82 responses from the agricultural survey, representing 18% of the large landowners.

The residential survey was conducted using multiple methods, including mail correspondence sent to random households in the watershed. There were two different sets of addresses used for postcard mailings of approximately 1000 each. There were also two social media blitzes done by the Clean Waters Partnership partners to get responses. The two social media blitzes corresponded to giveaways. One was in December of 2017 and offered free Mudlove bracelets to persons completing the survey. Another was done in February and offered a coupon for a reduced-price local car wash with opportunities to win one or three months of unlimited car washes. That incentive received the most responses totaling 676. In all there were 924 urban/residential respondents. After being reviewed for completeness, 914 responses were used.

Urban Survey Respondents			
Home Zip Code City/Town	No.	%	Total %
Warsaw	534	58%	83%
Winona Lake	89	10%	
Leesburg	80	9%	
Pierceton	37	4%	
Claypool	17	2%	
Larwell/Columbia City	56	6%	13%
Silver Lake/Akron	30	3%	
Milford/Etna Green	13	1%	
North Webster	20	2%	
15-30 miles away	10	1%	4%
Other	28	3%	
	914	100%	100%

Table 27 Urban Respondents by Location

The social indicator survey included demographic questions to ensure the respondents represented a broad spectrum of the community and gave the committee a general idea of who was responding. Participants in the survey were required to enter their home zip code to allow for geographical tracking to ensure that the committee was receiving local results that would be true to the attitudes and behaviors in the watershed (Table 5). Eighty-three (83) percent of all residential respondents were either in or directly adjacent to the watershed. Those zip codes were for residents in Warsaw, Winona Lake, Pierceton, Claypool, and Leesburg. Thirteen (13) percent of respondents were in communities adjacent to the watershed (North Webster, Larwell, Columbia City, Silver Lake, Akron, and Etna Green). Only four (4) percent of respondents were greater than 15 miles away from the watershed. Respondents in this category were not purged as they likely commute to the area for employment.

The survey also looked at how receptive respondents were to learn about and addressing water quality concerns. Seventy-nine (79) percent of respondents agreed or strongly agreed that the lakes are important to the local economy. Seventy-four (74) percent of respondents stated that they had used the streams, lakes, and ponds in and around their community for fishing, jogging, walking, swimming, picnicking, or just scenic appreciation in the last year. When asked to rate the water quality of their area, fifty-two (52) percent felt that the water quality was good, forty-one (41) percent thought it was okay but had a few concerns; three (3) percent believed that the water quality was poor.

The survey also looked at respondents' base knowledge of the destination of stormwater runoff from their property. Thirty-six (36) percent knew that their stormwater runoff went to a waterbody and many knew exactly which waterbody by name. Thirty-two (32) percent had no idea where their stormwater runoff went. Fourteen (14) percent said other and stated various answers, such as a ditch, a neighbor's field, a wetland, a pond, or even their basement. Eighteen (18) percent believed that the storm drains in their street went to the wastewater treatment facility. This question provided answers of (1) directly to a local lake or stream, (2) to a street drain and into a local lake or stream, (3) to a street drain and to a wastewater treatment facility, (4) I don't know, or (5) other. All the provided answers except "other" listed an end destination for their water runoff. Responses indicate an opportunity for public education in the areas of not just the thirty-two (32) percent who answered, "I don't know", but also a high percentage of respondents answering "other" and a high percentage of those answering that their runoff went to a "street drain and then to a wastewater treatment facility", as stormwater from only a very few enter into the sanitary sewer system and flow to a wastewater treatment facility.

The survey looked at respondents' knowledge of potential water pollutants. The results demonstrated that most residents have a basic understanding of some locally publicized topics such as lawn fertilizer, goose waste, and yard waste as pollutants. The results also show that residents have been introduced to many other topics including disposal of medications, landscaping, roof runoff, and stormwater flows. The CWP Education Committee will use the survey results to develop an effective education strategy and campaign to target messages that will increase residents' ability to identify pollutants and know when to seek answers so that they can actively reduce their pollution footprint.

Urban Stormwater Flows: In the Warsaw urban area, the Warsaw Utility confirms that approximately five (5) percent of the stormwater that enters storm drains goes to the wastewater treatment facility as a part of a combined sewer system. The remaining ninety-five (95) percent directly enters a creek, river, lake or pond. The areas with combined sewer are located within the 31 blocks of the immediate downtown of Warsaw. The storm drainage system and outfalls for the county can be viewed through the County's online GIS - https://beacon.schneidercorp.com/Application.aspx?AppID=152&LayerID=1998&PageTypeID=1&PageID=1047.

Eighty-two (82) landowners of 20+ agricultural acres completed the agricultural survey and, based on home zip codes, it also included a broad representation across the watershed (see Table 2, *Agricultural Large Landowner Respondent Zip Codes*). These landowners were asked about their uses for water during the last year. Sixteen (16) percent said none of the answers were correct; however, most responded that they did use water recreationally, with passive scenic appreciation being the highest percentage. Many also used local waters for boating, fishing, swimming, jogging, and kayaking. When asked whether there was a waterway next to their property, the percentage was much higher than in the urban survey. Seventy-three (73) percent responded that there was a waterway directly next to them. Forty-six (46) percent believe that their water is "great or okay", while thirty (30) percent have some concerns. Eighty-six (86) percent believe that the economic stability of the community depends on good water. Large agricultural landowners noted some concerns are soil erosion from farm fields (72%), fertilizer runoff from farmland (72%), stormwater runoff from parking lots and hard surfaces (67%), and loss of prime farmland (67%).

Comparable to the urban/suburban residential survey, large agricultural landowners identified more of the pollutants, such as nutrients, fertilizer, nitrates, but they did not always recognize how pollutants were related to each other. For example, more respondents identified that bacteria were a health concern than those who identified manure as a potential source. Similarly, some landowners identified nutrients as a large concern, but they did not identify sediment as a large concern, as well - even though sediment carries nutrients. Survey results will be used to guide the education committee's plan to target messages that will increase residents' ability to identify pollutants and know when to seek answers so that they can actively reduce their pollution footprint.

Agricultural Respondents		
Location	Zip Code	Responses
Atwood	46502	3
Bourbon	46504	3
Claypool	46510	10
Leesburg	46538	6
Leesburg	46539	2
Milford	46542	1
Nappanee	46550	1
Pierceton	46562	11
Larwell	46567	3
Warsaw	46580	22
Warsaw	46582	8
Winona Lake	46590	4
South Whitley	46787	2
Silver Lake	46982	3
St. Louis, MO	63122	1
Leesburg, FL	34748	1
Wyoming, OH	45215	1
		82

Table 28 Agricultural Respondents by Location

Review of the Watershed Problems and Causes

Stakeholder Concerns

The following stakeholder concerns were developed from stakeholder input and throughout the watershed inventory process. The steering committee evaluated the concerns and available data to determine the group's focus.

Stakeholder Concerns	Evidence	Within Project Scope?	Data Supported?	Able to Quantify?	Group Wants to Focus On?
Nutrient Loading	Evidence	Within Scope?	Data Supported?	Able to Quantify?	Group Focus?
High levels of nutrients in lakes and waterways	Pike Lake's trophic index is 65 (eutrophic), Winona Lake 59, Center Lake 57, Big Chapman 53, & Little Chapman 62	Yes	Yes	Yes	Yes
High levels of Phosphorus in waterways	Sampling sites showing an average of P samples exceeding .076 mg/L were Deeds Creek, Walnut Creek before Eagle Creek, & the Martin Peterson Ditch. Sampling sites that exceeded the benchmark 20% or more of sampling occurrences also included Wyland Ditch and Walnut Creek before the Tippecanoe River.	Yes	Yes	Yes	Yes
Urban runoff, i.e. yard waste nutrients entering storm drains and from lake residents	Stakeholder observation, Stormwater Utility Reports photo evidence	Yes	No	No	Yes
Fertilizer runoff	Sampling sites showing an average of nitrate samples exceeding 1.5 mg/L were Deeds Deeds, Wyland Ditch, Peterson Ditch, & Walnut Creek before Eagle Creek. Sampling sites that exceeded the benchmark 20% or more of the sampling occurrences also include Lones Ditch, Keefer Evans Ditch.	Yes	Yes	Yes	Yes
Urban ordinances currently do not allow native (tall) grasses	City of Warsaw Ordinances Ch 38 Environment, Vegetation limited to 9 inches high.	Yes	Yes	Yes	Yes
Fecal matter nutrient contamination	Sampling sites showing an average E. coli count exceeding 235 cfu/100ml were Deeds Creek, Heeter, Peterson and Wyland Ditches.	Yes	Yes	Yes	Yes

Table 29 Stakeholder Concerns & Evidence to Support Concerns

Bacteria	Evidence		Data Supported?	Able to Quantify?	Group Focus?
Fecal matter contamination, waterfowl, pet, human, farm	Sampling sites showing an average E. coli count exceeding 235 cfu/100ml were Deeds Creek, Heeter, Peterson Walnut Creek before Eagle, and Wyland Ditches.	Yes	Yes	Yes	Yes
Improper farm manure application or storage	Adjacent property CFO manure runoff and pasture into Fish Lake, Field Survey	Yes	Yes	No	Yes
Failed / failing septic systems	Stakeholder observation or perception	Yes	No	No	Yes
Reduce occurrence of microcystin toxins (algae)	In a study done by the Center for Lakes and Streams, Blue-green Algae in Northern Indiana Lakes: An Analysis of the Algal Toxin, Microcystin, Over 2010-2013 in lakes of Kosciusko County, Ind., by Bosch, Burk, Farwell, Millerd,& Underwood, one occurrence of one lake (of the all sports lakes) during 2010-13 exceeding the 4ppb of microcystin toxins recommended for human health contact by the Indiana Department of Environmental Education.	Yes	No	Yes	No. Inadequate Resources

Reduce occurrence of blue-green algae (cyanobacteria)	In a study done by the Center for Lakes and Streams, Blue-green Algae in Northern Indiana Lakes: An Analysis of the Algal Toxin, Microcystin, Over 2010-2013 in lakes of Kosciusko County, Ind., by Bosch, Burke, Farwell, Millerd,Underwood, Winona Lake samples were in moderate or high health risk category 56% of the time by the Indiana Department of Environmental Management standards of 20,000-100,000 cells/ml of blue-green algae in the moderate human health risk zone and over 100,000 cells/ml as high risk for human health.	Yes	Yes	No	Yes
Sedimentation	Evidence	Within Scope?	Data Supported?	Able to Quantify?	Group Focus?
Sediment filling the bottom of the lakes reducing WQ for aquatic wildlife	A Study of Sedimentation of Winona Lake by Ira T. Wilson, Heidelberg College. Proceedings of the Indiana Academy of Science - Open Access ... https://journals.iupui.edu/index.php/ias/article/download/4788/4609 - 1935 The total volume of sediment is shown to be 43.6% of the volume of the original basin. due to sedimentation. Sampling sites showing an average of suspended sediments exceeding the target of 25 ppm were Deeds Creek & Peterson Ditch.	Yes	Yes	No	Yes
Sedimentation in ditches & waterways	Sampling sites showing an average of suspended sediments exceeding the target of 25 ppm were Deeds Creek & Peterson Ditch.	Yes	Yes	Yes	Yes
Erosion from construction practices	Stakeholder documentation through pictures.	Yes	Yes	No	Yes

Waterway Maintenance	Evidence	Within Scope?	Data Supported?	Able to Quantify	Group Focus?
Improve bank stabilization lakes, & waterways	Bank stabilization needed on Pike, Winona, Center Lakes. Additional areas identified needing bank stabilization include Deeds Creek, Peterson Ditch, Walnut Creek.	Yes	Yes	Yes	Yes
Encourage natural stone lake front sea walls	Field Survey Observation / (IDNR, 2006)	Yes	Yes	Yes	Yes

Pollutants from Infrastructure or Lack of	Evidence	Within Scope?	Data Supported?	Able to Quantify?	Group Focus?
Improve Infrastructure & Maintenance Wastewater Treatment Plants (WWTP)	Lakeland Regional Sewer District WWTP (serving the Barbee Chain) came online protecting the chain of lakes but then adding nutrients to Deeds Creek/Pike Lake.	Yes	Yes	Yes	No. This is IDEM permitted and local group has no control.
	Pierceton WWTP has been cited for multiple compliance issues in 2017 including violations that affected their discharge to Deeds Creek, including discharging to receiving waters materials, floating debris, oil, or scum.	Yes	Yes	No	No. IDEM permitted.
Combined sewer overflows	Warsaw WWTP had Sanitary Sewer Overflows (SSOs) in 2016	Yes	Yes	Yes	No. IDEM Permitted.
	Town of Winona Lake had one SSO in 2015	Yes	Yes	Yes	No. No IDEM permitted.
Improve or add Infrastructure BMPs to reduce pollutants from Stormwater before discharging into waters.	Nitrate and Phosphorus results for 28 miles of open water, Walnut Creek before Eagle + Eagle Creek = 35 tons/yr Nitrates & 3.35 tons/yr P or 1.25 tons/yr/mile nitrates & .12 tons/yr/mile P. The final reading at Walnut Creek before Tippecanoe River was 82 tons/yr Nitrates and 7 tons/yr P. Subtracting off the initial leaves 23 tons Nitrates for an urban stretch of no more than 1.5 miles or 15 tons/yr/mile & phosphorus 4.7 tons/mile.	Yes	Yes	Yes	Yes
Minimal or no controls for urban runoff	Large urban areas (Warsaw, Town of Winona, Pierceton have direct discharge stormwater conveyances for municipal owned conveyances	Yes	Yes	Yes	Yes
Lack of sewer around large populated areas & lakes	Big & Little Chapman are unsewered	Yes	Yes	No	No. Group lacks resources.

Possibility of septic limitations being ignored to allow building and growth	Stakeholder observation or perception	Yes	No	No	Yes
Lack of green infrastructure (municipal) that could filter out nutrients, such as curb cuts	Currently one project under construction that is adding sediment basin filtering to municipal stormwater infrastructure.	Yes	Yes	Yes	Yes
Reduction of Flooding	Pike Lake has had a history of flooding	No	Yes	No	No. Group lacks resources.
Wildlife Habitat, Biotic Communities and Hydrology	Evidence	Within Scope?	Data Supported?	Able to Quantify?	Group Focus?
Improve health of the lakes	Develop a plan to protect lakes, stop pollution entering lakes	Yes	Yes	Yes	Yes
Develop a plan to manage wetlands	Wetlands have declined as proof of the difference between hydric soils map and wetlands maps	Yes	Yes	Yes	Yes
Improve habitat, protect and improve open space	Stakeholder observation or perception	Yes	No	No	Yes
Promote urban wildlife habitat, swales, and rain gardens	Stakeholder observation or perception	Yes	No	Yes	Yes
Reduce the size and reoccurrence of algal blooms	Stakeholder observation or perception	Yes	Yes	No	Yes
Reduce flooding	Newspaper evidence.	No	Yes	No	No. Group lacks resources.
Control/ Eliminate/ Educate Invasive species wildlife and plant community	Lake reports indicate Center, Winona, Pike, & Chapman Lakes continue to fight Eurasian watermilfoil.	Yes	Yes	Yes	Yes
Waterfowl management	Study titled, "Identifying causes of high E. coli concentrations at public beaches on Pike and Center lakes in Kosciusko County, Ind." by Burke, Barber, Bosch, 2014, Center for Lakes and Streams indicated E. coli levels prompting	Yes	Yes	No	Yes

	high E.coli that closed beaches were a result of gulls.				
Increase diversity and quantity of species in wildlife food web	Stakeholder observation or perception	Yes	No	No	Yes
Protect clubshell mussels in the Tippecanoe River	The Tippecanoe River is now free from logjams and is paddleable through the area where clubshell mussels are living.	Yes	Yes	No	Yes
Develop community awareness healthy soil = healthy water	Stakeholder observation in building the commitment to better communication and partnership of farmers and non-farm landowners and organizations.	Yes	Yes	No	Yes
Chemicals Entering Waterways	Evidence	Within Scope?	Data Supported?	Able to Quantify?	Group Focus?
Concern of BOD/CODs in streams and lakes	Stakeholder observation or perception	No	No	No	No. Data not supported.
Reduce chemicals entering waterways commercial, agriculture, & residential	Chemicals have had a history of entering lakes through storm pipes. Documented on Winona Lake.	Yes	Yes	No	Yes
Concern that chemicals are leaching through groundwater into lakes TCE/sewage/medications	Two TCE plumes are currently being remediated in the Winona Lake area.	No	Yes	No	No. IDEM responsibility.
Concerns about stormwater pollution, especially from state roads, i.e. SR 15 into Center Lake	There is no barrier or filtering mechanism on stormwater pipes transporting runoff of SR 15	Yes	Yes	Yes	Yes
Promote downspout disconnection and drainage into rain gardens and yards not into lakes or storm drains	Raingardens, rain barrels are uncommon in the urban areas of Warsaw. In 2017, the municipality held their first rain barrel program.	Yes	Yes	Yes	Yes

Public Education and Participation	Evidence	Within Scope?	Data Supported?	Able to Quantify?	Group Focus?
Grow a program that gets people paddling / watercourse section for recreation	Stakeholder perception or observation	Yes	No	No	Yes
Develop informed and conscientious citizens regarding water pollution	Press releases, public education events, social indicator survey helps identify needs and benchmark.	Yes	No	Yes	Yes
Educate and engage local business (agriculture, poultry, ranching) on issues of local pollution and environmental stewardship.	Press releases, public education events, social indicator survey helps identify needs and benchmark.	Yes	No	Yes	Yes
Mentor local youth in environmental conservation	Environmental public education programs of local organizations currently being evaluated.	Yes	Yes	Yes	Yes
Become a public pro-active environmental community and increase the area's ability to draw a contemporary workforce by providing high visibility approach to environmental stewardship	Currently creating a plan to educate citizens is a goal of this project.	Yes	Yes	Yes	Yes
Invite local populations to the watershed to *experience* specific ecosystems / natural resources	Press releases, events, reporting to politicians	Yes	No	Yes	Yes
Develop an increased level of appreciation of the lakes	The Social Indicator Survey showed a high level of respondents that use the lakes (>80%) but respondents failed to understand where stormwater goes and what pollutes stormwater. Their answers were generally split on how water gets polluted- between, Yes, No, and I don't know.	Yes	Yes	Yes	Yes
Non-lake resident education and how they are connected to the lake	32% of Urban Respondents of the social indicator survey did not know where the water that ran off their property went.	Yes	Yes	Yes	Yes

Develop local understanding and buy-in to help stop pollution at its sources from owners and other sources	Stakeholder observation or perception	Yes	No	No	Yes
Engage community (decision makers, community, businesses) on being part of the solution	Stakeholder observation or perception	Yes	No	No	Yes
Develop a plan that identifies the education and outreach activities needed for implementation	Stakeholder observation or perception	Yes	No	No	Yes
Engage diverse representation (businesses and geographical areas) to participate in the project	Stakeholder observation or perception	Yes	No	No	Yes
Preserve Lake Economic Viability and Community Culture	Stakeholder observation or perception	Yes	No	No	Yes
Preserve the local waters as community assets	Stakeholder observation or perception	Yes	No	No	Yes
Increase local stewardship	Stakeholder observation or perception	Yes	No	No	Yes
Increase local use / connection to the water	The Social Indicator Survey showed a high level of respondents that use the lakes (>80%) but respondents failed to understand where stormwater goes and what pollutes stormwater. Their answers were generally split on how water gets polluted- between, Yes, No, and I don't know.	Yes	Yes	Yes	Yes
Educate the public on the existence of endangered species (special) and their need for protection	The endangered clubshell mussel (Tippecanoe River) and the Blanding's turtle (wetlands), and the threatened Copperbelly water snake (wooded and permanently wet areas such as oxbows, sloughs, brushy ditches and floodplain woods) and the Eastern massasauga (Wetlands and adjacent uplands).	Yes	Yes	No	Yes

Identifying Problems in the Watershed

The following table matches concerns with identified problems found in the watershed.

Stakeholder Concerns	**Problem**
Nutrient Loading	**Problem**
High levels of nutrients in lakes and waterways	Excessive nutrient loading into the watershed and its tributaries degrades uses, such as biotic communities, aesthetics, and recreation. Excessive nutrients in the tributaries leading to the lakes degrades water quality in the lakes and leaves behind higher nutrient loads that remain and continue to degrade water quality indefinitely.
High levels of Phosphorus in waterways	
Urban runoff, i.e. yard waste nutrients entering storm drains and from lake residents	
Fertilizer runoff	
Urban ordinances currently do not allow native (tall) grasses	
Fecal matter nutrient contamination	
Bacteria	**Problem**
Fecal matter contamination, waterfowl, pet, human, farm	The Tippecanoe River and its tributaries have high pathogen loads, as indicated by high E. coli. This causes the river to fail to meet its designated use for recreational contact.
Improper farm manure application	
Failed / failing septic systems	
Reduce occurrence of microcystin toxins (algae)	
Reduce occurrence of blue-green algae (cyanobacteria)	
Sedimentation	**Problem**
Sediment filling the bottom of the lakes reducing WQ for aquatic wildlife	Excessive sediment loading into the watershed and its tributaries degrades uses, such as biotic communities, aesthetics, and recreation. Excessive nutrients in the tributaries leading to the lakes degrades water quality in the lakes and leaves behind higher nutrient loads that remain and continue to degrade water quality indefinitely.
Sedimentation in ditches & waterways	
Erosion from construction practices	

Waterway Maintenance	Problem
Improve bank stabilization lakes, & waterways	The public is not taking action to protect and improve the lakes and tributaries in the Walnut Creek - Tippecanoe River Watershed
Encourage glacial stone lake front sea walls	
Pollutants from Infrastructure or Lack of	**Problem**
Wastewater Treatment Plants (WWTP)	Lack of environmental education and / or buy-in to appropriate resources necessary to change behavior.
Lack of sewer around large populated areas & lakes	
inadequate controls for urban stormwater discharges	
Possibility of septic limitations being ignored to allow building and growth	
Lack of green infrastructure (municipal) that could filter out nutrients, such as curb cuts	Lack of environmental education and / or buy-in to appropriate resources necessary to change behavior.
Reduction of Flooding	
Wildlife Habitat, Biotic Communities and Hydrology	**Problem**
Improve health of the lakes	Biotic Communities in the Walnut Creek - Tippecanoe River Watershed and its tributaries are impaired due to poor water quality, poor habitat, and altered hydrology. This causes the lakes, streams, and river to fail to meet their designated use for aquatic life use support.
Develop a plan to manage wetlands	
Improve habitat, protect and improve open space	
Promote urban wildlife habitat, swales, and rain gardens	
Reduce the size and reoccurrence of algal blooms	
Reduce flooding	
Control/ Eliminate/ Educate Invasive species wildlife and plant community	
Waterfowl management	
Increase diversity and quantity of species in wildlife food web	

Protect clubshell mussels in the Tippecanoe River	
Develop community awareness healthy soil = healthy water	
Chemicals Entering Waterways	**Problem**
Concern of BOD/CODs in streams and lakes	Limited education, limited public and social pressure and/or financial inducements are present to encourage businesses, municipalities, residents to take necessary steps to reduce risks posed to water pollution.
Reduce chemicals entering waterways commercial, agriculture, & residential	
Concern that chemicals are leaching through groundwater into lakes TCE/sewage/medications	
Concerns about stormwater pollution, especially from state roads, i.e. SR 15 into Center Lake	
Promote downspout disconnection and drainage into rain gardens and yards not into lakes or storm drains	
Public Education and Participation	**Problem**
Grow a program that gets people paddling / watercourse section for recreation	Need to personally connect people to their local assets as a "sense of place”, "live, work, and play" needs to be more than a tagline.
Invite local populations to the watershed to *experience* specific ecosystems / natural resources	
Increase local use / connection to the water	
Develop a plan that identifies the education and outreach activities needed for implementation	Need a comprehensive environmental education program.
Lake Community not aware or doesn't care about environmental assets.	
Non-lake resident education and how they are connected to the lake	

Mentor local youth in environmental conservation	
Engage diverse representation (businesses and geographical areas) to participate in the project	Need to educate and connect businesses to benefits of water resources then include them in the future solutions
Educate and engage local business (agriculture, poultry, ranching) on issues of local pollution and environmental stewardship.	
Become a public pro-active environmental community and increase the area's ability to draw a contemporary workforce by providing high visibility approach to environmental stewardship	
Preserve the local waters as community assets	Need to develop a culture of water resources protection at all levels of community.
Develop an increased level of appreciation of the lakes	
Engage community (decision makers, community, businesses) on being part of the solution	
Preserve Lake Economic Viability and Community Culture	
Develop informed and conscientious citizens regarding water pollution	
Develop local understanding and buy-in to help stop pollution at its sources from owners and other sources	Limited understanding that preservation is needed NOW.
Increase local stewardship	
Preserve the local waters as community assets	
Educate the public on the existence of endangered species (special) and their need for protection	Public has limited knowledge of endangered species and there is limited local discussion and buy-in to protect diverse species.

Table 30 Stakeholder Concerns & Problems

Potential Causes of Problems and Their Sources in the Watershed

The table below was generated using water quality data, windshield surveys, GIS, and local knowledge. This data can be used for identifying water quality problems.

Problem	Potential Stressors	Potential Sources
Excessive nutrient loading into the watershed and its tributaries degrades uses, such as biotic communities, aesthetics, and recreation. Excessive nutrients in the tributaries leading to the lakes degrades water quality in the lakes and leaves behind higher nutrient loads that remain and continue to degrade water quality indefinitely.	Nutrient (Total Phosphorus and nitrate) levels exceed the targets set by the Clean Waters Partnership	Nutrient loading from AG fertilizers being applied too heavily or overspray. 44% of the watershed is row crop farming.
		Nutrient loading from residential fertilizer application or overspray. 16% of the watershed is develop land with concentrated urban housing and commercial properties.
		Nitrogen releases from tilled land from soils that do not have actively growing plants (living roots) to hold nitrogen in place.
		Nutrient loading from malfunctioning septic systems.
		Nutrient loading from insufficient buffers, which are present on over 5.5 miles of visible ditches.
		Yard waste entering lakes from adjacent properties.
		Yard waste entering lakes from urban storm drains. The City of Warsaw has over 70 miles of stormwater pipe that enters a waterway.
		Nutrient loading from waterfowl in all Pike Lake- Deeds Creek, Winona Lake - Eagle Creek, Eagle Creek - Walnut Creek, and Ruple Ditch - Tippecanoe River subwatersheds.

The Tippecanoe River and its tributaries have high pathogen loads, as indicated by high E. coli. This causes the river to fail to meet its designated use for recreational contact.	High Pathogen levels as indicated by E. coli concentrations that exceed state standards.	Pathogen loading from malfunctioning septic systems from Deeds Creek - Pike Lake, McCarter Ditch - Deeds Creek subwatershed, and Eagle Creek - Winona Lake subwatersheds, Sampling sites showing an average E. coli count exceeding 235 cfu/100ml were Deeds Creek, Heeter, Peterson and Wyland Ditches. (94% of all soils in the watershed are very limited for on-site septic systems.
		Pathogen Loading from pasture runoff. There are CFOs and pastured animal operations in all five subwatersheds. Walnut Creek - Eagle Creek and Eagle Creek - Winona Lake have the most hobby farms and pastured operations with six and four respectively.
		Pathogen loading from private properties (runoff and into water or storm drain) and public parks. This would be prevalent in the Walnut Creek - Eagle Creek, Winona Lake - Eagle Creek, and the Pike Lake - Deeds Creek subwatersheds.
		Pathogen loading from wildlife.
		Fowl populations around lakes and lake parks.
		Pathogen loading from public and private sanitary WWTPs. Town of Pierceton was cited for multiple violations in 2017. Town of Winona had one SSO in 2015, City of Warsaw had four SSOs in 2016.
Excessive sediment loading into the watershed and its tributaries degrades uses, such as biotic communities, aesthetics, and recreation. Excessive nutrients in the tributaries leading to	Suspended solids exceeded the target of the CWP watershed group.	Sediment loading from in stream and bank erosion. Streambank erosion occurs approximately along 5 miles of streams and ditches according to the desktop survey. Observations made during site investigations for snapshot monitoring day showed moderate to heavy silt is present in all sub watershed.

the lakes degrades water quality in the lakes and leaves behind higher nutrient loads that remain and continue to degrade water quality indefinitely.		Shoreline erosion is occurring on almost 2 miles of shoreline (Pike, Center, Winona)
		Erosive soils entering ditches, drains, and waterways. One third of all soils in the Pike Lake - Deeds Creek, McCarter Ditch - Deeds Creek, and Winona Lake - Eagle Creek subwatershed consists of highly erodible soils.
		Sediment loading from active construction sites in all five subwatersheds.
		Sediment loading from roads and parking lots in all five subwatersheds.
The public is not taking action to protect and improve the lakes and tributaries in the Walnut Creek - Tippecanoe River Watershed	The public lacks adequate knowledge about water quality.	Public does not have adequate information about water quality.
		Public does not feel connected to the cause.
	The public does not understand the need and the urgency.	Urgency has not been adequately conveyed to all stakeholders.
	Not enough diversity (economic & social) involved in the project.	Events not targeting all socioeconomic groups.
		Education or delivery of message not targeting all socioeconomic groups.
		Not enough private landowners are directly involved in CWP project.
	The public is uninvolved and feels uninvested in the water quality of the watershed.	Public not personally connected to their water resources.
		The public does not have adequate access to information on water quality.
Lack of environmental education and / or buy-in to appropriate resources necessary to change behavior.	Landowners lack resources to act.	Landowners don't have adequate technical support or know how to find it.
		Lack of funds to make necessary changes to protect water quality.

Limited education, limited public and social pressure and/or financial inducements are present to encourage businesses, municipalities, residents to take necessary steps to reduce risks posed to water pollution.	Local awareness of water quality issues does not establish a "common" need.	Limited social engagement of water quality issues.
		Water quality issues are not perceived as a "common man's" concern.
		Water recreation activities require resources that many in the population cannot afford.
		Lakes are somewhat exclusive limiting the public engagement.
		Water quality is not a headline.
Need to personally connect people to their local assets as a "sense of place", "live, work, and play" needs to be more than a tagline.	Need for additional opportunities.	Opportunities should be available in multiple venues.
		Lack of varying experience, age, and resources levels in opportunities to connect people to water.
		Water recreation activities require resources that many in the population cannot afford.
	Lack of knowledge of local opportunities.	Press release / announcements fail to reach into diverse socioeconomic groups.
		Opportunities available seem overwhelming for beginners.
Need to educate and connect businesses to benefits of water resources then include them in the future solutions.	Lack of adequate knowledge about water quality, the resources available, or the options for protecting water.	Business owners do not have adequate access to information on water quality.
		Businessowners do not have adequate technical support or know how to find it.
		Perception that resource cost is too high (time, money, etc..).
Need to develop a culture of water resource protection at all levels of community.	People should feel a part of a shared experience in protecting water quality.	People need clear and "clean" messaging to develop a sense of community or shared experience on water resources issues.

Limited understanding that preservation is needed NOW.	Lack of understanding in the state of water resources in the watershed.	The message currently is so positive that action is NOT required, at least not now The CWP needs to have a top ten or top five list to start developing a COMMON NEED to change behavior.
Biotic Communities in the Walnut Creek - Tippecanoe River Watershed and its tributaries are impaired due to poor water quality, poor habitat, and altered hydrology. This causes the lakes, streams, and river to fail to meet their designated use for aquatic life use support.	Habitat is of poor quality in lakes.	Poor water quality in the lakes is represented in its trophic index. Pike Lake being the most concerning at hypereutrophic. Sedimentation in the three Priority I subwatershed also degrades water quality. Additional concerns of Eurasian watermilfoil in the lakes damages habitat and competes with natives.
Public has limited knowledge of endangered species and there is limited local discussion and buy-in to protect diverse species.	Lack of understanding in local endangered species and the state of wildlife habitat in the watershed.	Lack of public conversation and awareness.

Pollutant Load Estimates

Pollutant loads were calculated using data collected during two years of bi-weekly sampling of 10 sites in the watershed. With this extent of data spanning two years of weather events, the following pollutant loads are not modeled but were calculated as averages of the flow intensity and concentration.

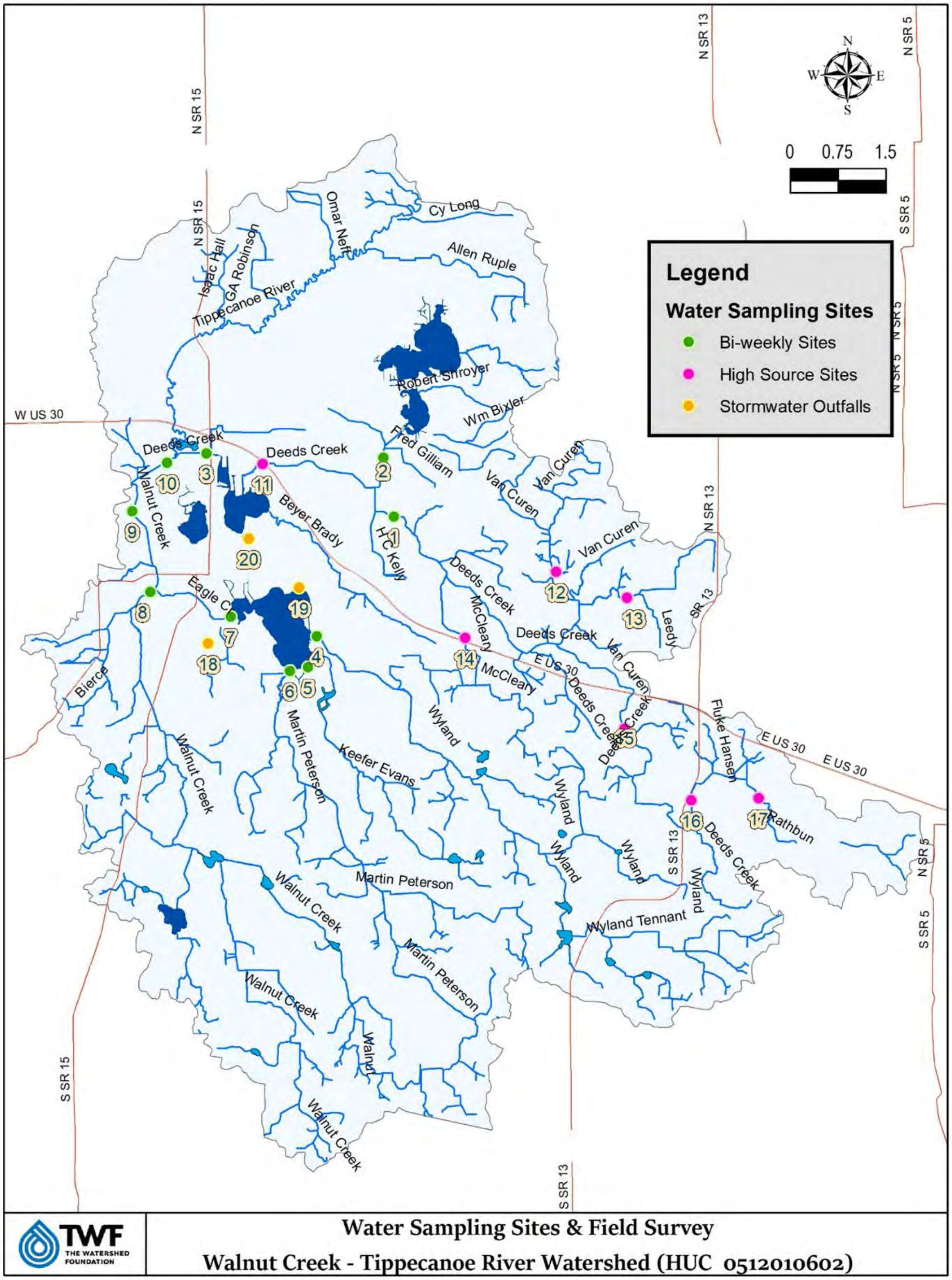


Figure 65 Water Sampling Sites Walnut Creek - Tippecanoe River Watershed

Sampling Site Pollutant Data – Load Reductions Needed

Site #	Waterbody	Nitrates (NO3)				Total Phosphorus				Suspended Solids			Subwatersheds Feeding into Sampling Points
		Current Loads lbs/yr.	Target Loads	Load Reduction Required lbs/yr	% Reduction Needed	Total Phosphorus lbs/yr	Target Loads	Load Reduction Required	% Reduction Needed	Current Loads Tons/Yr.	Target Loads	Load Reduction Required	
1	Deeds Creek before the Heeter Ditch tributary	183,389	85,607	97,782	53%	6,727	4,337	2,390	36%	664	713	-	McCarter Ditch - Deeds Creek Pike Lake - Deeds Creek
2	Heeter Ditch (3,500 lf of ditch exiting Chapman Lakes)	11,858	26,332	-	0%	788	1,334	-	0%	96	219	-	Pike Lake - Deeds Creek
3	Lones Ditch *exiting Pike Lake*	103,400	12,599	90,801	88%	3,310	6,383	-	0%	347	1,050	-	Pike Lake - Deeds Creek
6	Peterson Ditch entering Winona Lake	51,594	42,341	9,253	18%	2,618	2,145	473	18%	326	353	-	Winona Lake - Eagle Creek
5	Keefer Evans entering Winona Lake	7,447	11,427	-	0%	430	579	-	0%	42	95	-	Winona Lake - Eagle Creek
4	Wyland Ditch (Cherry Creek) entering Winona Lake	60,317	46,284	14,033	23%	2,199	2,345	-	0%	219	386	-	Winona Lake - Eagle Creek
7	Eagle Creek *exiting Winona*	47,886	139,675	-	0%	3,087	7,077	-	0%	240	1,164	-	Winona Lake - Eagle Creek
8	Walnut Creek Before Eagle Creek	69,510	64,354	5,156	7%	3,629	3,261	368	10%	121	536	-	Eagle Creek - Walnut Creek
9	Walnut Creek before Tippecanoe River	163,912	314,319	-	0%	14,362	15,926	-	0%	708	2,619	-	Ruple Ditch - Tippecanoe River
10	Tippecanoe River Fox Farm Road	278,832	656,170	-	0%	13,831	33,246	-	0%	1,103	5,468	-	Ruple Ditch - Tippecanoe River
	Totals	**978,145**				**50,981**		**3,231**		**3,867**	**-**		
Lakes accumulate pollutants. When sampling numbers in this watershed seem low, there is typically a lake collecting some of those pollutants.													

Table 31 Sampling Site Pollutant Data

Deeds Creek has the largest pollutant load in the watershed. Entering Pike Lake, the Creek does not meet water quality, exceeding the load by over 97,000 lbs/year. As Deeds Creek exits Pike Lake as Lones Ditch, the water still exceeds the nitrate pollutant load by over 90,000 lbs/year. This pollutant load is extremely high and at the proposed rate of BMP installation of spending $100,000 a year in load reduction BMPs, the nitrate reduction in five years would be approximately 40,000 lbs/year less per the STEPL model. Although this is a small amount of the 978,148 lbs/year total nitrates, if the committee focuses on the upper Deeds Creek, the reduction should affect both Deeds Creek and Lones Ditch (the exit of Deeds Creek from Pike Lake). These load numbers, with nitrate loading being similar entering and exiting Pike Lake begins to demonstrate that Pike Lake is losing its ability to provide the nutrient magnet that it once was.

Phosphorus could be reduced by 22,000 lbs/year in ten years if the watershed was in need of that sizeable reduction. Instead, using the plan as an installation guide, you would be able to reduce phosphorus in ten years to an adequate amount and thus meet water quality. This "reduction" will not end the need to further improve the water quality in the watershed.

One of the biggest concerns locally in this watershed goes beyond the pollutant loads for each individual sampling point. Locally, the government leaders, industry, businesses and residents are concerned that pollutants are filling the lakes and expediting eutrophication, especially the large residential lakes in the Warsaw and Winona Lake communities. Their fears are valid, especially when Pike Lake can be summarily seen as unable to absorb the pollutants that are now passing through it in Deeds Creek. All the lakes have a long history of collecting pollutants and solids. Improving and restoring their natural health will require more than just reductions of nitrates, phosphorus, sediment, and E. coli. Additional evaluation is needed to improve the state of Pike Lake, for example, to that of a recreational gem of the City of Warsaw. Flooding concerns, weed concerns, increased algae, and heat all pay a part in reducing the value of the lake for residents and wildlife. Additional "targeted" studies could create a roadmap to restoring the lake(s) and welcoming increased wildlife diversity back.

Load Reductions Needed to Achieve Target Loads

The following table shows the load reductions required to meet water quality targets in the watershed. If a zero is indicated, the pollutant levels are currently below the water quality target for that parameter.

Site #	Waterbody	Nitrates (NO3)		Total Phosphorus		Suspended Solids		Subwatersheds Feeding into Sampling Points
		Current Loads lbs/yr.	Load Reduction Required lbs/yr	Total Phosphorus lbs/yr	Load Reduction Required	Current Loads Tons/Yr.	Load Reduction Required	
1	Deeds Creek before the Heeter Ditch tributary	183,389	97,782	6,727	2,390	664	-	McCarter Ditch - Deeds Creek Pike Lake - Deeds Creek
2	Heeter Ditch (3,500 lf of ditch exiting Chapman Lakes)	11,858	-	788	-	96	-	Pike Lake - Deeds Creek
3	Lones Ditch *exiting Pike Lake*	103,400	90,801	3,310	-	347	-	Pike Lake - Deeds Creek
6	Peterson Ditch entering Winona Lake	51,594	9,253	2,618	473	326	-	Winona Lake - Eagle Creek
5	Keefer Evans entering Winona Lake	7,447	-	430	-	42	-	Winona Lake - Eagle Creek
4	Wyland Ditch (Cherry Creek) entering Winona Lake	60,317	14,033	2,199	-	219	-	Winona Lake - Eagle Creek
7	Eagle Creek *exiting Winona*	47,886	-	3,087	-	240	-	Winona Lake - Eagle Creek
8	Walnut Creek Before Eagle Creek	69,510	5,156	3,629	368	121	-	Eagle Creek - Walnut Creek
9	Walnut Creek before Tippecanoe River	163,912	-	14,362	-	708	-	Ruple Ditch - Tippecanoe River
10	Tippecanoe River Fox Farm Road	278,832	-	13,831	-	1,103	-	Ruple Ditch - Tippecanoe River

Table 32 Load Reductions Required

Receiving Bodies for Pollutant Loads

It is important to note when looking at Table 32 that lakes accumulate pollutants. When sampling results in this watershed seem low, there is typically a lake collecting many of those pollutants upstream. For example, *Winona Lake* is the receiving body for Wyland, Keefer Evans, and Peterson Ditches. Just looking at the sampling data for the three ditches entering the lake and ignoring unknown sources including stormwater outfall contributions and runoff from adjacent properties, there is a significant drop in pollutants exiting the lake from its only outfall at Eagle Creek. The three ditches bring in a total of 119,358 lbs./year in nitrates and only 47,886 lbs./year are leaving Winona Lake. Calculating the difference for nitrates, phosphorus, and sediment, there is a minimum of 71,472lbs/yr in nitrates, 2,100 lbs/yr of phosphorus and 466 tons/yr in sediment remaining in the lake.

> Winona Lake is 562 acres with a maximum depth of 80 feet.
>
> Pike Lake is 228 acres with a maximum depth of 35 feet.
>
> www.yesteryear.clunette.com/lakeguide.html

Pike Lake and Little Pike experience an even greater stress from nutrients. Not only is the lake's surface area much smaller (less than one fifth the size), it receives approximately one and one-half times as many nitrates and phosphorus and over twice the tons of sediment compared to Winona Lake. Heeter Ditch and Deeds Creek bring in 195,247 lbs/yr in nitrates, 7,515 lbs/yr in phosphorus and 760 tons/yr in sediment. Water discharging through Pike Lake's only outlet, Lones Ditch, contains 103,400 lbs/yr nitrates, 3,320 lbs/yr phosphorus, and 347 lbs/yr in sediment. That leaves a minimum of 91,847 lbs/yr nitrates, 3,310 lbs/yr phosphorus, and 413 tons/yr in sediment trapped in the lake.

Pike Lake is the receiving body for Deeds Creek & Heeter Ditch. This drainage area does not contain any lakes upstream of Pike.

There were no sampling sites upstream of Chapman Lake to calculate pollutant loads.

Walnut Creek south of Warsaw has multiple small lakes that filter pollutants before it reaches the city. Its water quality upstream of Warsaw meets the target standards set by the CWP committee. However, as it moves through the city it picks up a significant amount of pollutants and no longer meets those standards as it reaches the Tippecanoe River. When the pollutant load of Walnut Creek before the Tippecanoe River (9) is reduced by the pollutant load of Eagle Creek coming out of Winona (7) and Walnut Creek before Eagle Creek (8), the result is the amount of pollutants added during 17,500 feet of waterway (46,516 lbs/yr of nitrates, 7,646 lbs/yr of phosphorus, and 275 tons/yr of sediment. When you compare that to a rural waterway - Wyland Ditch has 101,737 feet of open channel (60,317 lbs/yr nitrates, 14,034 lbs/yr phosphorus, 219 tons/yr sediment). Wyland Ditch is 5.8 times longer in length. The urban area releases 2.65 lbs/ft/yr of waterway compared to the rural waterway releasing 0.6 lbs/ft/yr of nitrates. The sediment entering the waterway was an incredible 31 lbs/ft/yr in the urban area and 4.3 lbs/ft./yr along Wyland Ditch. Calculating rates per foot is not an actual loss per foot but does demonstrate the significance of an urban load on the watershed and reinforces the important of education and conservation efforts in the urban areas.

E. coli Sampling in the McCarter Ditch - Deeds Creek Subwatershed					
Site #	Waterbody	E. coli			
		Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL
1	Deeds Creek	650	>2419	36	62%
2	Heeter Ditch	319	>2419	1	30%
3	Lones Ditch	38	727	1	6%
4	Wyland Ditch	354	>2419	28	42%
5	Keefer Evans	223	1986	9	26%
6	Peterson Ditch	723	>2419	21	54%
7	Eagle Creek	24	345	0	19%
8	Walnut Creek Before Eagle Creek	298	>2419	1	33%
9	Walnut Creek before Tippecanoe River	172	1732	13	26%
10	Tippecanoe River East of Fox Farm Road	115	1119	13	11%
11	Deeds Creek	457	980	106	75%
12	Van Curen Ditch	783	>2419	30	75%
13	Van Curen Ditch	1117	>2419	435	100%
14	Deeds Creek	1096	>2419	236	100%
15	Deeds Creek	807	>2419	210	75%
16	Deeds Creek	1416	>2419	225	75%
17	Deeds Creek	1864	>2419	200	75%
18	Outfall into Kelly Park Pond	922	>2419	816	80%
19	Outfall into Winona Lake	130	>2419	23	33%
* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.					

Table 33 E. coli Testing Results

E. coli results also provide a significant amount of information. Sites # 1, 4, 6 are all at points receiving waters from the rural areas of the watershed where large animal operations are common. The field survey identified areas where the animal operation could be evaluated for further review.

Critical Areas

Critical areas are determined to be the most important areas to begin implementation first. Those areas may be determined to be critical for various reasons, such as time sensitivity, threat of permanent harm, or a natural succession of order where the furthest upstream area should be targeted first to stop the pollutants from flowing downstream.

The CWP technical committee met in December of 2017 and set priorities in determining critical areas. **Priority I Areas by Pollutant of Concern: The following table lists pollutants and waterways identified by priority level based on the data and findings of the steering committee.**

Priority I Areas	*E. coli*	Total Phosphorus	Nitrates (NO3)	Suspended Solids
McCarter Ditch	YES	YES	YES	YES
Deeds Creek	YES		YES	
Tennant Ditch	YES	YES	YES	YES
Peterson Ditch	YES	YES		YES
Priority II Areas	*E. coli*	Total Phosphorus	NO3	Suspended Solids
Keefer Evans	YES		YES	NO
Walnut Creek	YES	YES	YES	NO
Area Around Chapman Lake (Untested Pollutants)	YES			
Protection Area				
Tippecanoe River				

Table 34 Priority I, II, & III Areas Determined by the Committee

The technical committee also adopted a rated scale for each waterway on various parameters and concerns. The worksheet used by the committee can be found in the Appendix (Table 16). The worksheet was used to as a consensus building tool using a numerical system to provide as much objectivity to the process of evaluating the concerns in the watershed. Different people on the technical committee weighed in on their areas of expertise and shared their views to the committee, who then developed a consensus on the numerical value that was selected for each area and site. In the end, the committee looked at the final totals to determine if they felt that they had reflected the priorities of the committee. They used that information combined with the pollutant information to determine the critical areas for the watershed. Below are the final ratings as determined by the committee.

Figure 72 contains the areas prioritized by combining stakeholder concerns committee input and evaluation of the data (Priorities 1, 2, and Priority III).

Note: All public lakes in the watershed including Center, Pike, Winona, Big and Little Chapman, and Carr are listed as Priority I (from the lakeshore up to 12 feet landward) regardless of what the priority level of the land around them is classified. This prioritization is important to stop lakeshore erosion and lakebed resuspension and scouring through the implementation of shoreline stabilization projects.

Priority I Critical Areas
The Priority I area as shown in Figure 72 is limited to McCarter Ditch - Deeds Creek subwatershed, the Pike Lake Deeds Creek subwatershed (less the area around Chapman), and the Winona Lake – Eagle Creek subwatershed.

Pike Lake - Deeds Creek subwatershed and McCarter - Ditch Deeds Creek subwatershed:

Pike Lake is the receiving body to both subwatersheds. Pike Lake itself is rated at the upper end of the eutrophic state 68-65 (70 and above is considered hypereutrophic). The Trophic State Index (TSI) has generally been climbing from the mid-to-high 60s since 1998. The lake is high in nutrients, which is substantiated by the Deeds Creek monitoring results at site #1. Bi-weekly sampling for 21 months revealed data that exceeded the target benchmarks for nitrates 87% of the time, total phosphorus 46% of the time, *E*. coli 62% of the time, and 22% of the time for suspended solids. In addition, LARE studies for the last 20 years have raised concerns about nutrients entering Pike Lake. Deeds Creek and its tributaries serpentine through both subwatersheds. The chemical analysis for the last 2 years of biweekly sampling resulted in site #1 having the highest number of exceedances of target concentrations compared to all other monitoring sites.

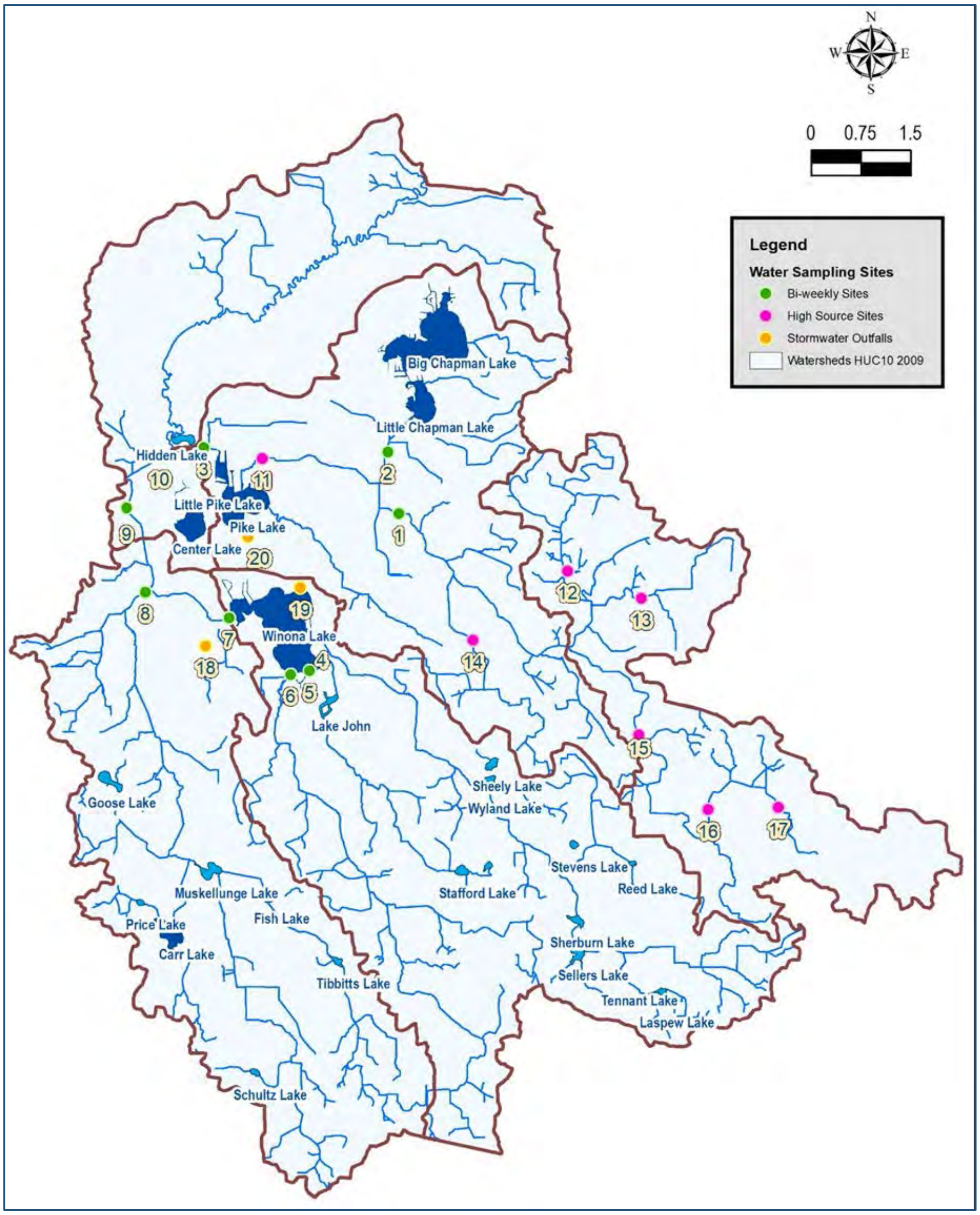


Figure 66 Waterways & Sampling Points

In an attempt to isolate the tributaries to Deeds Creek that could be the greatest sources of pollutants, additional monitoring was conducted in year two at six sites (#12-17) on the waterways feeding into the Deeds Creek from the Pike Lake - Deeds Creek and the McCarter - Ditch Deeds Creek subwatersheds. Results of the sampling indicate that the McCarter Ditch subwatershed is a strong contributor to the high levels being seen in sampling Sites #1 & #2.

All the sites (11-17) exceeded the E. coli either in seventy-five (75) percent or one hundred (100) percent of the samples taken. Sites 13 – 16 exceeded the target parameter either in seventy-five (75) percent or one hundred (100) percent of the time. Total Phosphorus was a problem for Site #12 & 13 and then also #15-17 where the samples exceeded the target seventy-five (75) or one hundred (100) percent of the time. Suspended Solids was less of a concern. One site (17) exceeded the target fifty (50) percent of the time.

In addition to Pike Lake – Deeds Creek and McCarter Ditch – Deeds Creek, the steering committee is proposing to include the Winona Lake – Eagle Creek subwatershed. Winona Lake – Eagle Creek Subwatershed is the largest subwatershed in the watershed. It has a significant number of agriculture acres that would benefit from BMPs. Both Martin Peterson Ditch and Wyland Ditch are high in nitrates (both exceeded the target threshold fifty-four percent of samples for nitrates) and phosphorus. The protection and improvement of water quality in Winona Lake is a long-term concern. Its TSI has increased from 52 to 60, and it has been classified as eutrophic for the last 20 years.

The area draining into Tennant Ditch in the headwaters of Wyland Ditch are important due to the concentration of highly erodible soils.

The land draining to Peterson Ditch is also a concern for highly erodible soils. Sampling at Site #6 provided water quality data on Peterson Ditch before its outlet to Winona Lake. During two years of testing at this site the pollutants exceeded the water quality target for *E. coli* 54% of the time, nitrates 54% of the time, phosphorus 25% of the time, and suspended solids 9% of the time. There is also evidence through field survey of heavy sedimentation in the southern part of Peterson Ditch. Through personal observation it was discovered that in-stream sediment depth exceeded three (3) feet in multiple places.

Keefer Evans was tested at Site #5 before flowing into Winona Lake and exceeded *E. coli* water quality targets 26% of the time and nitrates 24% of the time. Upstream of this site, the water flows though manmade Lake John which serves as a sediment trap filtering sediments and phosphorus.

In addition, as stated above, the committee believes strongly that shoreline restoration is an important BMP in the watershed for the protection of the large public lakes. That is why the committee included the shorelines (up to 12 feet landward) on Pike, Little Pike, Winona, Center, Little Chapman, and Big Chapman Lakes in the Priority I & II critical areas.

Early priority will be given to headwaters of Deeds Creek in the McCarter Ditch Subwatershed and any highly erodible land in this Priority Area whenever possible based on landowner participation. Shoreline restoration cost share incentive will also be promoted in the early phases of funding. This low dollar cost share will be used to incentivize waterway landowners to become early adopters of the initiative and set the example for their neighbors bringing high visibility success that will not only encourage additional participation in BMP adoption but also provide public success that will help the committee fundraise.

The committee will look to move to Priority II, then III areas as the landowners become fewer and more difficult to recruit from the Priority I Area and only after extensive work to publicize and recruit has become less effective. There is a large amount of work to do in this watershed and the committee believes that it is important to not stall when moving to the next priority areas but continue to work with willing landowners to reduce pollutants going into local waters. Being flexible to incorporate a high value target such as a cattle crossing or area of extensive erosion (other large pollutant site), even though it is not in the Priority I area would allow the most efficient use of funds and gain for water quality.

Priority II Critical Areas

Priority II consists of the tributaries entering Chapman Lakes (approximately 4,000 acres) and the Eagle Creek-Walnut Creek subwatershed (approximately 17,244 acres).

The Chapman Lakes area was determined a priority II level for multiple reasons. Big Chapman Lake's Trophic State Index has been in the high 40s (mesotrophic) and just entered the low 50s (eutrophic), testing at 52 in 2017. The Chapman Lakes area is also just a small part of the subwatershed (approximately 4,000 acres). The Chapman Lakes Foundation has provided active leadership in successfully partnering with Department of Natural Resources, Kosciusko County Soil & Water District, and The Watershed Foundation to complete restoration and water quality projects to maintain water quality and stop pollution entering the lakes. This is an important partnership to support through resources due to both its success and commitment to protecting water quality. It should be noted that none of the tributaries leading into Chapman Lakes were tested during this project. The closest monitoring site was Heeter Ditch, just downstream from Little Chapman. Heeter Ditch results are an inaccurate indicator of water quality in this subwatershed as the two lakes act as a filter for the water flowing through them.

The Eagle Creek-Walnut Creek subwatershed is also included in Priority II. This area has mixed use with rural residential, agricultural, and urban areas. Testing of Walnut Creek at Site #9 at the upper end of the subwatershed resulted in pollutant levels above the water quality targets in *E*. coli 32% of the time, nitrates 52%, and phosphorus 46% of the time. These results highlight water quality concerns in the headwaters of this subwatershed.

Just downstream of Site #8 is the confluence of Eagle Creek with Walnut Creek. Eagle Creek at Site #7 (as it leaves Winona Lake) is healthy and exceeded the pollutant benchmarks just 20% of the time for E. coli and 2% for nitrates, which is one (1) sample in two (2) years of sampling. Walnut Creek's water quality is improved by Eagle Creeks inflows. Pollutant levels of Walnut Creek before Eagle Creek exceeded E. coli target thresholds thirty-three (33) percent of the time, exceeded the nitrate threshold forty-four (44) percent of the time, and exceeded phosphorus fifty-two (52) percent of the time.

Pollution levels at Site # 9 (before flowing into the Tippecanoe River) exceeded target benchmarks for 26% of *E. coli* sampling, 11% nitrates, and 39% of total phosphorus sampling. Even though the concentrations of pollutants go down between Site #8 and Site #9, the total pollutant load based on pounds per year increases. Site #7 has 47,886 lbs/year nitrates and Site #8 (Walnut before Eagle) has 69,510 lbs/year nitrates, totaling 117,396 lbs/yr. Site# 9 (Walnut before the Tippecanoe has a nitrate load of 163,912. That would mean that in 1.5 miles of urban waterway, 46,516 lbs/year of nitrates are being added to the Creek, or over four (4) times the pollutant load per mile compared to the non-urban Walnut Creek area.

This subwatershed is identified as Priority II mostly because of the concentrations of pollutant loads entering the Tippecanoe River. As those pollutant concentrations are lower, the committee determined it would be more effective to start in other areas. It should be noted that there is a lack of data in the upstream portion of the watershed. The Eagle Creek – Walnut Creek subwatershed also has small private lakes that Walnut Creek flows through what most likely act as filters, primarily Tibbits, Fish, and Muskellunge Lakes. Additionally, the 2017 Agricultural Field Survey indicated that there is minimal use of cover crops for the farms in the southern tip of the subwatershed. Even with relatively high rates of conservation tillage through "avoidance of fall tilling", there would still be a winter/ spring nutrient release into the watershed without cover crops and other combination BMPs.

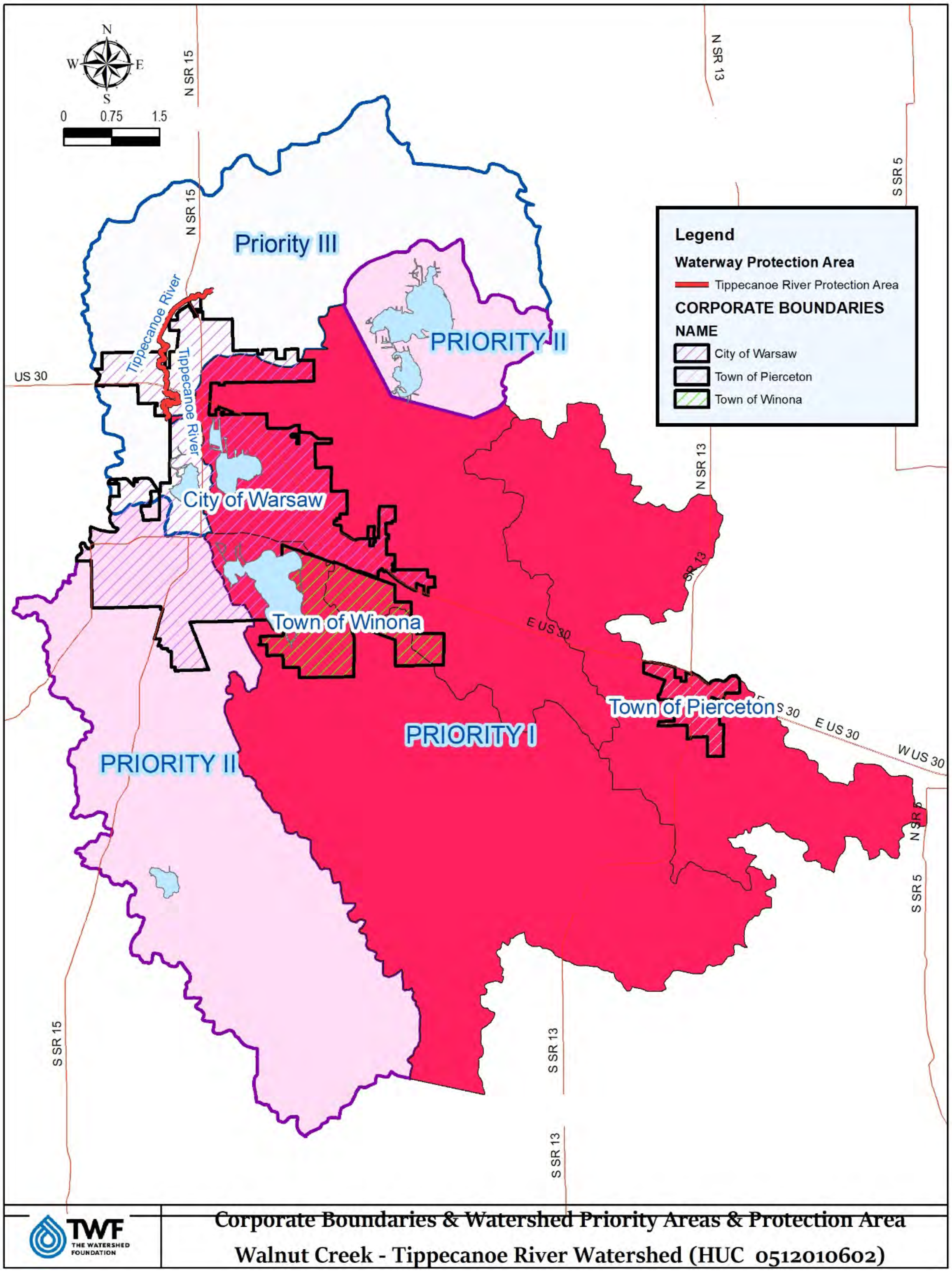


Figure 67 Proposed Critical Areas Walnut Creek - Tippecanoe River Watershed

Priority III Area

The Ruple Ditch – Tippecanoe River area is selected as a Priority III area. Farming in this area is almost exclusively

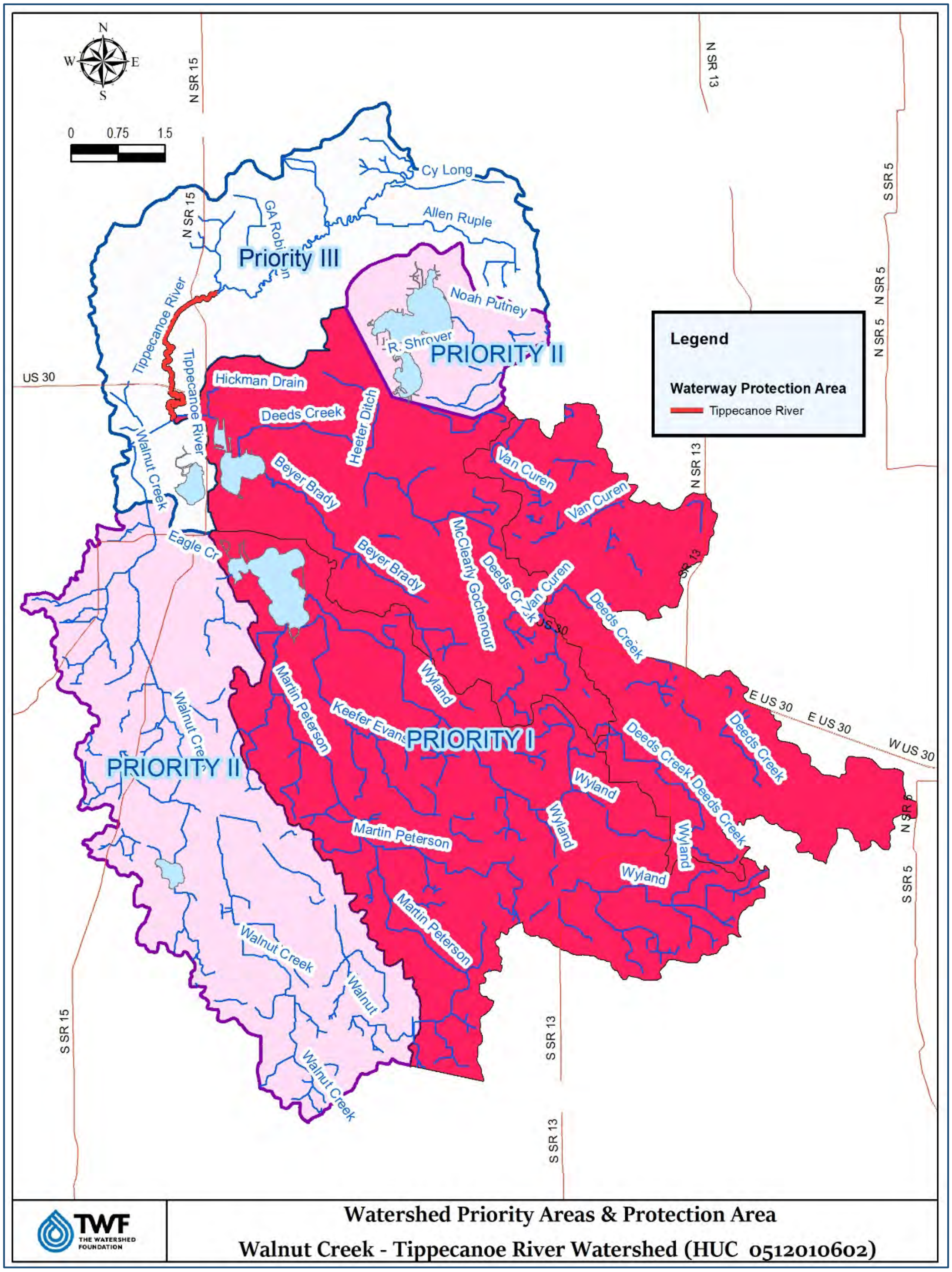


Figure 68 Watershed Priority Areas & Protection Zone

corporate farming. Poor conservation practices are prevalent here and the landowners have been less interested in working with local partners in the adoption of conservation practices. The steering committee believes that local family farms in priority Areas I & II are more likely to be early adopters of BMPs. The partners believe that by showing success in the other priority areas these landowners will also develop interest in BMP adoption and participate in conservation practices.

The Tippecanoe River between Fox Farm Road and just east of SR 15 is listed as a protection zone. ***The protection zone would be 200 feet adjacent to the edge of each bank***. This area is home to the endangered clubshell mussel, other mussels, and a Blue Heron rookery. The Blanding's turtle has been spotted at the wastewater treatment facility property on this stretch of river, as well. This area has had significant development in the last 10 years and is not yet completely developed. There is also a resurgence of recreation use of the Tippecanoe River in this stretch. Education and protective efforts are important in this area. Education should be focused to bring about changes in behavior that protect local waters and engage the public in conservation, recreation, and protection efforts. This area should be treated as a Priority I with regard to public outreach and local protection efforts.

Goal Statements

Goal 1: Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River. Currently, there are 978,144 lbs./year of nitrogen loading in the watershed and 50,981 lbs./year of phosphorus loading. This amount is an excess of 121,069 lbs./year of nitrogen and 3,230 lbs./year of phosphorus above the target levels set by the Clean Waters Partnership. Specific reduction goals include:

- A decrease in nitrates by 15,500 lbs./year in 5 years (or 1.5% reduction of the 981,144 lbs./year nitrates in the watershed) and a 10,500 lbs./year reduction in phosphorus in the next five years (or 20% reduction of the 50,981 lbs./year total of phosphorus in the watershed.) focusing on the Priority Area I first to reduce the pollutants entering Pike and Winona Lakes. Then moving to Priority Area II, then Priority Area III.
- An additional 2.6% reduction in the nitrate loading exceeding water targets and an additional 27% reduction in all phosphorus loading (25,000 N lbs./year; 11,000 P lbs./year) in the following 5 years (10-year mark).
- An additional 4% reduction of the nitrate loading exceeding water targets and a 60% reduction of phosphorus loading in the following 10 years (37,000 N lbs./year; 17,500 P lbs./year)
- Incentivize 20 landowners in the first 5 years to reconstruct their shoreline with natural features.
- Work with local partnerships, agencies, and organizations that provide financial and technical assistance to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.

Education and outreach, and BMP implementation are components of achieving the goals stated above. Lack of knowledge of the benefits/ savings associated with the BMPs results in lack of desire/motivation to install them – therefore, both education and BMP installation will be offered from the onset of the project.

GOAL 2: Reduce soil erosion and sedimentation, so current water quality conditions are protected or improved to Pike Lake and Winona Lake. Currently, sediment load entering Pike Lake is 760 tons/year and 586 tons/year to Winona Lake. However, only 347 tons/year are leaving Pike Lake, resulting in 413 tons/year remaining in Pike Lake and an estimated 346 tons/year remaining in Winona Lake. The watershed has a total sediment load of 3,867 tons/year. Specific targets include:

- A 23% decrease (900 tons/year) in the sediment load in the watershed in the next 5 years beginning in Priority Area I.
- An additional 50% decrease (1,500 tons/year) in the sediment load in the following 5 years (10-year mark).
- An additional 54% decrease (300 tons/year) in the sediment load in 20 years
- Add 75 acres of riparian buffers and filter strips to the watershed in 20 years

GOAL 3: Reduce *E. coli* concentrations to meet the water quality standard of 235 CFU/100 mL within the next 25 years at monitoring sites #1, 4, 6 where more than 45% of samples taken in 2016-2017 exceeded the state standard.

- Promote BMPs that control livestock direct access to streams to landowners of sites found during windshield survey of the watershed; identify other sites where direct access is occurring.
- Promote proper septic maintenance for landowners in the watershed by hosting workshops and distributing educational materials.

GOAL 4 Increase public awareness of how individual choices and activities impact water quality and engage stakeholders in behavior changing activities by creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.

- Increase educational signage at applicable, highly visible, locations in the Walnut Creek – Tippecanoe River watershed within a 10-year period. This signage will highlight best management practices, discourage litter, and offer general watershed education.

- Conduct educational workshops and distribute educational materials to help foster learning, and a passion for protecting the Walnut Creek – Tippecanoe River watershed that extends to people making individual behavior changes.
- Conduct a litter and trash pickup campaign in the watershed and educate the community that litter may contain hazardous materials that can cause adverse effects on water quality.

GOAL 5: To maintain rich biodiversity in the Walnut Creek – Tippecanoe River watershed, it is important to protect and enhance critical habitat and unique natural areas as well as threatened, endangered, and rare species.

- Coordinate with stakeholders (including City of Warsaw and Kosciusko County) to develop a plan to protect the critical protection area of the Tippecanoe River by implementing buffer zones from development and encouraging green infrastructure practices.
- Install BMPs to improve stream habitat in areas that have been hydrologically modified or the land has been denuded and no longer provide good quality habitat for aquatic life by installing BMPs such as critical area plantings or riparian buffer strips to provide overhead cover and shading to improve water temperature and improve oxygen holding capability. Waterways identified as low D.O. (sites # 1, 2, 7, 9) typically had summertime temperatures close to or exceeding 80 degrees Fahrenheit.
- Improve habitat and protection measures promoted in the Tippecanoe-Walnut Creek watershed by the hosting of educational workshops and distributing of educational materials promoting property owner habitat enhancements.
- Educate stakeholders on ways they can connect to local waters, become stewards of local state endangered and rare species, and understand the problems with invasive species.
- Install 30 acres of riparian buffers in the watershed in 20 years.

Goal 6: Hire both a watershed conservationist to recruit, educate, and provide technical support for landowners, and implement BMPs, ***and*** a watershed coordinator to build and maintain relationships with CWP partners, coordinate efforts and reports, and conduct educational events.

Best Management Practices (BMPs) are the practices that will be used in the watershed to reduce pollutant loads. BMPs are specific to reducing one or more pollutants and have been modeled in the STEPL application. TWF will be focusing on the indicate that we will prioritize implementation of our "Healthy Soil, Clean Water Package" – which Sam discussed is his email on 8/20/18. This package is what we have been encouraging in the Tippecanoe – Grassy Creek watershed for the past 6 years.

It includes no till, cover crops, precision nutrient management, buffers, and grassed waterways.

Agricultural BMP Practices for Implementation and/or Education

- Blind Inlets
- Conservation Buffer
- Conservation Cover
- Cover Crops
- Critical Area Planting
- Crop Residue Management
- Exclusion Fencing
- Forage and Biomass Planting
- Grassed Waterways
- Grazing Management Plan

- Heavy Use Area Protection (HUAP)
- Livestock Watering System
- Nutrient Management
- Stream Crossing
- Underground Outlets
- Water and Sediment Control Basin (WASCoB)

Urban BMP Practices for Implementation and/or Education

- Bioretention Practices
- Green Roof
- Green Infrastructure Retrofit
- Low Impact Development
- Pervious Pavement
- Pet Waste Management
- Waterfowl Management
- Rain Barrels
- Rain Gardens / Bioswales

Universal BMPs

- Clean Water Act Compliance
- Education
- Protection and Enhancement of Habitat Corridors
- Streambank and Lakeshore Improvement Stabilization
- Threatened and Endangered Species Protection

Descriptions of Best Management Practices

Agricultural Best Management Practices

USDA Department of Agriculture / Natural Resources Conservation Service Definitions

Advanced Nutrient and Pest Management

Nutrient Management is defined as the management of the 4R's of Nutrient Management: Right amount (rate), Right source, Right placement (method of application), Right timing of commercial fertilizers, manure, soil amendments, and organic by-products to agricultural landscapes as a source of plant nutrients while protecting local air, soil and water quality.

