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UPPER MIDDLE EEL RIVER WATERSHED MANAGEMENT PLAN

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Section 1
Watershed Community Approach

1.1 Watershed Community Initiative

A watershed is an area or region of land that drains water to a collective location, such as a stream or lake and eventually the water drains into an ocean. Watersheds come in all shapes and sizes and land use is reflected in the ecological integrity of the system. Each watershed is identified by a unique address known as a Hydrologic Unit Code (HUC). The smaller the HUC address the larger the watershed. For example, an 8-digit HUC encompasses/includes an area that is larger than a 12-digit HUC. Watershed boundaries ignore political borders and are geographically defined by elevation changes. All activities within a watershed can have an effect on water quality and the overall health of the watershed.

Water quality impairments occur due to various reasons, but are generally caused by one of two distinct types of pollution. The two types of pollution consist of *Point Source Pollution* and *Nonpoint Source Pollution*. Point source pollution occurs where a discrete pollution source can be identified. These pollution types often require a permit and are regulated to ensure designated uses to the receiving water. Examples of point source pollution are factory and sewage treatment plant outfalls that directly discharge into a waterway.

Nonpoint source (NPS) pollution occurs when rain or snowmelt carries pollutants from the landscape and transfers them into a body of water. This type of pollution is much harder to identify due to the lack of a single entry point. NPS pollution is also harder to remedy due to the lack of knowledge where the pollutants originate. An example of NPS pollution is discharge from agriculture fields into receiving waters other than tile.

Over time, pollutants build-up in the waterway and can settle into fish tissue, as well as riverbeds and banks. Eventually, receiving waters can become murky and polluted, rendering them unsafe for recreation such as swimming or fishing.

Sediment - ordinary soil - is the number one pollutant of our nation's waterways. When soil enters a waterway because of erosion, it can prevent sunlight from reaching aquatic plants, clog fish gills, choke organisms, smother fish spawning beds, and negatively affect nursery areas.

Chemical fertilizers and biological waste applied to agricultural fields contain nitrogen and phosphorous. These nutrients are beneficial for plant growth. Improper application of these fertilizers can cause nutrients to runoff into a receiving waterway. Once in the waterway, excessive nutrients can lead to an increased algae growth and cultural eutrophication. With an increased amount of algae in our lakes, ponds, and coastal water, water quality is greatly reduced. An abundance of nutrients being discharged into waterways has led to areas in large bodies of water, such as the Gulf of Mexico or Lake Erie, to be void of life due to a lack of oxygen. These locations are referred to as hypoxic zones. Additionally, some algae created in lakes due to these nutrients can be toxic to humans and pets alike and cause vast water hazard condition. In order to reduce the algae growth a reduction in pollution sources is needed.

Everyone, in some way, contributes to NPS pollution through regular household activities. You do not have to live near water for your actions to affect water quality. Even small actions such as fertilizer application to personal gardens, individual septic systems, home water softener drainage, etc., when combined by everybody in a watershed can affect large water bodies such as oceans and lakes. Homes on an individual septic system have the potential to release large quantities of pollutants into groundwater or surface water if systems are improperly install or installed on unsuitable soils.

The watershed approach is a flexible framework for managing the quality of water resources. It includes stakeholder involvement and management actions supported by sound science. The watershed plan is a strategy that provides assessment and management information for a geographically defined watershed. Using a watershed approach to restore impaired waters is beneficial because it addresses problems in a holistic manner and stakeholders are actively involved in selecting the management strategies that will be implemented to solve the problems.

1.2 Community Support

In 2007, Manchester University faculty began considering a cooperative project that would address water quality issues in the Eel River watershed. This consideration began after anecdotal accounts of increased sediment and algae blooms within the river had been occurring over the past couple decades. Manchester faculty verified the observations during a study where the effects of water quality parameters on smallmouth bass (*Micropterus dolomieu*) health and spawn success were documented. During this study it was found that the Eel River in North Manchester, Indiana regularly exceeded water quality targets for nitrogen, phosphorus, and sediment. This led to discussions with the Wabash and Miami County Natural Resources Conservation Service (NRCS), Manchester faculty, and the Indiana Department of Environmental Management (IDEM) to investigate the possibility of attaining a Clean Water Act (CWA) Section 319(h) Grant to address water quality concerns in the Eel River. Section 319(h) grants target improving in-stream water quality by reducing NPS pollution. This is accomplished by providing funding to universities, not-for-profits, and government agencies to develop and implement Watershed Management Plans (WMPs). Initial local stakeholder meetings addressed concerns about the level of nutrients and sediments entering the Eel River from the intensively agricultural watershed. Local leaders and stakeholders understood the pressing issue of NPS pollution, but there was little knowledge of current nutrient and sediment loads within the Eel River and its tributaries. Over time meetings culminated into Manchester University applying for a CWA Section 319(h) grant in 2008. It was decided that members of Manchester University, NRCS/SWCD (Wabash, Miami, and Kosciusko Counties), and local producers would comprise of the core group of leaders for the grant. Each entity provided their own expertise. Manchester University would provide water quality analysis and grant administration, and the NRCS/SWCD (Wabash, Miami, and Kosciusko Counties) would provide expertise on current agriculture practices and provide the link between the water quality data and producers within the watershed. Without the talented and dedicated effort and support of the core group and partners, this grant would not have been possible.

Manchester University's Environmental Studies Program was awarded the CWA 319(h) grant in January 2009 to begin work in the Middle Eel River Watershed. This planning project, funded with a 319(h) grant, was designed to identify critical watersheds where excessive NPS pollution was occurring in the Middle Eel River Watershed and develop a WMP. This grant project ended in December of 2012 with a finalized *Middle Eel River Watershed Management Plan* and a more in-depth look at the watershed. With this new knowledge of the watershed, Manchester University was awarded another CWA 319(h) grant in 2013 to implement the *Middle Eel River Watershed Management Plan*, including implementation of various best management practices (BMPs). After completion of the second CWA 319(h) grant project in December 2015 an in-depth understanding of water quality issues in the Middle Eel River Watershed was achieved. In 2016 Manchester University received another 319 grant for implementation of cost share practices within Beargrass Creek 12-Digit HUC.

Over the life of these initial grants in the Middle Eel River, 2009-2015, continuous water quality monitoring was being conducted. The results of the water quality monitoring sparked the question "what is producing the pollutant loads at the upstream testing location (West of North Manchester, Indiana)". This question led to the inclusion of stakeholders from Whitley and Huntington counties. These new stakeholders included local NRCS/SWCD and producers within the watershed. After discussing watershed activities upstream of the Middle Eel River Watershed, a decision of was made to apply for a CWA 205(j) grant with Kosciusko County SWCD as the grantee. The grant was awarded in 2016 to develop this plan, "Eel River Initiative: A Cooperative Conservation Strategy for the Upper Middle Eel River of Northern Indiana" WMP. This

WMP will focus on 10-digit HUC 0512010403 (Sugar Creek-Eel River) and 10-digit HUC 0512010404 (Clear Creek-Eel River) which are the next two (2) 10-digit HUCs upstream of the Middle Eel River Watershed. It will help define critical areas within the Upper Middle Eel River Watershed that are producing high pollutant loads and the development of the WMP to address water quality issues.

1.2.1 Description of Steering Committee

A Steering Committee was developed at the beginning of the grant to help guide the development of the WMP. Steering Committee members are considered local agriculture leaders that have a vast knowledge of the local landscapes and personalities within the watersheds. Members are comprised of individuals within the watershed that represent local agriculture agencies, not-for-profit businesses, education institutions, federal agencies, retired professionals, and local producers. The Steering Committee also provides assistance in conducting all grant requirements such as annual meetings, canoe floats, river clean-ups, etc. and is vital to the success of the grant. They meet quarterly to guide the WMP's development.

Table 1-1. Upper Middle Eel Watershed Steering Committee Members and their Affiliation

Member	Affiliation
Adam Jones	Wabash County NRCS District Conservationist
Amy Lybarger	Whitley County NRCS District Conservationist
Bobby Hettmansperger	Wabash County SWCD Board Member
Casey Jones	ACRES Land Trust Property Manager
Chad Schotter	Kosciusko County NRCS District Conservationist
Darci Zolman	Kosciusko County SWCD
Ed Braun	Retired Fisheries Biologist
Nadean Lamie	Whitley County SWCD
Herb Manifold	Manchester University Environmental Studies Grants Coordinator
Matt Linn	IDNR Fisheries Research Biologist
Scott Fettetrs	USFW Wetland Biologist
Stan Moore	Kosciusko County SWCD Board Member, Local Producer
Tashina Lahr-Manifold	Wabash County SWCD
Jerry Sweeten	Environmental Studies Professor Manchester University
Joe Updike	Retired NRCS District Conservationist
Stewart Stephan	Huntington County SWCD

1.2.2 Stakeholder Concerns

Stakeholders' involvement was generated through annual public meetings with local NRCS, SWCD, and producers. Both local NRCS and SWCD contacted landowners and invited them to stakeholder meetings. Stakeholder involvement was sought after to better understand how the public viewed the watershed and to share their thoughts on the current condition of the watershed. These meetings involved a description of the previous grants and the goal of the Upper Middle Eel River Initiative. It was clear from the meetings there was a general concern about water quality in the Upper Middle Eel River Watershed. Stakeholders are asked for their concerns about the watershed at each Steering Committee meeting, each public event (canoe float, river clean-up, and annual meeting), and through individual communication. Their knowledge better guides the development of the WMP to ensure concerns are addressed.

Table 1-2. List of Current Stakeholder Concerns.

Concern	Reason For Concern	Potential Problems
Increased Nitrogen Concentration/Loading	Nitrogen can be introduced into waterways through point sources and non-point sources. Nitrogen is readily available for plant uptake and can result in increased algal blooms	Increase Gulf of Mexico Hypoxic Zone, Increase Lake Eutrophication, Harmful Algal Blooms
Increased Phosphorus Concentration/Loading	Phosphorus can be introduced into waterways through point sources and non-point sources. Phosphorus is readily available for plant uptake and can result in increased algal blooms	Increase Lake Eutrophication, Harmful Algal Blooms.
Manure in the watershed	Excess Manure applied to agriculture fields can be introduced into waterways through non-point sources. Manure contains large amounts of nitrogen and phosphors and is readily available for plant uptake.	Increase Gulf of Mexico Hypoxic Zone, E. coli, Increase Lake Eutrophication, Harmful Algal Blooms
Increased Sediment Loading	Sediment by volume is the largest pollutant currently in the Eel River. Increased sediment comes from two sources, stream bank erosion and overland flow. Sediment can cause interstitial spaces in the river to be clogged. Some fish species rely on sight to feed and could reduce their effectiveness to obtain prey.	Increased Sedimentation, Loss of Interstitial Spaces, Reduction in Reactive Distance of Sight Feeding Fishes
Stream Bank Erosion	Increased drainage and more significant precipitation event have led to increased water flow in the Eel River.	Increase in Sediment Loads, Increased Channelization, Loss

	Due to this increased flow the original channel can no longer effectively transport high flow events. These events have begun to widen the channel causing streambank erosion.	of Floodplains, Unstable Banks, Steep Banks
Fish and Wildlife Habitat/Abundance/Health	Fish and wildlife rely on adequate habitat for survival, which is especially important to those species listed as threatened or endangered. Many species of aquatic life including fish, insects, and mussels rely on the Eel River. Increased sedimentation, dams, habitat fragmentation, and chemicals threaten the safety to fish and wildlife.	Lack Of Stream Buffers and Riparian Corridors, Fragmented Aquatic Habitats, Fragmented Landscapes, Increased Pollution Entering the Water
Flooding	As climate conditions consistently change more and more significant precipitation events have been documented. These large events along with landscape level changes has led to an increase the time the Eel River is considered at flood stage.	Loss Of Habitat, Increased Nitrogen/Phosphorus/Sediment Loading, Property and Property Damage
Lack of Riparian Buffer	Riparian buffers along waterways provide many ecosystem services. Services range from water treatment, to habitat, to migration corridors, etc. Many waterways currently do not possess a riparian on either side of the stream.	Lack Of Habitat, Loss of Water Treatment Opportunities, Increased Stream Bank Erosion
Lack of Forested Areas	Forested areas within watersheds provide sinks for pollutants of concern. Many forested areas also provide habitat and protection for many species.	Lack of Habitat, loss of Nutrient Sink
Lack of Wetlands	Wetland areas within watershed provide sinks for pollutants of concern. Many wetlands also provide habitat and protection for many species	Lack of Habitat, loss of Nutrient Sink
Failing Septic Systems	Failing septic systems can release nutrient rich wastewater directly into soils that are unable to treat high levels of nutrients. This can cause increased flow of nutrients from the soil into adjacent waterbodies.	Increased Nitrogen Pollution, Increased Phosphorus Pollution, E. Coli
Trash and Debris in the Eel River and Its Tributaries	Historically, rivers were used as landfills. Currently, much of this initial trash remains and can cause safety concerns in the river. During flood	Lack of Aesthetics, Human Safety

	events, trash and debris still enter the river and can harm humans.	
Lack of Water Education and Outreach	Limited understanding of watersheds and the natural processes within them, Limited understand of individuals impact on watersheds, and the goal of the WMP.	Lack of connection with the Eel River leads to thoughts about the river, (ex. Many people believe the river is dirty and unsafe to enter)

Upper Middle Eel River Watershed Management Plan

Section 2
PHYSICAL DESCRIPTION OF THE WATERSHED

2.1 Upper Middle Eel River Watershed Location

The Eel River Watershed (Figure 2-1), 8-digit HUC 05120104, in north central Indiana is a major tributary to the upper Wabash River (Gammon 1990). With a watershed area of 827.07 square miles, the Eel River is 94 miles long and originates in Allen County, Indiana. The stream flows in a southwesterly direction, passing through a total of six counties, descending approximately 2.41 feet per mile and drains into the Wabash River near Logansport in Cass County, Indiana (Gammon 1990).

The focus of this WMP is the Upper Middle Eel River Watershed (Figure 2-2) which consists of two sub-watersheds of the Eel River Watershed, 10-digit HUC 0512010404 (Clear Creek-Eel River) (downstream) with an average slope of 4.34%, and 10-digit HUC 0512010403 (Sugar Creek-Eel River) (upstream) with an average slope of 5.08%.

The Upper Middle Eel River Watershed is comprised of 26.25 river miles from Columbia City to North Manchester, Indiana and drains a land area of 163,034 acres (255 mi^2). The Upper Middle Eel River Watershed is within four counties as displayed in Table 2-1 and Figure 2-3.

Table 2-1. Upper Middle Eel River Watershed – acreage per county.

County	Acres
Wabash	36,073
Whitley	88,568
Kosciusko	32,213
Huntington	6,178
TOTAL	163,034

The Eel River, from South Whitley to its confluence with the Wabash River in Logansport (63 river miles), is designated as an outstanding river by the Indiana Department of Natural Resources (DNR) as noted in the Indiana Register, Volume 16, Number 6, (16 IR 1677) on March 1, 1993 under the title "Natural Resources Commission, Information Bulletin #4, Outstanding Rivers List for Indiana". The outstanding rivers list is a roster of streams in the State, which have particular environmental or aesthetic value.

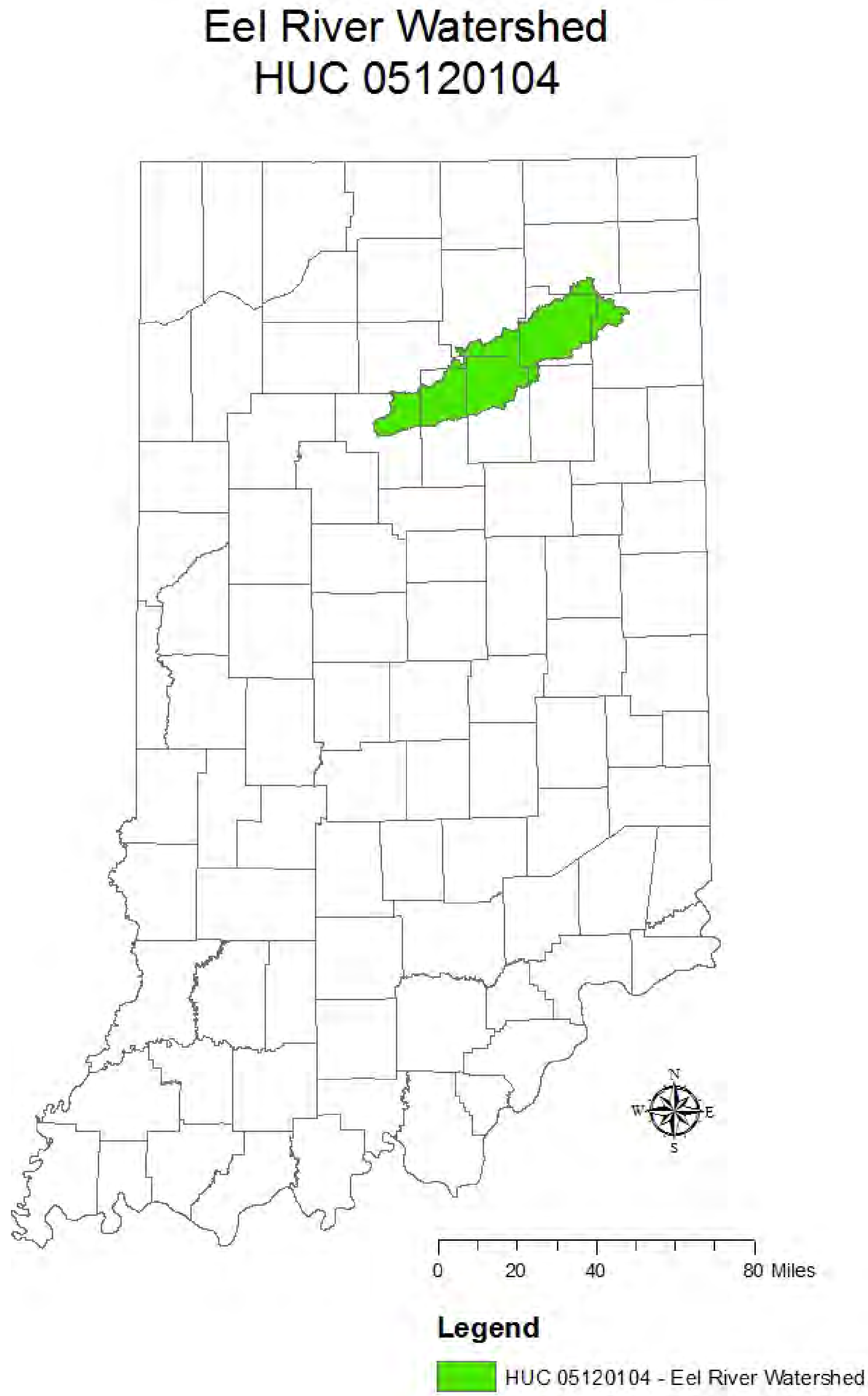

Figure 2-1. Eel River Watershed – 8-Digit HUC 05120104
(Eel River)

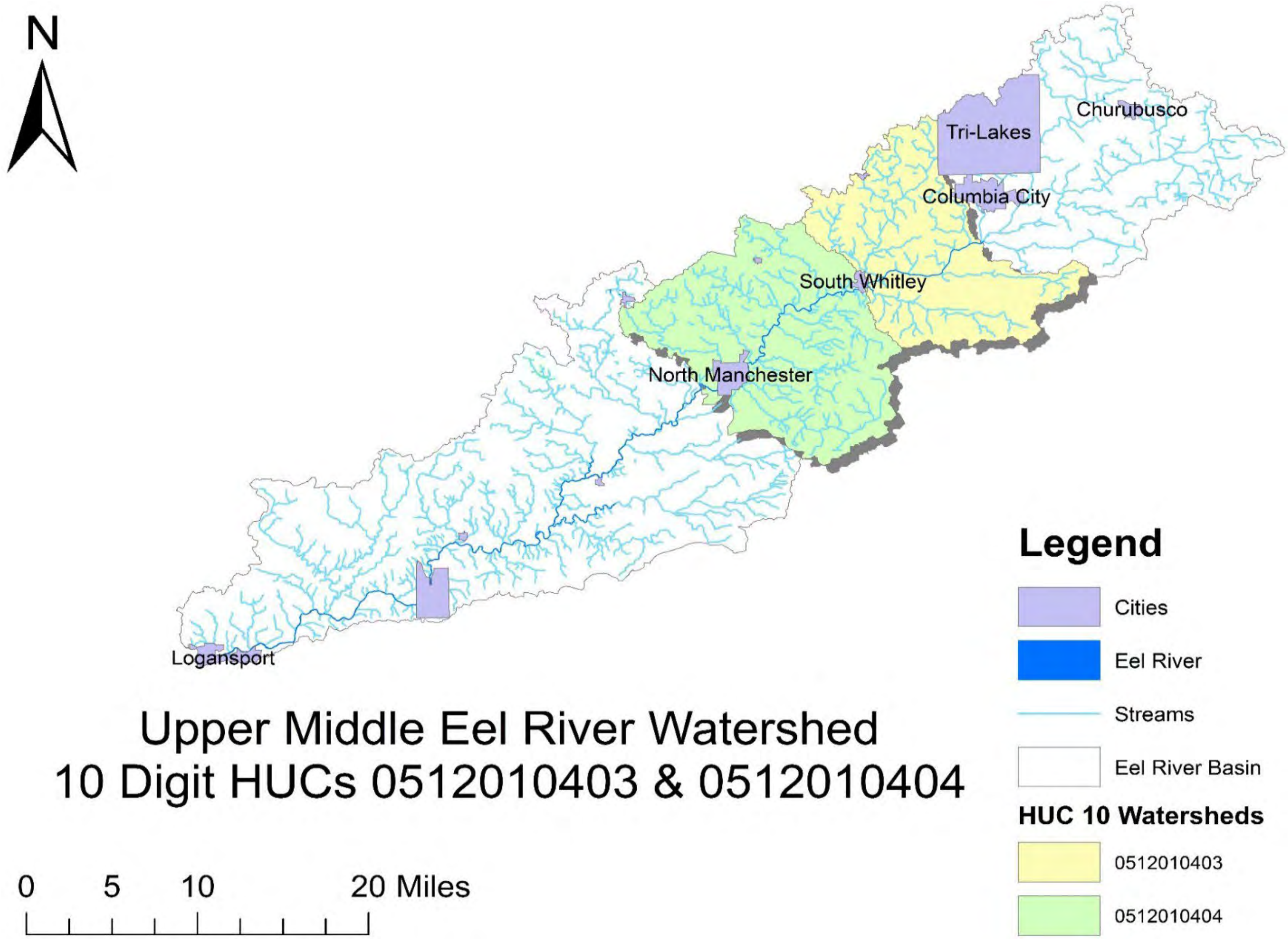

Figure 2-2. Upper Middle Eel River Watershed – 10-Digit HUCSs (0512010403 & 0512010404) within Eel River 8-Digit HUC 05120104.

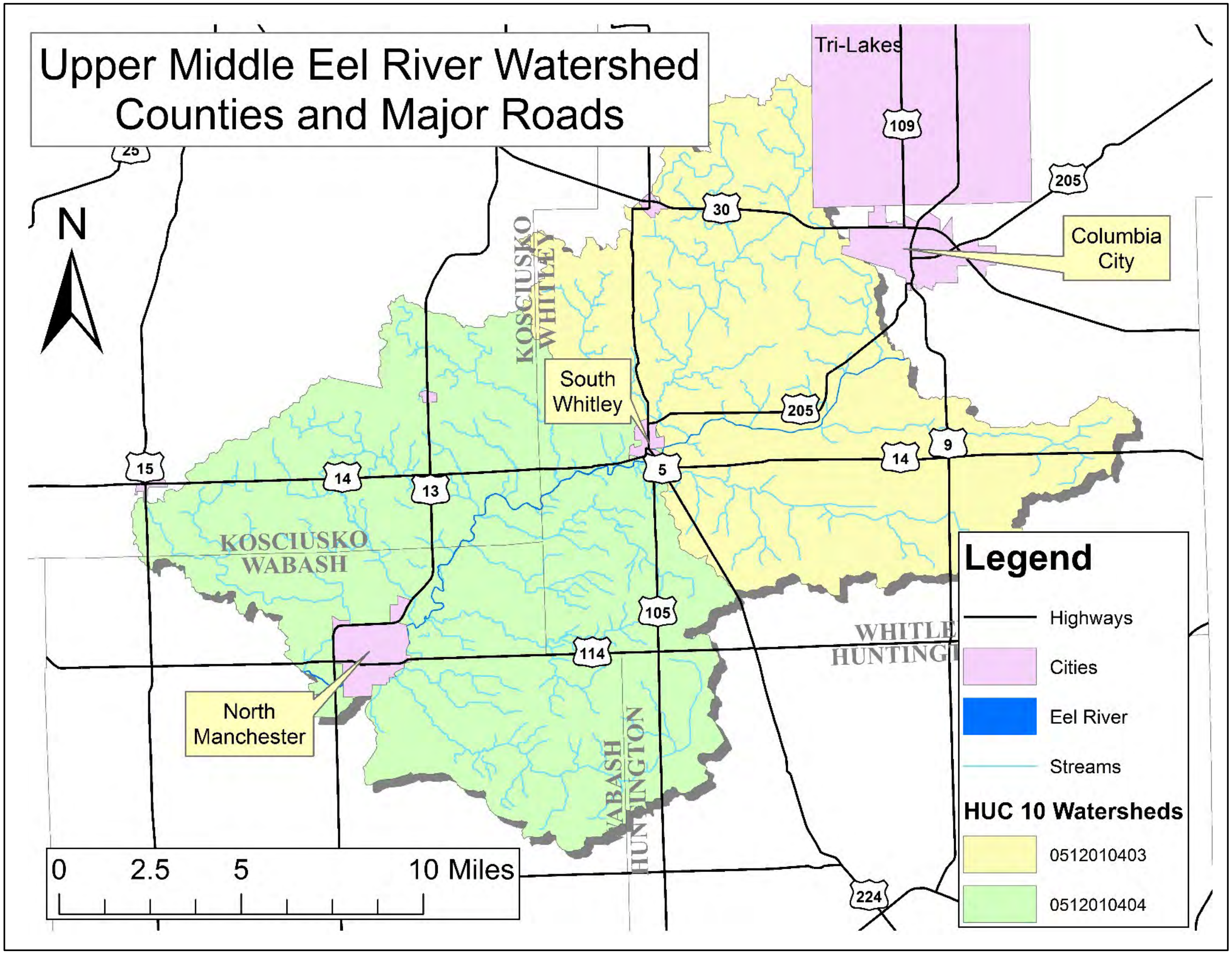

Figure 2-3. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Major Roads and Counties

2.2 Sub-Watershed 12 Digit HUCs

The Upper Middle Eel River watershed contains eleven (11) 12 digit HUCs listed in Table 2-2 and Figure 2-4.

Table 2-2. Upper Middle Eel River Watershed, 12 Digit HUCs, Geographic Names, and Watershed Areas (Indiana Natural Resources Conservation Service 2005)

HUC Name	12 digit HUC	Watershed Acres
Sub-watershed 0512010403 Sugar Creek – Eel River		
Black Lake-Spring Creek	51201040301	10,442
Shoenauer Ditch-Spring Creek	51201040302	18,078
Headwaters Sugar Creek	51201040303	19,776
County Farm Ditch-Eel River	51201040304	22,286
Sub-watershed 0512010404 Clear Creek – Eel River		
Mishler Ditch-Eel River	51201040401	13,091
Hurricane Creek-Eel River	51201040402	11,364
Plunge Creek-Eel River	51201040403	11,919
Simonton Creek-Eel River	51201040404	13,191
Pony Creek	51201040405	20,950
Nelson Creek-Clear Creek	51201040406	11,996
Swank Creek-Eel River	51201040407	9,940
	TOTAL ACRES	163,033

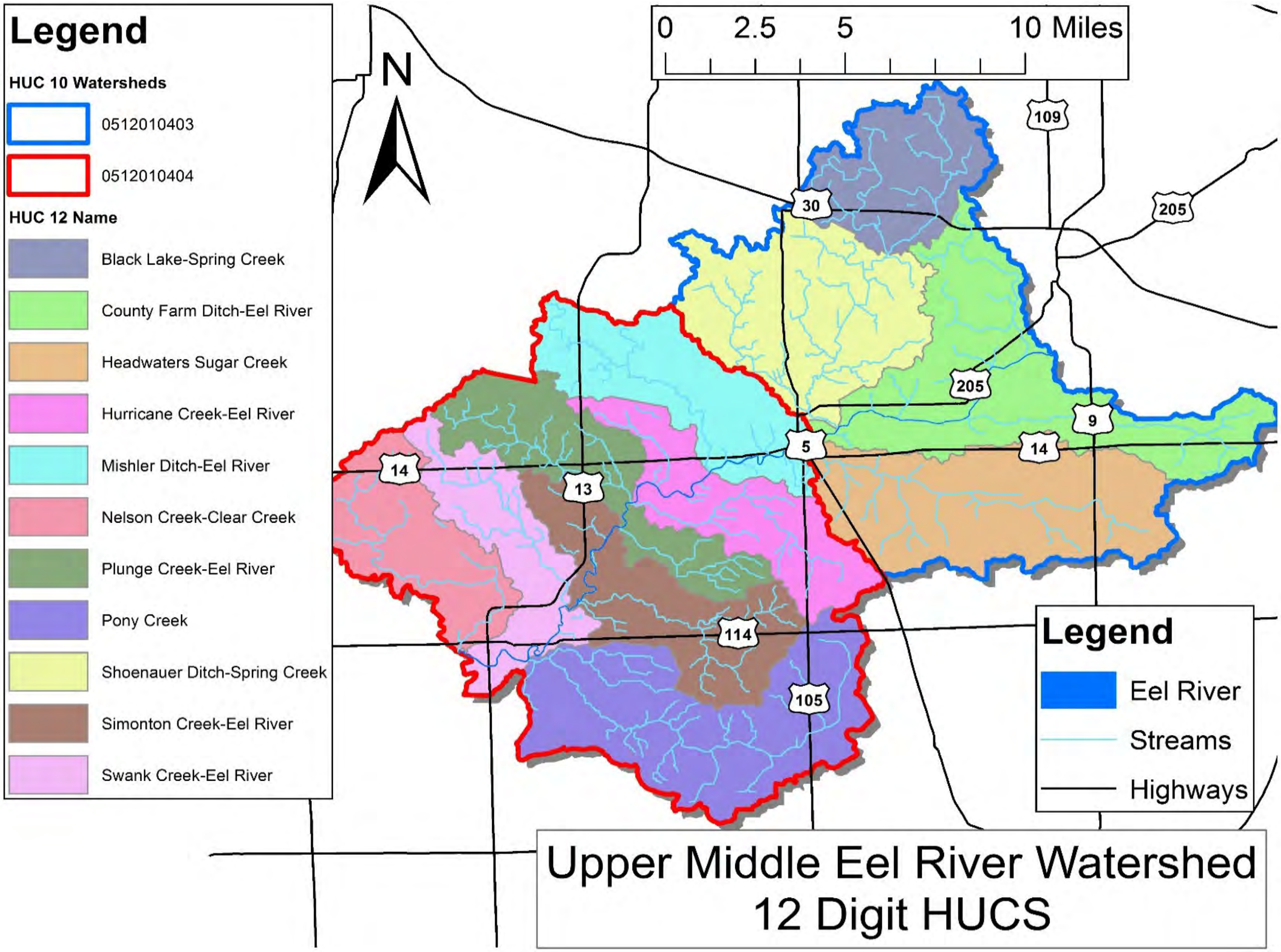

Figure 2-4. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River): 12-Digit HUCs with Watershed Names

2.3 Geology

Northern Indiana landscapes were most recently influenced by the Wisconsin glaciation that occurred over 14,000 years ago. Glaciers significantly altered landscapes within the watershed, from filling and damming rivers, which created lakes, to flattening the rolling hills that were present before the glaciers. The Wisconsin glaciation extended as far south as Terre Haute and Richmond, Indiana. As the glaciers melted, they deposited rock, dirt and sand that they picked up while traveling across the landscape from east to west. These periodic glaciations form the natural regions and ecoregions that are present in current day Indiana.

2.3.1 Natural Regions

The Eel River is the dividing line between two natural regions, the Central Till Plain to the south of the river and the Northern Moraine and Lake Region to the north of the river Figure 2-5.

The **Central Till Plain Natural Region** extends throughout the central portion of Indiana and is the largest natural region in the state. Nearly all the region was thickly covered and reshaped by glaciers of the Quaternary age. Glaciers covered parts of present-day Indiana at least three times during the Pleistocene Epoch (Center for Earth and Environmental Science 2003). Wisconsin and pre-Wisconsin (Illinoian and pre-Illinoian) age glaciers covered central Indiana and left deposits of till containing clay, silt, sand and gravel. Large amounts of sand and gravel outwash (glacial material that is deposited by water melting off glaciers) were deposited as both outwash plains and valley trains (Center for Earth and Environmental Science 2003). Patchy thin loess (A buff to gray windblown deposit of fine-grained, calcareous silt or clay) occurs on parts of the Wisconsin glacial deposits and swamp and lake deposits are common in poorly drained parts of the landscape. Unconsolidated deposits may be several hundred feet thick (Center for Earth and Environmental Science 2003).

Parts of glaciated Indiana are hilly and the **Northern Lakes Natural Region** typifies this kind of terrain and is noted for its spectacular scenery. Part of the topographic expression is the result of moraine (accumulated earth and stones deposited by a glacier) formation by active ice and by the overspreading of the region with ablation (the melting of snow or ice that runs off the glacier) or flow until that formed during times of glacial retreat. Large depression areas, some of which contain lakes, form when large blocks of the melting glacial ice are buried beneath outwash sediments. With time, the buried ice blocks melt leaving behind a kettle hole or a kettle lake (Center for Earth and Environmental Science 2003).

2.3.2 Ecoregions

Ecoregions are areas of relative homogeneity in the quality and quantity of ecological systems and their components including soils, vegetation, climate, geology and physiography and are determined by different patterns of human stresses on the environment and different patterns in the existing attainable quality of environmental resources (EPA Ecoregions of the United States 1999).

The approach used to compile ecoregion maps is based on the premise that ecological regions can be identified by analyzing the patterns and composition of biotic (living) and abiotic (non-living) phenomena that affect or reflect differences in ecosystem quality and integrity. These phenomena include geology, physiography, vegetation, climate, soils, land use, wildlife, and hydrology (EPA Ecoregions of the United States 1999).

The relative importance of each factor varies from one ecological region to another, regardless of the hierarchical level. Because of possible confusion with other meanings of terms for different levels of ecological regions, a Roman numeral classification scheme has been adopted for this effort. Level I is the coarsest level, dividing North America into 15 ecological regions. At Level II, the continent is subdivided into 52 classes, and at Level III, the continental United States contains 99 ecoregions. Level IV ecological regions are further subdivisions of level III units (EPA Ecoregions of the United States 1999).

The Eel River serves as a dividing line between two Level III Ecoregions as defined by the Environmental Protection Agency (EPA) (Figure 2-6). The watershed north of the Eel River falls within the Level III Ecoregion of The Southern Michigan/Indiana Drift Plains, while the watershed south of the Eel River falls within The Eastern Corn Belt Plains Region.

The northern portion of the watershed north of the river is located in The Lake Country, Ecoregion Level IV. The Lake Country is a hummocky and pitted moraine area characterized by many pothole lakes, ponds, marshes, bogs, and clear streams. The well-drained end moraines and kames (a hill of sorted and layered gravel and sand, deposited in openings in stagnating or retreating glaciers) once supported oak-hickory forests whereas wetter areas had been beech forests or northern swamp forests. The very poorly drained kettles had tamarack swamp, cattail-bulrush marshes, or sphagnum bogs (Griffith & Omernik 2008).

Majority of the watershed south of the river is located in The Clayey, High Lime Till Plains, Ecoregion Level IV. The Clayey, High Lime Till Plains is a transitional area with soils that are less productive and more artificially drained than the southern portion of this ecoregion, with fewer swampy areas than the northeastern portion of this ecoregion. Corn, soybean, wheat, and livestock farming are dominant and have replaced the original beech forests and scattered elm-ash swamp forests (Griffith & Omernik 2008).

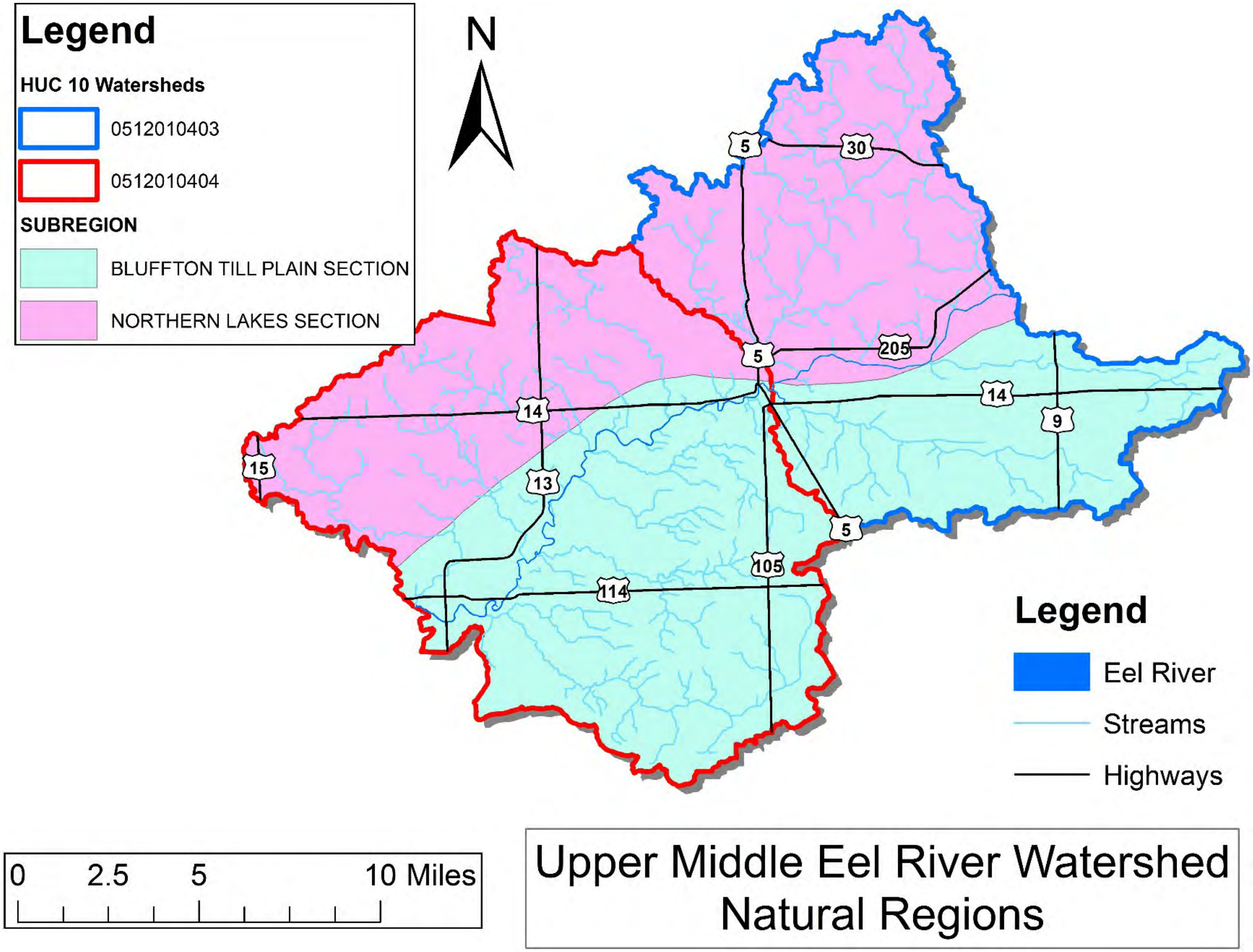

Figure 2-5. Natural Regions of Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River)

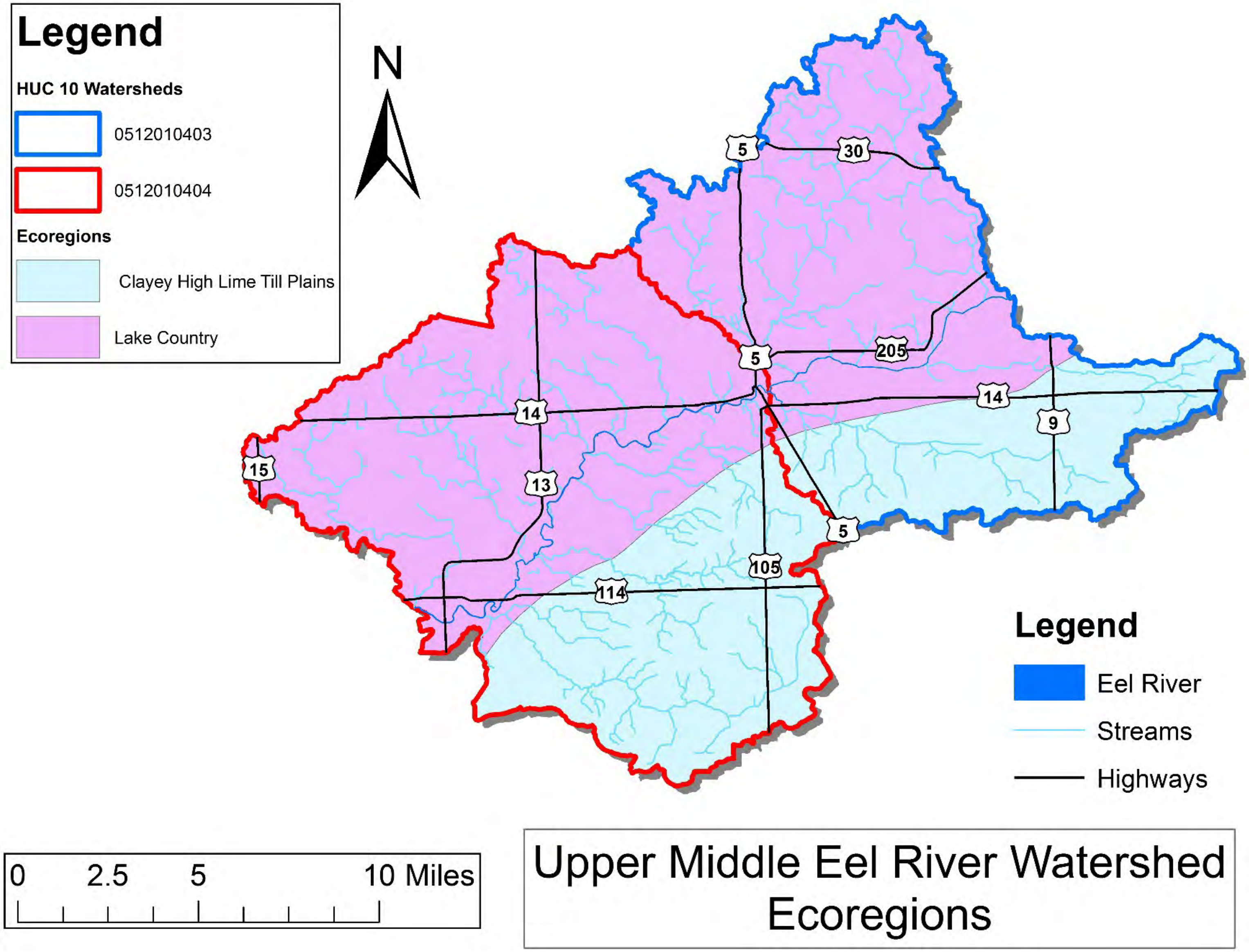

Figure 2-6. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Ecoregions- Indiana Geological Survey 1984

2.4 Soils

2.4.1 Hydrologic Soil Groups

Hydrologic group is a group of soils having similar runoff potential under similar storm and cover conditions. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonally high water table, and saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently.

Hydrologic groups are used in equations that estimate runoff from rainfall. These estimates are needed for solving hydrologic problems that arise in planning watershed-protection and flood-prevention projects, for planning or designing structures for the use, control, and disposal of water. They pertain to the minimum steady ponded infiltration under conditions of a bare wet surface.

Soils are classified by the Natural Resource Conservation Service (NRCS) into four Hydrologic Soil Groups based on the soil's runoff potential. The four Hydrologic Soil Groups are A, B, C and D. Where A soils generally have the smallest runoff potential and D soils the greatest (USDA TR-55).

Group A is sand, loamy sand or sandy loam types of soil. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

Group B is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly of moderately deep-to-deep, moderately well-to-well drained soils with moderately fine to moderately coarse textures.

Group C soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine-to-fine structure.

Group D soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This soil has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Hydrologic soils in the Upper Middle Eel River Watershed consists of 41.6% Group C, 30.5% Group D, 22.5% Group B and 4.5% Group A. Hydrologic Soil and their percent of the watershed are listed in Table 2-3.

Table 2-3. Upper Middle Eel River Watershed hydrologic soils by HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) including number of acres and percentage of watershed. (Choi, Engel & Theller, 2005)

Hydrologic Soil Group	**Group A Lowest Potential Runoff**	**Group B**	**Group C**	**Group D Highest Potential Runoff**
HUC 0512010403				
Acreage	3,613.5	8,330.1	27,572.3	30,457.0
% of Watershed	5.1%	11.8%	39.1%	43.2%
HUC 0512010404				
Acreage	3,746.8	28,431.3	40,172.9	19,339.5
% of Watershed	4.1%	30.8%	43.5%	20.9%
Watershed Totals				
Acreage	7,360.3	36,761.5	67,745.2	49,796.6
% of Watershed	4.5%	22.5%	41.6%	30.5%

2.4.2 Soil Associations

A soil association is a geographic area consisting of landscapes on which soils are formed. A soil association consists of one or more major soils series (soils that are very similar) and at least one minor soil series and is named for the major soil series in the geographic area (Figure 2-7). Soil associations provide a broad perspective of the soils and landscapes in the watershed, and provide a basis for comparing the potential of large areas of the watershed for general kinds of land use.

Soil Associations north of the Eel River consist primarily of Miami-Wawasee-Crosier, Blount-Glynwood-Morley, Fox-Ockley-Westland with very small sections of Spinks-Houghton-Boyer and Houghton-Adrian-Carlisle.

Soil Associations south of the Eel River consist of Blount-Glynwood-Morley, Blount-Pewamo-Glynwood, and small areas of Crosier-Brookston-Barry, and Rensselaer-Darroch-Whitaker.

Soil series definitions (Soil Survey of Wabash County 1979):

The Blount series consists of very deep soils that are moderately deep or deep to dense till. They are somewhat poorly drained, slowly permeable soils. They formed in till. These soils are on till plains and have slopes ranging from zero to six percent. Almost all areas of Blount soils are cultivated. Corn, soybeans, small grain, and meadow are the principal crops. Native vegetation is hardwood forest.

The Crosier series consists of very deep, somewhat poorly drained soils formed in till on till plains and moraines. They are moderately deep to dense till. Slope ranges from zero to four percent. Soils are used to grow corn, soybeans, and small grain (wheat and oats). Some areas are used for hay and pasture. A few areas are in woods. Native vegetation is deciduous forest.

The Miami series consists of very deep, moderately well drained soils that are moderately deep to dense till. The Miami soils formed in as much as 46 cm (18 inches) of loess or silty material and in the underlying loamy till. They are on till plains. Slope ranges from zero to 60 percent. Most areas are used to grow corn, soybeans, small grain, and hay. Much of the more sloping part is in permanent pasture or forest. Native vegetation is deciduous forest.

The Fox series consists of very deep, well-drained soils, which are moderately deep to, stratified calcareous sandy outwash. These soils formed in thin loess and in loamy alluvium or just in loamy alluvium overlying stratified calcareous sandy outwash on outwash plains, stream terraces, valley trains, kames, and glacial moraines. Slopes range from zero to 35 percent. Mean annual precipitation is about 762 mm (30 inches) near the type location. Mean annual air temperature is about 9.4 degrees C (49 F).

The Rensselaer series consists of very deep, poorly drained or very poorly drained soils formed in loamy sediments on till plains, stream terraces, outwash terraces, outwash plains, glacial drainage channels, and lake plains. Permeability is moderate. Slope ranges from zero to two percent. Soils are used to grow corn, soybeans, and small grain. Native vegetation is swamp grasses and deciduous hardwood forest.

The Spinks series consists of very deep, well drained soils formed in sandy eolian or outwash material. They are on dunes, moraines, till plains, outwash plains, beach ridges, and lake plains. Permeability is moderately rapid. Slope ranges from zero to 70 percent. Spinks soils are used mostly for hay production or pasture. Some areas are cropped to corn, wheat, oats, and soybeans. A small part is in orchards. Steeper areas are in forest or permanent pasture. The native vegetation is hardwoods, dominantly of oak and hickory.

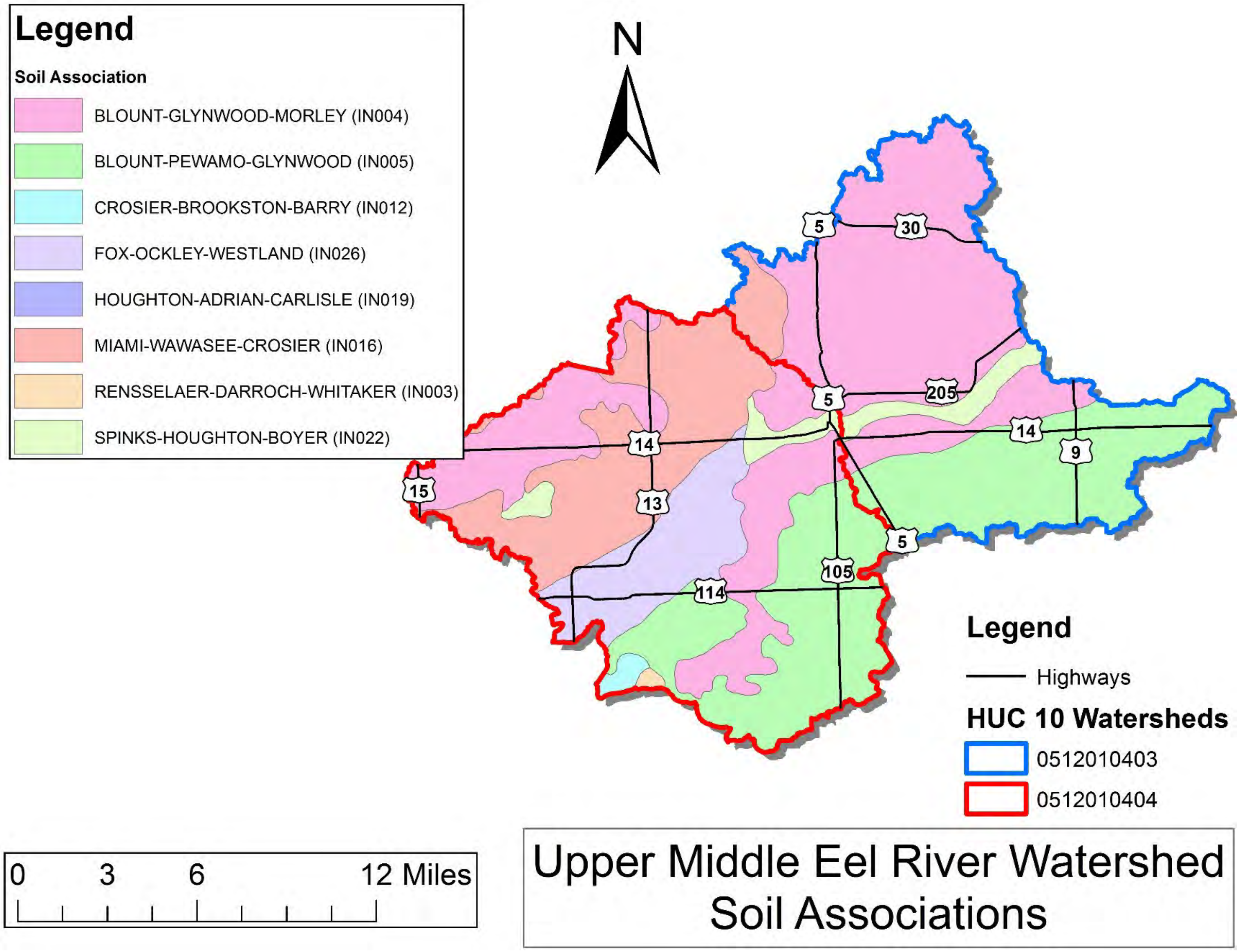

Figure 2-7. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Soil Associations

2.4.3 Hydric Soils

Several soils present within the watershed are classified by the local Natural Resource Conservation Service (NRCS) as hydric as can be seen in the following Figure 2-8. Hydric soils can pose threats to surface water when farmed due to excessive runoff of fertilizers, pesticides, and manure. Farmland located on hydric soils often requires the installation of field tiles to keep the fields from flooding or ponding. Hydric soils are not suitable soils for septic usage as they do not allow for proper filtration of the septic waste and may result in surface and/or groundwater contamination. Soils that are considered hydric are so classified for several reasons. The following explanation of hydric soils was taken from the NRCS, Field Office Technical Guide.

1. All Histols except for Folistels, and Histosols except for Folists.
2. Soils in Aquic suborders, great groups, or subgroups, Albolls suborder, Historthels great group, Histoturbels great group, Pachic subgroups, or Cumulic subgroups that.
    - A. Are somewhat poorly drained and have a water table at the surface (0.0 feet) during the growing season, or
    - B. Are poorly drained or very poorly drained and have either:
        - i. Water table at the surface (0.0 feet) during the growing season if textures are coarse sand, sand, or fine sand in all layers within a depth of 20 inches, or
        - ii. Water table at a depth of 0.5 feet or less during the growing season if permeability is equal to or greater than 6.0 in/hr. in all layers within a depth of 20 inches, or
        - iii. Water table at a depth of 1.0 foot or less during the growing season if permeability is less than 6.0 in/hr. in any layer within a depth of 20 inches.
    - C. Soils that are frequently ponded for long/very long duration at the growing season.
    - D. Soils that are frequently flooded for long/very long duration at the growing season.

Hydric soils, while posing a significant problem when farmed, also are quite beneficial as they are prime locations to create or restore wetlands. Wetlands are great resources as they supply many ecological benefits and could help prevent polluted runoff from reaching open water.

Table 2-4. Hydric soil breakdown in area and percentage in the UMERWI

	Acreage within Watershed	Percentage of Watershed
Hydric	18,334	11.2%
Partially Hydric	92,928	57.0%
Not Hydric	51,773	31.8%

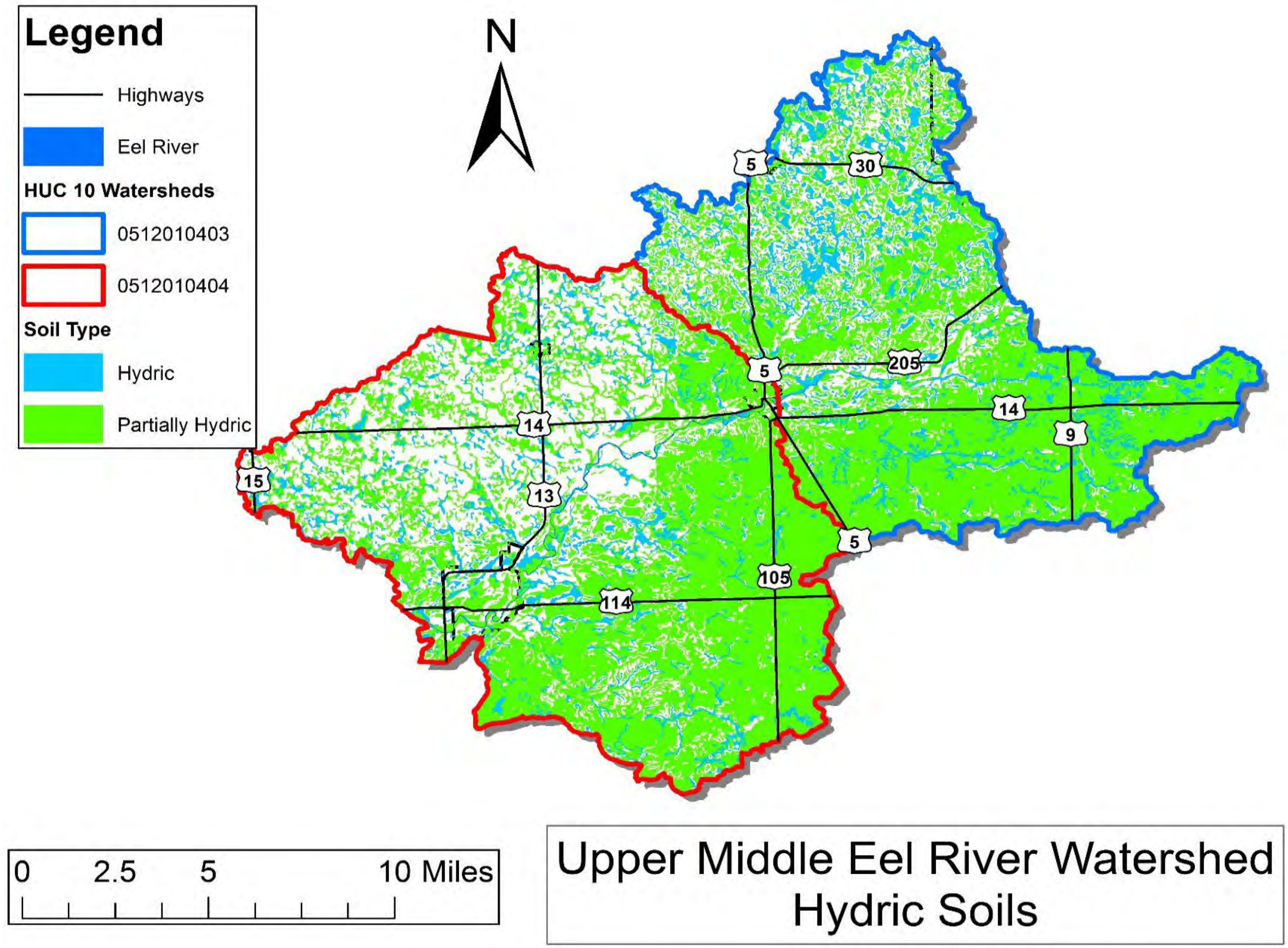

Figure 2-8. Hydric Soils in the Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River)

2.4.4 Highly Erodible Land

Highly erodible soils (HES) in the watershed were determined using the Indiana NRCS Highly Erodible Land (HEL) list. Highly erodible lands are more vulnerable to erosion, which may result in an increase of total suspended solids (TSS) in rivers, creek and ditches, negatively affecting the biological community. In addition, phosphorus binds with soil particles, and as soil erodes, it carries phosphorus with it and deposits it in streams, ditches and rivers. This can cause excess total phosphorus in the water, resulting in excessive algal growth and low dissolved oxygen. A map of HEL within the Middle Eel River Watershed is shown in Figure 2-9.

