VFC Index - Watershed (Plan)

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Project Manager: Kathleen Hagan

Whitewater River Watershed

WATERSHED MANAGEMENT PLAN




Whitewater River Watershed

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Project Introduction

Below you will find information that details the reasons the community set out to create a watershed management plan. In addition, you will find a list of some of the major parties involved, as well as a list of important community concerns that shaped the development of this project.

The Whitewater River Watershed Project is a community initiative created to conduct a watershed inventory, create a management plan, and host various community education events.

1.1 Project Inception

Due to increasing community concern over several of the streams in the Whitewater Watershed, the Dearborn County Soil and Water Conservation District (SWCD) began searching for partners and ways to implement action and change into the watershed. With support from the Butler, Franklin, and Hamilton County SWCDs, the process for completing an application for a federal 319 grant for nonpoint source pollution was finished in 2012.

The data and knowledge related to the water quality in the Whitewater River Watershed contained gaps in information. 18 stream segments of the Whitewater River Watershed were known to be listed on the 2012 303(d) impaired waters list for E.coli and six of those were also listed as impaired for dissolved oxygen. The 303(d) list was a government maintained list under the Environmental Protection Agency's (EPA) Clean Water Act. Refer to Figure 22, for the impaired waters under the Previous Watershed Basin Survey data section of the plan. Although these 18 segments are listed on the 2012 303(d) list, little was known about the extent, sources, and causes of the impairments.

The land in the Whitewater River Watershed is mainly used for agriculture (row crop and pastureland) and consists of steep rolling hillsides. Other land cover in the area includes urban (low-density) and forest vegetation (shrub land, woodland). The various land uses in the watershed have the potential to produce excess sediment loads to surface waters, stream bank erosion, and degradation of water quality from excessive E. coli.

Although some areas are listed on the 303(d) list as areas of impairment, there is also one tributary of the watershed listed in Category 4N (Aquatic Life Use EWH (Exceptional Warm water Habitat) – natural causes or sources). This designation comes from the Ohio Environmental Protection Agency (EPA) under their Ohio Water Quality Standards (Administrative Code Chapter 3745-1) which ranks the tributary as having exceptional or unusual biological communities. [1]

With the increasing community concern and support for the watershed growing, the 319 grant application was completed in 2012. The Federal Clean Water Act Section 319(h) provides funding for various types of projects and organizations that work to reduce and address nonpoint source water pollution. Nonpoint source pollution is caused by rainfall or snowmelt moving over and through the ground, which picks up and carries away natural and human-made pollutants with it, finally depositing them into lakes, rivers, wetlands, coastal waters and ground waters. Indiana Department of Environmental Management's (IDEM's) Section 319 Nonpoint Source

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[1] Ohio Environmental Protection Agency, 2004. Ohio Water Quality Standards (OAC 3745-1) Overview, http://www.epa.state.oh.us/portals/35/wqs/WQS_overview_Apr04.pdf

Program provides funding and technical assistance to groups that work on the watershed level with communities to develop locally-based solutions to nonpoint source pollution. [2] By providing education and outreach opportunities to enrich the communities' understanding and care for the watershed these programs seek to directly reduce sources of nonpoint source pollution.

1.2 Partners and Stakeholders

The Whitewater River Watershed Project needs support from not only members of the community but also various agencies and partners to have a successful project. This project receives support in the form of media outlets, assistance with workshops/events/activities, meeting space, and supplies from the four SWCDs located in the watershed (Dearborn, Franklin, Hamilton, and Butler). In addition, the project benefits from other partners such as the Ohio-Kentucky-Indiana Regional Council of Governments (OKI), Health Departments (Dearborn, Franklin, Hamilton, and Butler), and Oxbow, Inc. See Figure 1 for a complete list of key partners and roles for the project.

Figure 1: Key Partners and Stakeholders

Partner	What Partner Can Provide	Benefits to the Partner	Contact Person
SWCDs: Dearborn Franklin Hamilton Butler	Information, publicity, administrative, and technical support	Assist them in providing technical assistance, conservation planning, education and program information support to private land owners.	Vickie Smith Chris Fox Brian Bohl Lynn White /Chuck Goins
Indiana Department of Environmental Management	Guidance and funding for the grant	Accomplish their goals of improving water quality	Kathleen Hagan
South Dearborn Regional Sewer District	Assistance with water monitoring analysis	Provide technical and educational support	Bill Neyer
OKI Regional Council of Governments	Publicity, event partnerships	Accomplish the goals of OKI	Bruce Koehler
Health Departments: Dearborn	Distribute educational information/information on the project	Public relations and accomplishing their goals	John Grace Doug Baer
Hamilton County	Water quality data collection and analysis	Provide information about concerns	Brian Bohl

Partner	What Partner Can Provide	Benefits to the Partner	Contact Person
SWCD Friends of the Great Miami Rivers Unlimited	along with technical assistance and data interpretation	identified in the windshield survey and other data that was gathered	Michael Miller
Purdue Extension: Dearborn County Franklin County	Information, publicity, and technical support	Assist them in providing technical assistance, education, and program information support to private land owners	Mike Hornbach Anna Morrow

The Whitewater River Watershed Project needed a governing force to keep the project moving forward. So, after gathering community support at public meetings, we asked community leaders, stakeholders, and interested parties to participate on our Steering Committee. Steering Committee meetings were held at least quarterly to make crucial decisions regarding the future of the watershed project. Below, Figure 2 lists the members of the Whitewater River Watershed Project Steering Committee.

Figure 2: List of Steering Committee Members

Name	Affiliation
Chris Fox	Franklin County SWCD
Tim Hesselbrock	Landowner, Okeana, OH
Mike Kohlsdorf	Landowner, Brookville, IN
Lynn White	Butler County SWCD
Chuck Goins	Butler County SWCD
John Williams	NRCS District Conservationist, Butler & Hamilton Counties
Jon Seymour	Oxbow Inc.
Bruce Koehler	OKI Regional Council of Governments
Mike T. Schwab	Landowner &Franklin Co. SWCD Supervisor Cedar Grove, IN
Evan Divine	NRCS District Conservationist, Franklin Co.
Anna Morrow	Franklin Co. Purdue Extension
Ben Braeutigam	Great Parks of Hamilton County
Helen Kremer	Landowner, West Harrison, IN
Mike Hornbach	Dearborn Co. Purdue Extension
Brian Bohl	Hamilton County SWCD
Jane Fister	Landowner, Brookville, IN
John Kruse	Dearborn Co. SWCD, Supervisor
Kathy Scott	Landowner, West Harrison, IN
Jane Wittke	OKI Regional Council of Governments

1.3 Stakeholder Concerns

In moving forward with this project and in constructing a management plan, the first step was establishing the community's concerns. To do this, the Whitewater River Watershed Project held several public meetings. These meetings provided an outlet and an opportunity to not only educate the community on the status of the project, but also for the public to voice concerns and bring to attention issues they wanted to address. In addition, at each of the public meetings and at the Whitewater River Watershed Project steering committee meetings, attendees were asked and given the opportunity to complete a stakeholder concern survey. Below in Figure 3, you can see a compilation of the stakeholder concerns. Each of the concerns was ranked via frequency of response and grouped by media type (soil, water, air, plant, animal, and human) concern.

Figure 3: Stakeholder Concerns for the Whitewater River Watershed Project

Type	Stakeholder Concern	Frequency of Concern
Soil	Excessive gully erosion in cropland and pastures	6
	Too much conventional tillage of cropland	2
	Stream bank erosion	10
	Need for soils education involving, compaction, cover crops and nitrogen fixation issues.	4
	Sedimentation from erosion caused by overgrazing	5
Water	Livestock with direct access to streams	12
	E. coli within the streams	26
	Pollution from failing septic systems	31
	Drinking water contamination	10
	Pollution & Volume from Urban Runoff	7
Air	Drift from Chemical Application	9
Plant	Invasive species in watershed	11
	Low quality plants in pastures	8
	Need for more cover crops on cropland	7
	Lack of Riparian buffers along streams	6
Animals	Fencing of livestock from sensitive areas	30
	Overgrazing pastures	24
	Need for education on wildlife	3
	Overpopulation of wildlife in watershed	7
Humans	Unchecked Development	12
	Trash/Litter in streams	29

The Watershed

In this section you will find general information and descriptions of the Whitewater River Watershed.

2.1 The Origin of the Name

The Whitewater River Watershed, despite its name, contains no rapid (white) sections. However, it is said to be the swiftest river in the state of Indiana as it falls an average of six feet per mile. Because of the speed, depth, and location many people use the watershed for recreational canoeing, kayaking, and fishing.

2.2 Describing the Watershed

The Whitewater River Watershed (HUC 0508000308) includes approximately 159,907.7 acre area of land located in the northeastern portion of Dearborn County, the southeastern portion of Franklin County, the southwestern corner of Butler County, and the northwestern part of Hamilton County. This watershed is in two different states (Indiana and Ohio) so multi-state partnerships and communication are required. The approximate acreage in each county is: Dearborn 24,885, Franklin 87,313, Butler 20,664, and Hamilton 27,046 acres. A watershed is simply an area of land that water flows over and under on its way to a particular body of water. In the case of this project, the water in the watershed flows to the Lower Miami River and then on to the Ohio River. In the United States, watersheds are identified using a coding system referred to as Hydrologic Unit Codes (HUC). HUCs are used as a way of categorizing parts of a landscape based upon drainage. The shorter the HUC, the larger the watershed is. The Whitewater River Watershed falls within the 8 digit HUC, 05080003, noted by the larger outlined area in blue below in Figure 4. The 10 digit HUC for the Whitewater River Watershed Project is 0508000308. This covers the project area outlined in Figure 4 in pink.

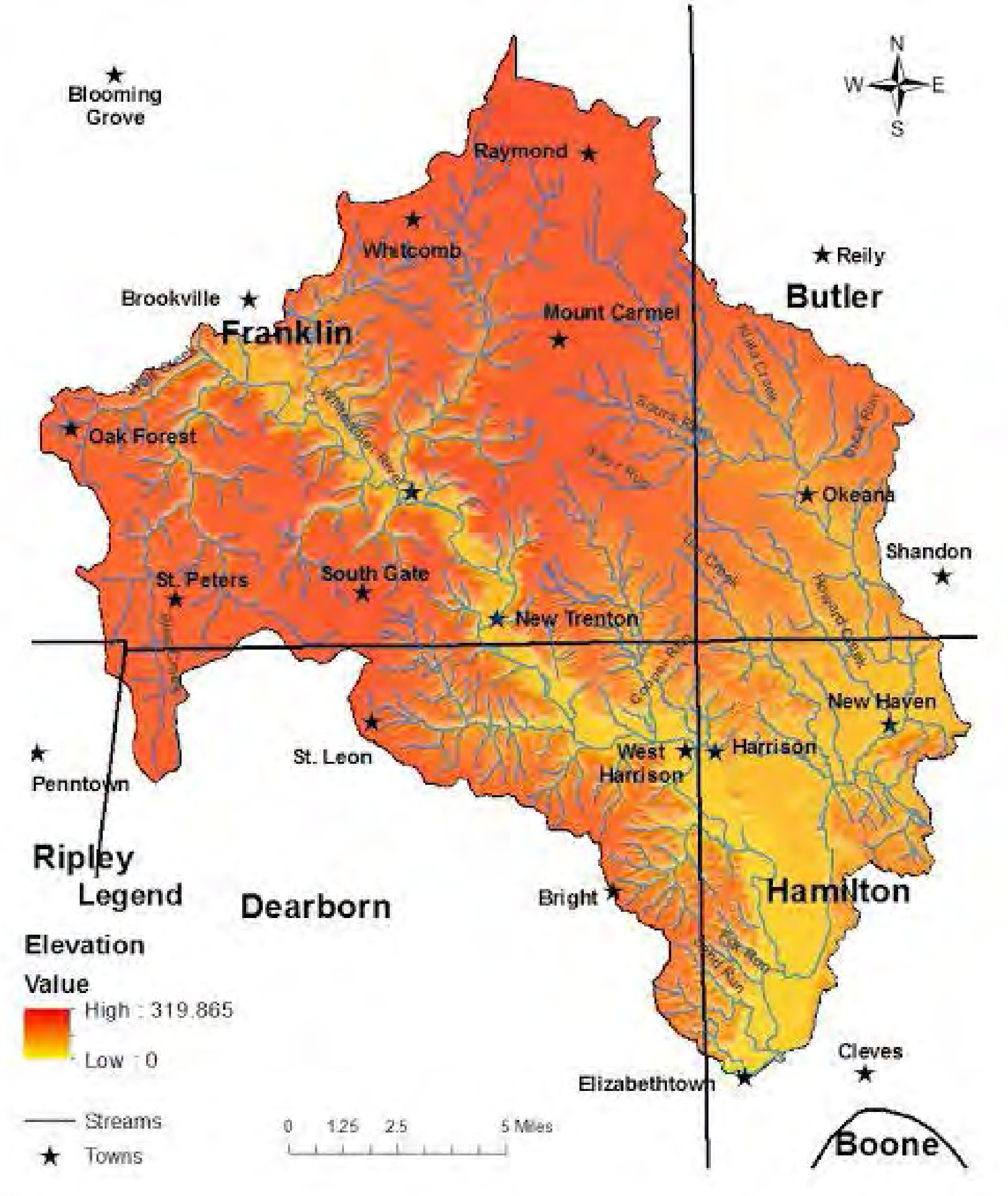
Figure 4: Location of Whitewater River Watershed

2.2 1. Geology/Topography

Like most watersheds in the United States, the Whitewater River Watershed's drainage pattern is mostly determined by elevation. In Figure 5 areas of lower elevation are marked in lighter colors (yellow). The water in the Whitewater River Watershed flows downhill from south of Brookville southeast until it reaches the confluence with the Great Miami just north of Elizabethtown.

Portions of the watershed are located in Eastern Corn Belt Plain (ECBP) and the Interior Plateau (IP) physiographic regions. These regions can shed light on the type of land present in the watershed. The ECBP contains extensive cropland with some natural forestland cover. The ECBP is characterized by small gently rolling glacial till plains that are broken up by moraines, kames, and outwash plains. The IP ecoregion has a till plain of low topographic relief that was formed from Illinoisan glacial drift. Layers of sandstone, siltstone, shale, and limestone make up much of the IP. It is not uncommon to find limestone outcrops or areas pitted with limestone sinks in IP areas.

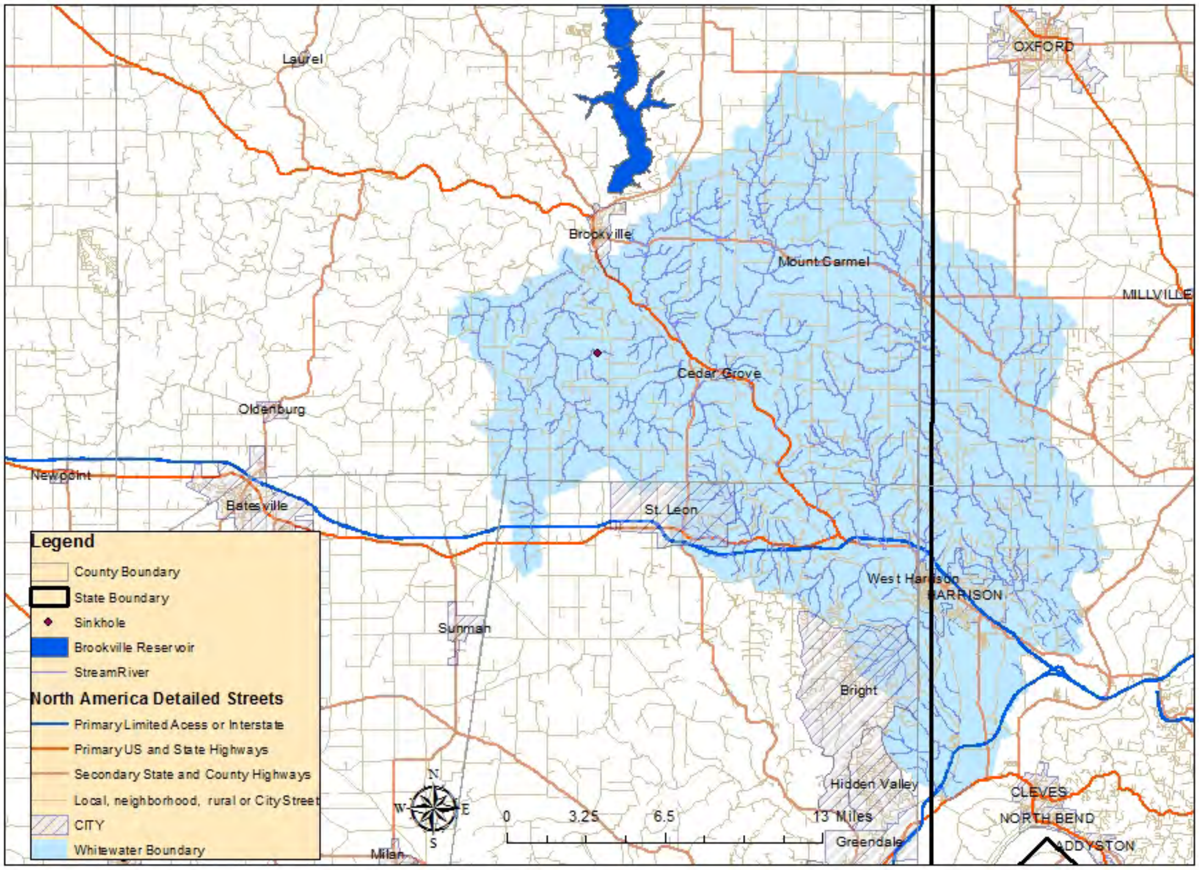
Figure 5: Elevation of the Whitewater River Watershed



In some areas, soil types found within the watershed may have a karst component. Karst is defined as a landscape with topographic depressions such as sinkholes and caves, caused by underground solutions of limestone bedrock. The hollow nature of karst terrain results in very high pollution potential because streams and surface runoff entering sinkholes or caves bypass natural filtration through the soil and provide direct conduits for contaminants. Groundwater can travel quite rapidly through these underground networks and contaminants can be transmitted quickly to wells and springs in the vicinity. This adds a degree of difficulty to the project; in establishing a "point" of the "nonpoint" source pollution. If water flows swiftly underground, well water may be unsafe for human consumption if the groundwater isn't filtered through an aquifer first. Most of the soils in the Whitewater River Watershed do not have a karst component.

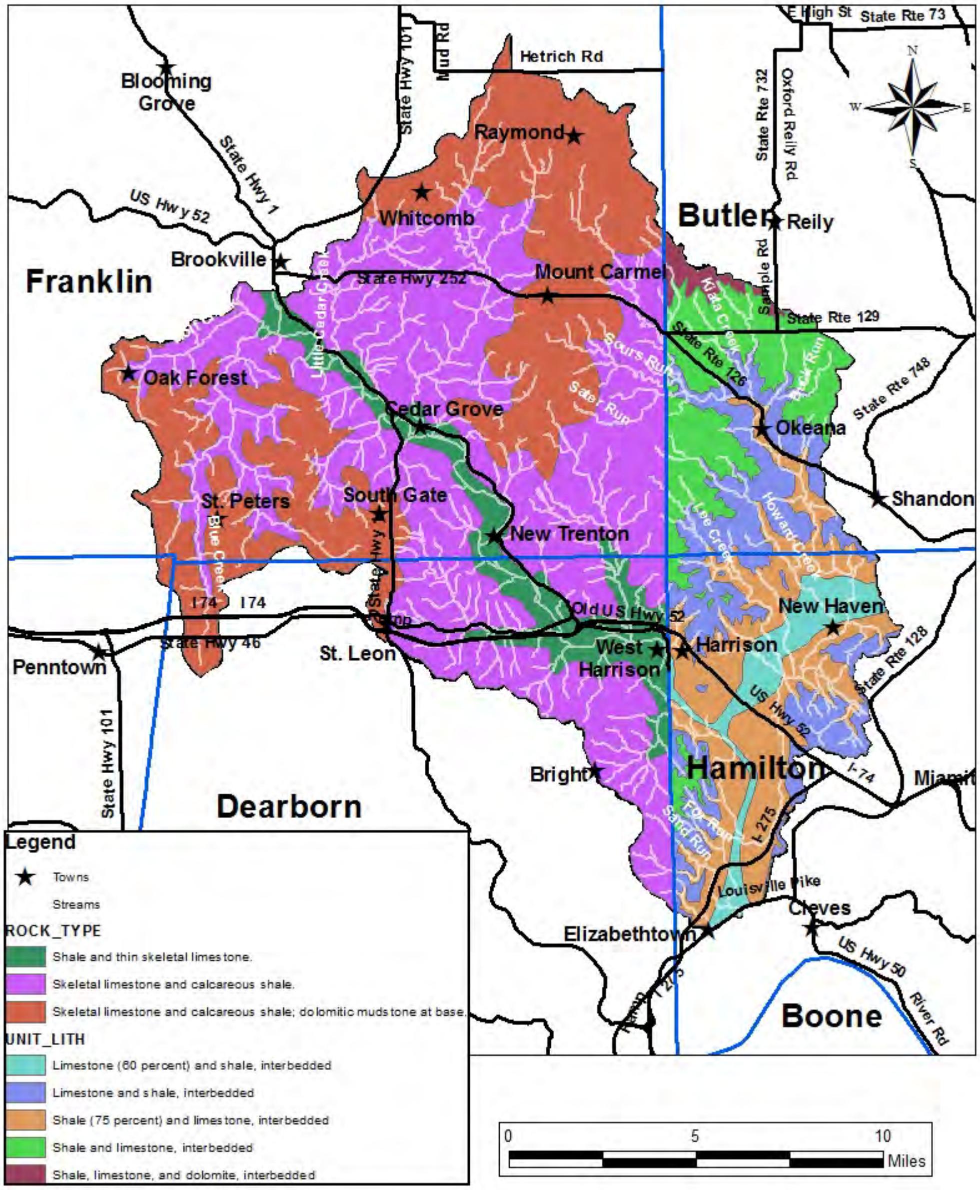
However, the Whitewater River Watershed is home to a sinkhole. Sinkholes show little outward signs of erosion, but can suddenly collapse causing major issues for watershed residents. From Figure 6 you can see the location of the sinkhole present in the watershed.

Figure 6: Sinkholes in the Whitewater River Watershed



The Watershed is entirely composed of bedrock from the Upper Ordovician periods. Fossils found in the area can date back to 485.4 to 443.4 million years ago. The Whitewater watershed's bedrock is comprised of shale and limestone. Figure 7 details the types of bedrock in the Whitewater River Watershed. Note: The bedrock shapefiles are from the states so they are 2 different sources with slightly different rock descriptions.

Figure 7: Geology in the Whitewater River Watershed



2.2.2. Hydrology

Defined as the total area of land draining to a particular water body, watersheds are delineated utilizing topography, which indicate areas of elevation and natural divides as discussed in the previous sections. However, drainage areas typically coincide with stream size. Just as smaller streams flow to combine with larger streams, smaller watersheds converge to form larger watersheds. In this way, watersheds are identified by scale and coded as such. Watersheds can be broken down into small portions called sub watersheds. The Whitewater River Watershed's 10 digit HUC (0508000308) can be broken down into 10 different sub watersheds (See Figure 8). These 10 sub watersheds are categorized using 12 digit HUC codes. See Figure 9 for a list of sub watershed HUC codes.

Figure 8: Sub Watersheds (12 digits HUCs) in the Whitewater River Watershed

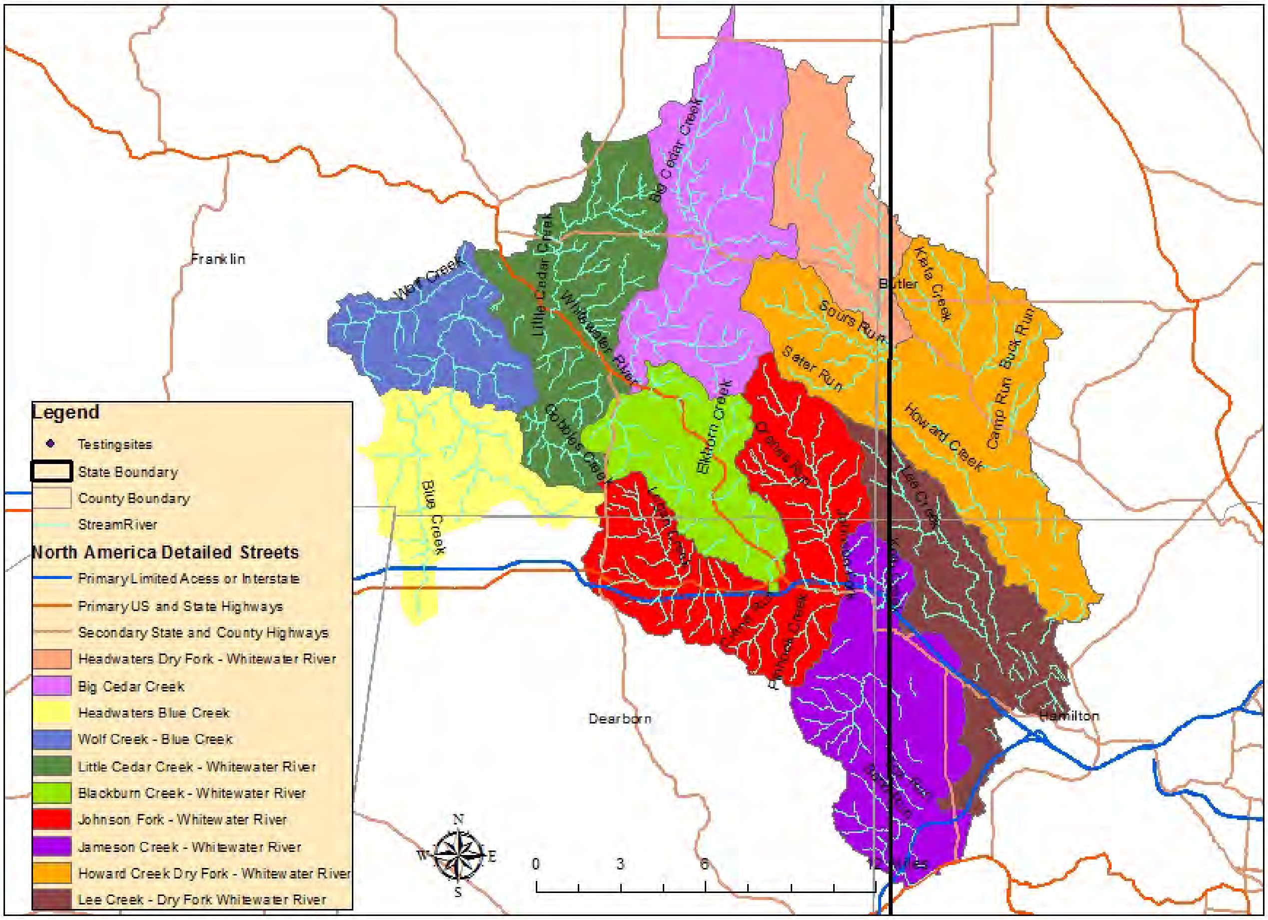
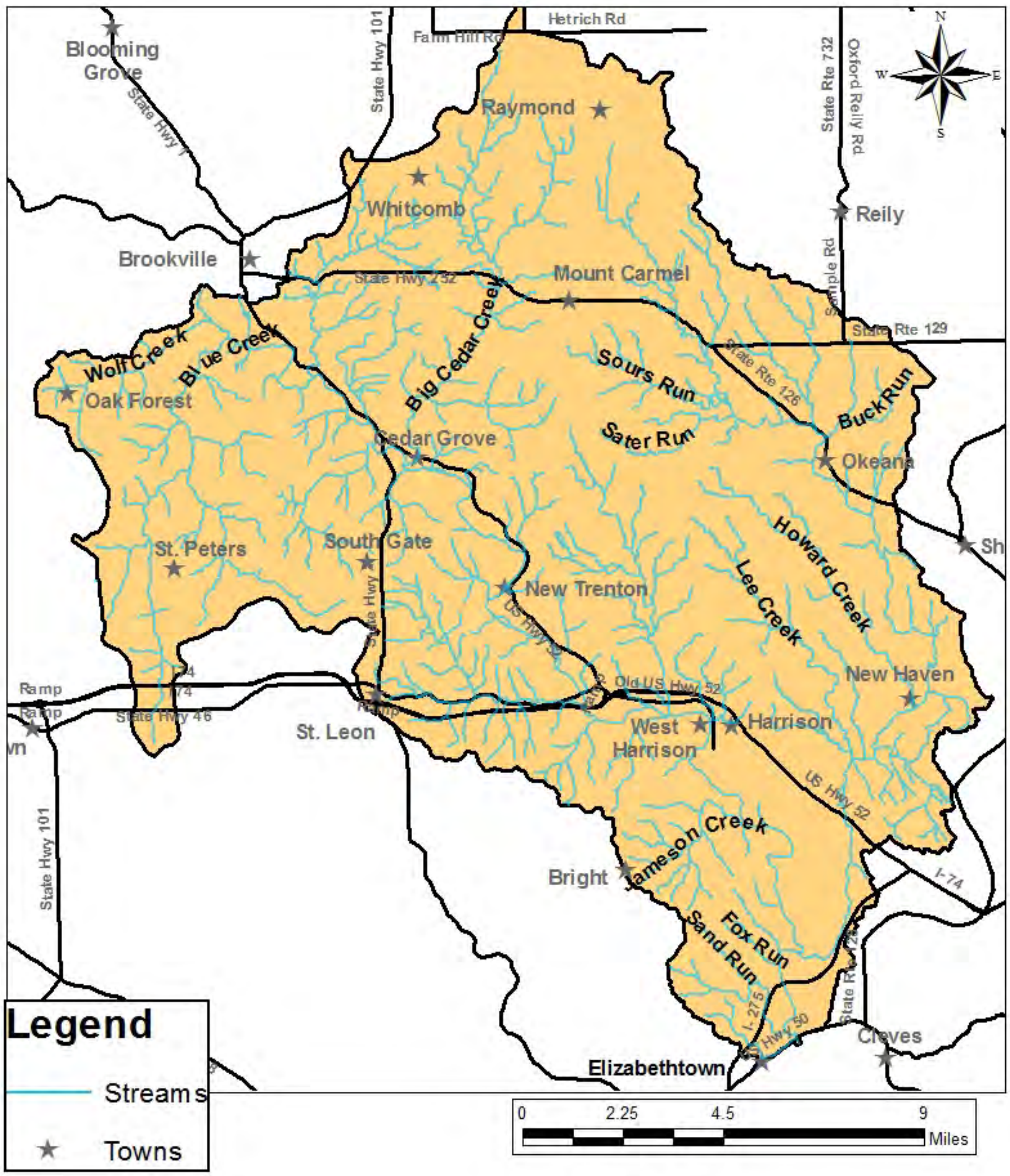


Figure 9: Sub Watershed Names with 12 Digit HUC Codes

Sub Watershed Name	12 Digit HUC Code
Headwaters Blue Creek	050800030801
Wolf Creek – Blue Creek	050800030802
Big Cedar Creek	050800030803
Little Cedar Creek – Whitewater River	050800030804
Blackburn Creek – Whitewater River	050800030805
Johnson Fork – Whitewater River	050800030806
Headwaters Dry Fork Whitewater River	050800030807
Howard Creek – Dry Fork Whitewater River	050800030808
Lee Creek – Dry Fork Whitewater River	050800030809
Jameson Creek – Whitewater River	050800030810

The Whitewater River Watershed is home to several major streams and rivers. Some of those rivers include: Whitewater River, Dry Fork Whitewater River, Little Cedar Creek, Big Cedar Creek, Blue Creek, Sand Run, and Wolf Creek (Figure 10). There are no legal drains located in the watershed.

Figure 10: Hydrology of the Whitewater River Watershed



The Whitewater River Watershed is home to a wealth of eco-tourism. Many tourists travel for the fishing and canoeing on the Whitewater River. Because the rivers are so widely used, there is a strong community interest and desire not only to improve, but to preserve the Whitewater River Watershed. The Whitewater River is also the fastest moving river in Indiana, making it a destination for canoeing and kayaking. The Whitewater River

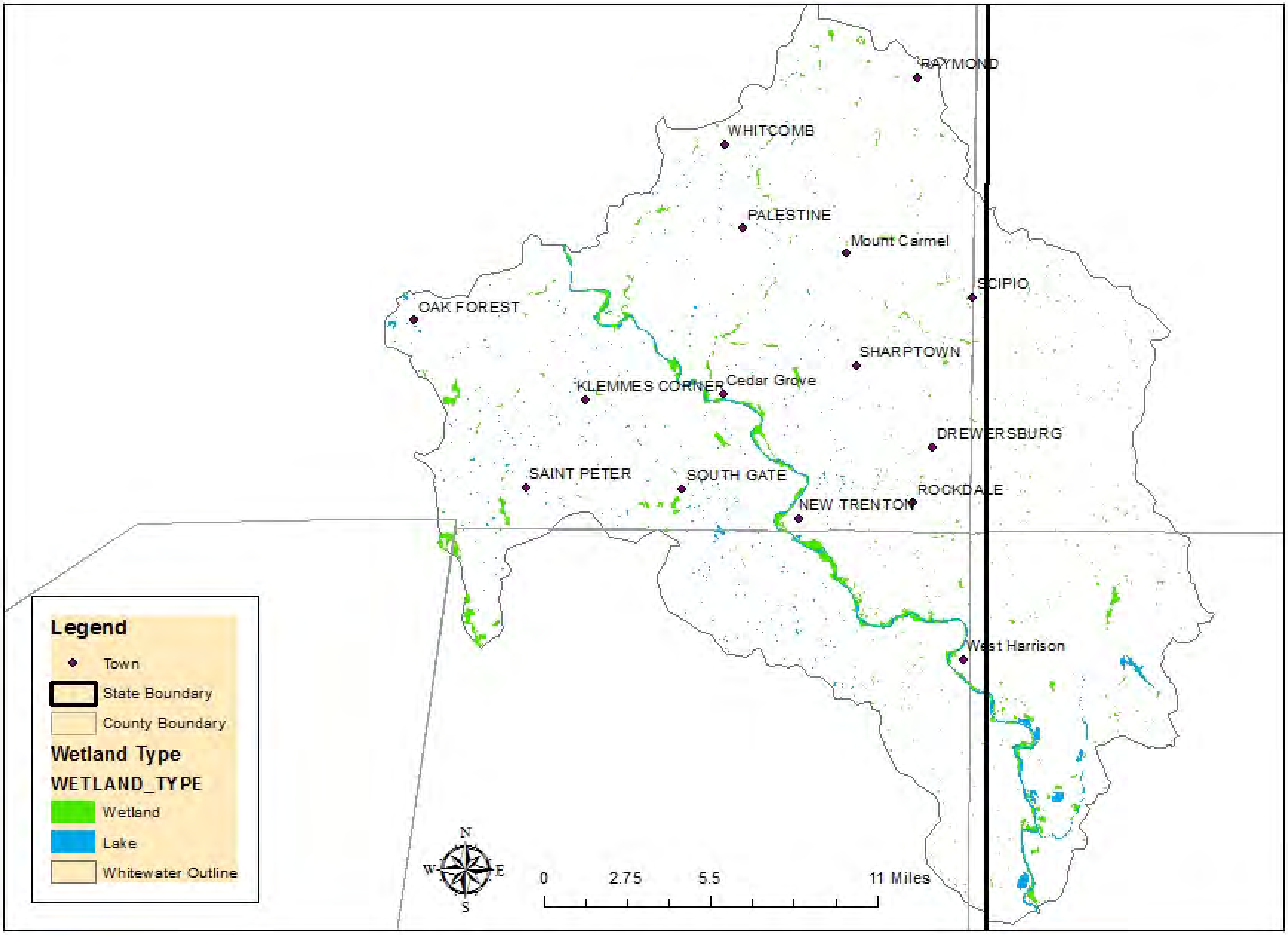
Watershed is also home to a large aquifer that supplies drinking water to many residents in Franklin County, IN and surrounding counties.

In the Whitewater River Watershed, there are roughly 486.9 miles of streams. Of the total number of streams, approximately 42% of the streams are perennial, or have constant water flowing through them and the remaining 58% of streams in the watershed are intermittent streams. Intermittent streams may have water flowing seasonally or after large rainfall events.

In addition to the miles of streams in the watershed, there are roughly 841 miles of ditches in the watershed and no legal drains. These streams and ditches are used by the residents of the watershed on a daily basis. The ditches are used for agricultural purposes and the streams are used as a place for recreation and as habitat for wildlife. There are also roughly 340.2 acres of wetlands in the watershed. Historically, the area in the Whitewater River Watershed was rich with wetland habitat. Due to human development and expansions, the wetlands have diminished over the years. See Figure 11 for locations of wetlands in the Whitewater River Watershed.

Historically the area of the Ohio River Basin has been a home to many wetlands. As development occurred many wetlands were lost. The remaining wetlands in the watershed serve as a natural filter and buffer for water. They also provide some recreation to residents of the watershed in the form of parks and protected land set aside for enjoying nature.

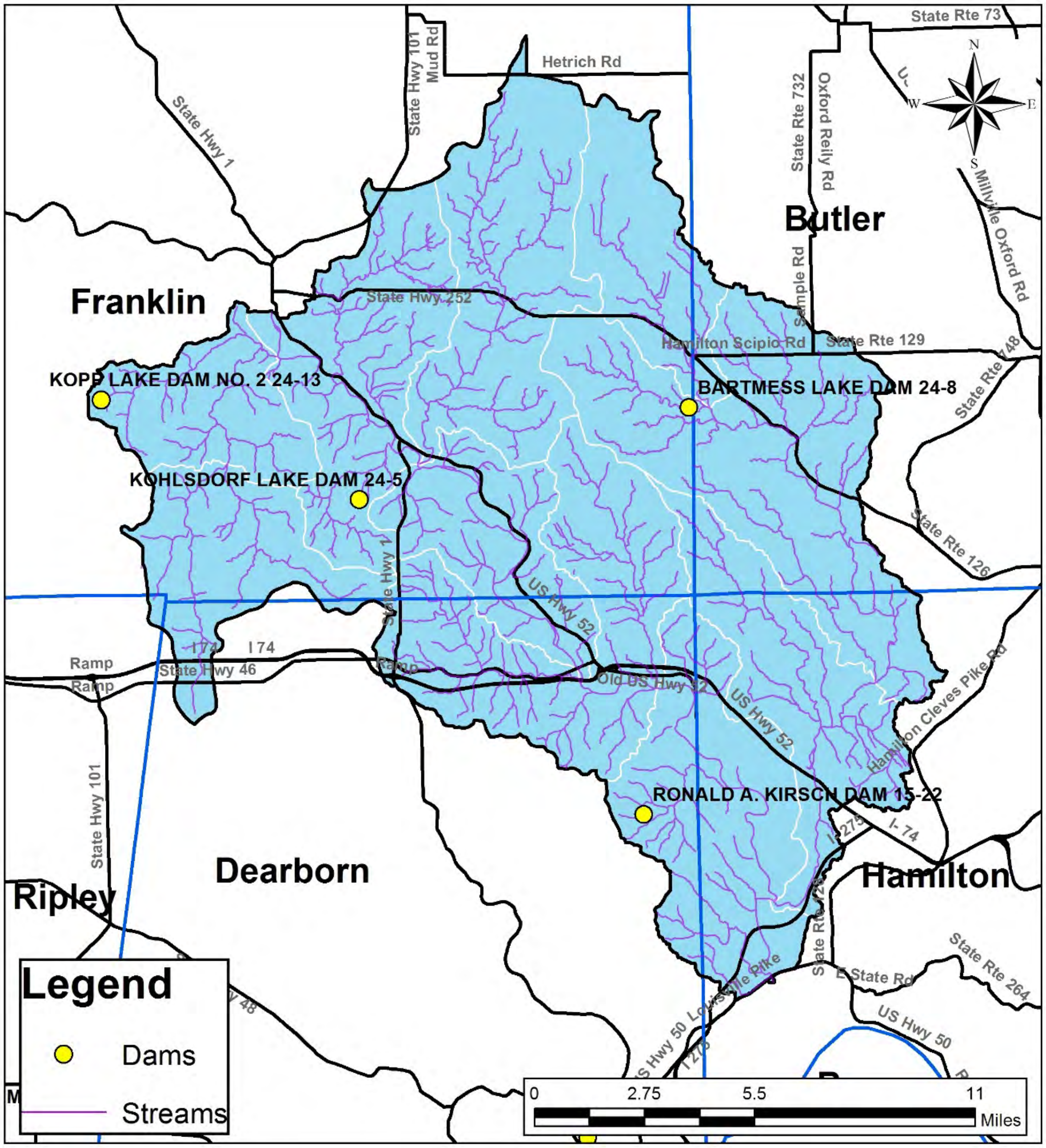
Figure 11: Wetlands and Lakes in the Whitewater River Watershed



The lakes in the Whitewater River Watershed consist of many small ponds that are less than an acre. Because of this, mapping results show the lakes as small blue dots (Figure 11). There are over 628 lakes and ponds in the Whitewater River Watershed. These lakes are smaller agriculture ponds that average 0.39 acres (1,589.85 m2). There are roughly 246 acres of lakes in the Whitewater River Watershed.

There are also man made alterations of the hydrology in the watershed. Because areas of southern Indiana and Ohio often experience flooding hazards, there are dams built in the watershed. The Whitewater River Watershed is home to 4 dams. For locations see Figure 12. There are also places in and near the watershed, especially around Brookville Reservoir, where water is controlled (via dam) for flow and flood control.

Figure 12: Dams in the Whitewater River Watershed



2.2.3 Soil Characteristics

The soils in the Whitewater River Watershed, as with any watershed, can dictate what types of land use are successful and how the overall water quality will be impacted by those uses. Due to the large area of the project, the number of individual types of soil would be too numerous to list or discuss. Instead the section below will discuss general soil regions. There are 8 types of general soil associations in the Whitewater River Watershed (Figure 13). [3]

[3] Soil association information found from USDA-NRCS Soil Survey Division: https://soilseries.sc.egov.usda.gov

Westland-Ockley-Fox (s2325): This type of soil consists of very deep, poorly drained, and very poorly drained soils. They are located in depressions and on flats, outwash plains, stream terraces, and glacial drainage channels. Slopes can range from 0 to 1 percent.

Sawmill-Lawson-Genesee (s2327): This type of soil association is a fine-silty soil The Sawmill soils consists of very deep, poorly drained soils that are formed on alluvium flood plains. Slopes range from 0 to 3 percent.

Reesville-Ragsdale-Fincastle (s2339): This soil consists of very deep, somewhat poorly drained soils that are underlain by loamy till. They are commonly found on till plains and moraines. Slopes in these soils can range between 0 and 7 percent.

Rossmoyne-Cincinnati-Bonnell (s2357): This type of soil association is part of the Avonburg series and consists of very deep, somewhat moderately drained soils that formed in loess and the underlying paleosol in till. It is typically used for general farming. This type of soil is distributed in southwestern Ohio, southeastern Indiana, and north-central Kentucky. Its slope can range from 0 to 25 percent.

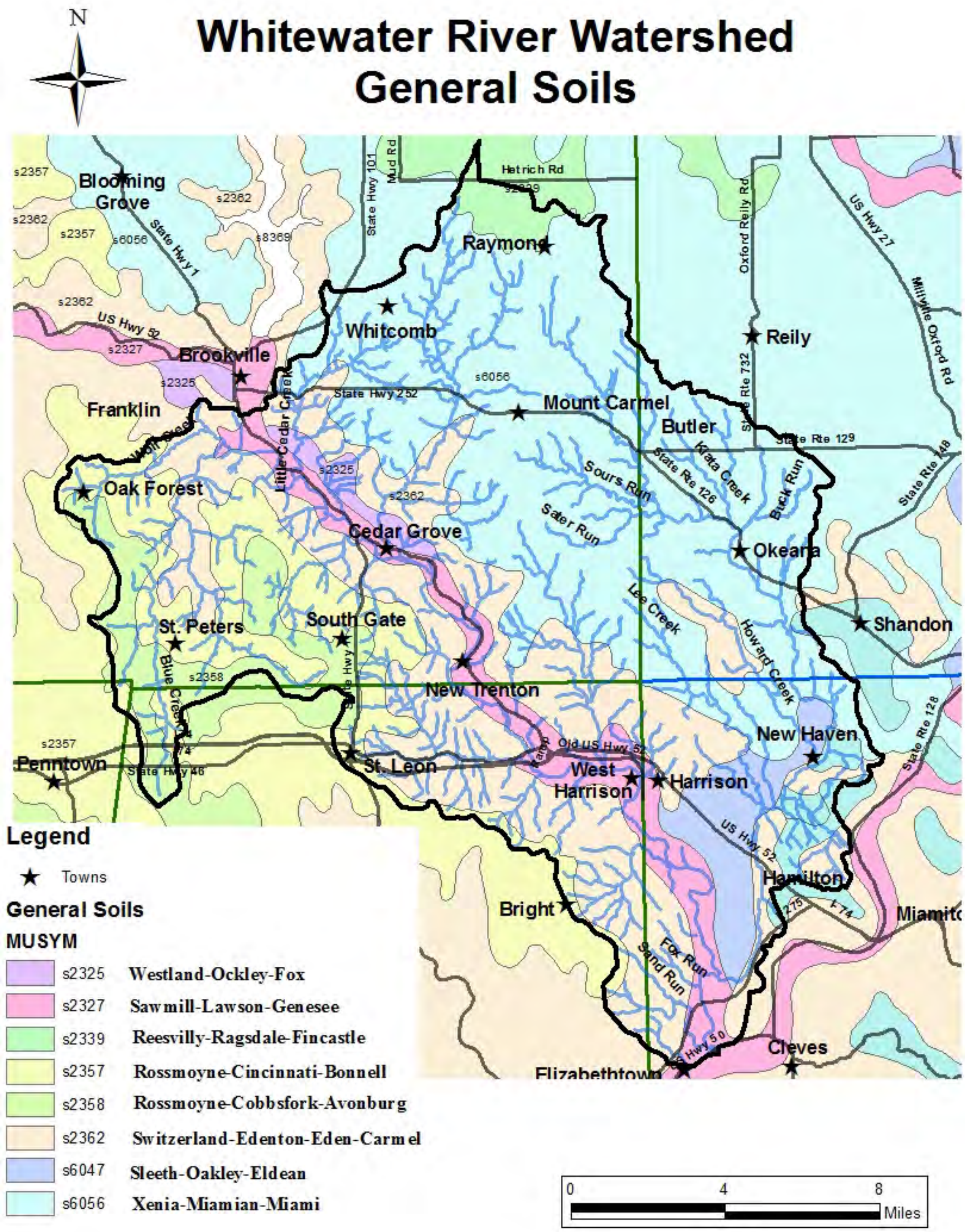
Rossmoyne-Cobbsfork-Avonburg (s2358): Like the Rossmoyne-Cincinnati-Bonnell this soil is also part of the Avonburg series. However, unlike the Cincinnati type, the Cobbsfork variety tends to be poorly drained. It is in southwestern Ohio, southeastern Indiana, and north-central Kentucky. Its slope can range from 0 to 9 percent.

Switzerland-Edenton-Eden-Carmel (s2362): This soil association consists of deep, moderately well drained soils. This soil is often found on farmland with the main crops being corn, soybeans, and tobacco. Slopes range from roughly 2 to 20 percent.

Sleeth-Ockley-Eldean (s6047): This type of soil consists of very deep, somewhat poorly drained soils that are stratified gravelly and sandy outwash. They are often found on outwash terraces, stream terraces, and outwash plains. Slopes in this soil association range from 0 to 2 percent.

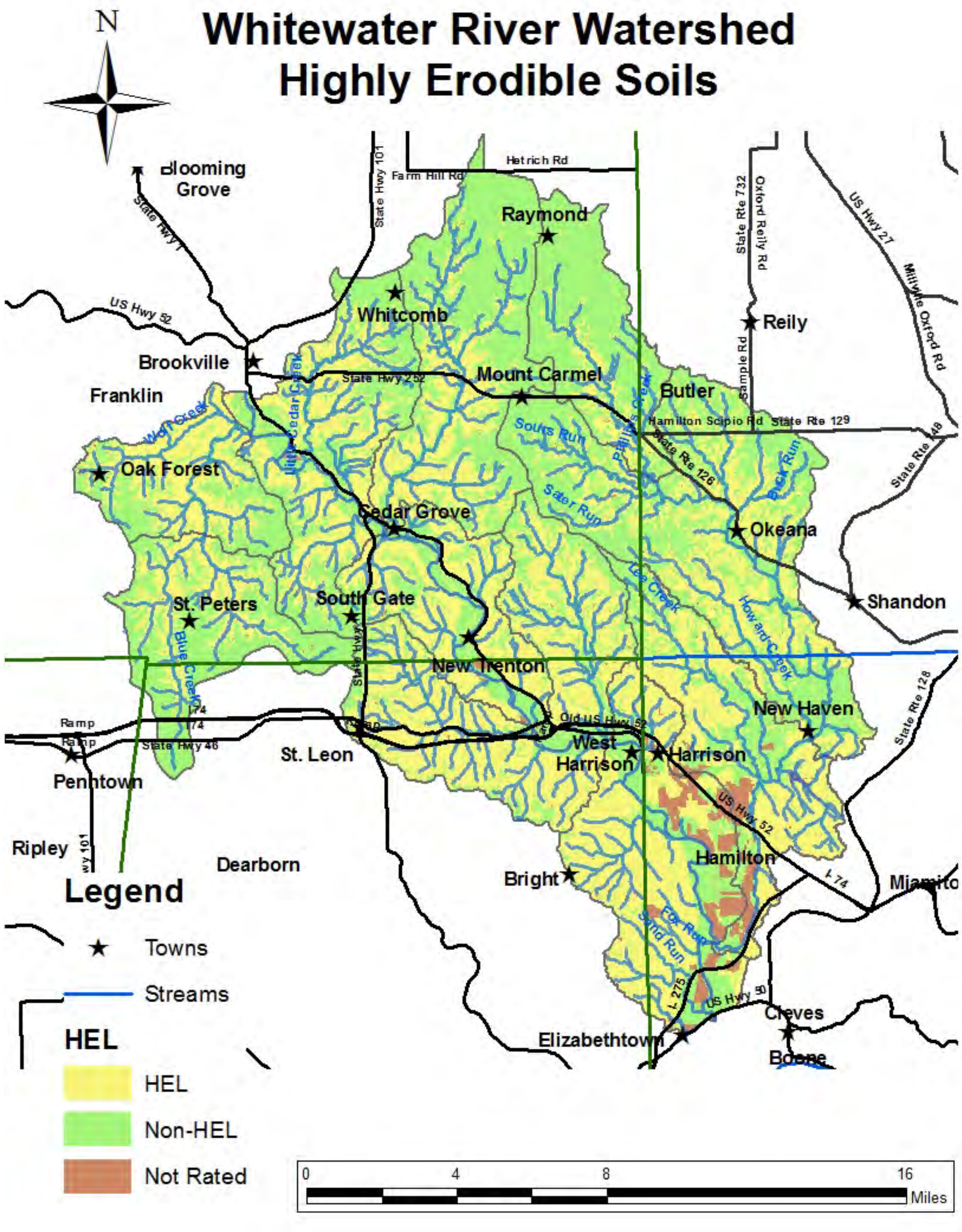
Xenia-Miamian-Miami (s6056): This soil association consists of very deep, moderately well drained soils that have very dense till. Xenia soils are often found on till plains or underlying loamy till. Slope ranges from 0 to 12 percent.