Blind Inlet
A blind inlet, similar to a French drain, is a structure that replaces a tile riser. The blind inlet is placed in the lowest point of farmed depressions or potholes to reduce the amount of sediment, nutrients, and other contaminants that would otherwise be transported to receiving ditches or streams. A blind inlet is located at the lowest elevation point of farmed depressions or potholes, where tile risers would normally be located. Compared to a tile riser, a blind inlet acts as a water treatment system. Blind inlets reduce the export of nutrients, pesticides, and sediment compared to tile risers. Blind inlets remove field obstructions (risers) and improve drainage in depressions where no tile riser exists.

Comprehensive Nutrient Management Plan
A comprehensive nutrient management plan (CNMP) is a conservation plan for an animal feeding operation (AFO). It documents how nutrients and contaminants will be managed in the production and land treatment areas of the farm to protect animal health, human health and the environment.

Conservation Buffer
Conservation buffers are small areas or strips of land in permanent vegetation, designed to intercept pollutants and manage other environmental concerns. Buffers include riparian buffers, filter strips, grassed waterways, shelterbelts, windbreaks, living snow fences, contour grass strips, crosswind trap strips, shallow water areas for wildlife, field borders, alley cropping, herbaceous wind barriers, and vegetative barriers.

Strategically placed buffer strips in the agricultural landscape can effectively mitigate the movement of sediment, nutrients, and pesticides within farm fields and from farm fields. When coupled with appropriate upland treatments, including crop residue management, nutrient management, integrated pest management, winter cover crops, and similar management practices and technologies, buffer strips should allow farmers to achieve a measure of economic and environmental sustainability in their operations. Buffer strips can also enhance wildlife habitat and protect biodiversity.

Conservation buffers slow water runoff, trap sediment, and enhance infiltration within the buffer. Buffers also trap fertilizers, pesticides, pathogens, and heavy metals, and they help trap snow and cut down on blowing soil in areas with strong winds. In addition, they protect livestock and wildlife from harsh weather and buildings from wind damage. If properly installed and maintained, they have the capacity to remove up to 50 percent or more of nutrients and pesticides, remove up to 60 percent or more of certain pathogens., and remove up to 75 percent or more of sediment.

Conservation buffers reduce noise and odor. They are a source of food, nesting cover, and shelter for many wildlife species. Buffers also provide connecting corridors that enable wildlife to move safely from one habitat area to another. Conservation buffers help stabilize a stream and reduce its water temperature. Buffers also offer a setback distance for agricultural chemical use from water sources.

Conservation Cover
Establishing and maintaining permanent vegetative cover. This practice is applied to support one or more of the following purposes: to reduce sheet, rill, and wind erosion and sedimentation, to reduce ground and surface water quality degradation by nutrients and surface water quality degradation by sediment, reduce emissions of particulate matter (PM), PM precursors, and greenhouse gases, enhance wildlife, pollinator and beneficial organism habitat. This practice applies on all lands needing permanent herbaceous vegetative cover. This practice does not apply to plantings for forage production or to critical area plantings. This practice can be applied on a portion of the field.

Cover Crops
Crops including grasses, legumes, and forbs for seasonal cover and other conservation purposes. Its purpose is to reduce erosion from wind and water, increase soil organic matter content, capture and recycle or redistribute nutrients in the soil profile, promote biological nitrogen fixation and reduce energy use, increase biodiversity, suppress weeds, manage soil moisture, and minimize and reduce soil compaction. All lands requiring vegetative cover for natural resource protection and or improvement are suitable for cover crops.

Critical Area Planting
Establishing permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices. The purpose is to stabilize stream and channel banks, and shorelines, stabilize areas with existing or expected high rates of soil erosion by wind or water, rehabilitate and revegetate degraded sites that cannot be stabilized using normal establishment techniques, and riparian areas.

Crop Residue Management

Conservation tillage systems have at least 30 percent of last year's crop residue on the soil at planting. Residue adequately controls erosion by both wind and water, among other conservation benefits. A producer can save at least 3.5 gallons of fuel per acre by going from conventional tillage methods to no-till. On a farm with 1,000 acres of cropland, these savings add up to 3,500 gallons of diesel fuel per year.

Exclusion Fencing
Fencing is constructed to control movement of animals, vehicles, or people. Examples include excluding livestock from streams and critical areas to improve water quality and soil health. Benefits include reduced soil erosion, sedimentation, pathogen contamination and pollution from attached substances.

Forage and Biomass Planting
Forage and biomass planting are the establishment of adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay, or biomass production. Its purpose is to improve or maintain livestock nutrition and/or health, provide or increase forage supply during periods of low forage production, reduce soil erosion, improve soil and water quality, produce feedstock for biofuel or energy production.

Grade Stabilization Structures
Grade Stabilization Structure: An earthen, concrete or other structure built across a drainageway to prevent gully erosion. A dam or embankment built across a gully or grass waterway drops water to a lower elevation while protecting the soil from gully erosion or scouring. Structures are typically either a drop spillway or a small dam and basin with a pipe outlet.

Grassed Waterways
A shaped or graded channel that is established with suitable vegetation to convey surface water at a non- erosive velocity using a broad and shallow cross section to a stable outlet to convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding, to prevent gully formation, and to protect/improve water quality.

Grazing Management Plan
A grazing management plan is a site-specific conservation plan developed for a client which addresses one or more resource concerns on land where grazing related activities or practices will be planned and applied. The grazing management plan can reduce soil erosion control, improve water quality, improve habitat for fish and wildlife, rangeland/pasture/grazed woodland health and productivity, and other identified resource concerns.

Heavy Use Area Protection (HUAP)
Heavy Use Area Protection (HUAP) is the stabilization of areas frequently and intensively used by people, animals or vehicles by establishing vegetative cover, surfacing with suitable materials, and/or installing needed structures. HUAP practice is installed to provide a stable, non-eroding surface for areas frequently used by animals, people or vehicles, or to protect and improve water quality.

Livestock Watering Systems
Livestock watering systems ensure that livestock have clean drinking water from natural sources such streams, ponds, springs or wells. Well-designed watering systems protect soil and water quality while improving livestock health and productivity. They are especially important in riparian areas near waterbodies. They reduce sediment and nutrient loading in streams and lakes by preventing bank and shore erosion and limiting the amount of livestock urine and feces deposited directly in the water.

Multiple access points can improve water quality and soil health by more evenly spreading manure and urine across a pasture, enhancing grass growth and avoiding runoff of nutrients into surface waters. Multiple watering points also keep livestock from overgrazing the area around any one tank and prevent soil erosion caused by livestock trailing habitually to and from the same spot. Similar conservation benefits are achieved with portable watering systems, which move water to the paddocks where livestock are currently grazing.

Manure Storage Structures

A waste storage facility that protects downstream water courses from manure runoff by storing manure until conditions are appropriate for field application. The type of manure storage structure depends upon the livestock operation, animal waste management system and planned field application.

No Till

No Till is a conservation practice that leaves the crop residue undisturbed from harvest through planting except for narrow strips that cause minimal soil disturbance. Crop residues are materials left in an agricultural field after the crop has been harvested. These residues include stalks and stubble (stems), leaves and seed pods. Good management of field residues can increase efficiency of irrigation and control of erosion. No-till can be used for almost any crop in almost any soil and can save producers labor costs and fuel. It's a sound investment for the environment and the farm.

In addition to energy efficiencies and cost savings, no-till has several environmental benefits. No-till increases the organic matter in the soil, making it more stable and helping prevent soil erosion. No-till reduces greenhouse gases because it requires less fuel and sequesters (stores) carbon in the soil. Other benefits of using no-till as part of a resource management system include: increased earthworm populations that improve soil quality—an average of 540,000 earthworms per acre versus 285,000 in conventional tillage; increased water infiltration by cutting evaporation and runoff by at least 70 percent, reduced tilling time per acre by as much as two-thirds, and improved wildlife habitat.

Nutrient Management

Nutrient management is using crop nutrients as efficiently as possible to improve productivity while protecting the environment. Nutrients that are not effectively utilized by crops have the potential to leach into groundwater or enter nearby surface waters via overland runoff or subsurface agricultural drainage systems. Too much nitrogen or phosphorus can impair water quality. Therefore, a major principle of crop nutrient management is to prevent the over-application of nutrients. This not only protects water quality but also benefits a farm's bottom line. The keys to effective crop nutrient management are developing and following a yearly plan and conducting soil tests to determine the nutrient needs of crops. (Increasingly, soil nitrate testing before applying fertilizer and plant tissue testing are also used.) It is essential to keep good records on the rate, method and timing of all nutrient applications. It is also important to note the source of the nutrients, be they purchased fertilizers, manure or other bio-solids, legumes or irrigation water. Residual nutrients in the soil must also be accounted for. Keeping good records help farmers compare expenses and returns from year to year. In short, good records provide solid information that helps farmers and crop consultants decide whether and how to adjust nutrient application rates, methods and timing.

For water quality purposes, nutrient management is especially important on slopes, on soils with high phosphorus levels and in environmentally sensitive areas. Sensitive areas include shoreland (land near rivers, stream, lakes and wetlands), areas around wells and surface drainage inlets, areas with sandy soil or shallow soil over bedrock (especially fractured bedrock) and wherever groundwater is close to the surface. Nutrient Management enhances profitability by significantly reducing purchased fertilizer costs, protects surface water quality by minimizing nutrients, organic matter and pathogens in agricultural runoff, protects groundwater in wellhead protection areas from nitrate contamination, improves soil quality and productivity by increasing nutrient retention and water holding capacity and enhancing soil structure, and helps protect public health when nutrient application occurs near municipal or domestic wells, residences, businesses, schools and public lands.

Prairie Restoration

This activity consists of restoring/renovating prairie habitat by establishing native vegetation and managing the restored plant community. Establishing and managing native prairie vegetation will provide food, cover, and nesting habitat for adapted species, especially grassland nesting birds.

This enhancement applies to sites that have soils that indicate it was once a prairie or can sustain native prairie species.

Prescribed Grazing
Prescribed grazing involves managing the harvest of vegetation with grazing and/or browsing animals. This practice is commonly used in a Conservation Management System with practices such as Brush Management, Fencing, Heavy Use Area Protection HUAP, Livestock Pipeline, Pond, Spring Development, Water Well, and Watering Facility.

Stream Crossing
A stream crossing provides a hard, stable area where cattle or equipment can cross a stream without damaging the streambed or banks. Benefits of a Stream Crossing include providing livestock access to pastures, improving access to crop and graze fields that are difficult to get to, improve cattle health by keeping them out of the mud, improve water quality by keeping cattle out of the stream.

Tree Planting
A variety of desired tree species, either seedling or seeds, are planted mechanically or by hand in understocked woodlands or open fields. Tree species are matched with soil types and selected to prevent soil erosion, increase income, or boost productivity of existing woodlands. Trees also provide protection from rill and sheet erosion, protects water quality by filtering excess nutrients and chemicals from surface runoff, increases infiltration rates, and provides long-term wildlife habitat.

Water and Sediment Control Basin (WASCoB)
A water and sediment control basin (WASCoB) is an earth embankment or a combination ridge and channel constructed across the slope of a minor drainageway. The purpose of this practice is to reduce gully erosion, trap sediment, and reduce and manage runoff. WASCOBs are constructed across small drainageways where they intercept runoff. The basin detains runoff and slowly releases it allowing sediment to settle. WASCoBs generally use an underground outlet to control the release and carry the runoff in a pipe to a receiving stream or ditch. This practice applies to sites where the topography is generally irregular, gully erosion is a problem, other conservation practices control sheet and rill erosion, runoff and sediment damages land and works of improvement, and stable outlets are available. (NRCS.USDA.GOV)

Wetland Restoration
The return of a wetland and its functions to a close approximation of its original condition as it existed prior to disturbance on a former or degraded wetland site.

Urban BMPs

Bioretention Practices
Bioretention is a terrestrial-based (up-land as opposed to wetland) water quality and water quantity control process. Bioretention employs a simplistic, site-integrated design that provides opportunity for runoff infiltration, filtration, storage, and water uptake by vegetation.
Bioretention areas are suitable stormwater treatment practices for all land uses, as long as the contributing drainage area is appropriate for the size of the facility. Common bioretention opportunities include landscaping islands, cul-de-sacs, parking lot margins, commercial setbacks, open space, rooftop drainage and streetscapes (i.e., between the curb and sidewalk). Bioretention, when designed with an underdrain and liner, is also a good design option for treating stormwater hotspots (PSHs). Bioretention is extremely versatile because of its ability to be incorporated into landscaped areas. The versatility of the practice also allows for bioretention areas to be frequently employed as stormwater retrofits. (Minnesota Stormwater Manual)

Green Roof
A green roof system is an extension of the existing roof which involves, at a minimum, high quality waterproofing, root repellent system, drainage system, filter cloth, a lightweight growing medium, and plants.

Green roof systems may be modular, with drainage layers, filter cloth, growing media, and plants already prepared in movable, often interlocking grids, or loose laid/built-up whereby each component of the system may be installed separately. Green roof development involves the creation of "contained" green space on top of a human-made structure. This green space could be below, at, or above grade, but in all cases, it exists separate from the ground. Green roofs can provide a wide range of public and private benefits and have been successfully installed in countries around the world.

Green roofs provide a variety of environmental benefits to aesthetic improvements, waste diversion, moderation of the heat island effect, improved air quality, and stormwater benefits. Some of the water benefits include; water is stored by the substrate and then taken up by the plants from where it is returned to the atmosphere through transpiration and evaporation, in summer, green roofs can retain 70-90% of the precipitation that falls on them, in winter, green roofs can retain between 25-40% of the precipitation that falls on them, green roofs not only retain rainwater, but also moderate the temperature of the water and act as natural filters for any of the water that happens to run off, and green roofs reduce the amount of stormwater runoff and also delay the time at which runoff occurs, resulting in decreased stress on sewer systems at peak flow periods.

Green Infrastructure Retrofit
A green infrastructure retrofit involves inserting green infrastructure into a site or neighborhood that is already developed and is not currently being redeveloped. Developed urban areas with large expanses of impervious surfaces produce large volumes of runoff may not be redeveloped for 20 – 50 years or more. A green infrastructure retrofit can reduce stormwater and pollutant impact without waiting for a neighborhood or transportation system to be redeveloped. Areas targeted could be known infrastructure problems, large impervious areas that lead to sensitive waterways, areas of known pollutant discharges, areas of chronic flooding problems, areas of channel erosion, or to support stream restoration projects.

Low Impact Development (LID)
LID employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat stormwater as a resource rather than a waste product. There are many practices that have been used to adhere to these principles such as bioretention facilities, rain gardens, vegetated rooftops, rain barrels and permeable pavements. By implementing LID principles and practices, water can be managed in a way that reduces the impact of built areas and promotes the natural movement of water within an ecosystem or watershed. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions. (EPA.gov)

Pervious Pavement
Pervious pavement alternatives to traditional pavement on our paved surfaces can help reduce runoff by infiltrating rainwater and melting snow. These include pervious asphalt, pervious concrete, interlocking pavers, and plastic grid pavers, allow rain and snowmelt to seep through the surface down to underlying layers of soil and gravel. In addition to reducing the runoff from the rain that falls on them, permeable pavements can help filter out pollutants that contribute to water pollution. Permeable pavements can also reduce the need for road salt and reduce construction costs for residential and commercial development by reducing the need for some conventional drainage features. (NRCS Conservation Practices, EPA.gov)

Pet Waste Control
Pets and urban wildlife are major sources of water contamination because pet waste contains harmful bacteria and parasites. Dog feces can contain fecal coliform bacteria, which can spread diseases like Giardia, Salmonella, and Campylobacter, causing serious illness in humans. The EPA list lists proper disposal of dog waste on the Nation Menu of BMPs for stormwater. Although dog waste may not be the leading fecal matter contributor in the watershed as a whole, dogs, particularly in an urban area, where dog waste over a hundred or more acres enter the storm drain collection system and exit a single outfall can become a health hazard in that waterbody.

Waterfowl Management
The purpose of waterfowl management is to reduce damage to agricultural, urban, and natural resources, as well as reducing threats to public health through the introduction of coliform bacteria into local waters.

Rain Barrels
Rain barrels capture water from a roof and hold it for later use such as on lawns, gardens, or indoor plants. Collecting roof runoff in rain barrels reduces the amount of water that flows from your property and thus reduces the pollutants flowing from your property. It's a great way to conserve water and it is free water for use in your landscape. (EPA.gov) Rain barrels are generally not a significant reducer of pollutants or stormwater because most are 55 to 200 gallons storage per property; however, they provide the individual an opportunity to participate in actively protecting water quality. That effort and education is invaluable as the multiplier effect where one effort can translate to a lifetime of many individual water protective efforts by a single person and then others whom they influence.

Rain Gardens / Bioswales
Rain gardens are depressional areas landscaped with native perineal plants that soak up rainwater. They are strategically located to capture runoff from impervious surfaces, such as roofs and streets. Rain gardens fill with a few inches of water after a rain event and then the water filters into the ground rather than running off into a storm drain. Stormwater runoff from developed areas increases urban flooding potential and carries pollutants from streets, parking lots, and lawns into local streams and lakes. Rain gardens can absorb most rainfall events and the "first flush" of other larger events. The "first flush" of any rain event is the first amount of rain flowing over surfaces and grabs most pollutants leaving cleaner water to flow behind.

Stormwater Basin
Stormwater basins are impoundments or excavated basins for the short-term detention of stormwater runoff from a completed development area followed by controlled release from the structure at downstream, pre-development flow rates. There are several types of detention devices, the most common being the dry detention basin and the extended dry detention basin. These structures hold and release the water through a controlled outlet over specified time period based on the design criteria. The extended detention basin drains more slowly or may retain a permanent pool of water. Stormwater infiltration basins are facilities constructed within highly permeable soils that provide temporary storage of stormwater runoff. An infiltration basin does not normally have a structural outlet to discharge runoff from a specific design storm. Instead, outflow from an infiltration basin is through the surrounding soil. An infiltration basin may also be combined with an extended detention basin to provide additional runoff storage from both stormwater quality and quantity management. (NRCS New Jersey)

Universal BMPs

Clean Water Act Compliance

Indiana has Administrative Code to address federal Clean Water Act laws related to stormwater discharges from urbanized areas, construction earth moving activities greater than 1 acre of disturbed land in any area, laws regulating stormwater from industrial sites, and National Pollutant Discharge and Elimination System (NPDES) discharges into waters of the US. These laws are written to protect and improve water quality by focusing on point source discharge activities that produce the largest pollutants by volume in the United States. Federal, state, and local jurisdictions are responsible for different aspects of the Clean Water Rules. It is important to provide local education, oversight, and agency cooperation of activities that are a part of the Clean Water Act legislation to protect local and regional waters.

Education
Public Education and Public Participation are two of the federally mandated minimum control measures for designated Municipal Separate Stormwater Sewer Systems (MS4) communities. They are required elements to be used as a method to affect behavior change. In this case, education and public participation methods are an important to use as a method of attitude and behavior change for the entire watershed. The Walnut Creek – Tippecanoe River Watershed has several education partners that should work together to provide a cohesive plan to identify needs and then develop a plan to affect watershed change and improvement.

Streambank and Lakeshore Improvement & Stabilization
Streambanks can erode for a variety of reasons. Changes in stream flow, sediment load, and erosion or deposition on the streambanks will cause the stream to seek a new balance. Increasing paved areas or removing vegetative ground cover in the watershed will reduce the infiltration of rainfall and cause more runoff from the land. This leads to higher stream flows with an increased capacity to scour streambeds and undercut streambanks. Soil erosion from adjacent lands will cause increased sediment build up if the stream flow is insufficient to carry the load of soil (sediment) along the stream.

In urban or suburban areas, it is likely that the stream channel has or is in the process of adjusting to increased runoff by eroding deeper and/or wider. Many urban streams which have eroded their banks so that the channel can carry greater flows will have lost the streamside vegetation that helps control bank erosion.

A healthy aquatic population in a stream depends on maintaining a variety of suitable habitats, adequate food supply, and clean water. Fish and the aquatic organisms on which they feed require a mixture of habitats such as fast-flowing riffles, deep pools cool water, rocks, snags, and overhanging vegetation. Streamside vegetation is important to wildlife because it provides a food supply, shade to cool the water, and cover for roosting, resting, nesting, and protection. (Georgia Soil & Water Conservation Committee, Guidelines for Streambank Restoration 2000)

Threatened and Endangered Species Protection
An “endangered” species is one that is in danger of extinction throughout all or a significant portion of its range. A “threatened” species is one that is likely to become endangered in the foreseeable future. Protecting threatened and endangered (T&E) wildlife and plants from the impacts of disease, invasive species, and predators should be a focus of all subwatersheds. Protecting threatened and endangered species requires consideration of their habitat including food, water, nesting and roosting living space, and preferred substrate for plants. The Watershed Management Plan contains a list of current endangered and threatened species.

Proposed BMPs, Pollutant Reduction Values, & Needs in the Watershed

The following table identifies typical BMPs used to reduce pollutant loads along with their pollutant reduction value and financial cost to implement. Additionally, most BMPs have a number of known potential landowners that could use that particular BMP on their property to reduce overall pollutant loading in the watershed. Each “known property” is actually a landowner that has one or more properties in that area. Thirty-one landowners were identified by TWF’s Conservationist with known property needs who also have a relationship with one or more of the partners of this project. Figure 73 maps the approximate location of one of the properties owned by each landowner. This is just a starting point for beginning the work in the watershed.

Crop or Pasture C / P	Suggested BMPs	Load Reductions			Unit	Rotations	Estimated Cost in Dollars (per unit)	No. of Known Properties in the Priority I Critical Area Needing BMP
		Nitrogen (lb/yr /ac)	Phosphorus (lb/yr/ac)	Sediment (t/yr/ac)				
P	Alternative Livestock Watering Systems (378, 516,574, 614, 642)	0.491	0.046	0.014	ea.	1	987.14	8
C	Blind Inlet (underground outlet) (620)	3.414	0.048	0.076	ea.	1	900.00	
C	Conservation Buffer (filter Strip) (393)	3.414	0.111	0.202	ac	1	630.43	16
P	Conservation Buffer (filter Strip) (393)	3.060	0.250	0.049	ac.	1	630.43	2
C	Conservation Cover Riparian Herbaceous & Forest Cover (390 & 391)	4.625	1.189	0.222	ac.	1	630.43	
C	Cover Crops (340)	1.910	0.389	0.076	ac.	2	35.00	22
C	Critical Area Planting (342)	0.256	0.048	0.025	ac	1	534.45	2
P	Critical Area Planting (342)	0.256	0.048	0.025	ac.	1	534.45	1
P	Forest Buffer (minimum 35 feet wide)	1.643	0.150	0.041	ac.	1	630.43	10
C	Crop Residue Management (329)	2.982	1.712	0.292		1	21.00	23
P	Exclusion Fencing (382)	0.821	0.134	0.047	ft.	1	1.41	2
P	Forage and Biomass Planting (512)	0.606	0.038	0.000	ac.	2	131.50	11
	Grade Stabilization Structure (420)	uk	uk	uk	cy.	1	81.90	12
P	Grassed Waterway (412)	0.688	0.090	0.032	ac.	1	2655.25	9
P	Grazing Management Plan - Written (110)	1.440	0.066	0.000	no.	1	2308.14	
P	Heavy Use Area Protection (HUAP) (561)	0.694	0.080	0.025	sf.	1	1.06	7
P	Litter Storage and Management (313, 367)	0.469	0.035	0.000	sf.	1	6.50	3
C	Nutrient Management (Basic NM manure / compost) (590)	1.261	0.088	0.000	ac	1	15.49	
C	Nutrient Management Adaptive (590)	2.022	1.102	0.000	no.		1880.26	19
C	Nutrient Management Plan Written) (102)	2.022	1.102	0.000	no.	1	6264.00	
P	Prescribed Grazing (528)	1.448	0.088	0.025	ac.	1	21.31	8
	Streambank Stabilization w/o Fencing	0.642	0.109	0.044	ft	1	38.36	
P	Stream Crossing (culvert) (578)	7.050	1.827	0.285	Dialnft	1	0.36	
	Wetland Restoration (657)	6.120	1.778	0.228	ac.	1	2921.15	1
C	Water and Sediment Control Basins (WASCOB) with Blind Inlet (638 + 620)	8.100	2.840	0.340	cy.	1	3100.00	10

Table 35 Load Reductions per BMP with Estimated Costs

Load Reductions per BMP – STEPL numbers

The following scenarios are based on possible BMP reductions for the 5 year, 10 year, and 20 year models. The reduction goals set were based on these models. The reduction rates and number of acres of pasture and cropland were taken from the STEPL model to ensure realistic reductions. Known sites in the watershed that currently require BMPs were also considered. Those were compiled by The Watershed Foundation's Conservationist. The Conservationist is a local farmer and landowner who has worked with The Watershed Foundation for over 10 years working with other local landowners on installing BMPs in the Grassy Creek – Tippecanoe River Watershed adjacent to the Walnut Creek – Tippecanoe River Watershed. He is a retired conservationist for Kosciusko County NRCS. His developed a list of BMPs needed on different sites and landowners that he believed would be possible early adopters of BMP installation based on his long-time involvement in the community and his relationships with landowners. See figure below.

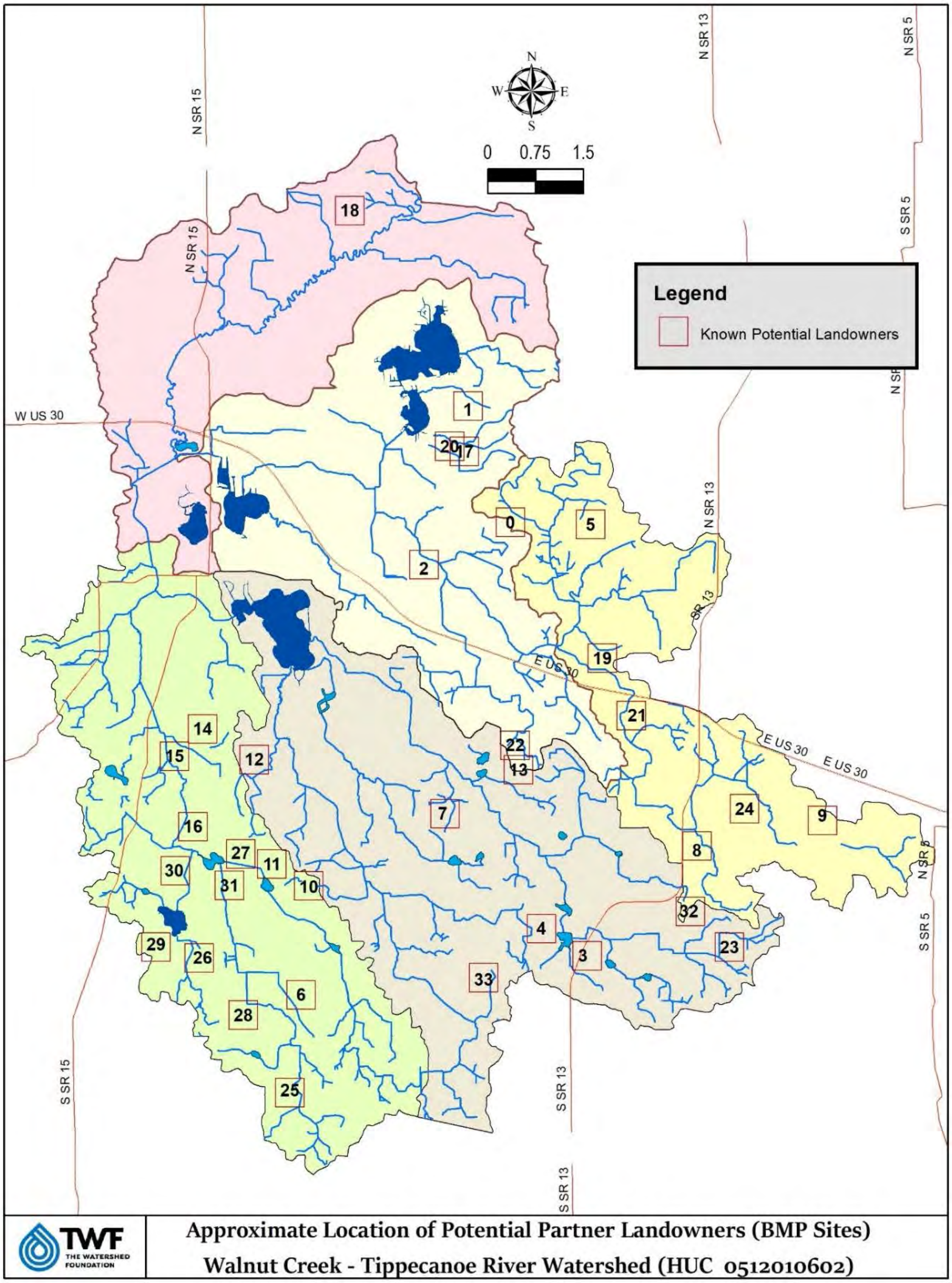


Figure 69 Approximate locations of Known Potential BMP sites

On the 20-year model Table 39 the sediment reduction is listed in red. It exceeded the total sediment load calculated in the waters of the watershed. The 20-year number for sediment was consequently reduced to take account for that anomaly. Additionally, cost is a realistic factor in implementing BMPs and reductions. The modeling done here worked with approximately $100,000 per year. If funding allowed additional BMPs to be installed, the reductions could be achieved at a faster rate.

5 Year Project Plan Based on Possible BMPs and Application Rates												
BMP Land Use Location	Practice	Acres Applied	Reduction N lb/ac/yr	Total N Reduction lb/yr	Reduction P lb/ac/yr	Total P Reduction lb/yr	Reduction Sediment t/ac/yr	Total Sediment Reduction t/yr	Cost per acre or lf	Cost per Application	# Yrs or # Applications	Total Cost
Crop	Cover Crops	2,780	1.91	5,318	0.38871	1,081	0.08	211	$35.00		2	$194,600
Crop	No Till 60% or greater	4,090	1.72	7,035	1.71241	7,004	0.29	1,196	$21.00		1	$85,890
Crop	Filter Strip (35ft)	20	3.41	68	1.10546	22	0.20	4	$630.43		1	$12,609
Crop	Nutrient Management Plan	1,960	2.02	3,963	1.10232	2,161	-	-		$1,880	10	$18,800
Crop	WASCoB combined with Blind Inlet	200	8.10	1,620	2.84000	568	0.34	68		$1,500	40	$60,000
Crop	WASCoB combined with Blind Inlet									$900	40	$36,000
Crop or Pasture	Critical Area Planting	30	0.69	21	0.08811	3	0.03	1	$534.35		1	$16,031
Pasture	Exclusion Fencing	36	0.83	30	0.13568	5	0.05	2	$1.41		8,000	$11,280
Pasture	Forage and Biomass Planting	100	0.61	61	0.03877	4	-	-	$131.50		2	$26,300
Pasture	Prescribed Grazing	310	1.44	448	0.08987	28	0.03	8	$21.31		1	$6,606
In-stream	In-stream BMPs to raise O2									$10,000	5	$50,000
			Totals	**18,562**		**10,874**		**1,490**				**$ 518,115**

Table 36 Sample Stepl Model Load Reductions in the Watershed 5 year model

10 Year Project Plan Based on Possible BMPs and Application Rates												
BMP Land Use Location	Practice	Acres Applied	Reduction N lb/ac/yr	Total N Reduction lb/yr	Reduction P lb/ac/yr	Total P Reduction lb/yr	Reduction Sediment t/ac/yr	Total Sediment Reduction t/yr	Cost per acre, lf, or application	Cost per Application	# Yrs or per Application	Total Cost
Crop	Cover Crops	6,546	1.91	12,521	0.38871	2,545	0.08	497	$35		2	$458,220
Crop	No Till 60% or greater	6,546	1.72	11,259	1.71241	11,209	0.29	1,913	$21		1	$137,466
Crop	Filter Strip (35ft)	45	3.41	154	1.10546	50	0.20	9	$630.43		1	$28,369
Crop	Nutrient Management Plan	5,727	2.02	11,579	1.10232	6,313	-	-		$1,880	29	$54,520
Crop	WASCoB combined with Blind Inlet	600	8.10	4,860	2.84000	1,704	0.34	205		$1,500	80	$120,000
Crop or pasture	WASCoB additional Pipe Expense									$900	80	$72,000
Pasture	Critical Area Planting	61.75	0.69	43	0.08811	5	0.03	2	$534.35		1	$32,996
Pasture	Exclusion Fencing	99	0.83	82	0.13568	13	0.05	5	$1.41		16,000	$22,560
Pasture	Forage and Biomass Planting	309	0.61	187	0.03877	12	-	-	$131.50		2	$81,267
Pasture	Prescribed Grazing	495	1.44	715	0.08987	44	0.03	13	$21.31		1	$10,548
In-stream	In-stream BMPs to raise O2									$10,000	10	$100,000
			Totals	41,400		21,896		2,644				$ 1,117,947

Table 37 Sample Stepl Model Load Reductions in the Watershed 10 year model

20 Year Project Plan Based on Possible BMPs and Application Rates												
BMP Land Use Location	Practice	Acres	Reduction N lb/ac/yr	Total N Reduction lb/yr	Reduction P lb/ac/yr	Total P Reduction lb/yr	Reduction Sediment t/ac/yr	Total Sediment Reduction t/yr	Cost per acre, lf, or application	Cost per Application	# Yrs or per Application	Total Cost
Crop	Cover Crops	15,000	1.91	28,692	0.38871	5,831	0.08	1,139	$35		2	$1,050,000
Crop	No Till	12,000	1.72	20,640	1.71241	20,549	0.29	3,508	$21		1	$252,000
Crop	Filter Strip (35ft)	75	3.41	256	1.10546	83	0.20	15	$630.43		1	$47,282
Crop	Nutrient Management Plan	8,500	2.02	17,186	1.10232	9,370	-	-		$1,880	30	$56,400
Crop	WASCoB combined with Blind Inlet	1,146	8.10	9,279	2.84000	3,253	0.34	391		$2,200	160	$352,000
Crop	WASCoB Required Pipe									$900	160	$144,000
Pasture	Heavy Use Area Protection (HUAP)	4	0.69	3	0.08000	0	0.03	0	$1.06		157,500	$166,950
Pasture	Litter Storage and Management	60	0.47	28	0.03500	2	-	-	$3,600	$6.50	3	$70,200
Pasture	Critical Area Planting	124	0.69	85	0.08811	11	0.03	4	$534.35		1	$65,992
Pasture	Alt. Livestock Watering System	40	0.49	20	0.04600	2	0.01	1		$987.14	8	$7,897
Pasture	Exclusion Fencing	124	0.83	102	0.13568	17	0.05	6	$1.41		20,000	$28,200
Pasture	Forage and Biomass Planting	741	0.61	449	0.03877	29	-	-	$131.50		2	$194,883
Pasture	Prescribed Grazing	618	1.44	892	0.08987	55	0.03	16	$21.31		1	$13,159
In-stream	In-stream BMPs to raise O2 Level									$10,000	10	$100,000
			Totals	**77,632**		**39,202**		**5,080**				**$2,548,964**

Table 38 Sample Stepl Model Load Reductions in the Watershed 20 year model

Action Plan

The following action plan demonstrates the goals broken down into milestones for each goal, naming the target audience, the possible partners, and the cost for each milestone. It is the roadmap for meeting the watershed target water quality goals. As nitrates are substantially higher than the phosphorus and sediment, the end of the 20-year term may not yield reduction to water quality standards. A new or revised plan may need to be developed.

The Watershed Foundation has been working in the Grassy Creek – Tippecanoe River Watershed for over 20 years with great success in large part due to their ability to work local specialists and partners to assist local landowners in understanding the benefits of protecting water quality through the implementation of effective BMPs. The Watershed Foundation hires a watershed conservationist to specifically do this work in the watershed.

Goal	NO3	Objective	Target Audience	Milestone	Cost	Possible Partners
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Nitrates	Develop a nutrient education program for farmers and develop a relationship with landowners and operators to provide technical support and cost-share of BMPs.	Landowners and Operators	Within 3 months of implementation, develop a cost-share program and strategy to offer cost-share BMPs to landowners and operators.	Estimate 2 weeks staff time = $2,800	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Within 3 months of implementation, utilize the 2018 social indicator survey information to develop an effective education campaign to reach farmers.	Estimate 1-week staff time = $1,400	
				Develop or acquire an education piece with 3 months of implementation to explain the program to farmers.	Estimate 1-week staff time = $1,400	
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in nutrient knowledge.	Estimate 2 weeks staff time = $2,800	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Nitrates	(1) Decrease nitrates by 15,500 lbs./year in the first five years, 40,500 lbs./year nitrates in 10 years, and 77,500 lbs./year nitrates in 20 years.	Landowners and Operators	During the first 2 years, implement no till on 1,900 acres. By the end of year 5, implement no till on 4,000; 6,500 acres by year 10; 12,000 acres by year 20.	252,000	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Plant 1,100 acres in cover crops during the first implementation grant. Participants would plant each year for two consecutive years. Plant 2,000 by year 5; 6,000 acres by year 10; 15,000 acres by year 20.	$1,050,000	
				Restore one wetland in the first 2 years. Install 4 wetlands in 20 years.	Estimated 5 acre each = $58,000	
				Install critical plantings in 12 acres during the first 2 years. Install 30 acres of critical plantings during the first five years; 60 acres by year 10; 120 acres by year 20.	$28,200	
				Install 8,000 ft of exclusion fencing in the first 5 years; Install 16,000 ft by the end of year 10; 20,000 ft by year 20.	$92,050	

Table 39 Action Register Nitrate Reduction Table 1/3

Table 40 Action Register Nitrate Reduction Table 2/3

Goal	NO3	Objective	Target Audience	Milestone	Cost	Possible Partners
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Nitrates	(1) Decrease nitrates by 15,500 lbs./year in the first five years, 40,500 lbs./year nitrates in 10 years, and 77,5000 lbs./year nitrates in 20 years.	Landowners and Operators	Install 20 acres of filter strips in the first 5 years; 45 acres by the end of year 10; 75 by the end of year 20.	$47,282	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Develop prescribed grazing plans for 120 acres in the first 2 years; 300 by the end of 5 years; 500 by the end of year 10; 600 by the end of year 20.	$12,786	
				Nitrogen load reductions are calculated for each BMP installed.	Estimated 1% staff time per year = $700	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.		(1) Decrease nitrates by 15,500 lbs./year in the first five years, 40,500 lbs./year nitrates in 10 years, and 77,5000 lbs./year nitrates in 20 years.	Landowners and Operators	Number of agricultural producers installing nutrient reducing BMPs is tracked from year 1 to 20.	Estimate 6 hours staff time = $120	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				At least 6 nutrient management workshops are held from year 1 to year 20.	Minimum $1200	
				At least 10 no-till and cover crop workshops are held between year 1 to year 20.	Minimum $2000	
				Utilize a minimum of one opportunity annually to provide information to farmers about nutrients.	Minimum $450	
				Personal interviews or surveys are conducted with participants before and after events; results indicate understanding of topic and positive attitude to possible change.	Estimate 6 hours staff time = $120	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Nitrates	(1) Decrease nitrates by 15,500 lbs./year in the first five years, 40,500 lbs./year nitrates in 10 years, and 77,5000 lbs./year nitrates in 20 years.	Landowners and Operators	Number of producers using no till or cover crops is tracked from year 1 to 20 and number increases over time. Make necessary adjustments if program is not meeting its participation goals.	Estimate 6 hours staff time = $120	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Develop nutrient management plans for at least 4 landowners in the first 2 years; 10 plans by end of year 5; 20 plans by end of year 10; 30 plans by the end of year 20.	$56,400	

Goal	NO3	Objective	Target Audience	Milestone	Cost	Possible Partners
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.		(1) Decrease nitrates by 15,500 lbs./year in the first five years, 40,500 lbs/year nitrates in 10 years, and 77,5000 lbs./year nitrates in 20 years.	Landowners and Operators	Install 25 WASCoBs & blind inlet combinations in the first five years. Install 40 by the end of the first 5 years; 80 by year 10; 160 by year 20.	$384,000	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Install 60 acres of forage and biomass plantings in the first 2 years. Forage and biomass planting will include 2 consecutive years of planting. Install 100 acres by the end of year 5; 300 acres by year 10; 700 acres by year 20.	$64,122	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Nitrates	(1) Decrease nitrates by 15,500 lbs./year in the first five years, 40,500 lbs./year nitrates in 10 years, and 77,5000 lbs./year nitrates in 20 years.	Unsewered Lake Associations & Lake Owners	Send an informational article to Lake Associations (unsewered lakes) to place in their newsletters on septic maintenance 10 times in 20 years.	Estimate 1-week staff time = $800	SWCD, Conservation District, Health Department
			Landowners, Agricultural Producers, Residents	Develop and implement (with partners) an on-line media campaign to increase knowledge of septic system care using the Clear Choices Clean Water materials. Conduct campaign twice during each 5-year period.	Estimate total 3 weeks staff time = $4200 On-line paid posts $200	SWCD, Health Department, All Clean Waters Partnership Partners
		Develop long-term adoption of BMPs	Landowners and Agricultural Producers	Provide technical assistance to landowner	Estimate 70% staff time = $50,960	Watershed Conservationist
(1) Reduce excessive nutrients in the watershed and its tributaries		Evaluate nutrient and sediment reduction program for effectiveness	General Public	Monitor NO3 concentrations in waterways	$2,000 / year Snapshot Monitoring Day	Lilly Center for Lakes & Streams (In-kind) & Volunteer monitoring thru snapshot monitoring day.
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in nutrient knowledge.	Estimate minimum $2000	SWCD, NRCS

Table 41 Action Register Nitrate Reduction Table 3/3

Table 42Action Register Phosphorus Reduction Table 1/3

Goal	P	Objective	Target Audience	Milestone	Cost	Possible Partners
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Phosphorus	Develop a nutrient education program for farmers and develop a relationship with landowners and operators to provide technical support and cost-share of BMPs.	Landowners and Operators	Within 3 months of implementation, develop a cost-share program and strategy to offer cost-share programs to landowners and operators.	Estimate 2 weeks staff time = $2,800	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Within 3 months of implementation, utilize the 2018 social indicator survey information to develop an effective education campaign to reach farmers.	Estimate 1-week staff time = $1,400	
			Landowners and Operators	Develop or acquire an education piece to explain the program to farmers.	Estimate 1-week staff time = $1,400	
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in nutrient knowledge.	Estimate 2 weeks staff time = $2,800	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Phosphorus	(1) Decrease phosphorus by 10,500 lbs./year in the first five years, 21,500 lbs. /year phosphorus in 10 years, and 39,000 lbs./year phosphorus in 20 years.	Landowners and Operators	During the first 2 years, implement no till on 1,900 acres. By the end of year 5, implement no till on 4,000; 6,500 acres by year 19; 12,000 acres by year 20.	252,000	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Plant 1,100 acres in cover crops during the first implementation grant. Participants would plant each year for two consecutive years. Plant 2,000 by year 5; 6,000 acres by year 10; 15,000 acres by year 20.	$1,050,000	
				Restore one wetland in the first 2 years. Install 4 wetlands in 20 years.	Estimate 5 acres each =$58,000	
				Install critical plantings in 12 acres during the first 2 years. Install 30 acres of critical plantings during the first five years; 60 acres by year 10; 120 acres by year 20.	$28,200	
				Install 8,000 ft of exclusion fencing in the first 5 years; Install 16,000 ft by the end of year 10; 20,000 ft by year 20.	$92,050	

Goal	P	Objective	Target Audience	Milestone	Cost	Possible Partners
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Phosphorus	(1) Decrease phosphorus by 10,500 lbs./year in the first five years, 21,500 lbs. /year phosphorus in 10 years, and 39,000 lbs./year phosphorus in 20 years.	Landowners and Operators	Install 20 acres of filter strips in the first 5 years; 45 acres by the end of year 10; 75 by the end of year 20.	$47,282	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Develop prescribed grazing plans for 120 acres in the first 2 years; 300 by the end of 5 years; 500 by the end of year 10; 600 by the end of year 20.	$12,786	
				Nitrogen and phosphorus load reductions are calculated for each BMP installed; results indicate phosphorus and sediment reductions exceed targets set forth in WMP by end of year 20 if the Partnership is able to install in the targeted Critical Area Priority I and then move to Critical Area Priority II.	Estimated 1% staff time per year = $700	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Phosphorus	(1) Decrease phosphorus by 10,500 lbs./year in the first five years, 21,500 lbs. /year phosphorus in 10 years, and 39,000 lbs./year phosphorus in 20 years.	Landowners and Operators	Number of agricultural producers installing nutrient reducing BMPs is tracked from year 1 to 20.	Estimate 6 hours staff time = $120	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				At least 6 nutrient management workshops are held from year 1 to year 20.	Minimum $1200	
				At least 10 no-till and cover crop workshops are held between year 1 to year 20.	Minimum $2000	
				Utilize a minimum of one opportunity annually to provide information to farmers about nutrients.	Minimum $450	
				Personal interviews or surveys are conducted with participants before and after events; results indicate understanding of topic and positive attitude to possible change.	Estimate 6 hours staff time = $120	
				Number of producers using no till or cover crops is tracked from year 1 to 20 and number increases over time. Make necessary adjustments if program is not meeting its participation goals.	Estimate 6 hours staff time = $120	

Table 43 Action Register Phosphorus Reduction Table 2/3

Table 44 Action Register Phosphorus Reduction Table 3/3

Goal	P	Objective	Target Audience	Milestone	Cost	Possible Partners
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Phosphorus	(1) Decrease phosphorus by 10,500 lbs./year in the first five years, 21,500 lbs. /year phosphorus in 10 years, and 39,000 lbs./year phosphorus in 20 years.	Landowners and Operators	Develop nutrient management plans for at least 4 landowners in the first 2 years; 10 plans by end of year 5; 29 plans by end of year 10; 30 plans by the end of year 20.	$56,400	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Install 25 WASCoBs & blind inlet combinations in the first five years. Install 40 by the end of the first 5 years; 80 by year 10; 160 by year 20.	$384,000	
				Install 60 acres of forage and biomass plantings in the first 2 years. Forage and biomass planting will include 2 consecutive years of planting. Install 100 acres by the end of year 5; 300 acres by year 10; 700 acres by year 20.	$64,122	
(1) Reduce excessive nutrients in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Phosphorus	(1) Decrease phosphorus by 10,500 lbs./year in the first five years, 21,500 lbs. /year phosphorus in 10 years, and 39,000 lbs./year phosphorus in 20 years.	Unsewered Lake Associations & Lake Owners	Send an informational article to Lake Associations (unsewered lakes) to place in their newsletters on septic maintenance 10 times in 20 years.	Estimate 1-week staff time = $800	SWCD, Conservation Districts, Health Department
			Landowners, Agricultural Producers, Residents	Develop and implement (with partners) an on-line media campaign to increase knowledge of septic system care using the Clear Choices Clean Water materials. Conduct campaign twice during each 5-year period.	Estimate total 3 weeks staff time = $4200 On-line paid posts $200	SWCD, Health Department, Conservation Districts, All Clean Waters Partnership Partners
	Decrease Phosphorus	Develop long-term adoption of BMPs	Landowners, Agricultural Producers	Provide technical assistance to landowner	Estimate 70% staff time = $50,960	Watershed Conservationist
		Evaluate nutrient and sediment reduction program for effectiveness	Everyone	Monitor P concentrations in waterways	$2,000 / year Snapshot Monitoring Day	Lilly Center for Lakes & Streams (In-kind) & Volunteer monitoring thru snapshot monitoring day.
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in nutrient knowledge.	Estimate minimum $2000	SWCD, NRCS

Table 45 Action Register Sediment Reduction Table 1/3

Goal	Soil	Objective	Target Audience	Milestone	Cost	Possible Partners
(2) Reduce soil erosion and sedimentation in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Soil Erosion & Sedimentation	Develop a nutrient education program for farmers and develop a relationship with landowners and operators to provide technical support and cost-share of BMPs.	Landowners and Operators	Within 3 months of implementation, develop a cost-share program and strategy to offer cost-share programs to landowners and operators.	Estimate 2 weeks staff time = $2,800	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Within 3 months of implementation, utilize the 2018 social indicator survey information to develop an effective education campaign to reach farmers.	Estimate 1-week staff time = $1,400	
				Develop or acquire an education piece to explain the program to farmers.	Estimate 1-week staff time = $1,400	
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in nutrient knowledge.	Estimate 2 weeks staff time = $2,800	
(2) Reduce soil erosion and sedimentation in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Soil Erosion and Sedimentation	(2) Reduce sedimentation by 900 tons/year in the next 5 years; 2,400 tons/year at the end of 10 years; 3,000 tons/year at the end of 20 years.	Landowners and Operators	During the first 2 years, implement no till on 1,900 acres. By the end of year 5, implement no till on 4,000; 6,500 acres by year 19; 12,000 acres by year 20.	252,000	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Plant 1,100 acres in cover crops during the first implementation grant. Participants would plant each year for two consecutive years. Plant 2,000 by year 5; 6,000 acres by year 10; 15,000 acres by year 20.	$1,050,000	
				Restore one wetland in the first 2 years. Install 4 wetlands in 20 years.	Estimate 5 acres each =$58,000	
				Install critical plantings in 12 acres during the first 2 years. Install 30 acres of critical plantings during the first five years; 60 acres by year 10; 120 acres by year 20.	$28,200	
				Install 8,000 ft of exclusion fencing in the first 5 years; Install 16,000 ft by the end of year 10; 20,000 ft by year 20.	$92,050	
				Install 20 acres of filter strips in the first 5 years; 45 acres by the end of year 10; 75 by the end of year 20.	$47,282	
				Develop prescribed grazing plans for 120 acres in the first 2 years; 300 by the end of 5 years; 500 by the end of year 10; 600 by the end of year 20.	$12,786	

Table 46 Action Register Sediment Reduction Table 2/3

Goal	Soil	Objective	Target Audience	Milestone	Cost	Possible Partners
(2) Reduce soil erosion and sedimentation in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Soil Erosion and Sedimentation	(2) Reduce sedimentation by 900 tons/year in the next 5 years; 2,400 tons/year at the end of 10 years; 3,000 tons/year at the end of 20 years.	Landowners and Operators	Nitrogen and phosphorus load reductions are calculated for each BMP installed; results indicate phosphorus and sediment reductions exceed targets set forth in WMP by end of year 20 if the Partnership is able to install in the targeted Critical Area Priority I and then move to Critical Area Priority II.	Estimated 1% staff time per year = $700	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Number of agricultural producers installing nutrient reducing BMPs is tracked from year 1 to 20.	Estimate 6 hours staff time = $120	
				At least 6 nutrient management workshops are held from year 1 to year 20.	Minimum $1200	
				At least 10 no-till and cover crop workshops are held between year 1 to year 20.	Minimum $2000	
(2) Reduce soil erosion and sedimentation in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Soil Erosion & Sedimentation	(2) Reduce sedimentation by 900 tons/year in the next 5 years; 2,400 tons/year at the end of 10 years; 3,000 tons/year at the end of 20 years.	Landowners and Operators	Utilize a minimum of one opportunity annually to provide information to farmers about nutrients.	Minimum $450	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of excess nitrogen and phosphorus loading in the watershed.
				Personal interviews or surveys are conducted with participants before and after events; results indicate understanding of topic and positive attitude to possible change.	Estimate 6 hours staff time = $120	
				Number of producers using no till or cover crops is tracked from year 1 to 20 and number increases over time. Make necessary adjustments if program is not meeting its participation goals.	Estimate 6 hours staff time = $120	
				Develop nutrient management plans for at least 4 landowners in the first 2 years; 10 plans by end of year 5; 29 plans by end of year 10; 30 plans by the end of year 20.	$56,400	
				Install 25 WASCoBs & blind inlet combinations in the first five years. Install 40 by the end of the first 5 years; 80 by year 10; 160 by year 20.	$384,000	

Table 47 Action Register Sediment Reduction Table 3/3

Goal	Soil	Objective	Target Audience	Milestone	Cost	Possible Partners
(2) Reduce soil erosion and sedimentation in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Soil Erosion & Sedimentation	(2) Reduce sedimentation by 900 tons/year in the next 5 years; 2,400 tons/year at the end of 10 years; 3,000 tons/year at the end of 20 years.	Animal Producers and Landowners	Install 60 acres of forage and biomass plantings in the first 2 years. Forage and biomass planting will include 2 consecutive years of planting. Install 100 acres by the end of year 5; 300 acres by year 10; 700 acres by year 20.	$64,122	Watershed Conservationist
		(2) Reduce sedimentation by 900 tons/year in the next 5 years; 2,400 tons/year at the end of 10 years; 3,000 tons/year at the end of 20 years.	Unsewered Lake Associations & Lake Owners	Send an informational article to Lake Associations (unsewered lakes) to place in their newsletters on septic maintenance 10 times in 20 years.	Estimate 1-week staff time = $800	SWCD, Health Department
			Landowners, Agricultural Producers, Residents	Develop and implement (with partners) an on-line media campaign to increase knowledge of septic system care using the Clear Choices Clean Water materials. Conduct campaign twice during each 5-year period.	Estimate total 3 weeks staff time = $4200 On-line paid posts $200	SWCD, Health Department, All Clean Waters Partnership Partners
(2) Reduce soil erosion and sedimentation in the watershed and its tributaries that degrade water quality and contribute to accelerated eutrophication of the lakes and degradation of the Tippecanoe River.	Decrease Soil Erosion & Sedimentation	Evaluate nutrient and sediment reduction program for effectiveness	General Public	By end of Year 5, Re-evaluate streams / water sites used for Snapshot monitoring Day for in-stream sedimentation	Estimate Minimum $2,000 / year Snapshot Monitoring Day	Lilly Center for Lakes & Streams (In-kind) & Volunteer monitoring thru snapshot monitoring day.
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in nutrient knowledge.	Estimate minimum $2000	SWCD, NRCS
		Develop long-term adoption of BMPs	Landowners and Agricultural Producers	Provide technical assistance to landowner	Estimate 70% staff time = $50,960	Watershed Conservationist

Table 48 Action Register E. coli Reduction Table 1/2

Goal	E. coli	Objective	Target Audience	Milestone	Cost	Possible Partners
(3) Reduce E. coli in the watershed and reduce health concerns associated with bacteria in local waterways, including at local beaches.	Reduce E. coli concentrations	Develop a bacteria/ water quality education program for farmers and develop a relationship with landowners and operators to provide technical support and cost-share of BMPs.	Landowners and Operators	Within 3 months of implementation, develop a cost-share program and strategy to offer cost-share programs to landowners and operators.	Estimate 2 weeks staff time = $2,800	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of E. coli in the watershed.
				Within 3 months of implementation, utilize the 2018 social indicator survey information to develop an effective education campaign to reach farmers.	Estimate 1-week staff time = $1,400	
				Develop or acquire an education piece to explain the program to farmers.	Estimate 1-week staff time = $1,400	
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement of bacteria knowledge.	Estimate 2 weeks staff time = $2,800	
(3) Reduce E. coli in the watershed and reduce health concerns associated with bacteria in local waterways, including at local beaches.	Reduce E. coli concentrations	(3) Reduce E. coli to watershed to meet the water quality standard of 235 CFU/100 mL within the next 25 years at monitoring sites #1, 4, 6 where more than 45% of samples taken in 2016-2017 exceeded the state standard.	Landowners and Operators	Restore one wetland in the first 2 years. Install 4 wetlands in 20 years.	Estimate 5 acres each =$58,000	Watershed Conservationist will work with local partnerships, agencies, and organizations that provide financial and technical assistance (NRCS, SWCD) to landowners and result in the reduction of E. coli in the watershed.
				Install critical plantings in 12 acres during the first 2 years. Install 30 acres of critical plantings during the first five years; 60 acres by year 10; 120 acres by year 20.	$28,200	
				Install 8,000 ft of exclusion fencing in the first 5 years; Install 16,000 ft by the end of year 10; 20,000 ft by year 20.	$92,050	
			Landowners and Operators	Install 20 acres of filter strips in the first 5 years; 45 acres by the end of year 10; 75 by the end of year 20.	$47,282	
				Develop prescribed grazing plans for 120 acres in the first 2 years; 300 by the end of 5 years; 500 by the end of year 10; 600 by the end of year 20.	$12,786	
				E. coli load reductions are calculated for each BMP installed; results indicate phosphorus and sediment reductions exceed targets set forth in WMP by end of year 20 if the Partnership is able to install in the targeted Critical Area Priority I and then move to Critical Area Priority II.	Estimated 1% staff time per year = $700	
				Number of agricultural producers installing E. coli reducing BMPs is tracked from year 1 to 20.	Estimate 6 hours staff time = $120	

Table 49 Action Register E. coli Reduction Table 2/2

Goal	E. coli	Objective	Target Audience	Milestone	Cost	Possible Partners
(3) Reduce E. coli in the watershed and reduce health concerns associated with bacteria in local waterways, including at local beaches.		Evaluate E. coli education program for effectiveness	Landowners and Operators	Personal interviews or surveys are conducted with participants before and after events; results indicate understanding of topic and positive attitude to possible change.	Estimate 6 hours staff time = $120	
	Reduce E. coli concentrations	Develop a bacteria/ water quality education program for residents	Unsewered Lake Associations & Lake Owners	Send an informational article to Lake Associations (unsewered lakes) to place in their newsletters on septic maintenance 10 times in 20 years.	Estimate 1-week staff time = $800	SWCD, Health Department
			Landowners, Agricultural Producers, Residents	Develop and implement (with partners) an on-line media campaign to increase knowledge of septic system care using the Clear Choices Clean Water materials. Conduct campaign twice during each 5-year period.	Estimate total 3 weeks staff time = $4200 On-line paid posts $200	SWCD, Health Department, All Clean Waters Partnership Partners
(3) Reduce E. coli in the watershed and reduce health concerns associated with bacteria in local waterways, including at local beaches.	Reduce E. coli concentrations	Evaluate E. coli reduction & education program for effectiveness	General Public	Monitor E. coli concentrations in waterways	Minimum $2,000 / year Snapshot Monitoring Day	Lilly Center for Lakes & Streams (In-kind) & Volunteer monitoring thru snapshot monitoring day.
				By the end of year four (2022 - 2023), resurvey the agricultural community in the watershed to identify improvement in E. coli knowledge.	Estimate minimum $2000	SWCD, NRCS
		Develop long-term adoption of BMPs	Landowners and Agricultural Producers	Provide technical assistance to landowner	Estimate 70% staff time = $50,960	Watershed Conservationist

Table 50 Action Register Public Education Goals Table 1/3

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(4) Increase public awareness of how individual choices and activities impact water quality and engage stakeholders in behavior changing activities Creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.	(4) Increase educational signage at applicable, highly visible, locations in the Walnut Creek – Tippecanoe River watershed within a 10-year period. This signage will highlight best management practices, discourage litter, and offer general watershed education.	Agricultural landowners, lakefront landowners and residents, public	Promote agricultural and lakeshore cost-share successes through the creation and installation of roadside or lakefront signs.	Estimate Farm Signs Minimum 40 signs in 10 years = $12000 Yard signs estimated at 100 at $10 each = $1000	CWP Partners, Local Business Sponsors
		Public	Work with local partners to place signage along the Tippecanoe River protection area to explain to the public how special that area of the river is. At a minimum make signs accessible to paddlers and persons on the greenway.	2 Full art signs @$700 each = $1,400 small metal waterway signs 20 @ $35	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		Public	Develop and install waterway signs by roads crossing waterways increasing public awareness of water quality, endangered species, and also discouraging litter.	40 signs @$30 each = $1200	
(4) Increase public awareness of how individual choices and activities impact water quality and engage stakeholders in behavior changing activities Creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.	(4) Conduct educational workshops and distribute materials to help foster learning and passion for protecting the watershed that extends to people making individual behavior changes.	Public	Develop an educational committee that will meet twice annually to guide educational efforts in the watershed. Should determine target populations for the year and create goals using the *results of the social indicator survey* to reach target populations through events or campaigns. Target populations could include businesses, contractors, rural landowners, urban landowners, gardeners, etc. Continue to look for ways to include information on endangered species and biodiversity.	Estimate staff time 1 week + $800	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		K-12 school children	Coordinate at least one meeting annually with local educators to provide a coordinated effort of environmental education to grades k-12 to review curriculum.	Estimate 6 hours staff time = $120	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		K-12 school children	Provide watershed and water quality and wildlife/habitat education to one or more schools annually within the watershed.	Estimated staff time 6 hours - $120	
			Partner with the SWCD to provide a river rafting experience to at least 100 local school -aged children.	Minimum $4,500/day	
		Adult Education	Meet at least once annually with local agencies and organizations that provide adult education regarding water quality, wildlife, and habitat. Coordinate efforts and make annual programming goals.	Estimated staff time 6 hours - $120	

Table 51 Action Register Public Education Goals Table 2/3

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(4) Increase public awareness of how individual choices and activities impact water quality and engage stakeholders in behavior changing activities Creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.	(4) Conduct educational workshops and distribute materials to help foster learning and passion for protecting the watershed that extends to people making individual behavior changes.	Public	Continue promotion using Clear Choices Clean Water campaign materials and website to provide education and map persons pledges to protect water quality. Will demonstrate 500 new pledges in the next 2 years.	Materials Estimate = $3,000	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		Public	Conduct a follow-up social indicator survey in 2022-23 to gage success on educational efforts and to use in developing current effective strategies to reach constituents.	Minimum $5,000	SWCD, NRCS, CWP & partners
		Public	Send bi-annual printed mailings to 6,000 stakeholders, as well as monthly electronic updates to 2,000 stakeholders updating them on water quality improvement efforts. Use to communicate information about recreational and wildlife to connect people to their waters.	Estimate $10000 Annually	TWF
		Public	Use social media 2 x per month to connect with 1,180 stakeholders updating them on water quality improvement projects and connecting them to local waters.	Estimate 4 hours staff time = $80	TWF
(4) Increase public awareness of how individual choices and activities impact water quality and engage stakeholders in behavior changing activities Creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.	(4) Conduct educational workshops and distribute materials to help foster learning and passion for protecting the watershed that extends to people making individual behavior changes.	Public	Plan and execute 3 field days / tours / river floats annually to highlight BMPs and related cost-share projects and other points of education and interest in the watershed to entice new audiences to participate. Events will utilize interest points gathered from the social indicator survey.	Estimate: $5,000 minimum	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups CWP & partners.
		Lakefront owners, agricultural landowners, public	Promote agricultural and lakeshore cost-share programs through the creation and distribution of one brochure or fact sheet for each, a page on the TWF website and installation of roadside or lakefront signs.	Estimate 4 hours staff-time 4 hours @ $20 each =$80	
		Public	Hold at least one educational workshop and 1 water festival each year to inform and empower residents to change personal choices and provide ideas for landowner habitat enhancements.	Minimum $300 workshop; Minimum $25,000 Festival	
		Public	Develop and utilize a 15' x 20' vinyl walkable watershed map to utilize at public exhibits and events to teach people about *their specific* watershed.	Estimate a Minimum of $200	

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(4) Increase public awareness of how individual choices and activities impact water quality and engage stakeholders in behavior changing activities Creating an educational program and materials to deliver to stakeholders regarding the value and importance of working to protect the health of the watersheds.	(4) Conduct educational workshops and distribute materials to help foster learning and passion for protecting the watershed that extends to people making individual behavior changes.	Public	Promote an anti-litter campaign on social media, websites, and news outlets. Pick a single item to focus on, such as fast food trash or plastic bags.	Estimate Minimum 1-week staff time = $600	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		Public	Partner with area organizations to have an annual watershed litter cleanup event that connects people to their local waters. Connecting people creates stewards of water quality. (This could also be a river and lake cleanup.) Publicize with a media blitz and reinforce the importance of protecting and maintaining local waters.	Estimate minimum $16,600 ($9,000 volunteer time, $2,000 staff time (80 hours), trash disposal services $800, supplies & support $2,500, coordinating organizations $2,000 staff time, media time $300.)	
	(4) Increase public awareness of how individual choices and activities impact water quality.	Public	Work with the local paddlers club to get their information out to the public. As their membership and participation grows, so does the stewardship of the local waters.	Estimated staff time 8 hours / year = $160	Paddlers 4 Conservation Service Group

Table 52 Action Register Public Education Goals Table 3/3

Table 53 Action Register Biodiversity & Habitat Goals Table 1/3

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(5) Maintain rich biodiversity in the Walnut Creek – Tippecanoe River watershed, protect and enhance critical habitat and unique natural areas as well as threatened, endangered, and rare species.	(5) Install BMPs to improve stream habitat in areas that have been hydrologically modified and no longer provide adequate transport of sediments along with a good quality habitat for aquatic life.	Landowners, Public	Develop and implement a plan to determine in-stream BMPs and locations that will improve water quality including parameters such as oxygen levels, temperature, sediment transport, fish habitat, etc. Low D.O. was present on sites # 1, 2, 7, & 9.	Minimum $10,000	County surveyor, NRCS, SWCD, Watershed Conservationist
		Landowners	Install 30 acres of riparian buffers making habitat for wildlife in the watershed in the next 20 years.	Estimated combined total of $50,000	Watershed Conservationist
(5) Protect the rich biodiversity and protect critical habitat and unique natural areas, threatened, endangered, and rare species.	(5) Get stakeholders educated and connected to local waters and the current state endangered, rare, and invasive species in the watershed.	Agricultural landowners, lakefront landowners and residents, public	Promote agricultural and lakeshore cost-share successes through the creation and installation of roadside or lakefront signs.	Estimate Farm Signs Minimum 40 signs in 10 years = $12000 Yard signs estimated at 100 at $10 each = $1000	Watershed Conservationist, SWCD, CWP Partners
		Public	Work with local partners to place signage along the Tippecanoe River protection area to explain to the public how special that area of the river is. At a minimum make signs accessible to paddlers and persons on the greenway.	2 Full art signs @$700 each = $1,400 small metal waterway signs 20 @ $35	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		Public	Develop and install waterway signs by roads crossing waterways increasing public awareness of water quality, endangered species, and discouraging litter.	40 signs @$30 each = $1200	
(5) Protect the rich biodiversity and protect critical habitat and unique natural areas, threatened, endangered, and rare species.	(5) Get people connected to local waters, become stewards of local endangered and rare species, and understand the problems with invasive species.	Public	Develop an educational committee that will meet twice annually to guide educational efforts in the watershed. Should determine target populations for the year and create goals using the *results of the social indicator survey* to reach target populations through events or campaigns. Target populations could include businesses, contractors, rural landowners, urban landowners, gardeners, etc. Continue to look for ways to include information on endangered species and biodiversity.	Estimate staff time 1 week + $800	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		K-12 school children	Coordinate at least one meeting annually with local educators to provide a coordinated effort of environmental education to grades k-12 to review curriculum.	Estimate 6 hours staff time = $120	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
			Provide watershed and water quality and wildlife/habitat education to one or more schools annually within the watershed.	Estimated staff time 6 hours - $120	

Table 54 Action Register Biodiversity & Habitat Goals Table 2/3

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(5) Protect the rich biodiversity and protect critical habitat and unique natural areas, threatened, endangered, and rare species.	(5) Get people connected to local waters, become stewards of local endangered and rare species, and understand the problems with invasive species.	K-12 Ed	Partner with the SWCD to provide a river rafting experience to at least 100 local school -aged children	Minimum $4,500/day	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		Adult Education	Meet at least once annually with local agencies and organizations that provide adult education regarding water quality, wildlife, and habitat. Coordinate efforts and make annual programming goals.	Estimated staff time 6 hours - $120	
(5) Maintain rich biodiversity in the Walnut Creek – Tippecanoe River watershed, protect and enhance critical habitat and unique natural areas as well as threatened, endangered, and rare species.	(5) Get them connected to local waters, become stewards of local endangered and rare species, and understand the problems with invasive species.	Public	Continue promotion using Clear Choices Clean Water campaign materials and website to provide education and map persons pledges to protect water quality. Will demonstrate 500 new pledges in the next 2 years.	Materials Estimate = $3,000	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
		Public	Conduct a follow-up social indicator survey in 2022-23 to gage success on educational efforts and to use in developing current effective strategies to reach constituents.	Minimum $5,000	TWF & CWP Partners
		Public	Send bi-annual printed mailings to 6,000 stakeholders, as well as monthly electronic updates to 2,000 stakeholders updating them on water quality improvement efforts. Use to communicate information about recreational and wildlife to connect people to their waters.	Estimate $10000 Annually	TWF & CWP Partners
		Public	Use social media 2 x per month to connect with 1,180 stakeholders updating them on water quality improvement projects and connecting them to local waters.	Estimate 4 hours staff time = $80	
	(5) Get them connected to local waters, become stewards of local endangered and rare species, and understand the problems with invasive species.	Public	Plan and execute 3 field days / tours / river floats annually to highlight BMPs and related cost-share projects and other points of education and interest in the watershed to entice new audiences to participate. Events will utilize interest points gathered from the social indicator survey.	Estimate: $5,000 minimum	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
(5) Maintain rich biodiversity in the Walnut Creek – Tippecanoe River watershed, protect and enhance critical habitat and unique		Lakefront owners, agricultural landowners, general public	Promote agricultural and lakeshore cost-share programs through the creation and distribution of one brochure or fact sheet for each, a page on the TWF website and installation of roadside or lakefront signs.	Estimate 4 hours staff-time 4 hours @ $20 each =$80	

natural areas as well as threatened, endangered, and rare species.		Public	Hold at least one educational workshop and 1 water festival each year to inform and empower residents to change personal choices and provide ideas for landowner habitat enhancements.	Minimum $300 workshop; Minimum $25,000 Festival	

Table 55 Action Register Biodiversity & Habitat Goals Table 3/3

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(5) Maintain rich biodiversity in the Walnut Creek – Tippecanoe River watershed, protect and enhance critical habitat and unique natural areas as well as threatened, endangered, and rare species.	(5) Get people connected to local waters, become stewards of local endangered and rare species, and understand the problems with invasive species.	Public	Develop and utilize a 15' x 20' vinyl walkable watershed map to utilize at public exhibits and events to teach people about *their specific* watershed.	Estimate a Minimum of $200	SWCD, KC Recycling, City of Warsaw. Kosciusko County, Lake Associations, Lilly Center for Lakes & Streams, Youth and service groups.
	(5) Educate stakeholders on ways they can connect to local waters, become stewards of local state endangered and rare species, and understand the problems with invasive species.	Public	Promote an anti-litter campaign on social media, websites, and news outlets. Pick a single item to focus on, such as fast food trash or plastic bags.	Estimate Minimum 1-week staff time = $600	
			Partner with area organizations to have an annual watershed litter cleanup event that connects people to their local waters. Connecting people creates stewards of water quality. (This could also be a river and lake cleanup.) Publicize with a media blitz and reinforce the importance of protecting and maintaining local waters.	Estimate minimum $16,600 ($9,000 volunteer time, $2,000 staff time (80 hours), trash disposal services $800, supplies & support $2,500, coordinating organizations $2,000 staff time, media time $300.)	
(5) Maintain rich biodiversity in the Walnut Creek – Tippecanoe River watershed, protect and enhance critical habitat and unique natural areas as well as threatened, endangered, and rare species.	(5) Educate stakeholders on ways they can connect to local waters, become stewards of local state endangered and rare species, and understand the problems with invasive species.	Public	Work with the local paddlers club to get their information out to the public. As their membership and participation grows, so does the stewardship of the local waters.	Estimated staff time 8 hours / year = $160	Paddlers 4 Conservation Service Group
	(5) Install BMPs to improve stream habitat in areas that have been hydrologically modified and no longer provide adequate transport of sediments along with a good quality habitat for aquatic life.	Landowners	Develop a plan to determine in-stream BMPs and locations that will improve water quality including parameters such as oxygen levels, temperature, sediment transport, fish habitat, etc. Low D.O. was present on sites # 1, 2, 7, & 9.	Minimum $10,000	County surveyor, NRCS, SWCD, Conservationist
			Install 30 acres of riparian buffers in the watershed in the next 20 years.	Estimated combined total of $50,000	
		Public	Install in-stream BMPs that will improve water quality conditions, including D.O.	Estimate $16,030	

Table 56 Implementation & Sustainability Goals Table 1/1

Goal	Objective	Target Audience	Milestone	Cost	Possible Partners
(6) Hire a watershed conservationist and a watershed coordinator.	(6) Hire a watershed conservationist to recruit, educate, and provide technical support for landowners implementing BMPs, and a watershed coordinator to build and maintain relationships with CWP partners, coordinate efforts and reports, and conduct educational events.	Agricultural and lakefront landowners and residents, public	Recruit, educate, and provide technical support for landowners implementing BMPs.	Minimum $70,000	Local Corporations, Government, Foundations, SWCD, DNR, local organizations
		TWF, CWP, Public	Build and maintain relationships with CWP partners, coordinate the grant activities, organize education events, and complete reporting requirements.	Minimum $13,000	

Tracking Effectiveness and Adaptive Management

Upon implementation of this plan, water quality monitoring will resume at all testing sites (#1-10) on at least a twice annual basis using Hoosier Riverwatch methodology. If professional lab services are offered as a donation of resources (or in-kind), or if grant funds can be obtained to cover their cost, professional monitoring will resume on an annual basis. Testing parameters considered will be the same as used in the development of this WMP. Results will be analyzed and tracked by The Watershed Foundation and project partners, such as the Steering Committee or Technical Team, Hoosier Riverwatch partners, and a professional lab. Additional sites may be added with additional resources or evidence of need from external data or other evidence in the watershed.

The implementation plan for all projects will be subject to a ***Rigorous Adaptive Management Review*** at the end of each year. Each activity (Education, Testing, and BMP Implementation Plan) will be reviewed for effectiveness where problems and/or concerns will be identified, evaluated and adjusted using the adaptive model: *Assess the Problem – Design – Implement – Evaluate – Adjust* and then repeat the process at the next interval. Special attention will be made at the milestone years (2, 5, 10, and 20 year increments). During milestone years, the partners will document the progress, evaluate the design, and make necessary recommendations for changes to the program, including modification of program goals using the adaptive management model. Water quality testing results will also be evaluated and compared with goals and expected results based on BMPs installed. The Watershed Foundation will then certify the conclusions and proposed adaptations of the plan and ensure concurrance with the Watershed Management Plan, grant obligations, or any other obligations, including completing any revisions required in the process.

Education and outreach will begin upon plan implementation, and the resulting data for social and administrative indicators will be tracked on an ongoing basis. Databases will be built from workshop/event participation. Public knowledge of water quality and related items set forth in this WMP will be measured through surveys and/or personal interviews at workshops and events. Kosciusko County SWCD, NRCS, Lilly Center for Lakes and Streams, Kosciusko County Health Department, local Steering Committee, are potential partners to assist in tracking these indicators.

BMP installation will be encouraged and promoted from the onset of implementation. BMP installation, and the related load reductions, will be tracked on an ongoing basis as BMPs are implemented Costs for installation will be borne on a cost-share basis with landowners when grant funding can be obtained by The Watershed Foundation and its partners. Landowners will be responsible for the total cost if cost-share is not an option. Technical assistance in either case will be provided by potential project partners NRCS and ISDA in coordination with the SWCD.

Detailed information on milestones and costs related to tracking environmental, social, and administrative indicators are included in the Action Register.

Future Activities

Walnut Creek – Tippecanoe River Watershed Management Plan is a culmination of research regarding the watersheds. The watersheds have been described, historic and present data water quality issues presented, and suggestions have been made for addressing water quality concerns in the watersheds. In order to make this information common knowledge, The Watershed Foundation will introduce the key findings of this plan to the public through public meetings, executive summaries to community leaders, and educational programs. By helping stakeholders identify with local waters and the watershed they call home, we can begin to foster passion and enthusiasm for conservation. Kosciusko County partners will work together providing educational experiences in an effort to yield increased awareness and passion to hopefully spark individuals' willingness to change behaviors so that they may have a positive impact on water quality.

Approval of this WMP and validation of this project's completion will move us forward to implementing what we have set forth in this document. Persons charged with this responsibility will be the supervisors and staff of The Watershed Foundation, Kosciusko County SWCD, Kosciusko County NRCS, along with the members of the Steering Committee that was formed during this project. Together, they will develop a cost-share program based on the goals and management strategies located in this plan.

Funds will be sought to initiate the implementation program by applying for a Year 2020 Section 319 Grant The Watershed Foundation has submitted a Letter of Intent in the application process and plans to submit an application by the September 1, 2019 deadline; anticipated start date will be last quarter 2020 if awarded. If not awarded, we will continue to seek Section 319 funds with subsequent applications.

Since watersheds are a living thing, the plan that was prepared must also be constantly review and revised for accuracy and effectiveness. Whether awarded an implementation grant or not, we will continue to monitor the walnut Creek – Tippecanoe River Watershed and its land use as well as continue to provide education to the residents and visitors of the watershed. The Watershed Foundation along with its partners will meet at least annually to evaluate the plan for effectiveness then consider and adjust the plan as needed to make it more effective.

