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Watershed Management Plan

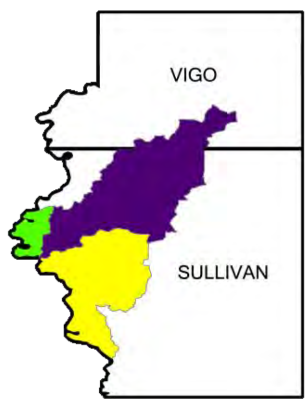
for

Turtle Creek Watershed

Turman Creek Watershed

and

Kelley Bayou Watershed



December, 2015

West Central Indiana Watershed Alliance
Sullivan County Soil and Water Conservation District
2316 North Section Street
Sullivan, IN 47882
(812) 268 – 5157 ext. 3
www.watershed-alliance.org

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Thanks/Dedication

This Watershed Management Plan was made possible through an IDEM 319 grant, obtained and facilitated by the Sullivan County Soil and Water Conservation District. Contributions to the WMP were supplied by the dedicated and committed TTK Advisory Committee. Numerous stakeholders and partners offered assistance and support throughout the planning phases of this project. The WCIWA would like to especially thank its sponsoring agency, the Sullivan County Soil and Water Conservation District, as well as the Natural Resources Conservation Service, The Nature Conservancy, Hoosier Energy, Wildlife, Land, and Resource Management, Indiana American Water, Indiana State Department of Agriculture, US Fish and Wildlife, the Department of Natural Resources, Purdue Extension, Merom Town Council, Merom Improvement Association, the Gill Township Levee Association, Island Levee Association, EA, Cardno, Deca Environmental, Sycamore Trails RC&D, CCSI, McCoy and McCoy Labs (formerly E.C. Labs), and various agencies within Sullivan County, including the County Council, Commissioners, and Highway Department. Webpage development was donated by Aaron Valandra and graphic designs supplied by Ryan Demarest. This planning initiative was also made possible through the support of neighboring county SWCDs, including the Vigo County SWCD, Clay County SWCD, Greene County SWCD, and the Crawford County (Illinois) SWCD.

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**This document was submitted to IDEM as a separately attached file*

1.0 Watershed Community Initiative

1.1 Community Project Initiative

After several years of successful conservation work in the neighboring Busseron Creek watershed, the West Central Indiana Watershed Alliance (WCIWA) and its parent organization, the Sullivan County Soil and Water Conservation District decided to shift focus back to a project that had been on hiatus: The Partnership for Turtle Creek.

The Partnership for Turtle Creek was formed in 1998 when representatives from Hoosier Energy became concerned about the degradation of the Turtle Creek Reservoir and sought solutions to their concerns by implementing management strategies in the surrounding Turtle Creek and Little Turtle Creek watersheds. As a result of this project, a Watershed Management Plan (WMP) was created for the Turtle Creek and Little Turtle Creek watersheds and the group received a National Excellence in Conservation Award from the Natural Resources Conservation Service (NRCS) in 2005.

Resource concerns cited by the Partnership for Turtle Creek are many of the same voiced today: excess sediment and nutrients in the streams and lake, eroding farmland and shorelines, degraded habitats, and E.coli impairments, to name a few. The WCIWA and the Sullivan County SWCD, along with input from other key organizations (NRCS, US Fish and Wildlife Service, Department of Natural Resources Division of Fish and Wildlife, DNR Lake and River Enhancement Program, Indiana Department of Environmental Management, The Nature Conservancy, Hoosier Energy, and partner SWCDs), county officials, and local stakeholders decided it would be prudent to revise and expand the work originally started by the Partnership for Turtle Creek.

The TTK (Turtle Creek, Turman Creek, Kelley Bayou) 319 Grant project includes the original Turtle Creek watershed and has broadened to encompass neighboring Turman Creek and Kelley Bayou watersheds. An updated and more comprehensive WMP will be developed, along with regular water monitoring. After the WMP is approved, a cost-share implementation program will commence, delivering conservation to the very stakeholders who have expressed their concerns.

1.2 Advisory Committee

The TTK Grant officially started on August 23, 2013 and a “Kick-Off” meeting was held at the Hoosier Energy Environmental Education Center (the original site of the Partnership for Turtle Creek meetings) on August 29th. Interest in the project was garnered through mass emails to interested parties, newspaper and radio advertisements, a revised website, and neighboring Busseron Creek project newsletters. In addition, Hoosier Energy furnished the paper, printing, and postage to mail announcement letters to every resident within the watershed. They also funded the creation of promotional magnets, featuring a new logo and pertinent information. These magnets have been distributed to individuals at local meetings and field days, the public library, and are slated to be used throughout the duration of the grant.

Some initial concerns were gathered from a Stakeholder Survey that was developed for the Kick-Off meeting (Table 2), though the bulk of concerns were gathered during a lengthy discussion at the January 14th, 2014 Advisory Committee meeting. Ongoing efforts to compile more resource concerns are continually encouraged via email updates, website, newsletters, and newspaper advertising.

Table 1 – TTK Advisory Committee

Advisory Committee Member	Affiliation
Bill Coulson	Sullivan SWCD Board Chairman, stakeholder
Bradley Smith	The Nature Conservancy
Brian O'Neill	EA Group
Bruce Marheine	WLRM (Wildlife, Land, and Resource Management
Trey Clark	WLRM (Wildlife, Land, and Resource Management
Carrie Green	Sullivan SWCD Coordinator/Educator
Michalene Reilly	Hoosier Energy
Lon Petts	Hoosier Energy
Charles Haney	Hoosier Energy
Don Chesnut	Hoosier Energy
Joe Freeze	Stakeholder
Jim Spence	Sycamore Trails RC & D
John "Jack" Gettinger	Stakeholder
Paul Gettinger	Stakeholder
Josh Brosmer	IDEM
Joe Eslinger	Stakeholder
Ray McCammon	Sullivan County Commissioner and Stakeholder
Gabe Blevins	Stakeholder, local contractor

1.3 TTK Advisory Committee and Stakeholder Concerns

Stakeholder concerns were collected starting at the very first TTK Kick-Off meeting on August 23, 2013 by means of a resource concerns survey, chiefly. On the January 14th, 2014 Advisory Committee meeting, the bulk of the meeting was spent discussing various issues within the watershed amongst a wide range of constituents. All issues and interests were collected by the Watershed Coordinator and compiled in list form. The list was distributed to the Advisory Committee and other individuals and partner organizations for review via email.

In addition, the Watershed Coordinator had also met with representatives from Hoosier Energy to discuss issues affecting the Turtle Creek Reservoir. Because of the overlapping nature of interests between Hoosier Energy and the TTK Watershed project, their concerns have also been included in the formulation of this comprehensive list.

Ongoing input is encouraged from stakeholders by email, newsletter, and newspaper announcements and will be included as new concerns are voiced. The list of concerns is featured below in Table 2.

Table 2 – Stakeholder Concerns

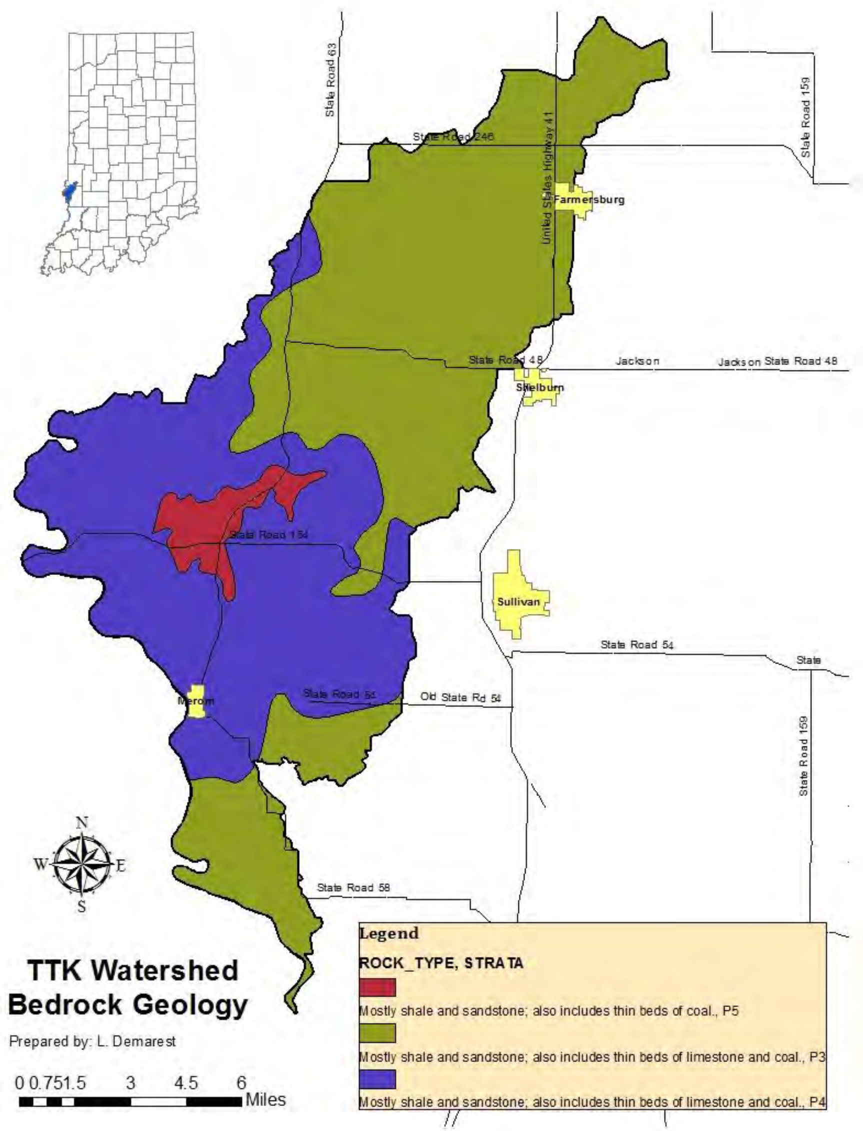
	General Concerns Throughout TTK Watershed (not in ranked order)
1	Sediment in streams
2	Erosion from agricultural fields
3	Nutrient loads from fertilizers, etc.
4	Trash, litter
5	Beavers
6	Invasive Species
7	Sheet and rill erosion
8	Livestock management
9	Soil health and quality
10	Improved habitat areas
11	Conservation easements - acquire more
12	Gas/oil well leaks
13	Historic mine activity (Northeast part of Turman Creek watershed)
14	Landfill proximity, pollutant leaching
15	Streambank/shoreline erosion
16	Large equipment difficult to maneuver on contoured land - need new solutions
17	Educating local students and citizens about resource concerns
18	Ditch maintenance
19	Improved waste disposal methods
20	Septic contributions to E.coli loads - educate public, promote new systems, loan programs
21	Keep water on land - prevent run-off, erosion, retain nutrients, save money)
22	Reduce pollutant inputs into reservoir (slow water, filter strips, buffers)
23	Purifying structures needed (wetlands, swales)
24	Farmer compensation for conservation practices
25	Promote cover crops
26	Find sustainable ways to promote conservation practice (beyond the timeline of the grant)
27	Suggest tax breaks/other incentives for conservation
28	Fracking/Irrigation
29	Additional studies of BMP (best management practice) effects in the watershed
30	Additional studies of pollutant leaching quantities through clay soils
	Turtle Creek Reservoir
1	15% lost volume
2	Excess sediment (8' recorded in places)
3	Algae-domination as a result of nutrient loading
4	Fish kills
5	Shoreline erosion
6	Ability to continue to use reservoir for power plant function
7	Develop a watershed management plan for areas surrounding reservoir

2.0 Watershed Inventory I – Geology/Topography, Hydrology, Soils, Land-Use, and Planning Efforts

2.1 Geology/Topography

The TTK watershed is a part of the glaciated Wabash Lowland, which averages no more than 500 ft. above sea level. Sandstone and shale of the Pennsylvanian age make up the dominant rock types in the region, along with thin seams of coal. A scant layer of glacial till can be found on the surface, but it has little effect on landforms in this region. Windblown loess mounds can be found in some areas.

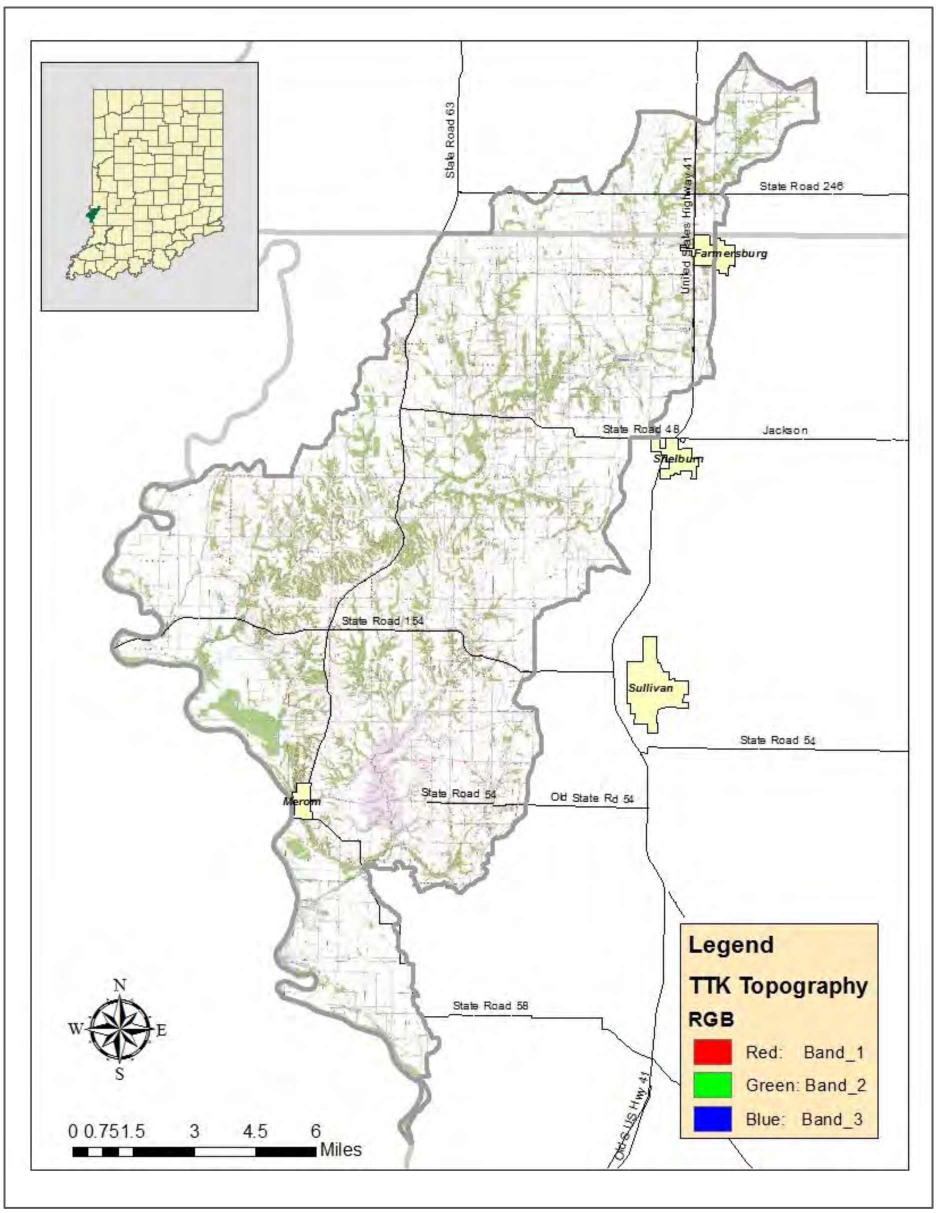
<u>Figure 1 - TTK Geology</u>



Areas bordering the Wabash River are, in general, extremely flat, with the exception of the Merom Bluff, which provides an impressive view of the Wabash River and an expanse of Illinois farmland from its location approximately 200 ft. above the river. Additionally, Merom Bluff Park is known to be a historical site that is treasured by residents. The Merom Chautauqua Festival is hosted each year on the bluff to celebrate the history and culture of the town.

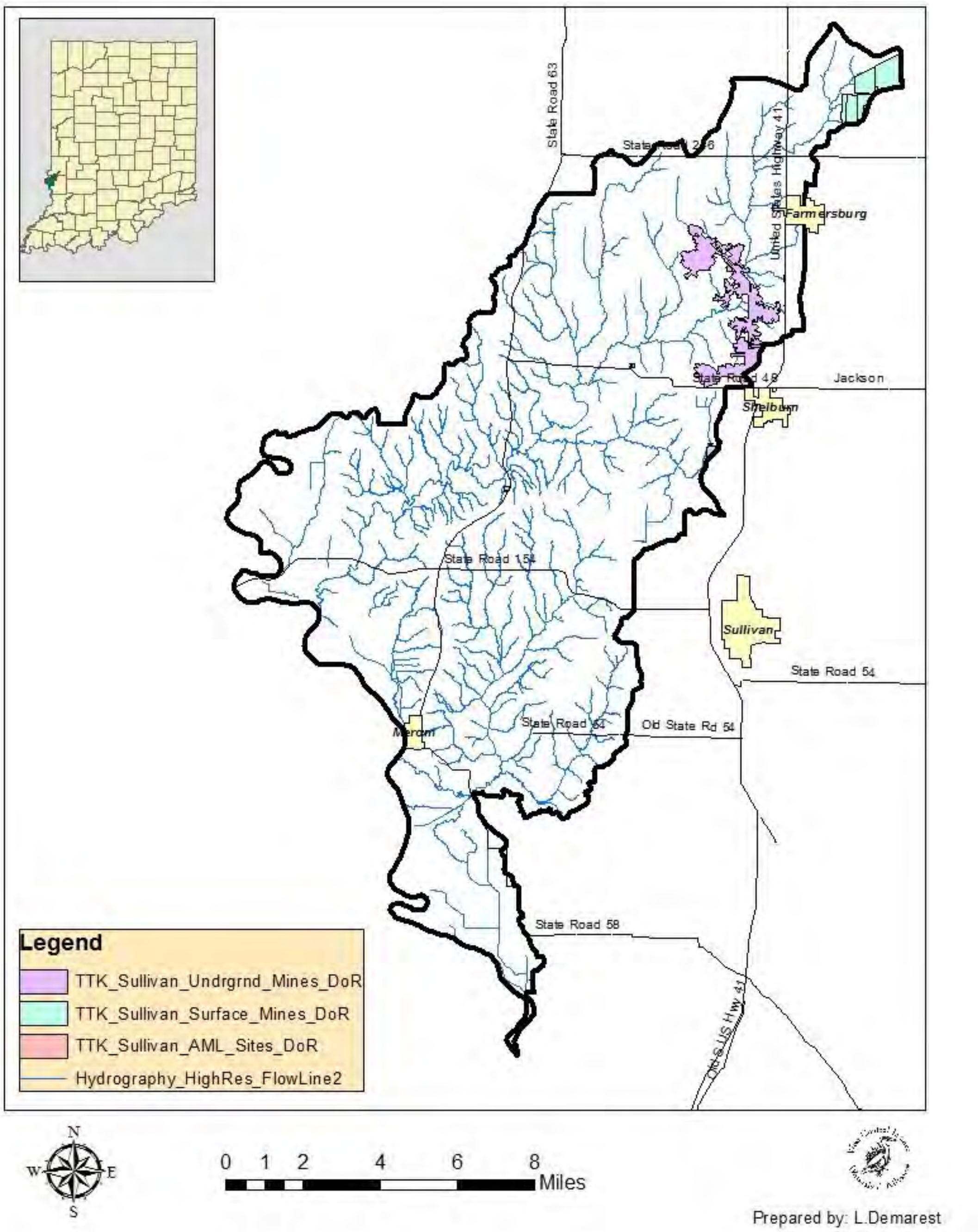
For the most part, land throughout the TTK watershed is relatively flat with approximately 1% slopes on average. Much of the farmland utilizes drainage tile to remove excess water that has a tendency to drain slowly from the flat lands. However, the interior regions of Turtle and Turman Creek watersheds are forested, with rolling ridges around the Graysville region and in the Dodd's Bridge subwatershed. Some of the highest elevations in the watershed are in this region, which is incidentally where much of the highly erodible land can be found.

Figure 2 - TTK Topography



There are no karst features noted in this region, however there are a handful of isolated mine-related voids that can be viewed on the map in Figure 3. The Thunderbird Pond is the site of a reclaimed mine (area shown on the map in purple) currently owned by AEP. Ongoing dam maintenance has proven to be costly and plans are currently being made to remove this dam and restore the stream. Funding for this project is currently being sought. This project will be discussed more at length in the Planning Efforts Section 2.5 of this WMP.

Figure 3 - TTK Mine-Related Features



2.2 Hydrology

Within the TTK watershed, there are 1,204.17 miles of stream which eventually empty into the Wabash River. The three main watersheds are divided up into seven smaller 12-digit subwatersheds. The Turman Creek watershed (0512011112) consists of three subwatersheds: Thunderbird Pond, Turman West Fork, and Town of Dodd's Bridge. The Kelley Bayou watershed is the Indiana portion of the larger Raccoon River (0512011113) watershed of the Wabash River, which spans into Illinois. The Turtle Creek watershed (0512011116) is made up of three smaller watersheds: Turtle Creek, Little Turtle Creek, and Buzzard Pond.

Table 3 - 12-Digit Subwatersheds

Name	Hydrologic Unit Code (HUC)	Area (Acres)
Thunderbird Pond	051201111201	22,734
West Fork	051201111202	20,872
Town of Dodd's Bridge	051201111203	14,680
Kelley Bayou	051201111303	14,107
Turtle Creek	051201111601	18,113
Little Turtle Creek	051201111602	16,969
Buzzard Pond	051201111603	8,195

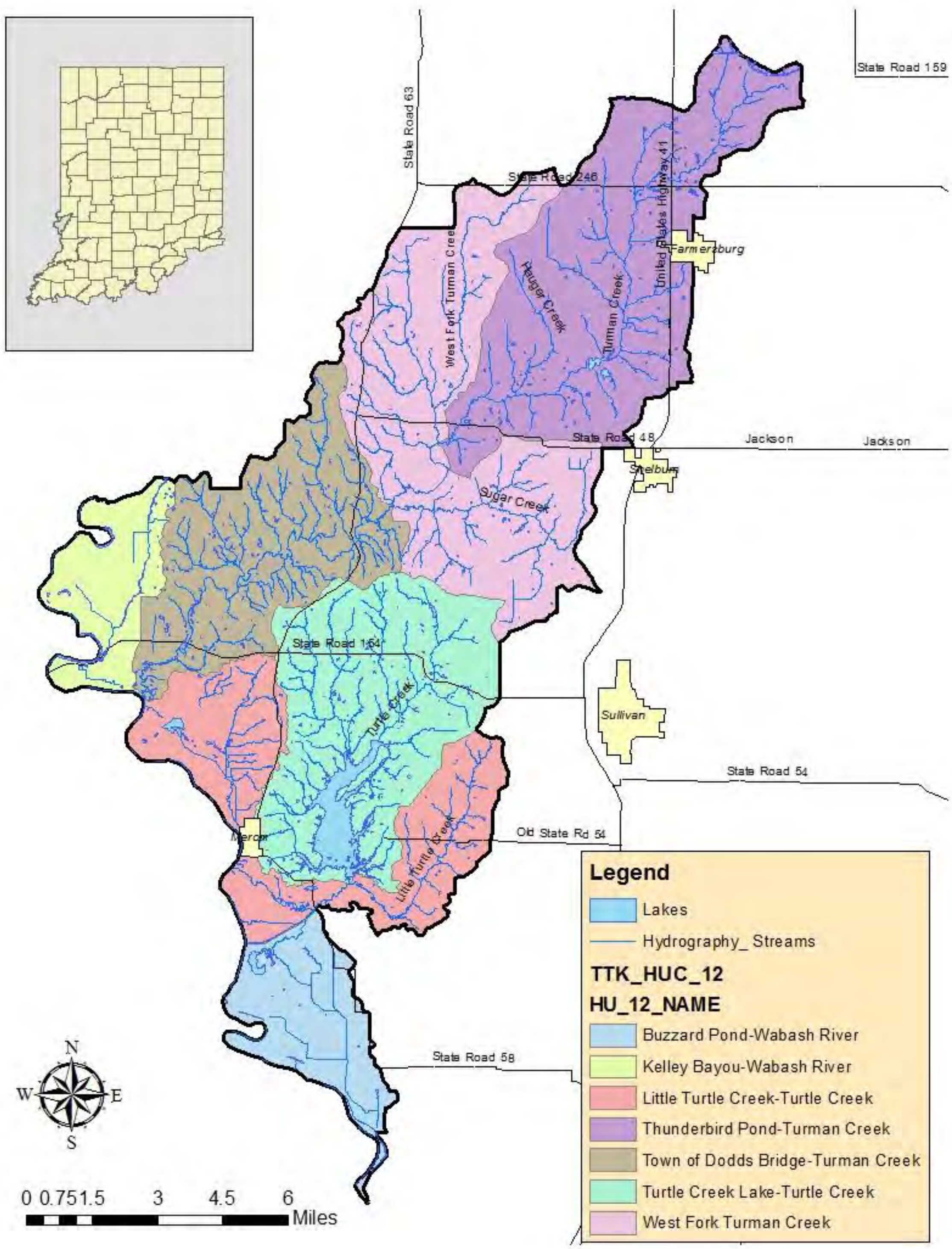
TTK Total Acreage = 115,670 acres (Sullivan 99,525 acres/Vigo 16,145 acres)

The headwaters of Turman Creek originate in the Thunderbird Pond subwatershed and travel south where they converge with Hauger Creek and the West Fork of Turman Creek in the West Fork subwatershed. Sugar Creek joins Turman Creek from the south as it enters the Town of Dodd's Bridge subwatershed. From there, Turman Creek continues to pick up several unnamed tributaries before eventually emptying into the Wabash River near Hutsonville.

The Kelley Bayou watershed represents the Indiana portion of the Raccoon River watershed, of which the larger portion extends into Illinois. The tributaries in Kelley Bayou are few and unnamed, but they converge and flow into the oxbow for which this area is named. This water eventually joins the Wabash, though it is greatly influenced by incidents of back-flooding from the large river.

The Turtle Creek watershed is made up of three subwatersheds: Turtle Creek, Little Turtle Creek, and Buzzard Pond. In 1980, the Turtle Creek Reservoir was created for use by Hoosier Energy and became a significant feature within the watershed. Turtle Creek flows into the reservoir from the northeast along with several other unnamed in-feeders. Little Turtle Creek originates on the east side of the reservoir and bends around to the south of the lake, picking up other small tributaries. Little Turtle Creek joins the original Turtle Creek south of the existing Turtle Creek Reservoir dam. The larger Turtle Creek continues west towards the Wabash River and after converging with unnamed streams from the Buzzard Pond subwatershed, finally meets the larger Wabash River south of the town of Merom.

Figure 4 - TTK Hydrology: 12-Digit HUCs, Streams, Lakes



There are a variety of ways in which stakeholders within the TTK watershed utilize the streams, lakes, and wetland areas. When it comes to lakes and ponds, there are 718 waterbodies identified throughout the TTK watershed, totaling 2,170 acres. The largest waterbody is the 1,550 acre Turtle Creek Reservoir which was created in 1980 for the chief purpose of cooling water for Hoosier Energy's Merom Generating Station. Aside from its main purpose, many individuals utilize this reservoir and other lakes and ponds for recreation such as fishing and hunting. The Turtle Creek Reservoir in particular is stocked with bluegill, sunfish, crappie, catfish, and largemouth bass. In-season goose and duck hunting is another option for outdoor enthusiasts. Hoosier Energy is responsible for managing the reservoir and representatives have expressed growing concern when it comes to the amount of sediment accumulating at the bottom of the lake after a recent bathymetric study.

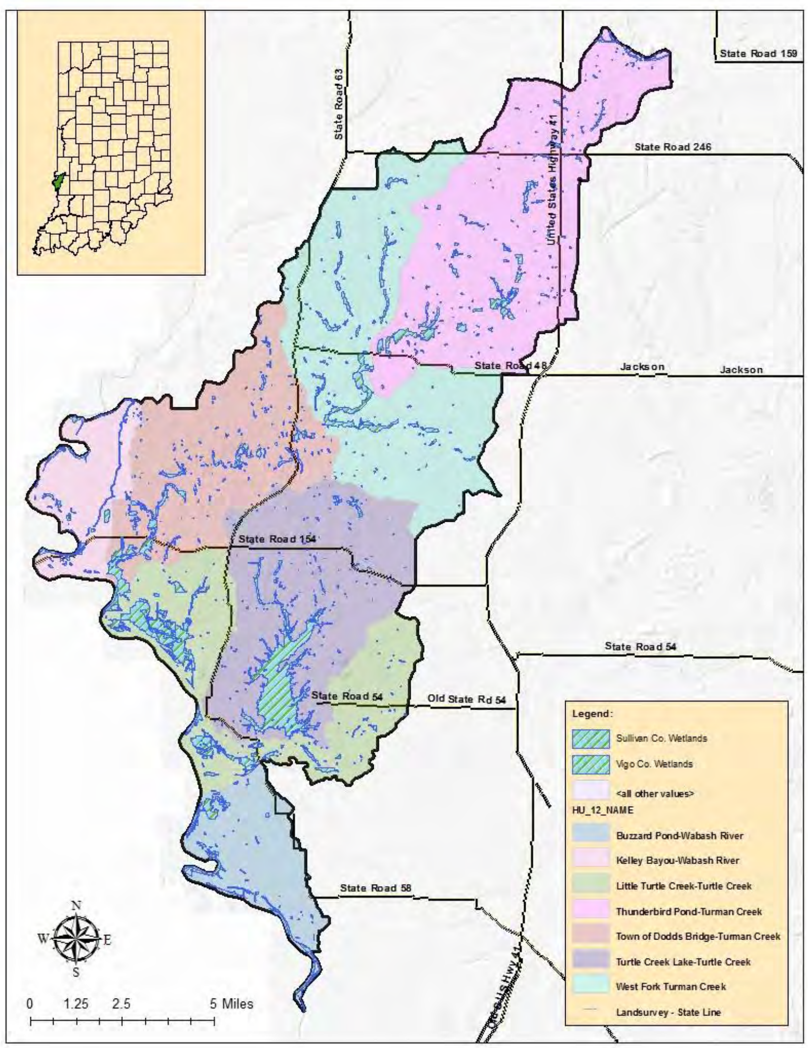
There are approximately 1,204.17 miles of streams within the TTK watershed. Streams are frequently used by landowners for the discharge of excess surface water. Subsurface tile drainage of cropland is a common practice throughout the watershed. Additionally, water from streams is also used for irrigating crops in the sandier, southern parts of the watershed. Pollutants in the form of applied fertilizers and pesticides can be introduced to stream waters through tile drainage and "fertigation" (the practice of injecting fertilizers, etc. into an irrigation system).

An estimated 418.84 miles of roadside ditch exist within the TTK watershed. This is based on the known miles of road in the watershed and the assumption that a constructed drainage ditch likely exists on at least one side of the length of road. According to the Sullivan County Engineer, Benji Boyd, legal drains are not employed in this region and no known maps have been located for use in current operations. Roadside and drainage ditches are maintained on an as-needed basis by Sullivan County. Due to budget and time constraints, engineering for ditches and the use of erosion control blanket and/or seed is rarely practiced. A backhoe is typically used to remove vegetative burden from ditches and to establish slope for drainage to the nearest stream. It is not uncommon to see bare soil in ditches when driving in rural Sullivan County.

Figure 5 - Ditch Maintenance, Sullivan County

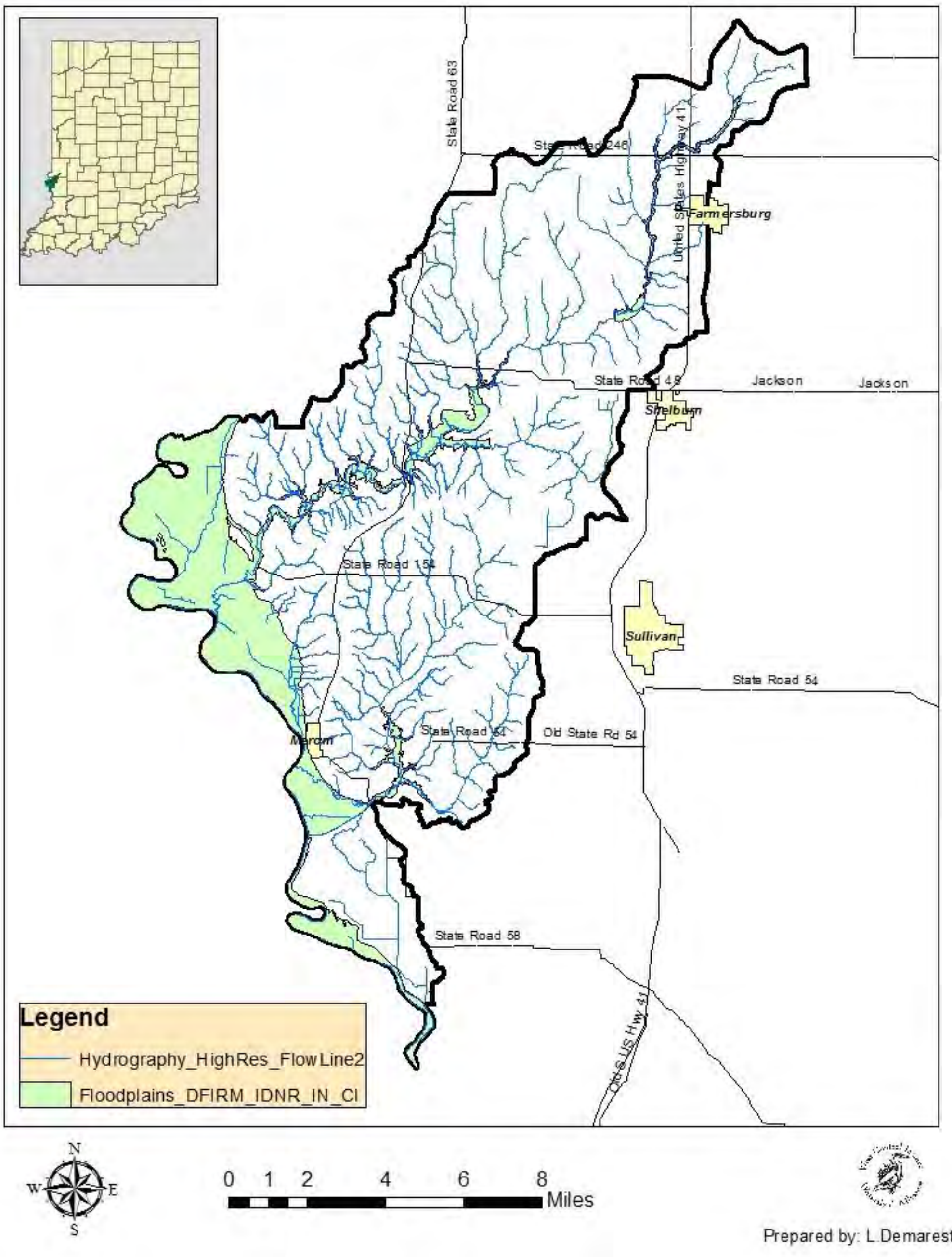
When it comes to wetlands, EPA provides the following definition: “Wetlands are areas where water covers the soil, or is present either at or near the surface of the soil all year or for varying periods of time during the year, including during the growing season.” Many wetland areas have been established along the Wabash corridor on private lands and throughout other low-lying tracts with the assistance of the Conservation Reserve Enhancement Program (CREP) and the Wetland Reserve Program (WRP). These areas provide habitat for a variety of migrating birds, amphibians, fish, and other species. Hunters, birders, and other hobbyists enjoy these wetland areas; a beneficial trend that has been gaining momentum for years, especially during the time of the first Turtle Creek Partnership grant, when riparian buffers and bottomland plantings were highly promoted through various cost-share programs. To date, there are 31,440.29 acres of wetlands and riparian areas reported throughout the TTK watershed, with 5,044.92 acres specifically listed as “Freshwater Emergent Wetland” or “Freshwater Forested/Shrub Wetland” rather than ponds, lakes, or riparian areas. The majority of this wetland acreage is privately owned and managed by local TTK stakeholders.