Figure 13: General Soils of the Whitewater River Watershed



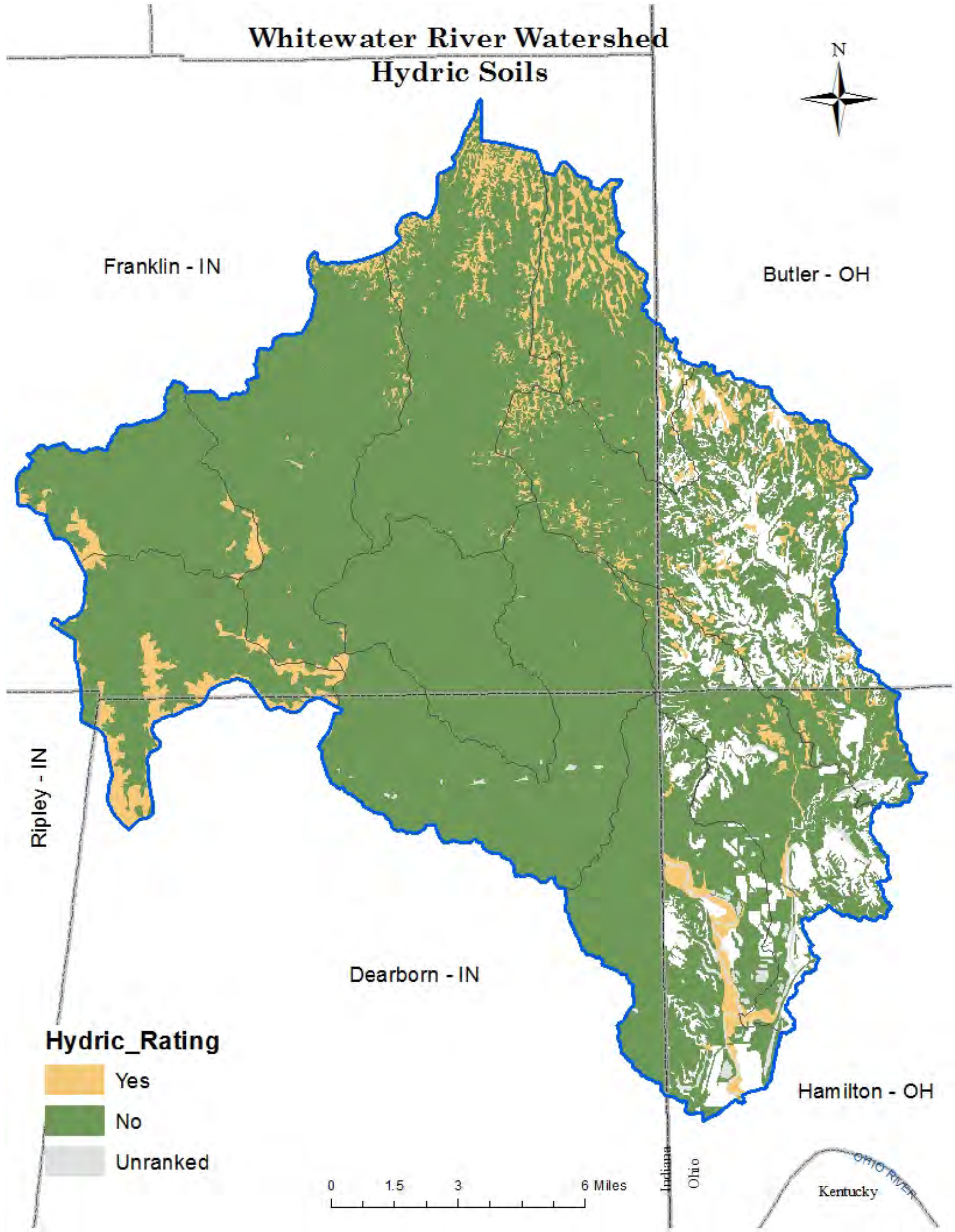
In planning for successful watershed management, it is important to know where the most highly erodible soils are. In Figure 14 below, the highest potential for erosion is marked on the map in yellow. Roughly 49% of the watershed is classified as highly erodible and is at a severe risk for erosion. There are 17,317.88 acres of highly erodible land (HEL) in Dearborn County, 38,258.28 acres of HEL in Franklin County, 9,333.41 acres of HEL in Butler County, and 13,605.25 acres of HEL in Hamilton County

Figure 14: Highly Erodible Lands in the Whitewater River Watershed



In addition to understanding where the highest potential for erosion is, it's important to understand what percentage of our watershed contains hydric soils. Hydric soils may be permanently or seasonally saturated with water like in swamps or wetlands. These soils result in anaerobic conditions even after they are drained. It is likely that these soils developed under wetland conditions. Therefore, they are a good indicator of historic or current wetland locations within the watershed and also locations where potential wetland creation or enhancement could occur in the future. Currently 11.3% of the Whitewater River Watershed is comprised of hydric soils (Figure 15).

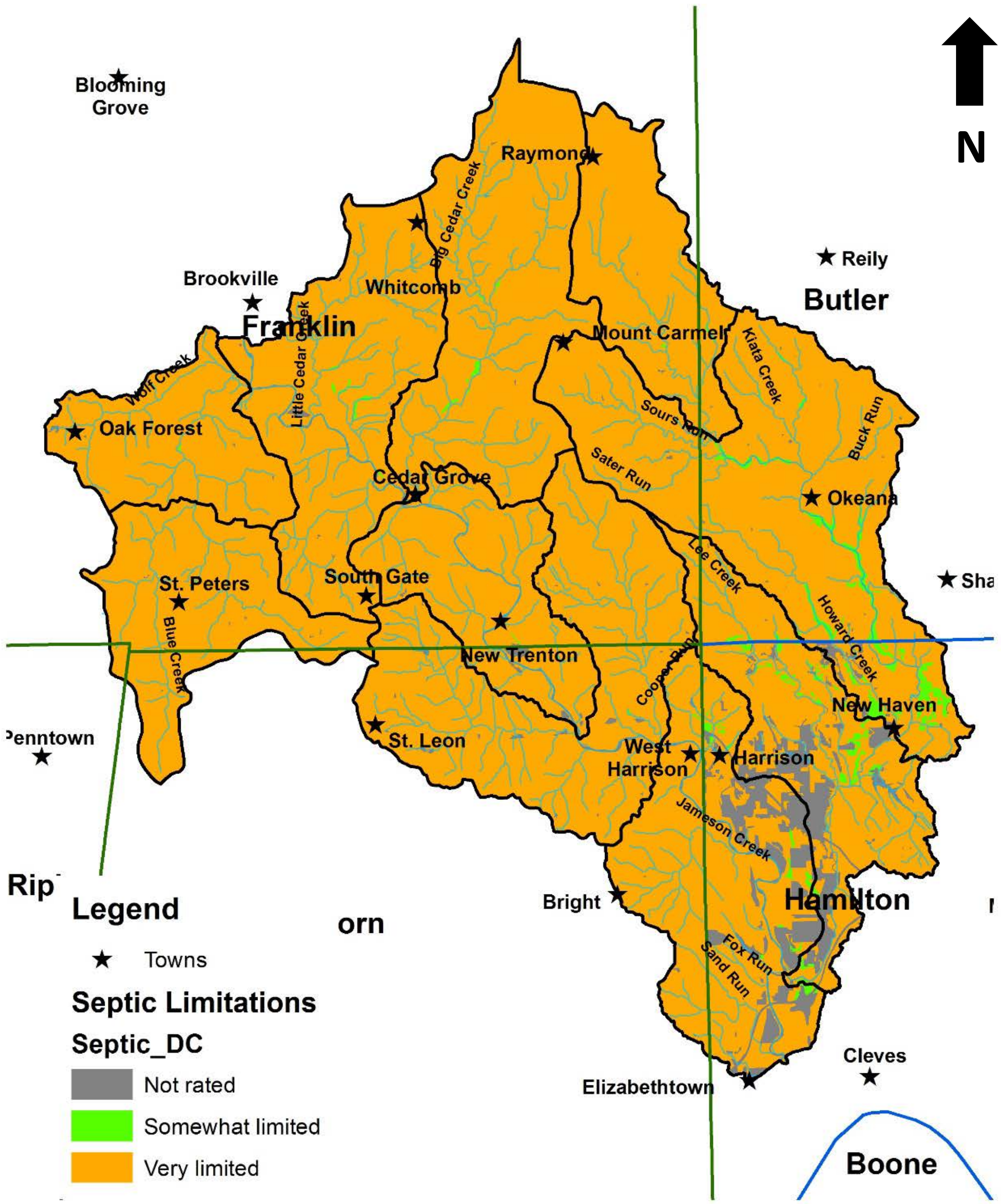
Figure 15: Hydric Soils in the Whitewater River Watershed



Finally it is important to know what areas of the watershed are compatible for septic system use, and what areas are not. Because of the rural nature of the watershed, often a septic system is the only option for homeowners. However, just because it is the only waste option offered for homeowners, doesn't mean the soil can support it. Of the land in the watershed 151,568 acres or 94.79% of the watershed has soils with very limited septic capabilities. Another 1,864.73 acres or 1.16% of the watershed has soils that are somewhat limited (Figure 16).

In addition, as population in the area has grown, many households have exceeded the capacity that the septic system was meant to serve. Still more septic systems are out of date and potentially leaking or leaching harmful materials into the soil. Throughout the project, stakeholders have expressed concerns about failing septic systems in the Whitewater River Watershed. Although there are not any areas of large communities that are unsewered, there are many individual homes and small communities that rely on septic systems.

Figure 16: Septic Limitation in the Whitewater River Watershed



2.2.4 Land Use

The land in the Whitewater River Watershed is mainly used for agriculture (row crop and pastureland). Forestland (mixed hardwood deciduous) also makes up a large portion of the watershed. A small percentage of the watershed is comprised of urban areas (low density), wetlands, and open water. The largest city in the watershed is Harrison, OH which has just fewer than 10,000 residents. Other smaller urban areas include St. Leon and Bright. The following landuse information is from the National Land Cover Database 2006 (NLCD 2006).

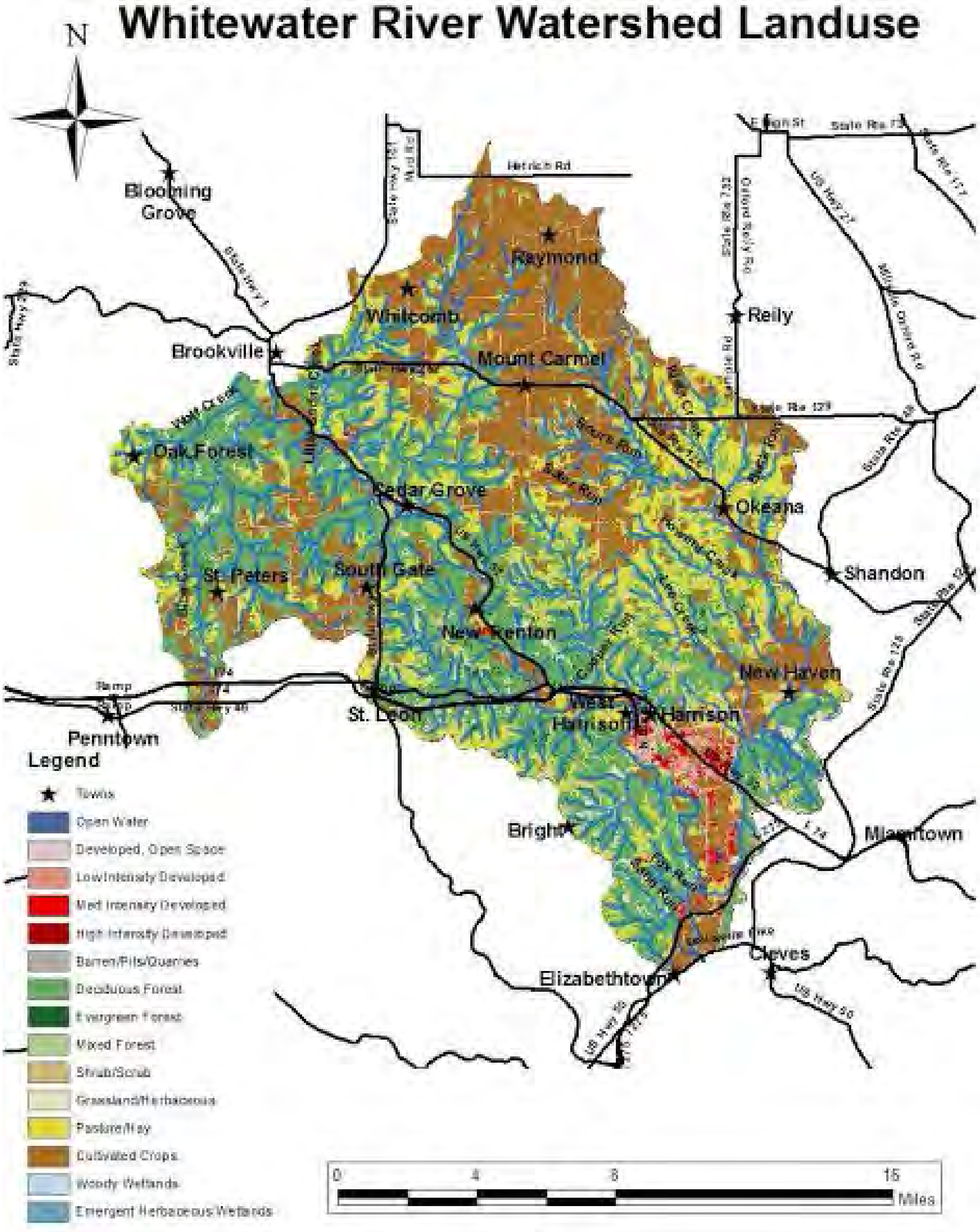
Whitewater River Area = 159,907 ac.
Deciduous Forest = 63,143 ac. – 39.5%
Cultivated Crops = 46,922 ac. – 29.3%
Pasture/Hay = 30,801 ac. – 19.3%
Developed, Open Space = 8,486 ac. – 5.3%
Developed, Low Intensity = 2,306 ac. – 1.4%
Grassland/Herbaceous = 2,156 ac. – 1.3%
Developed, Med Intensity = 1,516 ac. – 0.9%
Evergreen Forest = 1,495 ac. – 0.9%
Open Water = 1,079 ac. – 0.7%
Mixed Forest = 730 ac. – 0.5%
Shrub/Scrub = 607 ac. – 0.4%
Developed, High Intensity = 302 ac. – 0.2%
Woody Wetlands = 228 ac. – 0.1%
Emergent Herbaceous Wetlands = 118 ac. - < 0.1
Barren/Pits/Quarries = 18 ac. - < 0.1%

Since the majority of the land in the watershed is farmland, understanding the average size of a typical parcel is important. Most parcels of land are average (80-100 acres) or small (<25 acres) in size. There are 46,921 acres of cultivated crops making up 29% of the watershed. There are another 30,800 acres of pasture and hay land making up 19% of the watershed. This means that 48% of the watershed is used for agricultural purposes. Of this agriculture row crop land; 62% of corn in Dearborn County was mulch tilled and 38% was no-tilled. For the soybeans in Dearborn County 31 % was mulch tilled and 69% was no-tilled. In Franklin County, 70% of corn was conventionally tilled, 19% mulch tilled, and 11% no-tilled. For the soybeans in Franklin County, 14% was conventionally tilled, 25% mulch tilled, and 60% no-tilled (data from 2015 tillage transects). Butler and Hamilton Counties' cropland is approximately 50% no-tilled, 40% mulch tilled, and 10% conventionally tilled. Chemicals like pesticides, herbicides, and fertilizers are regularly applied to row crops in Indiana to obtain the highest yield possible. These chemicals can be carried into adjacent waterbodies through surface runoff and through tile drainage systems. The timing of application and amount of rainfall affects it greatly. Most local producers apply at least two applications of nitrogen to their corn crops acres and 1 application of phosphorus. Improved pastures and hay fields also typically receive a nitrogen and phosphorus application. Producers also typically use at least 2-3 applications of herbicides annually. The use of pesticides is also a concern. The majority of seed is pretreated with pesticides and over time the treatment will move throughout the soil and may be carried to a nearby waterbody. Chemicals are very expensive so producers try to apply only what the crop needs and the more testing and scouting the producer does, the more accurate application they can apply.

As time passes in the Whitewater River watershed, there is the potential for more urbanized areas. With expansion from the nearby city of Cincinnati into some of the larger towns in the watershed (Harrison), more and more people are moving into the area. As more people move into the area the potential for more non-point runoff from pet waste, fertilizers, chemicals, and septic systems increases. Storm water runoff from developed areas, not regulated under a permit, is a nonpoint source. Typically urban sources of nutrients are fertilizer application to lawns and pet waste, which is also a source of E. coli. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. However, inputs from urban sources are difficult to quantify. Approximately 8% of the watershed is classified as having developed landuse.

Wildlife such as deer, geese, ducks, etc. can be sources of E. coli. Little information exists surrounding feces depositional patterns of wildlife and a direct inventory of wildlife populations is generally not available. Higher concentrations of wildlife in the habitats (natural areas) could contribute to the E. coli and nutrients in the watershed, particularly during high flow conditions or flooding events. Ideal habitat for raccoons is forested areas near permanent water. Deciduous forest makes up 39% of the watershed with 63,142 acres. Deer can be found throughout the entire watershed while fowl and muskrats prefer wetland areas and permanent water. See Figure 17 for locations and details of land use in the watershed.

Figure 17: Land Use in the Whitewater River Watershed (NLCD 2006)



2.2.5 Planning Efforts

Making sure development proceeds in a way that is less harmful to overall water quality is a priority for the stakeholders in the Whitewater River Watershed. Development creates a risk for soil erosion, which could negatively affect water quality. Erosion concerns were voiced again and again by stakeholders. Construction and development sites that disturb over 1 acre of land will need to follow an approved storm water pollution prevention plan, which is required by Rule 5. State and county personnel review the pollution and prevention plans for Rule 5 and also conduct site inspections. There are no problem areas with unmanaged construction in the watershed. MS4s have their own restrictions and requirements that are typically stricter than Rule 5.

In addition to concerns over development erosion, the storm water runoff is also a concern for overall water quality. In Indiana, to assist in storm water runoff control and prevention, Municipal Separate Storm Sewer Systems (MS4s) permits are issued to various counties, cities, and groups. In the Whitewater River Watershed, there are several MS4s. For a complete listing see Figure 18. In addition MS4 plans in the area often have an educational component built in that could be used later on as a partnership for educational goals for the watershed project.

Figure 18: MS4 Entities in the Whitewater River Watershed

County	MS4 Entity	Permit Number
Hamilton	City of Harrison	1GQ00034*BG
Hamilton	Hamilton County and Others	1GQ00046*BG
Hamilton	Hamilton County Park District	1GQ00026*BG

There are also many other planning efforts that have taken place for parts of the Whitewater River Watershed. Dearborn County is revising their 2009 Comprehensive County Plan to incorporate more inclusions for natural resources and conservation. The previous plan did not include any information covering either of those topics.

IDEM developed a Total Maximum Daily Load (TMDL) for the Southern Whitewater River watershed (HUC: 0508000305, 0508000306, 0508000308) that is located in southeastern Indiana along the Ohio state border. The TMDL has been developed for nutrients and sediment impaired biological communities and E. coli. Data used for the TMDL analysis were collected from 33 stream sites (T1-T33) by IDEM between November 2013 and October 2014. Twelve additional sites (P1-P12) were sampled between April 2014 and October 2014 as part of the IDEM probabilistic monitoring program. This data, although not specifically targeted through the TMDL monitoring design, was also used in reassessing the watershed. The information and data from the TMDL was used in the development of this watershed management plan and can be found in more detail in the water quality data section.

Ohio-Kentucky-Indiana Regional Council of Governments (OKI) has also developed plans that covered parts of the Whitewater River Watershed. They are currently working on a transportation study for Bright, IN to I-74 and the 2040 Regional Transportation Plan which covers Dearborn, Hamilton, and Butler Counties along with 5 others. In 2011, OKI completed a 208 Water Quality Management Plan Update for Dearborn County. Information regarding potential septic system problem areas was used as a reference in this management plan.

The Safe Drinking Water Act and the Indiana Wellhead Protection Rule mandates a wellhead program for all Community Public Water Systems. The Wellhead Protection Program consists of two phases. Phase I involves the delineation of a Wellhead Protection Area (WHPA), identifying potential sources of contamination, and creating management and contingency plans for the WHPA. Phase II involves the implementation of the plan created in Phase I. Communities are required to submit an update to their Wellhead Protection Plan to IDEM every 5 years.

There are three Community Public Water Systems in the watershed on the Indiana side. Figure 19 identifies the systems and which phase they are currently in. A map of wellhead protection areas in Indiana is not available because the delineation of these areas are not made public.

Figure 19: Community Public Water System on the Indiana Side of the Watershed

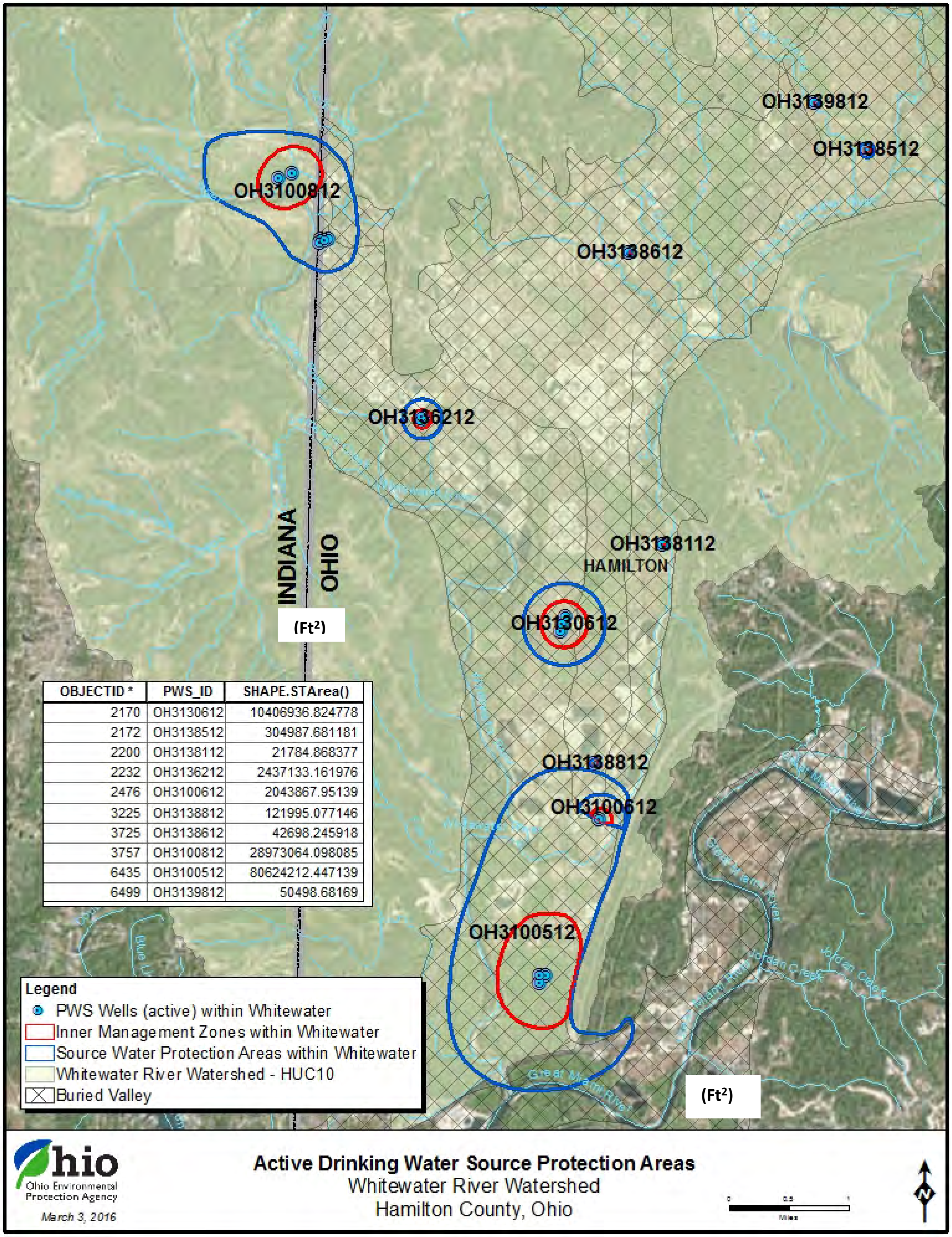
County Name	PWSID	System Name	Population	Next Plan Due	Due Date
Dearborn	5215008	North Dearborn Water Corporation	5175	5 Year Update	20-Oct-19
Dearborn	5215009	Tri-Township Water Corporation	9855	5 Year Update	03-Feb-20
Franklin	5224002	Franklin County Water Association	9018	5 Year Update	05-Jul-18

Each public water system in Ohio has two phases it goes through: assessment and protection for their drinking water source protection. There are 10 source water protection areas (SWPAs) in the Whitewater River Watershed in Ohio (see figure 20).

Assessment is determining the area around the public water system's well(s) or intake(s) that will be the focus of protection (delineation), and then listing all of the facilities or activities within that area that could potentially release chemicals that would contaminate the source water (inventory). Based on the delineation, inventory and the local geology, the likelihood of the source water becoming contaminated is determined (susceptibility analysis). Since 2001, Ohio EPA staff have provided public water systems with assessments; however, some public water systems prefer to hire a hydrogeological consulting firm.

Protection refers to the activities undertaken by the public water supplier and other interested parties to protect the source water protection area. For this purpose, Ohio EPA strongly encourages municipal public water suppliers to form a local planning team and develop a "Drinking Water Source Protection Plan."

Figure 20: Location and areas of the 10 SWPAs in the Whitewater River Watershed on the Ohio side



OBJECTID *	PWS_ID	SHAPE.STArea()
2170	OH3130612	10406936.824778
2172	OH3138512	304987.681181
2200	OH3138112	21784.868377
2232	OH3136212	2437133.161976
2476	OH3100612	2043867.95139
3225	OH3138812	121995.077146
3725	OH3138612	42698.245918
3757	OH3100812	28973064.098085
6435	OH3100512	80624212.447139
6499	OH3139812	50498.68169

2.2.6 Endangered Species

The Whitewater River Watershed is home to several endangered plant and animal species on both the state and federal level.   These species are known to inhabit some of the sensitive habitats found in the Whitewater River Watershed. [4]

Mammals:

Indiana Bat (*Myotis sodalis*): The Indiana Bat is a medium sized mouse eared bat that was once commonly distributed across the Midwestern and Eastern states. Due to the rapid spread of White Nose Syndrome, populations have been reduced by as much as 50%. Currently the Indiana bat is listed as endangered in Indiana, Ohio, and also on the federal endangered species list.

Northern Long-Eared Bat (*Myotis septentrionalis*): This small sized bat is listed as state endangered for both Indiana and Ohio. Its decline is attributed to the declining coniferous forests habitat and the outbreak of White Nose Syndrome.

Fish:

Variegate Darter (*Etheostoma variatum*): The variegate darter is one of the most colorful darter species and is restricted to the Ohio River drainage area. This colorful fish is listed as state endangered for Indiana.

Redside Dace (*Clinostomus elongates):* The redside dace is state endangered for Indiana and can only be found in the Whitewater River Watershed. Globally this small fish is rare and uncommon. Known for leaping into the air to capture insects, this little fish is found in small streams with high gradients and cool water.

Lake Sturgeon (*Acipenser fulvescens*): The lake sturgeon is listed as endangered in the state of Ohio and listed a species of special concern federally.

Reptiles and Amphibians:

Eastern Hellbender (*Cryptobranchus alleganiensis alleganiensis*): The Eastern Hellbender is listed as endangered in the state of Indiana. These salamanders grow to be on average about 2 feet long. In addition, they serve to fill unique niches in ecosystems where they can be both predator and prey.

Timber Rattlesnake (*Crotalus horridus*): As one of the 4 venomous snake species found in Indiana, the timber rattlesnake is listed as state endangered. Due to human disturbances and general fear of its venomous nature, the timber rattlesnake's population has dwindled over the years.

Cave Salamander (*Eurycea lucifuga*): The cave salamander (also known as the spotted tail salamander) is listed at state endangered in Ohio. The cave salamander lacks lungs and is often found in areas of exposed limestone or caves.

[4] Data and ranges for state and federal species provided by the US Fish and Wildlife Service, Indiana Department on Natural Resources, and Ohio Department of Natural Resources

Birds:

Bald Eagle (*Haliaeetus leucocephalus*): Known as the National Bird, the Bald eagle has been a national symbol since 1782. The Eagle is designated as state endangered (IN), and is thought to be in decline because of decreasing wetland habitat. The watershed is home to nesting pairs near Brookville Reservoir.

Peregrine Falcon (*Falco peregrinus*): Although listed as a species of "least concern" internationally, the Peregrine Falcon is listed as endangered in the state of Indiana. The falcon is known for its high speeds. While hunting, a dive can reach speeds of over 200 mph, making it one of the fastest animals in the animal kingdom.

Loggerhead Shrike (*Lanius ludovicianus*): The Loggerhead Shrike is listed as endangered in Indiana. This bird has a long hooked beak and feeds on insects, smaller birds, and lizards. Their population decline has been attributed to loss of suitable habitat and pesticide use.

Black-crowned Night-heron (*Nycticorax nycticorax*): This large bird has been listed as endangered in Indiana mainly due to decreasing habitat, since they prefer either salt or freshwater wetland areas.

Interior Least Tern (*Sternula antillarum athalassos*): The Interior Least Tern is listed as state endangered in Indiana. This small bird is a migratory bird that overwinters is Central America.

Barn Owl (*Tyto alba*): Though they are listed as endangered in Indiana, Barn Owls are one of the most widely distributed owls worldwide. With their white faces, they have been the inspiration for many ghost tales and hauntings in the Indiana area.

Upland Sandpiper (*Bartramia longicauda*): The Upland Sandpiper is listed as state endangered in the state of Ohio. Unlike many other sandpipers the Upland Sandpiper does not need water, but prefers open country and tall grass habitat. The increase of development in the area has likely contributed to the population decline in Ohio.

American Bittern (*Botaurus lentiginosus*): The American Bittern is a large, solitary bird that is listed as state endangered in Ohio. The decline in population is due to decreasing habitat in the area. The American Bittern prefers wetlands, marshes, and bogs.

Lark Sparrow (*Chondestes grammacus*): The Lark Sparrow is listed as state endangered in Ohio. The small brown bird breeds on the ground and overwinters in Central America. The population has declined due to human interference. Internationally, the Lark Sparrow is listed as "least concerned."

Mollusks:

Rayed Bean (*Villosa fabalis)*: The Rayed Bean is a freshwater mussel that is listed as endangered in the state of Ohio. Like many other mussels, populations have declined over the years due to human interference. The Rayed Bean mussel is extremely sensitive to pollution. The native range for the Rayed Bean is the Ohio River drainage area.

Pink Mucket (pearlymussel) (Lampsilis abrupta): The Pink Mucket is endangered in the state of Ohio. Native to the Midwestern area, the Pink Mucket was once found in over 25 streams in the Ohio area. But due to the construction of dams, construction of reservoirs, and declining water quality that specie's population has declined.

Fanshell (*Cyprogenia stegaria*): The Fanshell is listed as federally endangered. This species of mollusk is only known to have breeding populations in three rivers of the United States. The species is threatened by loss and degradation of its natural habitat.

Snuffbox mussel (*Epioblasma triquetra*): The Snuffbox mussel is listed as federally endangered in the Endangered Species Act. Known to attach to the gills of fish, this mollusk has experienced population declines because of human interference.

Sheepnose Mussel (*Plethobasus cyphyus*): The Sheepnose Mussel is listed as state endangered in Indiana and Ohio. Known as a freshwater or river mussel, their population has been on the decline due to their sensitivity to water pollution.

Insects:

Cobblestone Tiger Beetle (*Cicindela marginipennis*): The Cobblestone Tiger Beetle is listed as state endangered for Indiana and can be found in Franklin County, Indiana. The small black beetle is native to the mid-eastern United States.

Plains Clubtail (*Gomphus externus*): The Plains Clubtail is a medium to large dragonfly species that is listed as endangered in the state of Ohio. The Plains Clubtail prefers moderately flowing streams, large rivers with muddy bottoms, and occasionally lakes as habitat.

Blue Corporal (*Ladona Deplanata*): Listed as state endangered in Ohio, the Blue Corporal is a dragonfly that gets its name from the stripes on the females. The Blue Corporal prefers woodland habitat near slow moving streams or ponds.

Vascular Plants:

Running Buffalo Clover (*Trifolium stoloniferum*): The Running Buffalo Clover is listed as endangered in both Indiana and Ohio. The plant is typically found in rich soils in woodland habitats. This species of plant was once thought to be extinct, until populations were discovered in West Virginia in the late 1980's and now can be found in Dearborn County, Indiana.

Shaggy False-Gromwell (*Onosmodium hispidissimum*): Shaggy False-Gromwell is a state endangered species in Indiana, found in Franklin County. This plant blooms from June to July and prefers partly shaded prairie habitat. Due to the decrease of prairies nationwide, the population of the Shaggy False-Gromwell has declined.

Lake Cress (*Armoracia aquatic*): The Lake Cress is listed as state endangered in Indiana. The Lake Cress prefers wetland habitat. Due to human development and expansion, numbers of this plant have declined. The Lake Cress is found in Dearborn County, Indiana.

Matted Broomspurge (*Euphorbia serpens*): Matted Broomspurge is a state endangered plant in Indiana. Originally from Central America, it was originally introduced in the United States as a weed. This small fruiting plant prefers shaded rich soils.

Gray Beardtongue (*Penstemon canescens*): The Gray Beardtongue is a state endangered plant in Indiana. The stems can reach a maximum height of 1 meter. The Gray Beardtongue is a native plant to the southeastern United States.

Snowy Campion (*Silene nivea*): The Snowy Campion is a small flower listed as state endangered in Ohio. The plant produces small white flowers. Snowy Campion prefers stream bank habitat and is often found in patches of reed canary grass.

2.2.7 Relevant Relationships

In this section, you will find a discussion of relationships between the watershed characteristics discussed above like land cover, elevation, and hydrology. The Whitewater River Watershed contains several unique habitats with several valuable endangered species. Because of the unique habitat and species found in the watershed, protecting this valued resource is of great priority.

In some areas of the watershed there is a contrast of land use and competing interest. With local eco-tourism groups and conservation groups like the Ohio-Kentucky-Indiana Regional Council of Governments (OKI) there is a strong public desire to preserve the habitat of the Whitewater River Watershed. On the flip side of that coin, the land use in the watershed is mostly agricultural. In some counties and areas of Whitewater there is a resistance to new conservation practices in favor of land management the way it always has been. Balancing these competing interests from various groups will be a struggle that future management of the watershed will have to take into account.

The Whitewater River is the fastest flowing river in Indiana. It also has a great deal of movement not just within the water but also side to side, chipping away at the banks. Because of the flow and the natural meandering of the stream, stream bank erosion is a major problem for the Whitewater River. According to the Indiana Silver Jackets Hazard Mitigation Task Force, the Whitewater River is one of Indiana’s rivers that move horizontally the most. After large rain events the potential for more pollution to enter the watershed is compounded by flooding and erosion issues in other areas.

The Whitewater is also a place with ever-changing land use. As rural areas become more populated from pressure from the urban cities like Cincinnati to the watershed’s south west, more development occurs. Smaller community landowners often have no choice but to use a septic system for their property, even though it is built on land that is not completely conducive to the practice. The traditional septic system does not always work for new developments. Some sites require other systems to be installed, for example a mound system.

2.2.8 Data

In order to properly evaluate a watershed, an inventory and assessment of the watershed and known existing information and data is needed. By examining previous and current efforts of monitoring, it allows the project to have a better understanding of the condition of the watershed. The following sections detail the water quality and watershed assessment efforts.

One of the objectives of the project was to conduct biological, chemical, and habitat analysis at 21 different sites in the watershed (17 on the Indiana side and 4 on the Ohio side). This data would give us a clear idea of the current conditions of the watershed. For discussion of the data and results, it is easy to break down the sites and results into sub watersheds. For more information on the locations and names of the sub watersheds, see Figure 8. For each section below, the reported results of the data collected by the project (referred to as current data) is outlined by sub watersheds.

In addition to data collected by the Whitewater River Watershed Project, other sources of historical data exist. Historical data is limited to those 15 years in age because data older than that likely doesn't represent current land use. In addition, data older than 5 years is only to be used in trend or reference data. Historical data comes from sources such as:

- Indiana Department of Environmental Management (IDEM) water quality data
- Hamilton County SWCD, Friends of the Great Miami, and Rivers Unlimited Partnership Group
- Indiana's 303(d) listing of impaired streams and water bodies
- National Pollutant Discharge Elimination System (NPDES) violation data

Historically, streams listed on IDEM's 303(d) list prompted community involvement and concern in the Whitewater River Watershed. The term "303(d) list" is short for the list of impaired and threatened waters (stream/river segments, lakes) that the Clean Water Act requires all states to submit for EPA approval every two years on even-numbered years. The states identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards, and establish priorities on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors. States then provide a long-term plan for completing load reductions within 8 to 13 years from first listing.

Figure 21 is the 303 (d) list of impaired stream segments within the Whitewater River Watershed. Each entry has the impaired assessment unit IDs (AUIDs) for testing areas of Whitewater River Watershed. The table also contains the cause of impairment for those testing areas. The assessment categories are organized as follows:

- Category 1- Attaining the water quality standard and other applicable criteria for all designated uses and no use is threatened.

- Category 2- Attaining some of the designated uses; no use is threatened; and insufficient data and information are available to determine if the remaining uses are attained or threatened.

- Category 3- Insufficient data and information is available to determine if any designated use is attained.

- Category 4- Impaired or threatened for one or more designated uses, but does not require the development of a total maximum daily load (TMDL).

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

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

    C. Impairment is not caused by a pollutant.

- Category 5- The water quality standards or other applicable criteria are not attained.

    A. The waters are impaired or threatened for one or more designated uses by a pollutant(s), and require a TMDL.

    B. The waters are impaired due to the presence of mercury or PCBs, or both in the edible tissue of fish collected from them at levels exceeding Indiana's human health criteria for these contaminants.

23 stream segments within Whitewater River Watershed are listed on the 303 (d) list of impaired streams as impaired for E. coli (205 stream miles), biological communities(IBC) (31 stream miles), dissolved oxygen (DO) (70 stream miles), PCBs (38 stream miles), and mercury (34 stream miles) on the Indiana's Draft 2016 303(d) list (Figure 21). These impaired segments account for approximately 214 miles. Several of these streams had previously been listed as impaired in the Draft 2012 303(d) list. The goal of the Whitewater River Watershed Management Plan is to work toward a situation where all stream reaches are in Category 1. This can be accomplished by identifying the impairments and sources of those impairments. The work expressed within this document is working to identify impairments, sources and causes for those impairments, and action strategies and management techniques to address these impairments. Figure 22 below is from IDEM's 2016 TMDL report. It shows the impairments for both 2012 and 2016 (draft). Note: No additional testing was completed between 2012 and 2014, so the draft 2014 303d list of impairments were the same as the 2012.

Figure 21: Whitewater River Watershed impaired streams for 2016 (draft)

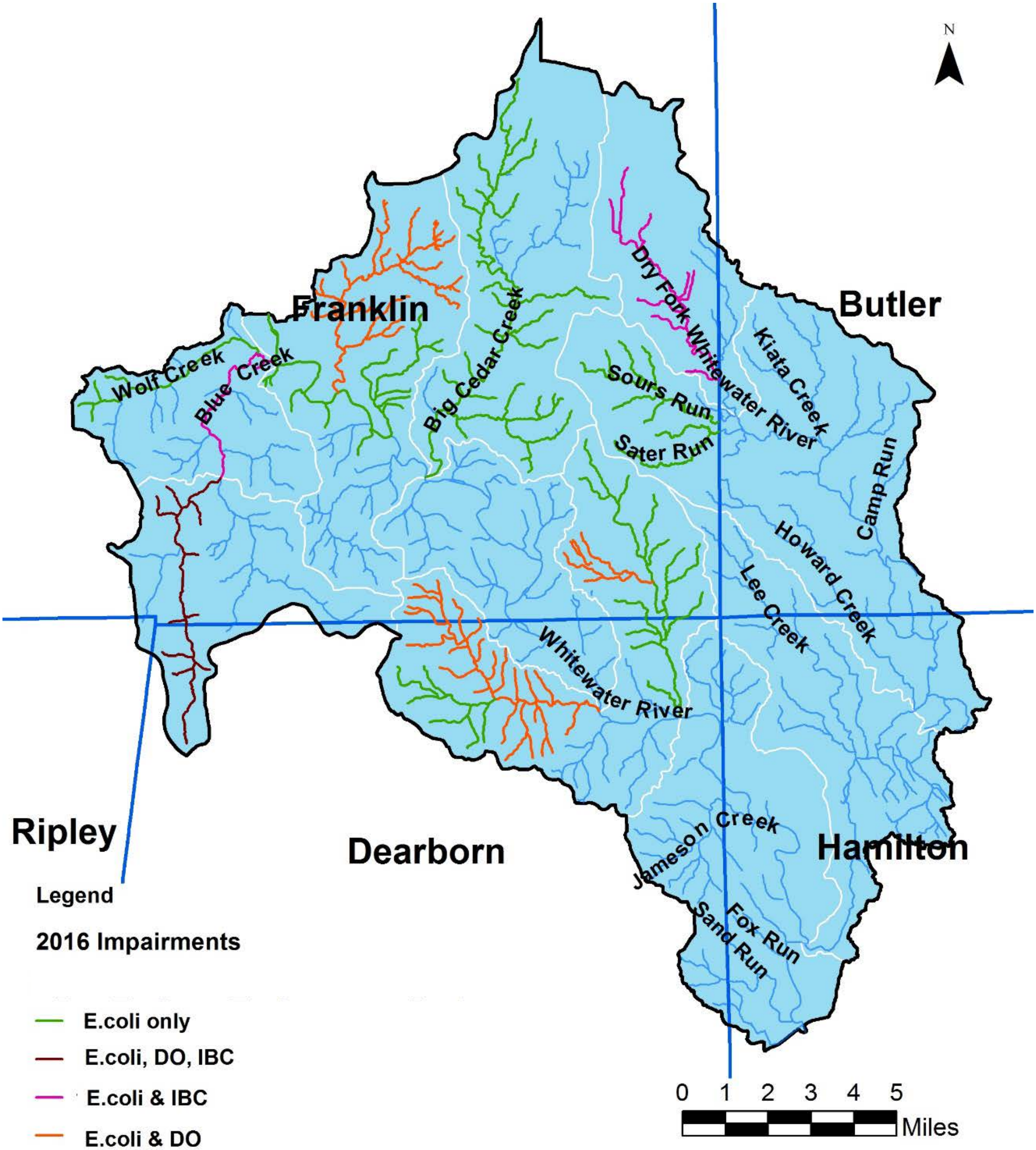


Figure 22: 303(d) Listings in the Whitewater River Watershed.

Sub watershed (12-digit HUC)	Previous AUID	Draft 2012 Section 303(d) Listed Impairment	New AUID	Updated Impairments to be Listed in 4A in 2016
Headwaters Blue Creek (050800030801)	ING0381_00		ING0381_01	E. coli, DO, IBC
	ING0382_00		ING0381_02	
	New		ING0381_T1001	
	New		ING0381_T1002	
	New		ING0381_T1003	
	New		ING0381_T1004	
Wolf Creek-Blue Creek (050800030802)	ING0382_01 ING0383_00	*E. coli*	ING0382_01	E. coli, IBC
	ING0384_T1001	*E. coli*	ING0382_02	E. coli
	New		ING0382_T1001	
	New		ING0382_T1002	
	New		ING0382_T1003	
	New		ING0382_T1004	
	New		ING0382_T1005	
	New		ING0382_T1006	
	New		ING0382_T1007	
	New		ING0382_T1008	
	New		ING0382_T1009	

Sub watershed (12-digit HUC)	Previous AUID	Draft 2012 Section 303(d) Listed Impairment	New AUID	Updated Impairments to be Listed in 4A in 2016
Big Cedar Creek (050800030803)	ING0387_00 ING0387_T1001 ING0387_T1002 ING0387_T1003		ING0383_01	E. coli
	ING0388_00	*E. coli*	ING0383_02	E. coli
	ING0387_T1004		ING0383_T1001	
	ING0387_01		ING0383_T1002	
	ING0388_T1001	*E. coli*	ING0383_T1003	E. coli
	ING0388_T1002	*E. coli*	ING0383_T1004	E. coli
	ING0388_T1003	*E. coli*	ING0383_T1005	E. coli
	ING0388_T1004		ING0383_T1006	
Little Cedar Creek (050800030804)	ING0384_00 ING0385_00 ING0386_00	DO, *E. coli*	ING0384_01	E. coli
	ING0385_00	DO, *E. coli*	ING0384_T1001	E. coli, DO
	ING0386_00		ING0384_T1002	
	ING0386_T1043 ING0386_00	DO, *E. coli*	ING0384_T1003	E. coli
	ING0386_00		ING0384_T1004	
Blackburn Creek (050800030805)	ING0389_T1019 ING0389_T1020	PCBs	ING0385_01	PCBs
	ING0389_T1009		ING0385_01A	
	ING0389_T1002 ING0389_T1003		ING0385_T1001	
	ING0389_T1001		ING0385_T1002	
	New		ING0385_T1003	
	ING0389_T1005		ING0385_T1004	
	ING0389_T1006		ING0385_T1005	
	ING0389_T1007		ING0385_T1006	
	ING0389_T1008		ING0385_T1007	
	New		ING0385_T1008	
	New		ING0385_T1009	

Sub watershed (12-digit HUC)	Previous AUID	Draft 2012 Section 303(d) Listed Impairment	New AUID	Updated Impairments to be Listed in 4A in 2016
	ING0389_T1010		ING0385_T1010	
Johnson Fork (050800030806)	ING038B_T1021 ING038A_T1041	*E. coli*	ING0386_01	
	ING038B_00	DO, *E. coli*	ING0386_02	E. coli
	ING038A_00 ING038A_T1001ING038A_T1002ING038A_T1003ING038A_T1004ING038A_T1006ING038A_T1007ING038A_T1008	*E. coli,* PCBs, Hg	ING0386_T1001	E. coli, DO, IBC, PCBs, Hg
	ING038A_T1005		ING0386_T1002	E. coli
	ING038A_T1009		ING0386_T1003	
	ING038C_00		ING0386_T1004	
	New		ING0386_T1005	
	ING038B_00	DO, *E. coli*	ING0386_T1006	E. coli, DO (4C)
	New		ING0386_T1006A	E. coli, DO (4C)
	ING038B_00	DO, *E. coli*	ING0386_T1007	E. coli
	ING038B_00	*E. coli*	ING0386_T1008	E. coli
Headwaters Dry Fork Whitewater River (050800030807)	ING038D_00		ING0387_02	E. coli, IBC
			ING0387_03	
Howard Creek (050800030808)	ING038E_00	*E. coli*	ING0388_01	E. coli
	New		ING0388_P1001	
	ING038E_00	*E. coli*	ING0388_T1005	E. coli
	New		ING0388_T1006	
	ING038E_00	*E. coli*	ING0388_T1007	E. coli
	ING038F_00		ING0388_T1008	
Lee Creek (050800030809)	ING038G_00		ING0389_01	
Jameson Creek (050800030810)	ING038C_T1022		ING038A_01	
	New		ING038A_01A	

Sub watershed (12-digit HUC)	Previous AUID	Draft 2012 Section 303(d) Listed Impairment	New AUID	Updated Impairments to be Listed in 4A in 2016
	New		ING038A_P1001	
	ING038C_00		ING038A_T1010	
			ING038A_T1011	
	ING038H_00		ING038A_T1012	

There are also 19 facilities in the watershed that have permits for discharging effluent through National Pollutant Discharge Elimination System (NPDES). In Figure 23, the location of the discharge pipes are shown and Figure 24 gives more details about each permit.

Figure 23: NPDES Facilities and Pipes in the Whitewater River Watershed

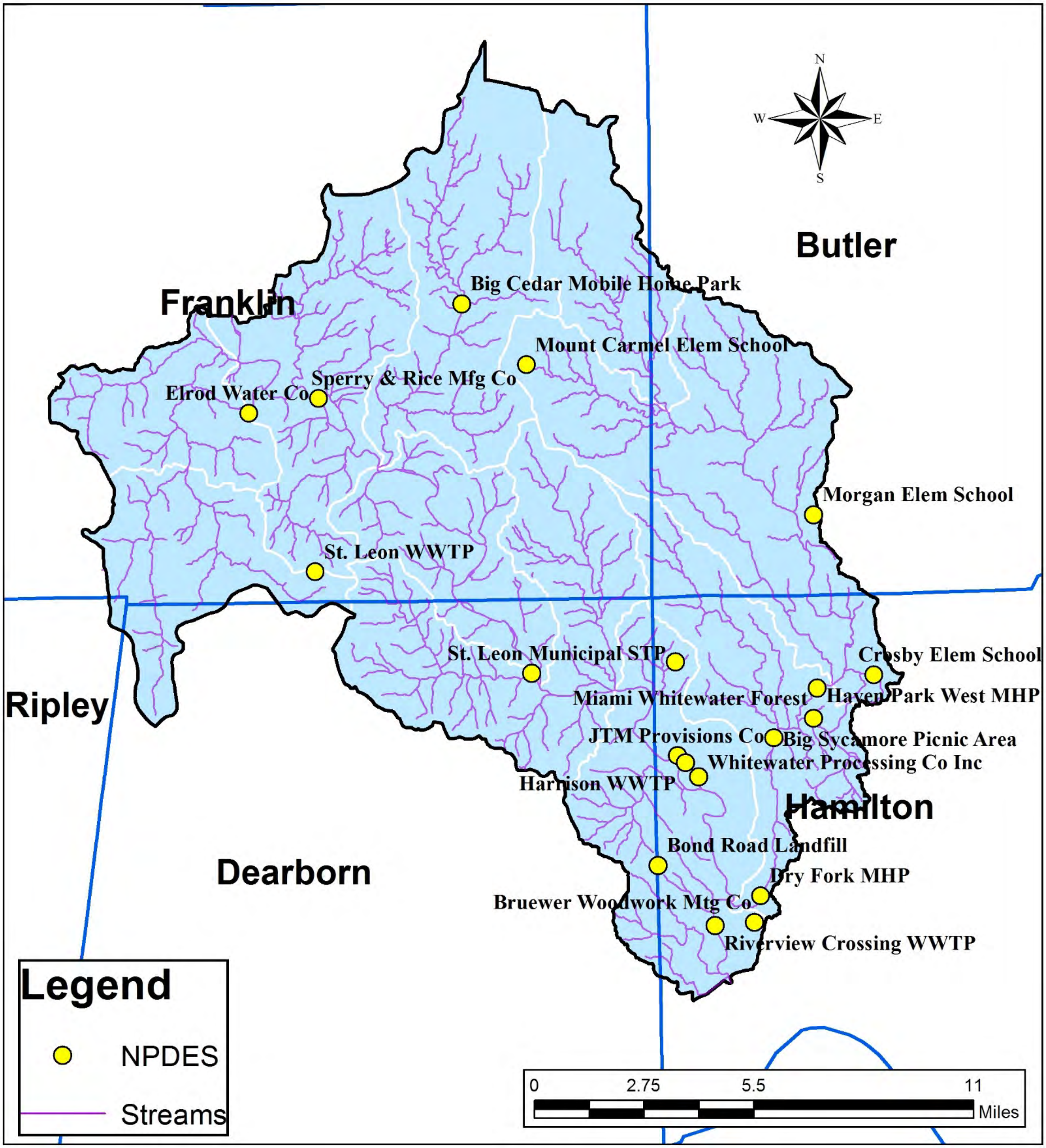


Figure 24: NPDES Permitted Wastewater Treatment Plants

Sub watershed	Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Headwaters Blue Creek	St. Leon WWTP	IN0058408	ING0385_01	Whitewater River	0.57
Big Cedar Creek	Big Cedar Mobile Home Park WWTP	IN0037168	ING0383_02	Tributary to Big Cedar Creek	0.0108
Little Cedar Creek	Sperry & Rice Mfg Co Elrod Water Co	IN0001473 IN0058947	NA NA	Whitewater River Unnamed Trib to Whitewater River	0.48 0.62
Johnson Fork	St. Leon Municipal STP	IN0058408	NA	Tributary to Whitewater River	0.3
Howard Creek	Mt. Carmel Elem. School Morgan Elementary School Crosby Elementary School	IN0054534 OH0127558 OH0127094	ING0388_01 NA	Sours Run Dry Fork Dry Fork	NA
Lee Creek	Dry Fork MHP Big Sycamore Picnic Area Miami Whitewater Forest Haven Park West MHP	OH0109380 OH0133728 OH0047261 OH0105589	NA	Dry Fork Dry Fork Whitewater River Dry Fork	NA
Jameson Creek	New Horizons MHP – Flora JTM Provisions Co Harrison WWTP Whitewater Processing Co Inc Bond Road Landfill Riverview Crossing WWTP Bruewer Woodwork Mfg Co	OH0132004 OH0093181 OH0021440 OH0141135 OH0115690 OH0118974 OH0118931	NA	Kolb Creek Whitewater River Whitewater River Whitewater River Fox Run Whitewater River Whitewater River	NA

There are a few facilities that have been in noncompliance within the last 5 years. but none of them have current significant violations. According to EPA's Enforcement and Compliance History Online (ECHO) site, serious violations are noted as significant noncompliance or significant violations. The following facilities had effluent exceedances for different pollutants: Elrod Water Company: TSS, Big Cedar Mobile Home Park: chlorine, BOD, E. coli, nitrogen, DO, and TSS, Sperry & Rice Manufacturing Co.: E. coli, BOD, DO, and trichloroethylene, Morgan Elementary School: nitrogen, Miami Whitewater Forest: BOD, Haven Park West: DO, Harrison: TSS, Whitewater Processing: BOD, E. coli, nitrogen, pH, DO, and TSS, Riverview Crossing: nitrogen, and New Horizons: BOD, nitrogen, DO, and TSS. The most recent formal action that took place was for Big Cedar Mobile Home Park and that was back in 2014. Overall the NPDES facilities in the Whitewater River Watershed are in good standing with their permits. See Figure 25 below, for more details on the permit compliances.