Table 2-5. Highly erodible soils located within the Upper Middle Eel River Watershed

	Acreage within Watershed	Percentage of Watershed
HEL	102,380	62.8%
Non-HEL	59,886	36.7%
Unquantified	767	0.5%

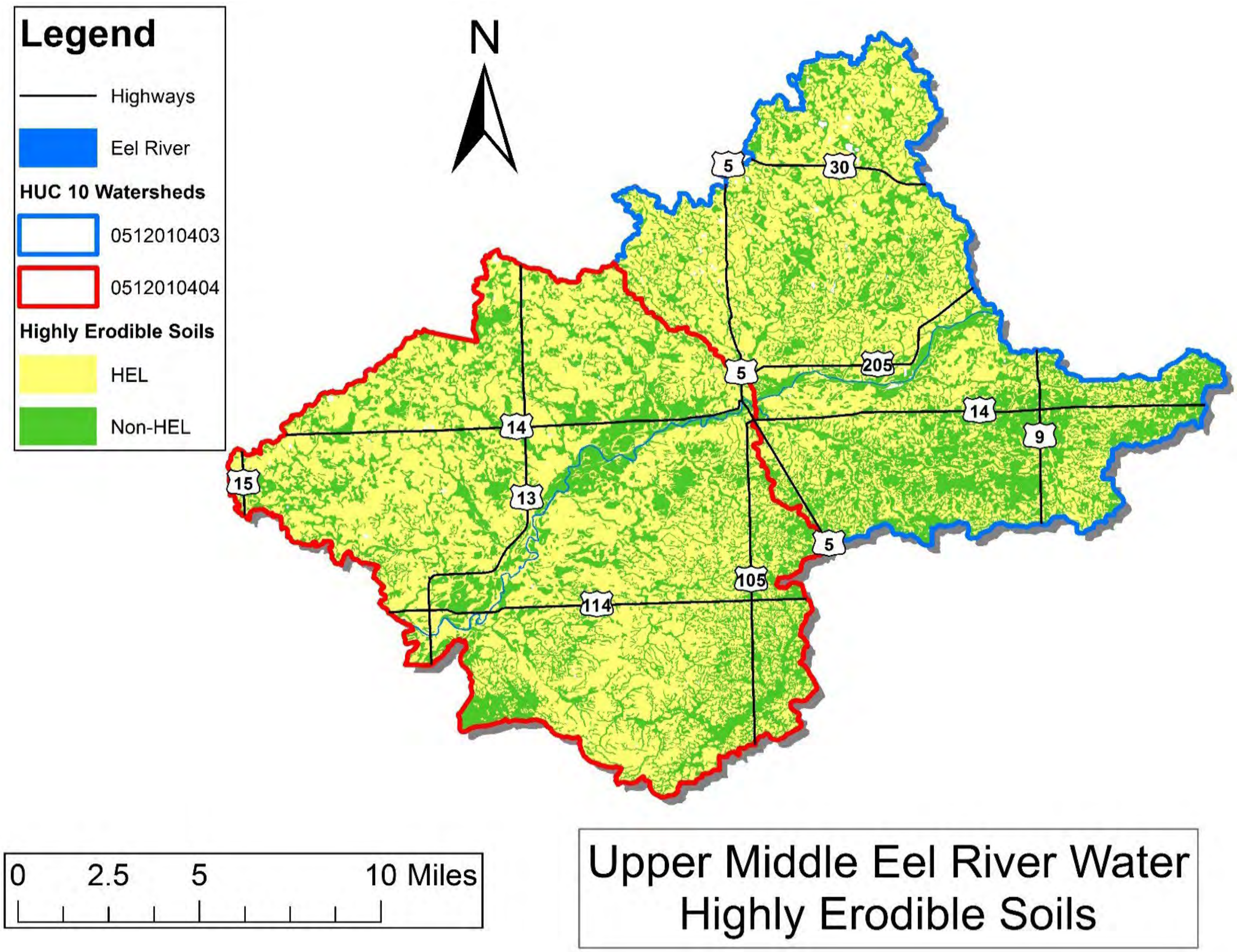

Figure 2-9. Upper Middle Eel River Watershed Initiative HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Highly Erodible Lands (HEL)

2.4.5 Septic System Suitability and Un-sewered/Sewerd areas

Septic tank absorption fields are subsurface systems of drains that distribute septic liquid waste evenly throughout the designated area and into the natural soil. Soil properties and landscape features that affect the ability of the soil to properly absorb and filter the effluent should be considered when designing a septic system. The majority of rural homesteads utilize septic systems to process wastewater. All major populated centers utilize a sewer system to handle household effluent. The majority of the watershed is rural and using a wide range of septic systems, it is important to note that nearly all (98%) of soils located within the project area are rated as “very limited” for septic usage according to the NRCS (Figure 2-10). About 1% of the soils located throughout the watershed is classified as “somewhat limited” for the installation of an on-site sewage treatment. Somewhat limited means that modifications can be made to either the site of septic installation or to the system itself to overcome any potential problems. A designation of “very limited” means that modifications to the septic system site, or septic system itself, are either impractical or impossible. The majority of the watershed soils are considered very limiting or somewhat limiting to support a septic system, thus other treatment methods such as centralized sewer systems or above ground mound systems should be explored.

Much of the population of the UMERW currently rely on septic system waste disposal. The number of failing septic systems is difficult to determine, as many of the systems are not on record with local health departments. The USEPA however estimates 25% of the household in the US utilize septic systems and anywhere from 1% - 5% of those are failing. It is worth noting that with the limited areas suitable for septic system, any failing septic system would fall within the very limiting soil type.

There are sewered communities located within the watershed. These two communities are North Manchester and South Whitley. Both municipalities treat their own wastewater at treatment plants located within the city and release their treated water into the Eel River.

Untreated waste from both individual septic systems and sewer systems has the potential to be released into adjacent waterbodies. Human’s untreated waste contains large concentration of nitrogen and phosphorus. Both of these chemicals are the leading causes of eutrophication of lakes and the dead zone in the Gulf of Mexico.

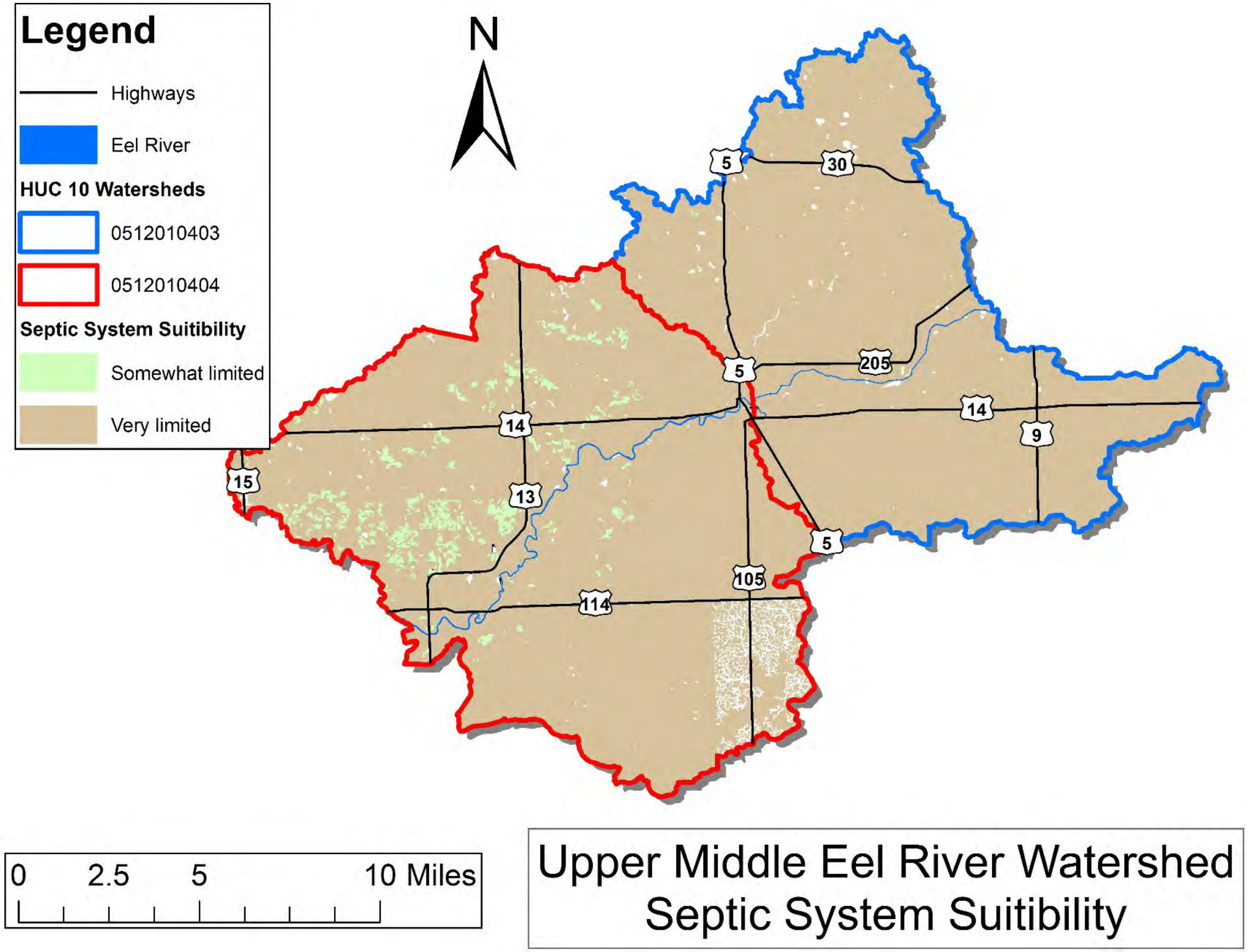

Figure 2-10. Upper Middle Eel River Watershed Initiative HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Septic System Suitability

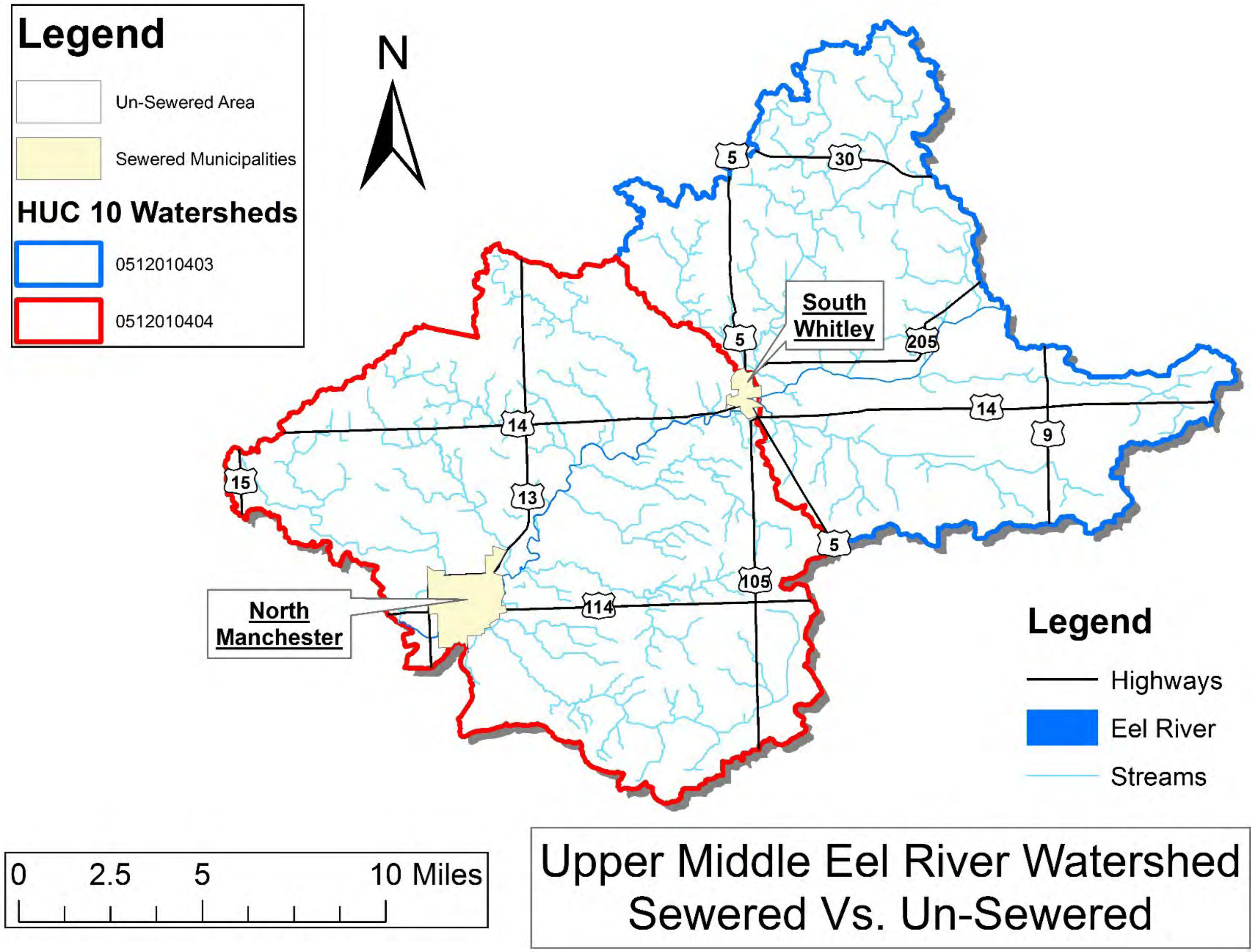

Figure 2-11. Upper Middle Eel River Watershed Initiative HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Sewered vs. Un-Sewerd Areas

2.4.6 Soil Characteristics and Stakeholder Concerns

Much of the Upper Middle Eel River Watershed contains soils that have the potential to cause negative effects on water resources and water quality within the watershed. The watershed contains approximately 70% of the soil in the C and D hydrologic group, which are the two highest runoff potential classes. Along with 62.8% of the watershed soils being classified as highly erodible soil. There is a large potential that during large precipitation event runoff from this soil could enter the stream. Comparing this analysis to stakeholder concerns, we find four concern that directly relate. Stakeholders are concerned about increased phosphorus and sediment loading and manure runoff. These parameters are directly related as phosphorus bind to clay particles in soil and both parameters move together. Thus, if phosphorus is moving then manure might be as well. With high soil runoff/erosion potential within the UMERW, it is evident that phosphorus and sediment run-off could be occurring. Lastly, stakeholders are concerned with stream bank erosion. With high runoff potential soils and highly erodible soils throughout the watershed there is a large potential for significant stream bank erosion to occur. Stakeholders are also concerned about failing septic systems. With 98% of the watershed being considered very limiting for septic systems there is huge potential for failing septic system to be occurring. Septic systems released into unsuitable soils cannot properly function before the septic water enters a waterbody or groundwater system. There is a large potential for excess nitrogen and phosphorus to be released and cause an increase in lake eutrophication and Gulf of Mexico dead zone

2.5 Tillage Transect

2.5.1 Tillage Practices

Conservation tillage is any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water. Two key factors influencing crop residue are (1) the type of crop, which establishes the initial residue amount and its fragility, and (2) the type of tillage operation prior to and including planting (USDA 2000).

2.5.1.1 Conservation Tillage Systems Include (USDA 2000):

No-till—the soil is left undisturbed from harvest to planting except for nutrient injection. Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, disk openers, in-row chisels, or roto-tillers. Weed control is accomplished primarily with herbicides. Cultivation may be used for emergency weed control.

Ridge-till—the soil is left undisturbed from harvest to planting except for nutrient injection. Planting is completed in a seedbed prepared on ridges with sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges. Weed control is accomplished with herbicides and/or cultivation. Ridges are rebuilt during cultivation.

Mulch-till—the practice of managing the amount, orientation and distribution of plant residues on the soil surface throughout the year round. The soil is disturbed prior to planting. Tillage tools such as chisels, field cultivators, disks, sweeps, or blades are used. Weed control is accomplished with herbicides and/or cultivation.

Reduced tillage (15-30% residue)—Tillage types that leave 15-30 percent residue cover after planting, or 500-1,000 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. Weed control is accomplished with herbicides and/or cultivation.

2.5.1.2 Conventional Tillage (USDA 2000):

Conventional tillage (less than 15% residue)—tillage types that leave less than 15 percent residue cover after planting, or less than 500 pounds per acre of small grain residue equivalent throughout the critical wind erosion period. Generally includes plowing or other intensive tillage. Weed control is accomplished with herbicides and/or cultivation. Conventional tillage systems include:

Conventional tillage with moldboard plow—any tillage system that includes the use of a moldboard plow.

Conventional tillage without moldboard plow—any tillage system that has less than 30 percent remaining residue cover and does not use a moldboard plow.

There are numerous benefits to a no-till system, according to Purdue University (Conservation Technology Information Center 2006), the top ten benefits of no-till are:

Reduces labor, saves time – As little as one trip for planting compared to two or more tillage operations means fewer hours on a tractor and fewer labor hours to pay…or more acres to farm. For instance, on 500 acres the timesaving's can be as much as 225 hours per year. That is almost four 60-hour weeks.

Saves fuel – Save an average 3.5 gallons an acre or 1,750 gallons on a 500-acre farm.

Reduces machinery wear – Fewer trips save an estimated $5 per acre on machinery wear and maintenance costs – a $2,500 savings on a 500-acre farm.

Improves soil tilth – A continuous no-till system increases soil particle aggregation (small soil clumps) making it easier for plants to establish roots. Improved soil tilth also can minimize compaction. Of course, compaction is also reduced by reducing trips across the field.

Traps soil moisture to improve water availability – Keeping crop residue on the surface traps water in the soil by providing shade. The shade reduces water evaporation. In addition, residue acts as tiny dams slowing runoff and increasing the opportunity for water to soak into the soil. Another way infiltration increases is by the channels created by earthworms and old plant roots. In fact, continuous no-till can result in as much as two additional inches of water available to plants in late summer.

Reduces soil erosion – Crop residues on the soil surface reduce erosion by water and wind. Depending on the amount of residues present, soil erosion can be reduced by up to 90% compared to an unprotected, intensively tilled field.

Improves water quality – Crop residue helps hold soil along with associated nutrients (particularly phosphorus) and pesticides on the field to reduce runoff into surface water. In fact, residue can cut herbicide runoff rates in half. Additionally, microbes that live in carbon rich soils quickly degrade pesticides and utilize nutrients to protect groundwater quality.

Increases wildlife – Crop residue provides shelter and food for wildlife, such as game birds and small animals.

Improves air quality – Crop residue left on the surface improves air quality because it: reduces wind erosion, thus it reduces the amount of dust in the air; reduces fossil fuel emissions from tractors by making fewer trips across the field; and reduces the release of carbon dioxide into the atmosphere by tying up more carbon in organic matter.

Figure 2-12 and Figure 2-13 show the relative percentage of no till, mulch till will crop residue remaining and conventional tillage for both corn and soybean within the counties of the UMERI. Corn no till ranges for Huntington County with only 30% of the corn field no tilled, up to Whitely county which documented 60% of the corn fields under no till practices. Conventional tillage is the least common practice after corn with only Wabash County exceeding 10% of the corn fields be conventional tilled. No till is more common after soybean with each county documenting greater than 30% of the soybean fields being no tilled. Conventional tillage is again higher in Wabash County with greater than 50% of the fields being conventional till after soybean crop.

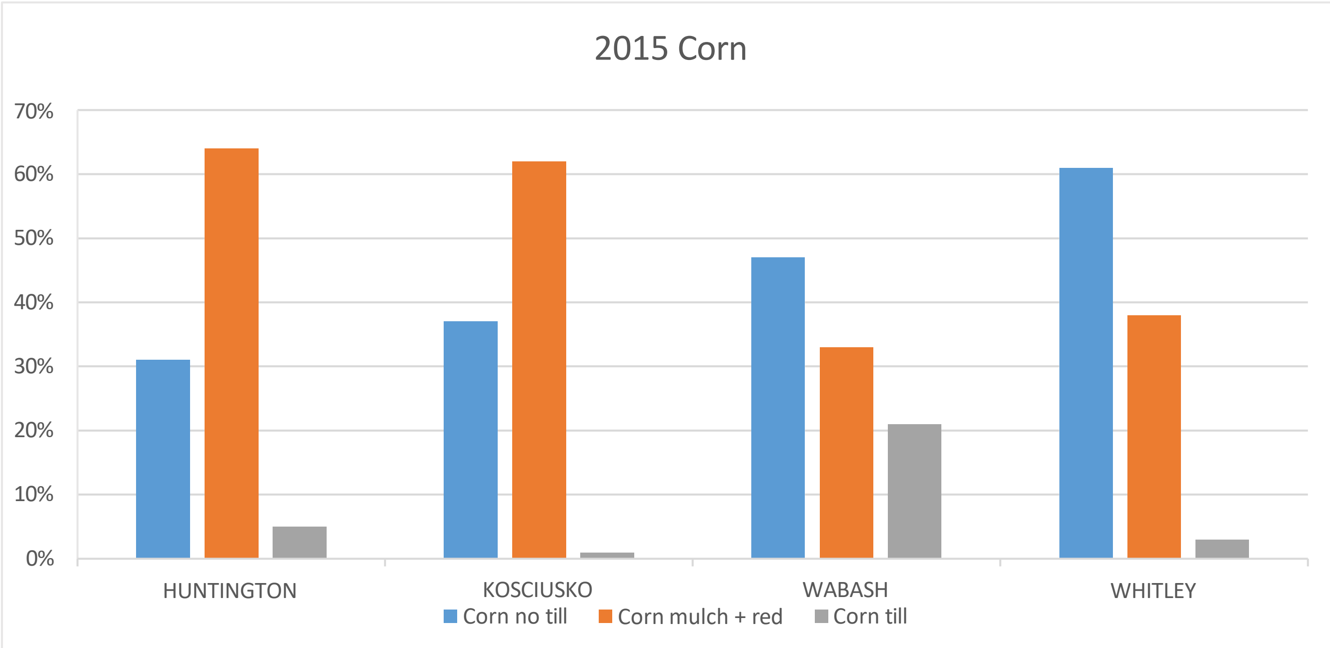

Figure 2-12. Relative frequency for corn tillage within UMERI counties in 2015 NRCS tillage transect data. Blue bars represent no tilled corn, Orange bars represent mulch tilled corn with remaining residue. Gray bars represent tilled corn.

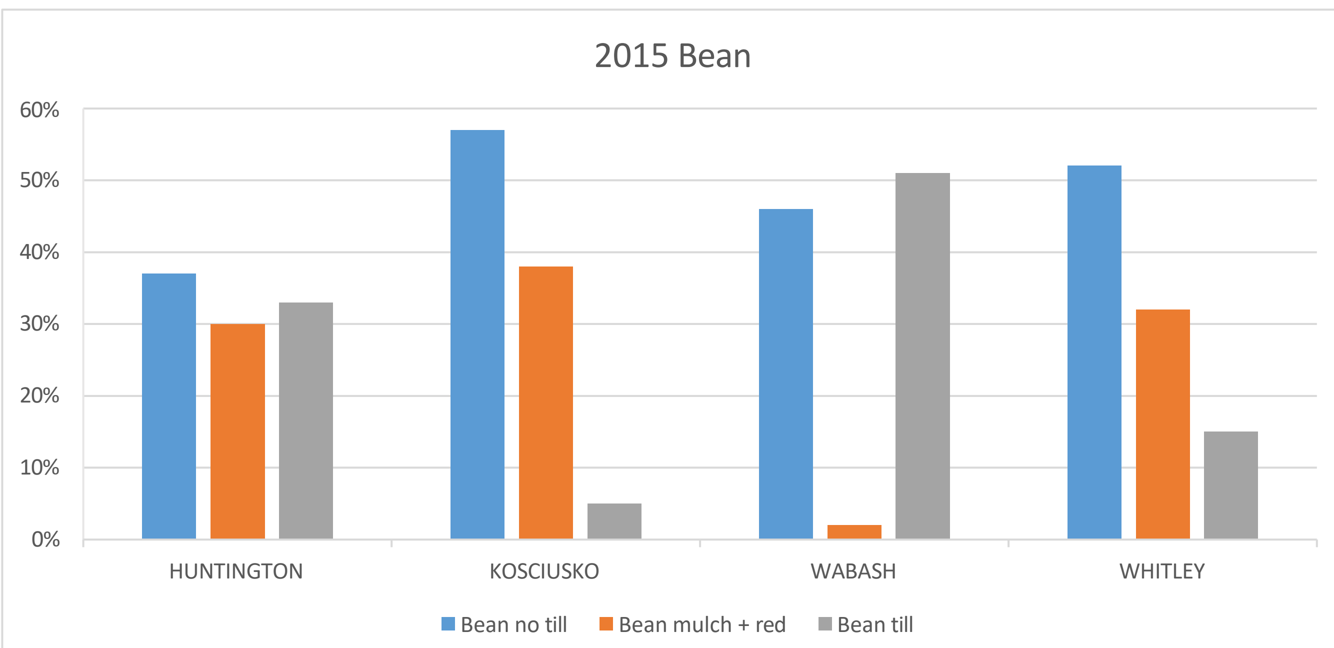

Figure 2-13. Relative frequency for soybean tillage within UMERI counties in 2015 NRCS tillage transect data. Blue bars represent no tilled soybeans, Orange bars represent mulch tilled soybeans with remaining residue. Gray bars represent tilled soybeans.

2.6 Climate

Indiana's climate is classified as temperate continental and humid. Continental climates have a pronounced difference in average seasonal temperatures between summer and winter. Humid climates are those where the normal annual precipitation exceeds annual evapotranspiration. In north central Indiana the wettest seasonal period is late spring and more than half (54%) of the annual precipitation occurs during the five-six month frost-free growing season. The average annual temperature for north central Indiana is 50-52°F and annual precipitation is 36-38" (Center for Earth and Environmental Science, 2003).

2.7 Hydrology

2.7.1 Stream Order

Stream order is a common stream classification system which helps describe a river's size and watershed area; the greater the stream order, the greater the size and watershed area. Using this system, the Eel River is a fifth order stream. A large number of first order streams are present in the watershed and most, if not all of these first order streams have been modified for agricultural drainage through straightening, ditching, dredging, and/or removal of riparian buffer areas. This has a direct influence on the amount of sedimentation, nutrients and E. coli reaching the streams. The drainage modifications do not only affect first order streams, however, first order streams comprise the majority of the watershed in terms of stream miles, and are where the largest amount on nonpoint source pollution enters the streams.

2.7.2 Stream Modification

According to the US Environmental Protection Agency's National Water Quality Inventory: Report to Congress (2004), hydromodification is the second leading cause of nonpoint source pollution in our rivers and streams. Hydromodification includes the laying of field tile, ditch maintenance, dam installation, and stream channelization in the tributaries. From the town of Collamer in Whitley County to its source in Allen County, the mainstem of the Eel River has been channelized resulting in degraded biotic habitats (Henschen 1987). From North Manchester downstream the mainstem of the river has not been channelized (Henschen, 1987), however the watershed was extensively ditched and drained prior to 1900 for agricultural use (Gammon 1990). Extensive tile drainage and ditching continues to this day within the watershed. Dredging and debrushing of the open drains destroys habitat, increases suspended sediment and nutrients and is expensive to maintain. Stream modification, driven by agriculture, is a major contributing factor to nonpoint source pollution in the watershed.

2.7.3 Stream Features

There is 359 stream miles of stream, rivers, ditches, and canals located within the Upper Middle Eel River Watershed. With 26 miles being contributed by the Eel River as it flows from Columbia City to North Manchester, Indiana. Table 2-6 and Figure 2-14 represent the various types of flowing water in the watershed according to the National Hydrography Dataset and county drainage boards, which defines each type of waterway as:

- Stream/River – A body of flowing water
- Artificial Path – A feature that represents flow through a two-dimensional feature, such as a lake of double-banked stream.
- Canal/Ditch – An artificial open waterway constructed to transport water, to irrigate or drain land, to connect two or more bodies of water, or to serve as a waterway for a watercraft.
- Legal Drain – Maintained by county officials, used to transport water from landscapes more readily.

Table 2-6. Stream Miles in the Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River)

	Artificial Path	**Stream/River**	**Canal/Ditch**	**Legal Drain**
Miles in UMERI	11.7	107.00	3.7	236.7
Percent	3.25%	29.80%	1.03%	65.92%

With an agricultural dominated landscape, much of the Eel River and tributaries (streams and ditches) have limited recreational opportunities for the public. However, the Indiana Department of Natural Resources maintains multiple public access sites for recreational canoeing, kayaking, and tubing. Two of these sites are located within the Upper Middle Eel River Initiative. With one site being located in Liberty Mills, Indiana and the other being located in South Whitley, Indiana. Fishing opportunities in the Eel River are limited to smallmouth bass, rock bass, and chub fishing. With the occasional largemouth bass, catfish, and walleye being captured. Little to no recreational uses for streams or ditches within the watershed have been documented. Stream and ditches are used to efficiently transport water from the headwaters of the watershed to insure proper agricultural production.

2.7.4 Legal Drains

Legal drains with the project are used to carry excess water from the land so that it may be utilized for agriculture uses. Due to flooding and ponding in agriculture landscapes, many of the tributaries have been channelized to increase the velocity of which the water can flow downstream and decrease the time agriculture fields are inundated with water. As seen in Figure 2-14 many of the tributaries have been channelized and straightened to aid in drainage. Legal drains are maintained by local drainage board and the county surveyor. Taxpayer dollars are used to ensure proper design and flow rate are achieved and maintained within the drain. Much of the waterways in the watershed are considered legal drains with Whitley County possessing more legal drains than any other county in the state. There are 236.7 stream miles of legal drain located within the UMERW.

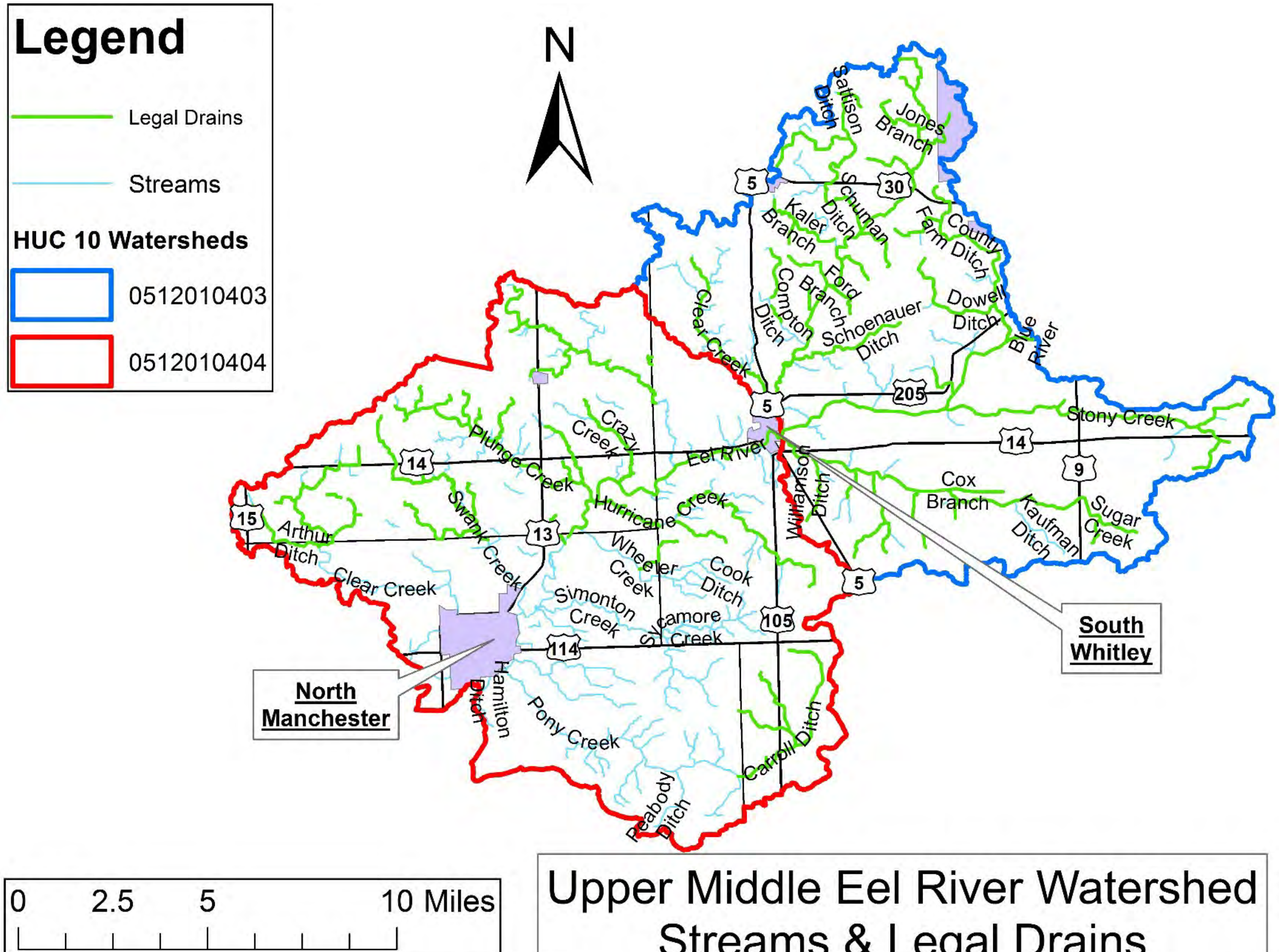

Figure 2-14. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Stream and Legal Drain Features

2.7.5 Lakes

The majority of lakes within the watershed are located on the north side of the Eel River. The largest lake in the watershed covers only 25 acres, and the smallest lake covers only 1 acre. There are 168 lakes with a total of 253 acres located within the watershed (Figure 2-15). These lakes provide little to no recreational use for the public.

Lakes serve many functions in a watershed; they store water, thereby helping to regulate stream flow; recharge ground water aquifers; moderate droughts; and serve as sinks and sediment traps. They provide habitat to aquatic and semiaquatic plants and animals, which in turn provide food for many terrestrial animals; and they add to the diversity of the landscape. Lakes within the watershed provide limited use for humans besides the recreational fishing, canoeing, and kayaking.

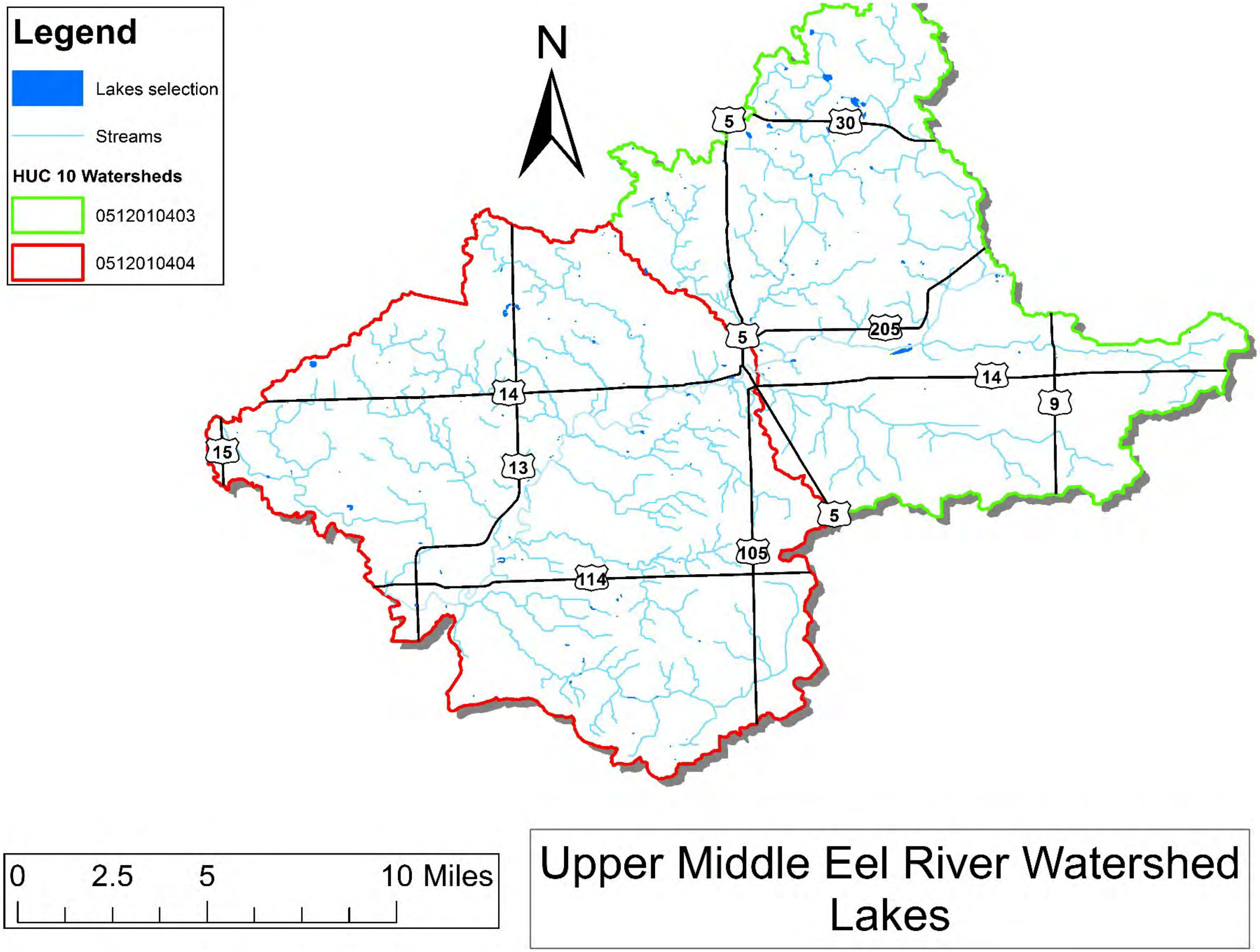

Figure 2-15. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Lakes

2.7.6 Wetlands

It is estimated that 24.1% of Indiana's surface was covered by wetlands before European settlement (Jackson, 1997). Indiana ranks fourth in the nation in percentage of wetlands lost, with an estimated 85% of wetlands lost. Much of Indiana's original wetlands were concentrated in northeastern Indiana.

Wetlands that remain in the Upper Middle Eel River Watershed concentrated north of the Eel River and range from less than 1 acre up to 76 acres in size. Freshwater Emergent, Freshwater Forested, and Shrub Wetlands comprise of 3.26% of the total land use within the watershed (Figure 2-16).

Wetlands provide various benefits within the watershed. Many wetlands are used to store excess surface water and provide pollutant treatment before the water is released into a waterway. Many of these wetlands provide diverse habitat from various wildlife species. Wetlands are used for wildlife and bird watching by the public. These multi-habitat locations are widely used by the hunting community as target hunting areas.

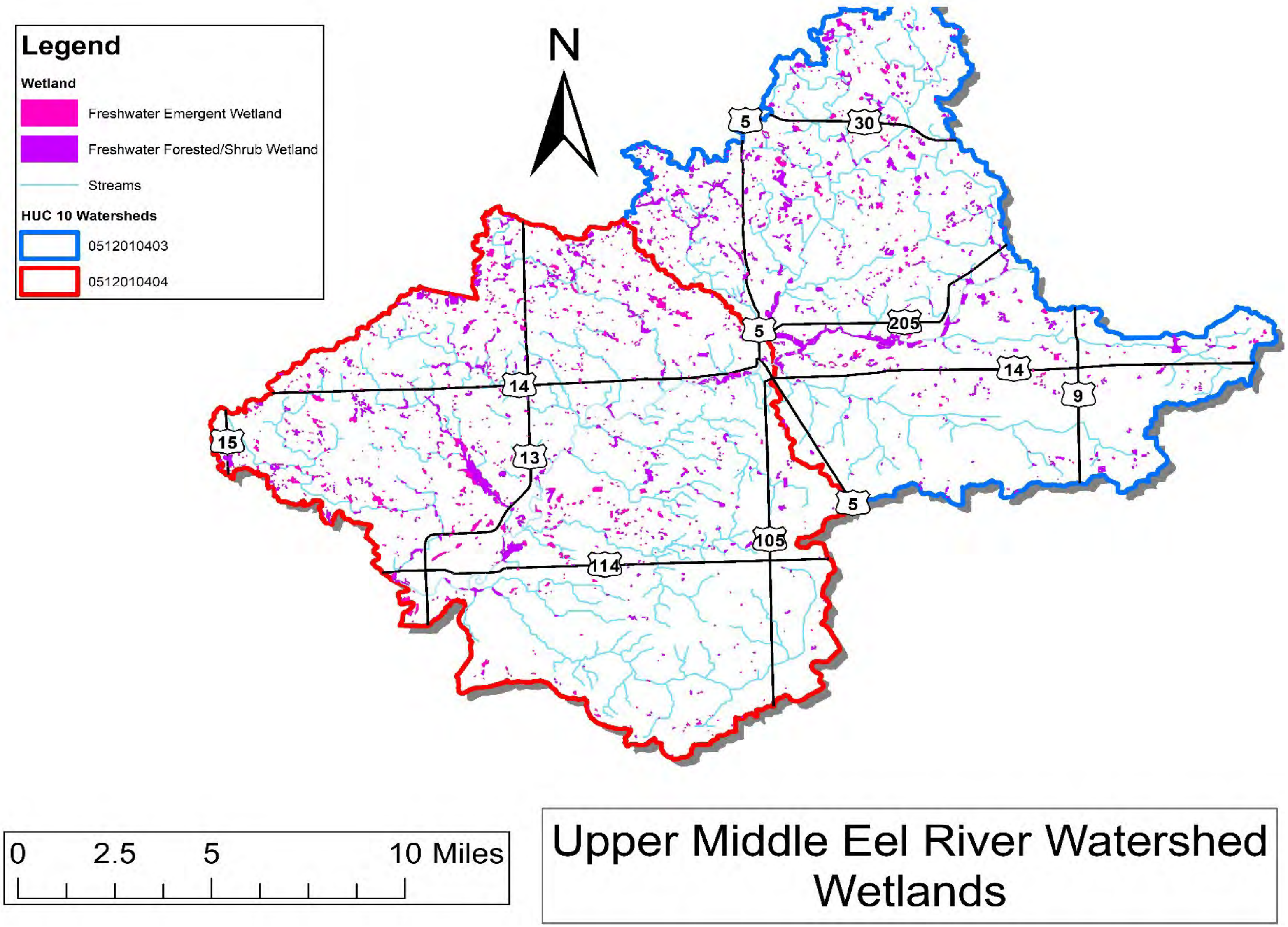

Figure 2-16. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Wetland

2.7.7 Hydrologic Characteristics & Stakeholder concerns

Many of the concerns expressed by the stakeholders directly relate to hydrologic characteristics. Many stakeholders are worried about the frequency of flood events in the UMERW. Flooding can be related to channelization of the stream and loss of wetland habitat. Streams that are channelized effectively transport water. With the meander of the streams removed, water in the channel is able to increase velocity and congregate in the stream channel at that same time. This cause a larger volume of water to be present and cause flood events. Additionally, with the loss of wetland habitat the upland storage of water has been reduce. Historically, wetlands provided water storage and would slowly release water back into the soil or adjacent waterbody. This storage allows for a gradual increase, decrease in flows, and reduce the frequency of flooding. Increased water discharge and velocity can cause increased pollutant loading (Nitrogen, Phosphorus, and Sediment). At lower flows and velocities, the stream has a greater potential to treat pollutants but at high flows the opportunity decreases and more pollutants are exported out of the watershed. High velocities in modified lead to increased shear stress on channel walls. This sheer stress is the leading cause of streambank erosion and banks sloughing off into the channel. Coupled with limited riparian buffer the stream bank is no longer armored and the level of shear stress required to create a bank failure is reduced. Lastly, with many of the streams being channelized habitat for aquatic species become limited. Natural stream comprise of many habitat variations, which include Riffles, Runs, Pools, Meanders, Woody Debris, Etc. During the channelization, process all these habitats are removed and replaced with a straight trapezoid ditch. Trapezoidal ditches limit the opportunity for various aquatic species to survive and only tolerant species will inhabit these locations.

2.8 Land Use

Prior to European settlement of Indiana in the 1800s, the landscape was one large natural area that contained 36,291 square miles of about 20 million acres of forestland, 2 million acres of prairie, 1.5 million acres of water and wetlands, plus glades, barrens and savanna totaling perhaps another million acres (Jackson, 1997). Over the recent past, land use in the Middle Eel River Watershed has seen a dramatic transition from natural area to intense agricultural use.

Current land use in the Upper Middle Eel River Watershed is predominantly cultivated crops (~79%), with only small acreage of residential and forested areas. Figure 2-17 shows the land use in the Upper Middle Eel River Watershed. Figure 2-18 shows land use as a percent of total watershed, broken down into six categories: cultivated crops (corn, soybeans, winter wheat, hay and alfalfa), pasture/range/grasslands, forested, urban, wetlands and other (other small acreage crops, fallow cropland, clouds, and open water). As can be seen in Figure 2-18, the predominant land use within the Upper Middle Eel River Watershed is Cultivated Crops.

Table 2-7. Land cover acreage and percentage of Upper Middle Eel River Watershed

Land Cover	Acreage	% of watershed
Open Water	612.7	0.4%
Developed, Open Space	8,882.9	5.4%
Developed, Low Intensity	1,535.0	0.9%
Developed, Medium Intensity	389.9	0.2%
Developed, High Intensity	103.0	0.1%
Deciduous Forest	14,940.9	9.2%
Evergreen Forest	33.4	0.0%
Shrub/Scrub	469.3	0.3%
Herbaceous	1,202.5	0.7%
Hay/Pasture	4,790.8	2.9%
Cultivated Crops	128,786.1	79.0%
Woody Wetlands	664.7	0.4%
Emergent Herbaceous Wetlands	620.0	0.4%

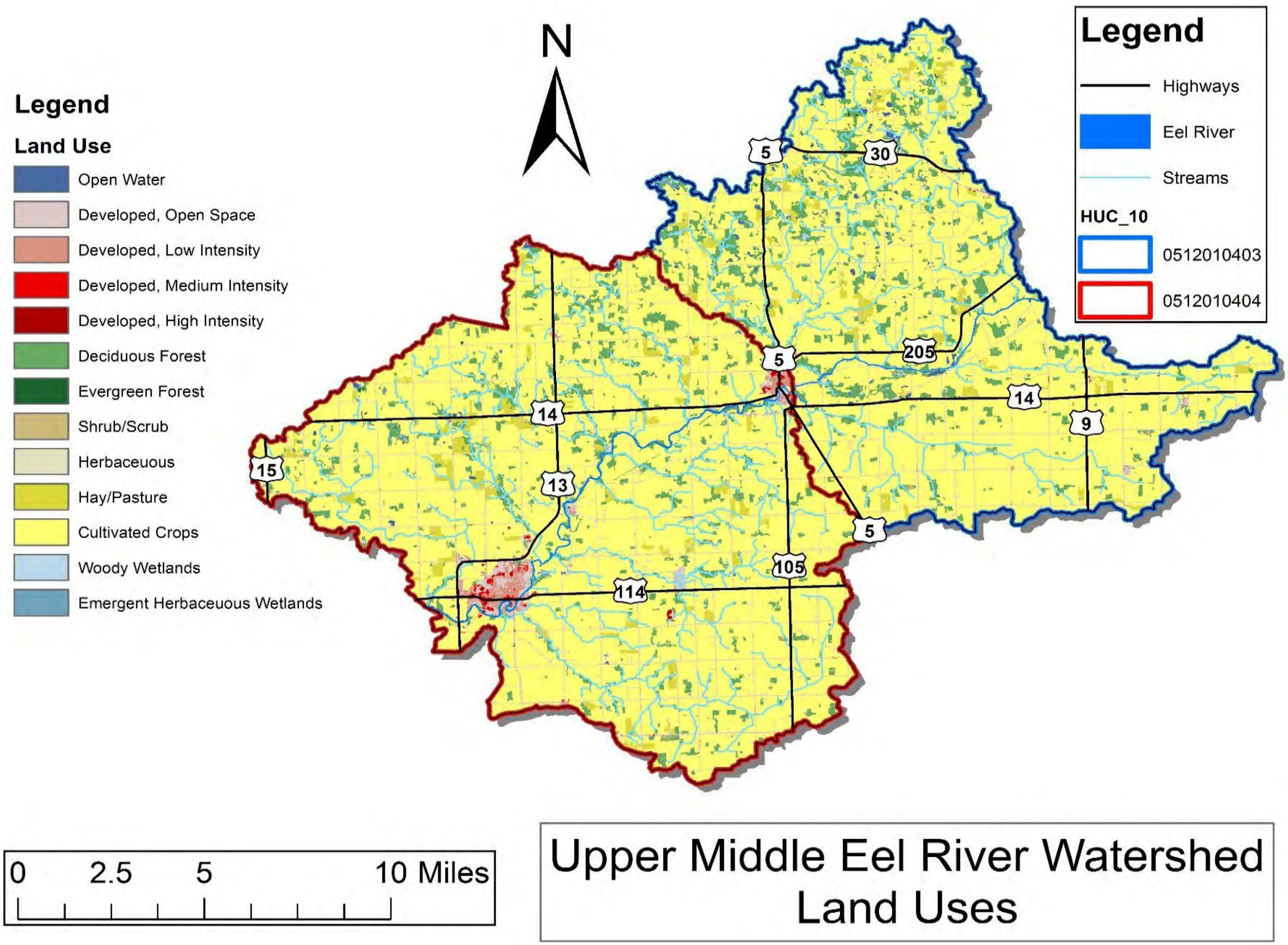

Figure 2-17. Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River) Land Uses

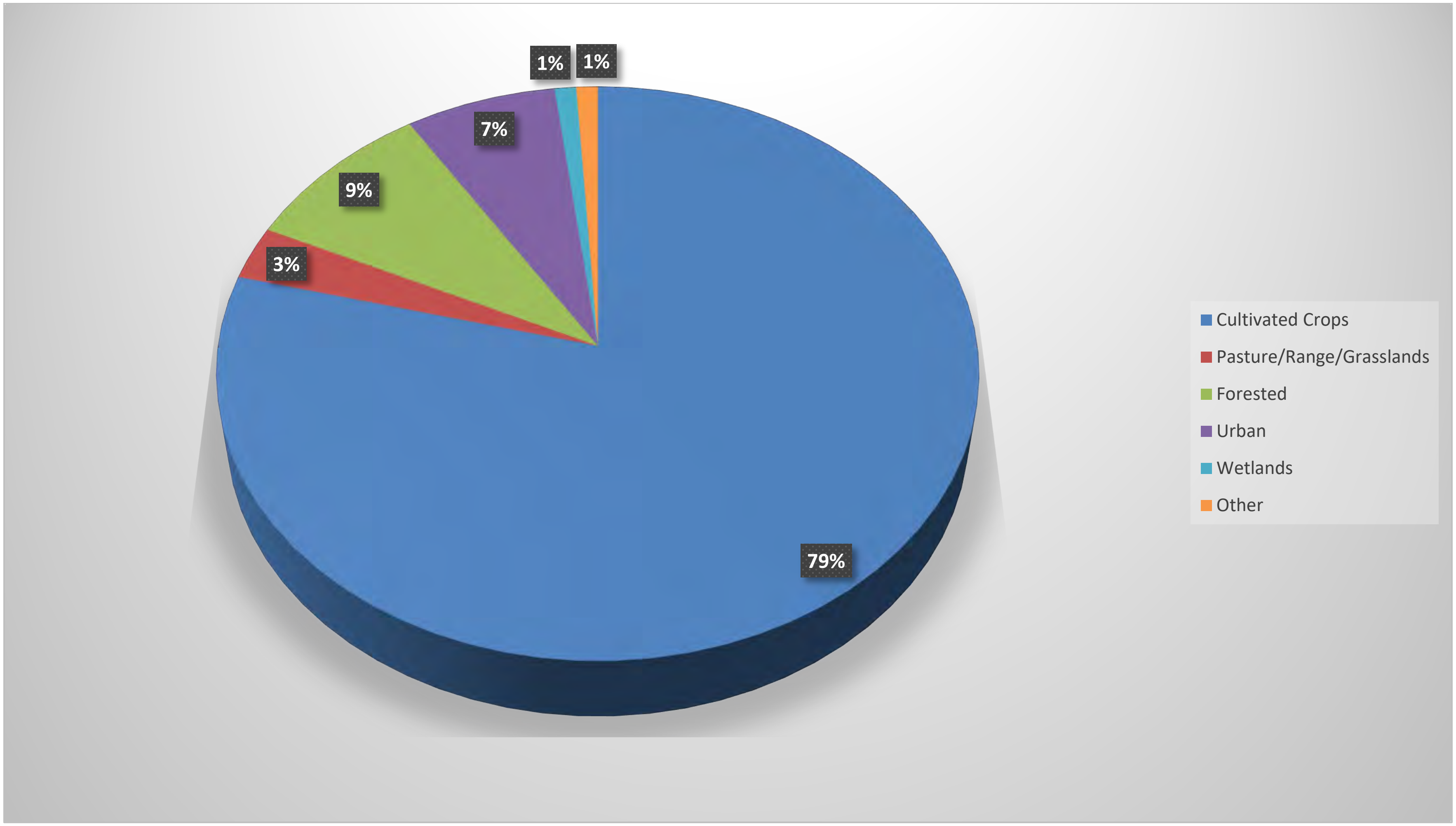

Figure 2-18. Land use by percentage in the Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River)

Particular land uses can greatly influence the quality of various waterways in a watershed. Urban centers generally comprise of impervious materials, such as asphalt roads, which forces water in an unnatural pattern. This process extends the time that surface water is subject to pollutants. Additionally, land in agricultural production has the potential to erode, especially if over worked or if it is conventionally tilled annually. Erosion of soil in agriculture landscapes carry large concentration of nutrient and other pollutants. Once these nutrients and pollutants reach the surface waterway they have the ability to affect aquatic plants and animals throughout the entire watershed. Livestock operations often can lead to high levels of bacteria in open water from manure storage areas that are not properly maintained or from livestock having direct access to open water sources. These two activities can also lead to high levels of sedimentation and nutrients in surface water. For the reasons listed above, it is very important to investigate land use activities in the project area to determine the best method of remediating the pollution coming from the various land uses in the project area. Below are examples of water pollutant risk currently present in the watershed.

2.8.1 Brownfields

Brownfields are defined by the US EPA as “real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant”. Examining these sites in closer detail to determine potential future uses for the sites by cleaning up any environmental hazards present, will help to protect the environment, can improve the local economy, and reduces pressure on currently undeveloped lands for future development. The US EPA, states, and local municipalities often offer assistance in the form of grants and low interest rate loans for the cleanup and redevelopment of identified and potential brownfield sites. There are no brownfield sites located within the UMERW.

2.8.2 NPDES Permits

IDEM administers the National Pollution Discharge Elimination System (NPDES) permit program required by the Clean Water Act (CWA). IDEM addresses activities that cause or may cause discharge of pollutants into the waters of the State. According to IDEM, the purpose of NPDES permits is to control point source pollution of the state’s waters. The NPDES permit requirements must ensure that, at a minimum, any new or existing point source discharger must comply with technology-based treatment requirements and water quality based effluent requirements that are contained in 327 IAC 5-5-2. According to 327 IAC 5-2-2, "Any discharge of pollutants into waters of the State as a point source discharge, except for exclusions made in 327 IAC 5-2-4, is prohibited unless in conformity with a valid NPDES permit obtained prior to discharge." This is the most basic principle of the NPDES permit program. (IDEM Office of Water

Quality, 2009). There are nine NPDES permits for wastewater facilities in the watershed, Figure 2-44, Confined Animal Feeding Operations also require NPDES permits and are addressed in the next section.

2.8.3 Feeding Operations

2.8.3.1 Animal Feeding Operations (AFO)

The U.S. EPA describes Animal Feeding Operations as:

> Animal Feeding Operations (AFOs) are agricultural operations where animals are kept and raised in confined situations. An AFO is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:
>
> - animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
> - crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
>
> AFOs that meet the regulatory definition of a concentrated animal feeding operation (CAFO) are regulated under the NPDES permitting program. The NPDES program regulates the discharge of pollutants from point sources to waters of the United States. CAFOs are point sources, as defined by the CWA To be considered a CAFO, a facility must first be defined as an AFO, and meet the criteria established in the CAFO regulation.

To be described AFOs must not exceed the quantity threshold of either CFO or CAFO. There are no documented AFOs located within the UMERWI. Only small hobby, CFO, and CAFO operations are present.

2.8.3.2 Confined Feeding Operations (CFO)

Confined feeding is the raising of animals in any confined area for at least 45 days during any year where there is no ground cover or vegetation over half of the confined area. CFOs are defined by Indiana law as any feeding operation engaged in the confined feeding of at least:

- 300 cattle or
- 600 swine or sheep
- 30,000 fowl (chickens, turkey or other poultry)
- 500 horses in confinement

IDEM regulates the CFOs through the Office of Land Quality which is responsible for permitting, compliance monitoring and enforcement activities as outlined in the Confined Feeding Control Law. The following criteria must be met in order to be a permitted CFO:

- Must have at least 180 days storage for manure and wastewater
- Be designed according to the design standards outlined in the CFO Guidance Manual
- Have sufficient acreage available for application of manure generated
- Provide adequate separation distances of the manure storage structures and confinement lots from roads, wells, and surface waters
- Include a manure management plan detailing soil testing, manure testing and manure application areas
- Provide record keeping at the CFO which includes:
    - Manure type
    - Amount of manure generated
    - Amount of manure applied to land
    - Manure storage methods
    - Type of application equipment used
    - Application rates based on laboratory analysis

2.8.3.3 Confined Animal Feed Operations (CAFOs)

The CAFO permit process and operational requirements are slightly different from CFOs. CAFOs in Indiana are required to obtain an NPDES permit through IDEM according to the USEPA Clean Water Act regulations for CAFOs finalized in 2003. CAFOs are considered to be point sources for pollution by the USEPA. IDEM developed a general permit for CAFOs (327 IAC 15-15) effective in February 2004. Two types of NPDES permits are available for CAFOs:

1. The general permit establishes uniform criteria to be followed by those with a general permit.

2. An individual permit provides an opportunity for IDEM to require additional protective measures, or for the farm to construct or operate in a manner different from that prescribed by the general permit regulation.

The main determining factor for requirement of an NPDES permit is the number and species of animals. The threshold for each species is shown in Table 2-8 .

Table 2-8. Threshold number and species that require CAFO NPDES permit.

Threshold Number Requiring NPDES Permit	Species
700	Mature Dairy Cows
1,000	Veal Calves
1,000	Cattle - other than mature dairy cows
2,500	Swine - above 55 pounds
10,000	Swine - less than 55 pounds
500	Horses
10,000	Sheep or Lambs
55,000	Turkeys
30,000	Laying Hens/Broilers with liquid manure handling system
125,000	Broilers with solid manure handling system
82,000	Laying Hens with solid manure handling system
30,000	Ducks with solid manure handling system
5,000	Ducks with a liquid manure handling system

Any CAFO seeking an NPDES permit must provide to IDEM the following information:

- A completed NPDES permit application form;
- A completed CFO approval application form;
- Confirmation that any necessary public notice requirements were conducted;
- Plans and specifications for the design and construction of the animal confinement structure and manure treatment and control facilities;
- At least two soil borings within the area of any liquid waste storage structures;
- A manure management plan outlining procedures for soil testing and manure testing;
- Soil Survey and Topographic Maps of manure application areas which outline field borders, identify the owner, and acres available;
- Farmstead plan showing the location of the buildings and waste storage structures in relation to the following features within 500 feet:
    - water wells
    - drainage patterns
    - property lines
    - roads
    - streams, ditches and tile inlets

The following conditions must be satisfied for IDEM to issue an NPDES permit:

- The submitted application forms must be complete with no missing applicable information;
- Confirmation that public notice requirements were satisfied;
- Provides at least 6 months of manure and wastewater storage capacity;
- Has sufficient acreage available for application of the manure and wastewater;

- Provides adequate separation distances of the manure storage structures and confinement lots from property lines, roads, wells, and surface waters;
- If a construction application is submitted that the structures are designed to be built according to the design standards outlined in the CFO rule and CFO Guidance Manual.

There are 63 CFO/CAFO located within the UMERW with 49 located in HUC 0512010404 (Clear Creek-Eel River) and 14 located within HUC 0512010403 (Sugar Creek-Eel River)

2.8.4 Combined Sewer Overflow (CSO)

The city of North Manchester is in the process of transitioning from a combined sewer overflow system to separated storm drains. South Whitley maintains functioning CSO in their community. In a combined sewer overflow system, storm water and sewage waste use the same pipes. Consequently, when a heavy rain occurs, the water draining off the land and the sewage combines and exceed the capacity of the drainage pipe. In order to maintain sewage service to the city, valves are opened which allows discharge of untreated sewage to the Eel River. This may cause an increase in nutrients, particularly phosphorus and nitrogen as well as an increase in E. coli concentrations, however this is a point source and is beyond the scope of this WMP.