Figure 6 - TTK Wetlands



Wetlands also act as a safe-guard against flooding by providing areas where excess water can be temporarily stored before being released slowly, either by gentle drainage, evaporation, or transpiration into the atmosphere through plants. Featured below are areas most prone to flooding in the TTK watershed. Levees have been constructed in places along the Wabash River and two different groups manage the respective levees: The Island Levee Association manages levees north of Highway 154, while the Gill Township Levee Association manages those to the south. The Gill Township Levee Association also regulates Roger's Ditch, most of which extends through the Busseron watershed. The levee groups assess a tax on local landowners for the ongoing maintenance of these structures.

Figure 7 - TTK Floodplains



Another interesting feature within the TTK watershed is the Kelley Bayou oxbow. There were originally two oxbows created from the circuitous route of the Wabash River, though the northernmost one has now been sealed off by a levee and is considered a permanent lake at this time. The southern oxbow still receives water from the Wabash River during flood stage and is also fed by a stream that drains from the Kelley Bayou watershed (though this stream is also impounded and the drain is controlled by the Island Levee Association, as needed). The Nature Conservancy describes the benefits of oxbows as follows:

> *"Some of the benefits that functional oxbows offer are habitat for fish and wildlife, floodwater storage, and removal of pollutants."*

The Nature Conservancy has taken special interest in the Kelley Bayou oxbow and donated funds for the WCIWA to conduct 12 months of water sampling at a site within the oxbow. Seasonal changes were observed and data was collected based on macroinvertebrates found. Additionally, a QHEI (Qualitative Habitat Evaluation Index) was collected. Monitoring parameters for Kelley Bayou were the same as the methods used for the 29 other sites being sampled in the TTK watershed (described at length in Part II).

Figure 8 - Kelley Bayou Oxbow, Sullivan County

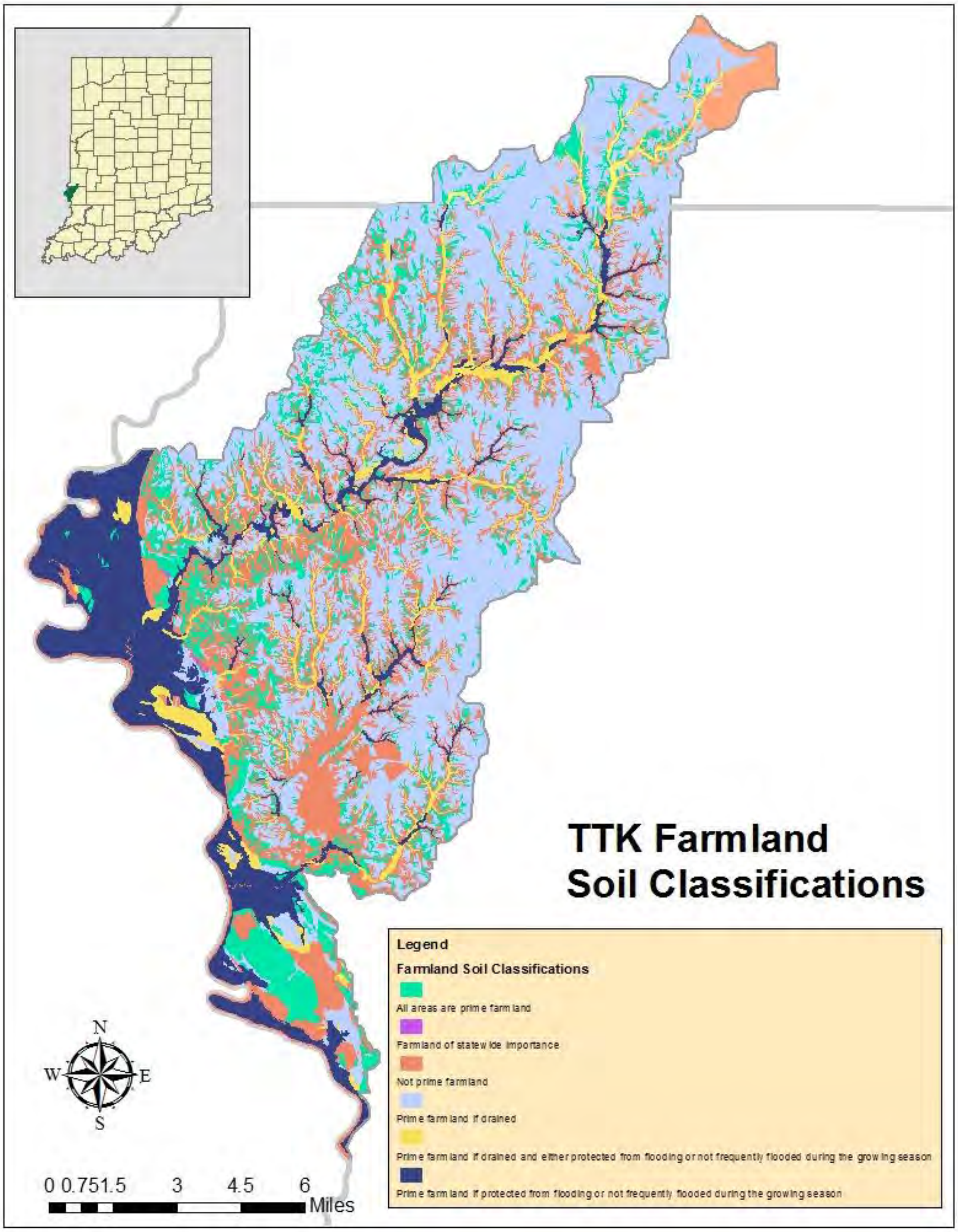
2.3 Soil Characteristics and Classifications

The TTK watershed is comprised of a variety of soil types, many of which are perfect for growing some of the best crops in the Midwest. Soils throughout the TTK watershed range from sandy to hydric to highly erodible in places. Soil types influence drainage and erodibility and are grouped into general soil associations. Soil associations are not generally regarded when it comes to making land management decisions. Specific soil types are consulted when it comes to determining whether or not land is considered to be highly erodible, hydric, or if it is suitable for proper septic system leaching. Soil types can also be used to determine if land is considered to be 'prime farmland' (Figure 9). Prime farmland is defined by the U.S. Department of Agriculture as follows:

"*Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forestland, or other land, but is not urban or built-up land or water areas. The soil quality, growing season and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied."*

Due to the productive nature of the soils throughout the TTK watershed, much of the land is actively farmed. In some cases, wooded areas are cleared in order to convert the land for farming purposes. If 'acceptable farming methods' are not applied, the soil is at definite risk for erosion and nutrient degradation. Excess sediment can be transported to streams and lakes during heavy rain events, degrading habitat and transporting field applied nutrients such as phosphorus. In other areas of the state, prime farmland can be at risk due to encroaching urbanization, though in the TTK watershed, this is not an immediate concern.

Figure 9 - TTK Farmland Soil Classification



Highly Erodible Soil

Soil loss is a definite concern within the TTK watershed, especially when it comes to soils that are classified as 'highly erodible' by NRCS. The NRCS Field Office Technical Guide (Section II) describes highly erodible land as follows:

"The Food Security Act of 1985 required that soil survey map units be separated into three categories on the basis of potential erodibility due to wind erosion and sheet and rill erosion. A Highly Erodible Soil Map Unit list designates the category assigned to each map unit. It has been determined that no map units are highly erodible because of only wind erosion in Indiana. The equation for determining potential erodibility from sheet and rill erosion is:

$$A = \frac{RK\,(LS)}{T}$$

(A) is the amount of soil loss in tons per acre, (R) is the rainfall factor, (K) is the soil erodibility factor, and (L) and (S) are slope length and steepness factors, respectively, and (T) is the tolerable soil loss in tons per acre.

A map unit is designated highly erodible (class 1) if the value (A) obtained from the equation is equal to or greater than 8 when the minimum slope length and minimum slope percent are used.

A map unit is designated potentially highly erodible (class 2) if the value obtained from the equation is less than 8 when the minimum slope length and minimum slope percent are used but equal to or greater than 8 when the maximum slope length and maximum slope percent are used.

A map unit is designated not highly erodible (class 3) if the value obtained from the equation is less than 8 when the maximum slope length and maximum slope percent are used.

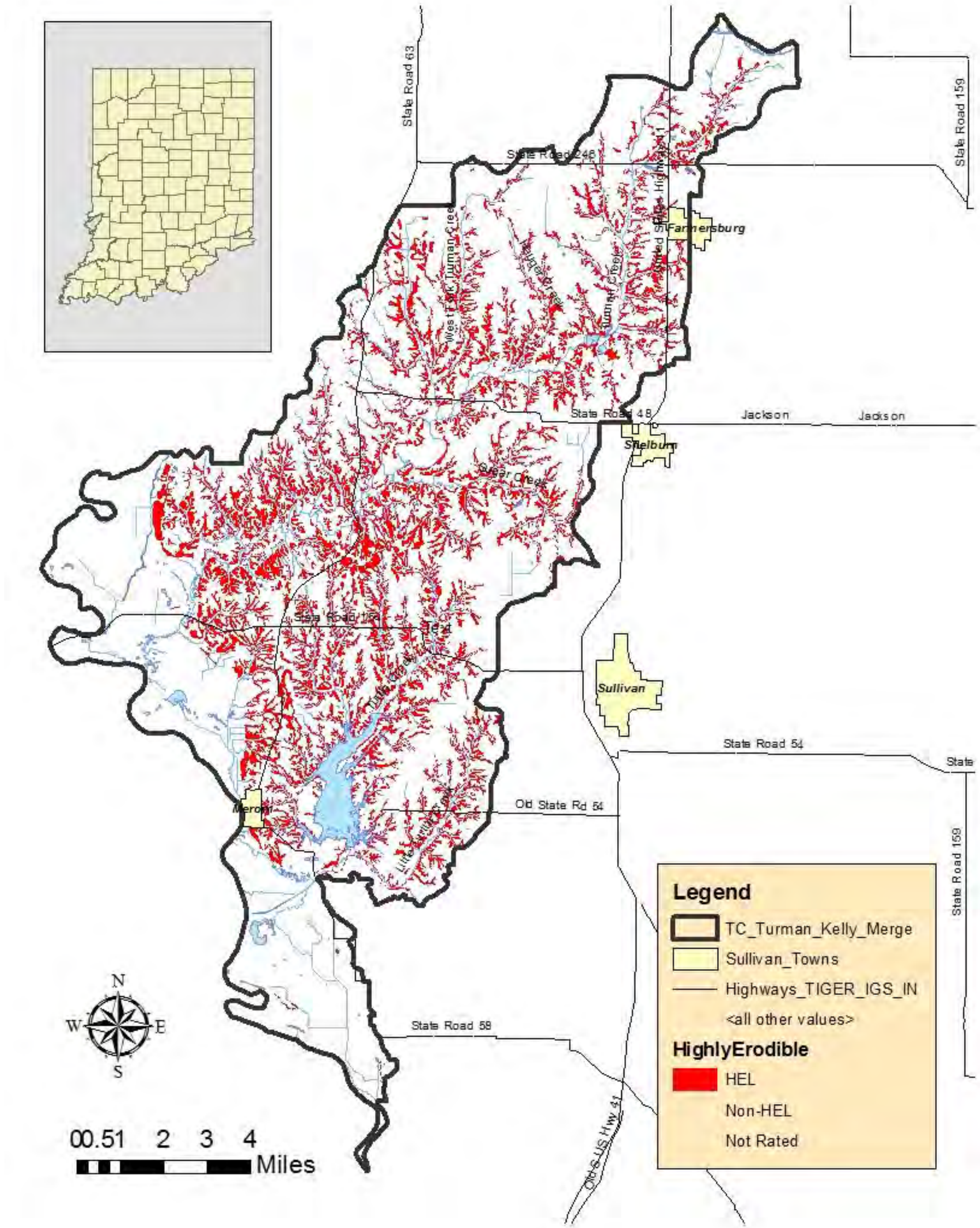
The minimum and maximum slope percent are obtained from the map unit name, i.e., Miami silt loam, 2 to 6 percent slopes. Two is the minimum value and 6 is the maximum value. The minimum and maximum slope lengths were determined by district conservationists, soil scientists and other local people."

In the TTK watershed, 17% of soils are considered to be highly erodible, especially in the areas where there are steeper slopes, such as the Dodd's Bridge and West Turman subwatersheds. Stakeholders have cited widespread concern about soil erosion during Advisory Committee meetings and other public venues. Soil erosion has been seen to degrade stream habitats and accumulate in lakes. Recent studies conducted by Hoosier Energy have demonstrated this transport of sediment into the lake.

Table 4 - TTK Highly Erodible Soils Quantified

Classification	Number of Acres	% of TTK Watershed
HEL (Highly Erodible Land)	17,099.93	17%
Non-HEL	80,675.67	79%
Not Rated	4,054.12	4%

Figure 10 - TTK Highly Erodible Soils



Hydric Soil

Much of the TTK watershed's soils can be classified as 'hydric'. In fact, 63% of the watershed's soils have the potential to be hydric. Hydric soils can indicate a soil's current or former propensity towards wetland characteristics and must not be disturbed for the purpose of cultivation or construction. The NRCS Hydric Soils Technical Notes states:

"*Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). These soils, under natural* *conditions, are either saturated or inundated long enough during the growing season to support growth and reproduction of hydrophytic vegetation."*

Figure 11 - TTK Hydric Soils

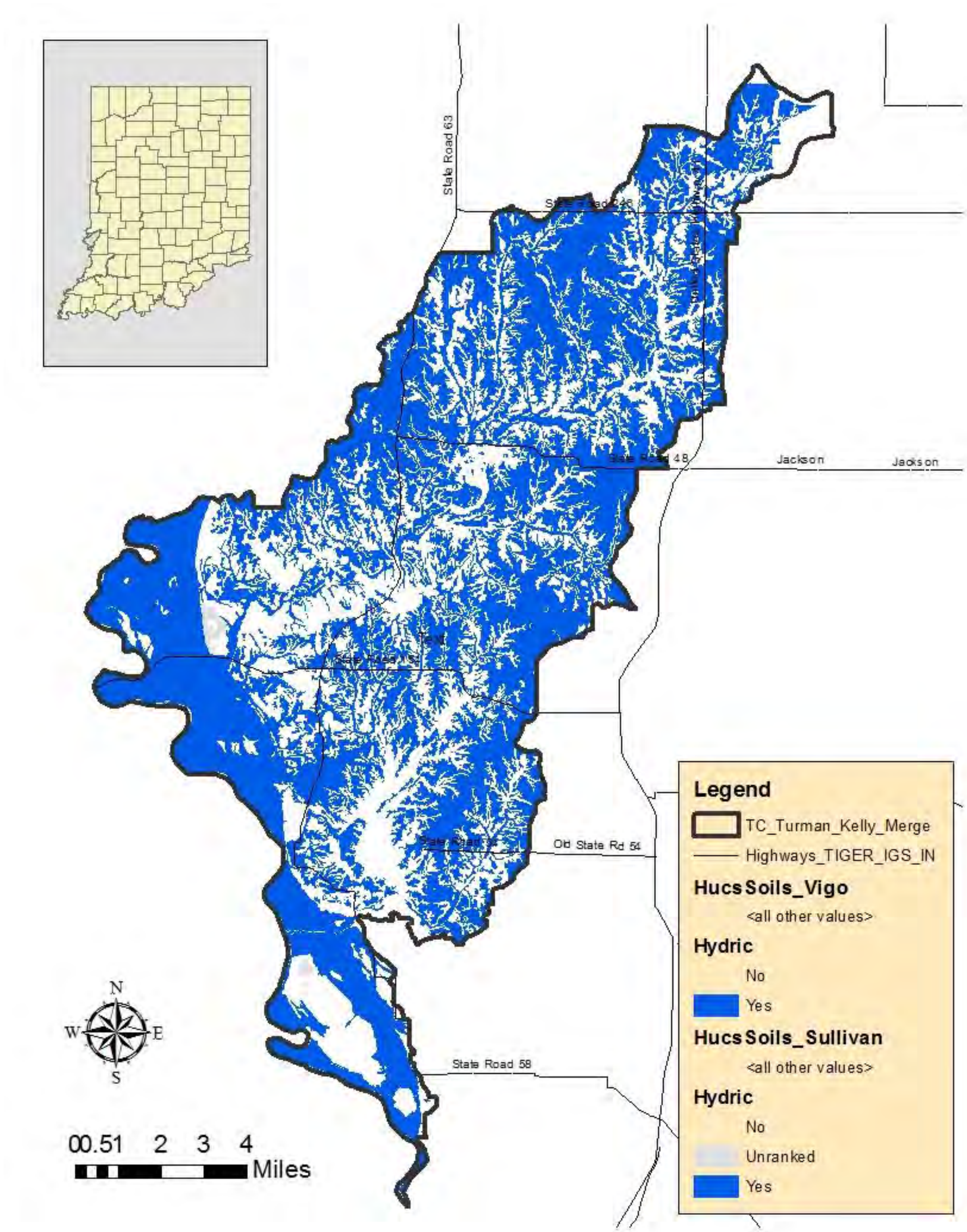


Table 5- TTK Hydric Soils Quantified

Classification	Number of Acres	% of TTK Watershed
Hydric	64,166.86	63%
Non-Hydric	37,368.92	36.7%
Not Ranked	293.95	0.3%

Septic Systems and Soil Suitability

The TTK watershed is classified as 'rural'. It is made up of many gravel roads and only a few towns. Farmersburg (2010 Census - population 1,118) is the largest population center within the watershed and only a portion is encompassed by TTK boundaries. Merom has a reported population of 228 (2010 Census). Farmersburg is the only populated areas in the watershed that utilizes a sewer system with waste treatment facility. Wastewater from Farmersburg is discharged into Busseron Creek, to the east. The Hoosier Energy facility in Merom has approximately 150 employees on-site each day. The facility uses a sanitary package plant with UV treatments on its discharge, while closely monitoring E.coli limits imposed by permit.

Excluding homes within the city limits of Farmersburg, stakeholders throughout the TTK watershed rely solely on septic systems. There is widespread concern about the lack of proper septic maintenance based on high E.coli concentrations reflected in the 2014-2015 twelve month TTK water monitoring study as well as first-hand reports cited by many stakeholders and interested parties. Based on available Census imagery, an estimated 3,000 homes are located in the TTK watershed and 90% of them are over 20 years old. Almost all homes in the TTK watershed are on private septic systems, many of which are in a state of failure, especially if they have not been maintained regularly. If a conservative estimate considers that 2/3 of the systems are failing, it can be assumed that over 24,000lbs of Phosphorus are delivered to streams each year. This problem could also be exacerbated due to the fact that much of the soil throughout the watershed is classified as Class C, which has moderately high run-off potential.

It should also be noted that the town of Merom was recently issued a Notice of Violation for discharge of raw sewage into waters of the State. This violation is in the process of being remedied with a mandate recently passed requiring residents to have private septic systems inspected by a professional. If a septic system fails inspection, the residents will be required to bring it into compliance by February 2016 or a monthly fine will be applied. If the resident is still not able to comply, a licensed contractor can be hired by the town of Merom to fix the septic system. The cost of hiring this professional will result in a lien against the property.

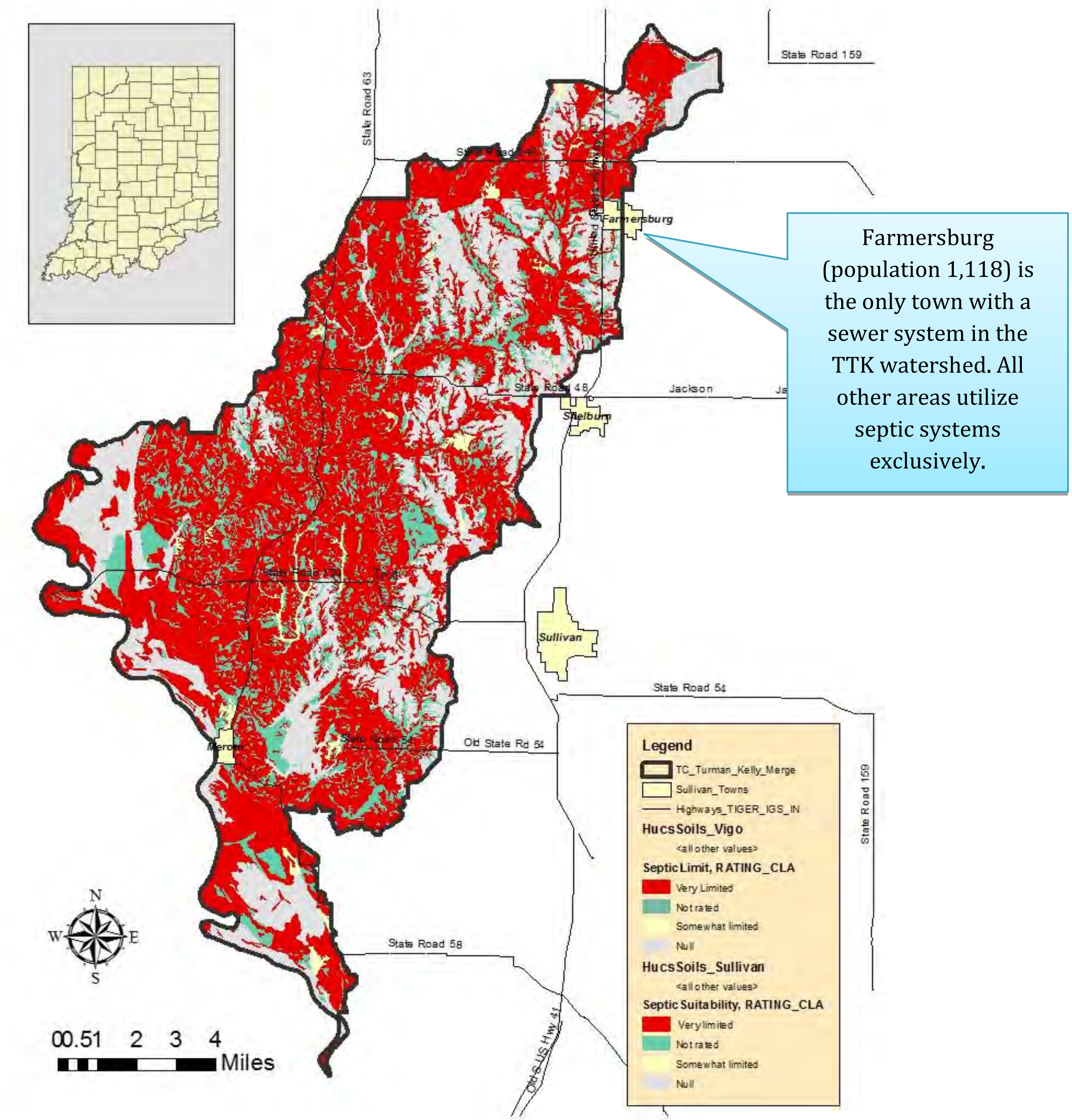
Featured below is a map showing areas of limited septic suitability. It is obvious that a very large portion of the watershed contains soils that are not ideal for septic systems. Of the few populated areas, only one utilizes a town-wide wastewater treatment system (Farmersburg). E.coli in public lakes and streams can pose a hazard to human health.

Table 6 - TTK Soil Septic Suitability Statistics

Classification	Number of Acres	% of TTK Watershed
Very Limited	57,637.9	49.8%
Somewhat Limited	5,533	4.8%
Not Rated	365.867	0.3%
Null*	52,133.23	45.1%

**Null values indicate that no data is available for these map units (same as Not Rated). No determinations can be made at this time as to whether or not the soil is suitable for septic systems.*

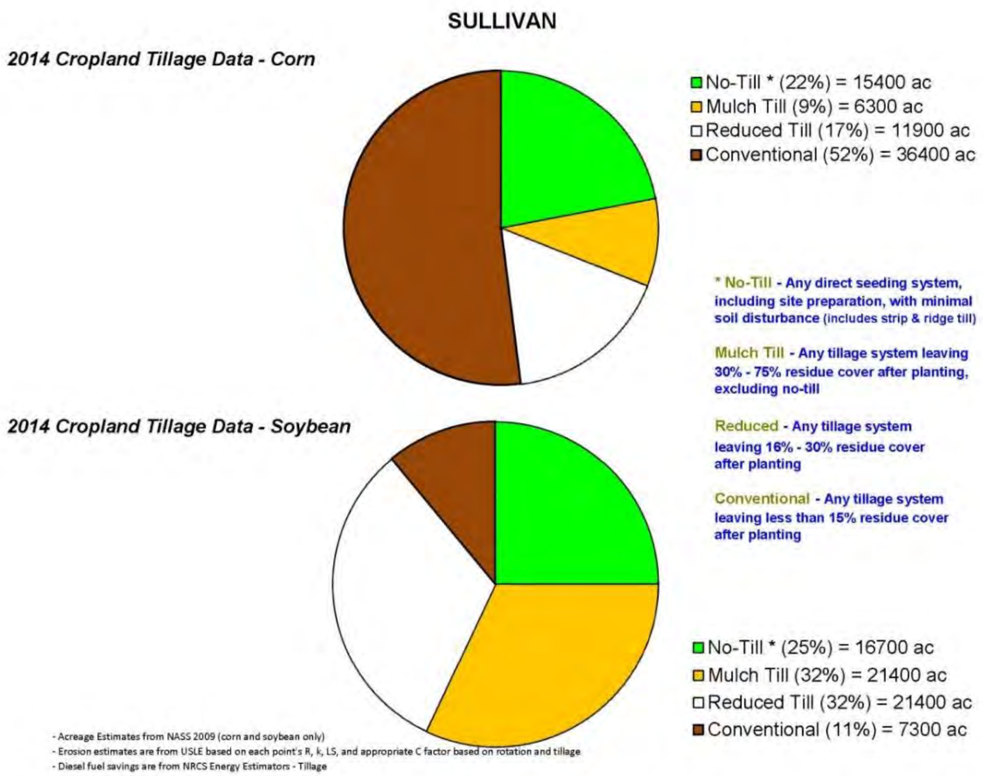
Figure 12 - TTK Soils: Septic Suitability and Sewered Population Centers



Tillage Transect

Tillage transects are completed annually in Sullivan County by representatives from NRCS, Indiana State Department of Agriculture (ISDA), and the Sullivan Co. SWCD. During the tillage transect, 562 fields are evaluated each year according to the current crop and tillage methods observed. The tillage transect is typically conducted in June each year and data has been collected for decades. Featured below is the data from the most recent tillage transect in Sullivan County. Tillage methods in southern Vigo County closely mirror those adopted in Sullivan County, so there was no need to feature the Vigo County Tillage Transect, as well.

Figure 13 - 2014 Tillage Transect Data – Sullivan County



Estimated Acres of SULLIVAN County Corn and Soybeans with indicated Tillage system for each Present crop (based on 2011 NASS data)

Present crop	No Till + Strip + Ridge acres	Mulch Till acres	Reduced Till acres	Conven-tional Tillage acres	Cover Crops acres	Risers / Inlets acres
Corn	15,400	6,300	11,900	36,400	3,500	2,800
Soybeans	16,700	21,400	21,400	7,300	3,300	6,700
TOTALS	32,100	27,700	33,300	43,700	6,800	9,500

SULLIVAN County's Tillage on Cropland - Impacts on Sheet/Rill EROSION in 2014:

If each Corn or Soybean site on the 2014 tillage transect in SULLIVAN County were:

CONVENTIONALLY TILLED = an estimated *807,100* tons of soil would be lost from sheet/rill

As a result of the actual tillage practices on SULLIVAN County's Corn and Soybean acres,

an estimated: ***403,700*** **tons of soil in 2014 are SAVED!**

SULLIVAN County's Tillage on Cropland - Impacts on DIESEL FUEL USED in 2014:

If each Corn or Soybean site on the 2014 tillage transect in SULLIVAN County were:

CONVENTIONALLY TILLED = an estimated *681,300* gallons of diesel fuel would be used

As a result of the actual tillage practices on SULLIVAN County's Corn and Soybean acres,

an estimated: ***108,400*** **gallons of diesel fuel in 2014 are SAVED!**

Project: Indiana Cropland Transect Survey

Year: 2014

County: SULLIVAN

Percent and Number of SULLIVAN County fields with indicated Tillage system for each Present crop.

Present crop	No Till %	No Till pts	Strip Till %	Strip Till pts	Ridge Till %	Ridge Till pts	Mulch Till %	Mulch Till pts	Reduced Till %	Reduced Till pts	Conventional Tillage %	Conventional Tillage pts	Tillage Unknown or N/A %	Tillage Unknown or N/A pts	Cover Crops %	Cover Crops pts	Ephemeral Erosion %	Ephemeral Erosion pts	Risers / Inlets %	Risers / Inlets pts
Corn	22%	40	0%	0	0%	0	9%	16	17%	31	52%	94	0%	0	5%	9	4%	8	4%	8
Soybeans	25%	52	0%	0	0%	0	32%	67	32%	66	11%	24	0%	0	5%	10	1%	2	10%	21
Small grains	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Hay/Pasture	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Fallow	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
Specialty Crops	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
CRP and similar	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0
TOTALS	21%	92	0%	0	0%	0	19%	83	22%	97	27%	118	0%	0	4%	19	2%	10	7%	29

SULLIVAN County's Tillage on Cropland - Impacts on Sheet/Rill EROSION in 2014:

If each Corn or Soybean site on the 2014 tillage transect in SULLIVAN County were:

CONVENTIONALLY TILLED = an estimated average of **5.9** tons of soil/acre/yr would be lost

SULLIVAN County's Conventionally-Tilled Corn will lose an average of **6.8** tons of soil/acre/yr in 2014

SULLIVAN County's Conventionally-Tilled Beans will lose an average of **4.7** tons of soil/acre/yr in 2014

REDUCE-TILLED = an estimated average of **4.2** tons of soil/acre/yr would be lost

SULLIVAN County's Reduce-Tilled Corn will lose an average of **5.3** tons of soil/acre/yr in 2014

SULLIVAN County's Reduce-Tilled Beans will lose an average of **3.9** tons of soil/acre/yr in 2014

MULCH TILLED = an estimated average of **3.6** tons of soil/acre/yr would be lost

SULLIVAN County's Mulch-Tilled Corn will lose an average of **3.7** tons of soil/acre/yr in 2014

SULLIVAN County's Mulch-Tilled Beans will lose an average of **2.7** tons of soil/acre/yr in 2014

NO-TILLED/STRIP/RIDGE TILLED = an estimated average of **1.2** tons of soil/acre/yr would be lost

SULLIVAN County's No-Tilled Corn will lose an average of **1.2** tons of soil/acre/yr in 2014

SULLIVAN County's No-Tilled Beans will lose an average of **1.0** tons of soil/acre/yr in 2014

***As a result of the actual TILLAGE practices on SULLIVAN County's Corn and Soybean acres, an estimated:* 3.0 tons of soil/acre/yr are SAVED!**

SULLIVAN County's cropland planted to small grains will lose an average of **0.6** tons of soil/acre/yr in 2014

SULLIVAN County's fallow lands will lose an average of **0.4** tons of soil/acre/yr in 2014

SULLIVAN County's CRP and pastureland will lose an average of **0.1** tons of soil/acre/yr in 2014

***As a result of the actual CONSERVATION PLANTINGS in SULLIVAN County, an estimated:* 5.3 tons of soil/acre/yr are SAVED!**

- Acreage Estimates from NASS 2009 (corn and soybean only)
- Erosion estimates are from USLE based on each point's R, k, LS, and appropriate C factor based on rotation and tillage
- Diesel fuel savings are from NRCS Energy Estimators - Tillage

2.4 Land Uses

The landscape of the TTK watershed is characterized primarily by agriculture, forest, wetlands, and pasture, with most of these acres being held by private landowners. Featured below is a map showing these designated land uses distributed throughout the TTK watershed.

Figure 14 - Map of Land Uses in TTK Watershed

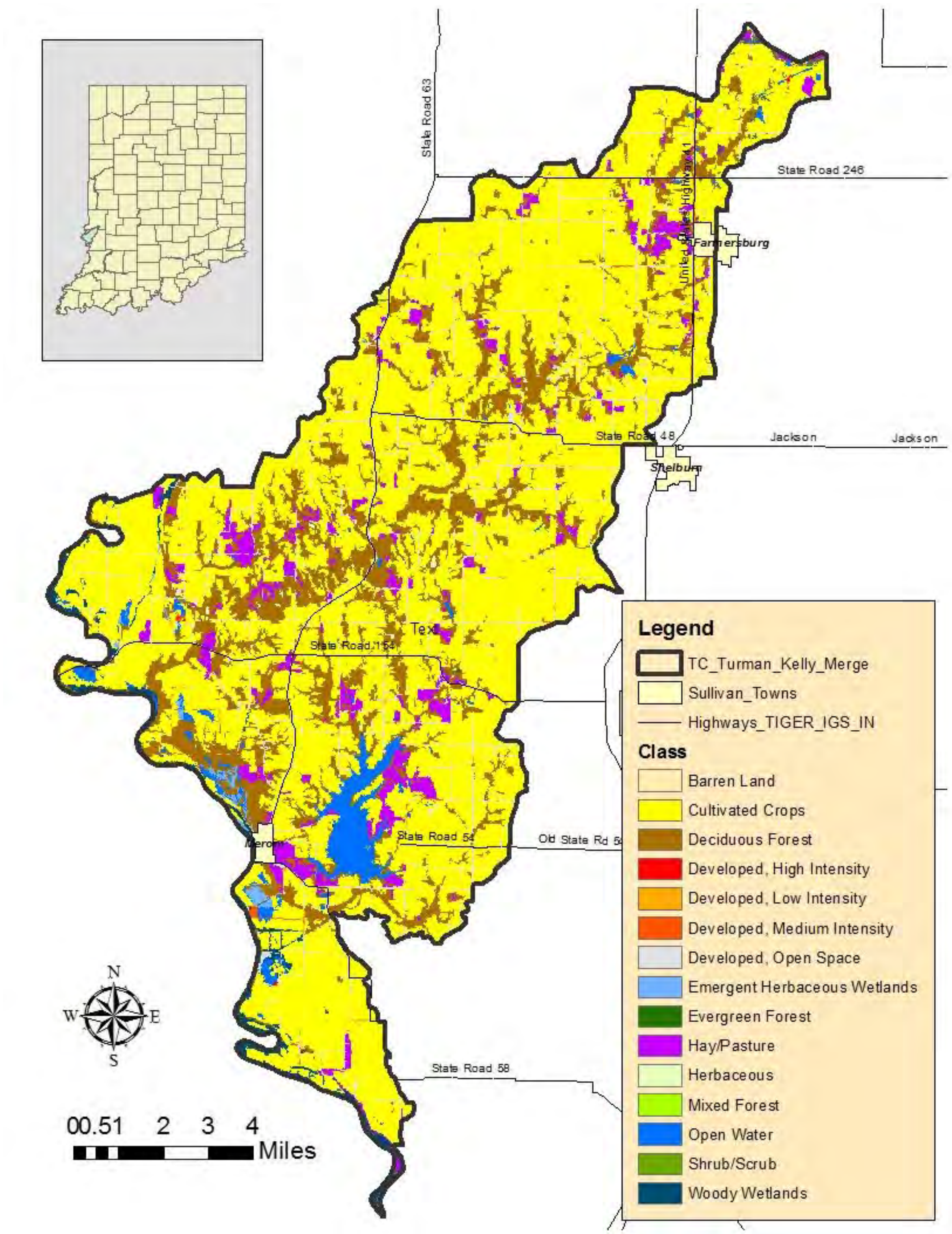


Table 7 - Land Use Statistics for TTK Watershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	69,211.36	67.9%
Deciduous Forest	16,788.07	16.5%
Developed, Open Space	5,458.12	5.4%
Pasture/Hay	4,323.99	4.2%
Open Water	3,289.98	3.2%
Woody Wetlands	1,139.49	1.1%
Developed, Low Intensity	754.11	<1%
Emergent Herbaceous Wetlands	382.13	<1%
Grassland/Herbaceous	202.37	<1%
Developed, Medium Intensity	164.27	<1%
Evergreen Forest	110.64	<1%
Barren Land	84.42	<1%
Developed, High Intensity	43.69	<1%
Shrub/Scrub	19.91	<1%
Total Acreage		**101,975.24 acres**

Most of the total acreage of TTK falls into Sullivan County, though a portion stretches up into Vigo County. Currently, a large percentage (67.9%) of the watershed is characterized by land devoted to agricultural production. Notable crops in the area include corn, soybeans, wheat, watermelon, canola, sorghum, millet, green beans, and alfalfa. Farming practices typically lean toward more conventional methods that rely on tillage and frequent application of fertilizer and other additives to fortify soil nutrients. Tillage Transect data in recent years (see Figure 13) confirms that the majority of agricultural land in the watershed falls under conventional tillage methods, which could be a contributing factor to the amounts of sediment found in TTK streams along with high turbidity levels, especially after a rainfall.