Figure 25: Summary of NPDES Permit Compliance History in the Whitewater River Watershed

Facility Name	City	State	Permit ID	Current Significant Violations	Quarters Non Comp (3 yrs)	CWA Current Compliance Status	Inspections (5 yrs)	Date Last Formal Action	Total Penalties (5 yrs)
ELROD WATER COMPANY	BROOKVILLE	IN	IN0058947	N	1	No Violation	3	--	$0
BIG CEDAR MOBILE HOME PARK	BROOKVILLE	IN	IN0037168	N	7	Noncompliance	4	5/12/2014	$1,850

Facility Name	City	State	Permit ID	Current Significant Violations	Quarters Non Comp (3 yrs)	CWA Current Compliance Status	Inspections (5 yrs)	Date Last Formal Action	Total Penalties (5 yrs)
SPERRY & RICE MANUFACTURING CO LLC	BROOKVILLE	IN	IN0001473	N	9	Noncompliance	7	9/12/2008	$0
ST LEON MUNICIPAL WWTP	WEST HARRISON	IN	IN0058408	N	2	No Violation	6		$0
MORGAN ELEM SCH	HAMILTON	OH	OH0127558	N	1	No Violation	1	--	$0
BRUEWER WOODWORK MANUFACTURING CO INC	CLEVES	OH	OH0118931	N	3	No Violation	2	--	$0
CROSBY SCHOOL *	HARRISON	OH	OH0127094	N	0	No Violation	1	--	$0
DRY FORK MHP	CLEVES	OH	OH0109380	N	4	No Violation	2	1/4/2013	$825
MIAMI WHITEWATER FOREST	HARRISON	OH	OH0047261	N	2	No Violation	2	--	$0
HAVEN PARK WEST INC	HARRISON	OH	OH0105589	N	1	No Violation	2	--	$0
HARRISON STP	HARRISON	OH	OH0021440	N	0	No Violation	9	2/3/2011	$0
BOND ROAD LANDFILL *	HARRISON	OH	OH0115690	N	8	No Violation	4	--	$0
WHITEWATER PROCESSING CO *	HARRISON	OH	OH0141135	N	8	Noncompliance	6	--	$0
RIVERVIEW CROSSING WWTP	HARRISON	OH	OH0118974	N	2	No Violation	0	--	$0
NEW HORIZONS MHP - FLORA	HARRISON	OH	OH0132004	N	3	No Violation	1	--	$0
BIG SYCAMORE PICNIC AREA	CINCINNATI	OH	OH0133728	N	4	No Violation	2	--	$0
JTM PROVISIONS COMPANY, INC.	HARRISON	OH	OH0093181	N	0	No Violation	1	--	$0

2.2.9 Water Quality Information

In establishing a plan for monitoring, the first step is to set targets to establish whether a result is acceptable or unacceptable. There are various targets levels for water depending on use. Drinking water targets are very stringent due to the importance for human health. For the purposes of this watershed and the typical use, the targets selected should be more representative of an aquatic habitat water quality standard. Having water that the community feels safe to recreate in, come into full body contact with, and provide resources for wildlife to thrive, is the goal in choosing benchmarks for water quality data (Figure 26). In addition, the Whitewater River Watershed has a large aquifer that supplies drinking water to many residents in Franklin County, IN and surrounding counties. Because of this, it is important that we maintain the highest level of water quality to protect human health, and make sure all residents of the watershed have a clean, safe drinking water source.

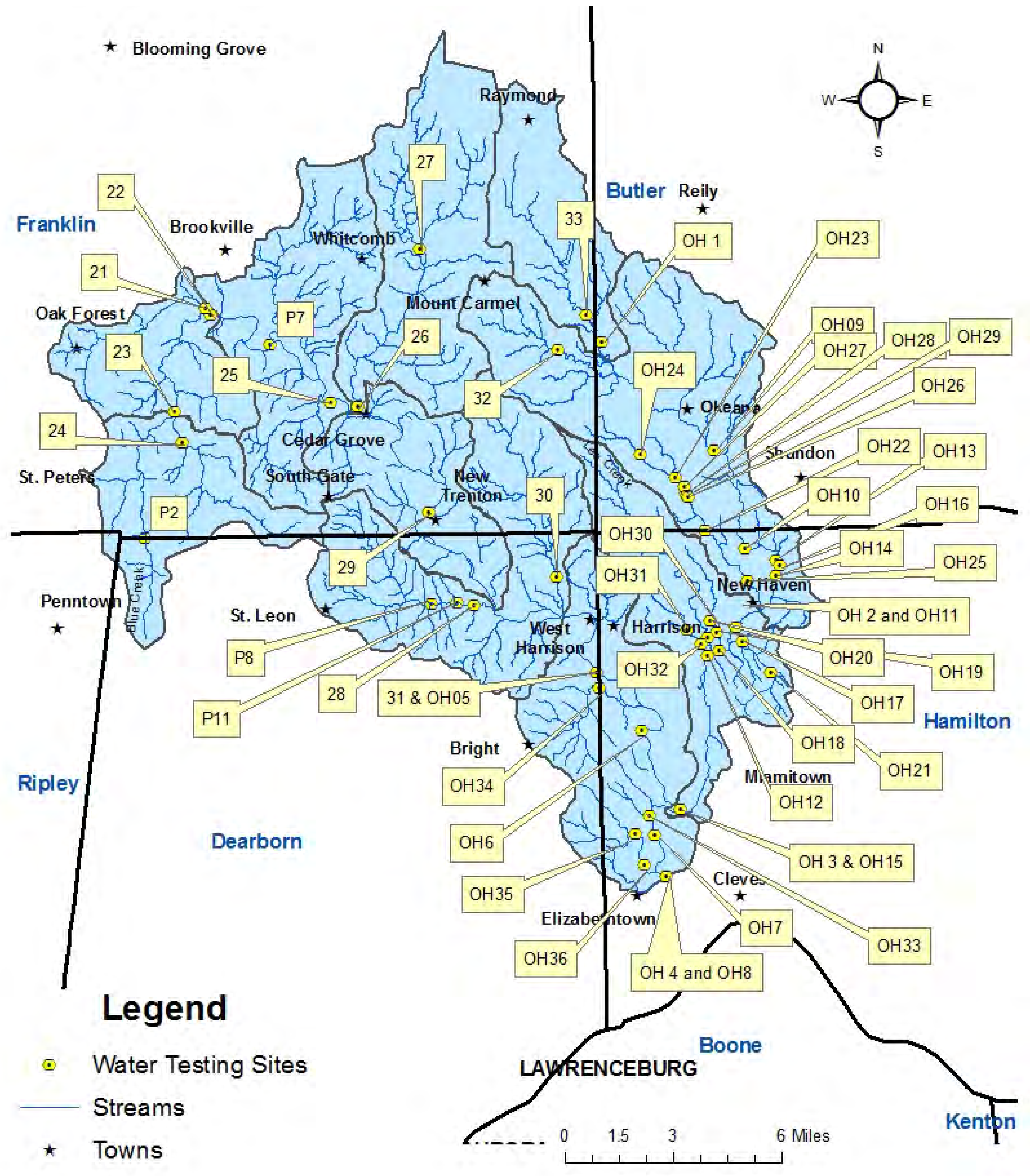
Figure 26: Water Quality Targets for Measured Parameters

Parameter	Target	Reference
pH	> 6.5 and < 9	Ohio Administrative Code 3745-1-34 to 3745-1-36
Temperature	Monthly standard	Indiana Administrative Code (327 IAC 2-1-6)
Dissolved oxygen	> 4 mg/L and < 12mg/L	Indiana Administrative Code (327 IAC 2-1-6) &

Parameter	Target	Reference
		Consolidated Assessment and Listing Methodology (CALM)
Alkalinity	200 mg/L – 600 mg/L	Divya.K.R and K.Manonmani (2013)
E. coli	< 235 cfu (or MPN) /100 mL Geo Mean <125 cfu/100mL	Indiana Administrative Code (327 IAC 2-1.5-8)
Nitrate-nitrite	< 1.0 mg/L	2001 OH EPA
Total Kjehldahl Nitrogen TKN	< 0.591 mg/L	U.S. EPA recommendation
Total phosphorus	< 0.06 mg/L	Ohio EPA "Technical Support Document for Nutrient Water Quality Standards for Ohio Rivers and Streams" (December 2011)
Total suspended solids	< 25 mg/L	Sediment in streams: sources, biological effects and control. American Fisheries Society, Bethesda, MD (Waters T.F., 1995)
Citizens Qualitative Habitat Evaluation Index	> 60 points	Ohio EPA "Methods for Assessing Habitat in Flowing Waters Using the Qualitative Habitat Evaluation Index (QHEI)" (June 2006) IDEM (2000)
Qualitative Habitat Evaluation Index	>51 points	Ohio EPA "Methods for Assessing Habitat in Flowing Waters Using the Qualitative Habitat Evaluation Index (QHEI)" (June 2006) IDEM (2000)
Pollution Tolerance Index	>16 points	Hoosier Riverwatch (2012)
Fish Index of Biotic Integrity (IBI)	>35	IDEM (2012)
Macroinvertebrate Index of Biotic Integrity (mIBI)	>35	IDEM (2012)
Turbidity	10.4 NTU	U.S. EPA recommendation

After selecting appropriate targets and parameters the next task is choosing sampling sites that are representative of your watershed. For the purposes of good representation while balancing feasibility, 17 sites in the Whitewater River Watershed were originally selected. These sites were tested monthly for chemical data (for a year November 2013 – October 2014), and once for biological and habitat data (July-August 2014). The original 17 sites were Sites 21-33 and OH1 – OH4. The project also used supplemental data from other sources from sites P2, P7, P8, and P11 (sampled by IDEM) and OH5 – OH36 (sampled by volunteers). Figure 27 details where each site was located.

Figure 27: Location of Sampling Sites for the Whitewater River Watershed Project



For further information about each site, see Figure 28 below which details which sub watershed the site is in and provides a brief description.

Figure #28: Whitewater River Sample Site Locations, Coordinates, Subwatersheds, and Descriptions

Site ID	Physical Location & Watershed Location	Coordinates	Subwatershed Name	Subwatershed HUC
IN21	Wolf Creek – Blue Creek Rd.	39.398714 - 85.018113	Wolf Creek	-02
IN22	Blue Creek – Highland Center Rd.	39.395809 - 85.015259	Wolf Creek	-02
IN23	Blue Creek – Blue Creek Rd.	39.357202 - 85.035169	Wolf Creek	-02
IN24	East Fork Blue Creek – Blue Creek Rd.	39.344938 - 85.031634	Blue Creek	-01
IN25	Whitewater River – SR 1	39.35938 - 84.954709	Little Cedar Creek	-04
IN26	Big Cedar Creek – US 52	39.35938 - 84.954709	Big Cedar Creek	-03
IN27	Big Cedar Creek – Big Cedar Rd.	39.420338 - 84.906855	Big Cedar Creek	-03
IN28	Logan Creek – SR 46	39.277358 - 84.882803	Johnson Fork	-06
IN29	Whitewater River – St. Peters Rod	39.314598 - 84.905164	Blackburn Creek	-05
IN30	Johnson Fork – Johnson Fork Rd.	39.287833 - 84.840265	Johnson Fork	-06
IN31	Whitewater River – Jamison Rd.	39.249309 - 84.820915	Jameson Creek	-10
IN32	Sours Run – Drewersburg Rd.	39.378871 - 84.836775	Howards Creek	-08
IN 33	Dry Fork Whitewater River – Dickson Rd	39.39258 – 84.8213	Headwaters Dry	-07
OH1	Dry Fork – Dwyer Rd	39.381266 - 84.813811	Headwaters Dry	-07
OH2	Dry Fork – Mt. Hope Rd	39.265971 - 84.748460	Howards Creek	-08
OH3	Dry Fork – Kilby Rd	39.193278 - 84.779393	Lee Creek	-09
OH4	Whitewater River – US Hwy 50	39.166818 - 84.787852	Jameson Creek	-10

Data for the Whitewater River Watershed Project was collected from a few different sources. For sites on the Indiana side of the project (21-33), data was collected and analyzed by IDEM. For the sites OH1-OH4 data was collected by Whitewater River Watershed Project staff and sent to the Dearborn Regional Sewer District lab and Belmont Laboratory to be analyzed.

2.2.9.1 Nitrogen

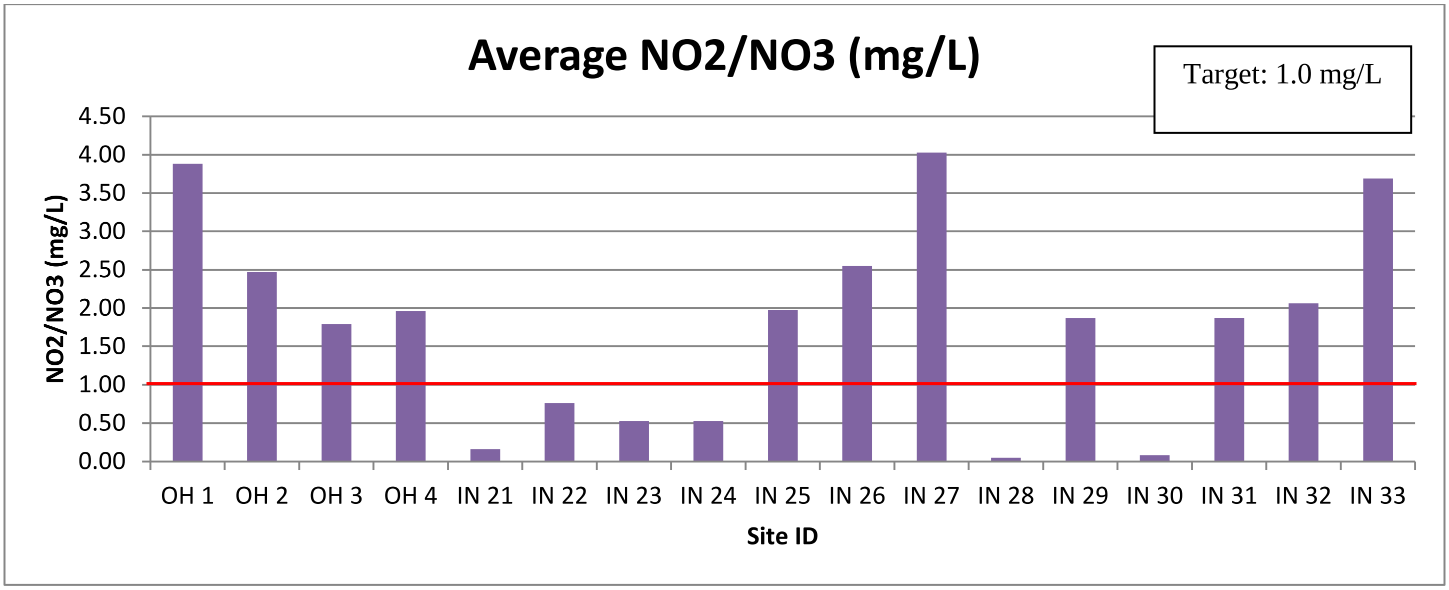
Roughly 80 percent of the air we breathe is nitrogen, and nitrogen is one of the earth's most common elements. It may be found in many physical states throughout our world. Sometimes it exists as a gas and it can also exist as organic nitrogen found in proteins, which is recycled by plants and animals.

In streams and rivers, nitrogen is often the limiting factor for nutrient budgets. Although nitrogen is essential as plant nutrients, too much in a system can cause significant water quality issues. Paired with phosphorus, nitrates in excess can cause eutrophication (a dramatic increase in aquatic plant growth). This in turn affects levels of dissolved oxygen available to aquatic species, increases temperature, and can have catastrophic effects on the ecosystem. In healthy systems, the natural level of ammonia or nitrate in surface water is less than 1 mg/L.

Sources of nitrates are everywhere. They include animal wastes, wastewater treatments plants, runoff from fertilized lawns/cropland, failing septics, and discharges from car exhausts. In the effluent of wastewater treatment plants, nitrate can range up to 30 mg/L. In addition to having many sources, nitrates are highly mobile in the waters. They can be passed through soil layers into underground water sources, leached from fertilizers on the surface, and discharged from pipes.

There is currently no set standard for nitrate concentration in surface water that is not being used as a public water supply. The only Indiana water quality standards available at this time states that nitrate+nitrite-nitrogen levels in surface water are not to exceed a 30-day average of 10 mg/L at a public water supply intake (327 IAC 2-1-6). The nitrate+nitrite reference condition for USEPA Aggregate Ecoregion IV, Ecoregion 71 is 1.2 mg/L and is based on median nitrate+nitrite concentrations for the top 25th percentile of streams sampled (2000). It has been shown that streams that have available nitrogen will go eutrophic when nitrate+nitrite levels exceed 1.5 mg/L. However, documents from IDEM and Ohio EPA show that for exceptional habitat the nitrate+nitrite should not exceed 1.0 mg/L. Since the project hopes to not only meet state limits but exceed expectations as one of Indiana's/ Ohio's cleanest streams a more stringent target was chosen. For this reason, 1.0 mg/L was set as the upper limit for the nitrogen water quality target. Figure 29 details the average nitrate+nitrite results for the project.

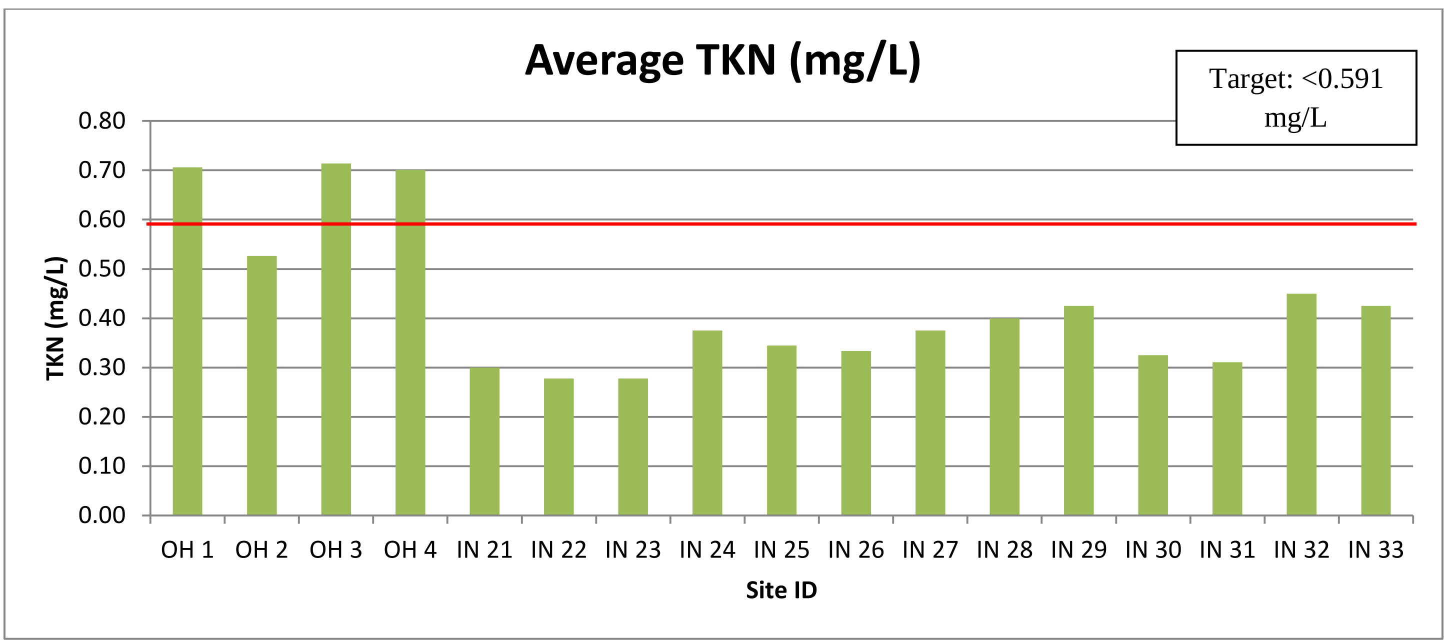
Figure #29: Average Nitrate+Nitrite Values in the Whitewater River Watershed (Nov 2013-Oct 2014)



In addition to measuring the nitrate+nitrite concentrations, the project also set out to measure the Total Kjeldahl nitrogen or TKN. TKN is the sum of organic nitrogen, ammonia (NH3), and ammonium (NH4+). It is often a required parameter in measuring near wastewater or sewage treatment plants.

According to recommendations from the US EPA, the maximum value for TKN should be 0.591 mg/L. Beyond this limit, overall water quality health may degrade. For this reason, the target for the parameter was set at less than 0.591 mg/L for the Whitewater River Watershed Project.

Figure #30: Average Total Kjeldahl Nitrogen Values in the Whitewater River Watershed



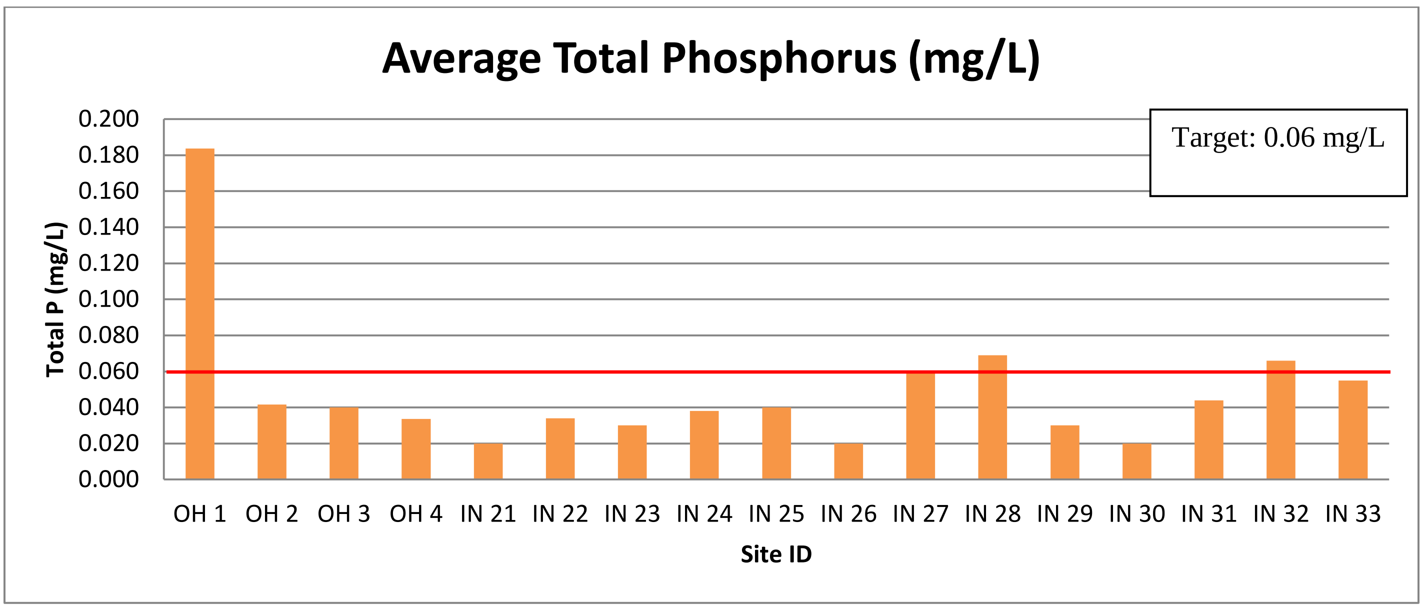
2.2.9.2 Phosphorus

Phosphorus is a naturally occurring nutrient in all aquatic systems. However, when additional sources begin to add phosphorus to the system water quality degrades. Additional sources like human waste, fertilizers, animal waste, detergents, and industrial waste can increase the phosphorus level in an aquatic system. Because phosphorus is often a limiting factor for plant growth in a system, when excess phosphorus is added to the system, plant growth explodes. This can result in algae blooms and eutrophication of the aquatic system. Eutrophication can lead to higher temperature, lower dissolved oxygen, and stresses aquatic life and can even result in fish kills.

Phosphorus cycles through different forms in aquatic systems. Not all forms of phosphorus can be used by aquatic life. Measuring total phosphate levels can indicate the potential for future eutrophication issues because it indicates levels that can convert to orthophosphate and be taken up by plants.

There is not currently an Indiana water quality standard for phosphorus. The dividing line between mesotrophic and eutrophic streams is a total phosphorus concentration of 0.07 mg/L (Dodds et al. 1998) or an orthophosphate concentration of 0.05 mg/L (Dunne and Leopold, 1978). However, on page 32 of the Ohio EPA Draft "Technical Support Document for Nutrient Water Quality Standards for Ohio Rivers and Streams" (December 2011), it is stated that "Where the use is EWH (exceptional warm water habitat), TP concentrations less than 0.06 mg/L would be protective". With many exceptional warm water habitat segments in the Whitewater River and Dry Fork Whitewater River tributaries, it seems reasonable to apply the 0.06 mg/L total phosphorus target. The results of the average total phosphorus values in the Whitewater River Watershed are summarized in Figure 31 below.

.**Figure #31: Average Total Phosphorus Values in the Whitewater River Watershed**



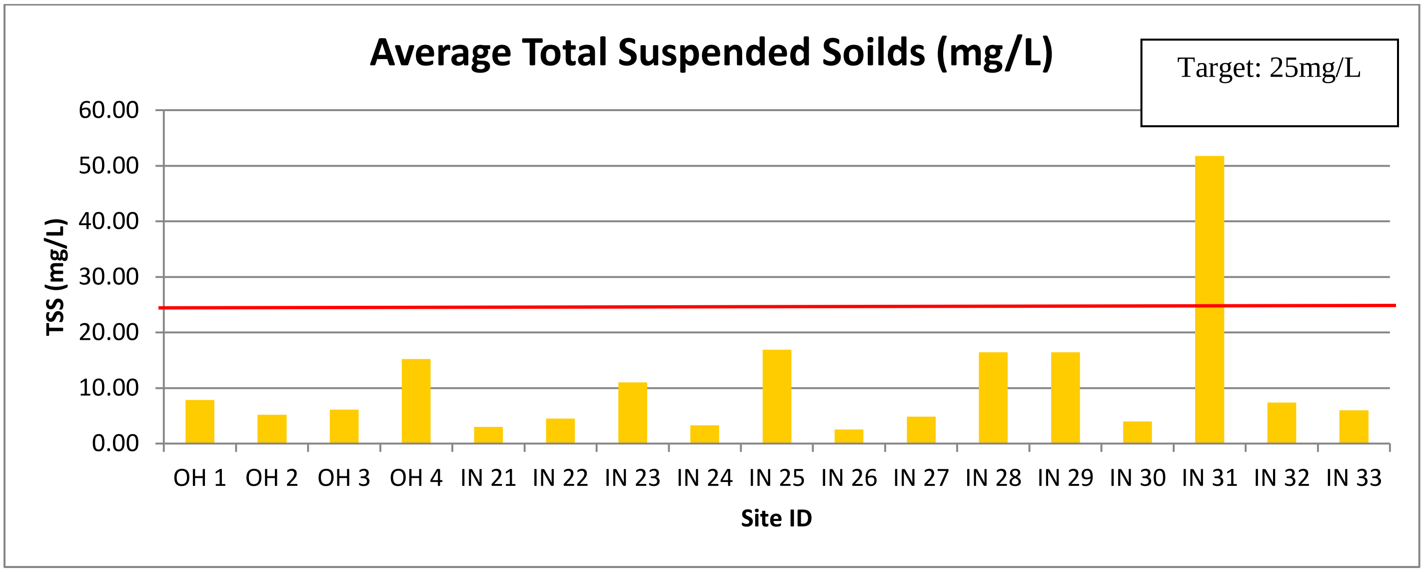
2.2.9.3 Total Suspended Solids and Turbidity

Total suspended solids (TSS) is a measurement that includes all the particles suspended in water that are too large to pass through a filter. The more TSS in a stream the cloudier the appearance of the water. There are many sources of suspended solids in a watershed. They can come from wastewater treatment plants and soil erosion from agriculture/development practices.

If TSS levels become too high, aquatic system begin to degrade. Suspended solids absorb more heat and increase the water temperature. The higher temperature decreases levels of dissolved oxygen which can put a strain on fish and other aquatic organisms. When TSS is too high, it can also limit habitat. Suspended solids can blanket and smother the bottom of the river bed.

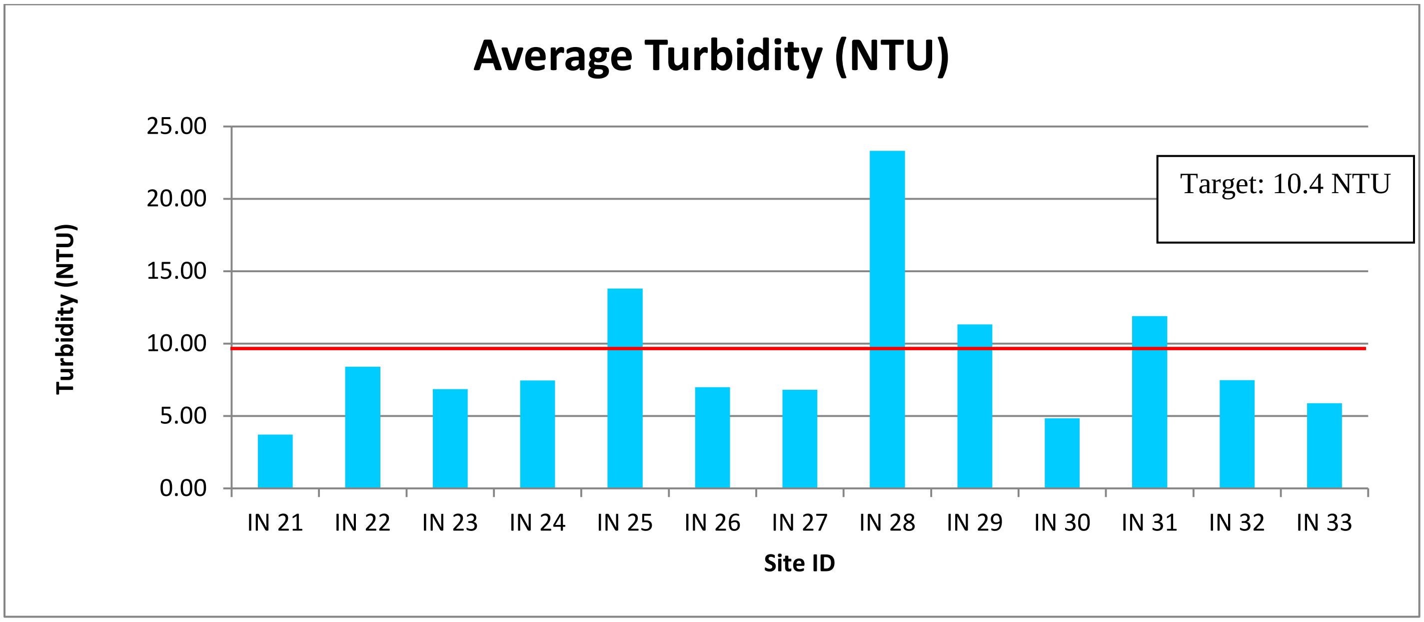
In Indiana, the range for TSS is 25-80 mg/L. However, in research suggested by Waters, levels above 25 mg/L can cause damage to aquatic systems. For this reason, less than 25 mg/L was selected as the target for the Whitewater River Watershed Project. Figure 32 below summarizes the average TSS at each testing site.

Figure #32: Average Total Suspended Solids in the Whitewater River Watershed



Turbidity is defined as the cloudiness or haziness of water. It's a key parameter in most water monitoring efforts. Turbidity is caused by large numbers of individual particles that are generally invisible to the naked eye. In the same way smoke clouds up the air, small particles make the water cloudy. When turbidity levels are too high, the amounts of light that can reach lower depths are reduced. Without that light submerged aquatic plants can't grow. This consequently negatively affects species which are dependent on them, such as fish and shellfish. High turbidity levels can also affect the ability of fish gills to absorb dissolved oxygen. The US EPA recommends a turbidity target of 10.4 NTU. For that reason 10.4 NTU was set as the target for turbidity for the Whitewater River Watershed Project. Turbidity was not a parameter tested by the project for the four Ohio sites (OH1, OH2, OH3, and OH4. See below the turbidity data from the Indiana sites collected by IDEM.

Figure #33: Average Turbidity in the Whitewater River Watershed



2.2.9.4 Escherichia coli (E. coli)

Escherichia coli (E. coli) is a fecal coliform bacteria that is found in the feces of many warm- blooded animals like humans, livestock, and waterfowl. This specific species of fecal coliform bacteria is used in many states as a water monitoring parameter. The US EPA has determined that E. coli bacteria populations above 235 colonies per 100mL indicate that more than eight out of a 1,000 people who come in contact with the water may become sick.

E. coli levels that are too high often occur throughout the year, though Indiana's water quality limit only applies to the recreation season (April through October) where the chance of someone coming into contact with unsafe water is highest. Sources of E. coli in the watershed include human waste and animal waste. Areas with levels of unsafe E. coli may indicate areas of failing septic systems, wastewater treatment plants or areas where livestock have direct access to the water.

Over the years, there have been many attempts to differentiate E. coli from humans and animals. While possible, the technology and resources to do so go far beyond a nonpoint source pollution project. Streams often contain a variety of species of bacteria, viruses, protozoa, fungi, and algae most of which occurs naturally and pose little risk to human health.

Figure 34 details the average levels of E. coli at each site throughout the testing season. In addition to the single test standard (235 CFU/100 mL) the state and this project also have targets for the geometric mean value of E. coli at a site. The geometric mean is calculated by averaging the values E. coli collected for 5 weeks in a row. The geometric mean varies from the standard mean. Because it's calculated over 5 weeks of results in a row, the geometric mean tends to dampen the effects of very high or very low values. These values may bias the mean if a standard average were calculated. Using the geometric mean is useful with analyzing bacteria levels since concentrations may increase from 10 to 10,000 in a short period. The target for this project is the same as the Indiana state standards set by IDEM. After 5 weeks the geometric mean E. coli (CFU/100 mL) must be less than 125 CFU/100mL. Figure 35 details the geometric mean results for each testing site.

Figure #34: Average E. coli Levels in the Whitewater River Watershed

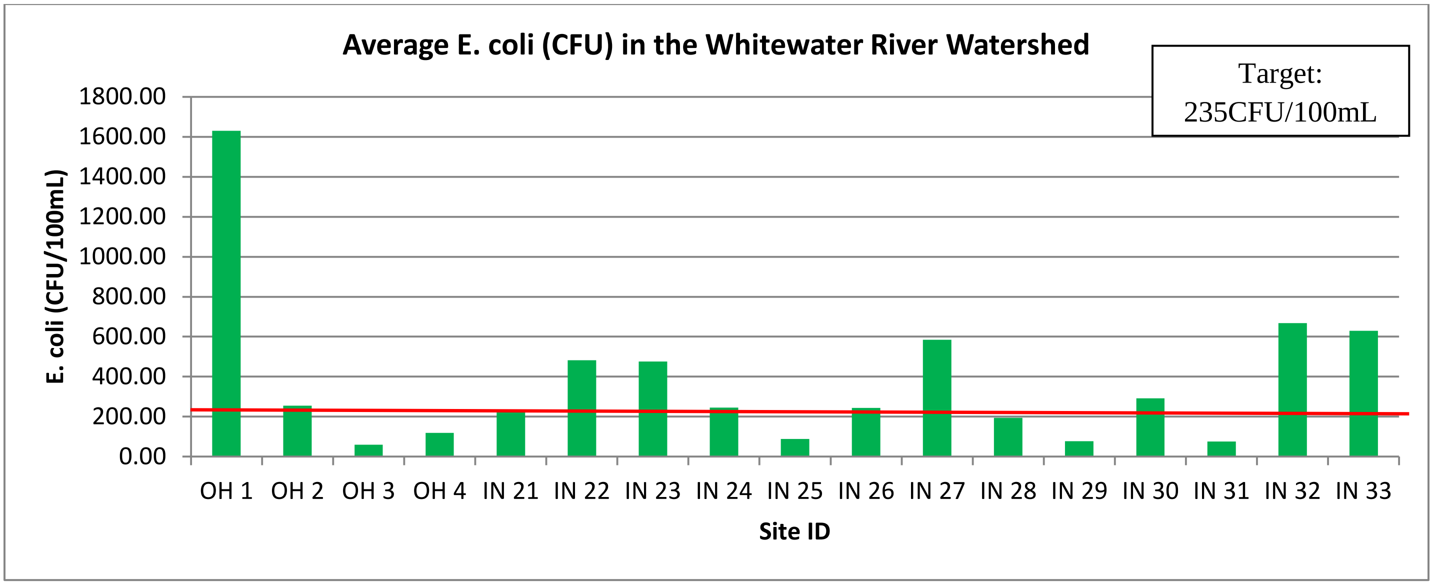
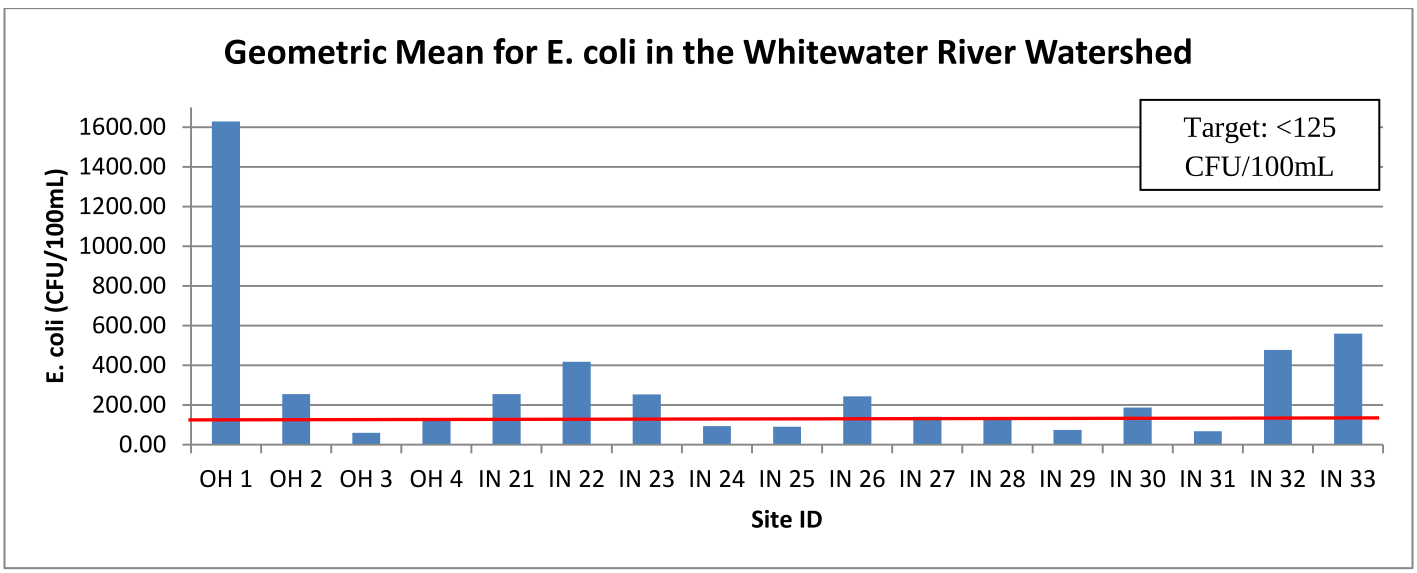


Figure #35: Geometric Mean for E. coli Levels in the Whitewater River Watershed



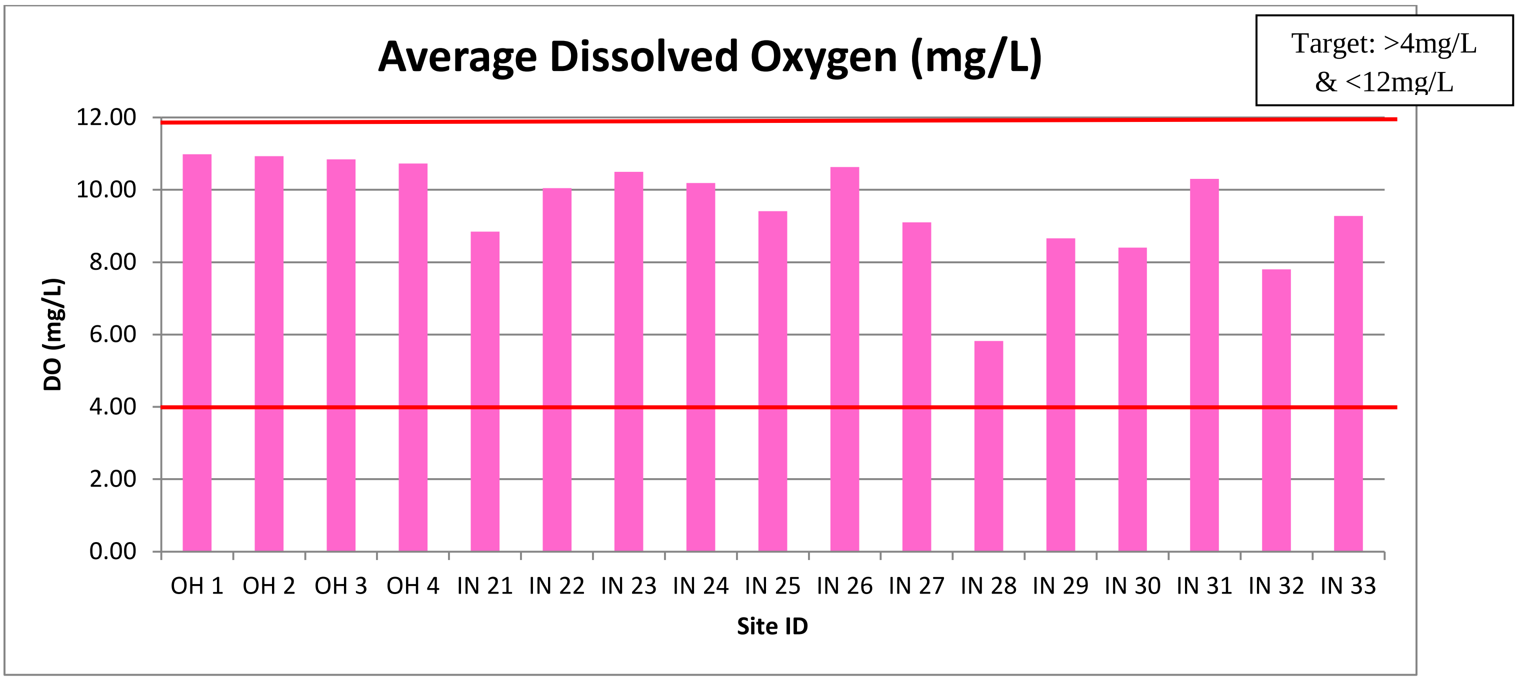
2.2.9.5 Dissolved Oxygen

In an aquatic system, there is a natural exchange and production of oxygen. The system gains oxygen from the atmosphere and from plants via photosynthesis. The system loses oxygen by aquatic organisms through respiration, decomposition, and from various chemical reactions. Oxygen is measured in an aquatic system in its dissolved form as dissolved oxygen (DO).

If more oxygen is being consumed than either produced or available in the aquatic system, dissolved oxygen levels decline and can cause organism mortality. Dissolved oxygen fluctuates not only seasonally, but can also vary within a 24 hour period. Oxygen capacity in water varies with temperature and altitude. Generally, colder water holds more oxygen than warmer water and water holds less oxygen at higher altitudes.

Target levels that are set for Dissolved Oxygen for the Whitewater River Watershed Project are levels greater than 4mg/L and less than 12mg/L. The target was selected using data from IDEM's standards.

Figure #36: Average Dissolved Oxygen Levels in the Whitewater River Watershed

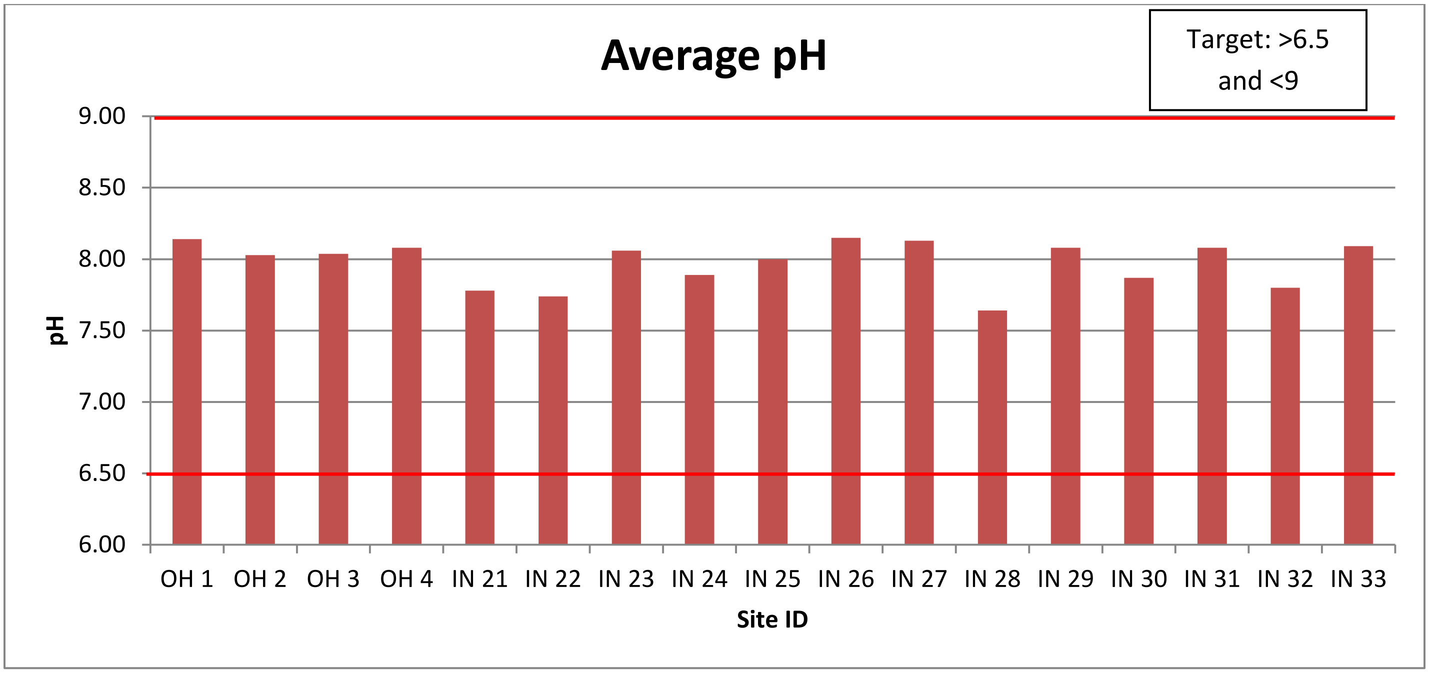


2.2.9.6 pH

The term pH is used to describe the alkalinity or acidity of system. Values are ranked of a scale of 1.0 to 14.0 where 1.0 is very acidic and 14.0 is very basic. Many different chemical and biological reactions in water are dependent on a certain pH level. The greatest percentage of aquatic life prefers a range between 6.5 and 8.0. When pH levels fall below or above this range, it can put stress on the organisms.

Changes in pH are often caused by acid rain, surrounding rock, and wastewater discharges. Keeping in mind research about the preferred range of pH by aquatic life, the target for pH for the Whitewater River Watershed Project was selected to be greater than 6.5 and less than 9. Figure 37 details the average pH at each of the testing sites.

Figure #37: Average pH in the Whitewater River Watershed



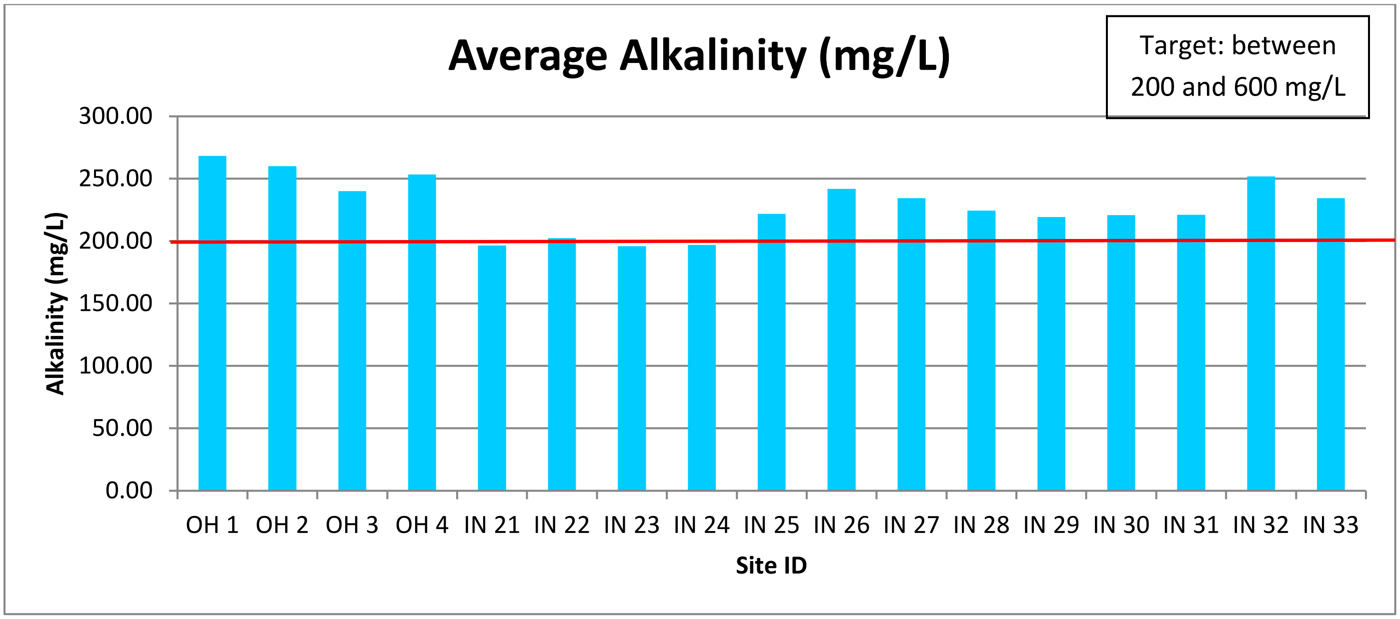
2.2.9.7 Alkalinity

Alkalinity is often a measurement that is associated with pH. Alkalinity is simply a measure of the buffering capacity, or ability to resist changes in pH, of an aquatic system. This is an important measurement since pH has a direct impact on aquatic organisms. Understanding the buffering capacity is important to understand the overall water quality health. Typically, areas of limestone bedrock and thick deposits of glacial tills are areas that provide good carbonate buffering.

Typically, small to moderate amounts of alkalinity in streams are good for the well-being of aquatic organisms. However, too much alkalinity can be harmful to wildlife. In addition, high alkalinity can also cause negative effects for human use, including scale buildup in fixtures, bad taste, and a reduction in the effectiveness of chlorine disinfection.

In Indiana, there are no set limits for Alkalinity in drinking water. The historical ranges in the area can be from 1 to 1,000 mg/L. According to research from Divya.K.R and K.Manonmani, optimal ranges of Alkalinity are between 200 and 600 mg/L. Over 600 mg/L the taste of the drinking water was said to be unpleasant. For that reason, the target range of 200-600 mg/L was chosen for our project.