2.8.5 Agricultural Tile Drainage

Tile drainage in Indiana is intimately tied to row crop agriculture. No agency tracts the placement or number of tile drains in Indiana fields or watersheds. Subsurface tile drains are common across the watershed and can be found by the discharge pipes seen in ditches and streams. It is well known that nitrate binds and moves with water. As water drains off the land through the tile drains it may carry excess nitrogen from the fields and cause an increase in the nitrogen concentrations in rivers and streams.

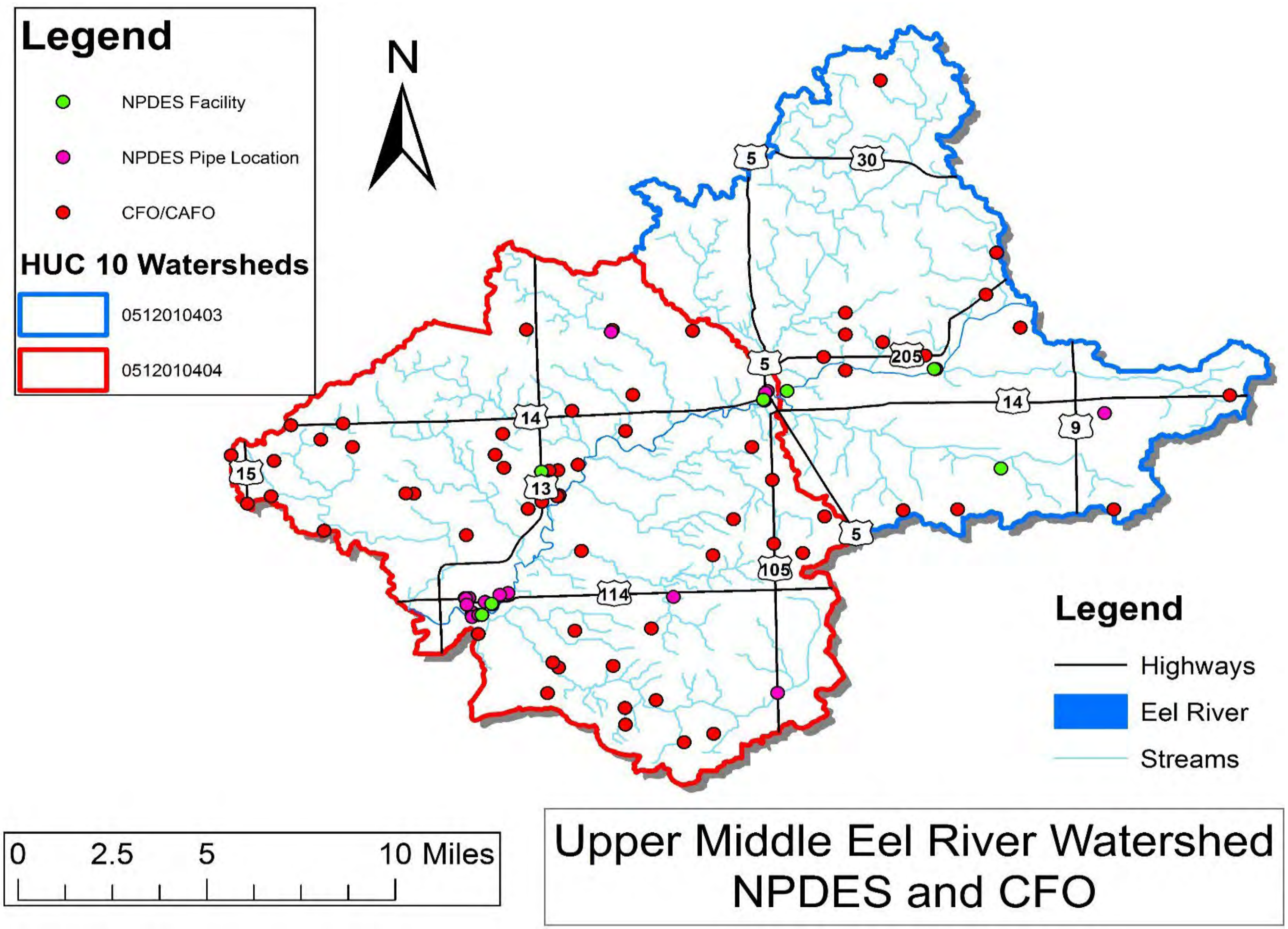

Figure 2-19. CFO/CAFO and NPDES locations within the Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River)

2.8.6 Urban and Suburban fertilizer Use & Pet/Wildlife Waste

While fertilizer use and pet waste in urban/suburban areas could increase levels of pollutants, the quantity and quality of the fertilizer/pet waster used in two small urban areas is hard to define. The contribution of nitrogen and phosphorus from urban fertilization/pet waste to receiving waterbodies is considered minimal compared to the extensive fertilization applied to agriculture fields that dominate the landscape.

2.8.7 Land Use & Stakeholder Concerns

Many of the concerns expressed by the stakeholders directly related to how the land uses are utilized in the watershed. With the conversion of the landscape from forest and prairie prior to European settlement to row-crop agricultural dominated landscape currently, many natural processes have been altered. Row crop agriculture requires nutrient inputs from fertilizers or manure to sustain high yields yearly. These nutrient inputs have the potential to enter adjacent waterbodies through both overland runoff and subsurface tile. With the conversion of forest to row crop agriculture the watersheds loses a landscape that acts as a nutrient sink to provide treatment before the water enters a waterbody. Additionally, much of the riparian buffers around the streams have been modified or removed to increase the land in row crop production. The removal of these buffers reduce the potential nutrients to be absorbed before they enter the waterway. Additionally, with a lack of riparian buffers the stability of the streambank is reduced and the potential for streambank erosion rose.

2.9 Prior and/or Additional Planning within the Watershed

No information has been found if any of the below comprehensive plans have implemented strategies included within the plans, or if there has been any improvement to the water quality within the watershed due to their implementation.

2.9.1 MS4 and Regional Sewer District Plans

There are no MS4 or Regional Sewer District Plans within the boundary of the UMERWI. Currently Whitley County is developing a sewer system plan for the entire county that would address some failing septic system issues.

2.9.2 Master Plans (City/County)

2.9.2.1 South Whitley

In 2014, the South Whitley city government released a comprehensive plan. The plan sets the course for actions, polices, and improvements that will preserve the charter of South Whitely and make it a desirable place to live, work, and visit. Much of the plan is focused on preserving the character and quality of South Whitley and guide economic development and future growth.

Throughout the plan, it is document that the town needs to be reconnected back to nature and scenic views. They propose a couple solutions to better connect urban areas with natural environments. One solution is to promote conservation development through conservation subdivisions model. This model provides home sites with additional open spaces that can be permanently protected through land trust. Such landscapes include wetlands, creeks, wooded lots, floodplains, and hydric soil sites.

The plan preconizes the Eel River as a great natural asset and is currently underutilized. The city of South Whitley plans to open up the banks to increase human interaction with the river. Additionally, a greenway is proposed to connect River Park and Hagan Park. This greenway would follow the Eel River and provide increased opportunities for individuals to interact with the river.

2.9.2.2 Whitley County Comprehensive Plan

In 2014, the Whitley County government released their updated comprehensive plan. In general, these plans are used to establish goal, policies, and recommendations for the development of the county. Both public and private sector decisions are guided by this plan. The primary intent of the plan is to create a safe and harmonious environment for the residents of Whitely County. In the 2014 plan there are five planning principles discussed to improve Whitley County. The five principles were; Focused Growth, Foster Safe and Convenient Circulation, Nurture Environmental Integrity, Advance Economic Development Efforts, and Enhance Quality of Life.

While much of the plan was focused on growth and bringing money to Whitley County. One Section in particular, nurture environmental integrity was focused on preserving and enhancing the ecosystem/environment of Whitley County. There were 11 objectives listed to help preserve/enhance the environmental quality.

1) Prohibit development in river and lake floodplains.
2) Develop and implement a county-wide storm water management and erosion control ordinance.
3) Include incentives for conservation and preservation of environmentally sensitive areas in the Whitley County Zoning Ordinance and Whitley County Subdivision Control Ordinance.
4) Modify the Whitley County Zoning Ordinance to regulate the use of alternative energy devices in a way that mitigates negative effects to neighboring properties.
5) Prohibit septic systems where soils are not suitable for such systems. Allow other on-site systems when consistent with the land classification plan.
6) Monitor Indiana's list of impaired waterbodies for Whitely County lands and stream segments.
7) Continue the county-wide recycling program and enhance the program by investigating local companies that can make use of the recycled materials.
8) Inventory environmental features that are unique, large in size, irreplaceable, or contain a rich diversity of species.
9) Target new environmentally sensitive areas for conservation and/or preservation.
10) Encourage and educate the development of the community about the benefits of buildings that are leadership in energy and environmental design (LEED) certified.
11) Create and publish an environmental toolbox that includes information about programs to conserve, sustain, and restore natural areas and a directory or environmental organizations and existing lake associations.

2.9.2.3 North Manchester Comprehensive Plan

The North Manchester Comprehensive Plan was released in 2015. Much of the plan is focused on development of new residence within the town and better ways to grow the city. There is very little in terms of natural areas and preserving the natural ecosystem.

It is planned to build a new park near downtown North Manchester. This park would be located directly adjacent to the south side of the Eel River. While the new park would not preserve the current landscape. It would provide streambank stabilization and trach/debris removal throughout the section. It is proposed to install many canoe/kayak launch sites on the eel river to provide better access to the river. This park will provide better human interaction between the citizens and the Eel River.

2.9.2.4 Huntington County Comprehensive Plan

Huntington County Comprehensive Plan is in nine sections, with the first two sections focused on the environment and park/recreations. List of all the sections are;

Environment, Parks and Recreation, Aesthetics and Identity, Alternative Transportation, Transportation, Community Facilities, Economic Development, Grown Management, Land Use. Much of the plan focuses on development in regard to environmental s stewardship not only focused on growth and urban sprawl. Below are the objectives of Section 1. Environment.

Section 1. Environment Objectives

1. Protect the local groundwater supply.
2. Protect the quality and quantity of water in Huntington County streams, rivers, and reservoirs.
3. Conserve natural areas such as forestland, wetlands, and prairies.
4. Protect and enhance the character of the natural environment present in Huntington County.
5. Protect and enhance the streams and riverbanks throughout the county.
6. Minimize conflicts between growth and the natural environment.
7. Protect and preserve natural drainage areas and the 100-year floodplain.
8. Reserve open space for future development of parks and recreations amenities and to provide habitats for plants and animals.
9. Reduce damage to life and property from flood and other natural hazards by situating them out of harm's way (500-year floodplain).

2.9.2.5 Kosciusko County Comprehensive Plan

Kosciusko County Comprehensive Plan was published in 1996 and is divided into five main sections. These five sections are: Community Goals, Land Use, Transportation, Infrastructure, Environment, and Policy and Plan Implementation. As with other counties, this plan will help shape how decisions are made throughout the county. Much of the plan is developed around growth and development. The Environmental Section has seven main objectives

1. Increase awareness of environmental issues.
2. Increase energy efficiency and demand-sided alternatives.
3. Provide incentives for participation in conservation programs.
4. Guide land use in an environmentally sensitive manner.
5. Increase awareness of recycling and alternative methods of waste disposal.
6. Minimize the impact of new development.
7. Coordinate governmental approaches to environmental quality.

2.9.3 Watershed Management Plan

Manchester University previous wrote a watershed management plan for the two downstream adjacent 10 digit HUC 0512010405 and HUC 0512010406. The initial plan was developed from 2009 through 2012 and followed the IDEM 2003 checklist. The initial plan documented that nearly all the watershed was row crop agriculture. Water quality monitoring was conducted at 6 tributary location and 3 stream gage station locations. Analysis of data suggest that agriculture production had increased nutrient loading to the Eel River. Each year three public events were held to education the public on issues within the Eel River. These events included annual public meeting, annual canoe float, and the annual river clean up. The plan documented three high priority critical area (Silver Creek, Beargrass Creek, and Little Weesau Creek). The steering committee selected 29 BMP to address water quality concerns within the watershed. In 2013 IDEM funds were received to implement the WMP in HUC 0512010405 and HUC 0512010406. Intensive water quality monitoring continued throughout the grant and continued to document increased pollutant loading. All implementation funds were spent within the watershed. Again, a primary goal of the project was to educate the public on water quality issues within the Eel River, thus the annual meetings, canoe float, and river clean up continued throughout the grant.

2.9.4 TMDL, Urban Retrofit Plans, LARE

There are no Total Daily Maximum Loads (TMDLs), Urban Retrofit Plans, or Lake and River Enhancement (LARE) plans located within the Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River).

2.9.5 Wellhead and Source Water Protection Plans

There are no surface source water protection plans within the watershed.

The majority of rural community and smaller incorporated areas acquire their drinking water from groundwater wells. Those communities are commonly known as community public water supply systems (CPWSS). A CPWSS is designated as such if it has 15 service connections or supplies drinking water to at least 25 people, according to the federal Safe Drinking Water Act. The entity controlling the system is required to develop a Wellhead Protection Plan (WHPP). A WHPP must contain five elements according to the IDEM; 1) Establishment of a local planning team, 2) Wellhead Protection Area Delineation of where ground water is being drawn from, 3) Inventory of existing and potential sources of contamination to identify known and potential areas of contamination within the wellhead protection area, 4) Wellhead Protection

Area Management to provide ways to reduce the risks found in step three, and 5) Contingency Plan in case of a water supply emergency. It is also important to identify areas for new wells to meet existing and future water supply needs.

There are two phases of wellhead protection. Phase I is the development of the WHPP which involves delineating the protection area and determining sources of potential contamination. Phase II is the implementation of the WHPP. All communities located within the project area have completed Phase I of the requirement and are slated to be working on Phase II. Table 2-9identifies those CPWSSs located within the project area and which phase they are currently in. A map of well head protection areas in Indiana is not available since the delineation of such areas is not made public.

Table 2-9. List of Well Head Protection Plans located in the UMERI

System Name	Population Served	Phase	Watershed
Meadow Acres Mobile Home Park	93	Phase 2	0512010404
South Whitley Municipal Water	1,750	5 Year Update	0512010404
North Manchester Municipal Water	5,907		0512010404

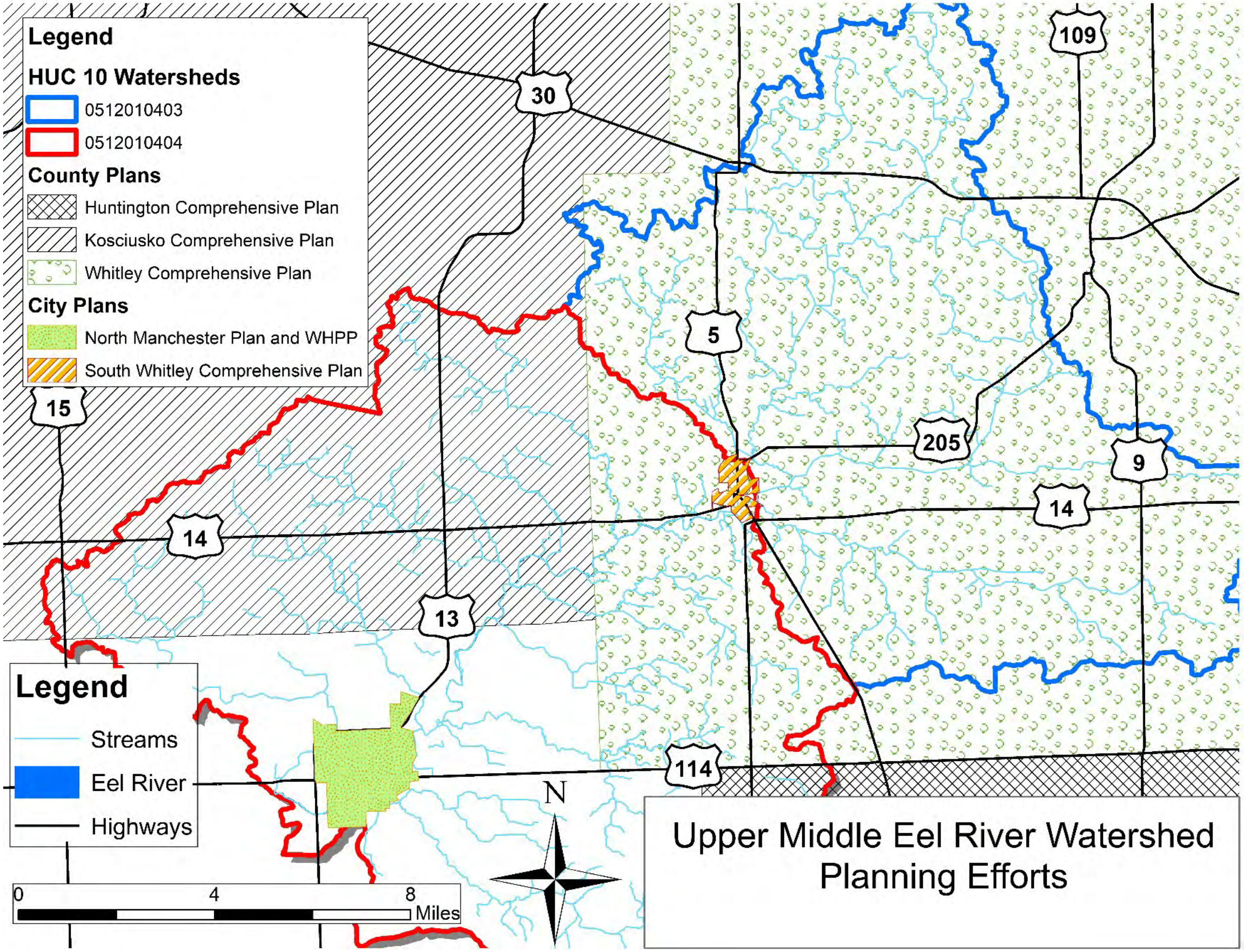

Figure 2-20. Previous planning efforts in the Upper Middle Eel River Watershed HUC 0512010403 (Sugar Creek-Eel River) and HUC 0512010404 (Clear Creek-Eel River)

2.10 Threatened and Endangered Species

The Indiana Department of Natural Resources (IDNR) maintains information on threatened and endangered species. The IDNR posts lists for each county, however, specific locations of these species is not available. Since specific locations of these species are not available, we must assume that since the Upper Middle Eel River Watershed encompasses portions of Wabash, Whitley, Huntington, and Kosciusko Counties, that it is possible for any of the listed species to occur within the watershed. The Federally Endangered, Threatened and Rare Species for the UMERWI Lists are included below. There are no federally endangered plant species located within the UMERWI.

Table 2-10. List of federally endangered and threatened species that could be documented in the Upper Middle Eel River Watershed

	Group	Common Name	Scientific Name	Status
Wabash	Clams	Fanshell	*Cyprogenia stegaria*	Endangered
	Clams	Rabbitsfoot	*Quadrula cylindrica*	Threatened
	Clams	Sheepnose Mussel	*Plethobasus cyphyus*	Endangered
	Clams	Ray Bean	*Villosa fabalis*	Endangered
	Clams	North Riffleshell	*Epioblasma torulosa rangiana*	Endangered
	Clams	Clubshell	*Pleurobema cordatum*	Endangered
	Clam	Snuffbox	*Epioblasma triquetra*	Endangered
	Mammals	Indiana bat	*Myotis sodalis*	Endangered
	Mammals	Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened
	Reptiles	Eastern Massasauga (=rattlesnake)	*Sistrurus catenatus*	Candidate
Whitley	Clams	Clubshell	*Pleurobema clava*	Endangered
	Mammals	Indiana bat	*Myotis sodalis*	Endangered
	Mammals	Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened
	Reptiles	Eastern Massasauga (=rattlesnake)	*Sistrurus catenatus*	Candidate
Huntington	Clams	Snuffbox mussel	*Epioblasma triquetra*	Endangered
	Mammals	Indiana bat	*Myotis sodalis*	Endangered
	Mammals	Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened
Kosciusko	Clams	Rayed Bean	*Villosa fabalis*	Endangered
	Clams	Clubshell	*Pleurobema clava*	Endangered
	Clams	White Catspaw	*Epioblasma obliquata perobliqua*	Endangered
	Clams	Northern Riffleshell	*Epioblasma torulosa rangiana*	Endangered

	Mammals	Indiana bat	*Myotis sodalis*	Endangered
	Mammals	Northern Long-Eared Bat	*Myotis septentrionalis*	Threatened
	Reptiles	Eastern Massasauga (=rattlesnake)	*Sistrurus catenatus*	Candidate
	Reptiles	Copperbelly water snake	*Nerodia erythrogaster neglecta*	Threatened

2.10.1 Habitats

2.10.1.1 Fanshell Mussel

This mussel is found in medium to large rivers. It buries itself in sand or gravel in deep water of moderate current, with only the edge of its shell and its feeding siphons exposed.

2.10.1.2 Rabbitsfoot Mussel

Rabbitsfoot generally inhabits small- to medium-sized stream and some larger rivers. It occurs shallow water areas along the bank and in shoals with reduced water velocity. Individuals have also been found in deep water runs (9-12 ft.). Primary substrate includes gravel and sand.

It has been estimated that the rabbitsfoot has been lost from approximately 64% of its historic range; only 11 populations range wide are currently viable. It is currently found in 13 states.

2.10.1.3 Sheepnose Mussel

Sheepnose mussels live in larger rivers and streams where they are usually found in shallow areas with moderate to swift currents that flow over coarse sand and gravel. However, they have also been found in areas of mud, cobble and boulders, and in large rivers, they may be found in deep runs.

2.10.1.4 Indiana Bat

Indiana bats hibernate during winter in caves or, occasionally, in abandoned mines. For hibernation, they require cool, humid caves with stable temperatures, under 50° F but above freezing. Very few caves within the range of the species have these conditions.

Hibernation is an adaptation for survival during the cold winter months when no insects are available for bats to eat. Bats must store energy in the form of fat before hibernating. During the six months of hibernation, the stored fat is their only source of energy. If bats are disturbed or cave temperatures increase, more energy is needed and hibernating bats may starve.

After hibernation, Indiana bats migrate to their summer habitat in wooded areas where they usually roost under loose tree bark on dead or dying trees. During summer, males roost alone or in small groups, while females roost in larger groups of up to 100 bats or more. Indiana bats also forage in or along the edges of forested areas.

2.10.1.5 Northern Long-Eared Bat

Winter Habitat: Northern long-eared bats spend winter hibernating in caves and mines, called hibernacula. They use areas in various sized caves or mines with constant temperatures, high humidity, and no air currents. Within hibernacula, surveyors find them hibernating most often in small crevices or cracks, often with only the nose and ears visible.

Summer Habitat: During the summer, northern long-eared bats roost singly or in colonies underneath bark, in cavities or in crevices of both live trees and snags (dead trees). Males and non-reproductive females may also roost in cooler places, like caves and mines. Northern long-eared bats seem to be flexible in selecting roosts, choosing roost trees based on suitability to retain bark or provide cavities or crevices. This bat has also been found rarely roosting in structures, like barns and sheds.

2.10.1.6 Snuffbox Mussel

The snuffbox is usually found in small- to medium-sized creeks, inhabiting areas with a swift current, although it is also found in Lake Erie and some larger rivers. Adults often burrow deep in sand, gravel or cobble substrates, except when they are spawning or the females are attempting to attract host fish. They are suspension feeders, typically feeding on algae, bacteria, detritus, microscopic animals, and dissolved organic material.

2.10.1.7 Rayed Bean Mussel

The rayed bean generally lives in smaller, headwater creeks, but it is sometimes found in large rivers and wave-washed areas of glacial lakes. It prefers gravel or sand substrates, and is often found in and around roots of aquatic vegetation. Adults spend their entire lives partially or completely buried in substrate, filtering water through their gills to remove algae, bacteria, detritus, microscopic animals, and dissolved organic material for food.

2.10.1.8 Clubshell Mussel

This mussel prefers clean, loose sand and gravel in medium to small rivers and streams. This mussel will bury itself in the bottom substrate to depths of up to four inches.

2.10.1.9 Eastern Massasauga

Massasaugas live in wet areas including wet prairies, marshes and low areas along rivers and lakes. In many areas, massasaugas also use adjacent uplands during part of the year. They often hibernate in crayfish burrows but may also be found under logs and tree roots or in small mammal burrows. Unlike other rattlesnakes, massasaugas hibernate alone.

2.10.1.10 Copperbelly Water Snake

Copperbelly water snakes need a mosaic of shallow wetlands or floodplain wetlands surrounded by forested uplands. Seasonally flooded wetlands without fish are favored foraging areas, and copperbellies frequently move from one wetland to another. Copperbellies hibernate, often in crayfish burrows, in forested wetlands and immediately adjacent forested uplands. They remain underground from late October until late April.

2.10.1.11 Northern Riffleshell

Northern riffleshell mussels are found in a wide variety of streams from large too small. It buries itself in bottoms of firmly packed sand or gravel with its feeding siphons exposed.

2.10.1.12 White Catspaw

White catspaw mussels prefers coarse sand or gravel bottoms of small to mid-sized freshwater streams and rivers. It prefers shallow water and requires a swift current to avoid being buried in silt.

2.11 Section 2 Summary

All of the elements described above, when combined, can provide a larger picture of how the watershed functions and what activities may pose a greater threat to our water resources.

This section will summarize the characteristics of the project area and describe how they relate to each other. This will be examined more closely in subsequent sections.

Agriculture is a primary driver of many relationships throughout the Upper Middle Eel River Watershed. Given the relatively flat topography and productive soils, row crop agriculture dominates the landscape. Artificial drainage speeds up the delivery of storm water to receiving streams and provides a direct conduit for fertilizer and chemical runoff. Regular management of open ditches and conversion of idle lands to row crop result in losses of environmentally valuable land which would normally provide benefits such as water quality improvement, flood protection, and wildlife habitat. Many of the soils within the watershed are considered highly erodible with a large runoff potential. When combined with a lack of riparian buffers, and increases in water velocities in the streams channels. These soils have a much high potential for runoff or stream bank erosion. Sedimentation can have a major effect on water quality and biota. Tillage data collected by each county in the watershed indicates a relatively fair adoption of conservation tillage practices. Conservation tillage requires a minimum of 30% residue cover on the land. This decreases the potential for soil erosion, decreases soil compaction, and can save the producer time and money by minimizing the number of passes made on each field while preparing for the next planting season.

A few rural communities are spread throughout the watershed. Generally, these communities do not carry services such as centralized wastewater treatment which are normally seen in today's populated areas. This creates potential for significant impacts from wastewater discharges to waterways. Soil within the UMERW was documented as being very limited in the suitability for septic systems. Many of older or unmaintained systems fail resulting in additional wastewater discharges to our streams and creeks. With failing septic systems and a lack of natural areas to treat nutrients from wastewater these areas provide a perfect conduit for nutrients to nearby waterways. Additionally, these rural setting make it difficult to provide intensive education and outreach programs to much of the watershed due to a lack of a centralized location where increased interaction can occur.

Urban development within the UMERW is low compared to other watershed throughout the state. Only incorporated cities of South Whitley and North Manchester are completely encompassed within the boundary of the UMERW. Columbia City is located just outside the northeast boundary of the watershed. While these cities are small their impact on water quality could be huge. During large precipitation events nine combined sewer overflows open and directly release untreated wastewater into the streams. These event can cause huge increases in nutrients and cause a biological oxygen demand bubble downstream of the CSO. During base flow conditions, wastewater treatment plants release treated water directly into the Eel River. Both the North Manchester and South Whitley wastewater treatment plants cannot treat for phosphorus. Thus, all the phosphorus is passed through the plant and released into the Eel River.

Overall, the landscape has been drastically altered to better serve humans since European settlement. These alterations have come in many forms from floodplain modifications, to urban development, to reduction in natural landscapes. These alterations have led the stakeholder to be concerned about the current water quality conditions present in the UMERW. All the concerns the stakeholder have are justified, and can be tied back to land use alterations.

Upper Middle Eel River
Watershed Management Plan

Section 3
Watershed Inventory by Sub-watershed

3.1 Water Quality

3.1.1 Water Quality Parameters

Dissolved Oxygen - Dissolved oxygen (DO) is the measure of oxygen in the water available for uptake by aquatic life. Typically, streams with a DO level greater than 8 mg/L are considered very healthy and streams with DO levels less than 2 mg/L are very unhealthy as there is not enough oxygen to sustain aquatic life. DO is affected by many factors including; temperature - the warmer the water the harder it is for oxygen to dissolve, flow – more oxygen can enter a stream where the water is moving faster and turning more, and aquatic plants – an influx of plant growth will use more oxygen than normal which does not leave enough available DO for other aquatic life, however photosynthesis will add oxygen to the water during the day. Thus, DO levels may change frequently when there is excessive aquatic plant growth. Excessive amounts of suspended or dissolved solids will decrease the amount of DO in the water. The state of Indiana has set a standard of at least an average of 5 mg/L per calendar day, but not less than 4 mg/L of DO for warm water streams. The US EPA recommends that DO not exceed 12 mg/L as to avoid super-saturation of DO in the water system.

Temperature - As mentioned above, temperature can affect many aspects of the health of the water system. Water temperature is a controlling factor for aquatic organisms. If there are too many swings in water temperature, metabolic activities of aquatic organisms may slow, speed up, or even stop. Many things can affect water temperature including stream canopy, dams, and industrial discharges. The state of Indiana has set a standard for water temperature (which may be found in 327 IAC 2-1-6) depending on if the waterbody is a cold or warm water system. The UMERW should range between 4.44°C and 29.44°C to meet the targeted value.

Escherichia coli - E. coli is a bacteria found in all animal and human waste. E. coli testing is used as an indicator of fecal contamination in the water. While not all E. coli is harmful, there are certain strains that can cause serious illness in humans. E. coli may be present in the water system due to faulty septic systems, CSO overflows, wildlife; particularly geese, and from contaminated stormwater runoff from animal feeding operations. Due to the serious health risks from certain forms of E. coli, and other bacteria that may be present in water, the state of Indiana has developed the full body contact standard of less than 235 CFU/100 ml of E. coli in any one water sample and less than 125 CFU/100 ml for the geometric mean of five (5) equally spaced samples over a 30 day period.

Turbidity -Turbidity is the measure of the cloudiness of the water that may be caused by sediment or an overgrowth of aquatic plants or animals. High levels of turbidity can block out essential sunlight for submerged plants and animals and may raise water temperatures, which then can decrease DO. Sediment in the water causing it to be turbid can clog fish gills and smother nests when it settles, thus affecting the overall health of the aquatic biota. Turbid water may be caused from farm field erosion, feedlot or urban stormwater runoff, eroding stream banks, and excessive aquatic plant growth. The US EPA recommends that the turbidity in the water measure less than 10.4 NTUs.

Total Suspended Solids - Total suspended solids (TSS) is a measure of particulate matter in a water sample. TSS is measured by passing a water sample through a series of sieves of differing sizes, drying the particulate, and weighing the dried matter. The amount of Total Suspended Solids (TSS) in the water system will have the same type of deleterious effect on water quality as mentioned above under turbidity including, debilitating aquatic habitat and life, and carrying other pollutants to the water such as fertilizers and pathogens. The Indiana state code standard for TSS is equal to or lesser than 30 mg/L.

Phosphorus - Phosphorus is an essential nutrient for aquatic plants however, too much phosphorus can create an over growth of plants which can lower the DO in a water system and decrease the amount of light that penetrates the surface thus killing other aquatic life that depends on these for survival. Some types of aquatic plants that thrive when phosphorus levels are high, such as blue-green algae, are toxic when consumed by humans and wildlife. Excessive amounts of phosphorus have also been found in ground water thus increasing the bacteria growth in underground water systems. Phosphorus can reach surface and ground water through contaminated runoff from row crop fields, and urban lawns where fertilizer has been applied, animal feeding operations, faulty septic tanks, and the disposal of cleaning supplies containing phosphorus in landfills or down the drain. Total phosphorus (TP) defines the sum of all phosphorus compounds that occur in various forms such as soluble, sediment tied, and organic bound. The state of Indiana has set a target of 0.076 mg/L of total phosphorus (under certain conditions) in a water sample to list a waterbody as impaired on the state's impaired water list as required by the CWA § 303(d), often referred to as the 303(d) list.

Nitrate -Nitrite – Nitrate and Nitrites can have the same effect on the water system as phosphorus, only to a much lesser degree. Nitrates-Nitrites can be found at levels up to 30mg/L in some waters before detrimental effects on aquatic life occur. With Nitrites only making up a small fraction of the total concentration. However, because infants who consume water with nitrate-nitrite levels exceeding the US EPA MCL of 10 mg/L can become ill, nitrates in drinking water should be of particular concern to people who use wells as their drinking water source. The most common sources of nitrates-nitrites are from fertilizer runoff from row crop fields, faulty septic systems, and sewage. Baseline nitrate-nitrite levels vary greatly across the country thus an overall standard has not been developed. However it is recommended that reference levels should be below 2.2 mg/L according to the US EPA 2002.

Habitat-. Habitat scores are based on the Qualitative Habitat Evaluation Index (QHEI). The QHEI provides an assessment tool used widely by stream biologists to quantify the physical parameters that provide habitat for fish and benthic macroinvertebrates. Research has clearly shown positive correlations between QHEI scores and biological-base indices like the Index of

Biotic Integrity (IBI). The QHEI is a tool that connects land use to habitat availability or degradation. QHEI scores greater than 60 suggest the stream reach is suitable for warm water habitat.

Index of Biotic Integrity (IBI)- IBI scores are based on twelve matrices that examine fish community structure and overall abundance of species/individuals. The IBI provides an assessment tool used widely by stream biologists to compare different site on their ability to support aquatic life. Research has clearly shown positive correlations between QHEI scores and the Index of Biotic Integrity (IBI). IBI scores greater than 35 suggest the stream reach is suitable for supporting aquatic life.

3.1.2 Water Quality Targets

Water quality were chosen to coincide with IDEM, USEPA, and OEPA targets for water quality parameters. These targeted values were chosen due to researched which documented a measurable decline in water quality above these targeted values. Additionally, these targets were chosen to coincide with the Middle Eel River watershed plan. By keeping the same targets throughout the entire Eel River Watershed and more homogenous monitoring program can be conducted.

Table 3-1. Water quality targets for the Upper Middle Eel River Watershed

Parameter	Target	Source
Dissolved Oxygen	>4 mg/L and <12 mg/L	IDEM
Temperature	4.44°C – 29.44°C	IDEM
Turbidity	10.4 NTU	USEPA
Total Suspended Solids	30 mg/L	IDEM
E Coli	235 CFU/100mL (single sample)	IDEM
Total Phosphorus	0.076 mg/L	IDEM
Nitrate-Nitrite	<2.2 mg/L	USEPA
QHEI	60	OEPA
IBI	35	(Frankenberger and Esman 2012)

3.1.3 Water Chemistry Data and Sampling Efforts

3.1.3.1 Manchester University

While it is well known that water chemistry is important in any water quality monitoring initiative, most often selected parameters are measured as grab samples and are taken daily, weekly, or at somewhat random intervals without knowledge of stream discharge. These data give only a small glimpse into the dynamic nature of streams and may not provide a clear representation of organismal exposure or loadings of any of the constituents being analyzed.

For this watershed study, there were nine primary sites for water monitoring; three on the mainstem, and six tributaries of the Upper Middle Eel River. Sampling at each location began in January of 2016 and ended in December of 2018.

The Quality Assurance Project Plan (QAPP) that was approved by IDEM outlines the monitoring program for the Initiative.

Three automatic water samplers with data loggers and stream discharge gages were installed on the mainstem: one at the most upstream site near Columbia City as the water enters the watershed, one at the watershed break between the two 10-digit HUCs near South Whitley, and one at the most downstream site of the watershed near North Manchester as the water exits the watershed (Blocher Gage). The upstream site is located just downstream from the town of Columbia City at river mile 75 or 41.117483° Latitude and -85.501248° Longitude. The middle site is just upstream from the town of South Whitley at river mile 66 or 41.080685° Latitude and -85.622100° Longitude. The downstream site is near the town of North Manchester or river mile 48 or 40.991636° Latitude and -85.808503° Longitude. These sites were strategically chosen in order to more precisely determine the contribution of nonpoint source pollution (NPS) from each 10 digit HUC and to determine the water quality coming into and leaving the watershed. Each gage station collects six samples a day during May and June. Samples are collected daily and analyzed for Nitrate-Nitrogen, Total Phosphorus, Turbidity, and Total Suspended Solids (TSS).

The six tributaries were selected as sampling sites because of their large watershed areas and major contribution to the mainstem. These six tributaries include Swank Creek, Pony Creek, Plunge Creek, Hurricane Creek, Sugar Creek, and Clear Creek. Testing tributary water monitoring consisted of weekly grab samples during base flow and daily grab samples following rain events.

The sampling approach for this project was a targeted design that focused on the assessment and quantification of the chemical, physical, and biological attributes of the stream reach. Due to the lack of consistent, rigorous water quality monitoring of the Upper Middle Eel River, baseline data was established using only the first year of data collected at sampling locations.

3.1.3.2 IDEM Sampling

Indiana is required to perform water quality analysis of its surface waters and report their findings to EPA in a report called the "Integrated Report" (IR) on a biannual basis, as mandated by the CWA§305(b). Prior to compiling the IR, a list of water bodies that do not meet state standards is developed as mandated by the Clean Water Act section 303(d). This has become commonly known as the 303(d) list. Many stream segments located within the UMERW are listed on the 2016 IDEM 303(d) list of impaired waters. As part of the IDEM monitoring process, water samples are analyzed for numerous substances. Those relative to this WMP include: nitrate-nitrogen, total phosphorus, pH, TSS, DO, turbidity, temperature, and *E. coli*. Data collected by IDEM ranging from 1998-2016 was analyzed and sorted for the purpose of this project. All data was downloaded from IDEM AIMS Database.

3.1.4 IDEM 303(d) List of Impaired Waters

IDEM is required to perform water monitoring as part of the Clean Water Act (CWA) Section 303(d) to identify waters that do not meet the state's water quality standards for designated uses. IDEM has divided the state into nine major water basins and the water quality monitoring strategy calls for rotating through each of the nine basins once every nine years. The Upper Middle Eel River Watershed was included in the 2015 rotation. According to IDEM's Surface Water Quality Monitoring Strategy, the following data is collected within each 12digit HUC to determine if the state water quality standards are being met:

- Physical or chemical water monitoring
- Fish Community Assessment
- *E. coli* monitoring
- Benthic aquatic macroinvertebrate community assessment
- Fish Tissue and superficial aquatic sediment contaminants monitoring
- Habitat evaluation

Water quality standards for the state of Indiana are designed to ensure that all waters of the state, unless specifically exempt, are safe for full body contact recreation and are protective of aquatic life, wildlife, and human health. The Upper Middle Eel River and its tributaries are required to be fishable, swimmable, and able to support warm water aquatic life. Each waterbody listed on the 303(d) list is placed into one or more of five (5) categories depending on the degree to which it supports its designated uses as determined by IDEM's assessment process. The following is a summary of the five (5) categories:

Category 1 All designated uses are supported and no use is threatened.

Category 2 Available data and/or information indicate that some, but not all of the designated uses are supported.

Category 3 There is insufficient available data and/or information to make a use support determination.

Category 4 Available data and/or information indicate that at least one designated use is impaired or is threatened, but a TMDL is not needed.

A. A TMDL has been completed that is expected to result in attainment of all applicable WQS and has been approved by U.S. EPA.

B. Other pollution control requirements are reasonably expected to result in the attainment of the WQS in a reasonable period of time

C. A pollutant does not cause impairment.

Category 5 Available data and/or information indicate that at least one designated use is not supported impaired or is threatened, and a TMDL is needed.

A. The waterbody AU is impaired or threatened for one or more designated uses by a pollutant(s) and require a TMDL.

B. The waterbody AU is impaired due to the presence of mercury and/or PCBs in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants.

All of the listed impaired water bodies within the Upper Middle Eel River Watershed are Category 5, A or B. There are currently no TMDLs for the Upper Middle Eel River Watershed. There are 109 total stream miles of impaired locations and specific impairments listed in the Indiana 303(d) list within the Upper Middle Eel River Watershed are listed in Table 3-2 and Table 3-3 (Figure 3-1).

Table 3-2. List of Impaired Waters for HUC 0512010404

HYDROLOGIC UNIT CODE	COUNTY	ASSESSMENT UNIT ID	ASSESSMENT UNIT NAME	CAUSE OF IMPAIRMENT	IR CATEGORY
051201040401	WHITLEY	INB0441_01	EEL RIVER	E. COLI	5A
051201040401	WHITLEY	INB0441_01	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040402	KOSCIUSKO	INB0442_01	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040403	KOSCIUSKO	INB0443_01	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040403	WHITLEY	INB0443_T1011	WHEELER CREEK	E. COLI	5A
051201040403	WHITLEY	INB0443_T1011	WHEELER CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040404	WABASH	INB0444_01	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040407	WABASH	INB0447_01	EEL RIVER	E. COLI	5A
051201040407	WABASH	INB0447_01	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040407	WABASH	INB0447_02	EEL RIVER	E. COLI	5A
051201040407	WABASH	INB0447_02	EEL RIVER	IMPAIRED BIOTIC COMMUNITIES	5A
051201040407	WABASH	INB0447_02	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040407	KOSCIUSKO	INB0447_T1001	SWANK CREEK	E. COLI	5A

051201040407	KOSCIUSKO	INB0447_T1002	SWANK CREEK - UNNAMED TRIBUTARY	E. COLI	5A

Table 3-3. List of Impaired Waters for HUC 0512010403

HYDROLOGIC UNIT CODE	COUNTY	ASSESSMENT UNIT ID	ASSESSMENT UNIT NAME	CAUSE OF IMPAIRMENT	IR CATEGORY
051201040301	WHITLEY	INB0431_03	SPRING CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040301	WHITLEY	INB0431_T1004	JONES BRANCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040301	WHITLEY	INB0431_T1005	SPRING CREEK - UNNAMED TRIBUTARY	IMPAIRED BIOTIC COMMUNITIES	5A
051201040301	WHITLEY	INB0431_T1007	SCHUMAN DITCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040301	WHITLEY	INB0431_T1009	ELON MAYNARD DITCH	DISSOLVED OXYGEN	5A
051201040302	WHITLEY	INB0432_06	SPRING CREEK	E. COLI	5A
051201040302	WHITLEY	INB0432_06	SPRING CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040302	WHITLEY	INB0432_07	SPRING CREEK	E. COLI	5A
051201040302	WHITLEY	INB0432_07	SPRING CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040302	WHITLEY	INB0432_T1007	KALER BRANCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040302	WHITLEY	INB0432_T1010	KING BRANCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040302	WHITLEY	INB0432_T1011	COMPTON DITCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040302	WHITLEY	INB0432_T1012	SCHOENAUER DITCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040302	WHITLEY	INB0432_T1013	CLEAR CREEK	E. COLI	5A
051201040302	WHITLEY	INB0432_T1013	CLEAR CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040303	WHITLEY	INB0433_03	SUGAR CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040303	WHITLEY	INB0433_04	SUGAR CREEK	E. COLI	5A
051201040303	WHITLEY	INB0433_T1011	HUFFMAN BRANCH	E. COLI	5A
051201040303	WHITLEY	INB0433_T1011	HUFFMAN BRANCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040303	WHITLEY	INB0433_T1012	GABLE DITCH	E. COLI	5A

051201040303	WHITLEY	INB0433_T1013	SUGAR CREEK - UNNAMED TRIBUTARY	E. COLI	5A
051201040303	WHITLEY	INB0433_T1014	SUGAR CREEK - UNNAMED TRIBUTARY	E. COLI	5A
051201040303	WHITLEY	INB0433_T1014	SUGAR CREEK - UNNAMED TRIBUTARY	IMPAIRED BIOTIC COMMUNITIES	5A
051201040304	WHITLEY	INB0434_04	EEL RIVER	IMPAIRED BIOTIC COMMUNITIES	5A
051201040304	WHITLEY	INB0434_04	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040304	WHITLEY	INB0434_05	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040304	WHITLEY	INB0434_06	EEL RIVER	PCBS (FISH TISSUE)	5B
051201040304	WHITLEY	INB0434_T1008	COUNTY FARM DITCH	IMPAIRED BIOTIC COMMUNITIES	5A
051201040304	WHITLEY	INB0434_T1009	EEL RIVER - UNNAMED TRIBUTARY	IMPAIRED BIOTIC COMMUNITIES	5A
051201040304	WHITLEY	INB0434_T1011	STONY CREEK	E. COLI	5A
051201040304	WHITLEY	INB0434_T1011	STONY CREEK	IMPAIRED BIOTIC COMMUNITIES	5A
051201040304	WHITLEY	INB0434_T1012	EEL RIVER- UNNAMED TRIBUTARY	E. COLI	5A

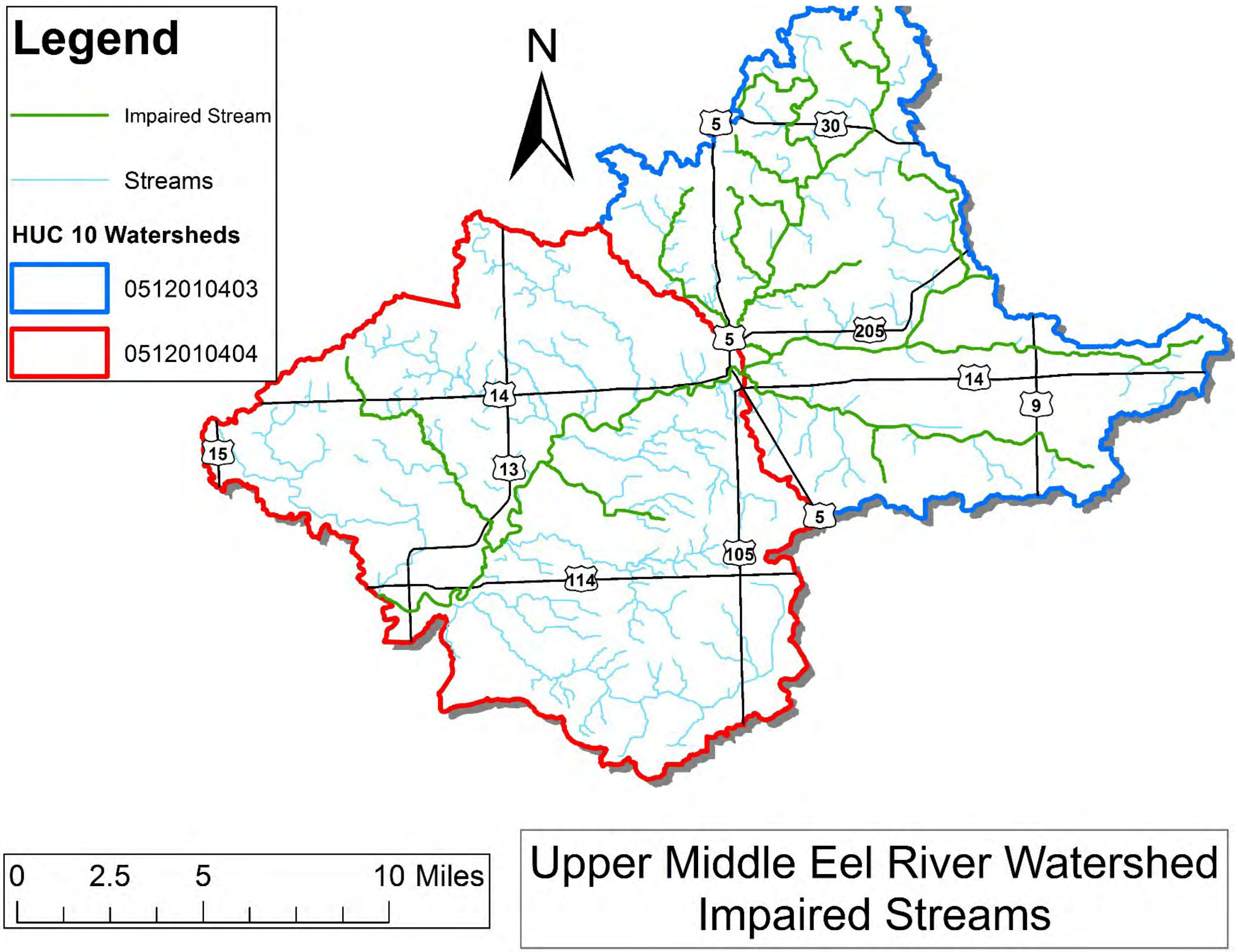

Figure 3-1. IDEM 303(d) Listed Impaired Streams in the Upper Middle Eel River Watershed

3.1 Water Quality Data per 12 Digit HUC Watershed

This Section discusses historic and current water quality data that has been collected within each HUC 12 watershed in the Upper Middle Eel River Watershed to help provide a picture of the overall health of each of the sub-watersheds and possible water quality stressors. There were no water quality testing locations within HUC 051201040301 (Black Lake –Spring Creek). This watershed consist only of headwater streams that do not directly drain into the Eel River. All stream water leave via a headwater stream into HUC 051201040302 (Shoenauer Ditch – Spring Creek). All data collected by IDEM was between 1998 and 2015, with majority of the samples being collected in 2003 and 2010.

3.1.1 HUC 051201040302 (Shoenauer Ditch - Spring Creek) Water Quality

Water quality data in the HUC 051201040302 (Schenauer Ditch – Spring Creek) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one site on Clear Creek near South Whitley. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1). IDEM operates 5 sample locations within the watershed. Locations of the sample sites are shown in Figure 3-2 and Table 3-4 through Table 3-9 show analysis of water quality.

Manchester University sampled water quality from Clear Creek at SR 5 just north of South Whitley Indiana. Samples were collected weekly during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Dissolved Oxygen and Water Temperature were both consistently below targeted ranges with only 4% and 7% of the samples exceeding the targeted ranges respectively. TSS exceeded targeted values in 27 of the 71 samples or 38% of the time. The remaining parameters consistently exceeded targeted ranges with each parameter exceeding the targeted values greater than 65% of the time. Both E. coli and Nitrate-Nitrite exceeded targeted values in 73% of the samples. Whereas Total Phosphorus exceeded the targeted value in 71 of the 73 samples. Turbidity exceeded targeted values in 49 of the 73 samples. Neither IBI nor QHEI scores fell below the targeted score.

Table 3-4. Manchester University Water Quality Analysis at Clear Creek

Clear Creek (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.0	mg/L	>4 and <12 mg/L	3/68	4%
Water Temperature	15.10	°C	4.44°C – 29.44°C	5/68	7%
E. Coli	72.97	CFU/100 ml	235 CFU/100mL (single sample)	27/37	73%
Nitrate-Nitrite	3.58	mg/L	2.2 mg/L	54/74	73%
Total Phosphorus	0.59	mg/L	0.76 mg/L	71/73	97%
Turbidity	86.97	NTU	10.4 NTU	49/73	67%
TSS	99.03	mg/L	30 mg/L	27/71	38%
Biological (IBI)	42	Points	35	0/2	0%
Habitat (QHEI)	65	Points	60	0/2	0%

IDEM sampled water from site WAE030-0083 within HUC 051201040302 five times in the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli and Turbidity samples each exceeded target values 4 out of 5 times.

Table 3-5. IDEM Site WAE30-0083 Water Quality Analysis

Clear Creek (IDEM site WAE30-0083)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.6	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	21	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	1098	CFU/100 ml	235 CFU/100mL (single sample)	4/5	80%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	19.2	NTU	10.4 NTU	4/5	80%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE030-0039 within HUC 051201040302 six times, with one sample collected in 2004 and the remaining 5 samples collected in the summer of 2010. Results of the sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli exceeded the targeted value 100% of the time and Turbidity exceeded target values 2 out of 6 times or 33% of the samples.

Table 3-6. IDEM Site WAE30-0039 Water Quality Analysis

Spring Creek (IDEM site WAE30-0039)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.5	mg/L	>4 and <12 mg/L	0/6	0%
Water Temperature	20.2	°C	4.44°C – 29.44°C	0/6	0%
E. Coli	728.6	CFU/100 ml	235 CFU/100mL (single sample)	6/6	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	13.5	NTU	10.4 NTU	2/6	33%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE030-0023 within HUC 051201040302 five times, during the summer and fall of 2003. Results of the sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli exceeded the targeted value 60% with one sample with exceeded 20,000 CFU/100mL. Turbidity exceeded target values 2 out of 5 times or 40% of the samples.

Table 3-7. IDEM Site WAE30-0023 Water Quality Analysis

Spring Creek (IDEM site WAE30-0023)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.75	mg/L	>4 and <12 mg/L	0/4	0%
Water Temperature	14.2	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	5,224.8	CFU/100 ml	235 CFU/100mL (single sample)	3/5	60%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	19	NTU	10.4 NTU	2/5	40%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE030-0013 within HUC 051201040302 five times, during the summer of 2003. Results of the sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli exceeded the targeted value 60% of the time and Turbidity exceeded target values 1 out of 5 times or 20% of the samples.

Table 3-8. IDEM Site WAE30-0013 Water Quality Analysis

Clear Creek (IDEM site WAE30-0013)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.75	mg/L	>4 and <12 mg/L	0/4	0%
Water Temperature	14	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	312	CFU/100 ml	235 CFU/100mL (single sample)	3/5	60%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	17	NTU	10.4 NTU	1/5	20%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE030-0009 within HUC 051201040302 four times, during the summer of 2003. Results of the sampling show that D.O., Nitrate-Nitrite, Total Phosphorus, and Total Suspended Sediment did not exceed targeted levels once during the testing. Turbidity exceeded target values 1 out of 4 times or 25% of the samples.

Table 3-9. IDEM Site WAE30-0009 Water Quality Analysis

Clear Creek (IDEM site WAE30-0009)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9	mg/L	>4 and <12 mg/L	0/4	0%
Water Temperature	-	°C	4.44°C – 29.44°C	-	-
E. Coli	-	CFU/100 ml	235 CFU/100mL (single sample)	-	-
Nitrate-Nitrite	1	mg/L	2.2 mg/L	0/3	0%
Total Phosphorus	0	mg/L	0.76 mg/L	0/2	0%
Turbidity	26.25	NTU	10.4 NTU	1/4	25%
TSS	4.33	mg/L	30 mg/L	0/3	0%
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

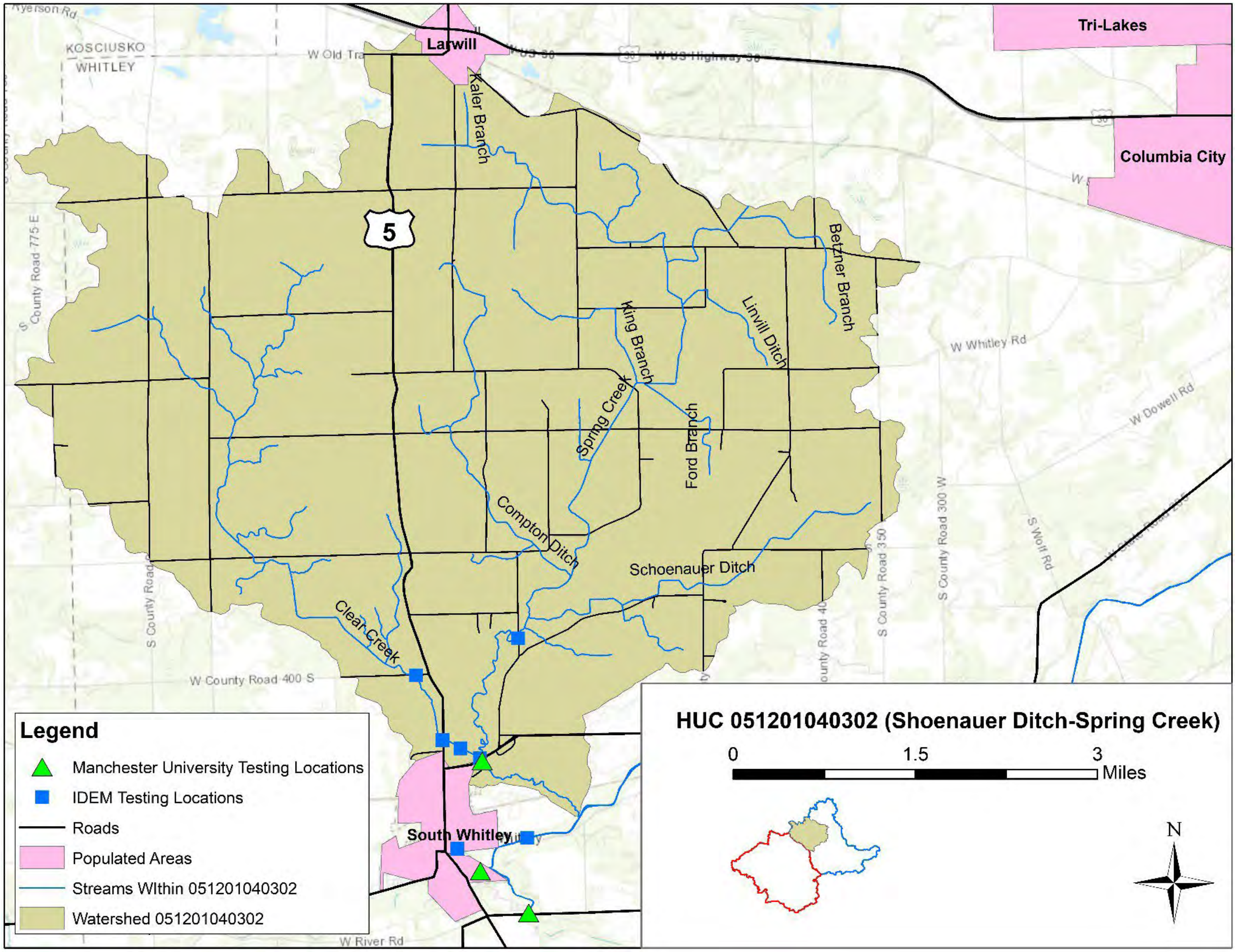

Figure 3-2. HUC 051201040302 (Shoenauer Ditch-Spring Creek) Water Quality Sample Sites

3.1.2 HUC 051201040303 (Headwaters Sugar Creek) Water Quality

Water quality data in the HUC 051201040303 (Headwaters Sugar Creek) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one site on Sugar Creek near South Whitley. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1). IDEM operates one sample location within the watershed. Locations of the sample sites are shown in Figure 3-3 and Table 3-10 and Table 3-11show analysis of water quality.

Manchester University sampled water quality from Sugar Creek at SR 14 just south of South Whitley Indiana. Samples were collected weekly during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Both Dissolved Oxygen and Water Temperature exceeded target ranges in less than 10% of the samples. Meanwhile the remaining parameters each exceeded the target range in greater than 50% of the samples. E. Coli exceeded the samples 20 out of 38 times or 53% of the samples. Nitrate-Nitrite and Total Phosphorus each exceeded targeted values 92% and 95% respectively. Whereas TSS and Turbidity each exceeded targeted values 58% and 76% respectively. IBI scores and QHEI scores showed different results. IBI samples did not exceed the targeted values once, whereas QHEI scores fell below targeted values both samples.

Table 3-10. Manchester University Sugar Creek Water Quality Analysis

Sugar Creek (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.92	mg/L	>4 and <12 mg/L	6/68	9%
Water Temperature	15.9	°C	4.44°C – 29.44°C	5/68	7%
E. Coli	1,872.8	CFU/100 ml	235 CFU/100mL (single sample)	20/38	53%
Nitrate-Nitrite	6.89	mg/L	2.2 mg/L	68/74	92%
Total Phosphorus	1.30	mg/L	0.76 mg/L	70/74	95%
Turbidity	284.83	NTU	10.4 NTU	56/74	76%
TSS	164.73	mg/L	30 mg/L	42/72	58%
Biological (IBI)	42	Points	35	0/2	0%
Habitat (QHEI)	50.5	Points	60	2/2	100%

IDEM sampled water from site WAE030-0045 within HUC 051201040303 six times, with one sample taken in the fall of 2004 and the remaining samples being taken in the summer of 2010. Results of that sampling show that D.O. Nitrate-Nitrite and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli exceeded the target value once and Turbidity samples exceeded target values 3 out of 6 times.