Further questions on this project may be directed to the Lyn Crighton at the Watershed Foundation 301 N. Main Street, North Webster, Indiana 46555. Phone: (574) 834-3242

Works Cited[1]

Annis, Robert B., Water Resources Research Institute. "Turbidity." *Grand Valley State University*, 5 February 2019, https://www.gvsu.edu/wri/education/water-resources-outreach-education-program-18.htm. Accessed 30 June 2019.

Barber, Miles, et al. "Identifying Causes of High E. coli Concentrations at Public Beaches on Pike and Center Lakes in Kosciusko County, Indiana." *Lilly Center for Lakes & Streams Grace College*, 2016, www.lakes.grace.edu/research/lilly-center-studies/. Accessed 24 April. 2019.

Bingham, Seth A., and Bosch, Nathan S. "Lake Impacts on Annual Business Revenues in Kosciusko County." *Lilly Center for Lakes & Streams Grace College*, 2016, www.lakes.grace.edu/research/lilly-center-studies/. Accessed 19 April. 2019.

Bosch, Nathan, S., et al. "Lake Impacts on Property Taxes and Values in Kosciusko County." *Lilly Center for Lakes & Streams Grace College*, 2013, www.lakes.grace.edu/research/lilly-center-studies/. Accessed 19 Apr. 2019.

Bosch, Nathan, S., et al. "Blue-green Algae in Northern Indiana Lakes: An Analysis of the Algal Toxin, Microsystin, Over 2010-2013 in Lakes of Kosciusko County, Indiana." *Lilly Center for Lakes & Streams Grace College*, 2014, www.lakes.grace.edu/research/lilly-center-studies/. Accessed 24 April. 2019.

Census, U.S. *American Fact Finder*. www.factfinder.census.gov/faces/nav/jsf/pages/community_facts.xhtml?src=bkmk. Accessed 24 April 2019.

Commonwealth of Virginia, Department of Game & Inland Fisheries. "Frog Friday: Northern Cricket Frog." *Commonwealth of Virginia*. 11 September 2015. virginia.gov. https://www.dgif.virginia.gov/blog/frog-friday-northern-cricket-frog/. Photograph. Accessed 30 April 2019.

Corvallis Environmental Research Laboratory and Environmental Monitoring & Support Laboratory. "Report on Winona Lake Kosciusko County Indiana EPA Region 5 Working Paper No. 348. U.S. Environmental Protection Agency Nation Eutrophication Survey." Corvallis, Oregon: EPA, 1976, https://nepis.epa.gov/Exe/ZyNET.exe/9100D720.txt?ZyActionD=ZyDocument&Client=EPA&Index=1976%20Thru%201980&Docs=&Query=Report%20Winona%20lake&Time=&EndTime=&SearchMethod=2&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&UseQField=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5CZYFILES%5CINDEX%20DATA%5C76THRU80%5CTXT%5C00000013%5C9100D720.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=15&FuzzyDegree=0&ImageQuality=r85g16/r85g16/x150y150g16/i500&Display=hpfr&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x. Accessed 24 April 2019.

[1] Works Cited follow 20116 MLA style format\as described by the Online Writing Lab (OWL) at Purdue U, www.owl.purdue.edu. Accessed April 2019.

Davey Resource Group. “Engineering Feasibility Study for Wyland Ditch in the Winona Lake watershed in Kosciusko County, Indiana October 2014.” Dnr.in.gov. Winona Lake Preservation Association. https://collab.dnr.in.gov/connect.ti/LARE/view?objectId=8367845. Accessed 3 July 2019.

Ehmke, Tanner, "American Society of Agronomy." *agronomy.org*. Publication (2013 (print ISSN 0162-5098, online ISSN 2325-3606)): 4-9. American Society of Agronomy. https://www.agronomy.org/publications/crops-and-soils/4601. Accessed 30 April 2019.

Farkas, Jillian, “Threatened and endangered species feature: the cautious copperbelly water snake.” *Michigan Department of Natural Resources*. 5 September 2014. https://content.govdelivery.com/accounts/MIDNR/bulletins/cd9101 Accessed 30 April 2019. Photograph. Accessed 30 April 2019.

Fondriest Environmental, Inc. “Minimum Dissolved Oxygen Requirements of Freshwater Fish.” n.d. Fondriest.com. https://www.fondriest.com/environmental-measurements/parameters/water-quality/dissolved-oxygen/. Accessed 30 April 2019.

Gough, Steve., Little River & Design. “Geomorphic Reconnaissance for Channel Stability Management for Peterson Ditch in Winona Lake Watershed in Kosciusko County, Indiana January 1999.” *Winona Lake Preservation Association*. https://collab.dnr.in.gov/connect.ti/LARE/view?objectId=8380101. Accessed 3 July 2019.

Hall, Carol, “Blanding’s Turtle.” Minnesota Department of Natural Resources. https://www-dev.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selectedElement=ARAAD04010. Photograph. Accessed 30 April 2019.

Ground Rules Inc., "City of Warsaw, Warsaw Comprehensive Plan." *City of Warsaw, Indiana*. September 2015. Warsaw.in.gov. https://www.warsaw.in.gov/DocumentCenter/View/1492/2015-Comprehensive-Plan-PDF?bidId=. Accessed 10 September 2018.

Grove, Glenn E. "Unconsolidated Aquifer Systems of Kosciusko County, Indiana." April 2008. *State of Indiana*. https://www.in.gov/dnr/water/files/46_Kosciusko_County_UNC_AQSYS_map.pdf. 10 2018. Accessed 15 September 2018.

Historic Map Works. Kosciusko County, Indiana Platt. Wayne Township, “Warsaw, Eagle Lake, Pike Lake, Center Lake Kosciusko County." 1879. *Kingman Brothers*. http://www.historicmapworks.com/Atlas/US/9867/. Map. Accessed 30 April 2019.

IDEM. “Section 303(d) List of Impaired Waters.” 2016. In.gov. State of Indiana. https://www.in.gov/idem/nps/2647.htm. Accessed 3 July 2019.

IDEM. “Volunteer Stream Monitoring Training Manual.” Publication 2017: pp.22-26, 66, 74-75, 77-78. *in.gov*. State of Indiana. https://www.in.gov/idem/riverwatch/files/volunteer_monitoring_manual.pdf. Accessed 30 April 2019.

IDEM and Indiana University. “Indiana Clean Lakes Program.” editions, 2011-2018. *indiana.edu*. https://clp.indiana.edu/lake-info-data/past-reports.html. Accessed 30 April 2019.

IDEM and Indiana University. “Interpreting Lake Data.” Indiana.edu. 23 July 2018. https://clp.indiana.edu/doc/fact-sheets/interpreting-lake-data.pdf. Accessed 30 April 2019.

IDNR, Division Fish and Wildlife. “Lakeshore Protection in Indiana.” Rev. 2006. *In.gov*. https://www.in.gov/dnr/water/files/seawall.pdf. Accessed 30 April 2019.

Indiana Natural Heritage Center, Division of Nature Preserves, Indiana Department of Natural Resources. "Indiana County Endangered, Threatened or Rare Species List County: Kosciusko." Indiana County Endangered, Threatened or Rare Species List County. Indiana Department of Natural Resources, 5 February 2018. https://www.in.gov/dnr/naturepreserve/files/np_kosciusko.pdf. Accessed 30 April 2019.

Indiana State Department of Agriculture. “Kosciusko 2017 Fall Cover Crop and Transect Data.” 2017. *State of Indiana*. https://www.in.gov/isda/2383.htm. Accessed 30 April 2019.

Kosciusko County Area plan Study Team. "Kosciusko County Comprehensive Plan." Spring 1996. *Kosciusko County Government*. https://www.kcgov.com/egov/documents/1311947245_644287.pdf. Accessed October 2018.

Kosciusko County Government, "Pike Lake Campground." 2016.Pictometry, *Kosciusko County Government GIS Pictometry*. https://beacon.schneidercorp.com/Application.aspx?AppID=152&LayerID=1998&PageTypeID=1&PageID=1047. Aerial Photograph. Accessed 30 April 2019.

Kosciusko County, Indiana Platt. "Wayne Township, Warsaw, Eagle Lake, Pike Lake, Center Lake Kosciusko County 1879." 2017. *Historic Map Works.* www.historicmapworks.com/Buy/Prints/US/77039/. Accessed 20 July 2018.

Lilly Center for Lakes & Streams. “Tippecanoe River Clean Up Project Completes Final Phase.” *InkFree News*, 27 October 2016, www.inkfreenews.com/2016/10/27/tippecanoe-river-clean-up-project-completes-final-phase/. Accessed 15 October 2018.

Ohio State University. “Northern Riffleshell.” *asce.ohio-state.edu*. Ohio State University. n.d. https://www.asc.ohio-state.edu/eeob/molluscs/NRS1.html. Photograph. Accessed 30 April 2019

New, J.F. and Associates. “Chapman Lakes Strategic Management Plan 2007.” 2007, *Chapman Lakes Foundation. State of Indiana*. https://www.in.gov/dnr/fishwild/files/Chapman_Lakes_Strategic_Lakes_Mngmnt_Plan_Kosciusko_Jan_2007.pdf. Accessed 7/7/2019.

New, J.F. “Lozier and Highland Park Drains Engineering Feasibility Study.” 2006, Chapman Lakes Conservation Association. *dnr.in.gov*. https://collab.dnr.in.gov/connect.ti/LARE/view?objectId=8370789. Accessed 30 April 2019.

New, J.F., “Winona Lake Bank Stabilization Project Design/ Build Project.” 2009. Winona Lake Preservation Association. *dnr.in.gov*. https://collab.dnr.in.gov/connect.ti/LARE/view?objectId=8380133. Accessed 3 July 2019.

Northeast Ohio Regional Sewer District. “Total Phosphorus.” *Ohiowea.org.* Ohio Water Environment Federation. http://www.ohiowea.org/docs/OWEA_Phosphorus_CSM.pdf. Presentation. Accessed 30 June 2019.

Robinson, Felicia. “Notice of Violation Case No. 2002-12223-W.” 2002, *State of Indiana*. www.in.gov/idem/oe/cause/NOV/12223-W.htm. Accessed 24 April 2019.

Sabalow, Ryan. “Warsaw Chemical, Site of Friday Fire, Had Been Sited for Unsafe Storage. *IndyStar*, 9 February 2015, www.indystar.com/story/news/2015/02/09/warsaw-chemical-site-friday-fire-cited-unsafe-storage/23143167/. Accessed 01 September 2018.

Sailor, T., “Chapman Lakes Natural Shoreline.” Chapman Lake, Warsaw, Indiana. Photograph, 26 August 2016.

Sailor, T., “Little Chapman Lake Natural Shoreline.” Little Chapman Lake, Warsaw, Indiana. Photograph, 26 August 2016.

Sailor, T., “Sediment Laden Runoff into Winona Lake from Warsaw Construction Project.” Winona Lake, Indiana. Photograph, July 2014.

Sailor, T., “Warsaw Chemical Fire 2015, Release of Toxic Chemicals into Winona.” Winona Lake, Indiana. Photograph, 6 February 2015.

State of Connecticut, Department of Energy & Environmental Protection. “Blue-spotted Salamander.” n.d. *State of Connecticut.* ct.gov. https://www.ct.gov/deep/cwp/view.asp?a=2723&q=325808. Photograph. Accessed 30 April 2019.

State of Connecticut, Department of Energy & Environmental Protection. “Common Mudpuppy.” n.d. *State of Connecticut.* ct.gov. https://www.ct.gov/deep/cwp/view.asp?A=2723&Q=325818. Photograph. Accessed 30 April 2019.

State of Indiana DNR., "Recommended Minimum Separation Distances for Private Wells." *State of Indiana, 2018*. state.In.gov. https://www.in.gov/isdh/files/private_well.pdf. Accessed 24 April 2019.

Tharp, W. E., et al., “Soil Survey of Kosciusko County, Indiana.” Soil Survey. Purdue University: USDA Natural Conservation Resources Service & Purdue University Agricultural Experiment Station, 1985. https://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/indiana/kosciuskoIN1922/kosciuskoIN1922.pdf. Accessed 22 April 2019.

USEPA. “The Spreadsheet Tool for Estimating Pollutant Load (STEPL).” U.S.EPA, 2018. https://www.epa.gov/nps/spreadsheet-tool-estimating-pollutant-loads-stepl. Accessed 30 April 2019.

USFWS. “Clubshell (Pleurobema clava).” U.S.FWS, n.d. https://www.fws.gov/midwest/endangered/clams/clubshell/index.html. Accessed 30 April 2019”.

USGS. “pH and Water.” *USGS.* usgs.gov. https://www.usgs.gov/special-topic/water-science-school/science/ph-and-water?qt-science_center_objects=0#qt-science_center_objects. Accessed 30 April 2019.

yourweatherservice.com. USClimateData.com. 10 2016. https://www.usclimatedata.com/climate/warsaw/indiana/united-states/usin0697. 10 2016.

GIS Data Sources

(IDEM, 2019) FLOODPLAINS_FIRM_IDNR_IN.SHP: FIRM Floodplains and Flood Hazard Zones in Indiana (Indiana Department of Natural Resources, 1:12,000, Polygon Shapefile)

(IDEM, 2018) BROWNFIELDS_IDEM_IN.SHP: Brownfield Locations in Indiana (Indiana Department of Environmental Management, Point Shapefile)

(IDEM, 2018) CLEANUP_SITES_IDEM_IN.SHP: State Cleanup Program sites in Indiana (Indiana Department of Environmental Management, Point Shapefile)

(IDEM, 2018) CONFINED_FEEDING_OPERATIONS_IDEM_IN: Confined Feeding Operation Facilities in Indiana (Indiana Department of Environmental Management, Point Shapefile)

(IDEM, 2016) IMPAIRED_WATERS_303D_2016_IDEM_IN.SHP: Impaired Waters in Indiana on the 2016 303(d) List of Impaired Waters (Indiana Department of Environmental Management, 1:24,000, Line Shapefile)

(IDEM, 2006) IMPAIRED_LAKES_IDEM_IN: Impaired Lakes in Indiana on the 303(d) List of 2006 (Indiana Department of Environmental Management, Polygon Shapefile)

(IDEM, 2016) IMPAIRED_WATERS_303D_2016_IDEM_IN.SHP: Impaired Waters in Indiana on the 2016 303(d) List of Impaired Waters (Indiana Department of Environmental Management, 1:24,000, Line Shapefile)

(IDEM, 2018) UST_IDEM_IN: Underground Storage Tanks in Indiana (Indiana Department of Environmental Management, Point Shapefile)

(IDEM, 2018) VRP_SITES_IDEM_IN: Voluntary Remediation Program Sites in Indiana (Indiana Department of Environmental Management, Point Shapefile)

(IDEM, 2018) NPDES_FACILITY_IDEM_IN: Indiana Wastewater Facilities Managed Under the National Pollutant Discharge Elimination System Permitting Program (Indiana Department of Environmental Management, Point Shapefile)

Indiana Geological Survey, 2002) LANDSURVEY_COUNTY_POLY_IN: County Boundaries of Indiana (Indiana Geological Survey, 1:24,000, Polygon Shapefile)

(INDOT, 2001) INCORPORATED_AREAS_INDOT_IN: Incorporated Boundaries in Indiana (Indiana Department of Transportation, Polygon Shapefile)

(INDOT, 2015) ROADS_2015_INDOT_IN: Indiana Roads from the Indiana Department of Transportation, 2015 (INDOT, 1:100,000, Line Shapefile)

(IDNR, 2019) MANAGED_LANDS_IDNR_IN.SHP: Managed Lands in Indiana (Indiana Department of Natural Resources, 1:24,000, Polygon Shapefile)

(Kosciusko, 2016) Cnty_Drain_with_Tippe: Regulated Drains in Kosciusko County (Kosciusko County GIS, 1:24,000 Line Shapefile)

(Kosciusko, 2016) Parcel_Data: Kosciusko County Parcel Data (Kosciusko County GIS, 1:24,000 Line Shapefile)

(Natural Resources Commission, 2004) RIVERS_OUTSTANDING_NRC_IN: Outstanding Rivers in Indiana Listed by the Natural Resource Commission (Bernardin-Lochmueller and Associates, 1:100,000, Line Shapefile)

(NRCS and USDA, 2002) SOILS_STATSGO_IN: Soil Associations in Indiana (U.S. Dept. of Agriculture, 1:250,000, Polygon Shapefile)

(NRCS, 2015) Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at https://websoilsurvey.nrcs.usda.gov/. Accessed 5 February 2019

(NRCS and USDA, 2011) WATERSHEDS_HUC10_2009_USDA_IN: Ten-digit Watershed Boundaries for Indiana (United States Department of Agriculture, 1:24,000 Polygon Shapefile)

(NRCS and USDA, 2011) WATERSHEDS_HUC12_2009_USDA_IN: Twelve-digit Subwatershed Boundaries for Indiana (United States Department of Agriculture, 1:24,000 Polygon Shapefile)

(USDA, 2016) CROPS_2016_USDA_IN.TIF: Crops in Indiana for 2016, Derived from National Agricultural Statistics Service (United States Department of Agriculture, 1:100,000, 30-Meter TIFF Image)

(USDA, 2004) CULTIVATED_AREAS_USDA_IN: Cultivated Areas in Indiana in 2004 (United States Department of Agriculture, 1:100,000, Polygon Shapefile)

(U.S. NPS, 2007) Rivers_NRI_NPS_IN: Nationwide Rivers Inventory for Indiana (U.S. National Park Service, 1:100,000, Line Shapefile)

(USFWS, 2014) WETLANDS_NWI_USFWS_IN: Wetlands and Deepwater Habitats of the National Wetlands Inventory (NWI) for Indiana (U.S. Fish & Wildlife Service, Polygon Shapefile)

(USGS, 2011) LAND_COVER_2011_USGS_IN: Land Cover in Indiana, Derived from the 2011 National Land Cover Database (United States Geological Survey, 30-Meter TIFF Image)

(USGS, 2008) AQUIFERS_BEDROCK_USGS_IN: Bedrock Aquifer Systems in Indiana (United States Geological Survey, 1:500,000, Polygon Shapefile)

(USGS, 2008) AQUIFERS_UNCONSOLIDATED_USGS_IN: Unconsolidated Aquifer Systems in Indiana (United States Geological Survey, 1:500,000, Polygon Shapefile)

(USGS, 2008) HYDROGRAPHY_HIGHRES_WATERBODYDISCRETE_NHD_USGS: Lakes, Ponds, Reservoirs, Swamps, and Marshes in Watersheds of Indiana (U. S. Geological Survey, 1:24,000, Polygon Shapefile)

(USGS, and USEPA 2008) HYDROGRAPHY_HIGHRES_FLOWLINE_NHD_USGS: Streams, Rivers, Canals, Ditches, Artificial Paths, Coastlines, Connectors, and Pipelines in Watersheds of Indiana (U. S. Geological Survey, 1:24,000, Line Shapefile)

(USGS and USEPA, 2008) HYDROGRAPHY_HIGHRES_WATERBODYDISCRETE_NHD_USGS: Lakes, Ponds, Reservoirs, Swamps, and Marshes in Watersheds of Indiana (U. S. Geological Survey, 1:24,000, Polygon Shapefile)

Appendix

Watershed Steering Committee		
#	Org Name/Area Represented	Name
1	Agricultural Community	David Ransbottom
2	Builders Association of Kosciusko & Fulton Counties	Brett Harter
3	Center for Lakes & Streams at Grace College	Nathan Bosch
4	Chapman Lakes Foundation	Peggy Wihebrink
5	County Council - District 4	Jon Garber
6	Kosciusko Area Planning Department	Matt Sandy
7	Kosciusko Chamber of Commerce	Rob Parker
8	Kosciusko County Soil & Water Conservation District	Darci Zolman
9	Kosciusko County Surveyors Office	Mike Kissinger/Jim Moyer
10	Kosciusko Emergency Management Agency	Ed Rock
11	Pierceton A-Large Resident	Andrea Baker
12	Pike Lake Assoc / Warsaw Common Council	Diane Quance
13	Resident At-Large / Center Lake Assn	Max Mock
14	The Watershed Foundation	Lyn Crighton
15	The Watershed Foundation	Chuck Brinkman
16	Town of Winona Lake	Craig Allebach
18	Winona Lake Preservation Assn	Joy Lohse
19	Zimmer Biomet, Inc.	Kirk Swaidner
20	Indiana-American Water	Chris Harrison
21	City of Warsaw - MS4, Storm Water Coordinator	Ryan Workman

Table 1 Steering Committee Members

Watershed Education & Outreach Committee		
#	Org Name	Name
1	KC Recycling Depot	Sarah Fruit
2	Center for Lakes & Streams	Caitlyn Yoder
3	Kosciusko County SWCD	Darci Zolman
4	Clean Waters Partnership	Theresa Sailor
6	The Watershed Foundation	Lyn Crighton
7	Volunteer - Clear Choices Clean Water	Alex Hall
8	The Watershed Foundation	Eileen Oaks
9	Chapman Lakes Foundation	Peggy Wihebrink
10	Pike Lake Assoc / Warsaw Common Council	Diane Quance
11	City of Warsaw	Ryan Workman

Table 2 Education Committee

Technical Committee		
#	Org Name	Name
1	The Watershed Foundation	Sam St.Clair
2	Center for Lakes & Streams	Nathan Bosch
3	Center for Lakes & Streams	Seth Bingham/Stephen Becker
4	Agricultural	David Ransbottom
5	IN American Water	Chris Harrison
6	Kosciusko County Surveyors Office	Jim Moyer
7	Zimmer, Inc.	Kirk Swaidner
8	Kosciusko County SWCD	Andrea Baker
9	Kosciusko Area Planning Department	Matt Sandy
10	City of Warsaw - MS4, Storm Water Coordinator	Ryan Workman
11	City of Warsaw - Utility Department	Brian Davison
12	City of Warsaw - Engineering	James Emans
13	Kosciusko Emergency Management Agency	Ed Rock
14	The Watershed Foundation	Chuck Brinkman
15	The Watershed Foundation	Therersa Sailor
16	The Watershed Foundation	Lyn Crighton
17	IDEM Watershed Specialist	Chelsea Cottingham
18	NRCS Kosciusko County	Chad Shotter

Table 3 Watershed Technical Committee

Ruple - Tippecanoe River Subwatershed

Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Tippecanoe River	Paddle Access Chinworth Bridge Trail at Lincoln HWY & N 350 W	Yes	No	No	No	N/A	N/A	Yes	No	Yes	PCBs, Total Mercury, E. Coli	13	uk
Walnut Creek	None Designated	Yes	No	No	No	N/A	N/A	Yes	No	Yes	PCBs	1.4	uk
Center Lake	Central Park	Yes	Yes	Yes	Yes	Yes	10mph	Yes	No	Yes	Phosphorus	120	42
Center Lake	Nye Park	Yes	No	Yes	No	N/A	N/A	Yes	No	Yes			42
Center Lake	Bixler Park	Yes	No	No	No	N/A	N/A	Yes	No	Yes			42
Hidden Lake	No Public Access										None Listed	23	uk

Pike Lake - Deeds Creek Watershed

Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory 2016	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Deeds Creek	None Designated									No	E. coli	11	uk
Beyer Brady Ditch	N/A									No	None Listed	4	uk
Hickman Ditch	N/A									No	None Listed	2	uk
McCleary Gochenour Ditch	N/A									No	None Listed	4	uk
Robert Shroyer	N/A									No	None Listed	0.5	uk
Noah Putney	N/A									No	None Listed	1	uk
Big Chapman Lake	Chapman Lake Public Access off of Chapman Lake Drive	Yes	No	Yes	Yes	Yes	None	Yes	No	No	None Listed	413	39
Little Chapman Lake	No Public Access	No	N/A	N/A	N/A	Yes	Yes	N/A	N/A	No	Phosphorus	200	31
Pike Lake	Pike Lake Park & Campground	Yes	Yes	Yes	Yes	Yes	None	Yes	No	Yes	Phosphorus, PCBs, Largemouth Bass 13+"	212	34
Pike Lake	Beyer Park	Yes	No	No	No	N/A	N/A	Yes	No	Yes			34
Pike Lake	Lucerne Park	Yes	No	No	No	Yes	None	Yes	No	Yes			34
Little Pike Lake	Access thru Pike Lake	No	No	No	No	Yes	None	N/A	No	No	Phosphorus	42	9

McCarter Ditch - Deeds Creek

Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Deeds Creek	No Public Access									No	E.Coli	11	uk
Van Curen Ditch	No Public Access									No	E.Coli	9.4	uk
Guy Ditch	No Public Access									No	E. coli	2.5	uk

Table 4 Walnut Creek - Tippecanoe River Watershed Streams & Lakes Table A

Winona Lake - Eagle Creek Subwatershed												
Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Wyland Ditch	N/A										None Listed	19	uk
Keefer - Evans Ditch	N/A										None Listed	6	uk
Martin Peterson Ditch	N/A										None Listed	15	uk
Winona Lake	Kiwanis Park Warsaw	Yes	No	Yes	Yes	Yes	None	Yes	No	Yes	PCBs, Common Carp 26+", White Bass 16+"	571	79
Winona Lake	Winona Lakes Limitless Park	Yes	Yes	Yes	Yes	Yes	None	Yes	No	Yes			79
Winona Lake	Kosciusko County Fairgrounds	Yes	No	Yes	No	Yes	None	Yes	Yes	Yes			79
Laspew Lake	No Public Access										None Listed	8.4	uk
Tennant Lake											None Listed	8.8	8
Sellers Lake											None Listed	26.6	21
Sherburn Lake											None Listed	14	uk
McPherson Lake											None Listed	6.7	uk
Stevens Lake											None Listed	7.6	uk
Reed Lake											None Listed	4.1	4
Wyland Lake											None Listed	9.1	38
Sheely Lake											None Listed	14.4	uk
Lake John											None Listed	23	uk
Eagle Creek - Walnut Creek Subwatershed													
Waterbody	Public Access Point	Public Access	Public Beach	Ramp	ADA Access	Motors Allowed	Motor Restrictions	Shoreline Fishing	Fee	Fish Advisory	303 (d) list Advisory	Area in Acres (Lakes) Length in Open Miles (Streams)	Maximum Depth (feet)
Eagle Creek	No Official Public Access Point, paddlers can access at Country Club Road or Logan Street										None Listed	1.5	uk
Walnut Creek	No Public Access										None Listed	27	uk
Schultz Lake	No Public Access										None Listed	7.2	uk
Tibbitts Lake											None Listed	9.4	uk
Carr Lake	East on CR 400S at SR 15 then south on Kinsey Rd. S, 1.1 mi	Yes	No	Yes	Yes	Yes	None	Yes	No	No	None Listed	80.1	35
Price Lake	No Public Access										None Listed	5.4	uk
Fish Lake											None Listed	17.3	uk
Muskellunge Lake											None Listed	31	21
Goose Lake											None Listed	27.7	53

Table 5 Walnut Creek - Tippecanoe River Watershed Streams & Lakes Table B

Walnut Creek - Tippecanoe River Watershed NPDES Facilities						
Facility Name	**Description**	**Permit Status**	**Discharge Water Body**	**Outfall Type / Ownership**	**Specific Type**	**Subwatershed**
Biomet Manufacturing Engineering	Private Facility	Effective	Hickman Ditch	Direct Discharge	Non-Contact Cooling	Pike Lake - Deeds Creek
Dalton Corp- Warsaw Manufactoring Facility	Private Facility	Effective	Winona Lake	Warsaw Storm Sewer	Non-Contact Cooling	Winona Lake - Eagle Creek
Mecks Wispering Pines MHP	Public/ Private	Effective	GA Robinson Ditch	Direct Discharge	Wastewater	Ruple-Tippecanoe River
Pierceton Water Department	Municipal or Water District	Effective / Non-Compliant 2017	Tributary to Deeds Creek	Direct Discharge	Water (Filter Flushing)	McCarter Ditch - Deeds Creek
Pierceton WWTP	Municipal or Water District	Effective / Non-Compliant 2013. 2015. 2016, 2017	Deeds Creek	Direct Discharge	Wastewater	McCarter Ditch - Deeds Creek
Suburban Acres MHP	Public/ Private	Effective	Tippecanoe River	Direct Discharge	Wastewater	Ruple-Tippecanoe River
Warsaw #1 WWTP	Municipal or Water District	Effective	Walnut Creek	Warsaw Sanitary Sewer or Combined Sewer Overflow into Walnut Creek	Wastewater	Eagle Creek-Walnut Creek
Warsaw #2 WWTP	Municipal or Water District	Effective	Tippecanoe River	Direct Discharge	Wastewater	Ruple-Tippecanoe River
Warsaw Foundry	Private Facility	Effective	WWTP / Center Lake	Warsaw Sanitary and Storm Sewer	Non-contact Cooling	Ruple-Tippecanoe River
Warsaw Mobile Home Park	Private Facility	Effective / Non-Compliant 2016	John Pyle Ditch	Direct Discharge	Wastewater	Eagle Creek-Walnut Creek
Zimmer Inc Bldg 19	Private Facility	Effective	Walnut Creek	Warsaw Storm Sewer	Non-Contact Cooling	Eagle Creek-Walnut Creek
TTP Inc	Private Facility	Terminated	Deeds Creek	uk	uk	Pike Lake - Deeds Creek
DA-LITE Screen Company	Private Facility	Terminated	RR/Airport Property	Direct Discharge	Non-Contact Cooling	Ruple-Tippecanoe River
Shamrock Mobile Home Park	Public/ Private	Terminated	Pike Lake	Warsaw Sanitary Sewer	Wastewater	Winona Lake - Eagle Creek
Information compiled for the Walnut Creek - Tippecanoe River Watershed Desktop Survey 2017 Non-compliance listed for last 4 years. May not be all-inclusive.						

Table 6 Walnut Creek - Tippecanoe River Watershed Permitted NPDES Facilities

Walnut Creek - Tippecanoe River Watershed Remediation Sites					
Facility Name	**Description**	**Status**	**Address**	**Actions**	**Subwatershed**
BDI Engineering	Private Facility	Effective	4130 Corridor Dr Warsaw	Nitrates - Public Drinking Water	Deeds Creek - Pike Lake
Warsaw WWTP #1	Municipal	Closed	794 W Center St Warsaw	Wastewater / Contamination	Eagle Creek - Walnut Creek
R & B Investors / Wildman Uniform & Linen	Private Facility	Effective	800 S Buffalo St Warsaw	Air Quality Permit	Eagle Creek - Walnut Creek
City Dump	Municipal Facility	Closed	West Center St, between Leiter & Walnut Creek	Legacy Contamination	Eagle Creek - Walnut Creek
Warsaw Manufactured Gas Plant	Private Facility	Effective	502 E. Winona Warsaw	VRP	Eagle Creek - Walnut Creek
Checker 22	Private Facility	Closed	1661 W Lake Street	LUST	Eagle Creek - Walnut Creek
Good Oil BP	Private Facility	Effective	625 S Buffalo Warsaw	LUST, Remediation	Eagle Creek - Walnut Creek
Peerless Cleaners	Private Facility	Effective	2020 E Winona Ave Warsaw	HW Site, VRP Remediation	Pike Lake - Deeds Creek
Warsaw Chemical	Private Facility	Effective	390 Argonne Rd Warsaw	HW Cleanup, Rule 6 No Exposure	Pike Lake - Deeds Creek
BDI Engineering	Private Facility	Effective	1212 N Detroit Warsaw	Drinking Water Typ.	Pike Lake - Deeds Creek
Warsaw Plating Works	Private Facility	uk	1900 E Jefferson St Warsaw	Legacy Contamination	Pike Lake - Deeds Creek
DaLite Screen Company	Private Facility	Effective	3100 N Detroit St Warsaw	Air Permit, Drinking Water (VOCs)	Ruple Ditch - Tippecanoe River
Warsaw Orthopedic / Medtronic	Private Facility	Effective	2500 Silveous Crossing Warsaw	Rule 6 - No Exposure, Air Permit, HW Generator	Ruple Ditch - Tippecanoe River
City of Warsaw WWTP # 2	Municipal	Effective	2056 N 150 W Warsaw	Final Closure Remediation	Ruple Ditch - Tippecanoe River
Atwood Farm	Private Facility	Effective	4811 W CR 100 N Warsaw	Nitrates , E. Coli - Public Drinking Water	Ruple Ditch - Tippecanoe River
R Vision Incorporated / Midwest Rake	Private Facility / Public Drinking	Effective	2666 S Country Club Rd Warsaw	Drinking Water Typ.	Winona Lake - Eagle Creek
Information compiled for the Walnut Creek - Tippecanoe River Watershed Desktop Survey 2017					

Table 7 Walnut Creek - Tippecanoe River Watershed Remediation Sites

Mobile Home / Concentrated Multi-family Communities with Septic Systems			
Facility Name	**Description**	**Status**	**Subwatershed**
Chapman Lake Mobile Home Park / Genes Mobile Home Park	Private Facility	Septic System / Drinking Water Testing	Ruple Ditch - Tippecanoe River
Lozier Camp Area Campground	Private Facility	Septic System	Ruple Ditch - Tippecanoe River
Campground Muskellunge Lake	Private Facility	Septic System	Eagle Creek-Walnut Creek
Campground Carr Lake	Private Facility	Septic System	Eagle Creek-Walnut Creek
Mobile Home Community Carr Lake	Private Facility	Septic System	Eagle Creek-Walnut Creek
Mobile Home Community Sellers Lake	Private Facility	Septic System	Winona Lake-Eagle Creek
Information compiled for the Walnut Creek - Tippecanoe River Watershed Desktop Survey			

Table 8 Mobile Home / Concentrated Multi-family Communities with Community Septic Systems

2016 Watershed Management Plan Water Quality Target Recommendations by the Technical Committee			
Water Quality Parameter	Identified Watershed Target	Source of Target	Background Information
Dissolved Oxygen (DO)	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code (327 IAC-2-1-6)	Dissolved Oxygen as measured in mg/L should fit in the 4-12 mg/L parameter; however, the technical committee advises that DO % saturation is determined using temperature and nutrient factors affecting oxygen supply, thus the saturation percentage of dissolved oxygen is key for understanding the available oxygen for aquatic life. 60% - 105% Dissolved Oxygen Saturation is required for the most diverse biota.
pH	Minimum 6 and maximum 9	Indiana Administrative Code (327 IAC-2-1-6)	USGS states importance to aquatic life: The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, copper, cadmium, etc.). For example, in addition to affecting how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. In the case of heavy metals, the degree to which they are soluble determines their toxicity. Metals tend to be more toxic at lower pH because they are more soluble. (Source: A Citizen's Guide to Understanding and Monitoring Lakes and Streams).
Escherichia coli (E. coli)	Max: 235 CFU/100mL in a single sample	Indiana Administrative Code (327 IAC-2-1-6)	Measurement used to identify potential presence of fecal bacterial that statistically could result in increased human health risks.
Total Suspended Solids (TSS)	25.0 mg/L	US EPA Recommendation for Excellent Fisheries	Total suspended solids (TSS) include all particles suspended in water which will not pass through a filter. Suspended solids are present in all waters both point source and non-point source discharges. As levels of TSS increase, a waterbody begins to lose its ability to support a diversity of aquatic life. TSS will absorb heat from sunlight, which increases water temperature and decreases levels of dissolved oxygen. Photosynthesis decreases, since less light penetrates the water then less oxygen is produced by plants and algae and there is a there further drop in dissolved oxygen. TSS can destroy fish habitat as SS can settle to the bottom, blanket a river bed, and smother eggs of fish and aquatic insects, and suffocate newly-hatched insect larvae. In adult fish TSS can clog gills, reduce growth rates, and lower resistance to disease. Water with TSS of less than 20 mg/L appears clear. Water with TSS between 40 and 80 mg/l tends to appear cloudy, and water with concentrations over 150 mg/l usually appears dirty. (michigan.gov)
Total Phosphorus (TP)	.076 mg/L	US EPA Recommended Target	Phosphorus is a nutrient for plants and is released in decomposing plant life. Along with natural sources such as leaves that fall into a water stream, it can be unnaturally introduced by stormwater that is contaminated with grass clippings or leaves, agricultural fertilizers, manure, and organic wastes in sewage and industrial effluent. The addition of unnatural sources speeds up eutrophication of rivers and lakes and grows unwanted algae including toxic variants. Soil erosion from unvegetated, partially vegetated, or cultivated lands can be a major contributor of phosphorus to streams. Bank erosion during floods also can transport significant phosphorous from the river banks and adjacent land into a stream.
Nitrates (NO3) nitrogen	1.5 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodds, W.K. et al., 1998, Table 1, pg. 1459, and in EPA-822-B-00-002 [PDF], p 27.)	Excess nitrogen (a plant nutrient) can cause overstimulation of growth of aquatic plants and algae, use up dissolved oxygen as they decompose, and block light to deeper waters. Lake and reservoir eutrophication can occur, which produces unsightly scums of algae on the water surface, can occasionally result in fish kills, and can even "kill" a lake by depriving it of oxygen. The respiration efficiency of fish and aquatic invertebrates can occur, leading to a decrease in animal and plant diversity, and affects our use of the water for fishing, swimming, and boating. Although nitrogen is abundant naturally in the environment, it is also introduced through sewage and fertilizers. Chemical fertilizers or animal manure is commonly applied to crops to add nutrients. Heavy rains can generate runoff containing these materials into nearby streams and lakes. Wastewater-treatment facilities that do not specifically remove nitrogen can also lead to excess levels of nitrogen in surface or groundwater. Source: usgs.gov

Table 9 Clean Waters Partnership Water Quality Targets

Sampling Site Location Descriptions

Site #	Waterway	Sampling Site Type	**Influences:** Rural Residential (R), Agricultural (A), Urban (U), Lake (L), Wastewater Plant (WWTP)	Location Description
1	Deeds Creek	Bi-weekly	A	Deeds Creek near E 100 N
2	Heeter Ditch	Bi-weekly	A, L	Heeter Ditch off of 175 N
3	Lones Ditch	Bi-weekly	A, U	Lones Ditch W of SR 15
4	Wyland Ditch	Bi-weekly	A, R, U	Wyland Ditch east of Winona Lake, E of Park Ave, Winona Lake
5	Keefer Evans Ditch	Bi-weekly	A, L, R, U	Keefer Evans Ditch south of Winona Lake, 2002 Eastwood Rd, Winona Lake
6	Martin Peterson Ditch	Bi-weekly	A, R	Martin Peterson south of Winona Lake, 741 E Lakewood Ave, Warsaw
7	Eagle Creek	Bi-weekly	A, L, R, U	Eagle Creek west of Winona Lake, 1109 Country Club Rd, Warsaw
8	Walnut Creek before Eagle Creek	Bi-weekly	A,R,U,	Walnut Creek south of Eagle Creek, 429 West Creek Dr, Warsaw
9	Walnut Creek before Tippecanoe River	Bi-weekly	U, A, R, L	Walnut Creek south of Tippecanoe River, at the intersection of Lake St, Warsaw
10	Tippecanoe River	Bi-weekly	U, A, R, L	Tippecanoe River east of WWTP outfall, east of Fox Farm Road
11	Deeds Creek	High Source	A	Deeds Creek at SR 30 east of Pike Lake
12	Van Curen Ditch	High Source	A	Van Curen Ditch at Old Rd 30
13	Leedy Ditch	High Source	A	Leedy Ditch at 600 E
14	Deeds Creek	High Source	A	Deeds Creek, SR 30 3426 SR 30 E
15	Deeds Creek	High Source	A, R	Pierceton Rd east of 600 E
16	Deeds Creek	High Source	A, WWTP	350 S and 725 E, W of Pierceton WWTP
17	Deeds Creek	High Source	A	8506 E Ryerson Rd, E of Pierceton WWTP
18	Outfall into Kelly Park Pond	Stormwater Outfall	U	Kelly Park, 130 Fawley St (STO-60-010)
19	Outfall into Winona Lake	Stormwater Outfall	U	2400 Winona Ave. (STO-047-039)
20	Outfall into Pike Lake	Stormwater Outfall	U	Warsaw Cemetery, 421 N Maple Street (STO-028-003)

Table 10 Sampling Site Location Descriptions

Summary of Sampling Data at All Sites																	
		E. coli				Nitrates (NO3)				Total Phosphorus				Suspended Solids			
Site #	Waterbody	Average Reading cfu/ 100mL	*Highest Reading cfu/ 100mL	Lowest Reading cfu/ 100mL	% Exceeded 235 cfu/ 100mL	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 1.5 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target .076 mg/L	Average Reading mg/L	Highest Reading mg/L	Lowest Reading mg/L	% Exceeded CWP Target 25 mg/L
1	Deeds Creek	650	>2419	36	62%	3.21	9.38	0.36	87%	0.118	0.606	0.015	46%	23	254	0	22%
2	Heeter Ditch	319	>2419	1	30%	0.67	2.40	0.09	9%	0.044	0.111	0.012	8%	11	48	0	7%
3	Lones Ditch	38	727	1	6%	1.23	3.37	0.00	39%	0.039	0.154	0.007	4%	8	32	0	2%
4	Wyland Ditch	354	>2419	28	42%	1.95	5.61	0.48	54%	0.072	0.544	0.014	22%	14	292	0	6%
5	Keefer Evans	223	1986	9	26%	0.96	3.86	0.09	24%	0.056	0.376	0.016	11%	11	162	0	4%
6	Peterson Ditch	723	>2419	21	54%	1.86	5.92	0.34	54%	0.090	0.738	0.013	25%	24	337	0	9%
7	Eagle Creek	24	345	0	19%	0.51	1.91	0.00	2%	0.033	0.064	0.014	0%	5	17	0	0%
8	Walnut Creek Before Eagle Creek	298	>2419	1	33%	1.62	4.97	0.09	44%	0.085	0.201	0.018	52%	6	20	0	0%
9	Walnut Creek before Tippecanoe River	172	1732	13	26%	0.78	2.37	0.07	11%	0.069	0.151	0.030	39%	7	33	0	0%
10	Tippecanoe River East of Fox Farm	115	1119	13	11%	0.64	1.55	0.09	2%	0.032	0.072	0.012	0%	5	16	0	0%
11	Deeds Creek	457	980	106	75%	1.51	1.87	1.34	25%	0.062	0.136	0.032	25%	11	31	1	25%
12	Van Curen Ditch	783	>2419	30	75%	1.35	2.10	0.93	25%	0.070	0.120	0.017	100%	6	6	2	0%
13	Leedy Ditch	1117	>2419	435	100%	2.58	3.25	1.98	100%	0.136	0.189	0.043	75%	17	36	6	25%
14	Deeds Creek	1096	>2419	236	100%	4.51	6.25	2.92	100%	0.050	0.088	0.020	25%	4	7	0	0%
15	Deeds Creek	807	>2419	210	75%	3.60	4.11	3.20	100%	0.170	0.198	0.096	100%	11	27	0	25%
16	Deeds Creek	1416	>2419	225	75%	5.71	7.66	3.93	100%	0.540	0.906	0.289	100%	10	26	2	0%
17	Deeds Creek	1864	>2419	200	75%	3.47	5.29	1.29	75%	0.140	0.167	0.115	100%	30	50	7	50%
18	Outfall into Kelly Park Pond	922	>2419	816	80%	0.50	1.10	0.12	100%	0.170	0.238	0.129	100%	30	75	12	33%
19	Outfall into Winona Lake	130	>2419	23	33%	0.30	0.74	0.00	83%	0.160	0.356	0.049	100%	237	679	3	50%
20	Outfall into Pike Lake	739	>2419	179	0.4	0.65	1.12	0.26	100%	0.430	0.712	0.091	100%	223	788	4	33%

* When the highest reading is >2419, the number that was calculated to be the average will be underreported. In some instances it could be significant. The percentage exceeding the limit should give an indication if E. coli is a prevalent problem at that site.

Table 11 Summary of Sampling Data at All Sites

Hoosier Riverwatch & Citizens Qualitative Habitat Evaluation Index Data														
Site #	Site Description	Sample #	2016 Date	Pollution Tollerance Index Rating (PTI) Score (23+ Excellent, 10 or less Poor)		Presence of Group 1 - Pollution Intollerant Organisms	2016 Date	Qualitative Habitat Evaluation Index (CQHEI)	Waterway Substrate (0-25)	Fish Cover Present (2-18)	Stream Shape and Human Alteration (0-20)	Stream Forests, Wetlands, Riparian, Erosion (0-19)	Water Depth & Velocity (0-15)	Riffles Runs (0-15)
1	Deeds Creek	A	7/6	20	Good	Yes	7/6	52.5	15	10	12	9.5	6	0
1	Deeds Creek	B	7/6	15	Fair	No								
2	Heeter Ditch	A	7/14	22	Good	Yes	7/6	29.5	0	8	9	4.5	8	0
2	Heeter Ditch	B	7/14	20	Good	Yes								
3	Lones Ditch	A	7/14	10	Poor	No	7/6	51.5	5	16	9	13.5	8	0
3	Lones Ditch	B	7/14	10	Poor	No								
4	Wyland Ditch	A	7/6	21	Good	Yes	7/6	55	16	8	9	3	6	13
4	Wyland Ditch	B	7/6	19	Good	Yes								
5	Keefer-Evans Ditch	A	7/6	26	Excellent	Yes	7/6	54.5	5	10	18	13.5	8	0
5	Keefer-Evans Ditch	B	7/6	20	Good	Yes								
6	Martin Peterson Ditch	A	7/6	4	Poor	No	7/6	48.5	15	10	9	8.5	6	0
6	Martin Peterson Ditch	B	7/6	4	Poor	No								
7	Eagle Creek	A	7/6	15	Fair	Yes	7/6	44.5	15	6	6	9.5	8	0
7	Eagle Creek	B	7/6	9	Poor	No								
8	Walnut Creek before Eagle Creek	A	7/14	11	Fair	Yes	7/6	66.5	16	10	15	10.5	9	6
8	Walnut Creek before Eagle Creek	B	7/14	9	Poor	No								
9	Walnut Creek before Tippy River	A	7/14	21	Good	Yes	7/6	57.5	10	12	12	13.5	10	0
9	Walnut Creek before Tippy River	B	7/14	20	Good	Yes								
10	Tippy River at Fox Farm Rd	A	7/14	25	Excellent	Yes	7/6	63.5	16	14	9	16.5	8	0
10	Tippy River at Fox Farm Rd	B	7/14	21	Good	Yes								
Denotes an area that received .18-.72 inches of rain in the 24 hours prior to monitoring. Results may not be typical. Macroinvertabrates that may normally have been found at that site could have been flushed by the heavy rain event.														

Table 12 Hoosier Riverwatch & CQHEI Data – 2016

Indiana Clean Lakes Program - Trends for Carlson Trophic Indices for Major Lakes										
Waterbody	2011	2012	2013	2014	2015	2016	2017	2018	Trend - Stable (S), Fluctuating (F), Degrading (D), Unknown (U)	Trophic Status - Oligotrophic (O), Mesotrophic (M), Eutrophic (E), Hypereutrophic (H)
Pike Lake			68	60	65				U	E-H
Winona Lake		54	66	51	60	52	56	59	S	E
Center Lake	51	49	50	45	57	42	44	41	S	M
Big Chapman Lake	48	46	48	46	48	46	53		S	M
Little Chapman Lake	58	59	60	60	60	57	62		S	E
Yellow shaded areas have no data for that year.										

Table 13 TSI Values for Larger Lakes in the Walnut Creek - Tippecanoe Watershed from the Indiana Clean Lakes Program (IDEM and Indiana University 2011-2018)

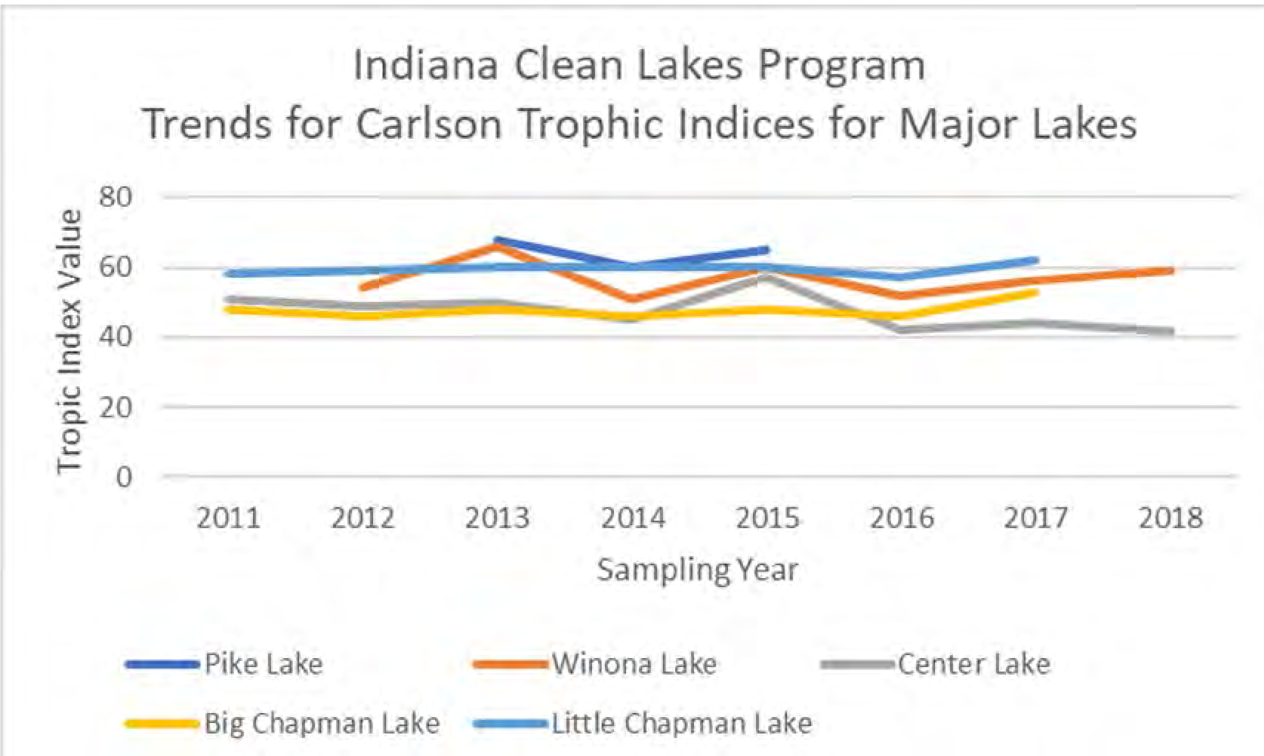


Table 14 Trends for Carlson Trophic Indices for Major Lakes in the Watershed - Indiana Lakes Program

Snapshot Water Monitoring Day Results - September 27, 2017									
Field Survey Done for each site prior to sampling to check channel silting									
Site #	Temp (˚F)	Turbidity (cm)	Dissolved Oxygen (mg/L)	Nitrite (mg/L)	Nitrate (ml/L)	Ortho-phosphate (mg/L)	pH	E.coli (CFU/ 100mL	Silting of Channel (inches)
DC03	60	60	5	0	0	0	7	0	2
DC04	60	16	2.5	0	0.15	0.8	7.5	900	24
DC07A	68	60	4	0.15	2	0	6.5	0	uk
DC08	70	24	8	0	0.5	0.2	7	350	0
DC 15	no flow								uk
DC 16	70	56	10	0	0.5	0.1	8.5	0	uk
DC 18	68	60	6	0	0.5	0.1	7.5	600	5+
DC24	68	60	8	0.5	0.5	0.1	8	200	0
DC25	67	60	6	0	0.5	0.2	8	250	uk
DC30	68	60	5	0	0.5	0.1	7.5	0	0
DC30A	66	60	4	0	0.5	0.1	7.5	300	4
DC33	62	60	7	0.5	0	0.1	8	100	uk
DC35	72	47.2	7	0	0	0	7.5	0	8
EC02	71	59	4	0	0	0.3	7.5	0	6
EC07	68	60	7	0	0.5	0.3	7.5	100	0
EC08	71	60	6	0	0.5	0.6	7	300	2
EC12	69	65	5	0	2	0.4	7	450	uk
EC20	64	65	5.5	0	0.1	0.2	7.5	800	uk
EC4A	71	120	5	0	0.5	0.4	6.5	50	uk
MC03	67	60	5.5	0	0.5	0.2	8.5	200	2
MC04A	65	60	11	0.15	10	0.3	8	200	uk
MC14	Did not get sampled in 2017								0
MC17	Did not get sampled in 2017								6
MC22	62	27.5 cm	4.5	0	0	0.3	8	750	6
RD05	71	59 cm	6	0	0	0	7	0	0
RD10	72	60 cm	11	0	0	0	7	0	0
RD13	65	15 cm	3	0	0	0.3	7.5	0	3
RD15	no flow								N/A
WL21	60	8 cm	5	0	0	0.4	7	300	uk
WL32	65	60 cm	8	0	0	0	7.5	250	uk
WL33	64	60 cm	6	0	0	0.05	7	300	0
WL35	63	65 cm	8.5	0	0.5	0.1	7	100	12
WL46A	58	32 cm	5	0	2	0.2	7.5	500	uk
T01	76.5	60	7	0	0	0	7.5	0	uk
Key: Ruple Ditch - RD, McCarter Ditch - MC, Winona Lake - WL, Deeds Creek - DC, Eagle Creek - EC									

Table 15 Snapshot Monitoring Day Results 2017

	Criteria to Meet Objectives	Carr Lake	Chapman Lakes	Center Lake	Pik Lakes	Winona Lake	Cherry Creek	Deeds Creek	Eagle Creek	Heeter Ditch	Keefer- Evans	Lones Ditch	Peterson Ditch	Tippecanoe River (Fox Farm Rd)	Walnut Creek b/f Eagle	Walnut Creek b/f Tippy River	Deeds Creek Ditch	Private Lakes	Initials
Objective: Reduce Sediment, Nutrients, & Pollution in Local Waterways	Total Suspended Solids (TSS)	1	1	3	3	3	2	3	1	2	2	1	3	1	1	1	2		NB
	Phosphorus (P)	2	1	2	2	2	2	3	1	1	1	1	3	1	2	2	2		NB
	Nitrates (NO3)	1	1	1	3	2	3	3	1	1	1	2	3	1	3	1	3		NB
	Septic Systems (Failing / Unsuitable Soils)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2.6		JM
	Urban Stormwater Quality	1	2	3	3	3	3	1	2	1	1	2.5	1	1.5	3	3	1		RW
	Industry- NPDES	1	1	2	2	3	1	2	3	1	1	1	1	3	3	3	2	1	KS
	Urban Impervious Surface	1	2	3	3	3	3	1	2	1	1	2.5	1	1.5	3	3	1		RW
	Agriculture - Row Crop Tillage	1	3	1	3	3	2	3	1	2	2	1	3	2	3	2	3		SS
	Agriculture (Manure) Unfenced Livestock /Land Application	3	1	1	2	2	1	2	1	2	1	1	2	1	2	1	2		1
Drains	Regulated Drains Assessment	1	1	1	3	1	2	3	1	3	1	3	3	1	1	1	3		JM
Objective: Protect & Improve Habitat	Endangered Species, Irreplaceability Values: Fish, Crayfish, Mussels	1	3	2	1	1	1	1	1	1	1	1	1	3	1	1	1	1	AB
	Invasive Species	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		AB
	Habitat CQEHI	2	2	2	2	2	1	1	2	3	1	1	2	1	1	1	2		NB
	Macroinvertebrates PTI Index	2	2	2	2	2	1	2	2	1	1	3	3	1	3	1	2		NB
Objective: Promote Local Lakes Culture (value of water)	Importance to Anglers	3	3	3	3	3	1	1	2	1	1	2	1	2	1	2	1		AB
	Economic Importance	1	2	2	2	3	1	1	1	1	1	1	1	2	1	1	1		NB
	Recreational Use (boating, swimming, etc...)	2	3	2	2	3	1	1	1	1	1	1	1	2	1	1	1		NB
Overall Ability to Complete Objective	Immediacy of Threats	7	7	6	10	9	7	10	8	5	6	5	8	5	8	8	10	4	Everyone
	Permanency of Threats	6	7	8	10	9	7	10	7	6	7	5	8	6	7	8	10	4	
	political will based on results and stakeholder desires and attitudes	2	5	4	4	4	4	5	2	4	4	2	5	2	2	2	4	2	
	Potential Landowner willingness to implement	4	2	2	3	4	3	4	2	3	4	2	4	2	3	2	3	3	
	Potential for securing funding	3	3	3	4	3	3	3	2	3	3	2	3	4	3	2	3	1	
Totals	Total Score	49	56	57	71	69	53	64	47	47	45	44	61	47	56	50	62.6	16	
	Ranking																		

AB - Andrea Baker, NB - Nate Bosch, KS - Kirk Swaidner, SS - Sam St. Clair, RW - Ryan Workman 5/3/2017

Table 16 Committee Priority Selection Worksheet

Hoosier Riverwatch

Biological Monitoring Data Sheet

Date: ____/____/____ **Volunteer ID:** ________ **Site ID:** ________

Stream Name: ______________________ **Latitude:** ______ **Longitude:** ______

Time ____:____ AM / PM **Time Sampling:** _____ **hrs** **Air Temp.:** _________ **°C**

Current Weather: ☐ Clear/Sunny ☐ Overcast ☐ Showers ☐ Rain (steady) ☐Storm (Heavy)

Worst Weather (past 48 hours): ☐ Clear/Sunny ☐ Overcast ☐ Showers ☐ Rain (steady) ☐Storm (Heavy)

Check Methods Used: ☐ Kick Seine Net (3 times) ☐ Dip Net (20 jabs or scoops)

Check Habitats Sampled: ☐ Undercut Banks ☐ Riffles ☐ Leaf Packs ☐ Snags/Vegetation ☐Sediment

Pollution Tolerance Index (PTI)

Record the taxa (group) represented in your sampling by either entering the number of organisms you counted or a ✓

Group 1 - Intolerant	Group 2 - Moderately Intolerant	Group 3 - Fairly Tolerant	Groups 4 - Very Tolerant
☐ Stonefly nymph	☐ Damselfly nymph	☐ Leech	☐ Aquatic worm
☐ Mayfly nymph	☐ Dragonfly nymph	☐ Midge larva	☐ Blood midge larva (red)
☐ Caddisfly larva	☐ Scud	☐ Planaria/ Flatworm	☐ Rat-tailed Maggot
☐ Riffle Beetle	☐ Sowbug	☐ Black fly larva	☐ Left-Handed or Pouch snail
☐ Dobsonfly Larva	☐ Cranefly larva		
☐ Right-Handed or Gilled snail	☐ Clam/Mussel		
☐ Water Penny	☐ Crayfish		
☐ **# of TAXA represented**	☐ **# of TAXA represented**	☐ **# of TAXA represented**	☐ **# of TAXA represented**
☐ Weighting Factor **(x4)**	☐ Weighting Factor **(x3)**	☐ Weighting Factor **(x2)**	☐ Weighting Factor **(x1)**

Pollution Tolerance Index Rating ☐

(Add the final index values for each group)

PTI Ratings	
Excellent	23 or More
Good	17 - 22
Fair	11 - 16
Poor	10 or Less

Please check other Biological Indicators you observed:

☐ Native Mussels ☐ Zebra Mussels ☐ Rusty Crayfish ☐ Aquatic Plants ______ % Algae Cover ______ Diversity Index

Figure 1 Volunteer Stream Monitoring Training Manual - Biological Monitoring Data Sheet (IDEM, 2017)

Macroinvertebrate Identification Key

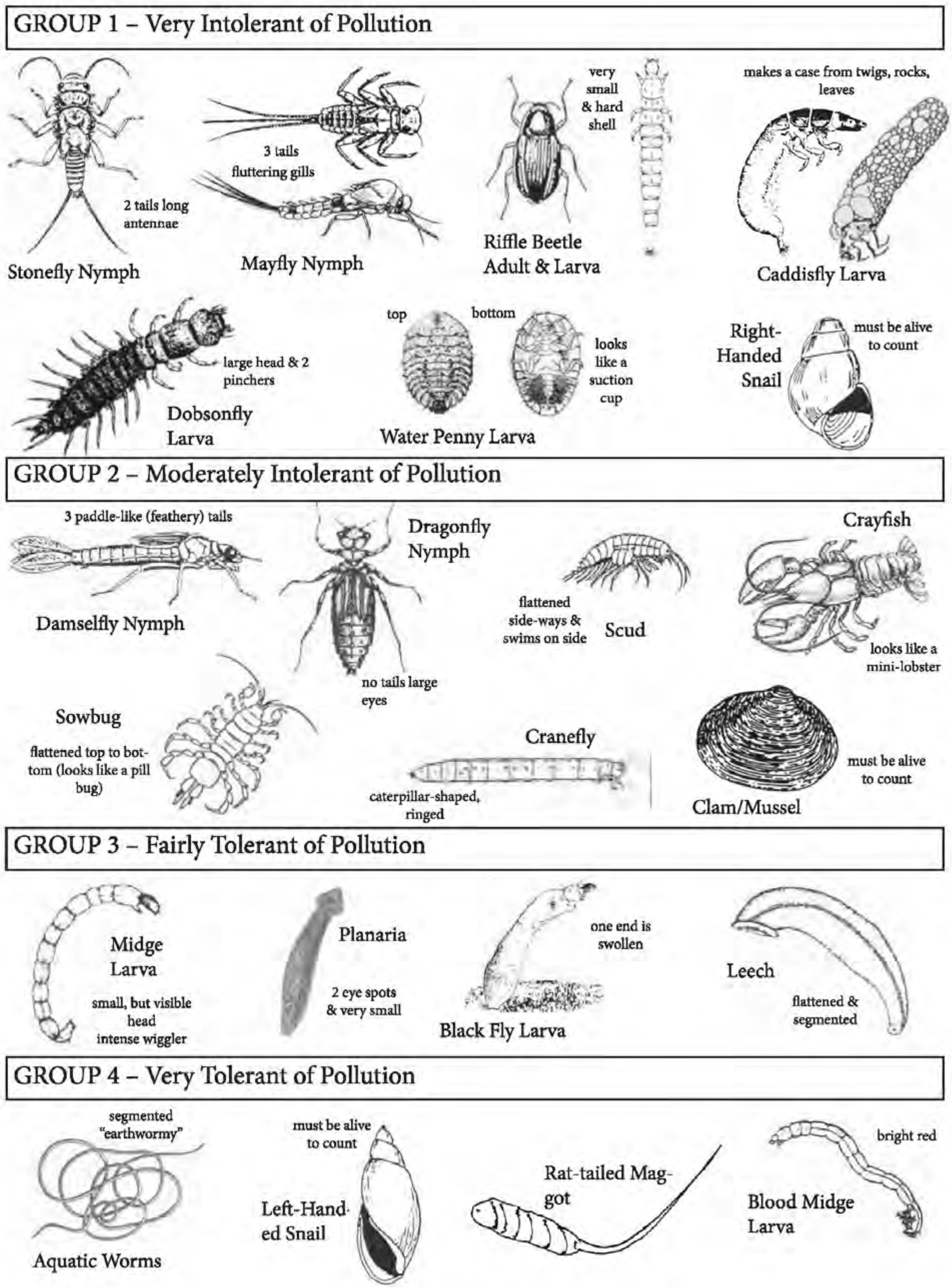


Figure 2 Volunteer Stream Monitoring Training Manual - Macroinvertebrate Identification Key Juvenile (IDEM, 2017)

Macroinvertebrate Adults Key

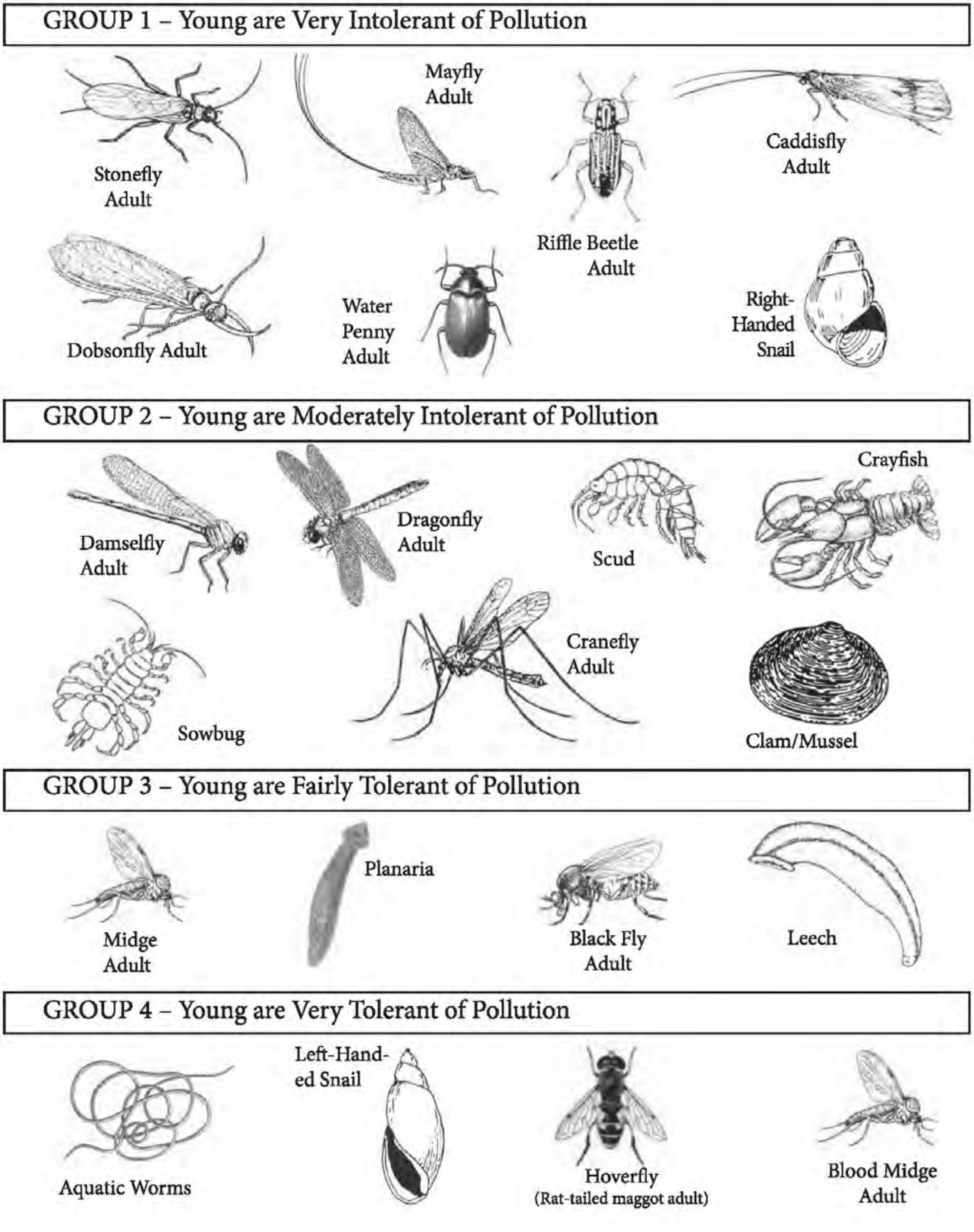


Figure 3 Volunteer Stream Monitoring Training Manual - Macroinvertebrate Identification Key Adult (IDEM, 2017)

Citizens Qualitative Habitat Evaluation Index (CQHEI)

Date: __/__/__ Volunteer ID: ____________ Site ID: ____________

Stream Name: ____________________________ CQHEI Total ☐

I. SUBSTRATE (bottom type) Score: ☐

a) Size

- ☐ Mostly Large (Fist Size or Bigger) 14 pt
- ☐ Mostly Medium (Smaller than Fist, larger than Fingernail) 10 pt
- ☐ Mostly Small (Smaller Than Fingernail, but Coarse, or Bedrock) 6 pt
- ☐ Mostly Very Fine (Not Coarse, Sometimes Greasy or Mucky) 0 pt

b) "Smothering"

Are Fist Size and Larger Pieces Smothered By Sands/Silts?

- ☐ No 5 pt
- ☐ Yes 0 pt

Symptoms: Hard to move pieces, often black on bottom.

c) "Silting"

Are Silts and Clays Distributed Throughout Stream?

- ☐ No 5 pt
- ☐ Yes 0 pt

Symptoms: Light kicking results in substantial clouding for more than a minute.

II. FISH COVER (hiding places) - Add 2 Points For Each One Present Score: ☐

- ☐ Underwater Tree Roots (Large) 2 pt
- ☐ Underwater Tree Rootlets (Small) 2 pt
- ☐ Shrubs/Small Trees Hang Over the Bank 2 pt
- ☐ Backwaters, Oxbows or Side Channels 2 pt
- ☐ Downed Trees, Logs, or Branches 2 pt
- ☐ Shallow, Slow Areas for Small Fish 2 pt
- ☐ Water Plants 2 pt
- ☐ Deep Areas (Chest Deep) 2 pt
- ☐ Undercut Banks 2 pt
- ☐ Boulders 2 pt

III. STREAM SHAPE and HUMAN ALTERATIONS Score: ☐

a) "Curviness" or "Sinuousity" of Channel

- ☐ 2 or More Good Bends 8 pt
- ☐ 1 or 2 Good Bends 6 pt
- ☐ Mostly Straight Some Wiggle" 3 pt
- ☐ Very Straight 0 pt

b) How Natural Is The Site?

- ☐ Mostly Natural 12 pt
- ☐ Few Minor Man-Made Changes (e.g., a bridge) 9 pt
- ☐ Many Man-Made Changes, but Some Natural Conditions left (e.g., trees, meanders) 6 pt
- ☐ Heavy, Man-made Changes (e.g., leveed or channelized) 0 pt

IV. STREAM FORESTS & WETLANDS (riparian area) & EROSION Score: ☐

a) Riparian Width Mostly:

- ☐ Wide (Can't throw a rock through it) 8 pt
- ☐ Narrow (can throw a rock through it) 5 pt
- ☐ None 0 pt

b) Land Use - Mostly:

- ☐ Forest/Wetland 5 pt
- ☐ Shrubs 4 pt
- ☐ Overgrown Fields 3 pt
- ☐ Fenced Pasture 2 pt
- ☐ Park (Grass) 2 pt
- ☐ Conservation Tillage 2 pt
- ☐ Suburban 1 pt
- ☐ Row Crop 1 pt
- ☐ Open Pasture 0 pt
- ☐ Urban/ Industrial 0 pt

c) Bank Erosion

- ☐ Stable Hard or Well-Vegetated Banks 4 pt
- ☐ Combination of Stable and Eroding Banks 2 pt
- ☐ Raw, Collapsing Banks 0 pt

d) Stream Shading

- ☐ Mostly 3 pt
- ☐ Partly 2 pt
- ☐ None 0 pt

V. DEPTH & VELOCITY Score: ☐

a) Deepest Pool is At Least:

- ☐ Chest Deep 8 pt
- ☐ Waist Deep 6 pt
- ☐ Knee Deep 4 pt
- ☐ Do Not Exist 0 pt

b) Check ALL The Flow Types That You See (Add Points):

- ☐ Very Fast: Hard to Stand in Current 2 pt
- ☐ Fast: Quickly Takes Object Downstream 3 pt
- ☐ Moderate: Slowly Takes Object Downstream 1 pt
- ☐ Slow: Flow Nearly Absent 1 pt
- ☐ None 0 pt

VI. RIFFLES/RUNS (areas where current is fast/turbulent, surface may be broken) Score: ☐

a) Riffles/Runs Are:

- ☐ Knee Deep or Deeper and Fast 8 pt
- ☐ Ankle/Calf Deep and Fast 6 pt
- ☐ Ankle Deep or Less and Slow 4 pt
- ☐ Do Not Exist 0 pt

b) Riffle/Run Substrates Are:

- ☐ Fist Size or Larger 7 pt
- ☐ Smaller Than Fist Size, but Larger Than Fingernail 4 pt
- ☐ Smaller Than Your Fingernails or Do Not Exist 0 pt

Figure 4 Volunteer Stream Monitoring Training Manual – Citizens Qualitative Habitat Evaluation Index (CQHEI) (IDEM, 2017)

Indiana County Endangered, Threatened and Rare Species List

County: Kosciusko

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Epioblasma obliquata perobliqua	White catspaw	LE	SE	G1T1	SX
Epioblasma torulosa rangiana	Northern Riffleshell	LE	SE	G2T2	S1
Lampsilis fasciola	Wavyrayed Lampmussel		SSC	G5	S3
Lampsilis ovata	Pocketbook			G5	S2
Ligumia recta	Black Sandshell			G4G5	S2
Obovaria subrotunda	Round Hickorynut	C	SE	G4	S1
Pleurobema clava	Clubshell	LE	SE	G1G2	S1
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Quadrula cylindrica cylindrica	Rabbitsfoot	LT	SE	G3G4T3	S1
Simpsonaias ambigua	Salamander Mussel	C	SSC	G3	S2
Toxolasma lividus	Purple Lilliput	C	SSC	G3Q	S2
Villosa fabalis	Rayed Bean	LE	SE	G2	S1
Villosa lienosa	Little Spectaclecase		SSC	G5	S3
Insect: Lepidoptera (Butterflies & Moths)					
Capis curvata	A Noctuid Moth		ST	G5	S2S3
Catocala praeclara	Praeclara Underwing		SR	G5	S2S3
Chortodes inquinata	Tufted Sedge Moth		ST	GNR	S1S2
Dasychira cinnamomea	A Moth		SR	G4	S1
Euphydryas phaeton	Baltimore		SR	G5	S2
Euphyes bimacula	Two-spotted Skipper		ST	G4	S2
Exyra rolandiana	Pitcher Window Moth		SE	G4	S1S2
Hemileuca sp. 3	Midwestern Fen Buckmoth		ST	G5T3T4	S1?
Hesperia leonardus	Leonard's Skipper		SR	G5	S2
Iodopepla u-album	A Noctuid Moth		SR	G5	S2
Leucania multilinea			SR	G5	S1S2
Lycaena helloides	Purplish Copper		SR	G5	S2S4
Lytrosis permagnaria	A Lytrosis Moth		ST	G3G4	S2
Macrochilo absorptalis	A Moth		SR	G4G5	S2S3
Papaipema appassionata	The Pitcher Plant Borer Moth		SE	G4	S1
Papaipema speciosissima	The Royal Fern Borer Moth		ST	G4	S2S3
Pieris oleracea	Eastern Veined White		SE	G5	S1
Fish					
Acipenser fulvescens	Lake Sturgeon		SE	G3G4	S1
Coregonus artedi	Cisco		SSC	G5	S2
Percina evides	Gilt Darter		SE	G4	S1
Amphibian					
Acris blanchardi	Northern Cricket Frog		SSC	G5	S4
Ambystoma laterale	Blue-spotted Salamander		SSC	G5	S2
Hemidactylium scutatum	Four-toed Salamander		SSC	G5	S2

Indiana Natural Heritage Data Center
Division of Nature Preserves
Indiana Department of Natural Resources
This data is not the result of comprehensive county surveys.