Figure #38: Average Alkalinity in the Whitewater River Watershed



2.2.9.8 Temperature

The temperature of the water controls many important reactions and functions. Some species, like trout and stone flies, are extremely sensitive to temperature. Temperature can vary greatly depending on the time of the year the sample is taken. Since Whitewater River is home to some of the best trout fishing in the state of Indiana year round, there is a concern by stakeholders of maintaining appropriate water temperature for trout. According to research from Girwood, most fish aren't active until temperature reaches around 50 degrees Fahrenheit (10.0°C). According to research from the USFWS, many species of trout begin to experience stress or lack of reproduction at 70 degrees Fahrenheit (21.1° C). Figure 39 illustrates the natural temperatures that are expected for streams in Indiana for each month of the year. Figure 40 details the temperature at each site throughout the project. All values met water quality standards.

Figure 39: Indiana Administrative Code – Water Quality Standards

Table 6-4

	Ohio River Main Stem °F(°C)	Other Indiana Streams °F(°C)
January	50 (10.0)	50 (10.0)
February	50 (10.0)	50 (10.0)
March	60 (15.6)	60 (15.6)
April	70 (21.1)	70 (21.1)
May	80 (26.7)	80 (26.7)
June	87 (30.6)	90 (32.2)
July	89 (31.7)	90 (32.2)
August	89 (31.7)	90 (32.2)
September	87 (30.7)	90 (32.2)
October	78 (25.6)	78 (25.5)
November	70 (21.1)	70 (21.1)
December	57 (14.0)	57 (14.0)

Figure #40: Temperature (°F) in the Whitewater River Watershed

Site Number	11/14 /2013	12/11/ 2013	1/14/ 2014	2/11/ 2014	3/18/ 2014	4/21/ 2014	5/20/ 2014	6/18/ 2014	7/15/ 2014	8/12/ 2014	9/23/ 2014	10/21/ 2014
OH 1	38.7	32.6	40.2	32.4	39.5	56.3	60.3	74	69.3	72.3	56	54.5
OH 2	40.4	33.2	41.1	32.2	41.5	58.8	61.7	77.4	72.8	75	57.7	55.8
OH 3	43.3	35	42.6	32.5	43.8	62.5	63.5	79.1	74.3	75.6	65.4	56.9
OH 4	48.7	34.9	41.1	32.5	44.6	60.8	60.2	78.1	72.9	76.2	65	57.7
IN 21	N/A	N/A	N/A	N/A	N/A	68.2	59.7	68.9	71.9	70	56	55.4
IN 22	43.1	35.9	39.3	32.7	40.5	65.3	60.5	74.8	73.8	72.5	57.9	55.4
IN 23	41.2	34.4	39.5	32.2	40.9	68	60.1	74.8	72.3	72.2	59.7	54
IN 24	N/A	N/A	N/A	N/A	N/A	65.8	58.2	73.2	71.4	73.5	57.8	54.3
IN 25	49.1	36.2	38	35.2	40	54.7	57.2	74.3	67	68.2	61.2	57.2
IN 26	33.9	32.1	37.5	32.1	35.6	49.6	60.5	72.8	64.1	67.8	N/A	49.4
IN 27	N/A	N/A	N/A	N/A	N/A	50.4	61.6	71	62.8	68	N/A	48.1
IN 28	N/A	N/A	N/A	N/A	N/A	58.4	64.7	75.1	70.6	70.97	58.4	53.4
IN 29	N/A	N/A	N/A	N/A	N/A	55.4	59.3	76.2	68	69.5	60	55.5
IN 30	N/A	N/A	N/A	N/A	N/A	57.5	64.8	73.5	67.6	68.8	59.2	51.9
IN 31	46.9	36.6	38.1	35.9	40.7	58.7	59.5	77.2	71.8	71.3	62.3	56.9
IN 32	N/A	N/A	N/A	N/A	N/A	52	60.9	71.7	64	64	51.9	49.6
IN 33	N/A	N/A	N/A	N/A	N/A	50.8	61.5	71.6	62.7	65.1	52.4	48.4

2.2.9.9 Supplemental Data

Due to limitations of staff and resources, supplemental data was needed from outside sources in order to better understand the current condition of the streams. The Ohio side of the watershed was not as geographically represented as the Indiana side due to the project's limitations, so supplemental data was needed to obtain a better geographical representation. The Lower Great Miami River Citizens' Water Quality Monitoring Program, overseen by Friends of the Great Miami, Rivers Unlimited, and Hamilton County SWCD, collected data at 32 different sites in Hamilton County & Butler County, Ohio from March 2014-November 2014. Those sites are OH5 –OH36. The data was collected the 3rd Saturday of each month and analyzed by volunteers. IDEM collected and analyzed the data from sites P2, P7, P8, and P11, which was collected May through September in 2014 as a part of IDEM's probabilistic monitoring program. Information from the supplemental data will be shown in the corresponding sub watershed summaries.

Figure 41: Whitewater River Supplemental Data Sample Site Locations, Coordinates, Sub Watersheds, and Descriptions

Site ID	Physical Location & Watershed Location	Latitude/Longitude Coordinates	Sub Watershed Name	Sub Watershed HUC
P2	Blue Creek, County Line Rd.	39.307 -85.052	Blue Creek	-01
P7	Whitewater River, River Road	39.383 -84.986	Little Cedar Creek	-04

Site ID	Physical Location & Watershed Location	Coordinates	Sub Watershed Name	Sub Watershed HUC
P8	Logan Creek, Covered Bridge Road	39.278 -84.905	Johnson Fork	-06
P11	Logan Creek, Higher Ground Lane	39.279 -84.891	Johnson Fork	-06
OH5	Whitewater River at State Street Bridge	39.249 -84.821	Jameson Creek	-10
OH6	Whitewater River – Lawrenceburg Rd.	39.226 -84.799	Jameson Creek	-10
OH7	Whitewater River – Suspension Bridge Rd.	39.183 -84.793	Jameson Creek	-10
OH8	Whitewater River – US Hwy 50	39.167 -84.788	Jameson Creek	-10
OH9	Dry Fork – Race Lane	39.337 -84.757	Howard Creek	-08
OH10	Dry Fork – Oxford Rd	39.297 -84.742	Howard Creek	-08
OH11	Dry Fork – Mt. Hope Rd.	39.265971 -84.748460	Howards Creek	-08
OH12	Dry Fork – West Rd.	39.255 -84.764	Lee Creek	-09
OH13	Dry Fork – Atherton Rd	39.293 -84.725	Howard Creek	-08
OH14	Dry Fork Whitewater River at Willey Rd.	39.286 -84.727	Howard Creek	-08
OH15	Dry Fork – Kilby Rd	39.193278 -84.779393	Lee Creek	-09
OH16	Dry Fork Whitewater River tributary at farm downstream Atherton Rd./upstream Willey Rd.	39.290 -84.724	Howard Creek	-08
OH17	Dry Fork Trib. – Habor Ridge Dr. – Miami Whitewater Lake outflow	39.26 -84.745	Lee Creek	-09
OH18	Dry Fork WWR Trib. NE of Lee Creek – Timberlakes Dr.	39.257 -84.757	Lee Creek	-09
OH19	Dry Fork WWR Trib. NE of Lee Creek – Dry Fork Rd	39.264 -84.759	Lee Creek	-09
OH20	Dry Fork WWR Trib. NE of Lee Creek New Haven Rd	39.269 -84.762	Lee Creek	-09
OH21	Dry Fork Trib. – Strimple Rd. – inflow to Miami Whitewater Lake	39.247 -84.731	Lee Creek	-09
OH22	Howard Creek – Howard Rd	39.305 -84.764	Howard Creek	-08
OH23	Howard Creek – Schradin Rd	39.326 -84.778	Howard Creek	-08
OH24	Howard Creek – California Rd	39.336 -84.795	Howard Creek	-08
OH25	Howard Creek – Oxford Rd	39.284 -84.742	Howard Creek	-08
OH26	Howard Creek – downstream 4075 Howard Creek Rd.	39.318 -84.771	Howard Creek	-08
OH27	Howard Creek – upstream 4075 Howard Creek Rd.	39.323 -84.773	Howard Creek	-08
OH28	Howard Creek Trib. @ 4075 Howard Creek Rd. – upstream sample	39.320 -84.772	Howard Creek	-08

Site ID	Physical Location & Watershed Location	Coordinates	Sub Watershed Name	Sub Watershed HUC
OH29	Howard Creek Trib. @ 4075 Howard Creek Rd. – downstream sample	39.319 -84.772	Howard Creek	-08
OH30	Lee Creek – Dry Fork Rd	39.262 -84763	Lee Creek	-09
OH31	Lee Creek Trib. – New Haven Rd	39.265 -84.773	Lee Creek	-09
OH32	Lee Creek Trib. – Dry Fork Rd	39.260 -84.766	Lee Creek	-09
OH33	Fox Run – Lawrenceburg Rd.	39.191 -84.795	Jameson Creek	-10
OH34	Jameson Creek – Lawrenceburg Rd	39.243 -84.819	Jameson Creek	-10
OH35	Sand Run – Sand Run Rd	39.184 -84.803	Jameson Creek	-10
OH36	Sand Run – Lawrenceburg Rd.	39.172 -84.799	Jameson Creek	-10

2.2.10 Habitat/ Biological Information

In an effort to gain a better understanding of the total representation of the water quality in the Whitewater River Watershed, data about the habitat and biological communities in the watershed were also collected. The following section details information about the Whitewater River Watershed windshield survey, citizen's quality habitat evaluation surveys, the pollution tolerance index surveys, and IDEM's biological and habitat data collected.

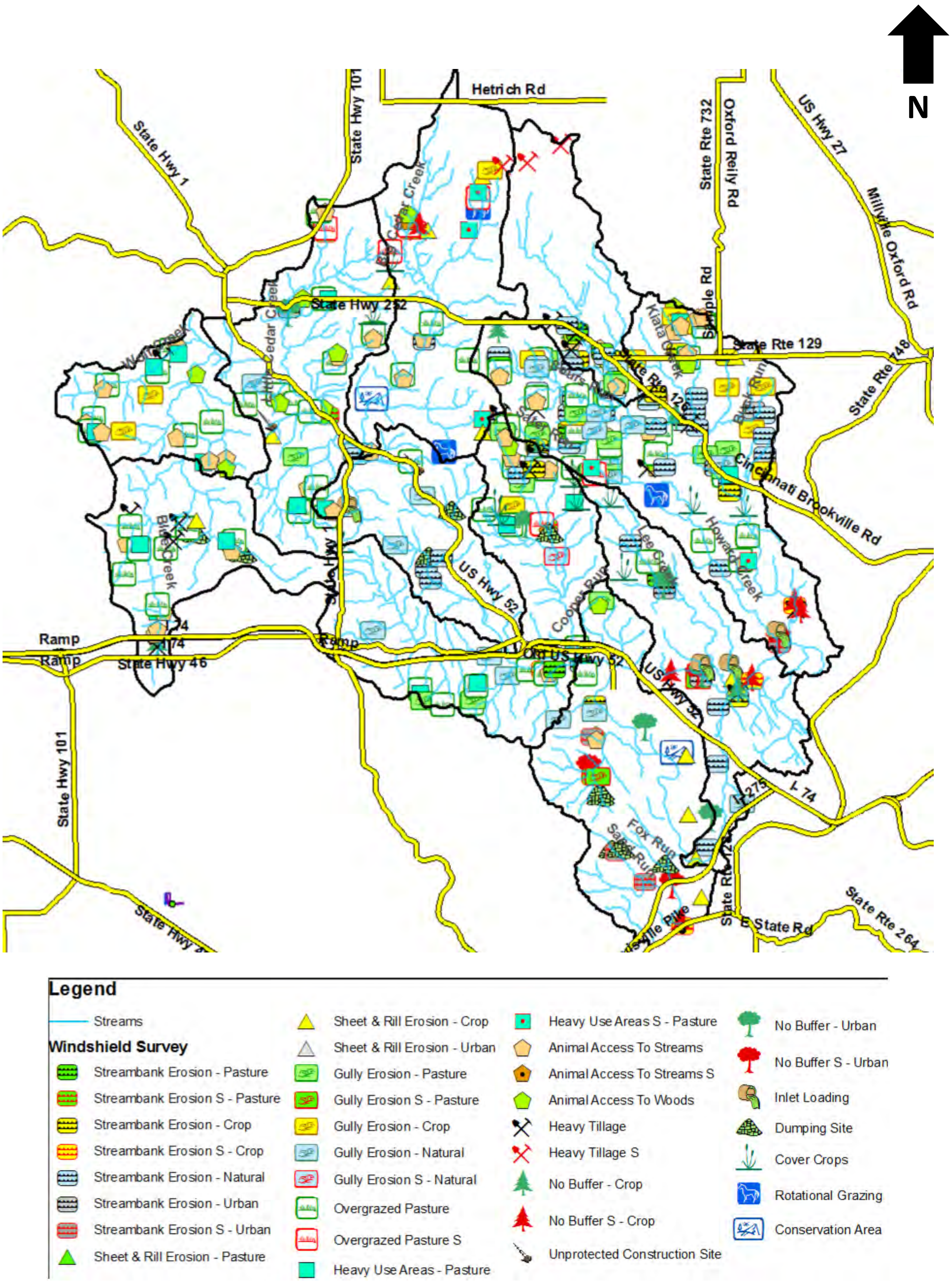
2.2.10.1 Whitewater River Watershed Inventory/Windshield Survey

In order to better understand the current condition and practices in the Whitewater River Watershed, a windshield survey was conducted in the fall of 2014 and in early winter of 2015 by members of the steering committee. The steering committee created a worksheet with all the concerns and practices listed that they wanted to collect data on. All members who volunteered to assist with the windshield survey used the same worksheet to document the data, along with severity, pictures and site locations. The results of the survey are summarized in Figure 42 & 43 below.

Figure #42: Areas of Concern Identified in the Windshield Survey

Problem / Area of Interest	Frequency / Occurrence
Streambank Erosion - Pasture	11
Severe Streambank Erosion - Pasture	6
Streambank Erosion – Crop	15
Severe Streambank Erosion – Crop	4
Streambank Erosion – Natural	43
Streambank Erosion - Urban	3
Severe Streambank Erosion - Urban	4
Sheet & Rill Erosion – Pasture	1
Sheet & Rill Erosion – Crop	14
Sheet & Rill Erosion - Urban	1
Gully Erosion - Pasture	23
Severe Gully Erosion - Pasture	1
Gully Erosion - Crop	15
Gully Erosion - Natural	28
Severe Gully Erosion - Natural	1
Overgrazed Pasture	62
Severe Overgrazed Pasture	6
Heavy Use Areas -Pasture	18
Severe Heavy Use Areas - Pasture	3
Animal Access To Streams	47
Severe Animal Access To Streams	2
Animal Access To Woods	16
Heavy Tillage	19
Severe Heavy Tillage	4
No Buffer - Crop	9
Severe No Buffer – Crop	5
Unprotected Construction Site	2
No Buffer – Urban	6
Severe No Buffer – Urban	4
Inlet Loading (any type)	5
Dumping Site	10
Exceptional – Cover Crops	11
Exceptional – Rotational Grazing	3
Exceptional – Conservation Area	2
Total Areas Observed	**404**

Figure 43: Overall Map of Concerns from the Windshield Survey



There were a total of 404 areas of interest identified in the survey. Of these areas, 9.9% (40 areas) were identified as severe and 3% (16 areas) were identified as exceptional. Some of the most common concerns documented were; streambank erosion - 86 areas, sheet & rill erosion – 16 areas, gully erosion – 68 areas, overgrazed pastures – 68 areas, heavy use areas in pastures – 21 areas, animal access to streams – 49 areas, animal access to woods – 16 areas, heavy tillage – 23 areas, no buffers – 14 areas, inlet loading – 5 areas, and dumping sites – 10 areas. Individual maps documenting the locations of each concern can be found in the sub watershed analysis section further below.

2.2.10.2 Whitewater River Watershed Qualitative Habitat Evaluation and Citizens Qualitative Habitat Evaluation

The Whitewater River Watershed Project also conducted an evaluation of the habitat at each site. Since habitat and riparian health correspond to the physical factors that affect aquatic life, conducting an analysis allows the project to compare changes over time and to other sites. The Citizens Qualitative Habitat Evaluation Index (CQHEI) is a system that was developed by the Ohio Environmental Protection Agency. The index compares conditions of substrates, fish cover, stream shape, depth, velocity, riparian areas, erosion, and riffles and runs.

The maximum score for the CQHEI is 114. However, according to the Hoosier Riverwatch manual, any score over 100 is considered exceptional stream quality. According to Hoosier Riverwatch, scores over 60 have been found to be conducive to the existence of aquatic life. Ohio EPA has produced a manual titled "Methods for Assessing Habitat in Flowing Waters Using the Qualitative Habitat Evaluation Index (QHEI)" (June 2006). On page 21, there is a table showing the QHEI ranges for various streams (excellent, good, fair, poor, very poor). For headwaters, the lower end of the "Good" rating is a score of 55. For larger streams, the lower end is 60, so an overall target QHEI of 60-65 seems reasonable. The Lower Whitewater River and several of its tributaries already exhibit QHEIs with scores of 65 and higher. For this reason the target for the Whitewater River Watershed project is set at 60 for both the QHEI, and the CQHEI on the Ohio side of the project.

For the Indiana side of the project, IDEM uses the Qualitative Habitat Evaluation Index (QHEI). Two separate habitat analysis were completed by IDEM, one by their fish sampling crew evaluating fish habitat and another with their macroinvertebrate sampling team that analyzed macro habitat. Each time the QHEI is composed of six metrics including substrate composition, instream cover, channel morphology, riparian zone and bank erosion, pool/glide and riffle-run quality, and map gradient. QHEI scores from hundreds of stream segments in Ohio have indicated that values greater than 60 are generally conducive to the existence of warm water faunas. Scores greater than 75 typify habitat conditions that have the ability to support exceptional warm water faunas (Ohio EPA, 1999). IDEM indicates that QHEI scores above 51 support a stream's aquatic life use designation, while scores less than 51 are deemed non-supporting of the stream's aquatic life use designation (IDEM, 2000).

In August of 2015 data was collected for the four project Ohio sites (OH1-OH4). Using the CQHEI the sites were evaluated for overall habitat health. The results from the CQHEI sampling can be viewed in Figure 44 below. Only one (25%) of the sites did not meet the project target for CQHEI of 60.

Figure#44: Average Citizen Qualitative Habitat Evaluation Index in the Whitewater River Watershed

Site ID	Score
OH1	72
OH2	74
OH3	67
OH4	55

CQHEI Ranges

Good	>60
Poor	<60

2.2.10.3 IDEM Biological Data

Understanding the current status and condition of the biological organisms and life in the watershed is crucial to making sure the overall water quality is optimum. On the Indiana side of the project, the Indiana Department of Environmental Management (IDEM) conducted macroinvertebrate biological monitoring and fish biological monitoring. Figure 45 below details the results from the fish (IBI) community sampling and the macroinvertebrate (mIBI) sampling.

Figure 45: IDEM fish and macroinvertebrate results for the Indiana side of the project

Site No.	mIBI Score	mIBI Class	QHEI mIBI	IBI Score	IBI Class	QHEI IBI
T21	36	Fair	62	38	Fair	64
T22	34	Poor	63	48	Good	52
T23	36	Fair	58	42	Fair	56
T24	40	Fair	64	40	Fair	64
T25	36	Fair	77	56	Excellent	82
T26	38	Fair	61	42	Fair	59
T27	42	Fair	58	40	Fair	68
T28	38	Fair	45	36	Fair	47
T29	34	Poor	73	50	Good	82
T30	42	Fair	59	46	Good	61
T31	34	Poor	65	54	Excellent	75
T32	36	Fair	56	38	Fair	58
T33	28	Poor	50	48	Good	63

Class Ranges for mIBI and IBI

Excellent	53-60	Poor	23-35
Good	45-52	Very Poor	12-22
Fair	36-44	No Organisms	12

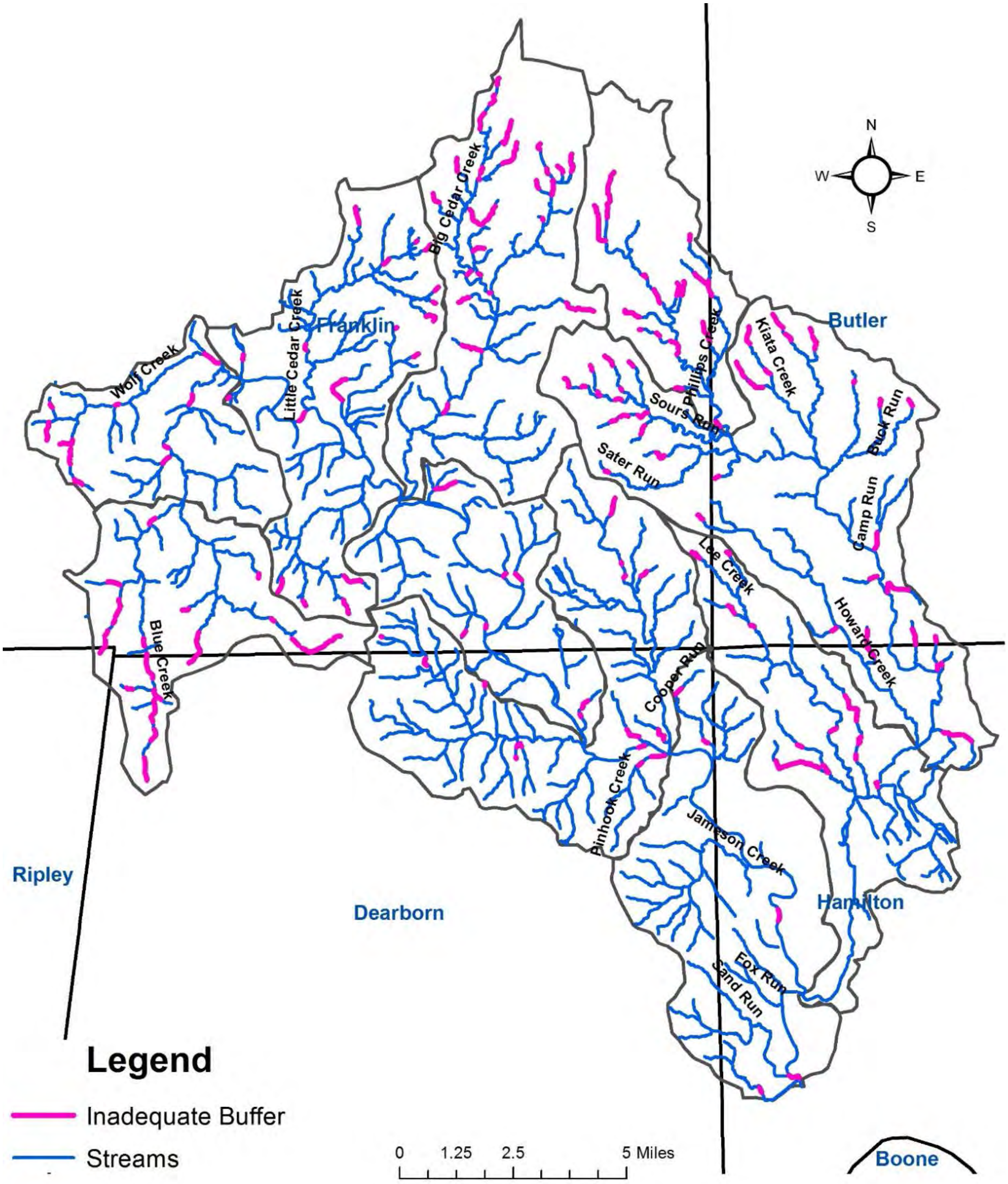
QHEI Ranges

Excellent/Good	>60
Fair/Poor	<60

2.2.10.4 Inadequate Riparian Buffer Data

Riparian buffers help stabilize the banks of the streams and also help capture pollutants. The quality and width of the buffer is a factor in the habitat evaluation. When evaluating the streams using aerial imagery, there are 40.5 stream miles with inadequate buffers in the Whitewater River Watershed. The stream miles were classified as inadequate, if the buffers were less than 20 ft.

Figure#46: Inadequate Riparian Buffers along Streams in the Whitewater River Watershed



Stream Miles of Inadequate Buffers by Subwatershed

Blue Creek _01	– 5.9 miles	Johnson Fork _06	– 2.2 miles
Wolf Creek _02	– 2.3 miles	Dry Fork _07	– 5.6 miles
Big Cedar Creek _03	– 7.2 miles	Howard Creek _08	– 8.3 miles
Little Cedar Creek _04	– 3.7 miles	Lee Creek _09	– 3.3 miles
Blackburn Creek _05	– 1.2 miles	Jameson Creek _10	– 0.8 miles

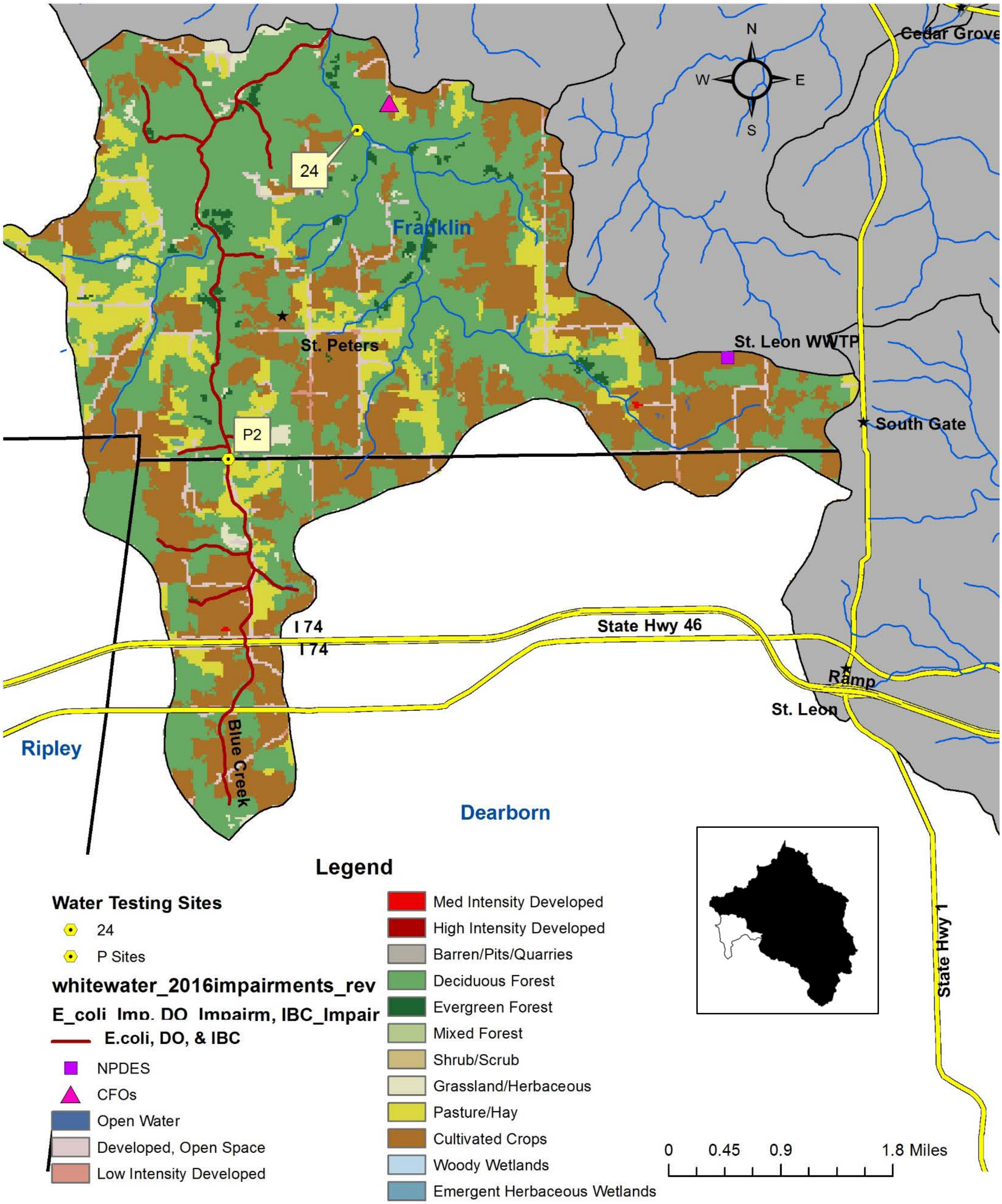
2.3 Watershed Inventory Summary

The following section summarizes all water quality data (biological, chemical, and habitat) and analyzes each sub watershed. Separating results and discussion by sub watershed allows a closer look at the land use, conditions, and results at a smaller scale level to provide more in-depth results.

2.3.1 Headwaters of Blue Creek Subwatershed (050800030801)

The Headwaters of Blue Creek sub watershed is located on the southwest side of the watershed and drains approximately 18 square miles. The land use in the Blue Creek sub watershed is mostly forested (50%) followed by agriculture (31%) and hay and pasture land (14%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. A portion of the Town of St. Leon is located in the subwatershed along with the small town of St. Peters. Since there is little development in this subwatershed the majority of homes pump to on-site septic systems. Based on the septic suitability of the soil, almost the entire subwatershed is classified as very limited. The landscape in the area consists of gentle rolling hills in the headwaters and becomes steeper towards the stream channels. Highly erodible soil types make up the majority of this subwatershed. There are large areas in the extreme headwaters identified as having hydric soil types. These areas could be potential areas for wetland restoration. There is one NPDES facility and one confined feeding operation, as well as, numerous small animal farms in this subwatershed. There are approximately 29 miles of stream in the subwatershed and 5.9 stream miles with inadequate buffers. According to the Draft 2016 List of Impaired Waters there are approximately 12.5 miles impaired for E. coli, DO, and IBC in the subwatershed. Site 24 and P2 are located in this subwatershed.

Figure 47: Headwaters of Blue Creek Subwatershed



This subwatershed hosts testing site 24 (Figure 47). Test site 24 is located in the East Fork of Blue Creek off of Blue Creek Road. Test site 24 was also sampled by IDEM in 2009 for E. coli only. The geometric mean result for E. coli at site 24 (IDEM T24 / GMW-08-0022) was 93.64 cfu/mL. The low number could possibly be attributed to large forested buffer zones surrounding the test site. However there is a confined feeding operation (CFO) upstream of the testing site. For a complete summary of water quality monitoring data at site 24 see Figure 48.

Based on IDEM's assessment, site 24 was deemed fully supporting for recreational and aquatic life uses. The geometric mean for E. coli was low and there were no particular parameters of concern.

Figure 48: Site 24 Water Quality Analysis – Headwaters of Blue Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.53	mg/L	1/7	14%
E. coli (Geomean)	93.64	CFU / 100mL	2/10	20%
Temperature	19.25	Celsius	0/11	0%
Dissolved Oxygen	10.2	mg/L	2/11	18%
pH	7.89	SU	0/11	0%
Total Phosphorus	0.038	mg/L	1/7	14%
TKN	0.329	mg/L	0/7	0%
Turbidity	7.46	NTU	0/11	0%
TSS	3.29	mg/L	0/7	0%
OHEI (macro)	64	-	0/1	0%
QHEI (fish)	64	-	0/1	0%
Macro mIBI	40/38	-	0/2	0%
Fish IBI	40	-	0/1	0%

In addition to site 24, the Headwaters of Blue Creek also has site P2 (IDEM GMW-05-0001). Site P2 was sampled in 2009 for E. coli only and was resampled in 2014. The site is far upstream in the headwaters of Blue Creek off of County Line Rd. Based on the results of the data collected the stream segment was assessed as impaired for E. coli, dissolved oxygen, and IBC (impaired biological communities). The geometric mean of E. coli at site P2 was 441.52 CFU/100mL which exceeds the state and project standards. Site P2 is surrounded by narrow riparian buffers and pieces of land used for agricultural purposes like livestock and row crops. Site testing at P2 also resulted in consistently low dissolved oxygen levels (below 4 mg/L – at all 10 sampling events). IDEM staff also noted a beaver dam at the P2 testing site. Site P2 also did not meet standards for macroinvertebrates (macros) and fish. The IBI for fish communities was 32 and the mIBI for macros was 28. IDEM staff noted the mucky, silt substrate at site P2. The staff from IDEM also noted a large amount of trash in the stream at the site. The site also exceeded the project target for total phosphorus of 0.06 mg/L. The average total phosphorus at site P2 was 0.19 mg/L. At levels of phosphorus that high, aquatic life could be stressed and negatively affected. For a complete summary of water quality monitoring data at site P2, see Figure 49.

Figure 49: Site P2 Water Quality Analysis – Headwaters of Blue Creek Subwatershed

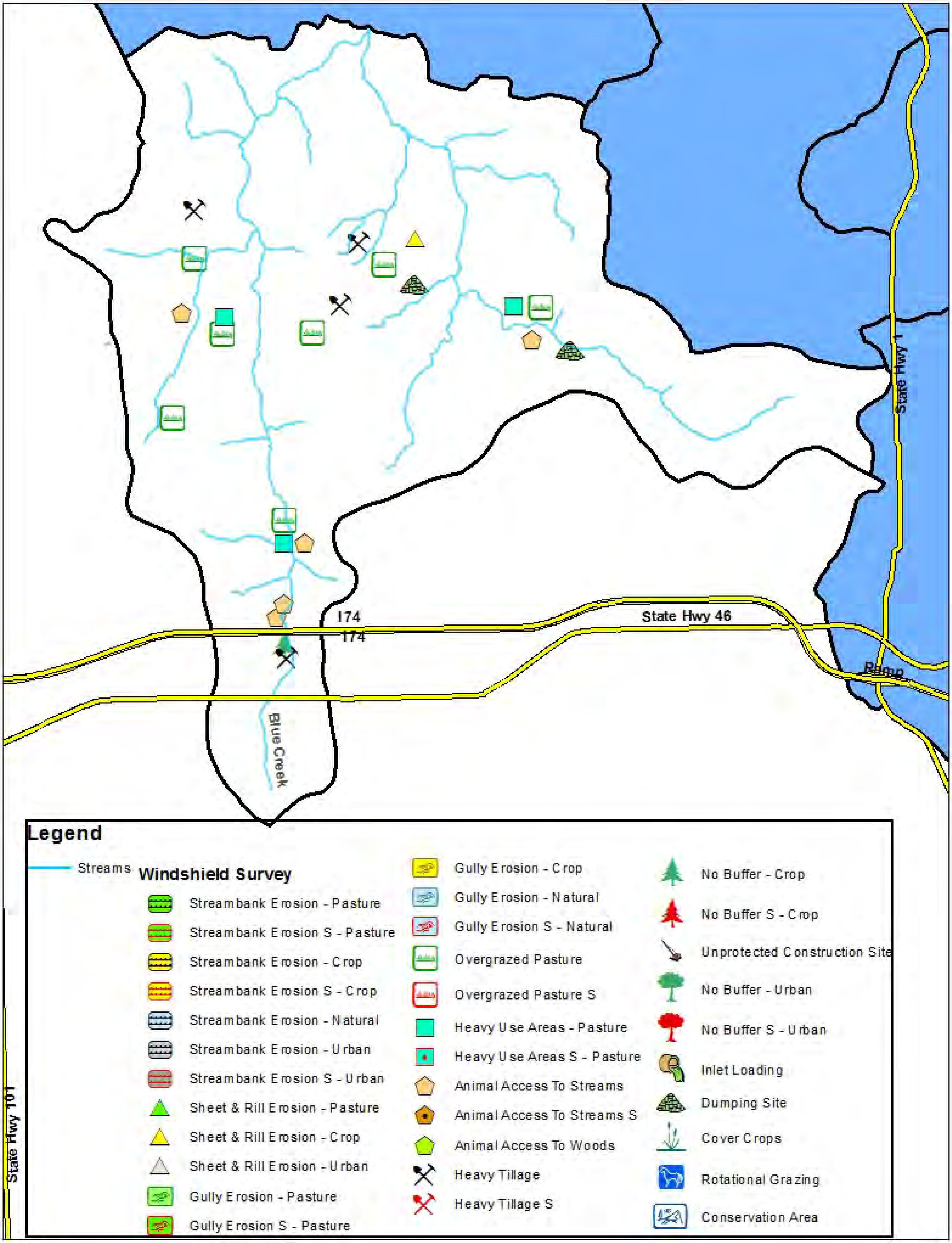
Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.15	mg/L	0/3	0%
E. coli (Geomean)	366.17	CFU / 100mL	4/5	80%
Temperature	18.58	Celsius	0/10	0%
Dissolved Oxygen	2.54	mg/L	10/10	100%
pH	7.36	-	0/10	0%
Total Phosphorus	0.19	mg/L	3/3	100%
TKN	0.75	mg/L	3/3	100%
Turbidity	88.65	NTU	3/10	30%
TSS	12.3	mg/L	0/3	0%
QHEI (macro)	46	-	1/1	100%
QHEI (fish)	62	-	0/1	0%
Fish IBI	32	-	1/1	100%
Macro mIBI	28	-	1/1	100%

A windshield survey was completed by volunteers in early 2015 to assess current condition and practices in the watershed. By identifying areas of concern and interest, it allows the project to better chart progress in the future. Windshield surveys were completed by volunteers from the steering committee and results were analyzed by project staff. For a complete summary of findings in the windshield survey see Figure 50 and Figure 51.

Figure 50: Windshield Survey Findings in the Headwaters of Blue Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Sheet & Rill Erosion - Crop	1
Overgrazed Pasture	7
Heavy Use Areas -Pasture	3
Animal Access To Streams	5
Heavy Tillage	4
No Buffer - Crop	1
Dumping Site	2
Total	**23**

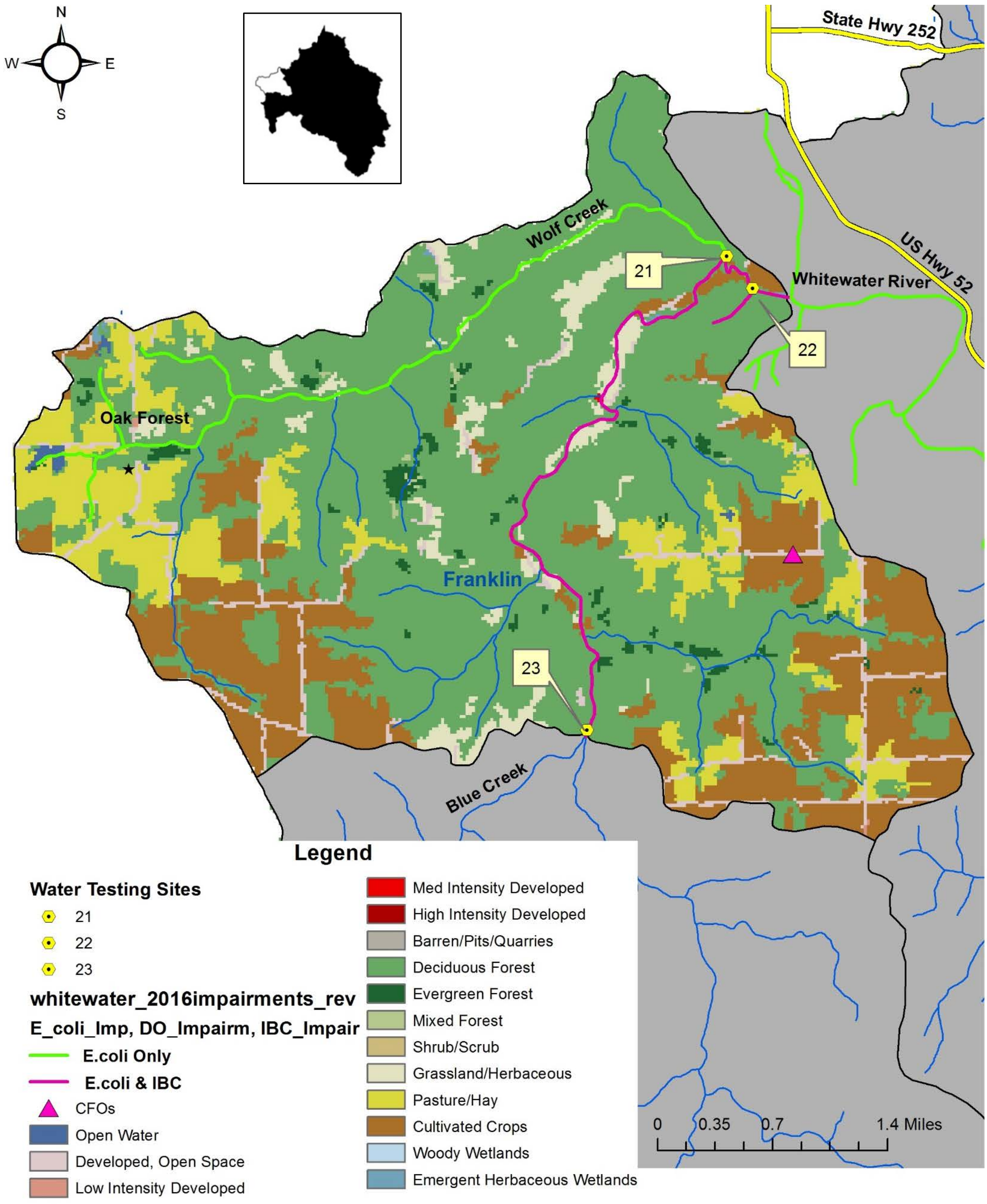
Figure 51: Windshield Result Locations in the Headwaters of Blue Creek Subwatershed



2.3.2 Wolf Creek Subwatershed (050800030802)

The Wolf Creek subwatershed is located in the northwest corner of the watershed and drains approximately 15 square miles into the mainstem of the Whitewater River through Blue Creek. The land use in the watershed is mostly forested (63%) followed by agriculture (17%) and hay and pasture land (16%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. The small town of Oak Forest is in this watershed, but the majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. There are no NPDES facilities and only one confined feeding operation, as well as, numerous small animal farms in this subwatershed. The landscape in the area consists of agricultural fields in the headwaters and becomes steeper towards the base of the subwatershed. Highly erodible soil types are found in the hillsides that drain into the creek and make up much of the eastern portion of the subwatershed. Most of the riparian areas in the watershed have a forested buffer area. There is a small area in the south eastern portion of the watershed where hydric soils exists. This area could be potential areas for wetland restoration. There are approximately 29 miles of stream in the subwatershed and 2.3 stream miles with inadequate buffers. There are 5.1 stream miles impaired for E. coli and IBC and 6.8 miles of E. coli impairment listed on the 2016 List of Impaired Waters. The subwatershed contains testing sites 21, 22, and 23.

Figure #52: Wolf Creek Subwatershed



At testing site 23 (IDEM GMW-08-0014), which is on Blue Creek, the geometric mean of E.coli was 253.44 CFU/mL. Throughout the year of sampling, the E.coli numbers were under the single sample target of 235 CFU/100mL. However, after two rainfall events the 5 week average results exceeded the geometric mean target. The chemical testing results for test site 23 were in compliance with most project targets and standards. There were 6 out of 16 testing occurrences where the Dissolved Oxygen (DO) was high (but associated nutrient and pH results did not indicate a nutrient impairment). IDEM staff noted that site conditions were pooled at times with very low flow in some places. Site 23 also exceeded the nitrate+nitrite target of 1.0 mg/L 25% (3 of 12 times) during testing. Although Indiana uses a less strict standard the Whitewater River Watershed Project chose a stricter standard of 0.06 mg/L for total phosphorus. Sample site 23 exceeded this standard 1 time. For a complete summary of water quality monitoring data at site 23 see figure 53.

Figure #53: Site 23 Water Quality Analysis – Wolf Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.529	mg/L	3/12	25%
E. coli (Geomean)	253.44	CFU / 100mL	3/9	33%
Temperature	14.53	Celsius	0/16	0%
Dissolved Oxygen	10.5	mg/L	6/16	38%
pH	8.06	SU	0/16	0%
Total Phosphorus	0.03	mg/L	1/12	8%
TKN	0.217	mg/L	0/12	0%
Turbidity	6.85	NTU	0/16	0%
TSS	11	mg/L	1/12	8%
QHEI (fish)	56	-	0/1	0%
QHEI (macro)	58	-	0/1	0%
Fish IBI	42	-	0/1	0%
Macro mIBI	36	-	0/1	0%

Testing site 22 (GMW-080-0003) is located in Blue Creek off of Highland Center Rd. The geometric mean for E. coli at site 22 was 418.71 CFU/100mL, which exceeds the project target. The two CFO's in the watershed are located upstream from sample site 22 and the land use surrounding the testing site is mostly agricultural. The site exceeded project targets while testing for the dissolved oxygen parameter (6 out of 16 occurrences dissolved oxygen were too high). The site also exceeded the target for nitrate+nitrite (1.0mg/L) 3 out of 12 testing occurrences and exceeded the total phosphorus on 2 out of 12 testing occurrences. The site did not meet the standard for the mIBI (score of 34, not supporting). For a complete summary of water quality monitoring data at site 22 see figure 54.

Figure #54: Site 22 Water Quality Analysis – Wolf Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.7625	mg/L	3/12	25%
E. coli (Geomean)	418.71	CFU / 100mL	3/10	30%
Temperature	14.84	Celsius	0/1	0%
Dissolved Oxygen	10.05	mg/L	6/16	38%
pH	7.74	-	0/16	0%
Total Phosphorus	0.034	mg/L	2/12	17%
TKN	0.24	mg/L	0/12	0%
Turbidity	8.4	NTU	0/16	0%
TSS	4.5	mg/L	0/12	0%
QHEI (fish)	52	-	0/1	0%
Fish IBI	48	-	0/1	0%
QHEI (macro)	63	-	0/1	0%
Macro mIBI	34	-	1/1	100%

Testing site 21 (GMW-08-0026) is located in Wolf Creek off of Blue Creek Rd. The geometric mean for E. coli was 255.39 CFU/100mL, which was greater than the target. This section of stream was already listed as impaired from E. coli on IDEM's 303d list based upon some historic sampling done in 2002. The geometric mean was high in this case because 2 samples (out of 10 occurrences) were high. There were significant rainfall events around the two higher occurrences. All other chemical parameters were within project target ranges. For a complete summary of water quality monitoring data at site 21 see figure 55.

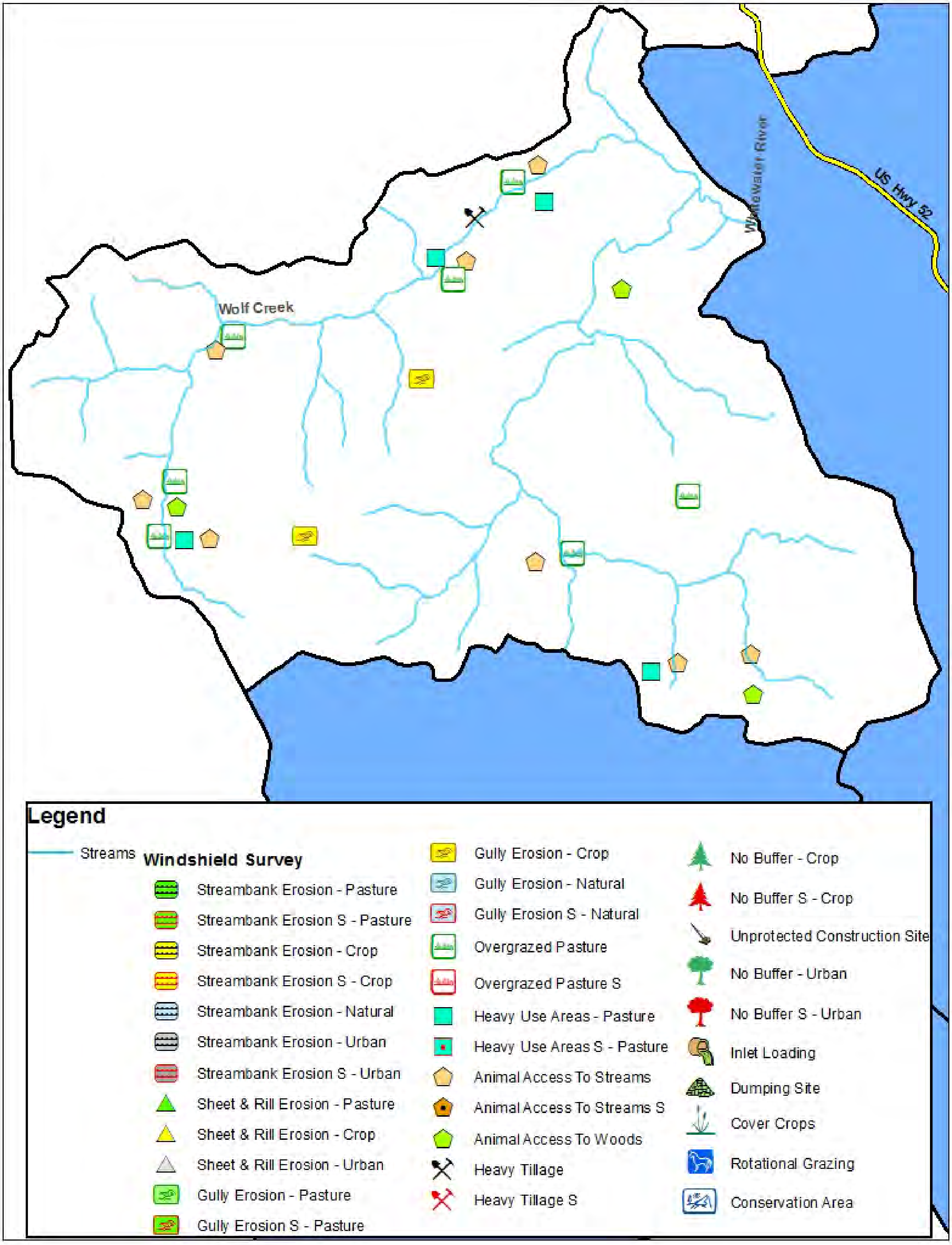
Figure #55: Site 21 Water Quality Analysis – Wolf Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.16	mg/L	0/1	0%
E. coli (Geomean)	255.39	CFU / 100mL	2/11	18%
Temperature	19.13	Celsius	0/11	0%
Dissolved Oxygen	8.84	mg/L	0/11	0%
pH	7.78	-	0/11	0%
Total Phosphorus	0.02	mg/L	0/7	0%
TKN	0.186	mg/L	0/7	0%
Turbidity	3.7	NTU	0/11	0%
TSS	3	mg/L	0/7	0%
QHEI (fish)	64	-	0/1	0%
Fish IBI	38	-	0/1	0%
QHEI (macro)	62	-	0/1	0%
Macro mIBI	36	-	0/1	0%

Figure 56: Windshield Survey Findings in the Wolf Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Gully Erosion – Crop	2
Overgrazed Pasture	7
Heavy Use Areas -Pasture	4
Animal Access To Streams	8
Animal Access To Woods	3
Heavy Tillage	1
Total	25

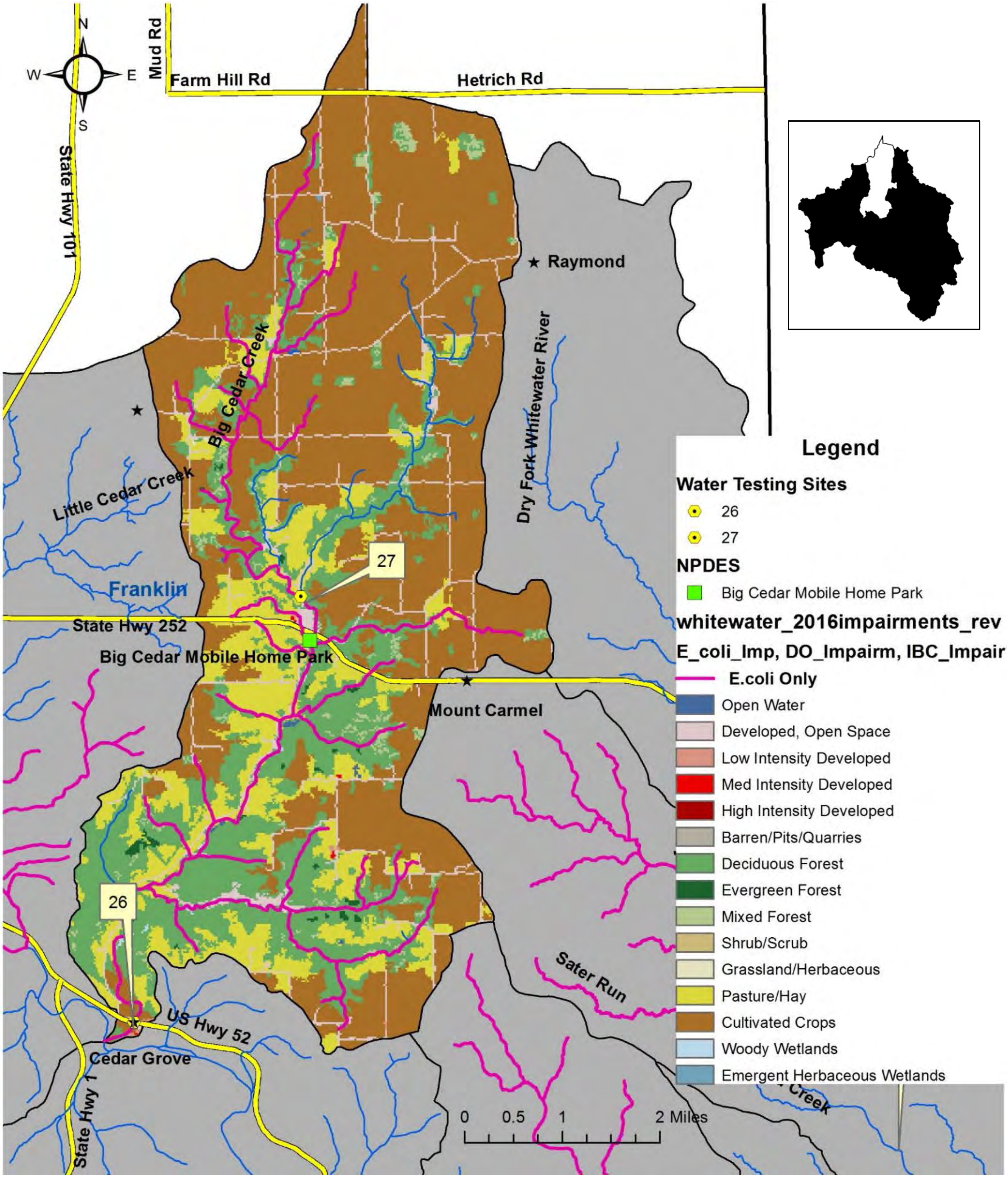
Figure 57: Windshield Result Locations in the Wolf Creek Subwatershed



2.3.3 Big Cedar Creek Subwatershed (050800030803)

The Big Cedar Creek subwatershed is located in the north center of the watershed and drains approximately 27 square miles into the mainstem of the Whitewater River. The land use is primarily agriculture (50%) followed by forested land (17%) and hay and pasture land (11%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. Buffers along riparian areas are small or lacking in most areas. There is one permitted facilities in the subwatershed, the Big Cedar Mobile Home Park WWTP and no CFOs. The subwatershed is mostly rural with a small portion of the town Cedar Grove which indicates homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. The landscape in the area consists of gentle rolling hills in the headwaters and becomes steeper towards the base of the subwatershed. The land use is primarily agricultural in the headwaters, with pasture land and forested areas making up the hills in the southern portion of the subwatershed. Highly erodible soil types make up nearly half of this subwatershed with the majority of the HEL lands located in the southern portion of the subwatershed, which is characterized by wooded hillsides. There are small areas in the northern portion of the subwatershed identified as having hydric soil types. These areas could be potential areas for wetland restoration. There are approximately 52 miles of stream in the subwatershed and 40.1 of them are listed for E. coli impairment on the 2016 List of Impaired Waters. There are approximately 7.2 stream miles with inadequate buffers. This subwatershed has the following water testing sites, 26 and 27.