Table 3-11. IDEM Site WAE30-0045 Water Quality Analysis

Sugar Creek (IDEM site WAE30-0045)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.3	mg/L	>4 and <12 mg/L	0/6	0%
Water Temperature	21.83	°C	4.44°C – 29.44°C	0/6	0%
E. Coli	137.75	CFU/100 ml	235 CFU/100mL (single sample)	1/4	25%
Nitrate-Nitrite	0	mg/L	2.2 mg/L	0/1	0%
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	46.67	NTU	10.4 NTU	3/6	50%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

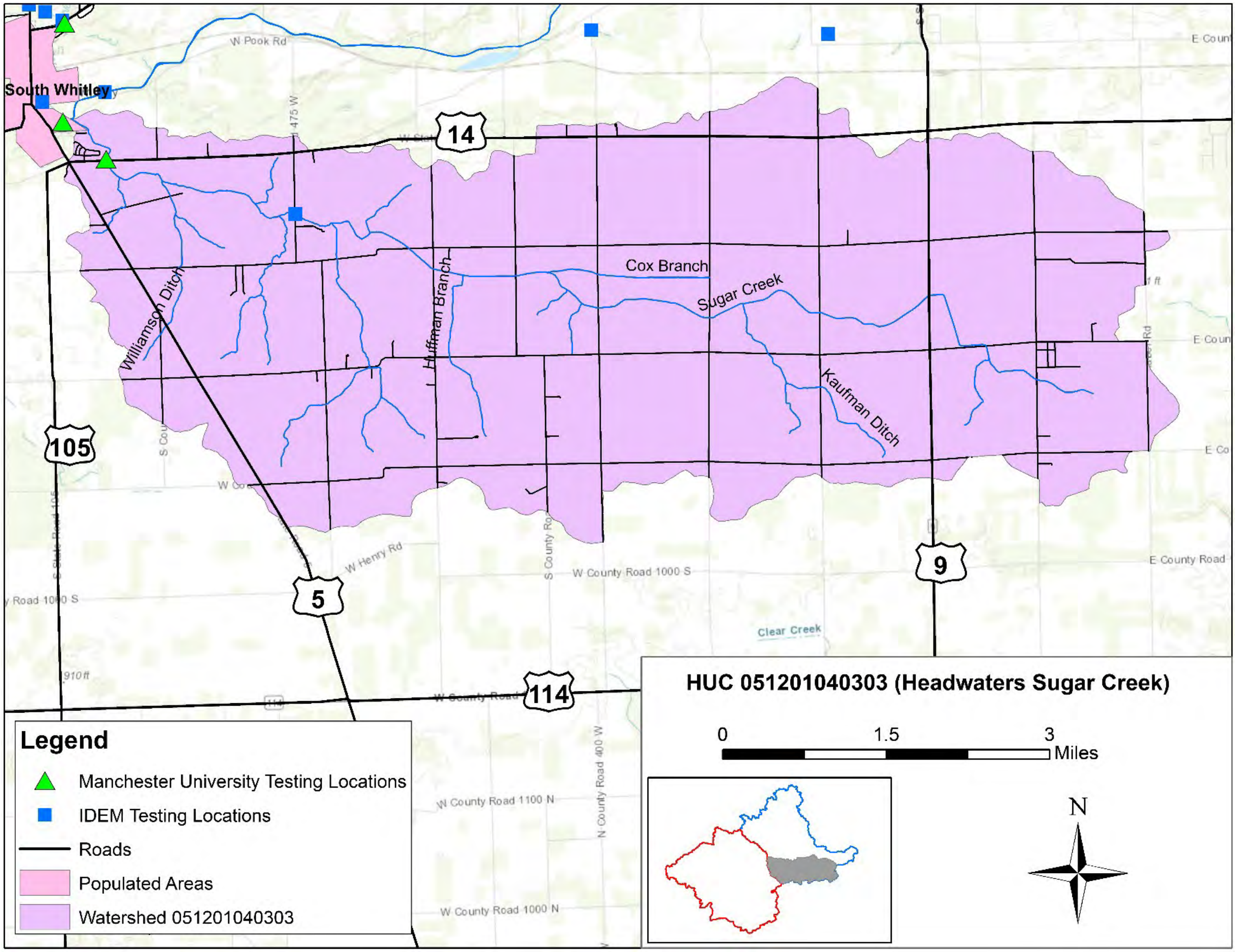

Figure 3-3. HUC 051201040303 (Headwaters Sugar Creek) Water Quality Sample Sites

3.1.3 HUC 051201040304 (County Farm Ditch) Water Quality

Water quality data in the HUC 0512010403034 (County Farm Ditch) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one gage site on the Eel River near Columbia City. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1) for stream gages. IDEM operates three sample locations within the watershed. Locations of the sample sites are shown in Figure 3-4 and Table 3-12 through Table 3-15 shows analysis of water quality.

Manchester University sampled water quality parameters on the Eel River at the watershed break between two 10 Digits HUCS 051210402 and 0512010403. This site captured water quality concentrations as the entered the study watershed. This gage site was located just downstream of Columbia City Indiana. Samples were collected 4 times daily during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Both Dissolved Oxygen and Water Temperature exceeded targeted ranges in less than 10% of the samples. Whereas E. coli, Nitrate-Nitrite, Total Phosphorus, TSS, and Turbidity each exceeded target values in greater than 60% of the samples. E. coli exceeded the targeted value in 34 of the 38 samples or 89%. Nitrate-Nitrite and Total phosphorus exceeded the target values most consistently with 99% and 100% of the samples exceeding the targeted value respectively. Turbidity and TSS concentration also consistently exceeded targeted values with 67% and 89% of the samples exceeding the targeted value respectively. Neither sample event at this site documented a biological score that fell below the targeted score. Whereas, both sampling events documented habitat scores that fell the target score.

Table 3-12. Manchester University Water Quality Analysis on the Eel River at the Watershed Boundary between HUC 0512010402 and HUC 0512010403

Eel River Columbia City Gage (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.6	mg/L	>4 and <12 mg/L	3/92	3%
Water Temperature	15.6	°C	4.44°C – 29.44°C	5/92	5%
E. Coli	2,070.9	CFU/100 ml	235 CFU/100mL (single sample)	34/38	89%
Nitrate-Nitrite	4.6	mg/L	2.2 mg/L	450/454	99%
Total Phosphorus	0.75	mg/L	0.76 mg/L	454/454	100%
Turbidity	73.5	NTU	10.4 NTU	403/454	67%
TSS	71.0	mg/L	30 mg/L	303/451	89%
Biological (fish)	42	Points	35	0/2	0%
Habitat	41	Points	60	2/2	100%

IDEM sampled water from site WAE030-0044 within HUC 051201040304 eight times, with one sample taken in the fall of 2004 and the remaining samples being taken in the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli exceeded the target value 75% of the time and Turbidity samples exceeded target values 4 out of 6 times.

Table 3-13. IDEM Site WAE30-0044 Water Quality Analysis

Eel River (IDEM site WAE30-0044)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9	mg/L	>4 and <12 mg/L	0/6	0%
Water Temperature	20.5	°C	4.44°C – 29.44°C	0/6	0%
E. Coli	712.25	CFU/100 ml	235 CFU/100mL (single sample)	6/8	75%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	22.67	NTU	10.4 NTU	4/6	66%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE030-0010 within HUC 051201040304 five time during the summer of 2003. Results of that sampling show that Total Suspended Solids and Water Temperature did not exceed targeted levels once during the testing. Dissolved Oxygen exceeded the targeted value once with a concentration of 14 mg/L. Meanwhile Nitrate-Nitrite exceeded the target in 50% of the samples. Total phosphorus exceeded the target value 100% of the time and Turbidity samples exceeded target values 4 out of 5 times.

Table 3-14. IDEM Site WAE30-0010 Water Quality Analysis

Stony Creek (IDEM site WAE30-0010)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	10.2	mg/L	>4 and <12 mg/L	1/5	20%
Water Temperature	19.4	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	-	CFU/100 ml	235 CFU/100mL (single sample)	-	-
Nitrate-Nitrite	3.5	mg/L	2.2 mg/L	2/4	50%
Total Phosphorus	1.25	mg/L	0.76 mg/L	4/4	100%
Turbidity	24.6	NTU	10.4 NTU	4/5	80%
TSS	7.25	mg/L	30 mg/L	0/4	0%
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE030-0084 within HUC 051201040304 six times, during the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Meanwhile E. coli exceeded the target value 100% of the time and Turbidity samples exceeded target values 2 out of 5 times.

Table 3-15. IDEM Site WAE30-0084 Water Quality Analysis

Stony Creek (IDEM site WAE30-0084)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.4	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	21.8	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	901.33	CFU/100 ml	235 CFU/100mL (single sample)	6/6	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	29.4	NTU	10.4 NTU	2/5	40%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

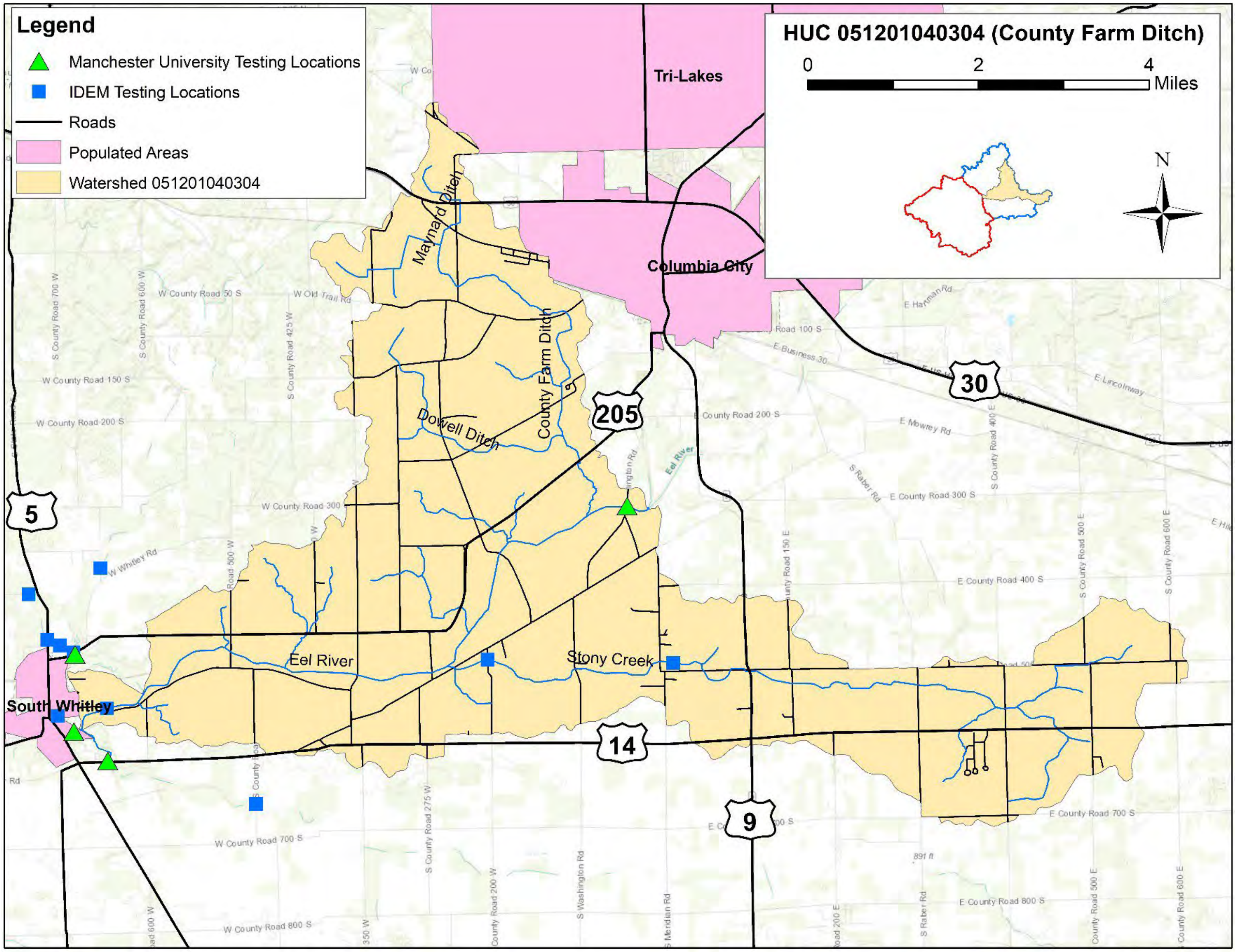

Figure 3-4. HUC 051201040304 (County Farm Ditch) Water Quality Sample Sites

3.1.4 HUC 051201040401 (Mishler Ditch – Eel River) Water Quality

Water quality data in the HUC 051201040401 (County Farm Ditch) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one gage site on the Eel River near South Whitley. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1) for stream gages. IDEM operates three sample locations within the watershed. Locations of the sample sites are shown in Figure 3-5 and Table 3-16 through Table 3-19 show analysis of water quality.

Manchester University sampled water quality parameters on the Eel River at the watershed break between two 10 Digits HUCS 051210403 and 0512010404. This site captured water quality concentrations at the break between the study watersheds. This gage site was located just upstream of South Whitley Indiana. Samples were collected 4 times daily during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Dissolved Oxygen concentration did not exceed the target range once during the sampling at the South Whitley gage station. Water Temperature exceeded targeted ranges 7 times or 2% of the recorded data. Whereas E. coli, Nitrate-Nitrite, Total Phosphorus, TSS, and Turbidity each exceeded target values in greater than 70% of the samples. E. coli exceeded the targeted value in 30 of the 38 samples or 79%. Nitrate-Nitrite and Total phosphorus exceeded the target values most consistently with 98% and 100% of the samples exceeding the targeted value respectively. Turbidity and TSS concentration also consistently exceeded targeted values with 90% and 74% of the samples exceeding the targeted value respectively. Both biological and habitat scores fell below the targeted range in 50% of the sampling events. Both scores were that fell below targeted values were collected 2017.

Table 3-16. Manchester University Water Quality Analysis on the Eel River at the Watershed Boundary between HUC 0512010403 and HUC 0512010404

Eel River – South Whitley Gage Station (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	7.73	mg/L	>4 and <12 mg/L	0/92	0%
Water Temperature	15.91	°C	4.44°C – 29.44°C	7/394	2%
E. Coli	2,435.26	CFU/100 ml	235 CFU/100mL (single sample)	30/38	79%
Nitrate-Nitrite	4.5	mg/L	2.2 mg/L	507/515	98%
Total Phosphorus	1.01	mg/L	0.76 mg/L	513/513	100%
Turbidity	158.38	NTU	10.4 NTU	464/516	90%
TSS	125.52	mg/L	30 mg/L	379/515	74%
Biological (fish)	37	Points	35	1/2	50%
Habitat	57.5	Points	60	1/2	50%

IDEM sampled water from site WAE040-0002 within HUC 051201040303 twenty six times for D.O., seventeen times for Turbidity, and twice for E. coli, Samples were collected randomly from 1998 – 2017. Results of that sampling show that D.O and E. coli both exceeded targeted levels once during the testing. Meanwhile Turbidity samples exceeded target values 12 out of 17 times.

Table 3-17. IDEM site WAE040-0002 Water Quality Analysis

Eel River (IDEM site WAE040-0002)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.69	mg/L	>4 and <12 mg/L	1/26	4%
Water Temperature	-	°C	4.44°C – 29.44°C	-	-
E. Coli	1,259	CFU/100 ml	235 CFU/100mL (single sample)	1/2	50%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	42.88	NTU	10.4 NTU	12/17	71%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE040-0021 within HUC 051201040401 five times during the summer of 2010. Results of that sampling show that D.O and Water Temperature neither exceeded targeted values. E. Coli exceeded targeted values in 80% of the samples Meanwhile Turbidity samples exceeded target values 4 out of 5 times.

Table 3-18. IDEM site WAE040-0021 Water Quality Analysis

Eel River (IDEM site WAE040-0021)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.6	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	22.6	℃	4.44℃ – 29.44℃	0/5	0%
E. Coli	914.6	CFU/100 ml	235 CFU/100mL (single sample)	4/5	80%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	37	NTU	10.4 NTU	4/5	80%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE040-0022 within HUC 051201040401 five times during the summer of 2010. Results of that sampling show that D.O and Water Temperature neither exceeded targeted values. E. Coli exceeded targeted values in 100% of the samples. Meanwhile Turbidity samples exceeded target values 4 out of 5 times.

Table 3-19. IDEM site WAE040-0022 Water Quality Analysis

Mishler Ditch (IDEM site WAE040-0022)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.8	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	20.6	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	1,395.8	CFU/100 ml	235 CFU/100mL (single sample)	5/5	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	16.4	NTU	10.4 NTU	4/5	80%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

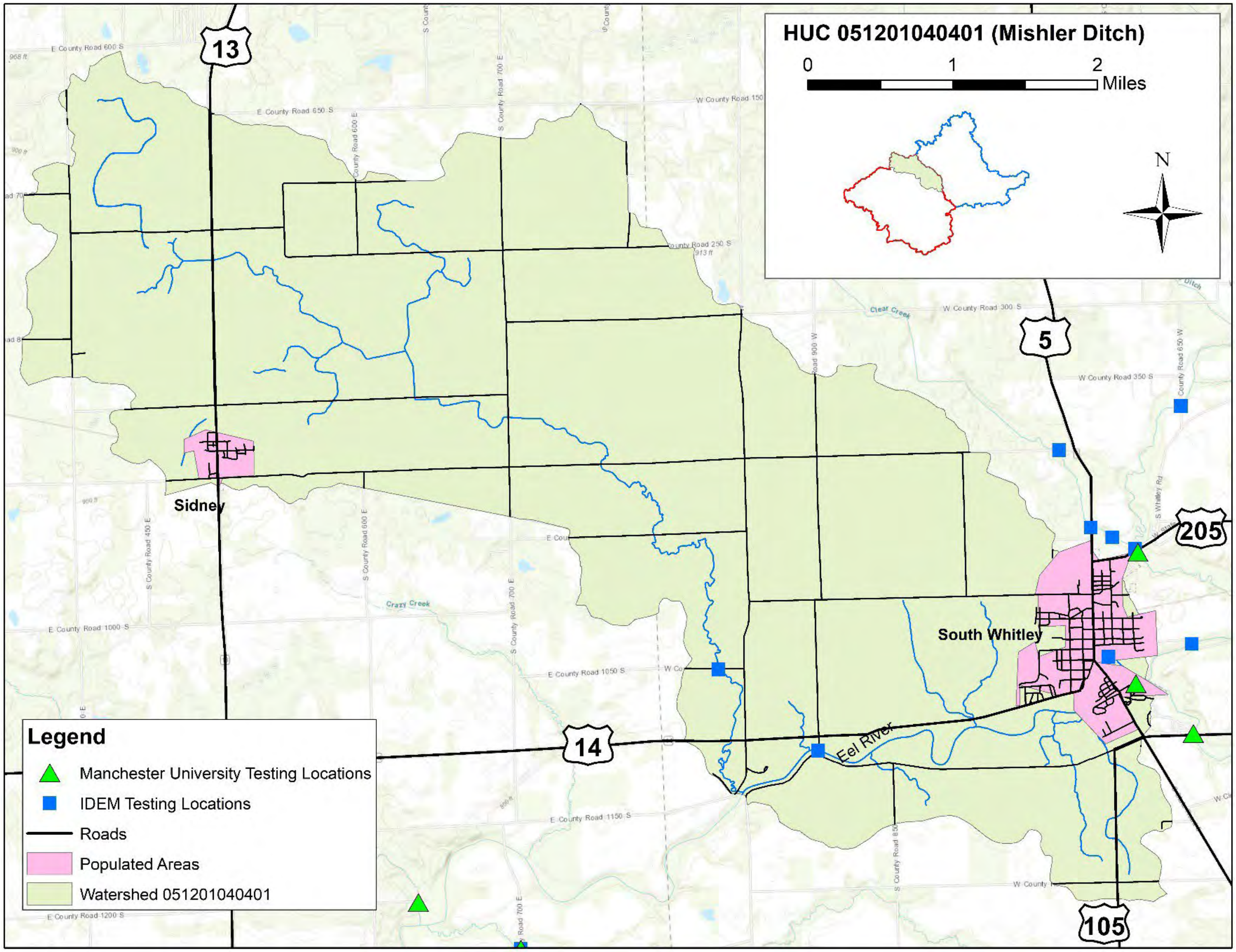

Figure 3-5. HUC 051201040401 (Mishler Ditch) Water Quality Sample Sites

3.1.5 HUC 051201040402 (Hurricane Creek – Eel River) Water Quality

Water quality data in the HUC 051201040402 (Hurricane Creek – Eel River) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one site on Hurricane Creek near South Whitley. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1). IDEM operates one sample location within the watershed. Locations of the sample sites are shown in Figure 3-6 and Table 3-20 and Table 3-21 show analysis of water quality.

Manchester University sampled water quality from Hurricane Creek at 700 E just northeast of North Manchester Indiana. Samples were collected weekly during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Both Dissolved Oxygen and Water Temperature exceeded target ranges in less than 10% of the samples. Meanwhile the remaining parameters each exceeded the target range in greater than 65% of the samples. E. Coli exceeded the samples 28 out of 38 times or 74% of the samples. Nitrate-Nitrite and Total Phosphorus each exceeded targeted values 92% and 100% respectively. Whereas TSS and Turbidity each exceeded targeted values 65% and 96% respectively. IBI scores fell below the targeted value in 2017. Whereas, QHEI scores fell below targeted values both samples.

Table 3-20. Manchester University Hurricane Creek Water Quality Analysis

Hurricane Creek (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	7.69	mg/L	>4 and <12 mg/L	2/69	3%
Water Temperature	15.07	°C	4.44°C – 29.44°C	5/69	7%
E. Coli	3,241.7	CFU/100 ml	235 CFU/100mL (single sample)	28/38	74%
Nitrate-Nitrite	7.56	mg/L	2.2 mg/L	67/73	92%
Total Phosphorus	1.97	mg/L	0.76 mg/L	73/73	100%
Turbidity	373.87	NTU	10.4 NTU	70/73	96%
TSS	227.11	mg/L	30 mg/L	46/71	65%
Biological (fish)	36	Points	35	1/2	50%
Habitat	39.5	Points	60	2/2	100%

IDEM sampled water from site WAE040-0024 within HUC 051201040402 six times during the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas both E. Coli and Turbidity samples exceeded the targeted value 100% of the time

Table 3-21. IDEM site WAE040-0024 Water Quality Analysis

Hurricane Creek (IDEM site WAE040-0024)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.2	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	20.8	℃	4.44℃ – 29.44℃	0/5	0%
E. Coli	1,006.67	CFU/100 ml	235 CFU/100mL (single sample)	6/6	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	15	NTU	10.4 NTU	5/5	100%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

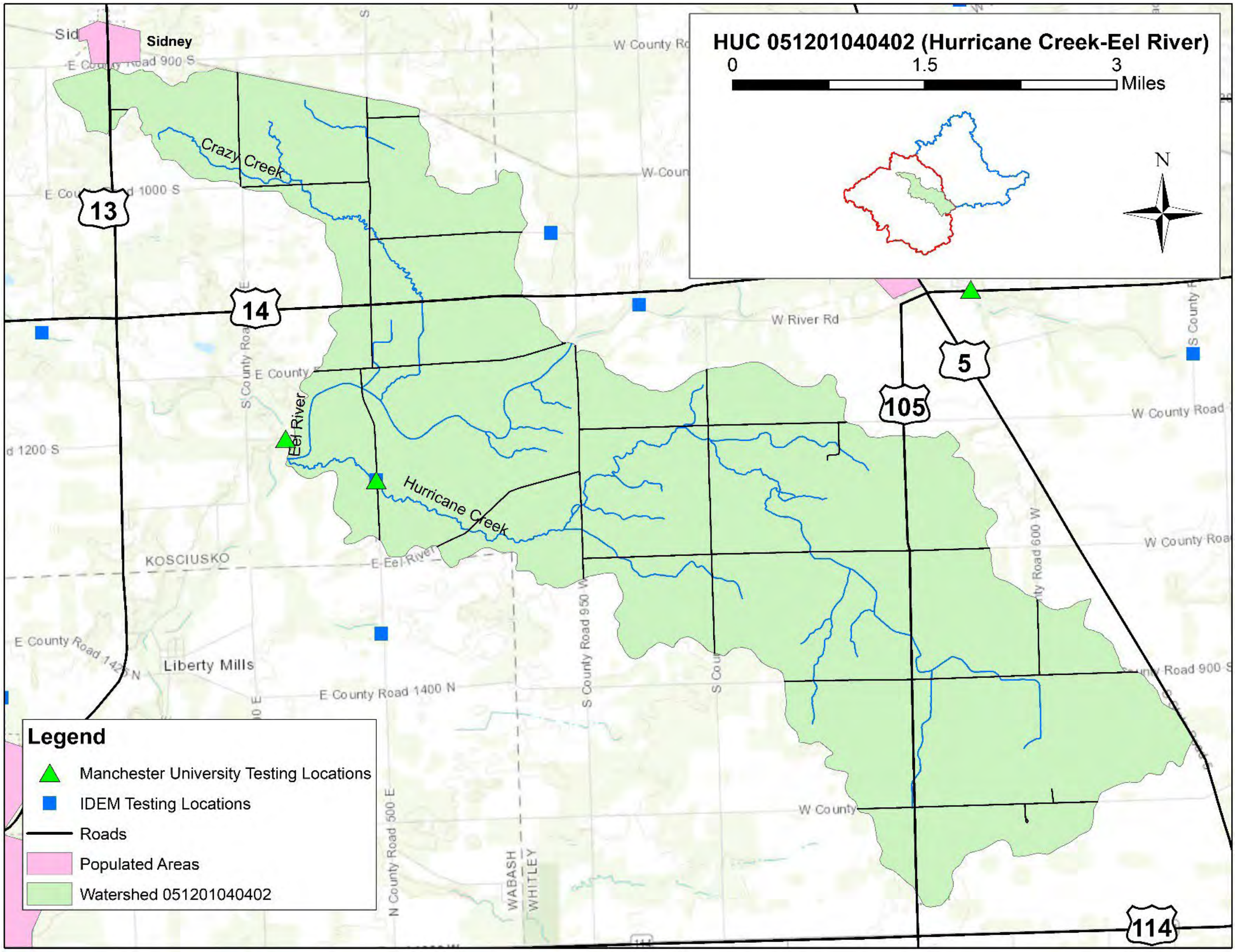

Figure 3-6. HUC 051201040402 (Hurricane Creek-Eel River) Water Quality Sample Sites

3.1.6 HUC 051201040403 (Plunge Creek – Eel River) Water Quality

Water quality data in the HUC 051201040402 (Plunge Creek - Eel River) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one site on Plunge Creek near South Whitley. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1). IDEM operates two sample locations within the watershed. Locations of the sample sites are shown in Figure 3-7 and Table 3-22 through Table 3-24 show analysis of water quality.

Manchester University sampled water quality from Plunge Creek on 1200 S just northeast of North Manchester Indiana. Samples were collected weekly during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Both Dissolved Oxygen and Water Temperature exceeded target ranges in less than 10% of the samples. Meanwhile the remaining parameters each exceeded the target range in greater than 35% of the samples. E. Coli exceeded the samples 27 out of 38 times or 71% of the samples. Nitrate-Nitrite and Total Phosphorus each exceeded targeted values 89% and 97% respectively. Whereas TSS and Turbidity each exceeded targeted values 38% and 57% respectively. IBI scores did not fall below the targeted value in either 2016 or 2017. Whereas, QHEI scores fell below targeted values in both samples.

Table 3-22. Manchester University Plunge Creek Water Quality Analysis

Plunge Creek (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.4	mg/L	>4 and <12 mg/L	3/68	4%
Water Temperature	14.8	℃	4.44℃ – 29.44℃	5/68	7%
E. Coli	1,332.2	CFU/100 ml	235 CFU/100mL (single sample)	27/38	71%
Nitrate-Nitrite	3.68	mg/L	2.2 mg/L	62/70	89%
Total Phosphorus	0.74	mg/L	0.76 mg/L	67/69	97%
Turbidity	82.7	NTU	10.4 NTU	39/68	57%
TSS	76.2	mg/L	30 mg/L	26/68	38%
Biological (fish)	41	Points	35	0/2	0%
Habitat	57	Points	60	2/2	100%

IDEM sampled water from site WAE040-0012 within HUC 051201040403 eight times during the summer and fall of 2003. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 80% of the time and Turbidity samples exceeded the targeted value 12.5% of the time

Table 3-23. IDEM Site WAS040-0012 Water Quality Analysis

Plunge Creek (IDEM site WAE040-0012)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.14	mg/L	>4 and <12 mg/L	0/7	0%
Water Temperature	15.13	°C	4.44°C – 29.44°C	0/8	0%
E. Coli	404.2	CFU/100 ml	235 CFU/100mL (single sample)	4/5	80%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	4.75	NTU	10.4 NTU	1/8	12.5%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE040-0019 within HUC 051201040403 ten times during the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 60% of the time and Turbidity samples exceeded the targeted value 56% of the time.

Table 3-24. IDEM Site WAE040-0019 Water Quality Analysis

Wheeler Creek (IDEM site WAE040-0019)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	6.4	mg/L	>4 and <12 mg/L	0/10	0%
Water Temperature	17.9	°C	4.44°C – 29.44°C	0/10	0%
E. Coli	2228	CFU/100 ml	235 CFU/100mL (single sample)	3/5	60%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	80	NTU	10.4 NTU	5/9	56%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

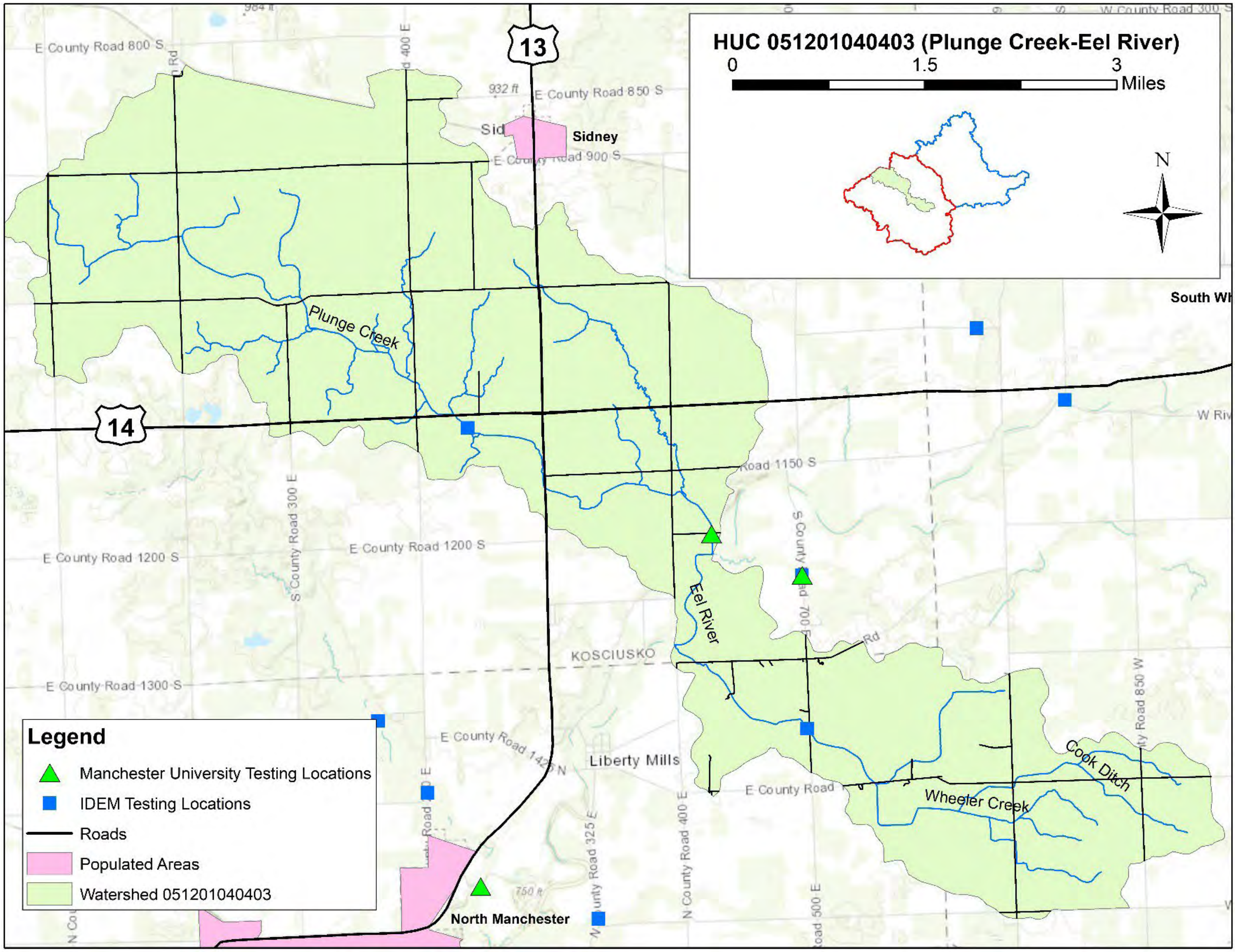

Figure 3-7. HUC 051201040403 (Plunge Creek-Eel River) Water Quality Sample Sites

3.1.7 HUC 051201040404 (Simonton Creek – Eel River) Water Quality

Water quality data in the HUC 051201040404 (Simonton - Eel River) watershed was analyzed by IDEM as part of regular state water quality monitoring. IDEM operates one sample location within the watershed. Location of the sample site is shown in Figure 3-8and Table 3-25 shows analysis of water quality.

IDEM sampled water from site WAE040-0028 within HUC 051201040404 five times during the summer and fall of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 100% of the time and Turbidity samples exceeded the targeted value 40% of the time

Table 3-25. IDEM Site WAE040-0028 Water Quality Analysis

Simonton Creek (IDEM site WAE040-0028)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.6	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	21.4	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	1,237.5	CFU/100 ml	235 CFU/100mL (single sample)	5/5	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	20.6	NTU	10.4 NTU	2/5	40%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

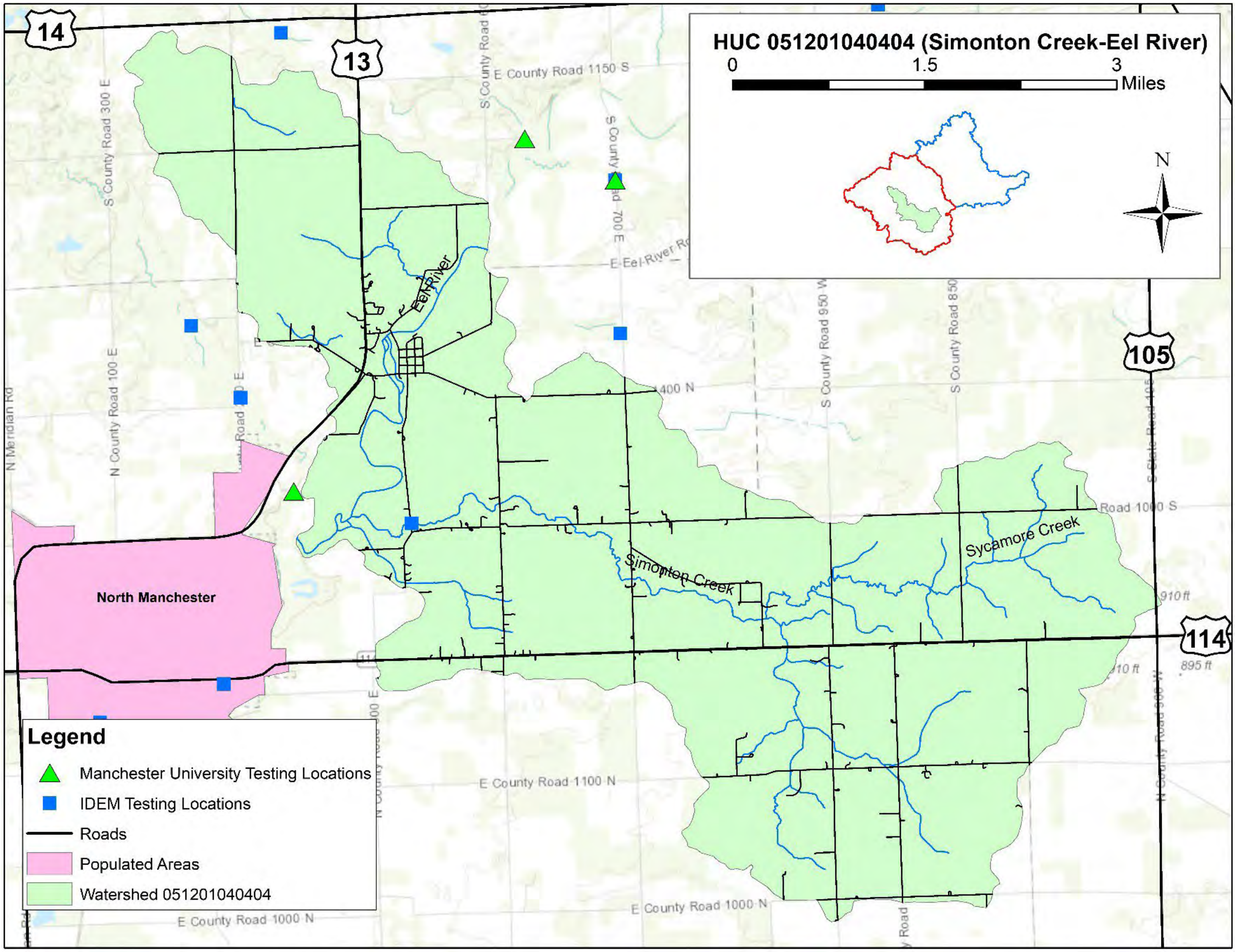

Figure 3-8. HUC 051201040404 (Simonton Creek-Eel River) Water Quality Sample Site

3.1.8 HUC 051201040405 (Pony Creek) Water Quality

Water quality data in the HUC 051201040405 (Pony Creek) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one site on Pony Creek near North Manchester. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1). IDEM operates one sample location within the watershed. Locations of the sample sites are shown in Figure 3-9 and Table 3-26 and Table 3-27show analysis of water quality.

Manchester University sampled water quality from Pony Creek on 1100 N just South of North Manchester Indiana. Samples were collected weekly during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Both Dissolved Oxygen and Water Temperature exceeded target ranges in less than 10% of the samples. Meanwhile the remaining parameters each exceeded the target range in greater than 50% of the samples. E. Coli exceeded the samples 33 out of 38 times or 87% of the samples. Nitrate-Nitrite and Total Phosphorus each exceeded targeted values 96% and 100% respectively. Whereas TSS and Turbidity each exceeded targeted values 54% and 68% respectively. IBI scores did not fall below the targeted value in either 2016 or 2017. Whereas, QHEI scores fell below targeted values in 2017.

Table 3-26. Manchester University Pony Creek Water Quality Analysis

Pony Creek (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.59	mg/L	>4 and <12 mg/L	3/67	5%
Water Temperature	15.7	°C	4.44°C – 29.44°C	6/67	9%
E. Coli	2,595.6	CFU/100 ml	235 CFU/100mL (single sample)	33/38	87%
Nitrate-Nitrite	6.3	mg/L	2.2 mg/L	72/75	96%
Total Phosphorus	1.7	mg/L	0.76 mg/L	74/74	100%
Turbidity	375.1	NTU	10.4 NTU	44/65	68%
TSS	241.1	mg/L	30 mg/L	39/72	54%
Biological (fish)	37	Points	35	0/2	0%
Habitat	59	Points	60	1/2	50%

IDEM sampled water from site WAE040-0029 within HUC 051201040403 five times during the summer and fall of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 100% of the time and Turbidity samples exceeded the targeted value 40% of the time

Table 3-27. IDEM Site WAE040-0029 Water Quality Analysis

Pony Creek (IDEM site WAE040-0029)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.4	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	22.8	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	585	CFU/100 ml	235 CFU/100mL (single sample)	3/3	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	28.2	NTU	10.4 NTU	2/5	40%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

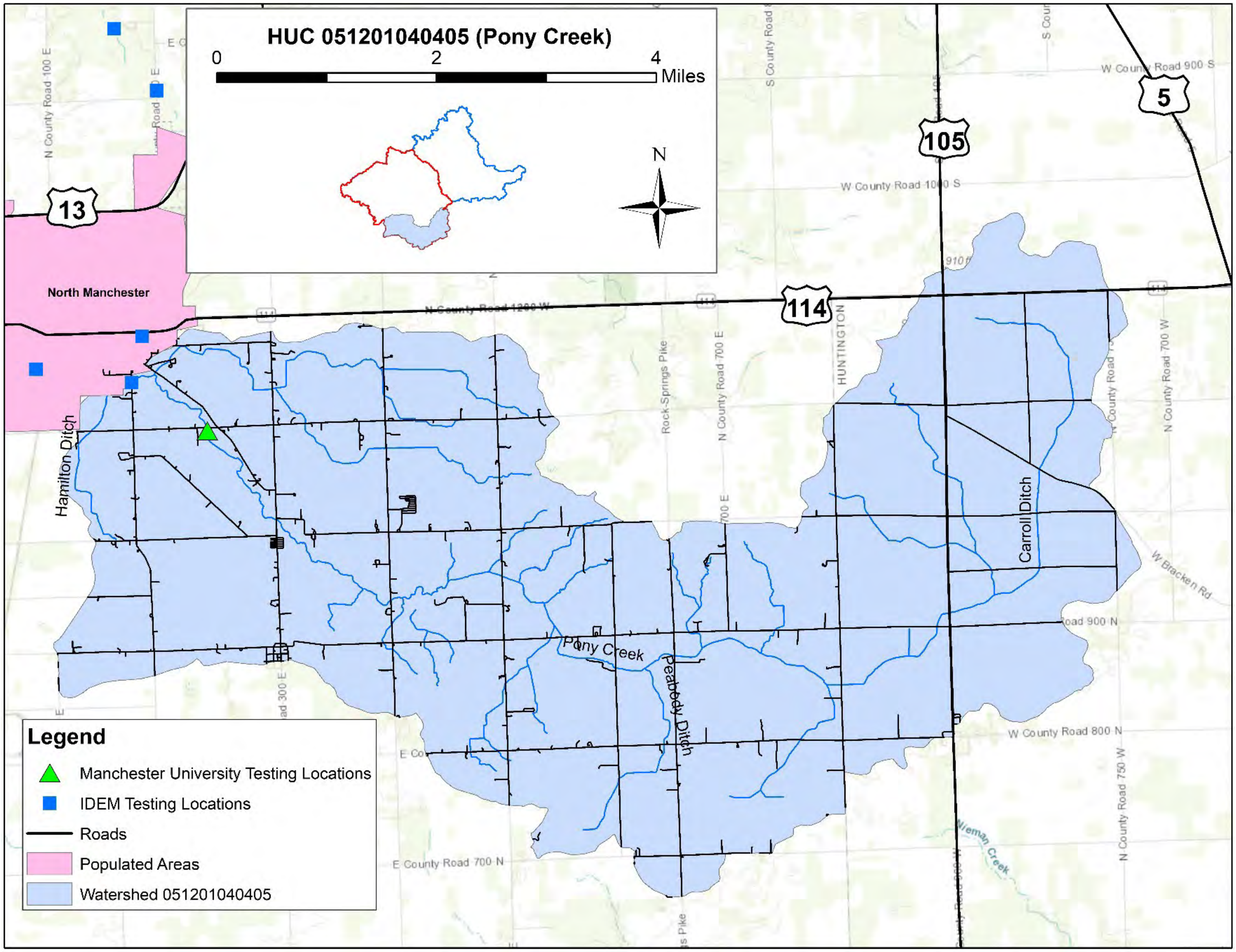

Figure 3-9. HUC 051201040405 (Pony Creek) Water Quality Sample Sites

3.1.9 HUC 051201040406 (Nelson Creek – Clear Creek) Water Quality

Water quality data in the HUC 051201040406 (Nelson Creek – Clear Creek) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one gage site on the Eel River near North Manchester. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1) for stream gages. IDEM operates two sample locations within the watershed. Locations of the sample sites are shown in Figure 3-10 and Table 3-28 through Table 3-30show analysis of water quality.

Manchester University sampled water quality parameters on the Eel River at the watershed break between two 10 Digits HUCS 051210404 and 0512010405. This site captured water quality concentrations as it left the study watersheds. This gage site was located just west of North Manchester Indiana. Samples were collected 4 times daily during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Dissolved Oxygen concentration exceeded the target range once during the sampling at the Blochers gage station. Water Temperature exceeded targeted ranges 51 times or 13% of the recorded data. All water temperature data points that exceeded targeted range were documented below 4.44°C and occurred during the winter months. Whereas E. coli, Nitrate-Nitrite, Total Phosphorus, TSS, and Turbidity each exceeded target values in greater than 60% of the samples. E. coli exceeded the targeted value in 25 of the 38 samples or 66%. Nitrate-Nitrite and Total phosphorus exceeded the target values most consistently with 99% and 100% of the samples exceeding the targeted value respectively. Turbidity and TSS concentration also consistently exceeded targeted values with 98% and 92% of the samples exceeding the targeted value respectively. Neither biological nor habitat scores fell below the targeted range in the sampling events.

Table 3-28. Manchester University Water Quality Analysis on the Eel River at the Watershed Boundary between HUC 0512010404 and HUC 0512010405

Eel River – Downstream Gage Station (Blochers) (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.6	mg/L	>4 and <12 mg/L	1/111	1%
Water Temperature	12.2	°C	4.44°C – 29.44°C	51/402	13%
E. Coli	1,951.4	CFU/100 ml	235 CFU/100mL (single sample)	25/38	66%
Nitrate-Nitrite	4.6	mg/L	2.2 mg/L	507/512	99%
Total Phosphorus	1.5	mg/L	0.76 mg/L	511/511	100%
Turbidity	217.5	NTU	10.4 NTU	500/512	98%
TSS	195.7	mg/L	30 mg/L	470/511	92%
Biological (fish)	50	Points	35	0/2	0%
Habitat	80	Points	60	0/2	0%

IDEM sampled water from site WAE040-0006 within HUC 051201040406 five times during the summer of 2010. Results of that sampling show that D.O and Water Temperature neither exceeded targeted levels during the testing. Meanwhile Turbidity samples exceeded target values 2 out of 5 times and E. Coli samples exceeded target values 3 out of 4 times.

Table 3-29. IDEM Site WAE040-0006 Water Quality Analysis

Clear Creek (IDEM site WAE040-0006)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.4	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	21.16	°C	4.44°C – 29.44°C	0/5	0
E. Coli	1,122	CFU/100 ml	235 CFU/100mL (single sample)	3/4	75%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	8.2	NTU	10.4 NTU	2/5	40%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE040-0031 within HUC 051201040406 five times during the summer of 2010. Results of that sampling show that D.O and Water Temperature neither exceeded targeted values. E. Coli exceeded targeted values in 100% of the samples Meanwhile Turbidity samples exceeded target values 3 out of 5 times.

Table 3-30. IDEM Site WAE040-0021 Water Quality Analysis

Eel River (IDEM site WAE040-0021)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.4	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	21.4	℃	4.44℃ – 29.44℃	0/5	0%
E. Coli	1,022.2	CFU/100 ml	235 CFU/100mL (single sample)	5/5	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	12.6	NTU	10.4 NTU	3/5	60%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

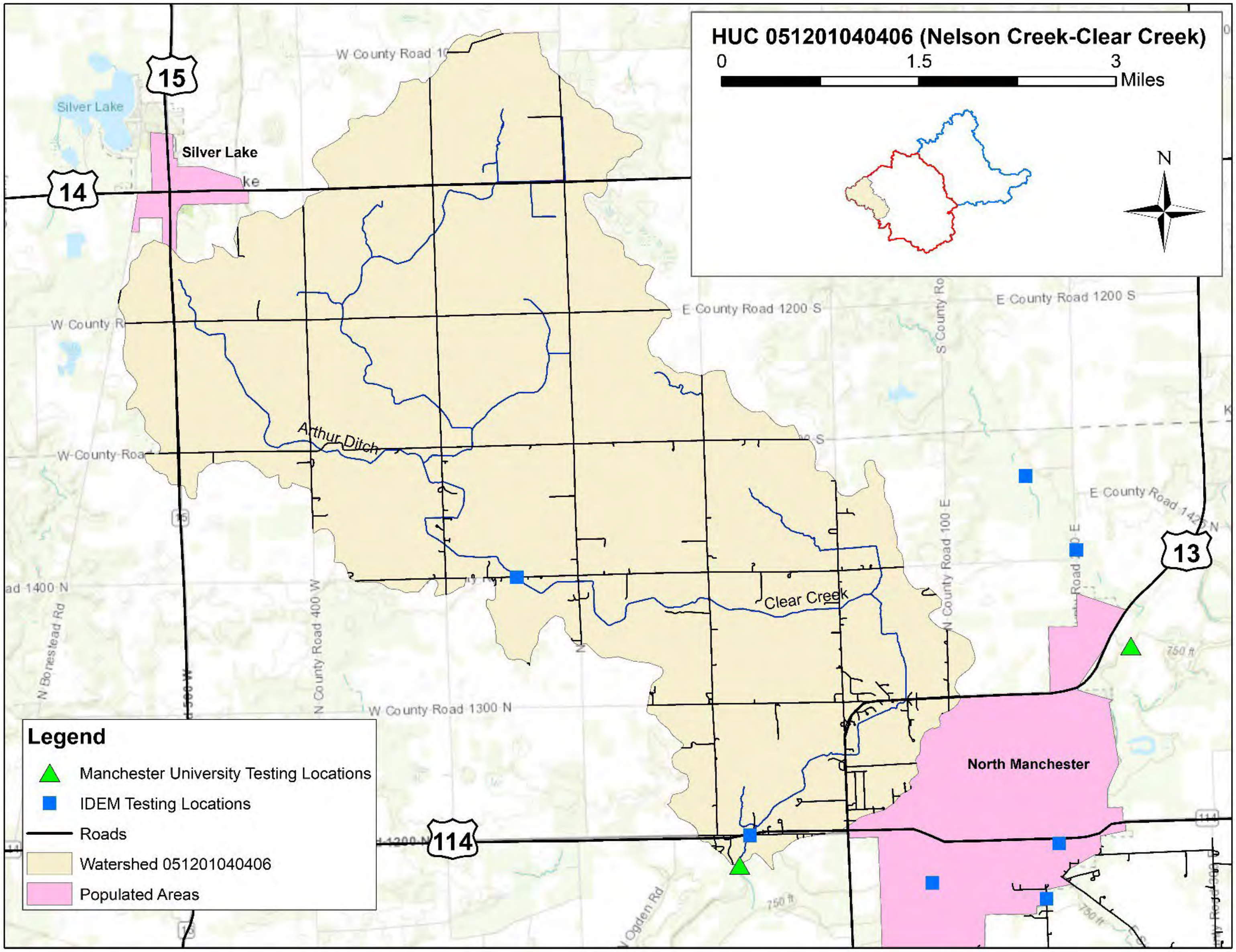

Figure 3-10. HUC 051201040406 (Nelson Creek-Clear Creek) Water Quality Sample Sites

3.1.10 HUC 051201040407 (Swank Creek – Eel River) Water Quality

Water quality data in the HUC 051201040407 (Swank Creek - Eel River) watershed was analyzed by the Manchester University as part of this project and by IDEM as part of regular state water quality monitoring. Samples analyzed by Manchester University were collected at one site on Plunge Creek near South Whitley. Sampling efforts followed Manchester University Quality Assurance Project Plan (Highlighted in Section 3.2.4.1). IDEM operates four sample locations within the watershed. Locations of the sample sites are shown in Figure 3-12 and Table 3-31 through Table 3-35 show analysis of water quality.

Manchester University sampled water quality from Swank Creek on private property just North of North Manchester Indiana. Samples were collected weekly during May and June and monthly thereafter. Samples collected from 2016-2017 were used for this analysis. Both Dissolved Oxygen and Water Temperature exceeded target ranges in less than 10% of the samples. Meanwhile the remaining parameters each exceeded the target range in greater than 40% of the samples. E. Coli exceeded the samples 27 out of 38 times or 75% of the samples. Nitrate-Nitrite and Total Phosphorus each exceeded targeted values 77% and 100% respectively. Whereas TSS and Turbidity each exceeded targeted values 42% and 74% respectively. IBI scores did not fall below the targeted value in either 2016 or 2017. Whereas, QHEI scores fell below targeted values in both 2016 and 2017.

Table 3-31. Manchester University Swank Creek Water Quality Analysis

Swank Creek (Manchester University Sample Site)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.4	mg/L	>4 and <12 mg/L	2/68	3%
Water Temperature	16.0	℃	4.44℃ – 29.44℃	5/68	7%
E. Coli	2,579.5	CFU/100 ml	235 CFU/100mL (single sample)	27/36	75%
Nitrate-Nitrite	3.4	mg/L	2.2 mg/L	56/73	77%
Total Phosphorus	0.71	mg/L	0.76 mg/L	72/72	100%
Turbidity	75.9	NTU	10.4 NTU	53/72	74%
TSS	65.0	mg/L	30 mg/L	30/71	42%
Biological (fish)	38	Points	35	0/2	0%
Habitat	40	Points	60	2/2	50%

IDEM sampled water from site WAE040-0001 within HUC 051201040407 nine times, with eight of those collected during the summer of 1998 and the remaining sample being collected in the fall of 2003. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 80% of the time and Turbidity samples exceeded the targeted value 71% of the time

Table 3-32. IDEM Site WAE040-0001 Water Quality Analysis

Eel River (IDEM site WAE040-0001)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.71	mg/L	>4 and <12 mg/L	0/7	0%
Water Temperature	19	°C	4.44°C – 29.44°C	0/9	0%
E. Coli	3,895.6	CFU/100 ml	235 CFU/100mL (single sample)	4/5	80%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	37	NTU	10.4 NTU	5/7	71%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE-04-0001 within HUC 051201040407 ten times during the spring and summer of 2015. Results of that sampling show Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 25% of the time and Turbidity samples exceeded the targeted value 10% of the time. Unlike other sites, this site seemed to be super saturated with dissolved oxygen. Two of the ten samples were higher than the targeted dissolved oxygen concentration, with another two samples just below the high D.O. concentration target.

Table 3-33. IDEM Site WAE040-0019 Water Quality Analysis

Wheeler Creek (IDEM site WAE040-0019)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	11.1	mg/L	>4 and <12 mg/L	2/10	20%
Water Temperature	16.1	°C	4.44°C – 29.44°C	0/10	0%
E. Coli	146	CFU/100 ml	235 CFU/100mL (single sample)	1/4	25%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	11.5	NTU	10.4 NTU	1/10	10%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE040-0027 within HUC 051201040407 five times, the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 100% of the time and Turbidity samples exceeded the targeted value 60% of the time

Table 3-34. IDEM Site WAE040-0027 Water Quality Analysis

Swank Creek (IDEM site WAE040-0027)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	8.6	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	20.2	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	1,311.75	CFU/100 ml	235 CFU/100mL (single sample)	5/5	100%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	54.2	NTU	10.4 NTU	3/5	60%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

IDEM sampled water from site WAE040-0030 within HUC 051201040407 five times, the summer of 2010. Results of that sampling show that D.O. and Water Temperature did not exceed targeted levels once during the testing. Whereas E. Coli exceeded the targeted value 33% of the time and Turbidity samples exceeded the targeted value 40% of the time

Table 3-35. IDEM Site WAE040-0030 Water Quality Analysis

Eel River (IDEM site WAE040-0030)					
Parameter	**Mean**	**Unit**	**Target**	**# of Times Does Not Meet Target**	**% Does not Meet Target**
D.O.	9.2	mg/L	>4 and <12 mg/L	0/5	0%
Water Temperature	22.8	°C	4.44°C – 29.44°C	0/5	0%
E. Coli	332.33	CFU/100 ml	235 CFU/100mL (single sample)	1/3	33%
Nitrate-Nitrite	-	mg/L	2.2 mg/L	-	-
Total Phosphorus	-	mg/L	0.76 mg/L	-	-
Turbidity	29	NTU	10.4 NTU	2/5	40%
TSS	-	mg/L	30 mg/L	-	-
Biological (fish)	-	Points	35		
Habitat	-	Points	60		

3.1.10.1 USGS Flow Gage

United States Geological Survey (USGS) maintains on flow gage within the UMERW. The gage is located on the Wabash Street Bridge in North Manchester Indiana in HUC 051201040407 (Swank Creek-Eel River). Data is available from the gage dates back to 1987. USGS gage is used as a reference to insure Manchester University gage stations are properly calibrated to correctly calculate flow. Figure 3-11 show a flow duration curve calculated for the gage station from 1987 – 2017. The graph show how often events flow are surpassed. For example, 80% of the flows exceed 100 cfs.