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting
State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list
GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank
SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status

Figure 5 Indiana County Endangered, Threatened, and Rare Species List Page 1 of 4

Indiana County Endangered, Threatened and Rare Species List

County: Kosciusko

Species Name	Common Name	FED	STATE	GRANK	SRANK
Lithobates pipiens	Northern Leopard Frog		SSC	G5	S2
Necturus maculosus	Common mudpuppy		SSC	G5	S2
Reptile					
Clemmys guttata	Spotted Turtle	C	SE	G5	S2
Clonophis kirtlandii	Kirtland's Snake	C	SE	G2	S2
Emydoidea blandingii	Blanding's Turtle	C	SE	G4	S2
Nerodia erythrogaster neglecta	Copperbelly Water Snake	PS:LT	SE	G5T3	S2
Sistrurus catenatus catenatus	Eastern Massasauga	LT	SE	G3	S2
Bird					
Botaurus lentiginosus	American Bittern		SE	G5	S2B
Certhia americana	Brown Creeper			G5	S2B
Chlidonias niger	Black Tern		SE	G4G5	S1B
Circus hudsonius	Northern Harrier		SE	G5	S2
Cistothorus palustris	Marsh Wren		SE	G5	S3B
Cistothorus platensis	Sedge Wren		SE	G5	S3B
Empidonax alnorum	Alder Flycatcher			G5	S2B
Falco peregrinus	Peregrine Falcon		SSC	G4	S2B
Grus canadensis	Sandhill Crane		SSC	G5	S2B,S1N
Haliaeetus leucocephalus	Bald Eagle		SSC	G5	S2
Ixobrychus exilis	Least Bittern		SE	G5	S3B
Mniotilta varia	Black-and-white Warbler		SSC	G5	S1S2B
Nycticorax nycticorax	Black-crowned Night-heron		SE	G5	S1B
Pandion haliaetus	Osprey		SE	G5	S1B
Rallus elegans	King Rail		SE	G4	S1B
Rallus limicola	Virginia Rail		SE	G5	S3B
Setophaga cerulea	Cerulean Warbler		SE	G4	S3B
Vermivora chrysoptera	Golden-winged Warbler	C	SE	G4	S1B
Mammal					
Condylura cristata	Star-nosed Mole		SSC	G5	S2?
Mustela nivalis	Least Weasel		SSC	G5	S2?
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Taxidea taxus	American Badger		SSC	G5	S2
Vascular Plant					
Actaea rubra	Red Baneberry		ST	G5	S1
Andromeda glaucophylla	Bog Rosemary		SR	G5T5	S2
Arethusa bulbosa	Swamp-pink		SX	G5	SX
Bidens beckii	Beck Water-marigold		ST	G5	S1
Carex aurea	Golden-fruited Sedge		SR	G5	S2
Carex bebbii	Bebb's Sedge		ST	G5	S2
Carex chordorrhiza	Creeping Sedge		SE	G5	S1

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SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

Figure 6 Indiana County Endangered, Threatened, and Rare Species List Page 2 of 4

Indiana County Endangered, Threatened and Rare Species List

County: Kosciusko

Species Name	Common Name	FED	STATE	GRANK	SRANK
Carex disperma	Softleaf Sedge		SE	G5	S1
Carex echinata	Little Prickly Sedge		SE	G5	S1
Carex flava	Yellow Sedge		ST	G5	S2
Carex pseudocyperus	Cyperus-like Sedge		SE	G5	S1
Cornus amomum ssp. amomum	Silky Dogwood		SE	G5T5	S1
Cornus canadensis	Bunchberry		SE	G5	S1
Cypripedium calceolus var. parviflorum	Small Yellow Lady's-slipper		SR	G5	S2
Cypripedium candidum	Small White Lady's-slipper		WL	G4	S2
Dichanthelium boreale	Northern Witchgrass		SR	G5	S2
Drosera intermedia	Spoon-leaved Sundew		SR	G5	S2
Eleocharis geniculata	Capitate Spike-rush		ST	G5	S2
Eriophorum angustifolium	Narrow-leaved Cotton-grass		SR	G5	S2
Eriophorum gracile	Slender Cotton-grass		ST	G5	S2
Eriophorum viridicarinatum	Green-keeled Cotton-grass		SR	G5	S2
Geranium robertianum	Herb-robert		ST	G5	S2
Juglans cinerea	Butternut		WL	G4	S3
Lathyrus ochroleucus	Pale Vetchling Peavine		SE	G5	S1
Lemna perpusilla	Minute Duckweed		SX	G5	SX
Lemna valdiviana	Pale Duckweed		SE	G5	S1
Malaxis unifolia	Green Adder's-mouth Orchid		SE	G5	S1
Matteuccia struthiopteris	Ostrich Fern		SR	G5	S2
Myriophyllum verticillatum	Whorled Water-milfoil		SR	G5	S2
Panax trifolius	Dwarf Ginseng		WL	G5	S2
Platanthera psycodes	Small Purple-fringe Orchis		SR	G5	S2
Potamogeton epihydrus	Nuttall Pondweed		SE	G5	S1
Potamogeton friesii	Fries' Pondweed		ST	G5	S1
Potamogeton oakesianus	Oakes Pondweed		SE	G5	S1
Potamogeton praelongus	White-stem Pondweed		ST	G5	S1
Potamogeton pusillus	Slender Pondweed		WL	G5	S2
Potamogeton richardsonii	Redheadgrass		SR	G5	S2
Potamogeton strictifolius	Straight-leaf Pondweed		ST	G5	S1
Prunus pensylvanica	Fire Cherry		SR	G5	S2
Scirpus subterminalis	Water Bulrush		SR	G5	S2
Selaginella apoda	Meadow Spike-moss		WL	G5	S1
Sparganium androcladum	Branching Bur-reed		ST	G4G5	S2
Spiranthes lucida	Shining Ladies'-tresses		SR	G4	S2
Stenanthium gramineum	Eastern Featherbells		ST	G4G5	S1
Symphyotrichum boreale	Rushlike Aster		SR	G5	S2
Tofieldia glutinosa	False Asphodel		SR	G5	S2
Utricularia resupinata	Northeastern Bladderwort		SE	G4	S1

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Figure 7 Indiana County Endangered, Threatened, and Rare Species List Page 3 of 4

Indiana County Endangered, Threatened and Rare Species List

County: Kosciusko

Species Name	Common Name	FED	STATE	GRANK	SRANK
Vaccinium oxycoccos	Small Cranberry		ST	G5	S2
Wolffiella gladiata	Sword Bogmat		SE	G5	S1
Zannichellia palustris	Horned Pondweed		SR	G5	S2
Zigadenus elegans var. glaucus	White Camas		SR	G5T4T5	S2
High Quality Natural Community					
Forest - upland dry-mesic Northern Lakes	Northern Lakes Dry-mesic Upland Forest			GNR	S1
Forest - upland mesic Central Till Plain	Central Till Plain Mesic Upland Forest			GNR	S3
Forest - upland mesic Northern Lakes	Northern Lakes Mesic Upland Forest			GNR	S1
Lake - lake	Lake		SG	GNR	S2
Wetland - beach marl	Marl Beach		SG	G3	S2
Wetland - bog acid	Acid Bog		SG	G3	S2
Wetland - bog circumneutral	Circumneutral Bog		SG	G3	S3
Wetland - fen	Fen		SG	G3	S3
Wetland - fen forested	Forested Fen		SG	G3	S1
Wetland - marsh	Marsh		SG	GU	S4
Wetland - meadow sedge	Sedge Meadow		SG	G3?	S1
Wetland - swamp shrub	Shrub Swamp		SG	GU	S2

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Figure 8 Indiana County Endangered, Threatened, and Rare Species List Page 4 of 4

Clean Waters Partnership Public Input

Please help us develop a plan for protecting and improving the waters in our community. By sharing your thoughts and concerns about the waters in our watershed, you will help us identify the most important local concerns.

Attachments:
clean_waters_partnership_handout_20160119.pdf
Date:

First Name: *

Last Name: *

Address: *

City, State, Zip Code: *

Email Address: *

What concerns do you have about our local waters - lakes, streams, and wetlands? : *

What would you like to see changed in order to protect and improve our water quality? : *

Do you live on or have property on a lake or stream? If so, which one?: *

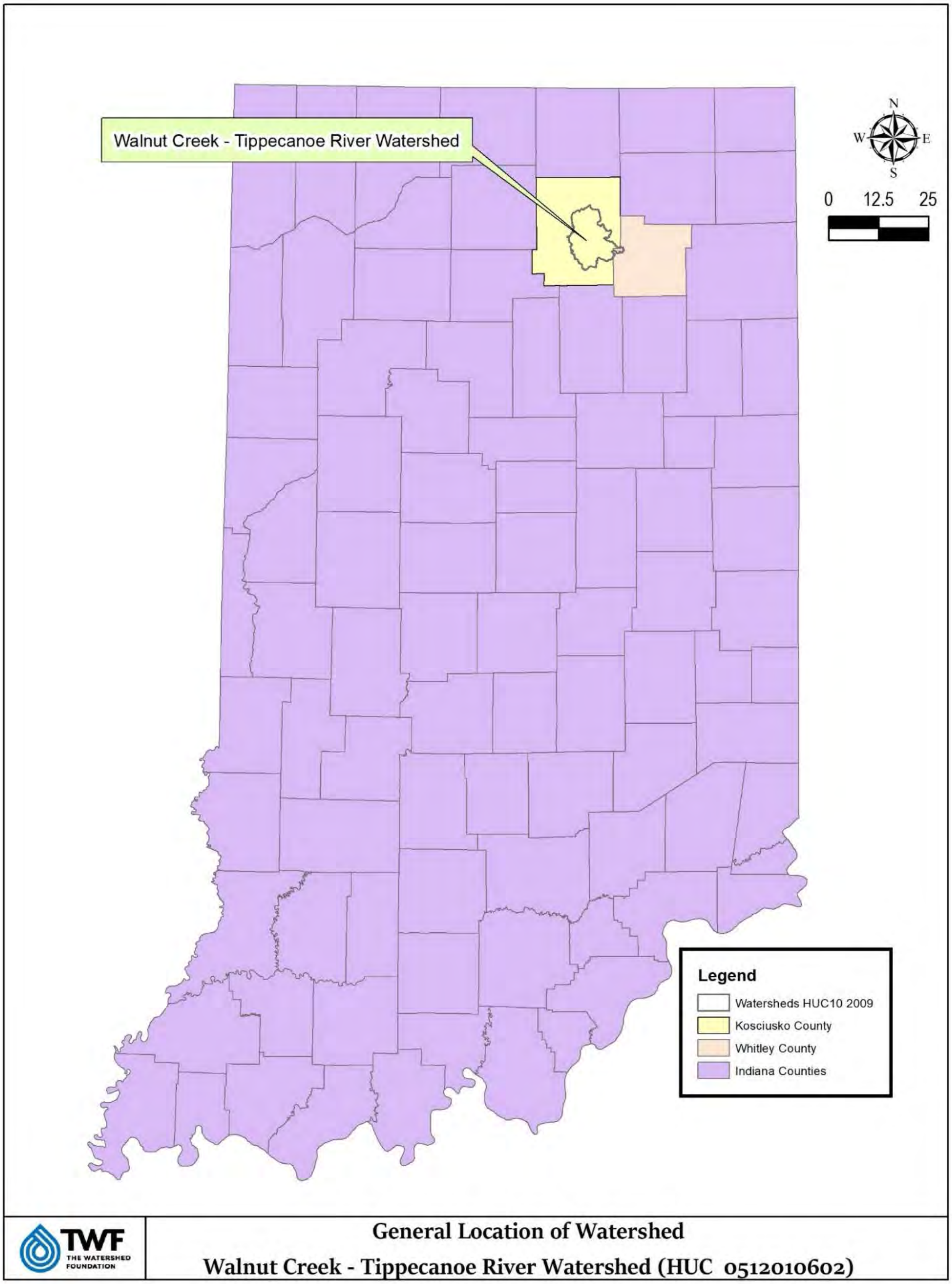
Is your residence location considered rural or urban?: *

How do you connect to our local waterways (ex: fishing, swimming, boating, paddling, viewing wildlife, enjoying the beauty?: *

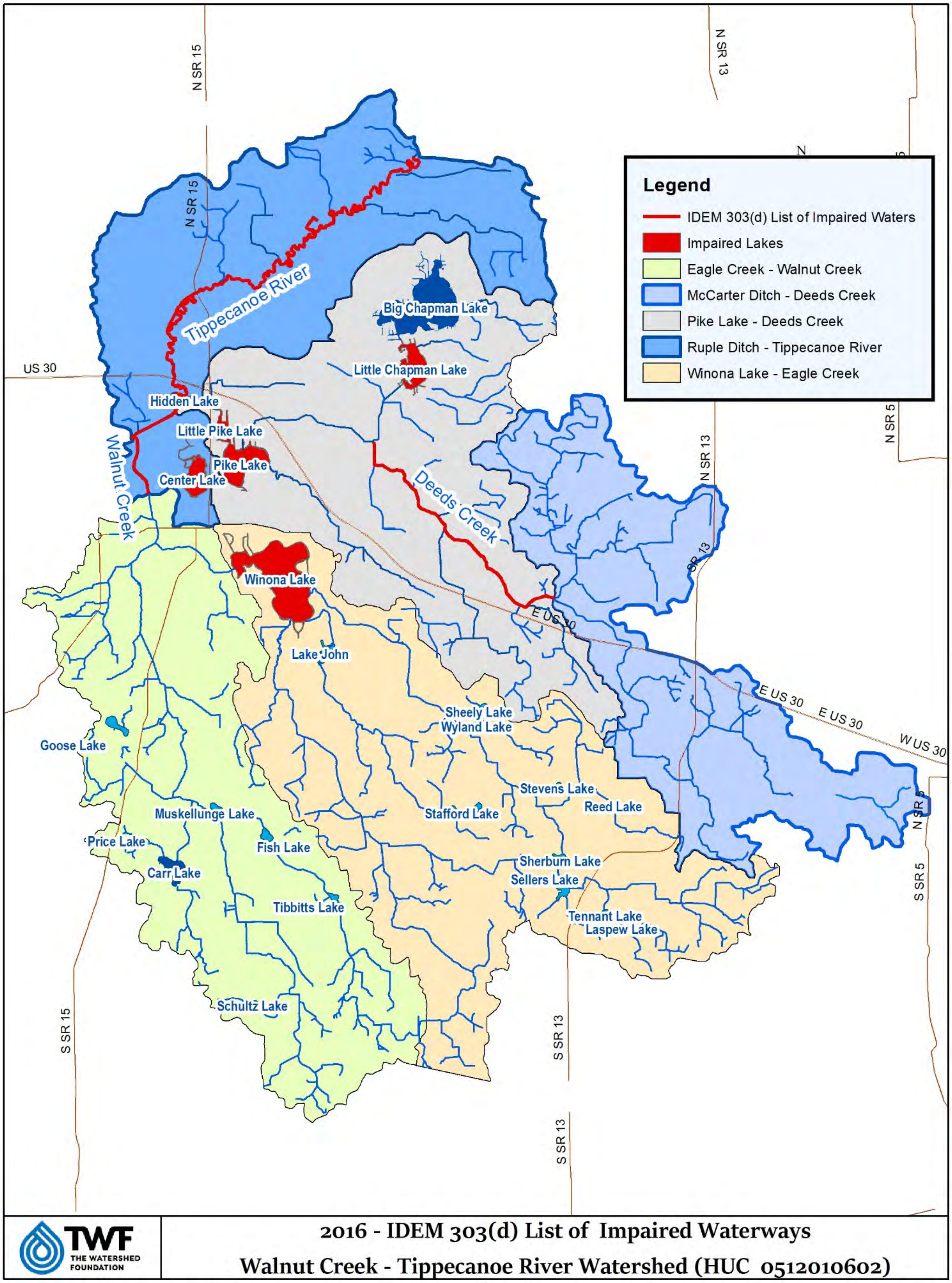
What is your occupation? (Optional) :

Figure 9 2016 TWF Web Survey to Gather Watershed Input

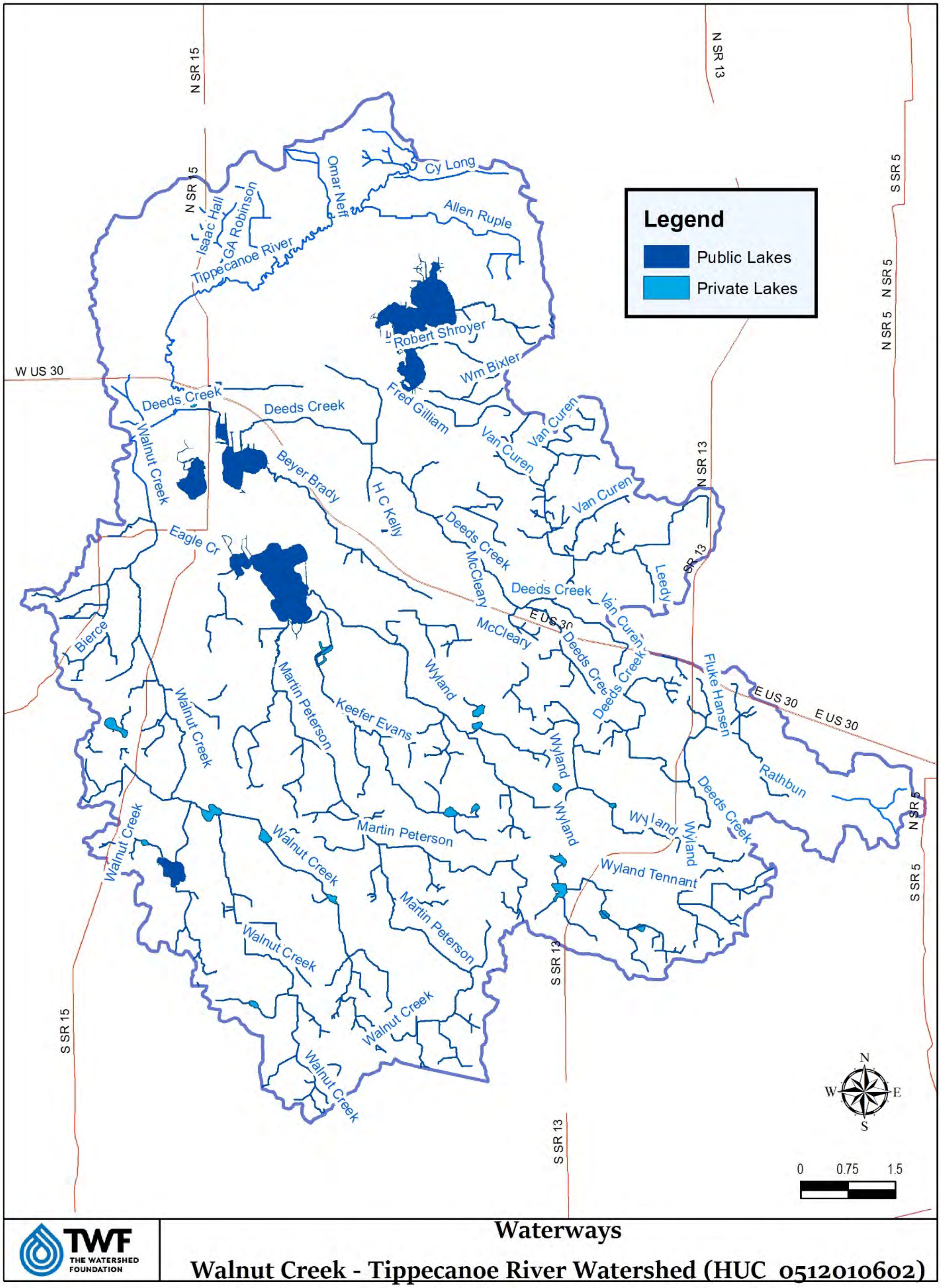
Maps



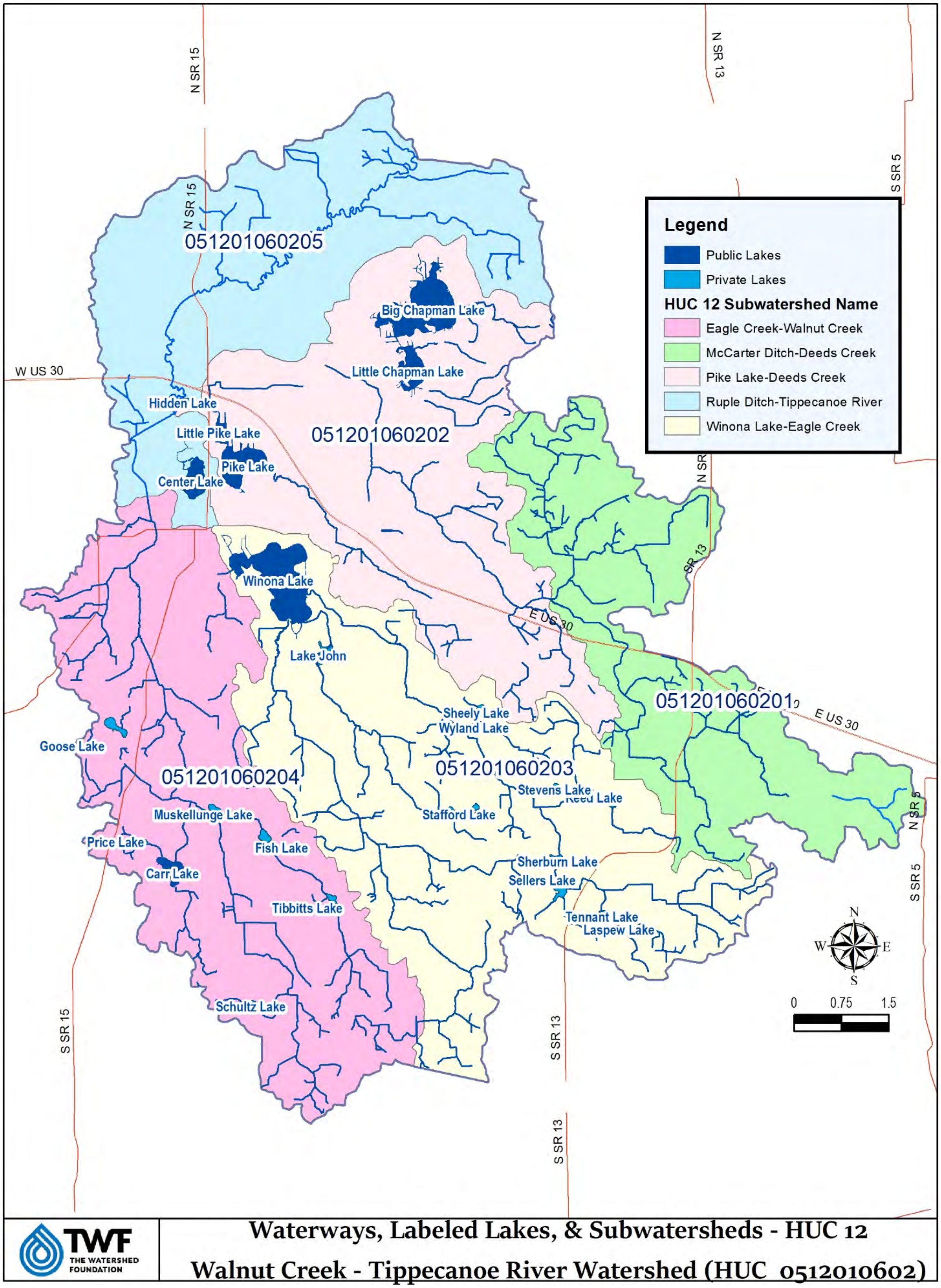
Map 1 Location Walnut Creek - Tippecanoe River Watershed in Northern Indiana



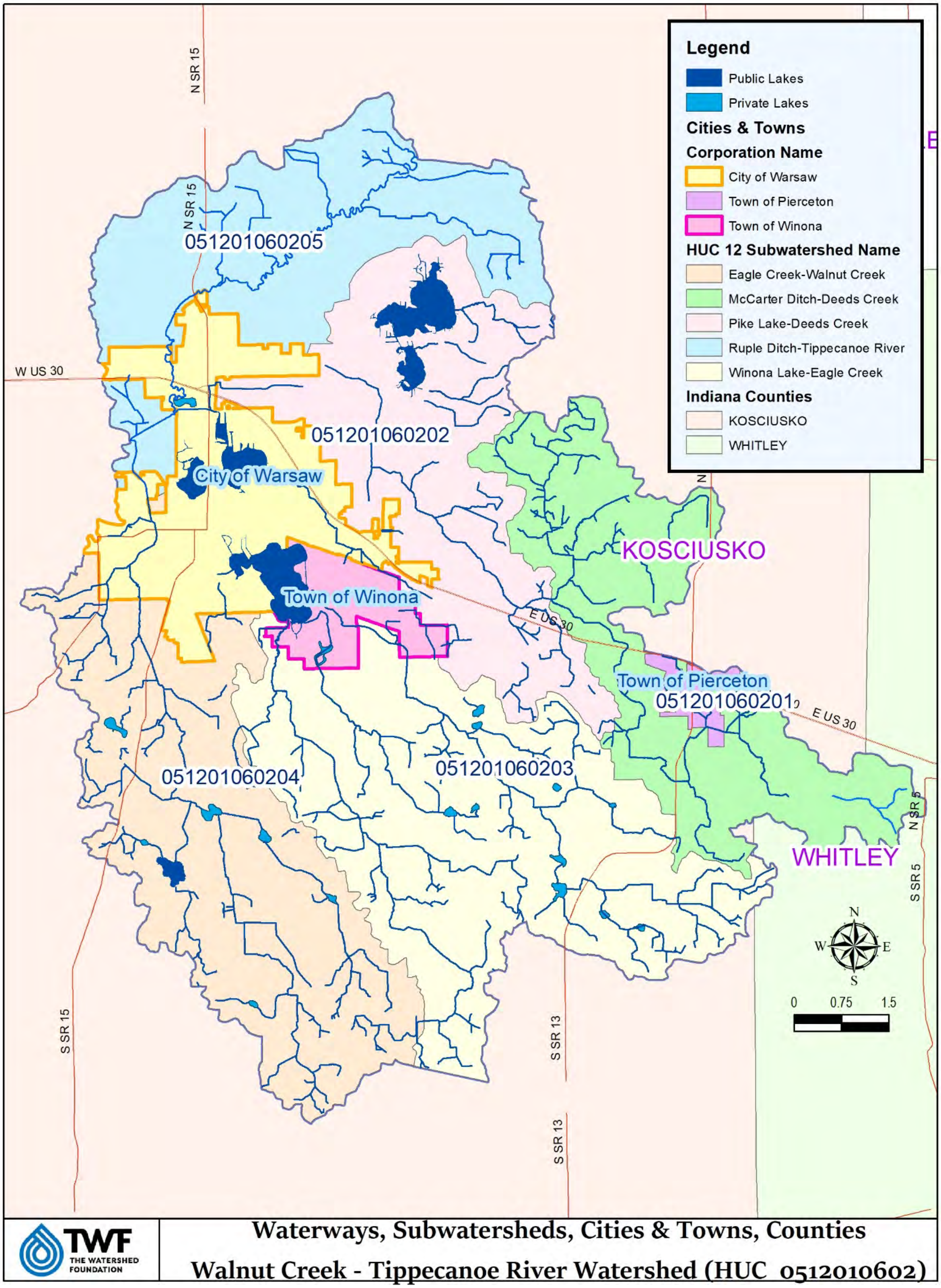
Map 2 303(d) List of Impaired Streams & Lakes in the Walnut Creek – Tippecanoe River Watershed (IDEM, 2016)



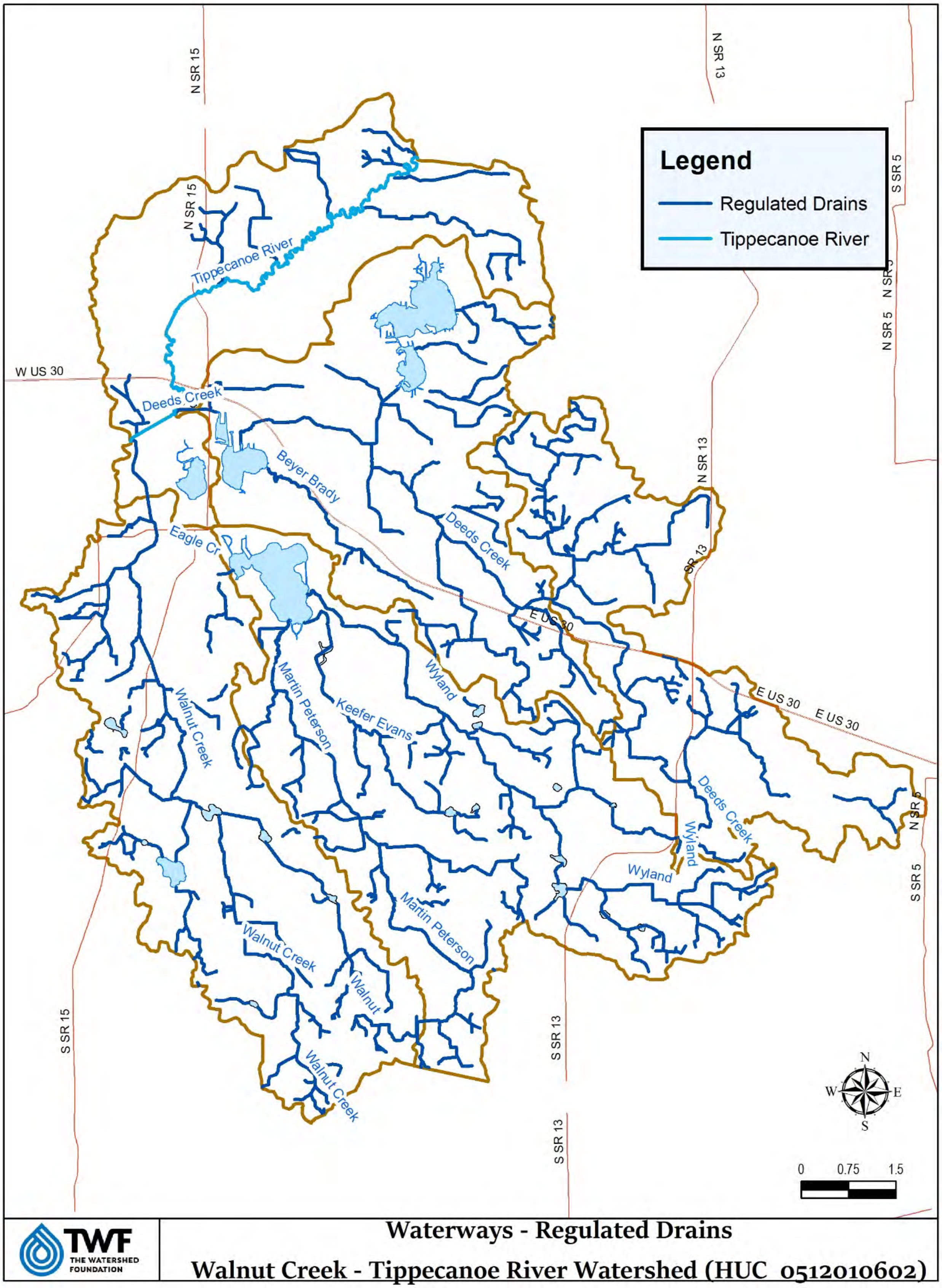
Map 3 Watershed with Labeled Waters (Kosciusko, 2016)



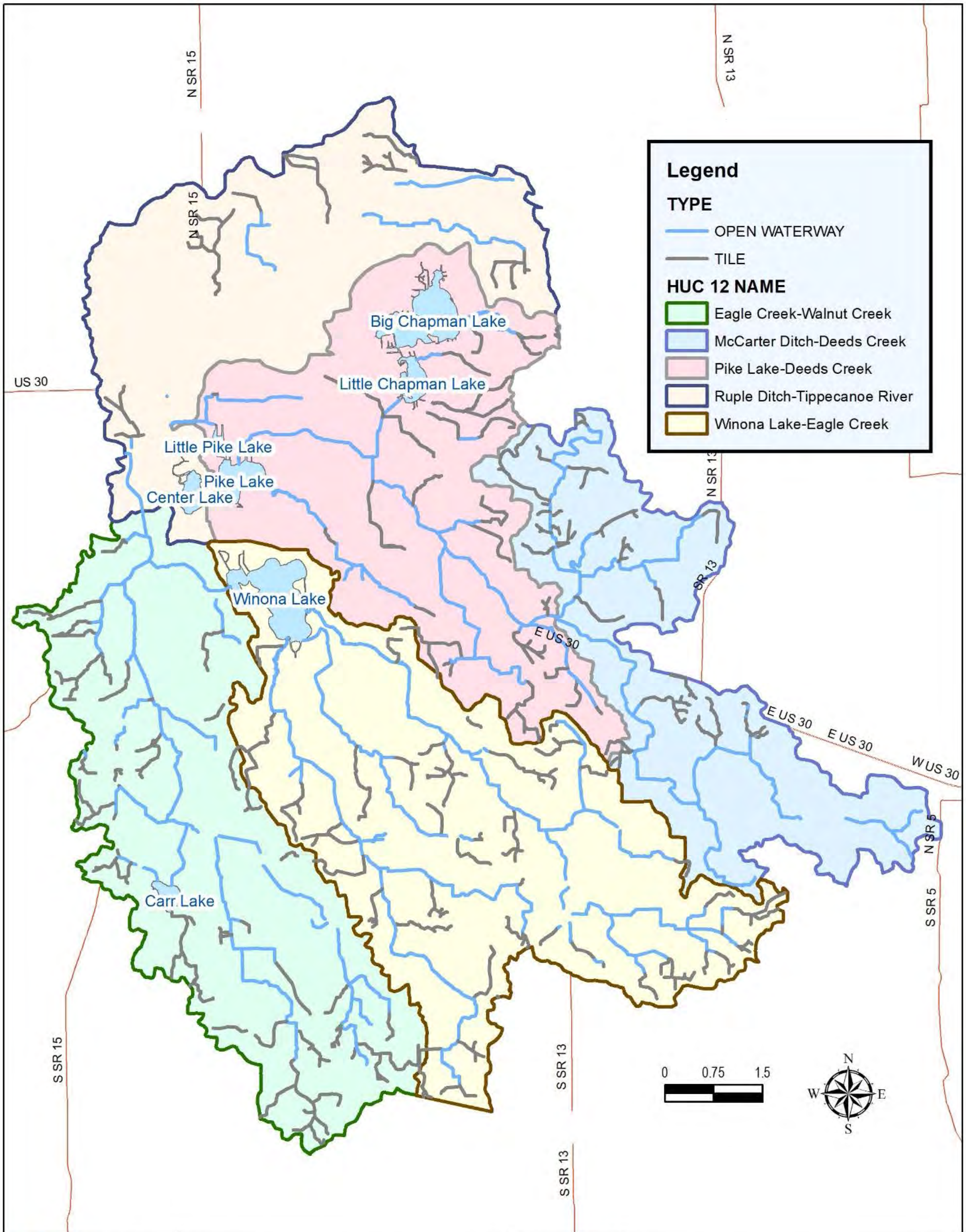
Map 4 Watershed Map with Subwatersheds and Labeled Lakes (Kosciusko, 2016), (USGS and USEPA, 2008)



Map 5 Waterways, Subwatersheds, Cities & Towns (INDOT, 2001), (NRCS and USDA, 2011)



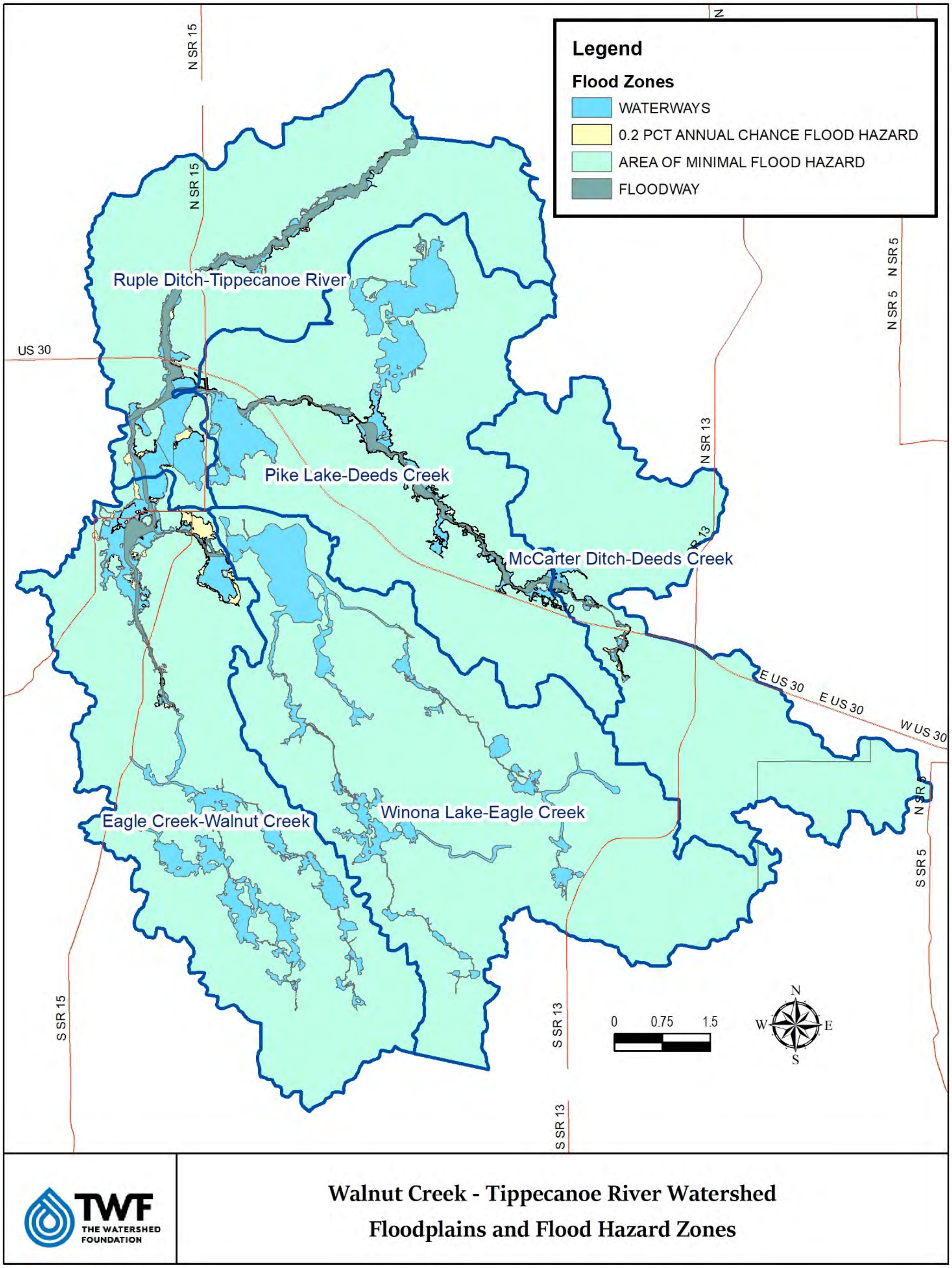
Map 6 Watershed Regulated Drains with the Tippecanoe River (Kosciusko, 2016), (USGS and USEPA, 2008)



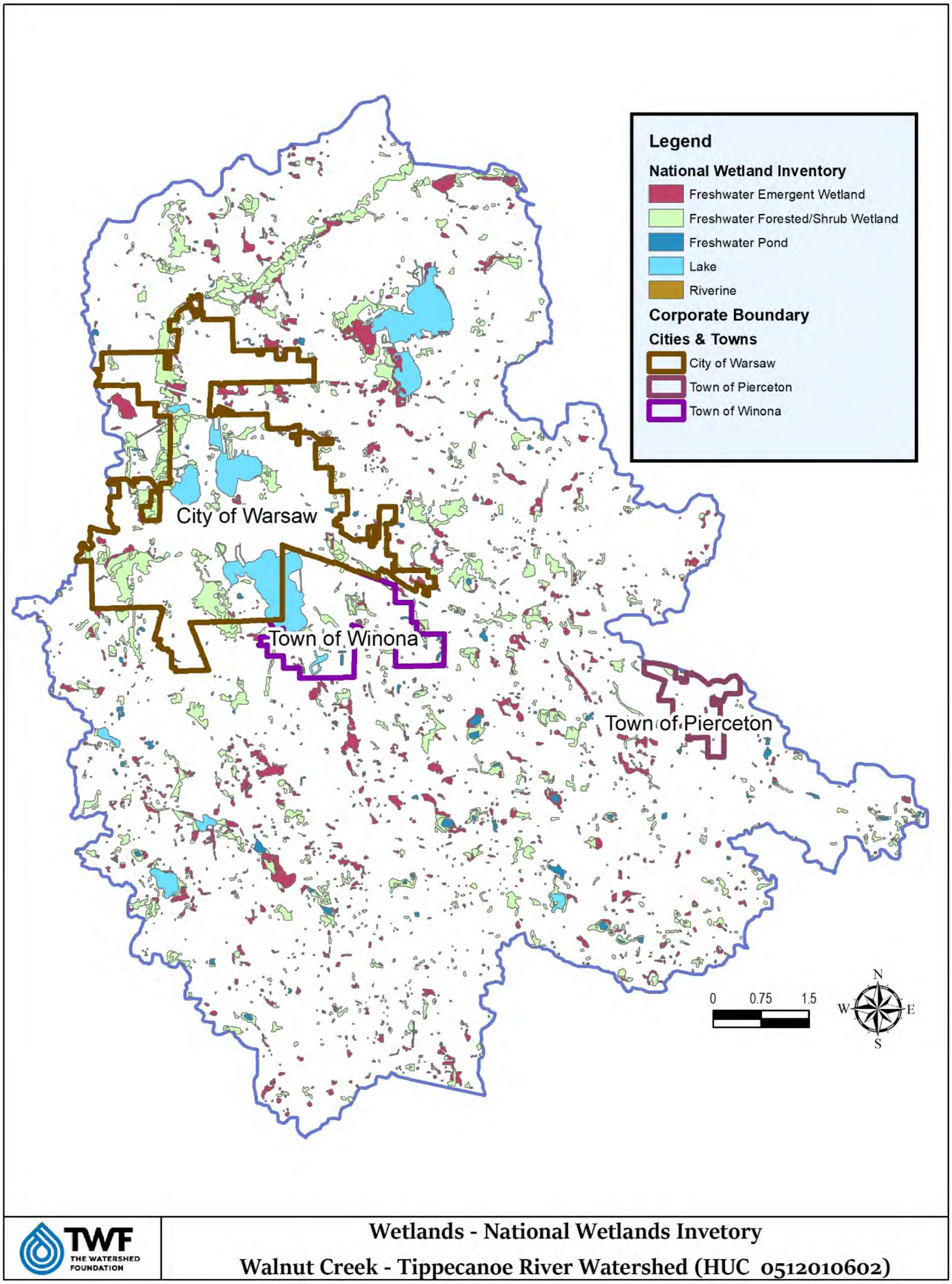
County Drains

Walnut Creek - Tippecanoe River Watershed (HUC 0512010602)

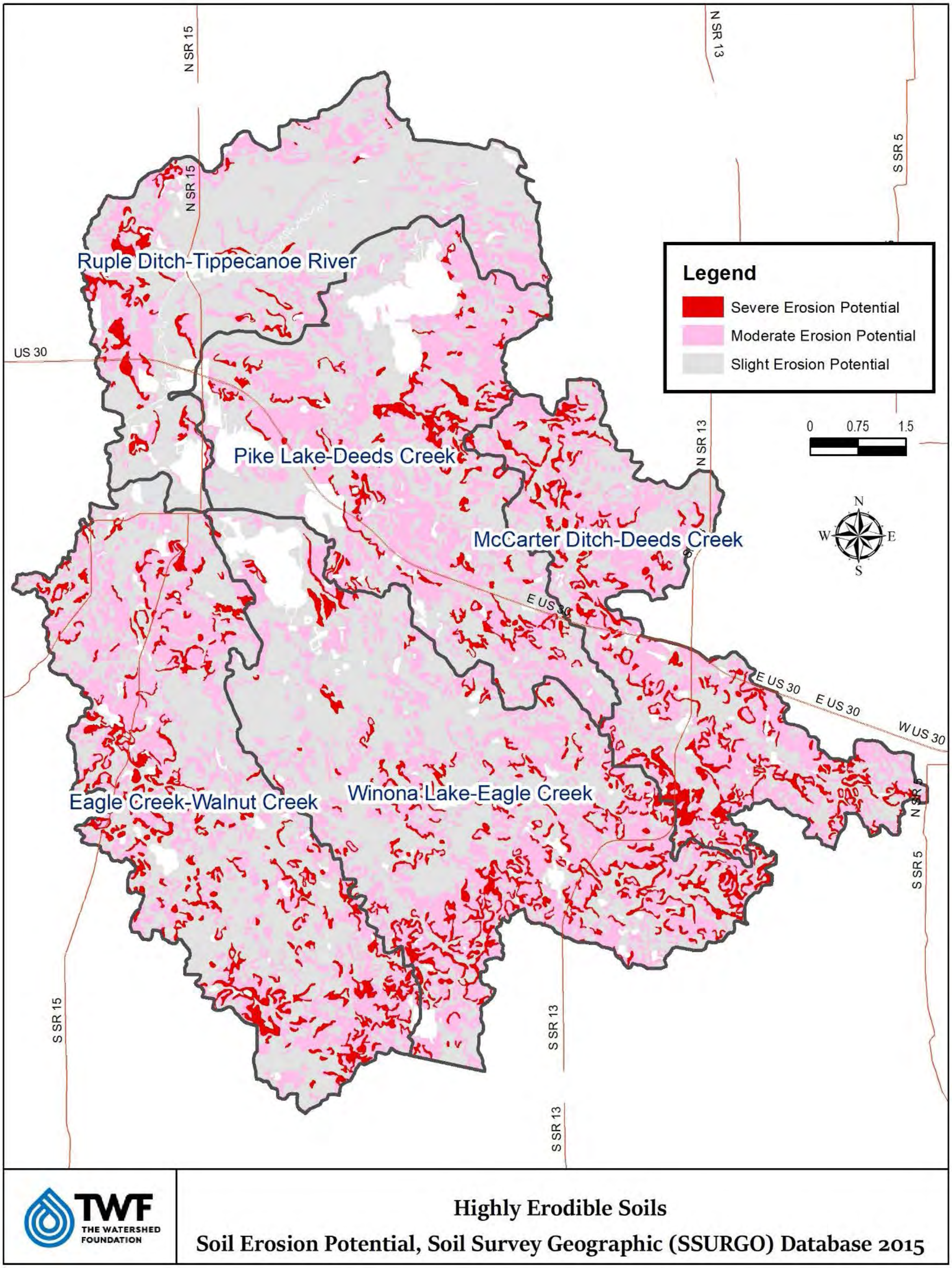
Map 7 Regulated Drains - Open Drains vs. Tile Drains, (Kosciusko, 2016)



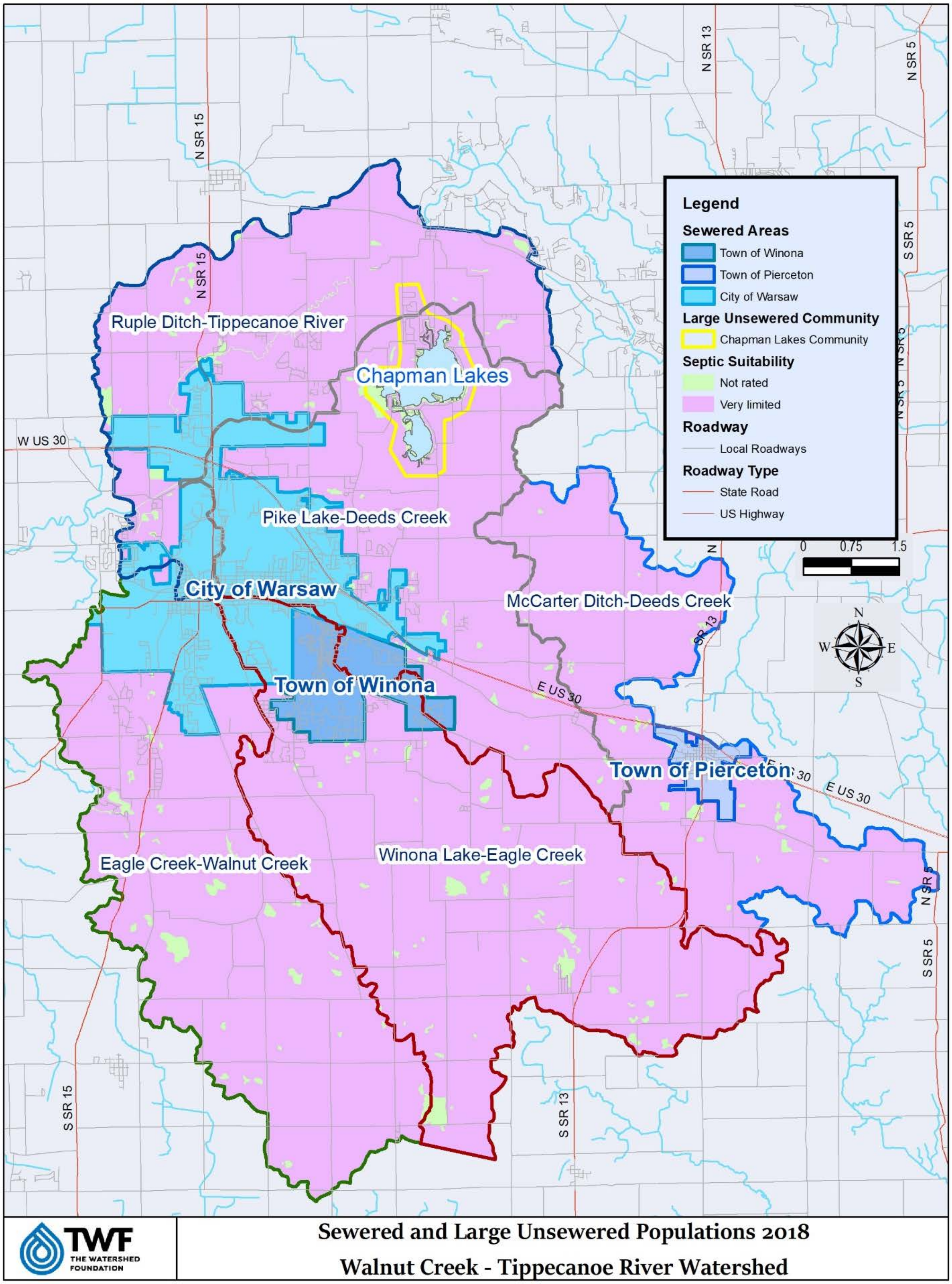
Map 8 Floodplains and Flood Hazard Zones 2019



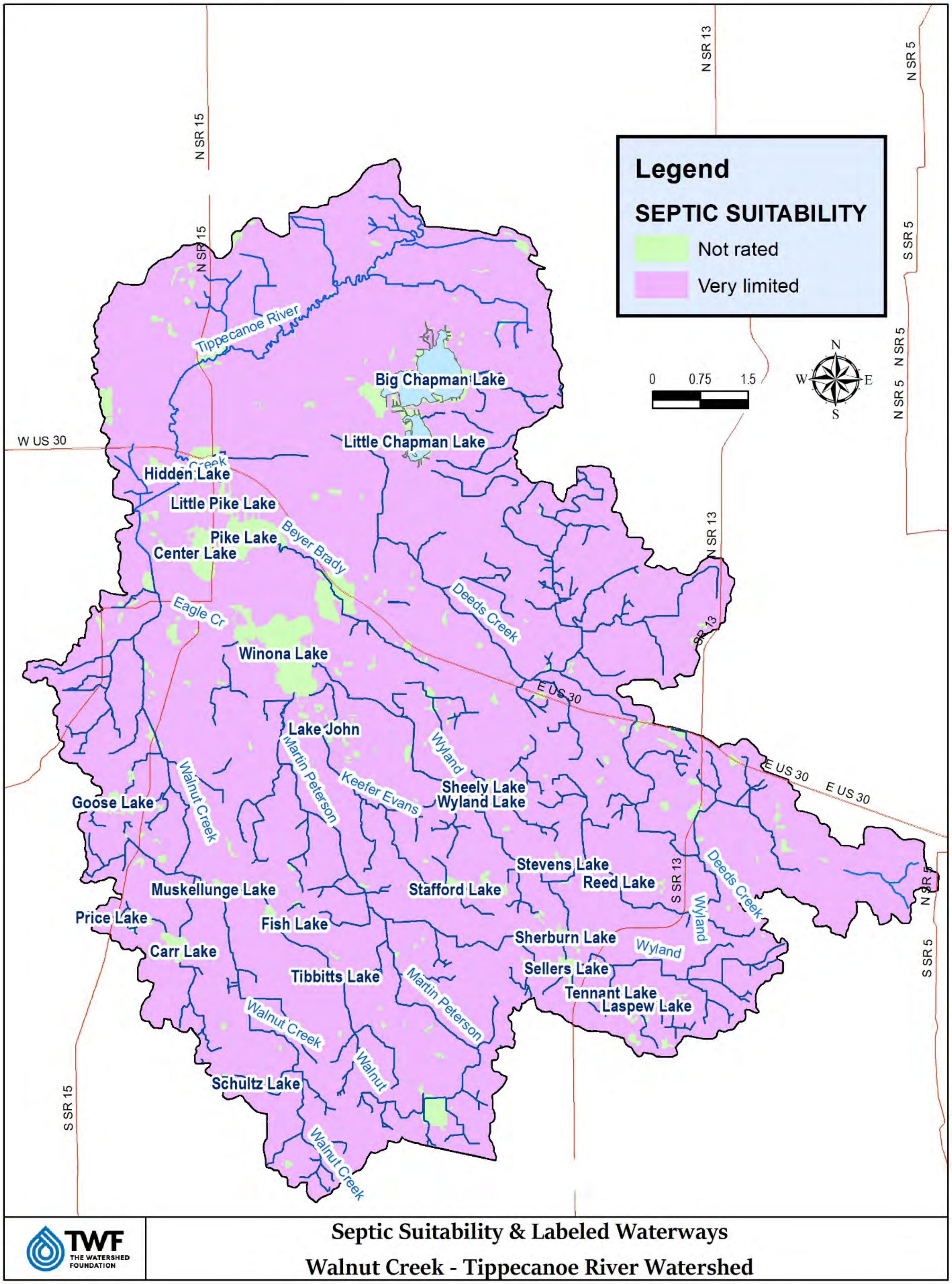
Map 9 National Wetlands Inventory (USFWS, 2014)



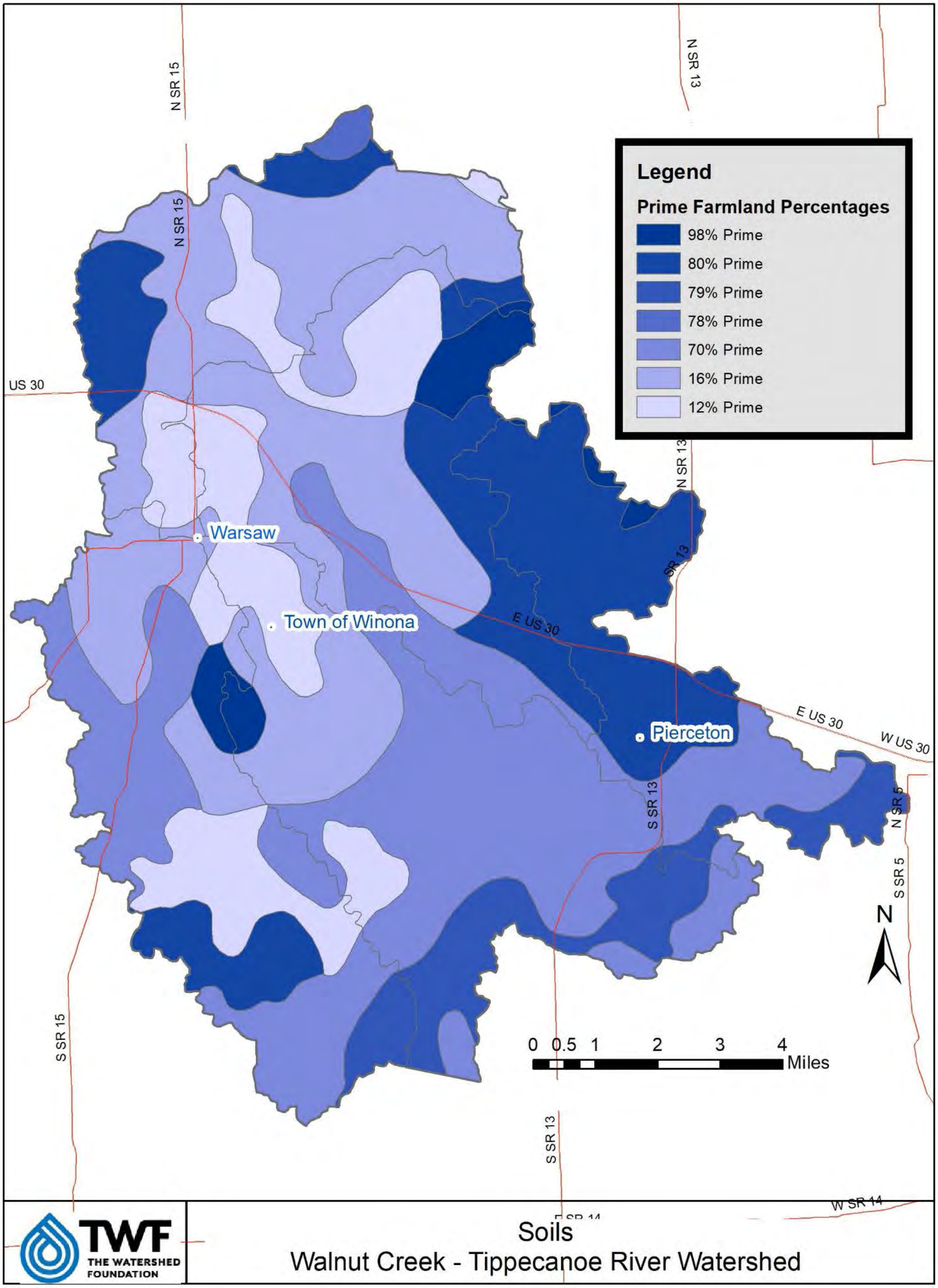
Map 10 Highly Erodible Soils Map, (NRCS and USDA, 2002)



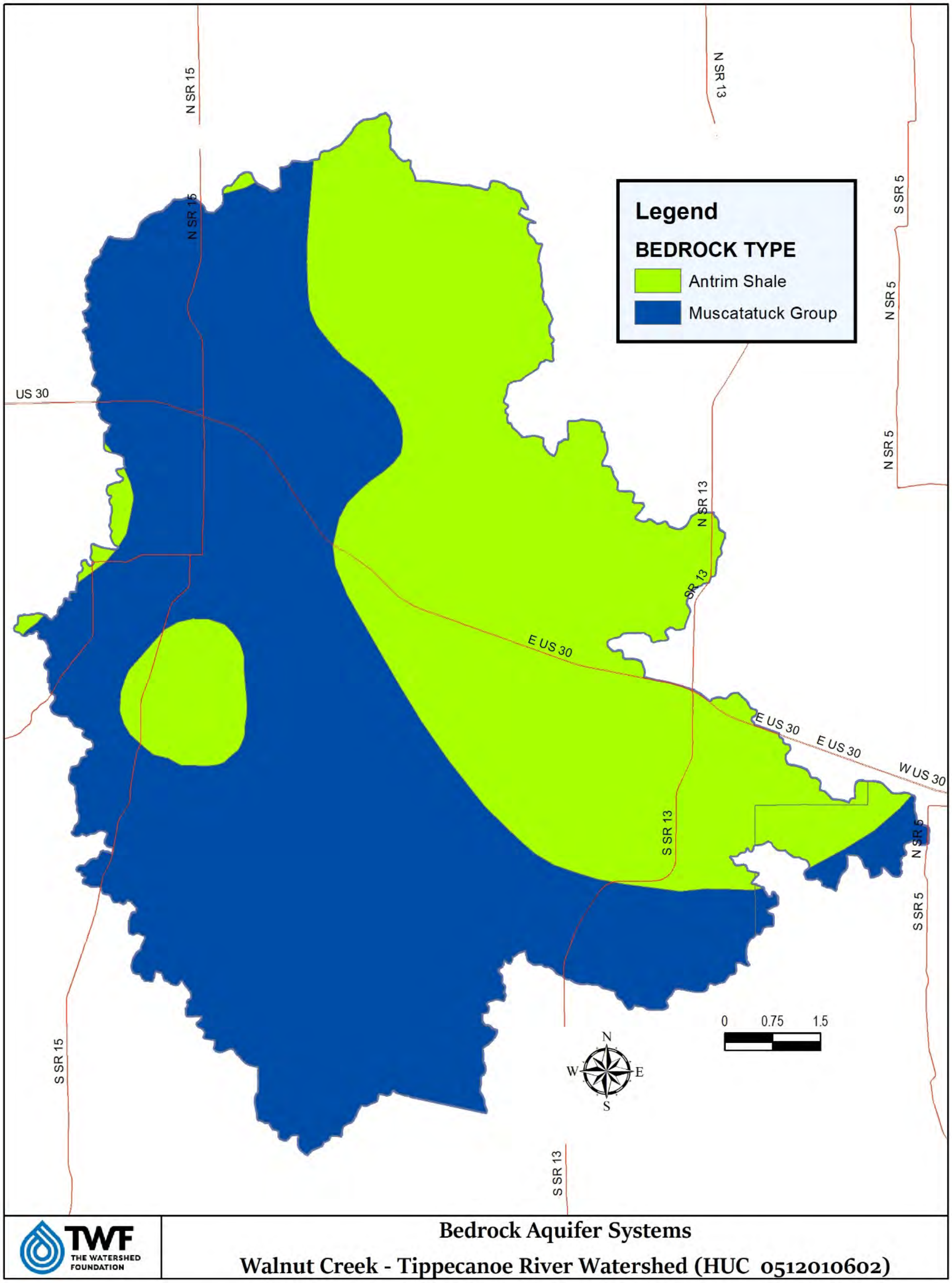
Map 11 Watershed Sewered Areas and Septic Suitability, (NRCS and USDA, 2002)



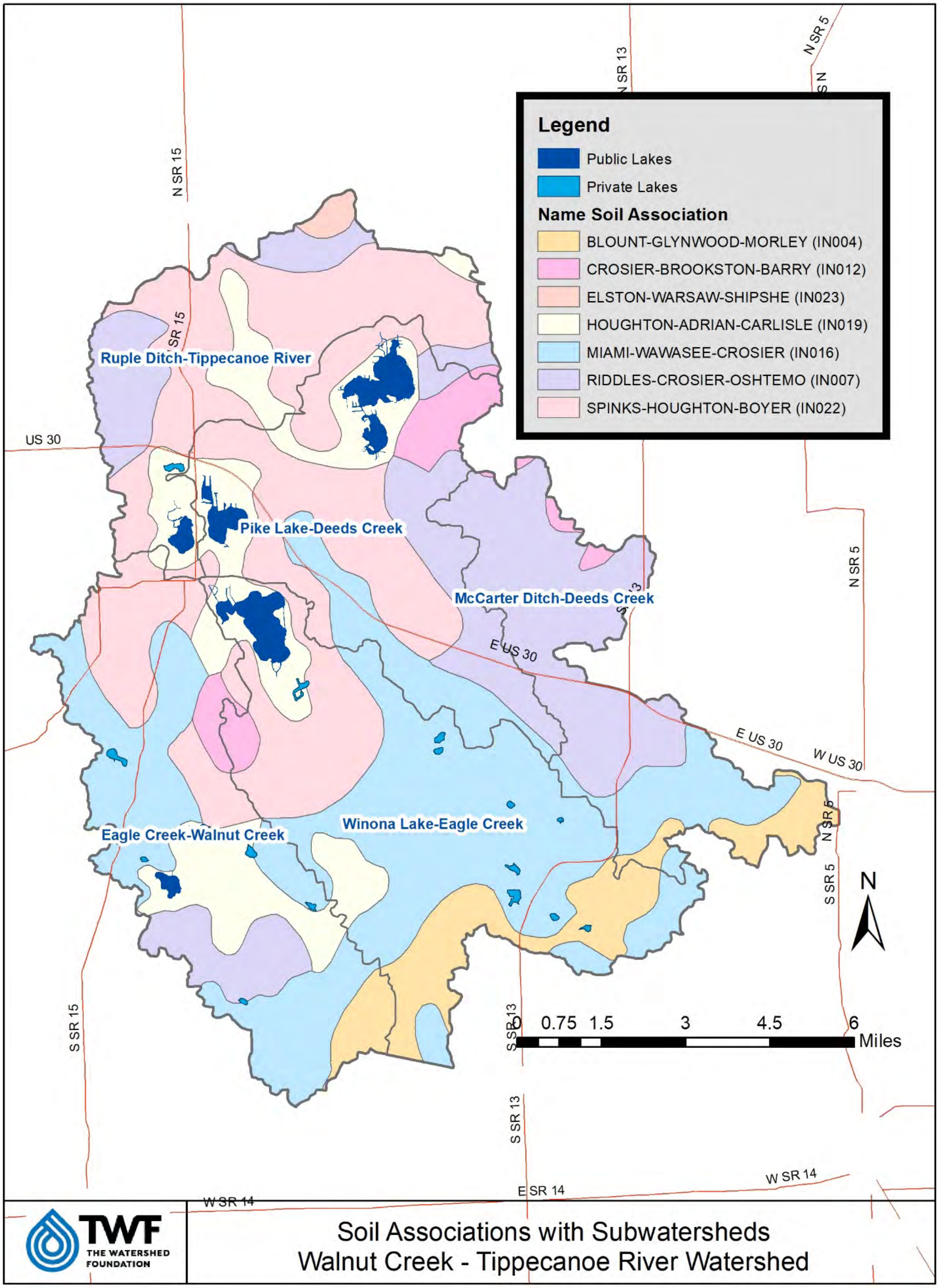
Map 12 Septic Suitability Labeled Waterways (NRCS and USDA, 2002)



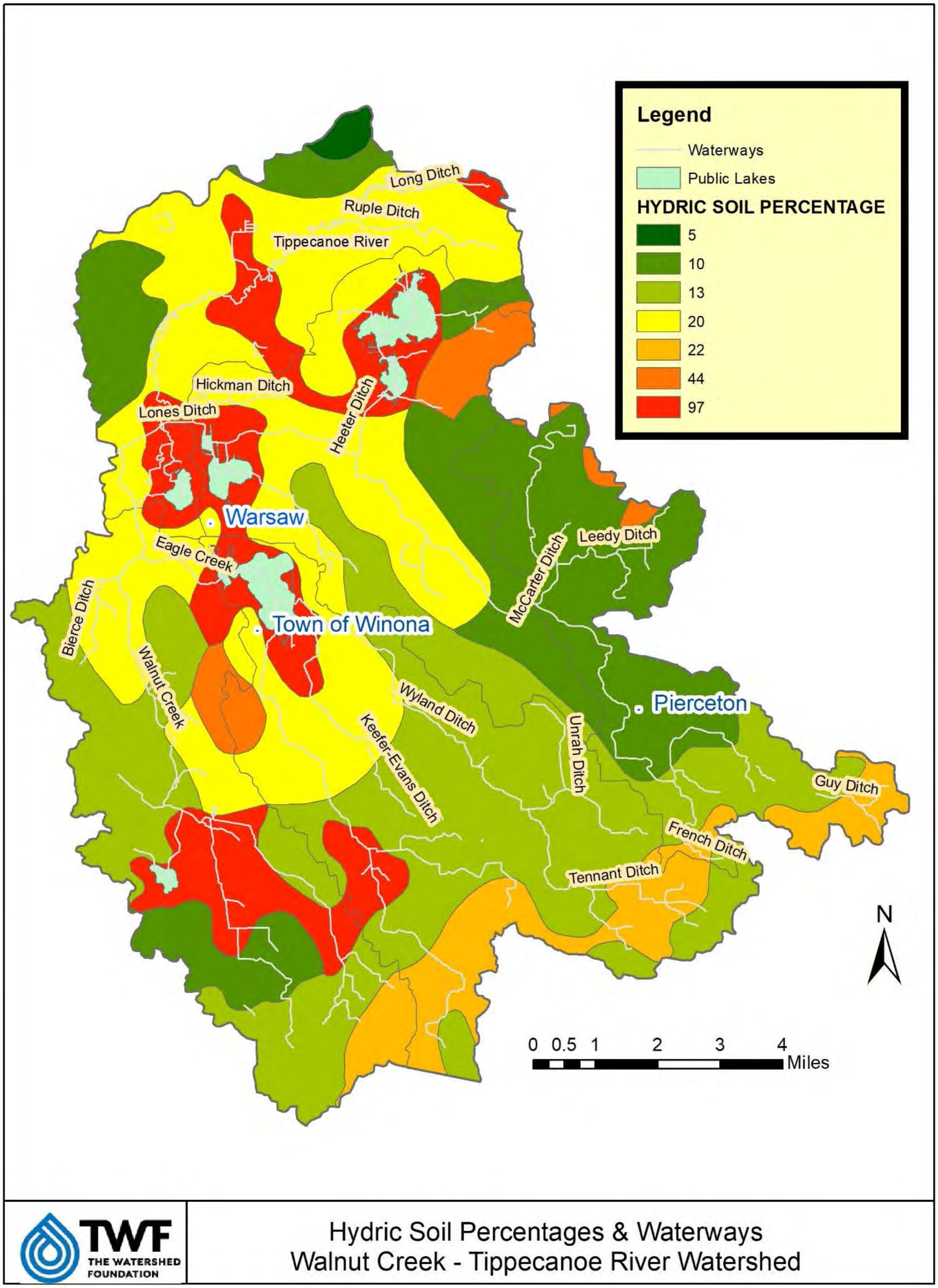
Map 13 Watershed Prime Farmland (NRCS and USDA, 2002)



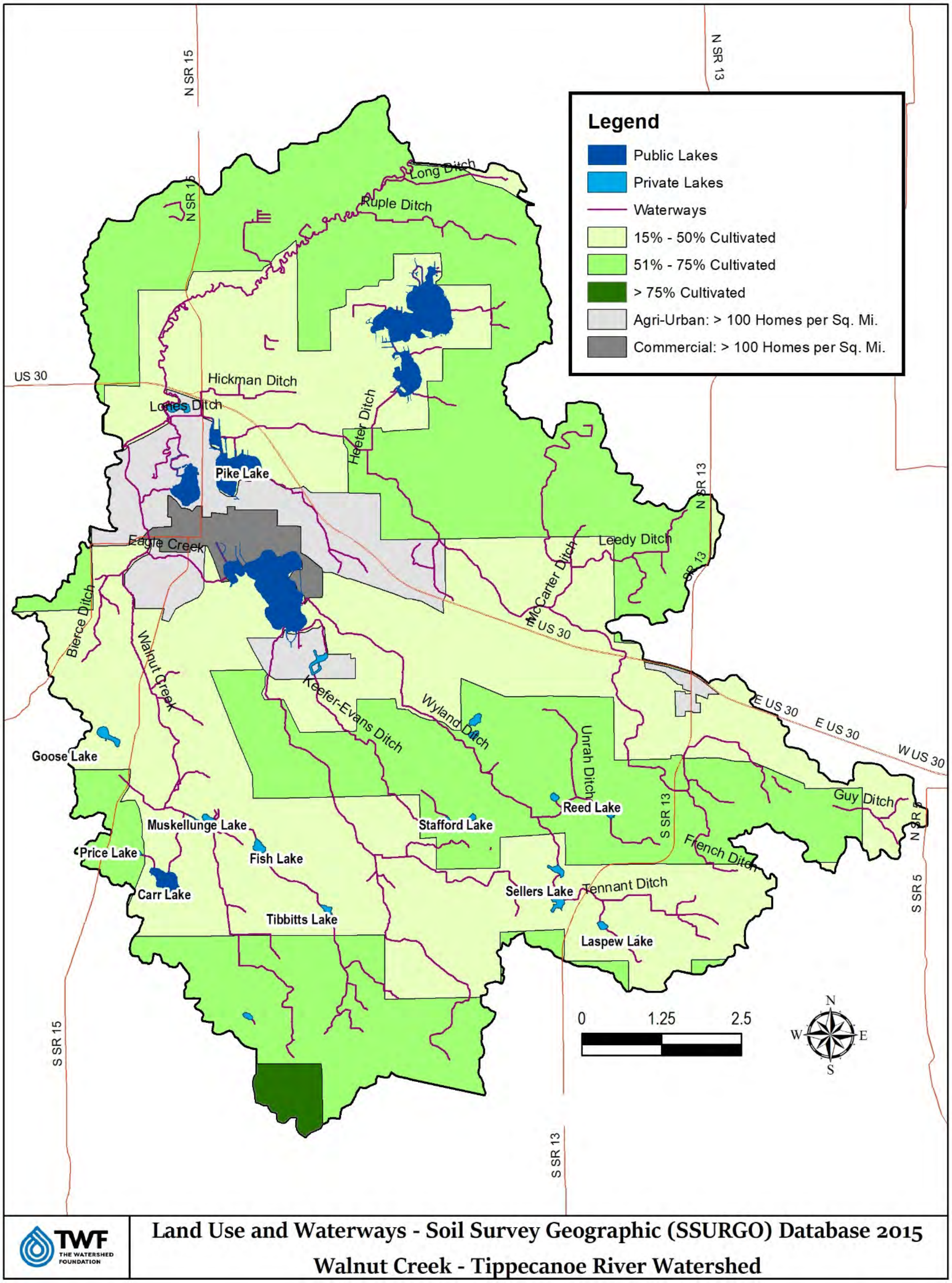
Map 14 Bedrock Aquifer Systems (USGS, 2008)



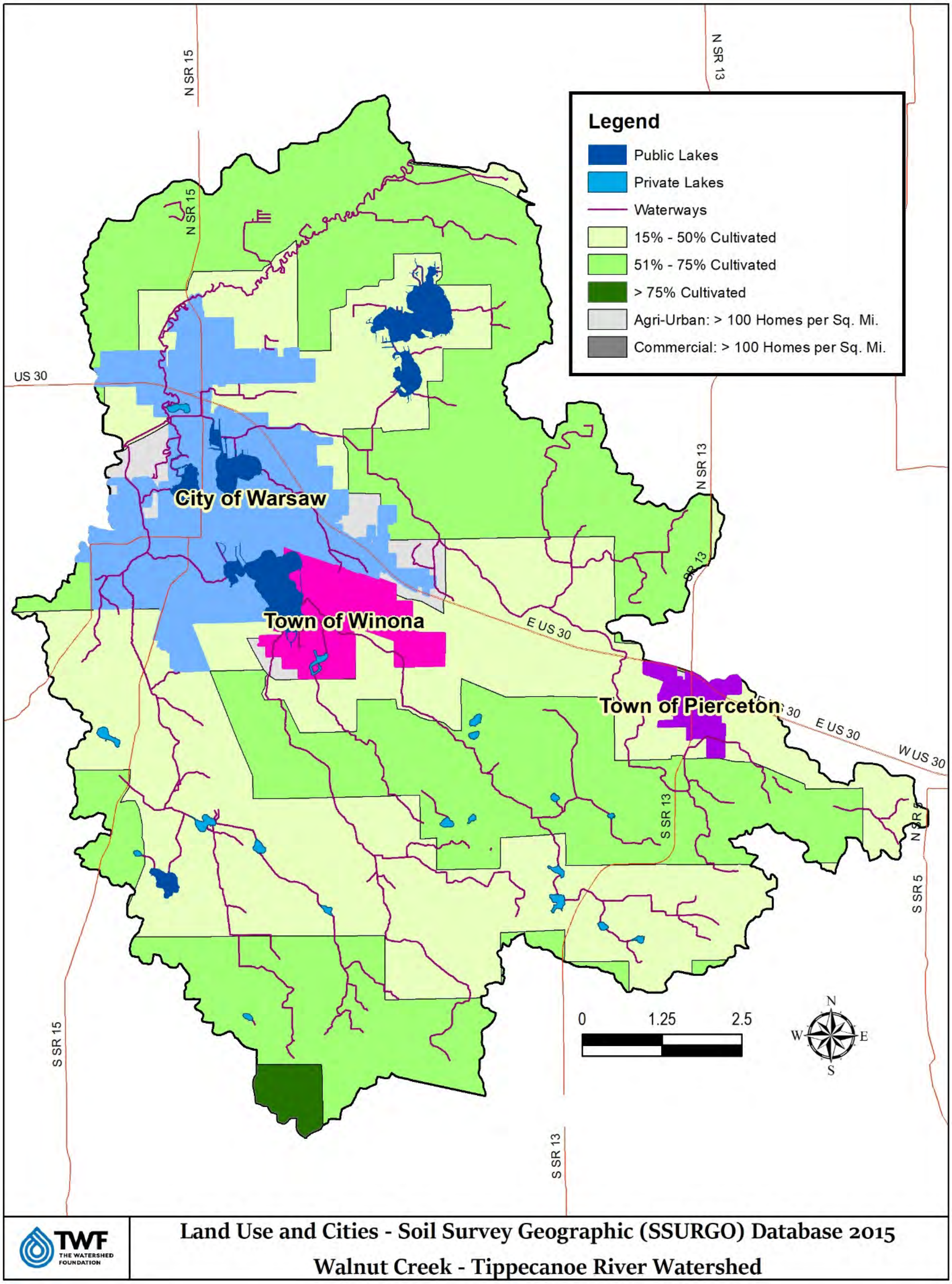
Map 15 Watershed Soils by Soil Association Groupings (NRCS and USDA, 2002)