Figure 58: Big Cedar Creek Subwatershed



Site 27 (GMW-08-0024) is located in Big Cedar Creek off of Big Cedar Road. The geometric mean for E. coli exceeds the standard with a result of 140.74 CFU/100mL. In 2009, IDEM collected data from a site just upstream of site 27 where the geometric mean for E. coli was 1,060 CFU/100mL. Landowners in the area report that there could be some septic issues in the area. DO for site 27 exceeded the standard 1 out of 10 testing occurrences. Nitrate values also exceeded the targets 66.6% of the time and Total Phosphorus (TP) exceeded the target 33.3% of the time. For a complete summary of water quality monitoring data at site 27, see figure 59.

Figure 59: Site 27 Water Quality Analysis – Big Cedar Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	4.03	mg/L	4/6	67%
E. coli (Geomean)	140.74	CFU / 100mL	4/9	44%
Temperature	17.5	Celsius	0/10	0%
Dissolved Oxygen	9.10	mg/L	1/10	10%
pH	8.13	-	0/10	0%
Total Phosphorus	0.06	mg/L	2/6	33%
TKN	0.375	mg/L	1/6	17%
Turbidity	6.805	NTU	0/10	0%
TSS	4.83	mg/L	0/6	0%
QHEI (fish)	68	-	0/1	0%
Fish IBI	40	-	0/1	0%
QHEI (macro)	58	-	0/1	0%
Macro mIBI	42	-	0/1	0%

Big Cedar Creek sub watershed also has site 26 (GMW-08-0016). The site is located in Big Cedar Creek off of US 52. Due to low flow, enough E. coli samples to calculate the geometric mean could not be obtained. However, 3 of the 8 samples exceeded the E. coli limit. Because this is greater than 10% of the samples, IDEM rules it impaired. There is a trailer park with a treatment facility near testing site 26 (Big Cedar Mobile Home Park). The park has been in enforcement for effluent violations (ammonia and TSS). Site 26 also had DO levels that were too high on 5 out of 14 occurrences. There was also an IDEM historical sampling site just downstream of site 26. Data from this site was collected in 2002. It was listed as impaired since the geometric mean for E. coli was 169.9 CFU/100mL. Site 26 also had high nutrient levels with both Nitrates and Total Phosphorus (TP) exceeding the targets. Nitrates exceeded on 6 out of 11 occurrences (54.5%) during testing and TP exceeded 1 out of 11 occurrences (9%) at test site 26. For a complete summary of water quality monitoring data at site 26, see figure 60.

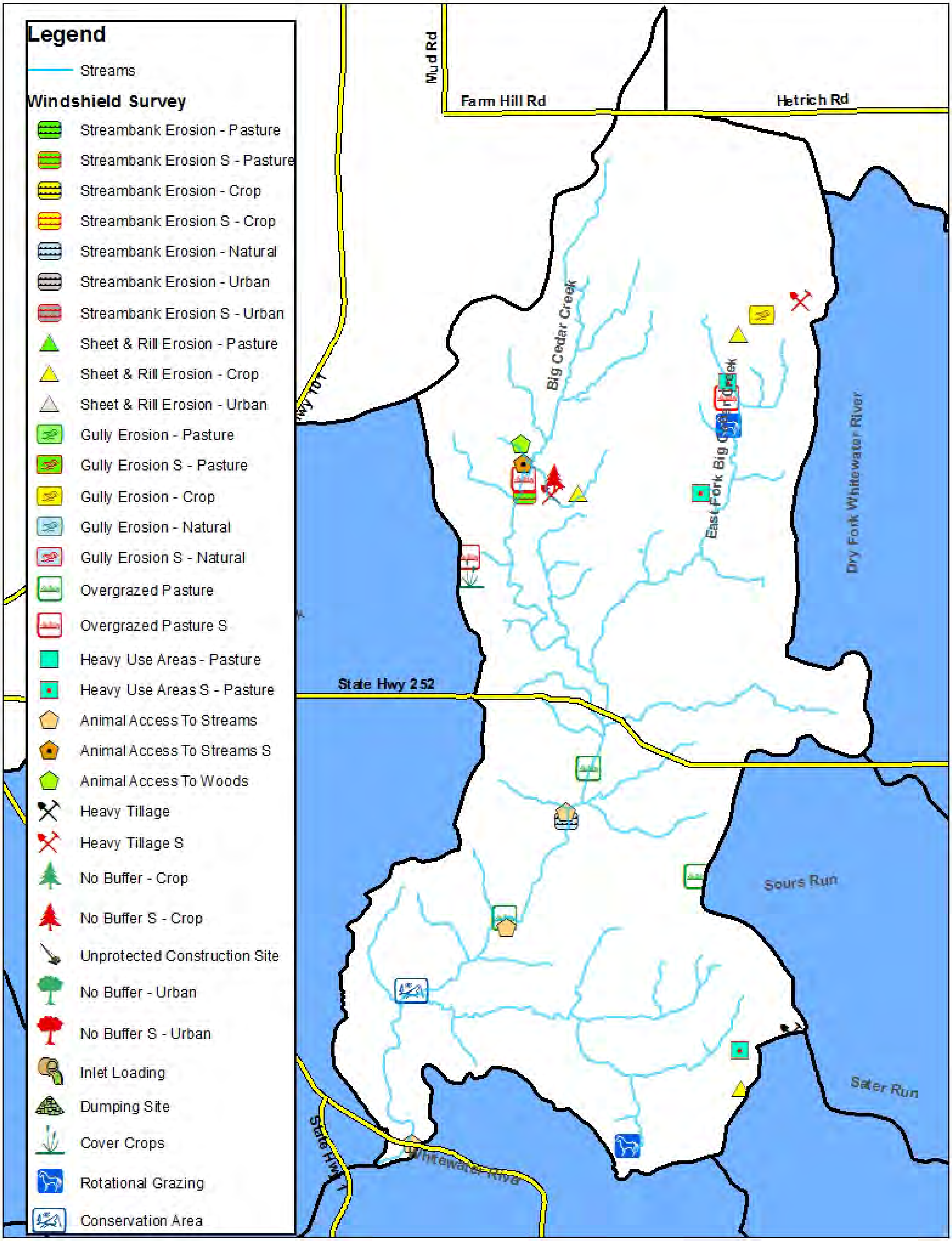
Figure 60: Site 26 Water Quality Analysis – Big Cedar Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.55	mg/L	6/11	55%
E. coli (Geomean)	NA	CFU / 100mL	3/8	38%
Temperature	11.92	Celsius	0/14	0%
Dissolved Oxygen	10.63	mg/L	5/14	35%
pH	8.15	-	0/14	0%
Total Phosphorus	0.02	mg/L	1/11	9%
TKN	0.286	mg/L	0/11	0%
Turbidity	6.9	NTU	0/14	0%
TSS	2.55	mg/L	0/11	0%
QHEI (fish)	59	-	0/1	0%
Fish IBI	42	-	0/1	0%
QHEI (macro)	61	-	0/1	0%
Macro mIBI	38	-	0/1	0%

Figure 61: Windshield Survey Findings in the Big Cedar Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Severe Streambank Erosion - Pasture	1
Streambank Erosion - Natural	1
Sheet & Rill Erosion – Crop	3
Gully Erosion - Crop	1
Overgrazed Pasture	3
Severe Overgrazed Pasture	3
Severe Heavy Use Areas -Pasture	3
Animal Access To Streams	3
Severe Animal Access To Streams	1
Animal Access To Woods	1
Heavy Tillage	1
Severe Heavy Tillage	2
No Buffer – Crop	1
Exceptional – Cover Crops	1
Exceptional – Rotational Grazing	2
Exceptional – Conservation Area	1
Total	**28**

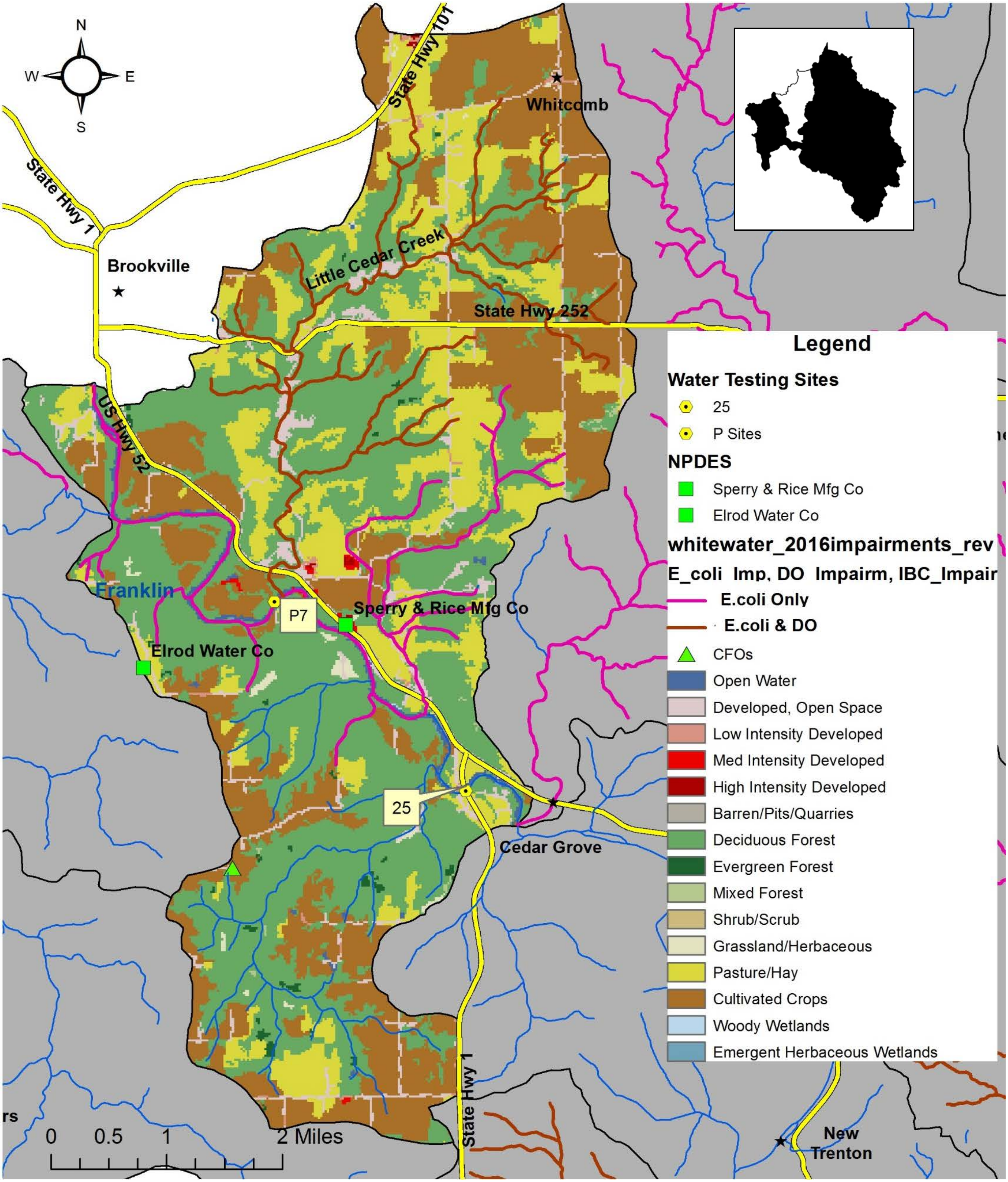
Figure 62: Windshield Result Locations in the Big Cedar Creek Subwatershed



2.3.4 Little Cedar Creek Subwatershed (050800030804)

The Little Cedar Creek subwatershed is located in the NW center of the watershed and drains approximately 27 square miles into the mainstem of the Whitewater River. The land use is primarily forest (45%) followed by agriculture (27%) and hay and pasture land (19%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. There are two permitted facilities in the subwatershed, Sperry and Rick Mfg. Co. and Elrod Water Company, and one CFO. The subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. This watershed has the very small town of Whitcomb and the southern growth of Brookville. The watershed has good riparian buffers but some areas along the mainstem are small. Highly erodible soil types make up most of the land in this watershed apart from the flat uplands in the north. There are areas in the south and east of the subwatershed identified as having hydric soil types. These areas could be potential areas for wetland restoration. There are approximately 63 miles of stream in the subwatershed and 3.7 stream miles with inadequate buffers. Approximately 24.9 stream miles are impaired for both E. coli and dissolved oxygen and another 20.5 miles for E. coli only according to the 2016 List of Impaired Waters. The sub watershed contains testing sites P7 and 25.

Figure 63: Little Cedar Creek Subwatershed



Testing site P7 (GMW-08-0013) is located in Whitewater River off of River Road. The geometric mean for E. coli at that site was 227.04 CFU/100mL which exceeds the state standard. Little Cedar Creek was already listed as impaired at the start of this project and listed on IDEM's 303d list. The site was initially listed as impaired for dissolved oxygen (DO) but none of the data collected during this project supported impairment for DO. Nitrates exceeded the project target 66.6% (2 of 3 occurrences) and the mean of 2.3 mg/L is much higher than the target for this project at 1.0 mg/L. Total phosphorus also exceeded the target of 0.06 mg/L on 2 out of 3 occurrences (66.6%) of the time and the mean of 0.16 mg/L exceeds the target. For a complete summary of water quality monitoring data at site P7 see figure 64.

Figure 64: Site P7 Water Quality Analysis – Little Cedar Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.3	mg/L	2/3	67%
E. coli (Geomean)	227.04	CFU / 100mL	2/5	40%
Temperature	20.49	Celsius	0/10	0%
Dissolved Oxygen	10.02	mg/L	1/10	10%
pH	8.08	-	0/10	0%
Total Phosphorus	0.16	mg/L	2/3	67%
TKN	0.79	mg/L	1/3	33%
Turbidity	34.5	NTU	2/10	20%
TSS	98.3	mg/L	2/3	67%
QHEI (fish)	83	-	0/1	0%
Fish IBI	44	-	0/1	0%
QHEI (macro)	56	-	0/1	0%
Macro mIBI	36	-	0/1	0%

Testing site 25 (GMW-08-0015) is located in Whitewater River off of State Road 1. The geometric mean for E. coli was 91.73 cfu/100mL which is low and under that state standard and project goal. Site 25 had levels of DO that were too high (3 out of 16 occurrences). Nitrates also exceeded the target 75% (9/12 occurrences) of the time. The mean of 1.98 mg/L exceeded the project target of 1.0 mg/L. For a complete summary of water quality monitoring data at site 25, see figure 65.

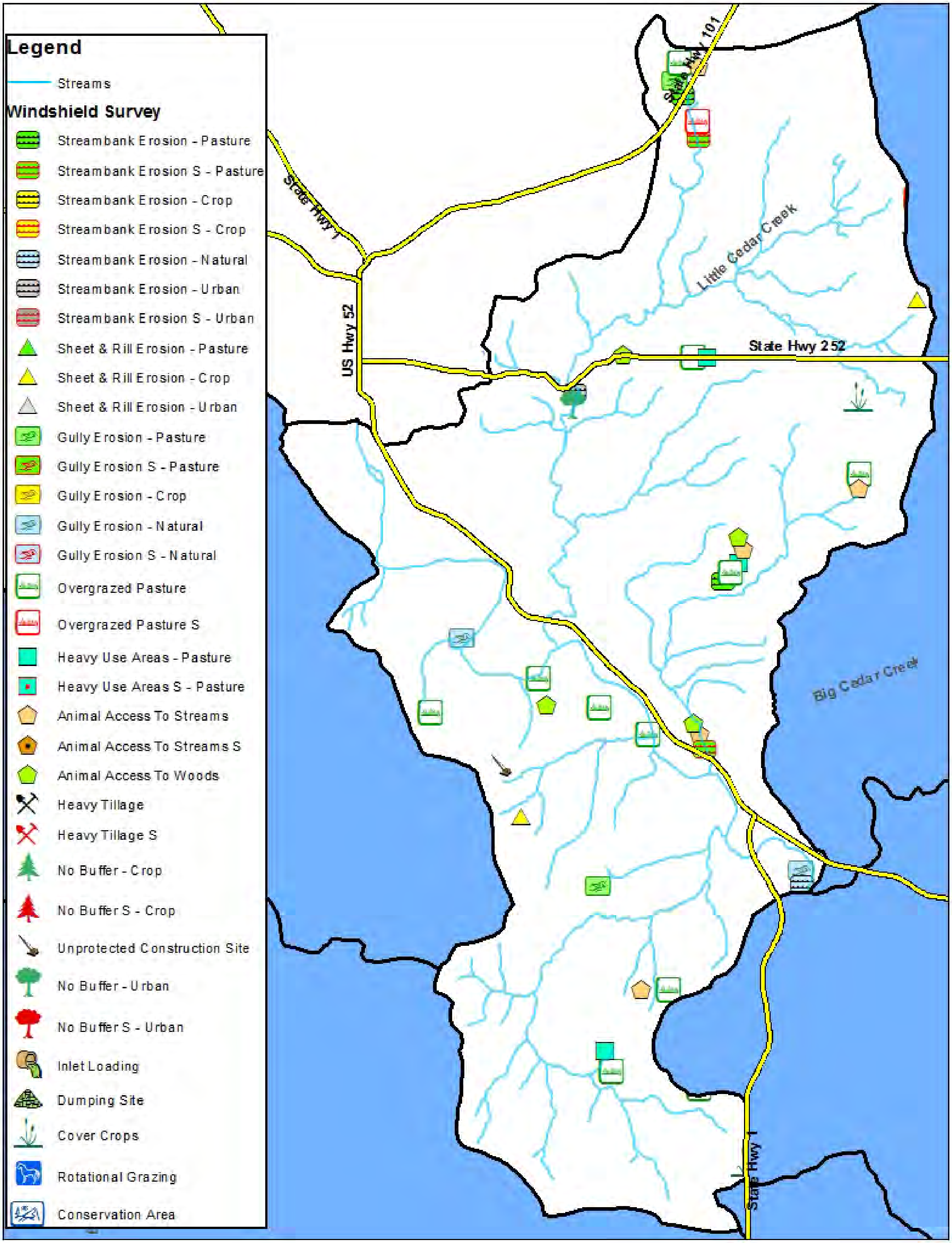
Figure 65: Site 25 Water Quality Analysis – Little Cedar Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.98	mg/L	9/12	75%
E. coli (Geomean)	91.73	CFU / 100mL	1/10	10%
Temperature	14.12	Celsius	0/16	0%
Dissolved Oxygen	9.41	mg/L	3/16	19%
pH	8.00	-	0/16	0%
Total Phosphorus	0.04	mg/L	0/12	0%
TKN	0.312	mg/L	1/12	8%
Turbidity	13.8	NTU	3/16	19%
TSS	16.9	mg/L	3/12	25%
QHEI (fish)	82	-	0/1	0%
Fish IBI	56	-	0/1	0%
QHEI (macro)	77	-	0/1	0%
Macro mIBI	36	-	0/1	0%

Figure 66: Windshield Survey Findings in the Little Cedar Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Streambank Erosion - Pasture	2
Severe Streambank Erosion - Pasture	2
Streambank Erosion – Natural	2
Sheet & Rill Erosion – Crop	2
Gully Erosion - Pasture	2
Gully Erosion - Natural	2
Overgrazed Pasture	10
Severe Overgrazed Pasture	1
Heavy Use Areas -Pasture	3
Animal Access To Streams	5
Animal Access To Woods	4
Unprotected Construction Site	1
No Buffer – Urban	1
Exceptional – Cover Crops	2
Total	**39**

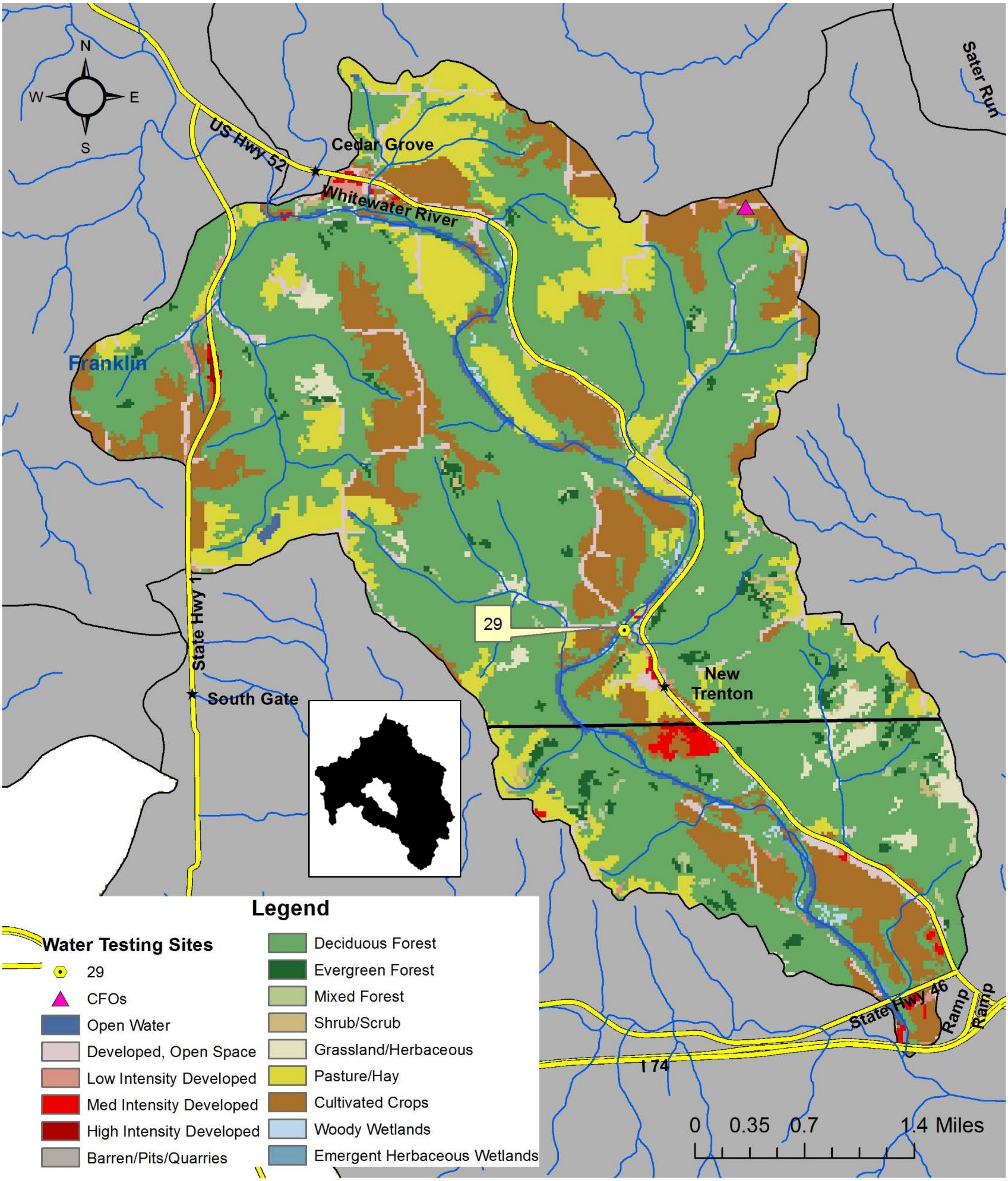
Figure 67: Windshield Result Locations in the Little Cedar Creek Subwatershed



2.3.5 Blackburn Creek Subwatershed (050800030805)

The Blackburn Creek subwatershed is centrally located within the Whitewater River Watershed and drains approximately 17 square miles into the mainstem of the Whitewater River. The land use is primarily forest (61%) followed by hay and pasture (19%) and agriculture (11%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. There is no permitted facility in the subwatershed and there is one CFO. There are two small towns along US 52, Cedar Grove and New Trenton, which are within the watershed. According to the Dearborn Co. Health Dept. there are two home sewage problem clusters identified that may be impacting this stream (Longnecker Road community with ~ 40 houses and Chappalow Ridge Rd ~40 houses). Based on the septic suitability of the soil, this entire subwatershed is very limited. Highly erodible soil types make up the valley walls of this subwatershed. There are little to no patches of the subwatershed identified as having hydric soil types. There are approximately 38 miles of stream in the subwatershed and 1.2 stream miles with inadequate buffers. Testing Site 29 was the only site for this watershed.

Figure 68: Blackburn Creek Subwatershed



The subwatershed contains site 29 (GMW-08-0030) and is located in Whitewater River off of St. Peters Rd. The geometric mean for E. coli at site 29 was 74.83 cfu/100mL, which meets the target and standards for E. coli. The fish IBI at this site was very good with a score of 50 and over 41 different fish species found. One of these species is the state endangered variegated darter. The mIBI was 34, which was below the target. However 48% of species were in the intolerant (of pollution) taxa and 0% were in the tolerant (of pollution) taxa. In addition, 11% of macroinvertebrates found were in the highest taxa (EPT). Water chemistry results at site 29 showed elevated nitrate levels. The mean nitrate was 1.87 mg/L which exceeded the project target of 1.0 mg/L. Site 29 also exceeded nitrate targets on 5 out of 7 occurrences or 71.4% of the time. For a complete summary of water quality monitoring data at site 29 see figure 69.

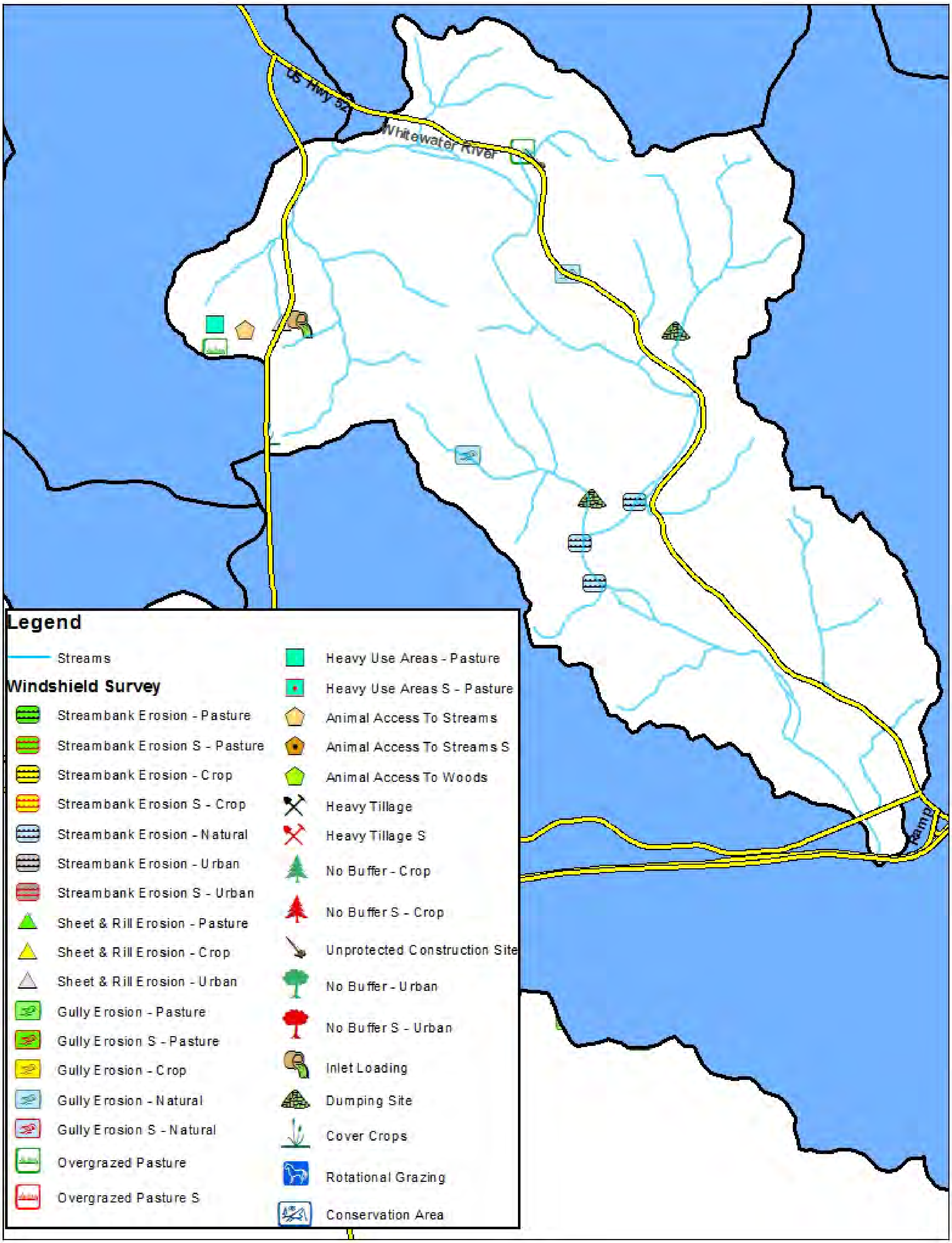
Figure 69: Site 29 Water Quality Analysis – Blackburn Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.87	mg/L	5/7	71%
E. coli (Geomean)	74.83	CFU / 100mL	0/10	0%
Temperature	18.96	Celsius	0/11	0%
Dissolved Oxygen	8.66	mg/L	0/11	0%
pH	8.08	-	0/11	0%
Total Phosphorus	0.03	mg/L	0/7	0%
TKN	0.379	mg/L	0/7	0%
Turbidity	11.32	NTU	0/11	0%
TSS	16.4	mg/L	2/7	29%
QHEI (fish)	82	-	0/1	0%
Fish IBI	50	-	0/1	0%
QHEI (macro)	73	-	0/1	0%
Macro mIBI	34	-	1/1	100%

Figure 70: Windshield Survey Findings in the Blackburn Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Streambank Erosion - Natural	3
Sheet & Rill Erosion - Urban	1
Gully Erosion - Natural	2
Overgrazed Pasture	2
Heavy Use Areas - Pasture	1
Animal Access To Streams	1
Unprotected Construction Site	1
Inlet Loading	1
Dumping Site	2
Total	**14**

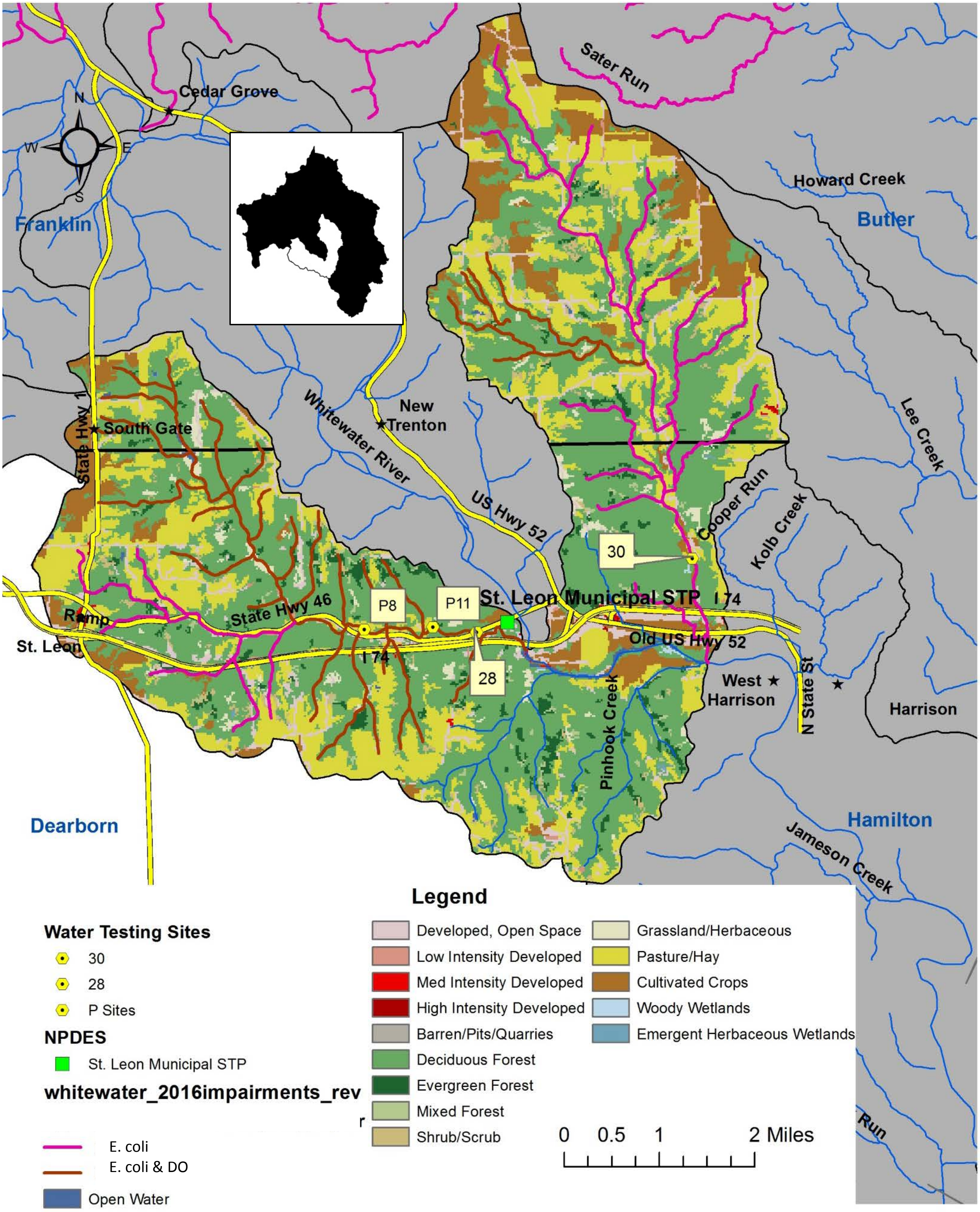
Figure 71: Windshield Result Locations in the Blackburn Creek Subwatershed



2.3.6 Johnson Fork Subwatershed (050800030806)

The Johnson Fork subwatershed is located in the south central portion of the watershed and drains approximately 33 square miles into the mainstem of Whitewater River. The land use is primarily forest (55%) followed by hay and pasture land (29%) and agriculture (8%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. The land use is primarily steep forested lands with wide riparian buffers surrounding the stream. Small crop fields do occur in the Whitewater Valley, however most agriculture in the watershed is pasture based. Highly erodible soil types make up nearly this entire subwatershed outside of the Whitewater Valley. There is one permitted facility and no CFOs in this subwatershed. The Town of St. Leon has part of its incorporated area within the watershed. The small town of South Gate is also in the watershed. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. There are few patches of the subwatershed identified as having hydric soil types, and are mostly along the main stem of the river. These areas could be potential areas for wetland restoration. There are approximately 77 miles of stream in the subwatershed and 2.2 stream miles with inadequate buffers. Approximately 32.4 miles are impaired for E. coli and DO and another 30.1 miles for E. coli only according to the 2016 List of Impaired Waters. The Johnson Fork sub watershed has the testing sites P8, P11, 28, and 30.

Figure 72: Johnson Fork Subwatershed



The testing site P8 (GMW-08-0003) is located in Logan Creek off of Covered Bridge Road. The geometric mean for P8 was 200.4 CFU/100mL. This exceeds the state standard for E. coli (geometric mean). Near site P8, there was an IDEM historical testing site. In 2009, the geometric mean for E. coli was 572.64 CFU/100mL. For a complete summary of water quality monitoring data at site P8, see figure 73.

Figure 73: Site P8 Water Quality Analysis – Johnson Fork Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.077	mg/L	0/3	0%
E. coli (Geomean)	200.4	CFU / 100mL	2/5	40%
Temperature	21.34	Celsius	0/10	0%
Dissolved Oxygen	7.05	mg/L	1/10	10%
pH	7.748	-	0/10	0%
Total Phosphorus	0.03	mg/L	0/3	0%
TKN	0.307	mg/L	0/3	0%
Turbidity	9.05	NTU	0/10	0%
TSS	5	mg/L	0/3	0%
QHEI (fish)	67/76	-	0/2	0%
Fish IBI	54/48	-	0/2	0%
QHEI (macro)	55	-	0/1	0%
Macro mIBI	36	-	0/1	0%

The testing site P11 (GMW-08-0005) is located in Logan Creek off of Higher Ground Lane. The geometric mean for P11 was 159.99 CFU/100mL, which exceeds the project target for E. coli. In addition to the high E. coli levels, the site also did not meet the target for macroinvertebrates (mIBI) with a score of 32. Chemistry results at site P11 were normal. For a complete summary of water quality monitoring data at site P11, see figure 74.

Figure 74: Site P11 Water Quality Analysis – Johnson Fork Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.049	mg/L	0/3	0%
E. coli (Geomean)	159.99	CFU / 100mL	2/5	40%
Temperature	20.72	Celsius	0/10	0%
Dissolved Oxygen	6.9	mg/L	0/10	0%
pH	7.79	-	0/10	0%
Total Phosphorus	0.04	mg/L	0/3	0%
TKN	1.08	mg/L	1/3	33%
Turbidity	10.21	NTU	0/9	0%
TSS	5.33	mg/L	0/3	0%
QHEI (fish)	72	-	0/1	0%
Fish IBI	48	-	0/1	0%
QHEI (macro)	64	-	0/1	0%
Macro mIBI	32	-	1/1	100%

The Johnson Fork subwatershed also hosts site 28 (GMW-08-0019), which is located in Logan Creek off of State Road 46. The geometric mean for E. coli at site 28 was 125.35 cfu/100mL, which just barely exceeds the project target and state limit for E. coli. The QHEI for both the fish and macro habitats were below the target for the project. Dissolved oxygen was low (below 4 mg/L) 3 out of the 11 times sampled. Biologists that did the sampling for IDEM noticed an oil sheen at times on the water at the site. The biologists also noted that there was very low flow with pooling in some places.

Figure 75: Site 28 Water Quality Analysis – Johnson Fork Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.05	mg/L	0/7	0%
E. coli (Geomean)	125.35	CFU / 100mL	3/10	30%
Temperature	19.39	Celsius	0/11	0%
Dissolved Oxygen	5.82	mg/L	3/11	27%
pH	7.64	-	0/11	0%
Total Phosphorus	0.069	mg/L	2/7	28%
TKN	0.479	mg/L	3/7	43%
Turbidity	23.31	NTU	3/11	27%
TSS	16.4	mg/L	2/7	29%
QHEI (fish)	47	-	1/1	100%
Fish IBI	36	-	0/1	0%
QHEI (macro)	45	-	1/1	100%
Macro mIBI	38	-	0/1	0%

The final testing site in the Johnson Fork subwatershed is test site 30 (GMW-08-0018). Testing site 30 is located in Johnson Fork Creek off of Johnson Fork Road. Near test site 30, there are good riparian buffers and a few small communities located upstream from the testing site. The geometric mean for E. coli at site 30 was 187.04 CFU/100mL. IDEM collected data in 2009 from the same site and the geometric mean for E. coli then was 482 CFU/100mL. There are some septic hot spots identified by OKI near testing site 30. There are areas on Old US 52 (30 houses/ 12 businesses) and the Chapel Ridge Road house areas. Officials from the Dearborn County Health Department estimate a 50% failure rate for septics in the county. This stream was previously listed as impaired for dissolved oxygen (DO), but the current data collected does not support that listing. Site 30 had 1 out of 11 instances where DO was high. For a complete summary of water quality monitoring data at site 30, see figure 76.

Figure 76: Site 30 Water Quality Analysis – Johnson Fork Subwatershed

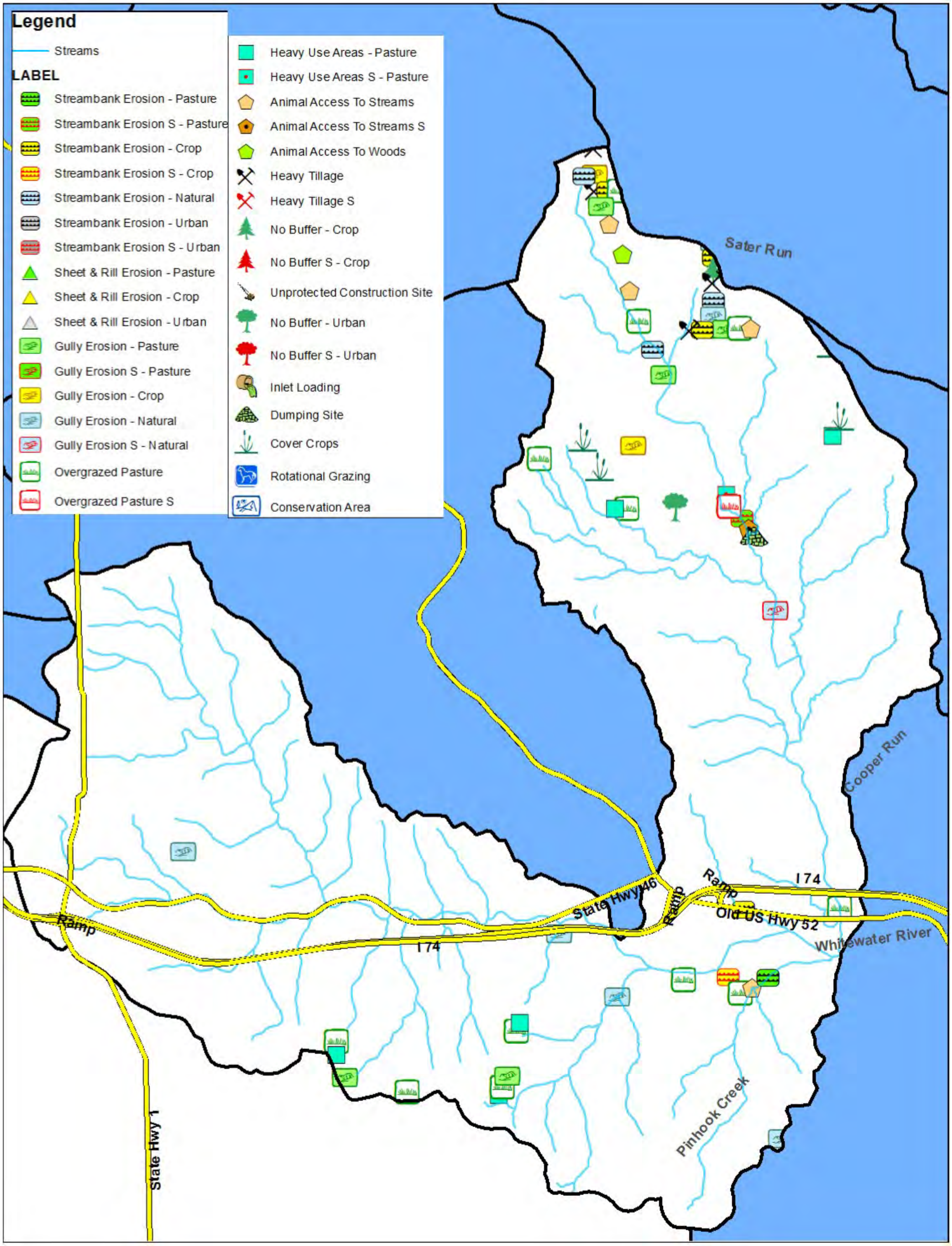
Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.08	mg/L	0/7	0%
E. coli (Geomean)	187.04	CFU / 100mL	3/9	33%
Temperature	19.81	Celsius	0/11	0%
Dissolved Oxygen	8.4	mg/L	1/11	9%
pH	7.87	-	0/11	0%
Total Phosphorus	0.02	mg/L	0/7	0%

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
TKN	0.186	mg/L	0/7	0%
Turbidity	4.84	NTU	0/11	0%
TSS	0.6	mg/L	0/7	0%
QHEI (fish)	61	-	0/1	0%
Fish IBI	46	-	0/1	0%
QHEI (macro)	59	-	0/1	0%
Macro mIBI	38/42	-	0/2	0%

Figure 77: Windshield Survey Findings in the Johnson Fork Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Streambank Erosion - Pasture	2
Severe Streambank Erosion - Pasture	1
Streambank Erosion – Crop	4
Severe Streambank Erosion – Crop	1
Streambank Erosion – Natural	3
Gully Erosion - Pasture	5
Gully Erosion - Crop	2
Gully Erosion - Natural	4
Severe Gully Erosion - Natural	1
Overgrazed Pasture	12
Severe Overgrazed Pasture	1
Heavy Use Areas -Pasture	5
Severe Heavy Use Areas - Pasture	1
Animal Access To Streams	4
Severe Animal Access To Streams	1
Animal Access To Woods	1
Heavy Tillage	4
No Buffer - Crop	1
No Buffer – Urban	1
Dumping Site	1
Exceptional – Cover Crops	3
Total	**58**

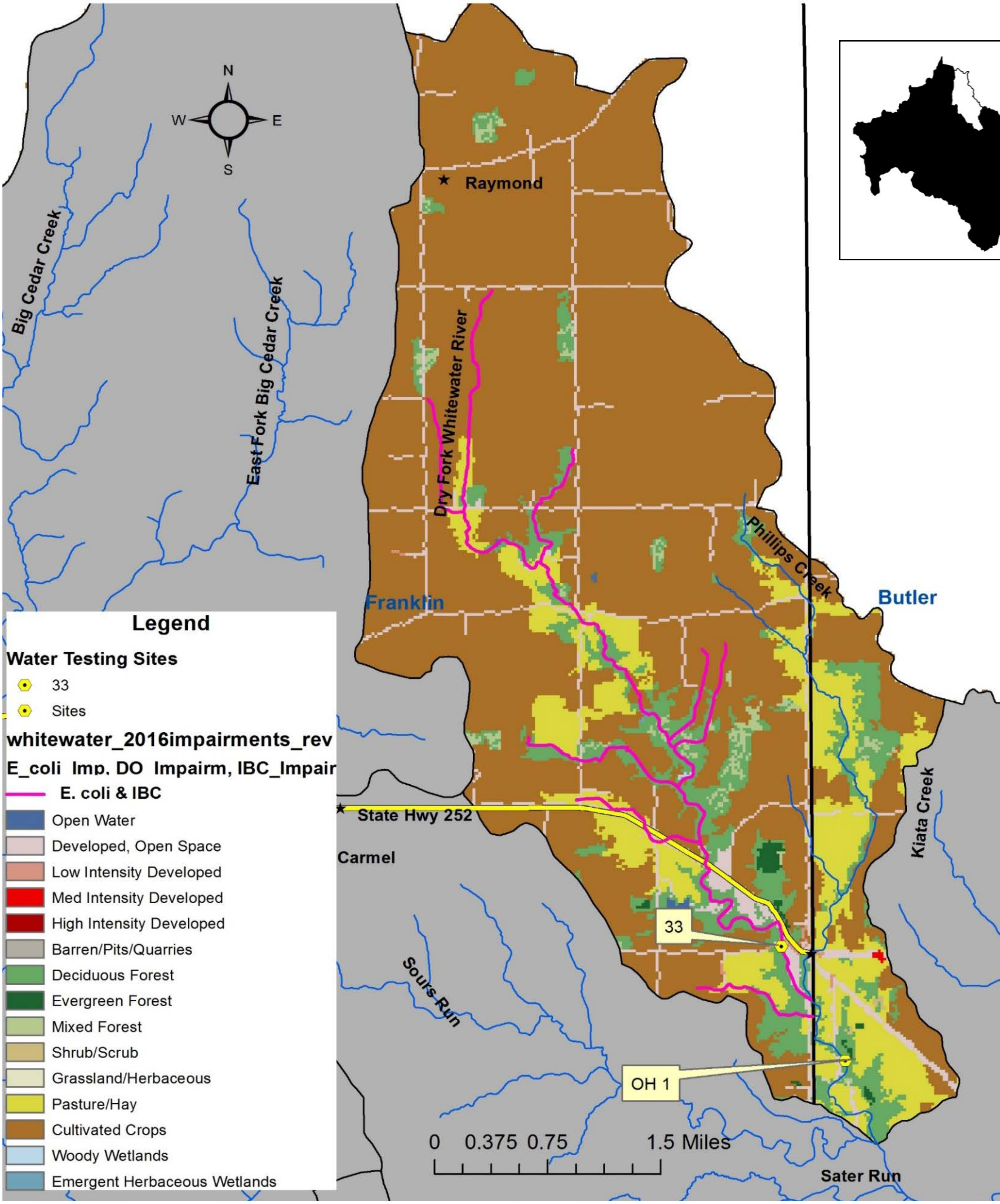
Figure 78: Windshield Result Locations in the Johnson Fork Subwatershed



2.3.7 Headwaters of Dry Fork Subwatershed (050800030807)

The Headwaters of Dry Fork subwatershed is located at the northeast portion of the watershed and drains approximately 16 square miles into Dry Fork Creek and the Whitewater River. The land use is primarily agriculture (66%) followed by hay and pasture land (18%) and forest (12%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. There are a couple of small towns (Raymond and Scipio) in the subwatershed. There are no permitted facilities or CFOs and the majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited. The landscape in the area is more level that what is typically found in the watershed leading to its agricultural intensity in contrast to much of the overall watershed. Highly erodible soil types are present in a small capacity in this subwatershed, with the majority of the HEL lands located on the sloping lands near waterways. There are small patches of the subwatershed identified as having hydric soil types. These areas could be potential areas for wetland restoration. There are approximately 21 miles of stream in the subwatershed and approximately 13.8 miles of them are impaired for both E. coli and IBC based on the 2016 List of Impaired Waters. There are approximately 5.6 stream miles with inadequate buffers. The sub watershed also contains sites 33 and OH 1.