Soil loss is a great concern for residents and producers in the watershed. Turbid waters and embedded streambeds do not provide adequate habitat for the fish and macroinvertebrates that contribute to a balanced ecosystem. Additionally, producers are concerned with soil run-off as this lowers productivity and soil health significantly. Soil particles can also bind with certain additives, such as phosphorus, and transport these nutrients into the streams in excess. Soil is also lost in ditches, due to the practice of cleaning ditches periodically and not utilizing seed or erosion control measures of any type to prevent soil from eroding during rain events.

Streambank and shoreline erosion are also primary concerns when it comes to the contribution of sediment in local streams. Logjams can create blockages in streams that cause water to reroute and cleave into banks, causing much soil loss. Advisory Committee members report incidents throughout the watershed where trees have been harvested or cleared improperly, leaving stumps and tops to be washed into streams, causing these blockages. Windshield surveys also corroborate this claim in many instances, especially under bridges. In addition, much of the agricultural land in the TTK watershed is also drained by tile systems.

Current estimates of the amount of agricultural land drained in the Midwest are unclear at this time, but ongoing research suggests that much of Indiana's original wetland areas have been deforested and drained in order to increase farming productivity. It is also a cause of great concern that the overloading of local streams from excess diversion of rain water and run-off is a major contributing factor to streambank erosion and damaging flood events.

Shoreline erosion in the Turtle Creek Reservoir is described in the original Partnership for Turtle Creek WMP as being a cause for major concern. Efforts in the past have been made to stabilize shorelines along the reservoir, especially in areas where the lake is receding in close proximity to homes. In 2003, the Partnership for Turtle Creek conducted a demonstration of various methods for shoreline stabilization, including native vegetation strips, gabion baskets, and straw wattles. Hoosier Energy has also used rip-rap to treat areas with serious erosion along the reservoir, but problems are still reported in other areas. A recent bathymetric survey of the reservoir determined excessive sediment on the bottom of the lake, with up to 8 feet of foreign sediment accumulated in places.

A number of conservation programs are currently available through NRCS, FSA, DNR, and ISDA to help remediate some of these resource concerns. These agencies offer cost-share programs (EQIP, CRP, LARE, and CWI) with financial incentives for the implementation of conservation BMPs. In addition, there are at least 20 producers who have expressed active interest in conservation practices to be funded through TTK 319 Implementation. Best management practices such as nutrient management, heavy use area protection, exclusion fence and rotational grazing, precision agriculture and no-till planter upgrades, water and sediment control basins (WASCOBs), cover crops, and grassed waterways have been mentioned by producers. Many projects are currently being planned for construction, regardless of cost-share funding availability.

Fertilizer Use

Fertilizer is primarily used in TTK for the purpose of increasing agricultural production. There are few areas of concentrated population, which decreases the prevalence of using fertilizers for lawns, golf courses, or other commercial sites in an effort to enhance aesthetics, as is often observed in cities. Private landowners may apply fertilizers and pesticides sparingly to gardens, decorative plants, and as needed to landscaping.

Agricultural fertilizer is typically applied as a mix of nitrogen, phosphorus, and potassium. Many producers apply fertilizer at the time of spring planting and often side-dress (apply fertilizer again after planting), if they possess the correct equipment. Side-dressing is a beneficial practice as it allows producers to apply fertilizer more directly and with better timing, rather than just placing all of it on the field at once which can increase the risk of it not being used by the crop, only to be washed away if a heavy rain occurs. More and more producers are experimenting with cover crops in the winter to increase organic matter in an effort to reduce the amounts of fertilizer applied. Very few organic producers exist within the TTK watershed, though there are a few. Production agriculture on a large scale can be difficult without the aid of fertilizers to increase productivity and other chemical additives to prevent pest predation and weed competition, however research is ongoing and many producers are expressing less skepticism.

Pet and Wildlife Waste

To estimate the amount of pet waste in the TTK watershed that may be contributing to the evidently high E.coli numbers in local streams, the 2010 US Census was consulted. It was found that approximately 6,840 people live in the TTK watershed (estimated according to the percent of the watershed that falls within each township) in 2,603 households. According to research conducted by the American Veterinary Medical Association, 56% of households claim pets (dogs, cats, birds, or horses). This could account for an estimated 1,457 households in TTK with pets. It is estimated that a 50 lb. dog will create about 1 lb. of waste each day, which would mean an estimated 531,805 lbs. of waste is created each year by pets in TTK. Pet waste, if not properly removed and discarded, could find its way into local streams after a heavy rain event and contribute to high E.coli counts.

The TTK watershed has an abundance of wildlife, especially large populations of deer and waterfowl. In a balanced ecosystem, wildlife waste is not considered to be a detriment to water quality, though in areas with concentrated populations, wildlife waste could be a concern. Many stakeholders enjoy recreational hunting in the TTK watershed and based on local reports (or lack thereof), no wildlife populations have grown large enough to be considered a negative contributor to water quality. Abundance of wildlife of any kind, in a rural area such as TTK is seen more as a favorable indicator of good habitat and forage. Ongoing efforts will continue to monitor dense populations of wildlife that may negatively impact water quality with fecal waste.

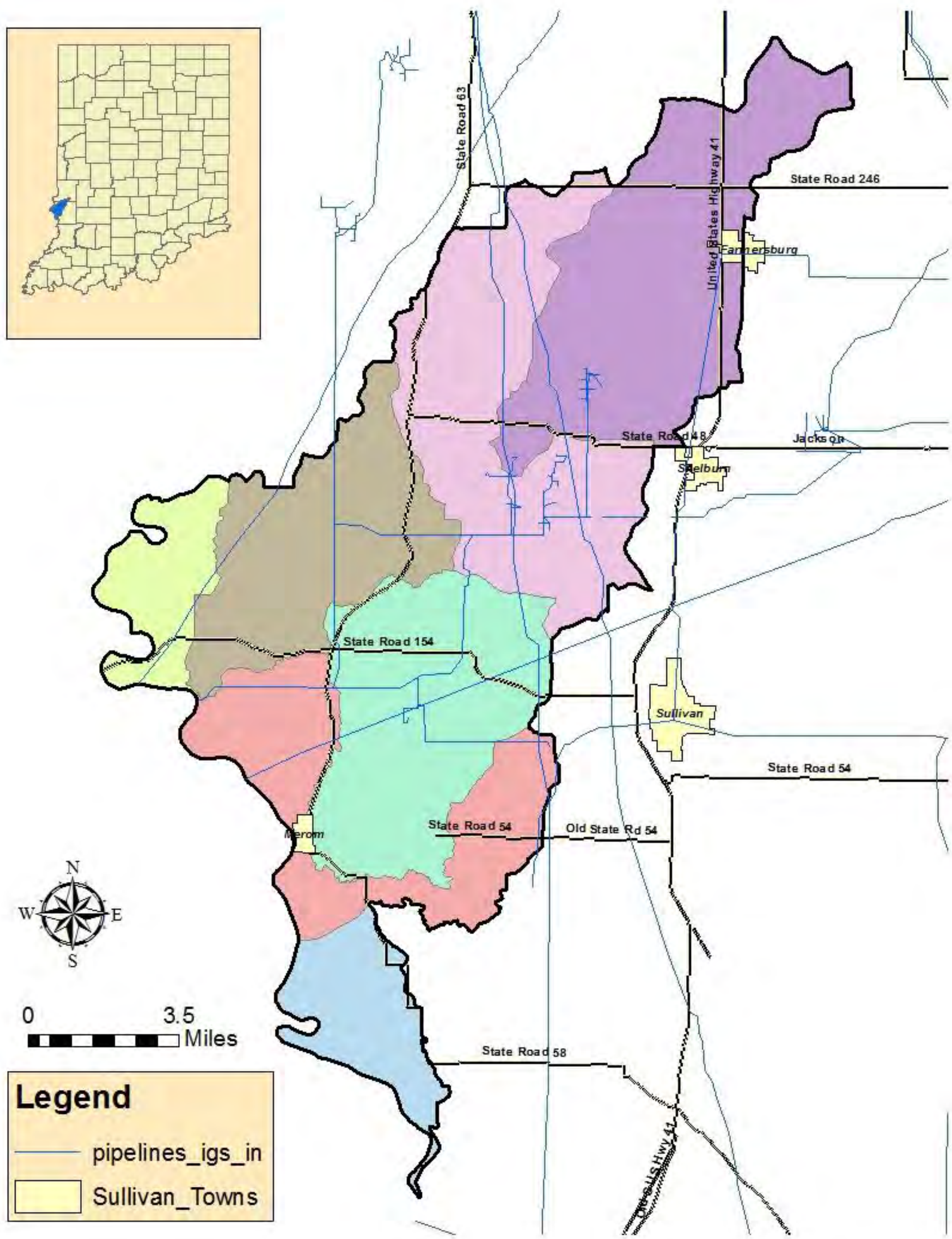
2.5 Planning Efforts

During an Advisory Committee meeting, planning efforts for development of any kind within the TTK watershed were discussed and few were mentioned. Due to the low population density and lack of urban areas within TTK, no major plans for city expansion exist at this time. However a few ongoing and anticipated projects within the watershed are worth noting.

Hoosier Energy has recently constructed a landfill east of the Merom Station, but does not report any plans for significant expansion in the future. Ongoing bathymetric surveys of the Turtle Creek Reservoir show significant sediment deposits in the lake. This, combined with the concern of surrounding landowners about shoreline erosion has motivated Hoosier Energy to seek strategies that will help prevent erosion on land upstream. Hoosier Energy seeks to promote conservation practices such as No-Till, grassed waterways, field borders and riparian buffers on the agricultural land surrounding the lake. The landfill will be required to follow permitting protocols associated with Rule 5 and on-site dumping.

Marathon has submitted a Rule 5 Erosion Control Plan for the future installation of a pipeline that will cross the watershed from east to west, mostly through the southern portion of the Turman Creek watershed. This project has the potential to contribute to erosion in the area if proper care is not taken to implement measures to reduce this, such as silt fence, grass blanket, sediment traps, and straw covering post-construction.

Figure 15 - Depiction of Underground Pipeline Locations in TTK Watershed



Another project of note is the proposed dam removal for the Thunderbird Pond. This large-scale project is currently being investigated by representatives from Cardno/JF New. Currently the property is owned and maintained by AEP, though the company is seeking options at this time for dam removal and stream restoration. Depending on the amount of funding available for the undertaking, a range of outcomes has been proposed, from basic dam removal to the 'ideal' project involving dam removal and extensive stream and wetland restoration. Cost estimates for this project range from $500,000-$900,000 and funding partners are currently being sought. Removing a dam can cause numerous short-term impacts, such as transport and deposition of accumulated sediment downstream, however long-term benefits can be achieved. Some of the long-term benefits of dam removal include reestablishment of natural stream flow and the ability for fish and other organisms to travel upstream, breed, and repopulate. Currently, Thunderbird Pond is not reported to be serving any great need for local residents, wildlife, or flood storage. The former mine has been reclaimed and ongoing research is being conducted to confirm that the effects of past mining will still be contained even after the dam is removed.

Otherwise, the occasional housing development or other construction project that will exceed 1 acre of disturbed topsoil is always a possibility. Projects of this nature (excluding farmland and construction associated with an individual's private homestead) are required by IDEM to submit an Erosion Control Plan and Notice of Intent to the Sullivan County SWCD in order to obtain a Rule 5 permit. These plans are kept on file at the Sullivan County SWCD office and are reviewed by an IDEM Stormwater Specialist. Site visits to inspect erosion control measures during construction are also subject to occur at any time according to the Stormwater Specialist's preference.

Population is widely distributed through the TTK area, with the largest towns being Merom and Farmersburg (population sizes 228 and 1,118, respectively). Neither town possesses any sort of development plan that is currently being utilized. No major road or highway construction is anticipated at this time; bridges and other structures are maintained or reconstructed on an as-needed basis and when funding allows. Drainage ditches follow this same protocol, as well.

The Gill Township and Island Levee Associations are in charge of inspecting and maintaining the levees that prevent the Wabash River from back-flooding into a significant amount of cropland in their respective areas; taxes are collected and the groups meet annually to determine what work (if any) must be done to maintain adequate function of all levees in the area.

Other Watershed Management Plans

In 2002 the Partnership for Turtle Creek was awarded a 319 grant for planning. A Watershed Management Plan for Turtle Creek and Little Turtle Creek watersheds was created and approved for the requirements at that time. A link to the entire plan is included here https://secure.in.gov/idem/nps/files/wmp_turtlecreek_4-151.pdf. This WMP is no longer considered sufficient by IDEM's current standards, but much information can be gleaned from the efforts made by the Partnership for Turtle Creek Advisory Committee at that time. The original Turtle Creek WMP established a solid baseline for determining water quality concerns in the area, as well as reinvigorating a once-active Advisory Committee and supportive group of partners. Original concerns were revisited and expanded upon in order to develop more comprehensive methods for determining water quality concerns in the area. Today's TTK WMP will offer more solutions for meeting load reduction goals, as well as more sophisticated methods for data collection and analysis. The Turtle Creek WMP must be acknowledged for providing a foundation for current watershed planning efforts in the area.

<u>Groundwater and/or Source Water Protection Plans</u>

Indiana American Water has a source water protection plan for Merom and coordinates an annual Wellhead Protection Plan meeting with Sullivan County emergency personnel, Hoosier Energy representatives, and local environmental groups. Having a protection plan in place safeguards against potential future harmful events such as chemical spill contaminations or natural disasters.

2.6 Threatened and Endangered Species

According to the most current information provided by the US Fish and Wildlife Service (February 2014), the species of highest concern in the TTK Watershed is the Indiana Bat, *Myotis sodalis*.

The Indiana Bat is known to roost in caves and mines throughout the winter. In the summer, it prefers to roost and forage in bottomlands, riparian corridors, and upland forests. These bats are social and often congregate in large groups, unlike many other types of bat found in Indiana. The loss of forest habitat has contributed to their lower numbers. In addition, the discovery of White Nose Syndrome, which is a fungus that causes widespread death of bats has been attributed to the large decline in population in recent years. This fungus affects almost all bat species in varying degrees throughout the Eastern United States by presumably interfering with hibernation, causing bats to waken in the middle of winter and perish due to inability to find food and regulate body temperature. The National Speleological Society and Bat Conservation International are currently researching this disease to determine specific causes, means of transmission, and ways to reduce further spread.

There are also a number of bivalve species listed as 'endangered' or 'threatened' in this area of the state. Freshwater mussels have been cited as Indiana's most endangered groups of animals. According to Indiana Fish and Wildlife's 2010 Wildlife Diversity Report, of the 77 freshwater mussel species found in the state, 19 are completely gone or no longer reproducing. A variety of explanations for this alarming decline have been proposed. Water pollution (point and nonpoint sources), loss of habitat, and encroachment of nonnative invasive species could all be contributing factors to these low scores. It is also historically known that various mussel species associated with the Wabash River and its tributaries were harvested in abundance for the use of their shells to make iridescent, mother-of-pearl buttons. In the TTK watershed, large amounts of sediment in the streambeds create unfavorable habitat for a variety of species, including mussels.

A full list of threatened and endangered species identified by the Indiana State Department of Natural Resources (IDNR) for Sullivan and Vigo counties is found in Appendix B

Table 8 - Endangered, Threatened, and Rare Species (Sullivan and Vigo counties)

**Summarized from 2013 DNR list – See Appendix B*

Species Name		Status Description
Vertebrate Animals		
1	Indiana Bat	Federally Endangered
2	Evening Bat	State Endangered
3	Eastern Red Bat	Special Concern (state)
4	Little Brown Bat	Special Concern (state)
5	Northern Myotis (bat)	Special Concern (state)
6	Eastern Pipistrelle	Special Concern (state)
7	Least Weasel	Special Concern (state)
8	American Badger	Special Concern (state)
9	Lake Sturgeon	State Endangered
10	Ohio Lamprey	Imperiled (state)
11	Greater Redhorse	State Endangered
12	Spottail Darter (fish)	Rare (state), Imperiled (state)
13	Eastern Hellbender	State Endangered
14	Northern Leopard Frog	Special Concern (state)
15	Northern Cricket Frog	Special Concern (state)
16	Northern Crawfish Frog	State Endangered
17	Eastern Spadefoot (toad)	Imperiled in State
18	Blanding's Turtle	State Endangered
19	Kirtland's Snake	State Endangered
20	Eastern Massasauga (snake)	State Endangered
21	Eastern Box Turtle	Special Concern (state)
22	Henslow's Sparrow	State Endangered
23	Short-eared Owl	State Endangered
24	American Bittern	State Endangered
25	Northern Harrier	State Endangered
26	Bald Eagle	Special Concern (state)
27	Least Bittern	State Endangered
28	Marsh Wren	State Endangered
29	Peregrine Falcon	State Endangered
30	Hooded Merganser	Imperiled (state) – Breeding grounds
31	Sharp-shinned Hawk	Special Concern (state)
32	Upland Sandpiper	State Endangered
33	Loggerhead Shrike	State Endangered
34	Yellow-Crowned Night Heron	State Endangered
35	Osprey	State Endangered
36	King Rail	State Endangered
37	Virginia Rail	State Endangered
38	Barn Owl	State Endangered
Invertebrate Animals		
39	Turquoise Bluet (damselfly)	Rare (state)
40	Eastern Fanshell Pearlymussel	Federally Endangered
41	Tubercled Blossom (mussel)	Federally Endangered

Table 8 (Cont.) - Endangered, Threatened, and Rare Species (Sullivan and Vigo counties)

Species Name		Status Description
42	Snuffbox (mussel)	Federally Endangered
43	Longsolid (mussel)	State Endangered
44	Pocketbook (mussel)	Imperiled (state)
45	Ring Pink (mussel)	Federally Endangered (state extinct)
46	Clubshell (mussel)	Federally Endangered
47	Ohio Pigtoe (mussel)	Special Concern (state)
48	Rough Pigtoe (mussel)	Federally Endangered
49	Pyramid Pigtoe (mussel)	State Endangered
50	Northern Riffleshell (mussel)	Federally Endangered
51	Pink Mucket (mussel)	Federally Endangered
52	Scaleshell (mussel)	Federally Endangered
53	Black Sandshell (mussel)	Imperiled (state)
54	Round Hickorynut (mussel)	Critically Imperiled (state)
55	White Wartyback (mussel)	Federally Endangered
56	Sheepnose (mussel)	Federally Endangered
57	Kidneyshell (mussel)	Special Concern (state)
58	Rabbitsfoot (mussel)	State Endangered
Vascular Plants		
59	Lake Cress	State Endangered
60	Heavy Sedge	State Endangered
61	Thinleaf Sedge	State Endangered
62	Rose Turtlehead	State 'Watch List'
63	Hairy Golden-aster	State Threatened
64	Secund Rush	State Endangered
65	Least Duckweed	State Endangered
66	Bottomland Broomrape	State Endangered
67	Spotted Pondweed	State Endangered
68	Royal Catchfly	State Threatened
69	Branching Bur-reed	State Threatened
70	Slick-seed Wild-bean	State Threatened
71	Prairie Gray Sedge	State Threatened
72	Cusp Dodder	State Endangered
73	Water-purslane	State Endangered
74	Slender-stalked Gaura	State Threatened
75	Carolina Woollywhite	State Endangered
76	Cattail Gay-feather	State Threatened
77	Narrow-leaved Puccoon	State Endangered
78	Shaggy False-gromwell	State Endangered
79	Canada Burnet	State Endangered
80	Buffalo Clover	State Endangered

2.7 ***Review of Relevant Relationships***

Population Centers and Soils Unsuitable for Septic Systems

Population centers within the TTK watershed are relatively small, including Merom, part of Farmersburg, a few other very small towns (Graysville, Dodd's Bridge, Riverton) and several modest housing developments. With the exception of Farmersburg, homes within the TTK watershed depend on septic systems for waste disposal. In fact, many septic systems were installed before regulations regarding drainage areas were mandated, so it is likely that many homes possess a system that does not have a large enough drainage field, causing contaminated water to reach surface water and streams before harmful bacteria has been properly filtered. Evidence of this assumption is reflected in the exceedingly high E.coli counts found during widespread water monitoring. Some sites showed high E.coli counts in the middle of winter, which suggests a constant influx of untreated water is reaching streams. Bacteria that should not survive cold temperatures is found to be present throughout the entire year at certain sites. In addition, nearly 50% of soils within the TTK watershed are classified as very limited for septic system suitability. It is evident that all of these factors can be contributing to the high levels of E.coli.

Topography and Soil Type

Though most of the land in the TTK watershed has a very gentle slope (less than 1%), there are areas that contain steep ridges and hills, especially around the Graysville area in the Dodd's Bridge subwatershed. Highly erodible soil types can be found on over 17,000 acres throughout the watershed, comprising 17% of the total land area. These types of soils are at risk for weathering and eroding, especially during heavy rains. In addition, there is an abundance of farmland throughout the TTK watershed, which if not properly managed with minimal tillage, filter strips and stream/ditch buffers, is always at risk for soil loss. It is not uncommon to see farming practices that occur in very close proximity to streams and ditches, with little to no grass buffer utilized. Due to the lack of slope in many places, much of this farmland is drained by subsurface tile which can transmit some contaminants directly into streams and ditches with little filtration.

Hydrology, Landuse, and Population Centers

The largest city in the area (Sullivan) lies outside of the TTK watershed's borders so there is not much pressure from urban development in the population centers of Merom and Farmersburg. The town of Merom has not seen much expansion in recent years, though failing septic systems are a concern in the small community. Farmersburg, which is at the northernmost point of the watershed, experiences some encroaching mines to the east and increased development along Highway 41. New establishments have constructed impervious parking lots, which increase the likelihood of untreated run-off reaching headwater streams.

Because the TTK watershed is mostly rural in nature, some industrial operations have utilized the unpopulated areas for harvesting resources. In a few areas of the watershed past mining practices have been reclaimed, but there is always the risk that materials could leach into groundwater and be transmitted to streams (though no pH anomalies were noted during 2014-

2015 monitoring in these areas). Oil wells are prevalent throughout the watershed and in several cases, a visible oil sheen could be observed on the water while monitoring at certain sites. This oil found in surface streams could also be due to the occasional practice (by private landowners) of spreading oil on gravel roads to minimize dust in the drier seasons. Additionally, Marathon is in the process of installing a pipeline that will run nearly the entire length of the TTK watershed. Hoosier Energy has also been a ‘population center’ of sorts. The generating station in Merom has about 150 employees on-site daily, along with the necessary infrastructure to carry out duties relating to the manufacture of energy resources. The Hoosier Energy generating station in Merom is subject to much regulatory oversight, though there is always a risk of an accident or occurrence that could cause pollutants to leave the site and enter surface water.

Soil Types and Location of Construction

The prevailing types of soil throughout the TTK watershed are silt-loam in nature and are considered to be non-HEL. There is not much construction occurring within the watershed outside of occasional expansion of the Hoosier Energy Merom generating station facilities, the Marathon pipeline installation, new farming operations and structures including a CFO, and the occasional private home construction. Any construction that disturbs more than 1 acre of topsoil is subject to obtaining an IDEM Rule 5 permit after creating an Erosion Control Plan. Construction sites of 1 acre or more will be obliged to implement appropriate erosion control measures, such as silt fence and seeding practices.

Endangered Species and Hydrology/Soil types

Highly erodible soils cause an abundance of sediment to be deposited in local streams from cropland, eroding streambanks, and unseeded ditches. Excess soil in streambeds damages habitat that is necessary for certain types of endangered species, including freshwater mussel varieties. In fact, habitat assessments during the summer of 2014 found that most sites were classified as ‘poor’, while some sites contained no detectable living creatures. Embedded streams provide little to no suitable habitat for beneficial macroinvertebrates. Additionally, poor septic soil suitability throughout the watershed contributes to the problem of unfiltered pollutants contaminating surface water, causing imbalances such as increased Nitrates/Nitrites and Phosphorus which can contribute to foreign algae and invasive duckweed growth in some cases. Unclean surface water deters wildlife, especially in the case of nesting and migrating birds.

3.0 Watershed Inventory II: Water Quality Assessment

3.1 Water Quality Data and Targets

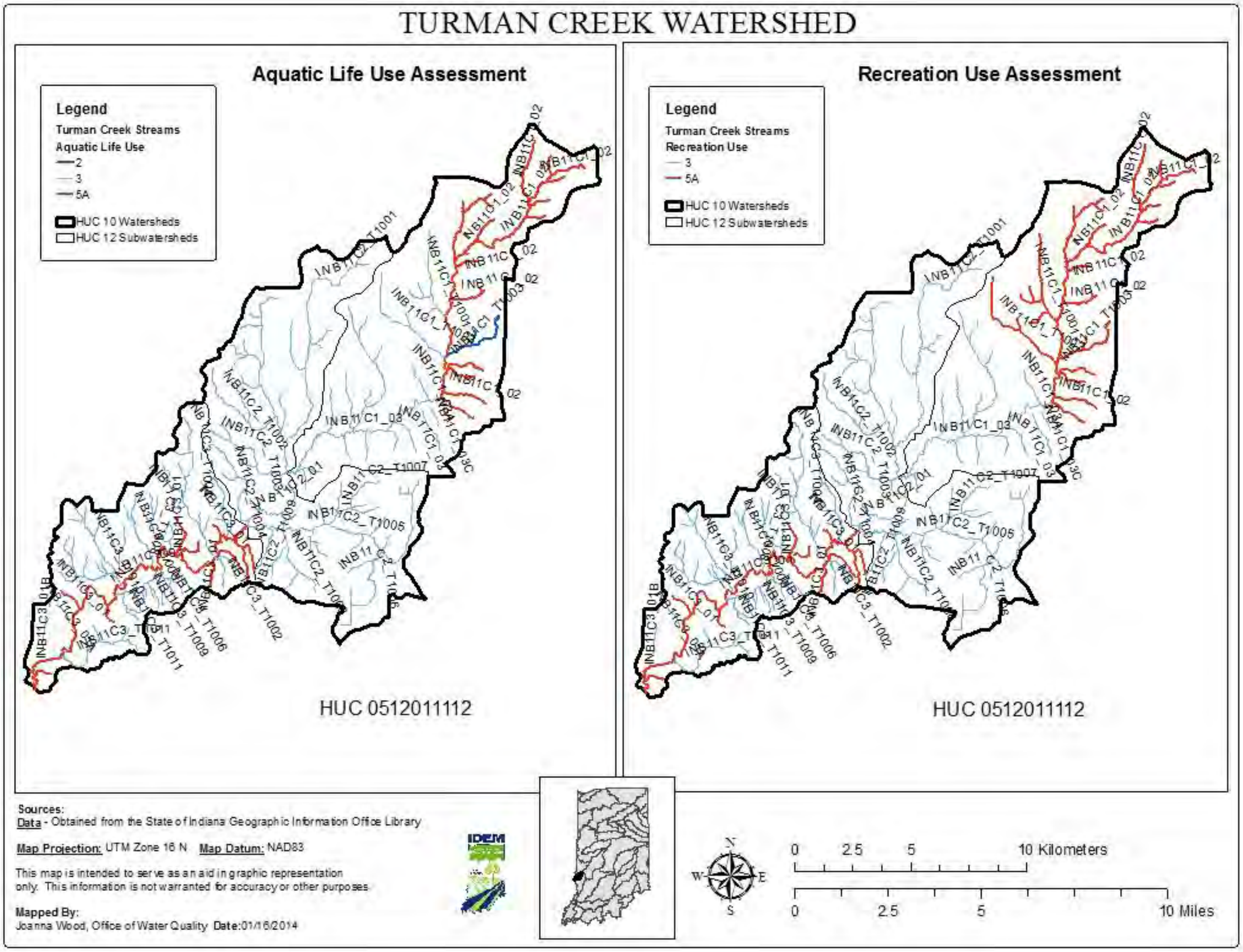
The TTK watershed is unique due to the lack of data that has been collected over the years in regards to water quality. Some marginal data sources were identified (EPA STORET, Hoosier Riverwatch, Partnership for Turtle Creek 319 grant) though much of this information comes from unknown collection methods and is not recorded clearly or to completion. The most accurate data sets were provided by IDEM’s Office of Water Quality, which will be referenced and utilized, while the other aforementioned sources will be largely disregarded due to their incomplete and often incoherent nature. To counteract this overall lack of data, a 12 month water monitoring study was conducted as part of the TTK 319 Planning and Implementation grant. Details regarding the method and frequency of water monitoring will be provided in this section. The data collected as a part of the TTK 319 Planning and Implementation grant, along with the information provided by IDEM's Office of Water Quality will be the chief sources from which water quality insight is derived for the purpose of planning.

As shown on Table 9 below, several stream segments with Turman Creek are given a 5A designation by IDEM's Water Quality Assessment Branch. IDEM's Category 5A of the Consolidated List classification states that the quality of the water falls below standard for recreational use or aquatic life use. Once a Total Mass Daily Load (TMDL) study is conducted for this watershed and approved by EPA, the stream segment can be moved to Category 4A where it will be considered impaired, but with guidelines (provided extensively by the TMDL) for improvements that will allow it to meet quality standards.

Table 9 - 2012 303(d) List Information for TTK

Waterbody	Segment ID	2006 303(d) Cause(s) of Impairment	Classification
Turman Creek	INB11C1_02	E.coli and Impaired Biotic Communities	5A
Turman Creek–Unnamed Tributary	INB11C1_T1001	E.coli	5A
Turman Creek – Unnamed Tributary	INB11C1_T1002	E.coli	5A
Turman Creek – Unnamed Tributary	INB11C1_1003	E.coli	5A
Turman Creek	INB11C3_01	E.coli and Impaired Biotic Communites	5A

Figure 16 - IDEM Assessment Branch – Turman Creek 5A Designations



Based on what is currently known, the only official impairments listed include five stream segments in the Turman Creek watershed listed as 5A. No comprehensive TMDL study has been conducted for any of these watersheds to date, so it was necessary to develop water quality targets based on state or national recommendations, and when possible, on parameters used in other areas or nearby watersheds (with the Advisory Committee's oversight). Listed below are the water quality targets (i.e. acceptable pollutant concentrations) designated for the TTK watershed.

Data and discussion of contributing factors for the impairments identified will be discussed at length for each of the seven 12-digit HUC subwatersheds in Section 3.5.

Table 10 - Water Quality Targets (Developed for TTK Water Monitoring)

Parameter	Water Quality Targets	Required Value or Recommended Value	Source for Requirements or Recommendations
Total Suspended Solids	10 mg/L	Recommended Value	Based on comparison of multiple regional WMPs
E.coli	<235 cfu/100mL	Required Value	Indiana Administrative Code
Nitrate/Nitrite	≤1.0 mg/L	Recommended Value	Based on comparison of multiple regional WMPs
Total Phosphorus	≤0.07 mg/L	Recommended Value	U.S. EPA recommendation
Qualitative Habitat Evaluation Index (QHEI)	≥ 40 points	Recommended Value	IDEM
Macroinvertebrate Index of Biotic Integrity (Pollution Tolerance Index)	≥ 17 points	Recommended Value	Hoosier Riverwatch
pH	6.0 to 9.0	Required Value	Indiana Administrative Code
Dissolved Oxygen	Min: 4.0 mg/L Max: 12.0 mg/L	Required Value	Indiana Administrative Code
Temperature	Monthly Standard	Required Value	Indiana Administrative Code
Turbidity	<10.4 NTU	Recommended Value	U.S. EPA recommendation

Windshield and Desktop Surveys

Choosing sampling locations was completd via desktop survey and then verified on-site. Analyzing aerial imagery through GIS programs along with regular water monitoring activity and participation in annual tillage transects provided insightful tools for gathering information about resource concerns present throughout the TTK watershed. Much time was spent in the field over the course of the 12 month water monitoring study identifying and verifying many of the concerns cited by members of the Advisory Committee and other stakeholders. Conducting water monitoring in all seasons also allowed for the photo documentation of each stream site's changes with fluctuating water levels, vegetetation, and nearby land uses. Many concerns stated by the Advisory Committee were verified through windshield surveys, including excessive sediment run-off, stream bank erosion, poorly maintained drainage ditches, log jams, flooding, trash, poor pasture management (including livestock with free access to streams), and widespread conventional tillage practices. Windshield surveys conducted in this comprehensive manner over the course of 12 months, yielded the following objective observations:

- No fewer than 24 sites were observed where livestock had unrestricted access to a stream and degraded pasture from overgrazing.
- Over 20 instances of what could be considered 'severe' streambank erosion were noted, typically in conjunction with log jams or lack of riparian buffer.
- Near one water monitoring site, the practice of spreading oil on a gravel road to minimize dust was observed (odor and visual confirmation) on three different occasions over a one mile stretch of road in the Dodd's Bridge subwatershed. A visible oil sheen was observed on the water during monitoring throughout the year.
- Trash, animal carcasses, and large household applicances have been dumped into streams near bridges at no fewer than 6 water monitoring sites.
- Problematic log jams (i.e. significantly changing stream flow and causing bank erosion) have been reported by 5 different stakeholders and confirmed in 3 water monitoring locations.
- Invasive Asian Carp were confirmed at 6 different water monitoring locations.
- Roadside ditches excavated and left with bare dirt (no permanent/temporary seed or erosion control blanket) on six different occasions.
- Invasive species such as Asian Bush Honeysuckle, Autumn Olive, Climbing Euonymous, Japanese Honeysuckle, Garlic Mustard, Phragmites, Watermeal, and Duckweed are common and problematic throughout the TTK watershed, especially along forest edges and in slow/non-flowing streams (aquatic species).
- Large accumulations of silt can be observed at most monitoring sites (25 out of 30), making sample collection difficult if an individual wades into a seemingly shallow stream. Many of these sites also have very poor macroinvertebrate populations.
- Farming practices occurring within less than 10' of stream edges and roadside ditches were common. Adequate buffers of 30' or more were less common in practice. The Nature Conservancy estimated stream buffers throughout TTK via desktop survey; results and discussion can be viewed in depth in Section 3.2 on Table 17 and Figure 18.