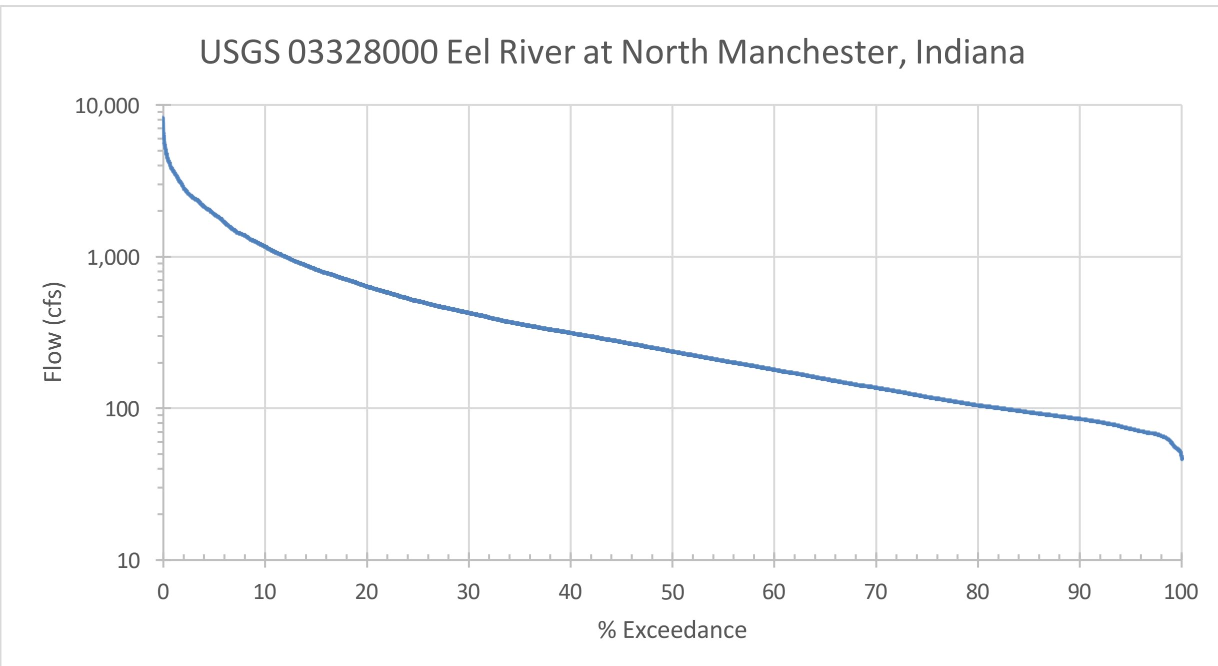

Figure 3-11. Flow duration curve for USGS 03328000 from 1987-2017

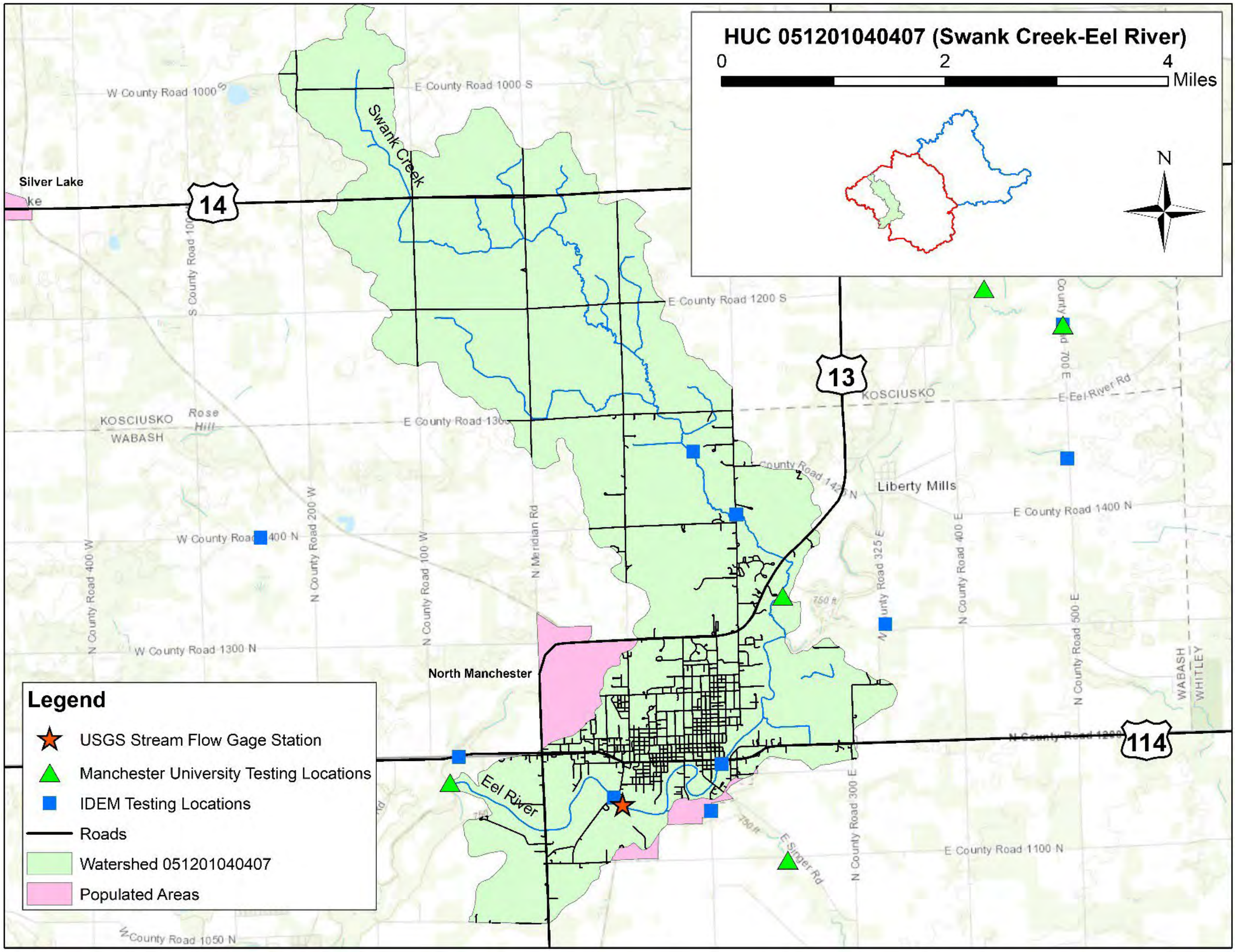

Figure 3-12. HUC 051201040407 (Swank Creek-Eel River) Water Quality Sample Sites

3.1.11 Summary of Water Quality

As can be observed from the sections above, the major water quality problems observed throughout the watershed are from nitrogen, phosphorus, *E. coli*, sediment and turbidity. Samples collected by Manchester University shows that Nitrate-Nitrogen exceeded the target of 2.2 mg/L in 96% (1843/1920) of the samples collected. Total Phosphorus exceeded the target value of 0.076 mg/L in 99.6% (1905/1913) of the samples. E. Coli exceed the target value of 235 cfu/100mL in 74% (251/339) of the samples. Total Suspended Solids exceed the target value of 30 mg/L in 72% (1368/1902) of the samples. Turbidity exceeded the target value of 10.4 NTU in 88% (1678/1907) of the samples. All of these pollutants can discharge from faulty septic systems, barnyard or animal feeding operation runoff, improper application of manure on crop land, conventional tillage on HEL and PHEL farmland, excess stormwater and CSO events. However, high nutrient, and turbidity levels can also come directly from row crop fields either through surface runoff or tile discharge. Neither dissolved oxygen nor water temperature exceeded targeted range in greater than 10% of the samples. Dissolved Oxygen exceeded targeted range of <4mg/L or >12 mg/L in 3% (23/703) of the samples. Water Temperature exceeded targeted range of <4.44°C or >29.44°C in 7.3% (94/1296) of the samples. Water Temperature only fell below targeted range during winter months with ice formation.

While any water quality data can be valuable, it is important to note that it can be difficult to combine various dataset. Due to collection methods, grab sample vs automatic water sampler, age of the data, frequency of the data collection, quantity of samples, parameters analyzed, and many more can make it impossible to accurately merge datasets. Due to these differences, data collected by IDEM will not be considered throughout the remainder of the plan. While this data was valuable in determining what historical data has been collected. Data collected by IDEM was mostly collected in the early 2000's. Due the continually changing climate, landscape, and hydrological patterns this data may not accurately describe the current water quality conditions. Additionally, data collected by IDEM analyzed a maximum of 10 grab samples through summer and autumn months. These samples do not accurately depict water quality parameters throughout the entire year. Lastly, data collected by IDEM only measured 4 parameters (DO, Water Temperature, E. coli, Turbidity) at majority of the sites. It was documented through the sub watershed inventory that DO, and Water Temperature were not a concern within the watershed. Whereas nitrate-nitrite, total phosphorus, and suspended sediment were all a major pollutant in the watershed and were a concern of the stakeholders. These parameters were not collected through IDEM sampling. It is for these reasons that only data collected by Manchester University in 2016 and 2017 will be used in the remainder of the plan and help identify priority areas.

3.1.12 Stakeholder Concerns Biological/Habitat

Stakeholder expresses concerns that there was not enough quality habitat to support abundant aquatic communities. Calculations of QHEI at each sample site show that 7 of the 9 sites do not score a 60 or better which is the targeted score. While habitat seems to be limiting at nearly all the sites, the IBI scores did not show the same response, with no site scoring below the targeted score of 35. Both Hurricane Creek and Pony Creek nearly fell below the IBI target with scores of 36 and 37 respectively. Subsequent years data will be needed to better understand the relationship between habitat and IBI scores.

No additional resources were found regarding previous studies biological and habitat data

3.2 Land Use by Sub-watershed

3.2.1 Survey Methods

Initial data and surveys were conducted using desktop applications. ESRI ArcGIS was used to determine areas within the watershed that are in a degraded condition. This determination was conducted using GIS data from indianamap.org. Data was analyzed for slope, current stream buffers, proximity of potential water pollution sources, etc. Upon completion of the desktop survey, A windshield survey was conducted throughout the watershed to identify areas where nonpoint source may be an issue. The survey was conducted from October through December 2017, with two people per vehicle, driving each road within each sub-watershed, and making note of any areas lack of riparian buffer, livestock access to open water, tillage practices, stream bank erosion, and stream conditions. The survey revealed several areas of stream bank erosion issues, channel modifications, lack of riparian buffer and conventional tillage practices. The windshield survey will be discussed in further detail, at the sub-watershed level.

3.2.2 Land Use Overview

This section will provide land use information pertaining to each 12 digit HUC located in the Upper Middle Eel River Watershed. Data was collected using a desktop analysis within ArcGIS. While there are differences between sub-watersheds, it is important to note that there are many trends that are similar between all the watersheds. Overall, the watershed is predominately agriculture with 79% of the land use in agriculture production. Much of the watershed is considered prime agriculture production land and has consistently be in cropland since the mid-1900's. Due to high agricultural production there is little to no movement to develop the watershed for industry or urban sprawl.

Fertilizer use within the watershed is very common due to the extensive agriculture production. Fertilizer in the form of nitrogen and phosphorus are applied on a yearly basis though the watershed. Many producers will apply slightly greater amount of fertilizer than necessary to insure optimal growth and that fertilizer is not the limiting factor in growth. With increase fertilizer application, atmospheric, and soil mineralization there is a pool of nutrients in present in the soil. Inevitability this excessive nutrient pool will be extracted from the watershed, by either harvestable grain or through the waterbodies.

According to county NRCS district conservationist hobby farms and small animal feeding operations (AFOs) are minimal throughout the watershed and were not quantified in this study. While inevitability these farms impact the watershed, their contribution to ecological degradation is considered minimal compared to other agriculture practices and CFO/CFAO.

Municipal wastewater sludge from North Manchester and South Whitley are applied to agricultural fields within the watershed. This sludge acts similar to fertilizers applied to agriculture fields and the same concerns apply to wastewater sludge as to animal manure and fertilizers

3.2.2.1 Riparian Buffers

Riparian (along the waters' edge) buffers are extremely important to water quality. Conservation riparian 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, and 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, and 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. Literature shows that a 30-meter buffer strip is the most effective, "The most effective buffers are at least 30-meters, or 100 feet wide, composed of native forest, and are applied to all streams, including very small ones." (Wenger and Fowler 2000).

3.2.2.2 Stream Bank Stabilization

Streambank erosion is a major concern of the stakeholders. It is evident through personal accounts that many stream banks are in significantly eroded. It is nearly impossible to quantify streambank erosion via desktop analysis. Thus, a windshield survey documented the extent of streambank at each bridge located within the UMERI. Stream bank erosion was recorded as slight, moderate, or severe. Analysis was completed using the Ohio EPA QHEI method for analyzing stream bank erosion.

3.2.2.3 LUST

The USEPA describes LUST as:

> A typical leaking underground storage tank (LUST) scenario involves the release of a fuel product from an underground storage tank (UST) that can contaminate surrounding soil, groundwater, or surface waters, or affect indoor air spaces. Early detection of an UST release is important, as is determining the source of the release, the type of fuel released, the occurrence of imminently threatened receptors, and the appropriate initial response. The primary objective of the initial response is to determine the nature and extent of a release as soon as possible.
>
> Warning signs of a release can be identified through inspection and monitoring, inventory control, and leak-detection technology. Once the release is confirmed, notification to the appropriate government agency must follow particular state or tribal requirements.
>
> In some cases, emergency response actions must be taken immediately without waiting for government approval or oversight. Initial actions are all focused on protecting public health, safety, and the environment. Under most state regulations, the operator or owner has specific time frames to conduct initial response actions, submit reports, complete an initial site characterization, and conduct free product removal. It is important that LUST personnel reinforce these required targets in the event that an enforcement action becomes necessary.

3.2.2.4 Brownfield and remediation sites

The USEPA Describes Brownfield as:

> A brownfield is a property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. It is estimated that there are more than 450,000 brownfields in the U.S. Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, takes development pressures off of undeveloped, open land, and both improves and protects the environment.

There are no current Brownfields or remediation sites within the UMERW

3.2.2.5 Combined Sewer Overflows

A combined sewer overflow (CSO) is a piped outfall that is part of a combined sewer system, which carries both sanitary waste and storm water runoff through the same pipe to the waste water treatment plant (WWTP). However, during rainfall events, the system is designed to discharge flows directly into a receiving waterbody once the WWTP storage capacity is exceeded. Each population center that contains CSOs is required to comply with the CWA and manage the discharges of combined sewers. A review of EPS Guidance for long-term control plan states, Many CSO communities enter into a consent decree or an Agreed Order (AO), which is a federally or state administered enforcement mechanism that compels the community to implement a plan to improve water quality. The consent decree or AO may include a Long Term Control Plan (LTCP) for construction of sewer system improvements as well as documented plans for the operation, maintenance and rehabilitation of the sewer system to minimize or eliminate CSO discharges to receiving waters.

3.2.2.6 Sanitary Sewers and Sanitary Sewer Overflows

Sanitary sewer systems collect and transport wastewater and limited amounts of stormwater to treatment facilities for appropriate treatment. Sanitary sewers are different than combined sewers, which collect large volumes of stormwater in addition to sewage and. Occasionally, sanitary sewers will release raw sewage. These types of releases are called sanitary sewer overflows (SSOs).

USEPA Identified Possible causes of SSOs include:

- blockages,
- line breaks,
- sewer defects that allow stormwater and groundwater to overload the system,
- power failures,
- improper sewer design, and
- vandalism.
-

EPA estimates there are at least 23,000 - 75,000 SSOs per year (not including sewage backups into buildings) in the U.S.

SSOs that reach waters of the U.S. are point source discharges. Like other point source discharges from municipal sanitary sewer systems, SSOs are prohibited unless authorized by a NPDES permit. Moreover, SSOs, including those that do not reach waters of the U.S., may be indicative of improper operation and maintenance of the sewer systems, and may violate NPDES permit conditions

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Both sewer systems in the UMERW are combined sewer systems. There are no SSO located in the watershed. North Manchester is recently design a strategy to replace the current combined sewer with a sanitary sewer. They are currently implementing this strategy.

3.2.2.7 Confided Feeding Operations

A description of CFO is documented in on page 63.

The Upper Middle Eel River Watershed contains a large number of confined feeding operations. Animal waste produced by these facilities is commonly used as a supplement to commercial fertilizer. Animal waste contains a large amount of nitrogen and phosphorus. Unlike commercial fertilizer which can be applied by side dressing. Animal waste is broadcast applied or injected into the soil column. This application occurs generally in the fall or spring when agriculture fields are barren. Without a current crop stand nutrients are stored in the soil waiting for assimilation by vegetative material. However, with the changing climate, it is common to receive late fall/winter or early spring rainfall events. These rainfall events can cause transport of nutrients from the soil into a receiving waterbody. Animal waste use is a primary concern within the watershed.

3.3 Land Use within Each HUC 12

3.3.1 Land Use 051201040301 (Black Lake-Spring Creek)

The primary land use in HUC 051201040301 (Black Lake-Spring Creek) is agriculture with 73% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-36 shows the quantity and percentage of each land use within HUC 051201040301 (Black Lake-Spring Creek) and Figure 3-13 spatially represented the land use across the watershed. Of the 73% agriculture land use, 71% is strictly considered cultivated crops. HUC 051201040301 (Black Lake-Spring Creek) is tied for the largest percentage of forest with 16% of the land use being classified as forest. Only 6% of the land use is developed, with 4% of that being classified as developed open space with <0.5% highly developed areas within the watershed.

The windshield survey was conducted 8th December 2017 for HUC 051201040301 (Black Lake-Spring Creek). During the survey, 14 fields were documented to have recently practiced conventional fall tillage. No-till farming practices were documented on 3 fields within the watershed with 2 of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was documented at 1 of the streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 11 stream crossings analyzed, 9 were documented in having moderate or severe stream bank erosion. Many of these locations were coupled with extensive stream modification, such as channelization, riparian buffer removal, etc. The windshield survey only documented 3 of the 11 stream crossing as having visible drainage tile present. Even though few drainage tile were documented, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW.

The windshield survey verified the lack of riparian buffers within the watershed. There are 25.7 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 15.4 stream miles or 60% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones.

There is one Confined Feeding Operation located in HUC 051201040301 (Black Lake-Spring Creek). With only one facility, there is a low density with only 0.06 CFO per square mile of watershed area. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. Table 3-38 defines the CFO located within HUC 051201040301 (Black Lake-Spring Creek). There are no NPDES permitted facilities, LUST, Brownfield, SSO, CSO located within HUC 051201040301 (Black Lake-Spring Creek).

Table 3-36. Land use statistics for HUC 051201040301 (Black Lake-Spring Creek)

	Acreages	**Percentage of watershed**
Open Water	147.2	1%
Developed, Open Space	463.7	4%
Developed, Low Intensity	77.6	1%
Developed, Medium Intensity	63.2	1%
Developed, High Intensity	-	-
Deciduous Forest	1,668.2	16%
Evergreen Forest	8.0	<0.5%
Shrub/Scrub	17.6	<0.5%
Herbaceous	7.8	<0.5%
Hay/Pasture	334.9	3%
Cultivated Crops	7,438.0	71%
Woody Wetlands	136.8	1%
Emergent Herbaceous Wetlands	81.4	1%
Total Acreage	10,444.3	

Table 3-37. Streams without 30 meter riparian buffer within HUC 051201040301 (Black Lake-Spring Creek)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
15.4	25.7	60%

Table 3-38. Confined animal feeding operations located within HUC 051201040301 (Black Lake-Spring Creek)

CFO ID	Name	Program	Sub-Program
4748	Cormany Farms	CF	CFOG

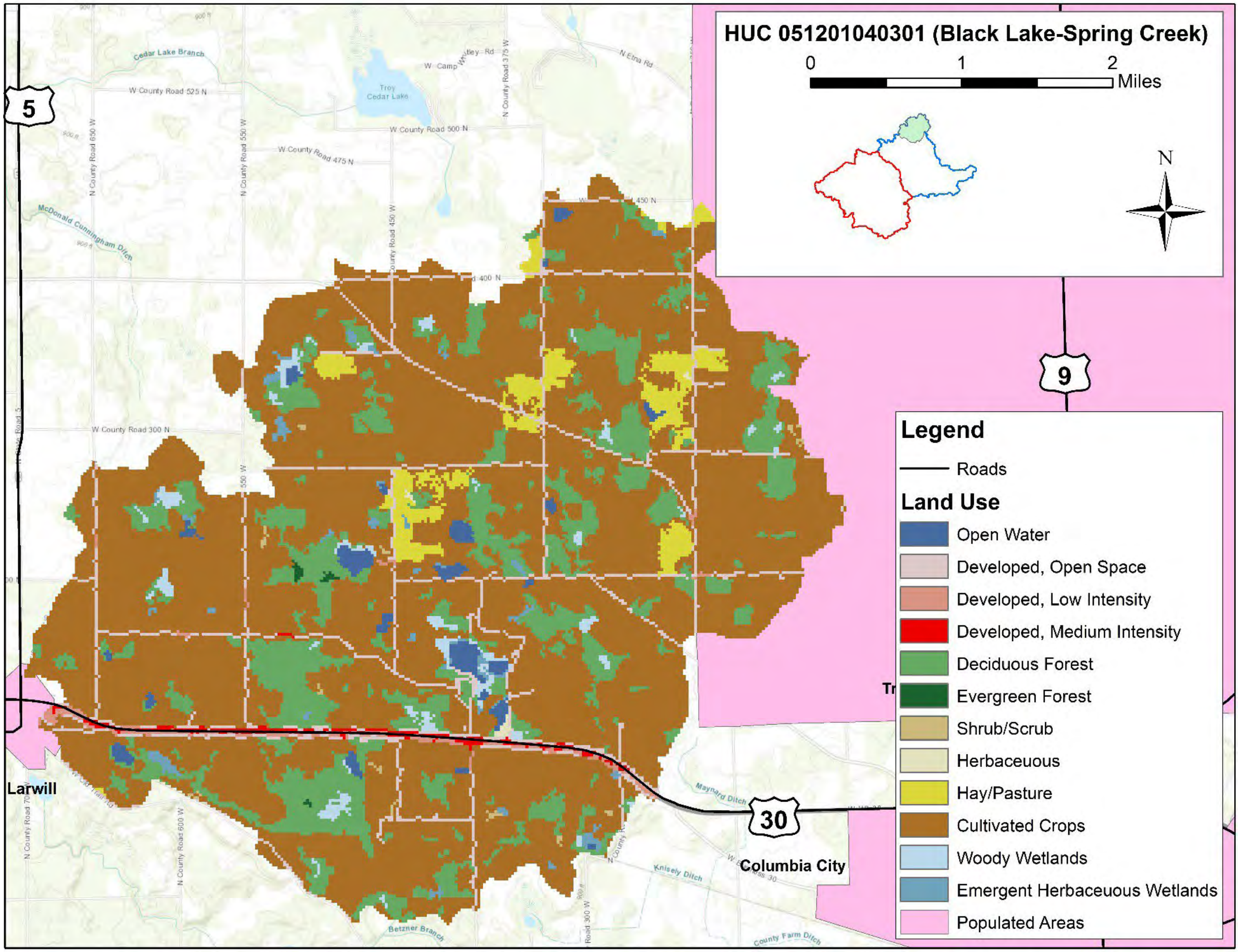

Figure 3-13. Land use within HUC 051201040301 (Black Lake-Spring Creek)

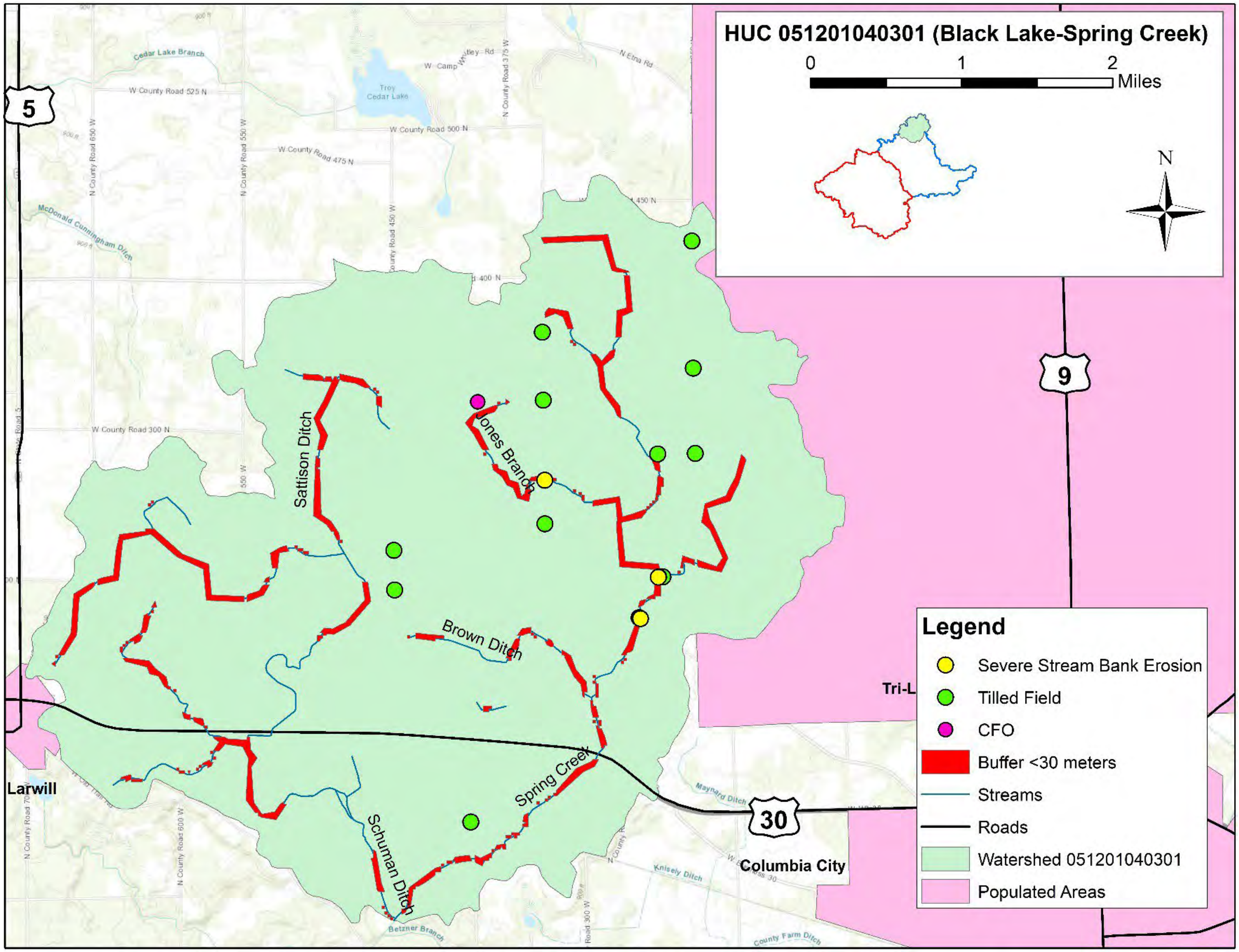

Figure 3-14. Potential pollution sources within HUC 051201040301 (Black Lake-Spring Creek)

3.3.2 Land Use 051201040302 (Shoenauer Ditch-Spring Creek)

The primary land use in HUC 051201040302 (Shoenauer Ditch-Spring Creek) is agriculture with 76% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-39 shows the quantity and percentage of each land use within HUC 051201040302 (Shoenauer Ditch-Spring Creek) and Figure 3-15 spatially represented the land use across the watershed. Of the 76% agriculture land use, 71% is strictly considered cultivated crops. HUC 051201040302 (Shoenauer Ditch-Spring Creek) is tied for the largest percentage of forest with 16% of the land use being classified as forest. Only 5% of the land use is developed, with all 5% being classified as developed open space with <0.5% highly developed areas within the watershed.

The windshield survey was conducted 8th December 2017 for HUC 051201040302 (Shoenauer Ditch-Spring Creek). During the survey, 7 fields were documented to have recently practiced conventional fall tillage. No-till farming practices were documented on 5 fields within the watershed with all of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was documented at 1 of the 22 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 22 stream crossings analyzed, 16 were documented in having moderate or severe stream bank erosion. Many of these locations were coupled with extensive stream modification, such as channelization, riparian buffer removal, etc. The windshield survey only documented 3 of the 22 stream crossing as having visible drainage tile present. Even though few drainage tile were documented, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW.

The windshield survey verified the lack of riparian buffers within the watershed. There are 43.5 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 24.2 stream miles or 56% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones.

There are two Confined Feeding Operation located in the watershed. With only two facilities, there is a low density with only 0.07 CFO per square mile of watershed area. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. Table 3-41 defines the CFO located within the watershed. There is one underground storage located within the watershed. If the contents held in the underground storage tank leak it could leach through the soil and reach groundwater contaminating drinking water wells of local residents, or leach into surface waters and decrease water quality and affect aquatic life. This storage tank is classified as leaking or has leaked in the past. Table 3-42 describes the underground storage tank. There are no NPDES permitted facilities, LUST, Brownfield, SSO, CSO located within HUC 051201040302 (Shoenauer Ditch-Spring Creek).

Table 3-39. Land use statistics for HUC 051201040302 (Shoenauer Ditch-Spring Creek)

	Acreages	**Percentage of watershed**
Open Water	169.7	1%
Developed, Open Space	953.4	5%
Developed, Low Intensity	41.6	<0.5%
Developed, Medium Intensity	2.0	<0.5%
Developed, High Intensity	1.1	<0.5%
Deciduous Forest	2,813.1	16%
Evergreen Forest	4.0	<0.5%
Shrub/Scrub	6.7	<0.5%
Herbaceous	30.0	<0.5%
Hay/Pasture	942.1	5%
Cultivated Crops	12,834.9	71%
Woody Wetlands	137.0	1%
Emergent Herbaceous Wetlands	143.9	1%
Total Acreage	18,079.4	1%

Table 3-40. Stream without 30 meter riparian buffer within HUC 051201040302 (Shoenauer Ditch-Spring Creek)

Stream with <30 meter Buffer (mi)	**Total Steam (mi)**	**% of Streams that have <30 meter buffer**
24.2	43.5	56%

Table 3-41. Confined animal feeding operations located within HUC 051201040302 (Shoenauer Ditch-Spring Creek)

CFO ID	Name	Program	Sub-Program
4784	Richard Hoffman/ Hoffman Farms	CF	CFOG
3650	Mayflower Farms	CF	CFOG

Table 3-42. Leaking underground storage tanks within HUC 051201040302 (Shoenauer Ditch-Spring Creek)

UST Facility ID	Incident Number	Facility Name	Address	County	Priority	Deposition
20142	199002034	WJ Carey Construction Company	7004 W 350 S South Whitley Indiana46787	Whitley	Low	Complaint

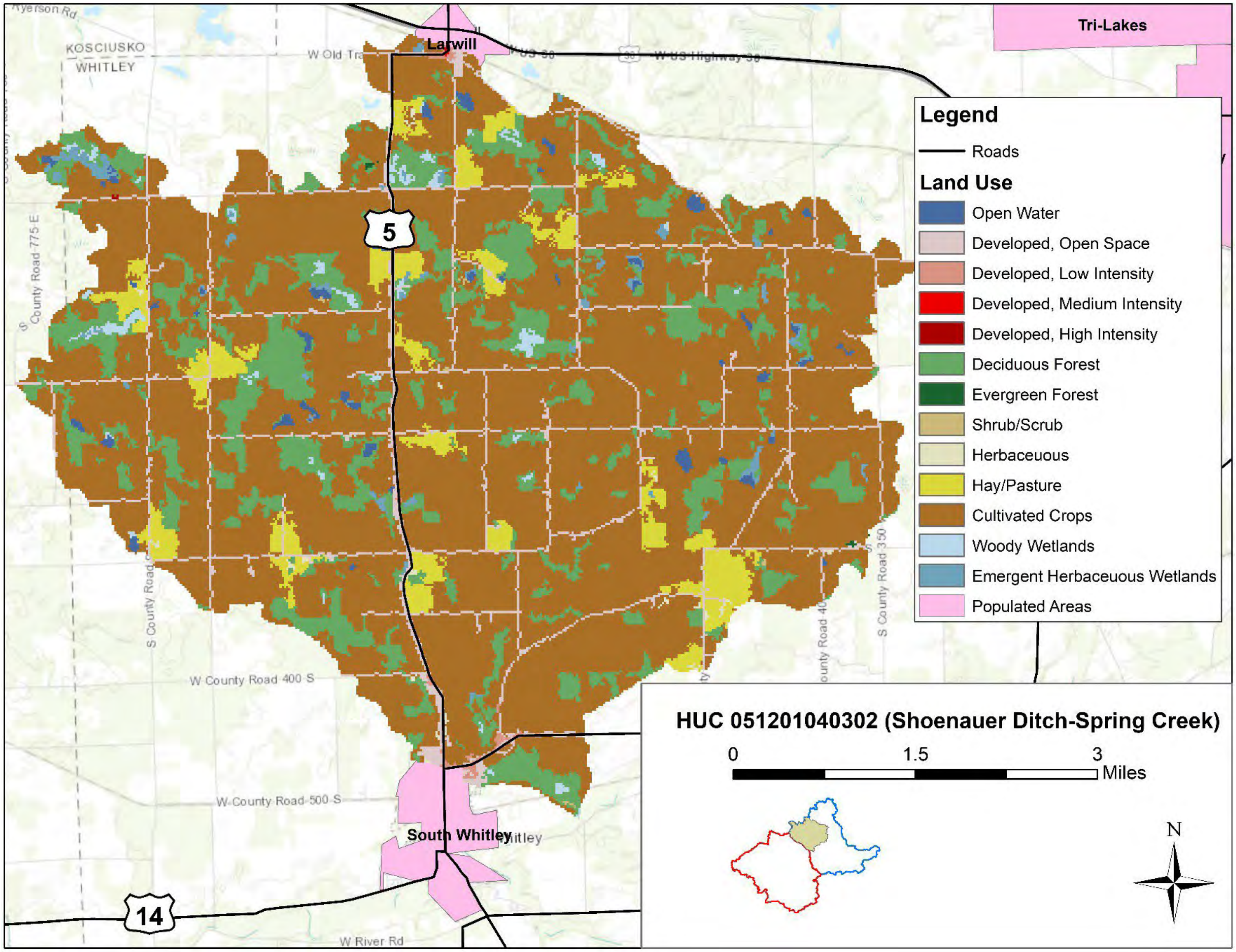

Figure 3-15. Land use within HUC 051201040302 (Shoenauer Ditch-Spring Creek)

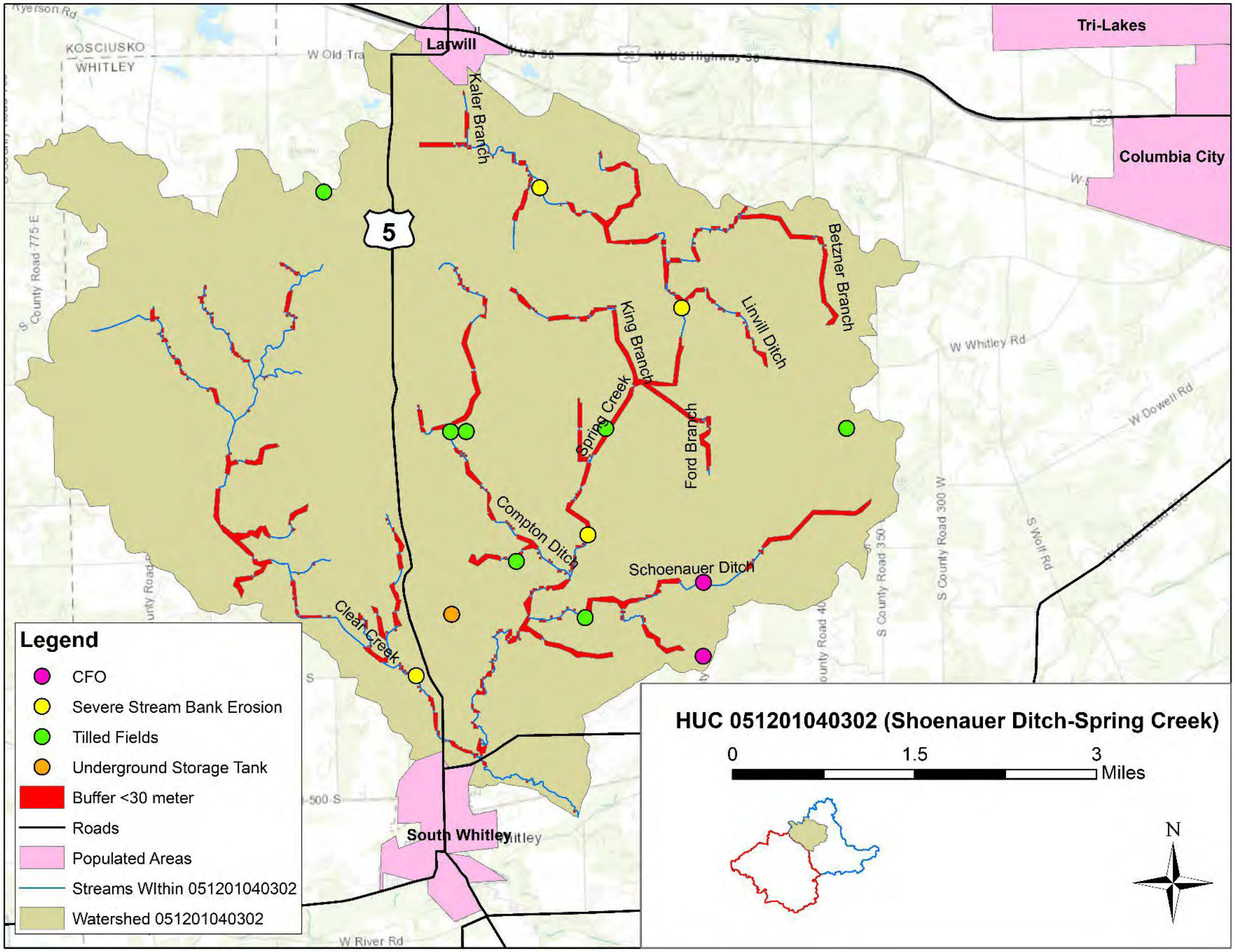

Figure 3-16. Potential pollutant sources within HUC 051201040302 (Shoenauer Ditch-Spring Creek)

3.3.3 Land Use 051201040303 (Headwaters Sugar Creek)

The primary land use in HUC 051201040303 (Headwaters Sugar Creek) is agriculture with 88% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-43 shows the quantity and percentage of each land use within HUC 051201040303 (Headwaters Sugar Creek) and Figure 3-17 spatially represented the land use across the watershed. Of the 88% agriculture land use, 88% is strictly considered cultivated crops. HUC 051201040303 (Headwaters Sugar Creek) is tied for the smallest percentage of forest with 5% of the land use being classified as forest. Only 5% of the land use is developed, with all 5% being classified as developed open space with no highly developed areas within the watershed.

The windshield survey was conducted 8th December 2017 for HUC 051201040303 (Headwaters Sugar Creek). During the survey, 46 of the 58 fields were documented to have recently practiced conventional fall tillage. With another 5 fields that had been plowed. No-till farming practices were documented on 7 fields within the watershed with all of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was not documented at any of the 19 streams crossings analyzed. One stream crossing was inside an animal pasture. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 19 stream crossings analyzed, 15 were documented in having moderate or severe stream bank erosion. Many of these locations were coupled with extensive stream modification, such as channelization, riparian buffer removal, etc. The windshield survey documented 15 of the 19 stream crossing as having visible drainage tile present. These drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW.

The windshield survey verified the lack of riparian buffers within the watershed. There are 30.1 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 24.2 stream miles or 80% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones.

There are two Confined Feeding Operation located in the watershed. With two facilities, there is a low density with only 0.10 CFO per square mile of watershed area. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There are two underground storage located within the watershed. If the contents held in the underground storage tank leak it could leach through the soil and reach groundwater contaminating drinking water wells of local residents, or leach into surface waters and decrease water quality and affect aquatic life. One of the storage tanks is classified as leaking or has leaked in the past. Table 3-46 describes the leaking underground storage tank. There is one NPDES Facility and one NPDES Pipe located within the watershed. The NPDES facility has been terminated. Whereas the NPDES pipe is still active and operated by the South Whitley wastewater treatment plant. There are no Brownfield, SSO, CSO located within HUC 051201040303 (Headwaters Sugar Creek).

Table 3-43. Land use statistics within HUC 051201040303 (Headwaters Sugar Creek)

	Acreages	Percentage of watershed
Open Water	11.1	<0.5%
Developed, Open Space	1,033.9	5%
Developed, Low Intensity	75.4	<0.5%
Developed, Medium Intensity	13.8	<0.5%
Developed, High Intensity	-	-
Deciduous Forest	991.4	5%
Evergreen Forest	-	-
Shrub/Scrub	92.1	<0.5%
Herbaceous	133.9	1%
Hay/Pasture	254.4	1%
Cultivated Crops	17,156.7	87%
Woody Wetlands	2.9	<0.5%
Emergent Herbaceous Wetlands	6.9	<0.5%
Total Acreage	19,772.5	

Table 3-44. Stream without a 30 meter riparian buffer within HUC 051201040303 (Headwaters Sugar Creek)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
24.2	30.1	80%

Table 3-45. Confined animal feeding operations within HUC 051201040303 (Headwaters Sugar Creek)

CFO ID	Name	Program	Sub-Program
3076	Dennis Easterday	CF	CFOG
3604	George Frazier	CF	CFOG
5010	Daniel Michel	CF	CFOG

Table 3-46. Leaking underground storage tank within HUC 051201040303 (Headwaters Sugar Creek)

UST Facility ID	Incident Number	Facility Name	Address	County	Priority	Deposition
18413	199311558	Washing Jefferson Ctr Sch	7961 Washington Center Road Columbia City Indiana	Whitley	Low	NFA-Unconditional

Table 3-47. NPDES facilities located within HUC 051201040303 (Headwaters Sugar Creek)

NPDES Facility ID	Facility Name	Address	County	Expiration Date	Outfall Stream
IN0031445	Washing Center School Wastewater Treatment Plant	7961 Washington Center Road Columbia City Indiana	Whitley	5/31/2010	Unnamed Ditch to Sugar Creek

Table 3-48. NPDES pipe outfalls located within HUC 051201040303 (Headwaters Sugar Creek)

NPDES Pipe ID	Facility Name	County	Status	Outfall Stream
IN0020567	South Whitley Wastewater Treatment Plant	Whitley	Active	Eel River

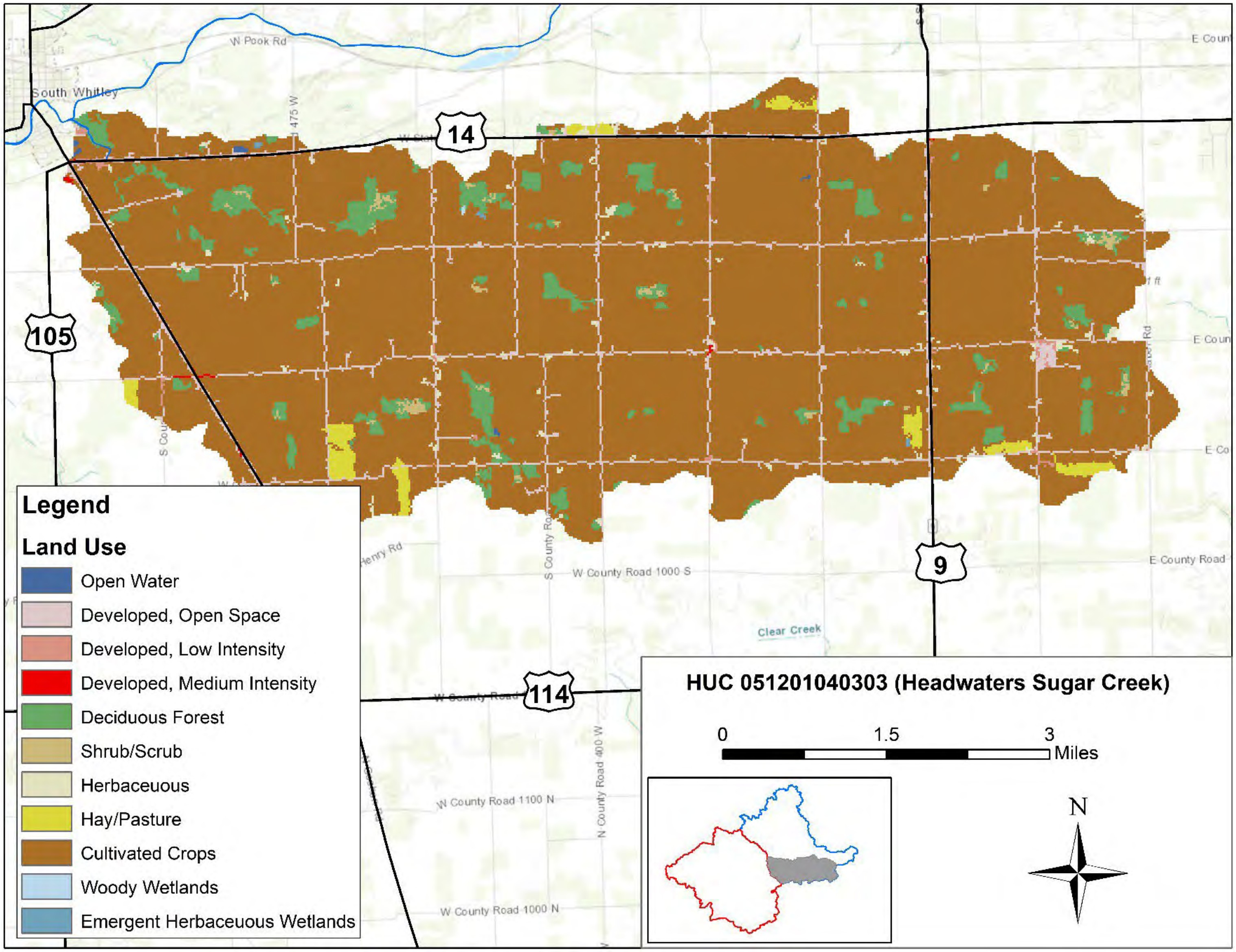

Figure 3-17. Land use within HUC 051201040303 (Headwaters Sugar Creek)

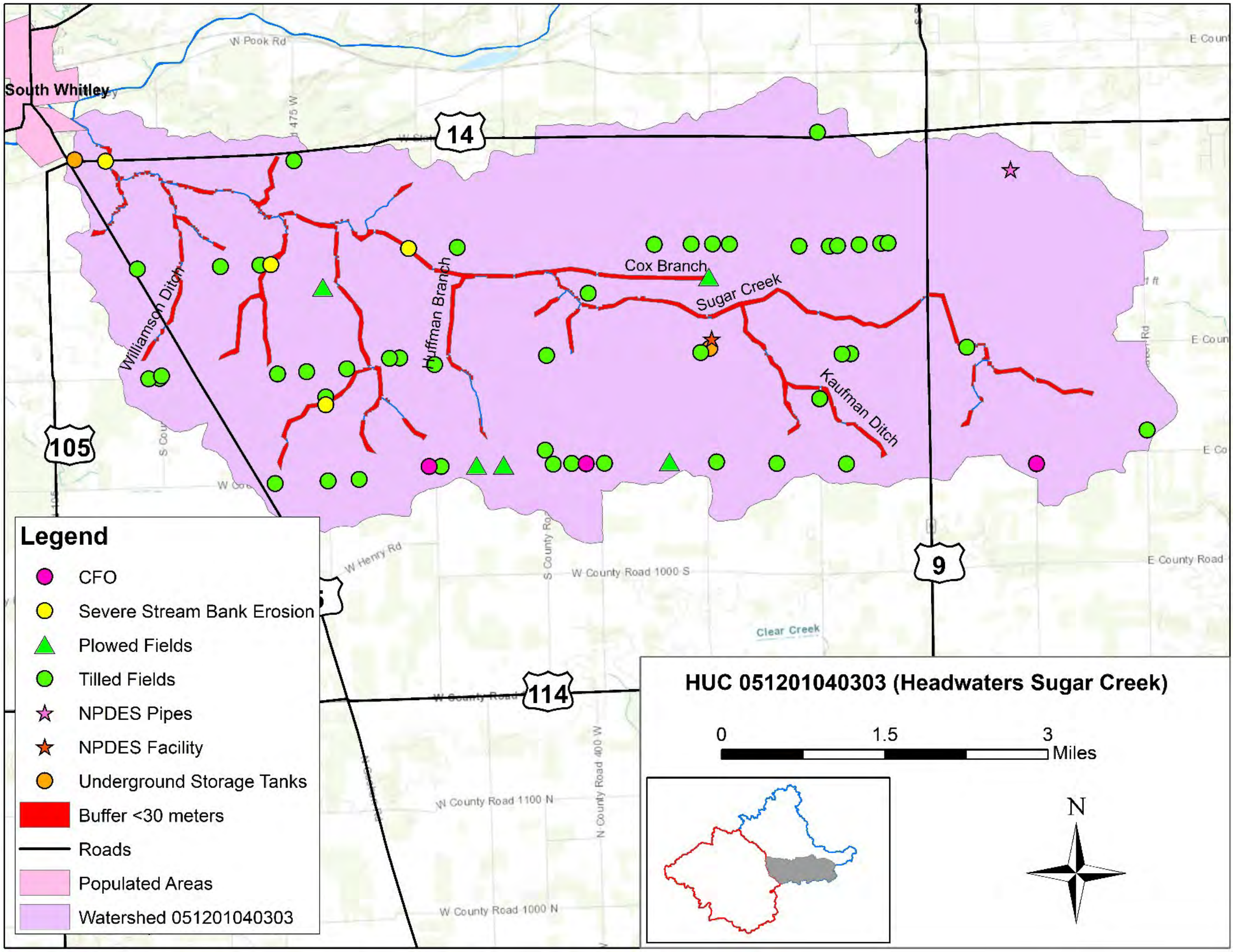

Figure 3-18. Potential pollutant sources within HUC 051201040303 (Headwaters Sugar Creek)

3.3.4 Land Use 051201040304 (County Farm Ditch)

The primary land use in HUC 051201040304 (County Farm Ditch) is agriculture with 81% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-49 shows the quantity and percentage of each land use within HUC 051201040304 (County Farm Ditch) and Figure 3-19 spatially represented the land use across the watershed. Of the 81% agriculture land use, 79% is strictly considered cultivated crops. HUC 051201040304 (County Farm Ditch) has 5% of the land use being classified as forest. Only 6% of the land use is developed, with all 5% being classified as developed open space with less than 0.5% of the watershed being considered highly developed areas.

The windshield survey was conducted 10th November, 27th November, and 8th December 2017 for HUC 051201040304 (County Farm Ditch). During the survey, 20 of the 32 fields were documented to have recently practiced conventional fall tillage. No-till farming practices were documented on 12 fields within the watershed with all of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was documented at one of the 22 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 22 stream crossings analyzed, 21 were documented in having moderate or severe stream bank erosion. Many of these locations were coupled with extensive stream modification, such as channelization, riparian buffer removal, etc. The windshield survey documented 12 of the 22 stream crossing as having visible drainage tile present. These drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW.

The windshield survey verified the lack of riparian buffers within the watershed. There are 44.4 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 29.8 stream miles or 67% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones.

There are eight Confined Feeding Operation located in the watershed. With eight facilities, the density with of CFO within the watersheds is 0.23 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There are three underground storage located within the watershed. If the contents held in the underground storage tank leak it could leach through the soil and reach groundwater contaminating drinking water wells of local residents, or leach into surface waters and decrease water quality and affect aquatic life. One of the storage tanks is classified as leaking or has leaked in the past. Table 3-52 describes the leaking underground storage tank. Note that there at two incident numbers. Each number relates to separate leaking events at that location. There are two NPDES facility and one NPDES pipe located within the watershed. One of the NPDES facility has been terminated, whereas the other facility is still currently effective. The NPDES pipe is still active and operated by the speedway sand and gravel incorporated. There are no Brownfield, SSO, CSO located within HUC 051201040304 (County Farm Ditch).

Table 3-49. Land use statistics within HUC 051201040304 (County Farm Ditch)

	Acreages	Percentage of watershed
Open Water	113.0	1%
Developed, Open Space	1,129.1	5%
Developed, Low Intensity	143.9	1%
Developed, Medium Intensity	37.4	<0.5%
Developed, High Intensity	2.2	<0.5%
Deciduous Forest	2,298.9	10%
Evergreen Forest	4.0	<0.5%
Shrub/Scrub	46.7	<0.5%
Herbaceous	169.9	1%
Hay/Pasture	523.5	2%
Cultivated Crops	17,642.2	79%
Woody Wetlands	96.3	<0.5%
Emergent Herbaceous Wetlands	77.4	<0.5%
Total Acreage	22,284.4	

Table 3-50. Stream without a 30 meter riparian buffer within HUC 051201040304 (County Farm Ditch)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
29.8	44.4	67%

Table 3-51. Confined animal feeding operations within HUC 051201040304 (County Farm Ditch)

CFO ID	Name	Program	Sub-Program
4313	Jeffery Sickafoose	CF	CFOG
667	Jeffery Sickafoose	CF	CFOG
6113	Strauss Veal	CF	CFOG
462	Harold Copp Copps Cow Palace	CF	CFOG
722	Myers Farms	CF	CFOG
2659	Hoffman Farms 2	CF	CFOG
800	Charles Oliver	CF	CFOG
3655	Hoffman Farms 1	CF	CFOG

Table 3-52. Leaking underground storage tank within HUC 051201040304 (County Farm Ditch)

UST Facility ID	Incident Number	Facility Name	Address	County	Priority	Deposition
13952	199008624	Whitko Bus Garage	606 E Front Street South Whitley Indiana 46787	Whitley	Low	NFA-Unconditional
	199101511					

Table 3-53. NPDES facilities located within HUC 051201040304 (County Farm Ditch)

NPDES Facility ID	Facility Name	Address	County	Expiration Date	Outfall Stream
IN0043982	Gateway Park Owners Association	PO Box 208 Columbia City Indiana 46725	Whitley	6/30/1986	Eel River
ING490104	Speedway Sand and Gravel Incorporated	4875 S 275 W Columbia City Indiana 46725	Whitley	10/31/2011	Eel River

Table 3-54. NPDES pipe outfalls located within HUC 051201040304 (County Farm Ditch)

NPDES Pipe ID	Facility Name	County	Status	Outfall Stream
ING490104	Speedway Sand and Gravel Incorporated	Whitley	Active	Eel River

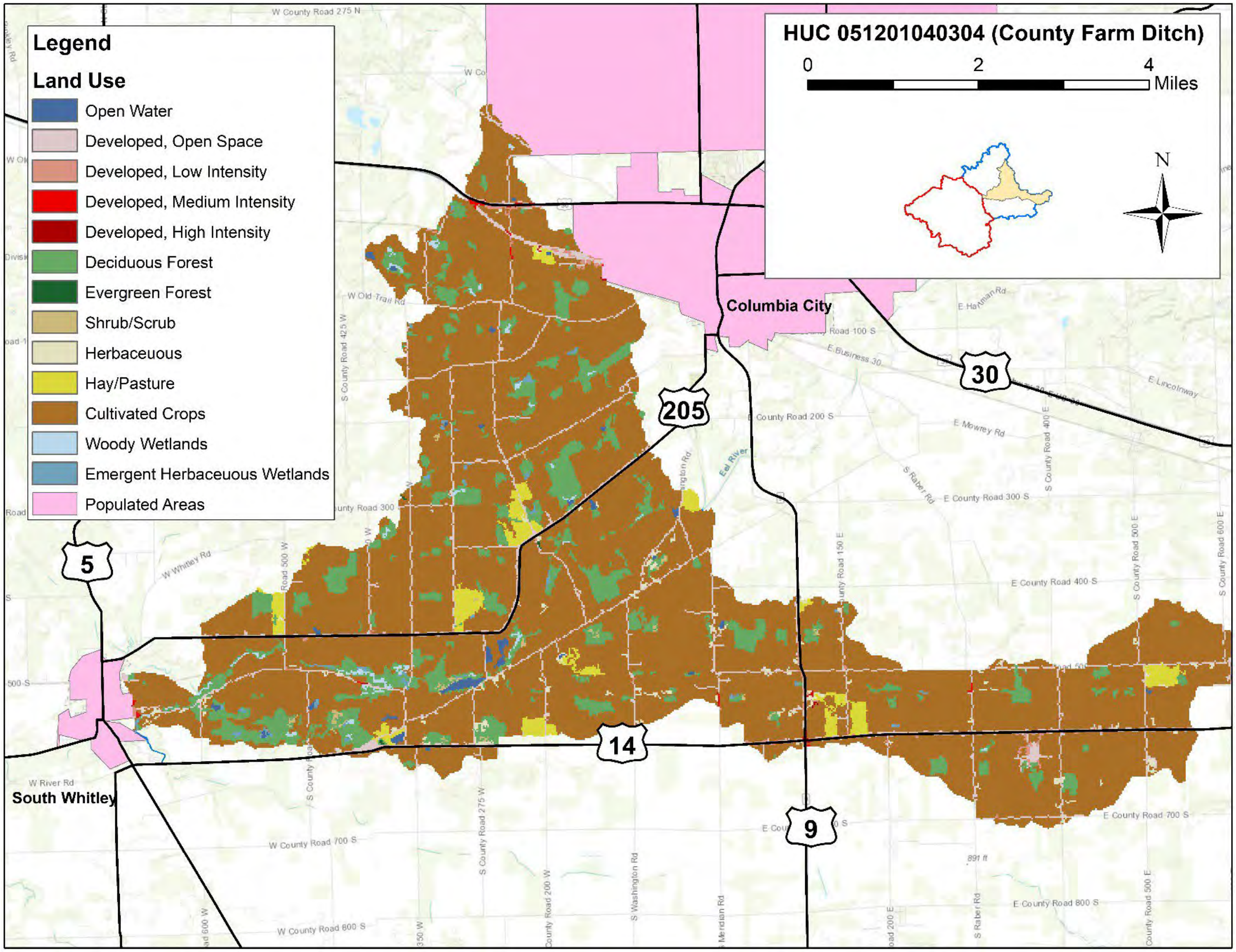

Figure 3-19. Land use within HUC 051201040304 (County Farm Ditch)

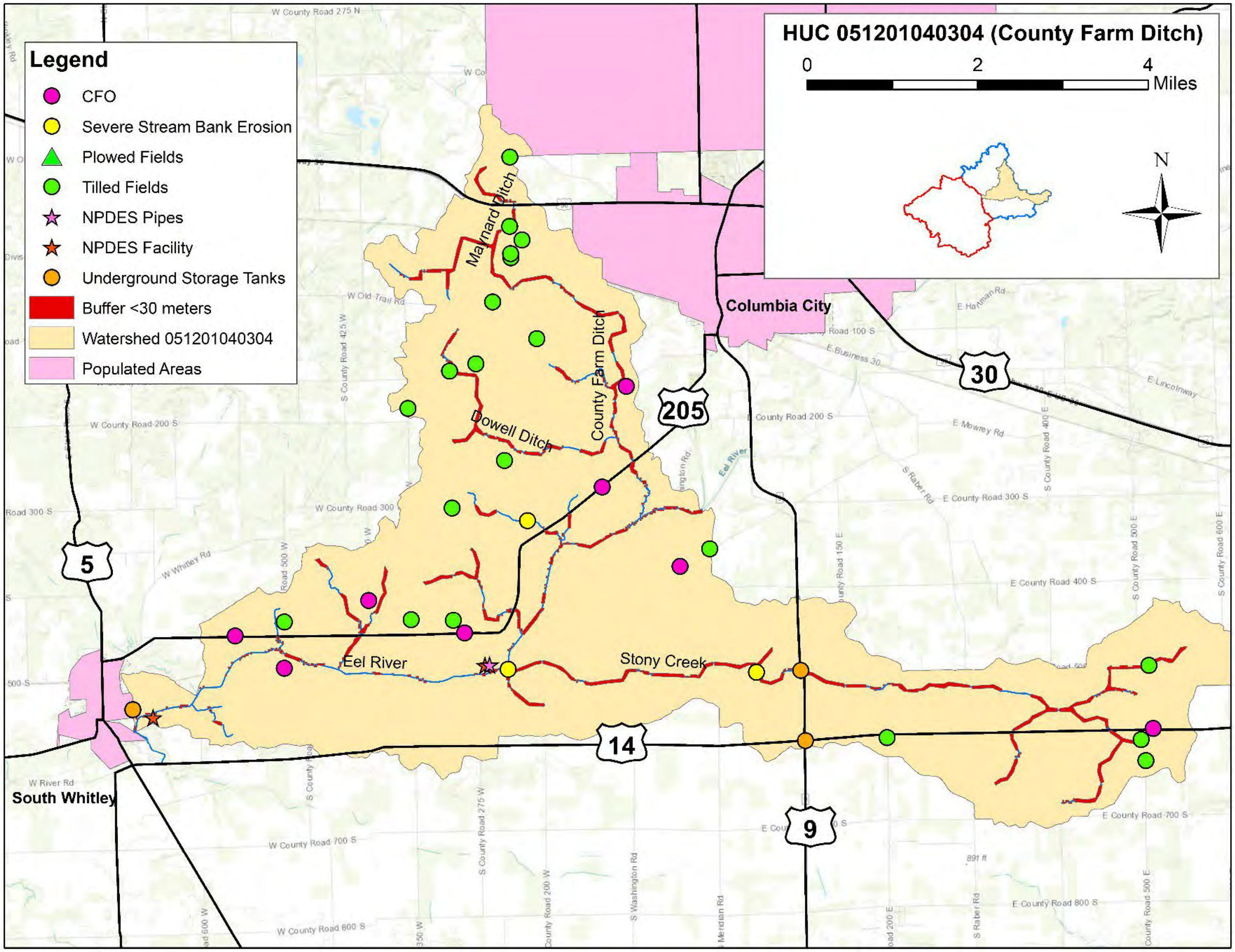

Figure 3-20. Potential pollutant Sources within HUC 051201040304 (County Farm Ditch)

3.3.5 Land Use 051201040401 (Mishler Ditch)

The primary land use in HUC 051201040401 (Mishler Ditch) is agriculture with 78% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-55 shows the quantity and percentage of each land use within HUC 051201040401 (Mishler Ditch) and Figure 3-21 spatially represented the land use across the watershed. Of the 78% agriculture land use, 75% is strictly considered cultivated crops. HUC 051201040401 (Mishler Ditch) has 12% of the land use being classified as forest. Only 8% of the land use is developed, with 6% being classified as developed open space with less than 0.5% of the watershed being considered highly developed areas. While it is not represented by the land use statistics, the windshield noted many unique characteristics throughout the watershed. It was noted that nearly half the fields within the watershed had recently been converted to seasonal grasses instead of intensive row crop agriculture. More windshield survey results are below

The windshield survey was conducted 4th December 2017 for HUC 051201040401 (Mishler Ditch). During the survey, 3 of the 5 fields were documented to have recently practiced conventional fall tillage. No-till farming practices were documented on 2 fields within the watershed with both of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. As noted earlier many of the fields had been converted to seasonal grasses and were not considered agriculture fields. Trash dumped into the stream was not documented at any streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 7 stream crossings analyzed, only 3 were documented in having moderate or severe stream bank erosion. The remaining sites only had slight streambank erosion. Only one site showed signs of recent channel modification and it corresponded with the one site that showed severe stream bank erosion. The remaining sites showed signs of past channel modification and minimal streambank erosion. Over time, the stream has altered the channel geometry and it has become more stable. This is due to lower sloped channel walls, which reduces shear velocity, which is the leading cause of streambank erosion. The windshield survey documented none of the 7 stream crossing as having visible drainage tile present. While it is anticipated that nearly all fields within the watershed use drainage tile due to low landscape gradient. It is unclear how active tiles located in fields converted to seasonal grass are and what concentration of nutrients are present within the discharge.