Figure 79: Headwaters of Dry Fork Subwatershed



Site 33 (GMW-08-0020) is located on the Dry Fork of Whitewater River off of Dickson Road. The site had a geometric mean result of 559.85 CFU/100mL. This exceeds the project target and state standards for E. coli. There was also some historical sampling done by IDEM at site 33 in 2009. In 2009, the geometric mean for E. coli was 231.14 CFU/100mL. The small unincorporated community of Scipio uses septic systems instead of city sewage lines. From the 2014 sampling data, the fish IBI received a score of 40 and the mIBI got a score of 28. The mIBI falls below project targets. Dissolved oxygen was high 1 out of 12 times it was sampled. Nitrates at test site 33 also exceeded project targets. The mean was 3.69 mg/L which was too high for the 1.0 mg/L target. Nitrates tested over the 1.0 mg/L target on 4 of 7 (57%) occurrences. For a complete summary of water quality monitoring data at site 33, see figure 80.

Figure 80: Site 33 Water Quality Analysis – Headwaters of Dry Fork Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	3.69	mg/L	4/7	57%
E. coli (Geomean)	559.85	CFU / 100mL	8/10	80%
Temperature	17.03	Celsius	0/11	0%
Dissolved Oxygen	9.28	mg/L	1/11	9%
pH	8.09	-	0/11	0%
Total Phosphorus	0.055	mg/L	1/7	14%
TKN	0.386	mg/L	1/7	14%
Turbidity	5.89	NTU	0/11	0%
TSS	6	mg/L	0/7	0%
QHEI (fish)	56/63	-	0/2	0%
Fish IBI	40/48	-	0/2	0%
QHEI (macro)	54/61	-	0/2	0%
Macro mIBI	38/28	-	1/2	50%

The Headwaters Dry Fork subwatershed also contains site OH1. All sites on the Ohio side of the program were sampled by the Whitewater River Watershed Project staff. Best efforts were made to duplicate sampling times and conditions of IDEM's sampling team, but some inconsistencies may exist. The mean for E. coli at site OH1 was 1861.86 CFU/100mL, which exceeds the project target and state standards. Nitrates also exceeded targets at site OH1 with a mean of 3.88 mg/L which exceeds the 1.0 mg/L goal. Nitrates exceeded the 1.0 mg/L target 83% of the time (10/12 occurrences). Dissolved oxygen (DO) was too high at site OH1 41.6% (5/12 occurrences). Oversaturation of DO can have negative effects on aquatic life. Total phosphorus exceeded the target of 0.06 mg/L 41.6% (5/12 occurrences) with a mean of 0.18 mg/L. For a complete summary of water quality monitoring data at site OH1, see figure 81.

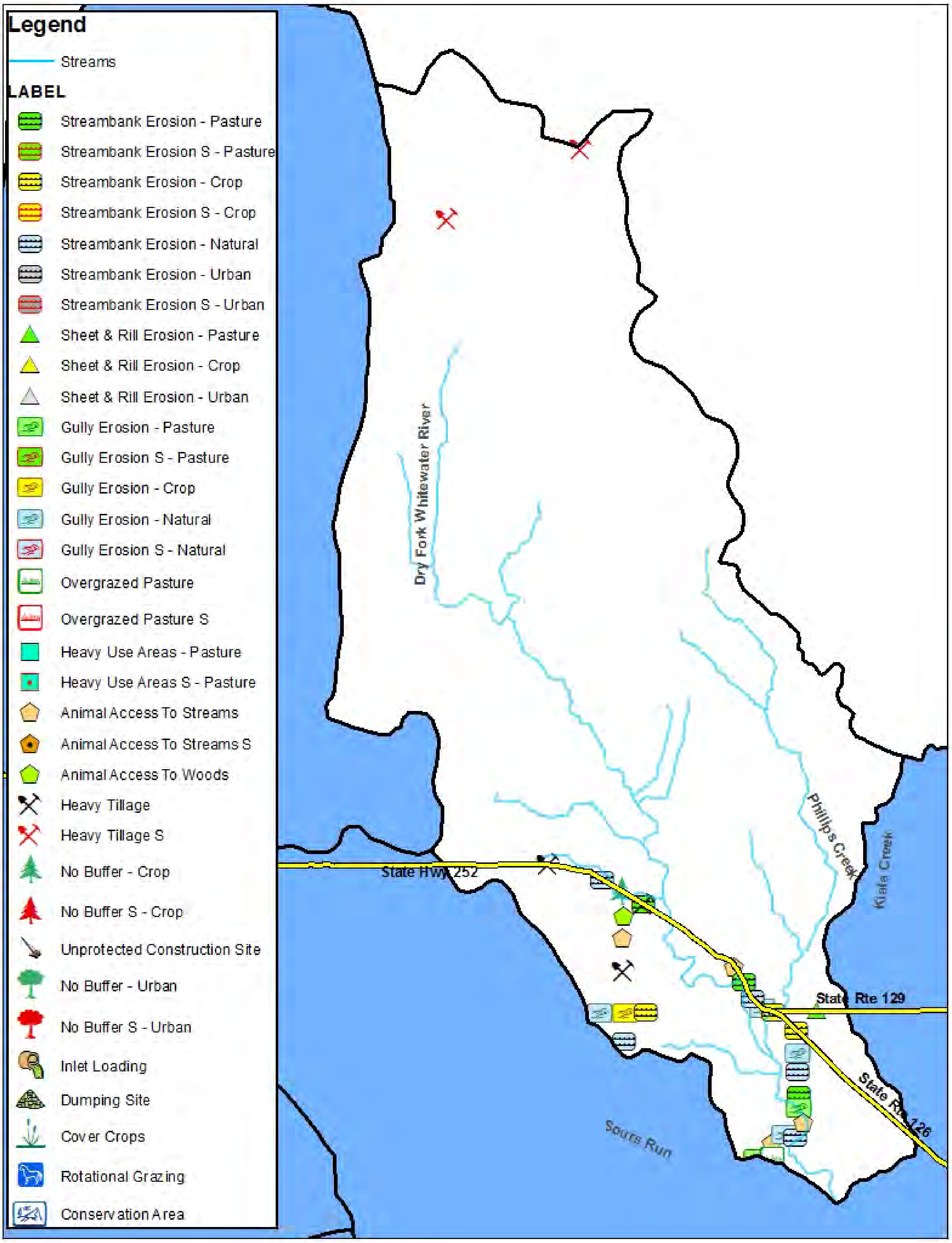
Figure 81: Site OH1 Water Quality Analysis – Headwaters of Dry Fork Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	3.88	mg/L	10/12	83%
E. coli	1,861.86	CFU / 100mL	4/7	57%
Temperature	20.18	Celsius	0/12	0%
Dissolved Oxygen	10.98	mg/L	5/12	42%
pH	8.14	-	0/12	0%
Total Phosphorus	0.18	mg/L	5/12	42%
TKN	0.706	mg/L	4/12	33%
Turbidity	7.38	NTU	0/12	0%
TSS	7.8	mg/L	0/12	0%
CQHEI	72	-	0/1	0%
Pollution Tolerance	24	-	0/1	0%

Figure 82: Windshield Survey Findings in the Headwaters of Dry Fork Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Streambank Erosion - Pasture	3
Streambank Erosion – Crop	3
Streambank Erosion – Natural	5
Sheet & Rill Erosion – Pasture	1
Gully Erosion - Pasture	1
Gully Erosion - Crop	1
Gully Erosion - Natural	4
Overgrazed Pasture	1
Animal Access To Streams	4
Animal Access To Woods	1
Heavy Tillage	3
Severe Heavy Tillage	2
No Buffer - Crop	1
Total	**30**

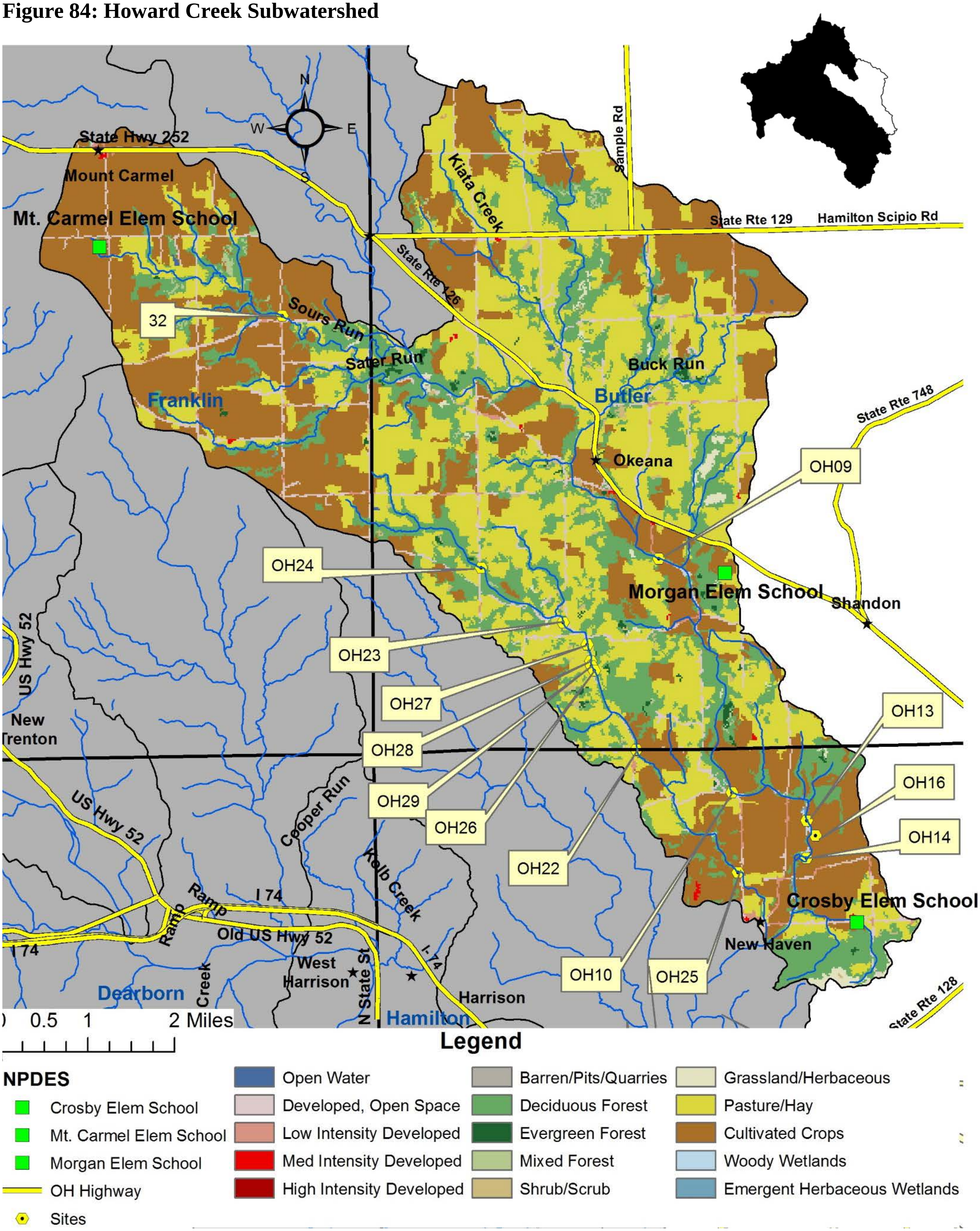
Figure 83: Windshield Result Locations in the Headwaters of the Dry Fork Subwatershed



2.3.8 Howard Creek Subwatershed (050800030808)

The Howard Creek Dry Fork subwatershed is located on the northeast side of the watershed and drains approximately 43 square miles into Dry Fork and the Whitewater River. The land use is primarily hay and pasture land (50%) followed by agriculture (33%) and forest (17%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. There are a few small towns located in the watershed, including Mount Carmel, Okeana, and New Haven. There are 3 permitted facilities and no CFOs in the subwatershed. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited with areas of somewhat limited along the main stream. Highly erodible soil types make up nearly a half of this subwatershed. This sub watershed has narrow riparian zones on most of the streams. There are many isolated patches of the subwatershed identified as having hydric soil types. These areas could be potential areas for wetland restoration. There are approximately 72.9 miles of stream in the subwatershed and 8.3 stream miles have inadequate buffers. Approximately 15.9 miles are impaired for E. coli according to the 2016 List of Impaired Waters. Site 32 and 13 supplemental sites are located in the subwatershed.

Figure 84: Howard Creek Subwatershed



The Howard Creek Subwatershed has testing site 32 (GMW-08-0027). Site 32 is located in Sours Run off of Drewersburg Road. The geometric mean result for site 32 was 478.15 CFU/100mL. This exceeds the project target and state standards for E. coli. Nitrates exceeded the target at site 32. The mean of 2.06 mg/L did not meet the 1.0 mg/L target. Nitrates were too high for the 1.0 mg/L target on 4 out of 7 occurrences (57%). For a complete summary of water quality monitoring data at site 32, see figure 85.

Figure 85: Site 32 Water Quality Analysis – Howard Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.06	mg/L	4/7	57%
E. coli Geomean	478.15	CFU / 100mL	7/10	70%
Temperature	16.86	Celsius	0/11	0%
Dissolved Oxygen	7.08	mg/L	1/11	9%
pH	7.80	-	0/11	0%
Total Phosphorus	0.066	mg/L	2/7	29%
TKN	0.457	mg/L	2/7	29%
Turbidity	7.47	NTU	0/11	0%
TSS	7.4	mg/L	0/7	0%
QHEI (fish)	62/58	-	0/2	0%
Fish IBI	38/38	-	0/2	0%
QHEI (macro)	54/56	-	0/2	0%
Macro mIBI	38/36	-	0/2	0%

Supplemental Data: The Ohio side of the subwatershed was not as geographically represented due to the project's limitations, so supplemental data was needed to obtain a better geographical representation. The Lower Great Miami River Citizens' Water Quality Monitoring Program, overseen by Friends of the Great Miami, Rivers Unlimited, and Hamilton County SWCD, collected data from March 2014-November 2014. Those sites are OH9, 10, 13, 14, 16, 22-29. The data was collected and analyzed by volunteers. 5 of the 13 sites did not meet the target for nitrates over 43% or more of the time. All of the sites did not meet the target for total phosphorus over 86% or more of the time (8 of them didn't meet 100% of the time). Half of the sites that were sampled for E.coli (5/10) did not meet the target 33% of more of the time. 2 sites did not meet the target for DO 50% or more of the time.

Figure 86: Site OH9- Dry Fork Whitewater River @ Race Lane Rd. Bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	3.32	mg/L	5/8	63%
pH	8.12	SU	0/9	0%
Total Phosphorus	0.34	mg/L	7/8	88%
E. coli (Geomean)	67.86	cfu/mL	3/8	38%
Turbidity	13.29	NTU	1/9	11%
Dissolved Oxygen	11.4	mg/L	3/9	33%

Figure 87: Site OH10- Dry Fork Whitewater River @ Oxford Rd. Bridge Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.82	mg/L	6/9	67%
pH	8.14	SU	0/9	0%
Total Phosphorus	0.25	mg/L	7/8	88%
E. coli (Geomean)	114.78	cfu/mL	2/9	22%
Turbidity	18.51	NTU	1/9	11%
Dissolved Oxygen	11.5	mg/L	10/23	43%

Figure 88: Site OH13- Dry Fork Whitewater River DS of Atherton Rd. Bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	3.1	mg/L	3/7	43%
pH	8.11	SU	0/8	0%
Total Phosphorus	0.27	mg/L	6/7	86%
E. coli (Geomean)	63.25	cfu/mL	2/7	29%
Turbidity	25.18	NTU	1/8	13%
Dissolved Oxygen	11.8	mg/L	4/8	50%

Figure 89: Site OH14- Dry Fork Whitewater River at Willey Rd. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.55	mg/L	3/7	43%
pH	8.11	SU	0/8	0%
Total Phosphorus	0.52	mg/L	6/7	86%
E. coli (Geomean)	162.38	cfu/mL	2/7	29%
Turbidity	27.16	NTU	1/8	13%
Dissolved Oxygen	12.2	mg/L	4/8	50%

Figure 90: Site OH16- Dry Fork Whitewater River tributary at farm downstream Atherton Rd./upstream Willey Rd. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	5.14	mg/L	5/5	100%
pH	7.62	SU	0/6	0%
Total Phosphorus	0.366	mg/L	5/5	100%
E. coli (Geomean)	220.81	cfu/mL	3/5	60%
Turbidity	7.57	NTU	0/6	0%
Dissolved Oxygen	8.8	mg/L	3/7	43%

Figure 91: Site OH22- Howard Creek @ Howard Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.84	mg/L	3/8	38%
pH	7.89	SU	0/10	0%
Total Phosphorus	0.311	mg/L	8/8	100%
E. coli (Geomean)	135.22	cfu/mL	2/9	22%
Turbidity	8.003	NTU	1/10	10%
Dissolved Oxygen	10.6	mg/L	3/8	38%

Figure 92: Site OH23- Howard Creek @ Schradin Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.45	mg/L	3/9	33%
pH	7.97	SU	0/10	0%
Total Phosphorus	0.41	mg/L	8/8	100%
E. coli (Geomean)	190.79	cfu/mL	4/9	44%
Turbidity	6.45	NTU	1/10	10%
Dissolved Oxygen	10.1	mg/L	2/8	25%

Figure 93: Site OH24- Howard Creek @ California Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.05	mg/L	3/10	30%
pH	7.84	SU	0/9	0%
Total Phosphorus	0.46	mg/L	7/8	88%
E. coli (Geomean)	24.69	cfu/mL	2/9	22%
Turbidity	9.26	NTU	1/9	11%

Figure 94: Site OH25- Howard Creek @ UC Field Station Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.77	mg/L	2/7	29%
pH	8.08	SU	0/9	0%
Total Phosphorus	0.36	mg/L	8/8	100%
E. coli (Geomean)	301.65	cfu/mL	4/8	50%
Turbidity	14.41	NTU	1/9	11%
Dissolved Oxygen	10.5	mg/L	7/20	35%

Figure 95: Site OH26- Howard Creek DS of 4075 Howard Creek Rd. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.65	mg/L	0/1	0%
pH	8.16	SU	0/1	0%
Total Phosphorus	0.468	mg/L	1/1	100%
Turbidity	1.87	NTU	0/1	0%
Dissolved Oxygen	10.4	mg/L	1/8	13%

Figure 96: Site OH27- Howard Creek US of 4075 Howard Creek Rd. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.25	mg/L	0/1	0%
pH	8.26	SU	0/1	0%
Total Phosphorus	0.6	mg/L	1/1	100%
Turbidity	6.46	NTU	0/1	0%
Dissolved Oxygen	11.3	mg/L	3/9	33%

Figure 97: Site OH28- Howard Creek Trib. @ 4075 Howard Creek Rd. - US sample Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.3	mg/L	0/1	0%
pH	7.56	SU	0/1	0%
Total Phosphorus	0.12	mg/L	1/1	100%
Turbidity	4.83	NTU	0/1	0%
Dissolved Oxygen	8.5	mg/L	0/8	0%

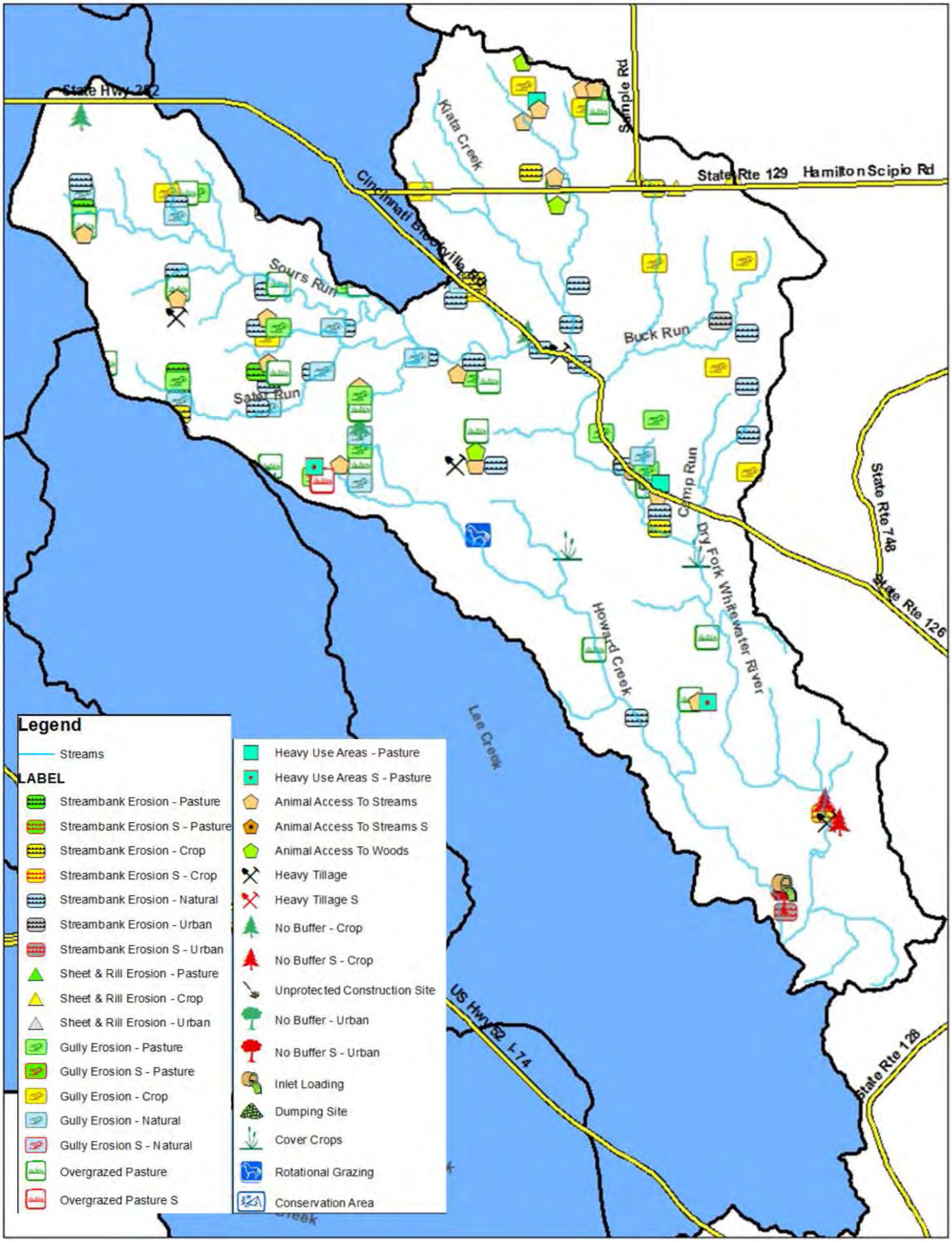
Figure 98: Site OH29- Howard Creek Trib. @ 4075 Howard Creek Rd. - DS sample Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.42	mg/L	2/9	22%
pH	7.46	SU	0/9	0%
Total Phosphorus	0.388	mg/L	7/7	100%
E. coli (Geomean)	42.72	cfu/mL	3/9	33%
Turbidity	9.94	NTU	0/9	0%

Figure 99: Windshield Survey Findings in the Howard Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Streambank Erosion - Pasture	3
Streambank Erosion – Crop	6
Severe Streambank Erosion – Crop	1
Streambank Erosion – Natural	24
Streambank Erosion - Urban	1
Severe Streambank Erosion - Urban	1
Sheet & Rill Erosion – Crop	3
Gully Erosion - Pasture	14
Gully Erosion - Crop	10
Gully Erosion - Natural	13
Overgrazed Pasture	18
Severe Overgrazed Pasture	1
Heavy Use Areas -Pasture	2
Severe Heavy Use Areas - Pasture	1
Animal Access To Streams	16
Animal Access To Woods	3
Heavy Tillage	5
No Buffer - Crop	3
Severe No Buffer – Crop	2
Severe No Buffer – Urban	1
Inlet Loading	2
Exceptional – Cover Crops	2
Exceptional – Rotational Grazing	1
Total	**133**

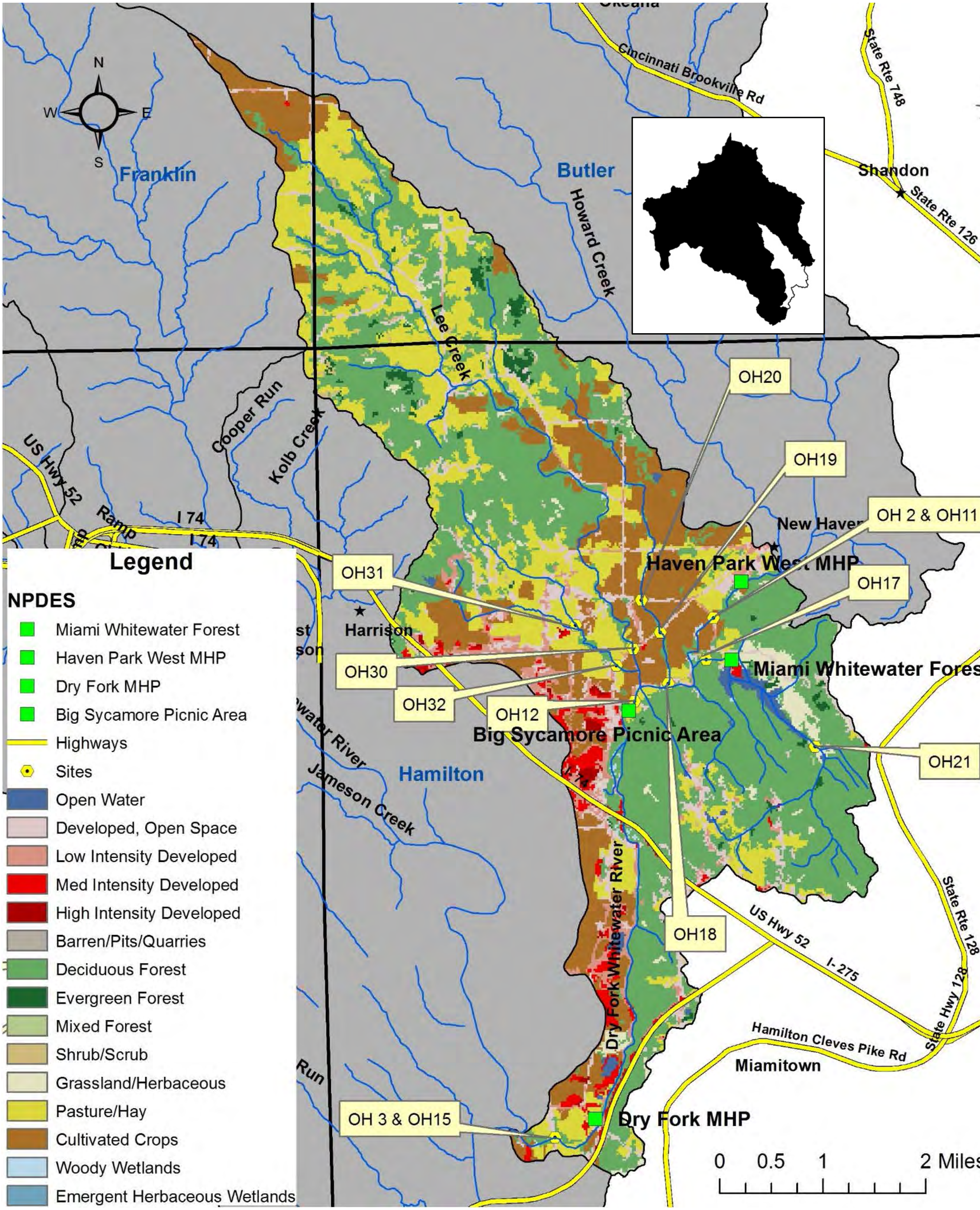
Figure 100: Windshield Result Locations in the Howard Creek Subwatershed



2.3.9 Lee Creek Subwatershed (050800030809)

The Lee Creek subwatershed is on the southeast side of the watershed and drains approximately 23 square miles into Dry Fork and the Whitewater River. The land use in the Lee Creek Sub watershed is mostly forested (53%) followed by hay and pasture land (24%), agriculture (18%), and developed (5%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. The developed areas are sprawl from the city of Harrison with no other small towns. Urban runoff may carry nutrients and pet waste (E. coli) into the streams. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. There are 4 permitted facilities in the subwatershed and no CFOs. Highly erodible soil types make up approximately half of this subwatershed. Most of the streams have some riparian zones but the agriculture areas are lacking. There are some isolated patches of the subwatershed identified as having hydric soil types. These areas could be potential areas for wetland restoration. There are approximately 45.3 miles of stream in the subwatershed and 3.3 stream miles have inadequate buffers. Lee Creek Sub watershed also contains test site OH2 & OH3 along with 11 supplemental sites.

Figure 101: Lee Creek Subwatershed



The mean for E. coli at site OH2 site was 255.43 CFU/100mL, which exceeds the project target and state standards. The nitrates at site OH2 were too high. The mean of 2.47 mg/L exceeded the project target of 1.0 mg/L. In addition, nitrates exceeded the target 7 of 12 occurrences (58%). Site OH2 also had high dissolved oxygen (DO) levels. The DO exceeded the target 5 out of 12 (41%) times. Total phosphorus (TP) was also high on 2 out of 12 occasions (16%). However the average TP of 0.04 mg/L did not exceed the project target of 0.06 mg/L. For a complete summary of water quality monitoring data at site OH2, see figure 102.

Figure 102: Site OH2 Water Quality Analysis – Lee Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.47	mg/L	7/12	58%
E. coli	255.43	CFU / 100mL	2/7	29%
Temperature	21.97	Celsius	0/12	0%
Dissolved Oxygen	10.93	mg/L	5/12	42%
pH	8.03	-	0/12	0%
Total Phosphorus	0.04	mg/L	2/12	17%
TKN	0.527	mg/L	5/12	42%
Total Suspended Solids	5.17	mg/L	0/12	0%
CQHEI (OH sites)	74	-	0/1	0%
Pollution Tolerance Index	21	-	0/1	0%

The Lee Creek sub watershed also contains testing site OH3. The site for OH3 is downstream of the city of Harrison in Dry Fork off of Kilby Road. Land use around the testing site is mostly rural agricultural use. The site has good buffers. The mean for E. coli at test site OH3 was 60.71 CFU/100mL. This is well under the project target and the state standards. The nitrates at site OH3 were too high. The mean of 1.79 mg/L exceeded the project target of 1.0 mg/L. In addition, nitrates exceeded the target 6 of 12 occurrences (50%). Site OH3 also had high dissolved oxygen (DO) levels. The DO exceeded the target 5 out of 12 (41%) times. Total phosphorus (TP) was also high on 2 out of 12 occasions (16%). However the average TP of 0.04 mg/L did not exceed the project target of 0.06 mg/L. For a complete summary of water quality monitoring data at site OH3, see figure 103.

Figure 103: Site OH3 Water Quality Analysis – Lee Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.79	mg/L	6/12	50%
E. coli	60.71	CFU / 100mL	0/7	0%
Temperature	24.21	Celsius	0/12	0%
Dissolved Oxygen	10.85	mg/L	5/12	42%
pH	8.04	-	0/12	0%
Total Phosphorus	0.04	mg/L	2/12	17%
TKN	0.714	mg/L	6/12	50%
Total Suspended Solids	6.13	mg/L	0/12	0%
CQHEI (OH sites)	67	-	0/1	0%
Pollution Tolerance Index	26	-	0/1	0%

Supplemental Data: The Ohio side of the subwatershed was not as geographically represented due to the project's limitations, so supplemental data was needed to obtain a better geographical representation. The Lower Great Miami River Citizens' Water Quality Monitoring Program, overseen by Friends of the Great Miami, Rivers Unlimited, and Hamilton County SWCD, collected data from March 2014-November 2014. Those sites are OH11, 12, 15, 17-21, and 30-32. The data was collected and analyzed by volunteers. Three of the 11 sites did not meet the target for nitrates over 71% or more of the time. All of the sites did not meet the target for total phosphorus over 83% or more of the time (9 of them didn't meet 100% of the times). Over half of the sites that were sampled for E.coli (7/10) did not meet the target 33% of more of the time. 5 of the 8 sites sampled did not meet the target for DO 30% or more of the time.

Figure 104: Site OH11- Dry Fork Whitewater River @ Mt. Hope Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.9	mg/L	4/7	57%
pH	8.07	SU	0/7	0%
Total Phosphorus	0.26	mg/L	5/6	83%
E. coli (Geomean)	80.9	cfu/mL	3/7	43%
Turbidity	24.12	NTU	1/7	14%

Figure 105: Site OH12- Dry Fork Whitewater River @ West Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.27	mg/L	3/8	38%
pH	8.03	SU	0/9	0%
Total Phosphorus	0.56	mg/L	8/8	100%
E. coli (Geomean)	160.7	cfu/mL	1/8	13%
Turbidity	37.7	NTU	1/9	11%
Dissolved Oxygen	11.3	mg/L	4/11	36%

Figure 106: Site OH15- Dry Fork Whitewater River@ Kilby Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.33	mg/L	2/6	33%
pH	7.99	SU	0/7	0%
Total Phosphorus	0.35	mg/L	5/5	100%
E. coli (Geomean)	25.56	cfu/mL	1/6	17%
Turbidity	40.16	NTU	1/7	14%
Dissolved Oxygen	9.8	mg/L	3/12	25%

Figure 107: Site OH17- Dry Fork Trib. – Habor Ridge Dr. – Miami Whitewater Lake outflow Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.93	mg/L	1/9	11%
pH	8.03	SU	0/9	0%
Total Phosphorus	0.23	mg/L	8/8	100%
E. coli (Geomean)	35.7	cfu/mL	3/9	33%
Turbidity	14.06	NTU	1/9	11%

Figure 108: Site OH18- Dry Fork WWR Trib. NE of Lee Creek – Timberlakes Dr. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.04	mg/L	5/7	71%
pH	8.13	SU	0/9	0%
Total Phosphorus	0.31	mg/L	7/7	100%
E. coli (Geomean)	133.36	cfu/mL	3/7	43%
Turbidity	21.2	NTU	3/9	33%
Dissolved Oxygen	9.2	mg/L	3/9	33%

Figure 109: Site OH19- Dry Fork Whitewater River trib. - NE Lee Creek @ Dry Fork Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.15	mg/L	3/9	33%
pH	7.81	SU	0/10	0%
Total Phosphorus	0.311	mg/L	8/8	100%
E. coli (Geomean)	256.46	cfu/mL	5/9	56$
Turbidity	20.32	NTU	2/10	20%
Dissolved Oxygen	7.1	mg/L	4/10	40%

Figure 110: Site OH20- Dry Fork Whitewater River trib. - NE Lee Creek @ New Haven Rd Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.46	mg/L	3/8	38%
pH	7.89	SU	0/9	0%
Total Phosphorus	0.28	mg/L	8/8	100%
E. coli (Geomean)	232.15	cfu/mL	3/8	38%
Turbidity	18.63	NTU	2/9	22%
Dissolved Oxygen	8.6	mg/L	3/15	20%

Figure 111: Site OH21- Dry Fork Trib. – Strimple Rd. – inflow to Miami Whitewater Lake Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.76	mg/L	1/7	14%
pH	7.63	SU	0/9	0%
Total Phosphorus	0.31	mg/L	5/6	83%
E. coli (Geomean)	13.68	cfu/mL	2/7	29%
Turbidity	11.49	NTU	0/7	0%

Figure 112: Site OH30- Lee Creek @ Dry Fork Rd. Bridge Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.87	mg/L	4/9	44%
pH	7.99	SU	0/10	0%
Total Phosphorus	0.30	mg/L	8/8	100%
E. coli (Geomean)	117.64	cfu/mL	3/9	33%
Turbidity	35.16	NTU	1/10	10%
Dissolved Oxygen	10.8	mg/L	3/10	30%

Figure 113: Site OH31- Lee Creek @ New Haven Rd. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.7	mg/L	0/1	0%
pH	8.27	SU	0/1	0%
Total Phosphorus	1.4	mg/L	1/1	100%
E. coli (Geomean)	NA	cfu/mL	-	-
Turbidity	2.58	NTU	0/1	0%
Dissolved Oxygen	10.1	mg/L	2/10	20%

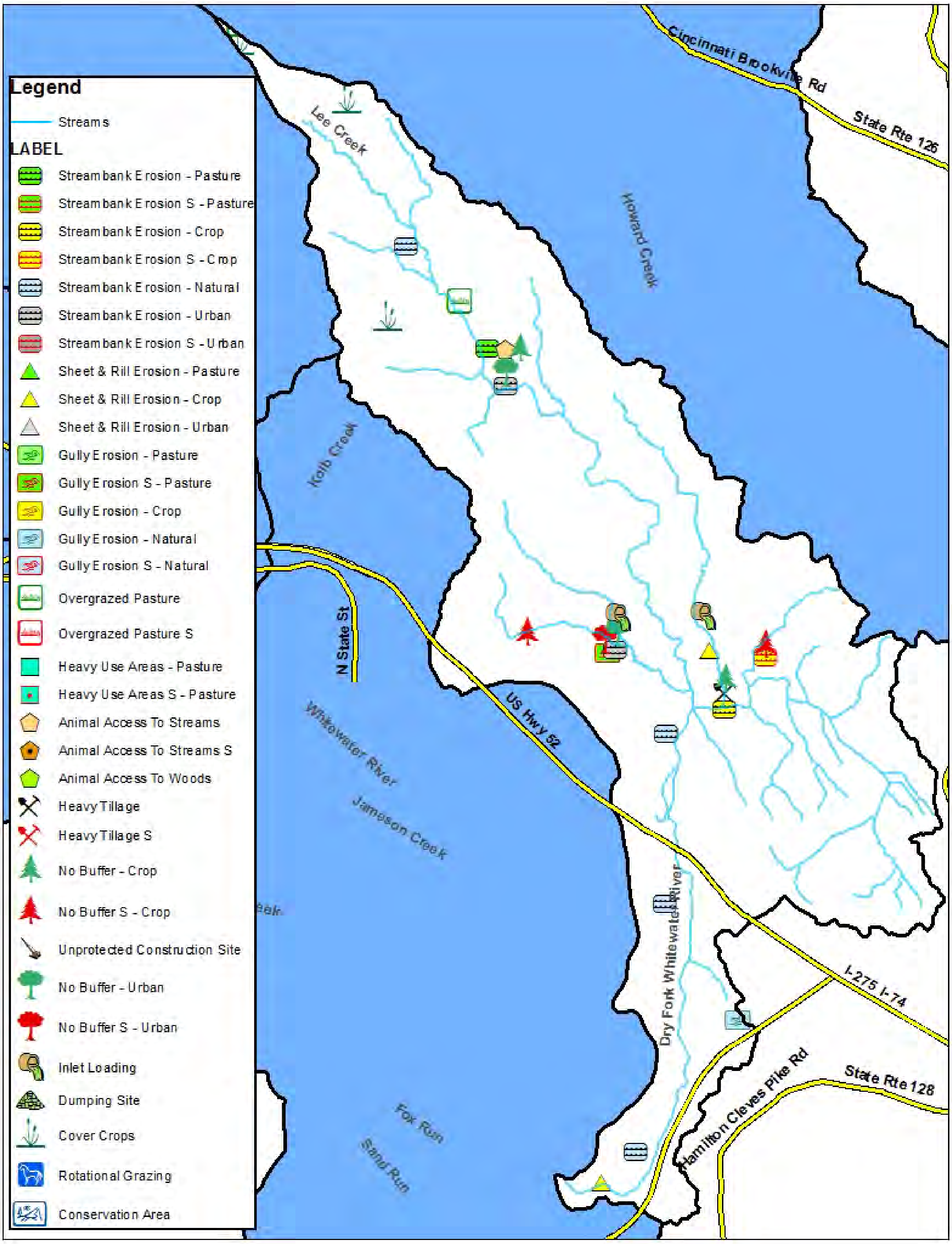
Figure 114: Site OH32- Lee Creek trib. - SW @ Dry Fork Rd. bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.69	mg/L	6/8	75%
pH	8.06	SU	0/10	0%
Total Phosphorus	0.299	mg/L	2/2	100%
E. coli (Geomean)	546.33	cfu/mL	6/9	67%
Turbidity	6.70	NTU	1/10	10%
Dissolved Oxygen	10.0	mg/L	3/10	30%

Figure 115: Windshield Survey Findings in the Lee Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Streambank Erosion – Pasture	1
Severe Streambank Erosion - Pasture	1
Streambank Erosion – Crop	1
Severe Streambank Erosion – Crop	1
Streambank Erosion – Natural	4
Streambank Erosion - Urban	2
Sheet & Rill Erosion – Crop	2
Gully Erosion - Natural	1
Overgrazed Pasture	1
Animal Access To Streams	1
Heavy Tillage	1
No Buffer - Crop	2
Severe No Buffer – Crop	2
No Buffer – Urban	2
Severe No Buffer – Urban	1
Inlet Loading	2
Exceptional – Cover Crops	3
Total	**28**

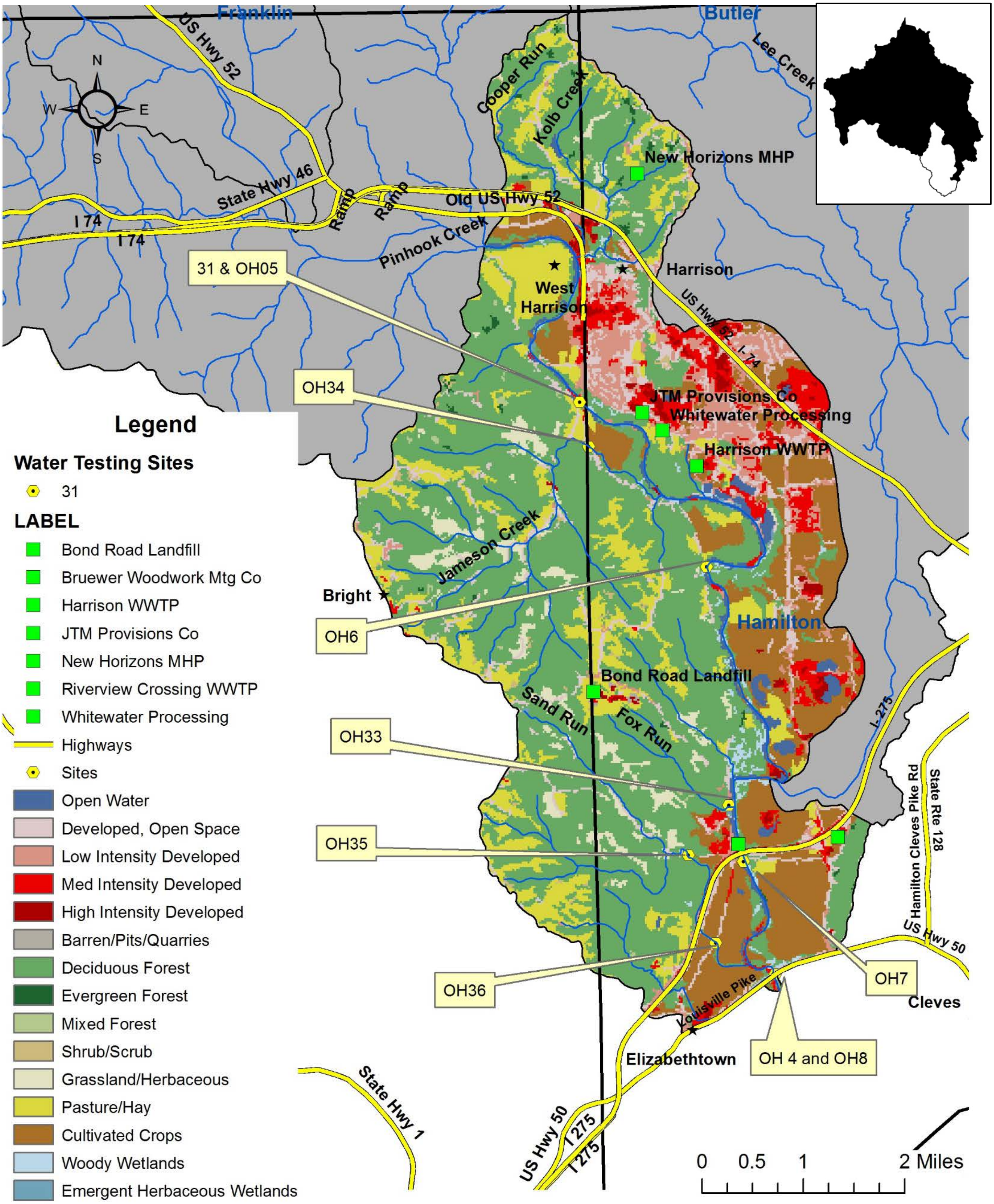
Figure 116: Windshield Result Locations in the Lee Creek Subwatershed



2.3.10 Jameson Creek Subwatershed (050800030810)

The Jameson Creek subwatershed is located on the southern tip of the watershed and drains approximately 29 square miles into the mainstem of the Whitewater River. The land use is primarily forested land (52%) followed by agriculture (19%), developed (16%), and hay and pasture land (13%). Runoff from the agricultural land and pastures can carry nutrients, sediment, and E. coli. This watershed is the most urbanized subwatershed in the entire Whitewater River Watershed. Urban runoff may carry nutrients and pet waste into the streams. There are 7 permitted facilities in the subwatershed and no CFOs. The City of Harrison and town of West Harrison and their sprawl make up the majority of the developed areas in the watershed. A portion of the town of Bright is also in the watershed. The rest of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. The landscape in the area consists of steeper drainages in the headwaters which reduce in slope as they approach the mainstem. Highly erodible soil types make up nearly half of this subwatershed. The majority of the HEL lands are located in the western portion of the subwatershed, which is predominantly forested interspersed with pasture land. Large areas around the mainstem of the Whitewater River of the subwatershed are identified as having hydric soil types. These areas could be potential areas for wetland restoration. The subwatershed has around 55.8 miles of streams with none of them listed as impaired on the 2016 List of Impaired Waters. There are approximately 0.9 miles of stream with inadequate buffers. Sites 31 and OH4 are located in this subwatershed along with 8 supplemental sites.

Figure 117: Jameson Creek Subwatershed



The Jameson Creek subwatershed contains testing site 31. Site 31 (GMW-08-0021) is located in Whitewater River off of Jamison Road. The geometric mean for E. coli at site 31 was 68.052 CFU/100mL. This meets the project target and state standards. The mIBI did not meet targets with a score of 34. However of the macroinvertebrates sampled, 19% were in the EPT Taxa and 61% of the bugs sampled were intolerant (meaning they have a low tolerance of pollution and tend to be found in clean water). Dissolved Oxygen (DO) was high on 4 out of 16 occurrences. Nitrates were too high at test site 31. The mean of 1.875 mg/L exceeds the project target of 1.0 mg/L. Nitrates exceeded this target on 6 out of 12 occurrences (50%). For a complete summary of water quality monitoring data at site 31, see figure 118.

Figure 118: Site 31 Water Quality Analysis – Jameson Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.875	mg/L	6/12	50%
E. coli (Geomean)	68.52	CFU / 100mL	0/10	0%
Temperature	15.04	Celsius	0/16	0%
Dissolved Oxygen	10.3	mg/L	4/16	25%
pH	8.08	-	0/16	0%
Total Phosphorus	0.044	mg/L	0/12	0%
TKN	0.296	mg/L	0/12	0%
Turbidity	11.9	NTU	1/16	6%
TSS	15.8	mg/L	2/12	17%
QHEI (fish)	75	-	0/1	0%
Fish IBI	54	-	0/1	0%
QHEI (macro)	65	-	0/1	0%
Macro mIBI	34	-	1/1	100%

The Jameson Creek subwatershed also contains testing site OH4. All data from sites on the Ohio side of the project were collected by project staff and then analyzed in the lab of the South Dearborn Regional Sewer District and Belmont Laboratory. The mean for E. coli at site OH4 was 119.71 CFU/100mL. Site OH4 is located off of the bridge of US Hwy 50. The stream bank sediment is very mucky and almost like quick sand to stand in. The Pollution Tolerance Index (PTI) is used to evaluate biotic integrity at the site by sampling macroinvertebrates. The PTI at site OH4 was 2 which receives a rating of “bad.” Nitrates were elevated at test site OH4. The mean of 1.96 mg/L exceeds the project target of 1.0 mg/L. Nitrates exceeded this target on 10 out of 12 occurrences (83%). For a complete summary of water quality monitoring data at site OH4, see figure 119.

Figure 119: Site OH4 Water Quality Analysis – Jameson Creek Subwatershed

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	1.96	mg/L	10/12	83%
E. coli	119.71	CFU / 100mL	1/7	14%
Temperature	24.06	Celsius	0/12	0%
Dissolved Oxygen	10.73	mg/L	4/12	33%
pH	8.08	-	0/12	0%
Total Phosphorus	0.03	mg/L	1/12	8%
TKN	0.701	mg/L	9/12	75%
Total Suspended	15.25	mg/L	2/12	17%
CQHEI	55	-	1/1	100%
Pollution Tolerance	2	-	1/1	100%

Supplemental Data: The Ohio side of the subwatershed was not as geographically represented due to the project's limitations, so supplemental data was needed to obtain a better geographical representation. The Lower Great Miami River Citizens' Water Quality Monitoring Program, overseen by Friends of the Great Miami, Rivers Unlimited, and Hamilton County SWCD, collected data from March 2014-November 2014. Those sites are OH5-8, and 33-36. The data was collected and analyzed by volunteers. Half of the sites (4/8) did not meet the target for nitrates over 56% or more of the time. All of the sites besides one did not meet the target for total phosphorus 100% of the time (the one site didn't meet 75% of the time). A quarter of the sites (2/8) did not meet the target 56% of more of the time for E.coli and 5 sites failed 33% of the time. One site didn't meet the target for turbidity 89% of the time.