Additionally, aerial photographs of sediment plumes into the Turtle Creek Reservoir were provided in the original Turtle Creek WMP (Figure 20) and also observed during the TTK Boat Tour in the fall of 2014. Disappearing islands and shoreline erosion were also documented during that time by participants. The Hoosier Energy land manager provided an overview of rented lands adjacent to the reservoir where farming practices were taking place with minimal field buffers and conventional tillage in some cases.

Degraded habitat and poor macroinvertebrate scores were recorded at an abundance of sites throughout the entire TTK watershed, which could be due to the excessive amounts of sediment and silt present in stream beds. In many cases, stream depth would appear to be shallow, but wading in proved that the sediment accumulation was much, much deeper!

TTK Water Monitoring Program

To counteract this overall lack of pollutant concentration data, water monitoring for the TTK 319 Planning and Implementation project was conducted at 30 individual testing sites on a monthly basis for one year, from April 2014-March 2015. Sites were chosen based on observations gathered during desktop GIS surveys. Chosen sites were then deemed ideal after verifying ease of access via windshield survey. In general, monitoring sites were chosen along bridges and lesser traveled roads for safety and convenience when collecting samples. Throughout the watershed, sites are evenly distributed and placed in locations where the best data can be obtained, either by examing upstream 'control' sites or downstream confluences of several or more tributaries. The method for choosing monitoring sites was designed to isolate specific pollutant sources in order to help with ranking critical areas within the watershed.

These 30 sites were monitored in all seasons, however in several instances, flooding and/or drought prevented the collection of samples. Disconnected, stagnant pools do not yield suitable, consistant data and flooded streams can pose hazards for individuals collecting samples. The watershed coordinator used discretion when it came to the timing of sampling so that weather would interfere as little as possible with the quality of data collected.

TSS, E.coli, Nitrate/Nitrite, and Total Phosphorus data for each subwatershed will be included in Section 3.2 along with each subwatershed description. Each concentration exceeding the water quality target will be highlighted in red. The rest of the data collected at each site with the YSI probe and Hoosier Riverwatch methods will be included in Appendix D for further reference.

Table 11 lists latitude and longitude descriptions for each site location, as well as its associated tributary. A map of the sites can be found below on Figure 17.

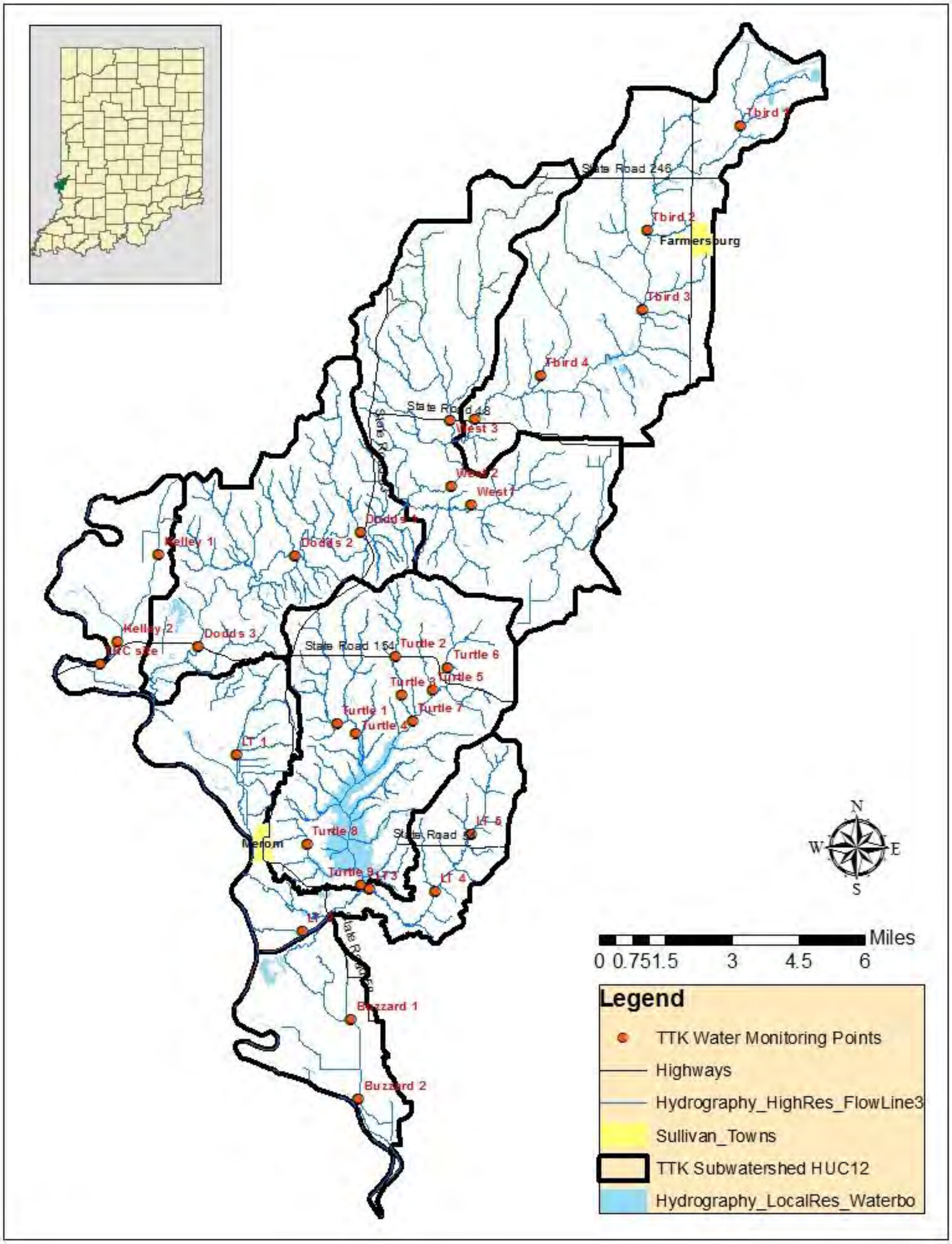
Table 11-Latitude/Longitude of TTK Monitoring Sites

Site #	ID	Latitude	Longitude	Stream
1	Tbird 1	39° 17' 26.54" N	87° 22' 5.24" W	Turman Creek
2	Tbird 2	39° 15' 24.30" N	87° 24' 25.89" W	Turman Creek
3	Tbird 3	39° 13' 50.75" N	87° 24' 33.66" W	Turman Creek
4	Tbird 4	39° 12' 32.29" N	87° 27' 6.47" W	Hauger Creek
5	Tbird 5	39° 11' 40.83" N	87° 28' 46.39" W	Turman Creek
6	West 1	39° 10' 0.27" N	87° 28' 49.80" W	Sugar Creek
7	West 2	39° 10' 21.85" N	87° 29' 20.94" W	Turman Creek
8	West 3	39° 11' 39.63" N	87° 29' 22.78" W	Turman - West Fork
9	Dodds 1	39° 9' 27.99" N	87° 31' 37.92" W	Unnamed Tributary
10	Dodds 2	39° 8' 59.28" N	87° 33' 16.24" W	Turman Creek
11	Dodds 3	39° 7' 12.95" N	87° 35' 41.51" W	Turman Creek
12	Kelley 1	39° 8' 59.19" N	87° 36' 41.86" W	Unnamed Tributary
13	Kelley 2	39° 6' 59.71" N	87° 37' 58.51" W	Unnamed Trib/Bayou

Table 11(Cont.) - Latitude/Longitude of TTK Monitoring Sites

14	Kelley 3	39°6'57.707" N	87°37'59.17" W	Oxbow of Wabash River
15	LT 1	39° 5' 5.42" N	87° 34' 42.22" W	Unnamed Tributary
16	LT 2	39° 1' 39.00" N	87° 33' 1.54" W	Turtle Creek
17	LT 3	39° 2' 29.21" N	87° 31' 20.40" W	Little Turtle Creek
18	LT 4	39° 2' 27.15" N	87° 29' 41.94" W	Little Turtle Creek
19	LT 5	39° 3' 33.59" N	87° 28' 48.70" W	Little Turtle Creek
20	Buzzard 1	38° 59' 55.72" N	87° 31' 47.42" W	Unnamed Tributary
21	Buzzard 2	38° 58' 21.73" N	87° 31' 35.31" W	Unnamed Tributary
22	Turtle 1	39° 5' 42.77" N	87° 32' 11.62" W	Unnamed Tributary
23	Turtle 2	39° 7' 1.73" N	87° 30' 43.54" W	Unnamed Tributary
24	Turtle 3	39° 6' 17.42" N	87° 30' 34.70" W	Unnamed Tributary
25	Turtle 4	39° 5' 31.12" N	87° 31' 42.18" W	Unnamed Tributary
26	Turtle 5	39° 6' 23.34" N	87° 29' 47.74" W	Unnamed Tributary
27	Turtle 6	39° 6' 49.34" N	87° 29' 24.17" W	Turtle Creek
28	Turtle 7	39° 5' 45.90" N	87° 30' 17.20" W	Turtle Creek
29	Turtle 8	39° 3' 20.94" N	87° 32' 55.67" W	Unnamed Tributary
30	Turtle 9	39° 2' 34.00" N	87° 31' 33.49" W	Turtle Creek

Figure 17 - TTK Watershed Monitoring Point locations



Various parameters were tested with a combination of lab and in-field methods. Table 12 below indicates all testing parameters and methods. A Quality Assurance Project Plan (QAPP), which details all aspects of the study, was developed prior to the TTK monitoring program and can be referenced in Appendix C. Results of water testing will be discussed at length for each of the seven HUC12 subwatersheds in Section 3.2.

Table 12: Parameters Monitored

Parameter	Protocol	Site Information
Turbidity	Field – Riverwatch Turbidity Tube, convert to NTUs	All sites, monthly for one year, then quarterly
Color	Field – Visual Inspection	All sites, monthly for one year, then quarterly
Odor	Field – Olfactory Evaluation	All sites, monthly for one year, then quarterly
Temperature	Field – YSI 556 Multi-parameter instrument	All sites, monthly for one year, then quarterly
Specific Conductivity	Field – YSI 556 Multi-parameter instrument	All sites, monthly for one year, then quarterly
Total Dissolved Solids (TDS)	Field – YSI 556 Multi-parameter instrument	All sites, monthly for one year, then quarterly
Salinity	Field – YSI 556 Multi-parameter instrument	All sites, monthly for one year, then quarterly
Dissolved Oxygen (DO)	Field – YSI 556 Multi-parameter instrument	All sites, monthly for one year, then quarterly
pH	Field – YSI 556 Multi-parameter instrument	All sites, monthly for one year, then quarterly
Stream Flow	Field–Global Water Flow Meter and Riverwatch Calculation sheet	All sites, monthly for one year, then quarterly
E.coli	Lab Analysis by E.C. Labs	All sites, monthly for one year

Table 12: Parameters Monitored (Cont.)

Parameter	Protocol	Site Information
Nitrate, Nitrite	Lab Analysis by E.C. Labs	All sites, monthly for one year
Total Suspended Solids (TSS)	Lab Analysis by E.C. Labs	All sites, monthly for one year
Total Phosphorus	Lab Analysis by E.C. Labs	All sites, monthly for one year
Herbicide/Pesticide	Lab Analysis by E.C. Labs	Turtle 1, 3, 6Spring 2015 only
Macroinvertebrates	Field–Combo Hoosier Riverwatch/IDEM methods	One time, annually (July-Oct), all sites
Habitat Assessment	Field – QHEI methods	One time, annually, all sites

3.2 Water Quality Information

In Section 3.5, each subwatershed will be analyzed in depth to provide a more targeted look at resource concerns existing within each of the smaller HUC 12 regions. Detailed maps showcasing landuse, water monitoring sites, and other industrial/commercial uses will be outlined as they pertain to each individual subwatershed. An overview of collected data, relationships, and trends for the entire watershed will be discussed in Section 4.1.

While compiling information for this watershed management plan, the following items were not found for any of the seven subwatersheds (either in relation to water quality or habitat/biological information) and will therefore not be discussed in Section 3.5:

- IDEM 303d List Impairments
- Office of Land Quality data
- Past or ongoing LARE studies
- USGS monitoring data and flow gauges (some bacterial data and one flow gauge exist for the Wabash River but will be excluded for the purposes of this focused watershed management plan)
- Prior TMDL studies conducted

- x Permitted wastewater sludge locations
- x Combined Sewer Overflow (CSOs) or Sanitary Sewer Overflow (SSOs) events
- x CAFOs (large scale Confined Animal Feeding Operations)

The following items will be addressed, as applicable to each HUC 12 subwatershed:

- ✓ IDEM Office of Water Quality Assessment Branch data (5A listed streams)
- ✓ LUSTs (Leaking Underground Storage Tanks)
- ✓ Preexisting Watershed Management Plans (Turtle Creek + Little Turtle Creek)
- ✓ CFOs (Confined Feeding Operations)
- ✓ Brownfields and Remediation sites
- ✓ NPDES facilities and NPDES pipe locations
- ✓ Past mining activities
- ✓ Stream miles in need of buffers and/or bank stabilization
- ✓ TTK monitoring data collected, including monitoring site locations, monthly data for each site, and average loads for each site
- ✓ Land Use according to each subwatershed

For further information on these specific items, refer to Sections 3.4 and the individual watershed descriptions in Section 3.5.

3.3 Habitat/Biological Information

Habitat Assessments

Habitat information was collected one time during the 12 month study at each site. Habitat evaluation scores were determined by using the Midwest Biodiversity Institute's Qualitative Habitat Evaluation Index (QHEI) field sheet (Appendix E) along with guidance from the QHEI Manual produced by the State of Ohio EPA, Division of Surface Water. www.epa.state.oh.us/portals/35/documents/QHEIManualJune2006.pdf Using the QHEI method allows for a variety of parameters to be evaluated and scored. Parameters include stream substrate, stream embeddedness, instream cover, channel morphology, riparian/buffer zones, presence of pools and riffles, velocity of water, and bank erosion severity. The highest possible value a site could achieve is 100. Based on IDEM's guidance for other TMDL studies in nearby watersheds, the following QHEI scores denote a stream's habitat quality.

Table 13 - QHEI Score Ranges

High Quality	≥ 70
Good Quality	60-69
Intermediate	50-59
Poor Quality	40-49
Very Poor Quality	<40

Shown below is a summary of each site's QHEI score and the corresponding rating. This data was collected during the fall of 2014.

Table 14 – 2014 QHEI Scores for TTK Monitoring Sites

Site ID	2014 QHEI Score	QHEI Rating
Buzzard 1	35	Very Poor
Buzzard 2	34	Very Poor
Dodds 1	63	Good
Dodds 2	30	Very Poor
Dodds 3	29	Very Poor
Kelley 1	34	Very Poor
Kelley 2	36	Very Poor
Kelley 3	38	Very Poor
LT 1	63	Good
LT 2	35	Very Poor
LT 3	49	Poor
LT 4	53	Intermediate
LT 5	50	Intermediate
Tbird 1	62	Good
Tbird 2	46	Poor
Tbird 3	36	Very Poor
Tbird 4	48	Poor
Tbird 5	47	Poor
Turtle 1	69	Good
Turtle 2	54	Intermediate
Turtle 3	54	Intermediate
Turtle 4	47	Poor
Turtle 5	36	Very Poor
Turtle 6	39	Very Poor
Turtle 7	37	Very Poor
Turtle 8	50	Intermediate
Turtle 9	46	Poor
West 1	51	Intermediate
West 2	28	Very Poor
West 3	50	Intermediate

Biological Assessments

To evaluate biotic integrity in the TTK watershed, macroinvertebrate sampling was conducted on each of the 30 monitoring sites in the fall of 2014. Methods for collecting macroinvertebrates utilized a combination of Hoosier Riverwatch and IDEM techniques. As stipulated in the TTK Quality Assurance Project Plan for water monitoring, the kick seine method was utilized for each site. During collection, the watershed coordinator would choose a place in the stream displaying the best possible habitat conditions for finding macroinvertebrates. Habitats used for macroinvertebrate sampling included riffles, undercut banks and snags, and in many cases, only sediment. Once the best sampling habitat was chosen, a two-person team would operate a kick seine, with one individual standing upstream and disturbing the habitat enough so that debris and organisms would be dislodged and washed downstream to be collected in the net by the second individual. Then, the seine would be taken ashore so that organisms could be collected and identified.

Due to the large number of sites sampled and for the purpose of treating each site with consistent procedures, the duration spent collecting and identifying macroinvertebrates conformed to a precisely timed operation. In-stream seine usage involved exactly 1-minute of 'kicking' while macroinvertebrate identification was limited to a 3-minute 'pick' through the net. In the worst cases on some sites, this procedure would be repeated in an alternate habitat location if no organisms were found on the first attempt. Otherwise, this 1-minute 'kick', 3-minute 'pick' procedure was carried out once on each site.

Macroinvertebrates were categorized according to the Biological Monitoring Data Sheet provided by www.HoosierRiverwatch.com and attached in Appendix F. Based on each taxa's ability to withstand certain degrees of water pollution and the number of each taxa collected, a PTI (Pollution Tolerance Index) Rating was designated for the site. Macroinvertebrate sampling will continue annually on each site in the future.

Table 15 - Macroinvertebrate Pollution Tolerance Index Ratings

Excellent	23+
Good	17-22
Fair	11-16
Poor	≤10

Table 16 - 2014 Macroinvertebrate Pollution Tolerance Scores for TTK Sites

Site ID	2014 Macro PTI Score	Macro Rating
Buzzard 1	1	Poor
Buzzard 2	3	Poor
Dodds 1	1	Poor
Dodds 2	4	Poor
Dodds 3	6	Poor
Kelley 1	4	Poor
Kelley 2	4	Poor
Kelley 3	8	Poor
LT 1	0	Poor
LT 2	7	Poor
LT 3	4	Poor
LT 4	4	Poor
LT 5	2	Poor
Tbird 1	14	Fair

Table 16 (Cont.) - 2014 Macroinvertebrate Pollution Tolerance Scores for TTK Sites

Tbird 2	19	Good
Tbird 3	14	Fair
Tbird 4	1	Poor
Tbird 5	11	Fair
Turtle 1	0	Poor
Turtle 2	5	Poor
Turtle 3	1	Poor
Turtle 4	14	Fair
Turtle 5	0	Poor
Turtle 6	5	Poor
Turtle 7	1	Poor
Turtle 8	7	Poor
Turtle 9	0	Poor
West 1	0	Poor
West 2	3	Poor
West 3	3	Poor

3.4 Land Use Information

Stream Miles in Need of Buffers/Streambanks Requiring Stabilization

In order to quantify stream miles in need of buffers, the best approach is to utilize desktop GIS survey methods. It is difficult to examine each and every stream segment in the TTK watershed due to the inaccessibility of private lands, however an overall estimation can be garnered by examining aerial imagery. During the summer of 2015, The Nature Conservancy voluntarily undertook the task of analyzing aerial imagery for the TTK watershed in order to label each of 10,000 stream segments with a 'Y' or 'N' designation to represent whether or not a sufficient (30' width or more) buffer is present. Below is a map indicating which stream segments were categorized according to whether or not they possessed sufficient buffers.

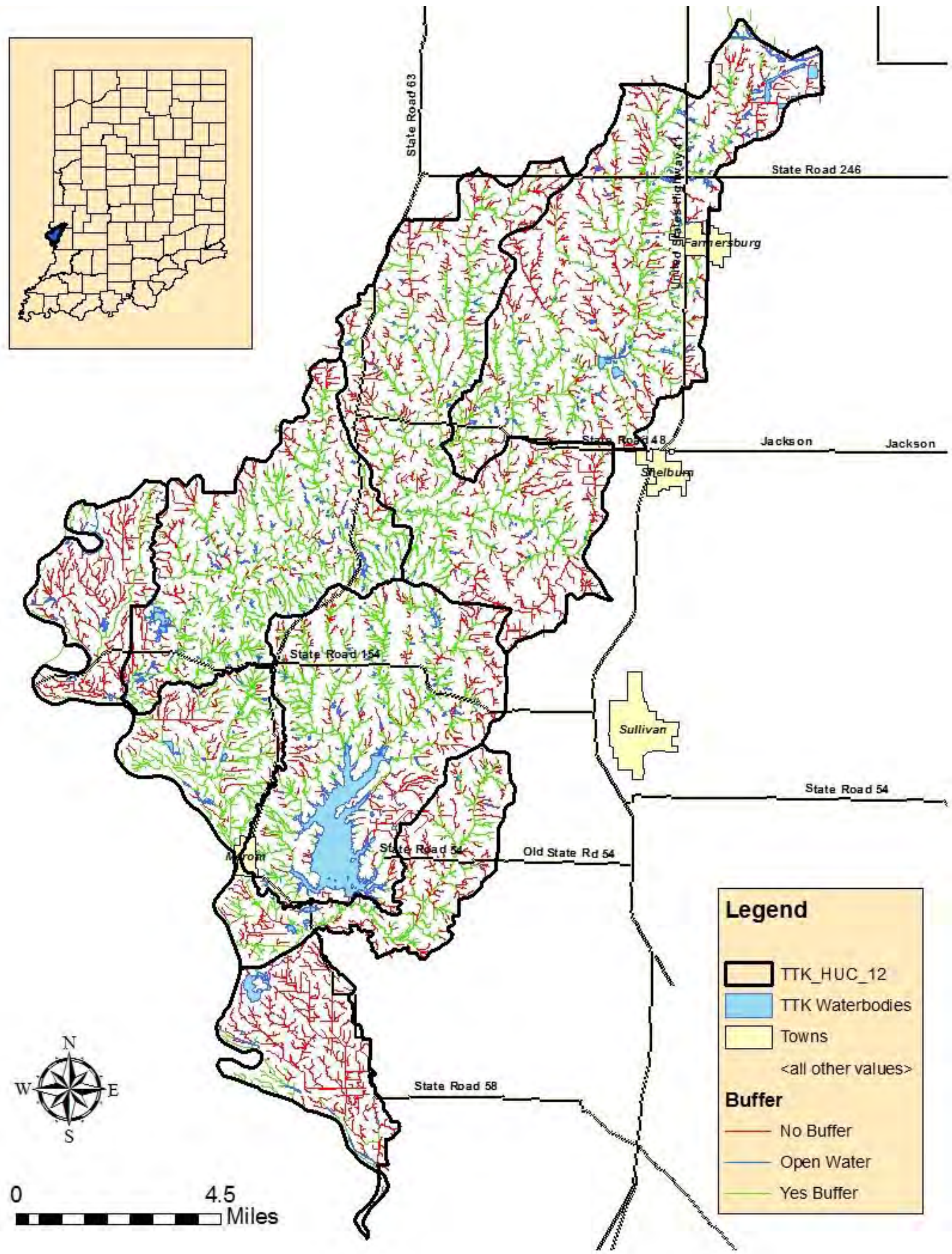
Based on observations during windshield surveys, tillage transects, aerial maps, and water monitoring, lack of sufficient buffer width is a problem throughout the watershed. In many cases, farming practices occur much too close to streams and ditches. As described in Section 2.4, over 67% of the TTK watershed is utilized for agriculture, totaling 69,211.36 acres in cultivated crops.

At this time, The Nature Conservancy has completed the stream buffer identifiers for the entire TTK watershed, which is primarily utilized for row crops. It was found that 557.73 miles (46.3%) of streams lacked a sufficient buffer when analyzed, which could be a large contributing factor when it comes to sediment being transported into the watershed's streams and lakes. With nearly half of the TTK watershed's streams lacking a sufficient buffer, it is easy to see why erosion and excessive sedimentation is a primary concern for the TTK Advisory Committee.

Table 17 – TTK Stream Buffer Statistics

Buffer	Total Mileage	% of Watershed
Yes	629.88 miles	52.3%
No	557.73 miles	46.3%
Open Water	16.55 miles	1.4%

Figure 18 - TNC Desktop Analysis of TTK Stream Buffers



When it comes to streambank stabilization, the Sullivan SWCD and NRCS offices get a number of inquiries each year presenting a need for this BMP. However, due to the complexity of the engineering required, the high cost of construction, and the permitting often needed to successfully implement this practice, it is difficult to offer solutions. It is not as straightforward to pursue cost-share for streambank stabilization as it can be with other conservation practices, so in many instances programs such as CRP are suggested in order to establish buffers.

Log jams have also been identified by the Advisory Committee as a 'concern', especially around the Dodd's Bridge subwatershed. Pictured below is a significant log jam at the Dodds 2 monitoring site. Log jams can cause streams to flow around these obstructions, creating significant bank erosion.

Figure 19 - Log Jam – Dodds 2 Monitoring Site (November 2014)

In addition, many landowners opt to remove riparian buffers in order to create more tillable land for farming. Loss of stabilizing root systems along streams is another contributing factor to bank erosion.

Hoosier Energy has also identified numerous sites along the Turtle Creek Reservoir where bank erosion is occurring due to high winds. Efforts have been in the past to stabilize these banks with rip-rap, gabion baskets, and various vegetative practices. A comprehensive report concerning Land Management Recommendations for the Merom Generating Station was compiled in 2013 and can be found in Appendix G. Featured on Figure 20 below is a map from the original Partnership for Turtle Creek WMP depicting areas of erosion surrounding the Turtle Creek Reservoir.

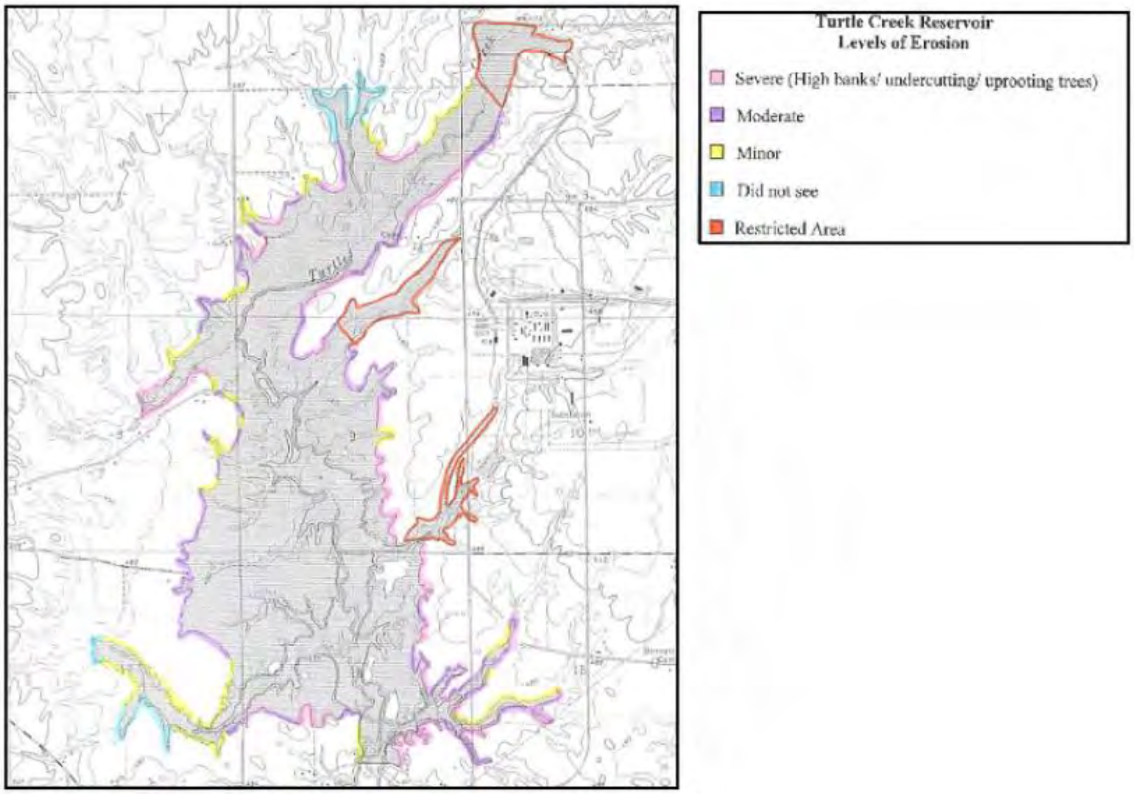


Figure 20 – Severity of Shoreline Erosion on Turtle Creek Reservoir

<u>Brownfields/ Remediation Sites</u>

EPA defines Brownfields as follows:

"*Brownfields are real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant"*

Often, remediation efforts are undertaken to bring the property back into a condition for future use. At this time, there is one brownfield identified in the TTK watershed in the town of Farmersburg in Thunderbird Pond subwatershed: Hopewell Gas Station. This site is also listed as a remediation site. There are no factories or industrial facilities located in Farmersburg.

Another site listed for remediation can be found in the Little Turtle subwatershed. It is a site owned by Peabody Mine, though no recent mining activities were found to have occurred at this location.

<u>Leaking Underground Storage Tanks (LUSTs)</u>

The IDEM Office of Land Quality oversees the identification and remediation of LUSTs. At this time, several LUSTs were located within the TTK watershed, though it is unclear from the map information if they still currently pose pollution problems or merely represent historic incidents. Two LUSTs were pinpointed in the Turtle Creek subwatershed and four were found in the

Thunderbird Pond subwatershed. More information can be found on the following webpage regarding the IDEM LUST program: http://www.in.gov/idem/landquality/2342.htm

Fertilizer Usage

A large percentage of land is devoted to cultivated crops in the TTK watershed, and in order to increase productivity, fertilizer is often applied to fields in the spring. A smaller number of producers still apply manure in the fall, though this is not typically an annual practice. In heavy rainfall events, fertilizer can be transmitted into streams via run-off and cause high nutrient loading.

Currently, fertilizer costs are very high and many producers are transitioning to precision application methods in order to save money and apply less. It is also becoming more common for producers to side-dress nitrogen after planting, thereby splitting up the amounts of fertilizer and applying less at a time. Voluntary programs such as INField Advantage (formerly On Farm Network) allow producers to assess nitrogen application through grant-funded cornstalk sampling and analysis. Ongoing education regarding nutrient management is important to ensure that producers and landowners manage fertilizer inputs properly and in a sparing manner.

Because the majority of the TTK watershed is rural, urban/suburban fertilizer is applied sparsely on private yards and gardens according to landowner preference. There are no golf courses, nurseries, or other large sources of urban/suburban fertilizer usage in the region.

NPDES Facilities and Pipe Locations

According to EPA, NPDES permits are issued for the following conditions:

"*As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters."*

In the TTK watershed, there are a small number of NPDES facilities and the outlet pipes for which they are responsible. Though there are a number of NPDES pipe locations present throughout the watershed, not all of the NPDES facilities discharging water are present within the watershed's boundaries. A table on information regarding NPDES facilities and NPDES outlets can be viewed below on Table 18. All facilities are required to regularly submit samples for lab analysis in order to ensure continued permit compliance. Reports, compliance history, and supporting documentation can be found on IDEM's Virtual File Cabinet http://vfc.idem.in.gov/

Table 18 – NPDES Facilities and Pipe Information in the TTK Watershed

Description	Name	ID #	Compliance Status	Additional Notes	Subwatershed Location
FACILITY	Peabody Midwest Mining (Farmersburg)	INGO40062	No OWQ compliance issues reported	none	Not located in TTK watershed
OUTLET	Peabody Midwest Mining (Farmersburg)	INGO40062	No OWQ compliance issues reported	none	Thunderbird Pond
OUTLET	Peabody Midwest Mining (Farmersburg)	INGO40062	No OWQ compliance issues reported	none	Thunderbird Pond
OUTLET	Peabody Midwest Mining (Farmersburg)	INGO40062	No OWQ compliance issues reported	none	Thunderbird Pond
OUTLET	Peabody Midwest Mining (Farmersburg)	INGO40062	No OWQ compliance issues reported	none	Thunderbird Pond
FACILITY	Poet Biorefining - Farmersburg LLC	IN0063169	No OWQ compliance issues reported	Industrial Organic Chemicals	Not located in TTK watershed
OUTLET	Poet Biorefining - Farmersburg LLC	IN0063169	No OWQ compliance issues reported	none	Thunderbird Pond
OUTLET	Heartland Gas Pipeline	ING670044	No OWQ compliance issues reported	none	West Turman
OUTLET	Heartland Gas Pipeline	ING670044	No OWQ compliance issues reported	none	West Turman
OUTLET	Heartland Gas Pipeline	ING670064	No OWQ compliance issues reported	Nat. Gas Pipeline, Hydrostatic Test Water	West Turman
FACILITY/*OUTLET*	Graysville Sand and Gravel	ING490090	OWQ compliance notice - missing reports	INACTIVE (as of 2008)	Dodd's Bridge
FACILITY	Hoosier Energy Generating Station	IN0050296	OWQ Enforcement Notice* 12/30/15	Violation regarding discharge temperature	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	Currently in compliance	Sludge Landfill Run-off	Turtle Creek

Table 18 (Cont.) – NPDES Facilities and Pipe Information in the TTK Watershed

Description	Name	ID #	Compliance Status	Additional Notes	Subwatershed Location
OUTLET	Hoosier Energy Generating Station	IN0050296	No OWQ compliance issues reported	Landfill Run-off - INACTIVE	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	No OWQ compliance issues reported	Stabilized Flue Gas Run-off - INACTIVE	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	Currently in compliance	Sludge Storage/Overflow Run-off	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	Currently in compliance	Metal Cleaning Waste	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	Currently in compliance	N-C Cooling Steam Electric	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	Currently in compliance	Sanitary Wastewater Treatment	Turtle Creek
OUTLET	Hoosier Energy Generating Station	IN0050296	No OWQ compliance issues reported	Point of Reservoir - INACTIVE	Turtle Creek
FACILITY	Merom Municipal Water Works	IN0061328	No OWQ compliance issues reported	Permit expired 10/31/2011	Little Turtle Creek
OUTLET	Merom Municipal Water Works	IN0061328	No OWQ compliance issues reported	Presumed INACTIVE	Little Turtle Creek

**Note: Information regarding this enforcement incident can be found on IDEM's Virtual File Cabinet*
http://vfc.idem.in.gov/search-results.aspx?xAIID=12019&PageNum=12

As represented on the table above, only one compliance incident was noted, with Hoosier Energy Generating Station of Merom listed as the responsible facility. This compliance issue regarding elevated discharge temperature into the Turtle Creek Reservoir occurred in 2013 and has since been resolved.

Hobby Farms and Animal Feeding Operations (AFOs)

Livestock does not take precedence when it comes to agriculture in the TTK watershed. The large expanses of flat landscapes and prime farmland are typically relegated to row crops, whereas ridges and small lots can be fenced and grazed. Because the TTK watershed is mostly flat in topography, row crops prevail. It is difficult to quantify the exact number of small hobby farms or other animal operations in the TTK watershed, however, based on windshield surveys there are at least three dozen landowners possessing horses, goats, small cattle operations, swine, and poultry. Sullivan and Vigo counties have robust 4-H programs and a large number of youth participants raise livestock to show and auction at the county fair.