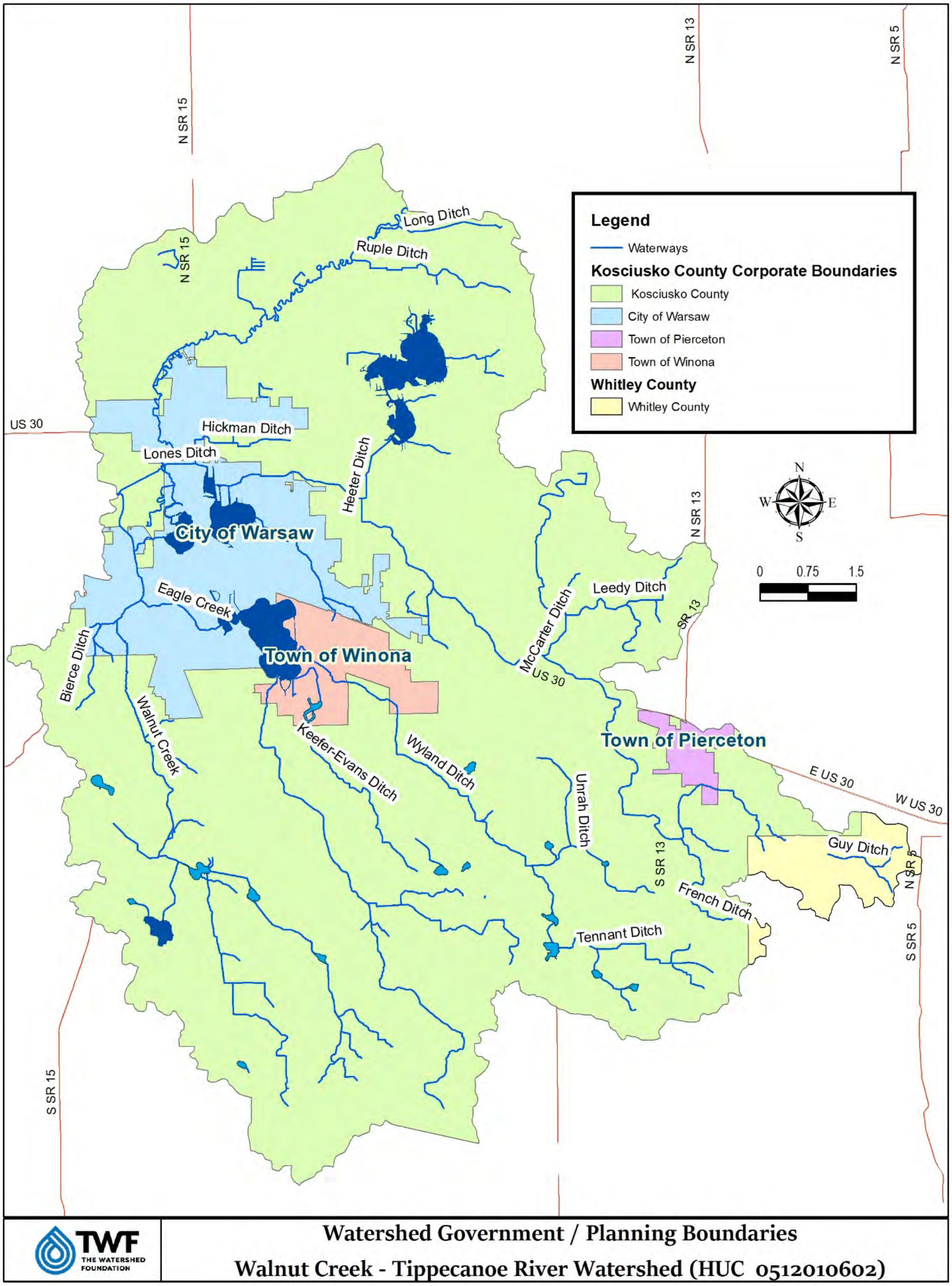
Map 16 Hydric Soils (NRCS and USDA, 2002)



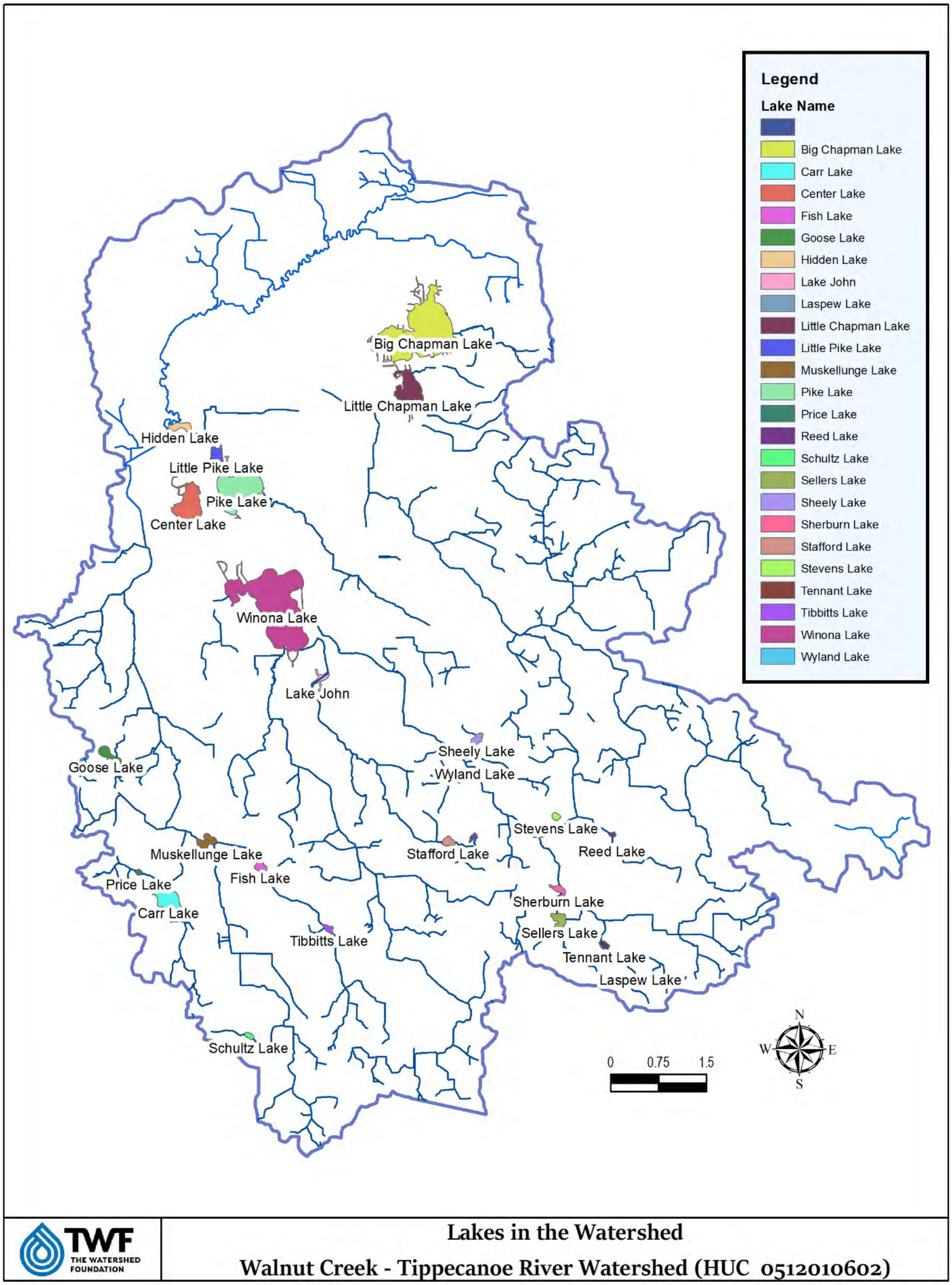
Map 17 Watershed Land Use and Major Roads (NRCS, 2015)



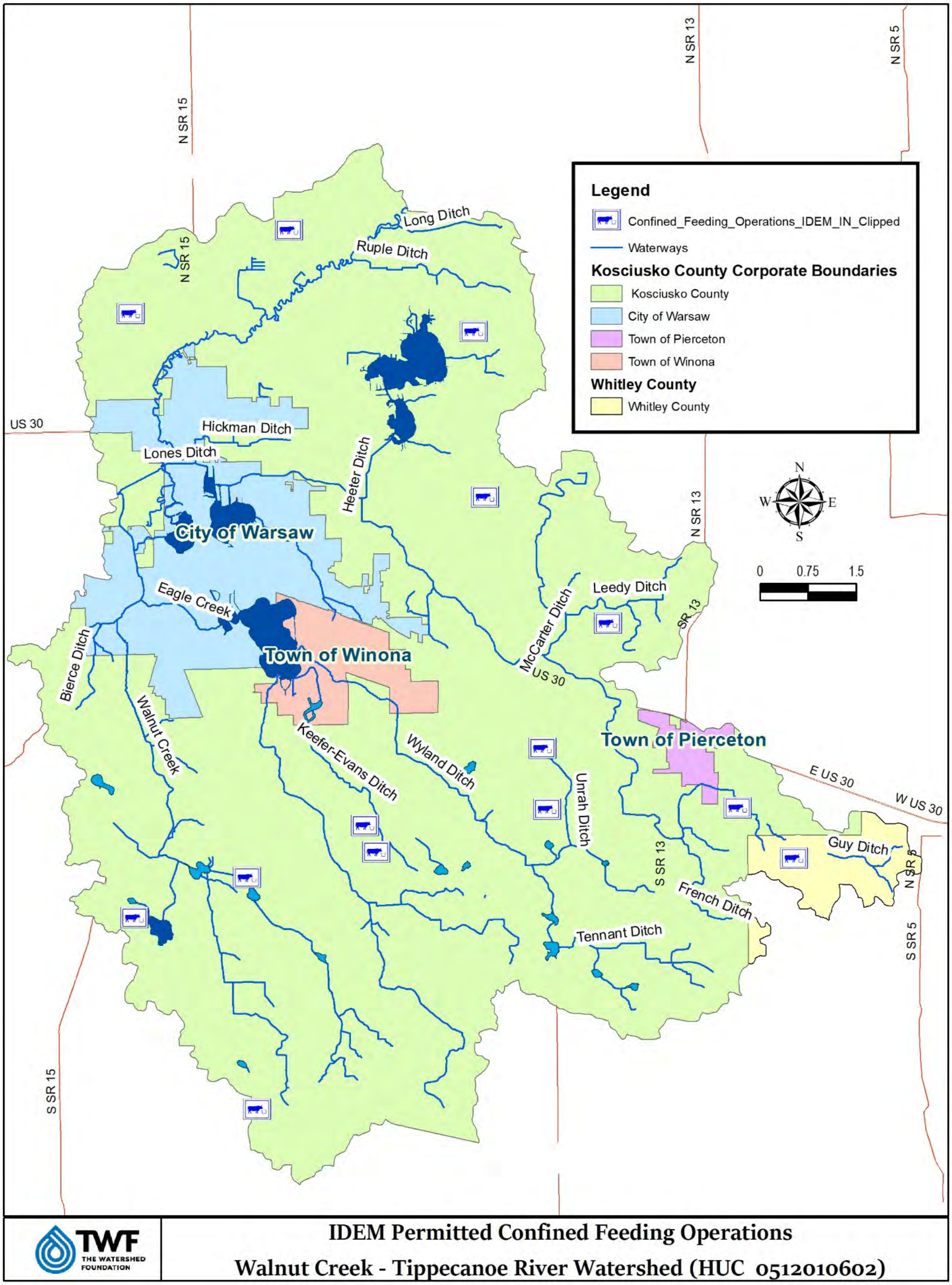
Map 18 Watershed Land Use and Citie (NRCS, 2015)



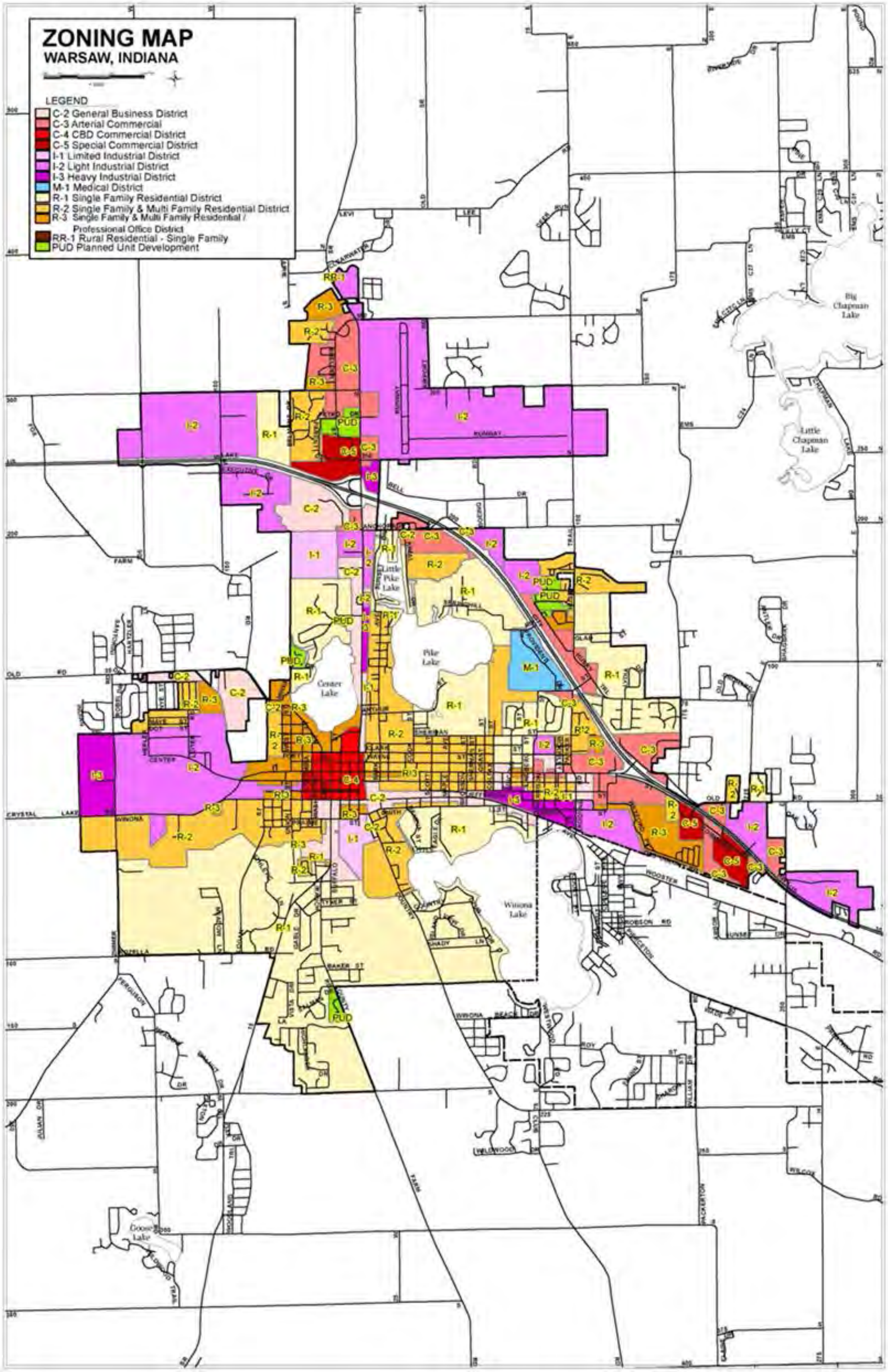
Map 19 Watershed Government / Planning Boundaries (INDOT, 2001)



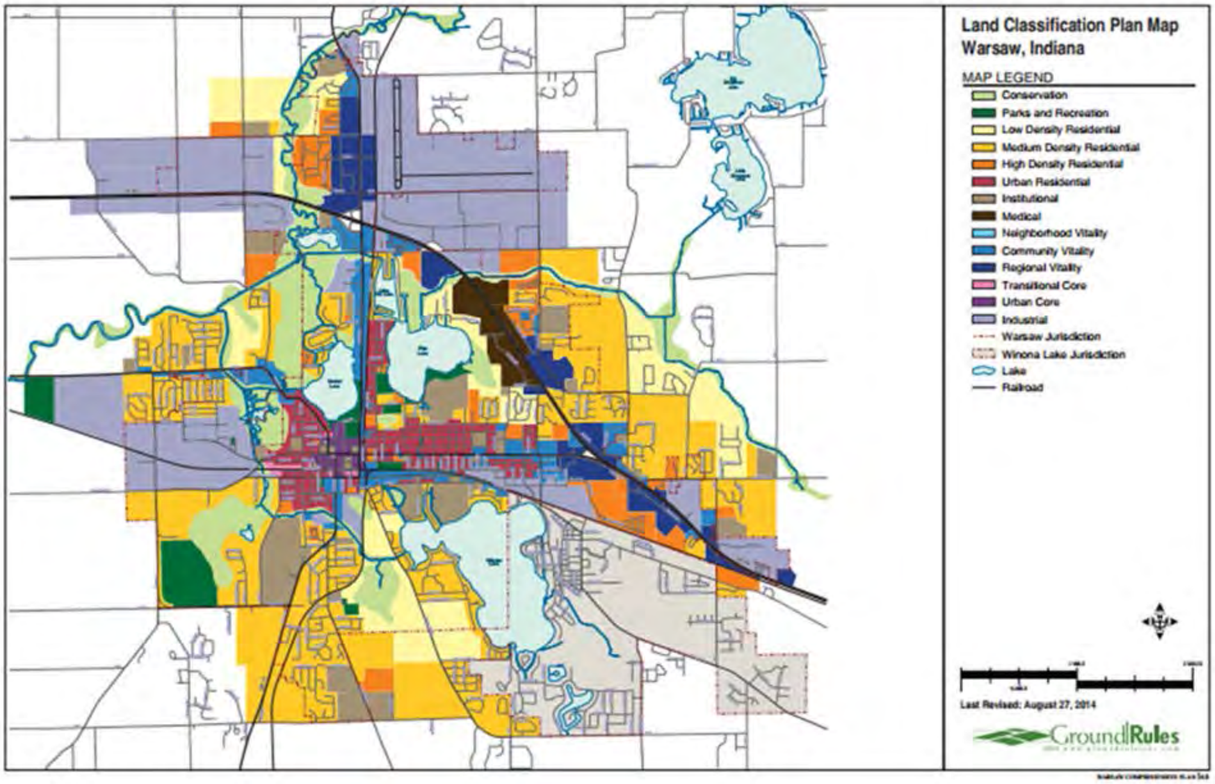
Map 20 Lakes in the Watershed (USGS, 2008)



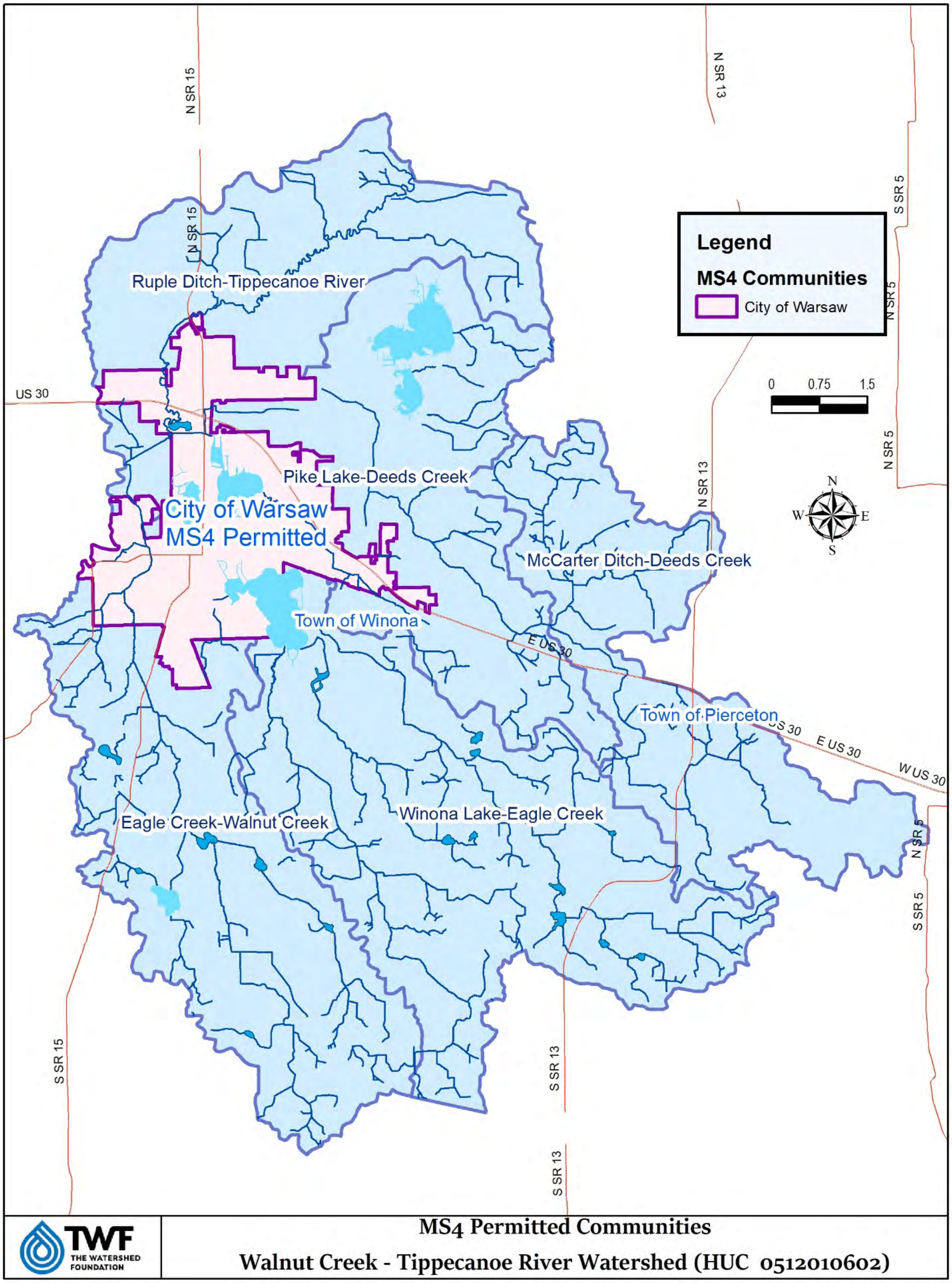
Map 21 IDEM Permitted Confined Animal Feeding Operations (IDEM, 2018)



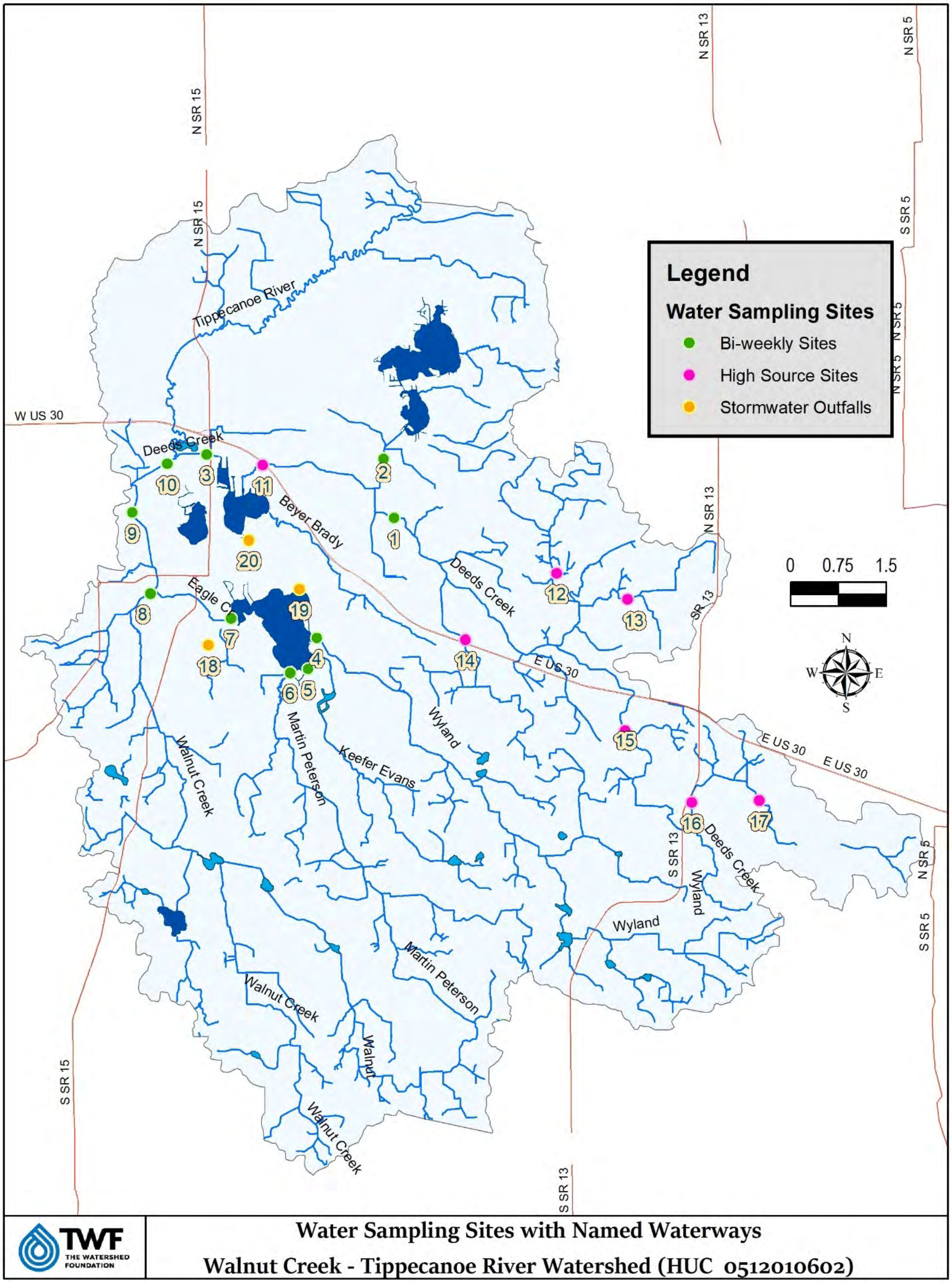
Map 22 City of Warsaw Zoning Map (Inc.)



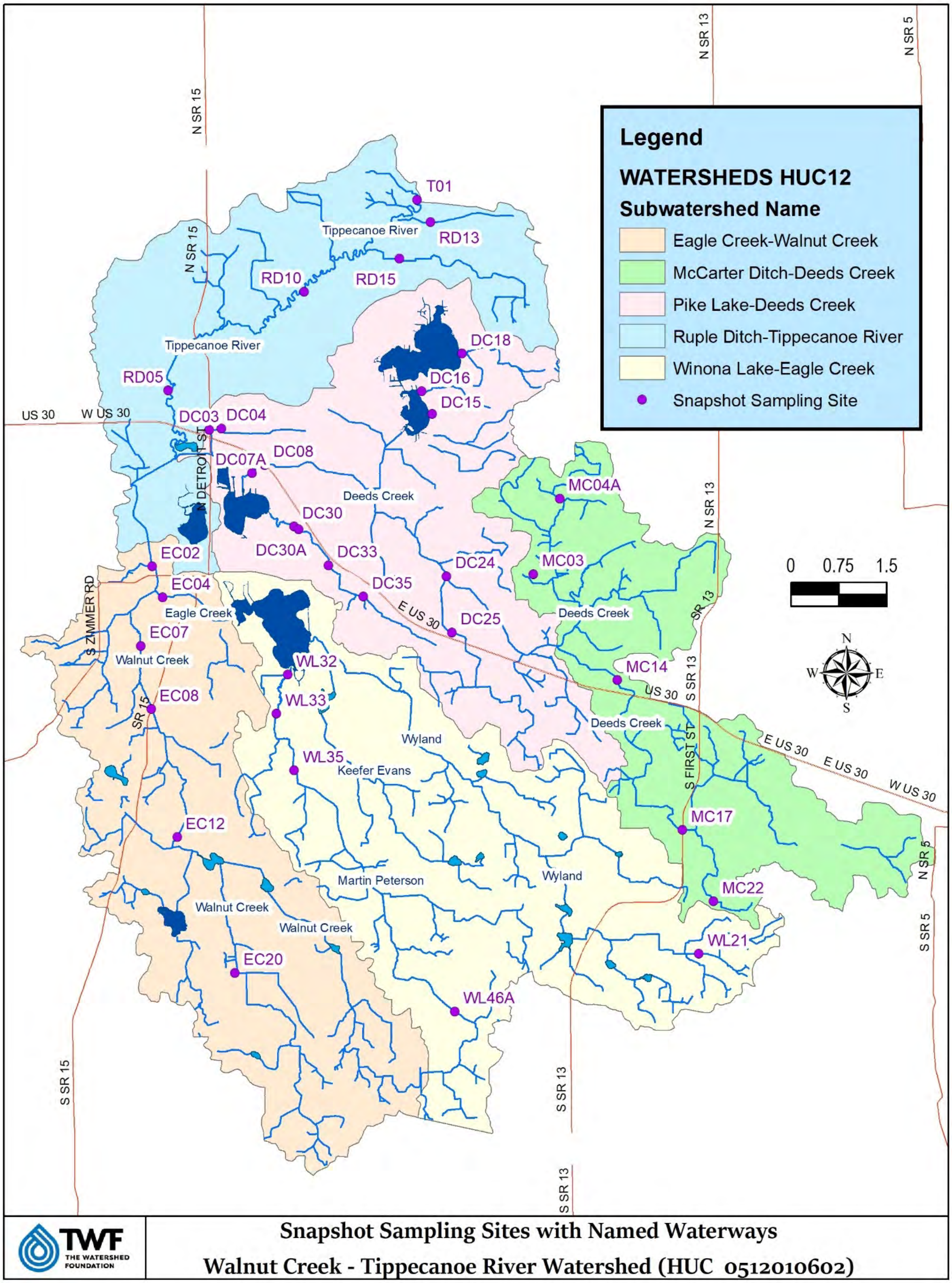
Map 23 Warsaw Future Land Classification Map, 2015 Warsaw Comprehensive Plan (Inc.)



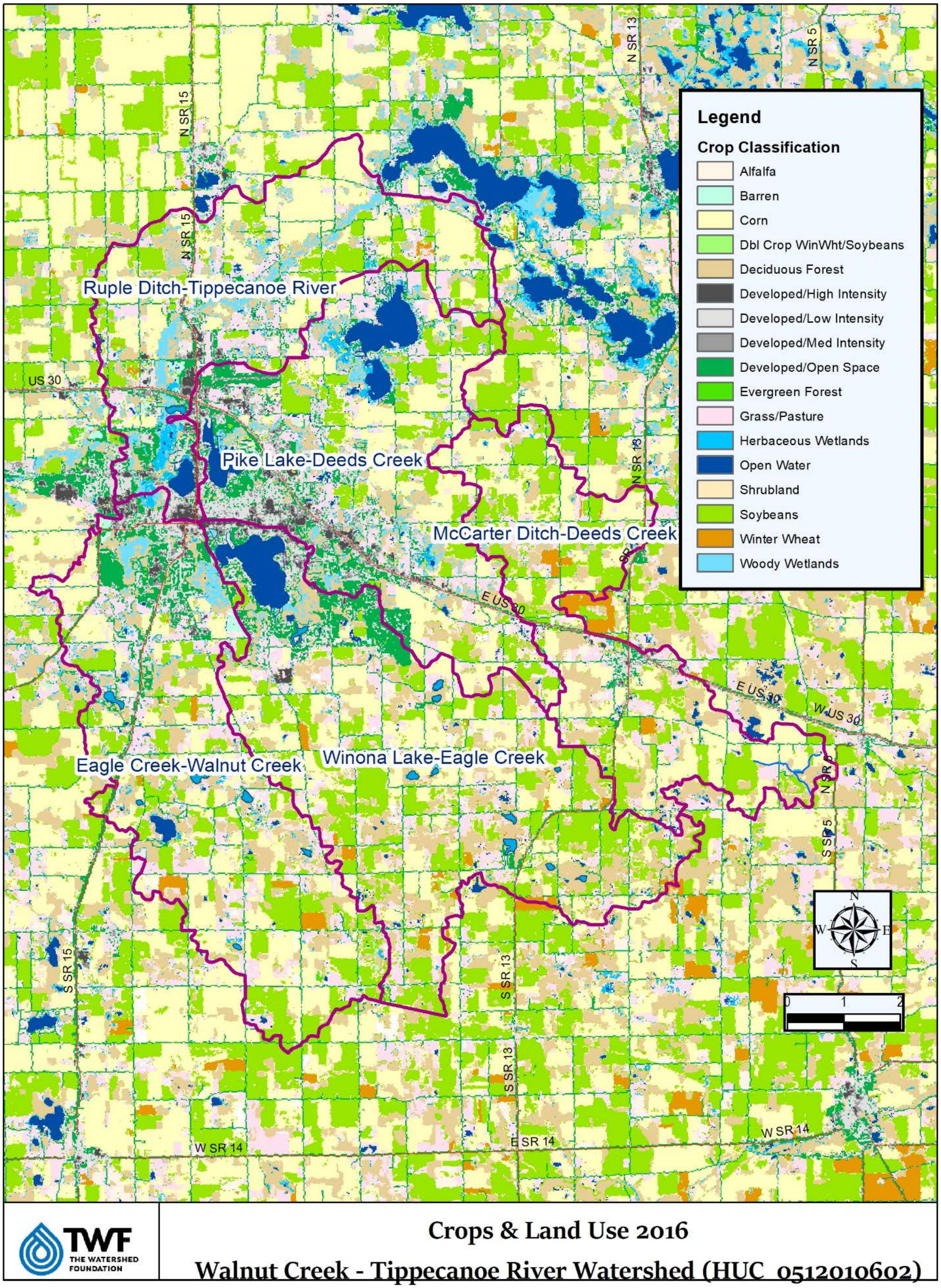
Map 24 MS4 Communities in the Walnut Creek - Tippecanoe River Watershed 2016



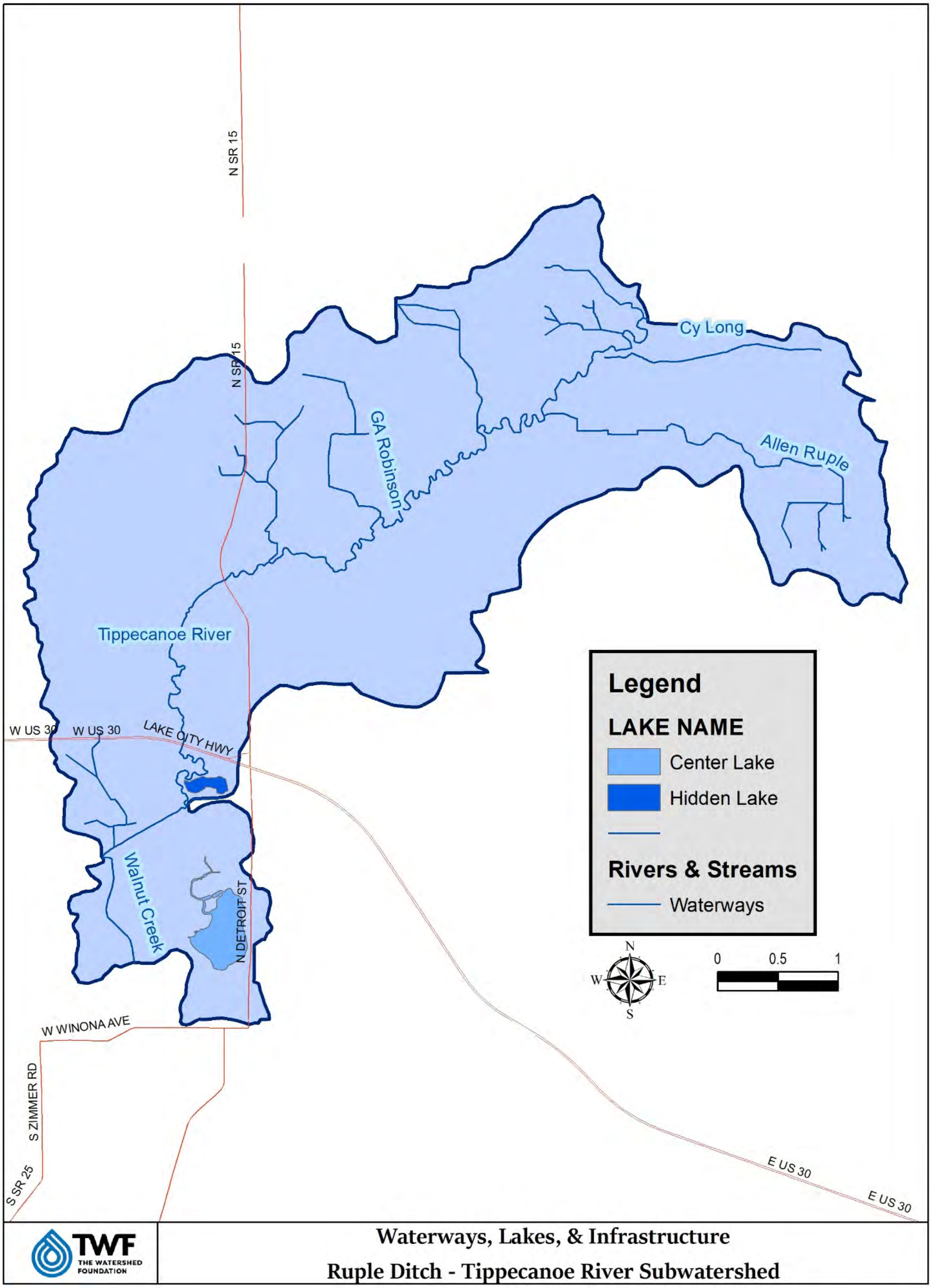
Map 25 Walnut Creek - Tippecanoe River Sampling Sites



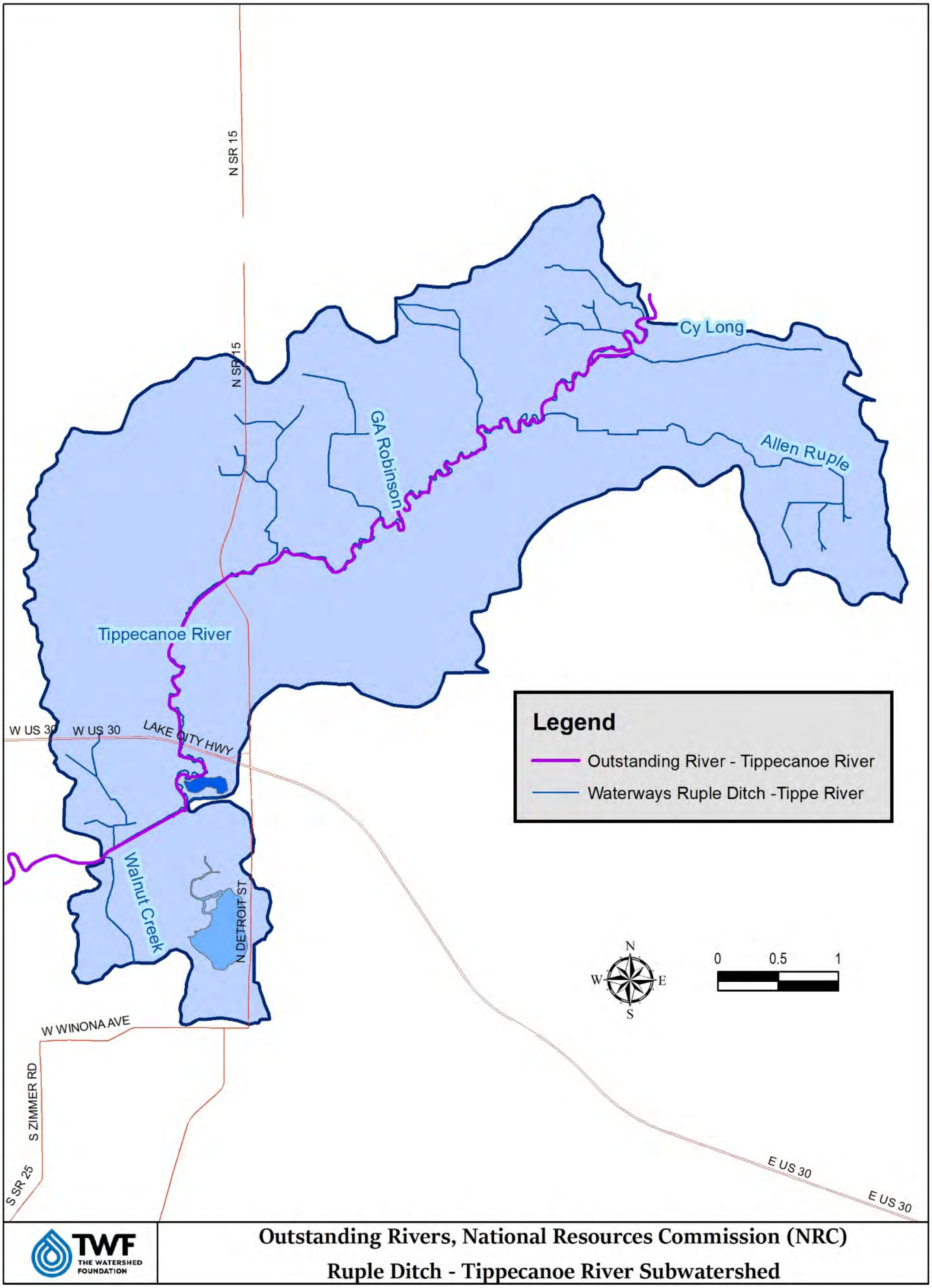
Map 26 Snapshot Monitoring Day Sampling Sites 2017



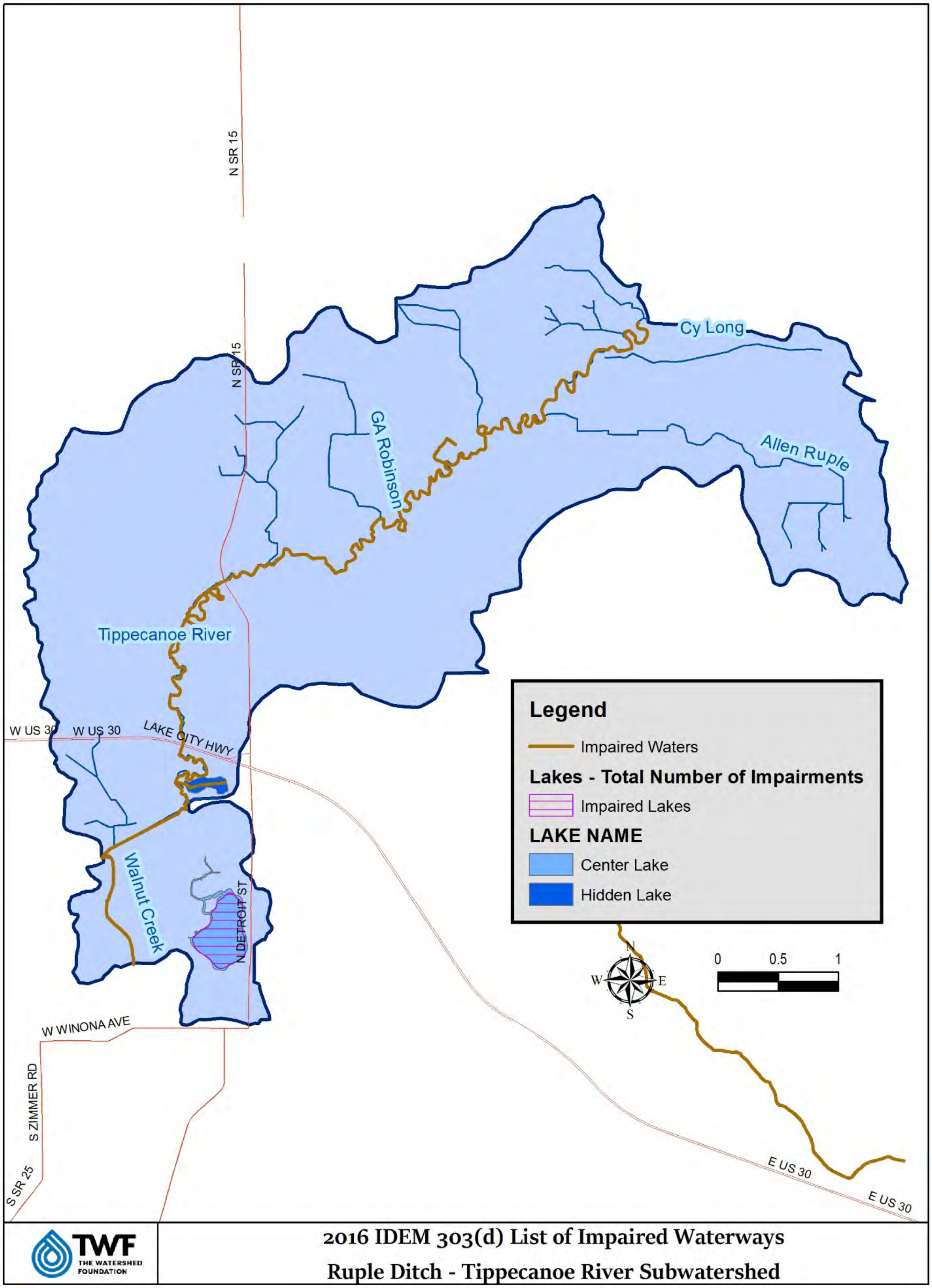
Map 27 Crop & Land Use Information (USDA, 2016)



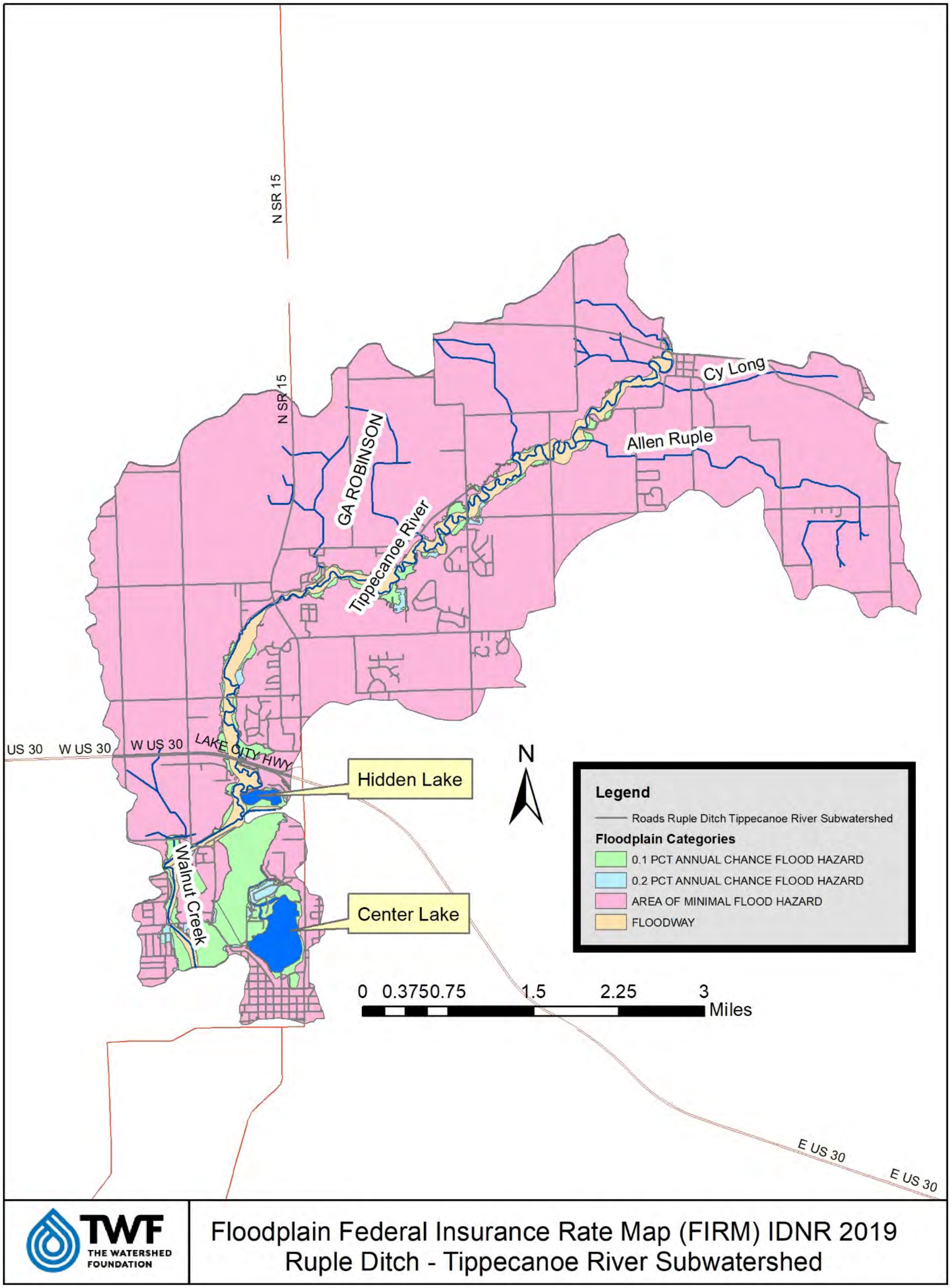
Map 28 Ruple Ditch - Tippecanoe River Subwatershed Waterways



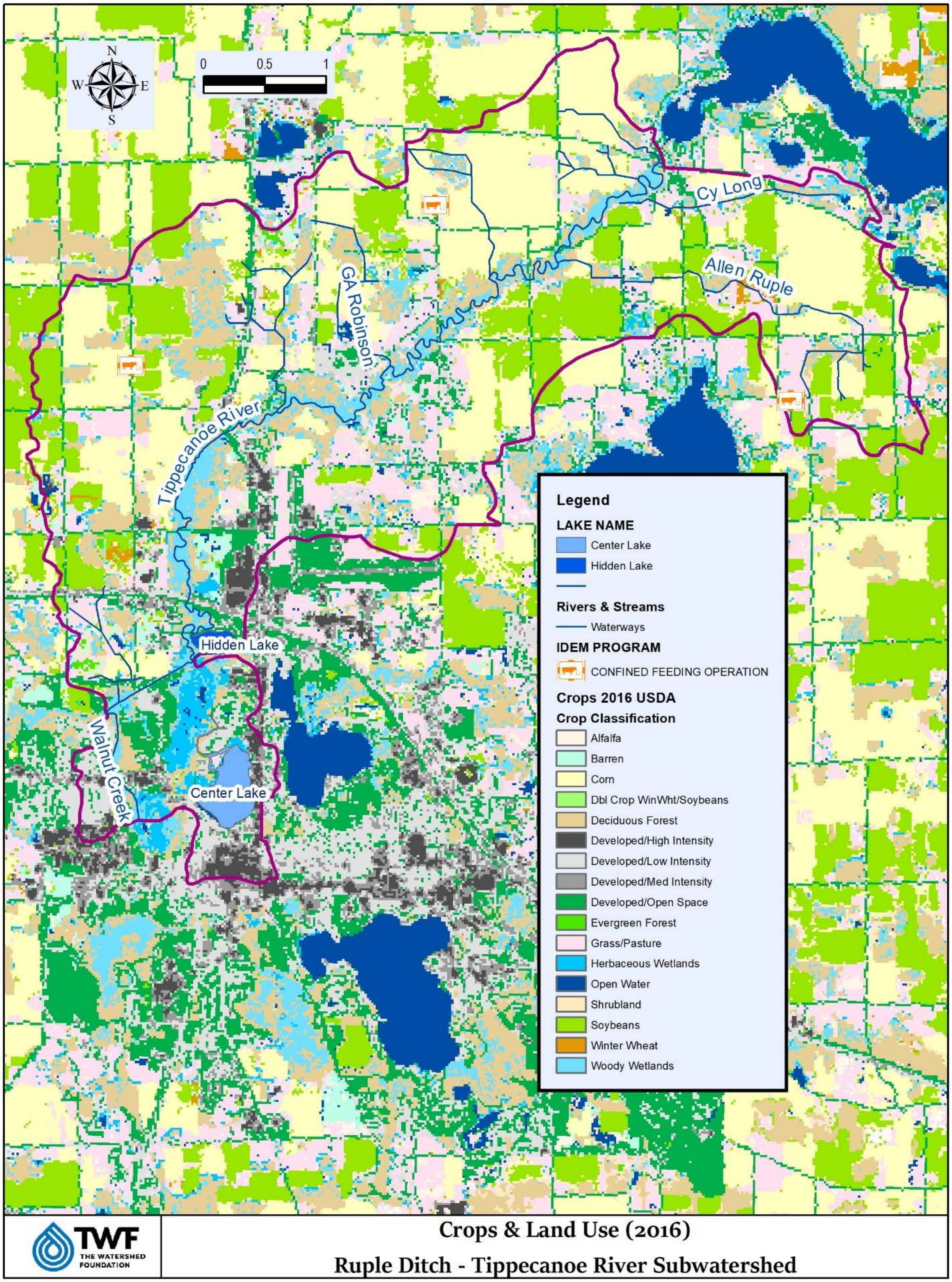
Map 29 Ruple Ditch - Tippecanoe River Subwatershed Outstanding Rivers



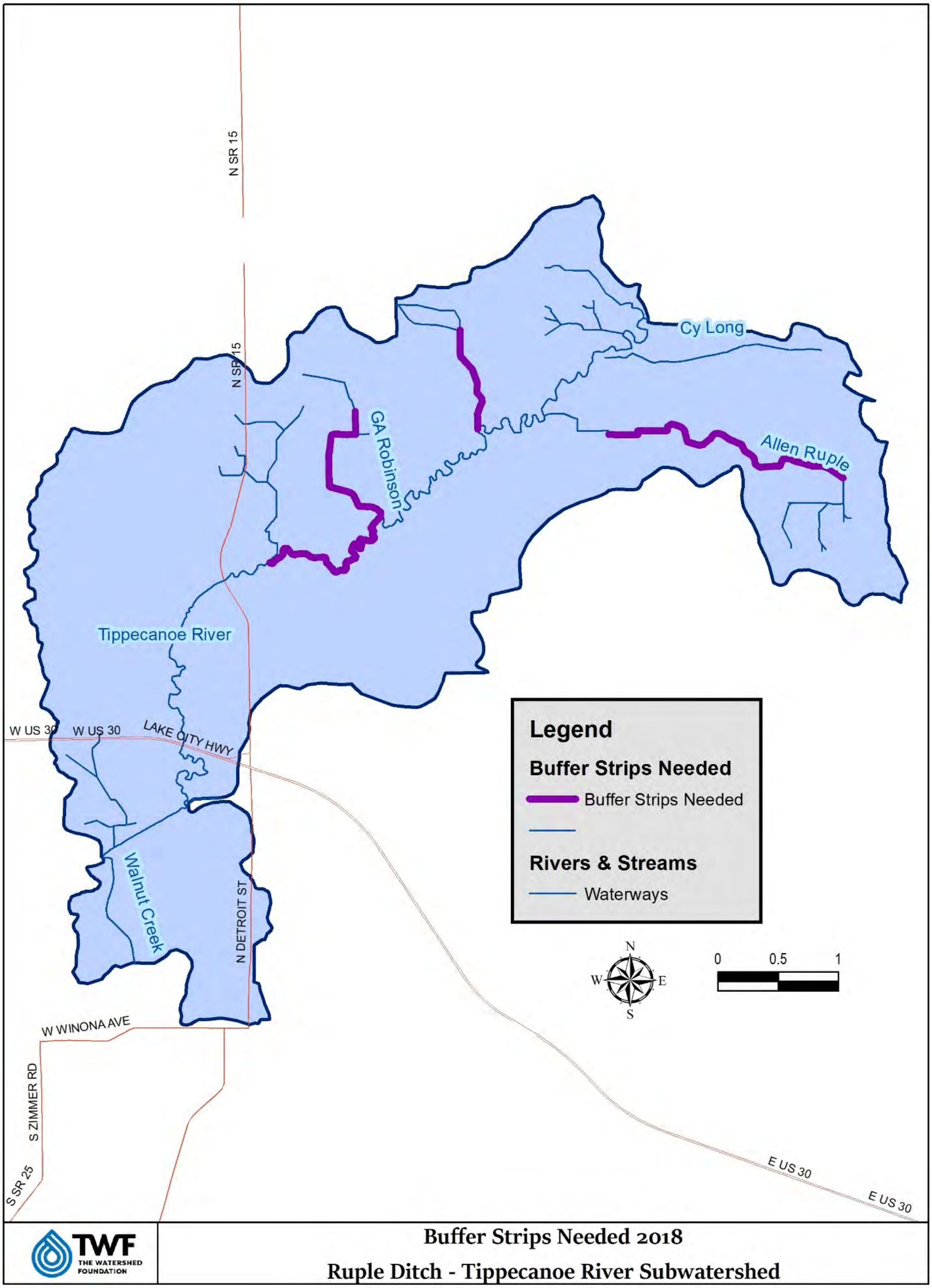
Map 30 Ruple Ditch - Tippecanoe River Subwatershed 303(d) List Impairments 2016



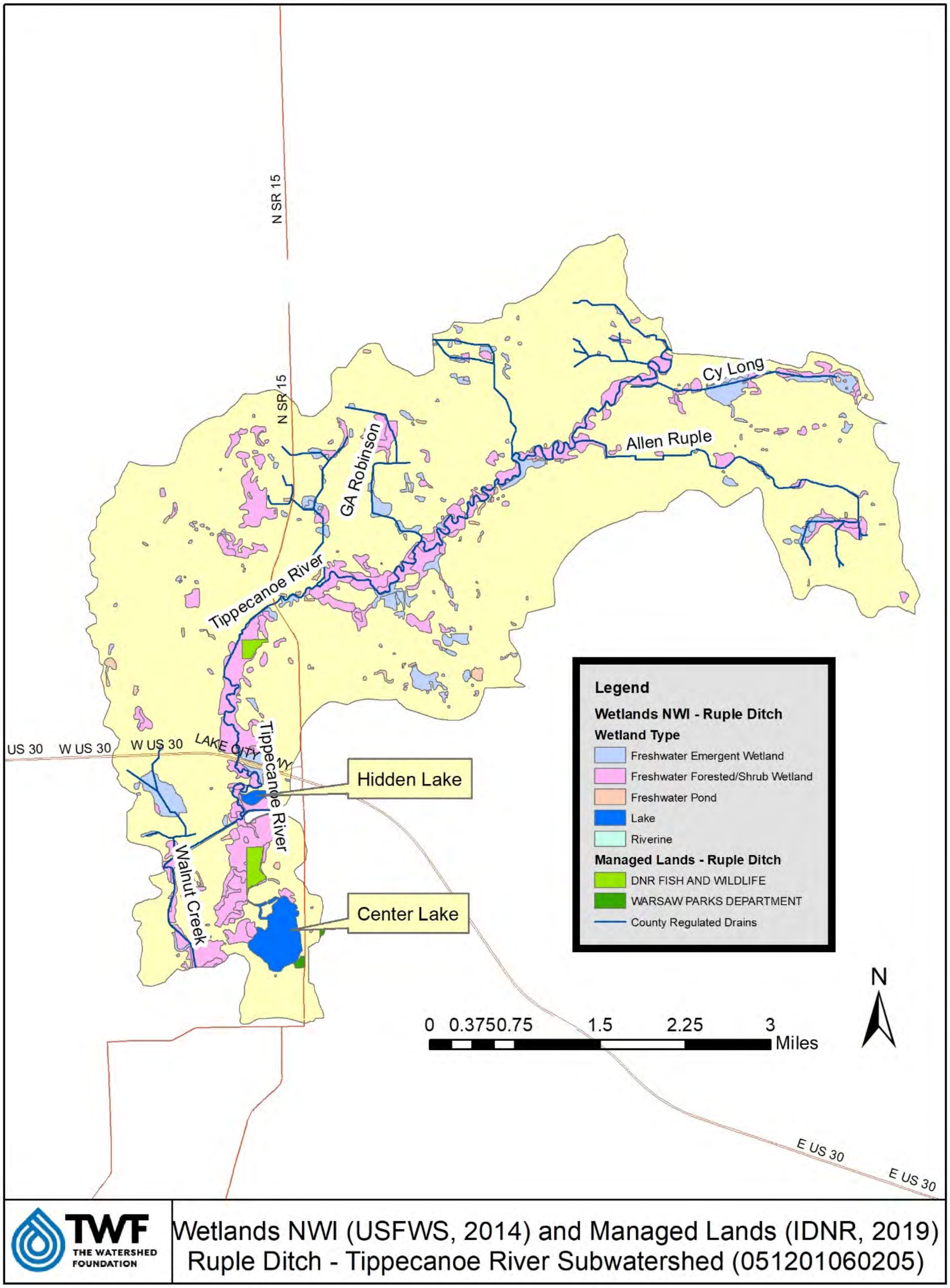
Map 31 Ruple Ditch - Tippecanoe River Subwatershed FIRM Maps (IDNR,2019)



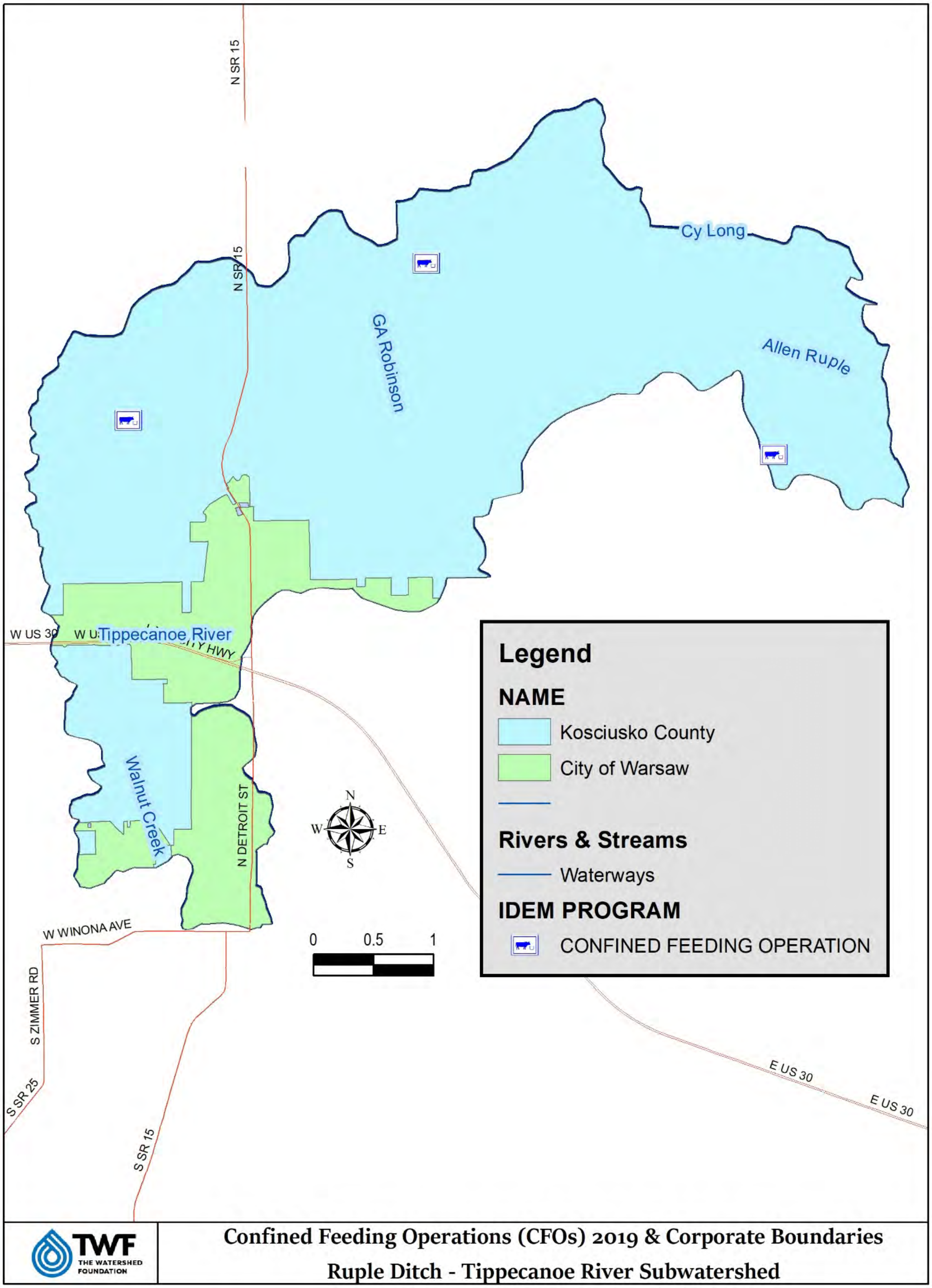
Map 32 Ruple Ditch - Tippecanoe River Subwatershed Crop Map



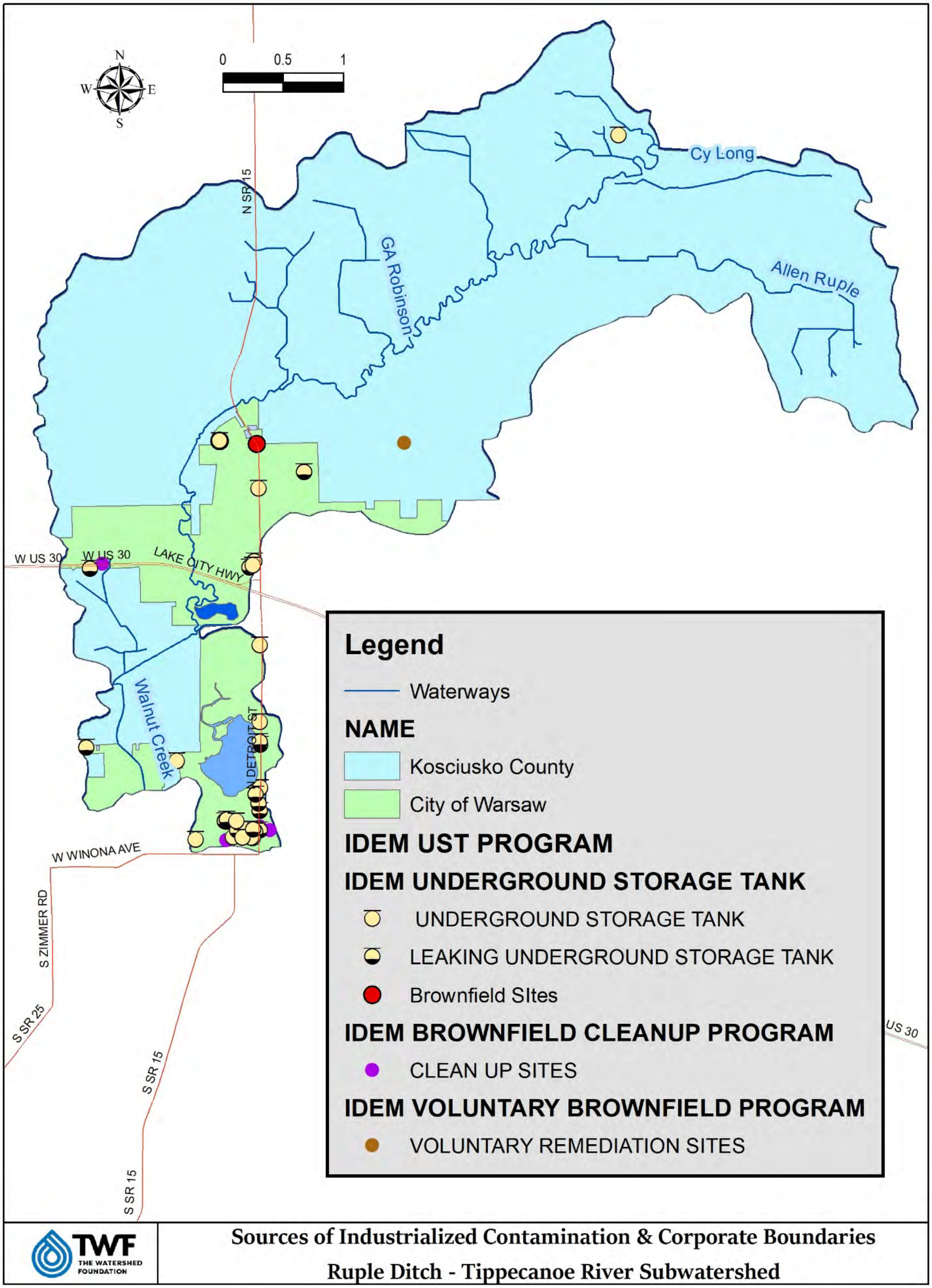
Map 33 Ruple Ditch - Tippecanoe River Subwatershed Locations Needing Buffer Strips



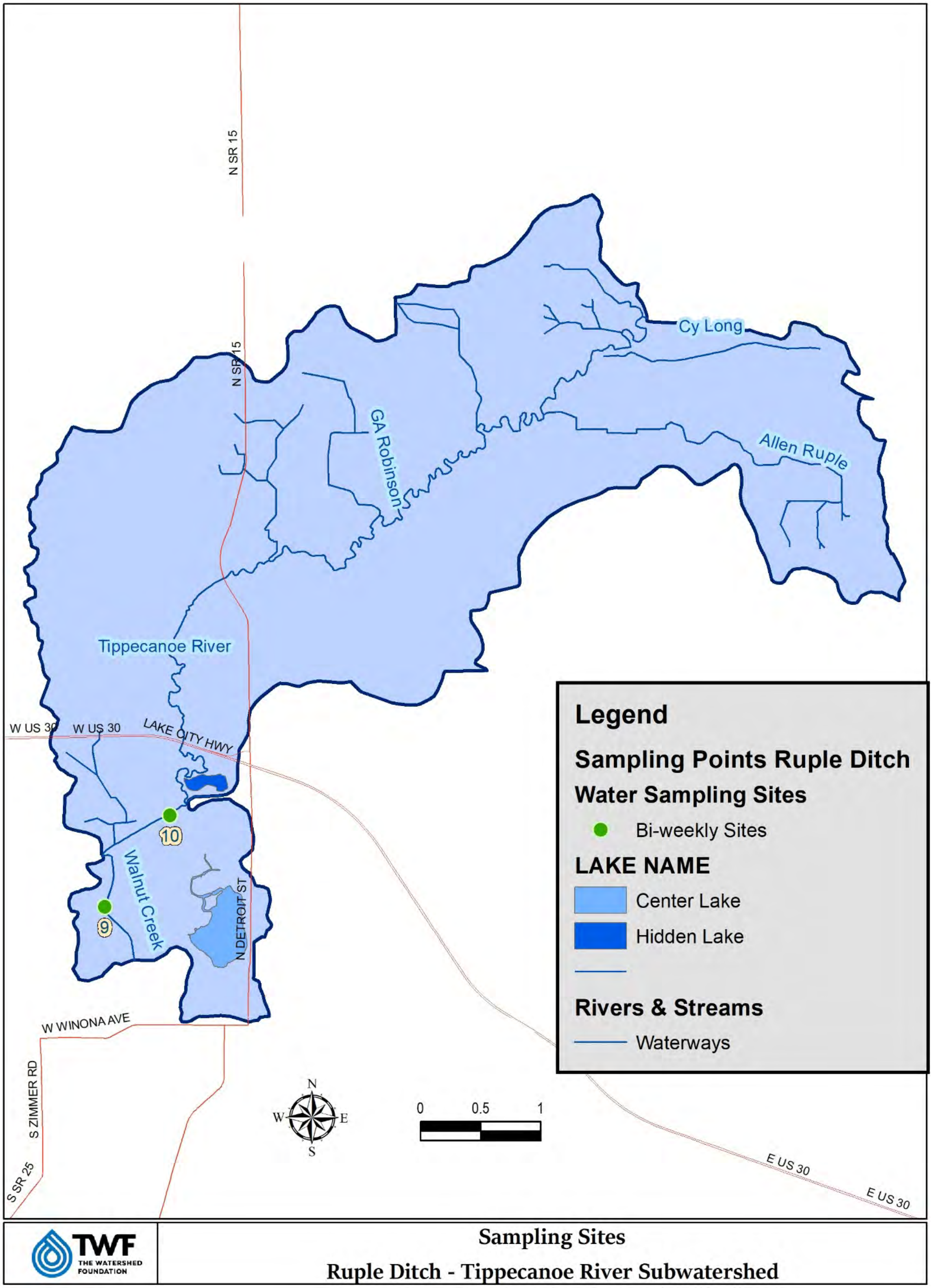
Map 34 Ruple Ditch - Tippecanoe River Subwatershed Wetlands (NWI) & Managed Lands (IDNR 2014)



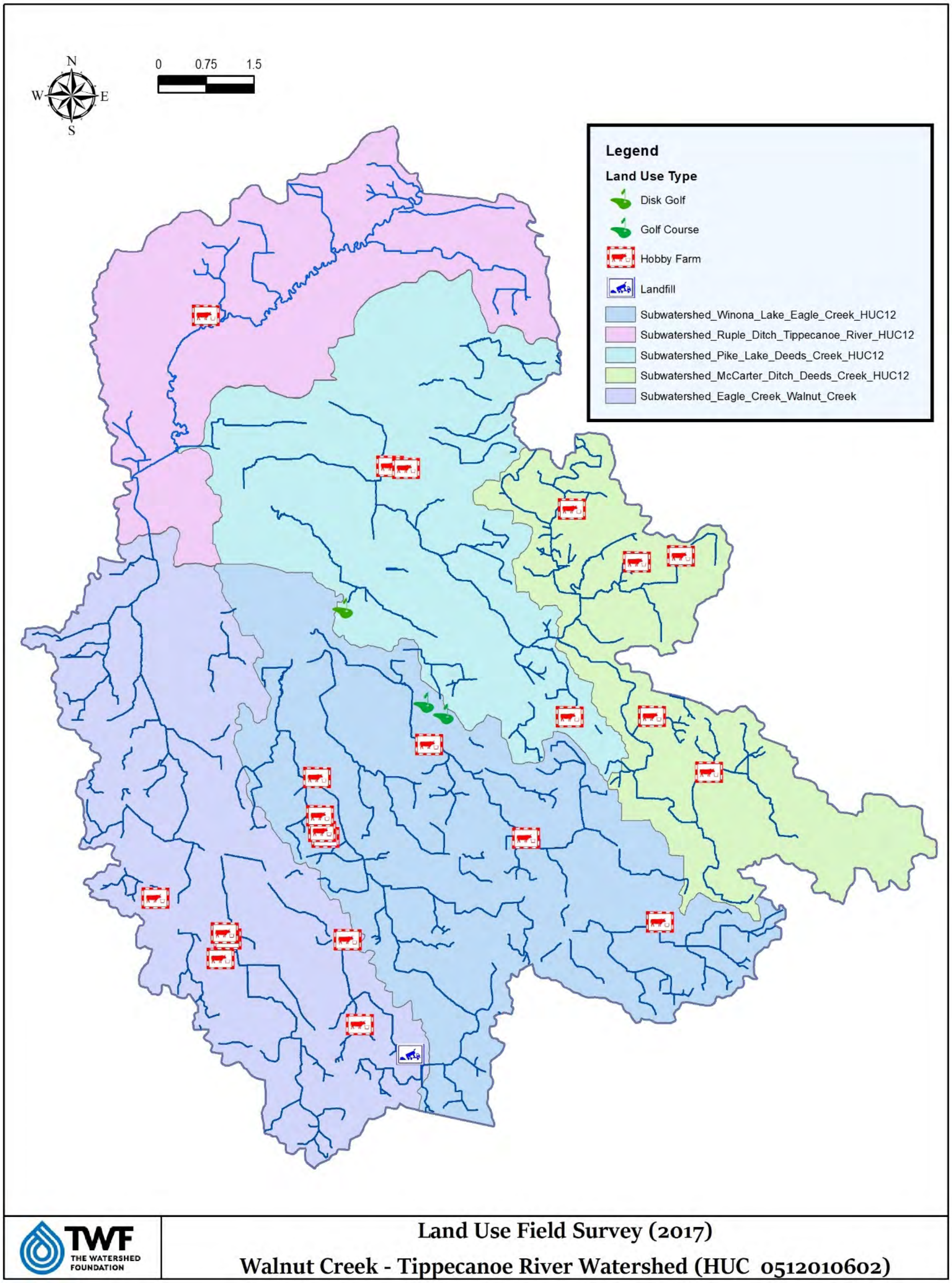
Map 35 Ruple Ditch - Tippecanoe River Confined Feeding Operations & Corporate Boundaries