Figure 120: Site OH5- Whitewater River at State Street Bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.61	mg/L	4/9	44%
pH	8.08	SU	0/9	0%
Total Phosphorus	0.35	mg/L	6/8	75%
E. coli (Geomean)	147.70	cfu/mL	3/9	33%
Turbidity	90.53	NTU	2/9	22%

Figure 121: Site OH6- Whitewater River at 7777 Lawrenceburg Rd. Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.81	mg/L	7/9	78%
pH	8.01	SU	0/9	0%
Total Phosphorus	0.38	mg/L	8/8	100%
E. coli (Geomean)	10.94	cfu/mL	3/9	33%
Turbidity	100.237	NTU	2/9	22%

Figure 122: Site OH7- Whitewater River @ Suspension Bridge Rd. Bridge Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.53	mg/L	5/9	56%
pH	8.02	SU	0/9	0%
Total Phosphorus	0.33	mg/L	8/8	100%
E. coli (Geomean)	19.72	cfu/mL	3/9	33%
Turbidity	74.61	NTU	2/9	22%

Figure 123: Site OH8- Whitewater River @ Rt. 50 Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	2.23	mg/L	5/9	56%
pH	8.05	SU	0/9	0%
Total Phosphorus	0.51	mg/L	8/8	100%
E. coli (Geomean)	18.42	cfu/mL	3/9	33%
Turbidity	95.56	NTU	3/9	33%

Figure 124: Site OH33- Fox Run @ Lawrenceburg Rd Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.96	mg/L	5/9	56%
pH	7.86	SU	0/9	0%
Total Phosphorus	0.31	mg/L	9/9	100%
E. coli (Geomean)	32.22	cfu/mL	3/9	33%
Turbidity	17.10	NTU	8/9	89%

Figure 125: Site OH34- Jameson Creek @ Lawrenceburg Rd Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.76	mg/L	3/9	33%
pH	7.98	SU	0/9	0%
Total Phosphorus	0.32	mg/L	9/9	100%
E. coli (Geomean)	38.58	cfu/mL	5/9	56%
Turbidity	9.95	NTU	2/9	22%

Figure 126: Site OH35- Sand Run @ Sand Run Rd Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.88	mg/L	3/9	33%
pH	7.87	SU	0/9	0%
Total Phosphorus	0.33	mg/L	9/9	100%
E. coli (Geomean)	6.30	cfu/mL	1/9	11%
Turbidity	11.21	NTU	2/9	22%

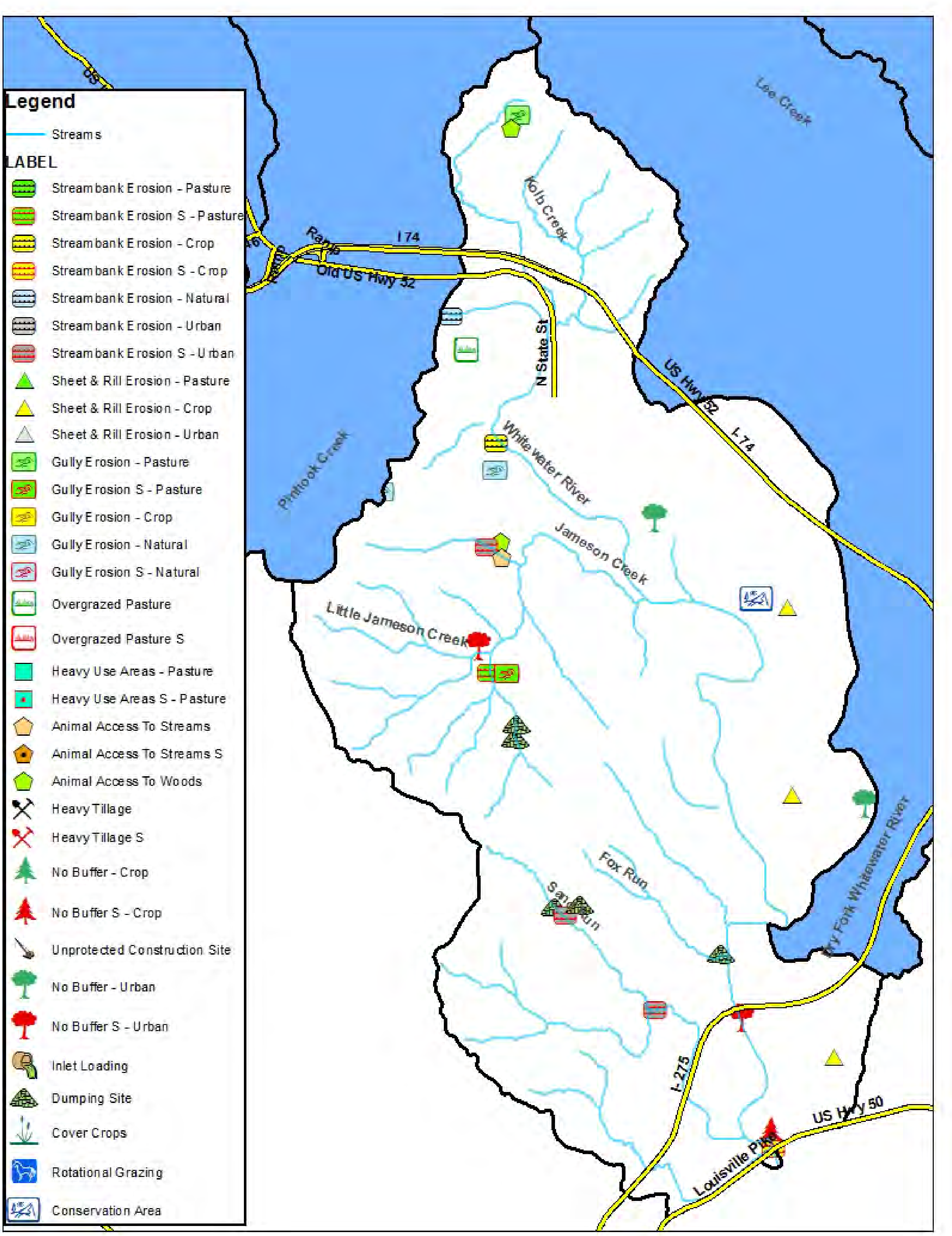
Figure 127: Site OH36- Sand Run @ Lawrenceburg Rd Water Quality Analysis

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Nitrates	0.91	mg/L	2/7	29%
pH	8.05	SU	0/7	0%
Total Phosphorus	0.38	mg/L	7/7	100%
E. coli (Geomean)	64.04	cfu/mL	5/7	71%
Turbidity	21.85	NTU	3/7	43%

Figure 128: Windshield Survey Findings in the Jameson Creek Subwatershed

Problem or Area of Concern/Interest	Frequency/ Occurrence
Severe Streambank Erosion – Pasture	1
Streambank Erosion – Crop	1
Severe Streambank Erosion – Crop	1
Streambank Erosion – Natural	1
Severe Streambank Erosion – Urban	3
Sheet & Rill Erosion – Crop	3
Gully Erosion – Pasture	1
Severe Gully Erosion – Pasture	1
Gully Erosion – Natural	2
Overgrazed Pasture	1
Animal Access To Streams	1
Animal Access To Woods	2
Severe No Buffer – Crop	1
No Buffer – Urban	2
Severe No Buffer – Urban	2
Dumping Site	5
Exceptional – Conservation Area	1
Total	**29**

Figure 129: Windshield Result Locations in the Jameson Creek Subwatershed



Watershed Inventory Summary Conclusion

Over the past couple of years a lot of information and data was collected to obtain a better understanding of the Whitewater River Watershed. The Whitewater River Watershed is mostly rural. The largest city in the watershed is Harrison, OH which has just fewer than 10,000 residents. Other smaller urban areas include St. Leon and Bright. The largest landuse of the Whitewater River Watershed is forested (40%) followed by cropland (29%), pasture (19%), and developed (8%).

The Whitewater River Watershed is a very unique and sensitive watershed. The watershed is the home to several endangered plant and animal species on both the state and federal level. It is known throughout the state for its excellent scenery and flow. During the recreational season, the Whitewater River is used very frequently by kayakers and canoers. The watershed also has many wellhead protection areas in Indiana and source water protection areas in Ohio. There is a large aquifer that supplies water to many surrounding counties and communities. There is no known contamination of the ground water but it is still a concern for the future.

The Whitewater River Watershed has many streams that are on the draft 2016 List of Impaired Waters. E. coli is the largest impairment of the watershed with 205 stream miles listed. There are 70 stream miles listed for dissolved oxygen and 31 stream miles for biological communities on the 2016 List of Impaired Waters. The water monitoring data also revealed 51% (27/53) of the sites exceeded the targets for E. coli and turbidity, 64% (34/53) exceeded the target for nitrogen, and 72% (38/53) of sites exceeded the target for total phosphorus. Based on the soils, 95% of the watershed has very limited septic capabilities. There are 19 permitted facilities throughout the watershed. According to compliance reports with EPA, none of them have any serious compliance issues currently. There are also 4 CFOs in the watersheds with no known issues.

The windshield survey revealed a total of 404 areas of interest. Of these areas, 9.9% (40 areas) were identified as severe and 3% (16 areas) were identified as exceptional. Some of the most common concerns documented were; streambank erosion - 86 areas, sheet & rill erosion – 16 areas, gully erosion – 68 areas, overgrazed pastures – 68 areas, heavy use areas in pastures – 21 areas, animal access to streams – 49 areas, animal access to woods – 16 areas, heavy tillage – 23 areas, no buffers – 14 areas, inlet loading – 5 areas, and dumping sites – 10 areas. Almost all of the areas documented are a type of erosion or can lead to erosion. The 49 areas with animal access to streams leads to a direct source of E. coli. In figures 130 and 131 below, see a summary of the data that highlights the windshield data, 2016 list of impaired streams, NPDES facilities, and CFOs for the Whitewater River Watershed.

Figure 130: Watershed Inventory Summary Map

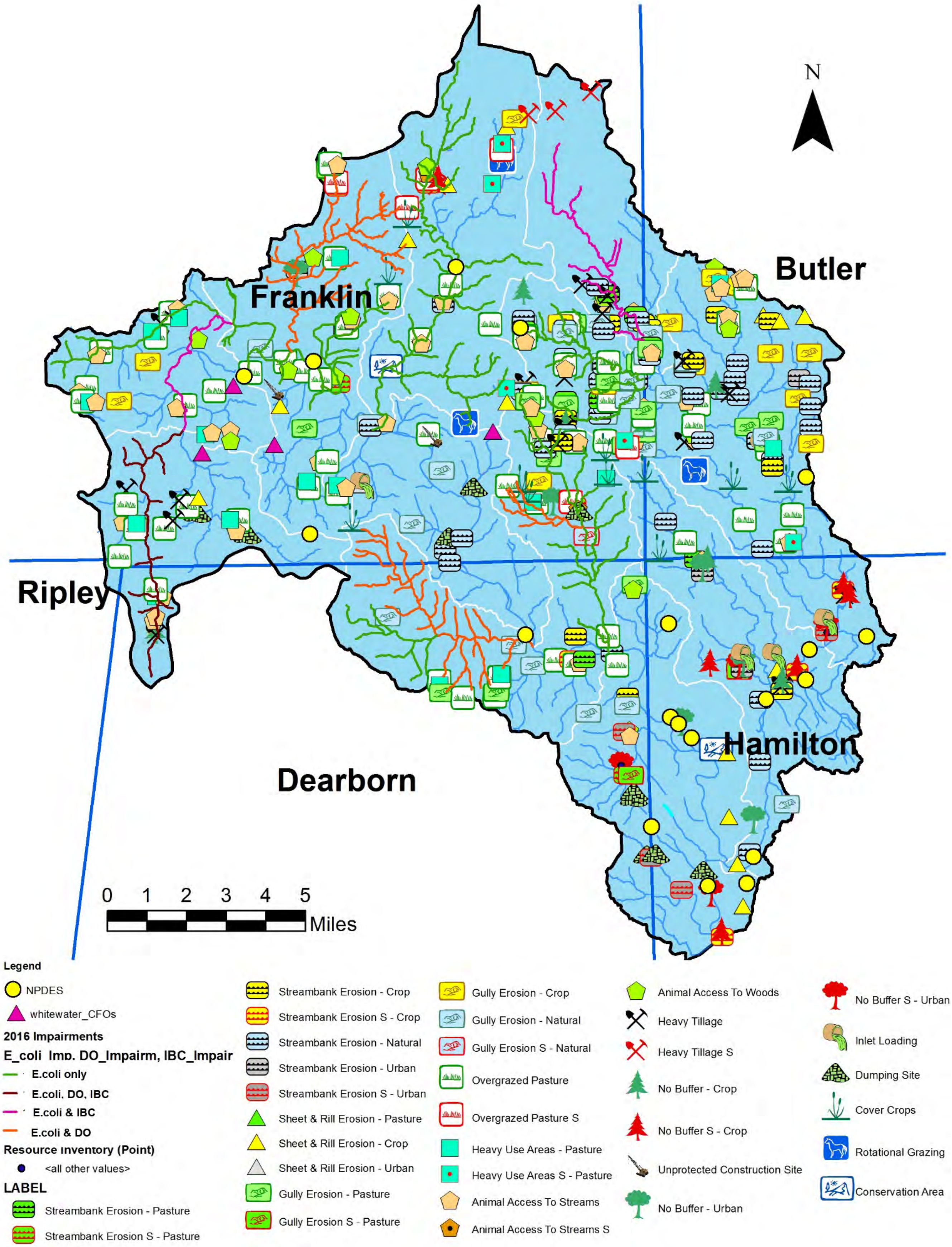


Figure 131: Subwatershed Summary Data

Subwatershed	Landuse (%)				IDEM 303(d)List (stream miles)				Parameters of Concern						Primary Resource Concerns (Windshield Survey)
	Agriculture	Pasture	Forest	Developed	E. coli, DO, IBC	E. coli, IBC	E. coli, DO	E. coli only	E. coli	Sediment	Phosphorus	Nitrogen	DO	Biology	
Blue Creek (-01)	31	14	50		12.5				*	*	*		*	*	Overgrazed Pasture Animal Access To Streams Heavy Tillage
Wolf Creek (-02)	17	16	63			5.1		6.8	*	*		*	*	*	Animal Access To Streams Overgrazed Pasture Heavy Use Areas
Big Cedar Creek (-03)	50	11	17					40.1	*	*		*	*		Overgrazed Pasture Animal Access To Streams Heavy Use Areas Sheet & Rill Erosion - Crop
Little Cedar Creek (-04)	27	19	45				24.9	20.5	*	*	*	*	*		Overgrazed Pasture Animal Access To Streams Animal Access To Woods
Blackburn Creek (-05)	11	19	61									*			Gully Erosion – Natural Overgrazed Pasture Dumping Sites
Johnson Fork (-06)	8	29	55				32.4	30.1	*	*			*	*	Overgrazed Pasture Gully Erosion – Pasture Animal Access To Streams Heavy Use Areas
Headwaters Dry Fork (-07)	66	18	12			13.8			*	*		*	*	*	Streambank Erosion – Natural Gully Erosion – Natural Animal Access To Streams
Howard Creek (-08)	33	50	17					15.9	*	*	*	*	*		Streambank Erosion – Natural Overgrazed Pasture Animal Access To Streams
Lee Creek (-09)	18	24	53	5						*	*	*	*		Streambank Erosion – Natural No Buffer – Crop No Buffer – Urban
Jameson Creek (-10)	19	13	52	16							*	*	*	*	Dumping Site Streambank Erosion – Urban No Buffer – Urban Sheet & Rill Erosion – Crop

2.4 Analysis of Stakeholder Concerns

In order to best understand how the residents of the watershed view their watershed, a stakeholder concern survey was handed out at many project events, fairs, and meetings. Each stakeholder was asked to check a box if they felt the particular concern listed was a problem in the Whitewater River Watershed. The list of concerns they were to choose from was formulated from input via larger and longer surveys that the steering committee filled out. There were no limits on how many or how few boxes each survey recipient could check. For a complete list of results from the survey see Figure 3. Of the 41 surveys completed there were 5 categories that at least 30% of stakeholder viewed as a concern:

- E. coli within the streams – 63.4%
- Pollution from failing septic systems – 75.6%
- Fencing off livestock from sensitive areas – 73.2%
- Overgrazing Pastures – 58.5%
- Trash/Litter in Streams – 70.7%

In deciding how to move forward in improving the quality of the watershed each concern must be analyzed. Figure 132 details each concern, the evidence for each concern, whether the concerns are supported by data, if the concern is quantifiable, if the concern is in the project's scope, and which concerns the project will be focusing on.

- Separating concerns into tiers (1-3) based upon priority
    - Tier 3 = education components, outreach
    - Tier 2 = limited cost share, programs, partnering
    - Tier 1 = cost share, programs, partnering, etc.

The Whitewater River Watershed Project Steering Committee also grouped the concerns from the stakeholder concern survey into groups based upon similarity. In figure 132 below groups are assigned a particular color. Concerns that were not assigned a group were also not identified as a priority or a focus for this project.

- Group 1: Cropland and Erosion Management – green
- Group 2: Livestock and Pasture Management – blue
- Group 3: Septic System Failures and Sewage Management – yellow
- Group 4: Stream Bank and Riparian Management – red
- Group 5: Pollution of Water – purple
- Group 6: Invasive Species Management – orange
- No Group: - grey

Figure 132: Analysis of Stakeholder Concerns

Concern	Concern Supported by Data?	Evidence for Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
Excessive gully erosion in cropland and pastures	Yes	68 areas on windshield survey Aerial photos / GIS	Yes	Yes	Tier 2
Too much conventional tillage of cropland	Yes	23 areas on windshield survey % of fields on	Yes	Yes	Tier 2

Concern	Concern Supported by Data?	Evidence for Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
		tillage transect – 70% conventional for corn (Franklin Co.)			
Need for soils education involving, compaction, cover crops and nitrogen fixation issues.	Yes	Lack of use of cover crops (Cover Crop transect data)	No	Yes	Tier 3
Need for more cover crops on cropland	Yes	Cover crop transect data 29 areas on windshield survey # of HEL fields	Yes	Yes	Tier 1
Sedimentation from erosion caused by overgrazing	Yes	68 areas on windshield survey	Yes	Yes	Tier 1
Livestock with direct access to streams	Yes	49 areas on windshield survey	Yes	Yes	Tier 1
Fencing of livestock from sensitive areas	Yes	65 areas on windshield survey	yes	Yes	Tier 1
Overgrazing Pastures	Yes	68 areas on windshield survey	yes	Yes	Tier 1
E. coli within the streams	Yes	Project Data: 27 sites exceed state limit for 5 week Geometric Mean (125cfu/mL).	Yes	Yes	Tier 1

Concern	Concern Supported by Data?	Evidence for Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
		Streams listed on the 303d list for E.coli (205 miles)			
Pollution from failing septic systems	Yes	OKI hotspots County Health Department Data – Complaints, replacement permits, and known violations	Yes	Yes	Tier 2
Stream bank erosion	Yes	86 areas on windshield survey Photos/GIS IDEM QHEI	Yes	Yes	Tier 2
Lack of Riparian Buffers along Streams	Yes	Aerial photos measurements 24 areas on windshield survey	Yes	Yes	Tier 1
Drinking Water Contamination	No	# of wells Aquifer service area (if applicable)	Conditional – may be a serious concern in the future	Yes	Tier 3
Pollution and Volume from Urban Runoff	No	% of impervious coverage Conductivity	Yes	Yes	Tier 3
Trash/ Litter in streams	Yes	10 areas on windshield survey Bags picked up at cleanups, Anecdotal	Yes	Yes	Tier 2

Concern	Concern Supported by Data?	Evidence for Concern	Concern Quantifiable?	Concern Part of Project Scope?	Focusing on Concern?
		Evidence			
Invasive species in watershed	No	Anecdotal evidence Infrared honeysuckle survey Notices of nuisance plants/species	No	Yes	Tier 3
Low quality plants in pastures	No	No points found on windshield survey	Yes	No	No
Drift from Chemical Application	No	Possible complaints to state chemist	No	No	No
Need for education on wildlife	No	None found	No	No	No
Overpopulation of Wildlife in the watershed	No	None found	Yes	No	No
Unchecked Development	No	SWCD Rule 5 Information	No	No	No

Identifying Problems and Causes

3.1 Identifying Local Concerns and Problems

Several water quality problems have been identified within the Whitewater River Watershed through various sources. Concerns were brought up and discovered during the initial stages of the project, during sampling, via surveys, and at workshops and events. These concerns often reflect problems identified through water monitoring and windshield surveys. This section tries to connect the concerns with their associated problems and identify potential causes to those problems. Problems that are identified through these various methods will be the basis for management and planning to address the causes of each problem.

The steering committee identified specific problems relating to each concern on which the group wished to focus (See

Figure 132 Analysis of Stakeholder Concerns). Figure 133 links stakeholder concerns to specific water quality problems and generalized water quality problem categories. By further discussing the problems associated with each concern that the steering committee decided to focus on, a better grasp of direction for the project can be obtained.

Figure 133: Stakeholder Concerns and Related Problems

Concerns	Specific Problems	Problem Category
Excessive gully erosion in cropland and pastures	Erosion can increase suspended sediment and degrade stream habitat. Eroded cropland and pastureland (without any natural buffer) can also cause high nutrient levels and E. coli to enter the watershed	• Sedimentation • Degraded Habitat • High Nutrient Levels • High E. coli Levels
Too much conventional tillage of cropland	Conventional tillage practices strip the ground of natural water quality filters and increase the potential for erosion. Excessive erosion of cropland can suspend solids and nutrients.	• Sedimentation • High Nutrient Levels • Degraded Habitat
Stream bank erosion	Excessive stream bank erosion degrades habitat for wildlife by causing excessive sedimentation and high nutrient levels.	• Sedimentation • High Nutrient Levels • Degraded Habitat
Need for soils education involving, compaction, fertilizer, cover crops and nitrogen fixation issues.	Poorly managed soils can cause increased levels of nutrients, poor filtration of rainwater, and increased levels of E. coli (compaction of septic soils). In addition, conventionally tilled cropland can cause increased sedimentation.	• High Nutrient Levels • High E. coli Levels • Sedimentation
Sedimentation from erosion caused by overgrazing	Runoff from poorly managed pastureland can cause increased E. coli and nutrient levels in streams. Erosion causes increased sedimentation which degrades the streams habitat.	• High E. coli Levels • High Nutrient Levels • Sedimentation • Degraded Habitat
Livestock with direct access to streams	Erosion from trampled banks increases suspended sediments; degraded stream habitat; nutrient and *E. coli* inputs;	• High Nutrient Levels • High E. coli Levels • Sedimentation • Degraded Habitat
E. coli within the streams	Too high E. coli levels make public streams unsafe for recreation.	• High E. coli Levels
Pollution from failing septic systems	Failing septic systems increase the amount of E. coli and nutrients in streams and degrade habitat.	• High E. coli Levels • High Nutrient Levels

Concerns	Specific Problems	Problem Category
Drinking water contamination	Drinking water that is contaminated from pollutants poses a danger to human health. Excessive nutrients and high E. coli levels can all cause adverse health effects in the population.	• High E. coli Levels • High Nutrient Levels
Pollution and Volume from Urban Runoff	Pollution from urban sources can increase nutrient and E. coli levels in the watershed from sources like lawn fertilizers and pet waste. Runoff volume from urban sources can increase streambank erosion.	• High E. coli Levels • High Nutrient Levels • Sedimentation • Degraded Habitat
Invasive species in the watershed	Invasive species can decrease the quality of that habitat in areas. They also out-compete the native species in the area causing a decrease in biodiversity.	• Degraded Habitat • Decrease in Biodiversity
Need for more cover crops on cropland	Cover crops provide a natural filtration system and erosion control. Without them, higher levels of E. coli, nutrients, and sediment can enter the waterbodies.	• Sedimentation • High E. coli Levels • High Nutrient Levels • Degraded Habitat
Lack of Riparian Buffers along Streams	Buffer areas provide a natural filter for water before entering the stream. Without them stream can have higher nutrient levels, higher E. coli level, and overall degraded habitat. Buffers also help bank stabilization.	• High E. coli Levels • High Nutrient Levels • Degraded Habitat • Sedimentation
Fencing of livestock from sensitive areas	When livestock have access to sensitive areas they can increase E. coli, sediment, and nutrient levels.	• Sedimentation • High E. coli Levels • High Nutrient Levels • Degraded Habitat
Overgrazing Pastures	Pastures that have been overgrazed increase the potential for higher nutrient level and high E. coli level nearby. There is also a potential for more erosion and more sedimentation.	• Sedimentation • High Nutrient Levels • High E. coli Levels • Degraded Habitat
Trash/ Litter in streams	Trash may contain hazardous materials; reinforces public perception that trash in natural areas is acceptable	• Trash • Degraded Habitat • Decrease in Biodiversity

3.2 Identifying Potential Stressors

Potential stressors for each problem category were also identified. A stressor is an event, agent, or series of actions that produce a problem. For the purpose of watershed management planning, identifying stressors and causes of water quality problems give direction to the project for the future and help manage that watershed most effectively. Figure 134 looks at those problem categories and associates some potential stressors.

Figure 134: Problem Categories and Potential Stressors

Problem Categories	Potential Stressors	Background Information
Trash	Peoples learned behavior and lack of knowledge of the pollution consequence to the environment	• Dumping sites - 9 pts (HUC _10, _05, _01)
High E. coli levels	E. coli levels exceed water quality standards	• 51% of testing sites (27/53) exceeded the geometric mean target (<125 cfu/mL) • Readings after rain events high in all sub watersheds (as high as 10,100 in HUC_07) • 205 miles impaired on 2016 List of Impaired Waters for E. coli
Sedimentation	Sedimentation	• 51% of the testing sites (27/53) exceeded the target for turbidity (<10.4 NTU) (_08, _09, _10) • TMDL – TSS reductions needed in 4 subwatersheds
High Nutrient Levels	Nutrient levels exceed water quality targets; Insufficient public understanding of nutrient sources	• Average Nitrogen exceeds project target (1.0 mg/L) at 64% (34/53) of testing sites (HUCs 03, _04, _05, _07, _09, _08, _10) • Average Total Phosphorus exceeds project target (0.06 mg/L) at 72% (38/53) of testing sites (_08, _09, _10)
Degraded Habitat	Sedimentation; Lack of Riparian Vegetation; High Volume of Urban Runoff	• 8 sites with values below QHEI/CQHEI targets • No buffers - 24 pts (9 severe) (HUCs 09 _08, & _10) • 40.5 stream miles with inadequate buffers (_01, _03, _07, _08) • 8% developed landuse (HUCs_09 & _10)
Decrease in Biodiversity	Sedimentation; Lack of Riparian Buffer; High nutrient levels that upset natural balance	• 31 stream miles impaired for biotic communities (_01, _02, & _07) • Average Nitrogen exceeds project target (1.0 mg/L) at 64% (34/53) of testing sites (_03, _04,

Problem Categories	Potential Stressors	Background Information
	of ecosystem	_05, _07, _09, _08, _10) • Average Total Phosphorus exceeds project target (0.06 mg/L) at 72% (38/53) of testing sites (_08, _09, _10) • 51% of the testing sites (27/53) exceeded the target for turbidity (<10.4 NTU) (_08, _09, _10) • 40.5 stream miles with inadequate buffers (_01, _03, _07, _08) • TMDL – TSS reductions needed in 4 subwatersheds

3.3 Identifying Sources

The steering committee linked identified water quality problems categories and stressors for those problems to sources based on windshield survey data and other observations made in the watershed (Figure 135). Sources can be the result of any nonpoint source pollution.

Figure 135: Potential Pollutant Sources per Problem Category

Problem Categories	Potential Stressors	Potential Sources	Magnitude
Trash	Peoples learned behavior and lack of knowledge of the pollution consequence to the environment	Peoples learned behavior and lack of knowledge of the pollution consequence to the environment	• Illegal dumping of materials into ditches, streams, and sinkholes (all sub watersheds) • Dumping sites - 9 pts (HUC _10, _05, _01)
High E. coli levels	E. coli levels exceed water quality standards	Inadequate or improper septic system designs & maintenance	• Failing Septic systems (Anecdotal Evidence – all sub watersheds) • OKI identified septic hotspots (Johnson Fork sub watershed) • 95% of watershed has very limited soils for septic systems • Local Health Departments estimate failure rates at 50%
		Inadequate buffers	• No buffers - 24 pts (9 severe) (_09 _08, & _10)

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			• 40.5 stream miles with inadequate buffers (_01, _03, _07, _08)
		Livestock with access to streams and sensitive areas	• Livestock access to sensitive areas - 65 pts (2 severe) (_08, _02, _04, & _01)
		Improper manure management	• No current data available but the potential problem does exist with the amount of livestock present
Sedimentation	Sedimentation	Erosion	• 282 pts with erosion identified from the windshield survey Streambank – 86 pts (14 severe) (_08, _07, _06, _09) Sheet & Rill – 16 pts (_03, _08, _10) Gully Erosion – 68 pts (2 severe) (_08, _06) Overgrazed Pasture – 68 pts (6 severe) (_08, _06, _04) Heavy Use Areas – 21 pts (3 severe) (_06, _02) Heavy Tillage – 23 pts (4 severe) (_07,_08, _06, _01) • 49% of watershed area is considered highly erodible land
		Lack of knowledge/ Lack of planning for cropland	• Lack of cover on fields (cover crops/ residue) Tillage (Conventional & Mulch Franklin Co – 89% of corn 39% of soybeans Dearborn Co – 62% of corn 31% of soybeans Butler & Hamilton – 50% of cropland • Heavy Tillage - 23 pts (4 severe) (_07,_08, _06, _01) • No Buffers – 24 pts (9 severe) (_09, _08, _10) • 40.5 stream miles with inadequate buffers (_01, _03, _07, _08)

<table>
<tr><th>Problem Categories</th><th>Potential Stressors</th><th>Potential Sources</th><th>Magnitude</th></tr>
<tr><td rowspan="4">High Nutrient Levels</td><td rowspan="4">Nutrient levels exceed water quality targets

Insufficient public understanding of nutrient sources

Disregard for consequences of excess fertilizer use</td><td>Inadequate or improper septic system designs & maintenance</td><td>• Failing Septic systems (Anecdotal Evidence – all sub watersheds)
• OKI identified septic hotspots (Johnson Fork sub watershed)
• 95% of watershed has very limited soils for septic systems
• Local Health Departments estimate septic system failure rates at 50%</td></tr>
<tr><td>Fertilizer Use

Improper manure management</td><td>• Cropland – (fertilizer use) makes up 29% of the watershed (46,922 acres)
• 8% of watershed is developed - Excessive fertilizer use is a potential problem but no current data is available (_09 & _10)
• No current data available but the potential problem does exist with the amount of livestock present</td></tr>
<tr><td>Livestock with access to streams and sensitive areas</td><td>• Livestock access to sensitive areas - 65 pts (2 severe) (_08, _02, _04, & _01)</td></tr>
<tr><td>Erosion</td><td>• 282 pts with erosion identified from the windshield survey
Streambank – 86 pts (14 severe) (_08, _07, _06, _09)
Sheet & Rill – 16 pts (_03, _08, _10)
Gully Erosion – 68 pts (2 severe) (_08, _06)
Overgrazed Pasture – 68 pts (6 severe) (_08, _06, _04)
Heavy Use Areas – 21 pts (3 severe) (_06, _02)
Heavy Tillage – 23 pts (4 severe) (_07,_08, _06, _01)</td></tr>
<tr><td>Degraded Habitat</td><td>Sedimentation</td><td>Erosion</td><td>• 282 pts with erosion identified from the windshield survey
Streambank – 86 pts (14 severe) (_08, _07, _06, _09)
Sheet & Rill – 16 pts (_03, _08, _10)
Gully Erosion – 68 pts (2 severe) (_08, _06)
Overgrazed Pasture – 68 pts (6 severe) (_08, _06, _04)
Heavy Use Areas – 21 pts (3 severe)</td></tr>
</table>

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			(_06, _02) Heavy Tillage – 23 pts (4 severe) (_07,_08, _06, _01)
	Lack of Riparian Vegetation	Lack of Riparian Vegetation;	• No buffers - 24 pts (9 severe) (_09 _08, & _10) • 40.5 stream miles with inadequate buffers (_01, _03, _07, _08)
	High Volume of Runoff	Runoff from urban areas	• 8% developed landuse (_09 & _10)
Decrease in Biodiversity	Sedimentation	Erosion	• 282 pts with erosion identified from the windshield survey Streambank – 86 pts (14 severe) (_08, _07, _06, _09) Sheet & Rill – 16 pts (_03, _08, _10) Gully Erosion – 68 pts (2 severe) (_08, _06) Overgrazed Pasture – 68 pts (6 severe) (_08, _06, _04) Heavy Use Areas – 21 pts (3 severe) (_06, _02) Heavy Tillage – 23 pts (4 severe) (_07,_08, _06, _01)
	Lack of Riparian Vegetation	Lack of Riparian Vegetation;	• No buffers - 24 pts (9 severe) (_09 _08, & _10) • 40.5 stream miles with inadequate buffers (_01, _03, _07, _08)
	High nutrient levels that upset natural balance of ecosystem	Inadequate or improper septic system designs & maintenance	• Failing Septic systems (Anecdotal Evidence – all sub watersheds) • OKI identified septic hotspots (Johnson Fork sub watershed) • 95% of watershed has very limited soils for septic systems • Local Health Departments estimate septic system failure rates at 50%
		Fertilizer Use Improper manure management	• Cropland – (fertilizer use) makes up 29% of the watershed (46,922 acres) • 8% of watershed is developed - Excessive fertilizer use is a potential problem but no current data is available (_09 & _10) • No current data available but the potential

Problem Categories	Potential Stressors	Potential Sources	Magnitude
			problem does exist with the amount of livestock present
		Livestock with access to streams and sensitive areas	• Livestock access to sensitive areas - 65 pts (2 severe) (_08, _02, _04, & _01)

3.4 Calculating Loads

Estimating the total amount of a contaminant in a watershed is a challenging task. However, load estimation is very useful for any watershed plan to determine how much reduction in pollutants is needed to achieve water quality standards or targets. In addition, quantifiable goals and objectives give projects a way of measuring improvement and success. Load is defined as the amount of a pollutant (usually in pounds, kilograms, or tons) that passes through a point on a stream or river in a certain amount of time (often in one day or one year). In order to estimate load on a particular day (instantaneous load), two things are needed:

- Concentration of the pollutant, usually in units of mass per volume (often mg/liter or parts per million)
- Flow rate, or the amount of water that flows during a certain amount of time. This flow rate is in units of volume per time (for example, cubic feet per second.)

There are models available to help estimate load reduction amounts. The project used a web-based version of the USGS LOADEST model to estimate sediment and nutrient loads in the watershed. The model is based on the assumption that concentration varies with flow and uses regression equations to estimate loads for a specified time period. Stream flow data from the USGS gage at Brookville and project water quality data from Site T31 (the site closest to the watershed outlet) were used to calculate annual loads for nutrients and sediment (Figures 136-138). E. coli reductions required for the Indiana portion of the project were obtained from the Southern Whitewater TMDL and the same methods were used to determine the reductions needed for the Ohio portion of the project (Figure 139).

3.5 Load Reduction Estimates

The Whitewater River Watershed has an estimated current load of nitrate-nitrite of 2,206,726 lbs. per year. In order to meet the watershed's nitrate-nitrite target of 1.0 mg/L, the watershed needs to reduce it nitrate-nitrite load by 1,471,151 lbs. per year which is a 66% reduction.

Figure 136: Load Reduction Required to Meet Nitrate-Nitrite Goal

T31 - Nitrate-Nitrite (target - 1.0 mg/L)	Total	Per acre	**Whitewater WMP Area** Total (lb/yr)
Estimated Annual Load :	**12,245,020** lb/yr	**13.8** lb/ac/yr	**2,206,726**
Maximum Annual Load to Meet Target :	**4,083,668** lb/yr	**4.6** lb/ac/yr	**735,575**
Load Reduction Needed to Meet Target :	**8,161,351** lb/yr	**9.2** lb/ac/yr	**1,471,151**

The Whitewater River Watershed has an estimated current load of total phosphorus of 95,945 lbs. per year. In order to meet the watershed's total phosphorus target of 0.06 mg/L, the watershed needs to reduce it total phosphorus load by 47,972 lbs. per year which is a 50% reduction.

Figure 137: Load Reduction Required to Meet Total Phosphorus Goal

T31 - Total Phosphorus (target - 0.06 mg/L)	Total	Per acre	**Whitewater WMP Area** Total (lb/yr)
Estimated Annual Load :	**493,480** lb/yr	**0.6** lb/ac/yr	**95,945**
Maximum Annual Load to Meet Target :	**245,020** lb/yr	**0.3** lb/ac/yr	**47,972**
Load Reduction Needed to Meet Target :	**248,459** lb/yr	**0.3** lb/ac/yr	**47,972**

The Whitewater River Watershed has an estimated current load of total suspended solids (TSS) of 22,643 lbs. per year. In order to meet the watershed's TSS target of 25 mg/L, the watershed needs to reduce it TSS load by 13,472 lbs. per year which is a 75% reduction.

Figure 138: Load Reduction Required to Meet Total Suspended Solids (TSS) Goal

T31 - TSS (target - 25 mg/L)	Total	Per acre	**Whitewater WMP Area** Total (lb/yr)	**Whitewater WMP Area** Total (tons/yr)
Estimated Annual Load :	**252,116,450** lb/yr	**283.2** lb/ac/yr	45,285,861	**22,643**
Maximum Annual Load to Meet Target :	**102,091,718** lb/yr	**114.7** lb/ac/yr	18,341,413	**9,171**
Load Reduction Needed to Meet Target :	**150,024,731** lb/yr	**168.5** lb/ac/yr	26,944,447	**13,472**

Figure 139 provides a summary of E. coli data in the Whitewater River subwatersheds to show which are impaired due to pathogens. It shows the total of number of samples taken and the % of time that target value was exceeded. The percent reductions are based on both the maximum reported E. coli value and the geomean value for each site.

Figure 139: Percent Reduction Required to Meet E. coli Goal

Subwatershed	Site #	Total # of Samples	% of Samples Violating Target	Maximum CFU/100mL	% Reduction Based on Max. Value	Geomean CFU/100mL	% Reduction Based on Geomean
Headwaters of Blue Creek	24	10	20%	1,732.9	86%	93.64	0%
	P2	5	80%	2,419.6	90%	366.17	66%
Wolf Creek	21	10	20%	1,119.9	79%	255.39	51%
	22	10	30%	2,419.6	90%	418.71	70%
	23	10	30%	2,419.6	90%	253.44	51%
Big Cedar Creek	26	8	38%	488.4	52%	243.48	49%
	27	9	44%	1,732.9	86%	140.74	11%
Little Cedar Creek	25	10	10%	290.9	19%	91.73	0%
	P7	5	40%	4,907	95%	227.04	45%
Blackburn Creek	29	10	0%	157.6	0%	74.83	0%
Johnson Fork	28	10	30%	920.8	74%	125.35	0%
	30	10	30%	1,299.7	82%	187.04	33%
	P8	5	40%	2,419.6	90%	200.4	38%
	P11	5	40%	770.1	69%	159.99	22%
Headwaters of Dry Fork	33	10	80%	1,553.1	85%	559.85	78%
	OH1	7	57%	10,100	98%	1,629.13	92%
Howard Creek	32	10	70%	1,732.9	86%	478.15	74%
Lee Creek	OH2	7	29%	991	76%	255.43	39%
	OH3	7	0%	173	0%	60.71	0%
Jameson Creek	31	10	0%	113.7	0%	68.52	0%
	OH4	7	14%	436	46%	119.71	0%

Setting Goals and Identifying Critical Areas

4.1 Goal Statements

Goals were developed to address the problems and concerns discussed above and improve water quality and health in Whitewater River Watershed. Generally, the goals should address one of the major problem categories discussed above: trash, high E. coli levels, sedimentation, high nutrient levels, degraded habitat, and decrease in biodiversity.

Some of the primary goals address more than one problem category. For example, reducing nutrient loads will also create potential for increased aquatic biodiversity by making habitat more suitable for sensitive species. The six goals selected are not listed in any particular order and does not indicate a level of importance.

Goal #1: Reduce soil erosion and sedimentation so current water quality conditions are protected or improved by the year 2030. The current sediment load is 37,941 tons of sediment per year and the maximum annual load to meet the target of 25 mg/L TSS is 9,171 tons of sediment. 28,770 tons need to be reduced to meet the target parameter.

- Decrease the tons of sediment load per year in the watershed by 15% in 3 years - 5,700 Tons
- Decrease 30% (tons of sediment per year) in 6 years – 11,400 Tons
- Decrease 45% (tons of sediment per year) in 9 years – 17,100 Tons
- Decrease 60% (tons of sediment per year) in 12 years – 22,800 Tons
- Decrease 75%+ (tons of sediment per year) in 15 years – 28,500+ Tons

Goal #2: Nutrients need to be reduced within the watershed. Currently 64% of our testing sites exceed the target for nitrogen and 72% of our testing sites exceed the target for phosphorus. The current annual load for nitrogen is 2,206,726 lbs/year and the current load for phosphorus is 95,945 lbs/year. The load reduction needed to meet the target levels for nitrogen and phosphorus are 1,471,151 pounds nitrogen and 47,972 pounds of phosphorus. We would like to see the following decreases:

- Decrease the lbs. of nitrogen load per year in the watershed by 2% in 3 years – 44,135 lbs.
- Decrease 4% (lbs. of nitrogen per year) in 6 years – 88,269 lbs.
- Decrease 6% (lbs. of nitrogen per year) in 9 years – 132,404 lbs.
- Decrease 8% (lbs. of nitrogen per year) in 12 years – 176,538 lbs.
- Decrease 10% (lbs. of nitrogen per year) in 15 years – 220,673 lbs.

- Decrease the lbs. of phosphorus load per year in the watershed by 10% in 3 years – 9,595 lbs.
- Decrease 20% (lbs. of phosphorus per year) in 6 years – 19,189 lbs.
- Decrease 30% (lbs. of phosphorus per year) in 9 years – 28,784 lbs.
- Decrease 40% (lbs. of phosphorus per year) in 12 years – 38,378 lbs.
- Decrease 50% (lbs. of phosphorus per year) in 15 years – 47,973 lbs.

Goal #3: - The overall goal is to reduce E. coli concentrations throughout the watershed not only to meet water quality standards but to have the impaired streams segments (205 miles) delisted. A total of 51% (27/53) of samples tested for E. coli exceeded the geometric mean of 125 CFU/100 mL water quality standard. E. coli reductions needed based on geometric mean range from 0 to 92% and reductions needed based on maximum value range 0 to 98%.

- Decrease reductions needed to 80% or less in 5 years
- Decrease reductions needed to 65% or less in 10 years
- Decrease reductions needed to 50% or less in 15 years

Goal #4: Increase public awareness and provide education on how individual choices and activities impact the watershed

- Create a "Friends of the Whitewater River Watershed" group and start annual festival/event within five years
- Create an educational program and material to deliver to groups regarding the value and importance of the watershed work with local municipalities to draft BMP guidelines for sustainable growth, increase educational signage in 10 years (local governments)
- Development of more public access points on public lands to the river and construction of necessary facilities (i.e restrooms and educational/nature center etc) to improve the enjoyment and use the Whitewater River in 15 years
- Conduct a baseline survey of the community's knowledge and views of the watershed

Goal #5- Aquatic organisms' diversity and populations have been declining and are impaired in some watersheds. Because of the rich biodiversity in the Whitewater, maintaining the high quality in some areas is crucial. We want to protect and enhance critical habitat and unique natural areas of the Whitewater River, its tributaries, and the entire watershed including threatened, endangered, and rare species. We would like to see:

- Increase in macroinvertebrate populations and diversity in the next 15 years (mIBI Scores >35),
- Delist the critical watersheds from the IDEM 303(d) list for impaired biotic communities
- DO levels meet State water quality standards with minimums above 4 mg/L within 15 years
- Work with the US Fish & Wildlife and local agencies to determine habitat areas to protect and those areas that need restoration in 5 years.
- Install practices to protect or restore the selected habitat areas in 10 years
- Continue habitat improvement/protection and monitor changes in population in response to improvements in 15 years
- Promote and educate community about fishing and other recreational uses in the watershed
- The group would evaluate all available sources of monitoring data from outside sources to establish progress of the Whitewater

Goal #6: Reduce litter and trash in the watershed. Litter and trash may contain hazardous materials that can cause adverse effects on water quality. Trash and litter reinforces public perception that trash in natural areas is acceptable. We would like to see:

- Decrease in roadside and stream bank litter achieved through cleanups and outreach efforts
- Increase signage that discourages public littering

The Steering Committee chose to set the goals within a 15 year period because things change so quickly. As a committee, nobody knows what the future holds or what new practices or technologies will come about. Not all of the goals that are set can be achievable in 15 years. The nitrogen goal to meet the target is definitely not feasible in 15 years. The committee decided to breakdown the goal to 10% reduction in nitrogen in 15 years, which is only 15% of the reduction needed to meet the target parameter, to make the goal more achievable. The sediment and phosphorus goals are more realistic to meet in the 15 year period but will still be challenging. The committee believes the plan and goals will need to be revisited and updated every 4 to 5 years, and these goals are a good starting point.

4.2 Indicators

Below you will find indicator tables for each type of goal that detail how the Whitewater River Watershed project will achieve the goals selected. Goals are broken up into general topics on land use or by action type such as cropland, hay land, natural, and urban areas. Each objective also has an action plan, target audience, and time schedule.

4.2.1 Sedimentation

Goal #1: Reduce soil erosion and sedimentation so current water quality conditions are protected or improved by the year 2030. The current sediment load is 37,941 tons of sediment per year and the maximum annual load to meet the target of 25 mg/L TSS is 9,171 tons of sediment. 28,770 tons need to be reduced to meet the parameter target.

Figure 140: Sedimentation Goal Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Agricultural Cropland					
Plant cover crops on HEL fields	Education through field days/workshops Education through publications Provide financial assistance to plant cover crop	Agricultural landowners and operators	Watershed, SWCD, and Partner Staff	2015 - 2030	# of people attending workshops # of publications distributed # of acres planted Reduction of sediment
Increase the number of acres being no-tilled	Education through workshops and field days Education through publications Provide financial assistance to landowners who convert from tillage to no-till	Agricultural landowners and operators	Watershed, SWCD, and Partner Staff	2015 - 2030	# of people attending workshops # of publications distributed # of acres converted Reduction of sediment
Establish buffers in sensitive areas	Provide financial assistance to landowners to establish grassed waterways Provide financial assistance to landowners to establish filter strips	Agricultural landowners and operators	Watershed, SWCD, and Partner Staff	2015 - 2030	# of landowners enrolled in cost-share programs for buffers # of feet of buffers installed Reduction of sediment
Pasture/Hayland					
Reduce acres of overgrazed pasture	Educate livestock owners on stocking density through publications and field days	Landowners with livestock	Watershed, SWCD, and Partner Staff	2015 - 2030	# of people attending field days

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
	Educate livestock owners on proper overwintering practices through field days and publications				# of publications distributed # of prescribed grazing plans implemented Reduction of sediment
	Provide financial assistance to implement prescribed grazing plans				
Reduce livestock access to sensitive areas along streams and woodlands	Education through publications	Landowners with livestock	Watershed, SWCD, and Partner Staff	2015 - 2030	# of publications # of head removed from sensitive areas Reduction of sediment
	Provide financial assistance for fencing and watering systems				
Natural Areas					
Increase riparian buffers along streams	Education through workshops and publications	Landowners	Watershed, SWCD, and Partner Staff	2015 - 2030	# of landowners who attended workshops # acres and length of established buffers Reduction of sediment
	Provide financial assistance to establish riparian buffers				
Promote and provide education on smart growth	Distribute literature about benefits of smart growth	Developers, County Officials, and General Public	Watershed, SWCD, and Partner Staff	2015 - 2030	# of publications distributed
Urban					
Promote the use of urban best management practices	Educate urban landowners about best management practices that would help reduce runoff through publications and workshops	Urban Landowners	Watershed, SWCD, and Partner Staff	2015 - 2030	# of publications # of people who attend workshops USGS Flow – Volume of Runoff

4.2.2 Nutrients

Goal #2: Nutrients need to be reduced within the watershed. Currently 64% of our testing sites exceed the target for nitrogen and 72% of our testing sites exceed the target for phosphorus. The current annual load for nitrogen is 2,206,726 lbs./year and the current load for phosphorus is 95,945 lbs./year. The load reduction needed to meet the target levels for nitrogen and phosphorus are 1,471,151 pounds nitrogen and 47,972 pounds of phosphorus.

Figure 141: Nutrients Goal Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Cropland					
Educate landowners and operators on proper nutrient management and application	Education through publications and workshops Provide financial assistance to farmers for the development and implementation of nutrient management plans	Landowners and Operators	Watershed, SWCD, and Partner Staff	2015-2030	# of publications distributed # of people attending workshops # of nutrient management plans developed # of nutrient management plans implemented Reduction of nutrients
Promote the use of cover crops on all cropland acres	Education through publications and field days Provide financial assistance to plant cover crops	Landowners and Operators	Watershed, SWCD, and Partner Staff	2015-2030	# of publications distributed # of people attending workshops # of acres planted to cover crops Reduction of nutrients
Livestock					
Promote proper manure application	Education through publications and workshops Provide financial assistance to farmers for the development and implementation of nutrient management plans	Livestock Owners	Watershed, SWCD, and Partner Staff	2015-2030	# of publications distributed # of people attending workshops # of nutrient management plans developed # of nutrient management plans implemented Reduction of nutrients
Promote good pasture management by	Educate livestock owners on pasture management through	Livestock Owners	Watershed, SWCD, and Partner Staff	2015-2030	# of publications # of people attending field

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
maintaining adequate grazing heights	publications and field days				days # of cost-share participants implementing an improved pasture management plan Reduction in nutrients # of prescribed grazing plans implemented
	Provide financial assistance to implement improved pasture management systems				
Urban					
Promote proper nutrient management	Education through publications and workshops	General public	Watershed, SWCD, and Partner Staff	2015-2030	# of publications # of people attending workshops # of people in the watershed that pledge to do various activities on the Clear Choices, Clean Water website – covering fertilizer, septic maintenance, and several other items.

4.2.3 E. coli

Goal #3: - The overall goal is to reduce E. coli concentrations throughout the watershed not only to meet water quality standards but to have the impaired streams segments (205 miles) delisted. A total of 51% (27/53) of samples tested for E. coli exceeded the geometric mean of 125 CFU/100 mL water quality standard. E. coli reduction needed based on geometric mean ranges from 0 to 92% and reductions needed based on maximum value ranges 0 to 98%.

Figure 142: E. coli Goal Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Livestock					
Fence livestock away from streams and ponds	Educate livestock owners on the importance of access control through publications	Livestock Owners	Watershed, SWCD, and Partner Staff	2015-2030	# of publications # farmers willing to exclude livestock # of head excluded Reduction in E. Coli #/amount of exclusion fences
	Provide financial assistance for exclusion and alternative watering systems				

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
					installed
Promote good pasture management by maintaining adequate grazing heights	Educate livestock owners on pasture management through publications and field days Provide financial assistance to implement improved pasture management systems	Livestock Owners	Watershed, SWCD, and Partner Staff	2015-2030	# of publications # of people attending field days # of cost-share participants implementing an improved pasture management plan Reduction in E. Coli #/amount of improved pasture BMPs implemented
Septic System/Sewage					
Educate homeowners and renters about the importance of septic system maintenance and proper working conditions	Develop and distribute publications about septic system maintenance Hold Septic System workshops	Homeowners and Renters	Watershed, SWCD, and Partner Staff	Within 3 years	# of publications distributed # of people who attend workshops Reduction of E. Coli
Educate septic contractors and developers on appropriate sites feasible for septic system functionality	Hold workshops on proper site selection and installation	Contractors and Developers	Watershed, SWCD, and Partner Staff	Within 5 years	# of people attending workshops
Work with local sewer districts on extending service to problem areas with failing systems	Assist in identifying priority areas Provide data and support for funding	Local Sewer Districts and Public Officials	Watershed, SWCD, and Partner Staff	Within 10 years	# of priority areas identified # of failing systems hooked onto service Reduction of E. Coli

4.2.4 Education and Public Awareness

Goal #4: Increase public awareness on how individual choices and activities impact the watershed

Figure 143: Education and Public Awareness Goal Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Outreach					
Create a "Friends of the Whitewater River Watershed" group	Establish volunteer group	Landowners and General Public	Watershed, SWCD, and Partner Staff	Within 5 years	# of people in group
	Hold an annual event or develop publication to promote the watershed			2017-2030	# of people attending event
Educate community on the value and importance of the watershed	Hold educational events/workshops	General Public	Watershed, SWCD, and Partner Staff	2015-2030	# of people who attended events/workshops
	Develop publications highlighting watershed accomplishments			2015-2030	# of publications
	Promote sustainable growth			Within 5 years	# of programs and publications
	Install educational signage throughout the community			Within 10 years	# of signs
	Develop and distribute publications on best management practices			Within 5 years	# of publications
Improve the enjoyment and use the Whitewater River	Develop publication on public river access locations	General Public	Watershed, SWCD, and Partner Staff	Within 5 years	# of publications
	Development more public access points on the river			Within 10 years	# of access points
	Build educational stations along river			Within 15 years	# of stations
	Build restroom facilities along the river			Within 15 years	# of facilities

4.2.5 Biodiversity

Goal #5- Aquatic organisms' diversity and populations have been declining and are impaired in some watersheds. Because of the rich biodiversity in the Whitewater, maintaining the high quality in some areas is crucial. We want to protect and enhance critical habitat and unique natural areas of the Whitewater River, its tributaries, and the entire watershed including threatened, endangered, and rare species.

Figure 144: Biodiversity Goal Indicators

Objective	Action - Cost	Target Audience	Performed By	Time Schedule	Indicator
Critical Area Restorations					
Work with local agencies and partners to determine areas to protect and areas that need restoration	Assist in identifying areas	Local Agencies	Watershed, SWCD, and Partner Staff	5 years	# of areas identified
	Provide data and support for restoration				
	Provide financial assistance to restore critical areas			10 years	# of areas restored
Dissolved Oxygen & Macros					
Obtain DO levels of 4 mg/L or above and delist streams for impaired biotic communities	Provide financial assistance to install riparian buffers	Generals Public, Landowners, Public Officials, and Local Agencies	Watershed, SWCD, and Partner Staff	Within 15 years	# of stream segments that meet or is above 4 mg/L for DO # of stream segments delisted mIBI scores IBC delisting # of feet of riparian buffers installed Reduction of sediment and nutrients
	Provide financial assistance for bmps that reduce nutrient and sediment loading				
	Monitor changes in populations and habitat				

4.2.6 Trash and Litter

Goal #6: Reduce litter and trash in the watershed. Litter and trash may contain hazardous materials that can cause adverse effects on water quality. Trash and litter reinforces public perception that trash in natural areas is acceptable.