The windshield survey and desktop survey did not accurately correspond in regards to the riparian buffers within the watershed. The desktop survey using land use statistics documented that there are 27.8 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 13.6 stream miles or 49% of the total stream miles. This is the second lowest lack of riparian buffer within the UMERW. Verification by the windshield survey was to some extent successful. Only one of the stream crossing analyzed documented farming practices being directly adjacent to the stream. All other stream crossing analyzed documented >10 meters of riparian buffer comprised of forest or grasslands.

There are three Confined Feeding Operation located in the watershed. With three facilities, the density with of CFO within the watersheds is 0.15 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There are ten underground storage located within the watershed. If the contents held in the underground storage tank leak it could leach through the soil and reach groundwater contaminating drinking water wells of local residents, or leach into surface waters and decrease water quality and affect aquatic life. Six of the storage tanks are classified as leaking or has leaked in the past. Table 3-58 describes the leaking underground storage tank. Note that there at two incident numbers for one underground storage tank. Each number relates to separate leaking event at that location. There is one NPDES facility and four NPDES pipe located within the watershed. The NPDES facility is still currently effective and is the South Whitley wastewater treatment plant. There are four combined sewer overflows within the watershed. All the CSO's are operated by South Whitley wastewater treatment plant. Two of the CSO are currently active and release untreated or partially untreated wastewater directly into the Eel River when influent exceeds plant capacity. There are no Brownfield or SSO located within HUC 051201040401 (Mishler Ditch).

Table 3-55. Land use statistics within HUC 051201040401 (Mishler Ditch)

	Acreages	Percentage of watershed
Open Water	113.0	1%
Developed, Open Space	1,129.1	5%
Developed, Low Intensity	143.9	1%
Developed, Medium Intensity	37.4	<0.5%
Developed, High Intensity	2.2	<0.5%
Deciduous Forest	2,298.9	10%
Evergreen Forest	4.0	<0.5%
Shrub/Scrub	46.7	<0.5%
Herbaceous	169.9	1%
Hay/Pasture	523.5	2%
Cultivated Crops	17,642.2	79%
Woody Wetlands	96.3	<0.5%
Emergent Herbaceous Wetlands	77.4	<0.5%
Total Acreage	22,284.4	

Table 3-56. Stream without a 30 meter riparian buffer within HUC 051201040401 (Mishler Ditch)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer

13.6	27.8	49%

Table 3-57. Confined animal feeding operations within HUC 051201040401 (Mishler Ditch)

CFO ID	Name	Program	Sub-Program
4671	JOHN H DOME	CF	CFOG
256	BILL PATRICK	CF	CFOG
4261	DAYNE E WILKINSON	CF	CFOG

Table 3-58. Leaking underground storage tank within HUC 051201040401 (Mishler Ditch)

UST Facility ID	Incident Number	Facility Name	Address	County	Priority	Deposition
7989	199008601	Rudd's Friendly Service	117 North State Steet South Whitley Indiana 46787	Whitley	Low	NFA-Unconditional Closure
9365	199703151	Whitley Trailer Court & Sales	702 South State Street South Whitley Indiana 46787	Whitley	High	NFA-Unconditional Closure
10503	198911514	Whitley Manufacturing Co Inc	108 West 1st Street South Whitley Indiana 46787	Whitley	Medium	NFA-Unconditional Closure
	199305513					Active
13848	199008624	D & C Construction Co Inc	7210 W River Road South Whitley Indiana 46787	Whitley	Low	NFA-Unconditional Closure
19158	199411513	Seamco	503 East Broad Street South Whitley Indiana 46787	Whitley	Low	NFA-Unconditional Closure
22934	199903573	Johnson Bros Signs	307 South State Street South Whitley Indiana 46787	Whitley	Low	NFA-Conditional Closure

Table 3-59. NPDES facilities located within HUC 051201040401 (Mishler Ditch)

NPDES Facility ID	Facility Name	Address	County	Expiration Date	Outfall Stream
IN0020567	South Whitley Wastewater Treatment Plant	600 South Main Street South Whitley Indiana 46787	Whitley	6/30/2013	Eel River

Table 3-60. NPDES pipe outfalls located within HUC 051201040401 (Mishler Ditch)

NPDES Pipe ID	Facility Name	County	Status	Outfall Stream
IN0062642	Town of Sidney	Kosciusko	Active	Unknown
IN0020567	South Whitley Wastewater Treatment Plant	Whitley	Active	Eel River
IN0020567	South Whitley Wastewater Treatment Plant	Whitley	Active	Eel River
IN0020567	South Whitley Wastewater Treatment Plant	Whitley	Active	Eel River

Table 3-61. Combined sewer overflows located within HUC 051201040401 (Mishler Ditch)

Interest ID	City	NPDES Number	CSO Number	Receiving Stream	Status	County	Wastewater Type
55320	City of South Whitley	IN0020567	004CP -- CSO - Partial Treatment - When influent exceeds plant capacity	Eel River	Active	Whitley	Treated CSO
55320	City of South Whitley	IN0020567	005C -- Lift Station at WWTP	Eel River	Active, Discharge Prohibited	Whitley	Untreated CSO
55320	City of South Whitley	IN0020567	002C -- CSO - Intersection of Wayne and State St - Inactive 07/01/13	Eel River	Inactive	Whitley	Untreated CSO
55320	City of South Whitley	IN0020567	003C -- CSO - 118 East Front Street - Inactive 07/01/13	Eel River	Inactive	Whitley	Untreated CSO

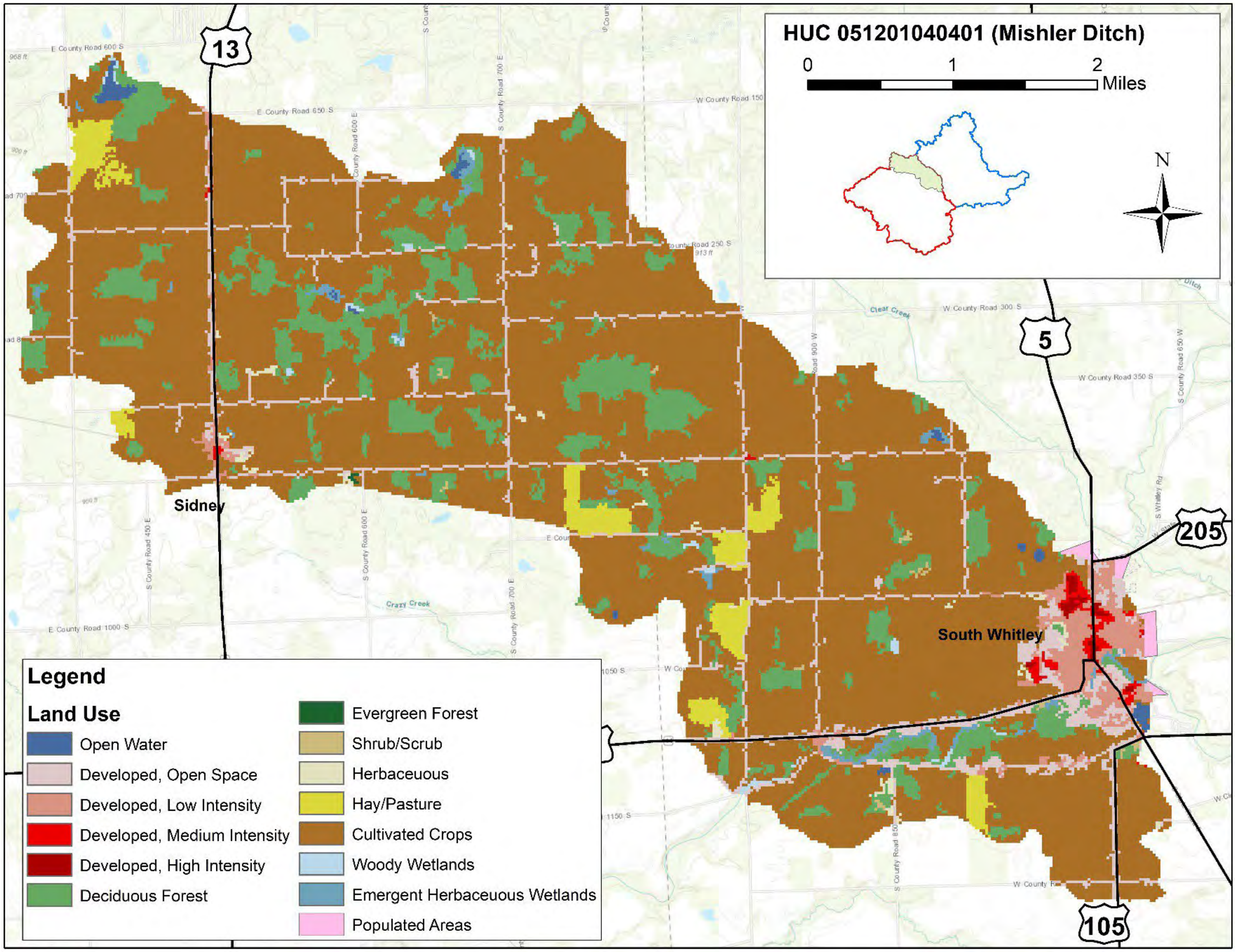

Figure 3-21. Land use within HUC 051201040401 (Mishler Ditch)

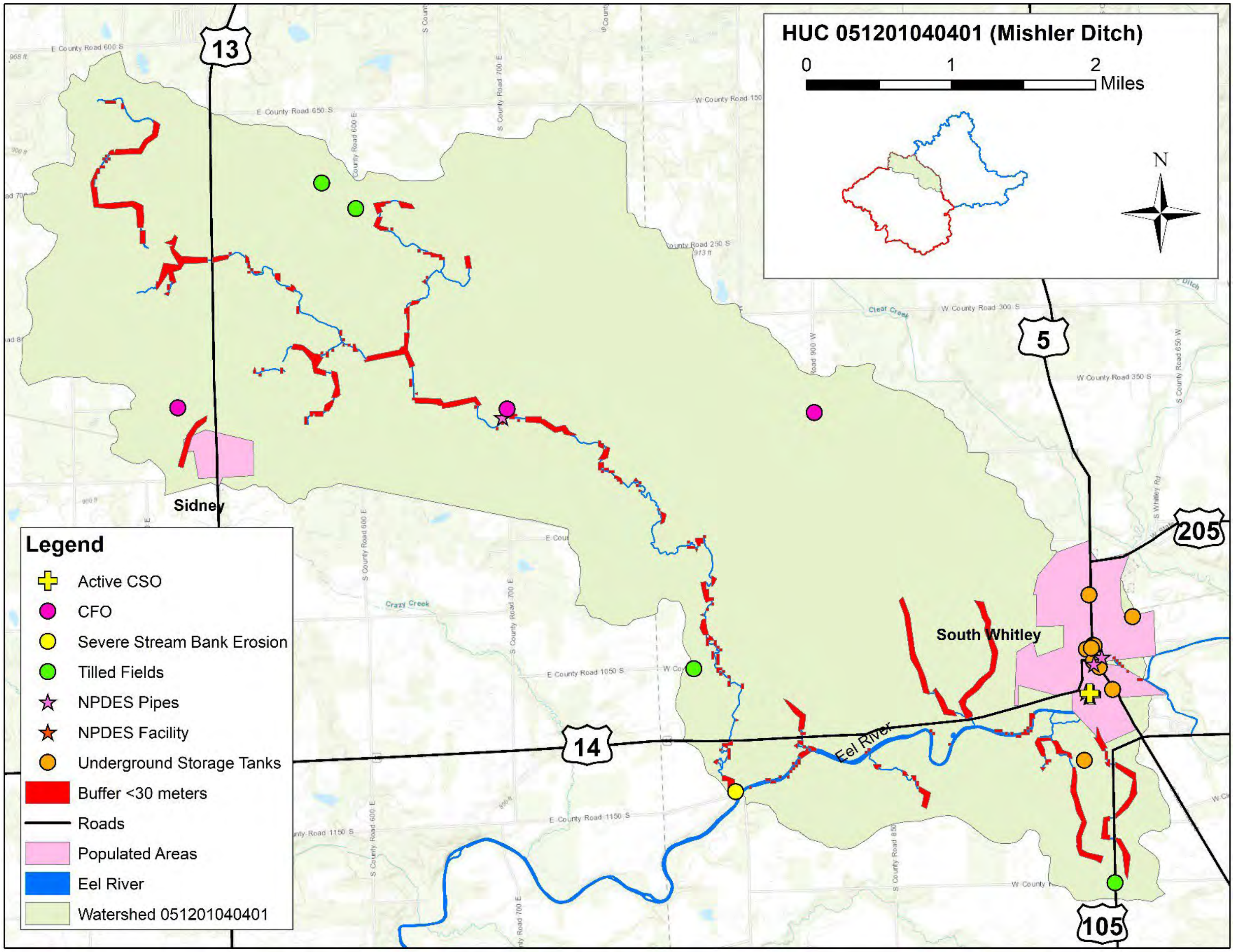

Figure 3-22. Potential pollutant sources within HUC 051201040401 (Mishler Ditch)

3.3.6 Land Use 051201040402 (Hurricane Creek-Eel River)

The primary land use in HUC 051201040202 (Hurricane Creek-Eel River) is agriculture with 86% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-62 shows the quantity and percentage of each land use within HUC 051201040202 (Hurricane Creek-Eel River) and Figure 3-23 spatially represented the land use across the watershed. Of the 86% agriculture land use, 84% is strictly considered cultivated crops. HUC 051201040202 (Hurricane Creek-Eel River) has 11% of the land use being classified as forest. Only 5% of the land use is developed, with all 5% being classified as developed open space with less none of the watershed being considered highly developed areas.

The windshield survey was conducted 10th November, 13th November, and 4th December 2017 for HUC 051201040202 (Hurricane Creek-Eel River). During the survey, 13 of the 15 fields were documented to have recently practiced conventional fall tillage, with 4 of those fields being plowed. No-till farming practices were documented on 2 fields within the watershed with one of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was documented at one of the 11 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 11 stream crossings analyzed, 10 were documented in having moderate or severe stream bank erosion. Many of these locations were coupled with extensive stream modification, such as channelization, riparian buffer removal, etc. The windshield survey documented only 1 of the 11 stream crossing as having visible drainage tile present. Drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW.

The windshield survey verified the lack of riparian buffers within the watershed. There are 30.4 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 17 stream miles or 56% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones.

There are seven Confined Feeding Operation located in the watershed. With seven facilities, the density with of CFO within the watersheds is relativity high compared to other sites with 0.39 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There are no Brownfield, SSO, LUST, NPDES Facilities, NPDES Pipes or CSO located within HUC 051201040202 (Hurricane Creek-Eel River).

Table 3-62. Land use statistics within HUC 051201040202 (Hurricane Creek-Eel River)

	Acreages	Percentage of watershed
Open Water	7.3	<0.5%
Developed, Open Space	466.1	4%
Developed, Low Intensity	19.1	<0.5%
Developed, Medium Intensity	1.1	<0.5%
Developed, High Intensity	-	-
Deciduous Forest	922.9	8%
Evergreen Forest	-	-
Shrub/Scrub	49.6	<0.5%
Herbaceous	68.5	1%
Hay/Pasture	233.5	2%
Cultivated Crops	9,513.8	84%
Woody Wetlands	44.5	<0.5%
Emergent Herbaceous Wetlands	35.4	<0.5%
Total Acreage	11,361.9	

Table 3-63. Stream without a 30 meter riparian buffer within HUC 051201040202 (Hurricane Creek-Eel River)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
17	30.4	56%

Table 3-64. Confined animal feeding operations within HUC 051201040202 (Hurricane Creek-Eel River)

CFO ID	Name	Program	Sub-Program
2797	Steven Sickfaoose	CF	CFOG
1953	Cory Sickafoose	CF	CFOG
4240	Allan Boocher	CF	CFOG
4173	Sonrise Pork LLC	CF	CFOG
1563	David Schwartz	CF	CFOG
4426	Dean Wendel	CF	CFOG
255	Joseph Auker	CF	CFOG

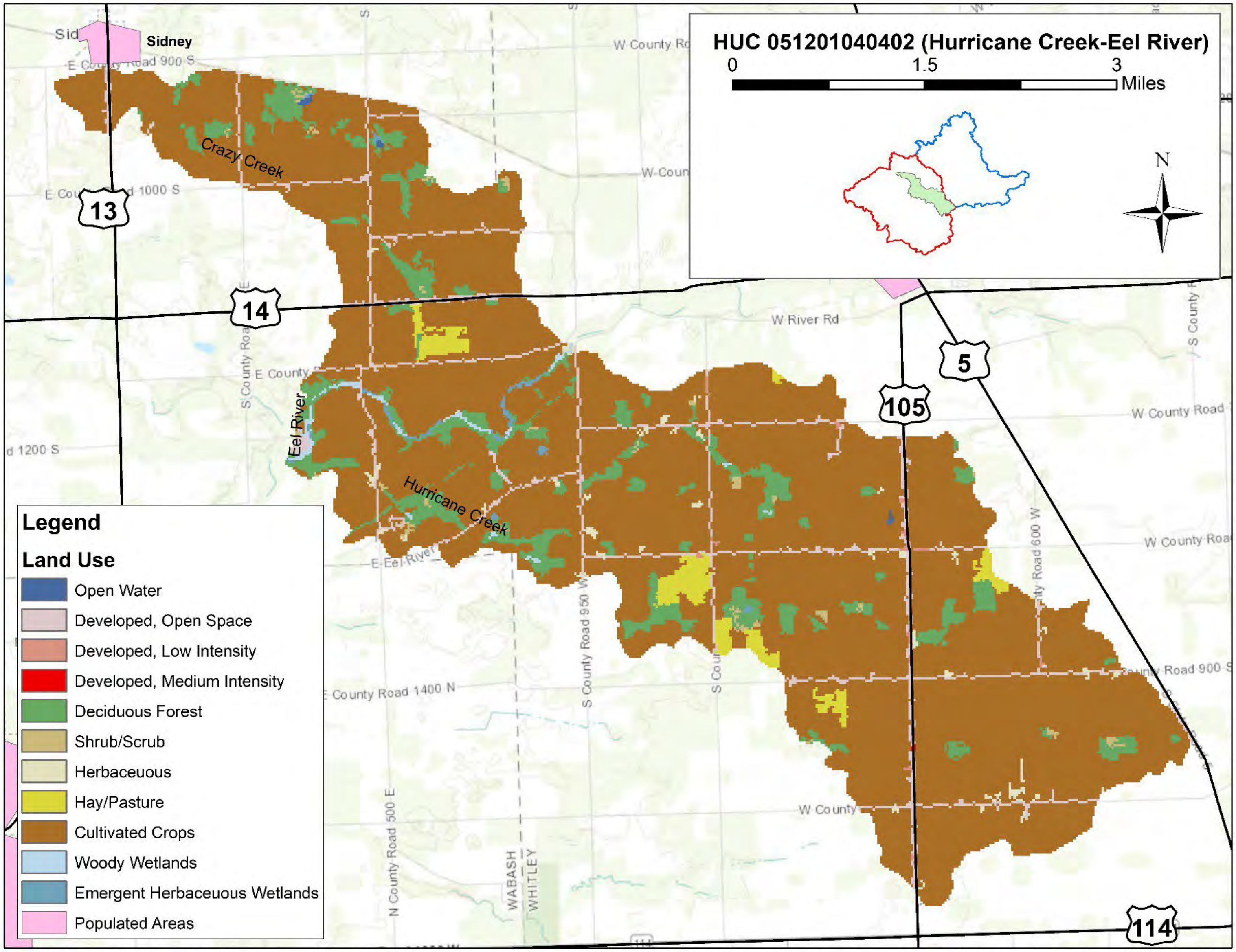

Figure 3-23. Land use within HUC 051201040202 (Hurricane Creek-Eel River)

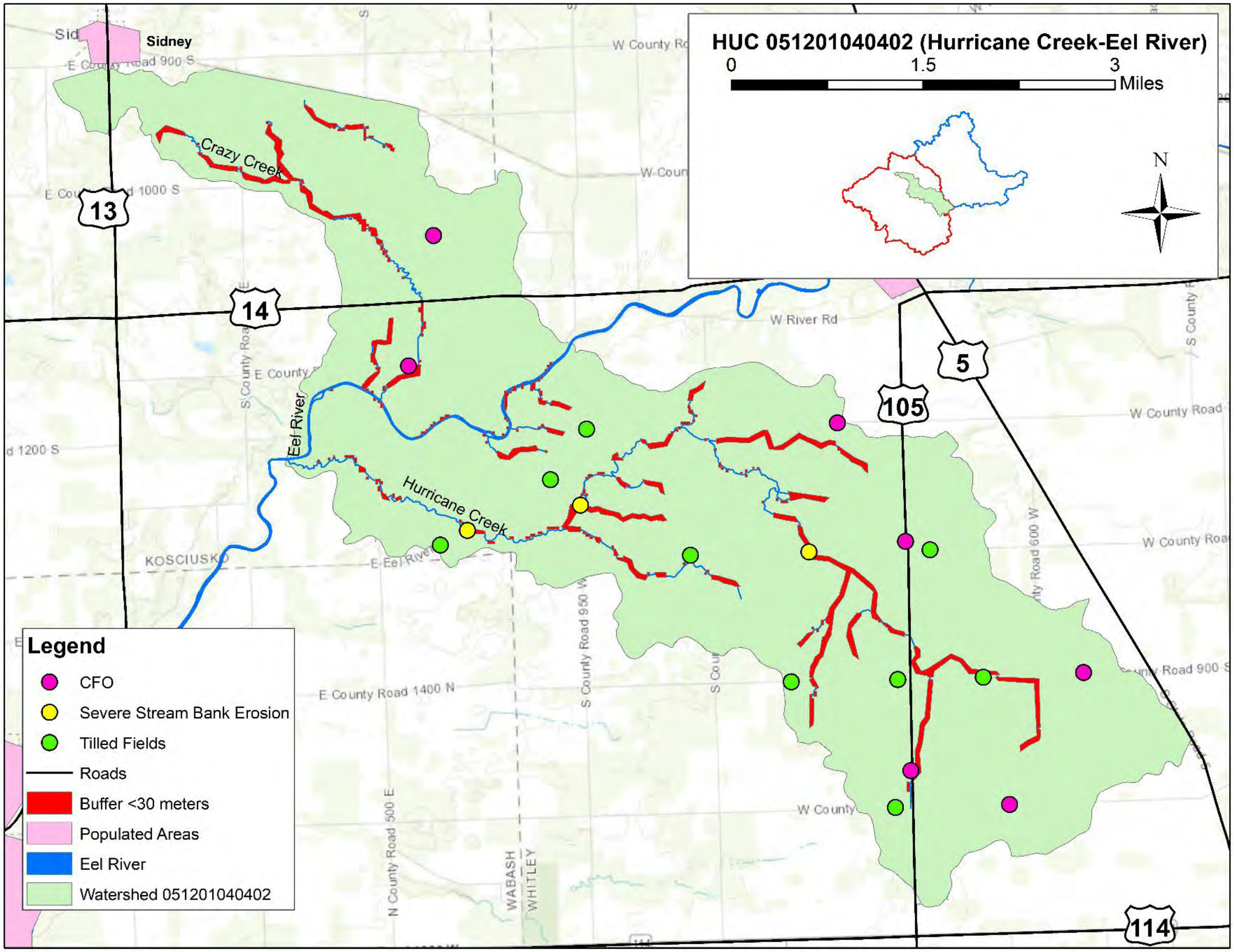

Figure 3-24. Potential pollutant sources within HUC 051201040202 (Hurricane Creek-Eel River)

3.3.7 Land Use 051201040403 (Plunge Creek-Eel River)

The primary land use in HUC 051201040403 (Plunge Creek-Eel River) is agriculture with 83% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-65 shows the quantity and percentage of each land use within HUC 051201040403 (Plunge Creek-Eel River) and Figure 3-25 spatially represented the land use across the watershed. Of the 83% agriculture land use, 79% is strictly considered cultivated crops. HUC 051201040403 (Plunge Creek-Eel River) has 11% of the land use being classified as forest. Only 5% of the land use is developed, with all 5% being classified as developed open space with no area of the watershed being considered highly developed.

The windshield survey was conducted 10th November, 13th November, 27th November and 4th December 2017 for HUC 051201040403 (Plunge Creek-Eel River). During the survey, 10 of the 13 fields were documented to have recently practiced conventional fall tillage. Two of the fields with fall tillage were plowed using a moldboard plow. No-till farming practices were documented on 3 fields within the watershed with all of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was documented at 2 of the 13 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 13 stream crossings analyzed, 6 were documented in having moderate or severe stream bank erosion. However, 10 of the 13 stream analyzed showed minimal signs of recent streambank modification. The remaining 3 stream crossings had recent modification and correspond with severe streambank erosion. While there is still extensive streambank erosion, most of the site have begun to alter the stream channel geometry and stabilize the banks. The windshield survey documented 2 of the 13 stream crossing as having visible drainage tile present. These drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW. Pasture animal access to the stream was documented at 5 of the stream crossings analyzed. Pasture runoff and direct contamination from pastured animals may be of concern within the watershed.

The windshield survey verified the lack of riparian buffers within the watershed. There are 33.9 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 17.9 stream miles or 53% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones. With animal pasture directly adjacent or crossing the stream in multiple locations.

There are three Confined Feeding Operation located in the watershed. With three facilities, the density with of CFO within the watersheds is 0.16 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There are no Brownfield, SSO, LUST, NPDES Facilities, NPDES Pipes or CSO located within HUC 051201040403 (Plunge Creek-Eel River).

Table 3-65. Land use statistics within HUC 051201040403 (Plunge Creek-Eel River)

	Acreages	Percentage of watershed
Open Water	9.3	<0.5%
Developed, Open Space	577.8	5%
Developed, Low Intensity	24.2	<0.5%
Developed, Medium Intensity	4.2	<0.5%
Developed, High Intensity	-	-
Deciduous Forest	1,292.6	11%
Evergreen Forest	3.3	<0.5%
Shrub/Scrub	34.9	<0.5%
Herbaceous	48.9	<0.5%
Hay/Pasture	453.0	4%
Cultivated Crops	9,429.1	79%
Woody Wetlands	25.6	<0.5%
Emergent Herbaceous Wetlands	22.0	<0.5%
Total Acreage	11,925.0	

Table 3-66. Stream without a 30 meter riparian buffer within HUC 051201040403 (Plunge Creek-Eel River)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
17.9	33.9	53%

Table 3-67. Confined animal feeding operations within HUC 051201040403 (Plunge Creek-Eel River)

CFO ID	Name	Program	Sub-Program
4759	Dale Sherwood	CF	CFOG
6152	Chris Schwartz	CF	CFOG
259	Chris Deneve	CF	CFOG

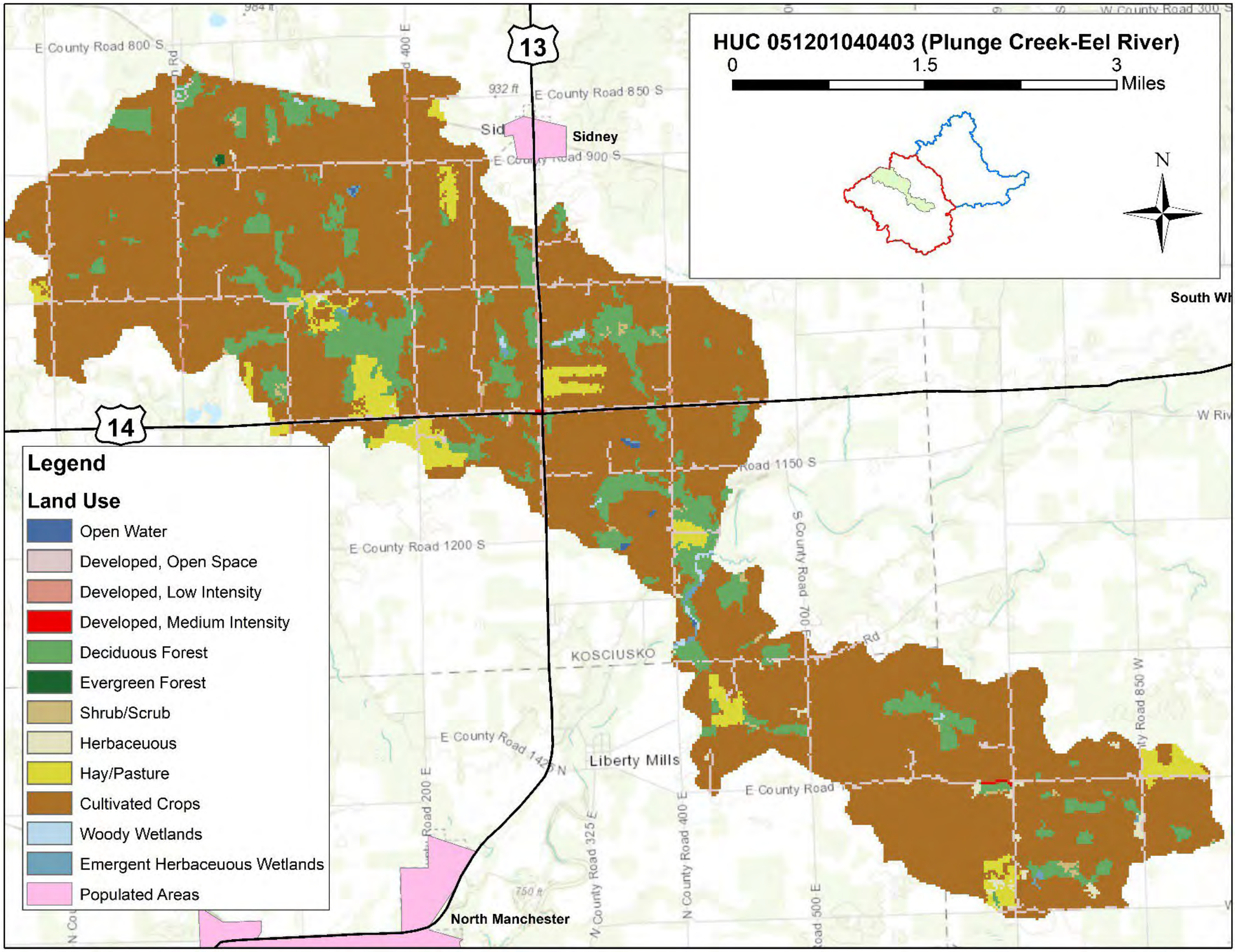

Figure 3-25. Land use within HUC 051201040403 (Plunge Creek-Eel River)

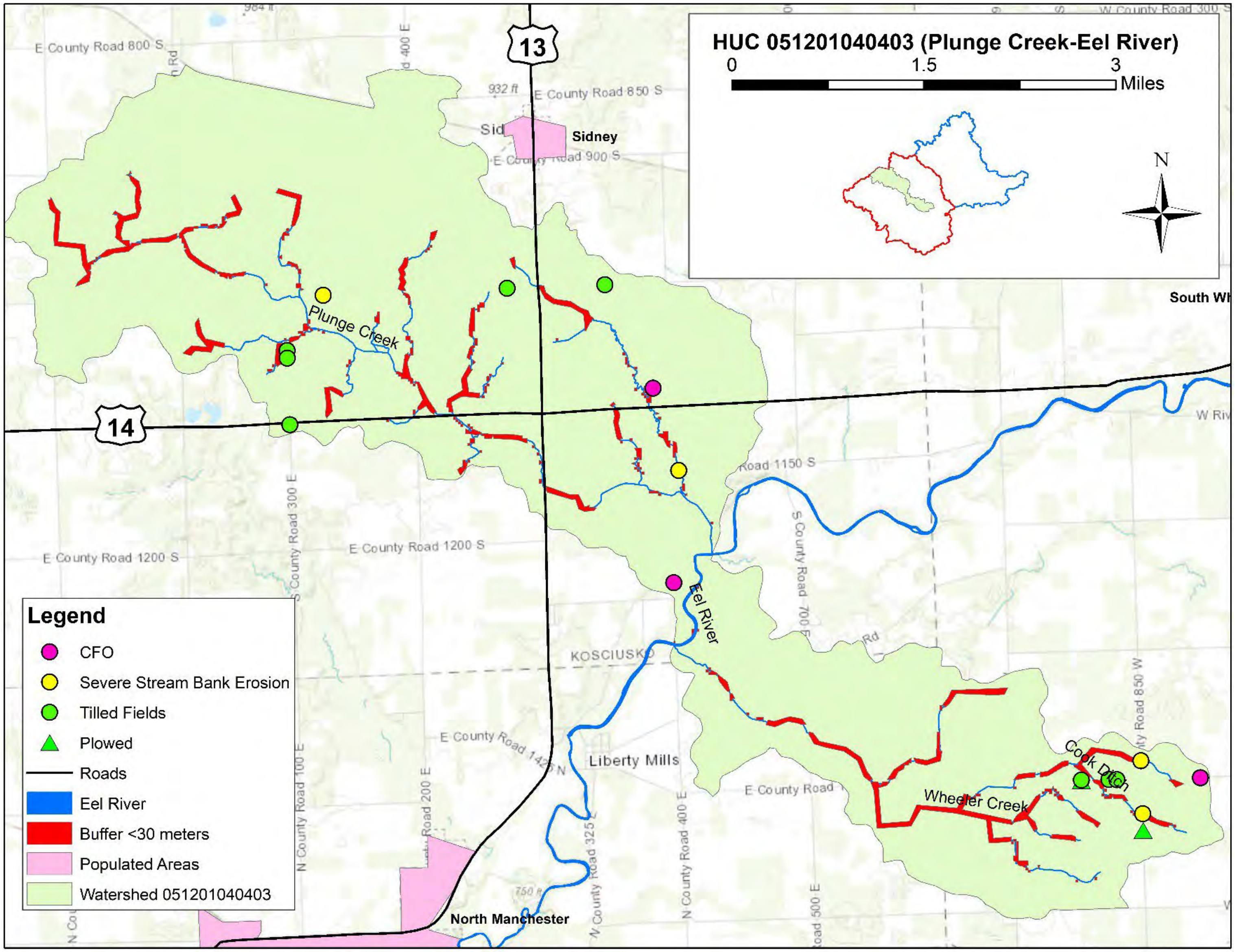

Figure 3-26. Potential pollutant sources within HUC 051201040403 (Plunge Creek-Eel River)

3.3.8 Land Use 051201040404 (Simonton Creek-Eel River)

The primary land use in HUC 051201040404 (Simonton Creek-Eel River) is agriculture with 85% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-68 shows the quantity and percentage of each land use within HUC 051201040404 (Simonton Creek-Eel River) and Figure 3-27 spatially represented the land use across the watershed. Of the 85% agriculture land use, 84% is strictly considered cultivated crops. HUC 051201040404 (Simonton Creek-Eel River) has 6% of the land use being classified as forest. Only 7% of the land use is developed, with 6% being classified as developed open space with <0.5% area of the watershed being considered highly developed.

The windshield survey was conducted 13th November and 27th November 2017 for HUC 051201040404 (Simonton Creek-Eel River). During the survey, 9 of the 14 fields were documented to have recently practiced conventional fall tillage. No-till farming practices were documented on 5 fields within the watershed with all of those fields having an active fall cover crop growing. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was not documented at any of the 11 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 13 stream crossings analyzed, all 13 were documented in having moderate or severe stream bank erosion. However, 8 of the 13 stream analyzed showed minimal signs of recent streambank modification. While there is still extensive streambank erosion, most of the sites have begun to alter the stream channel geometry and stabilize the banks. The windshield survey documented no stream crossing as having visible drainage tile present. These drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW. Pasture animal access to the stream was documented at 2 of the stream crossings analyzed.

The windshield survey verified the lack of riparian buffers within the watershed. There are 31.1 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 16.3 stream miles or 52% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones. With animal pasture directly adjacent or crossing the stream in multiple locations.

There are thirteen Confined Feeding Operation located in the watershed. With thirteen facilities, the density with of CFO within the watersheds is highest across all watersheds with 0.63 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There is one NPDES facility and two NPDES pipe located within the watershed. The NPDES facility is still currently effective and is the Meadow Acres Mobile Home Park. The two NPDES pipes are both active and operated by Meadow Acres Mobile Home Park and Dexter Axle. There are no Brownfield, SSO, LUST, or CSO located within HUC 051201040404 (Simonton Creek-Eel River).

Table 3-68. Land use statistics within HUC 051201040404 (Simonton Creek-Eel River)

	Acreages	Percentage of watershed
Open Water	15.3	<0.5%
Developed, Open Space	771.3	6%
Developed, Low Intensity	85.0	1%
Developed, Medium Intensity	9.8	<0.5%
Developed, High Intensity	17.6	<0.5%
Deciduous Forest	739.9	6%
Evergreen Forest	1.6	<0.5%
Shrub/Scrub	37.6	<0.5%
Herbaceous	177.5	1%
Hay/Pasture	184.8	1%
Cultivated Crops	11,043.0	84%
Woody Wetlands	51.4	<0.5%
Emergent Herbaceous Wetlands	56.7	<0.5%
Total Acreage	13,191.4	

Table 3-69. Stream without a 30 meter riparian buffer within HUC 051201040404 (Simonton Creek-Eel River)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
17.9	33.9	53%

Table 3-70. Confined animal feeding operations within HUC 051201040404 (Simonton Creek-Eel River)

CFO ID	Name	Program	Sub-Program
4385	Eagle Farms Incorporated	CF	CFOG
6093	D & D 2	CF	CFOG
2258	Eel River Veal	CF	CFOG
4993	Eel River Veal Barn 4	CF	CFOG
227	Marcus Schwartz	CF	CFOG
426	Hi Grade Egg Producers	CF	CFOG
6595	South View Farms Incorporated	CF	CFOG
2883	Mark T Rose	CF	CFOG
4960	Jafaco Holdings Incorporated	CF	CFOG
2259	Midwest Veal LLC Michigan Veal 2	CF	CFOG
2417	Hoosier Veal Incorporated	CF	CFOG
2424	Bear Cub Farms	CF	CFOG
2546	Strauss Family Partnership D & D 1	CF	CFOG

Table 3-71. NPDES facilities located within HUC 051201040404 (Simonton Creek-Eel River)

NPDES Facility ID	Facility Name	Address	County	Expiration Date	Outfall Stream
IN0053783	Meadow Acres Mobile Home Park	12600 South State Road 13 North Manchester Indiana 46962	Wabash	12/31/2012	Eel River

Table 3-72. NPDES pipe outfalls located within HUC 051201040404 (Simonton Creek-Eel River)

NPDES Pipe ID	Facility Name	County	Status	Outfall Stream
ING250057	Dexter Axel	Wabash	Active	Unnamed Ditch to Simonton Creek
IN0053783	Meadow Acres Mobile Home Park	Wabash	Active	Eel River

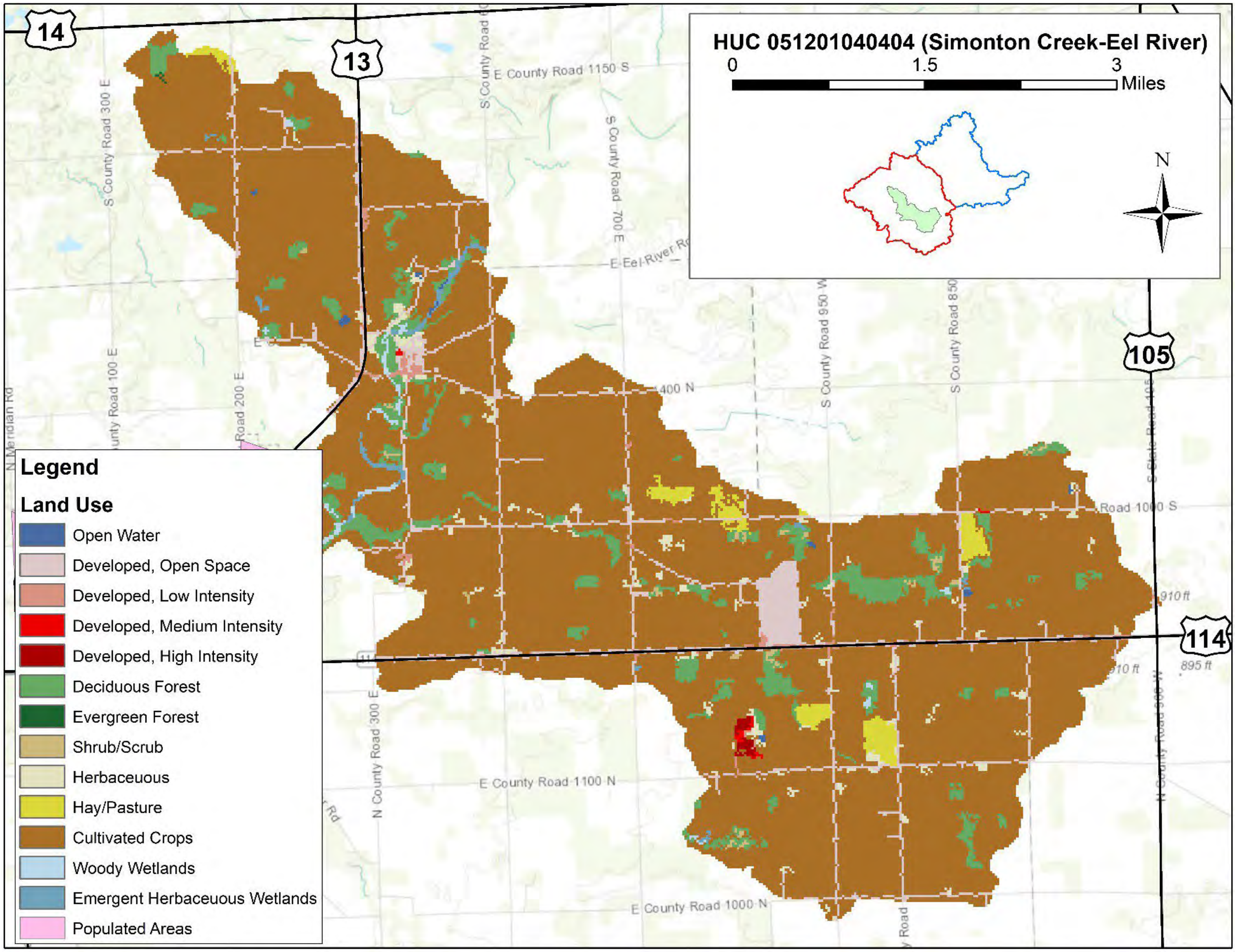

Figure 3-27. Land use within HUC 051201040404 (Simonton Creek-Eel River)

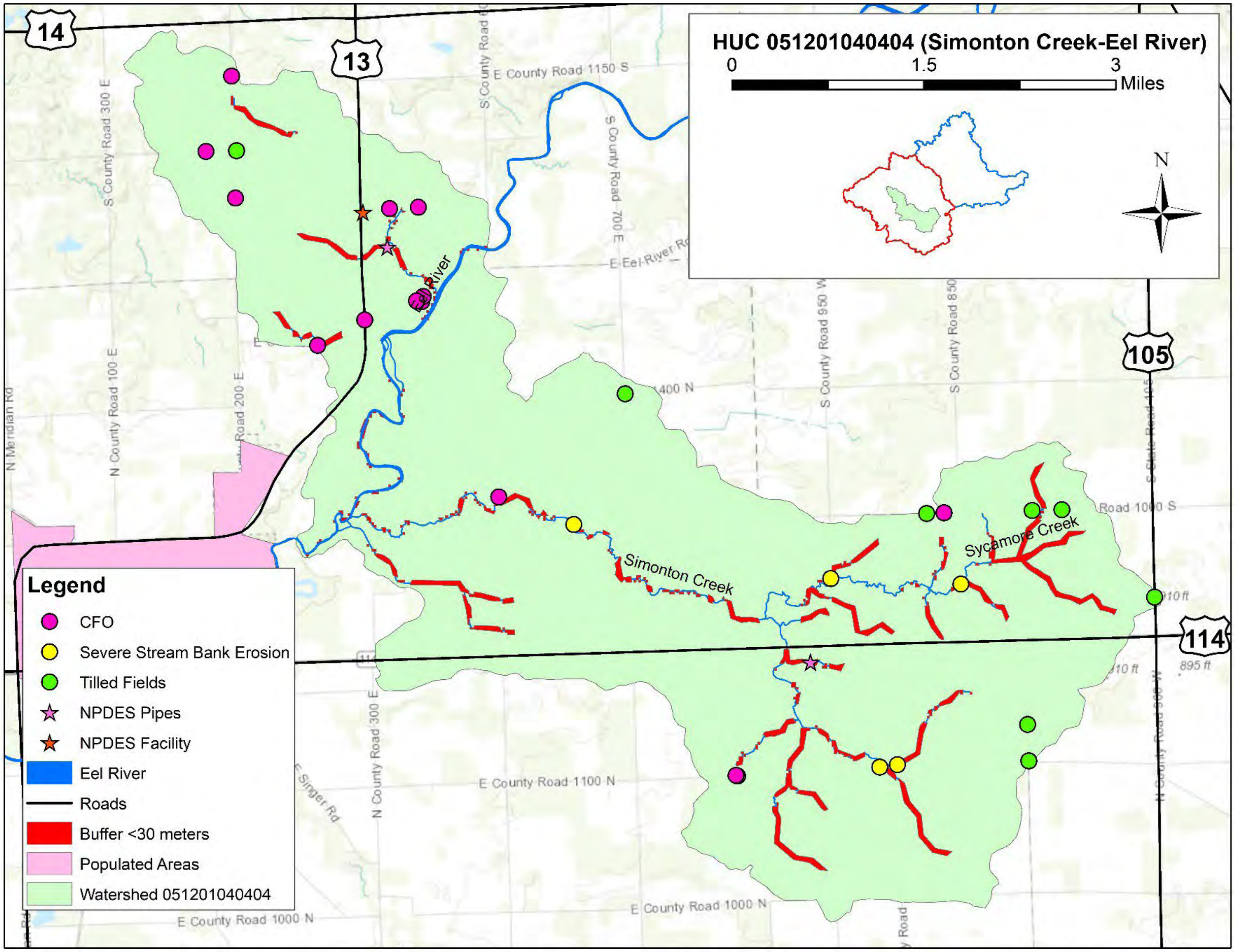

Figure 3-28. Potential pollutant sources within HUC 051201040404 (Simonton Creek-Eel River)

3.3.9 Land Use 051201040405 (Pony Creek)

HUC 051201040405 (Pony Creek) is the largest 12-Digit HUC watershed within the UMERWI with a 20,951.4 acre watershed. The primary land use in within the watershed is agriculture with 87% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-73 shows the quantity and percentage of each land use within HUC 051201040405 (Pony Creek) and Figure 3-29 spatially represented the land use across the watershed. Of the 87% agriculture land use, 85% is strictly considered cultivated crops. HUC 051201040405 (Pony Creek) has 5% of the land use being classified as forest. Only 6% of the land use is developed, with 6% being classified as developed open space with <0.5% area of the watershed being considered highly developed.

The windshield survey was conducted 13th November 2017 for HUC 051201040405 (Pony Creek). During the survey, all 57 fields surveyed were documented to have recently practiced conventional fall tillage. No-till farming practices were not documented on any field within the watershed. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was documented at one of the 33 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 33 stream crossings analyzed, 28 were documented in having moderate or severe stream bank erosion. Likewise, 32 of the 33 stream analyzed showed extensive signs of recent stream modifications and channelization. These modification have led to an increase in water velocity and erosion potential of the stream water. The windshield survey documented 10 stream crossings as having visible drainage tile present. While this is only 1/3 of the total streams crossing analyzed, drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW. Pasture animal access to the stream was documented at only one of the stream crossings analyzed.

The windshield survey verified the lack of riparian buffers within the watershed. There are 45.5 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 33.8 stream miles or 74% of the total stream miles. HUC 051201040405 (Pony Creek) has the lowest percentage of existing riparian buffers within the UMERWI. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones. With animal pasture directly adjacent or crossing the stream in multiple locations.

There are eleven Confined Feeding Operation located in the watershed. With eleven facilities, the density with of CFO within the watersheds is 0.34 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There is one NPDES pipe located within the watershed. The NPDES pipes is operated by Bippus regional sewer district and releases directly into Pony Creek. It is important to note that the incorporated area of Bippus is located outside the UMERI watershed. There are no Brownfield, SSO, LUST, or CSO located within HUC 051201040405 (Pony Creek).

Table 3-73. Land use statistics within HUC 051201040405 (Pony Creek)

	Acreages	Percentage of watershed
Open Water	12.5	<0.5%
Developed, Open Space	1,164.0	6%
Developed, Low Intensity	68.5	<0.5%
Developed, Medium Intensity	14.2	<0.5%
Developed, High Intensity	0.4	<0.5%
Deciduous Forest	1,065.5	5%
Evergreen Forest	-	-
Shrub/Scrub	74.7	<0.5%
Herbaceous	216.8	1%
Hay/Pasture	433.4	2%
Cultivated Crops	17,886.1	85%
Woody Wetlands	11.3	<0.5%
Emergent Herbaceous Wetlands	3.8	<0.5%
Total Acreage	20,951.4	

Table 3-74. Stream without a 30 meter riparian buffer within HUC 051201040405 (Pony Creek)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
33.8	45.5	74%

Table 3-75. Confined animal feeding operations within HUC 051201040405 (Pony Creek)

CFO ID	Name	Program	Sub-Program
1861	R & S Farms	CF	CFOG
801	Gene Michel	CF	CFOG
805	Jack Michel	CF	CFOG
4423	James F Lyons	CF	CFOG
1007	Allen Rice Farms Incorporated	CF	CFOG
3519	2001 Incorporated	CF	CFOG
3553	Renz Farms	CF	CFOG
3399	Little Moo Veal Farm	CF	CFOG
1947	Tate Farms Incorporated	CF	CFOG
4667	Andrew & Jenifer Rice	CF	CFOG
4669	Haupert Farms	CF	CFOG

Table 3-76. NPDES pipe outfalls located within HUC 051201040405 (Pony Creek)

NPDES Pipe ID	Facility Name	County	Status	Outfall Stream
ING0061310	Bippus Regional Sewer District	Wabash	Active	Pony Creek

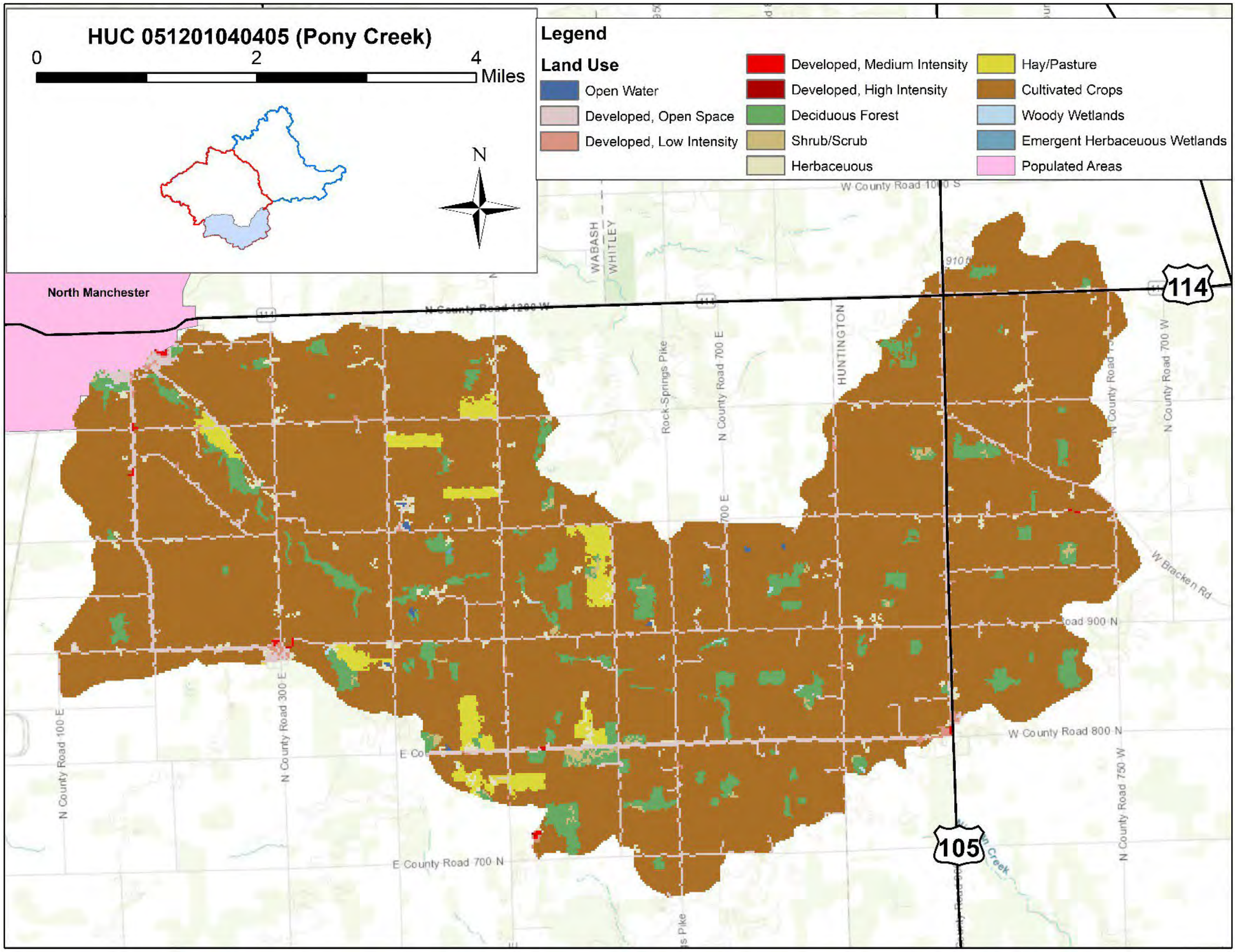

Figure 3-29. Land use within HUC 051201040405 (Pony Creek)

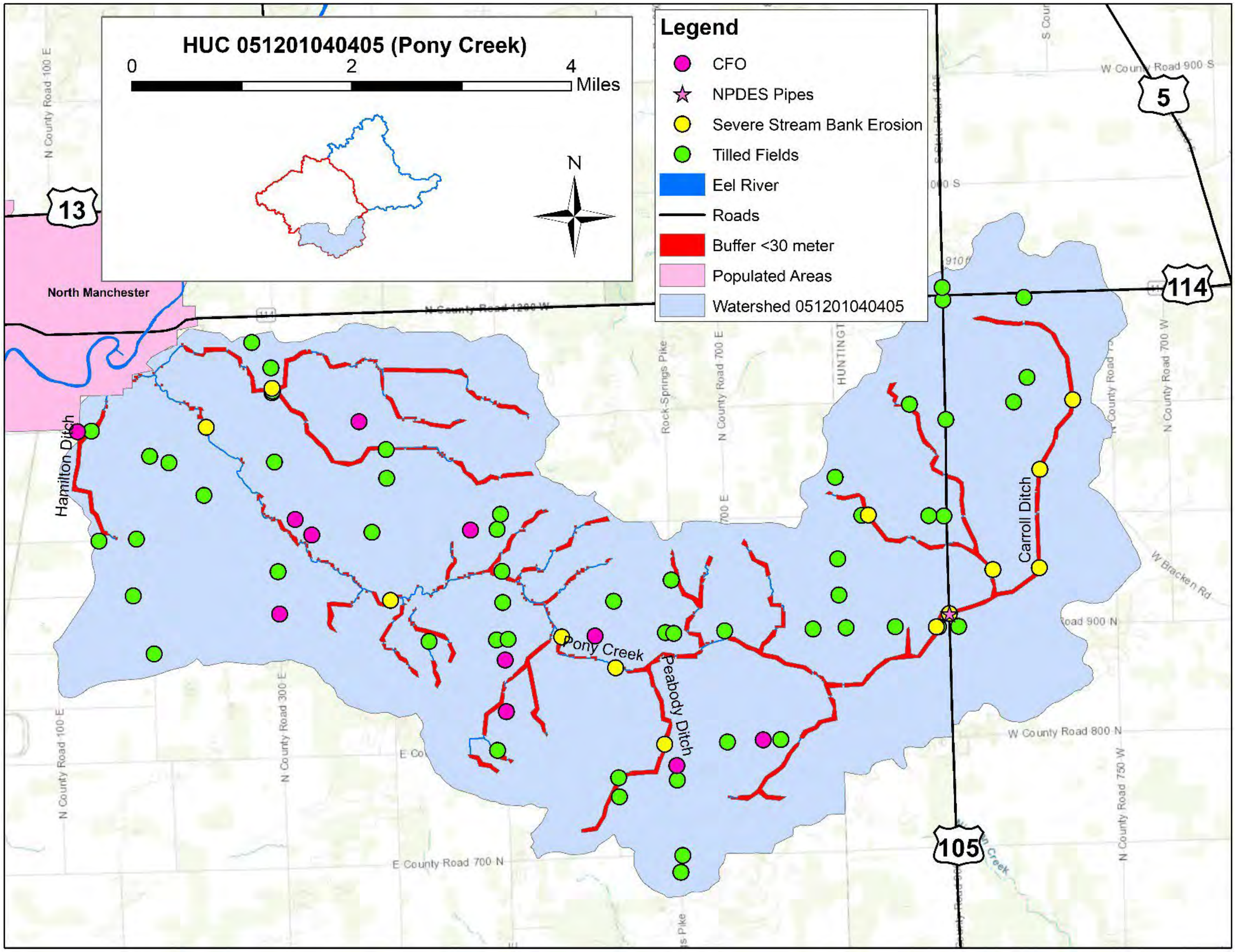

Figure 3-30. Potential pollutant sources within HUC 051201040405 (Pony Creek)

3.3.10 Land Use 051201040406 (Nelson Creek-Clear Creek)

The primary land use in HUC 051201040406 (Nelson Creek-Clear Creek) is agriculture with 84% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-77 shows the quantity and percentage of each land use within HUC 051201040406 (Nelson Creek-Clear Creek) and Table 3-77Figure 3-31 spatially represented the land use across the watershed. Of the 84% agriculture land use, 81% is strictly considered cultivated crops. HUC 051201040406 (Nelson Creek-Clear Creek) has 6% of the land use being classified as forest. Only 6% of the land use is developed, with 5% being classified as developed open space with no area of the watershed being considered highly developed.

The windshield survey was conducted 4th December 2017 for HUC 051201040406 (Nelson Creek-Clear Creek). During the survey, all 13 fields surveyed were documented to have recently practiced conventional fall tillage. No-till farming practices was not documented within the watershed. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was not documented at any of the 5 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Out of the 5 stream crossings analyzed, all 5 were documented in having moderate or severe stream bank erosion. However, 2 of the 5 stream analyzed showed minimal signs of recent streambank modification. Whereas, the remaining 3 streams sampled showed recent stream bank modification and channelization and corresponded when the most severe erosion present within the HUC 051201040406 (Nelson Creek-Clear Creek). The windshield survey documented 3 stream crossing as having visible drainage tile present. These drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW. Pasture animal access to the stream was documented not documented at any of the stream crossings analyzed.