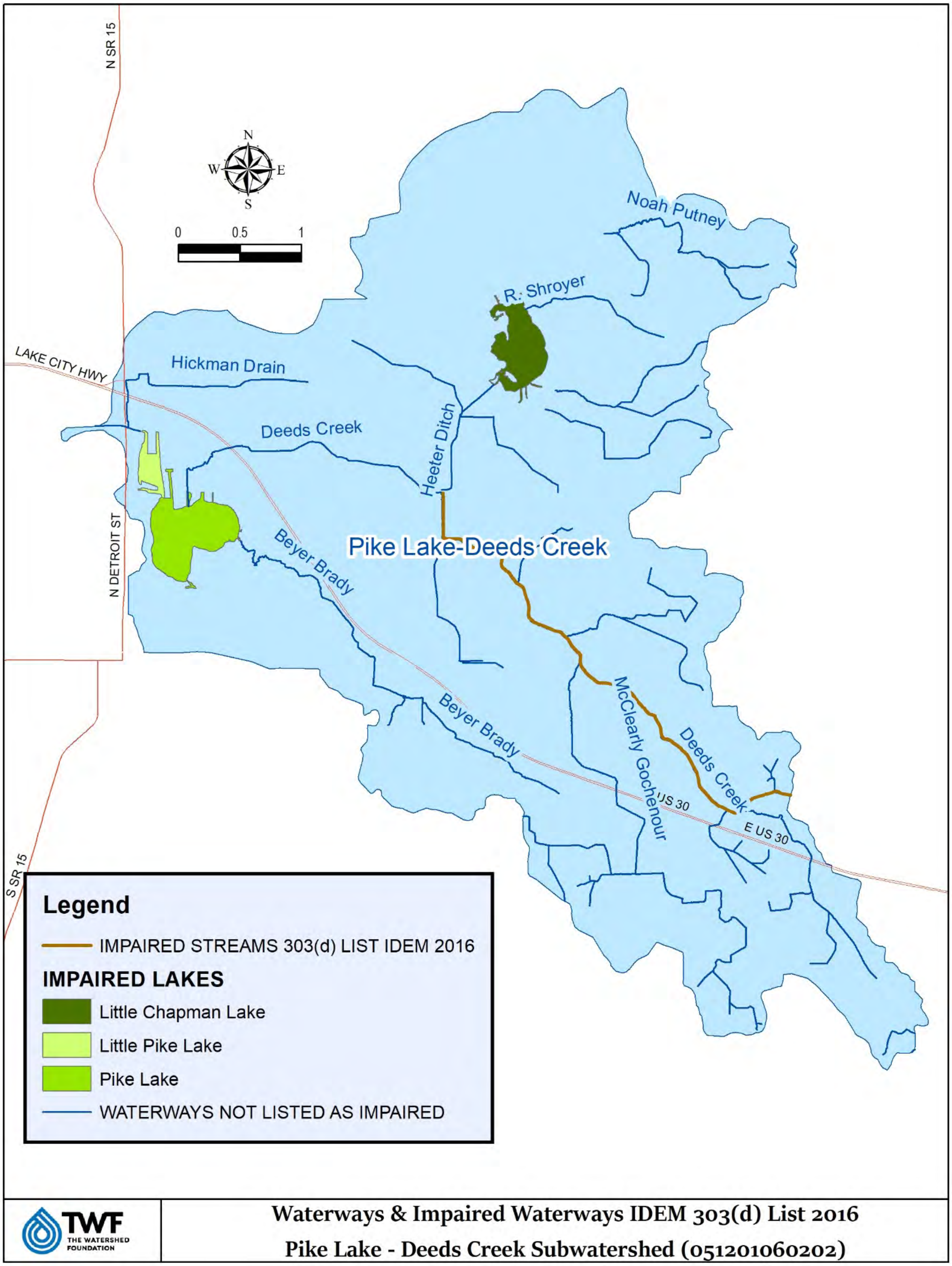
Map 36 Ruple Ditch - Tippecanoe River Subwatershed Sources of Potential Industrial Contamination (IDEM, 2018)



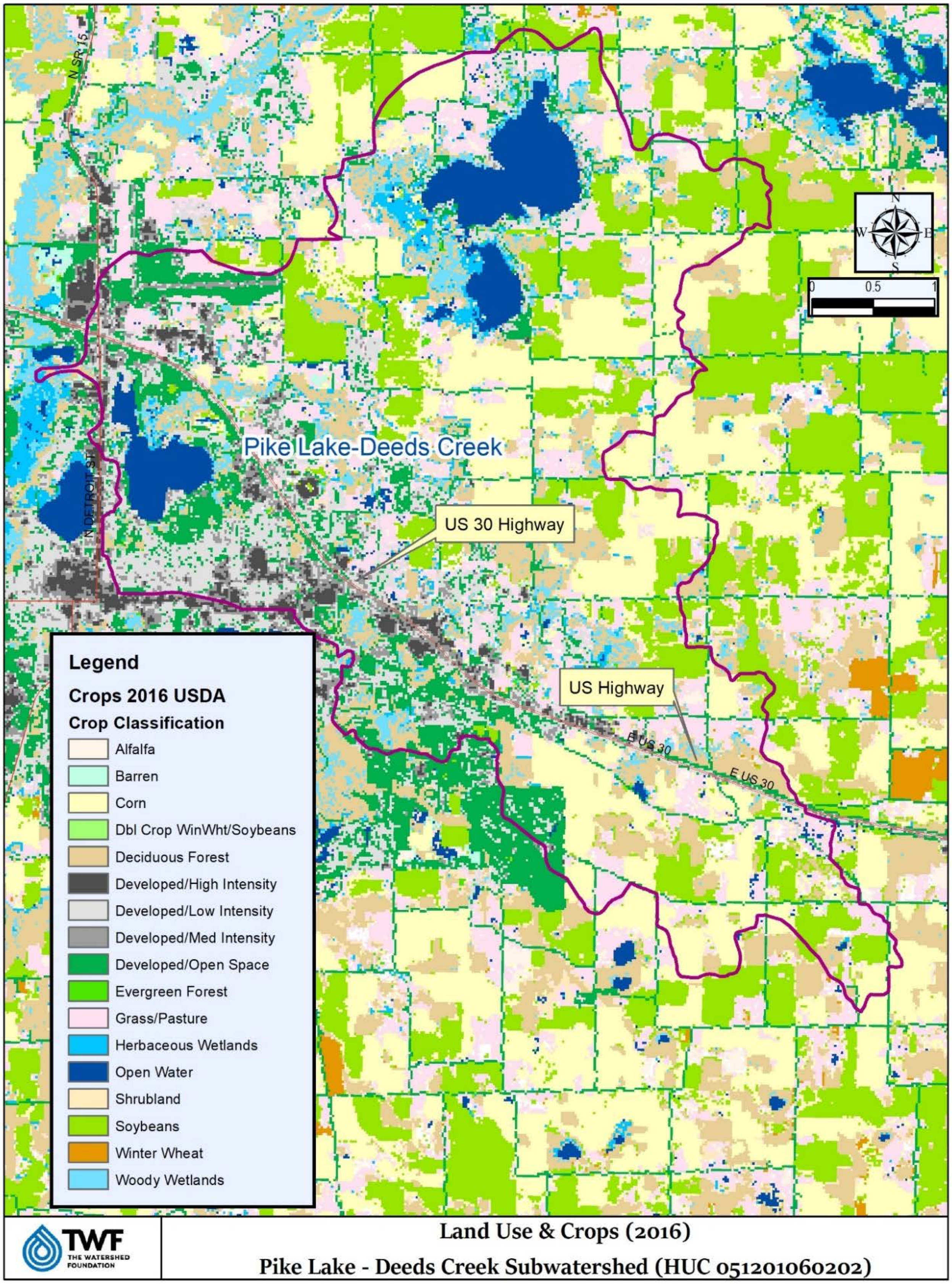
Map 37 Ruple Ditch - Tippecanoe River Sampling Sites



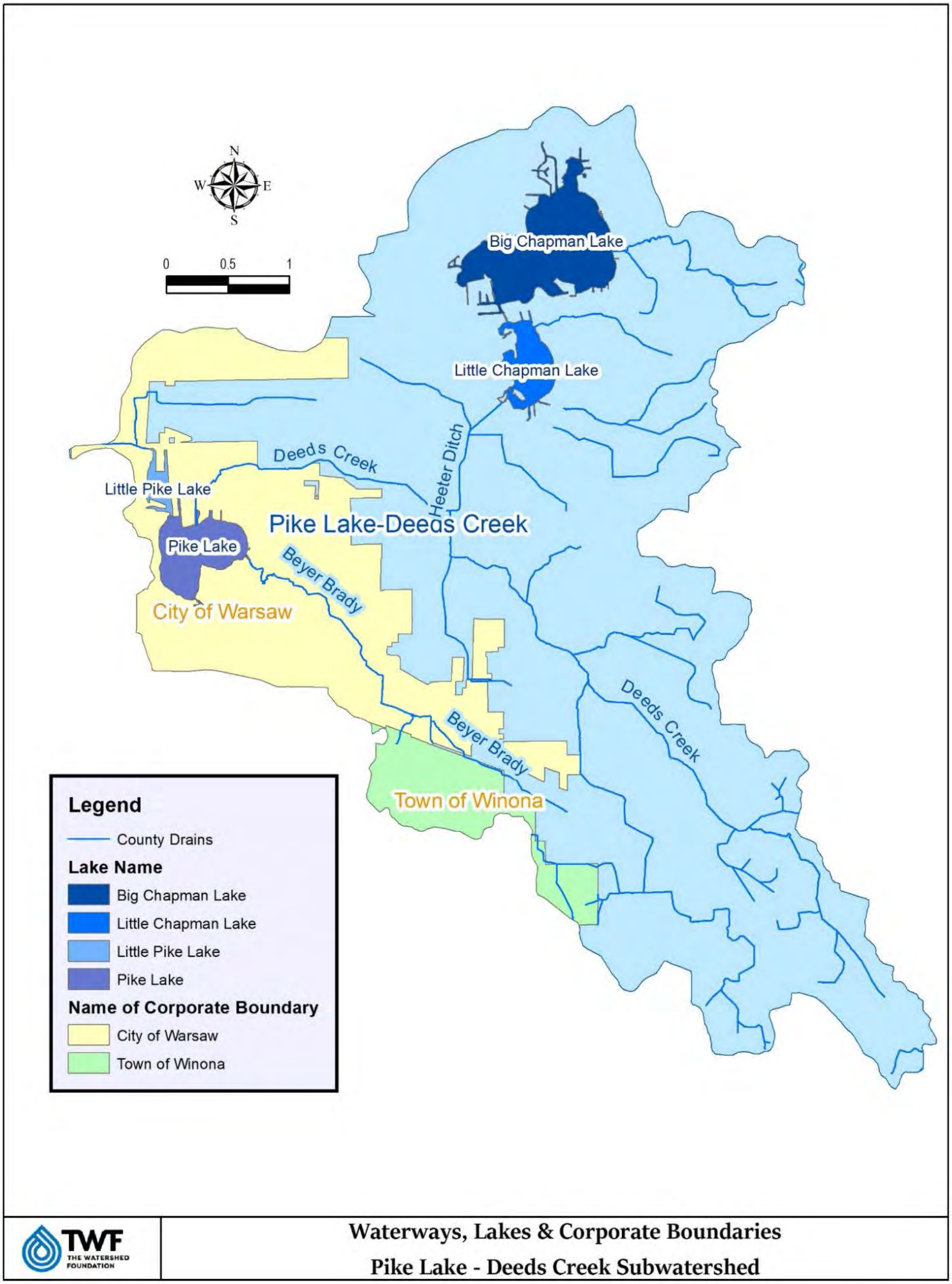
Map 38 Field Survey (2017) Walnut Creek - Tippecanoe River Watershed



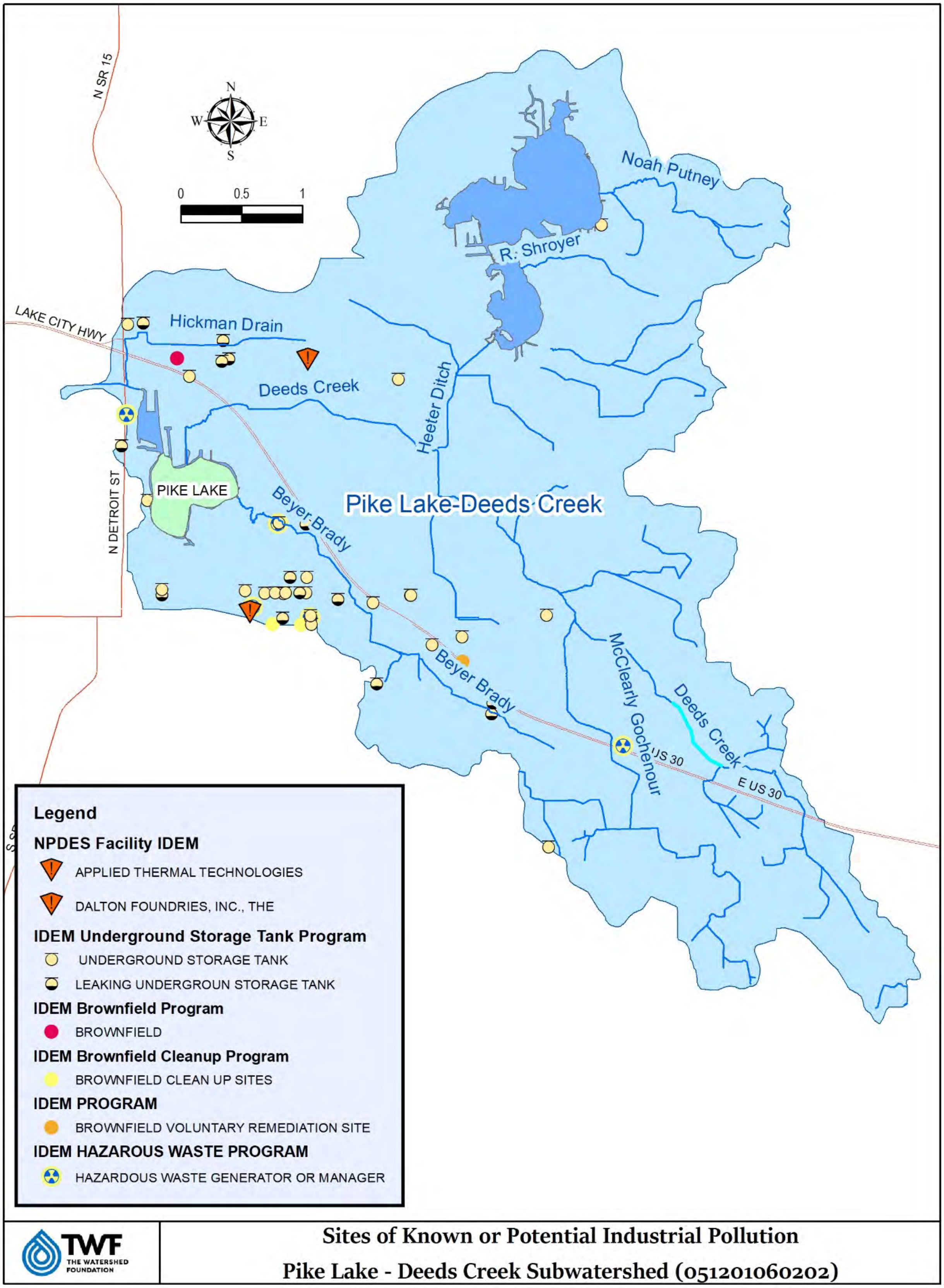
Map 39 Pike Lake -Deeds Creek Waterways & Impaired Waters IDEM 303(d) List 2018



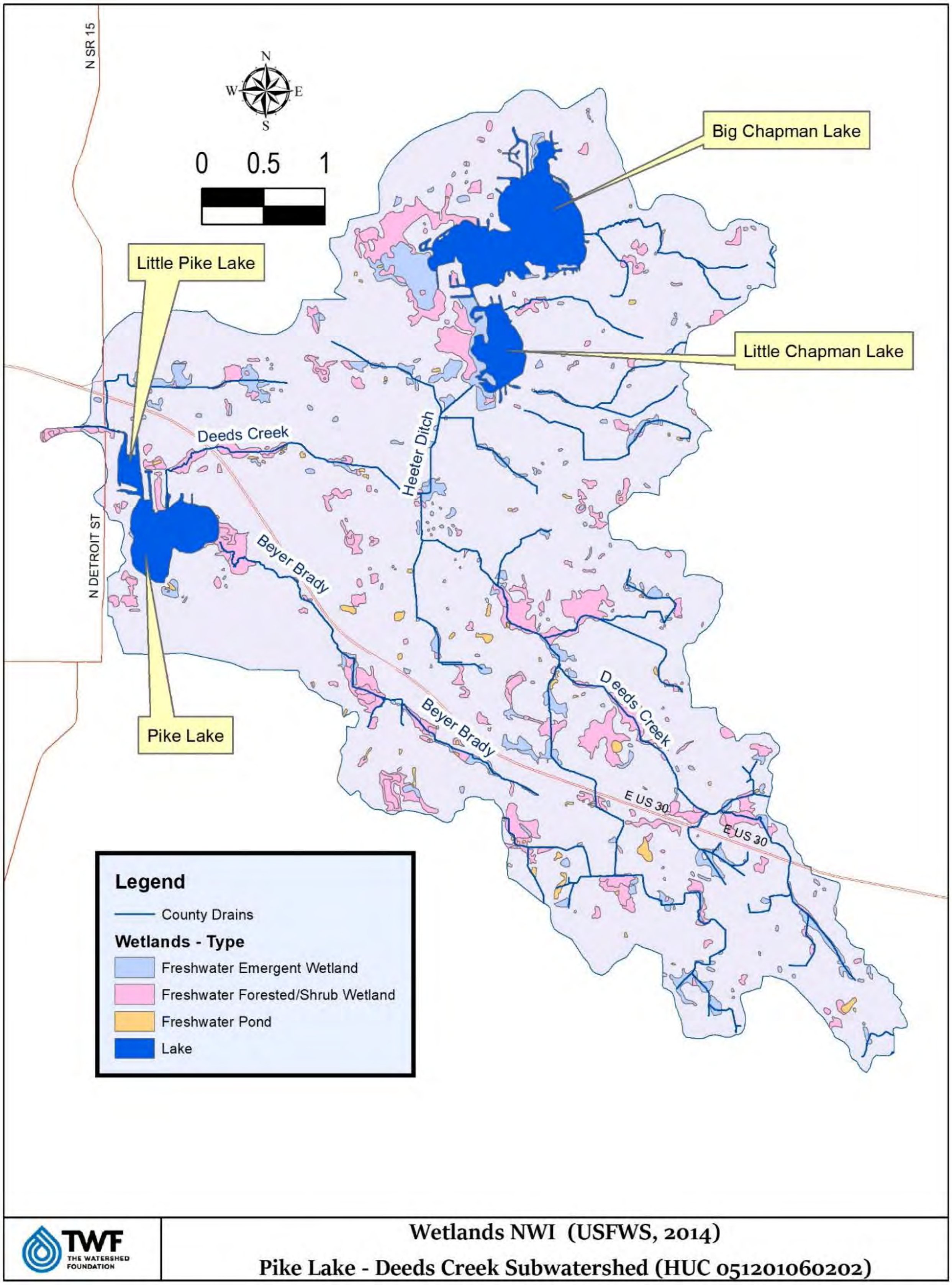
Map 40 Pike Lake - Deeds Creek Subwatershed Crops & Land Use (2016)



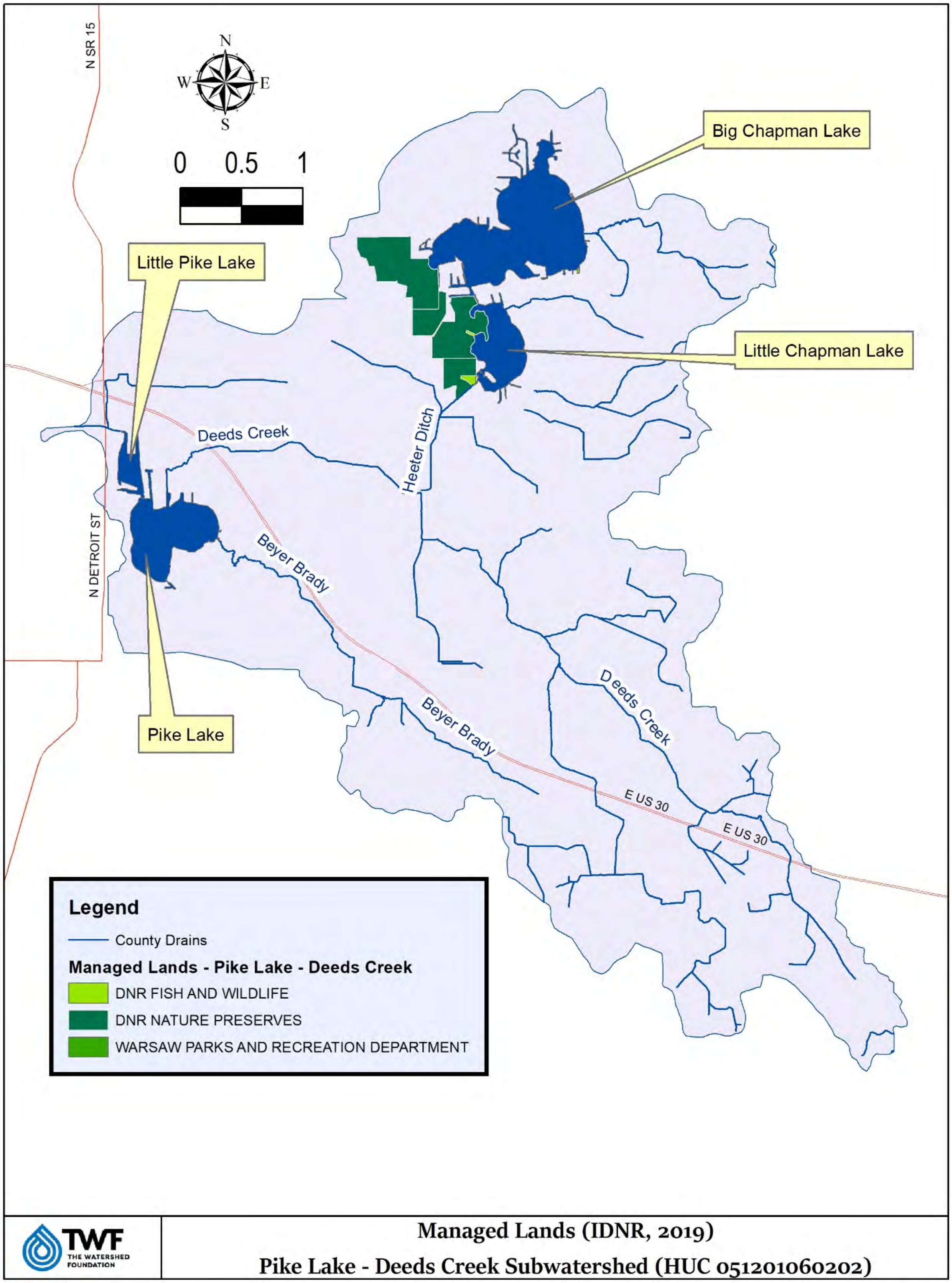
Map 41 Pike Lake - Deeds Creek Subwatershed Corporate Boundaries and Waterways



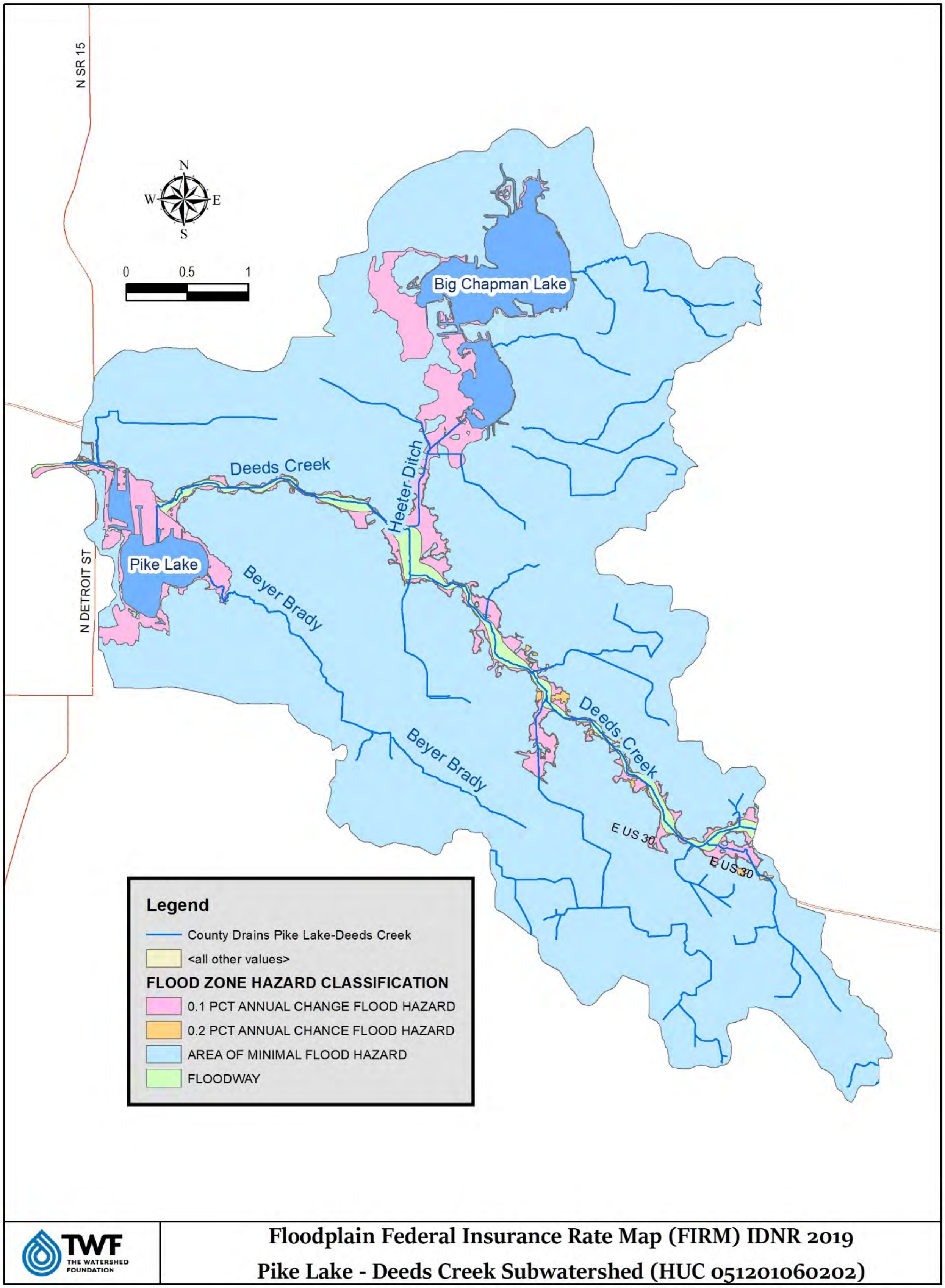
Map 42 Pike Lake - Deeds Creek Subwatershed Sites of Potential Industrial Contamination



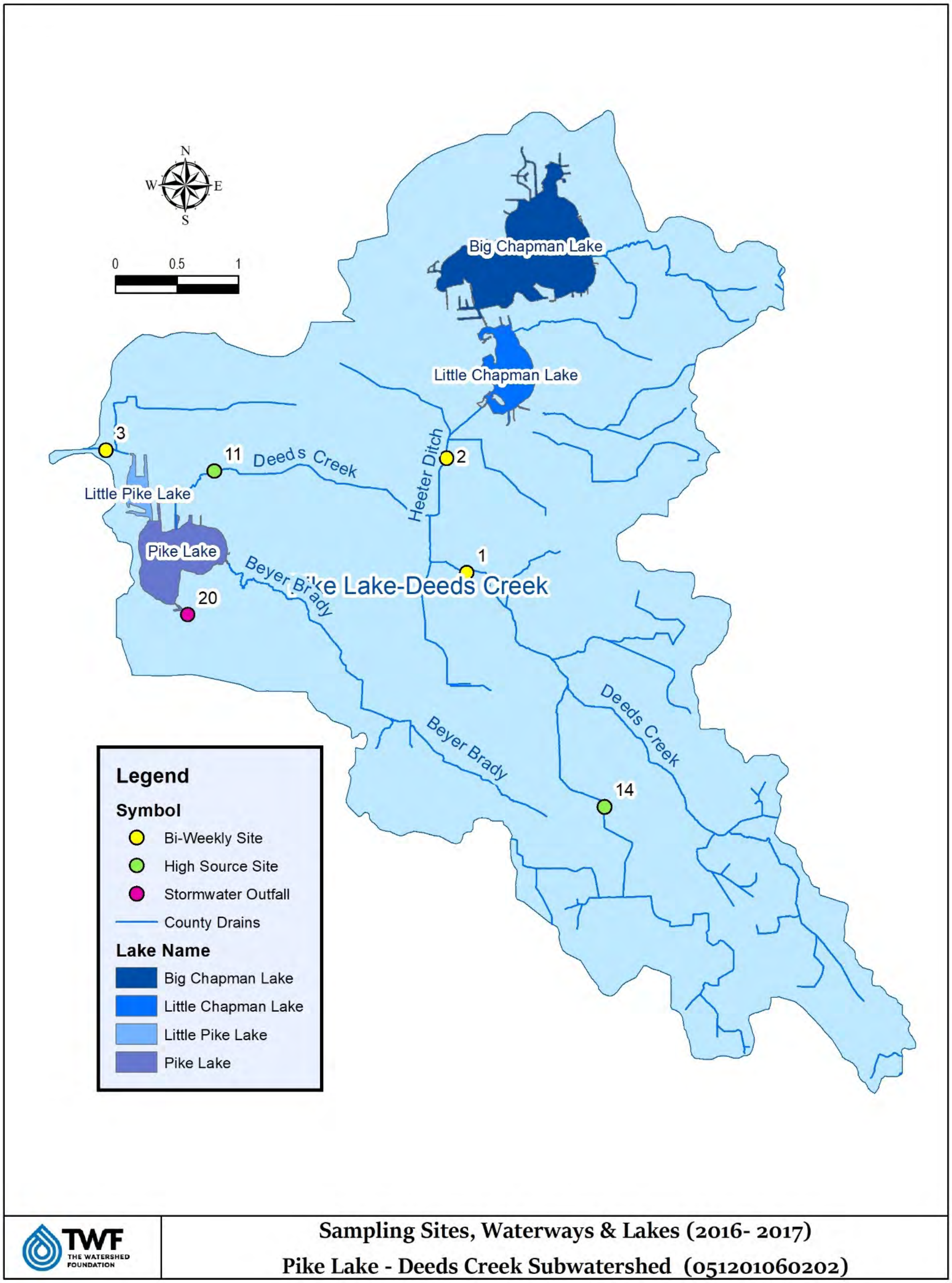
Map 43 Pike Lake - Deeds Creek Subwatershed Wetlands NWI, USFWS



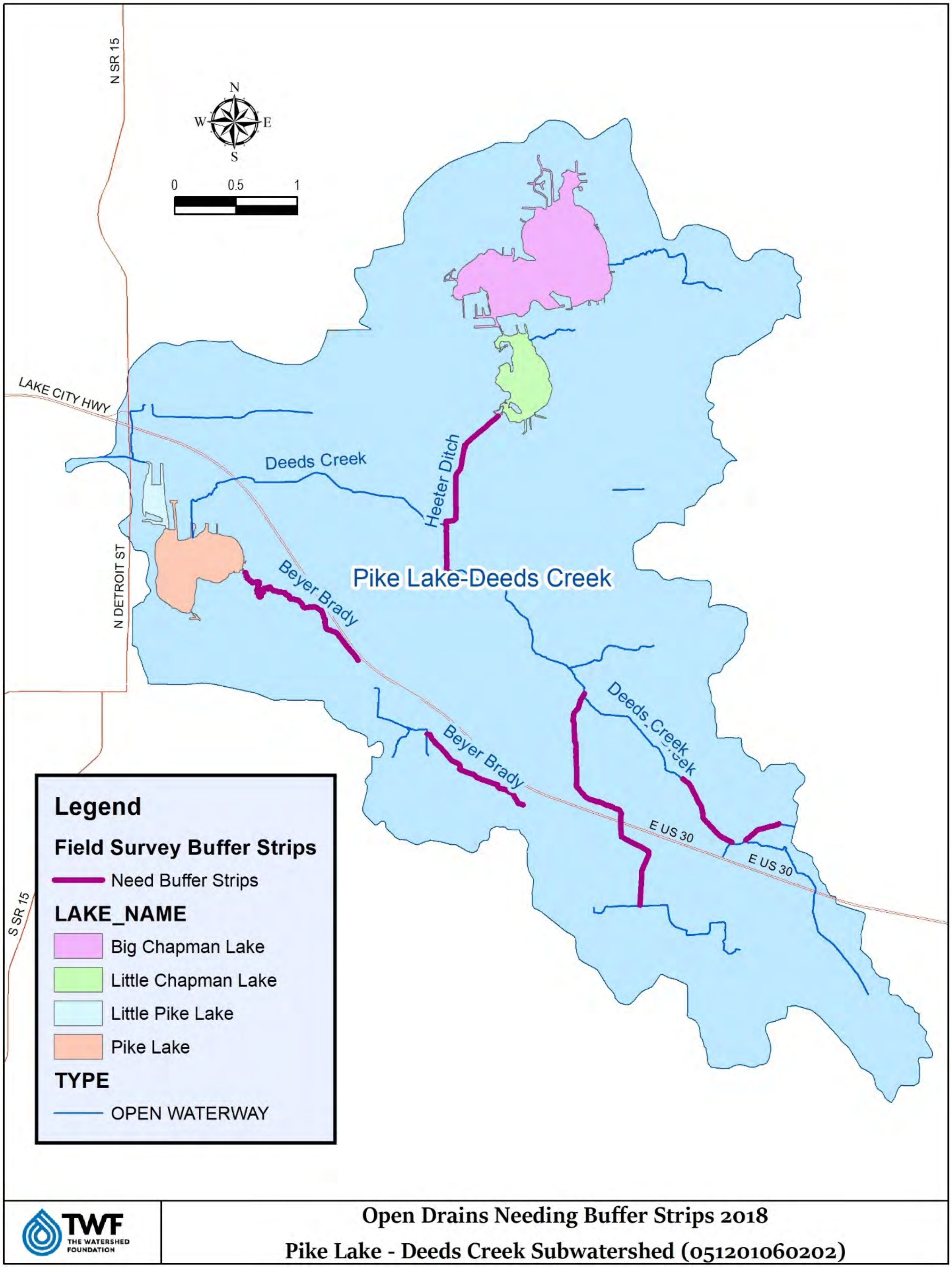
Map 44 Pike Lake - Deeds Creek Subwatershed Managed Lands (IDNR, 2019)



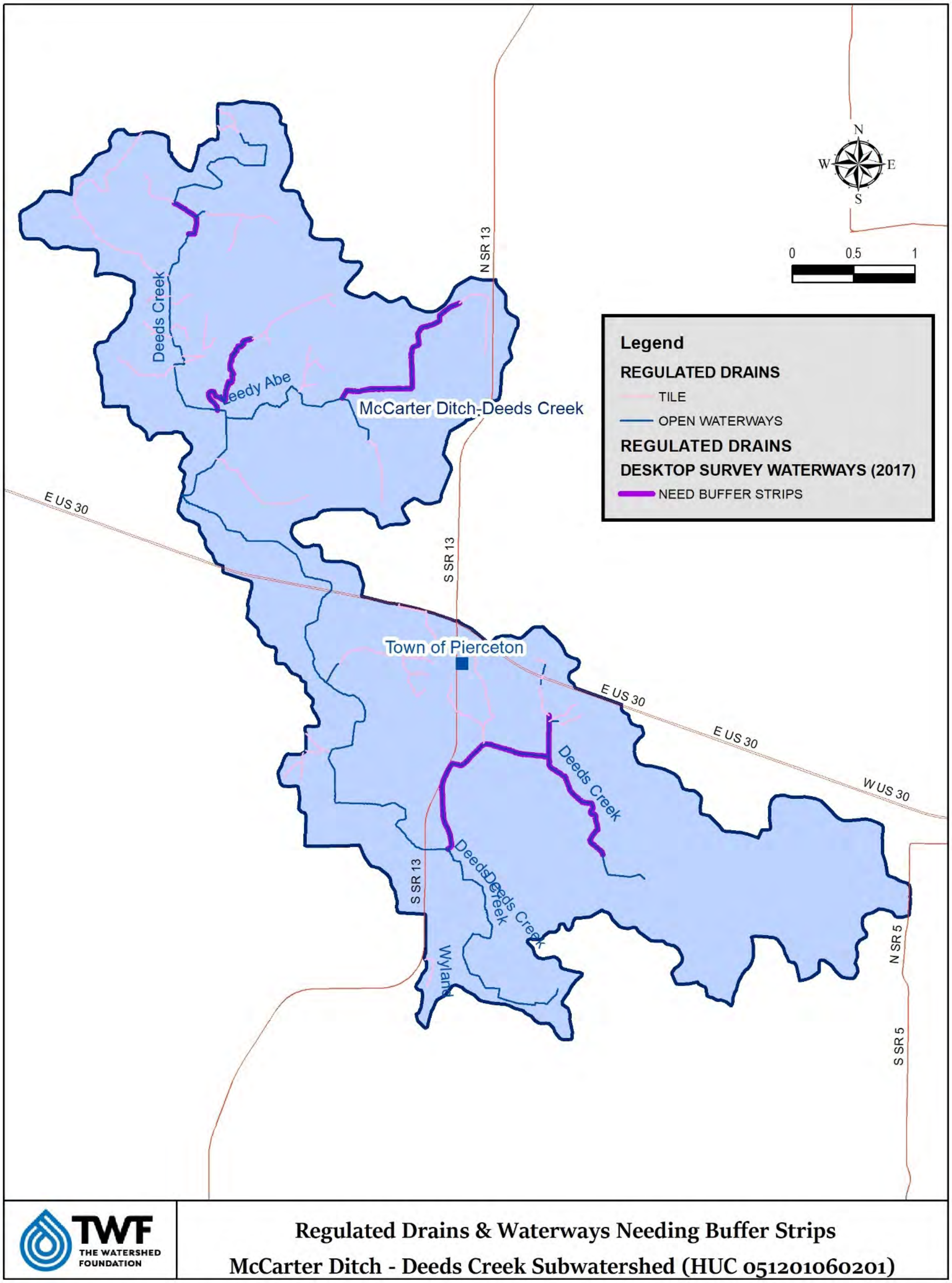
Map 45 Pike Lake - Deeds Creek Subwatershed FIRM Map (IDNR, 2019)



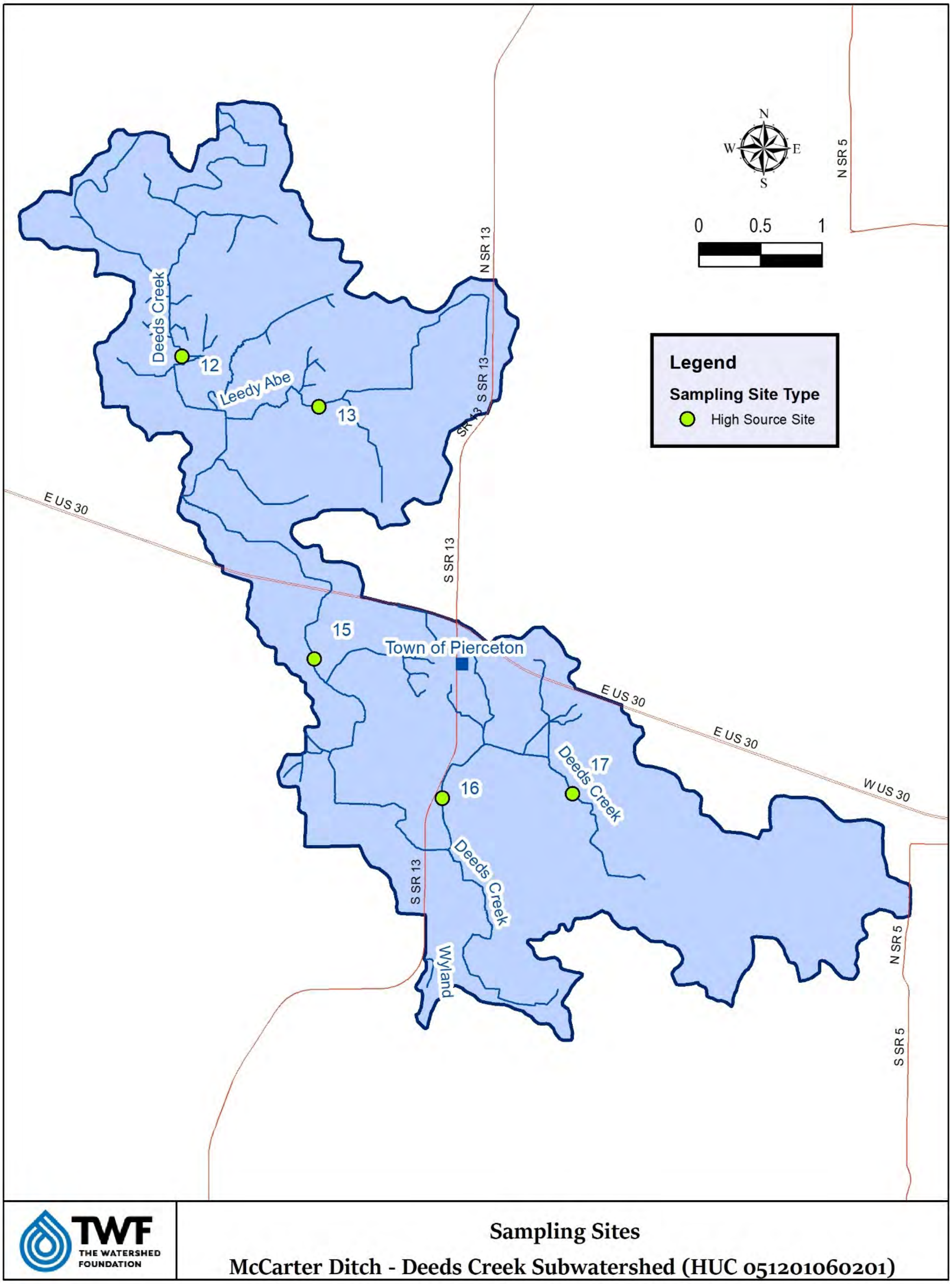
Map 46 Pike Lake - Deeds Creek Subwatershed Waterways, Sampling Sites



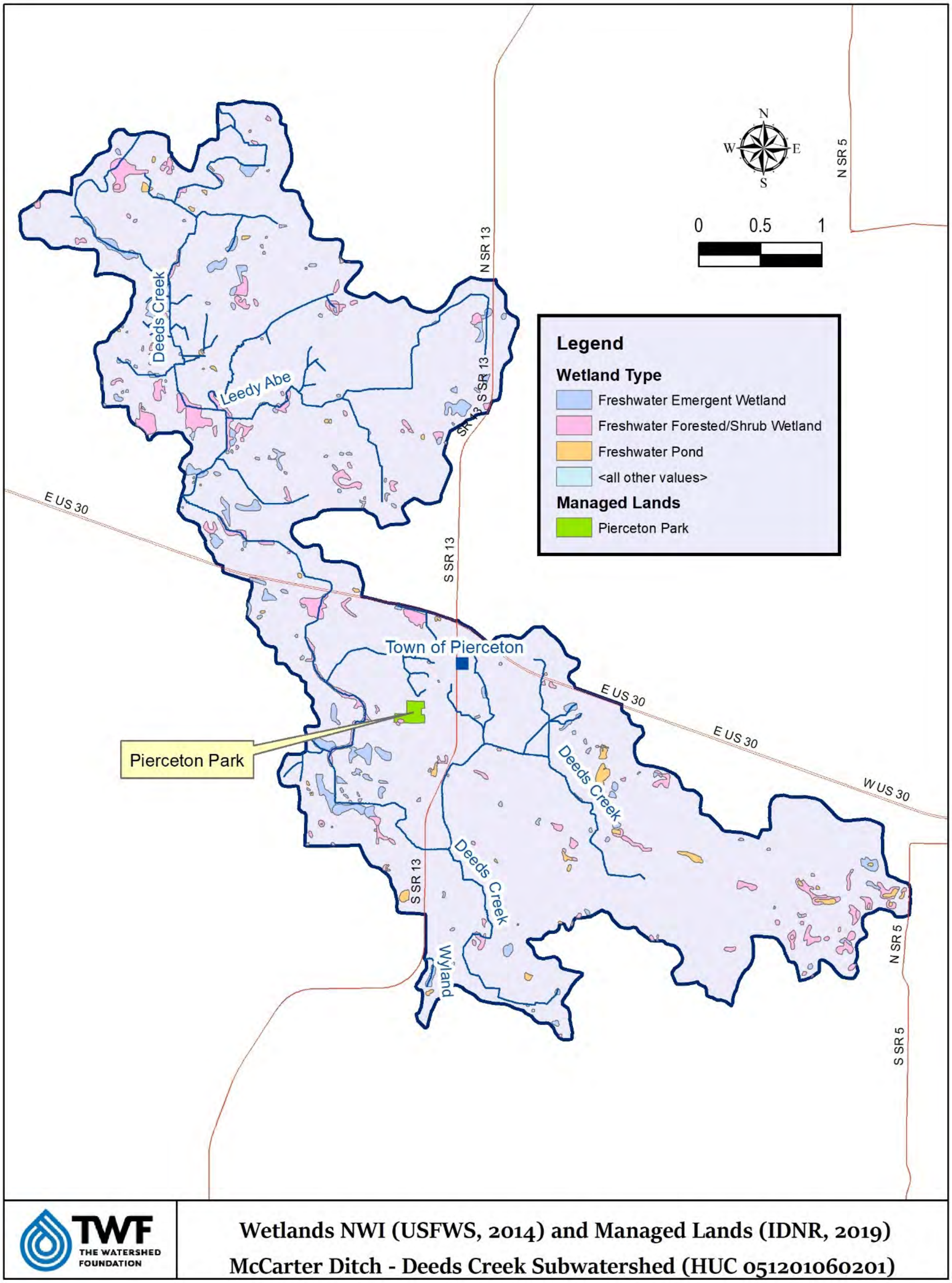
Map 47 Pike Lake - Deeds Creek Subwatershed Waterways & Waterways Needing Buffers



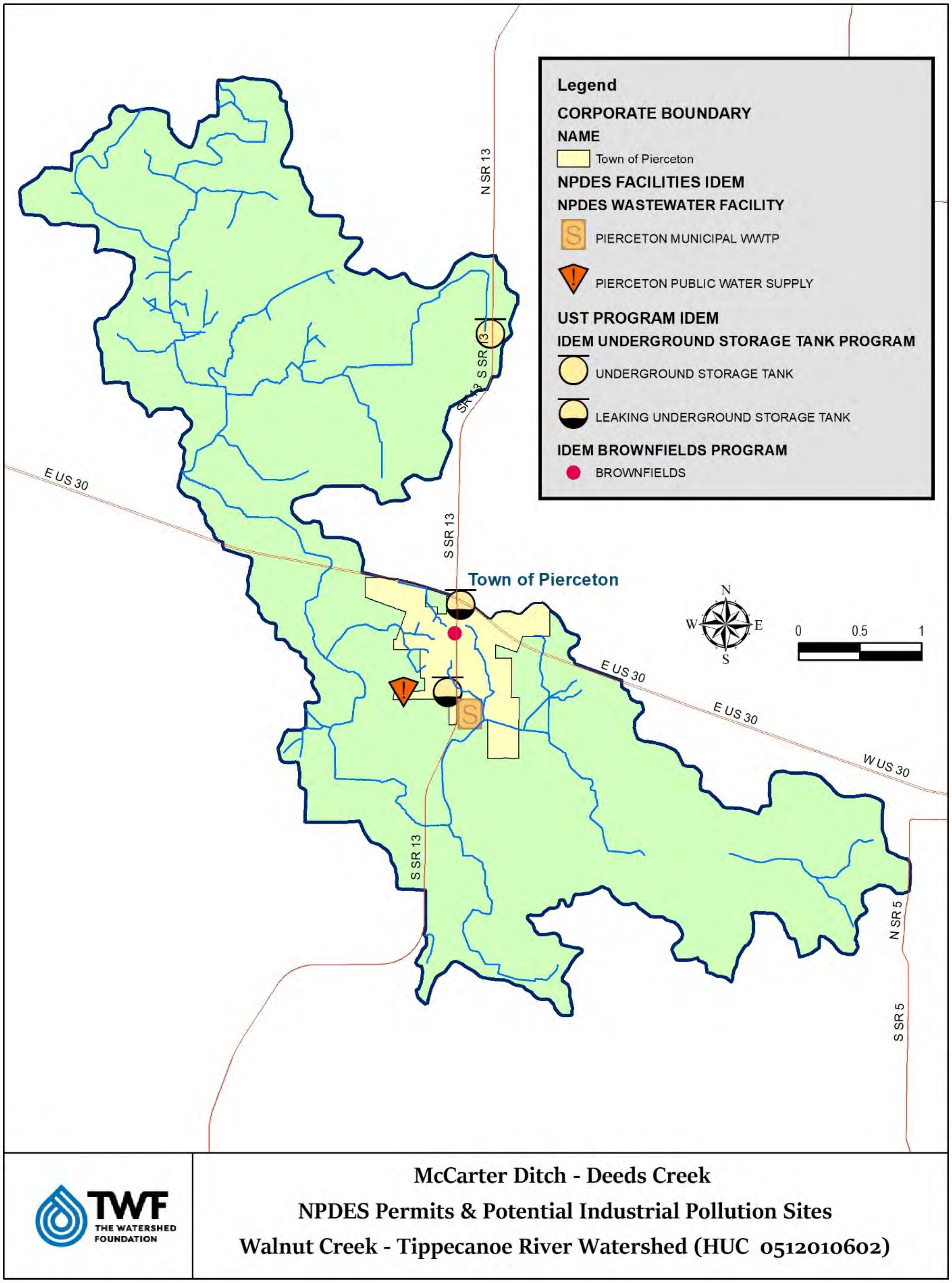
Map 48 McCarter Ditch - Deeds Creek Subwatershed Waterways and Waters Needing Buffers (2018)



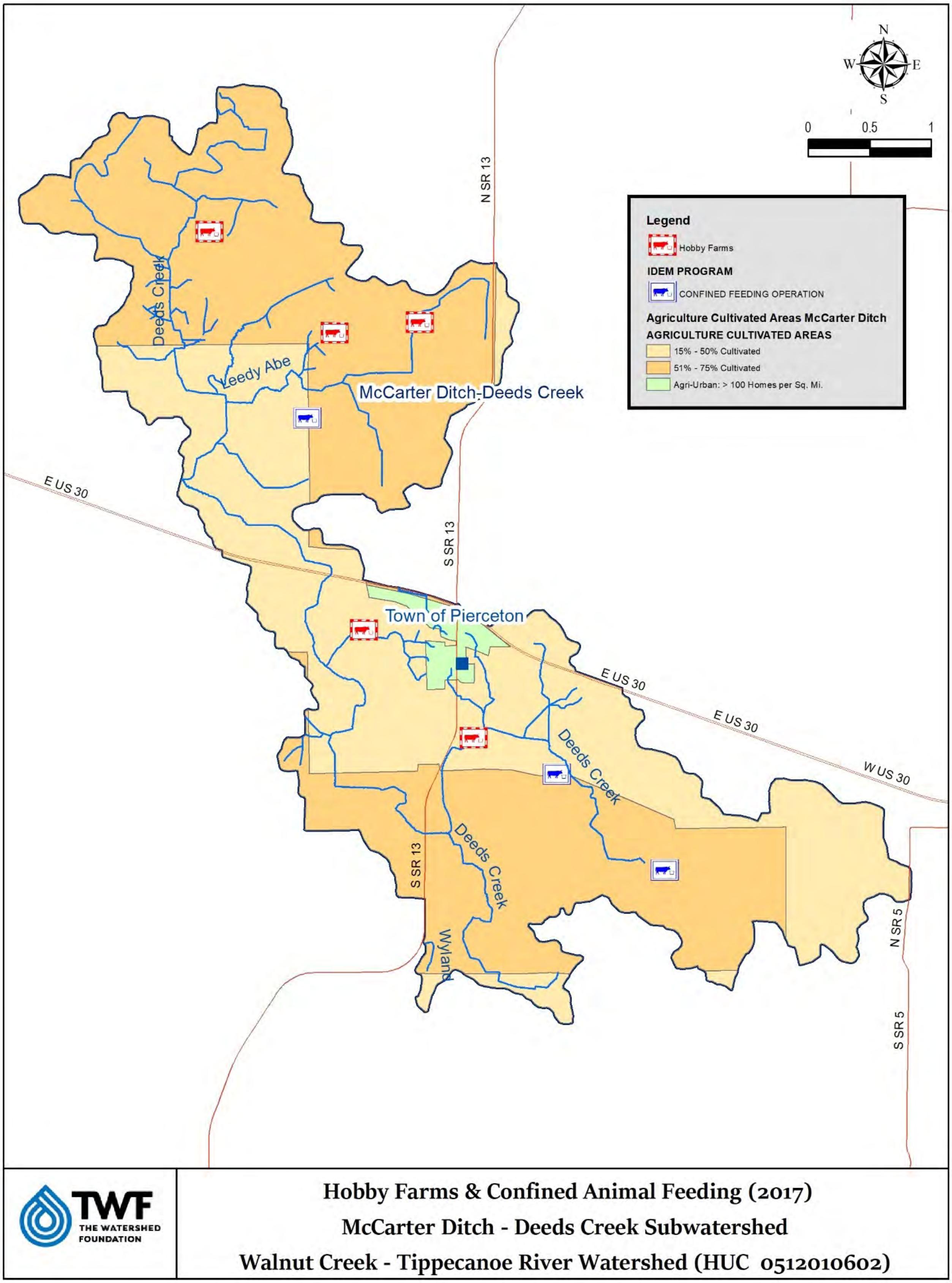
Map 49 McCarter Ditch - Deeds Creek Subwatershed Sampling Sites



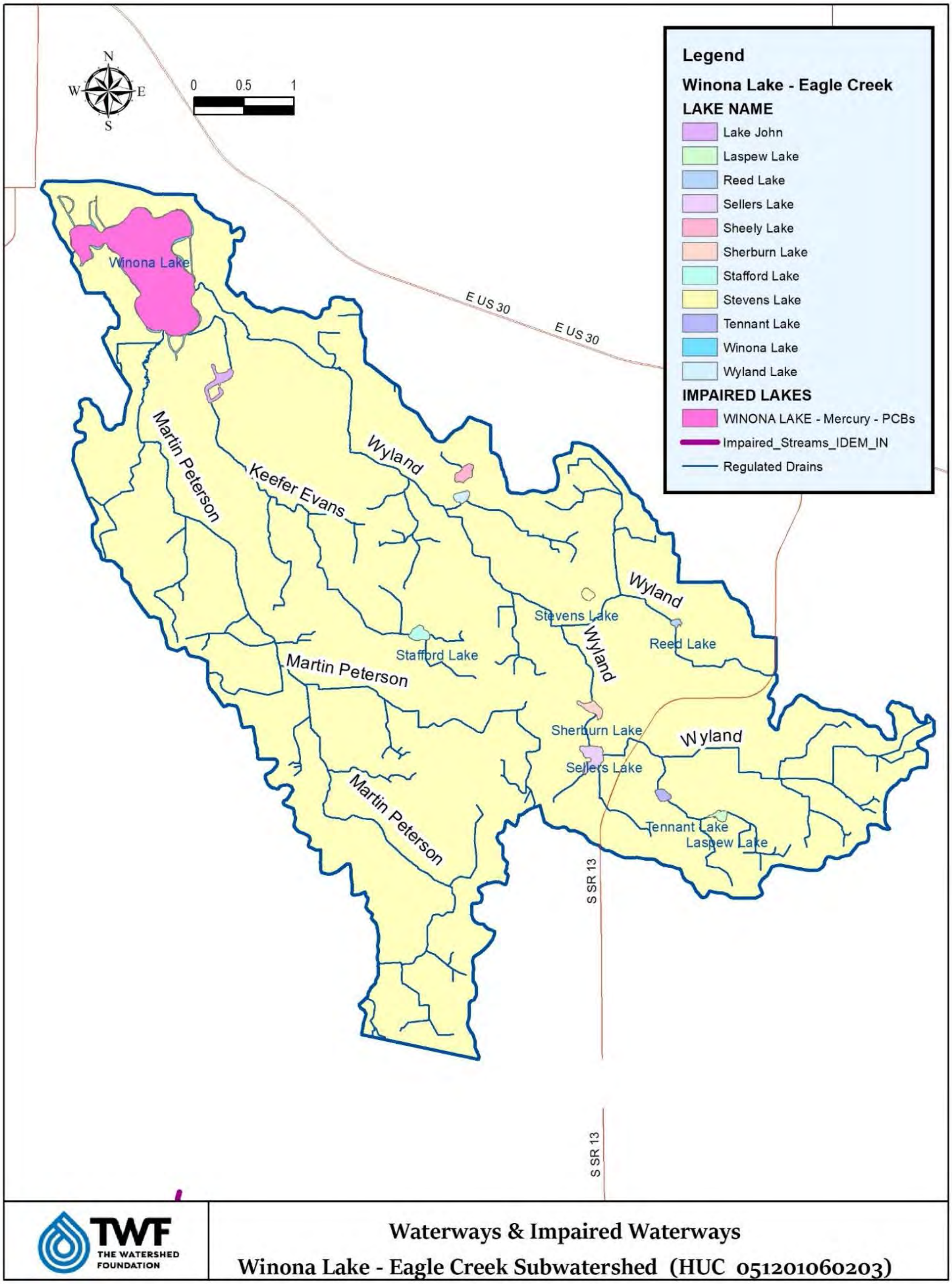
Map 50 McCarter Ditch - Deeds Creek Subwatershed Wetlands and Managed Lands



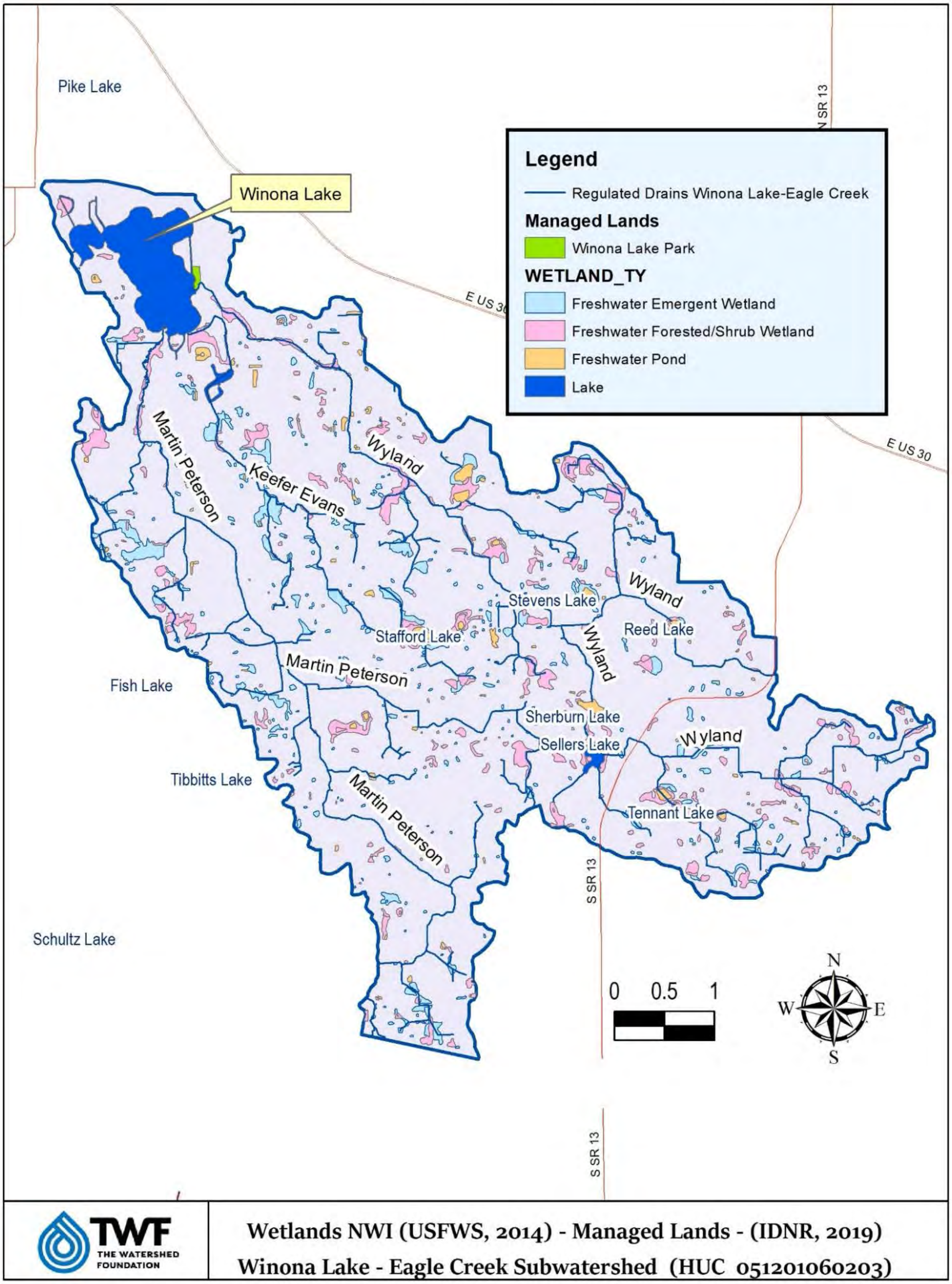
Map 51 McCarter Ditch - Deeds Creek Subwatershed NPDES Permits & Potential Industrial Pollution Sites



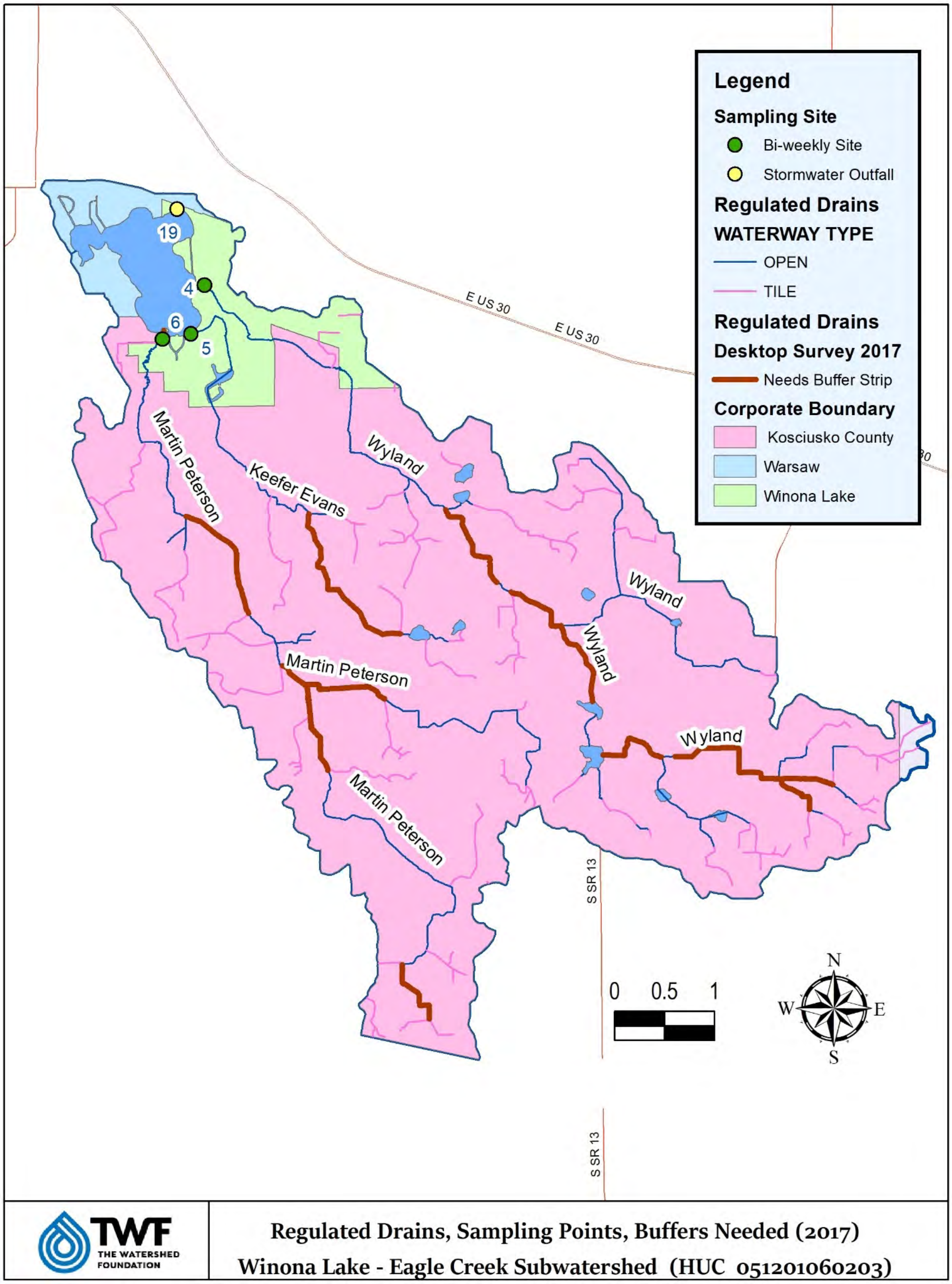
Map 52 McCarter Ditch - Deeds Creek Subwatershed Agribusiness



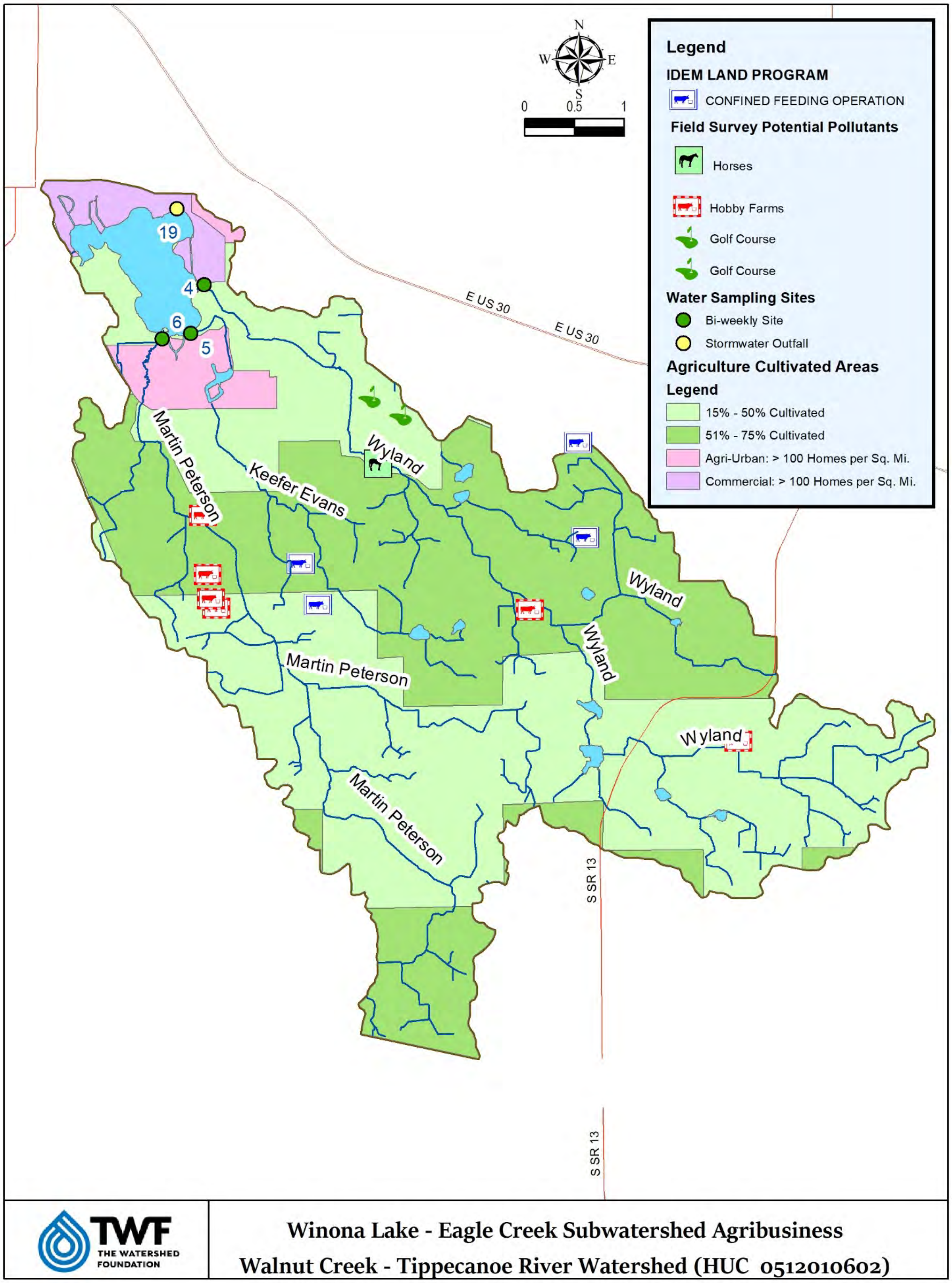
Map 53 Winona Lake - Eagle Creek Subwatershed Waterways, Lakes, Impaired Waters



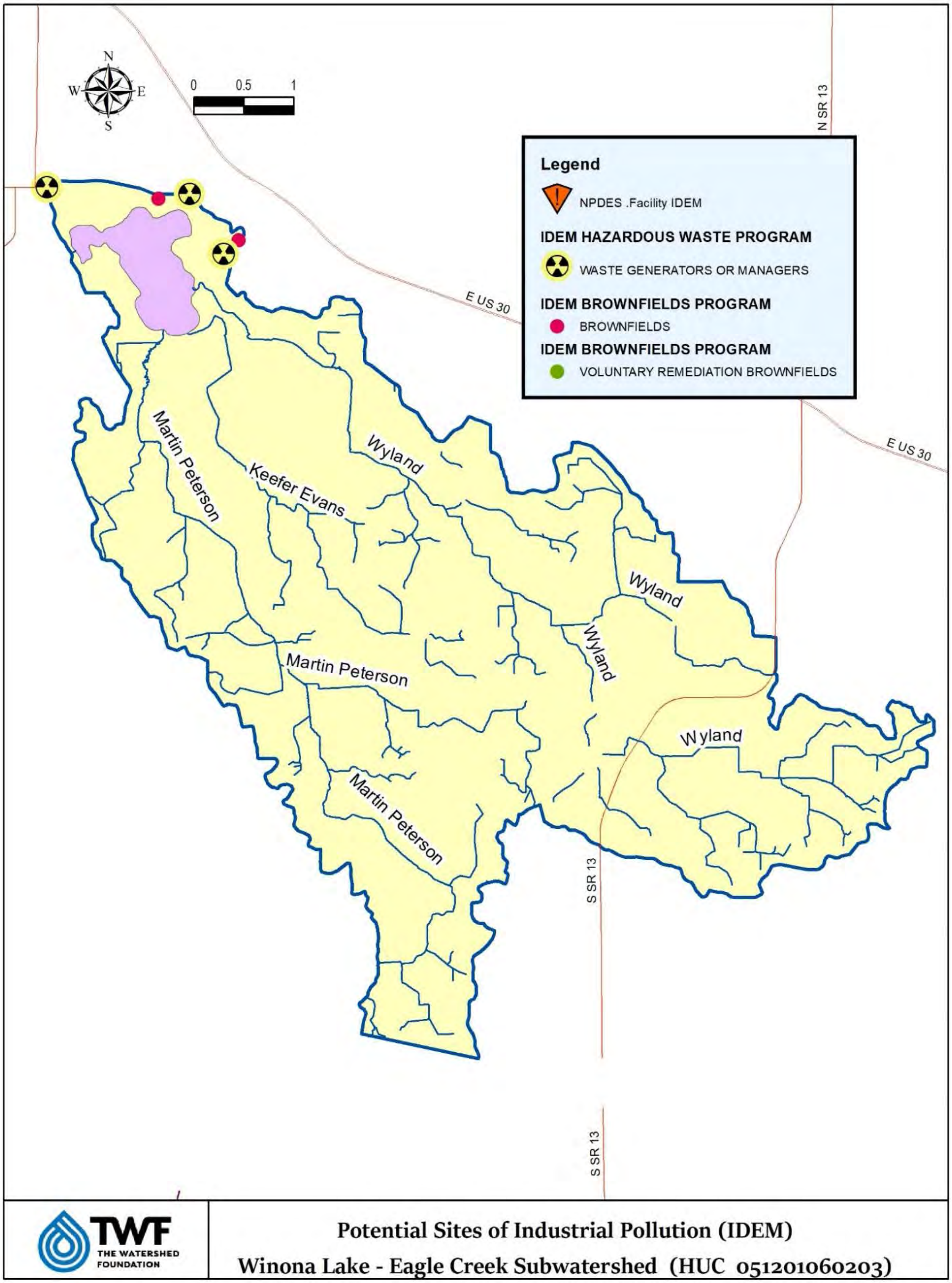
Map 54 Winona Lake - Eagle Ceek Subwatershed Wetlands NWI & Managed Lands



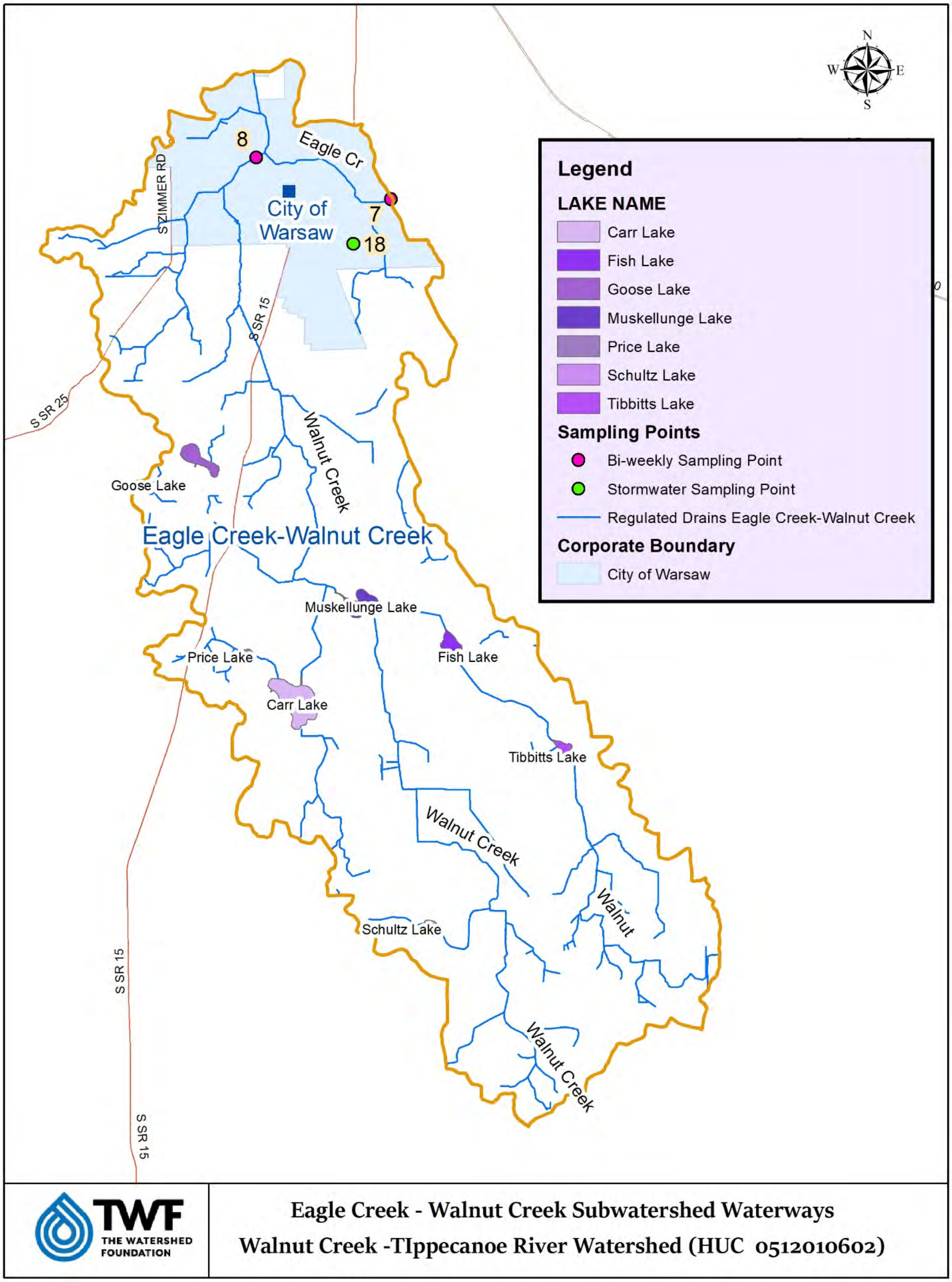
Map 55 Winona Lake - Eagle Creek Subwatershed Sampling Sites, Waters Needing Buffers, Corporate Boundaries