Figure 145: Trash and Litter Goal Indicators

Objective	Action	Target Audience	Performed By	Time Schedule	Indicator
Outreach & Awareness					
Reduction in roadside and stream bank litter achieved through cleanups and outreach efforts	Educate public how trash can be harmful to water quality through publications	General Public	Watershed, SWCD, and Partner Staff	2015-2030	# of publications distributed # of people attending clean-ups Amount of trash collected
	Hold biannual cleanups				
Increase signage that discourages public littering	Install signs near dumping sites and throughout the watershed to discourage littering and dumping	General Public	Watershed, SWCD, and Partner Staff	Within 5 years	# of signs installed Decrease number of dumping sites and litter

4.3 Identification of Critical Areas

One of the most crucial steps in watershed management planning is defining the critical areas in the project. For our purposes, a critical area is an area in the watershed which has the worst water quality, produces high pollutant loads, and where best management practices are needed the most.

There are a variety of ways to best meet the criteria of a critical area, and the Whitewater River Watershed project considered a variety of criteria and factors in determining which subwatershed would be defined as critical areas. Water monitoring data in the form of nutrient, dissolved oxygen, sediment, E. coli data, and biology was used to compare subwatersheds to one another. Biological data was compared in various subwatersheds to determine overall quality of aquatic life. Habitat data in the form of indexes and windshield surveys were considered. Data over land use types, current practices in the watershed, windshield survey data, and individual account and recommendations were all factored into the ranking process. The Whitewater River Steering Committee analyzed the overall data available for each subwatershed and the individual monitoring sites located in each subwatershed. After analyzing every component, the steering committee voted on what number to assign each category for each subwatershed.

For each category the subwatershed was assigned a 1 or a 2. In this case, a 1 indicated that the sub watershed had a relatively low impact on that parameter while a 2 indicated that the subwatershed had a high impact on that parameter. Since the parameters the committee is most concerned about are nitrate+nitrite, total phosphorus, DO, and E. coli those factors were double weighted (score multiplied by 2). If a subwatershed had E. coli levels that were consistently above targets (all sites exceeded) an additional 2 points was awarded.

Criteria for scoring

Nitrate+Nitrite, Total Phosphorus, E.coli, and Dissolved Oxygen – When the sampling sites in the subwatershed had averages above the project target and/or multiple results that exceeded the project target, the subwatershed received a score of 2. When sampling sites in the subwatershed had averages below the project target and no more than one result that exceeded the project target, the subwatershed received a score of 1.

Sediment – The subwatersheds with the highest percentage of erosion concerns identified in the windshield survey along with averages above the project target and multiple exceedances received a score of 2. Subwatersheds with less erosion concerns identified in windshield survey and/or averages below project target and/or few exceedances scored a 1.

Habitat – The subwatersheds with sampling sites with QHEI scores below the project targets scored a 2 and subwatersheds with sampling sites with QHEI scores above the project targets scored a 1.

Macroinvertebrates – The subwatersheds with sampling sites with mIBI scores below the project targets scored a 2 and subwatersheds with sampling sites with QHEI scores above the project targets scored a 1.

Urban Pollution - Subwatersheds with the highest percentages of urban landuse and highest amount of urban related concerns identified in the windshield survey received a score of 2. The other subwatersheds received a score of 1.

Agricultural Pollution – Subwatersheds with the highest percentages of agricultural landuse and highest amount of agriculture related concerns identified in the windshield survey received a score of 2. The other subwatersheds received a score of 1.

The scores for each subwatershed were then totaled in each category to calculate a total score. Those subwatersheds that showed elevated concentrations of multiple water quality concerns at multiple sample sites received the top scores in the table. Those subwatersheds that showed moderate concern received a middle range score. The subwatersheds with little to no concerns rank the lowest. As a result of the score, natural rankings and divides appeared. Those that ranked the highest were identified as high priority watersheds and should receive a higher priority when applying for BMP implementation. Those that ranked medium were identified as medium priority watersheds and should receive a lower priority when applying for BMP implementation. Those that ranked low were identified as no priority.

After examining the data, the committee chose to examine the two testing sites in the Headwaters of Blue Creek subwatershed. One testing site (site 24) is the "cleanest" and displays the best results of all of the testing sites in the watershed. However the other testing site P2 is one of the most impaired areas of the watershed. After comparing the land use around the testing site, the committee felt that it was best to divide the area of the Headwaters of Blue Creek subwatershed. The area to the east of Blue Creek (near site 24) would be labeled as no priority, while the area to the west of Blue Creek would be labeled as high priority.

For the purposes of visual depiction and communication, the sub watersheds with highest concern (weighted score) were assigned a "red" status/color, while those with 'moderate' concern were assigned a "green" status/color. All remaining sub watersheds with lesser or limited concerns are white. Figures 146 & 147 are the table and map of the watershed indicating the areas of high priority, medium priority, and no priority areas for implementation based off the above scoring techniques.

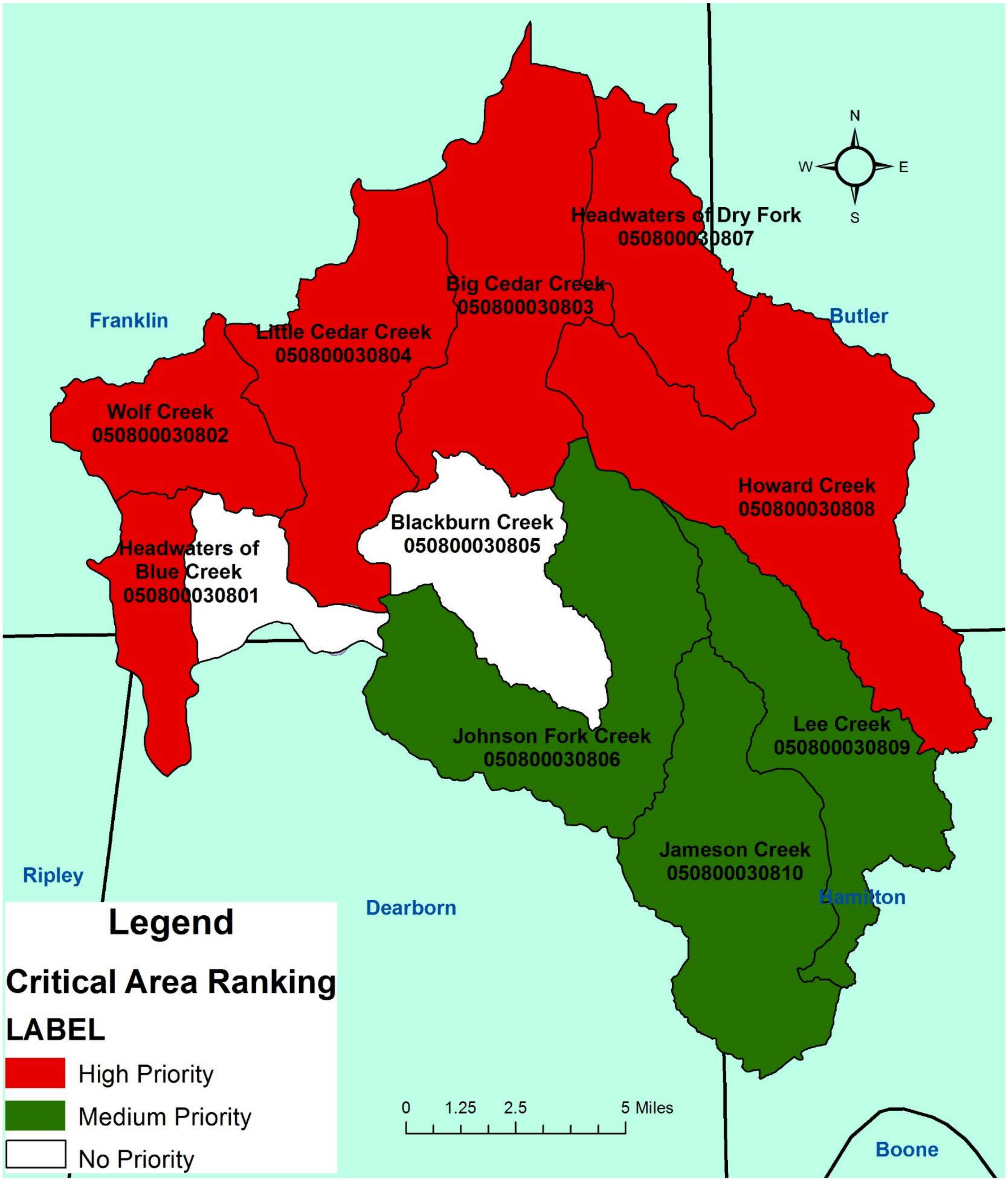
Figure 146: Critical Area Ranking Scores for the sub watersheds in the Whitewater River Watershed

Sub watershed	Nitrate+Nitrite*	Total P*	E. coli*	Sediment	Dissolved Oxygen*	Habitat	Macroinvertebrates	Urban Pollution	Agricultural Pollution	Score	Rank
Headwaters Blue Creek – West - 050800030801	2	4	4	2	4	2	2	1	2	23	**2**
Headwaters Blue Creek – East - 050800030801	2	2	2	1	2	1	1	1	1	13	**8**
Wolf Creek - 050800030802	4	2	6	1	4	1	1	1	2	22	**3**
Big Cedar Creek - 050800030803	4	4	6	1	2	1	1	2	2	23	**2**
Little Cedar Creek – 050800030804	4	4	4	2	2	1	1	1	2	21	**4**
Blackburn Creek – 050800030805	4	2	2	1	2	1	2	1	1	16	**7**
Johnson Fork – 050800030806	2	2	6	1	2	1	1	1	1	17	**6**
Headwaters Dry Fork - 050800030807	4	4	6	1	4	1	2	1	2	25	**1**
Howard Creek – 050800030808	4	4	4	2	2	1	1	1	2	21	**4**
Lee Creek – 050800030809	4	2	4	1	4	1	1	1	2	20	**5**
Jameson Creek – 050800030810	4	2	2	2	4	1	2	2	1	20	**5**

*Based on Monthly Water Quality Sampling data from October 2013 – October 2014, windshield data, Rivers Unlimited – Great Miami Watershed group (collected 2013-2014), and land use data

Score	Priority
21-25	High Priority
17-20	Medium Priority
13-16	No Priority

Figure 147: Location of Critical Areas in the Whitewater River Watershed



Applying Improvement Measures

In order to best improve water quality certain management strategies are put on the land and are referred to as Best Management Practices or BMPs.

BMPs are effective, practical, structural or nonstructural methods which prevent or reduce the movement of sediment, nutrients, bacteria, and other pollutants from the land to surface or ground water, or which otherwise protect water quality from potential adverse effects of various land use activities. These practices are developed to achieve a balance between water quality protection, conservation, and the land production within natural and economic limitations.

A thorough understanding of BMPs, their purpose and their application are of vital importance in selecting BMPs that will improve water quality the most in the Whitewater River Watershed Project. Each parcel of land is unique and faces its own challenge or challenges. Therefore, there may be more than one applicable BMP for meeting the challenges of that particular area. The right BMPs are ones that are practical and economical while maintaining both water quality and the productivity of the land.

5.1 Best Management Practices (BMP's)

In deciding which Best Management Practices (BMP's) to implement, the Whitewater River Watershed Steering Committee met to discuss which practices would improve water quality the most. Numerous BMPs were selected by the steering committee for implementation in the Whitewater River Watershed to address the main stakeholder concerns in the watershed. In addition to structural BMPs, the steering committee included multiple topics for educational outreach. Implementation of both of these practices should result in improved water quality and habits of stakeholders in the watershed. It is important to note that no single practice will address all issues; rather, it will be necessary to implement a combination of practices, or conservation system, to make lasting change in the Whitewater River Watershed.

5.1.1 Agricultural Management Practices

Agricultural best management practices are implemented on agricultural lands, typically row crop agricultural lands and pastures, in order to protect water resources and aquatic habitat while improving land resources and quality. These practices control nonpoint source pollutants reducing their loading to the Whitewater River Watershed by minimizing the volume of available pollutants. Potential agricultural best management practices designed to control and trap agricultural nonpoint sources of pollution include:

- Alternate Watering Systems
- Buffer Strip (Shrub/Tree)
- Conservation Tillage (No till end goal)
- Cover Crop
- Drainage Water Management
- Filter Strip (grass)
- Hay/Pasture Planting
- Livestock Restriction or Rotational Grazing
- Manure Management
- Nutrient Management
- Roof runoff & collection structures
- Heavy Use Area Protection

These practices are appropriate for all of the subwatersheds since the watershed is mostly agricultural. In addition, crop and pasture resource concerns were observed in every subwatershed during the windshield survey (Figures 42-43). Priority for bmp implementation will be based on the ranking of the critical areas (High – Blue Creek West, Wolf Creek, Big Cedar, Little Cedar, Dry Fork, and Howard Creek), (Medium – Johnson Fork, Lee Creek, and Jameson Creek), and (No Priority – Blue Creek East and Blackburn). The high priority critical areas will receive funding first.

Alternate Watering Systems

Alternative watering systems provide an alternate location for livestock to seek water rather than using a surface water source. This removes the negative impacts of livestock access to streams including direct deposit of manure and bank erosion and destabilization, while improving the health of livestock by providing a clean water source and better footing while drinking. This results in less E. coli, phosphorus, nitrogen, and sediment entering a surface waterbody. Two main types of alternative watering systems are used including pump systems and gravity systems.

Buffer Strip/Filter Strip

Installing natural buffers or filters along major and minor drainages and sinkholes in the watershed helps reduce the nutrient and sediment loads reaching surface and subsurface waterbodies. Buffers provide many benefits including restoring hydrologic connectivity, reducing nutrient and sediment transport, improving recreational opportunities and aesthetics, and providing wildlife habitat. Sediment, phosphorus, nitrogen, and E. coli are at least partly removed from water passing through a naturally vegetated buffer. The percentage of pollutants removed depends on the pollutant load, the type of vegetation, the amount of runoff, and the character of the buffer area. The most effective buffer width can vary along the length of a channel. Adjacent land uses, topography, runoff velocity, and soil and vegetation types are all factors used to determine the optimum buffer width.

Many researchers have verified the effectiveness of filter strips in removing sediment from runoff with reductions ranging from 56-97% (Arora et al., 1996; Mickelson and Baker, 1993; Schmitt et al., 1999; Lee et al, 2000; Lee et al., 2003). Most of the reduction in sediment load occurs within the first 15 feet of installed buffer. Smaller additional amounts of sediment are retained and infiltration is increased by increasing the width of the strip (Dillaha et al., 1989). Filter strips have been found to reduce sediment-bound nutrients like total phosphorus but to a lesser extent than they reduce sediment load itself. Phosphorus predominately associates with finer particles like silt and clay that remain suspended longer and are more likely to reach the strip's outfall (Hayes et al., 1984). Filter strips are least effective at reducing dissolved nutrients like those of nitrate and phosphorus, and atrazine and alachlor, although reductions of dissolved phosphorus, atrazine, and alachlor of up to 50% have been documented (Conservation Technology Information Center, 2000). Simpkins et al. (2003) demonstrated 20-93% nitrate-nitrogen removal in multispecies riparian buffers. Short groundwater flow paths, long residence times, and contact with fine textured sediments favorably increased nitrate-nitrogen removal rates. Additionally, up to 60% of pathogens contained in runoff may be effectively removed. Computer modeling also indicates that over the long run (30 years), filter strips significantly reduce amounts of pollutants entering waterways.

Both filter strips and buffer strips should be designed as permanent plantings to treat runoff and should not be considered part of the annual rotation of adjacent cropland. Filter strips should receive only sheet flow, and they should be installed on stable banks. A mixture of grasses, forbs, and herbaceous plants should be used. In more permanent plantings, shrubs and trees should be intermingled to form a stable riparian community.

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, zero till, slot plant, row till, direct seeding, or 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.

Several researchers have demonstrated the benefits of conservation tillage in reducing pollutant loading to streams and lakes. A comprehensive comparison of tillage systems showed that no-till results in 70% less herbicide runoff, 93% less erosion, and 69% less water runoff volume when compared to conventional tillage (Conservation Technology Information Center, 2000). Reductions in pesticide loading have also been reported (Olem and Flock, 1990).

Cover Crops

Cover crops include legumes, such as clover, hairy vetch, field peas, alfalfa, and soybean, and non-legumes, such as rye, oats, wheat, radishes, turnips, and buckwheat which are planted prior to or following crop harvest. Cover crops are typically grown for one season 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. Both wind and water erosion move soil particles that have phosphorus attached. Sediment that reaches water bodies may release phosphorus into the water. The cover crop vegetation recovers plant-available phosphorus in the soil and recycles it through the plant biomass for succeeding crops. Runoff water can wash soluble phosphorus from the surface soil and crop residue and carry it off the field. Cover crops are a familiar conservation practice throughout the watershed. Additional operators will likely consider this practice beneficial as information on benefits of reduced fertilizer use become available.

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 (Frankenberger et al., 2006). Drainage water management can be used in concert with a suite of other conservation practices including cover crops and conservation tillage.

Grassed Waterway

Grassed 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. This BMP can reduce sediment concentrations of nearby waterbodies and pollutants in runoff. The vegetation improves the soil aeration and water quality due to its nutrient removal through plant uptake and absorption by soil. The waterways can also provide wildlife corridors and allows more land to be natural areas.

Hay/Pasture Planting

This practice applies to all lands suitable to the establishment of annual, biennial or perennial species for forage or biomass production. This practice does not apply to the establishment of annually planted and harvested food, fiber, or oilseed crops. This practice has many benefits which includes: improve or maintain livestock nutrition and/or health, provide or increase forage supply during periods of low forage production, reduce soil erosion, improve soil and water quality, and produce feedstock for biofuel or energy production.

Livestock Restriction or Rotational Grazing – (Fencing)

Livestock that have unrestricted access to a stream or wetland have the potential to degrade the waterbody's water quality and biotic integrity. Livestock can deliver nutrients and pathogens directly to a waterbody through defecation. Livestock also degrade stream ecosystems indirectly. Trampling and removal of vegetation through grazing of riparian zones can weaken banks and increase the potential for bank erosion. Trampling can also compact soils in a wetland or riparian zone decreasing the area's ability to infiltrate water runoff. Removal of vegetation in a wetland or riparian zone also limits the area's ability to filter pollutants in runoff. The degradation of a waterbody's water quality and habitat typically results in the impairment of the biota living in the waterbody.

Restoring areas impacted by livestock grazing often involves several steps. First, the livestock in these areas should be restricted from the waterbody or stream to which they currently have access. If necessary, an alternate source of water should be created for the livestock. Second, the wetland or riparian zone where the livestock have grazed should be restored. This may include stabilizing or reconstructing the banks using bioengineering techniques. Minimally, it involves installing filter strips along banks or wetland edge and replanting any denuded areas. Finally, if possible, drainage from the land where the livestock are pastured should be directed to flow through a constructed wetland to reduce pollutant loading, particularly nitrate-nitrogen loading, to the adjacent waterbody. Complete restoration of aquatic areas impacted by livestock will help reduce pollutant loading, particularly nitrate-nitrogen, sediment, and pathogens.

A livestock exclusion system is a system of permanent fencing (board, barbed, etc) installed to exclude livestock from streams and areas, not intended for grazing. This will reduce erosion, sediment, and nutrient loading, and improve the quality of surface water. Education and outreach programs focusing on rotational grazing and exclusionary fencing are important in the success of this BMP.

Manure Management

Large volumes of manure are generated by both small, unregulated animal operations and by confined feeding operations located throughout the Whitewater River Watershed. With new rules in place by Indiana State Chemist Office in 2012, manure management plans are required for anyone planning on spreading manure on fields. The new rules determine the need for waste utilization plans, use and length of staging areas, and setbacks for applications. Many entities have manure management plans in place and are currently using these plans to manage the volume of manure produced on their facility. Manure management planning includes consideration of the volume and type of manure produced annually, crop rotations by field, the volume of manure and nutrients needed for each crop, field slope, soil type and manure collection, transportation, storage, and distribution methods. Manure management planning uses similar techniques to nutrient management planning concerning nutrient budgets. Managing manure also includes facilities and proper storage of manure. Structures to assist with the protection of manure runoff may be offered to producers with a resource need.

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.

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. 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. Nutrient management plans may consider the use of Nitrogen Stabilizers as a method to retain nitrogen in the fields for crop production and decrease the amount of nitrogen leaving fields through leaching and runoff to nearby surface or subsurface channels.

The advances in technology have made it possible to improve accuracy in planting and applying fertilizers, manure, and pesticides. Upgrading systems to these newer technologies would give the added benefit of reduced use of these products and would allow for the reduction of runoff of these products to the streams and sinkholes within the watershed. Upgrades to existing equipment would include variable rate technology system, GPS system upgrades or variable rate manure application upgrades. Other possible benefits would be from auto swath and auto steer equipment upgrades. These systems would prevent over applications and prevent applications from going in undesirable areas. Producers must follow regulations and setback requirements from sensitive areas like sinkholes and streams when applying fertilizer to the land.

Roof runoff and collection structures

Runoff from impervious surfaces like roofs can carry a significant amount of nonpoint source pollutants to nearby streams. It is recommended that structures that collect, control, and transport precipitation from roofs be installed to reduce this effect. A container that collects and stores rainwater from rooftops (via gutters and downspouts) for later use for irrigation, livestock watering, or slow release during dry periods is recommended. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. Collection structures, like cisterns, help to reduce peak volume and velocity of stormwater runoff to streams.

As conservation practices are implemented throughout the watershed, a continuous pollutant load reduction total can be calculated using the StepL and Region5 load reduction tools. These pollutant loads can be recorded so that progress can be tracked for the purpose of verifying when watershed pollutant load reduction goals are achieved, both short-term and long-term. See the following figure for expected load reductions for agricultural bmps.

Heavy Use Area Protection

Heavy Use Area Protection is used to stabilize a ground surface that is frequently and intensively used by people, animals, or vehicles. Natural vegetation cannot withstand intense use so the area becomes unstable and vulnerable to erosion. These intensely used areas are very common in grazing systems around the water tanks and feeding areas, especially during the winter when all vegetation is dormant.

Figure 148: Agricultural BMP Expected Load Reductions

Practices	Amount	Sediment (T/yr)	Phosphorus (lbs./yr)	Nitrogen (lbs./yr)	Target Amount to Install	Targeted Subwatersheds
Alternate Watering Systems	1 acre	3	4	8.5	3,750 acres (@75 systems)	**High Priority:** Headwaters Blue Creek (West) - 050800030801 Wolf Creek – 050800030802 Big Cedar Creek - 050800030803 Little Cedar Creek – 050800030804 Headwaters Dry Fork - 050800030807 Howard Creek – 050800030808 **Medium Priority:** Johnson Fork – 050800030806 Lee Creek – 050800030809 Jameson Creek – 050800030810
Buffer Strip (Shrub/Tree)	1 acre	9	9	17	2.3 acres	
Conservation Tillage/No till	1 acre	11	9	12	3,000 acres	
Cover Crop	1 acre	1.7	2.6	5.1	22,500 acres	
Drainage Water Management	1 acre	0.5	1.4	7.9	3,000 acres	
Filter Strip (grass)	1 acre	9	9	17	10 acres	
Livestock Restriction or Rotational Grazing (Fencing)	1 acre	3	4	8.5	3,750 acres	
Grassed Waterway	0.1 acre	18	18	36	10 acres	
Hay/Pasture Planting	1 acre	17.6	17.9	35.7	500 acres	
Manure Management	1 acre	NA	5	35.2	750 acres	
Nutrient Management	1 acre	4	0.7	NA	6,000 acres	
Roof Runoff & Structures	1 unit	NA	454	NA	20 units	
Heavy Use Area Protection	1 HUAP	90	67	134	60 HUAPs	

5.1.2 Urban Management Practices

Development and the spread of impervious surfaces are occurring throughout the Whitewater River watershed. As impervious surfaces continue to spread throughout the watershed, the volume and velocity of stormwater entering the Whitewater River will also increase. The best way to mitigate stormwater impacts is to infiltrate, store, and treat stormwater onsite before it can run off into the streams in the area. Urban best management practices designed to complete these actions are as follows:

- Bioretention Practices
- Detention Basin
- Grass Swale
- Green Roof
- Pervious Pavement

- Phosphorus-free Fertilizers
- Rain Barrels/ Cisterns
- Rain Garden
- Trash Control and Removal
- Urban Wildlife Population Control

These practices would mainly be feasible for the subwatersheds of Lee Creek and Jameson Creek since they contain the watershed's urban areas and had the most urban resource concerns identified during the windshield survey. The steering committee classified the concern of pollution and volume from urban runoff as a Tier 3 concern, which will be addressed through education. The promotion and education of these practices will take place with the intention of landowners and businesses installing them on their own or utilizing other programs if available.

Bioretention Practices

Bioretention practices use biofiltration or bioinfiltration to filter runoff by storing it in shallow depressions. Bioretention uses plant uptake and soil permeability mechanisms in a variety of manners typically in combination. Potential practices include sand beds, pea gravel, overflow structures, organic mulch layers, plant materials, gravel underdrains, and an overflow system to promote infiltration. Bioinfiltration can also be used to treat runoff from parking lots, roads, driveways and other areas in the urban environment. Bioretention should not be used in highly urbanized areas instead it should be used in areas where onsite storage space is available, and there is no risk of subsurface collapse.

Detention Basin

Detention basins are large, open, unvegetated basins designed to hold water for short periods following a rain event (dry detention basin) or continuously (wet detention basin). Detention basins are designed to hold water for longer periods with the goal of reducing sediment flow from the basin or provide filtration of stormwater before it enters the basin through the use of urban pond buffers. Additionally, oils, grease, nutrients, and pesticides can also settle in the basin. The nutrients are then used by the plants for growth and development.

Grass Swale

Grass swales are used in urban areas and are often considered landscape features. Swales are graded to be linear with a shallow, open channel of a trapezoidal or parabolic shape. Vegetation that is water tolerant is planted within the channel which promotes the slowing of water flow through the system. Swales reduce sediment and nutrients as water moves through the swale and water infiltrates into the groundwater.

Green Roof

A green roof is a building partially or completely covered with vegetation and a growing medium planted on top of a waterproof membrane. Irrigation and drainage systems carry water from the roof through the plant material and medium to the building drainage system. Green roofs absorb rainwater, provide insulation, reduce air temperatures, and provide habitat for wildlife. Green roofs can retain up to 75% of rainwater gradually releasing it via condensation and transpiration while retaining sediment and nutrients.

Pervious Pavement

Pervious pavement comes in many forms including porous pavement and modular block pavement. Both types of pervious pavement can be installed on most any travel surface with a slope of 5% or less.

Pervious pavement has the approximate strength characteristics of traditional pavement with the ability to percolate water into the groundwater system. The pavement reduces sediment and nutrient transmission into the groundwater as water moves through the pores in the pavement. When installed, porous pavement includes a stone layer, filter fabric, and a filter layer covered by porous pavement. Correctly mixed porous pavement eliminates fine aggregates found in typical pavements. Porous asphalt is a type of porous pavement, which includes a mix of Portland cement, coarse aggregates, and water that results in the formation of interconnected voids.

Modular pavement consists of individual blocks made of pervious material such as sand, gravel, or sod interspersed with strong structural material such as concrete. The blocks are typically placed on a sand or gravel base and designed to provide a load-bearing surface that is adequate to support personal vehicles, while allowing infiltration of surface water into the underlying soils. They usually are used in low-volume traffic areas such as overflow parking lots and lightly used access roads. An alternative to pervious and modular pavement for parking areas is a geotextile material installed as a framework to provide structural strength. Filled with sand and sodded, it provides a completely grassed parking area.

Phosphorus-free Fertilizers

Phosphorus-free fertilizers are those fertilizers that supply nitrogen and minor nutrients without the addition of phosphorus. Phosphorus increases algae and plant growth which can cause negative impacts on water quality within aquatic systems. The Clear Choices, Clean Water (2010) program estimates that a one acre lawn fertilized with traditional fertilizer supplies 7.8 pounds of phosphorus to local waterbodies annually. Established lawns take their nutrients from the soil in which they grow and need little additional nutrients to continue plant growth. Fertilizers are manufactured in a variety of forms including that without phosphorus. Phosphorus-free fertilizer should be considered for use in areas where grass is already established.

Rain Barrel/Cisterns

A rain barrel, or larger cistern, is a container that collects and stores rainwater from your rooftop (via your home's disconnected downspouts) for later use on your lawn, garden, or other outdoor uses. Rainwater stored in rain barrels can be useful for watering landscapes, gardens, lawns, and trees. Rain is a naturally soft water and devoid of minerals, chlorine, fluoride, and other chemicals. In addition, rain barrels help to reduce peak volume and velocity of stormwater runoff to streams and storm sewer systems. Although rain barrels do not specifically reduce nutrient or sediment loading to waterbodies, their presence can reduce the first flush of water reaching storm drains.

Rain Garden

Rain gardens are small-scale bioretention systems that be can be used as landscape features and small-scale stormwater management systems like single-family homes, townhouse units, some small commercial development, and to treat parking lot or building runoff. Rain gardens provide a landscape feature for the site and reduce the need for irrigation, and can be used to provide stormwater depression storage and treatment near the point of generation. These systems can be integrated into the stormwater management system since the components can be optimized to maximize depression storage, pretreatment of the stormwater runoff, promote evapotranspiration, and facilitate groundwater recharge. The combination of these benefits can result in decreased flooding due to a decrease in the peak flow and total volume of runoff generated by a storm event.

Additionally, rain gardens can be designed to provide a significant improvement in the quality of the stormwater runoff. These systems should not be installed in or near sinkholes. Adding additional drainage to these features can cause further dissolution of limestone, which in turn may cause further collapse.

Trash Control and Removal

Trash and debris located throughout urban areas indicate that these materials can have a significant negative impact on water quality within the Whitewater River. A majority of trash observed occurs adjacent to streets, road right of ways, sidewalks, and streams in the watershed. Surveys in larger urban areas indicate that plastic bottles, Styrofoam cups, and paper are the most common trash items found in or adjacent to storm drains. It is necessary to quantify the impacts of trash on Whitewater River and the town's wastewater treatment facilities to determine if it is necessary to address trash in additional efforts.

As conservation practices are implemented throughout the watershed, a continuous pollutant load reduction total can be calculated using the StepL and Region5 load reduction tools. These pollutant loads can be recorded so that progress can be tracked for the purpose of verifying when watershed pollutant load reduction goals are achieved, both short-term and long-term. See the following figure for expected load reductions for urban bmps.

Figure 149: Urban BMP Expected Load Reductions

Practices	Amount	Sediment (T/yr)	Phosphorus (lbs./yr)	Nitrogen (lbs./yr)	Target Amount to Install	Targeted Subwatersheds
Bioretention Practices	1 acre	5.9	8	48	5 acres	Lee Creek – 050800030809 Jameson Creek – 050800030810
Detention Basin	1 unit	0.1	0.1	5.6	5 units	
Grass Swale	1 acre	1.4	3.3	14.9	5 acres	
Green Roof	1 unit	0.2	0.2	0.8	2 units	
Pervious Pavement	1 acre	1	4.5	47.9	3 acres	
Phosphorus-free Fertilizers	1 acre	0	2	0	100 acres	
Rain Barrels/ Cisterns	1 unit	0.2	0.2	0.8	50 units	
Rain Garden	1 unit	1.4	1.8	12.6	30 units	
Trash Control and Removal	-	NA	NA	NA	NA	

5.1.3 Miscellaneous Practices

Other practices that may be beneficial to the water quality and aquatic life that are not specific to agricultural, urban, or forestry land uses are included here. These other best management practices are as follows:

- Live Stakes
- Riparian Buffers

- Septic System Care and Maintenance
- Streambank Stabilization
- Stream Crossings
- Threatened and Endangered Species Protection

Live Stakes

Live stakes are live shrub or woody plant cuttings driven into the channel bank as stakes. Their purpose is to protect streambanks from the erosive forces of flowing water and to stabilize the soils along the channel bank. This technique is applicable along streambanks of moderate slope, (usually 4:1 or less), in original bank soil (not on fill), and where active erosion is light and washout is not likely. This technique is often applicable in combination with other vegetative or structural stabilization methods. This can be used on all sizes of channels and all character types. It is an economical practice, especially when cuttings are available locally, that can be done quickly with minimum labor. It results in a permanent, natural installation that improves riparian habitat.

Riparian Buffers

Riparian buffers are important for good water quality. Riparian zones help to prevent sediment, nitrogen, phosphorus, pesticides, and other pollutants from reaching a stream. Riparian buffers are most effective at improving water quality when they include a native grass or herbaceous filter strip along with deep-rooted trees and shrubs along the stream.

Herbaceous Riparian cover includes grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats. Benefits include:

- Provide or improve food and cover for fish, wildlife and livestock,
- Improve and maintain water quality.
- Establish and maintain habitat corridors.
- Increase water storage on floodplains.
- Reduce erosion and improve stability to stream banks and shorelines.
- Increase net carbon storage in the biomass and soil.
- Enhance pollen, nectar, and nesting habitat for pollinators.
- Restore, improve, or maintain the desired plant communities.
- Dissipate stream energy and trap sediment.
- Enhance stream bank protection as part of stream bank soil bioengineering practices.

Forested Riparian Cover is an area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. The benefits include:

- Create shade to lower or maintain water temperatures to improve habitat for aquatic organisms.
- Create or improve riparian habitat and provide a source of detritus and large woody debris.
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Reduce pesticide drift entering the water body.
- Restore riparian plant communities.
- Increase carbon storage in plant biomass and soils.

Septic System Care and Maintenance

Septic, or on-site waste disposal systems, are the primary means of sanitary flow treatment outside of incorporated areas. Because of the prohibitive cost of providing centralized sewer systems to many areas, septic tank systems will remain the primary means of treatment into the future. Annual maintenance of septic systems is crucial for their operation, particularly the annual removal of accumulated sludge. The cost of replacing failed septic tanks is about $5,000-$15,000 per unit based on industry standards.

Property owners are responsible for their septic systems under the regulation of the County Health Department. When septic systems fail, untreated sanitary flows are discharged into open watercourses that pollute the water and pose a potential public health risk. Septic systems discharging to the ground surface are a risk to public health directly through body contact or contamination of drinking water sources. Additionally, septic systems can contribute significant amounts of nitrogen and phosphorus to the watershed. Therefore, it is imperative for homeowners not to ignore septic failures. If plumbing fixtures back up and/or will not drain then the system is failing. Funding for this practice is limited.

Streambank Stabilization

Streambank stabilization or stream restoration techniques are used to improve stream conditions so they more closely mimic natural conditions. The most feasible restoration options return the stream to natural stream conditions without restoring the stream to its original condition. Restoration and stabilization options are limited by available floodplain, modifications to natural flows, and development structure locations. Reestablishment of riparian buffers, restoration of stream channels, stabilization of eroding stream banks, installation of riffle-pool complexes, and general maintenance can all improve stream function while reducing sediment and nutrient transport into and within the system.

Stream Crossings

Stream crossings are a stabilized area or structure (temporary or permanent) constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles. Streams are long, linear ecosystems. The processes that nourish these ecosystems are interrelated and dependent on "continuity" of the stream corridor. Our transportation and access needs often result in fragmentation of streams. Many stream crossings, such as bridges and culverts, act as barriers to fish and wildlife. Awareness of the effects of stream crossings plays an important role in maintaining stream continuity.

The design and condition of stream crossings determines whether a stream can function naturally and whether animals can move unimpeded along the stream corridor. These are key elements in assuring the overall health of the system.

Properly constructed stream crossings should be made available for agricultural equipment crossings, recreational vehicle crossings, livestock crossings, and logging activities. Currently, several stream crossings in the watershed are disrupting aquatic habitat, wildlife migration, and stream hydrology. A standard stream crossing practice designed to limit these effects should be constructed in place of failing or improperly constructed crossings.

Threatened and Endangered Species Protection

Threatened and endangered species are those plant and animal species whose survival is in peril. Federally and state listed species identified within the Whitewater River Watershed are highlighted in the Watershed Inventory. Threatened species are those that are likely to become endangered in the foreseeable future. Federally endangered species are those that are in danger of extinction throughout all or a significant portion of their range. A state-endangered species is any species that is in danger of extinction as a breeding species in Indiana.

Protecting threatened and endangered species requires consideration of their habitat including food, water, and nesting and roosting living space for animals and preferred substrate for plants and mussels. Corridors for species movement are also necessary for long-term protection of these species. Protection of habitat can include providing clean water and available food but likely requires protection of the physical living space and associated corridor. Conservation management plans should be developed for each species, if they are not already in place. Such plans should consider habitat needs including purchase or protection of adjacent properties to current habitat locations, hydrologic needs, pollution reduction, outside impacts, and other techniques necessary to protect threatened and endangered species.

As conservation practices are implemented throughout the watershed, a continuous pollutant load reduction total can be calculated using the StepL and Region5 load reduction tools. These pollutant loads can be recorded so that progress can be tracked for the purpose of verifying when watershed pollutant load reduction goals are achieved, both short-term and long-term. See the following figure for expected load reductions for the miscellaneous bmps.

Figure 150: Miscellaneous BMP Expected Load Reductions

Practices	Amount	Sediment (T/yr)	Phosphorus (lbs./yr)	Nitrogen (lbs./yr)	Target Amount to Install	Targeted Subwatersheds
Live Stakes	1 ft.	0.4	0.5	2.9	500 ft.	**<u>High Priority:</u>** Headwaters Blue Creek (West) - 050800030801 Wolf Creek – 050800030802 Big Cedar Creek - 050800030803 Little Cedar Creek – 050800030804 Headwaters Dry Fork - 050800030807 Howard Creek – 050800030808 **<u>Medium Priority:</u>** Johnson Fork – 050800030806 Lee Creek – 050800030809 Jameson Creek – 050800030810
Riparian Buffers	1 ft.	5.4	5.4	9.1	2,000 ft.	
Septic System Care and Maintenance	1 system	NA	6.5	55	75 systems	
Streambank Stabilization	500 ft.	100	100	200	1,500 ft.	
Stream Crossings	1 unit	32.4	32.4	64.8	15 units	
Threatened and Endangered Species Protection	1 acre	NA	NA	NA	NA	

The target amount of BMPs proposed to be installed are not required to be implemented exactly as the quantities suggest. These targets are simply guidelines for achieving the goals. These BMPs were chosen based on landuse and windshield survey concerns identified and water quality data . The figure below lists the total expected load reductions for the target number of BMPs that is proposed to be installed. It also compares the expected load reduction with the load reduction that is required to meet the water quality targets. Based on these estimated BMPs and load reductions, the reductions needed to meet sediment and phosphorus water quality targets will be achieved and likely exceeded. While additional reductions will be required to meet the nitrogen water quality target, the estimated reductions will be enough to achieve the project’s 10% reduction goal by 2030.

Figure 151: BMP Expected Load Reductions for Targeted Practice Installation

Practices	Target Amount to Install	Sediment (T/yr)	Phosphorus (lbs./yr)	Nitrogen (lbs./yr)
Alternate Watering Systems	3,750 acres (@ 75 systems)	11,250	15,000	31,875
Buffer Strip (Shrub/Tree)	2.3 acres	21	21	39
Conservation Tillage/No till	3,000 acres	33,000	27,000	36,000
Cover Crop	22,500 acres	38,250	58,500	114,750
Drainage Water Management	3,000 acres	1,500	4,200	23,700
Filter Strip (grass)	10 acres	90	90	170
Livestock Restriction or Rotational Grazing (Fencing)	3,750 acres	11,250	15,000	31,875
Grassed Waterway	10 acres	1,800	1,800	3,600
Hay/Pasture Planting	500 acres	8,800	8,950	17,850
Manure Management	750 acres	NA	3,750	26,400
Nutrient Management	6,000 acres	24,000	4,200	NA
Roof Runoff & Structures	20 units	NA	9,080	NA
Heavy Use Area Protection	60 HUAPs	5,400	4,020	8,040
Live Stakes	500 ft.	200	250	1,450
Riparian Buffers	2,000 ft.	10,800	10,800	18,200
Septic System Care and Maintenance	75 systems	NA	488	4,125
Streambank Stabilization	1,500 ft.	300	300	600
Stream Crossings	15 units	486	486	972
Threatened and Endangered Species Protection	NA	NA	NA	NA
Bioretention Practices	5 acres	30	40	240
Detention Basin	5 units	0.5	0.5	28
Grass Swale	5 acres	7	17	75
Green Roof	2 units	0.4	0.4	1.6
Pervious Pavement	3 acres	3	14	144
Phosphorus-free Fertilizers	100 acres	0	200	0
Rain Barrels/ Cisterns	50 units	10	10	40
Rain Garden	30 units	42	54	378
Trash Control and Removal	NA	NA	NA	NA
Load Reduction from Target Amount of BMPs		147,239.9	164,270.9	320,552.6
Load Reduction needed to meet water quality targets		28,770	47,972	1,471,151
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		Exceeds	Exceeds	1,150,598.4 still required to meet target

5.2 - Implementation Program Design

In order to address the problems associated with degraded water quality in the Whitewater River Watershed, practices must be implemented to ensure that water does not degrade further and the quality improves over time. The goals identified within the plan will address many of the problems identified within the watershed. In order to reach those goals a series of management strategies must be considered. First, an analysis of the most cost-effective of Best Management Practices should be considered to efficiently address the issues with the funding available. Secondly, the concerns need to be associated with practices that would be able to achieve the goals listed. Lastly, those practices should be considered for their urgency and feasibility of implementation. Some problems can spiral out of control if not addressed in a timely manner. For example, once a stream bank becomes destabilized, the forces of water can quickly erode away large sections of stream bank. This problem would be of high urgency. On the other hand, the feasibility is the ease of installing practices or addressing concerns. In this same example, stream banks that become destabilized are sometimes extremely expensive to fix and may not hold up to the power the water has on the installed structures. This can be especially true if the cause of this bank destabilization is not addressed first. Additionally, the destabilization may be on a landowner's property that may not be able to afford such costly repairs. This example shows that this practice might have a low feasibility.

Moving Forward into the Future

6.1 Action Register

Creating an action register is a great tool to help facilitate implementation of goals and objectives of the watershed management plan. It includes specific and measurable objectives that the project wishes to carry out to improve the water quality. Figure 152 below details the action plan and strategies for the Whitewater River Watershed. In it you will find objectives, milestones for objectives, cost estimates for objectives, possible partners, and technical assistance.

Figure 152: Action Plan and Strategies for the Whitewater River Watershed

<table>
<tr><th>Goal</th><th>Objective</th><th>Target Audience</th><th>Milestones</th><th>Cost</th><th>Potential Partners/ Technical Assistance</th></tr>
<tr><td rowspan="9">Reduce soil erosion and sedimentation so current water quality conditions are protected or improved by the year 2030

(Reduction of 28,770 tons is needed)</td><td>Educate and promote installation of BMPs through field days/workshops</td><td rowspan="9">Producers, Landowners, Residents, and County Agencies</td><td>Hold 1 field days/workshops annually</td><td rowspan="9">$575,000</td><td rowspan="9">SWCD
NRCS
Purdue
ISDA
US Fish & Wildlife
IDEM
OHEPA
OKI</td></tr>
<tr><td>Education through publications</td><td>Develop 4 publications annually</td></tr>
<tr><td>Provide financial assistance to convert tillage to no-till systems</td><td>Convert 1,500 acres to no-till by 2023 - 3,000 acres by 2030</td></tr>
<tr><td>Provide financial assistance to plant cover crops</td><td>Plant 1,500 acres annually</td></tr>
<tr><td>Provide financial assistance to establish grassed waterways</td><td>Establish 4 acres of grassed waterways every 5 years – 12 acres by 2030</td></tr>
<tr><td>Provide financial assistance to establish filter strips</td><td>Establish 4 acres of filter strips every 5 years – 12 acres by 2030</td></tr>
<tr><td>Provide financial assistance to implement prescribed grazing plans</td><td>Implement 5 prescribed grazing plans annually</td></tr>
<tr><td>Provide financial assistance for fencing and watering systems</td><td>Install 5 systems of fence and watering systems annually</td></tr>
<tr><td>Provide financial assistance to establish riparian buffers</td><td>Establish 700 ft. of riparian buffers every 5 years – 2,100' by 2030</td></tr>
</table>

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
	Promote and provide education on smart growth		Develop an educational publication every 5 years		
	Promote the use of urban bmps		Develop publication biannually		
			Hold 5 workshops by 2030		
The current annual load for nitrogen is 2,206,726 lbs./year and the current load for phosphorus is 95,945 lbs./year. The load reduction needed to meet the target levels for nitrogen and phosphorus are 1,471,151 pounds nitrogen and 47,972 pounds of phosphorus.	Educate and promote installation of BMPs through field days/workshops	Producers, Landowners, Residents, and County Agencies	Hold 1 field day/workshop annually	$875,000	SWCD NRCS Purdue ISDA US Fish & Wildlife IDEM OHEPA
	Education through publications		Develop 4 publications annually		
	Provide financial assistance to plant cover crops		Plant 1,500 acres annually		
	Provide financial assistance to farmers for the development and implementation of nutrient management plans		Implement 5 nutrient management plans annually		
	Provide financial assistance to implement improved pasture management systems		Implement 5 improved pasture management systems annually		
	Provide financial assistance to farmers for the development and implementation of manure management plans		Implement 3 manure management plans annually		
	Educate and promote proper nutrient management to the general public		Develop a publication or hold a workshop biannually		
The overall goal is to reduce E. coli concentrations throughout the watershed not only to meet water quality standards but to have the impaired streams segments (205 miles) delisted. E. coli reduction needed based on geometric mean ranges from 0 to 92% and reductions needed based on maximum value ranges 0 to 98%.	Educate livestock owners on the importance of pasture management & access control through field days/workshop	Producers, Landowners, Contractors, Realtors, and Residents	Hold field day bi-annually	$500,000	SWCD NRCS Purdue ISDA US Fish & Wildlife IDEM OHEPA Health Departments Consultants Friends of the Great Miami Required by staff and partners
	Educate livestock owners on the importance of pasture management & access control through publications		Develop 2 publications annually		
	Provide financial assistance to exclude livestock from sensitive areas		Exclude 30 head annually from sensitive areas		
	Provide financial assistance to implement improved pasture management systems		Implement 5 improved pasture systems annually		
	Educate and promote proper septic maintenance		Develop publication biannually	1,000	
	Hold workshop for contractors and realtors on proper septic system sites and installation		Hold 1 contractor/realtor workshop every 5 years - 3 by 2030		
	Hold workshop on proper septic maintenance for landowners in the watershed		Hold 1 landowner workshop every 4 years - 4 by 2030		
	Seek outside sources of funding for data collection on progress monitoring of E. coli		Collect data at least once every 6 years – 2 times by 2030	10, 000	

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
	levels in the watershed				
	Provide data and support to local sewer districts on extending service to problem areas with failing systems		Make contact with local sewer districts to provide information and give assistance at least once every 7 years - 2 times by 2030		
Increase public awareness on how individual choices and activities impact the watershed	Create a "Friends of the Whitewater River Watershed" group	Producers, Landowners, Residents, and County Agencies	Develop a volunteer group within 5 years	$25,000	Environmental Groups Residents Government Agencies OKI IDNR ODNR IDEM
			Hold annual event or develop publication to promote the watershed annually		
	Develop publications to promote recreational use of the river		Develop a publication to promote recreational use of the river every 3 years - 5 by 2030		
	Promote sustainable growth and bmps		Develop publication annually		
	Install educational signage throughout the community		Install 5 signs throughout the community about the watershed by 2025		
	Develop more public access points on the river		Create 2 more public access points on the river by 2025		
	Build educational stations along river		Build 2 educational stations by 2030		
	Promote the creation of restroom facilities along the river		Look for grants and funding to build facilities by 2030		
Protect and enhance critical habitat and unique natural areas of the Whitewater River, its tributaries, and the entire watershed including threatened, endangered, and rare species	Provide financial assistance to install bmps to improve water quality	Producers, Landowners, Residents, Environmental groups, and County Agencies	See milestones for sediment, nutrients, and E. coli goals	See above	SWCD NRCS Purdue ISDA US Fish & Wildlife IDEM OHEPA Consultants
	Help identify areas which need restoration and provide data and financial assistance		Identify 8 areas by 2020	$50,000	
			Provide data and assistance to restore 5 areas between 2020 and 2030		
	Monitor changes in populations and habitat		Collect data at least once every 6 years – 2 times by 2030	$20,000	
	Provide financial assistance to install riparian buffers		Establish 700 ft. of riparian buffers every 5 years – 2,100' by 2030	10,000	
Reduce litter and trash in the watershed	Decrease in roadside and stream bank litter achieved	Producers, Landowners,	Hold bi-annual clean-ups	$1,000	Volunteers

Goal	Objective	Target Audience	Milestones	Cost	Potential Partners/ Technical Assistance
	through cleanups and outreach efforts	Residents, Environmental groups, and County Agencies			County Agencies
	Increase signage that discourages public littering		Install 15 signs by 2030	$2,000	

6.2 Future Activities

In moving forward, the next step for the project is to start implementing this management plan for the Whitewater River Watershed. The Steering Committee along with the local county SWCDs have already submitted a grant application for implementation, which would provide funds for a cost-share program to install best management practices (BMPs) and an education and outreach program. If the grant is awarded, the steering committee will develop a cost-share program that will include steps to meeting the goals and management strategies of this plan. In order to track the project's progress of reaching its goals and improving water quality, information and data will need to be continually collected during implementation.

Figure 153: **Strategies for Tracking Goals and Effectiveness of Implementation**

Tracking Strategy	Frequency	Total Estimated Cost	Partners	Technical Assistance
BMP Load Reductions	Continuous	NA	SWCDs & NRCS	Staff and Partners
Water Monitoring	Every 3-4 years	$20,000	SWCDs, IDEM, Rivers Unlimited, Friends of the Great Miami	Staff and Partners
Attendance at Workshop/Field Days	Yearly	NA	NA	NA
Post Workshop Surveys for Effectiveness	Yearly	$2,000	SWCDs & Purdue Extension	NA
Number of Educational Publications	Yearly	NA	NA	NA
Windshield Survey	Every 3-4 years	NA	NA	Staff and Committee
Aerial Surveillance	Every 3-4 years	NA	NA	Staff and Committee
River Surveillance	Every 3-4 years	$500	Canoe Liveries & Rivers Unlimited	Staff, Committee, and Partners
Infrared Surveillance (levels of cover crop usages and invasive plants	Yearly	$15,000	Consultant	Consultant
USGS Flow – Volume of Runoff	Yearly	NA	NA	NA

The tracking strategies described in figure 153, will be used to document changes and aid in the plan re-evaluation. Work completed towards each goal/objective will be documented in a tracking database which will include scheduled and completed activities, numbers of individuals attending or efforts completed toward each objective, and load calculations or monitoring results for each goal, objective, and strategy. Rivers Unlimited and the Ohio SWCDs already have a volunteer monitoring program with a QAPP. The project would like to expand the current monitoring program on the Ohio side to at least the 13 original monitoring sites on the Indiana side when the Friends of Whitewater River group is established. Samples are collected monthly March-November on the third Saturday of each month for the Ohio volunteer monitoring program. The current parameters tested include Nitrates, Total Phosphorous, pH, Conductivity, Turbidity, E. coli, and Dissolved Oxygen (DO - % saturation and concentration). The data is made available within the month of collection on their web site at http://www.riversunlimited.org/wqm/data.html as an Excel spreadsheet. As long as the timing and methodology are the same for all sites, the data would be comparable across the entire watershed. Overall project progress will be tracked by measureable items such as workshops held, BMPs installed, meetings held, etc. Load reductions will be calculated for each BMP installed. These values and associated project details including BMP type, location, size, cost, installer, and more will be tracked over time. Individual landowner contacts and information will be tracked for both identified and installed bmps. The Whitewater River Watershed Coordinator is responsible for updating and maintaining the tracking database. The Dearborn County SWCD will be responsible for the long-term housing of tracking database and if there is a time when the watershed does not have a coordinator. Both the watershed coordinator and the Dearborn County SWCD representative will be able to share all tracking information with the steering committee.

Watersheds are continually changing as land use and management changes. The Whitewater River Watershed Management Plan should be re-evaluated and updated by the steering committee and partners. The committee set milestones for the goals and objectives and to determine the progress made and the plan should be re-evaluated and updated at a minimum every 4-5 years.

The Dearborn County SWCD will be responsible for maintaining all records for the project. Dearborn County SWCD – 10729 Randall Ave., Aurora, IN 47001 – (812) 926-2406 ext. 3