Overgrazed pastures and crowded barn lots can be observed throughout the watershed. In many cases, these small operations allow livestock free access to streams, which can contribute to bank erosion and nutrient loading. In many cases, these small farms do not generate enough revenue to qualify for cost-share programs through NRCS and FSA. Farms must show proof of at least $1,000 profit margin in order to be considered a 'farm' for conservation incentive programs such as EQIP. Ongoing education and outreach through the Sullivan County SWCD, Purdue Extension, and the WCIWA offer technical assistance and advice to livestock owners.

Confined Feeding Operations (CFO)

Confined Feeding Operations are defined by IDEM as follows:

"A CFO is an AFO [Animal Feeding Operation] engaged in the confined feeding of at least 300 cattle, or 600 swine or sheep, or 30,000 fowl, such as chickens, turkeys, or other poultry. CFOs are issued a State no discharge permit. The IDEM regulates these confined feeding operations, as well as smaller operations which have violated water pollution rules or laws, under IC 13-18-10."

Six CFOs were identified throughout the TTK Watershed, including one in the Dodd's Bridge subwatershed, one in the Little Turtle subwatershed, one in the Turtle Creek subwatershed, and three in the Thunderbird Pond subwatershed. The CFOs in the TTK watershed raise poultry and after searching IDEM's Enforcement Database, no records could be found to show that any of these operations have ever fallen out of compliance. As stated in the description above, poultry CFOs typically maintain 30,000 birds and do not emit discharge.

Subwatershed Descriptions and Load Calculations [Preface]

In the pages that follow, each of the seven subwatersheds will be described in further depth. The land use statistics, monitoring sites, and other commercial uses will be examined in detail. Each subwatershed description will include maps with pertinent information as well as a summary of collected lab data from the monthly monitoring conducted over the course of 12 months. Parameters summarized will include E.coli, Total Suspended Solids, Total Phosphorus, Nitrates/Nitrites, and flow. A full account of all collected monitoring data can be found in Appendix D, though any data that may support nonpoint/point source pollutant sources will be mentioned accordingly.

Load Calculation Tool		* User needs to input values in gray boxes	
mass based pollutants		E. coli	
input			
TSS, N, P etc (mg/l)	20.5	cfu/100 ml	328
Flow (cfs)	3.56	Flow	0.8
Target Concentration		Target Concentration	
(mg/l)	10	cfu/100 ml	235
output			
Current Load (lb/day)	393.40	Current Load (cfu/day)	6.42E+09
Current Load (ton/year)	71.79	Current Load (cfu/year)	2.34E+12
Target Load (lb/day)	191.90	Target Load (cfu/day)	4.60E+09
Target Load (ton/year)	35.02	Target Load (cfu/year)	1.68E+12
load reduction needed			
(ton/year)	36.77	(cfu/year)	6.64E+11
% reduction	51.2	% reduction	28.4

Figure 21- Example of IDEM Load Calculation Tool

Load calculations were conducted by averaging all monthly concentrations together to obtain an average monthly concentration for each pollutant at each of the 30 monitoring sites. The same method was also used to calculate an average flow for each monitoring site. Once an average pollutant concentration and an average flow had been calculated for each site, the numbers were entered into the IDEM Load Calculation Tool featured above in Figure 21. This approach was deemed to be the a more accurate way of calculating a site's loads rather than averaging monthly pollutant loads together because it would neutralize some of the high numbers generated from anomalous high or low flow events throughout the year, creating a more accurate snapshot of each site.

Obtaining flow calculations is vital when determining pollutant loads. High and low pollutant concentrations are relative to a stream's flow. In other words, a stream with a small flow and a high pollutant concentration may still be less of a problem than a large stream with a lower concentration. The larger stream is still discharging more pollutant due to its larger volume. Occasionally, the stream was not flowing due to low water conditions, impoundment, or ponding behind an obstruction such as a log jam. In this case, flow was labeled as "BDL" or 'Below Detection Limit' and it was assumed that zero pollutant was being discharged during that time.

3.5 Subwatershed Descriptions and Data

Thunderbird Pond 051201111201

The Thunderbird Pond is the northernmost watershed, with 8,135 acres reaching into Vigo County and 14,599 acres in Sullivan County. It represents the headwaters of Turman Creek and is the largest of the seven subwatersheds that comprise the TTK watershed project area. A portion of the town of Farmersburg is included within the watershed, as well as areas with former mining activity (both surface and underground). Five sites were selected for sampling in the Thunderbird Pond watershed, though sampling had to be discontinued at Tbird 1 because access became restricted due to its proximity to active mining property.

After collecting 12 months of data from the five Thunderbird Pond water monitoring sites, several water quality issues were observed. E.coli loads were quite high along with TSS and Phosphorus loads. Even in the upstream portions of Turman Creek, the sediment loads exceeded water quality targets by a great deal. Phosphorus, binding with soil particles, persists in the environment longer, which is reflected in these results. Interestingly, the only site that exceeded the Nitrogen target was Tbird 4; all other sites were within range.

Based on stakeholder reports, there could be a few contributing factors that may be causing the high E.coli loads at several sites, including improperly functioning septic systems. In fact, much of the soil in this area is deemed very poor when it comes to septic suitability. There is also a large amount of HEL in the Thunderbird Pond subwatershed, which likely contributes to the high sediment loads found in streams.

As previously highlighted in Section 3.1, IDEM's Office of Water Quality Assessment Branch has identified several stream segments within Thunderbird Pond that have been categorized as 5A. These impaired streams comprise the headwaters of Turman Creek. "Preliminary" impairments are given a 5A designation, deeming the listed streams as impaired for recreational use due to high E.coli levels, as well as exhibiting impaired biotic communities (Section 3.1, Figure 16). However, based on macroinvertebrate sampling conducted during the fall of 2014, PTI scores were among some of the highest for the TTK watershed, though certainly not exemplary.

Thunderbird Pond also contains the densest population area of any subwatershed, with a major highway running through Farmersburg. Several LUSTs and NPDES pipe locations can be found in this subwatershed, along with a brownfield site undergoing remediation. Surface and underground mining activities have occurred in the past, though the Thunderbird Pond (underground) mine has been reclaimed. Years ago, a dam was constructed by the railroad company AEP to traverse a low-lying area near the mine and the Thunderbird Pond was created. At this time, feasibility studies are currently being conducted by Cardno to investigate the removal of the dam and restoration of the original stream. Partnership with other agencies and funding sources for this project are currently being pursued, as well. Dam removal is often a great benefit to stream systems when it comes to fish and macroinvertebrates due to the reestablishment of natural stream flow. However, steps must be taken to contain the sediment that has accumulated behind the dam, ensuring that it isn't carried downstream in large quantities. At this time, the Thunderbird Pond is serving no great function as a site used for public recreation or significant wildlife habitat. Continued maintenance of the dam by the company AEP is proving to be expensive, so dam removal would serve as a long-term, permanent solution. The TTK WMP will be updated as new information regarding this project is obtained.

In general, the Thunderbird Pond subwatershed land uses can be characterized as follows:

Table 19 - Land Use Statistics for Thunderbird Pond Subwatershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	16,292.17	71.7%
Deciduous Forest	3,426.97	15.1%
Developed, Open Space	1,247.74	5.5%
Pasture/Hay	862.71	3.80%
Developed, Low Intensity	325.43	1.4%
Open Water	229.28	1.0%
Developed, Medium Intensity	108.23	<1%
Grassland/Herbaceous	92.88	<1%
Evergreen Forest	63.19	<1%
Barren Land	49.77	<1%
Emergent Herbaceous Wetlands	18.62	<1%
Developed, High Intensity	14.14	<1%
Shrub/Scrub	0.78	<1%
Woody Wetlands	n/a	0%
Total Acreage		**22,731.91 acres**

Figure 22 - Thunderbird Pond Water Monitoring Sites

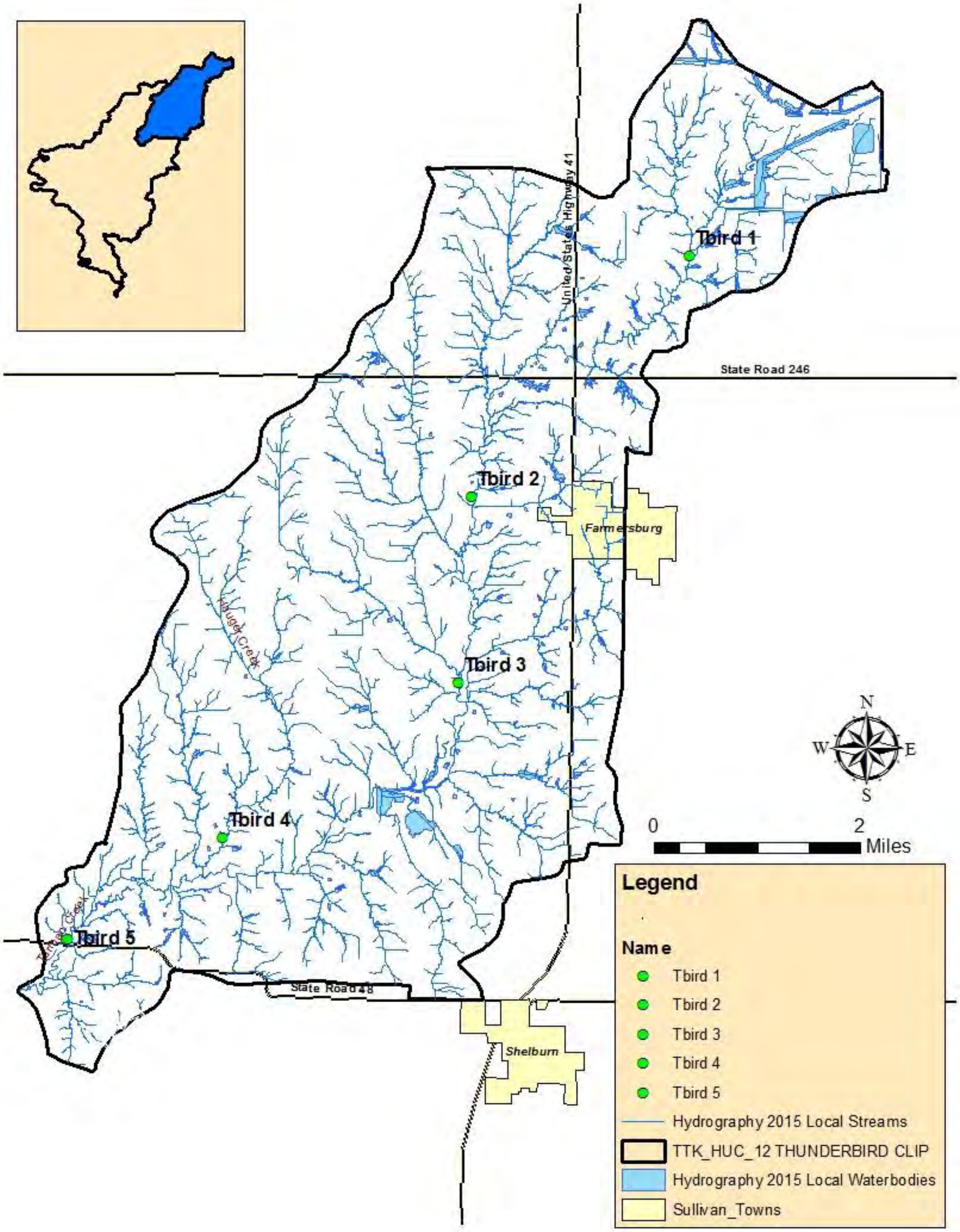


Figure 23 - Thunderbird Pond Land Use Information

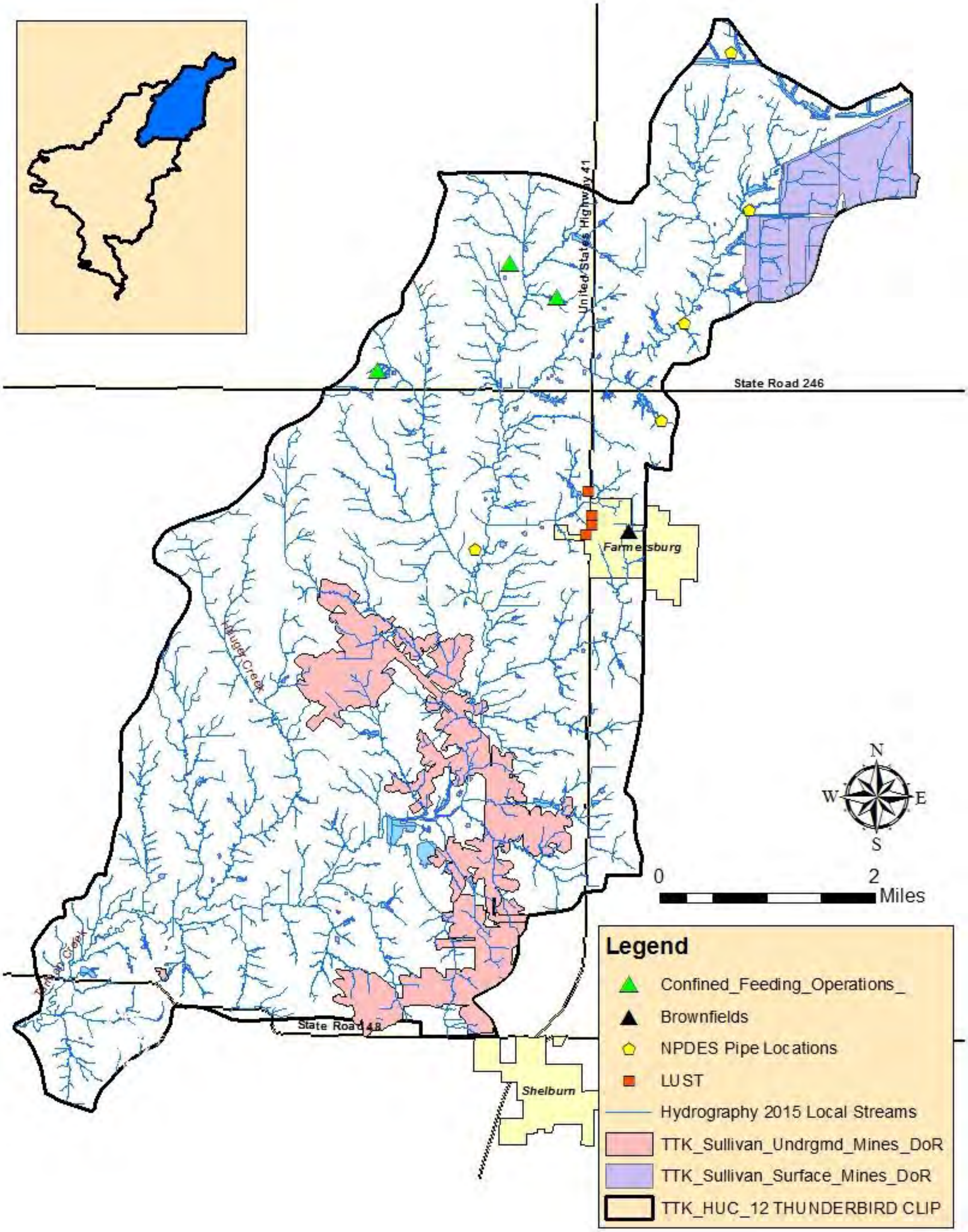


Figure 24 - Thunderbird Pond Land Use Classifications

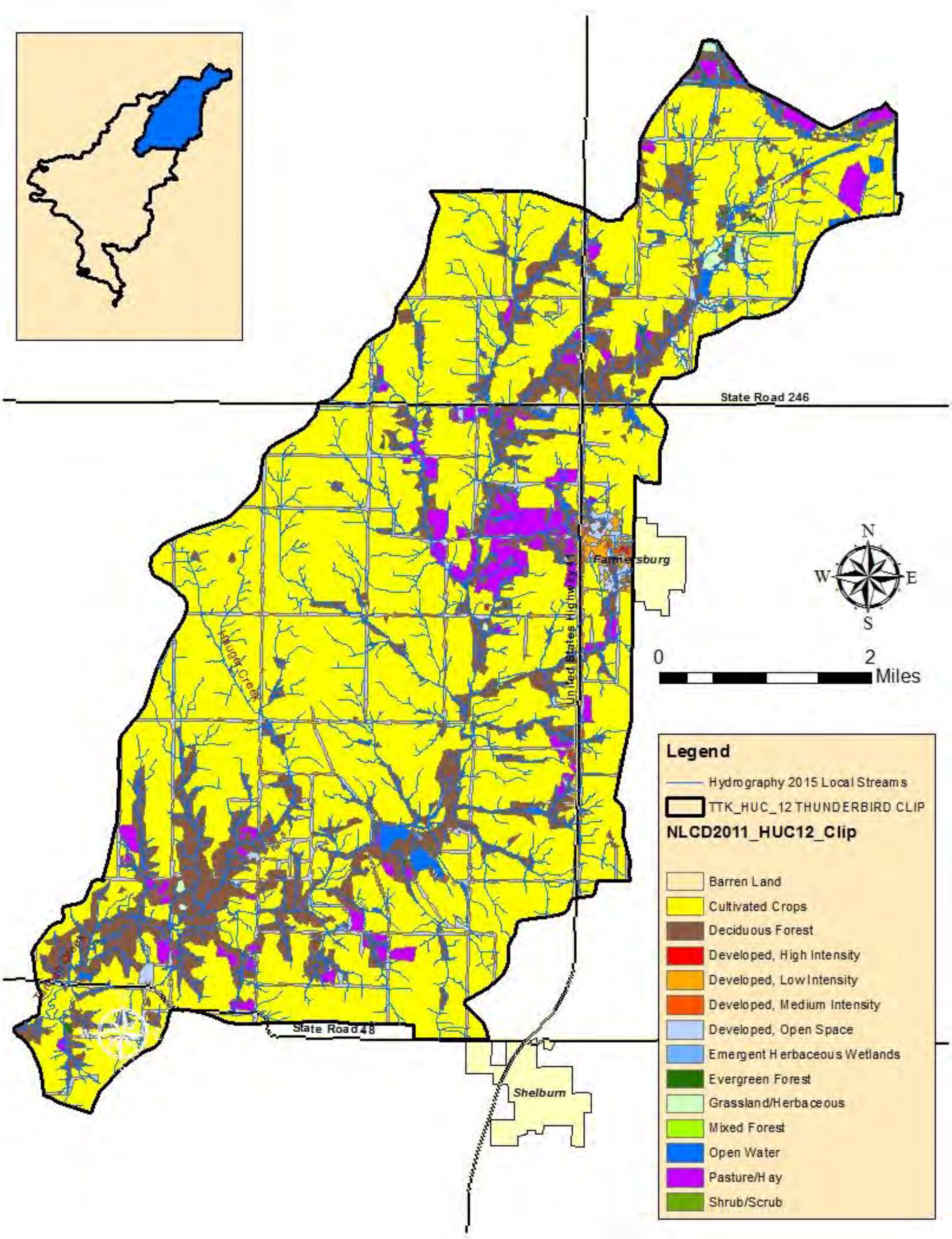


Table 20 – Lab Data Summary for Thunderbird Pond Monitoring Sites

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: Tbird 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	224.700	14.000	0.075	0.00	4.250
May 2014	866.400	59.000	1.280	0.19	10.200
June 2014	101.200	13.000	0.088	0.08	3.060
July 2014	68.300	7.000	0.000	0.15	1.020
Aug. 2014	156.500	11.000	0.000	0.05	0.708
Sept. 2014	235.900	0.000	0.000	0.04	0.570
Oct. 2014	28.100	12.000	0.274	0.00	3.116
Nov. 2014	648.800	8.000	0.000	0.08	2.720
Dec. 2014	NS	NS	NS	NS	NS
Jan. 2015	NS	NS	NS	NS	NS
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	NS	NS	NS	NS	NS

Site ID: Tbird 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,553.100	34.000	0.193	0.150	1.910
May 2014	1,299.700	136.000	1.360	0.650	25.500
June 2014	648.800	20.000	0.329	0.120	1.360
July 2014	613.100	0.000	0.097	0.190	3.825
Aug. 2014	261.300	8.000	0.133	0.150	0.00
Sept. 2014	613.100	6.000	0.000	0.090	0.00
Oct. 2014	191.800	6.000	0.278	0.130	3.188
Nov. 2014	23.500	4.000	0.177	0.110	3.400
Dec. 2014	214.300	19.000	0.718	0.130	2.040
Jan. 2015	77.000	6.000	1.048	0.140	1.530
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	365.000	482.000	0.621	0.930	7.650

Site ID: Tbird 3	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	344.800	12.000	0.877	0.090	5.100
May 2014	1,046.200	396.000	1.620	1.300	42.500
June 2014	325.500	16.000	0.541	0.120	0.850
July 2014	920.800	8.000	0.129	0.190	3.400
Aug. 2014	387.300	6.000	0.097	0.190	0.00
Sept. 2014	251.300	0.000	0.065	0.090	0.00
Oct. 2014	461.100	6.000	0.967	0.220	3.188
Nov. 2014	131.400	8.000	0.462	0.240	3.400
Dec. 2014	488.400	14.000	1.850	0.150	2.550
Jan. 2015	687.000	7.000	2.158	0.220	3.400
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	649.000	359.000	0.742	0.880	34.000

Site ID: Tbird 4	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	648.800	9.000	0.646	0.00	1.530
May 2014	1,119.900	246.000	3.820	1.12	6.120
June 2014	214.300	4.000	3.510	0.49	0.680
July 2014	0.00	NS	0.000	NS	0.00
Aug. 2014	1,553.100	0.000	0.138	0.11	0.035
Sept. 2014	0.00	NS	0.000	NS	0.00
Oct. 2014	178.500	4.000	2.720	0.00	0.595
Nov. 2014	613.100	11.000	1.560	0.07	0.510
Dec. 2014	117.800	10.000	3.510	0.10	0.255
Jan. 2015	37.000	2.000	3.42	0.00	0.510
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	488.000	399.000	0.844	0.680	20.400

Site ID: Tbird 5	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	517.200	36.000	0.000	0.00	5.100
May 2014	1,119.900	1,460.000	1.750	2.85	0.00
June 2014	1,046.200	37.000	0.707	0.11	2.125
July 2014	1,119.900	16.000	0.084	0.92	6.800
Aug. 2014	2,419.600	26.000	0.099	1.60	5.310
Sept. 2014	172.200	6.000	0.000	0.11	0.638
Oct. 2014	648.800	21.000	1.110	0.00	9.563

Nov. 2014	114.500	7.000	0.352	0.100	1.020
Dec. 2014	579.400	21.000	1.780	0.180	10.200
Jan. 2015	60.000	11.000	1.635	0.330	7.650
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	435.000	85.000	0.536	0.650	102.000

Table 21 – Pollutant Load Summary for Thunderbird Pond Monitoring Sites

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
Tbird 1	291.24	8.33E+12	19.3%
Tbird 2	532.79	2.18E+12	55.9%
Tbird 3	517.53	4.13E+13	54.6%
Tbird 4	451.86	1.12E+13	48%
Tbird 5	748.43	9.13E+13	68.6%

Site Name	Average TSS Concentration (mg/L)	Average Load (ton/year)	% Reduction Needed
Tbird 1	15.50	48.88	35.5%
Tbird 2	65.55	295.53	84.7%
Tbird 3	75.64	665.56	86.8%
Tbird 4	62.27	170.61	83.9%
Tbird 5	156.91	2,110.62	93.6%

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Tbird 1	0.21	0.66	None Required (-376.20%)
Tbird 2	0.45	2.03	None Required (-122.20%)
Tbird 3	0.86	7.57	None Required (-16.30%)
Tbird 4	1.83	5.01	45.40%
Tbird 5	0.73	9.82	None Required (-37.00%)

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Tbird 1	0.07	0.22	None Required (0.00%)
Tbird 2	0.25	1.13	72.0%
Tbird 3	0.34	2.99	79.4%
Tbird 4	0.23	0.63	69.60%
Tbird 5	0.62	8.34	88.7%

West Turman Creek 051201111202

The West Turman subwatershed ranked among the highest of any of the seven subwatersheds when it came to all lab-tested pollutant concentrations and calculated pollutant loads. Though only three monitoring sites were chosen in the West Turman subwatershed, the frequently failing results give an overview of the problems that exist within this drainage area. The West Turman subwatershed includes Turman Creek as well as a complex network of infeeding streams, emerging mostly from agricultural land, forests, livestock pastures, and many instances of 'rural sprawl': small groupings of homes and hobby farms that have been established west of the towns of Farmersburg and Shelburn, within close proximity to Highway 41.

Most of the land in the West Turman subwatershed is utilized for row crop agriculture, and windshield surveys often confirmed that farming practices occur very close to streams with little to no buffer. Livestock is not common here, though there are at least a dozen pastures with livestock, some of which have direct stream access. There are no urban areas in this subwatershed; only septic systems are utilized and it is likely that many have outlived their functional lifespans, due to the regular presence of extremely elevated E.coli concentrations at monitoring sites, even during the middle of winter.

The streams at the monitoring sites are very silty, with eroding stream banks that make for difficult access at times. Two of the three sites also seem to be popular spots for dumping trash. It is common to see new debris at each monthly monitoring event, including couches, television monitors, tires, mattresses, and bundles of hoses and bottles that could be the remains of discarded meth labs. The West 2 monitoring site frequently has an oily sheen on the surface, which could be due to the oil well in close proximity or illegal dumping of waste. As expected, macroinvertebrate PTI scores were 'poor' for all sites.

As far as developed land, a few acres have been utilized for surface mining and two NPDES pipe locations were identified (Table 18). Otherwise, there are no plans for extensive development known in this area. Land use statistics are as follows:

Table 22 - Land Use Statistics for West Turman Subwatershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	16,147.74	77.4%
Deciduous Forest	2,948.35	14.1%
Developed, Open Space	1,129.97	5.4%
Pasture/Hay	452.83	2.2%
Developed, Low Intensity	114.03	<1%
Open Water	21.77	<1%
Grassland/Herbaceous	27.26	<1%
Developed, Medium Intensity	11.41	<1%
Emergent Herbaceous Wetlands	6.40	<1%
Evergreen Forest	5.64	<1%
Developed, High Intensity	3.29	<1%
Shrub/Scrub	2.30	<1%
Barren Land	1.41	<1%
Woody Wetlands	n/a	0%
Total Acreage		**20,872.40 acres**

Figure 25 - West Turman Water Monitoring Sites

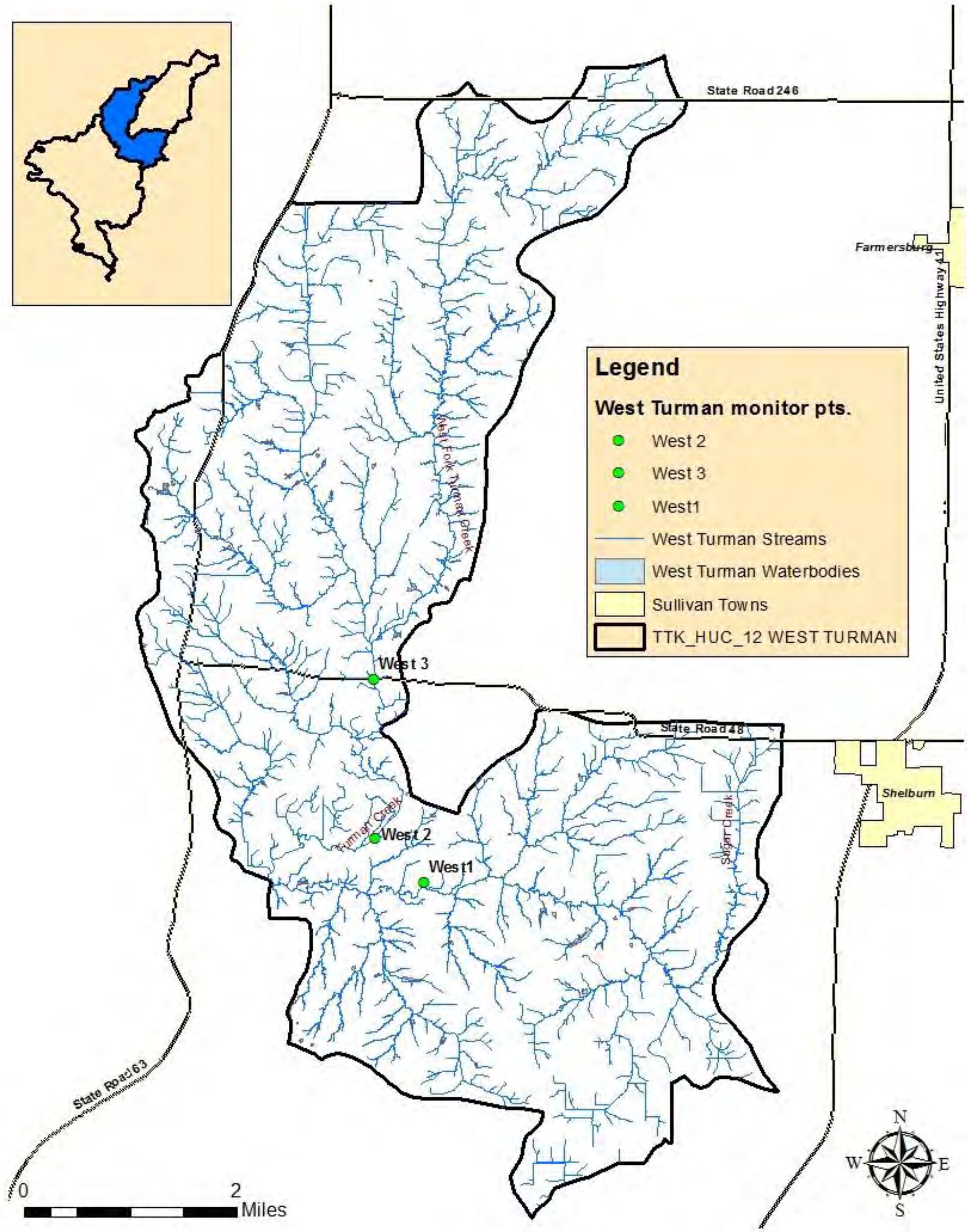


Figure 26- West Turman Land Use Information

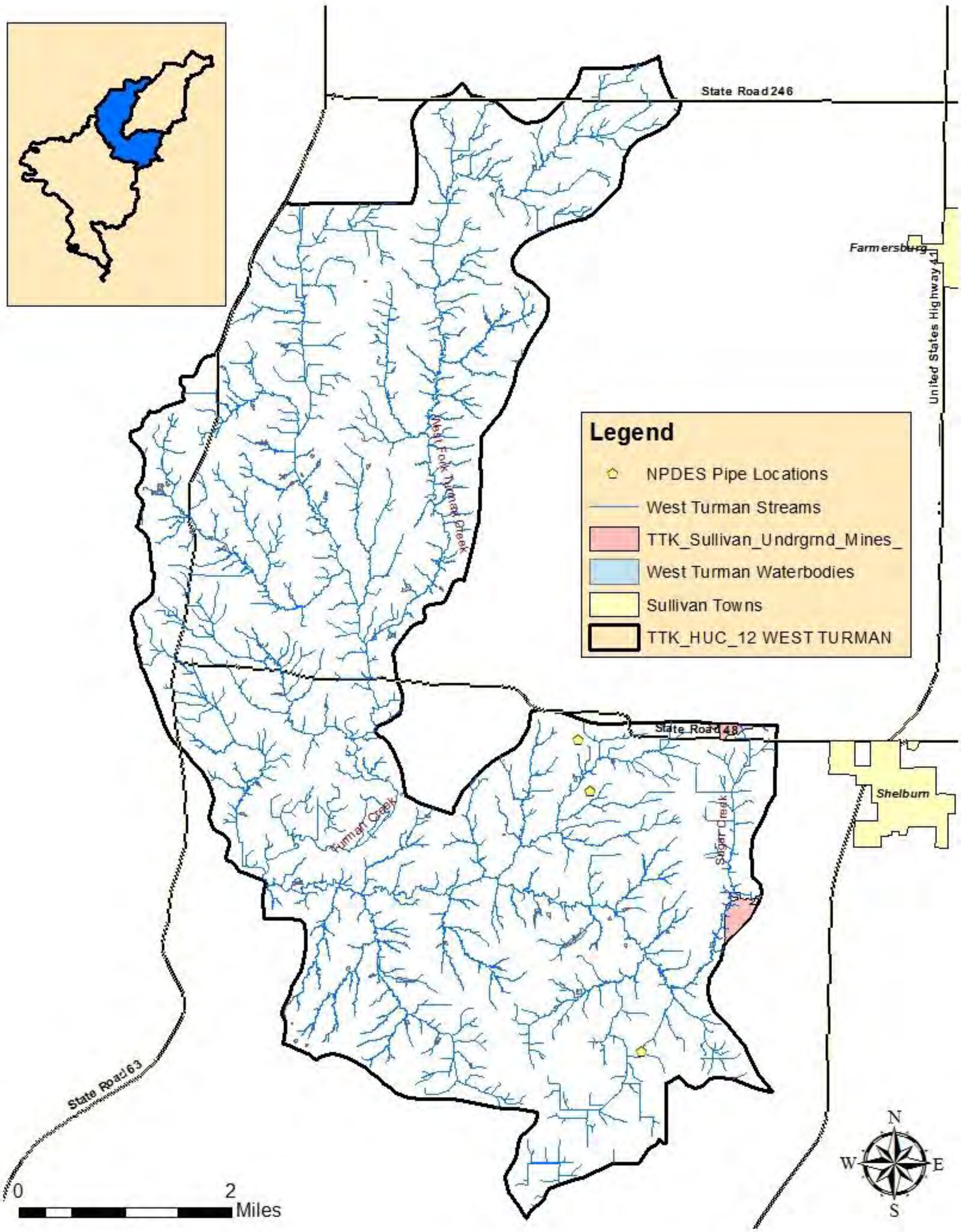


Figure 27 - West Turman Land Use Classifications

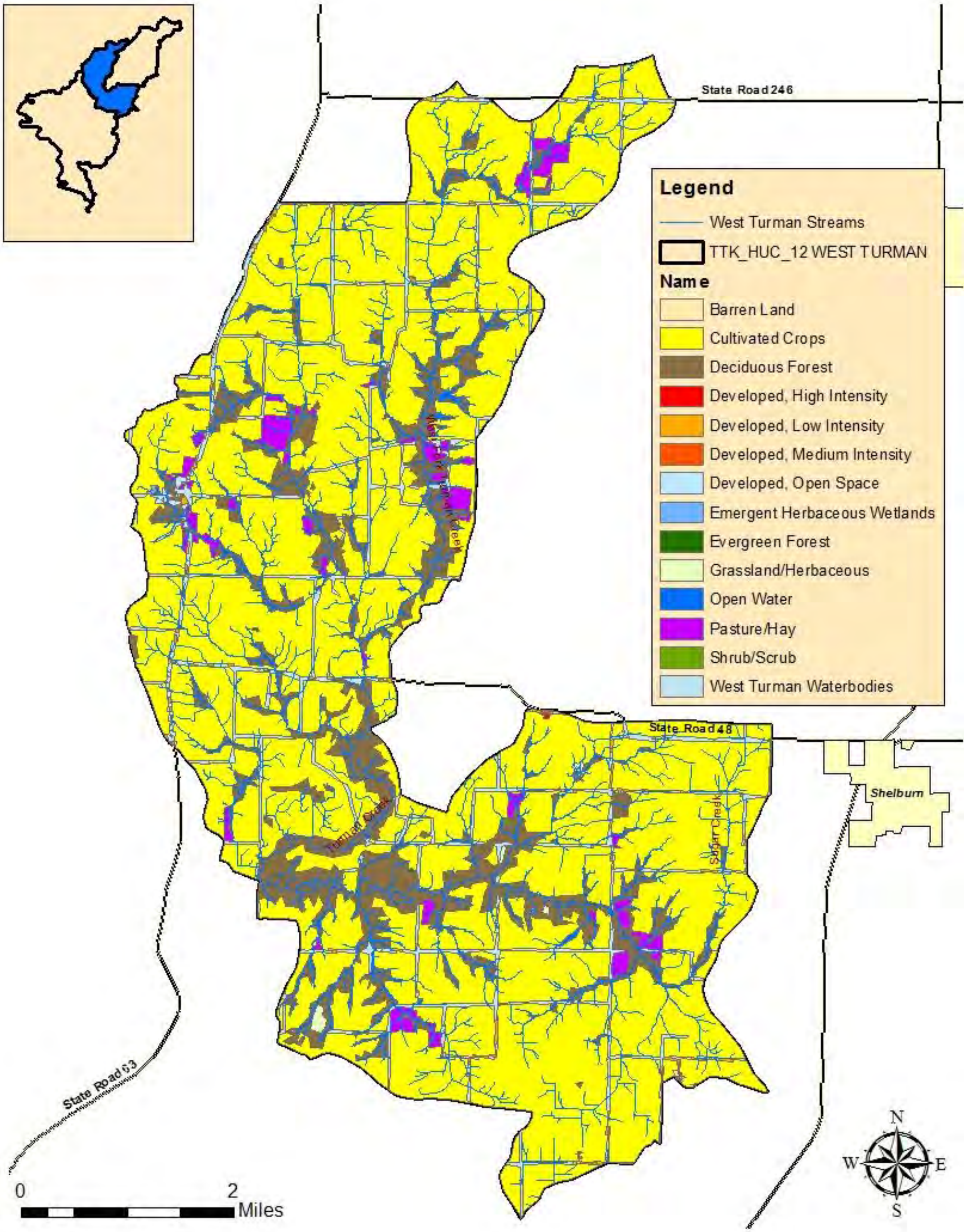


Table 23 – Lab Data Summary for West Turman Creek Monitoring Sites

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: West 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,203.300	26.000	0.435	0.080	7.650
May 2014	1,046.200	432.000	4.040	1.500	38.250
June 2014	290.900	0.000	3.820	0.110	0.680
July 2014	275.500	8.000	0.000	0.260	0.035
Aug. 2014	98.700	20.000	0.090	0.270	0.018
Sept. 2014	172.500	5.000	0.253	0.060	0.280
Oct. 2014	328.200	4.000	1.330	0.220	0.850
Nov. 2014	65.700	7.000	0.392	0.180	2.125
Dec. 2014	517.200	8.000	2.110	0.140	2.720
Jan. 2015	80.000	8.000	2.289	0.170	1.700
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	649.000	366.000	0.415	0.690	17.000