The windshield survey verified the lack of riparian buffers within the watershed. There are 22.8 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 15.1 stream miles or 66% of the total stream miles. Verification by the windshield survey was successful. Farming practices consistently were documented to be directly adjacent to the stream with little to no buffer zones.

There are eleven Confined Feeding Operation located in the watershed. With eleven facilities, the density with of CFO within the watersheds is second highest across all watersheds with 0.59 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There is one underground storage located within the watershed. If the contents held in the underground storage tank leak it could leach through the soil and reach groundwater contaminating drinking water wells of local residents, or leach into surface waters and decrease water quality and affect aquatic life. This underground storage has not been reported as leaking or had leaked in the past. There is one NPDES facility and two NPDES pipe located within the watershed. There are no Brownfield, SSO, LUST, NPDES Facilities, NPDES Pipes, or CSO located within HUC 051201040406 (Nelson Creek-Clear Creek).

Table 3-77. Land use statistics within HUC 051201040406 (Nelson Creek-Clear Creek)

	Acreages	Percentage of watershed
Open Water	37.1	<0.5%
Developed, Open Space	654.7	5%
Developed, Low Intensity	99.9	1%
Developed, Medium Intensity	13.3	<0.5%
Developed, High Intensity	-	-
Deciduous Forest	759.7	6%
Evergreen Forest	9.3	<0.5%
Shrub/Scrub	63.4	1%
Herbaceous	155.2	1%
Hay/Pasture	410.5	3%
Cultivated Crops	9,744.9	81%
Woody Wetlands	28.7	<0.5%
Emergent Herbaceous Wetlands	22.2	<0.5%
Total Acreage	11,999.1	-

Table 3-78. Stream without a 30 meter riparian buffer within HUC 051201040406 (Nelson Creek-Clear Creek)

Stream with <30 meter Buffer (mi)	Total Steam (mi)	% of Streams that have <30 meter buffer
15.1	22.8	66%

Table 3-79. Confined animal feeding operations within HUC 051201040406 (Nelson Creek-Clear Creek)

CFO ID	Name	Program	Sub-Program
2796	Nick Gaerte	CF	CFOG
2143	Leonard Pyle	CF	CFOG
1037	Epsilon Egg Corporation	CF	CFOG
6652	Martins Chicken Farm LLC	CF	CFOG
421	Walter Kiser	CF	CFOG
6168	Rollin Acres Holsteins LLC	CF	CFOG
3832	Bouse Farms Incorporated	CF	CFOG
1912	Eugene Wise	CF	CFOG
2895	Terry L Ayres	CF	CFOG
3392	Precision Pullets LLC	CF	CFOG
3410	Conley Farms	CF	CFOG

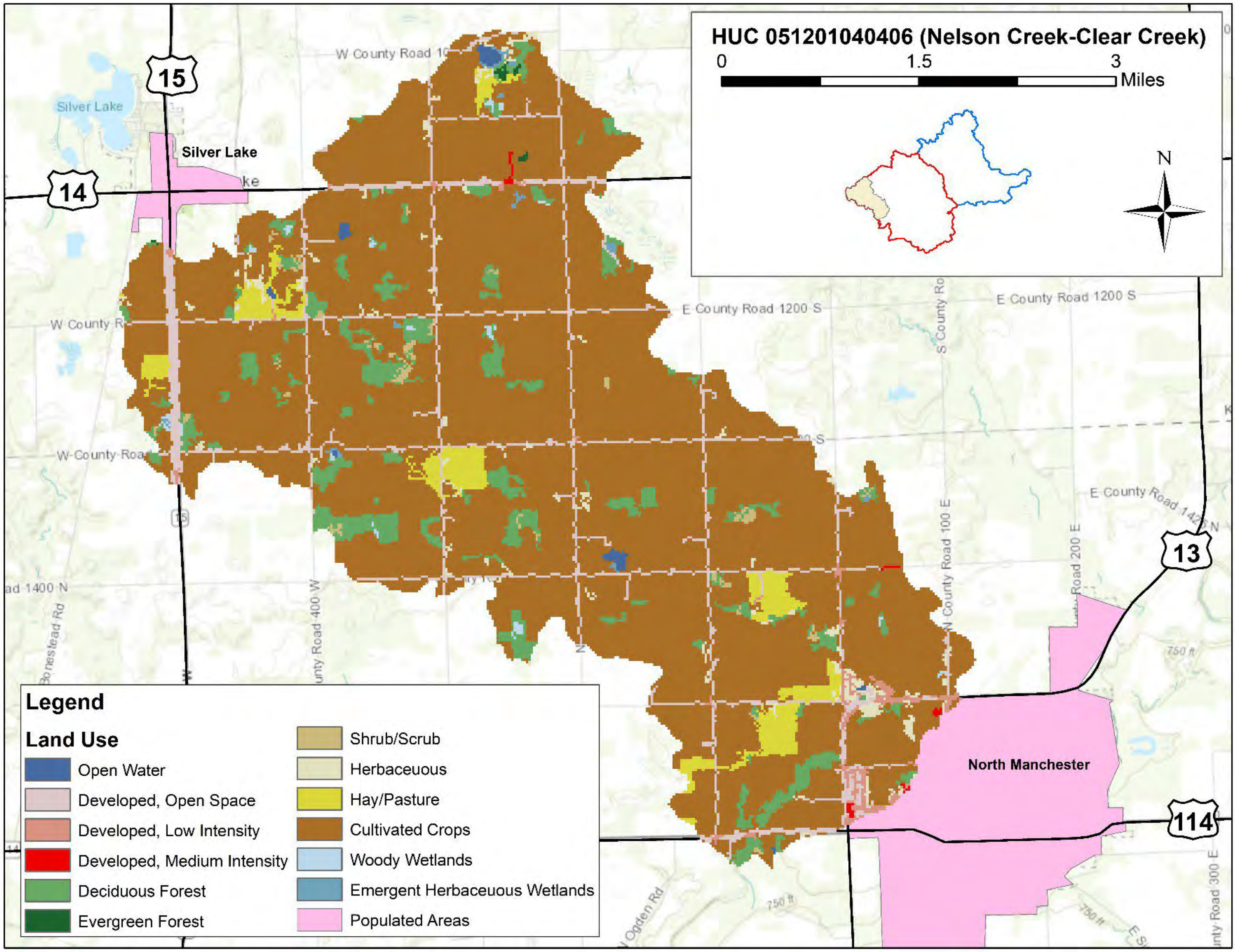

Figure 3-31. Land use within HUC 051201040406 (Nelson Creek-Clear Creek)

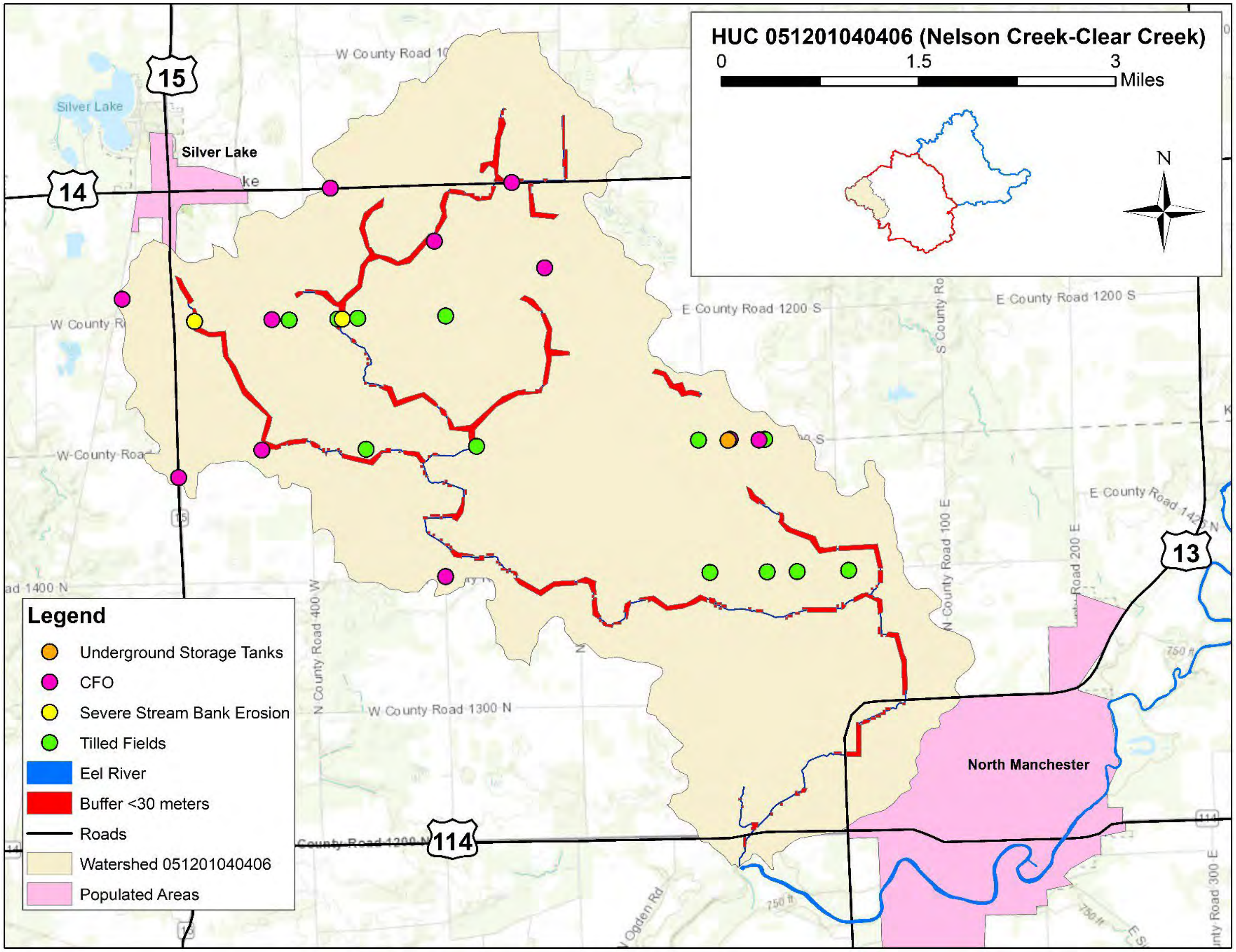

Figure 3-32. Potential pollutant sources within HUC 051201040406 (Nelson Creek-Clear Creek)

3.3.11 Land Use 051201040407 (Swank Creek-Eel River)

HUC 051201040407 (Swank Creek-Eel River) is the smallest 12-Digit HUC watershed within the UMERWI with a 9,937.5 acre watershed area. The primary land use within the watershed is agriculture with 71% of the land being classified as agricultural by the National Land Cover Dataset. Table 3-80 shows the quantity and percentage of each land use within HUC 051201040407 (Swank Creek-Eel River) and Figure 3-33 spatially represented the land use across the watershed. Of the 71% agriculture land use, 64% is strictly considered cultivated crops, this is the least percentage of cultivated crop coverage within the UMERW. HUC 051201040407 (Swank Creek-Eel River) has 8% of the land use being classified as forest. Nearly 1/5 (18%) of the watershed is considered developed, with 9% being classified as developed open space and 1% area of the watershed being considered highly developed. The town of North Manchester makes up all the developed areas within the watershed.

The windshield survey was conducted 4th December 2017 for HUC 051201040407 (Swank Creek-Eel River). During the survey, only one field surveyed was documented to have recently practiced conventional fall tillage. No-till farming practices was documented on two fields within the watershed. Remaining fields in the watershed were in other tillage practice, current production, or it was undetermined what fall practices were being represented. Trash dumped into the stream was not documented at any of the 7 streams crossings analyzed. Stream bank erosion is a major issue within the UMERW and the amount of sediment being eroded in the streambank may overshadow any upland sediment targeted conservation practices. Of the 7 stream crossings surveyed none were documented as having severe streambank erosion and 5 were considered to have moderate streambank erosion. Only two sites were documented in having recent channel modification. Both of these sites showed moderate stream bank erosion. The remaining stream crossing showed past channel modification but over time the stream as manipulated the channel geometry and reduced the potential for excessive stream bank erosion. The windshield survey documented 2 stream crossings as having visible drainage tile present. While this is only 1/3 of the total streams crossing analyzed, drainage tiles are common throughout the watershed and, local farmers and NRCS representatives suggest that nearly all fields within the watershed possess drainage tile due to the relative low landscape gradient within the UMERW. Pasture animal access to the stream was documented at only one of the stream crossings analyzed.

The windshield survey and desktop survey accurately correspond in regards to the riparian buffers within the watershed. The desktop survey using land use statistics documented that there are 24.4 total stream miles within the watershed. Streams that lack at least a 30 meter buffer make up 9.4 stream miles or 39% of the total stream miles. This is the highest amount of riparian buffer within the UMERW. Verification by the windshield survey was successful. None of the stream crossing analyzed documented farming practices being directly adjacent to the stream. All stream crossing analyzed documented >10 meters of riparian buffer comprised of forest, wetlands, or grasslands.

There is one Confined Feeding Operation located in the watershed. With one facility, the density with of CFO within the watersheds is 0.06 CFO per square mile. There is potential for spills and/or leaks from the manure holding facilities or while being transferred to other farms as fertilizer. There are 26 underground storage located within the watershed. If the contents held in the underground storage tank leak it could leach through the soil and reach groundwater contaminating drinking water wells of local residents, or leach into surface waters and decrease water quality and affect aquatic life. Eleven of the storage tanks are classified as leaking or has leaked in the past. Table 3-83 describes the leaking underground storage tank. Note that there at two incident numbers for two underground storage tank. Each number relates to separate leaking events at that location. There are two NPDES facility and thirteen NPDES pipe located within the watershed. One NPDES facility is still currently effective and is the North Manchester wastewater treatment plant. The other NPDES facility is terminated and was operated by Grandstaff Rendering SVC Incorporated. There are seven combined sewer overflows within the watershed. All the CSO's are operated by North Manchester wastewater treatment plant. Six of the CSO are currently active and release untreated into the Eel River when influent exceeds plant capacity. There are no Brownfield or SSO located within HUC 051201040407 (Swank Creek-Eel River).

Table 3-80. Land use statistics within HUC 051201040407 (Swank Creek-Eel River)

	Acreages	**Percentage of watershed**
Open Water	38.3	<0.5%
Developed, Open Space	865.6	9%
Developed, Low Intensity	623.2	6%
Developed, Medium Intensity	172.6	2%
Developed, High Intensity	58.5	1%
Deciduous Forest	821.5	8%
Evergreen Forest	1.1	<0.5%
Shrub/Scrub	27.1	<0.5%
Herbaceous	141.2	1%
Hay/Pasture	683.2	7%
Cultivated Crops	6,324.5	64%
Woody Wetlands	97.9	1%
Emergent Herbaceous Wetlands	83.0	1%
Total Acreage	9,937.5	

Table 3-81 Stream without a 30 meter riparian buffer within HUC 051201040407 (Swank Creek-Eel River)

Stream with <30 meter Buffer (mi)	**Total Steam (mi)**	**% of Streams that have <30 meter buffer**
9.4	24.4	39%

Table 3-82. Confined animal feeding operations within HUC 051201040407 (Swank Creek-Eel River)

CFO ID	Name	Program	Sub-Program
2133	Ayres and Company LLC	CF	CFOG

Table 3-83. Leaking underground storage tank within HUC 051201040407 (Swank Creek-Eel River)

UST Facility ID	Incident Number	Facility Name	Address	County	Priority	Deposition
1874	200903500	Floyds Sunoco	307 East Main Steet North Manchester Indiana 46962	Wabash	High	Active
6159	199109514	Paul's Phillips "66"	811 West Main Street North Manchester Indiana 46762	Wabash	High	Active
6752	199406510	Emro Marketing Wake Up #6069	904 West Highway 114 North Manchester Indiana 46962	Wabash	Low	NFA-Unconditional Closure
	199406523				Medium	NFA-Unconditional Closure
8471	201403514	Manchester Trading Post	3 West Stateroad 114 North Manchester Indiana 46962	Wabash	Medium	NFA-Unconditional Closure
	199102534				Low	NFA-Unconditional Closure
8904	199812592	Tonart Corp Dba Snyder Motors	500 East Main Street North Manchester Indiana 46962	Wabash	Low	NFA-Unconditional Closure
10192	200511500	Crystal Flash Petroleum #36	410 East Main Street North Manchester Indiana 46962	Wabash	Low	NFA-Unconditional Closure
11167	198907094	Manchester Elementary School	301 River Road North Manchester Indiana 46962	Wabash	Low	NFA-Unconditional Closure
16165	199701519	C & H Marathon	301 East Main North Manchester Indiana 46962	Wabash	High	Monitored natural attenuation (active)

19761	199208518	INDOT Project #r-19479	810 West Main Street North Manchester Indiana 46962	Wabash	Low	NFA-Unconditional Closure
22664	199803550	Future Police And Fire Station	709 West Main Street North Manchester Indiana 46962	Whitley	Low	NFA-Unconditional Closure

Table 3-84. NPDES facilities located within HUC 051201040407 (Swank Creek-Eel River)

NPDES Facility ID	Facility Name	Address	County	Expiration Date	Outfall Stream
IN0020362	North Manchester Wastewater Treatment Plant	503 South Maple Street North	Wabash	12/31/2014	Eel River
		Manchester Indiana 46962			
IN0004871	Grandstaff Rendering SVC Incorporated	905 West State Road 114 North Manchester Indiana 46962	Wabash	6/4/1975	Unknown

Table 3-85. NPDES pipe outfalls located within HUC 051201040407 (Swank Creek-Eel River)

NPDES Pipe ID	Facility Name	County	Status	Outfall Stream
ING250067	INVENSYS APPLIANCE CONTROLS	Wabash	Active	Eel River
INP000048	SOTA FINISHES	Wabash	Active	Eel River
IN0002755	EATON CONTROLS DIVISION SOUTH	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River
IN0020362	NORTH MANCHESTER WWTP	Wabash	Active	Eel River

Table 3-86. Combined sewer overflows located within HUC 051201040407 (Swank Creek-Eel River)

Interest ID	City	NPDES Number	CSO Number	Receiving Stream	Status	County	Wastewater Type
53888	City of North Manchester	IN0020362	002C -- CSO - E Fifth St / East St	Eel River	Active	Wabash	Untreated CSO
53888	City of North Manchester	IN0020362	005C -- CSO - S Mill / Main and S Mill / South	Eel River	Active	Wabash	Untreated CSO
53888	City of North Manchester	IN0020362	006C -- CSO - Front / Main Streets	Eel River	Active	Wabash	Untreated CSO
53888	City of North Manchester	IN0020362	008C -- CSO - Wabash Rd, W Side of Old RR - Inactive	Eel River	Inactive	Wabash	Untreated CSO
53888	City of North Manchester	IN0020362	009C -- CSO - Wabash Rd, E Side of Old RR	Eel River	Active	Wabash	Untreated CSO
53888	City of North Manchester	IN0020362	010C -- CSO - S Sycamore at Covered Bridge	Eel River	Active	Wabash	Untreated CSO
53888	City of North Manchester	IN0020362	101C -- CSO - WWTP Bypass	Eel River	Active	Wabash	Untreated CSO

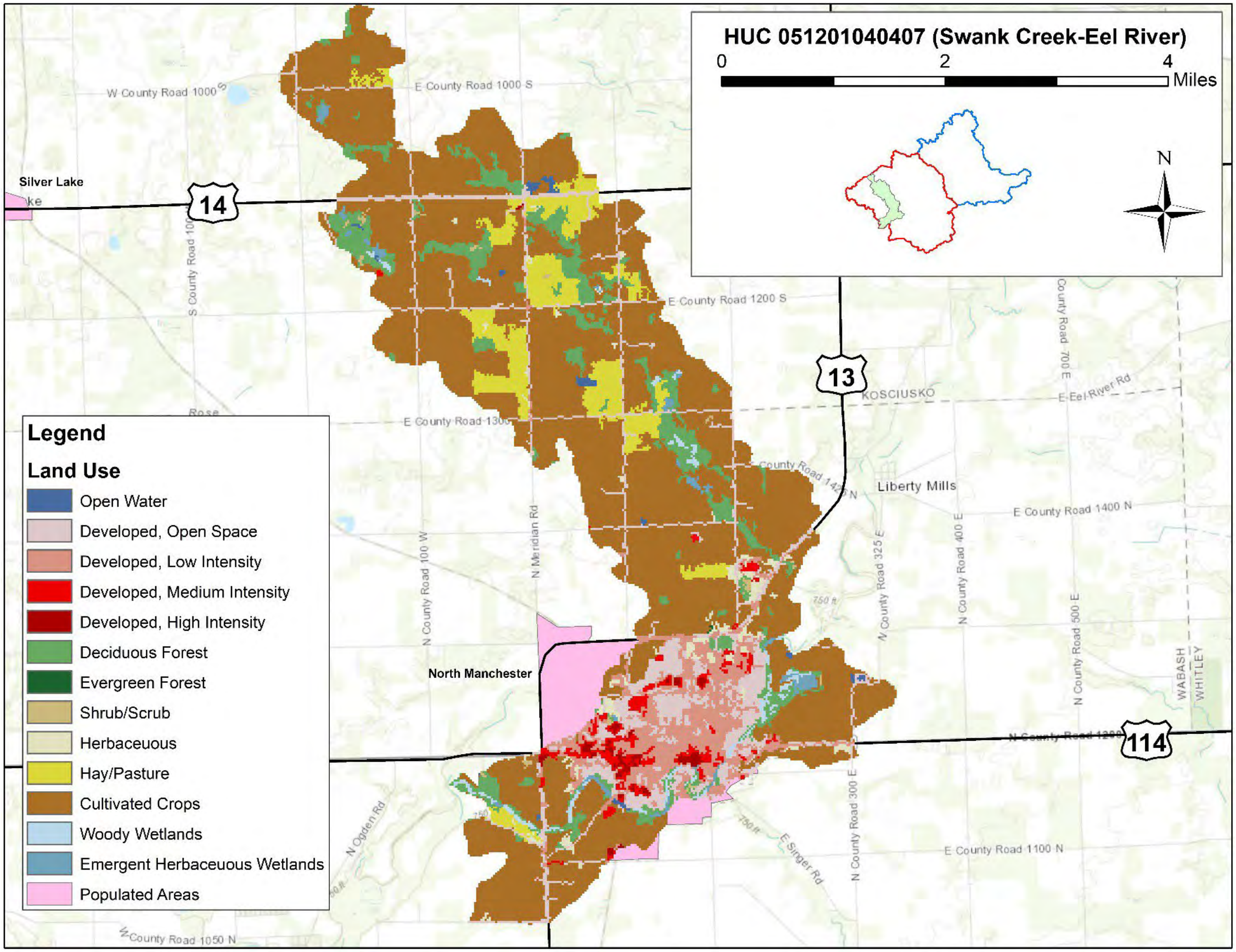

Figure 3-33. Land use within HUC 051201040407 (Swank Creek-Eel River)

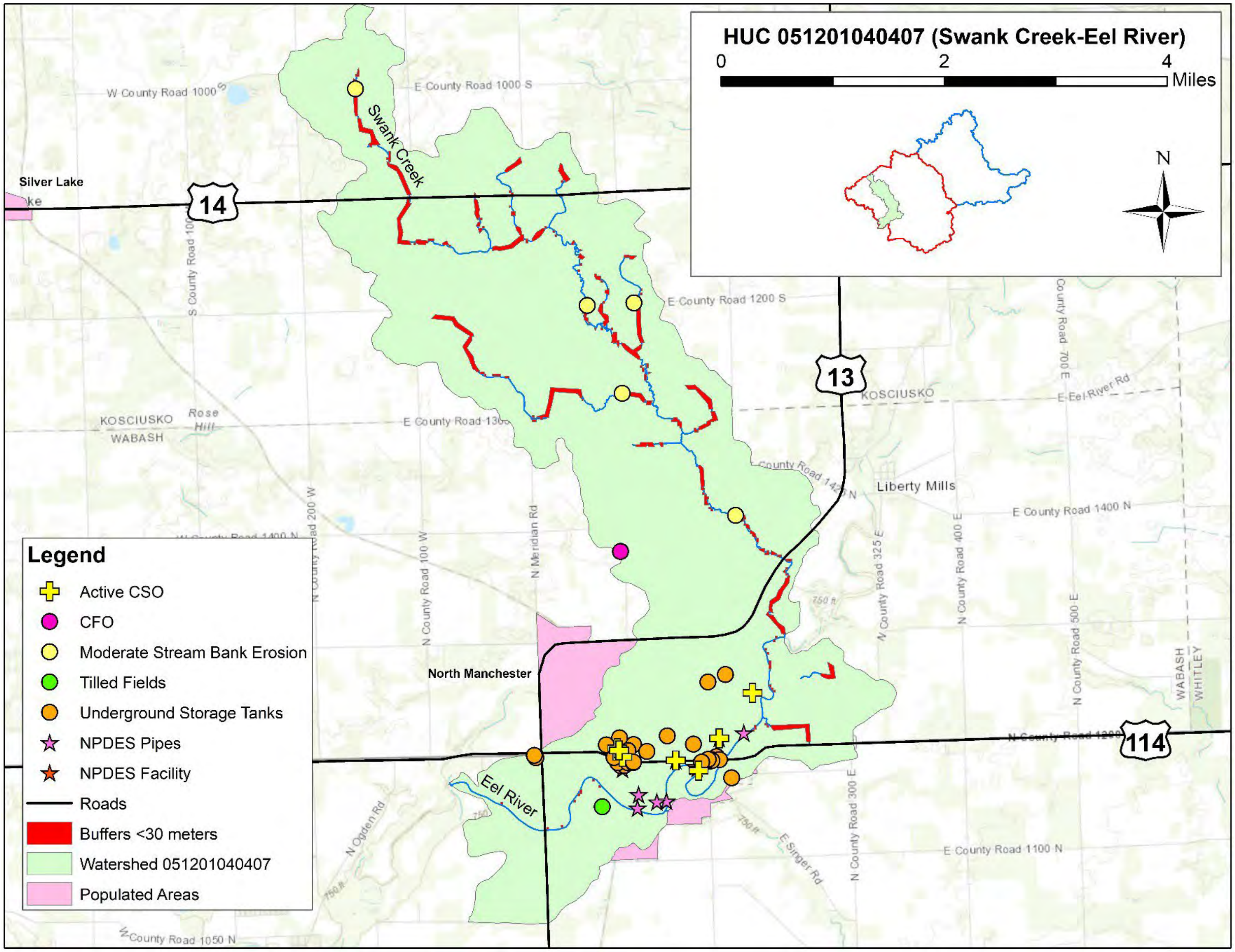

Figure 3-34. Potential pollutant sources within HUC 051201040407 (Swank Creek-Eel River)

3.4 Watershed Inventory Summary

To better understand the water quality problems in the Upper Middle Eel River Watershed and what influences may be contributing to those problems, a map was developed outlining the water quality issues in each watershed as well as showing the results of the land use inventory, as well as other points of interest that may be contributing to the degradation of water quality (Figure 3-35). As can be seen in the figure E. coli, and turbidity were elevated in nearly all watersheds and nutrients were elevated in nearly all sites where nutrient concentrations were measured.

After examining water quality and land uses throughout the UMERW, it can be determined that the problems and concerns contributing to water quality impairments within the watershed are homogenous throughout the project area, with the exception of areas with NPDES permitted discharge. Nearly all the watershed (79%) is dominated by row crop agriculture, particularly corn and soybean production. With 63 CFO/CAFO spread throughout the watershed. There is a significant amount of land classified as forest and wetland that are important to protect and preserve. Forest and wetlands that should be protected and preserved for its flood control and pollution sink capabilities.

The soils in the UMERW are ideal for row crops as they are nutrient rich soils, however there is a significant amount conventional tillage still being used which may be an explanation for the high turbidity levels found throughout the watershed. Another possible explanation for the high turbidity levels found throughout the watershed is that 62% of the watershed is considered highly erodible land. Additionally, 70% of the soils within the watershed are classified into the two highest runoff potential class. This land requires special consideration when being worked, though many landowners are unaware of those precautions.

The majority of the project area is rural, and centralized sewer systems are only present in the incorporated areas. Therefore, it can be assumed that on-site sewage treatment is prevalent throughout the project area which poses a significant threat to water quality since 98% of the soils are classified as “Very Limited” and 1% are classified as “Somewhat Limited” for septic placement. This further justifies the assumption that leaking septic systems may be contributing to bacteria, nutrient, and sediment contamination in the UMERW.

There is a significant lack of riparian buffer throughout the UMERW with 65% of the stream miles having a riparian buffer of less than 100 feet. Riparian buffers help to slow the movement of surface flow to streams and ditches, decreases the erosion potential power of stormflow on streambanks, allows for more infiltration of water which helps prevent the potential for flooding and allows for pollutants to be absorbed by plants before it reaches adjacent waterbodies.

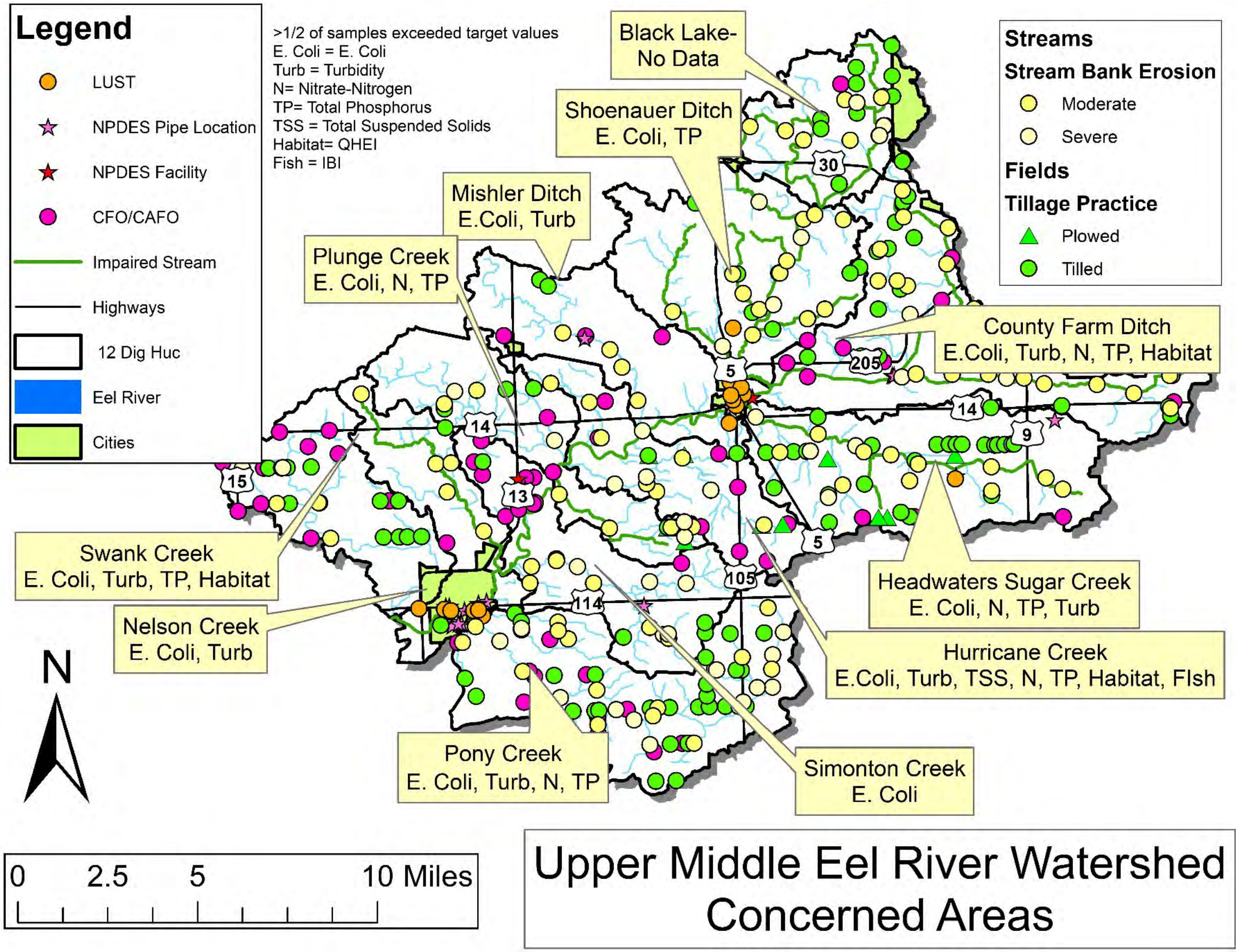

Figure 3-35. Areas of concern with possible problem sources.

3.5 Analysis of Stakeholder concerns

Stakeholders in the Upper Middle Eel River Watershed expressed concerns regarding water quality and land uses during the public meeting held in 2016 and additional concerns were raised after performing the watershed inventory. These concerns are outlined in Table 3-87 as well as whether or not the concerns are supported by the collected data, quantifiable, outside the scope of this project, and whether or not the steering committee would like to focus implementation efforts on the concerns. Concerns that were not chosen to be focused on are flooding, failing septic systems, and trash/debris in the river, due to limited resources or they are being address by government agencies or groups. It was decided not to focus on flooding due to lack or resources to directly prevent or reduce flood impacts. Additionally, flood prevention and support are already covered by other government agencies. It is worth noting that implementation of best management practices to address other concerns will provide water storage in the uplands and help reduce the flooding. While failing septic systems are important to address, due to limited resources and complexity of septic system renovations a decision was made not to address them. It should be noted through education and outreach septic systems will be covered as a potential nutrient input. This could help educate individuals on how to properly treat wastewater on their properties. Lastly, trash/debris will not be focused on due to limited resources and lack of knowledge on the extent of trash and debris in the river. It should be noted that through education and outreach programs better river stewardship will be covered which could help reduce amount of trash/debris in the river.

Table 3-87. Analysis of Stakeholder concerns

Concern	Supported By Data	Evidence	Able to Quantity	Outside Scope	Group wants to focus on
Increased Nitrogen Concentration/Loading	Yes	All testing locations showed increased nitrate-nitrogen concentrations. Tributaries ranged from 45% up to 100% of the samples collected exceeding the target value	Yes	No	Yes
Increased Phosphorus Concentration/Loading	Yes	All testing locations showed increased total phosphorus concentrations. All samples collected exceeded the target value	Yes	No	Yes
Manure in the watershed	Yes	Nutrients in manure often can be related back to nutrient pollution. E. coli level were elevated in water samples. Tributaries ranged from 25% up to 100% of the samples collected exceeding the target value	Yes	No	Yes

Increased Sediment Loading	Yes	All testing locations showed increased sediment concentrations. Tributaries ranged from 20% up to 98% of the samples collected exceeded the target value for Turbidity, and ranged from 23% up to 92% of the samples collected exceeding the target values for TSS	Yes	No	Yes
Stream Bank Erosion	Yes	(We know it is occurring, will quantify on Fall windshield survey)	Yes	No	Yes
Fish and Wildlife Habitat/Abundance/ Health	Yes	In stream habitat assessments, documented 4 of the 9 sampling sites did not meet the targeted QHEI score of 60. Fish surveys documented 1 of the 9 sites did not meet the targeted IBI score of 35. Habitat present provides little opportunity for endangered species.	Yes	No	Yes
Flooding	Yes	All riparian areas are considered to be in the floodplain. Data from USGS flow gage show that the river has entered major flood 4 times since 2008 and moderate flood stage 13 times since 2008. Three of the top 5 crest heights have been since 2008.	Yes	No	No
Lack of Riparian Buffer	Yes	66% of the stream miles within the watershed lack a riparian buffer of >30 meters. This buffer area is often row crop agriculture planted directly adjacent to the waterway	Yes	No	Yes
Lack of Forested Areas	Yes	Row crop agriculture dominates the landscape as it covers 79% of the watershed. Much of this area used to be forest. Currently only 9% of the watershed are, considered forested. Much of the forest areas are fragmented woodlots sprinkled across the landscape.	Yes	No	Yes
Lack of Wetlands	Yes	Row crop agriculture dominates the landscape as it covers 79% of the landscape. With much of the watershed soil considered hydric or partially hydric, wetlands would have previously been abundant. Currently <1% of the watershed is considered wetlands.	Yes	No	Yes
Failing Septic Systems	Yes	Only North Manchester and South Whitley operate a wastewater treatment plant. Most of the watershed is un-sewered and rely on on-site waste	Yes	No	No

		treatment. 99% of the soils within the watershed are considered very limiting or somewhat limiting for the use of an underground septic system			
Trash and debris in the river	No	The quantity of trash/debris in the river was calculated.	No	No	No
Lack of Water Education and Outreach	No	As per State law each CSO community must develop a plan to educate the public on water quality and stormwater management. Those communities are North Manchester and South Whitley. It is not clear how much of the water quality education reaches the public.	No	No	Yes

Upper Middle Eel River Watershed Management Plan

Section 4
Identify Problems and Causes

4.1 Problems Causes of Water Quality Issues

In this section concerns identified by stakeholders in the watershed will be linked to problems found through the watershed investigation. Additionally, potential causes for the problems identified will be expressed. Finally, potential sources will be identified. Table 4-1 shows the connection between those concerns the stakeholders have chosen to focus efforts on, problems found in the watershed, and the potential causes of those problems. Table 4-2 takes it a step further by identifying potential sources to the problems found in the watershed.

Table 4-1. Concerns, Problems, Potential Cause(s)

Concerns	Problems	Potential Cause(s)
▪ Manure in the watershed ▪ Increased sediment loading ▪ Stream bank erosion ▪ Lack of riparian buffer ▪ Lack of forested areas ▪ Lack of wetlands ▪ Lack of water education and outreach	Streams are turbid and high TSS levels are documented in stream samples	• Large percentage of land use in agriculture • Streambank erosion documented as moderate or severe at 136 stream crossing (84%) • Unstable substrate in waterways documented in low QHEI Score • Conventional tillage documented at 126 of the surveyed fields (52%) • Moldboard plow used on 11 of the surveyed fields (4%) • Lack of cover on agriculture fields with 200 fields with no fall cover crops (83%)
▪ Manure in the watershed ▪ Lack of riparian buffer ▪ Lack of forested areas ▪ Lack of wetlands ▪ Lack of water education and outreach	High levels of e. coli were documented in stream samples	• Improperly managed manure • Improper septic system maintenance and failing systems • Direct livestock access to waterbodies • Lack of education and outreach • CSOs operation in watershed
▪ Increased nitrogen concentration/loading ▪ Increased phosphorus concentration/loading ▪ Manure in the watershed ▪ Increased sediment loading ▪ Stream bank erosion ▪ Lack of riparian buffer ▪ Lack of forested areas	High levels of nutrients were documented in stream samples	• Large percentage of land use in agriculture • Streambank erosion documented as moderate or severe at 136 stream crossing (84%) • Unstable substrate in waterways documented in low QHEI Score • Conventional tillage documented at 126 of the surveyed fields (52%) • Moldboard plow used on 11 of the surveyed fields (4%)

<table>
<tr><td>▪ Lack of wetlands
▪ Lack of water education and outreach</td><td></td><td>• Lack of cover on agriculture fields with 200 fields with no fall cover crops (83%)</td></tr>
<tr><td>▪ Increased nitrogen concentration/loading
▪ Increased phosphorus concentration/loading
▪ Manure in the watershed
▪ Increased sediment loading
▪ Stream bank erosion
▪ Fish and wildlife habitat/abundance/ health
▪ Lack of riparian buffer
▪ Lack of forested areas
▪ Lack of wetlands
▪ Lack of water education and outreach</td><td>Best management practices are underutilized</td><td>• 17% of the watershed was covered with fall cover crops during windshield survey
• Streambank erosion documented as moderate or severe at 136 stream crossing (84%)
• Conventional tillage documented at 126 of the surveyed fields (52%)
• Moldboard plow used on 11 of the surveyed fields (4%)</td></tr>
<tr><td>▪ Increased nitrogen concentration/loading
▪ Increased phosphorus concentration/loading
▪ Manure in the watershed
▪ Increased sediment loading
▪ Stream bank erosion
▪ Fish and wildlife habitat/abundance/ health
▪ Lack of riparian buffer
▪ Lack of forested areas
▪ Lack of wetlands
▪ Lack of water education and outreach</td><td>Stream sections within the watershed are listed on the idem impaired waters list.</td><td>• Large percentage of land use in agriculture
• Streambank erosion documented as moderate or severe at 136 stream crossing (84%)
• Unstable substrate in waterways documented in low QHEI Score
• Conventional tillage documented at 126 of the surveyed fields (52%)
• Moldboard plow used on 11 of the surveyed fields (4%)
Lack of cover on agriculture fields with 200 fields with no fall cover crops (83%)
• Nitrate-Nitrogen, Total Phosphorus, Turbidity, TSS, E. coli all averaged above targeted ranges for all water quality sites</td></tr>
<tr><td>▪ Increased nitrogen concentration/loading</td><td>CSOs discharge untreated</td><td>• Lack of sanitary sewer
• Lack of wastewater storage at WWTP</td></tr>
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▪ Increased phosphorus concentration/loading ▪ Lack of water education and outreach	sewage into the eel river	• Increased perception events
▪ Increased sediment loading ▪ Stream bank erosion ▪ Fish and wildlife habitat/abundance/ health ▪ Lack of riparian buffer ▪ Lack of forested areas ▪ Lack of water education and outreach	There are limited recreational opportunities on the eel river	• Increased perception and flooding make the river unsafe • Very few recreational fish species to catch • Lack of education and outreach on how to utilize the river. • Lack of knowledge on public access sites

4.2 Potential Sources of Water Quality Problem

Now that stakeholder concerns have been linked to water quality problems and potential causes of those problems, and a thorough watershed inventory has been conducted, potential sources to the problems can be identified. Outlining the sources to the problems found in the watershed will help to narrow the land area of where to focus efforts which will have the greatest impact on improving water quality.

Table 4-2. Water Quality Problems, Potential Cause(s), and Potential Sources

Problem	Potential cause(s)	Potential sources
Streams are turbid and high TSS levels are documented in stream samples	• Large percentage of land use in agriculture • Streambank erosion documented as moderate or severe at 136 stream crossing (84%)	• Lack of spring/fall cover on agriculture field across the watershed potentially erode sediment in a waterway • Flood events suspend sediment that had been deposited on the channel bottom.

	• Unstable substrate in waterways documented in low QHEI score • Conventional tillage documented at 126 of the surveyed fields (52%) • Moldboard plow used on 11 of the surveyed fields (4%) • Lack of cover on agriculture fields with 200 fields with no fall cover crops (83%)	• Streambank erosion (needs quantified)
High levels of E. coli were documented in stream samples	• Improperly managed manure • Improper septic system maintenance and failing systems • Direct livestock access to waterbodies • Lack of education and outreach • CSO operation in watershed	• 64 CFO/CAFO throughout the watershed. Manure produced at these facilities are applied to agriculture fields and potentially migrate to waterways • 99% of the watershed soils are limiting for septic system suitability, but nearly all rural areas utilize septic systems. Failing septic systems in improper soil cannot properly treat wastewater and e. coli can reach the stream • During large precipitation event (>0.5 inch) 14 CSOs on the eel river open and release untreated sewage • Minimal education opportunities to better educate on water quality issues in the watershed

High levels of nutrients were documented in stream samples	• Large percentage of land use in agriculture • Streambank erosion documented as moderate or severe at 136 stream crossing (84%) • Unstable substrate in waterways documented in low QHEI score • Conventional tillage documented at 126 of the surveyed fields (52%) • Moldboard plow used on 11 of the surveyed fields (4%) • Lack of cover on agriculture fields with 200 fields with no fall cover crops (83%)	• 64 CFO/CAFO throughout the watershed. Manure produced at these facilities are applied to agriculture fields and potentially migrate to waterways • Agriculture fields require applied fertilizer to more effectively grow crops. This fertilizer is not 100% used for the crop and portions are suitable to erosion into adjacent waterbodies • Tile drainage is common throughout the watershed. Tiles act as conduits for nutrients to pass below the root zone of plants and be released directly into the stream • 99% of the watershed soils are limiting for septic system suitability, but nearly all rural areas utilize septic systems. Failing septic systems in improper soil cannot properly treat wastewater and nutrients can reach the stream • During large precipitation events (>0.5 inch) 14 CSO on the eel river open and release untreated sewage • Minimal education opportunities to better educate on water quality issues in the watershed
Best management practices are underutilized	• 17% of the watershed was covered with fall cover crops during windshield survey • Streambank erosion documented as moderate or severe at 136 stream crossing (84%) • Conventional tillage documented at 126 of the surveyed fields (52%)	• Lack of education about BMP and how to use them across the watershed • Lack of cost share dollar for producers to implement bmp • Producers unwilling to change farming practices across the watershed. • Lack of outreach about current water quality issues to producers in the watershed

	• Moldboard plow used on 11 of the surveyed fields (4%) •	
Stream sections within the watershed are listed on the idem impaired waters list.	• Large percentage of land use in agriculture • Streambank erosion documented as moderate or severe at 136 stream crossing (84%) • Unstable substrate in waterways documented in low QHEI score • Conventional tillage documented at 126 of the surveyed fields (52%) • Moldboard plow used on 11 of the surveyed fields (4%) Lack of cover on agriculture fields with 200 fields with no fall cover crops (83%) Nitrate-nitrogen, total phosphorus, turbidity, TSS, E. coli all averaged above targeted ranges for all water quality sites	• 64 CFO/CAFO throughout the watershed. Manure produced at these facilities are applied to agriculture fields and potential migrate to waterways • Agriculture fields require applied fertilizer to more effectively grow crops. This fertilizer is not 100% used for the crop and portions are suitable to erosion into adjacent waterbodies • Tile drainage is common throughout the watershed. Tiles act as conduits for nutrients to pass below the root zone of plants and be released directly into the stream • 99% of the watershed soils are limiting for septic system suitability, but nearly all rural areas utilize septic systems. Failing septic systems in improper soil cannot properly treat wastewater and nutrients can reach the stream • During large perception event (>0.5 inch) 14 CSO on the eel river open and release untreated sewage • Minimal education opportunities to better educate on water quality issues in the watershed • 4 of the 9 sample sites did not meet QHEI targeted value • 1 of the 9 sample sites did not meet IBI targeted value
CSOs discharge untreated sewage into the eel river	• Lack of sanitary sewer • Lack of wastewater storage at WWTP • Increased perception events	• During large perception event (>0.5 inch) 14 CSO on the eel river open and release untreated sewage

		• Rainfall and flooding have increased over the past decade. 3 of 5 historic flood crest have been from 2008 – 2017.
There are limited recreational opportunities on the eel river	• Increased perception and flooding make the river unsafe • Very few recreational fish species to catch • Lack of education and outreach on how to utilize the river. • Lack of knowledge on public access sites	• Lack of game fish in the river • Lack of sizable fish in the river • Muddy water is unpleasing to relax in • People are concerned about the safety of the river

4.3 Pollution Loads and Necessary Load Reductions

The UMERWI collected water samples from 6 of the 11 twelve digit HUC watersheds within the project boundary. Samples were collected weekly during the field season (May and June), then monthly thereafter. During precipitation events within the field season, samples were collected daily instead of weekly. Minimal samples were collected from the remaining 5 twelve digit HUCs. For consistency, pollutant loading and critical areas will utilize the intensive sampling collected by the UMERWI only.

Current pollution loads and load reductions were analyzed for nitrogen, total phosphorus, and sediment. E. coli loads cannot be accurately determined using current load models. Pollutant loads were based on analysis of mean stream flow and mean pollutant concentration. It is important to note that E. coli is a major concern of the UMERWI and E. coli totals will be assessed in critical area determination. Table 4-3 is a reminder of the target concentrations for each of the parameters of concern that were set by this project's steering committee. Table 4-4 through Table 4-6 shows the current and target loads and load reductions needed for nitrate-nitrite, total phosphorus, and sediment. As can be seen in the following tables, load reductions were necessary in all 6 of the 12 digit HUC watersheds for total phosphorus and nitrate-nitrite and in 5 of the 12 digit HUC watersheds for sediment.

Load calculations were numerical calculations based on data collected at Manchester University. Daily loads were determine based on concentrations of pollutant of concern multiplied by stream flow rate.

Table 4-3. Water quality parameter targets for the UMERWI

Parameter	Target
Dissolved Oxygen	>4 mg/L and <12 mg/L
Temperature	4.44°C – 29.44°C
Turbidity	10.4 NTU
Total Suspended Solids	30 mg/L
E Coli	235 CFU/100mL (single sample)
Total Phosphorus	0.076 mg/L
Nitrate-Nitrite	2.2 mg/L
QHEI	60
IBI	35

Table 4-4. Current Nitrate-Nitrate Loads, Target loads, and Reduction needed to meet target load.

12 Digit Watershed			Nitrate-Nitrite		
Code	Name	Mean Flow (cfs)	Current tons/year	Target Tons/year	Reduction Needed
051201040405	Pony Creek	40	259.92	86.62	173.29
051201040402	Hurricane Creek	19.3	140.05	41.80	98.25
051201040407	Swank Creek	17.3	42.13	37.46	4.56
051201040403	Plunge Creek	38.4	108.56	83.16	25.40
051201040303	Sugar Creek	16.3	114.17	35.42	78.87
051201040302	Clear Creek	19.65	63.98	42.55	21.43

Table 4-5. Current Total Suspended Solids (TSS) Loads, Target loads, and Reduction needed to meet target load.

12 Digit Watershed			Total Suspended Solids		
Code	Name	Mean Flow (cfs)	Current tons/year	Target Tons/year	Reduction Needed
051201040405	Pony Creek	40	3,633.53	1,180.95	2,452.59
051201040402	Hurricane Creek	19.3	1,739.64	569.81	1,169.83
051201040407	Swank Creek	17.3	622.68	510.76	111.92
051201040403	Plunge Creek	38.4	1,358.07	1,133.71	224.36
051201040303	Sugar Creek	16.3	1,378.90	481.24	897.66
051201040302	Clear Creek	19.65	516.02	580.14	-

Table 4-6. Current Total Phosphorus Loads, Target loads, and Reduction needed to meet target load.

12 Dig Watershed			Total Phosphorus		
Code	Name	Mean Flow (cfs)	Current tons/year	Target Tons/year	Reduction Needed
051201040405	Pony Creek	40	50.07	2.99	47.08
051201040402	Hurricane Creek	19.3	27.96	1.44	26.47
051201040407	Swank Creek	17.3	8.87	1.29	7.58
051201040403	Plunge Creek	38.4	16.64	2.87	13.77
051201040303	Sugar Creek	16.3	14.24	1.22	13.01
051201040302	Clear Creek	19.65	6.44	1.47	4.97

Upper Middle Eel River Watershed Management Plan

Section 5
Critical Areas

Consideration of primary and secondary critical areas within the project watershed takes into consideration many factors. First, it is important to document the major water quality issues present within the watershed as documented previous within this WMP. Agriculture production is the dominate land use within the watershed with nearly 80% of the entire watershed in cultivated crops. The second largest land use within the watershed is deciduous forest with only 9% of the watershed. Urban space only occupies 6.6% of the land use with 5.4% being considered open urban. With this significant difference in land use and throughout previous sections, it is well documented that agriculture production is of major concern with its effects on water quality. Individual 12 digit HUC agriculture land use ranged from 64% to 87%. Most 12 digit watersheds were around 80% of their land use as being cultivated crops. With no significant difference between agriculture land use throughout the 12 digit HUC it is impossible to determine priority area based on land use alone. Another concern for water quality is animal waste produced from CFO/CAFO's. While some 12 digit watersheds contain more CFO/CAFO than others, this is not an appropriate matrix to determine critical areas. Agriculture practices rarely are confined by watershed bounds and it is a common practice for manure to be transported many miles from animal facilities before it is applied to fields. Additionally it has been documented through other research at Manchester University that regardless of form, rather manure or manufactured, fertilizer is applied at similar concentrations to agriculture fields throughout the watershed. Fertilizer application strategies plays a more important role in application rates than the origin of the fertilizer. For this reason, CFO/CAFO concentration per 12 digit HUC is not an accurate determination of critical areas. Analysis of the windshield survey data can begin to provide clued to critical area determine. HUC 0512010405 (Pony Creek) and HUC 0512010303 (Headwaters Sugar Creek) both nearly doubled the frequency of fields within the watershed that practiced fall tillage practices. Stream bank erosion also exceeded 90% of the surveyed streams within the watershed. Whereas HUC 0512010401 (Mishler Creek) land use was document as being changed to more seasonal grasslands and only 3 fields were document with fall tillage within the watershed. Data collected on the windshield survey has helped to eliminate Mishler Creek as a critical area. While desktop analysis of land use statistics and other physical characteristics is beneficial it is impossible based on the datasets to accurately determine critical areas, due to the homogeneous nature of the watershed landscape and agriculture practices present within the project area. The only accurate assessment of water quality issues is to collect water quality data from stream samples. This data provide exact measurements of pollutant concentrations that can be used to accurately compare watersheds.

Not all water quality data collection is created equally. It is the goal of this WMP to document and provide an implementation strategy for reducing nitrogen, phosphorus, and sediment pollution in the UMERW. Data that does not include these parameters is not useful in comparison of the watersheds. It is impossible to accurately compare all watersheds, due to a significant lack of pollutant data in many of the watersheds. While it is possible to run loading models at a watershed scale, these models have significant error and many times do not correctly assess watershed pollutant loading. Secondly models are only as accurate as the data in which is supplied to the model. With a lack of data at many of the 12 digit watersheds these models would not provide accurate results to compare watershed.

According to IDEM " FFY 2019 CLEAN WATER ACT SECTION 319 GRANT SOLICITATION ANNOUNCEMENT AND GUIDANCE" it is a priority to "focus funds on restoration activities that will make a **measurable improvements in water quality**, protect water quality designated uses, and implement Indiana state nutrient reduction strategy." In order to achieve measurable improvements in water quality, a baseline datasets of appropriate parameters must exist on the critical areas. IDEM data does exist throughout the watershed. However, it is limited in scale (<5 samples per site) and only limited parameters were analyzed with not nutrient data available. It is for these above reasons that only Manchester University data will be utilized in determinate of critical areas. Manchester University datasets at six of the 12 digit HUC can provided the necessary baseline dataset to assess and measure the pollutant loading as implementation occurs.

Primary and secondary critical areas are considered essential areas for implementation of practices to improve or protect water quality, biotic community and/or habitat. Analysis of landscapes and water quality data indicates that all the 12 digit watersheds within the Upper Middle Eel River Watershed are impaired and could be considered critical areas. However, it is important to prioritize the 12 digit watersheds to determine the most effective strategy for water quality improvement. The Steering Committee determined critical areas in two categories; primary priority and secondary priority. The critical area and priority designations will be used in the ranking process for the cost-share program and implementation.

The critical area ranking of testing tributaries was accomplished by creating a holistic scoring system for water quality impairments that includes the chemical, biological, and physical analysis of each testing tributary. A point system was developed to rank testing tributaries within the watershed using the following criteria:

Chemical Analysis:
Highest annual load for parameter of concern: 5 Points
Second highest annual load – 4 Points
Third highest annual load – 3 Points

Biological Analysis:
IBI (As opposed to the chemical analysis, a high IBI score is good)
Lowest IBI – 5 Points
Second lowest IBI – 4 Points
Third lowest IBI – 3 Points

Physical Analysis:
QHEI (As opposed to the chemical analysis, a high QHEI score is good)
Lowest QHEI – 5 Points

Second lowest QHEI – 4 Points
Third lowest QHEI - 3 Points

This is a relative ranking process and only ranks the testing tributaries in comparison to each other and does not indicate the overall stream health

The critical area ranking results for each testing tributary in the watershed are shown in Table 5-1 through Table 5-3.

Table 5-1. Upper Middle Eel River Watershed point ranking results of Testing Tributaries – 2016.

Testing Tributary	QHEI Ranking	IBI Ranking	E. coli Ranking	Nitrate Ranking	Total Phosphorus Ranking	TSS Ranking	2016 TOTAL Score
Pony Creek	-	4	5	5	5	5	24
Hurricane Creek	4	5	4	4	4	4	25
Swank Creek	5	-	-	-	-	-	5
Plunge Creek	-	3	-	-	3	-	6
Sugar Creek	3	-	3	3	-	3	12
Clear Creek	-	3	-	-	-	-	3

Table 5-2. Upper Middle Eel River Watershed point ranking results of Testing Tributaries – 2017.

Testing Tributary	QHEI Ranking	IBI Ranking	E. coli Ranking	Nitrate Ranking	Total Phosphorus Ranking	TSS Ranking	2017 TOTAL Score
Pony Creek	-	-	5	5	5	5	20
Hurricane Creek	5	5	3	3	4	4	24
Swank Creek	4	4	4	-	-	-	12
Plunge Creek	-	3	-	-	3	3	9
Sugar Creek	3	3	-	4	-	-	10
Clear Creek	-	-	-	-	-	-	0

Table 5-3. Upper Middle Eel River Watershed point ranking results of Testing Tributaries – total combined scores 2016 and 2017.

Testing Tributary	QHEI Ranking	IBI Ranking	E. coli Ranking	Nitrate Ranking	Total Phosphorus Ranking	TSS Ranking	2016 & 2017 Combination TOTAL Score
Pony Creek	-	4	10	10	10	10	44
Hurricane Creek	9	10	7	7	8	8	49
Swank Creek	9	4	4	-	-	-	17
Plunge Creek	-	6	-	-	6	3	15
Sugar Creek	6	3	3	7	-	3	22
Clear Creek	-	3	-	-	-	-	3

Using this methodology, the highest priority critical areas are those that scored the highest number of points relative to each other. Using this ranking criteria, the primary critical areas in the Upper Middle Eel River Watershed are Pony Creek (HUC -051201040405), Hurricane Creek (HUC - 051201040402), and Sugar Creek (HUC – 051201040303) (Figure 5-1). Table 5-4 shows the parameters of concern for each high priority critical 12 digit watershed in the Upper Middle Eel River Watershed.

HUC 051201040405 (Pony Creek) is considered a primary critical are and was documented to contribute the highest loads and/or concentrations in E. Coli, Total Suspended Solids, Nitrate-Nitrite, and Total Phosphorus. Additionally, IBI scores were reduced in Pony Creek throughout the research at Manchester University. Holistically HUC 0512010403 (Hurricane Creek) was documented as the most degraded stream. Hurricane Creek ranked high in all matrix of concern. IBI scores were the lowest and QHEI scores tied for lowest within the watershed. Likewise, Hurricane creek ranked second or tied for second for contributing the highest load in E. Coli, Nitrate-Nitrite, Total Phosphorus, and Total Suspended Sediment. The final primary critical area documented in the UMERWI was HUC 0512010303 (Headwaters Sugar Creek). Sugar creek was documented in having the largest percentage of plowed agricultural fields and ranked as a large contributor of pollutants in all categories except for total phosphorus.

The secondary priority critical areas chosen by the Steering Committee have somewhat lower combined impairments and are: Swank Creek (HUC - 0512010400407), Plunge Creek (HUC -051201040403), Clear Creek (HUC-051201040302), (Figure 5-1). Table 5-5 shows the parameters of concern for each secondary critical 12 digit watershed in the Upper Middle Eel River Watershed.

Figure 5-2 through Figure 5-7 provides the water monitoring results for each parameter of concern for each testing tributary for 2016 and 2017 and demonstrate the impairments throughout the Upper Middle Eel River Watershed in all the testing tributaries.

Table 5-4. Upper Middle Eel River Watershed – Primary Critical Area – 12 digit watersheds with parameters of concern.

Upper Middle Eel River Primary Critical Areas		
12 Digit HUC	**HUC Name**	**Parameter of Concern**
051201040405	Pony Creek	***Low*** - IBI ***High*** - *E. coli*, TSS, nitrate-nitrite and total phosphorus
051201040402	Hurricane Creek	IDEM 303(d) List for high *PCB in Fish Tissue* ***Low*** – IBI and QHEI ***High*** - *E. coli*, TSS, nitrate-nitrate and total phosphorus
051201040303	Sugar Creek	IDEM 303(d) List for E. Coli, impaired biotic communities ***Low*** - IBI & QHEI ***High*** - *E. coli*, nitrate-nitrite and TSS

Table 5-5.Upper Middle Eel River Watershed – Secondary Critical Area – 12 digit watersheds with parameters of concern.