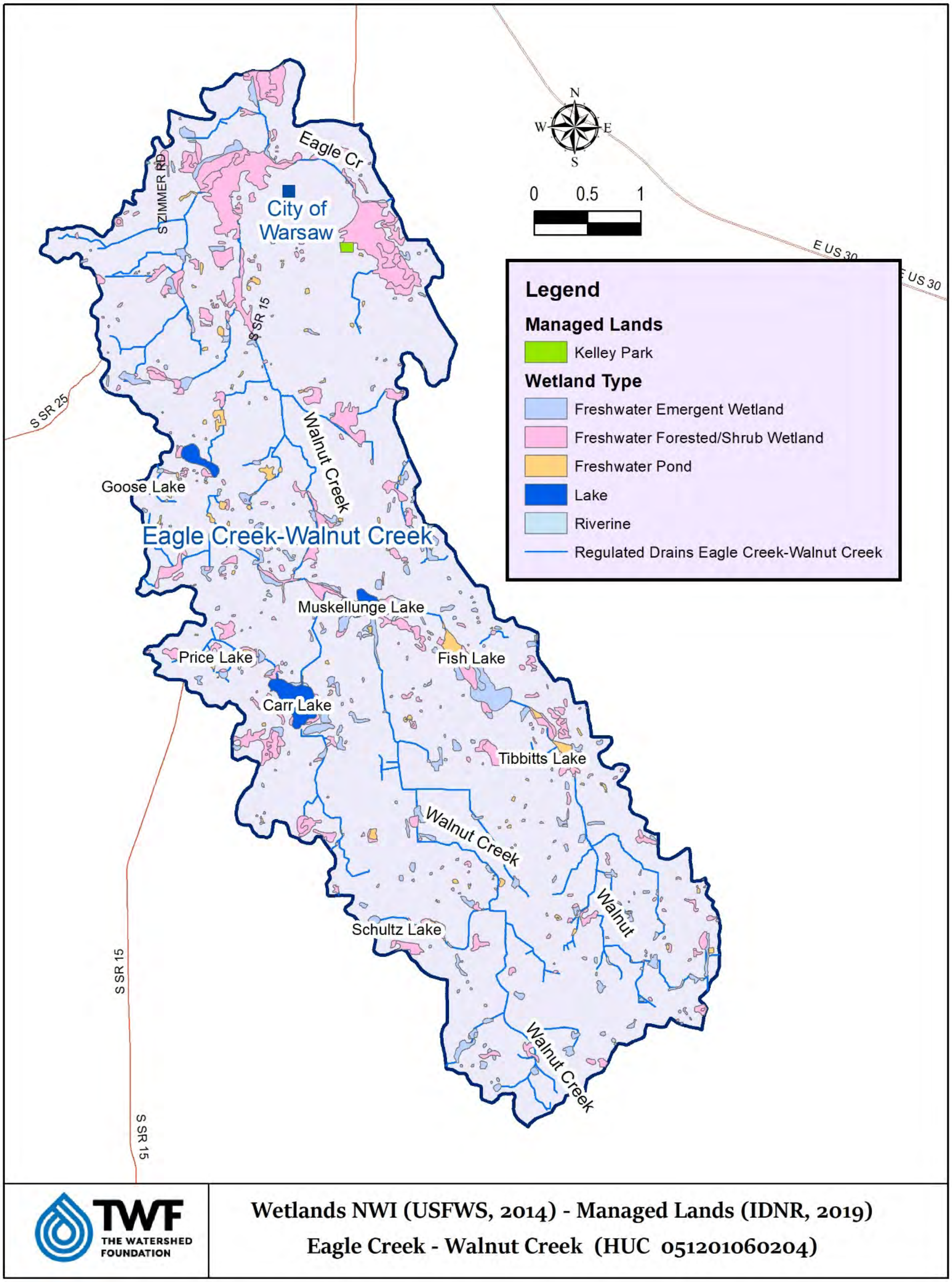
Map 56 Winona Lake - Eagle Creek Subwatershed Agribusiness



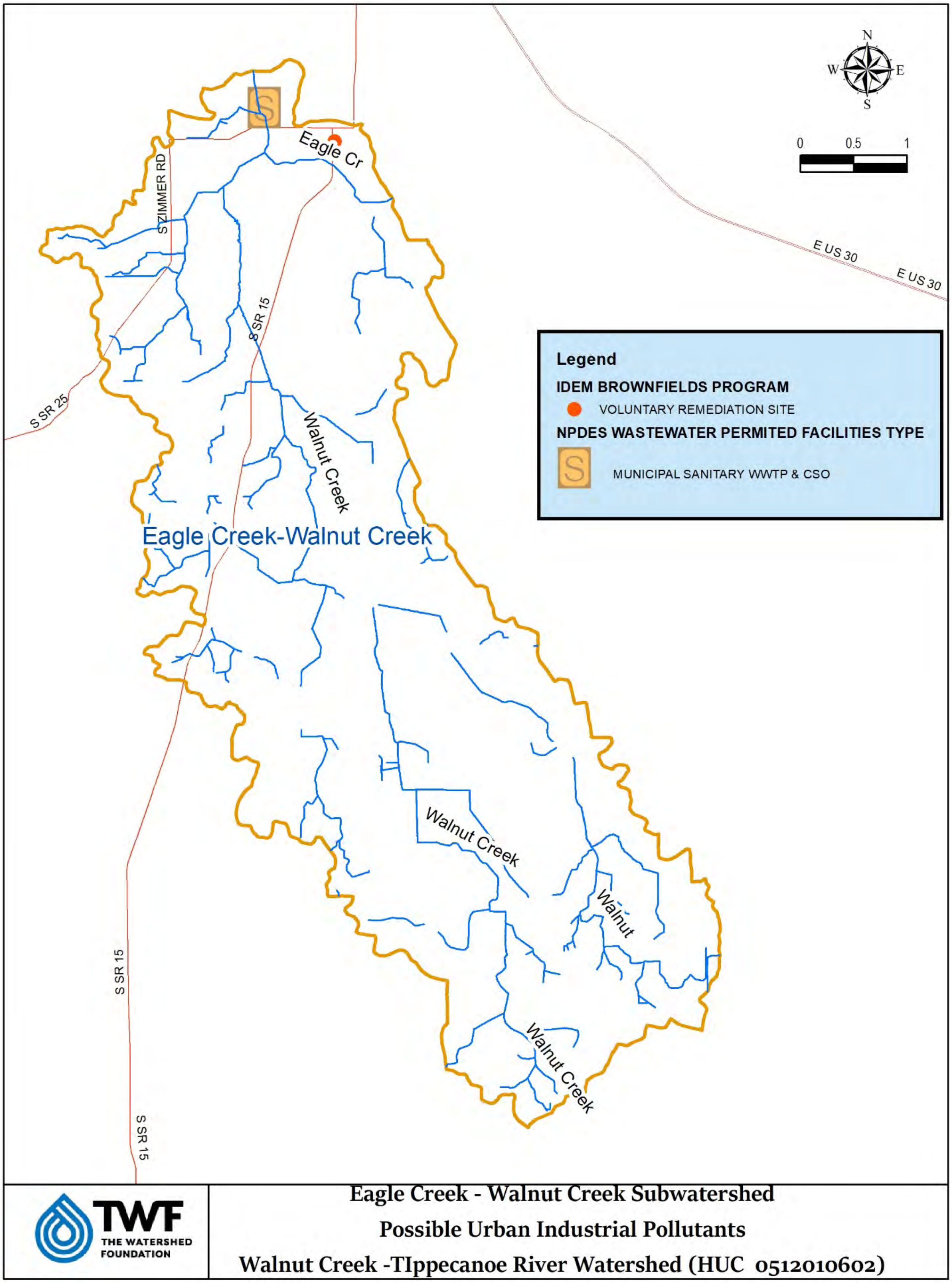
Map 57 Winona Lake - Eagle Creek Subwatershed Sites of Potential industrial Pollution



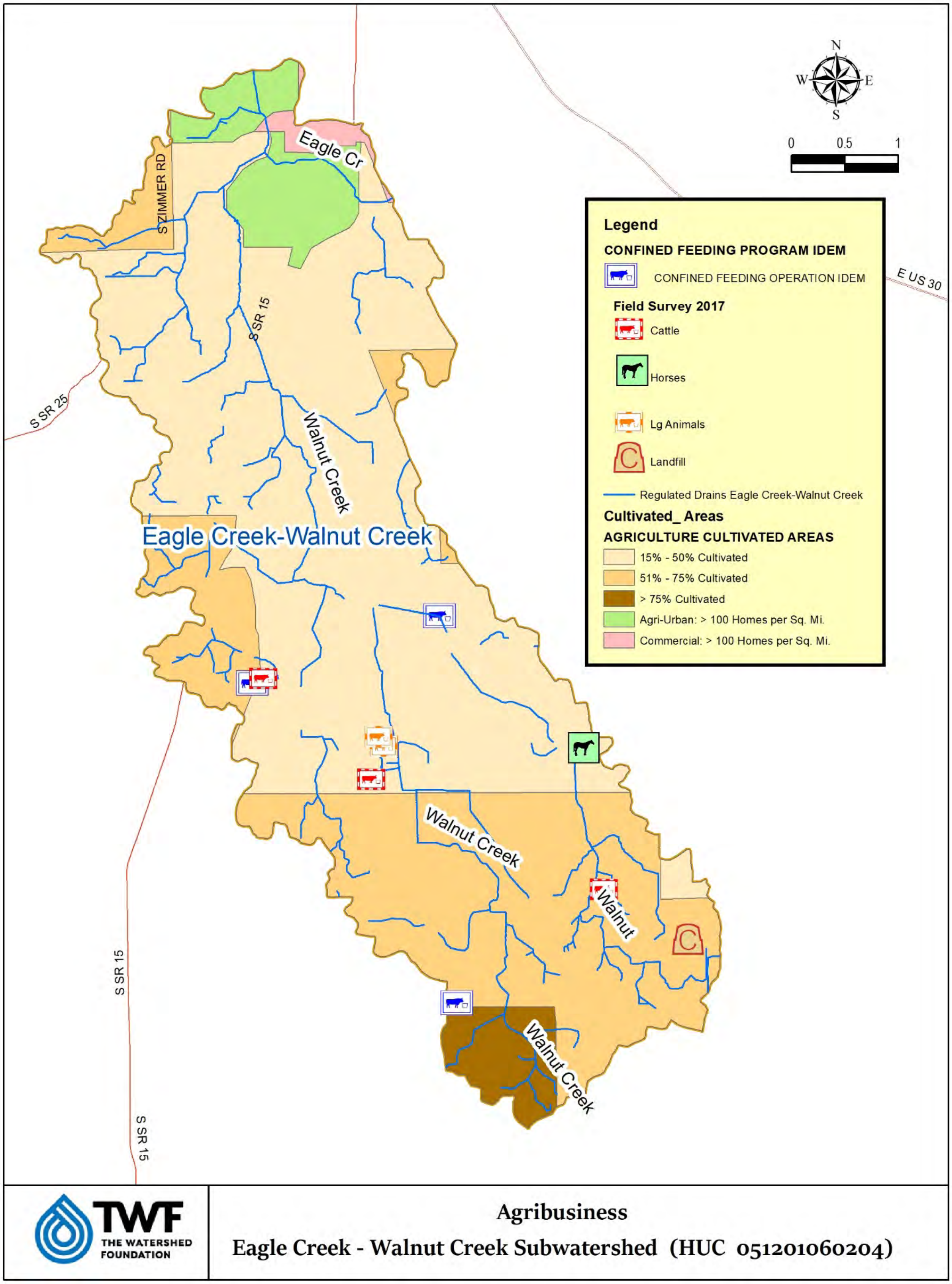
Map 58 Eagle Creek - Walnut Creek Subwatershed Waterways, Sampling Sites, & Corporate Boundaries



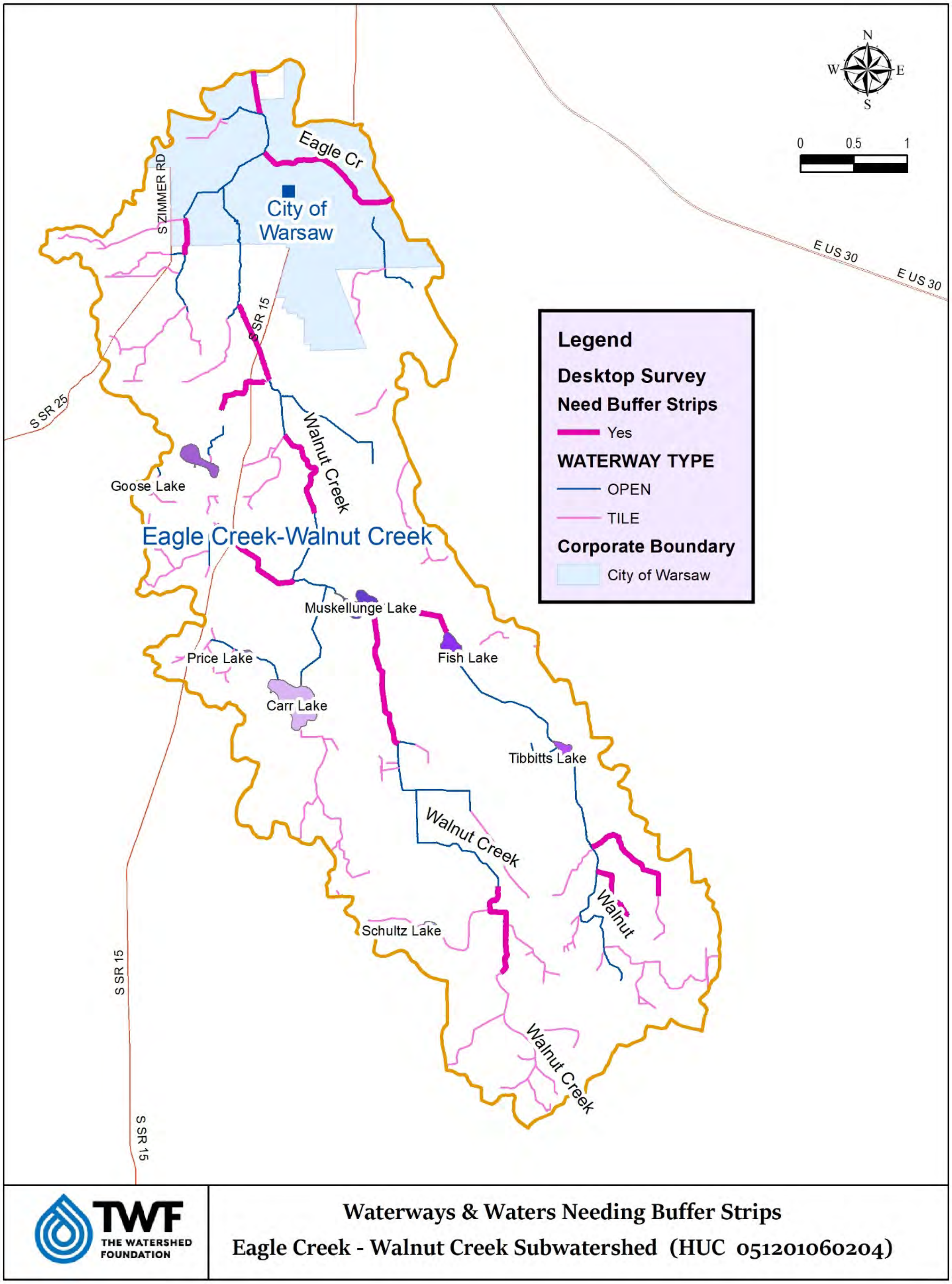
Map 59 Eagle Creek - Walnut Creek Subwatershed Wetlands and Managed Lands



Map 60 Eagle Creek - Walnut Creek Subwatershed Possible Sites of Industrial Pollution



Map 61 Eagle Creek - Walnut Creek Subwatershed Agribusiness and Field Survey



Map 62 Eagle Creek - Walnut Creek Subwatershed Waterways Needing Buffer Strips 2018

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	EC (cfu/ 100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Cherry Creek A	1/27/2016	O	O	1.4	0.92	13.63	96.8	83.6	0.162	25	55.7	0.02	2.44	7.09	0.007	0.0363	1.34	688	0	0.14	
Cherry Creek A	2/11/2016	SN	O	-4.0	-0.03	13.49	94.1	83.9	0.053	26.7	56.5	0.02	2.22	6.43	0.006	0.035	0.946	703	2.1119	0.16	
Cherry Creek A	2/22/2016	P/C	C/S	6.6	3.74	14.42	110.4	41.0	0.037	25.2	54.3	0.01	1.61	4.39	0.012	0.0198	0.723	675	0	0.14	
Cherry Creek A	3/9/2016	P/C	O	16.1	10.58	11.90	108.5	39.9	0.034	26.4	57.5	0.02	2.79	3.86	0.01	0.0343	1.188	655	5.9	0.13	
Cherry Creek A	3/23/2016	P/C	C	13.9	10.50	11.30	102.0	88.2	0.023	26	58	0.02	2.33	4	0.004	0.0318	1.059	664	4.7847	0.14	
Cherry Creek A	4/7/2016	R	R	4.2	7.19	11.40	94.9	298.7	0.052	32.2	59.7	0.01	1.26	2.25	0.003	0.0246	0.868	679	14.24	0.13	
Cherry Creek A	4/20/2016	C/S	C/S	15.8	14.10	12.22	119.9	214.3	0.004	20.6	46.8	0.01	1.91	0.96	0.005	0.0139	0.91	644	6.7911	0.1	
Cherry Creek A	5/4/2016	P/C	O	7.7	12.39	9.61	89.5	290.9	0.034	20.5	45.4	0.02	1.75	2.81	0.005	0.0359	0.996	615	7.6206	0.13	
Cherry Creek A	5/18/2016	C	S	18.9	15.00	10.84	107.6	81.6	0.026	22.2	45.5	0.01	1.81	3.42	0.012	0.037	0.986	638	16.881	0.09	
Cherry Creek A	6/1/2016	P/C	O	24.3	19.14	8.47	91.0	207.6	0.035	26.8	46.4	0.02	1.63	7.8	0.039	0.072	0.796	712	2.1096	0.15	
Cherry Creek A	6/16/2016	O	O	22.7	19.99	7.91	87.20	816.4	0.034	31.1	59	0.01	1.27	10.08	0.046	0.069	0.898	701	7.2993	0	
Cherry Creek A	6/23/2016	ST	O	28.10	20.71	8.29	90.4	2419.2	0.237	11.9	25.7	0.11	5.61	4.72	0.046	0.5436	5.434	413	291.58	0.14	
Cherry Creek A	7/7/2016	C	S	28.6	21.58	7.12	81.0	770.1	0.013	22.6	40.6	0.01	1.69	7.77	0.032	0.0667	1.193	640	5.1921	0.14	
Cherry Creek A	7/21/2016	S	S	30.2	21.65	8.64	97.9	648.8	0.024	27.2	42.2	0	1.38	8.39	0.03	0.0655	0.584	690	8.8	0.14	Edge point was estimated
Cherry Creek A	8/4/2016	S	S	34.9	21.86	9.16	104.7	770.1	0.03	30.9	44	0	1.29	10.08	0.038	0.063	0.501	735	0	0.19	Edge point was estimated
Cherry Creek A	8/17/2016	O	C	26.0	22.25	8.80	101.2	224.7	-0.001	33.3	41.1	0	1.35	12.23	0.038	0.0897	0.46	715	2.6246	0.18	
Cherry Creek A	8/31/2016	S	P/C	28.8	22.20	7.49	86.0	488.4	0.025	27.1	34.7	0	0.74	8.29	0.039	0.0768	0.798	639	3.9551	0.25	
Cherry Creek A	9/14/2016	S	O	24.3	20.96	8.33	93.3	307.6	0.03	18	29.4	0	0.48	5.83	0.013	0.1005	1.114	531	14.265	0.15	
Cherry Creek A	9/28/2016	S	O	15.4	14.23	10.04	97.7	248.1	0.016	30	37.2	0	0.87	9.64	0.027	0.059	0.553	700	1.1135	0.16	
Cherry Creek A	10/12/2016	S	S	24.1	14.42	9.97	96.7	214.2	-0.003	35.4	45.5	0	0.76	9.49	0.021	0.041	0.485	762	0.9479	0.15	
Cherry Creek A	10/25/2016	S	S	9.2	9.77	9.56	83.7	155.3	0.006	24.8	48	0	1	8.07	0.018	0.0351	0.794	692	0.748	0.31	
Cherry Creek A	11/8/2016	S	C	11.7	11.04	10.02	89.9		0.004	28.2	42.4	0	0.52	7.32	0.016	0.031	0.672	700	2.2701	0.18	E. coli samples were unable to be processed because lab was closed due to holiday schedule
Cherry Creek A	11/22/2016	S	C	3.2	4.05	15.87	121.1	45.0	0	28.2	42.9	0.01	0.64	6.26	0.007	0.018	0.633	706	1	0.19	
Cherry Creek A	12/6/2016	O	O	3.4	4.42	17.36	128.4	77.1	0.206	23	44.8	0.04	1.5	8.23	0.015	0.0476	1.291	673	3.3	0.17	
Cherry Creek A	12/19/2016	SN	S	-14.6	0.00	14.30	95.2	43.5	0.195	28.9	49.8	0.03	1.47	9.05	0.009	0.0347	1	744	0.9	0.21	
Cherry Creek A	1/4/2017	O	C	-4.4	2.06	14.18	101.6	117.8	0.129	24	48.5	0.03	5.38	7.15	0.026	0.094	1.595	635	9.5108	0.13	
Cherry Creek A	1/17/2017	R	C	5.2	4.76	13.33	102.7		0.105	20.7	37	0.03	4.09	6.59	0.032	0.118	1.563	551	23.993	0.1	Timing of rain event EC samples could not be dropped off before lab closed
Cherry Creek A	1/19/2017	C	C	7.0	3.59	14.56	108.8	83.6	0.115	19.2	41.7	0.03	5.32	7.1	0.027	0.082	1.5	579	15.126	0.13	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Cherry Creek A	1/31/2017	C	O	2.5	3.24	13.49	99.5	39.3	0.121	23	49.7	0.02	3	7.52	0.012	0.042	1.046	657	5.5	0.15	
Cherry Creek A	2/8/2017	R	O	5.3	4.10	14.00	104.3	143.9	0.055	18.9	37.1	0.01	4.09	6.65	0.014	0.1081	1.394	582	23.672	0.29	
Cherry Creek A	2/23/2017	C	S	26.1	11.33	10.99	99.8	145.0	0.047	22.8	44.8	0	2.84	3.98	0.004	0.0375	0.979	654	3.3	0.2	
Cherry Creek A	3/1/2017	R	O	10.0	9.49	10.22	90.4	387.3	0.044	20.1	35.6	0	2.85	5.11	0.01	0.1175	1.295	574	30.9	0.15	
Cherry Creek A	3/16/2017	SN	S	6.3	2.17	14.24	104.5	28.2	0.049	21.2	51.4	0.02	1.98	5.36	0.005	0.028	0.719	660	2	0.13	
Cherry Creek A	3/30/2017	C	R	5.4	8.89	8.82	76.7	155.3	0.025	21.1	37.2	0	2.41	3.08	0.005	0.0454	0.911	592	17.614	0.16	
Cherry Creek A	4/11/2017	R	C	11.0	12.38	9.48	90.3	83.3	0.0	17.0	35.4	0.0	2.8	3.9	0.0	0.1	1.3	574.0	12.9	0.2	
Cherry Creek A	4/24/2017	S	S	18.9	14.53			461.1	0.0	21.2	42.3	0.0	1.6	1.1	0.0	0.0	0.8	644.0	4.4	0.1	DO sensor malfuction
Cherry Creek A	5/10/2017	R	C	19.9	13.02	11.28	107.4	95.9													Nutrient data not returned due to lab error
Cherry Creek A	5/22/2017	R	S	19.5	16.41	9.23	93.0	1203.3	0.2	14.0	25.7	0.0	3.4	4.6	0.0	0.2	0.8	523.0	56.4	0.4	
Cherry Creek A	6/1/2017	S	S	27.0	17.81	8.35	88.5	91.0	0.1	13.0	25.7	0.0	1.9	6.3	0.0	0.1	1.4	537.0	18.9	0.2	
Cherry Creek A	6/15/2017	R	S	31.0	21.92	8.22	92.7	727.0	0.0	24.8	42.1	0.0	2.0	8.3	0.0	0.1	0.8	650.0	3.2	0.2	
Cherry Creek A	6/29/2017	S	O	29.0	19.45	7.75	83.5	686.7	0.0	20.7	32.5	0.0	1.4	6.2	0.0	0.1	1.0	633.0	4.7	0.2	
Cherry Creek A	7/10/2017	S	O	27.3	21.64	5.65	63.8	233.3	0.1	9.3	16.8	0.1	1.5	5.7	0.0	0.2	0.8	396.0	38.4		
Cherry Creek A	7/12/2017	R	O	26.2	21.94	4.84	54.2	328.2	0.1	11.2	18.7	0.1	1.2	7.1	0.0	0.1	0.8	450.0	22.4		
Cherry Creek A	7/26/2017	S	O	23.9	22.09	4.17	47.7	461.1	0.1	14.0	23.3	0.0	1.1	8.2	0.0	0.1	0.5	545.0	11.5		
Cherry Creek A	8/9/2017	S	S	28.8	18.77	9.40	100.9	488.4	0.0	21.1	32.2	0.0	1.4	8.6	0.0	0.1	0.8	648.0	12.1		
Cherry Creek A	9/13/2017	O	R	19.4	16.24	8.41	85.1	365.4	0.0	28.4	34.7	0.0	1.2	7.8	0.0	0.0	0.5	691.0	0.7		
Cherry Creek A	9/20/2017	S	S	29.0	20.24	7.05	77.6	547.5	0.0	23.5	40.9	0.0	1.1	8.8	0.0	0.1	0.3	624.0	7.5		
Cherry Creek A	9/27/2017	S	O	23.6	19.50	6.37	66.8	261.3	0.0	28.5	31.2	0.0	0.5	9.6	0.0	0.0	0.5	700.0	1.3		
Cherry Creek A	10/11/2017	R	C	17	16.14	7.12	71.5	461.1	0.0	22.2	25.9	0.0	0.6	8.4	0.0	0.1	0.6	570.0	2.8		
Cherry Creek A	10/25/2017	R	O	9.5	10.29	9.5	84.2	178.5	0.0	24.1	33.6	0.0	0.8	9.4	0.0	0.0	0.7	692.0	0.7		
Cherry Creek A	11/8/2017	S	S	10	8.65	11.67	101	125.9	0.2	18.5	27.8	0.0	1.2	7.1	0.0	0.1	1.1	624.0	1.3		
Cherry Creek A	11/15/2017	S	R	7.3	7.38	10.62	89.2	>2419.2	0.1	18.5	25.5	0.0	1.4	6.7	0.0	0.0	0.7	572.0	7.3		
Cherry Creek A	11/29/2017	S	S	11.3	7.42	12.07	100.9	235.9	0.1	20.8	35.8	0.0	1.9	7.6	0.0	0.1	1.0	638.0	4.8		
Cherry Creek A	12/13/2017	SN	C	-1	1.2	13.44	94.6	139.6	0.1	22.7	45.3	0.1	1.7	7.9	0.0	0.0	0.8	675.0	2.0		

Table 16 Wyland Ditch (a.k.a. Cherry Creek) Sampling Data (Site #4)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/ 100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Deeds Creek	1/26/2016	R	O	0.8	3.28	11.41	87.0	8.07	547.5	0.146	41.9	66.1	0.01	3.16	7.67	0.018	0.0592	0.746	820	4.6	0.1	
Deeds Creek	2/9/2016	SN	SN	-0.1	1.66	12.05	88.1	8.18	285.1													Nutrient data was compromised from lab
Deeds Creek	2/22/2016	P/C	C/S	7.2	2.27	12.75	93.0	7.90	214.3	0.051	42.7	66.2	0.01	2.16	4.66	0.013	0.0416	0.513	805	3.325	0.16	
Deeds Creek	3/2/2016	SN	O	-2.2	1.04	12.90	93.9	7.97	78.0	0.078	33.4	55.2	0.01	5.43	6.04	0.014	0.0495	0.813	714	4.6598	0.12	
Deeds Creek	3/9/2016	P/C	O	16.8	9.57	9.60	85.9	8.11	54.6	0.044	35.6	58	0.01	4.66	3.82	0.009	0.0355	0.849	749	2.7	0.14	
Deeds Creek	3/23/2016	P/C	C	15.7	9.41	9.25	81.1	8.01	52.9	0.041	41.1	59.9	0.01	3.61	4.19	0.005	0.0339	0.61	768	3.252	0.15	
Deeds Creek	4/7/2016	R	R	8.1	7.03	10.16	84.3	8.00	1299.7	0.08	25.2	31.7	0.01	4.66	4.84	0.054	0.2806	1.4	570	103.66	0.15	
Deeds Creek	4/20/2016	C/S	P/C	16.3	12.00	8.15	76.0	8.14	111.9	0.022	24.9	36.5	0.01	0.36	1.39	0.008	0.0147	0.676	727	2.849	0.14	
Deeds Creek	5/4/2016	P/C	R	10.0	11.64	8.05	73.5	7.81	131.3	0.047	31.1	45.2	0.03	3.79	5.99	0.021	0.0466	0.865	717	5.0761	0.12	
Deeds Creek	5/18/2016	C	S	13.4	12.00	7.95	77.6	7.86	105.0	0.019	35	44.9	0.02	3.73	4.75	0.014	0.033	0.712	737	2.1119	0.19	
Deeds Creek	6/1/2016	P/C	P/C	21.1	19.85	4.47	48.8	7.93	45.5	0.056	42.5	50.1	0.06	2.26	6.57	0.028	0.062	0.695	777	4.9261	0.15	
Deeds Creek	6/16/2016	O	S	23.0	21.38	3.19	35.7	7.96	150	0.109	53.5	65.5	0.07	1.29	7.95	0.05	0.085	0.923	812	5.9382	0.2	
Deeds Creek	6/23/2016	ST	O	26.5	20.23	6.40	69.4	8.16	2419.2	0.472	12.4	17.2	0.23	9.38	5.93	0.094	0.6069	3.945	407	254.18	0.15	
Deeds Creek	7/7/2016	S	S	22.5	20.27	5.09	57.5	7.72	1413.6	0.047	47	50.1	0.03	2.75	6.59	0.022	0.098	1.078	815	12.82	0.18	
Deeds Creek	7/21/2016	S	S	22.9	21.57	4.18	47.3	7.78	547.5	0.145	53.1	59.6	0.02	1.56	6.84	0.034	0.1044	0.68	845	11.7	0.07	
Deeds Creek	8/4/2016	S	S	20.3	21.83	4.29	49.1	7.51	547.5	0.158	118.8	63.6	0.01	1.12	10.15	0.004	0.11	0.703	1062	12.1	0.28	
Deeds Creek	8/17/2016	O	O	21.0	21.38	4.67	52.6	7.50	613.1	0.177	77.8	64.4	0.01	2.16	13.93	0.075	0.184	0.816	885	11.782	0.25	
Deeds Creek	8/31/2016	S	P/C	22.3	21.40	5.84	61.9	8.95	1732.9	0.089	51.3	58.8	0	2	11.31	0.07	0.2074	0.938	829	39.39	0.3	
Deeds Creek	9/14/2016	S	O	20.0	19.02	6.80	72.9	7.97	770.1	0.08	33.7	46.6	0	2.49	9.5	0.069	0.2022	1.25	699	40.089	0.16	
Deeds Creek	9/28/2016	S	R	13.3	13.90	6.82	65.7	7.91	289.7	0.043	81.8	64.1	0	2.01	8.5	0.026	0.105	0.644	969	18.218	0.24	
Deeds Creek	10/12/2016	S	R	13.9	14.05	7.48	72.1	7.94	166.4	0.062	68.7	73.2	0.01	2.39	8.71	0.031	0.076	0.61	920	5.5606	0.26	
Deeds Creek	10/25/2016	S	S	9.2	9.62	8.16	70.6	8.18	201.4	0.037	47.8	61.8	0	3.34	10.22	0.037	0.0749	0.789	860	4.8971	0.34	
Deeds Creek	11/8/2016	S	C	13.1	10.11	8.87	77.5	7.68		0.023	42.6	60	0.01	2.94	9.26	0.017	0.056	0.706	863	2.2762	0.2	E. coli samples, lab was closed due to holiday schedule
Deeds Creek	11/22/2016	S	C	6.0	3.20	11.30	82.8	7.57	193.5	0.01	46.2	64.7	0.01	2.1	8.02	0.016	0.043	0.642	870	1	0.19	
Deeds Creek	12/6/2016	O	O	8.2	4.38	12.13	92.6	7.60	160.7	0.062	35.4	58.7	0.02	3.99	9.78	0.023	0.05	0.819	822	0	0.17	
Deeds Creek	12/19/2016	SN	S	-18.0	0.16	12.85	85.3	7.94	35.9	0.108	47.8	62.6	0.02	2.92	9.7	0.012	0.0425	0.612	904	5.3	0.2	
Deeds Creek	1/4/2017	O	S	-3.8	3.27	12.07	89.2	8.03	1553.1	0.155	25	36.2	0.01	6.55	7.88	0.093	0.2292	1.438	623	35.879	0.13	
Deeds Creek	1/17/2017	R	C	8.0	4.62	12.30	93.9	8.03		0.084	18.6	26.3	0.03	4.41	6.72	0.148	0.376	2.122	499	100.73	0.1	Timing of rain EC samples could not be dropped off before lab closed
Deeds Creek	1/19/2017	C	C	6.5	3.86	12.93	96.5	8.13	488.4	0.046	25.4	42.7	0.02	6.95	7.72	0.051	0.121	1.173	636	14.117	0	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Deeds Creek	1/31/2017	C	O	8.8	3.17	12.59	92.7	8.27	435.2	0.067	31.1	52.6	0.02	3.79	8.23	0.02	0.054	0.59	741	5.2	0.15	
Deeds Creek	2/8/2017	R	SN	7.1	4.71	11.78	91.1	8.36	727.0	0.08	21.8	28.8	0	5.77	6.86	0.103	0.2435	1.307	540	41.302	0.26	
Deeds Creek	2/23/2017	C	S	13.9	9.61	9.03	78.3	8.44	86.0	0.023	33.4	49.7	0	3.54	3.94	0.007	0.0335	0.701	740	3.4	0.2	
Deeds Creek	3/1/2017	R	O	13.6	9.34	9.49	83.2	7.59	2419.2	0.054	28.5	41.6	0	3.32	4.8	0.025	0.1604	0.896	630	53	0.16	
Deeds Creek	3/16/2017	SN	S	3.9	0.87	15.32	103.1	8.28	149.7	0.024	34.8	60.6	0.01	2.61	5.08	0.011	0.033	0.609	770	3.5	0.12	
Deeds Creek	3/30/2017	C	R	5.6	8.32	7.86	68.3	8.62	231.0	0.023	28.7	41.5	0	4.04	4.03	0.027	0.0717	0.8	690	10.833	0.16	
Deeds Creek	4/11/2017	R	C	11.0	11.63	8.20	76.0	7.82	135.4	0.046	21.7	36.6	0	3.6	5.08	0.016	0.069	0.904	618	19	0.21	
Deeds Creek	4/24/2017	S	S	15.9	12.66			7.98	88.4	0.037	33	50	0.03	2.33	1.56	0.005	0.03	0.702	750	4.0363	0.15	DO sensor malfuction
Deeds Creek	5/10/2017	R	P/C	14.0	11.14	10.41	95.0	7.64	186.0	0.0	27.4	38.0	0.0	3.6	6.1	0.0	0.1	0.9	707.0	0.9	0.3	
Deeds Creek	5/22/2017	R	S	16.5	14.04	7.37	71.1	7.76	1299.7	0.1	17.8	22.8	0.0	5.2	8.0	0.1	0.2	0.6	547.0	30.7	0.3	
Deeds Creek	6/1/2017	S	S	18.9	14.93	7.96	79.2	7.72	76.6	0.1	24.6	31.8	0.0	3.3	8.4	0.0	0.1	1.1	671.0	18.3	0.2	
Deeds Creek	6/15/2017	R	O	24.4	20.24	5.95	65.3	7.84	2419.2	0.3	23.1	24.4	0.1	4.9	7.8	0.1	0.3	1.9	525.0	53.2	0.2	
Deeds Creek	6/29/2017	S	S	25.0	17.73	6.06	63.2	8.58	261.3	0.0	42.0	45.4	0.0	3.2	7.7	0.0	0.1	1.2	818.0	22.0	0.2	
Deeds Creek	7/10/2017	S	R/ST	22.9	19.15	5.31	57.4	8.51	268.2	0.1	18.1	26.9	0.0	2.9	8.8	0.0	0.2	0.5	583.0	30.0		
Deeds Creek	7/12/2017	R	O	24.1	20.24	5.26	57.2	8.82	>2419.2	0.1	16.1	21.5	0.0	2.6	8.4	0.0	0.4	0.4	518.0	126.5		
Deeds Creek	7/26/2017	S	O	25.1	19.15	4.66	50.8	7.50	461.1	0.1	32.2	36.4	0.0	2.5	10.8	0.0	0.1	0.5	758.0	30.5		
Deeds Creek	8/9/2017	S	S	21.2	17.42	6.70	69.4	7.76	360.9	0.1	51.1	49.7	0.0	2.3	8.4	0.0	0.1	0.7	878.0	14.5		
Deeds Creek	9/13/2017	O	O	18.7	16.30	5.44	55.4	7.70	325.5	0.1	52.4	55.5	0.0	1.7	9.7	0.0	0.1	0.5	871.0	6.4		
Deeds Creek	9/20/2017	S	O	22.0	18.36	5.67	60.1	7.62	2419.2	0.1	35.6	43.2	0.0	1.7	10.6	0.0	0.1	0.5	701.0	19.6		
Deeds Creek	9/27/2017	S	O	19.9	19.40	3.89	42.1	7.67	235.9	0.1	62.9	54.7	0.0	1.4	11.9	0.0	0.1	0.6	923.0	9.7		
Deeds Creek	10/11/2017	R	O	18.9	16.44	5.49	55.7	7.89	1299.7	0.1	58.3	51.6	0.0	1.4	11.4	0.0	0.1	0.8	855.0	11.0		
Deeds Creek	10/25/2017	R	S	10.7	9.47	7.18	62.5	7.72	727.0	0.1	59.1	51.6	0.0	2.2	12.0	0.0	0.1	0.8	883.0	7.5		
Deeds Creek	11/8/2017	S	S	4.4	7.64	9.40	79.0	7.59	613.1	0.1	28.1	41.4	0.0	3.3	10.2	0.0	0.1	1.2	716.0	8.3		
Deeds Creek	11/15/2017	S	R	7.7	7.39	8.96	75.2	7.71	365.4	0.1	42.3	51.7	0.0	2.7	11.1	0.0	0.0	0.7	863.0	4.8		
Deeds Creek	11/29/2017	S	S	2.5	7.22	9.77	77.2	7.66	344.8	0.1	39.9	49.9	0.0	3.0	10.1	0.0	0.1	0.7	813.0	4.8		
Deeds Creek	12/13/2017	SN	C	-4.2	0.45	10.82	74.7	7.67	325.5	0.1	48.0	59.8	0.0	2.5	9.1	0.0	0.0	0.5	865.0	4.1		

Table 17 Deeds Creek Sampling Data (Site#1)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Eagle Creek	1/27/2016	O	O	-2.5	1.36	13.30	103.3	8.40	30.9	0.046	33.3	47.8	0.01	0.61	3.89	0.005	0.0433	1.024	620	0	0.14	
Eagle Creek	2/11/2016	SN	SN	-8.8	2.21	15.61	111.7	8.61	3.0	0.095	32.9	47.9	0	0.58	3.51	0.006	0.045	0.923	615	2.7804	0.14	
Eagle Creek	2/22/2016	P/C	C/S	4.6	4.33	17.84	139.9	8.80	0	0.078	32.8	45.8	0	0.38	2.62	0.007	0.037	0.9	603	4.4682	0.13	
Eagle Creek	2/29/2016	R	P/C	5.5	4.03	16.01	123.2	8.83	4.1	0.017	33.8	47.3	0	0.39	2.19	0.009	0.0468	0.977	598	6.5627	0.13	
Eagle Creek	3/9/2016	P/C	O	17.8	6.18	15.70	130.2	9.04	2.0	0.051	34.3	48.6	0	0.48	1.28	0.002	0.04	1.009	612	12.8	0.14	
Eagle Creek	3/23/2016	P/C	C	11.3	8.42	14.65	125.8	8.80	1.0	0.032	35.8	54.5	0	0.48	0.41	0	0.0349	1.028	608	16.348	0.15	
Eagle Creek	4/7/2016	R	R	3.6	7.44	11.77	98.6	8.80	1.0	0.037	33.7	49.2	0	0.49	0.19	0.002	0.0379	0.955	610	12.393	0.16	
Eagle Creek	4/20/2016	C/S	C/S	14.7	16.08	11.11	111.7	8.75	5.2	0.031	73	67.8	0.05	1.91	0.19	0.005	0.0174	0.808	603	15.337	0.15	
Eagle Creek	5/4/2016	P/C	O	8.6	13.53	8.14	77.8	8.20	46.7	0.08	32.5	49.6	0.01	0.46	1.16	0.002	0.0212	0.776	611	1.6233	0.13	
Eagle Creek	5/18/2016	C	S	16.0	15.26	9.88	98.1	8.43	111.2	0.048	32.1	48.6	0.01	0.59	0.43	0.004	0.015	0.86	608	3.824	0.06	
Eagle Creek	6/1/2016	P/C	O	26.2	24.55	8.79	105.4	8.54	22.8	0.064	32.3	48.2	0.01	0.44	0.84	0.005	0.024	0.806	596	5.6053	0.15	
Eagle Creek	6/16/2016	O	O	21.5	24.76	9.81	118.0	8.64	47.9	0.029	33.8	57.6	0.01	0.11	1.62	0.002	0.02	1.222	560	9.7932	0.15	
Eagle Creek	6/23/2016	ST	O	28.1	24.57	7.87	96.3	8.59	344.8	0.075	32.8	47.7	0.01	0.21	1.52	0.002	0.0137	1.196	541	2.2099	0.14	Estimated using high flow protocol techniques
Eagle Creek	7/7/2016	S	C	27.9	25.10	8.86	105.7	8.40	15.8	0.035	30.3	43.8	0.02	0.47	2.34	0.005	0.0286	1.247	525	4.171	0.13	
Eagle Creek	7/21/2016	S	S	28.3	27.77	8.82	111.8	8.25	37.3	0.047	30.6	43.6	0.01	0.28	2.62	0.003	0.0205	0.827	516	10.1	0.14	
Eagle Creek	8/4/2016	S	S	28.4	28.58	8.33	107.7	8.02	7.4	0.066	32.3	44.4	0.01	0.11	3.07	0.006	0.0188	0.713	497	4.5	0.18	
Eagle Creek	8/17/2016	O	C	25.0	25.86	6.28	77.2	7.74	54.7	0.102	35.2	43	0	0.32	4.59	0.009	0.0379	2.261	495	0	0.17	
Eagle Creek	8/31/2016	S	P/C	27.6	27.10	7.73	96.7	9.37	29.2	0.025	32.9	42.3	0	0	3.23	0.001	0.014	0.702	481	3.2658	0.24	
Eagle Creek	9/14/2016	S	O	22.8	24.28	8.01	96.5	8.43	9.7	0.025	32	41.1	0	0.15	3.11	0.002	0.0183	0.631	488	0	0.17	
Eagle Creek	9/28/2016	S	O	12.8	20.86	7.57	84.8	8.16	26.9	0.05	32.7	42.3	0	0.04	3.54	-0.005	0.027	0.708	500	2.9962	0.15	
Eagle Creek	10/12/2016	S	P/C	20.6	18.06	8.33	87.0	8.33	9.7	0.036	32.4	42.5	0	0.02	3.51	0.004	0.019	0.661	509	1.8115	0.16	
Eagle Creek	10/25/2016	S	S	8.2	14.64	8.00	78.2	8.47	1.0	0.046	34.3	41.6	0	0.09	3.7	0.005	0.0187	0.654	529	1.7969	0.3	
Eagle Creek	11/8/2016	S	C	11.0	13.97	9.70	91.6	8.04		0.038	34.8	45.1	0	0.03	3.52	0.002	0.02	0.677	552	0	0.19	E. coli samples were unable to be processed because lab was closed due to holiday schedule
Eagle Creek	11/22/2016	S	C	3.7	7.57	12.70	103.3	8.19	16.9	0.06	35.5	46	0.01	0.05	3.29	0.007	0.02	0.623	568	2	0.17	
Eagle Creek	12/6/2016	O	O	3.4	4.98	12.26	94.7	8.12	14.8	0.252	34.4	44	0.02	0.09	4.46	0.007	0.0349	0.811	586	0.9	0.16	
Eagle Creek	12/21/2016	C	O	-0.1	2.66	14.80	101.4	8.24	5.2													Dangerous weather & lab's holiday schedule nutrient sample was not taken for this site
Eagle Creek	1/4/2017	O	C	-5.0	2.67	15.10	109.7	8.24	32.7	0.186	35	44.3	0.01	0.45	3.92	0.008	0.0642	1.171	598	2.9196	0.14	
Eagle Creek	1/17/2017	R	C	5.9	4.16	16.22	115.9	8.59		0.111	34.5	43.6	0.02	0.64	4.12	0.014	0.055	1.086	594	0	0.12	Because of timing of rain event EC samples could not be dropped off before lab closed for the day
Eagle Creek	1/19/2017	C	C	3.4	2.01	15.61	111.6	8.55	3.0	0.099	36	44.9	0.03	0.76	4.33	0.014	0.051	1.016	598	2.2042	0.14	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Eagle Creek	1/31/2017	C	O	1.6	1.68	15.31	108.6	8.65	3.1	0.07	32.1	46	0	0.95	4.27	0.011	0.044	0.771	603	0.7	0.17	
Eagle Creek	2/8/2017	R	O	3.0	2.79	15.65	114.0	8.78	1.0	0.027	32.2	42.1	0	1.16	3.45	0.007	0.0501	0.804	590	0	0.27	
Eagle Creek	2/23/2017	C	S	22.4	7.47	15.50	128.0	9.30	<1	0.048	33.9	43.5	0	1.22	1.96	0.006	0.0371	1.119	596	7.8	0.2	
Eagle Creek	3/1/2017	R	O	11.3	6.58	13.16	108.0	8.36	6.3	0.054	32.8	42.9	0	1.21	1.92	0.004	0.0441	0.931	603	8.1	0.16	
Eagle Creek	3/16/2017	SN	S	4.8	3.10	14.78	109.9	9.03	5.2	0.016	31.5	51.6	0.01	0.83	1.29	0.005	0.054	1.112	611	17.1	0.13	
Eagle Creek	3/30/2017	C	R	4.5	8.34	9.33	80.0	9.28	2.0	0.056	33.2	42.9	0	1.14	0.57	0.005	0.046	1.101	606	9.4959	0.17	
Eagle Creek	4/11/2017	R	C	12.1	10.93	11.24	103.6	8.55	4.1	0.058	31.4	42.9	0	1.3	0.49	0.005	0.0397	1.002	600	9.4	0.22	
Eagle Creek	4/24/2017	S	S	21.1	17.27			8.72	8.1	0.074	32.5	44.8	0.02	0.88	0.55	0.002	0.028	0.931	594	6.3491	0.14	DO sensor malfuction
Eagle Creek	5/10/2017	R	C	16.4	13.36	11.57	111.6	8.30	0.0	0.059	30.3	42.4	0	1.18	0.73	0.008	0.0299	0.725	590	2.6024	0.31	
Eagle Creek	5/22/2017	R	S	22.4	18.06	10.21	109.0	8.42	20.3	0.068	28.8	40.4	0	0.92	0.02	0	0.035	0.983	570	6	0.4	
Eagle Creek	6/1/2017	S	S	25.0	20.28	10.45	117.1	8.55	2.0	0.069	25.3	36.9	0	1.18	0.81	0.007	0.0418	1.031	555	5.2527	0.14	
Eagle Creek	6/15/2017	R	S	25.8	26.18	9.49	116.3	8.60	44.1	0.111	29	41.6	0.03	0.64	0.66	0.008	0.03	0.983	514	6.4	0.15	
Eagle Creek	6/29/2017	S	O	26.5	22.68	7.18	82.5	9.04	18.9	0.093	26.8	37.1	0	0.48	1.86	0.008	0.0339	1.23	537	5.8	0.19	
Eagle Creek	7/10/2017	S	O	25.0	24.88	6.83	83.5	9.45	39.9	0.087	24	34.8	0.03	0.67	0.7	-0.001	0.0485	0.444	488	12.2		Estimated using high flow protocol techniques
Eagle Creek	7/12/2017	R	O	27.8	24.61	5.39	63.7	9.25	201.4	0.12	22.3	32.3	0.04	0.61	1.55	0.001	0.0413	0.544	472	4.3		Estimated using high flow protocol techniques
Eagle Creek	7/26/2017	S	O	23.5	26.55	4.27	52.0	8.02	14.5	0.133	20.5	29	0.03	0.39	3.75	0.002	0.0369	1.035	467	2.038		
Eagle Creek	8/9/2017	S	S	23.6	24.53	9.97	120.3	8.49	12.2	0.042	22.1	30.5	0.02	0.22	4.44	0.006	0.033	1.041	484	6.4608		
Eagle Creek	9/13/2017	O	R	18.0	20.36	8.00	88.6	8.33	24.3	0.042	25.6	32.4	0	0	4.63	0.005	0.0341	1.122	498	5.6298		
Eagle Creek	9/20/2017	S	S	29.6	23.63	7.30	85.7	8.38	30.9	0.042	26.1	35.5	0	0	4.1	0.004	0.023	0.872	493	4.954		
Eagle Creek	9/27/2017	S	O	21.3	25.35	7.00	84.9	8.41	35.9	0.036	27.2	34.3	0	0.02	4.08	0.006	0.022	0.811	496	4.8109		
Eagle Creek	10/11/2017	R	C	15.4	20.09	6.99	76.1	8.25	25.3	0.065	26.8	33.5	0	0.08	4.89	0.009	0.0292	0.938	507	2.8756		
Eagle Creek	10/25/2017	R	S	11.0	14.94	7.74	75.7	8.19	16.8	0.106	28.1	33.5	0	0.05	5.24	0.004	0.0254	0.864	530	1.4		
Eagle Creek	11/8/2017	S	S	8.8	10.48	9.39	84.9	7.98	12.2	0.252	28.7	35.3	0	0.11	5.2	0.013	0.0261	0.85	560	5.0541		
Eagle Creek	11/15/2017	S	R	6.7	7.27	9.87	82.1	7.95	47.4	0.275	29	35.3	0	0.71	5.34	0.007	0.0281	0.869	569	1.3504		
Eagle Creek	11/29/2017	S	S	9.3	7.00	11.98	98.5	8.11	13.4	0.244	31.6	37.5	0	0.51	4.99	0.007	0.045	1.038	579	6.0362		
Eagle Creek	12/13/2017	SN	C	-2.4	1.92	15.08	93.4	8.34	20.1	0.189	36	65.7	0	0.68	4.23	0.012	0.0399	1.024	586	5.8441		

Table 18 Eagle Creek Sampling Data (Site#3)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Heeter Ditch	1/26/2016	R	O	-0.7	2.26	13.09	96.1	8.25	1.0	0.108	25.6	39	0	0.45	1.89	0.001	0.0367	0.99	543	14.5	0.16	
Heeter Ditch	2/9/2016	SN	SN	-4.2	3.21	11.05	84.0	7.69	22.6	0.101	23.2	43.6	0	0.51	3.05	0.003	0.063	0.965	561	45.861	0.14	
Heeter Ditch	2/22/2016	P/C	C/S	2.2	3.59	11.55	88.7	7.72	<1	0.097	23.1	45	0	0.41	3.13	0.01	0.0201	0.646	555	4.4803	0.13	
Heeter Ditch	3/2/2016	SN	O	-3.8	3.30	11.68	87.9	8.07	23.1	0.092	24.3	42.5	0	1	3.02	0.002	0.0257	0.796	564	0	0.13	
Heeter Ditch	3/9/2016	P/C	O	15.8	7.49	11.06	93.8	8.15	39.9	0.056	25.1	38.7	0	0.69	1.92	0.003	0.0295	0.75	540	7.9	0.13	
Heeter Ditch	3/23/2016	P/C	C	11.4	8.65	11.02	95.0	8.22	3.1	0.042	26.9	35.9	0	0.39	1.11	0.001	0.0246	0.72	528	8.6705	0.14	
Heeter Ditch	4/7/2016	R	R	4.0	7.71	10.37	87.5	8.19	27.8	0.029	25	36.7	0	1.05	1.12	0.005	0.042	0.818	517	14.592	0.15	
Heeter Ditch	4/20/2016	C/S	C/S	12.8	13.97	9.83	95.3	8.49	71.7	0.061	46.1	45.1	0.01	1.89	1.73	0.007	0.0122	0.665	524	8.2116	0.14	
Heeter Ditch	5/4/2016	P/C	R	9.2	13.44	8.30	78.9	7.92	52.9	0.069	23.1	36.3	0	0.34	2.43	0.001	0.0242	0.755	521	5.8823	0.12	
Heeter Ditch	5/18/2016	C	S	13.1	13.78	10.4	100.5	8.06	22.8	0.062	24.2	35.8	0.01	0.39	3.54	0.007	0.02	0.707	522	5.2355	0.17	
Heeter Ditch	6/1/2016	P/C	P/C						79.4													No flow - Too much vegetation and low water levels
Heeter Ditch	6/16/2016	O	S	23.6	18.70	3.97	42.1	7.87	1986.3	0.051	20.8	77.3	0.03	0.39	6.81	0.003	0.018	0.963	678	0	0.18	weeds & low water level = zero/negative flow, moved site downstream and sampled from a culvert
Heeter Ditch	6/23/2016	ST	O	30.2	23.76	5.42	63.6	7.91	1203.3	0.346	21.3	32.6	0.04	2.4	5.71	0.015	0.0947	2.195	455	22.893	0.14	Edge point was estimated
Heeter Ditch	7/7/2016	S	S	25.0	22.53	3.81	44.9	7.34	72.3	0.108	24.4	36	0.04	0.3	4.98	0.006	0.03	1.089	497	0	0.14	
Heeter Ditch	7/21/2016	S	S	26.8	19.22	2.85	29.3	7.39	125.9	0.041	19.7	59.5	0.04	0.43	7.06	0.002	0.0185	0.517	651	1.1	0.17	
Heeter Ditch	8/4/2016	S	S	26.6	17.27	2.69	27.7	7.30	461.1	0.064	19.8	66.8	0.02	0.52	9.65	0.006	0.0174	0.555	674	4.4	0.23	
Heeter Ditch	8/17/2016	O	O	21.0	17.68	3.98	41.5	7.26	648.8	0.266	20.2	67.9	0	0.83	13.34	0.004	0.0532	0.817	692	5.42	0.21	
Heeter Ditch	8/31/2016	S	P/C	23.6	20.41	4.67	48.6	8.80	866.4	0.145	19.3	57.6	0	0.56	10.22	-0.001	0.072	0.984	630	48.445	0.26	
Heeter Ditch	9/14/2016	S	O	19.3	18.03	3.59	37.8	7.52	1203.3	0.181	20.4	54.8	0	0.59	9.74	0.003	0.0604	1.119	614	36.423	0.18	
Heeter Ditch	9/28/2016	S	R	11.6	13.43	5.03	48.4	7.55	261.3	0.153	19.7	54.4	0	0.4	10.59	0.003	0.032	0.636	626	6.6145	0.18	
Heeter Ditch	10/12/2016	S	P/C	17.7	13.67	5.54	54.3	7.67	387.3	0.11	35	99	0	0.61	10.24	0	0.021	0.601	627	3.9494	0	
Heeter Ditch	10/25/2016	S	S	6.2	9.26	7.51	59.8	7.94	77.6	0.187	22.1	53.6	0	0.55	9.25	0.007	0.0244	0.749	632	5.1369	0.33	
Heeter Ditch	11/8/2016	S	C	12.0	12.03	6.89	59.8	7.80		0.1	25.8	55.2	0.02	0.77	6.09	0.003	0.031	0.759	608	3.7735	0.21	E. coli samples were unable to be processed because lab was closed holiday schedule
Heeter Ditch	11/22/2016	S	C	0.5	5.36	8.98	67.1	7.61	26.5	0.12	23.3	51.5	0.01	0.34	5.18	0.005	0.028	0.744	602	4	0.18	
Heeter Ditch	12/6/2016	O	O	2.2	4.37	14.38	111.1	7.82	10.9	0.083	25.5	36.3	0.01	0.36	1.52	0	0.0363	0.77	524	4	0.16	
Heeter Ditch	12/21/2016	C	O	-2.8	2.30	12.95	91.6	7.62	9.7													Dangerous weather & lab's holiday schedule nutrient sample was not taken for this site
Heeter Ditch	1/4/2017	O	S	-4.0	2.64	12.27	89.0	7.73	41.3	0.081	24.9	43	0	1.68	2.26	0.007	0.0516	1.017	547	23.047	0.13	
Heeter Ditch	1/17/2017	R	C	6.4	4.06	14.37	108.5	8.33		0.145	23.4	34.1	0.01	1.29	1.71	0.052	0.085	1.819	471	27.35	0.1	Rain event EC samples could not be dropped off before lab closed for the day
Heeter Ditch	1/19/2017	C	C	3.4	3.78	15.67	118.4	8.48	48.0	0.117	24.7	31.5	0.01	0.98	1.7	0.038	0.107	1.134	488	13.104	0.13	EC start time was 19.5 hrs. after delivery due to lab error
Heeter Ditch	1/31/2017	C	O	2.0	2.76	12.64	91.8	8.31	19.9	0.114	24.6	36.7	0.01	0.63	4.58	0.01	0.044	0.735	522	18.4	0.15	
Heeter Ditch	2/8/2017	R	O	6.6	3.01	13.45	98.4	8.29	64.4	0.033	23.2	34.4	0	1.61	4.22	0.013	0.0601	0.847	510	1.5432	0.14	
Heeter Ditch	2/23/2017	C	S	17.1	6.52	11.47	92.1	8.63	4.1	0.064	25.5	36.9	0	0.83	3.26	0.004	0.0301	0.789	535	8.1	0.2	
Heeter Ditch	3/1/2017	R	O	12.2	7.69	10.33	86.8	7.54	78.9	0.053	24.1	42.5	0	1.86	3.33	0.004	0.0712	0.992	535	15	0.16	
Heeter Ditch	3/16/2017	SN	S	2.1	3.03	12.57	93.4	8.51	6.3	0.034	23.4	42.6	0	0.39	2.2	0.007	0.044	0.967	517	16.5	0.12	
Heeter Ditch	3/30/2017	C	R	4.1	8.49	8.22	70.4	8.79	21.3	0.098	24.4	35.3	0	0.79	1.53	0.006	0.0563	0.863	536	9.6618	0.16	
Heeter Ditch	4/11/2017	R	C	7.7	10.28	9.26	83.8	8.17	21.8	0.099	24.9	30.4	0	0.54	1.1	0.005	0.052	0.857	507	21.7	0.2	
Heeter Ditch	4/24/2017	S	S	15.1	15.38			8.06	60.5	0.104	25.3	39.9	0.01	0.27	2.89	0.004	0.038	0.785	535	7.2613	0.14	DO sensor malfuction
Heeter Ditch	5/10/2017	R	P/C	16.5	13.10	12.79	120.4	7.86	17.3	0.0	24.4	32.7	0.0	0.5	3.1	0.0	0.0	0.7	516.0	2.0	0.3	
Heeter Ditch	5/22/2017	R	S	14.1	16.29	8.49	87.2	7.89	148.3	0.1	22.9	30.4	0.0	0.9	2.6	0.0	0.1	1.0	497.0	7.6	0.3	
Heeter Ditch	6/1/2017	S	S	18.3	18.60	8.68	93.7	7.97	26.2	0.1	22.9	30.1	0.0	0.5	3.0	0.0	0.0	1.0	484.0	6.8	0.2	
Heeter Ditch	6/15/2017	R	O	24.3	22.46	5.10	55.2	7.79	1046.2	0.1	26.5	39.0	0.0	0.4	4.4	0.0	0.0	0.9	490.0	2.1	0.2	
Heeter Ditch	6/29/2017	S	S	25.2	20.60	5.81	63.1	8.38	68.3	0.0	23.3	33.7	0.0	0.3	2.9	0.0	0.0	1.1	495.0	5.3	0.2	
Heeter Ditch	7/10/2017	S	R	21.6	22.78	4.35	51.2	8.42	1413.6	0.1	21.8	29.8	0.0	0.3	3.2	0.0	0.1	0.5	431.0	23.7		
Heeter Ditch	7/12/2017	R	O	24.2	23.41	4.26	48.1	8.81	1986.3	0.1	20.4	28.0	0.0	0.5	3.8	0.0	0.1	0.7	409.0	21.2		
Heeter Ditch	7/26/2017	S	O	24.5	24.71	3.82	44.7	7.36	148.3	0.1	20.9	27.3	0.0	0.1	5.9	0.0	0.1	1.1	421.0	17.2		
Heeter Ditch	8/9/2017	S	S	21.2	20.47	7.61	68.4	7.53	260.2	0.1	22.3	33.9	0.0	0.2	7.2	0.0	0.0	0.8	483.0	6.7		
Heeter Ditch	9/13/2017	O	O	20.6	15.80	2.95	28.7	7.26	228.2	0.0	20.1	61.1	0.0	0.7	8.5	0.0	0.0	0.6	671.0	2.8		
Heeter Ditch	9/20/2017	S	O	23.6	19.58	3.75	40.9	7.18	686.7	0.1	21.4	44.8	0.0	0.3	7.6	0.0	0.0	0.9	568.0	2.1		
Heeter Ditch	9/27/2017	S	O	20.1	20.09	1.41	15.5	7.25	101.4	0.1	22.9	43.2	0.0	0.3	7.3	0.0	0.0	0.6	567.0	0.0		
Heeter Ditch	10/11/2017	R	R	15.3	15.40	3.10	30.7	7.44	>2419.2	0.1	20.0	47.5	0.0	0.6	9.3	0.0	0.0	0.8	617.0	0.7		
Heeter Ditch	10/25/2017	R	S	6.0	9.84	5.23	45.5	7.41	240.0	0.2	20.5	52.9	0.0	0.6	10.6	0.0	0.0	0.9	666.0	2.8		
Heeter Ditch	11/8/2017	S	S	5.0	8.27	9.12	78.2	7.55	613.1	0.3	20.0	21.6	0.0	0.5	5.9	0.0	0.1	1.1	428.0	13.1		
Heeter Ditch	11/15/2017	S	R	7.8	7.25	9.13	76.2	7.60	33.2	0.3	23.2	28.1	0.0	0.9	5.0	0.0	0.0	1.0	491.0	7.4		
Heeter Ditch	11/29/2017	S	S	2.7	5.41	11.06	87.2	7.53	5.2	0.2	26.3	31.6	0.0	0.7	3.1	0.0	0.0	0.9	501.0	9.8		
Heeter Ditch	12/13/2017	SN	C	-4.1	1.97	10.05	72.4	7.65	13.0	0.0	23.5	41.7	0.0	0.5	2.1	0.0	0.1	0.9	537.0	27.4		

Table 19 Heeter Ditch Sampling Data (Site#2)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/ 100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Keefer-Evans	1/27/2016	O	O	-1.0	1.51	13.17	95.4	8.08	73.3	0.069	33.5	66.6	0.01	1.53	4.63	0.002	0.0268	1.16	776	6.7	0.14	
Keefer-Evans	2/11/2016	SN	SN	-9.1	-0.02	13.35	92.9	8.25	13.4	0.065	37	66	0.01	0.76	3.31	0.004	0.031	0.76	751	7.6754	0.12	
Keefer-Evans	2/22/2016	P/C	C/S	5.0	4.13	13.20	100.9	8.42	26.2	0.051	35.2	63.5	0.01	0.56	3.26	0.008	0.0189	0.552	732	0.8347	0.11	
Keefer-Evans	2/29/2016	R	O	3.6	6.06	13.35	103.2	8.33	60.1	0.037	35.4	63.7	0.01	0.56	2.64	0.006	0.0364	0.769	715	9.7817	0.11	
Keefer-Evans	3/9/2016	P/C	O	16.5	11.75	10.94	102.5	8.50	22.3	0.044	31.6	61.6	0.01	1.64	2.54	0	0.0371	0.979	704	7.8	0.11	
Keefer-Evans	3/23/2016	P/C	C	12.9	10.97	10.48	95.4	8.27	43.5	0.036	34.3	64.2	0.01	1.39	2.54	0	0.0238	0.864	716	5.0084	0.13	
Keefer-Evans	4/7/2016	R	R	2.7	7.09	11.25	93.4	8.39	139.6	0.087	17.4	33.3	0.01	2.33	5.15	0.039	0.3757	2.015	456	161.53	0.13	
Keefer-Evans	4/20/2016	C/S	C/S	16.5	16.31	8.84	90.1	8.42	866.4	0.052	22.7	50.2	0.02	1.8	1.48	0.008	0.0213	1.024	656	14.362	0.14	
Keefer-Evans	5/4/2016	P/C	O	7.7	13.66	8.72	84.3	8.08	224.7	0.049	31.4	57.1	0.01	0.26	2.9	0.001	0.0274	0.837	658	6.5789	0.1	
Keefer-Evans	5/18/2016	C	S	18.8	15.53	9.87	99.7	8.21	90.5	0.03	26.2	44.7	0.01	0.8	0.91	0.008	0.016	0.968	610	4.1322	0.07	
Keefer-Evans	6/1/2016	P/C	O	24.9	22.07	6.75	77.1	8.08	235.9	0.073	36.7	52.7	0.01	0.14	4.37	0.016	0.041	0.895	637	0	0.12	
Keefer-Evans	6/16/2016	O	O	22.6	23.34	6.32	73.9	8.15	770.1	0.056	41.4	67.3	0.01	0.09	9.03	0.019	0.051	1.147	645	1.1073	0.13	
Keefer-Evans	6/23/2016	ST	O	23.7	23.17	4.48	51.6	7.87	547.5	0.426	20	33.4	0.33	1.76	7.18	0.008	0.1407	5.521	462	53.501	0.11	
Keefer-Evans	7/7/2016	S	C	27.0	24.37	3.92	46.9	7.63	198.9	0.083	28.2	39.8	0.04	0.31	6.08	0.019	0.0526	1.537	630	1.0193	0.13	
Keefer-Evans	7/21/2016	S	S	27.5	25.39	4.55	54.9	7.82	307.6													Nutrient sample was compromised in transit to lab
Keefer-Evans	8/4/2016	S	S	28.4	24.16	5.59	66.5	7.69	435.2	0.1	43.4	53.2	0.01	0.26	19.35	0.026	0.0636	0.961	694	3.3	0.18	
Keefer-Evans	8/17/2016	O	C	26.0	24.37	5.76	69.2	7.68	129.1	0.133	44	52.9	0	0.59	18.98	0.016	0.0711	0.946	682	0.6916	0.15	
Keefer-Evans	8/31/2016	S	P/C	28.5	25.09	4.60	56.4	8.99	117.2	0.182	38.7	50.2	0	0.38	6.53	0.015	0.0505	0.97	666	2.7247	0.22	
Keefer-Evans	9/14/2016	S	O	22.3	21.93	5.38	61.1	8.11	73.8	0.073	38.1	51	0	0.36	2.1	0.004	0.047	0.818	662	8.8889	0.17	
Keefer-Evans	9/28/2016	S	O	13.5	14.93	7.80	76.7	8.02	71.2	0.057	44.8	54.5	0	0.25	8.9	0.017	0.046	0.674	706	1.3298	0.13	
Keefer-Evans	10/12/2016	S	P/C	20.5	15.31	7.43	71.5	8.14	156.5	0.072	46.9	56.9	0.01	0.23	8.85	0.015	0.037	0.637	737	2.3697	0.13	
Keefer-Evans	10/25/2016	S	S	9.2	9.86	7.27	62.8	8.24	83.3	0.144	43.4	56.6	0	0.44	8.92	0.005	0.0321	0.773	749	0	0.28	
Keefer-Evans	11/8/2016	S	C	12.5	12.03	7.74	69.3	7.79		0.108	44.7	60.4	0.11	0.51	8.92	0.011	0.036	0.685	768	2.8435	0.18	E. coli samples were unable to be processed because lab was closed due to holiday schedule
Keefer-Evans	11/22/2016	S	C	4.6	3.54	12.72	95.0	8.03	37.9	0.31	44.7	64.5	0.03	0.4	10.6	0.011	0.034	0.868	802	0	0.15	
Keefer-Evans	12/6/2016	O	O	4.3	3.31	14.69	110.2	8.10	44.1	0.276	37.2	62.2	0.03	1.05	10.98	0.014	0.0371	1.076	781	1	0.14	
Keefer-Evans	12/21/2016	C	O	0.0	0.07	12.39	83.6	7.97	90.9													Dangerous weather& lab's holiday schedule nutrient sample was not taken
Keefer-Evans	1/4/2017	O	C	-3.6	2.45	14.81	104.1	8.03	33.2	0.148	29.1	56.2	0.03	2.95	6.95	0.008	0.0373	1.153	698	10.443	0.11	
Keefer-Evans	1/17/2017	R	C	5.4	3.65	13.57	101.0	8.15		0.083	28.3	47.9	0.04	3	5.89	0.017	0.049	1.134	626	5.6179	0.09	Rain event EC samples could not be dropped off before lab closed for the day
Keefer-Evans	1/19/2017	C	C	2.9	3.97	13.07	97.9	8.15	63.1	0.065	27.5	48.4	0.03	3.86	6.15	0.021	0.061	1.288	620	3.2733	0.11	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Keefer-Evans	1/31/2017	C	O	2.0	2.42	14.10	101.9	8.49	79.4	0.067	32.5	60.6	0.02	2.31	6.19	0.005	0.026	0.879	706	3.9	0.14	
Keefer-Evans	2/8/2017	R	O	3.5	4.88	13.25	102.0	8.58	62.0	0.025	31	60	0	1.99	4.92	0.007	0.0389	0.691	701	12.785	0.31	
Keefer-Evans	2/23/2017	C	S	24.3	12.10	11.17	102.7	8.89	56.5	0.027	33.2	60.1	0	1.68	3.37	0.009	0.0206	0.787	723	4.3	0.19	
Keefer-Evans	3/1/2017	R	O	10.4	9.88	10.50	93.3	7.97	325.5	0.033	33.5	58.5	0	1.2	4.58	0.004	0.0397	0.823	715	9.2	0.15	
Keefer-Evans	3/16/2017	SN	S	5.2	1.36	15.04	107.6	8.82	14.8	0.041	34.6	71.3	0.01	0.93	5.37	0.004	0.029	0.688	755	4.8	0.11	
Keefer-Evans	3/30/2017	C	R	6.0	10.21	8.64	77.8	8.96	135.4	0.038	29.3	57.2	0	0.92	5.1	0.005	0.0867	1.178	678	36.163	0.14	
Keefer-Evans	4/11/2017	R	C	11.3	13.94	8.95	88.4	8.14	27.8	0.07	25	44.3	0	2.46	5.95	0.004	0.0431	1.29	624	11.8	0.2	
Keefer-Evans	4/24/2017	S	S	20.2	16.41			8.24	248.1	0.104	32.5	49.8	0.01	0.34	7.02	0.005	0.054	1.15	632	15.625	0.12	DO sensor malfuction
Keefer-Evans	5/10/2017	R	C	17.6	14.12	10.22	99.1	8.04	36.4	0.1	24.6	42.2	0.0	1.8	4.0	0.0	0.0	1.1	622.0	4.2	0.3	
Keefer-Evans	5/22/2017	R	S	23.4	18.97	8.19	89.2	8.03	178.5	0.1	26.1	44.5	0.0	0.5	4.2	0.0	0.1	0.4	629.0	11.4	0.4	
Keefer-Evans	6/1/2017	S	S	28.9	21.17	6.34	70.4	7.91	65.7	0.2	20.0	32.7	0.0	1.3	7.3	0.0	0.1	1.5	583.0	6.5	0.1	
Keefer-Evans	6/15/2017	R	S	32.3	26.43	4.80	58.0	8.03	159.7	0.1	34.4	47.9	0.1	0.4	17.8	0.0	0.1	1.1	677.0	6.8	0.2	
Keefer-Evans	6/29/2017	S	O	26.6	21.86	5.31	59.9	8.70	344.8	0.1	32.7	46.6	0.0	0.4	18.4	0.0	0.1	1.1	702.0	6.4	0.2	
Keefer-Evans	7/10/2017	S	O	24.5	23.83	4.39	51.7	8.64	167.4	0.2	11.8	20.7	0.1	0.7	7.7	0.1	0.1	0.8	397.0	17.5		
Keefer-Evans	7/12/2017	R	O	28.0	23.44	3.98	43.3	8.61	178.5	0.2	14.9	23.3	0.1	0.5	9.8	0.0	0.1	0.7	472.0	13.6		
Keefer-Evans	7/26/2017	S	O	23.6	24.58	2.84	33.2	7.54	121.1	0.1	22.5	30.6	0.0	0.3	11.7	0.0	0.1	0.6	605.0	4.9		
Keefer-Evans	8/9/2017	S	S	24.8	22.30	6.66	76.0	7.99	118.7	0.1	30.1	45.1	0.0	0.2	10.7	0.0	0.1	1.2	709.0	10.8		
Keefer-Evans	9/13/2017	O	R	18.1	18.42	5.13	54.4	7.86	128.1	0.1	39.5	56.6	0.0	0.2	6.6	0.0	0.0	0.8	734.0	2.7		
Keefer-Evans	9/20/2017	S	S	29.3	23.95	4.85	57.1	7.85	517.2	0.1	33.7	58.7	0.0	0.1	8.5	0.0	0.1	0.5	695.0	10.6		
Keefer-Evans	9/27/2017	S	O	22.1	22.54	4.86	59.1	7.84	48.4	0.1	38.1	53.0	0.0	0.2	11.2	0.0	0.1	0.8	743.0	5.6		
Keefer-Evans	10/11/2017	R	C	16.7	17.75	5.18	53.9	7.91	648.8	0.1	37.3	50.6	0.0	0.2	11.8	0.0	0.1	1.0	720.0	4.8		
Keefer-Evans	10/25/2017	R	O	8.4	10.55	7.88	70.7	8.12	325.5	0.1	38.1	55.7	0.0	0.3	13.4	0.0	0.0	0.9	783.0	2.8		
Keefer-Evans	11/8/2017	S	S	8.0	9.45	11.98	104.6	7.99	1299.7	0.1	31.8	55.0	0.0	0.6	11.8	0.0	0.1	1.3	745.0	26.0		
Keefer-Evans	11/15/2017	S	R	6.7	6.22	10.53	85.4	7.88	1986.3	0.1	31.2	48.7	0.0	1.2	10.2	0.0	0.1	1.2	714.0	20.2		
Keefer-Evans	11/29/2017	S	S	9.9	7.06	10.44	85.7	7.90	11.0	0.1	31.2	48.7	0.0	1.4	8.9	0.0	0.0	0.9	704.0	5.3		
Keefer-Evans	12/13/2017	SN	C	-1.8	2.05	11.60	83.4	8.05	8.5	0.2	22.4	43.3	0.0	1.5	9.3	0.0	0.0	0.8	789.0	3.3		