Site ID: West 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	0.000	16.000	1.020	0.110	2.130
May 2014	1,119.900	1,380.000	3.090	2.800	107.100
June 2014	238.200	40.000	2.760	0.210	10.200
July 2014	248.100	20.000	0.570	0.260	12.750
Aug. 2014	365.400	8.000	0.183	0.160	0.425
Sept. 2014	517.200	0.000	0.145	0.100	1.275
Oct. 2014	261.300	7.000	2.180	0.00	25.500
Nov. 2014	178.000	8.000	1.180	0.070	5.100
Dec. 2014	325.500	20.000	2.490	0.170	76.500
Jan. 2015	36.000	7.000	2.498	0.310	26.560
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	326.000	193.000	0.972	0.590	3.060

Site ID: West 3	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,413.600	19.000	3.280	0.090	9.520
May 2014	1,046.200	1,180.000	6.220	2.900	31.880
June 2014	1,203.300	13.000	5.390	0.150	2.550
July 2014	1,011.200	9.000	1.940	0.240	0.850
Aug. 2014	0.00	NS	0.000	NS	0.00
Sept. 2014	866.400	12.000	0.517	0.160	0.00
Oct. 2014	275.500	5.000	3.980	0.00	9.120
Nov. 2014	131.700	0.000	2.890	0.040	1.360
Dec. 2014	172.700	9.000	4.060	0.080	6.375
Jan. 2015	328.000	7.000	4.137	0.140	3.060
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	517.000	148.000	1.240	0.860	57.375

Table 24 – Pollutant Load Summary for West Turman Creek Monitoring Sites

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
West 1	429.75	2.49E+13	45.3%
West 2	328.69	7.22E+13	28.5%
West 3	633.24	6.27E+13	62.9%

Site Name	Average TSS Concentration (mg/L)	Average Load Ton/Year	% Reduction Needed
West 1	80.36	512.48	87.60%
West 2	154.45	3,737.77	93.5%
West 3	127.45	1,391.61	92.2%

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
West 1	1.38	8.80	27.50%
West 2	1.55	37.51	35.5%
West 3	3.04	33.19	67.10%

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
West 1	0.33	2.10	78.8%
West 2	0.43	10.41	83.7%
West 3	0.42	4.59	83.3%

Dodd's Bridge 0512011112013

The Dodd's Bridge subwatershed is named for a town that is no more than a few houses surrounding a crossroad today. There are over 14,000 acres that make up the Dodd's Bridge subwatershed, though most of it differs slightly from the other subwatersheds due to the presence of more rolling topography, especially around the Graysville area. For that reason, most of the forested areas of the TTK watershed can be found in the Dodd's Bridge subwatershed, along with the bulk of grazed livestock and hobby farms.

Three monitoring sites were chosen for the Dodd's Bridge subwatershed, with Dodds 3 representing the furthest downstream monitoring point on Turman Creek. The IDEM Office of Water Quality Assessment Branch also cited streams categorized with 5A impairments in this region (see Section 3.1. Figure 16). Streams data from the Assessment Branch showed water was unsuitable for recreational use due to high E.coli levels, and that biotic integrity failed to meet established state standards. Based on macroinvertebrate collection assays completed in the fall of 2014 for the TTK monitoring program, PTI scores were among some of the lowest in the entire TTK watershed. In the cases of the Dodd's Bridge monitoring sites, much accumulated sediment was found in the streambeds, making it nearly impossible for macroinvertebrates to persist.

Logjams and woody debris are often reported throughout the Dodd's Bridget subwatershed and evidence was readily observed, especially at the Dodds 2 monitoring site (Figure 19). The abundance of woody debris collected in the streams of Dodd's Bridge is likely due to poorly executed logging practices within the past several decades (as reported by local stakeholders). Depending on one's perspective, logjams can be viewed as a source of beneficial habitat for fish, macroinvertebrates, and other organisms or as a problematic occurrence, capable of causing streambank erosion, flooding, and potential safety hazards to man-made structures such as bridges.

Within the Dodd's Bridge subwatershed, one CFO exists, as well as one NPDES pipe location for a gravel quarry that is no longer operational. Land use statistics are as follows:

Table 25 - Land Use Statistics for Dodd's Bridge Subwatershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	8,603.32	58.6%
Deciduous Forest	4,254.89	29.0%
Pasture/Hay	900.33	6.1%
Developed, Open Space	691.25	4.7%
Open Water	76.00	<1%
Developed, Low Intensity	53.10	<1%
Grassland/Herbaceous	34.63	<1%
Emergent Herbaceous Wetlands	22.67	<1%
Woody Wetlands	19.18	<1%
Evergreen Forest	13.64	<1%
Shrub/Scrub	9.32	<1%
Barren Land	1.18	<1%
Developed, Medium Intensity	0.81	<1%
Developed, High Intensity	0.22	<1%
Total Acreage		**14,680.32 acres**

Figure 28 - Dodd's Bridge Water Monitoring Sites

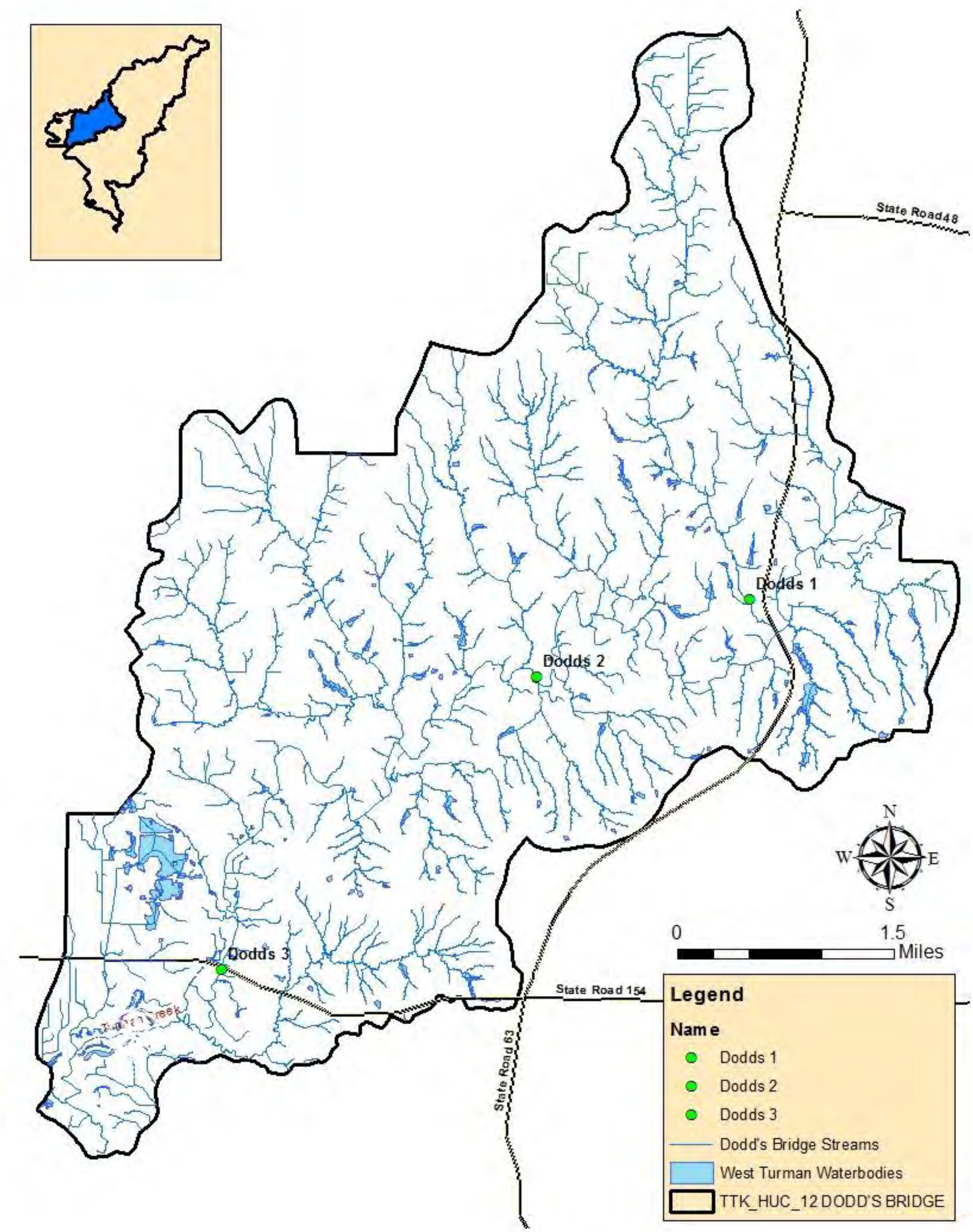


Figure 29- Dodd's Bridge Land Use Information

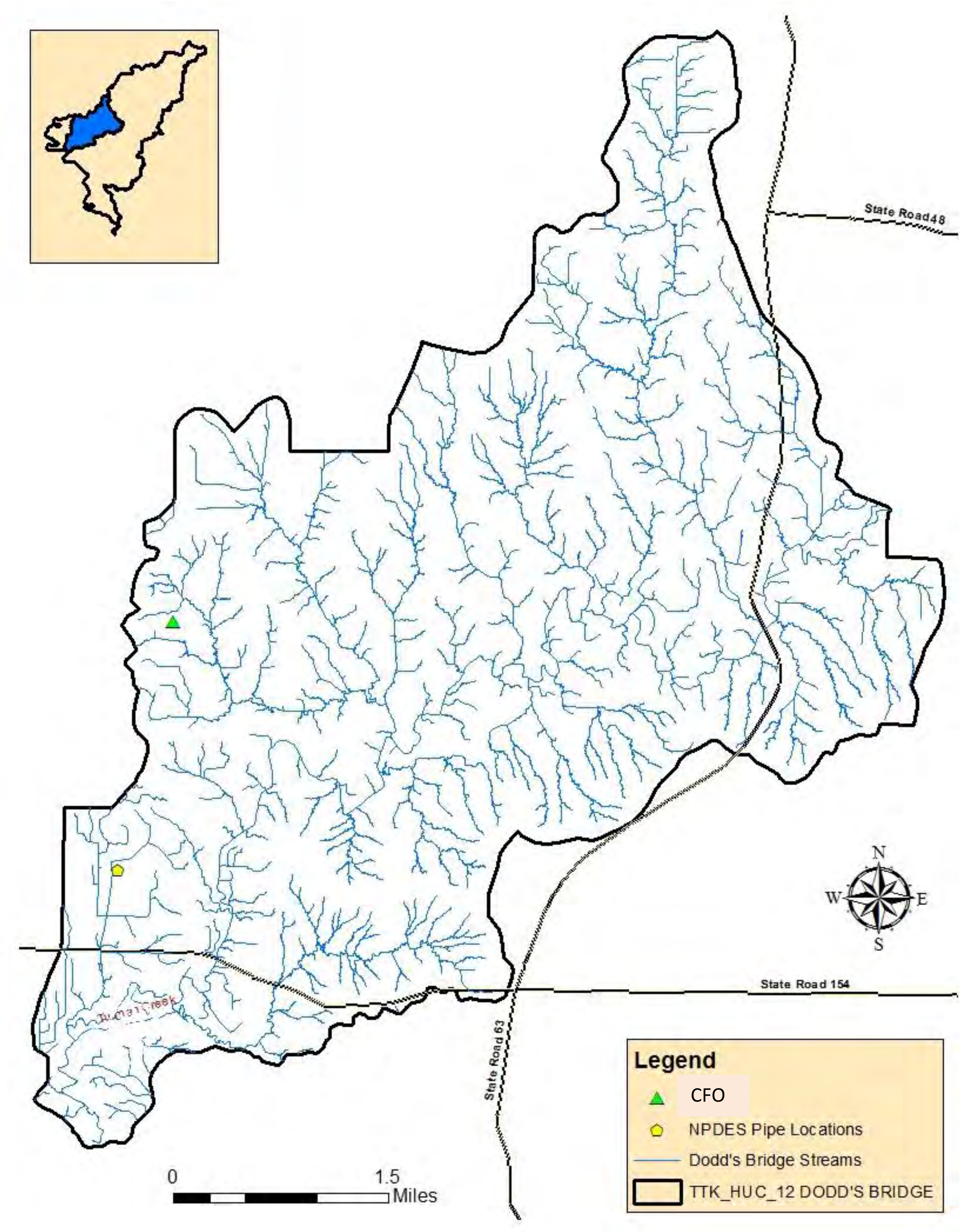


Figure 30 - Dodd's Bridge Land Use Classifications

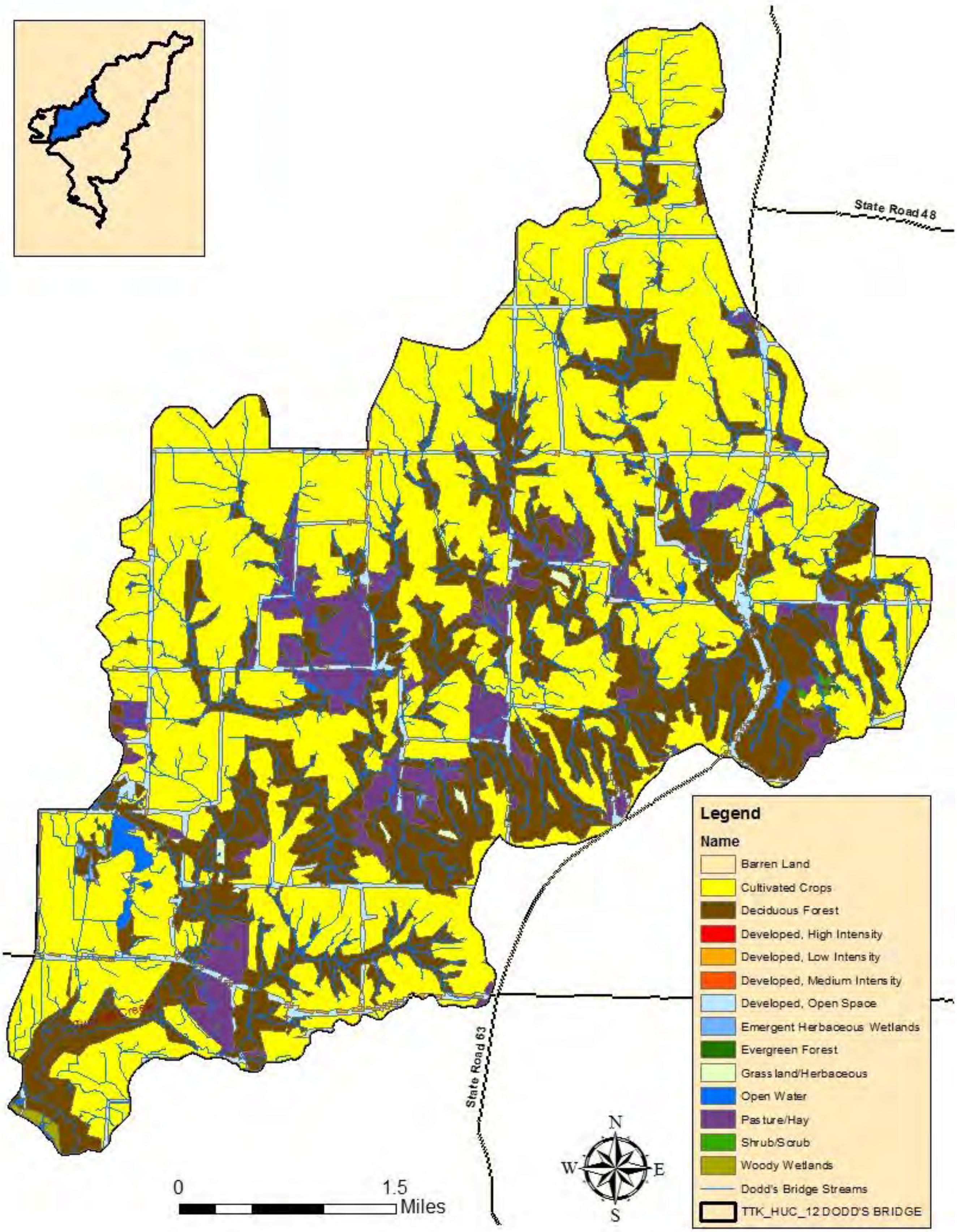


Table 26 – Lab Data Summary for Dodd's Bridge Subwatershed

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: Dodds 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	686.700	14.000	2.220	0.000	1.530
May 2014	1,046.200	184.000	0.539	1.090	8.500
June 2014	770.100	15.000	4.220	0.000	8.500
July 2014	325.500	9.000	0.988	0.250	0.085
Aug. 2014	NS	NS	0.000	NS	0.00
Sept. 2014	1,046.200	7.000	0.155	0.120	2.550
Oct. 2014	238.200	6.000	3.960	0.170	17.000
Nov. 2014	65.700	6.000	2.260	0.020	2.720
Dec. 2014	141.400	0.000	4.610	0.080	13.600
Jan. 2015	210.000	3.000	4.391	0.190	21.250
Feb. 2015	19.000	0.000	Lab Error	0.000	19.125
Mar. 2015	387.000	401.000	1.681	0.910	122.400

Site ID: Dodds 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	866.400	17.000	0.756	0.020	10.200
May 2014	1,119.900	320.000	3.860	0.490	51.000
June 2014	290.900	24.000	2.880	0.190	4.675
July 2014	344.800	22.000	0.604	0.250	11.460
Aug. 2014	344.800	15.000	0.078	0.900	0.00
Sept. 2014	344.800	15.000	0.201	0.100	0.680
Oct. 2014	172.200	8.000	1.840	0.000	2.550
Nov. 2014	101.900	7.000	1.070	0.170	1.870
Dec. 2014	410.600	18.000	2.290	0.170	30.600
Jan. 2015	NS	NS	NS	NS	NS
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	387.000	175.000	0.647	0.570	1.360

Site ID: Dodds 3	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	613.100	73.000	2.640	0.770	0.00
May 2014	920.800	136.000	3.500	0.490	20.400
June 2014	218.700	19.000	3.000	0.200	0.00
July 2014	78.800	12.000	0.472	0.220	7.650
Aug. 2014	172.200	12.000	0.138	0.200	6.375
Sept. 2014	387.300	8.000	0.407	0.120	0.00
Oct. 2014	98.500	7.000	1.960	0.000	9.563
Nov. 2014	115.300	0.000	0.905	0.010	4.250
Dec. 2014	206.400	15.000	2.190	0.160	6.800
Jan. 2015	23.000	6.000	1.937	0.120	20.400
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	461.000	251.000	0.692	0.580	1.530

Table 27 – Pollutant Load Summary for Dodd's Bridge Subwatershed

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
Dodds 1	411.33	6.65E+13	42.9%
Dodds 2	438.33	4.48E+13	46.4%
Dodds 3	299.55	1.87E+13	21.5%

Site Name	Average TSS Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Dodds 1	53.75	957.34	81.40%
Dodds 2	62.10	776.51	83.90%
Dodds 3	49.00	337.29	79.60%

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Dodds 1	2.27	40.43	55.90%
Dodds 2	1.42	15.98	29.60%
Dodds 3	1.62	11.15	38.30%

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Dodds 1	0.24	4.27	70.80%
Dodds 2	0.29	3.26	75.90%
Dodds 3	0.26	1.79	73.10%

Turtle Creek 051201111601

The Turtle Creek subwatershed is special because it was the starting point for watershed management planning and 319 grants in Sullivan County. After observing much sediment accumulation and diminished fish populations in the Turtle Creek Reservoir, representatives from Hoosier Energy and local stakeholders became concerned. An Advisory Committee was formed and a Watershed Management Plan for Turtle Creek and Little Turtle Creek was written and approved in 2001. Committed stakeholders were passionate about this project, and several are currently participating in the TTK Advisory Committee today! Much was accomplished during the time of the original Turtle Creek Watershed Project, including the promotion of stream buffers, shoreline erosion repair, and widespread environmental education. Requirements for Watershed Management Planning according to IDEM's current standards have changed since the original Turtle Creek WMP was written, but much useful insight can still be gained. A link to the original Turtle Creek WMP can be found here: http://www.in.gov/idem/nps/files/wmp_turtlecreek_4-151.pdf

The Turtle Creek subwatershed is also unique in that it possesses the largest waterbody in Sullivan County. This 1,550 acre Turtle Creek Reservoir, managed by Hoosier Energy, serves as a cooling reservoir for their industrial facility while receiving much recreational usage from fishing, hunting, and bird-watching enthusiasts. The land surrounding the reservoir is mostly utilized for row-crop agriculture, hay, and the occasional residential cluster.

Hoosier Energy is an NPDES facility (see Table 18) with several NPDES discharge pipes and a newly constructed on-site landfill. At this time, Hoosier Energy is in compliance with all permits, though there was a past incident involving discharge temperatures that exceeded the state standards. Environmental representatives from Hoosier Energy are key participants on the TTK Advisory Committee, seeking to offer solutions at a watershed level for the problems they have been encountering in the reservoir. As much as 8 feet of accumulated sediment was reported from a recent bathymetric study conducted by EA. Shoreline erosion around the reservoir is a problem due to high winds in this area, though sediment plumes have been documented at the upper ends of the reservoir where streams flow into the lake.

Hoosier Energy generously contributed extra funding for more sites to be monitored in the Turtle Creek watershed as a part of the TTK study. However, data collected yielded results that indicated the pollutant loads were not as severe in the Turtle Creek watershed as were found in other subwatersheds throughout TTK. In fact, much of the year, the small infeeding streams were dry, which indicates that sediment is being brought into the reservoir in several large 'dumps' during high flow events throughout the year. The sites Turtle 4 and 7 were typically back-flooded from the reservoir and do not technically qualify as 'stream' sites, making their results atypical from the rest of the collected samples. In general, monitoring sites on the northeastern side of the reservoir showed the highest pollutant loads, especially for E.coli, Total Phosphorus, and Total Suspended Solids. Overall, QHEI assessments yielded some of the better scores in the TTK watershed, with sites ranged from 'poor' to 'good', however macroinvertebrate PTI scores were uniformly 'poor' with the exception of the Turtle 4 site.

The town of Merom is present within the Turtle Creek subwatershed, and though it only has a population of 200, it was issued a Notice of Violation by IDEM in 2004 for untreated discharge entering Waters of the U.S. Recently, the Town Council of Merom has undertaken steps to achieve compliance by requiring residents to furnish proof of functioning septic systems. If they are unable to do so, they will be fined until their system is compliant with state standards. The

Turtle 8 monitoring site, east of Merom, was found to have very high E.coli loads, even in the middle of winter, which indicates a constant source of contaminant, whether from the town itself, nearby livestock feeding areas, or the use of manure as fertilizer on adjacent crop fields.

Merom is currently working in partnership with the TTK Advisory Committee and WCIWA to improve its environmental practices. The Town of Merom was recently awarded an Environmental Grant from Indiana American Water in 2015 for various improvements around the historic Bluff Park, as well as for ditch stabilization on areas most in need of repair.

Other items of note include one LUST in the Turtle Creek watershed, though it is not associated with Hoosier Energy activities. There are two CFOs in the Turtle Creek watershed. Land use statistics are as follows:

Table 28 - Land Use Statistics for Turtle Creek Subwatershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	11,020.70	60.8%
Deciduous Forest	2,718.25	15.0%
Open Water	1,638.00	9.0%
Pasture/Hay	1533.91	8.5%
Developed, Open Space	897.84	5.0%
Developed, Low Intensity	149.39	<1%
Developed, Medium Intensity	33.40	<1%
Grassland/Herbaceous	31.57	<1%
Emergent Herbaceous Wetlands	27.40	<1%
Developed, High Intensity	21.57	<1%
Evergreen Forest	22.42	<1%
Shrub/Scrub	6.43	<1%
Woody Wetlands	6.12	<1%
Barren Land	6.01	<1%
Total Acreage		**18,107.00 acres**

Figure 31 - Turtle Creek Water Monitoring Sites

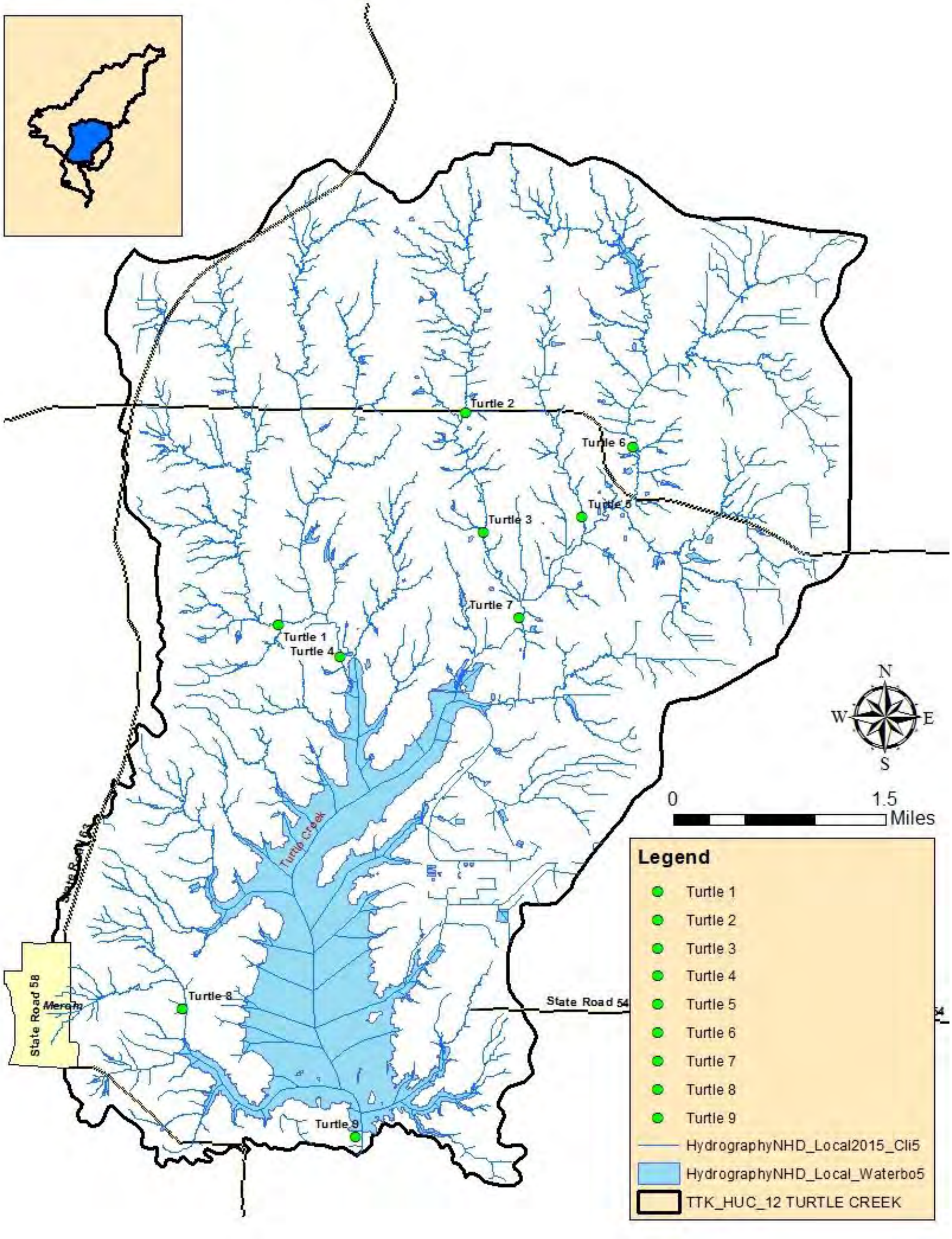


Figure 32 - Turtle Creek Land Use Information

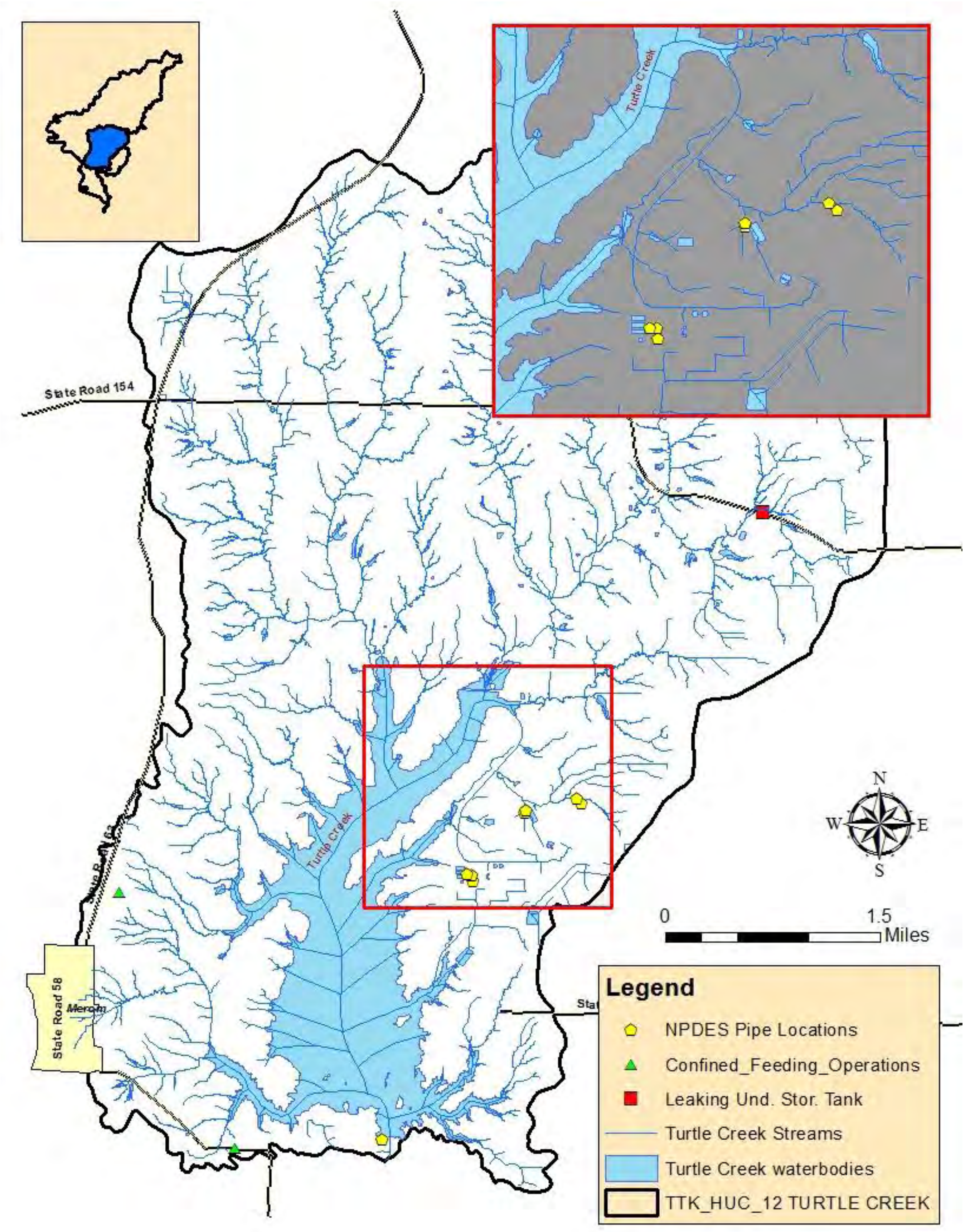


Figure 33 - Turtle Creek Land Use Classifications

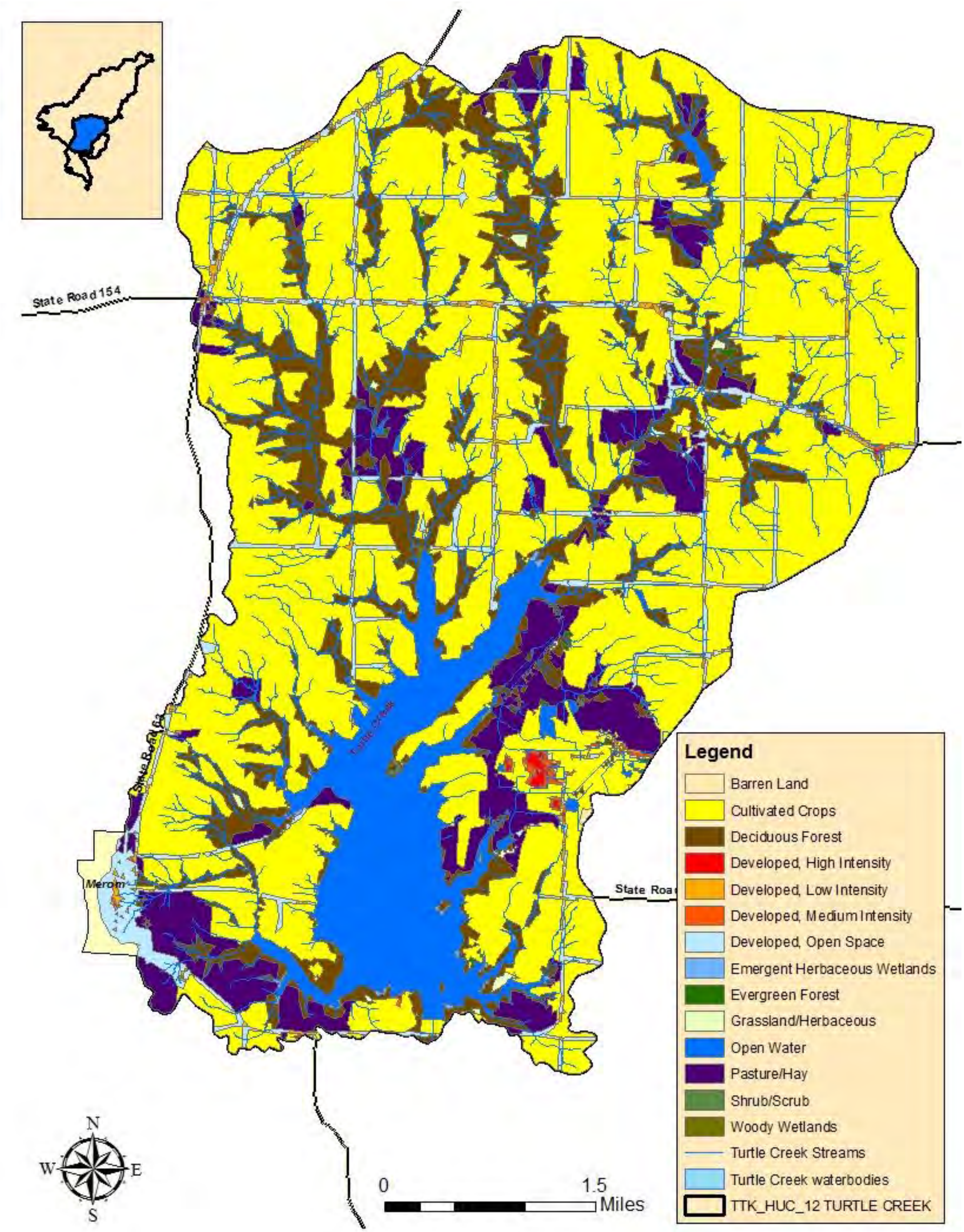


Table 29 – Lab Data Summary for Turtle Creek Subwatershed

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: Turtle 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	435.200	21.000	2.100	0.22	5.360
May 2014	365.400	4.000	2.590	0.10	5.100
June 2014	387.300	10.000	1.410	0.12	0.425
July 2014	0.00	NS	0.000	NS	0.00
Aug. 2014	0.00	NS	0.000	NS	0.00
Sept. 2014	235.900	4.000	0.201	0.13	0.128
Oct. 2014	161.600	10.000	0.758	0.00	0.283
Nov. 2014	71.700	4.000	0.111	0.04	0.085
Dec. 2014	325.500	11.000	1.470	0.08	0.425
Jan. 2015	34.000	4.000	1.617	0.26	0.680
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	124.000	21.200	3.12	0.00	2.720