Upper Middle Eel River Secondary Critical Areas		
12 Digit HUC	**HUC Name**	**Cause for Listing**
051201040407	Swank Creek	IDEM 303 (d) List for impaired biotic community, PCBs, E. coli ***Low –*** IBI and QHEI ***High*** - *E. coli*
051201040402	Plunge Creek	IDEM 303 (d) List for *E. coli* and PCBs ***Low –*** IBI ***High*** - TSS and total phosphorus
051201040302	Clear Creek	IDEM 303 (d) List for *E. coli*, impaired biotic communities, ***Low –*** IBI

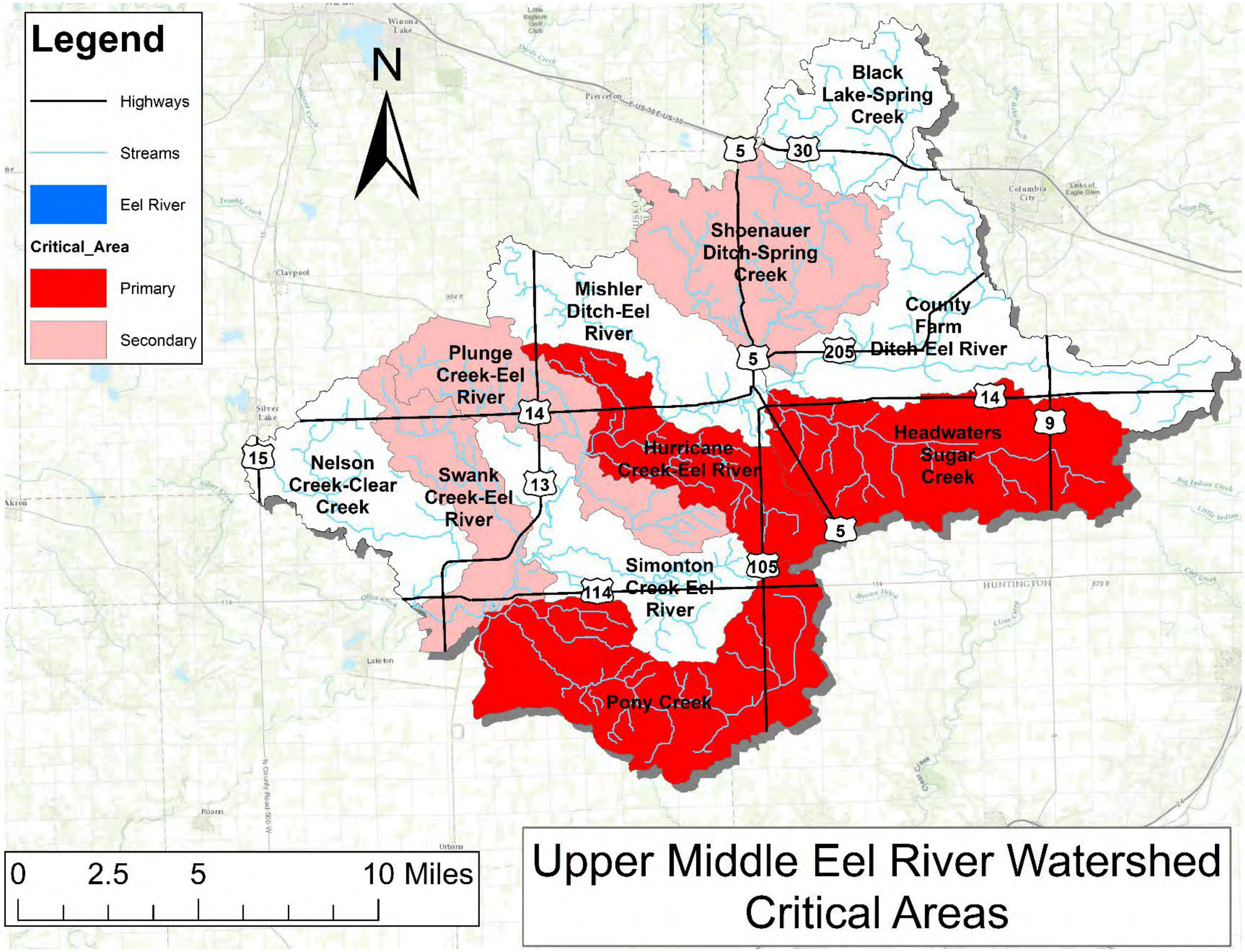

Figure 5-1. Location of 12 digit HUC primary and secondary critical areas located within the Upper Middle Eel River Watershed

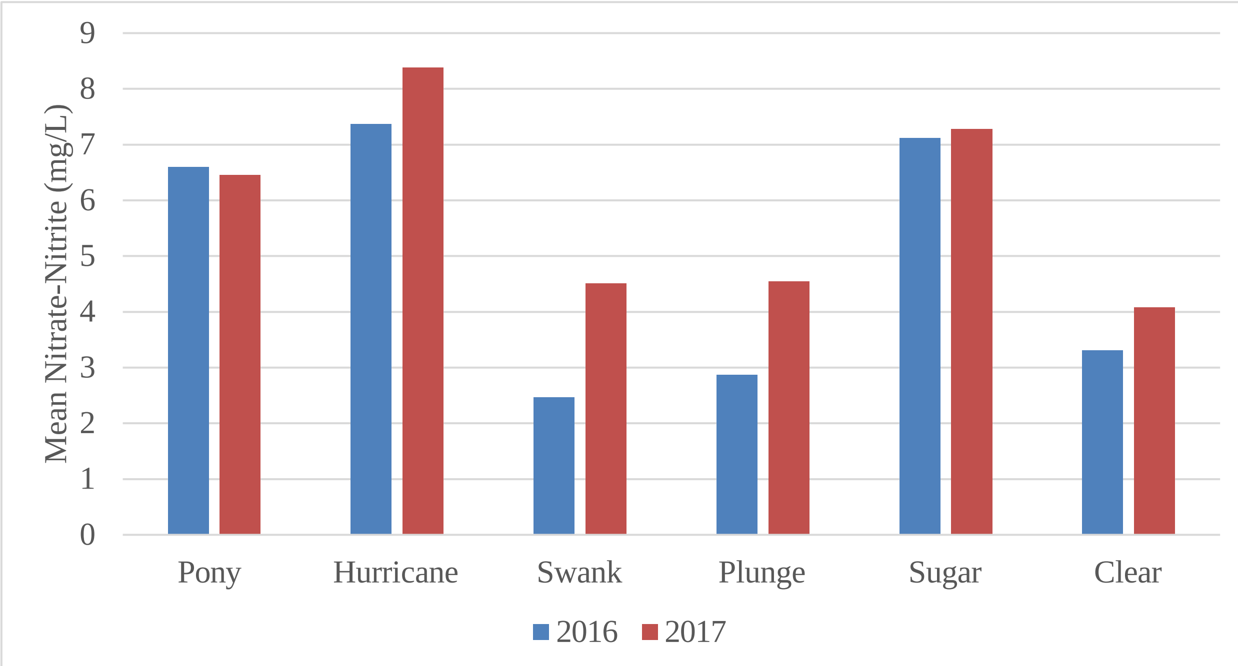

Figure 5-2. Upper Middle Eel River Watershed 2016 and 2017 mean nitrate-nitrite (mg/L) concentrations for each testing tributary. Targeted concentration is 2.2 mg/L

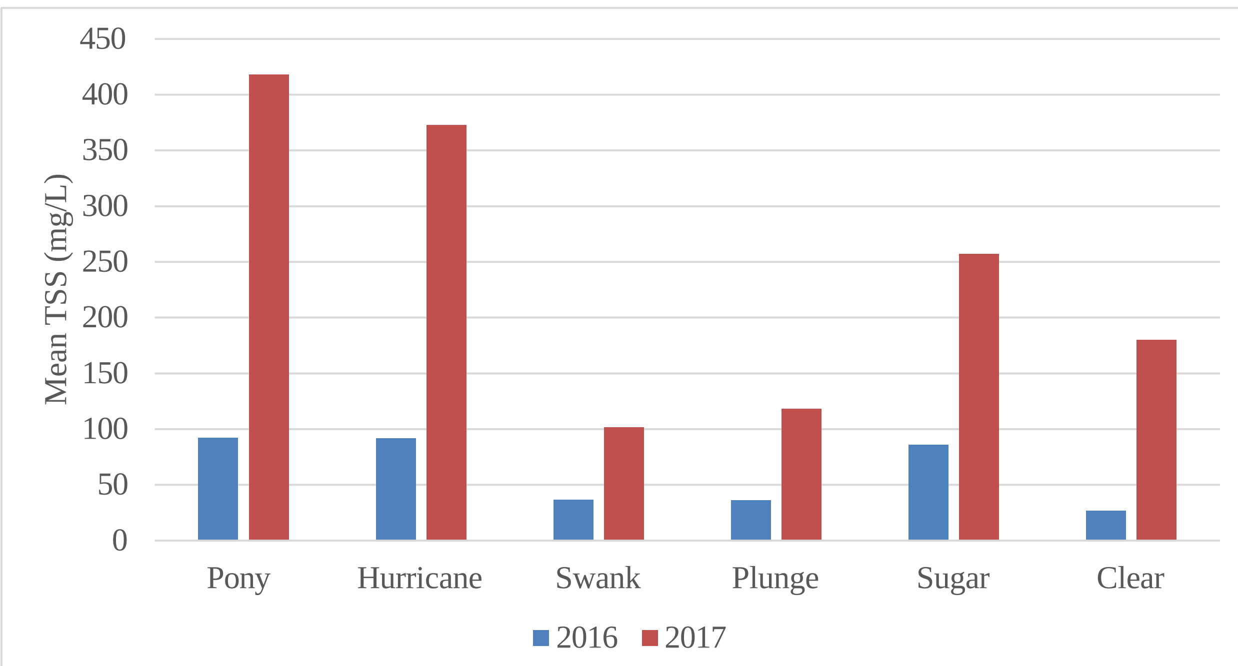

Figure 5-3. Upper Middle Eel River Watershed 2016 and 2017 mean total suspended solids (mg/L) concentrations for each testing tributary. Targeted concentration is 30 mg/L

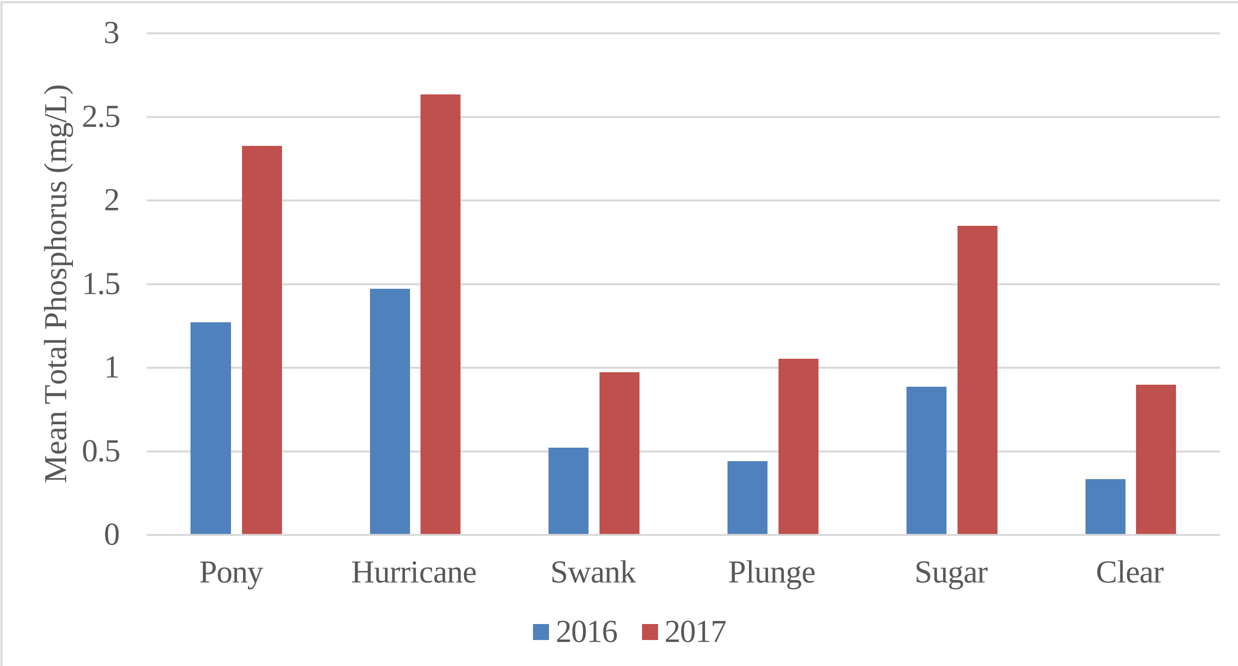

Figure 5-4. Upper Middle Eel River Watershed 2016 and 2017 mean total phosphorus (mg/L) concentrations for each testing tributary. Targeted concentration is 0.076 mg/L

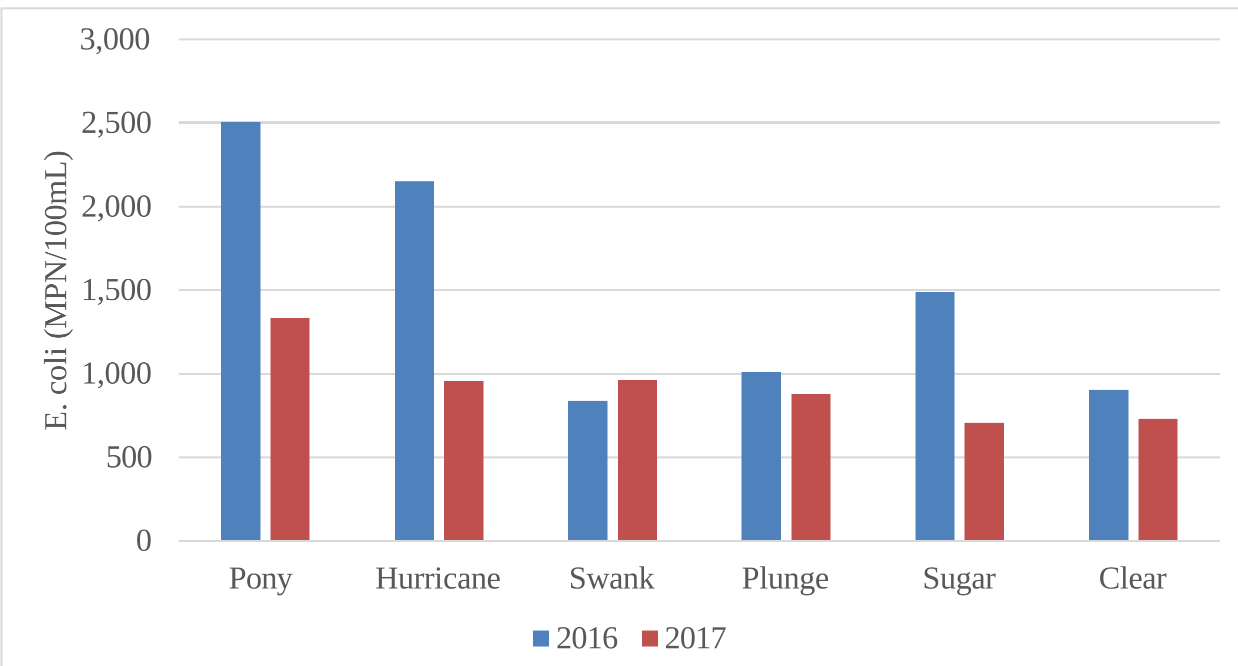

Figure 5-5. Upper Middle Eel River Watershed 2016 and 2017 mean E. coli (MPN/100mL) concentrations for each testing tributary. Targeted concentration is 235 mg/L

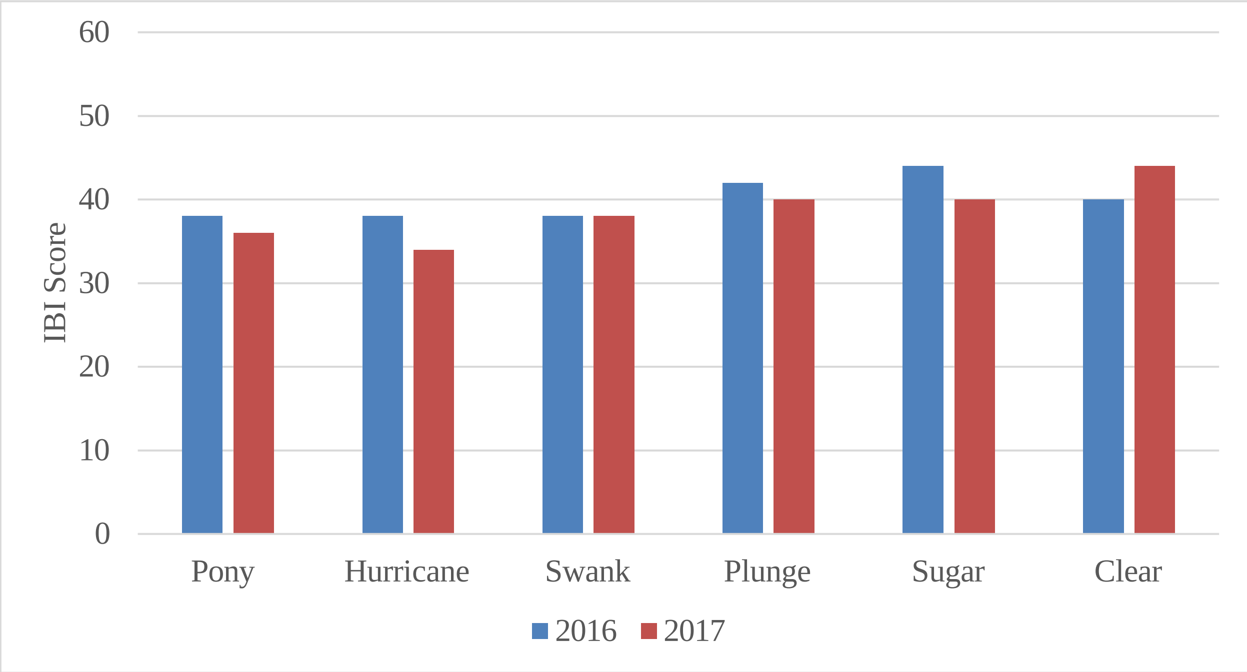

Figure 5-6. Upper Middle Eel River Watershed 2016 and 2017 index of biotic integrity score for each testing tributary. Targeted concentration is 35 mg/L

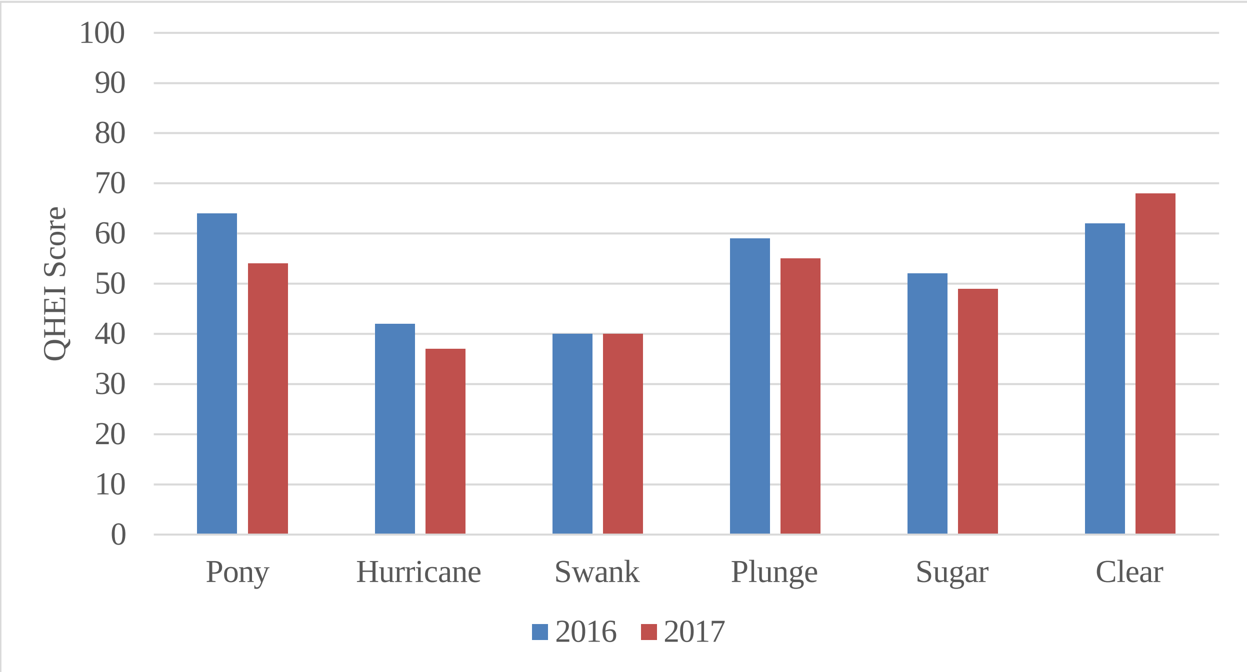

Figure 5-7. Upper Middle Eel River Watershed 2016 and 2017 qualitative habitat evaluation index score for each testing tributary. Targeted concentration is 60 mg/L

Upper Middle Eel River
Watershed Management Plan

Section 6
Goals, Management Measures, and Objectives

6.1 Goals

Critical Areas were selected by the steering committee by quantification of data collected by Manchester University throughout the UMERW. After determination of the critical areas it is important to determine what goal will be set forward in the WMP. It is important to the steering committee that all goal will have the opportunity to be quantified, thus the selection of data rich watersheds at the critical areas. It is the overall goal of the project to reduce pollutant loads and reduce the quantity of pollutant sources that are influencing the Gulf of Mexico, Lake Eutrophication, and instream biota. However, in order to reach this overall goal, more attainable goals were developed. Each goal will lead to the overall improvement in water quality. It is also important to be able to measure the progress being made toward meeting each of the goals. Therefore, indicators were determined that will be used as a measurement tool and are listed in the following section as well.

6.1.1 Reduce Nitrate-Nitrite Loading

Water quality sampling within the UMERW has documented increased levels of Nitrate-Nitrite pollution within the watershed. All six tributaries that were sampled by Manchester University averaged Nitrate-Nitrite concentration above the targeted concentration. The average Nitrate concentration at these 12 digit HUC was 5.24 mg/L with one site that averaged nearly 8 mg/L. Nitrate-Nitrite concentration exceeded the target value of 1.6 mg/L in 87% of the samples collected. Samples collected from the mainstem of the Eel River documented a similar trend, with the Nitrate- Nitrite concentration average of 4.6 mg/L at the three gage sites. Concentrations exceeded the targeted value in 99% of the >1,500 samples taken from the mainstem of the Eel River

Goal Statement – Nitrate-Nitrite

The goal of this project to reduce Nitrate-Nitrite in water samples to meet the targeted level of 1.6 mg/L in 33% of the samples by 2030, 66% of the samples by 2040, and in 100% of the samples collected by 2050.

Indicators

Water Quality and Administrative indicators will be used to determine the progress towards meeting the Nitrate-Nitrite reduction goal in the UMERW.

Water Quality Indicator

Water samples will be collected at a minimum monthly throughout the year at the six 12 digit watershed samples sites and the three gage sites that were operated by Manchester University throughout the WMP development grant. Ideally, the sampling protocol that Manchester University has developed would continue to for the most accurate dataset analysis and comparison. Water quality monitoring will begin after five years of implementation. To determine if the goals are being reached. It would be expected to see a progressive increase in the quantity of samples that meet the target level of 1.6 mg/L for Nitrate-Nitrite each year.

Administrative Indicator

The quantity of new best management practices that have the potential to reduce Nitrate-Nitrite levels will be monitored and the estimated load reduction based on installed BMP will be calculated.

6.1.2 Reduce Total Phosphorus Loading

Water quality sampling within the UMERW has documented increased levels of Total Phosphorus pollution within the watershed. All six tributaries that were sampled by Manchester University averaged Total Phosphorus concentration above the targeted concentration. The average Total Phosphorus concentration at these 12 digit HUC was 1.17 mg/L with that is greater than 15 times the targeted concentration. Total Phosphorus concentration exceeded the target value of 0.076 mg/L in 98% of the samples collected at the 12 digits HUCs. Samples collected from the mainstem of the Eel River documented a similar trend, with the Total Phosphorus concentration average of 1.08 mg/L at the three gage sites. Concentrations exceeded the targeted value in 100% of the >1,500 samples taken from the mainstem of the Eel River

Goal Statement – Total Phosphorus

The goal of this project to reduce Total Phosphorus in water samples to meet the targeted level of 0.076 mg/L in 33% of the samples by 2030, 66% of the samples by 2040, and in 100% of the samples collected by 2050.

Indicators

Water Quality and Administrative indicators will be used to determine the progress towards meeting the Total Phosphorus reduction goal in the UMERW.

Water Quality Indicator

Water samples will be collected at a minimum monthly throughout the year at the six 12 digit watershed samples sites and the three gage sites that were operated by Manchester University throughout the WMP development grant. Ideally, the sampling protocol that Manchester University has developed would continue to for the most accurate dataset analysis and comparison. Water quality monitoring will begin after five years of implementation. To determine if the goals are being reached. It would be expected to see a progressive increase in the quantity of samples that meet the target level of 0.076 mg/L for Total Phosphorus each year.

Administrative Indicator

The quantity of new best management practices that have the potential to reduce Total Phosphorus levels will be monitored and the estimated load reduction based on installed BMP will be calculated.

6.1.3 Reduce E. coli Concentration

Water quality sampling within the UMERW has documented increased levels of E.coli concentrations within the watershed. Out of the six tributaries that were sampled by Manchester University, five sites averaged E.coli concentration above the targeted concentration. The average E.coli concentration at these 12 digit HUC was 1,949.13 CFU/100mL with three site that averaged >2,500 CFU/100 mL. E.coli concentration exceeded the target value of 235 CFU/100 mL in 72% of the samples collected. Samples collected from the mainstem of the Eel River documented a higher concentration of E.coli, with the concentration average of 2,152 CFU/100 mL at the three gage sites. Concentrations exceeded the targeted value in 78% of the samples taken from the mainstem of the Eel River

Goal Statement – E. Coli

The goal of this project to reduce E.coli in water samples to meet the targeted level of 235 CFU/mL in 33% of the samples by 2030, 66% of the samples by 2040, and in 100% of the samples collected by 2050.

Indicators

Water Quality and Administrative indicators will be used to determine the progress towards meeting the E.coli reduction goal in the UMERW.

Water Quality Indicator

Water samples will be collected at a minimum monthly throughout the year at the six 12 digit watershed samples sites and the three gage sites that were operated by Manchester University throughout the WMP development grant. Ideally, the sampling protocol that Manchester University has developed would continue to for the most accurate dataset analysis and comparison. Water quality monitoring will begin after five years of implementation. To determine if the goals are being reached. It would be expected to see a progressive increase in the quantity of samples that meet the target level of 235 CFU/mL for E.coli in a single sample each year.

Administrative Indicator

The quantity of new best management practices that have the potential to reduce E.coli levels will be monitored and the E. Coli concentration level based on installed BMP will be calculated.

6.1.4 Reduce Total Suspended Solid Loading

TSS by volume is by many orders of magnitude the largest water pollutant in the Eel River. Water quality sampling within the UMERW has documented increased levels of TSS pollution within the watershed. All six tributaries that were sampled by Manchester University averaged TSS concentrations above the targeted concentration. The average TSS concentration at these 12 digit HUC was 145.53 mg/L and 213 NTU with three site that averaged >150 mg/L. TSS concentration exceeded the target value of 30 mg/L in 49% of the samples collected. Turbidity samples exceeded the targeted value of 10.4 NTU in 73% of the samples. Samples collected from the mainstem of the Eel River documented a lower average TSS concentration of 130 mg/L and 149 NTU. However the targeted concentrations exceeded more frequently on the mainstem with both TSS and NTU values exceeding the targeted value in 85% of the >1,500 samples taken from the mainstem of the Eel River

Goal Statement – Total Suspended Solids

The goal of this project to reduce Total Suspended Solids in water samples to meet the targeted level of 30 mg/L in 33% of the samples by 2030, 66% of the samples by 2040, and in 100% of the samples collected by 2050.

Indicators

Water Quality and Administrative indicators will be used to determine the progress towards meeting the Total Suspended Solids reduction goal in the UMERW.

Water Quality Indicator

Water samples will be collected at a minimum monthly throughout the year at the six 12 digit watershed samples sites and the three gage sites that were operated by Manchester University throughout the WMP development grant. Ideally, the sampling protocol that Manchester University has developed would continue to for the most accurate dataset analysis and comparison. Water quality monitoring will begin after five years of implementation. To determine if the goals are being reached. It would be expected to see a progressive increase in the quantity of samples that meet the target level of 30 mg/L for Total Suspended Solids each year.

Administrative Indicator

The quantity of new best management practices that have the potential to reduce Total Suspended Solids levels will be monitored and the estimated load reduction based on installed BMP will be calculated.

6.1.5 Improve Instream Aquatic Habitat and Increase Biotic Scores

Biological and instream Habitat assessments throughout the watershed have documented some reductions in quantifiable scores. The target values set forth by this WMP is a minimum score of 35 for the IBI and 60 for the QHEI. Fisheries surveys conducted during the summer field season documented only one survey that fell below a score of 35 at the six tributaries sites and once at the Eel River gage sites. However, the QHEI did not follow this same pattern with 67% of the surveys documenting a score less than 60 at the tributaries sites and a 50% of the surveys below 60 at the Eel River gage sites. The targeted value for the IBI was set at the threshold that is considered supporting of fish life, but not necessarily a health stream system. Increased IBI score up into the 40's and 50's would document a shift in the stream ecosystem and a possible surrogate for better water quality.

Goal Statement – Improve IBI and QHEI above targeted value

The goal of this project to improve IBI and QHEI scores in all tributaries and mainstem site to exceed the targeted levels of 35 and 60 respectively. By 2030 IBI scores should be at minimum 38 and 60 for QHEI. By 2040 IBI scores should be at minimum 42 and 65 for QHEI. By 2050 IBI scores should be at minimum 48 and 65 for QHEI.

Indicators

Water Quality and Administrative indicators will be used to determine the progress towards meeting the IBI and QHEI goals in the UMERW.

Water Quality Indicator

Annual biological and habitat monitoring will be conducted at the six 12 digit watershed samples sites and the three gage sites that were operated by Manchester University throughout the WMP development grant. Biological monitoring will begin after five years of implementation. To determine if the goals are being reached is would be expected to see a progressive increase in the quantity of samples that exceed the target level of 35 for IBI and 60 for QHEI each year.

Administrative Indicator

The quantity of new best management practices that have the potential to increase IBI and QHEI levels will be monitored and analysis of effectiveness will be completed.

6.1.6 Improve Public Awareness of Nonpoint Source Pollution and General Understanding of the Eel River Watershed

Another important aspect of improving water quality is the public involvement. Recreational opportunities are limited on the Eel River and many misconceptions about the river are present within the local communities. Many individuals have commented that the river is “dirty”, “unsafe”, etc. Many of these same individuals lack the understanding of watersheds and their personal impacts on the river ecosystem. Additionally, many agriculture producers within the watershed are unclear of their effects on water quality and believe that there are no fish in headwater streams. Fisheries creel surveys and surveys at public events have confirmed similar that there is a limited knowledge about the Eel River amongst the public.

Goal Statement – Public Outreach

The goal of this project is to create and promote an education and outreach program throughout the UMERW to emphasis individual impacts on water quality and what recreational resources the Eel River can provide by 2025.

Indicators

Social and Administrative indicators will be used to determine the progress towards meeting the increased public awareness goal in the UMERW.

Social Indicator

Pre and post education and outreach surveys regarding water quality, watersheds concept, and reactional opportunities will be conducted to determine individuals’ knowledge regarding these concepts. Fisheries creel surveys will be completed to monitor the fishing activity on the Eel River. It would be expected as public outreach become more frequent that an increase in river fishing, public knowledge on the Eel River, and event participation will be documented.

Administrative Indicator

The participation numbers at each UMERWI event will be tracked and will be tracked at all public events.

6.2 Best Management Plan Implementation

In order to address critical areas, best management practices and conservation measures will need to be taken. The UMERW Steering Committee considered many management practices and measures available to address the critical areas and will be the focus of phase two of the UMERW project. In the table below, several practices and measures are outlined, and the predicted load reduction is presented for each BMP. Load reduction estimates were determined using either the Region 5 or STEP-L models and assumptions that were used to determine the load reductions in each of the models is outlined in the table as well. The model that was used to determine load reductions for each practice is identified in the table below. The following list is not all- inclusive and other practices and management measures may be added to the list in the future. Selected practices with descriptions are listed below Table 6-2.

Table 6-1. Best Management Practices chosen by the steering committee to address parameters of concern within the Upper Middle Eel River Watershed. (Additional BMP can be added to address particular scenarios if they will address pollutants of concern)

Practice Code	Conservation Practice	Target Pollutant	Unit	Ave. Cost per Unit	75% Cost-Share
472	**Access Control**	***E. coli*, nutrients**	**Ac.**	**$44.83**	**$33.62**
316	**Animal Mortality Facility**	***E. coli***	**Animal Unit**	**$158.51**	**$118.88**
342	**Critical Area Planting**	**Sediment**	**Ac.**	**$291.76**	**$218.82**
340	**Cover Crops**	**Sediment, nutrients**	**Ac.**	**$36.07**	**$27.05**
	Equipment Modification (Conservation Tillage, Cover Crops, and /or Precision Nutrient Application)	**Sediment, *E. coli*, nutrients**	**No.**		**Cap $10,000**
382	**Fence**	***E. coli*, nutrients**	**Ft.**	**$1.41**	**$1.06**
393	**Filter Strip**	**Sediment, nutrients**	**Ac.**	**$559.20**	**$419.40**
410	**Grade Stabilization Structure**	**Sediment**	**No.**	**$154.32**	**$115.74**
412	**Grassed Waterway (with Erosion Control Blanket)**	**Sediment, nutrients**	**Ac.**	**$2,790.66**	**$2,093.00**
606	**Subsurface Drain (only with other BMP's)**	**Nutrients**	**Ft.**	**$4.89**	**$3.67**

561	**Heavy Use Area Protection**	**Sediment**	**Sq. Ft.**	**$1.06**	**$0.80**
468	**Lined Waterway Outlet**	**Sediment, nutrients**	**Ft.**	**$1.30**	**$0.98**
590	**Nutrient Management**	**Nutrients**	**Ac.**	**$5.96**	**$4.47**
582	**Open Channel (2-Stage Ditch)**	**Sediment, nutrients**	**Ft.**	**$8.89**	**$6.67**
512	**Pasture & Hay Planting**	**Sediment, nutrients**	**Ac.**	**$224.10**	**$168.08**
516	**Pipeline**	**Sediment**	**Ft.**	**$1.70**	**$1.28**
528	**Prescribed Grazing**	**Sediment,**	**Ac.**	**$33.45**	**$25.09**
329/345	**Residue Mngt. No Till**	**Sediment, nutrients**	**Ac.**	**$15.88**	**$11.91**
578	**Stream Crossing**	***E. coli*, nutrients**	**No.**	**$3.38**	**$2.54**
585	**Strip Cropping**	**Sediment, nutrients**	**Ac.**	**$1.23**	**$0.92**
587	**Structure for Water Control**	**Nutrients**	**No.**	**$2,955.52**	**$2,216.64**
391	**Riparian Forested Buffer**	**Sediment, nutrients**	**Ac.**	**$744.13**	**$558.09**
620	**Blind Outlet**	**Sediment**	**CU Yd**	**$36.68**	**$27.51**
313	**Waste Storage Facility**	***E. coli*, nutrients**	**Sq. Ft.**	**$1.70**	**$1.28**
638	**Waste & Sediment Control Basin**	**Sediment, nutrients**	**Cu Yd**	**$2.22**	**$1.67**
614	**Watering Facility**	***E. coli*, nutrients**	**No.**	**$569.12**	**$426.84**
605	**Denitrifying Bioreactor**	***Nitrogen***	**Cu Yd**	**$35.13**	**$26.34**
657	**Wetland Restoration**	**Sediment, nutrients**	**Ac.**	**$1,471.68**	**$1,103.76**

Table 6-2. Possible placement of BMPs to address particular issues of concern in critical areas and estimated load reductions. 1) Region 5 model, 2) STEPL. (Bold represents primary critical areas)

Critical Area	Reason for Being Critical	BMP	Assumptions Used	Estimated Load Reduction per BMP		
				Sediment tons	Phosphorus lbs	Nitrogen lbs
Pony Creek, Hurricane Creek, Sugar Creek	High Nitrate-Nitrite	Education and Outreach		N/A	N/A	N/A
		Access Control		N/A	N/A	N/A
		Cover Crops[2]	Planted a day after harvest. Cover crop killed and left as residue on field (one hundred acre)	3.6 tons/ acre/year	7 lbs/ acre/year	57.4 lbs/ acre/year
		Filter Strips[1]	One Arce of contributing area	0.12 tons/ year	0.47	0.88
		Grass Waterways[1]	Width: 10 ft Depth: 1 ft Length: 300 ft	14.9 tons/year	12.6 lbs/year	25.2 lbs/year
		Blind Inlet		N/A	N/A	N/A
		Nutrient Management[2]	Managed on 100 acres	N/A	16.6 lbs/year	36 lbs/year
		Two-Stage Ditch[1]	Length: 1000 ft Height: 10 ft Existing lateral movement: 0.3 75% efficiency	95.6 tons/year	95.6 lbs/year	191.3 lbs/year
		Drainage Water Management		N/A	N/A	N/A
		No Till[2]	Applied to 100 acres	27.8 tons/year	59.6 lbs/year	147.3 lbs/year

		Riparian Buffer[1]	Model for streambank protection was used for 1000 feet both banks	151 lbs/year	151 lbs/year	306 lbs/year
		Bioreactor[2]	Contributing Area 100 Acres	N/A	N/A	106 lbs/year
		Waste Storage	Based on 10,000 Swine	N/A	617 lbs/year	3,343 lbs/year
		Access Control		N/A	N/A	N/A
Pony Creek, Hurricane Creek, Plunge Creek	Total Phosphorus	Cover Crops[2]	Planted a day after harvest. Cover crop killed and left as residue on field (one hundred acres)	3.6 tons/ acre/year	7 lbs/ acre/year	57.4 lbs/ acre/year
		Filter Strips[1]	One Arce of contributing area	0.12 tons/ year	0.47	0.88
		Grass Waterways[1]	Width: 10 ft Depth: 1 ft Length: 300 ft	14.9 tons/year	12.6 lbs/year	25.2 lbs/year
		Blind Inlet		N/A	N/A	N/A
		Nutrient Management		N/A	N/A	N/A
		Two-Stage Ditch[1]	Length: 1000 ft Height: 10 ft Existing lateral movement: 0.3 75% efficiency	95.6 tons/year	95.6 lbs/year	191.3 lbs/year
		Drainage Water Management		N/A	N/A	N/A

		No Till[2]	Applied to 100 acres	27.8 tons/year	59.6 lbs/year	147.3 lbs/year
		Waste Storage	Based on 10,000 Swine	N/A	617 lbs/year	3,343 lbs/year
		Cover Crops[2]	Planted a day after harvest. Cover crop killed and left as residue on field (one hundred acres)	3.6 tons/ acre/year	7 lbs/ acre/year	57.4 lbs/ acre/year
		Filter Strips[1]	One Arce of contributing area	0.12 tons/ year	0.47 lbs/year	0.88 tons/year
		Grass Waterways[1]	Width: 10 ft Depth: 1 ft Length: 300 ft	14.9 tons/year	12.6 lbs/year	25.2 lbs/year
		Blind Inlet		N/A	N/A	N/A
		Two-Stage Ditch[1]	Length: 1000 ft Height: 10 ft Existing lateral movement: 0.3 75% efficiency	95.6 tons/year	95.6 lbs/year	191.3 lbs/year
Pony Creek, Hurricane Creek, Sugar Creek, Plunge Creek	TSS	No Till[2]	Applied to 100 acres	27.8 tons/year	59.6 lbs/year	147.3 lbs/year
		Wetland Restoration				
		Prescribed Grazing[1]	Applied to 1 acre	3 tons/year	3 lbs/year	6 lbs/year
		Two-Stage Ditch[1]	Length: 1000 ft Height: 10 ft	95.6 tons/year	95.6 lbs/year	191.3 lbs/year

			Existing lateral movement: 0.3 75% efficiency			
		Two-Stage Ditch[1]	Length: 1000 ft Height: 10 ft Existing lateral movement: 0.3 75% efficiency	95.6 tons/year	95.6 lbs/year	191.3 lbs/year
Pony Creek, Hurricane Creek, Sugar Creek, Swank Creek, Clear Creek, Plunge Creek	Low IBI					
Hurricane Creek, Sugar Creek, Swank Creek	Low QHEI					

Cover Crops

Cover crops include legumes, such as clover, hairy vetch, and alfalfa, and non-legumes, such as rye, oats, wheat, radishes, turnips, and buckwheat which are planted prior to or following crop harvest. Cover crops typically grow for one season to one year and are typically grown in non-cropping seasons. Cover crops are used to improve soil quality and future crop harvest by improving soil tilth, reducing wind and water erosion, increasing available nitrogen, suppressing weed cover, and encouraging beneficial insect growth. Cover crops reduce phosphorus transport by reducing soil erosion and runoff. The cover crop vegetation recovers plant-available nutrients in the soil and recycles them through the plant biomass for succeeding crops.

Drainage Water Management

Subsurface tile drainage is an essential water management practice on highly productive fields. As a result of tile drainage, nitrate carried in drainage water enters adjacent surface waterbodies. Drainage water management is necessary to reduce nitrate loads entering adjacent surface waterbodies from tile drainage networks. Drainage water management uses water control structures within lateral drains to vary the depth of tile outlets. Typically, the outlet is raised after harvest to limit outflow from the tile and reduce nitrate transport to adjacent waterbodies; lowered in the spring and fall to allow tile water to flow freely from the field to adjacent waterbodies; and raised in the summer to help store water making it available for crops. Drainage water management can be used in concert with a suite of other conservation practices including subirrigation, cover crops and conservation tillage to promote a systems approach and be better stewards of water quantity.

Grass Waterway

Grass waterways are natural or constructed channels established for transport of concentrated flow at safe velocities using adequate channel dimensions and proper vegetation. They are generally broad and shallow by design to move surface water across farmland without causing soil erosion. Grassed waterways are used as outlets to prevent rill and gully formation. The vegetative cover slows the water flow, minimizing channel surface erosion. When properly constructed, grassed waterways can safely transport large water flows downslope. These waterways can also be used as outlets for water released from contoured and terraced systems and from diverted channels.

No-till & Conservation Tillage

Conservation tillage refers to several different tillage methods or systems that leave at least 30% of the soil covered with crop residue after planting (Holdren et al., 2001). Tillage methods encompassed by conservation tillage include no-till, mulch-till, ridge-till, and strip till. The purpose of conservation tillage is to reduce sheet and rill erosion, maintain or improve soil organic matter content, conserve soil moisture, increase available moisture, reduce plant damage, and provide habitat and cover for wildlife. The remaining crop residue helps reduce soil erosion and runoff volume.

Nutrient Management

Nutrient management is the management of the amount, source, placement, form, and timing of the application of plant nutrients and soil amendments to minimize the transport of applied nutrients into surface water or groundwater and can be in commercial/non-manure fertilizer or manure-based fertilizers. Nutrient management seeks to supply adequate nutrients for optimum crop yield and quantity, while also helping to sustain the physical, biological, and chemical properties of the soil. A nutrient budget for nitrogen, phosphorus, and potassium is developed considering all potential sources of nutrients including, but not limited to, animal manure, commercial fertilizer, crop residue, and legume credits. Realistic yields are based on soil productivity information, potential yield, or historical yield data based on a 5-year average. Nutrient management plans specify the form, source, amount, timing, and method of application of nutrients on each field in order to achieve realistic production levels while minimizing transport of nutrients to surface and/or groundwater.

Two-Stage Ditch

When water is confined to stream or ditch channel it has the potential to cause bank erosion and channel down-cutting. Current ditch design generates narrow channels with steep sides. Water flowing through these systems often result in bank erosion, channel scour and flooding. A relatively new technique focuses on mitigating these issues through an in-stream restoration called a two-stage ditch. The design of a two-stage ditch incorporates a floodplain zone, called benches, into the ditch by removing the ditch banks roughly 2-3 feet above the bottom for a width of about 10 feet on each side depending on the size of the channel. This allows the water to have more area to spread out on and decreases the velocity of the water. This not only improves the water quality, but also improves the biological conditions of the ditches where this is located.

Waste Storage

Animal waste is a major source of pollution to waterbodies. To protect the health of aquatic ecosystems and meet water quality standards, manure must be safely managed. Good management of manure keeps livestock healthy, returns nutrients to the soil, improves pastures and gardens, and protects the environment, specifically water quality. Poor manure management may lead to sick livestock, unsanitary and unhealthy conditions for humans and other organisms, and increased insect and parasite populations. Proper management of animal waste can be done by implementing BMPs, through safe storage, by application as a fertilizer, and through composting. Proper manure management can effectively reduce E. coli concentrations, nutrient levels and sedimentation. Manure management can also be addressed in education and outreach to encourage farmers to participate in this BMP.

6.3 Action Register and Schedule

The goals set forward by this WMP will help achieve the overall country goal to reduce the impact of the Midwest on the Gulf of Mexico hypoxic zone. In order to systematically achieve these ambitious goals a set of objectives has been developed and will be executed to work toward the final goal. Each objective has milestones to breakdown the objective down into specific actions and deliverables and provide a set timeline for completion. The following tables are action registers which outline the measures that will need to be implemented in order to reach the goals set for the WMP. The first table is a general action register for the project as a whole, identifying specific tasks that need to be accomplished to implement the entire WMP including hiring personnel and acquiring funding, providing education and outreach, and cost share development and promotion. Action Registers for each address the pollutants or management measures that are causing the areas to be impaired. The critical area Action Registers outline the number of BMPs that will need to be installed within critical area to reach the necessary load reductions to meet target levels. Milestones are set for each of the BMPs stating how many, and/or what size of BMP will be installed to meet the goals set by this project. BMPs are not determined per sub-watershed as it is unknown where implementation will be successful, but rather the total number, or size, or BMP needed to reach the total load reduction necessary to meet the target load is presented. Technical assistance for the project comes in many forms such as: member of steering committee, funding resources, BMP expertise, social networking, event sponsoring, event management, etc. Each objective and milestone relies on built partnerships and their technical assistance in which they provide. Partnerships and technical assistance can be found followed each milestone.

6.3.1 General Action Register for Implementation of UMERWI WMP

Table 6-3. Action Register for Implementation of the UMERW WMP

Hire Personnel and Acquire Necessary Funding					
Objective	**Target Audience**	**Implementation Timeframe**	**Milestone**	**Estimated Cost**	**Partners (P)/Technical Assistance (TA)**
Implement the Upper Middle Eel River Watershed Management Plan	Eel River Watershed Stakeholders and public	Within 3 years of the WMP approval and ongoing	Hire Watershed Coordinator to implement the WMP (6 months)	$45,000/Year	Wabash, Whitley, Huntington, Kosciusko County SWCD and NRCS, IDEM, IDNR (P and TA)
			Secure Funding to Implement the WMP and office overhead	$3,000	
			Secure Funding to Promote Education and Outreach	INS	

INS: Included in Salary

Table 6-4. Action Register for Implementation of Education and Outreach Program

Education and Outreach					
Objective	**Target Audience**	**Implementation Timeframe**	**Milestone**	**Estimated Cost**	**Partners (P)/Technical Assistance (TA)**
Develop and Implement an Agriculture based Education and Outreach program [1]	Eel River Watershed Agriculture Producers	Within 2 years of WMP approval	Develop outreach plan (6 months)	INS	Wabash, Whitley, Huntington, Kosciusko County SWCD and NRCS (P and TA), Local Purdue Extension (P),
			Distribute agriculture based brochure at outreach events & mailed to producers (1 yr)	$1,000	
			Distribute agriculture based newsletters electronically & by mail (every 6 months)	$1,000	
			Hold annual workshops and BMP field days (starting after 1 yr)	$1,000/Year	
Develop and Implement a Watershed based Education and Outreach Program [2]	Eel River Watershed General Public	Within 2 years of WMP approval	Develop Outreach Plan (6 months)	INS	Wabash, Whitley, Huntington, Kosciusko County SWCD and NRCS (P and TA) ACRES land Trust (P), Miller Canoe Rental (P), Stockdale Mill Foundation (P), North Manchester Center for History (P)
			Distribute Watershed Based Brochure at outreach events (1 yr)	$1,000	
			Distribute Watershed Based Newsletters electronically (6 mo.)	$1,000	
			Hold Annual Public River Event (1 Year)	$2,000/Year	

INS: Included in Salary

1. Agriculture topics will promote soil health, BMPs listed in Table 6-1, and cost-share opportunities.
2. Watershed topics will highlight water connectivity, water quality concerns, local natural resources, & improvement opportunities

Table 6-5. Action Register for Tracking Goal Indicators

Milestones for Indicators					
Objective	**Target Audience**	**Implementation Timeframe**	**Milestone**	**Estimated Cost**	**Partners (P)/Technical Assistance (TA)**
Develop and Analyze Social Survey for Reactional Opportunities within and the overall conception of the Eel River	Eel River Watershed Stakeholder and Public	Within 2 years of WMP approval	Social Indicator Study to determine reactional usage of the Eel River (every 2 years)	$500	Wabash, Whitley, Huntington, Kosciusko County SWCD and NRCS (P and TA) North Manchester Center for History (P), Stockdale Mill Foundation (P)
			Social Indicator Study to Determine general knowledge of public about the Eel River (every 2 years)	$500	
			Hold Annual Workshops to Present Data and Findings about the Eel River	$1,000	
Water Quality Sampling	Eel River Watershed Stakeholder	Within 5 years of WMP approval	Water Quality Monitoring follows design developed by Manchester University	$40,000/Year	Wabash, Whitley, Huntington, Kosciusko County SWCD and NRCS Ecosystems Connections Institute, LLC, IDEM, IDNR (P and TA)

INS: Included in Salary

6.3.2 Action Register for Implementation of Cost Share Program

Implementation of the cost share program will provide estimate of overall pollutant load reduction. This section will focus on the action register items focused on the implementation of BMP into the critical areas. The action register includes data regarding the quantity of BMP that will be installed, the total that will be installed over 30 years, the cost of implementation over 30 years, and the estimated load reduction. It is important to address that the load reduction of individual BMP could vary based on many variables. First, BMP that are continually or permanently installed often increase in load reduction potential. For example, when no till practices are used there will be greater organic matter and load reduction potential in year 5 than in year 1. Secondly, practices implemented in series have a greater potential to reduce pollutants than individual practices. For example, a field with a drainage water control structure and cover crops has a greater potential to remove nutrients than each practice individually. For these reasons estimated nutrient removal could underestimate overall load reduction. However, it should be noted that the model would predict that each practice would be continuous, thus if a practice would be removed from the field the models would not accurately depict the correct pollutant load reduction. Water quality testing 5 years of implementation will aid in understanding what the actual load reduction is from BMP efforts. All BMP implementations will involve partnerships and technical assistance from Wabash, Whitley, Huntington, and Kosciusko County NRCS and SWCD. IDEM and IDNR can provided technical assistance in the form of implementation funding.

Table 6-6. Action Register for Implementation of Cost Share program

Objective	Target Audience	Implementation Timeframe	Action	Milestone	Quantity		Load Reduction			Estimated Cost
					Annual	Total	Sediment Tons/year	Phosphorus Lbs/year	Nitrogen Lbs/year	
Implement Agriculture BMP in UMERW Primary Critical Areas to Reduce Pollutant Loading	Agriculture Producers in Critical Areas	Within 30 Years of WMP Approval	Cover Crops	1,000 new acres per year	1,000 ac	30,000 ac	36	70	574	$1,082,100
			Two Stage Ditch	1 project per 2 years	500 lf	6,000 lf	47.8	47.8	85	$240,000
			No Till	1,000 new acres per year	1,000	30,000	278	596	1473	$200,000
			Bioreactor	1 project per 5 years	.20	6 reactors	-	-	21.2	$60,000
			Riparian Buffer	1,500 feet annually	1,500 lf	45,000	226.5	226.5	459	$500,000
			Grass Waterways	1,500 feet annually	1,500 lf	45,000 lf	74.5	63	126	$957,083
			Nutrient Management	1,000 ac	1,000 ac	30,000 ac	-	166	360	$178,800
			Prescribed Grazing	500 ac	500 ac	15,000 ac	1,500	1,500	3,000	$501,750
			Blind Inlet	2	60					$60,000
			Drainage Water Management	2	60					$177,331

6.4 Pollutant Load Reduction Estimates

Items summarized in the BMP action register were determined by analysis of anticipated landowner wiliness to participate in the cost share program and the technical expertise provided by local NRCS district conservationist on practice they believed suitable and probable in the UMERW. BMP were analyzed using the Spreadsheet Tool for Estimating Pollution Load (STEPL) or the Region 5 Load reduction model. It is important to note that not all BMP options were available within these two models. Additionally, both models predict BMP will be a success and many times these models overestimate actual BMP success. For example, application of cover crops is a very complex project. Even though cover crops may be applied to 1000 acres annually only 50-75% of those acreages of cover crop might grow, thus the models are over predicting the loading reduction. Participation by agriculture producers in the critical watershed is crucial for the to meet the estimated of BMP implementation developed in the BMP action register. These load reductions are a best educated guess scenarios that only consider individual BMP working individually on an annual basis. As already stated early that BMP used in successive years have a cumulative effect of pollutants reduction and subsequent years BMP have a higher potential to remove pollutants. Additionally, BMP used in conjunction or a "Treatment Train" have the potential to remove a larger quantity of pollutants than individual BMP do separated.

Table 6-7 shows the estimated load reduction after implementation of the Action Registers for all critical areas. As can be seen in Table 6-7, according to estimated load reductions from various models only sediment can reach the necessary load reduction if all BMP implemented continue for all 30 years. Both total phosphorus and nitrogen goals will be met by the end of the 30 years. These agriculture systems are very complex and model reduction are questionable at best, as they cannot take into consideration all variable for individual BMP implementation and legacy pollutants already existing in the stream channel. Largescale landscape level modification for agriculture production has occurred since the 1800's. It is unrealistic to believe that in 30 or 50 years that the complexities of the landscape could be altered enough to meet the reduction goals. In today's society, there is an ever-growing human population that required or agriculture producers to innovate and increase yields to supply enough resources for the population. With this goal in mind many operations are focused on increased yields and not water quality of the Eel River.

Table 6-7. Estimated annual pollutant load reduction and cumulative reduction over 30 years with estimated cost for implementation of above described cost share.

Funding Resources: IDEM, USFWS, NRCS, IDNR, Local Producers				
	Sediment (tons/year)	**Phosphorus (lbs/year)**	**Nitrogen (lbs/year)**	**Estimated total Cost**
Estimated Load Reduction	2,162	2,669	6,098	$3,957,064
Necessary Annual Load Reduction	4,520.08	173,120	700,820	
Annual Percent Reduction	47%	2%	0.8%	
Estimated Load Reduction at Project End	64,884	80,079	182,946	

Upper Middle Eel River
Watershed Management Plan

Section 7 Future Activities

7.1 Indicator Tracking

Water Quality Indicator

Water quality monitoring will commence 3-5 years after implementation efforts in the UMERW have begun and continue throughout the remainder of the implementation period. Ideally, the monitoring design created by Manchester University will be followed but as financial resources are limited, a reduced monitoring design focused on monthly grab samples at the three critical watershed outlets will be developed. Data will be compared to based line data collected by Manchester University from 2015-2018. Analysis of load reduction will be compared to estimate provide by the Region 5 and STEPL models. Water quality monitoring described by Manchester University cost $40,000 annual whereas a reduced plan would cost $5,000 annually. Water quality analysis will be conducted by an external consulting firm.

Administrative Indicator

After BMP implementation begins all practices will be documented and recorded into a database. Datasets will include practice type, potential load reduction, how successful the project was, was the practice adopted after cost share was removed, and more as needed. These load reductions can be compared to water quality data to determine actual effectiveness. Participation at all UMERW events (public and agriculture) will be recorded. An increase in participation numbers could indicated an increase public awareness of the Eel River Watershed and issues that are present within the watershed boundary. Local NRCS and SWCD offices will tract BMP implementation and event participation. There is no cost associated with this indicator as it is built into their salaries.

Social Indicator

A public survey will be conducted every 5 years through different delivery methods. Surveys will be focused on knowledge of the Eel River, current agriculture practices, interest in the Eel River, overall conception of the Eel River, and individual effects on water quality. With continued public outreach these surveys should assess the how the general public interacts with the watershed and there understand on current issues. The watershed coordinator will develop the surveys and distribute the surveys with the assistance from local NRCS and SWCD. Cost associated with the surveys is material good at $2,000 per a survey.

Technical Assistance

Assistance provided to landowners and operators for improved BMP implementation will be provided by be local NRCS and SWCD offices located within the county. Overall plan implementation technical assistance can be addressed to Kosciusko County SWCD at (574) 267-7445 ext 3 or kosciuskoswcd@gmail.com

7.2 Future WMP Activities

This Watershed Management Plan is full of useful information about the Upper Middle Eel Watershed. Information includes land use statistics, current practices, pollutant sources, and extensive water quality monitoring data for much of the UMERW. This information is not well documented or well known in other portions of the community therefore major aspects of the WMP will be introduced to the public at multiple annual meetings held throughout the watershed. Providing data regarding the extent of the pollutant loads and water quality issues will help describe the concern within the watershed and hopefully entice a change in behaviors to improved water quality.

In order to continue the informative data collection, water quality monitoring will commence after implementation efforts in the UMERW have begun and continue throughout the remainder of the implementation period. Ideally, the monitoring design created by Manchester University will be followed but as financial resources are limited, a reduced monitoring design focused on grab samples at the three critical watershed outlets will be developed by the SWCD. To implement this monitoring program, Hoosier Riverwatch training and volunteers will be utilized.

Following the approval of this WMP the UMERW steering committee will develop a cost-share program that will include at least the BMP outline in the Action Register. The cost share program will rely on the technical expertise of the local NRCS DC to include practices that are feasible throughout the UMERW critical areas. A vital aspect of any cost share program success is the education and outreach aspects. Field days, meetings, workshops, river events will all be held annually to insure a constant engagement with the local stakeholder and public of the Eel River Watershed. It is encouraged that this WMP be used by other organizations with the Eel River Watershed to help define and prioritize planning efforts so that a cohesive implementation approach can be utilized. The first and most important priority of the UMERW is to locate and secure funding resources to implement projects and begin completing objectives outlined in the action registers. Manchester University will distribute this WMP to all stakeholder organization group located in the UMERW as well as have hard copies on hand and available to loan if needed.

While this WMP is a good reference point for this particular point in time, these watersheds are very dynamic and continually change as land uses change, towns expand, political influences change, populations increased, etc. For these reasons and many more the impact on water quality and pollutant loads are unclear in the future. As the watershed changes, adaptive management will be utilized. This adaptive management style will allow the review of our administrative, social, and environmental indicators and modification to our efforts as needed. Therefore, the WMP must remain a living document and the goals, objective, and actions outlined will be revaluated at least every 10 years to address these new features and develop a systematic approach to reaching the overall end goal. Kosciusko County SWCD will be responsible for the measurement of success, through the 10-year re-evaluation and revision of the WMP.

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