Table 20 Keefer-Evans Sampling Data (Site#5)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	1/26/2016	R	O	-0.9	2.02	14.34	105.8	8.32	2.0	0.07	51.3	53	0.01	2.54	3.86	0.003	0.0332	1.146	744	4.4	0.14	
Lones Ditch	2/9/2016	SN	SN	-5.4	4.23	16.08	126.1	8.42	1.0	0.001	51.2	51.1	0.01	2.1	3.19	0.003	0.154	0.816	745	31.968	0.14	
Lones Ditch	2/22/2016	P/C	C/S	1.5	5.21	14.95	119.1	8.58	0	0.071	53.4	51.5	0.01	1.64	3.71	0.005	0.0251	0.695	758	4.4964	0.14	
Lones Ditch	3/2/2016	SN	O	3.8	3.62	12.24	93.5	8.51	5.2	0.087	68.4	53.1	0.01	1.83	4.31	0.002	0.0375	0.759	803	7.7669	0.15	
Lones Ditch	3/9/2016	P/C	O	14.5	8.33	11.94	103.8	8.55	2.0	0.052	58.1	53.5	0.01	2.38	3.75	0.008	0.0376	0.806	763	9.6	0.14	
Lones Ditch	3/23/2016	P/C	C	8.2	9.88	11.40	101.2	8.42	1.0	0.019	58.1	52.1	0.02	2.18	2.75	0.002	0.0357	0.833	739	14.772	0.15	
Lones Ditch	4/7/2016	R	R	2.5	7.88	10.75	90.6	8.39	3.0	0.045	61.4	45.8	0.01	1.59	2.5	0.003	0.0314	0.747	752	15.887	0.15	
Lones Ditch	4/20/2016	C/S	C/S	12.2	16.54	10.87	112.5	8.71	3.0	0.035	27.2	34.4	0.01	0.57	0.31	0.007	0.0125	0.836	696	13.771	0.15	
Lones Ditch	5/4/2016	P/C	R	8.4	14.19	8.75	84.0	8.22	69.1	0.065	46.5	44.4	0.02	1.24	0.71	0.005	0.0233	0.739	703	8.2576	0.14	
Lones Ditch	5/18/2016	C	S	14.4	14.66	9.78	96.1	8.26	13.2	0.055	46	41.2	0.02	1.58	1.12	0.007	0.023	0.789	693	12.371	0.18	
Lones Ditch	6/1/2016	P/C	P/C	22.0	24.24	8.67	103.0	8.32	71.2	0.169	48.2	40.2	0.02	0.92	2.48	0.01	0.033	0.804	693	4.3668	0.13	
Lones Ditch	6/16/2016	O	S	23.3	25.23	7.75	94.0	8.33	93.3	0.042	52.7	49.1	0.02	0.36	4.87	0.001	0.029	1.125	680	9.4043	0.16	
Lones Ditch	6/23/2016	ST	S	30.6	25.72	8.55	105.5	8.55	126.6	0.065	47.8	41	0.02	0.62	4.35	0.002	0.017	1.076	633	2.9014	0.14	Time not recorded
Lones Ditch	7/7/2016	S	S	23.8	24.66	8.51	102.4	8.26	66.3	0.042	46.7	37.7	0.05	1.24	5.26	0.005	0.034	1.18	613	3.1612	0.14	
Lones Ditch	7/21/2016	S	S	26.5	27.05	7.85	97.8	8.17	80.9	0.052	50.8	36.1	0.02	0.45	5.82	0.003	0.0371	0.758	591	10.1	0.14	
Lones Ditch	8/4/2016	S	S	24.2	27.21	6.75	84.3	7.78	55.6	0.095	54.2	36.5	0.01	0.15	6.15	0.005	0.0374	0.809	572	11.3	0.19	
Lones Ditch	8/17/2016	O	O	21.0	25.64	7.50	91.5	7.89	73.3	0.026	54.1	35.4	0	0.28	6.5	0.002	0.0637	0.796	531	9.4408	0.17	
Lones Ditch	8/31/2016	S	P/C	23.3	26.00	6.70	79.6	8.99	21.1	0.05	55.5	35.6	0	0	3.95	-0.001	0.0329	0.691	568	7.1243	0.23	
Lones Ditch	9/14/2016	S	O	22.2	23.91	7.26	86.0	8.19	26.2	0.053	55.5	37.5	0	0.15	5.81	0.001	0.039	0.511	600	13.175	0.17	
Lones Ditch	9/28/2016	S	R	11.5	19.78	6.81	74.0	7.90	27.5	0.046	58.2	37.6	0	0.09	6.61	-0.007	0.028	0.588	633	5.3795	0.16	
Lones Ditch	10/12/2016	S	P/C	18.4	17.56	8.05	84.0	8.14	32.3	0.054	76.6	48.5	0	0	6.88	0.005	0.021	0.593	647	3.0643	0	
Lones Ditch	10/25/2016	S	S	6.1	13.88	8.11	77.2	8.34	4.1	0.098	56.2	38.5	0	0.37	7.72	0.005	0.0244	0.659	668	3.546	0.31	
Lones Ditch	11/8/2016	S	O	11.4	13.72	9.21	88.1	7.82		0.175	55.8	42	0.04	0.48	8.53	0.005	0.026	0.792	700	1.032	0.19	E. coli samples were unable to be processed because lab was closed due to holiday schedule
Lones Ditch	11/22/2016	S	C	1.9	6.34	10.85	87.0	7.97	9.8	0.19	58	45.9	0.04	0.57	8.35	0.009	0.022	0.727	732	1	0.18	
Lones Ditch	12/6/2016	O	O	4.4	4.05	11.90	119.5	8.09	6.3	0.255	55.5	47.7	0.04	1.12	8.89	0.014	0.0339	0.867	745	0	0.17	
Lones Ditch	12/21/2016	C	O	-3.8	1.95	13.06	92.6	7.92	51.2													Dangerous weather & lab's holiday schedule nutrient sample was not taken for this site
Lones Ditch	1/4/2017	O	S	-3.8	2.98	11.60	85.0	7.97	61.3	0.15	49	47.2	0.02	2.78	6.6	0.014	0.0473	0.92	729	1.3586	0.14	
Lones Ditch	1/17/2017	R	C	7.5	3.39	12.41	91.9	8.71		0.13	46.5	42.1	0.02	3.37	6.53	0.035	0.007	1.047	683	7.5528	0.1	Because of timing of rain event EC samples could not be dropped off before lab closed for the day
Lones Ditch	1/19/2017	C	C	3.4	2.93	12.88	93.4	8.30	74.3	0.127	50.8	41.9	0.02	3.29	6.69	0.039	0.084	1.178	682	8.3612	0.14	Deep water - high flow est. tech. used for points 6.8-10.8m, the EC sample test start time was 19.5 hrs. after delivery due to lab error
Lones Ditch	1/31/2017	C	O	2.3	2.07	13.09	93.5	8.43	3.1	0.081	43.9	43.1	0.02	2.72	6.87	0.019	0.055	0.799	694	8.4	0.15	
Lones Ditch	2/8/2017	R	O	4.4	3.45	14.28	105.9	8.66	3.1	0.023	45.6	41.5	0	2.93	6	0.005	0.0388	0.678	699	19.563	0.29	
Lones Ditch	2/23/2017	C	S	16.8	9.37	11.39	97.2	8.78	2.0	0.054	49.8	43.1	0	2.51	4.41	0.004	0.0404	0.718	734	10.8	0.2	
Lones Ditch	3/1/2017	R	O	11.3	8.64	10.02	87.6	7.97	14.8	0.059	46.6	41.7	0	2.41	4.11	0.004	0.0379	0.821	679	9.8	0.16	
Lones Ditch	3/16/2017	SN	S	2.8	2.93	14.31	104.7	8.80	2.0	0.043	42.9	49.2	0.01	1.63	3.65	0.004	0.034	0.874	717	7	0.12	
Lones Ditch	3/30/2017	C	R	4.2	9.68	8.91	79.1	9.07	3.0	0.06	47.6	42.6	0	2.11	2.33	0.005	0.0393	0.821	710	9.9999	0.16	
Lones Ditch	4/11/2017	R	C	6.7	12.52	9.11	86.6	8.13	5.2	0.064	41.7	35.7	0	2.38	3	0.002	0.0414	0.995	655	12.8	0.21	Estimated using high flow protocol techniques
Lones Ditch	4/24/2017	S	S	14.5	16.75			8.61	4.1	0.072	40.7	38.8	0.02	1.41	1	0.003	0.028	0.838	655	10.893	0.13	DO sensor malfuction
Lones Ditch	5/10/2017	R	P/C	15.6	13.18	12.06	114.7	8.08	13.2	0.1	38.2	34.8	0.0	1.8	2.6	0.0	0.0	0.854	652	5.1	0.3	
Lones Ditch	5/22/2017	R	S	15.2	18.06	9.20	97.4	8.24	22.6	0.1	36.9	35.0	0.0	1.5	0.9	0.0	0.0	0.885	639	10.1	0.4	Estimated using high flow protocol techniques
Lones Ditch	6/1/2017	S	S	19.4	19.54	9.08	100.4	8.16	14.5	0.0	29.5	27.1	0.0	2.0	4.0	0.0	0.0	0.921	584	4.5	0.2	Estimated using high flow protocol techniques
Lones Ditch	6/15/2017	R	S	24.2	25.12	7.85	95.0	8.75	281.2	0.1	39.6	35.8	0.0	1.1	6.4	0.0	0.0	1.013	593	5.3	0.2	
Lones Ditch	6/29/2017	S	C	26.1	21.98	7.09	78.9	8.89	27.2	0.1	39.1	30.0	0.0	0.8	7.5	0.0	0.0	1.363	614	11.2	0.2	
Lones Ditch	7/10/2017	S	R/ST	21.4	23.67	6.98	82.3	9.17	161.6	0.1	32.1	28.1	0.1	1.2	7.3	0.0	0.1	0.525	547	24.3		Estimated using high flow protocol techniques
Lones Ditch	7/12/2017	R	O	24.5	23.82	5.58	64.6	9.20	727.0	0.1	29.6	25.2	0.1	1.2	7.5	0.0	0.1	0.579	520	8.9		
Lones Ditch	7/26/2017	S	O	26.2	25.49	5.48	67.3	8.01	24.9	0.2	30.2	24.6	0.0	0.4	8.8	0.0	0.1	1.203	506	6.3		
Lones Ditch	8/9/2017	S	S	20.9	23.16	9.41	11.0	7.99	22.6	0.1	37.5	27.0	0.0	0.0	10.1	0.0	0.1	1.100	527	7.6		
Lones Ditch	9/13/2017	O	O	19.0	19.79	7.58	82.0	7.93	17.1	0.1	49.8	29.3	0.0	0.1	8.8	0.0	0.0	0.810	621	3.4		
Lones Ditch	9/20/2017	S	O	23.0	22.86	7.25	84.4	7.93	39.9	0.1	46.3	31.5	0.0	0.0	8.8	0.0	0.0	0.812	594	5.5		
Lones Ditch	9/27/2017	S	O	20.5	24.61	4.75	57.0	7.75	29.2	0.1	50.9	30.6	0.0	0.0	9.3	0.0	0.0	0.756	616	0.7		
Lones Ditch	10/11/2017	R	OC	14.0	19.85	6.01	65.2	7.91	228.2	0.1	49.3	30.0	0.0	0.1	9.2	0.0	0.0	0.765	611	5.4		
Lones Ditch	10/25/2017	R	S	7.0	13.62	6.91	65.0	7.88	6.3	0.1	53.4	31.6	0.0	0.2	9.4	0.0	0.0	0.726	661	21.7		
Lones Ditch	11/8/2017	S	S	6.6	9.13	8.57	74.9	7.77	96.0	0.2	50.2	35.8	0.0	0.6	10.0	0.0	0.0	0.945	692	6.9		Estimated using high flow protocol techniques
Lones Ditch	11/15/2017	S	R	6.0	7.00	9.17	75.9	7.80	14.8	0.2	48.8	35.1	0.0	1.3	10.0	0.0	0.0	0.751	692	0.7		Estimated using high flow protocol techniques
Lones Ditch	11/29/2017	S	S	5.2	6.37	9.77	79.0	7.75	7.4	0.1	47.0	37.0	0.0	1.6	9.0	0.0	0.0	0.779	678	4.0		
Lones Ditch	12/13/2017	SN	C	-4.8	1.08	11.22	78.9	7.99	3.0	0.1	41.4	47.8	0.0	0.6	7.9	0.0	0.0	0.678	696	0.0		

Table 21 Lones Ditch Sampling Data (Site#7)

Stream Name	Date	Prior Day's Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/ 100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Peterson Ditch	1/27/2016	O	O	-1.7	1.88	12.93	95.0	8.22	107.1	0.098	26.3	76.9	0.01	1.66	7.78	0.005	0.0196	0.648	758	1.9	0.12	
Peterson Ditch	2/11/2016	SN	SN	-9.4	0.23	13.53	95.0	8.34	129.6	0.071	29.7	76.7	0.01	1.69	7.44	0.005	0.019	0.552	779	2.0876	0.15	
Peterson Ditch	2/22/2016	P/C	C/S	5.1	3.55	14.01	107.4	8.35	83.3	0.031	27.7	76.6	0.01	1.14	5.82	0.009	0.0181	0.464	741	1.5649	0.14	
Peterson Ditch	2/29/2016	R	O	3.8	5.10	12.45	94.2	8.09	224.7	0.061	18.9	47.4	0.02	5.92	5.63	0.028	0.1482	1.464	537	41.041	0.11	
Peterson Ditch	3/9/2016	P/C	O	16.3	10.44	11.83	107.7	8.44	224.7	0.025	25.4	70.5	0.01	3.02	4.4	0.002	0.025	0.708	693	4.3	0.13	
Peterson Ditch	3/23/2016	P/C	C	12.3	9.72	10.96	97.0	8.21	133.4	0.019	26.4	72.6	0.01	2.04	5.44	0.002	0.0204	0.57	726	2.5706	0.14	
Peterson Ditch	4/7/2016	R	R	3.0	6.90	10.60	87.5	8.05	>2419.2	0.087	17.4	33.3	0.01	2.33	5.15	0.039	0.3757	2.015	456	161.53	0.13	
Peterson Ditch	4/20/2016	C/S	C/S	16.4	11.95	11.17	104.4	8.47	137.6	0.909	32.2	60.4	0.02	1.21	4.34	0.007	0.0131	1.675	909	2.5706	0.12	
Peterson Ditch	5/4/2016	P/C	O	9.3	11.20	9.22	84.4	8.05	275.5	0.029	25.9	57.7	0.02	1.88	5.98	0.005	0.0369	0.813	672	2.8168	0.14	
Peterson Ditch	5/18/2016	C	S	16.0	12.50	10.13	94.4	8.12	104.6	0.02	21.6	61.5	0.01	1.88	5.8	0.011	0.022	0.661	707	4.329	0.12	
Peterson Ditch	6/1/2016	P/C	O	24.5	17.55	8.58	89.7	8.32	325.5	0.038	22.1	70.5	0.01	1.22	7.34	0.013	0.029	0.502	755	3.9603	0.15	
Peterson Ditch	6/16/2016	O	O	24.8	18.95	7.55	81.1	8.35	461.1	0.038	22.4	79.2	0.02	1.21	9.17	0.013	0.038	0.799	731	3.2894	0.16	
Peterson Ditch	6/23/2016	ST	O	28.1	20.09	6.74	74.0	7.94	2419.2	0.481	8.3	13.5	0.1	3.62	4.31	0.096	0.4304	3.399	287	187.5	0.11	
Peterson Ditch	7/7/2016	S	C	27.3	18.3	6.64	70.4	7.82	816.4	2.15	154.3	68.1	0.27	2.15	9.53	0.017	0.0698	4.883	1235	2.8818	0.16	
Peterson Ditch	7/21/2016	S	S	28.4	19.00	8.31	89.0	8.13	461.1	0.028	22.6	75.3	0	1.06	8.44	0.006	0.0343	0.418	768	11.2	0.13	
Peterson Ditch	8/4/2016	S	S	28.4	19.66	8.77	96.3	7.93	1986.3	0.03	38.3	78.5	0	0.83	8	0.013	0.0322	0.413	822	3	0.2	
Peterson Ditch	8/17/2016	O	C	26.0	19.77	8.17	89.4	7.90	488.4	0.015	52.1	74.8	0	1.08	11.12	0.017	0.0645	0.58	852	5.3333	0.19	
Peterson Ditch	8/31/2016	S	P/C	29.5	20.13	7.90	77.6	9.97	829.7	0.042	32.5	70.1	0	0.67	10.1	0.02	0.0546	0.568	781	5.8517	0.27	
Peterson Ditch	9/14/2016	S	O	22.7	18.22	8.14	84.1	8.25	594.4	0.003	28.8	60.4	0	0.78	9.87	0.017	0.0732	0.545	721	9.5124	0.18	
Peterson Ditch	9/28/2016	S	O	13.7	13.70	8.78	84.2	8.17	770.1	0.027	43	74	0	0.47	10.63	0.015	0.046	0.368	841	3.5971	0.17	
Peterson Ditch	10/12/2016	S	P/C	21.7	14.04	8.72	84.0	8.25	980.4	0.045	68.3	73.9	0.01	0.65	10.06	0.014	0.036	0.476	939	0	0.18	
Peterson Ditch	10/25/2016	S	S	8.7	9.76	9.48	81.0	8.36	63.1	0.02	34.2	70.3	0	0.87	10.45	0.013	0.0374	0.601	814	2.7573	0.32	
Peterson Ditch	11/8/2016	S	C	11.2	10.76	8.73	78.1	7.85		0.021	33.4	69.8	0	0.44	9.84	0.012	0.03	0.488	817	1.1402	0.21	E. coli samples were unable to be processed because lab was closed due to holiday schedule
Peterson Ditch	11/22/2016	S	C	2.9	4.22	14.85	111.7	8.10	43.7	0.01	36.8	67.6	0	0.36	8.45	0.009	0.023	0.457	820	2	0.2	
Peterson Ditch	12/6/2016	O	O	3.7	4.71	13.86	105.6	8.09	21.8	0.076	31.3	72.1	0.02	1.86	9.83	0.013	0.0322	0.831	788	0	0.18	
Peterson Ditch	12/19/2016	SN	S	-19.0	0.34	13.29	89.3	7.94	64.4	0.098	31.9	73.3	0.01	1.11	10.67	0.004	0.0194	0.516	833	26.2	0.2	
Peterson Ditch	1/4/2017	O	C	-3.1	2.69	13.47	97.4	7.98	2419.2	0.758	26.3	45.6	0.04	4.78	7.27	0.134	0.3524	2.8	608	42.288	0.12	
Peterson Ditch	1/17/2017	C	R	5.0	4.37	13.33	101.8	8.11		0.485	17.1	25.3	0.08	3.12	5.93	0.241	0.454	2.97	440	111.19	0.09	Because of timing of rain event EC samples could not be dropped off before lab closed for the day
Peterson Ditch	1/19/2017	C	C	2.8	4.39	12.67	96.4	8.11	74.4	0.132	21.1	50.6	0.03	5.12	7.41	0.028	0.092	1.383	615	12.285	0.12	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Peterson Ditch	1/31/2017	C	O	2.0	4.33	13.02	99.6	8.42	125.0	0.066	24.4	68.9	0.02	2.21	8.43	0.008	0.026	0.707	738	2.4	0.15	
Peterson Ditch	2/8/2017	R	O	4.3	4.92	13.94	107.2	8.18	579.4	0.163	21.0	35	0.01	4.87	6.63	0.06	0.2208	1.521	515	52.12	0.2	
Peterson Ditch	2/23/2017	C	S	24.3	10.61	12.02	107.4	8.87	104.8	0.026	25.7	63.7	0	1.93	6.1	0.008	0.0238	0.527	719	4.9	0.19	
Peterson Ditch	3/1/2017	R	O	10.9	9.55	10.11	84.6	7.61	>2419.2	0.103	21.6	26.9	0	3.93	6.11	0.027	0.7383	4.001	505	337.8	0.14	
Peterson Ditch	3/16/2017	SN	S	5.7	2.22	18.71	114.3	8.65	43.7	0.023	23.4	73.7	0.01	1.29	6.95	0.007	0.019	0.491	744	7.5	0.12	
Peterson Ditch	3/30/2017	C	R	4.7	8.32	8.35	70.9	8.72	238.2	0.020	26	53.5	0	2.28	5.5	0.008	0.039	0.639	682	15.1	0.16	
Peterson Ditch	4/11/2017	R	C	11.4	11.56	9.77	91.2	7.98	63.1	0.021	19	50	0	2.62	6.23	0.010	0.0533	0.933	642	11.3	0.21	
Peterson Ditch	4/24/2017	S	S	20.6	13.59			8.47	547.5	0.029	23.6	66.1	0.01	1.07	3.09	0.003	0.022	0.565	733	2.9498	0.14	DO sensor malfuction
Peterson Ditch	5/10/2017	R	C	16.8	11.59	11.13	95.9	7.88	121.0	0.040	19.6	57	0	2.12	7.17	0.011	0.0438	0.702	693	6.4794	0.30	
Peterson Ditch	5/22/2017	R	S	23	14.66	8.93	88.8	7.68	>2419.2	0.137	16.6	34.6	0	3.31	7.97	0.050	0.1726	0.663	552	30	0.40	
Peterson Ditch	6/1/2017	S	S	26.1	15.01	8.62	86.3	7.96	105.0	1.169	56.6	52.3	0.06	2.23	8.65	0.019	0.0818	2.705	838	10.309	0.16	
Peterson Ditch	6/15/2017	R	S	32.5	19.11	8.57	91.4	8.38	770.1	0.025	25.2	76.8	0.01	1.54	8.6	0.014	0.043	0.525	750	2	0.17	
Peterson Ditch	6/29/2017	S	O	26.8	17.53	7.89	83.2	9.11	461.1	0.035	22.6	69.9	0	1.43	8.71	0.012	0.0412	1.548	757	6.1	0.17	
Peterson Ditch	7/10/2017	S	O	24	20.07	5.44	60	8.75	1553.1	0.176	10.9	26.8	0.07	1.81	6.24	0.064	0.2205	0.785	433	43.7		
Peterson Ditch	7/12/2017	R	O	26.6	20.2	4.92	53.3	8.62	1046.2	0.156	13	27.7	0.08	1.48	7.54	0.061	0.2105	0.917	487	30.2		
Peterson Ditch	7/26/2017	S	O	23.1	18.59	4.57	48.7	7.59	517.2	0.087	23.9	47.8	0.02	1.3	10.46	0.027	0.1058	1.071	699	9.6082		
Peterson Ditch	8/9/2017	S	S	23.9	16.64	9.01	92.7	8.05	1203.3	0.034	21.4	63.7	0	1.07	9.69	0.01	0.0481	0.601	753	6.8587		
Peterson Ditch	9/13/2017	O	R	18.2	15.77	7.81	78.5	8.06	>2419.2	0.029	25.4	73.9	0	0.66	9.02	0.014	0.0281	0.38	778	1.3541		
Peterson Ditch	9/20/2017	S	S	29.1	18.47	7.04	74.8	7.9	>2419.2	0.064	32	60.3	0.01	0.99	9.42	0.014	0.06	0.386	710	10.33		
Peterson Ditch	9/27/2017	S	O	21.3	18.73	5.94	63.6	8.03	613.1	0.026	26	71.9	0	0.34	10.79	0.016	0.037	0.383	789	2.0804		
Peterson Ditch	10/11/2017	R	C	15	15.83	6.74	67.2	7.97	2419.2	0.03	26.3	54.8	0	0.45	10.35	0.02	0.058	0.523	719	5.5594		
Peterson Ditch	10/25/2017	R	S	8.9	9.94	8.81	77.5	8.09	178.5	0.325	83	61.5	0	0.74	11.08	0.009	0.0421	1.209	999	0		
Peterson Ditch	11/8/2017	S	S	9.4	8.85	10.89	94.9	7.8	648.8	0.061	28.4	62.9	0	2.25	9.69	0.012	0.0449	0.923	764	4.9157		
Peterson Ditch	11/15/2017	S	R	7.5	7.76	9.74	81.7	7.82	410.6	0.008	25.8	59.1	0	1.31	9.24	0.014	0.0348	0.453	732	5.9327		
Peterson Ditch	11/29/2017	S	S	9	8.12	10.83	91.6	7.91	81.3	0.065	28.7	64.5	0	1.58	9.72	0.005	0.0263	0.627	771	2.0311		
Peterson Ditch	12/13/2017	SN	C	-1.7	1.82	12.24	88.0	8.02	146.7	0.058	22.1	43.7	0.02	1.55	8.95	0.009	0.0139	0.427	779	0		

Table 22 Martin Peterson Ditch Sampling Data (Site #6)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/ 100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Walnut Creek (Eagle)	1/26/2016	R	O	-0.7	2.17	11.85	87.7	8.18	93.3	0.105	29	59.1	0.02	2.99	5.76	0.006	0.0456	1.462	725	5.4	0.15	
Walnut Creek (Eagle)	2/9/2016	SN	O	-3.2	1.28	12.52	90.2	8.22	53.8	0.049	26.8	57.2	0.01	2.63	4.49	0.003	0.035	1.098	703	5.6243	0.14	
Walnut Creek (Eagle)	2/22/2016	P/C	C/S	3.0	2.79	12.93	96.1	8.23	27.5	0.061	28.8	59.1	0.01	2.02	4.42	0.01	0.0289	0.858	715	3.9154	0.13	
Walnut Creek (Eagle)	3/2/2016	SN	O	-2.7	2.42	12.91	95.5	8.35	66.3	0.062	25	54.9	0.01	3.31	4.81	0.003	0.0437	1.069	667	-2.923	0.12	Edge point was estimated
Walnut Creek (Eagle)	3/9/2016	P/C	O	18.2	9.91	10.32	93.0	8.33	29.5	0.036	25.9	55.7	0.01	2.95	3.08	0.002	0.0349	1.077	680	7.3	0.13	
Walnut Creek (Eagle)	3/23/2016	P/C	C	11.2	10.11	9.41	83.9	8.10	63.3	0.025	29.3	54.3	0.02	2.33	2.31	0.001	0.0295	1.002	694	8.6313	0.14	
Walnut Creek (Eagle)	4/7/2016	R	R	3.9	6.93	9.86	81.7	8.16	1203.3	0.029	24.9	42.1	0.01	2.44	2.39	0	0.0512	1.16	610	13.139	0.14	
Walnut Creek (Eagle)	4/20/2016	C/S	C/S	15.3	13.47	9.39	90.8	8.36	88.4	0.034	33.6	50.2	0.01	0.54	2.41	0.007	0.018	1.008	675	10.406	0.15	
Walnut Creek (Eagle)	5/4/2016	P/C	O	9.0	12.64	7.87	68.2	7.91	248.1	0.04	21.9	44.8	0.02	1.68	2.59	0.009	0.0426	1.058	648	6.9821	0.12	
Walnut Creek (Eagle)	5/18/2016	C	S	18.7	13.50	8.68	82.6	7.95	1.0	0.042	22.7	39.6	0.01	1.71	2.7	0.003	0.049	1.057	658	5.3078	0.19	
Walnut Creek (Eagle)	6/1/2016	P/C	P/C	25.7	20.07	7.18	78.9	8.17	248.9	0.138	28	50.4	0.05	1.22	7.52	0.05	0.097	0.939	708	4.7169	0.15	
Walnut Creek (Eagle)	6/16/2016	O	O	21.5	22.17	7.03	79.4	8.03	387.3	0.064	22.6	61.8	0.02	0.51	8.38	0.052	0.107	1.345	633	6.8681	0.17	
Walnut Creek (Eagle)	6/23/2016	ST	O	28.1	22.22	4.36	47.5	8.12	2419.2	0.16	13.6	27	0.12	3.19	5.87	0.054	0.1238	2.668	434	8.9186	0.13	
Walnut Creek (Eagle)	7/7/2016	S	S	27.4	22.44	5.55	64.1	7.75	195.6	0.043	24	36.7	0.02	1.25	7.1	0.05	0.1068	1.608	614	4.1194	0.15	
Walnut Creek (Eagle)	7/21/2016	S	S	27.7	23.42	6.74	78.8	8.01	150.0	0.052	24.9	46.3	0.01	0.69	7.81	0.041	0.0929	0.87	635	10.8	0.12	
Walnut Creek (Eagle)	8/4/2016	S	S	29.0	22.81	7.25	84.4	7.86	186.0	0.061	27.9	54.3	0.01	0.54	8.42	0.061	0.097	0.747	669	9.2	0	
Walnut Creek (Eagle)	8/17/2016	O	C	24.0	22.60	7.30	84.9	7.85	260.2	0.024	28.9	50.4	0	0.81	11.86	0.065	0.1247	0.686	656	4.1067	0.18	
Walnut Creek (Eagle)	8/31/2016	S	P/C	26.7	23.65	6.46	76.3	9.40	183.5	0.063	22.9	41.1	0	0.44	10.63	0.057	0.1035	0.959	597	5.9132	0.25	
Walnut Creek (Eagle)	9/14/2016	S	O	23.6	21.21	6.96	78.4	8.13	980.4	0.058	20.4	38.8	0	0.67	10.75	0.036	0.1198	1.21	600	14.44	0.16	
Walnut Creek (Eagle)	9/28/2016	S	R	13.4	14.38	8.92	86.7	8.15	146.7	0.04	33.3	51.2	0	0.6	10.72	0.045	0.082	0.689	705	1.9493	0.17	
Walnut Creek (Eagle)	10/12/2016	S	P/C	20.4	14.82	8.82	86.8	8.29	90.7	0.006	36.4	60.2	0.01	0.57	9.39	0.027	0.055	0.662	712	5.8873	0	
Walnut Creek (Eagle)	10/25/2016	S	S	7.7	9.66	8.75	75.5	8.30	146.7	0.018	24.5	46.9	0	0.82	10.27	0.03	0.0591	0.933	679	0.7874	0.32	
Walnut Creek (Eagle)	11/8/2016	S	C	11.2	10.80	6.38	57.6	7.67		0.005	29.2	52.1	0.01	0.57	10	0.028	0.058	0.821	720	1.0752	0.2	E. coli samples were unable to be processed because lab was closed
Walnut Creek (Eagle)	11/22/2016	S	C	3.8	3.15	14.58	106.2	8.09	131.3	0	60.5	55.2	0.01	0.74	6.8	0.012	0.027	0.768	737	1	0.19	
Walnut Creek (Eagle)	12/6/2016	O	O	1.6	3.35	13.52	101.6	8.01	63.7	0.116	27.4	49.9	0.02	1.76	7.66	0.014	0.0429	1.11	711	-2.1	0.18	
Walnut Creek (Eagle)	12/21/2016	C	O	-1.0	0.21	11.90	79.0	7.86	27.8													Dangerous weather & lab's holiday schedule nutrient sample was not taken for this site
Walnut Creek (Eagle)	1/4/2017	O	S	-2.8	1.19	13.28	89.7	7.96	344.8	0.166	25	42.7	0.03	4.65	6.42	0.031	0.0863	1.536	642	8.7719	0.13	
Walnut Creek (Eagle)	1/17/2017	R	C	5.2	4.09	12.24	92.9	8.10		0.126	24.7	36.5	0.03	3.67	5.99	0.047	0.1	1.437	563	6.6389	0.12	Because of timing of rain event EC samples could not be dropped off before lab closed for the day
Walnut Creek (Eagle)	1/19/2017	C	C	2.7	2.62	12.02	90.2	8.12	127.4	0.165	20	39.3	0.03	4.97	6.38	0.059	0.109	1.526	592	6.8284	0.12	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Walnut Creek (Eagle)	1/31/2017	C	O	1.5	2.22	12.57	89.3	8.34	58.3	0.127	24.5	48.6	0.02	3.31	6.67	0.021	0.064	1.153	670	8.4	0.15	
Walnut Creek (Eagle)	2/8/2017	R	O	1.1	3.15	12.05	92.6	8.32	260.2	0.067	22.7	38.9	0	3.75	6.17	0.025	0.0885	0.981	611	12.903	0.31	
Walnut Creek (Eagle)	2/23/2017	C	S	22.9	10.12	9.05	79.6	8.58	43.2	0.035	26.9	47	0	2.96	2.15	0.004	0.0357	1.131	680	9.6	0.2	
Walnut Creek (Eagle)	3/1/2017	R	O	10.5	9.53	8.94	78.2	7.68	613.1	0.046	25.7	39	0	2.4	2.62	0.008	0.0719	1.023	621	11.1	0.15	
Walnut Creek (Eagle)	3/16/2017	SN	S	5.3	1.16	15.97	108.2	8.61	63.1	0.018	26.8	54.5	0.01	1.97	2.5	0.006	0.026	0.903	700	6.5	0.12	
Walnut Creek (Eagle)	3/30/2017	C	R	4.2	8.93	7.30	63.2	8.67	96.0	0.024	24.2	39.9	0	2.13	1.79	0.006	0.0355	0.921	652	20	0.16	
Walnut Creek (Eagle)	4/11/2017	R	C	10	12.4	6.7	63.4	7.86	45.7	0.042	21.7	34.4	0	2.49	2.68	0.007	0.0463	1.248	606	7.6	0.21	
Walnut Creek (Eagle)	4/24/2017	S	S	18.6	14.92			8.1	86	0.085	27	43.8	0.03	1.29	2.83	0.017	0.049	0.884	672	4.2417	0.14	DO sensor malfuction
Walnut Creek (Eagle)	5/10/2017	R	C	17.3	12.75	8.58	80.5	7.73	29.8	0.066	20.3	32.5	0	1.93	3.46	0.018	0.0574	1.052	612	2.0949	0.32	
Walnut Creek (Eagle)	5/22/2017	R	S	20.4	16.03	6.32	60.9	7.69	>2419.2	0.096	17.9	28.3	0	2.41	4.6	0.036	0.1167	1.374	568	8	0.4	
Walnut Creek (Eagle)	6/1/2017	S	S	27	17.9	4.63	48.8	7.86	81.6	0.087	16.8	24.5	0	1.49	6.62	0.069	0.1192	1.356	548	4.9929	0.19	
Walnut Creek (Eagle)	6/15/2017	R	S	26.2	22.15	3.78	43	7.85	579.4	0.161	29	41.4	0.05	0.98	9.52	0.106	0.182	1.101	646	3.1	0.17	
Walnut Creek (Eagle)	6/29/2017	S	O	27.1	20.05	4.93	53.8	8.55	172.2	0.044	21.2	39.7	0	1.3	7.88	0.042	0.0971	1.287	656	5.2	0.18	
Walnut Creek (Eagle)	7/10/2017	S	O	26.4	22.2	2.83	29.7	8.66	62.4	0.125	10	14	0.07	1.01	5.95	0.098	0.1689	0.64	350	6		Too deep to cross/no bridge; high flow estimation protocol not used
Walnut Creek (Eagle)	7/12/2017	R	O	26.1	22.77	5.22	55.8	9.09	365.4	0.109	12.4	15.7	0.06	0.52	6.95	0.124	0.2008	0.752	400	2.9		Too deep to cross/no bridge; high flow estimation protocol not used
Walnut Creek (Eagle)	7/26/2017	S	O	23.9	23.11	2.68	30.3	7.38	129.6	0.091	17.7	23.5	0.02	0.64	8.65	0.107	0.1808	0.574	555	2.2865		
Walnut Creek (Eagle)	8/9/2017	S	S	25.7	19.81	4.58	50.1	7.71	261.3	0.09	24.2	34.7	0.01	0.63	7.85	0.068	0.1216	1.046	652	0.7628		
Walnut Creek (Eagle)	9/13/2017	O	R	18.7	16.47	4.85	49.1	7.69	152.9	0.06	32.3	45.7	0.01	0.35	6.55	0.045	0.0959	0.681	721	4.4809		
Walnut Creek (Eagle)	9/20/2017	S	S	28.9	20.47	3.15	34.8	7.42	770.1	0.029	23.2	36.6	0.01	0.18	7.78	0.083	0.147	0.411	586	3.6522		
Walnut Creek (Eagle)	9/27/2017	S	O	21.1	20.96	2.2	24.5	7.51	79.4	0.064	27	38	0.01	0.09	10.3	0.119	0.187	0.865	663	0.7502		
Walnut Creek (Eagle)	10/11/2017	R	OC	16.8	17.5	3.54	36.8	7.7	344.8	0.054	23.9	36.2	0	0.25	9.46	0.11	0.1801	0.877	641	2.1739		
Walnut Creek (Eagle)	10/25/2017	R	S	9.7	10.14	4.45	39.2	7.72	488.4	0.013	28.2	38	0	0.2	7.7	0.071	0.122	0.871	676	4.2		
Walnut Creek (Eagle)	11/8/2017	S	S	7.9	7.43	8.03	67.5	7.65	579.4	0.084	21	40.1	0	0.84	5.46	0.023	0.0638	1.172	661	3.5662		
Walnut Creek (Eagle)	11/15/2017	S	R	6.4	6.43	8.31	68.1	7.71	218.7	0.048	24.8	39.7	0	1.31	5.7	0.022	0.0466	0.834	688	2.0107		
Walnut Creek (Eagle)	11/29/2017	S	S	8.5	6.41	8.68	70.2	7.66	62	0.108	25.8	38.1	0	1.91	7.06	0.019	0.0538	1.118	662	2.092		
Walnut Creek (Eagle)	12/13/2017	SN	O	-2.2	0.52	10.78	74.4	7.92	108.6	0.125	26.4	75.4	0.02	0.88	6.07	0.025	0.0398	0.963	713	2.4509		

Table 23 Walnut Creek Sampling Data (Site #8)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Walnut Creek (Tippy)	1/26/2016	R	O	-1.1	1.40	11.96	86.3	8.15	41.9	0.099	41.6	50.8	0.01	1.22	5.09	0.005	0.0581	1.198	692	12.2	0.14	
Walnut Creek (Tippy)	2/9/2016	SN	SN	-4.3	1.33	12.12	87.5	8.16	47.2	0.058	39.1	52.1	0.01	1.08	4.29	0.006	0.045	0.954	688	6.8259	0.15	
Walnut Creek (Tippy)	2/22/2016	P/C	C/S	2.0	2.6	12.17	91.8	8.13	17.5	0.105	40.5	53.2	0.01	0.84	3.9	0.008	0.0383	0.844	696	5.3144	0.14	
Walnut Creek (Tippy)	3/2/2016	SN	O	-3.1	2.00	12.94	94.8	8.55	27.8	0.061	35.2	48.9	0.01	1.5	3.37	0.002	0.0373	0.961	646	0	0.13	Stream depth was too deep to use flowmeter, high flow estimation technique used
Walnut Creek (Tippy)	3/9/2016	P/C	O	16.1	9.45	10.71	94.9	8.49	23.1	0.054	38.2	49.4	0.01	1.18	1.89	0.002	0.0357	0.961	666	3.4	0.14	Stream depth was too deep to use flowmeter, high flow estimation technique used
Walnut Creek (Tippy)	3/23/2016	P/C	C	10.7	9.58	9.03	79.7	8.18	13.4	0.04	42.9	52.4	0.01	0.89	1.38	0	0.0296	0.837	680	4.5872	0.16	Stream depth was too deep to use flowmeter, high flow estimation technique used
Walnut Creek (Tippy)	4/7/2016	R	R	3.5	7.37	9.31	77.7	8.26	139.6	0.047	33	43.1	0.01	1	1.25	0.004	0.0352	0.865	609	10.591	0.14	Stream depth was too deep to use flowmeter, high flow estimation technique used
Walnut Creek (Tippy)	4/20/2016	C/S	C/S	14.4	15.13	5.75	56.2	8.14	78.9	0.064	26.4	48.3	0.03	1.82	2.11	0.007	0.0361	1.038	668	8.3877	0.15	
Walnut Creek (Tippy)	5/4/2016	P/C	R	9.0	13.39	5.36	51.8	7.71	272.3	0.093	30.6	42.2	0.02	0.95	3.84	0.015	0.0935	1.12	663	32.666	0.16	
Walnut Creek (Tippy)	5/18/2016	C	S	19.1	13.97	7.05	65.6	7.90	80.1	0.086	35.3	42.9	0.01	0.71	2.16	0.011	0.043	0.901	652	2.0121	0.19	Edge and partial flow were estimated because water became too deep
Walnut Creek (Tippy)	6/1/2016	P/C	P/C	24.4	21.50	5.95	57.9	7.94	290.9	0.166	40.5	48.1	0.03	0.46	5.41	0.027	0.096	0.997	693	6.6225	0.16	
Walnut Creek (Tippy)	6/16/2016	O	O	22.4	22.77	4.79	55.1	7.98	387.3	0.187	40.8	61.2	0.03	0.2	6.94	0.037	0.106	1.398	672	14.507	0.18	
Walnut Creek (Tippy)	6/23/2016	ST	O	30.6	24.20	5.33	61.7	8.26	1732.9	0.127	23.9	37.4	0.06	1.21	3.97	0.02	0.0913	1.658	484	6.1728	0.13	Estimated using high flow protocol techniques
Walnut Creek (Tippy)	7/7/2016	S	S	28.8	23.56	4.44	51.7	7.63	214.3	0.103	32.9	39.3	0.03	0.55	6.06	0.02	0.1016	1.474	595	6.3761	0.16	
Walnut Creek (Tippy)	7/21/2016	S	S	27.6	24.92	4.74	56.8	7.75	248.1	0.113	36.8	44	0.02	0.31	6.09	0.013	0.1016	1.031	612	26	0.1	
Walnut Creek (Tippy)	8/4/2016	S	S	27.4	23.34	4.76	55.8	7.55	307.6	0.17	45.2	48.5	0.02	0.23	7.93	0.045	0.0864	0.77	670	6.9	0.26	
Walnut Creek (Tippy)	8/17/2016	O	C	22.0	21.99	4.40	52.8	7.56	770.1	0.197	49.8	54.9	0	0.51	12.76	0.053	0.1324	0.635	719	3.808	0.24	
Walnut Creek (Tippy)	8/31/2016	S	P/C	24.5	24.36	5.53	58.8	8.98	307.6	0.129	35.2	43.6	0	0.13	7.72	0.029	0.0819	0.937	576	15.594	0.27	
Walnut Creek (Tippy)	9/14/2016	S	O	23.3	22.14	5.32	60.9	7.99	344.8	0.11	34.6	43.4	0	0.33	7.65	0.022	0.0912	0.839	580	12.658	0.18	
Walnut Creek (Tippy)	9/28/2016	S	R	13.4	16.09	6.70	67.5	7.87	101.2	0.125	46.7	51.7	0	0.19	7.67	0.02	0.06	0.704	669	6.1823	0.19	
Walnut Creek (Tippy)	10/12/2016	S	P/C	19.2	15.66	6.90	67.4	8.01	98.8	0.113	50.8	58	0	0.15	7.8	0.02	0.047	0.648	691	3.9904	0.23	
Walnut Creek (Tippy)	10/25/2016	S	S	6.5	10.93	6.67	57.3	8.10	185.0	0.078	44.6	45.1	0	0.3	7.49	0.018	0.0532	0.759	644	3.3112	0.32	
Walnut Creek (Tippy)	11/8/2016	S	C	11.1	12.39	5.89	54.6	7.62		0.029	41.4	45.1	0	0.07	6.25	0.004	0.053	0.68	608	2.0181	0.19	E. coli samples not processed, lab was closed due to holiday
Walnut Creek (Tippy)	11/22/2016	S	C	1.5	4.31	11.61	86.2	7.92	58.1	0.09	45.9	53.3	0.01	0.22	6.3	0.013	0.034	0.689	688	2	0.19	
Walnut Creek (Tippy)	12/6/2016	O	O	3.6	3.49	12.11	87.4	7.96	70.3	0.176	37.8	44.6	0.02	0.54	6.41	0.015	0.037	0.801	651	0	0.18	
Walnut Creek (Tippy)	12/21/2016	C	O	-3.0	0.33	11.72	76.3	7.91	24.6													Dangerous weather & lab's holiday schedule nutrient sample was not taken
Walnut Creek (Tippy)	1/4/2017	O	S	-5.4	1.50	12.87	88.8	8.05	116.9	0.145	34.5	41.7	0.02	1.62	5.11	0.014	0.0666	1.114	616	5.1546	0.14	Estimated using high flow protocol techniques
Walnut Creek (Tippy)	1/17/2017	R	C	4.0	3.47	12.79	94.6	8.27		0.107	34.5	39.5	0.02	1.54	5.04	0.024	0.058	1.093	584	2.4979	0.11	Est. using high flow protocol techniques. Timing of rain event EC samples could not be dropped off before lab closed
Walnut Creek (Tippy)	1/19/2017	C	C	2.8	2.12	13.99	95.3	8.23	54.7	0.116	30.4	40.3	0.03	2.37	5.45	0.027	0.068	1.275	594	3.2284	0.13	Est. using high flow protocol techniques. The EC sample test start time was 19.5 hrs. after delivery due to lab error
Walnut Creek (Tippy)	1/31/2017	C	O	1.7	1.62	12.43	88.0	8.33	28.8	0.077	36.1	46.8	0.02	1.61	5.58	0.012	0.045	0.891	651	3.3	0.16	Water too deep, high flow est. tech. was used for points 4.5-14.4m
Walnut Creek (Tippy)	2/8/2017	R	O	4.5	3.76	11.61	86.5	8.38	88.2	0.047	32.3	35.8	0	1.77	4.7	0.009	0.056	0.907	596	8.9504	0.31	Water too deep high flow est. tech. was used for points 6.6-14.6m
Walnut Creek (Tippy)	2/23/2017	C	S	20.1	8.86	9.63	82.2	8.64	18.7	0.062	39	42.8	0	1.5	2.5	0.007	0.0434	0.956	660	5.2	0.22	Water too deep, high flow est. tech. was used for points 4.5-14.4m
Walnut Creek (Tippy)	3/1/2017	R	O	11.1	9.05	9.20	80.1	7.88	150.0	0.086	34.4	37.8	0	1.35	2.43	0.012	0.0641	0.787	576	15.6	0.16	
Walnut Creek (Tippy)	3/16/2017	SN	S	2.9	1.21	14.33	101.6	8.70	104.6	0.042	37.2	53.3	0.01	1.06	2.41	0	0.038	0.989	688	15.3	0.13	
Walnut Creek (Tippy)	3/30/2017	C	R	4.4	9.01	7.44	64.9	8.22	39.5	0.049	35.2	42.4	0	1.37	1.49	0.007	0.0391	0.895	650	0	0.17	
Walnut Creek (Tippy)	4/11/2017	R	C	10	12.88	7.05	67.7	7.98	35.9	0.1	31.2	38.1	0.0	1.5	1.6	0.0	0.0	1.0	610.0	6.4	0.2	Estimated using high flow protocol techniques
Walnut Creek (Tippy)	4/24/2017	S	S	18.2	15.43			7.94	62.1	0.1	47.2	38.2	0.0	0.5	4.5	0.0	0.1	1.0	700.0	7.5	0.2	DO sensor malfuction
Walnut Creek (Tippy)	5/10/2017	R	C	16.1	12.9	8.65	81.2	7.84	193.5	0.1	30.0	39.1	0.0	1.2	2.0	0.0	0.0	0.9	616.0	0.0	0.3	
Walnut Creek (Tippy)	5/22/2017	R	S	18.9	16.97	5.72	59.7	7.81	920.8	0.1	24.8	31.9	0.0	1.3	3.3	0.0	0.1	1.1	563.0	6.6	0.4	
Walnut Creek (Tippy)	6/1/2017	S	S	24.6	19.12	5.75	60.2	8.1	72.7	0.1	24.7	31.3	0.0	1.0	3.7	0.0	0.1	1.1	563.0	6.6	0.2	Estimated using high flow protocol techniques
Walnut Creek (Tippy)	6/15/2017	R	S	26.3	23.36	2.53	29.4	7.8	283.2	0.2	39.9	38.7	0.0	0.4	6.6	0.1	0.2	1.1	591.0	2.1	0.2	
Walnut Creek (Tippy)	6/29/2017	S	O	25.6	20.93	4.44	49.3	8.48	104.6	0.1	35.5	37.8	0.0	0.6	6.0	0.0	0.1	1.0	635.0	10.0	0.2	
Walnut Creek (Tippy)	7/10/2017	S	O	26.7	22.83	3.37	38.4	8.57	214.3	0.1	17.1	23.9	0.1	0.9	3.7	0.0	0.1	0.6	425.0	16.1		Estimated using high flow protocol techniques
Walnut Creek (Tippy)	7/12/2017	R	O	26.4	23.72	4.56	42.2	8.9	325.5	0.1	18.1	23.5	0.1	0.5	4.2	0.1	0.1	0.6	427.0	5.0		Estimated using high flow protocol techniques
Walnut Creek (Tippy)	7/26/2017	S	R	24	24.53	1.54	17.8	7.29	86.0	0.1	25.9	25.2	0.0	0.3	6.7	0.1	0.1	1.0	524.0	0.7		Estimated using high flow protocol techniques
Walnut Creek (Tippy)	8/9/2017	S	S	24.2	21.3	3.94	44.2	7.61	129.6	0.1	34.0	30.7	0.0	0.3	6.8	0.0	0.1	0.8	594.0	4.8		
Walnut Creek (Tippy)	9/13/2017	O	R	19	18.2	4.2	44.4	7.57	191.8	0.1	40.3	43.5	0.0	0.2	7.4	0.0	0.1	0.8	660.0	4.7		
Walnut Creek (Tippy)	9/20/2017	S	S	28	21.55	3.27	36.5	7.49	517.2	0.1	31.1	39.7	0.0	0.1	7.4	0.0	0.1	0.3	566.0	4.7		
Walnut Creek (Tippy)	9/27/2017	S	O	21.6	22.29	2.89	32.7	7.57	155.3	0.2	35.9	40.9	0.0	0.1	8.4	0.1	0.1	0.8	619.0	4.2		
Walnut Creek (Tippy)	10/11/2017	R	R	14.4	17.77	4.12	43.1	7.68	461.1	0.1	32.4	30.0	0.0	0.2	7.5	0.1	0.1	0.8	535.0	3.6		
Walnut Creek (Tippy)	10/25/2017	R	S	8.5	11.06	5.06	45.2	7.71	160.7	0.1	37.4	35.9	0.0	0.1	8.6	0.0	0.1	0.8	628.0	2.7		
Walnut Creek (Tippy)	11/8/2017	S	S	9.7	8.13	6.83	58.6	7.64	307.6	0.1	27.9	37.2	0.0	0.3	5.9	0.0	0.0	0.9	589.0	2.1		Estimated using high flow protocol techniques
Walnut Creek (Tippy)	11/15/2017	S	R	7.2	6.71	7.48	64.1	7.62	160.7	0.1	35.1	35.2	0.0	0.9	5.9	0.0	0.0	0.7	596.0	2.7		
Walnut Creek (Tippy)	11/29/2017	S	S	8	6.47	8.33	67.6	7.62	40.4	0.1	36.9	37.5	0.0	0.9	6.7	0.0	0.1	1.0	631.0	11.7		Estimated using high flow protocol techniques
Walnut Creek (Tippy)	12/13/2017	SN	C	-2.2	0.75	10.28	71.0	8.05	52.9	0.1	29.8	42.5	0.0	0.3	5.7	0.0	0.0	0.8	697.0	1.3		

Table 24 Walnut Creek at the Tippecanoe River (Site #9)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (oC)	Water Temp (oC)	DO (mg/L)	DO (%sat)	pH	EC (cfu/ 100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Tippy River	1/26/2016	R	O	-0.7	2.26	12.94	95.9	8.26	21.8	0.023	29.3	37.6	0	0.67	4.6	0.004	0.0234	0.736	572	3.2	0.15	
Tippy River	2/9/2016	SN	SN	-5.2	2.08	13.34	98.5	8.29	41.9	0.015	29.1	37	0.01	0.68	4.04	0.006	0.021	0.59	586	0.9689	0.14	
Tippy River	2/22/2016	P/C	C/S	1.3	3.20	12.85	97.7	8.26	57.6	0.04	31	38.6	0.01	0.66	4.12	0.006	0.0239	0.624	600	2.7124	0.13	
Tippy River	3/2/2016	SN	O	-3.0	2.53	21.31	108.0	8.35	22.8	0.055	40.1	42.2	0.01	1.2	4.02	0.001	0.0277	0.639	645	0.9814	0.13	Stream depth was too deep to use the flowmeter and high flow estimate technique was not used
Tippy River	3/9/2016	P/C	O	15.4	7.45	11.50	99.3	8.53	36.9	0.025	30.8	36.7	0	0.79	3.4	0.002	0.0241	0.592	581	2.6	0.14	
Tippy River	3/23/2016	P/C	C	9.4	8.44	10.33	92.9	8.31	35.0	0.032	33.7	38	0.01	0.79	2.93	0.002	0.0237	0.626	592	7.4627	0.15	
Tippy River	4/7/2016	R	R	2.4	7.29	10.54	88.3	8.35	48.8	0.033	29.4	35	0.01	0.9	2.84	0.004	0.0267	0.615	568	8.2212	0.15	
Tippy River	4/20/2016	C/S	C/S	13.4	14.93	8.93	88.7	8.50	28.2	0.025	38.6	46.6	0.02	0.58	1.31	0.006	0.012	0.782	571	9.0702	0.16	
Tippy River	5/4/2016	P/C	R	8.6	13.57	7.85	74.8	8.08	81.6	0.043	26	33.9	0.01	0.46	1.77	0.003	0.0227	0.636	558	5.7707	0.12	
Tippy River	5/18/2016	C	S	19.7	13.70	8.57	82.0	8.31	96.0	0.033	24.8	32.1	0.01	0.43	1.38	0.003	0.02	0.642	547	4.0858	0.18	
Tippy River	6/1/2016	P/C	P/C	22.9	22.00	6.87	77.8	8.08	248.9	0.129	28.3	36.1	0.02	0.42	3.92	0.014	0.045	0.752	568	1.0695	0.13	
Tippy River	6/16/2016	O	S	24.0	23.32	6.28	73.2	8.18	135.4	0.053	28.4	43.5	0.01	0.23	5.19	0.007	0.032	0.921	554	6.9767	0.15	Edge point was estimated
Tippy River	6/23/2016	ST	O	28.5	25.35	7.60	92.7	8.43	290.9	0.081	34	37.8	0.02	0.84	5.09	0.004	0.0351	1.169	563	2.1881	0.13	
Tippy River	7/7/2016	S	S	25.8	23.76	6.29	73.7	7.93	101.9	0.041	29	34.6	0.01	0.41	5.15	0.005	0.0453	0.978	529	5.1334	0.14	
Tippy River	7/21/2016	S	S	26.4	24.76	6.24	74.6	7.96	172.2	0.058	32.5	38.7	0.01	0.33	6.74	0.003	0.0373	0.648	562	10.3	0.12	
Tippy River	8/4/2016	S	S	20.5	24.50	5.75	68.6	7.72	166.4	0.202	33.5	39.1	0	0.15	7.02	0.008	0.0328	0.578	544	7.4	0.19	
Tippy River	8/17/2016	O	O	22.0	23.61	6.35	74.5	7.73	137.6	0.038	36.9	42.8	0	0.52	8.95	0.003	0.0648	0.533	542	5.5096	0.16	
Tippy River	8/31/2016	S	P/C	24.3	24.77	5.85	70.5	9.08	285.1	0.042	28.6	32.3	0	0.09	5.26	0.006	0.0507	0.64	480	16.139	0.24	
Tippy River	9/14/2016	S	O	25.4	22.30	6.94	79.8	8.13	111.2	0.042	32.2	34.6	0	0.36	5.77	0.005	0.0337	0.437	513	10.274	0.18	
Tippy River	9/28/2016	S	R	12.2	16.54	7.88	79.6	8.00	55.6	0.02	30.9	35.7	0	0.2	7.13	0.003	0.025	0.449	545	3.4051	0.15	
Tippy River	10/12/2016	S	P/C	21.3	16.56	8.33	84.4	8.17	59.1	0.029	31.5	36	0	0.09	6.17	0.007	0.017	0.489	508	0.8795	0.19	
Tippy River	10/25/2016	S	S	7.6	11.77	8.49	77.7	8.29	32.3	0.028	33.6	36.2	0	0.29	7.36	0.006	0.0185	0.492	566	1.6978	0.31	
Tippy River	11/8/2016	S	O	11.8	12.93	8.57	80.4	7.74		0.032	27.1	32.8	0	0.13	6.61	0.004	0.021	0.526	513	4.1885	0.19	E. coli samples were unable to be processed because lab was closed due to holiday schedule
Tippy River	11/22/2016	S	C	3.5	6.09	13.65	107.5	8.00	24.3	0.04	630.3	35.7	0.01	0.22	6.55	0.009	0.022	0.528	552	12	0.17	
Tippy River	12/6/2016	O	O	3.2	4.73	15.80	120.1	8.08	18.7	0.065	28.9	34	0	0.38	7.21	0.005	0.0166	0.559	551	0	0.18	
Tippy River	12/21/2016	C	O	-2.4	0.83	12.93	90.1	8.05	26.2													Due to dangerous weather conditions and lab's holiday schedule nutrient sample was not taken for this site
Tippy River	1/4/2017	O	S	-3.8	2.04	12.88	90.7	8.08	41.9	0.065	30.4	35.1	0.01	0.99	6.22	0.009	0.0332	0.706	572	1.3985	0.14	
Tippy River	1/17/2017	R	C	3.4	3.00	13.80	100.7	8.31		0	26.7	36.6	0	1.31	6.34	0.004	0.04	0.879	535	4.0485	0.13	Because of timing of rain event EC samples could not be dropped off before lab closed for the day
Tippy River	1/19/2017	C	C	3.6	2.28	13.80	101.1	8.34	30.5	0	26.6	32.2	0	0.99	6.85	0.014	0.035	0.87	539	3.8759	0.14	The EC sample test start time was 19.5 hrs. after delivery due to lab error
Tippy River	1/31/2017	C	O	1.3	1.65	13.00	92.1	8.49	31.7	0.018	25.8	34.1	0.01	0.87	6.66	0.01	0.024	0.612	552	3	0.17	
Tippy River	2/8/2017	R	O	3.1	3.31	14.30	102.1	8.60	22.8	0.002	26.1	32.6	0	1.45	5.9	0.005	0.0293	0.586	562	0	0.3	
Tippy River	2/23/2017	C	S	17.8	7.24	11.42	93.7	8.79	13.4	0.031	27.4	33.4	0	1.24	4.98	0.005	0.0229	-0.055	570	5.6	0.21	
Tippy River	3/1/2017	R	O	12.0	7.69	10.55	88.5	7.91	125.9	0.038	26.9	33	0	1.13	5.77	0.008	0.0353	0.484	545	9.4	0.16	
Tippy River	3/16/2017	SN	S	1.2	1.84	13.36	96.7	8.72	14.8	0.03	24.8	38.3	0.01	0.75	4.8	0.006	0.023	0.798	570	9.5	0.12	
Tippy River	3/30/2017	C	R	5.7	8.78	8.84	75.7	9.00	29.9	0.04	26.8	32.6	0	1.16	3.74	-0.005	0.0247	0.581	569	5.698	0.16	
Tippy River	4/11/2017	R	C	7.2	11.21	8.50	78.7	8.07	101.7	0.028	22.6	29.6	0	1.07	3.96	0.002	0.0262	0.708	530	2.2	0.21	
Tippy River	4/24/2017	S	S	16.0	15.60			8.38	248.1	0.042	26.4	34.4	0.01	0.85	1.4	0.002	0.022	0.675	570	4.0691	0.14	DO sensor malfuction
Tippy River	5/10/2017	R	P/C	17.5	12.90	9.70	92.4	7.85	36.4	0.034	23.9	31	0	1	2.09	0.003	0.0251	0.617	555	1.9493	0.31	
Tippy River	5/22/2017	R	S	19.6	17.54	7.85	83.0	8.10	101.9	0.08	30.8	32.3	0	1.18	1.65	0.002	0.0504	0.834	596	10.5	0.38	
Tippy River	6/1/2017	S	S	21.2	18.33	6.67	70.6	8.04	166.4	0.038	22.4	27.3	0	0.91	3.24	0.007	0.0374	0.56	530	1.9493	0.18	Estimated using high flow protocol techniques
Tippy River	6/15/2017	R	S	24.9	24.40	6.77	80.0	8.19	128.9	0.098	30.7	34.8	0.03	0.73	5.95	0.01	0.051	0.985	547	7.8	0.16	
Tippy River	6/29/2017	S	C	26.5	21.12	6.40	71.9	8.72	68.3	0.046	26.1	30.7	0	0.58	6.13	0.005	0.0424	1.05	548	12.4	0.19	
Tippy River	7/10/2017	S	R	22.2	23.13	4.29	49.7	8.61	214.2	0.08	27.1	26.2	0.03	0.66	6.95	0.001	0.0609	0.473	521	16.2		Estimated using high flow protocol techniques
Tippy River	7/12/2017	R	O	25.7	23.49	4.28	46.5	8.90	1119.9	0.112	23.7	23.2	0.03	0.56	6.86	0.008	0.0724	0.504	481	9.6		Estimated using high flow protocol techniques
Tippy River	7/26/2017	S	O	25.3	25.08	4.20	51.1	7.66	69.1	0.09	23.7	24.3	0.02	0.29	8.06	0.006	0.0543	0.836	491	6.812		Estimated using high flow protocol techniques
Tippy River	8/9/2017	S	S	21.3	21.62	6.29	72.9	7.84	77.1	0.077	26.2	27.9	0	0.18	8.17	0.007	0.0482	0.761	520	7.5244		
Tippy River	9/13/2017	O	R	18.2	18.36	6.69	71.1	7.90	66.3	0.042	29.3	32.8	0	0.22	7.35	0.006	0.0204	0.544	557	0.7047		
Tippy River	9/20/2017	S	O	24.5	21.70	6.45	72.0	7.80	218.7	0.054	30.4	32.4	0	0.14	8.04	0.007	0.031	0.612	530	3.406		
Tippy River	9/27/2017	S	O	21.8	23.03	4.83	55.8	7.83	137.6	0.055	25.7	29.2	0	0.09	8.17	0.014	0.031	0.55	506	1.3395		
Tippy River	10/11/2017	R	OC	14.5	18.17	6.05	63.3	7.89	410.6	0.058	32.7	30.5	0	0.23	8.86	0.013	0.0324	0.542	547	1.4781		
Tippy River	10/25/2017	R	S	7.9	12.30	7.55	69.5	7.93	137.6	0.031	25.8	26.5	0	0.16	8.41	0.008	0.0193	0.596	512	1.9		
Tippy River	11/8/2017	S	S	9.8	8.49	8.92	76.4	7.76	111.2	0.115	32.9	31	0	0.41	8.69	0.017	0.0295	0.736	576	3.6576		Estimated using high flow protocol techniques
Tippy River	11/15/2017	S	R	6.4	7.33	9.85	83.0	7.78	37.9	0.063	28.4	29	0	0.98	8.55	0.011	0.022	0.561	545	2.1156		Estimated using high flow protocol techniques
Tippy River	11/29/2017	S	S	7.6	6.23	10.38	83.1	7.77	18.7	0.058	28.9	30.4	0	0.92	7.74	0.01	0.0226	0.629	548	2.0776		Estimated using high flow protocol techniques
Tippy River	12/13/2017	SN	C	-5.0	1.21	11.98	84.4	7.95	66.9	0.011	26.6	49.7	0.02	1.55	6.9	0.01	0.0195	0.474	587	0		

Table 25 Tippecanoe River Sampling Data (Site#10)

Stormwater Outfalls																											
Location Name	Date	Sample ID #	Prior Weather (48hrs.)	Current Weather	BAR	Air Temp (°C)	Water Temp (°C)	DO (mg/L)	pH	DO (%sat)	% of Pipe Full	Nuts ID #	E. Coli ID #	EC (cfu/100 mL)	NH3 (mg/l)	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	8/15/2016	16228SWL	R	R																							No flow from the storm drain
Location Name	Date	Sample ID #	PW (48hrs	W	BAR	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Pike Lake	8/15/2016	16228SWP	R	R	989.4	21.8	21.63	5.98	7.95	68.0	5.0	WC176	S2	>2419.2	0.034	44.5	51.4	0	1.12	10.74	0.031	0.0914	0.443	652	15.138	0.39	
Location Name	Date	Sample ID #	PW (48hrs	W	BAR	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Winona	8/15/2016	16228SWW	R	R	989.3	22.4	24.41	7.22	8.39	86.4	10.0	WC177	S3	>2419.2	-0.001	31.4	26	0	0.48	7.46	0.026	0.0853	0.341	455	2.6501	0.14	
Location Name	Date	Sample ID #	PW (48hrs	W	BAR	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Kelly Park	8/15/2016	16228SWK	R	R	989.3	21.9	21.25	6.90	8.35	77.4	5.0	WC178	S4	>2419.2	0.038	40.1	12.9	0	1.1	4.02	0.046	0.1551	0.734	362	20.444	0.08	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	1/12/2017	17012SWL	R	R	981.6	8.2	0.11	12.58	8.23	84.4	10	WC293	S1	32.3	0.166	128.8	10.8	0	0.37	4.7	0.029	0.075	0.717	676	6.7	0.27	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Pike Lake	1/12/2017	17012SWP	R	R	980.6	2.9	2.65	14.18	8.29	102.6	15	WC294	S2	178.5	0.224	14.8	3.6	0	0.31	1.16	0.025	0.229	1.324	170	123.1	0.23	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Winona	1/12/2017	17012SWW	R	R	981.4	2.1	4.55	14.00	8.38	105.9	10	WC295	S3	159.7	0.199	19.8	10.8	0	0.21	2.49	0.027	0.1345	0.862	235	75.7	0.31	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Kelly Park	1/12/2017	17012SWK	R	R	981.3	1.5	1.59	14.62	8.07	102.6	15	WC296	S4	1119.9	0.175	40.1	7.2	0	0.52	4.13	0.038	0.1286	0.875	394	21.9	0.26	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	2/7/2017	17038SWL	C	R	966.7	11.5	4.04	10.12	8.25	75.8	10	WC338	S3	129.6	0.227	56.6	13.2	0	0.49	6.16	-0.002	0.2399	1.974	590	135.85	0.33	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Pike Lake	2/7/2017	17038SWP	C	R	966.6	11.9	8.73	11.42	8.71	96.1	15	WC337	S2	410.6	0.311	23.1	7.6	0	0.26	0.93	0.02	0.9984	4.789	204	788.01	0.29	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Winona	2/7/2017	17038SWW	C	R	967.8	11.9	9.91	11.18	8.70	96.8	10	WC336	S1	23.1	0.23	29.2	19.2	0	0.26	3.94	0.019	0.1912	0.771	340	678.83	0.3	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Kelly Park	2/7/2017	17038SWK	C	R	966.2	12.5	6.05	12.57	8.33	99.5	5	WC339	S4	816.4	0.099	54.7	10.6	0	0.32	3.25	0.025	0.1376	0.623	455	20.602	0.16	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	7/7/2017	17188SWL	S	R	1013.5	20.3	20.5	3.51	7.79	45.9	15	WC0468	S4	116.9	0.105	31	1	0.01	0.29	7.09	0.017	0.0948	-0.099	379	8.2	0.14	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Pike Lake	7/7/2017	17188SWP	S	R	1013.5	19.2	20.78	8.30	8.7	69.3	20	WC0467	S3	686.7	0.207	2.5	1.3	0	0.4	0.51	0.03	0.7129	0.377	64	391.3	0.11	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Winona	7/7/2017	17188SWW	S	R	1013.1	20.6	22.94	6.35	8.36	71.4	20	WC0465	S1	56.3	0.073	-9	-9	-9	-9	3.4	0.005	0.3561	0.097	265	570.8	-9	
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Kelly Park	7/7/2017	17188SWK	S	R	1015.3	19	20.04	5.53	8	59.1	20	WC0466	S2	1119.9	0.246	4.3	2.4	0	0.26	1.68	0.03	0.2387	0.934	90	74.6	0.11	
Stormwater Outfalls																											
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	10/6/2017																										NO FLOW
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Pike Lake	10/6/2017	17279PIK	C	R	1019.1	19.6	18.02	5.73	7.4	59.4	2-5%	GC3442			0.048	68.5	19.2	0	1.08	7.17	0.204	0.2909	0.293	619	4.1522		Lab closed
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Winona	10/6/2017	17279WIN	C	R	1019	21.5	21.08	7.00	7.69	77.1	15-20%	GC3440			0.046	55.2	77.1	0	0.1	13.45	0.018	0.049	0.263	826	3.465		Lab closed
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Kelly Park	10/6/2017	17279KEL	C	R	1019	19.9	19.42	7.19	7.44	77.6	5-10%	GC3441			0.035	38	34.1	0	0.12	5.55	0.026	0.1651	0.634	444	30.612		Lab closed
Stormwater Outfalls																											
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Lones Ditch	11/15/2017																										NO FLOW
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Pike Lake	11/15/2017	17319SWP	O	O	1019.3	5	7.99	7.10	7.54	58.9	10	WC0607	SW2	2419.2	0.025	11.9	3.4	0	0.7	1.86	0.137	0.2348	0.075	155	19.027		
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Winona	11/15/2017	17319SWW	O	O	1019.6	5	9.82	10.00	7.47	84.4	15	WC0606	SW1	410.6	0.011	8.3	11.2	0	0.74	2.82	0.049	0.1668	0.644	196	88.311		
Location Name	Date	Sample ID #	PW (48hrs	W	Bar P (mba	AT (°C)	WT (°C)	DO(mg/L)	pH	DO(%sat)	% of Pipe F	Nuts ID #	E. Coli ID #	EC (cfu/100	NH3 (mg/	CL (mg/l)	SO4 (mg/l)	NO2 (mg/l	NO3 (mg/l	SIO2 (mg/l	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (unit	SS (mg/l)	F (mg/l)	Notes:
Kelly Park	11/15/2017	17319SWK	O	O	1017.9	3.33	7.77	5.55	7.54	44.9	10	WC0608	SW3	1553.1	0.007	10.8	10.6	0	0.65	3.98	0.027	0.1889	0.589	242	12.474		

Table 26 Stormwater Sampling Sites (Sites #17-20)

Stream Name	Date	Prior Weather	Current Weather	Air Temp (°C)	Water Temp (°C)	DO (mg/L)	DO (%sat)	pH	EC (cfu/100 mL)	NH3 (mg/l)	CL (mg/l)	S04 (mg/l)	NO2 (mg/l)	NO3 (mg/l)	SIO2 (mg/l)	SRP (mg/l)	TP (mg/l)	TKN (mg/l)	COND (units)	SS (mg/l)	F (mg/l)	Notes:
HS1	4/25/2017	S	S	19.3	15.57			8.17	105.8	0.036	37.5	49	0.02	1.45	2.63	0.007	0.036	0.772	722	5.9951	0.15	DO sensor malfunction
HS2	4/25/2017	S	S	18.7	13.68			7.97	29.5	0.055	28	59	0.05	2.1	3.56	0.004	0.017	0.812	785	2.3952	0.18	DO sensor malfunction
HS3	4/25/2017	S	S	18.0	13.53			8.19	435.2	0.055	15.2	26.7	0.02	1.98	1.4	0.007	0.043	1.05	656	6.2892	0.12	DO sensor malfunction
HS4	4/25/2017	S	S	17.3	12.77			8.23	235.9	0.025	17.5	55.4	0.03	6.25	4.42	0.008	0.02	1.079	695	0	0.11	DO sensor malfunction
HS5	4/25/2017	S	S	17.4	14.44			7.95	209.8	0.034	37.2	72.7	0.05	4.11	3.29	0.054	0.096	0.742	775	0	0.15	DO sensor malfunction
HS6	4/25/2017	S	S	16.9	13.20			7.89	224.7	0.034	50.9	50.1	0.04	4.26	3.2	0.145	0.229	0.677	817	2.0964	0.13	DO sensor malfunction
HS7	4/25/2017	S	S	17.6	14.30			8.08	>2419.2	0.061	15.3	15	0.08	5.29	2.18	0.024	0.115	1.171	560	50.153	0.1	DO sensor malfunction
HS1	7/11/2017	R	O	26.700	21.60	5.27	59.80	8.87	450	0.078	23.9	28.2	0	1.87	7.89	0.023	0.1364	0.603	572	31.163	N/A	
HS2	7/11/2017	R	O	29.300	22.18	5.25	60.00	8.67	250	0.146	15.2	23.7	0.06	1.37	9.68	0.06	0.12	0.672	545	7.9946	N/A	
HS3	7/11/2017	R	O	27.700	21.20	5.18	57.80	8.69	566	0.104	16.8	11.5	0.04	2.46	9.03	0.049	0.1755	0.604	552	36.448	N/A	
HS4	7/11/2017	R	O	29.800	19.06	5.87	63.00	8.75	1150	0.091	12.8	36.8	0.03	5.76	9.78	0.051	0.0877	0.828	643	7.0422	N/A	
HS5	7/11/2017	R	O	29.000	20.25	5.42	59.40	8.68	350	0.083	19.4	31.4	0.05	3.2	8.94	0.08	0.1946	0.767	606	27.17	N/A	
HS6	7/11/2017	R	O	28.100	20.25	5.60	60.20	8.75	600	0.08	26.8	26.2	0.02	3.93	8.33	0.13	0.2889	0.696	601	26.387	N/A	
HS7	7/11/2017	R	O	27.700	21.22	4.89	55.90	8.68	200	0.063	10.1	7.5	0.05	4.29	6.87	0.079	0.1674	0.628	418	24.177	N/A	
HS1	10/4/2017	R	R	21.9	17.49	7.43	74.9	8.60	980.4	0.014	63.4	58.8	0	1.34	10.82	0.016	0.0459	0.358	886	1.384	N/A	QUANTA MALFUNCTION: REDO QUANTA SAMPLE TAKEN AT 11:20
HS2	10/4/2017	R	C	20.8	18.72	4.48	47.3	8.32	>2419.2	0.096	28.9	32.2	0	0.93	12.15	0.029	0.0873	0.6	602	7.1382	N/A	QUANTA MALFUNCTION: REDO QUANTA SAMPLE TAKEN AT 11:20
HS3	10/4/2017	R	S	22.0	18.66	3.85	40.8	8.43	>2419.2	0.073	306.3	27.4	0	2.63	13.14	0.066	0.1888	1.577	1640	13.698	N/A	QUANTA MALFUNCTION: REDO QUANTA SAMPLE TAKEN AT 11:20
HS4	10/4/2017	R	C	25.0	17.85	3.49	36.4	8.48	>2419.2	0.021	15.6	63.3	0	2.92	11.12	0.019	0.0706	0.772	704	3.8402	N/A	
HS5	10/4/2017	R	C	22.8	3.40	3.41	34.6	8.45	>2419.2	0.077	62.6	79.5	0	3.46	9.52	0.087	0.1984	0.773	915	9.0655	N/A	SURFACE FLOW
HS6	10/4/2017	R	PC	23.8	18.68	3.08	32.8	8.20	>2419.2	0.078	101.7	50.8	0	7.66	7.61	0.743	0.9059	0.903	896	6.9979	N/A	
HS7	10/4/2017	R	PC	25.7	18.05	3.01	30.6	8.50	>2419.2	0.044	14.3	16.6	0	1.29	10.17	0.044	0.1344	0.59	662	6.5573	N/A	NO FLOW
HS1	11/2/2017	R	O	16.0	9.92	8.90	78.5	7.67	290.9	0.033	54.6	58.8	0.01	1.4	10.38	0.008	0.0315	0.524	858	4	0.15	
HS2	11/2/2017	R	O	15.6	12.16	7.99	73.8	7.54	435.2	0.253	27.8	47.9	0.04	1.01	10.86	0.019	0.0539	1.076	781	5.9	0.2	
HS3	11/2/2017	R	O	15.5	11.63	7.00	64.7	7.43	1046.2	0.095	144.9	29.7	0.04	3.25	11.9	0.018	0.1368	0.552	1198	13.2	0.17	
HS4	11/2/2017	R	O	14.9	12.53	7.52	71.0	7.57	579.4	0.025	16.7	84.1	0.01	3.11	11.01	0.014	0.0316	0.76	801	4.2	0.12	
HS5	11/2/2017	R	R	14.6	10.47	8.12	73.0	7.51	248.1	0.058	59.2	79.7	0.02	3.64	10.26	0.07	0.1784	0.759	949	6.8	0.18	
HS6	11/2/2017	R	R	15.5	12.93	7.51	70.3	7.35	2419.2	0.114	96.7	64.5	0.03	6.97	11.42	0.562	0.7267	0.836	1038	5.2	0.22	
HS7	11/2/2017	R	R	16.2	9.92	8.66	76.8	7.71	>2419.2	0.026	16	25	0.01	2.99	9.14	0.039	0.1327	0.737	682	40.7	0.13	ESTIMATED USING A SECOND POINT AND FLOW METER FOR REFERENCE

Table 27 High Source Sampling Sites (Sites #11-17)

Walnut Creek - Tippecanoe River Watershed Field Survey												
	Fall Tillage	Minimal Fall Tillage	No Fall Tillage	No-Till	Cover Crop	Pasture	Hay	Fallow	CRP	Hobby Farms	Animals Next to Water	Visually Identified Filter Strips Needed
Clay Twp West (So. End of Walnut Creek) DONE	1	0	10	3	2	2	3	0	0	0	1	0
Clay Twp. East (So. End of mostly Peterson Ditch) DONE	12	15	33	17	15	0	5	5	2	0	2	2
Monroe TWP (Keefer Evans) INCOMPLETE	10	0	30	0	0	0	5	2	0	0	0	0
Plain Twp. West (North of Warsaw off of SR15) INCOMPLETE	2	0	5	0	0	0	0	0	0	0	0	0
Plain Twp. East (Big Chapman and north) DONE	0	9	26	0	0	0	0	7	0	0	0	0
Tippecanoe Twp, West (Small area east of Chapman Lakes) DONE	0	0	8	0	0	4	0	0	0	0	0	0
Washington West (SR30 to the north & south, lower Deeds Creek Ditch) NOT COMPLETED	Field Report Not Completed											
Washington East (Pierceton, bottom of Deeds Creek Ditch) DONE	2	0	8	0	0	0	0	0	0	0	0	4
Wayne Twp. West (Walnut Creek, South of Warsaw) NOT COMPLETED												
Wayne Twp. East (Peterson, Keefer Evans, Cherry, So. Of Warsaw) INCOMPLETE	3	0	4	0	0	0	0	1	0	0	0	0
Jackson Twp. West (Bottom Tip of Keefer Evans) DONE	1	3	0	0	0	1	0	0	0	1	0	0

Table 28 Field Survey Data by Township in the Walnut Creek - Tippecanoe River Watershed 2017-2018