Site ID: Turtle 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	613.100	17.000	0.560	1.270	6.800
May 2014	920.800	7.000	0.585	0.050	1.530
June 2014	0.00	NS	0.000	NS	0.00
July 2014	0.00	NS	0.000	NS	0.00
Aug. 2014	0.00	NS	0.000	NS	0.00
Sept. 2014	96.000	0.000	0.000	0.050	0.021
Oct. 2014	365.400	11.000	0.079	0.00	0.043
Nov. 2014	105.400	0.000	0.000	0.030	0.142
Dec. 2014	1,553.100	11.000	0.508	0.050	0.340
Jan. 2015	12.000	4.000	0.645	0.340	0.680
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	115.000	85.300	1.150	0.070	2.040

Site ID: Turtle 3	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	387.300	25.000	0.354	0.200	1.660
May 2014	387.300	0.000	0.335	0.080	8.500
June 2014	0.00	NS	0.000	NS	0.00
July 2014	0.00	NS	0.000	NS	0.00
Aug. 2014	0.00	NS	0.000	NS	0.00
Sept. 2014	151.500	0.000	0.102	0.07	0.255
Oct. 2014	127.400	0.000	0.000	0.00	0.383
Nov. 2014	67.700	7.000	0.000	0.01	0.085
Dec. 2014	613.100	16.000	0.413	0.13	0.450
Jan. 2015	18.000	3.000	0.384	0.36	0.680
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	93.000	16.300	1.12	0.00	13.600

Site ID: Turtle 4	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	579.400	18.000	1.630	0.170	0.00
May 2014	920.800	62.000	2.770	0.170	0.00
June 2014	275.500	24.000	1.590	0.130	0.00
July 2014	198.900	15.000	0.000	0.260	0.00
Aug. 2014	125.900	19.000	0.086	0.130	0.00
Sept. 2014	204.600	16.000	0.120	0.12	0.00
Oct. 2014	517.200	6.000	0.960	0.00	0.00
Nov. 2014	83.600	8.000	0.106	0.00	0.00
Dec. 2014	613.100	13.000	1.390	0.16	0.00
Jan. 2015	NS	NS	NS	NS	NS
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	152.000	19.000	2.77	0.00	0.00

Site ID: Turtle 5	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	488.400	15.000	0.946	0.210	0.00
May 2014	980.400	22.000	0.839	0.120	0.00
June 2014	0.000	0.000	0.000	NS	0.00
July 2014	0.000	0.000	0.000	NS	0.00

Aug. 2014	1,986.300	10.000	0.466	0.190	0.011
Sept. 2014	77.600	5.000	0.344	0.070	0.00
Oct. 2014	235.900	4.000	0.225	0.000	0.560
Nov. 2014	24.600	0.00	0.000	0.000	0.085
Dec. 2014	1,413.600	11.000	0.651	0.100	0.340
Jan. 2015	66.000	29.000	0.900	0.360	0.340
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	285.000	10.300	1.830	0.000	0.765

Site ID: Turtle 6	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	275.500	13.000	1.090	0.210	40.800
May 2014	461.100	9.000	1.660	0.050	0.960
June 2014	866.400	4.000	1.100	0.840	0.028
July 2014	0.00	NS	0.000	NS	0.00
Aug. 2014	1,299.700	23.000	0.186	0.230	0.071
Sept. 2014	123.600	6.000	0.152	0.090	0.991
Oct. 2014	261.300	8.000	0.917	0.00	0.283
Nov. 2014	52.100	5.000	0.320	0.010	0.170
Dec. 2014	866.400	33.000	0.864	0.180	0.283
Jan. 2015	96.000	6.000	0.952	0.370	3.400
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	79.000	20.700	1.640	0.400	20.400

Site ID: Turtle 7	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	547.500	30.000	1.020	0.210	0.00
May 2014	816.400	10.000	1.770	0.120	5.100
June 2014	344.800	24.000	1.060	0.120	0.00
July 2014	259.500	10.000	0.083	0.240	0.00
Aug. 2014	1,732.900	32.000	0.550	0.270	0.00
Sept. 2014	396.800	18.000	0.205	0.120	0.00
Oct. 2014	203.500	19.000	0.656	0.00	0.00
Nov. 2014	151.500	7.000	0.307	0.010	0.00
Dec. 2014	1,046.200	13.000	1.090	0.180	8.925
Jan. 2015	NS	NS	NS	NS	NS
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	162.000	24.300	1.620	0.450	3.188

Site ID: Turtle 8	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	613.100	142.000	9.730	0.440	9.180
May 2014	1,732.900	7.000	4.260	0.320	3.830
June 2014	235.900	31.000	2.220	0.210	0.00
July 2014	0.00	NS	0.000	NS	0.00
Aug. 2014	0.00	NS	0.000	NS	0.00
Sept. 2014	2,419.600	22.000	3.140	0.340	0.850
Oct. 2014	365.400	0.000	1.390	0.00	2.260
Nov. 2014	648.800	7.000	0.830	0.014	0.213
Dec. 2014	488.400	10.000	2.540	0.160	1.700
Jan. 2015	88.000	6.000	0.378	0.330	0.255
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	214.000	50.000	2.247	0.250	3.060

Site ID: Turtle 9	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	19.500	18.000	0.000	0.090	86.060
May 2014	8.600	13.000	0.483	0.120	59.500
June 2014	204.600	16.000	0.000	0.120	3.400
July 2014	39.300	14.000	0.000	0.210	5.100
Aug. 2014	7.500	17.000	0.000	0.100	2.720
Sept. 2014	22.600	18.000	0.000	0.080	127.500
Oct. 2014	7.400	25.000	0.000	0.030	20.400
Nov. 2014	6.300	16.000	0.095	0.00	40.800
Dec. 2014	275.500	23.000	0.326	0.180	85.000
Jan. 2015	61.000	14.000	0.585	0.350	6.375
Feb. 2015	6.000	8.900	0.000	0.140	10.200
Mar. 2015	17.000	18.000	0.146	0.080	102.000

Table 30 – Pollutant Load Summary for Turtle Creek Subwatershed

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
Turtle 1	194.60	2.40E+12	None Required (-20.8%)
Turtle 2	343.71	3.23E+12	31.6%
Turtle 3	167.75	3.49E+12	None Required (-40.1%)
Turtle 4	367.10	0.00 (no flow)	n/a
Turtle 5	505.25	8.61E+11	53.5%
Turtle 6	398.28	2.18E+13	41.0%
Turtle 7	566.11	8.70E+12	58.5%
Turtle 8	618.74	1.07E+13	62.0%
Turtle 9	56.28	2.30E+13	None Required (-317.6%)

Site Name	Average TSS Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Turtle 1	8.11	11.03	None Required (-23.3%)
Turtle 2	12.30	12.76	18.70%
Turtle 3	6.12	14.02	None Required (-63.4%)
Turtle 4	20.00	0.00 (no flow)	n/a
Turtle 5	9.66	1.81	None Required (-3.5%)
Turtle 6	11.61	69.97	13.90%
Turtle 7	18.73	31.72	46.60%
Turtle 8	25.00	47.73	60.00%
Turtle 9	16.74	753.49	40.30%

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Turtle 1	1.22	1.66	18.0%
Turtle 2	0.32	0.33	None Required (-212.50%)
Turtle 3	0.25	0.57	None Required (-300.00%)
Turtle 4	1.14	0.00 (no flow)	n/a
Turtle 5	0.56	0.11	None Required (-78.60%)
Turtle 6	0.81	4.88	None Required (-23.50%)
Turtle 7	0.84	1.42	None Required (-19.00%)
Turtle 8	2.43	4.64	58.80%
Turtle 9	0.14	6.30	None Required (-614.30%)

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Turtle 1	0.09	0.12	22.20%
Turtle 2	0.17	0.18	58.80%
Turtle 3	0.08	0.18	12.50%
Turtle 4	0.11	0.00 (no flow)	n/a
Turtle 5	0.10	0.02	30.00%
Turtle 6	0.22	1.33	68.20%
Turtle 7	0.17	0.29	58.80%
Turtle 8	0.19	0.36	63.20%
Turtle 9	0.13	5.85	46.20%

Little Turtle Creek 051201111602

The Little Turtle Creek subwatershed was also included in the original Partnership for Turtle Creek watershed planning efforts, though emphasis at the time was placed on land surrounding the Turtle Creek Reservoir. Much of the land in this watershed is owned by Hoosier Energy and farmed on rental agreements or not currently in use. The Little Turtle Creek subwatershed has an unusual U-shaped drainage area, with the two hemispheres showing distinctly different land uses. Areas on the western half consist mostly of forest and wetland areas, where occasional livestock pastures can be observed. It is not widely farmed land, due to the high risk of flooding. This area also represents some of the best acreage for wildlife in the county and many food plots and habitat acres have been established, as well as most of the county's CREP and WRP acreage, bordering the Wabash River. The eastern half of the Little Turtle Creek subwatershed however, is devoted mostly to row-crop agriculture, with narrow (or absent) riparian buffers and occasional livestock pastures.

For the current TTK watershed planning efforts, five sites were selected in the Little Turtle Creek subwatershed for monitoring and some of the highest pollutant loads were reported in these areas, especially at LT3 and LT4 despite their upstream orientation. High concentrations of TSS, E.coli, Total Phosphorus, and Nitrates/Nitrites were recorded at these sites, which were some of the sandiest sites in the watershed. It is likely that many of these pollutants were not filtered out or 'tied up' as with other soil types, but rather leached quickly through the sand and into surface streams.

LT1 was the only monitoring site on the western hemisphere of the Little Turtle Creek subwatershed, though there was some complication with access as it necessitated driving through private land, so was avoided during peak hunting seasons. Incidentally, it was dry much of the year as reported by the landowner and confirmed during monitoring activities. The LT2 site qualifies as the furthest downstream site for the Turtle Creek watershed, just before it flows into the Wabash River. Streams in the Little Turtle subwatershed are distinctly sandy, which may also account for the poor macroinvertebrate PTI scores. Sand is an ever-changing substrate in flood conditions, making it difficult to populations of macroinvertebrates to establish themselves.

There is one NPDES pipe location in the Little Turtle Creek subwatershed (Table 18), just south of the Town of Merom, which is the source of the Notice of Violation previously detailed.

Land use statistics for the Little Turtle subwatershed are as follows:

Table 31 - Land Use Statistics for Little Turtle Subwatershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	8086.73	61.2%
Deciduous Forest	2913.29	22.1%
Developed, Open Space	752.78	5.7%
Open Water	583.51	4.4%
Emergent Herbaceous Wetlands	281.01	2.1%
Pasture/Hay	264.15	2.0%
Woody Wetlands	236.98	1.8%
Developed, Low Intensity	50.14	<1%
Barren Land	26.05	<1%
Developed, Medium Intensity	5.51	<1%
Evergreen Forest	5.75	<1%
Grassland/Herbaceous	3.55	<1%
Developed, High Intensity	1.35	<1%
Shrub/Scrub	1.09	<1%
Total Acreage		**13,210.80 acres**

Figure 34 - Little Turtle Water Monitoring Sites

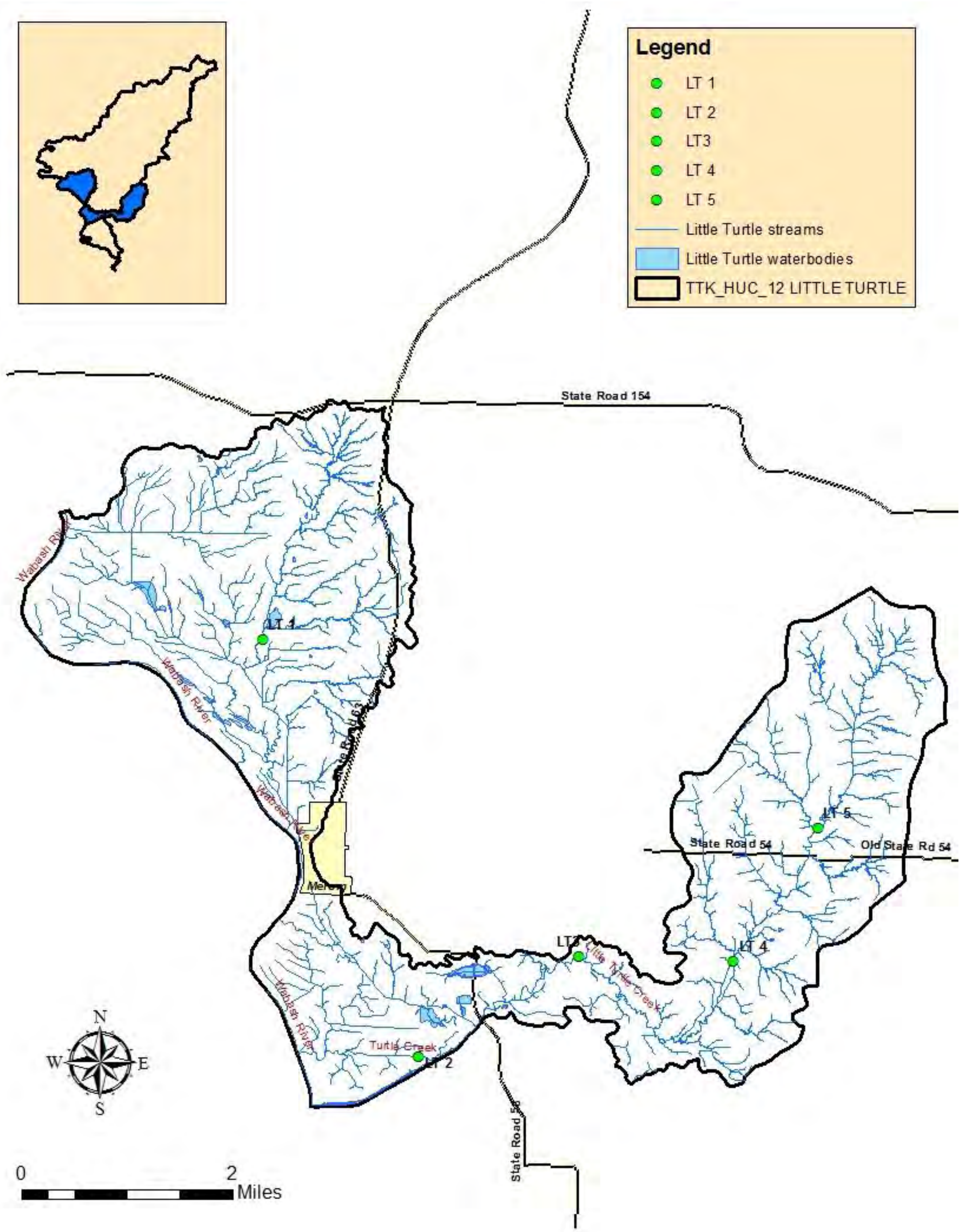


Figure 35 - Little Turtle Land Use Information

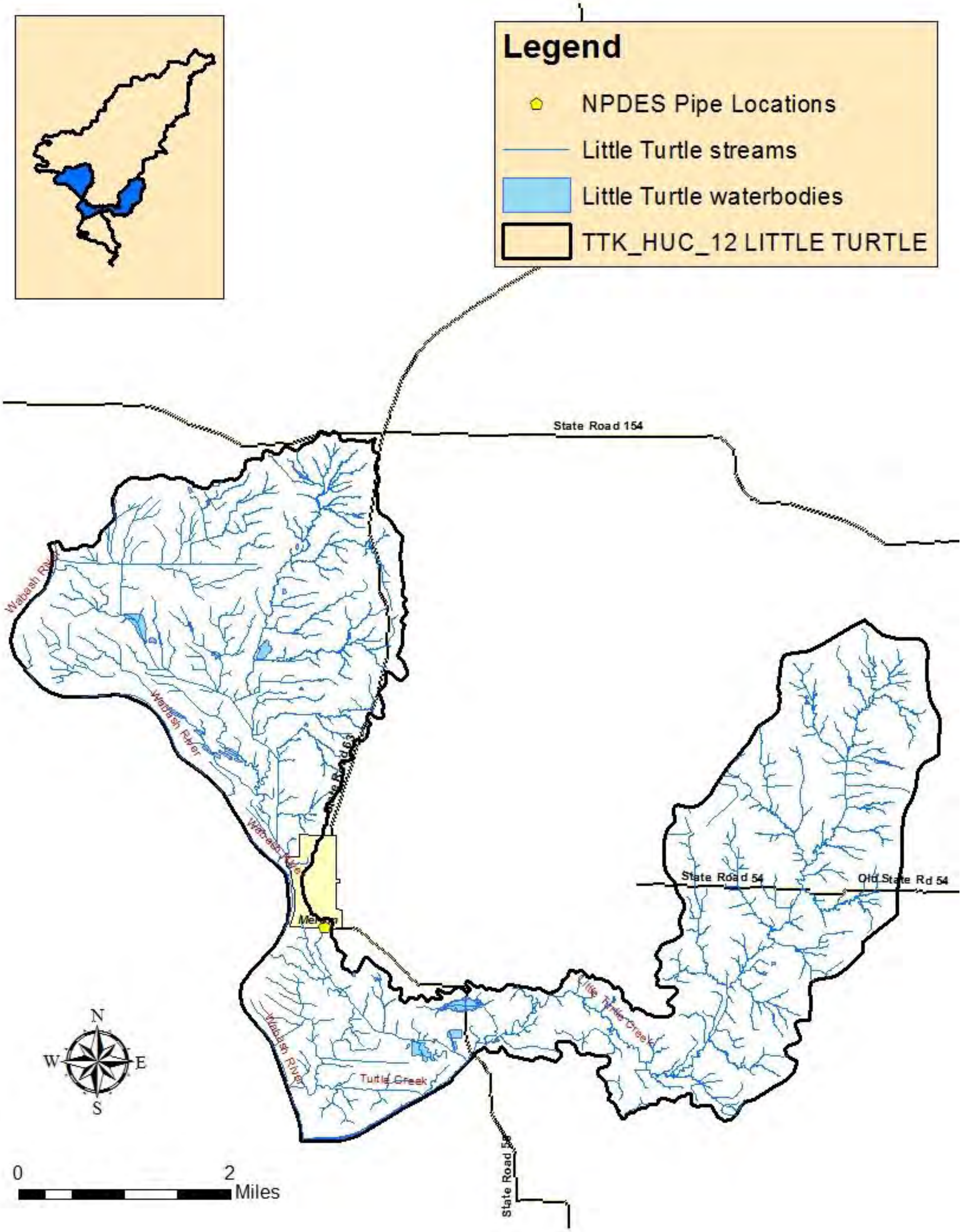


Figure 36 - Little Turtle Land Use Classifications

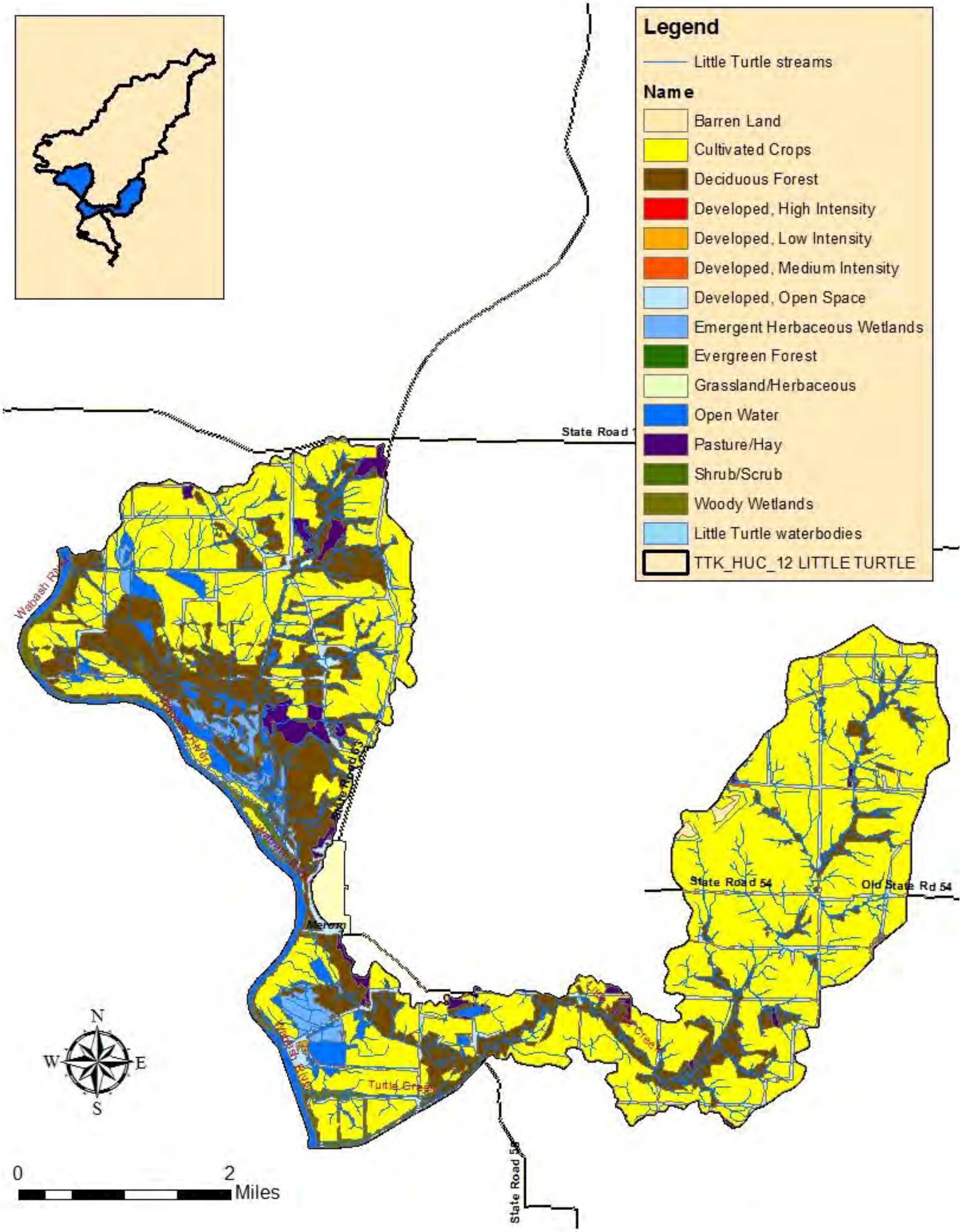


Table 32 – Lab Data Summary for Little Turtle Creek Subwatershed

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: LT 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,046.200	798.000	1.680	0.690	38.250
May 2014	293.300	26.000	1.860	0.210	20.400
June 2014	410.600	19.000	0.127	0.230	0.106
July 2014	NS	NS	0.000	NS	0.00
Aug. 2014	NS	NS	0.000	NS	0.00
Sept. 2014	NS	NS	0.000	NS	0.00
Oct. 2014	365.400	25.000	0.000	0.00	1.130
Nov. 2014	NS	NS	NS	NS	NS
Dec. 2014	344.800	10.000	1.950	0.100	0.340
Jan. 2015	201.000	6.000	1.640	0.220	0.990
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	130.000	128.000	2.243	0.290	1.530

Site ID: LT 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,046.200	1,320.000	1.650	2.000	0.00
May 2014	112.600	25.000	0.752	0.600	6.380
June 2014	579.400	13.000	0.790	0.150	0.00
July 2014	275.500	0.000	0.545	0.210	3.825
Aug. 2014	150.000	7.000	0.426	0.120	6.800
Sept. 2014	328.200	109.000	0.062	0.410	107.100
Oct. 2014	121.100	21.000	0.318	0.010	8.500
Nov. 2014	27.800	7.000	0.948	0.070	4.250
Dec. 2014	461.100	30.000	0.472	0.150	61.200
Jan. 2015	47.000	9.000	1.212	0.240	5.950
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	68.000	87.000	0.439	0.420	91.800

Site ID: LT 3	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,119.900	802.000	2.560	0.950	30.600
May 2014	248.100	15.000	4.290	0.110	5.440
June 2014	313.000	13.000	3.540	0.500	1.913
July 2014	517.200	9.000	3.260	0.270	1.130
Aug. 2014	613.100	0.000	4.070	0.080	0.509
Sept. 2014	2,419.600	42.000	1.050	0.320	1.700
Oct. 2014	203.500	8.000	2.500	0.00	2.125
Nov. 2014	45.500	0.000	1.880	0.020	0.510
Dec. 2014	325.500	38.000	2.680	0.170	3.740
Jan. 2015	29.000	40.000	1.264	0.270	5.100
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	192.000	182.000	1.635	0.220	12.240

Site ID: LT 4	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,046.200	345.000	2.800	0.840	149.180
May 2014	547.500	11.000	4.150	0.460	3.400
June 2014	290.900	13.000	1.970	0.110	1.700
July 2014	686.700	17.000	0.867	0.410	0.340
Aug. 2014	686.700	13.000	0.309	0.180	0.043
Sept. 2014	1,203.300	47.000	0.653	0.350	2.550
Oct. 2014	816.400	12.000	1.980	0.00	1.360
Nov. 2014	157.600	0.000	1.210	0.020	2.040
Dec. 2014	980.400	16.000	2.490	0.160	8.500
Jan. 2015	78.000	5.000	1.949	0.250	2.380
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	154.000	66.000	1.557	0.250	34.000

Site ID: LT 5	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	1,299.700	352.000	2.140	0.380	31.280
May 2014	290.900	9.000	2.490	0.020	9.180
June 2014	648.800	16.000	1.080	0.300	0.106
July 2014	0.00	NS	0.000	NS	0.00

Aug. 2014	0.00	NS	0.000	NS	0.00
Sept. 2014	579.400	32.000	0.428	0.270	1.700
Oct. 2014	517.200	5.000	0.000	0.020	0.453
Nov. 2014	65.000	0.000	0.473	0.00	0.142
Dec. 2014	275.500	11.000	1.710	0.190	1.020
Jan. 2015	47.000	4.000	2.855	0.240	0.510
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	111.000	86.500	1.115	0.270	3.060

Table 33 – Pollutant Load Summary for Little Turtle Creek Subwatershed

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
LT 1	279.13	1.56E+13	15.8%
LT 2	292.45	7.02E+13	19.6%
LT 3	547.85	2.89E+13	57.1%
LT 4	604.34	1.01E+14	61.1%
LT 5	348.59	1.34E+13	32.6%

Site Name	Average TSS Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
LT 1	101.20	624.68	90.10%
LT 2	148.00	3,915.30	93.20%
LT 3	104.45	607.24	90.40%
LT 4	49.55	910.62	79.80%
LT 5	46.86	198.86	78.70%

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
LT 1	0.95	5.86	None Required (-5.30%)
LT 2	0.69	18.25	None Required (-44.90%)
LT 3	2.61	15.17	61.70%
LT 4	1.81	33.26	44.80%
LT 5	1.12	4.75	10.70%

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
LT 1	0.17	1.05	58.80%
LT 2	0.40	10.58	82.50%
LT 3	0.26	1.51	73.10%
LT 4	0.28	5.15	75.00%
LT 5	0.15	.64	53.30%

Buzzard Pond 051201111603

The Buzzard Pond subwatershed is one of the smallest of the seven subwatersheds, with a total of 6,713.42 acres, almost exclusively utilized for row crop farming. This area is predominately sandy and much of the agricultural land is irrigated. Specialty crops such as melons, canola, and sorghum are also grown in this area. Some CREP and WRP acreage also exists in this subwatershed along the Wabash River corridor. It is also a notable part of the county because of the levee that prevents flooding from the Wabash River. Streams in the Buzzard Pond subwatershed are basically drainage ditches, which are levee-controlled so they remain impounded much of the year, except when allowed to drain. These ditches are infrequently maintained by dredging, though this practice is cost-prohibitive and only takes place when deemed absolutely necessary.

Two monitoring sites were chosen for the Buzzard Pond subwatershed; both were adjacent to agricultural fields with minimal buffer establishment. Results for nutrients were quite high in this area, presumably due to the prevalence of tiled drained sandy soils, which likely leach nutrients through the soil profile more quickly than they can be adsorbed by soil. It is also likely that many of the irrigated fields in this area also employ 'fertigation' methods. However, it should be noted that several stakeholders in this area voluntarily participate in the INField Advantage program and are working to assess the amounts of nitrogen applied to fields versus what the crop actually uses and retains. These conscientious application practices will help to minimize NO_2/NO_3 concentrations in local streams throughout the watershed in the future.

There are no NPDES pipes, CFOs, LUSTs, or other notable features in this area. Land use statistics are as follows:

Table 34 - Land Use Statistics for Buzzard Pond Subwatershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	5,164.84	76.9%
Woody Wetlands	477.47	7.1%
Developed, Open Space	386.53	5.8%
Open Water	362.59	5.4%
Pasture/Hay	151.71	2.3%
Deciduous Forest	125.94	1.9%
Developed, Low Intensity	36.96	≤ 0.1%
Developed, Medium Intensity	4.49	≤ 0.1%
Developed, High Intensity	2.89	≤ 0.1%
Emergent Herbaceous Wetlands	n/a	0%
Barren Land	n/a	0%
Evergreen Forest	n/a	0%
Grassland/Herbaceous	n/a	0%
Shrub/Scrub	n/a	0%
Total Acreage		**6,713.42 acres**

It should be noted that there is a USGS streamflow gauge located in this area, though it was not used for collecting information on flow. This streamflow gauge is situated along the Wabash River, and therefore is not of use when it comes to determining flow for the TTK water monitoring study.

Figure 37 - Buzzard Pond Water Monitoring Sites

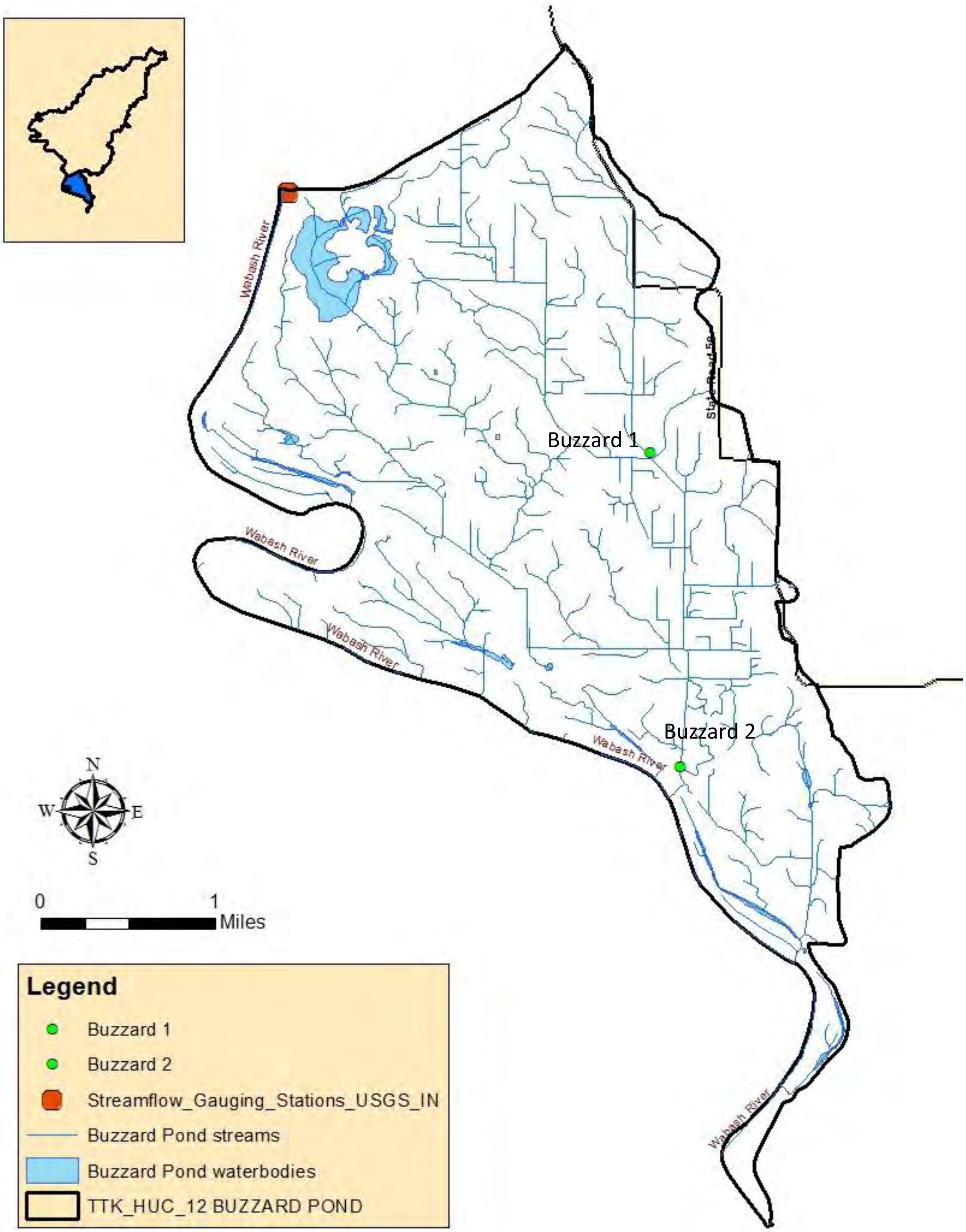


Figure 38 - Buzzard Pond Land Use Classifications

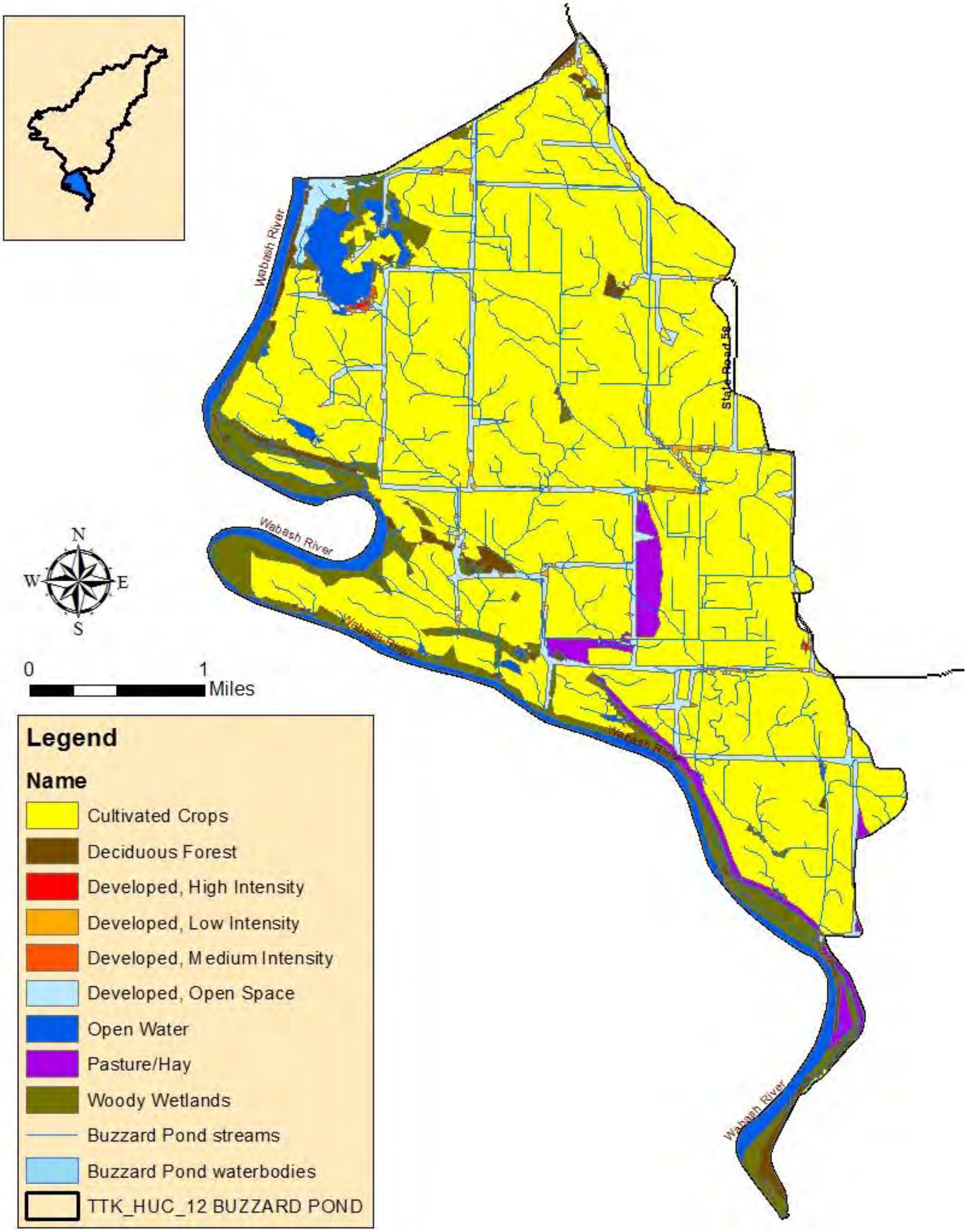


Table 35 – Lab Data Summary for Buzzard Pond

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: Buzzard 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	980.400	72.000	8.820	0.390	13.600
May 2014	65.700	13.000	9.130	0.060	13.600
June 2014	613.100	36.000	6.750	0.140	5.440
July 2014	228.200	64.000	3.880	0.540	2.039
Aug. 2014	53.700	15.000	2.430	0.130	0.227
Sept. 2014	396.800	20.000	1.450	0.450	2.040
Oct. 2014	118.700	16.000	3.350	0.000	1.360
Nov. 2014	79.400	7.000	4.100	0.000	1.7
Dec. 2014	107.600	22.000	3.580	0.240	7.65
Jan. 2015	11.000	5.000	5.951	0.220	0
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	75.000	38.200	2.120	0.510	0

Site ID: Buzzard 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	816.400	146.000	3.280	0.630	45.900
May 2014	77.100	11.000	6.310	0.140	17.000
June 2014	204.600	11.000	4.950	0.100	30.600
July 2014	224.700	22.000	2.900	0.290	5.100
Aug. 2014	248.100	8.000	0.812	0.130	1.600
Sept. 2014	517.200	31.000	1.650	0.260	0.000
Oct. 2014	98.800	46.000	2.950	0.00	0.000
Nov. 2014	26.200	0.00	3.360	0.00	6.8
Dec. 2014	83.900	96.000	1.760	0.61	5.1
Jan. 2015	548.000	60.000	5.996	0.52	0
Feb. 2015	6.000	16.800	Lab Error	0.08	0
Mar. 2015	30.000	43.500	1.905	0.50	0

Table 36 – Pollutant Load Summary for Buzzard Pond

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
Buzzard 1	248.15	9.59E+12	5.3%
Buzzard 2	240.08	2.00E+13	2.1%

Site Name	Average TSS Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Buzzard 1	28.02	119.42	64.30%
Buzzard 2	40.94	376.24	75.60%

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Buzzard 1	4.69	19.99	78.70%
Buzzard 2	3.26	29.96	69.30%

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Buzzard 1	0.24	1.02	70.80%
Buzzard 2	0.27	2.48	74.10%

Kelley Bayou 051201111303

The Kelley Bayou subwatershed is a unique, small watershed that represents the Indiana portion of a larger watershed area, called the Raccoon River watershed, which also comprises a portion of Illinois. Kelley Bayou gets its name due to two distinct bayou features that were formed when the Wabash River took a different route and essentially 'cut-off' two small lakes. The northernmost lake is now confined by a levee and does not experience fluctuation during Wabash River flood events. It is often used by local residents as a favorite fishing spot. The southernmost lake, however, is still greatly influenced by back-flooding from the Wabash at least once a year. It can also be greatly affected by droughts. Local stakeholders report a large-scale fish kill several years ago during a damaging drought; the smell was reported to have been detectable for miles around.

The Nature Conservancy has taken a special interest in this oxbow feature and has contributed extra funding for the monitoring of the Kelley 3 site for the duration of one year. For the purpose of the overall TTK water monitoring study, the Kelley 3 site has been excluded when calculating loads due to its incongruity when compared to other stream sites with flowing water. However, it represents an unusual feature within the watershed, presenting an opportunity to collect data and learn more. It is common to see an abundance of wildlife at this site, including Bald Eagles, Great Blue Herons, cormorants, egrets, wood ducks, coots, a variety of fish including gar, and even freshwater glass shrimp.

The other two monitoring sites for the Kelley Bayou subwatershed are also levee-controlled. Much of the year, there is no detectable flow. Both monitoring sites possess a substantial riparian buffer zone, though QHEI scores were poor due mostly to lack of in-stream cover and an abundance of silt. Macroinvertebrate PTI scores were also poor, likely due to the routinely low Dissolved Oxygen levels recorded throughout the year in these impounded streams.

Figure 39 - Freshwater Glass Shrimp

Land use in the Kelley Bayou watershed is primarily agricultural. There are only a handful of homes within this area, and only a few producers farm the bulk of the land. No plans or evidence of development can be found here. Statistics for land use are as follows:

Table 37 - Land Use Statistics for Kelley Bayou Watershed

Land Use Characterization	Number of Acres	% of Watershed
Cultivated Crops	3,895.86	69.1%
Deciduous Forest	400.36	7.1%
Woody Wetlands	399.73	7.0%
Open Water	378.83	6.7%
Developed, Open Space	352.00	6.2%
Pasture/Hay	158.35	2.8%
Emergent Herbaceous Wetlands	26.03	<1%
Developed, Low Intensity	25.06	<1%
Grassland/Herbaceous	12.48	<1%
Developed, Medium Intensity	0.43	<1%
Developed, High Intensity	0.23	<1%
Barren Land	n/a	0%
Evergreen Forest	n/a	0%
Shrub/Scrub	n/a	0%
Total Acreage		**5,649.36 acres**

Figure 40 - Kelley Bayou Water Monitoring Sites

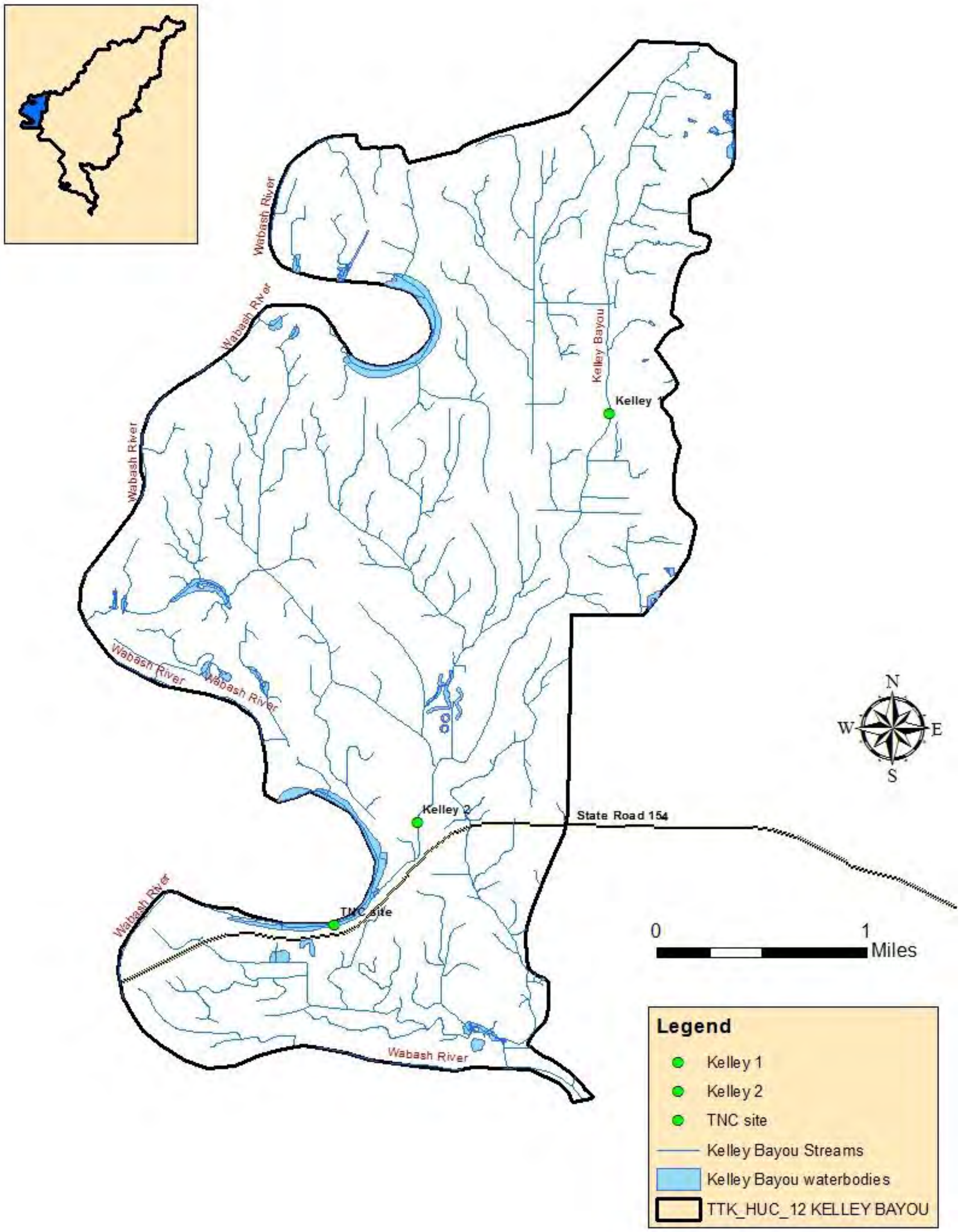


Figure 41 - Kelley Bayou Land Use Classifications

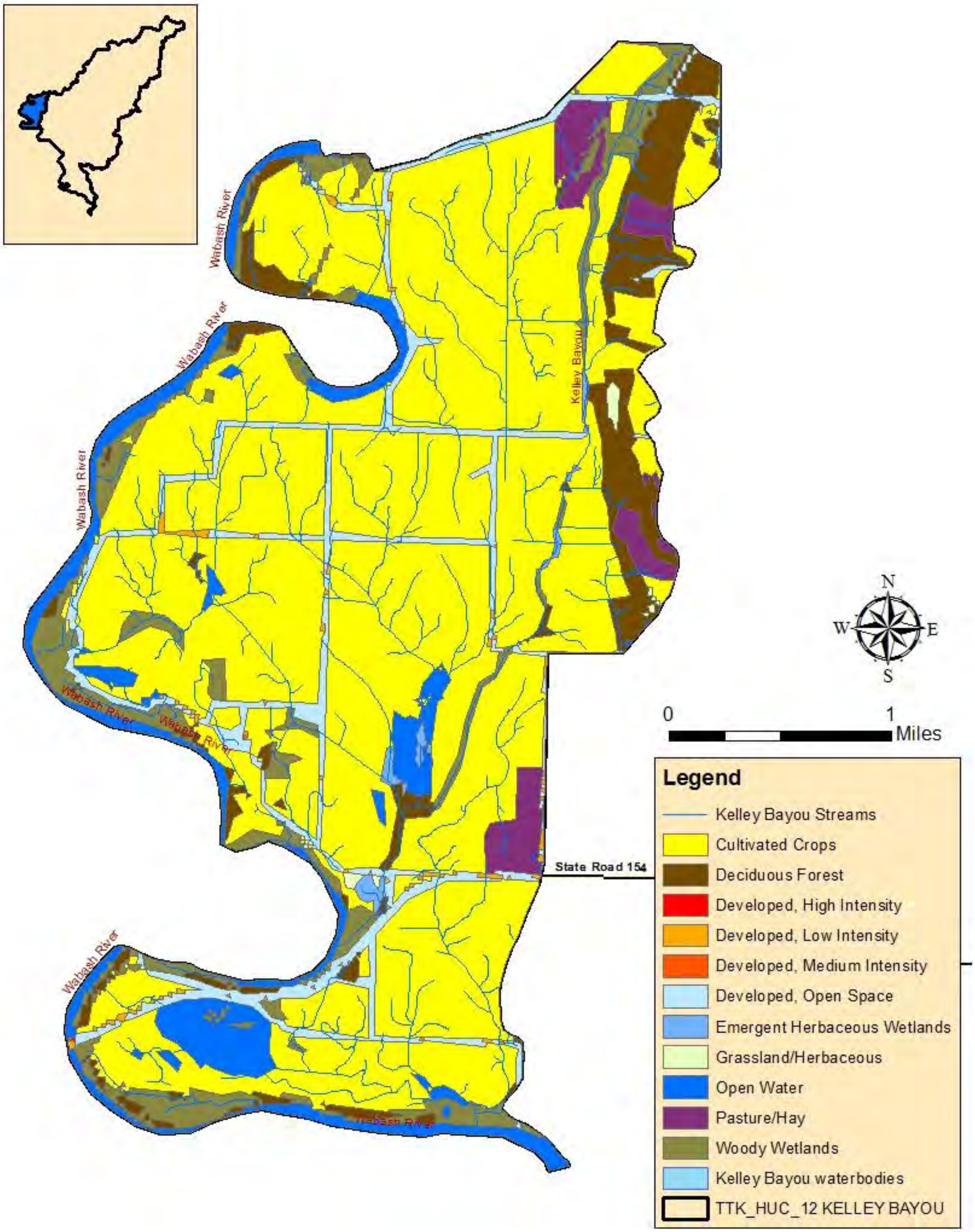


Table 38 – Lab Data Summary for Kelley Bayou

Key for Values Highlighted in Red:

E.coli	*≥235 cfu/100ml*
TSS (Total Suspended Solids)	*≥10.0 mg/L*
NO_2/NO_3 (Nitrate/Nitrite)	*≥1.0 mg/L*
Total Phosphorus	*≥0.07 mg/L*

*According to established Water Quality Targets (Table 10)

Site ID: Kelley 1	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	85.500	95.000	1.750	0.170	8.500
May 2014	344.800	28.000	2.320	0.100	8.500
June 2014	191.800	19.000	2.120	0.660	5.950
July 2014	105.000	23.000	0.317	0.350	0.00
Aug. 2014	72.700	8.000	0.157	0.120	0.00
Sept. 2014	613.100	15.000	0.277	0.170	0.00
Oct. 2014	74.400	4.000	0.344	0.00	0.00
Nov. 2014	30.900	6.000	0.079	0.090	0.00
Dec. 2014	51.200	9.000	0.518	0.080	3.400
Jan. 2015	22.000	6.000	1.015	0.110	0.00
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	NS	NS	NS	NS	NS

Site ID: Kelley 2	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014	125.000	24.000	1.640	0.160	0.00
May 2014	190.400	7.000	5.310	0.140	0.00
June 2014	387.900	ND	3.350	0.180	0.00
July 2014	488.500	9.000	0.142	0.310	0.00
Aug. 2014	387.300	12.000	0.486	0.400	0.00
Sept. 2014	83.900	0.000	0.117	0.180	0.00
Oct. 2014	275.500	5.000	1.440	0.00	23.375
Nov. 2014	120.100	26.000	0.000	0.66	2.125
Dec. 2014	43.500	6.000	0.238	0.05	8.925
Jan. 2015	105.000	1.000	0.66	0.00	0.00
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	NS	NS	NS	NS	NS

Site ID: Kelley 3 (TNC)	E.coli Concentration (cfu/100ml)	Total Suspended Solids (mg/L)	NO_2/NO_3 Concentration (mg/L)	Phosphorus Concentration (mg/L)	Flow (cfs)
Apr. 2014					
May 2014					
June 2014					
July 2014	22.800	40.000	0.000	0.430	0.00
Aug. 2014	34.100	35.000	0.000	0.580	0.00
Sept. 2014	34.500	335.000	0.000	0.990	0.00
Oct. 2014	65.000	24.000	1.700	ND	0.00
Nov. 2014	45.700	17.000	0.000	0.030	0.00
Dec. 2014	13.500	10.000	0.994	0.200	0.00
Jan. 2015	12.000	44.000	0.697	0.140	0.00
Feb. 2015	NS	NS	NS	NS	NS
Mar. 2015	NS	NS	NS	NS	NS

Table 39 – Pollutant Load Summary for Kelley Bayou

Site Name	Average E.coli Concentration (cfu/100ml)	Average Load (cfu/year)	% Reduction Needed
Kelley 1	159.14	3.74E+12	None Required (-47.7%)
Kelley 2	220.71	6.78E+12	None Required (-6.5%)
Kelley 3 (TNC)	32.51	0.00 (no flow)	n/a

Site Name	Average TSS Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Kelley 1	21.30	55.21	53.10%
Kelley 2	9.00	30.48	None Required (-11.10%)
Kelley 3 (TNC)	72.14	0.00 (no flow)	n/a

Site Name	Average NO_2/NO_3 Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Kelley 1	0.89	2.31	None Required (-12.40%)
Kelley 2	1.34	4.54	25.40%
Kelley 3 (TNC)	0.48	0.00 (no flow)	n/a

Site Name	Average Phosphorus Concentration (mg/L)	Average Load (Ton/Year)	% Reduction Needed
Kelley 1	0.19	0.49	63.20%
Kelley 2	0.21	0.71	66.70%
Kelley 3 (TNC)	0.34	0.00 (no flow)	n/a

4.0 Watershed Inventory III: Watershed Inventory Summary

4.1 Important Findings, Relationships, and Trends

Pollutant Load Zones [Preface]

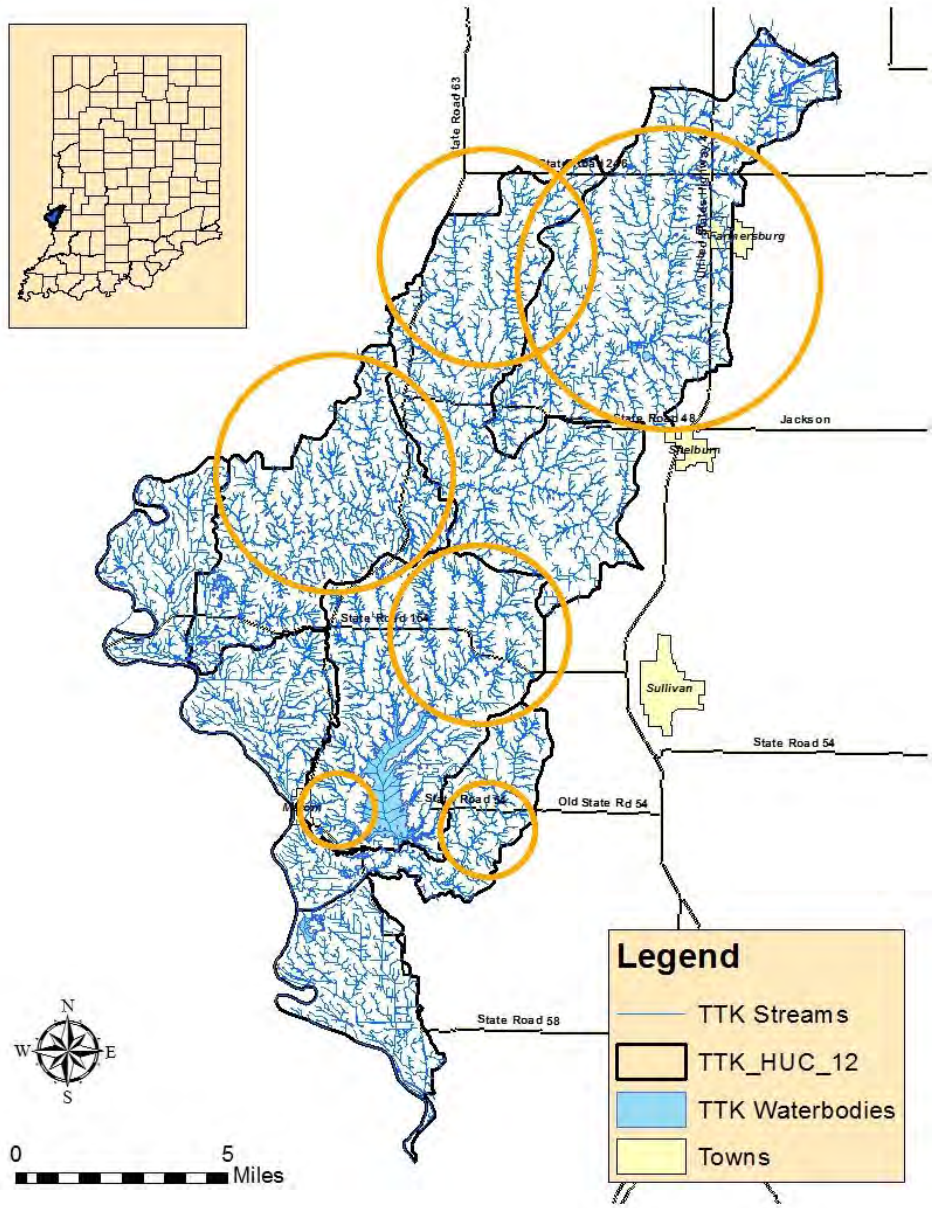
An abundance of data was collected as a part of the TTK 12 month water monitoring study, and from it several interesting observations emerged. The findings of this 12 month study not only helped the Advisory Committee determine critical areas within the TTK watershed, but also encouraged discussion regarding some of the pollutant load 'hot spots' that emerged as a result of the data collected. Featured below on Figures 41-45 are a series of maps depicting areas within the TTK watershed that were found to have high loads for either E.coli, TSS, Nitrates/Nitrites, Total Phosphorus as well as low QHEI and PTI scores. These 'hot spots' correspond to a grouping of monitoring sites that represent an area in the watershed that yielded higher pollutant loads when compared to surrounding sites. These pollution zones are not rendered to any type of scale and merely serve to offer a visual representation of regions where certain pollutant loads were elevated. These circles were drawn based on careful observation of data and comparison of pollutant loads throughout the watershed, and were created to assist the Advisory Committee with prioritizing critical areas. A complete set of all collected data can be found in Appendix D.

E.coli Findings

In general, E.coli was found to be a pervasive problem throughout the entire TTK watershed, which is the case for most other watersheds in the state of Indiana. However, after 12 months of data collection, some sites were routinely worse than others, even showing high pollutant loads in the middle of winter when all live bacteria should feasibly be unable to persist. High E.coli samples collected in winter could indicate that a stream is receiving regular inputs of bacteria, perhaps from livestock with stream access, such as in the cases of the zones found in Dodd's Bridge and Little Turtle subwatersheds where an increase in grazed land is noted. Other high levels of E.coli bacteria could be introduced due to older, malfunctioning septic systems. With the poor septic suitability of many soils in the watershed, it is likely that septic systems are not able to properly leach all harmful substances out before effluent reaches surface streams and groundwater. In some cases, private landowners have been reported to configure their septic systems for 'straight-piping' to local ditches and streams, such as in the case of the Town of Merom.

Featured below on Figure 41 is a representation (not to scale) of areas throughout the watershed where E.coli concentrations were routinely high, especially in comparison with other monitoring sites. Though E.coli loads were a problem throughout the watershed, the zones below represent those drainage areas where a distinct 'spike' in pollutant loads was noted. This visual depiction simply outlines areas within the watershed that should be considered a priority when it comes to E.coli.

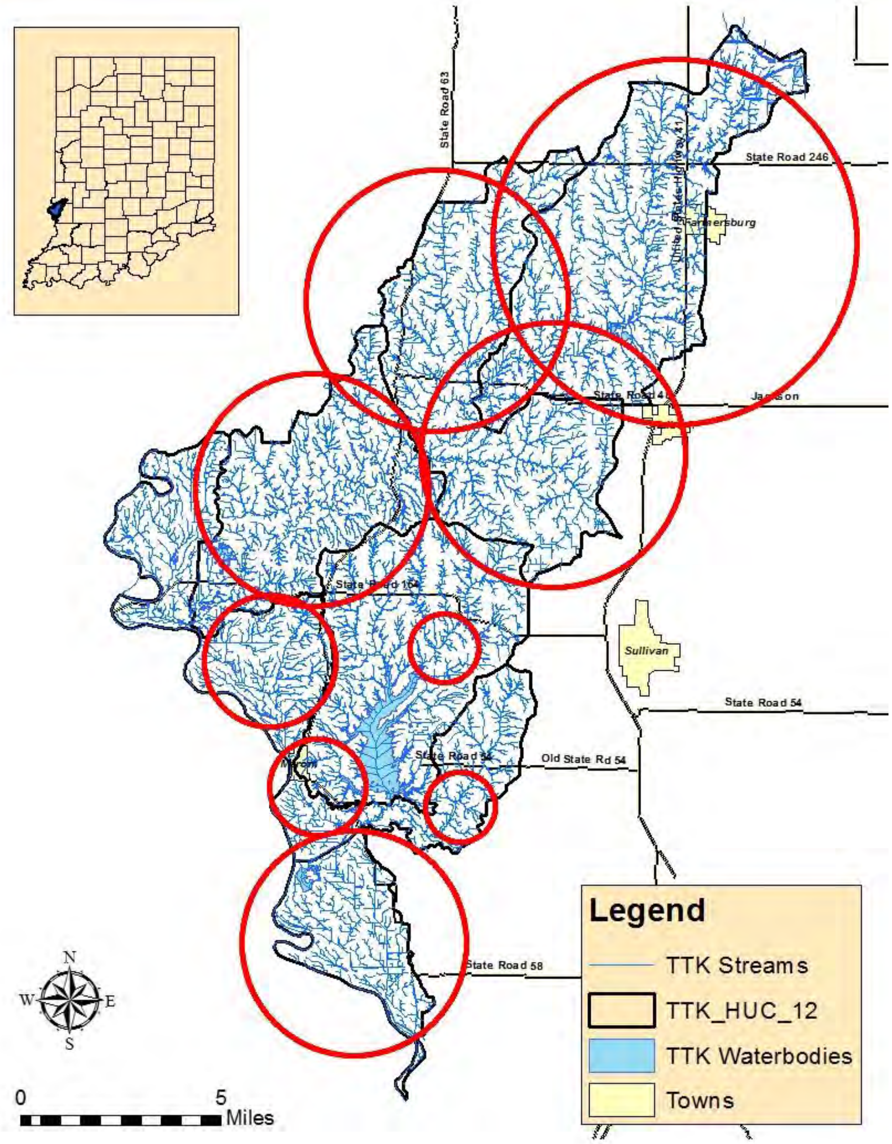
Figure 42 – TTK E.coli Pollutant Load Zones



TSS Findings

Sediment is also a widespread and serious problem throughout the entire TTK watershed. As shown below, there are several zones where sediment loads are consistently exceeding water quality targets. As previously stated, much of the land in the TTK watershed is utilized for growing crops and according to the TNC buffer study, over 46% of the streams are not properly buffered. Conventional tillage activities could be contributing to TSS loads, as well as high velocity flood water eroding stream banks at certain times of the year. Increased flow leads to increased TSS and turbidity, though over the course of 12 months, these high flow events were averaged with low flow events to provide a more realistic overview of loads throughout the seasons. Represented below are the zones where the highest TSS loads were consistently found in certain regions of the watershed.

Figure 43 – TTK Total Suspended Solids Pollutant Load Zones



Nutrient Findings (NO_2/NO_3 and Total Phosphorus)

Interestingly, Nitrogen was discovered to be the most minor when it came to pollutant loads. Most of the concentrations were well within state drinking water standards (10.0 mg/L), though the water quality target for TTK is lower in order to facilitate better biological populations. It could be that many producers are using Nitrogen more sparingly, due to its high cost and the availability of precision technology. Total Phosphorus loads, however, were much higher. This could be due to Phosphorus' ability to bind with soil particles and persist in the environment longer than Nitrogen. In fact, high Phosphorus loads can be observed in relation to areas with high TSS loads. When considering both Nitrogen and Phosphorus collectively as 'nutrients', it is easy to see that there are areas within the TTK watershed that routinely fail to meet water quality standards. More investigation will be needed in order to better correlate the nutrient data with current land use, though it may be assumed that agricultural activities, malfunctioning septic systems, livestock access to streams, and/or decomposing organic matter could all be contributing factors to these high nutrient loads.

Figure 44 – TTK Nitrate/Nitrite Pollutant Load Zones

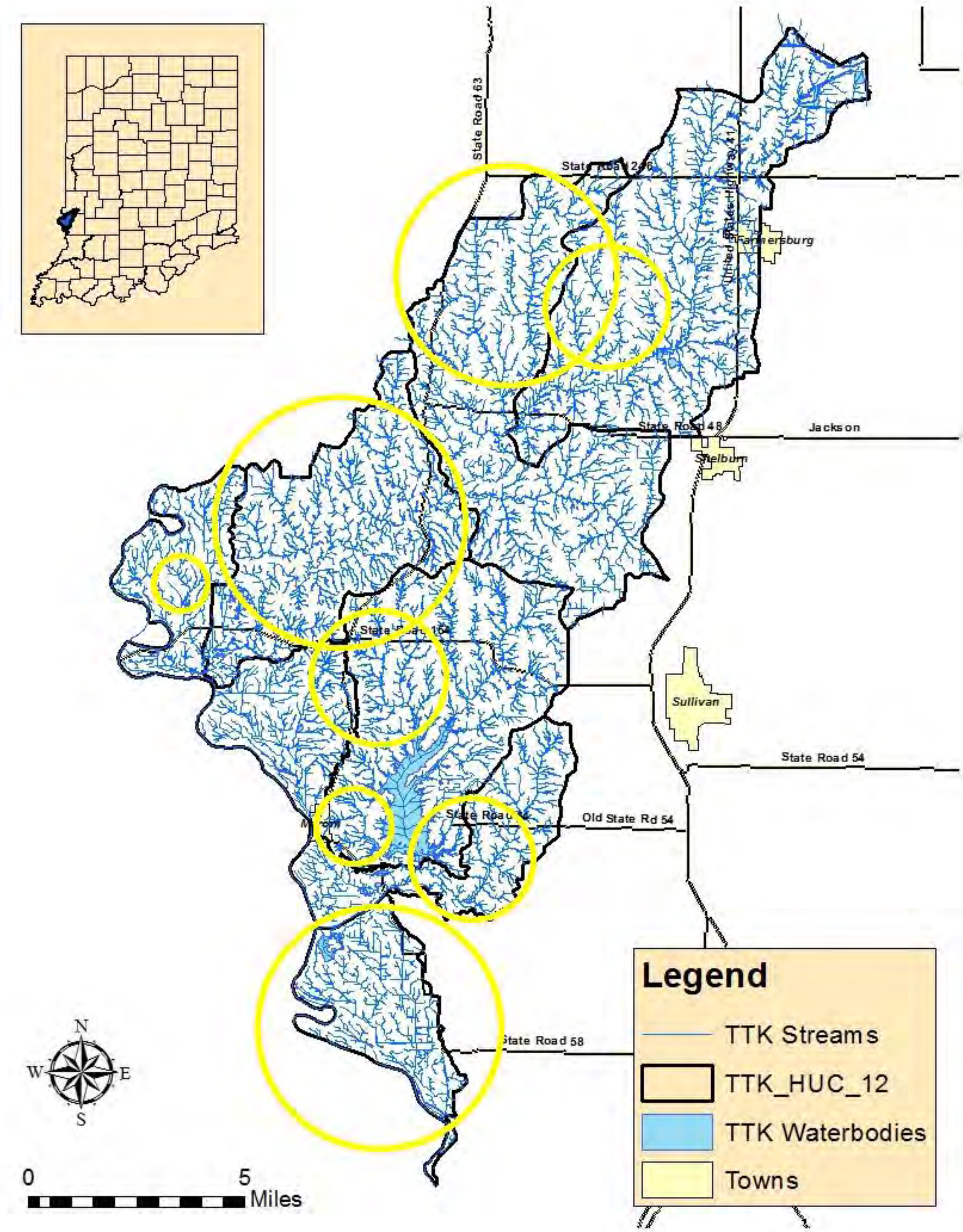
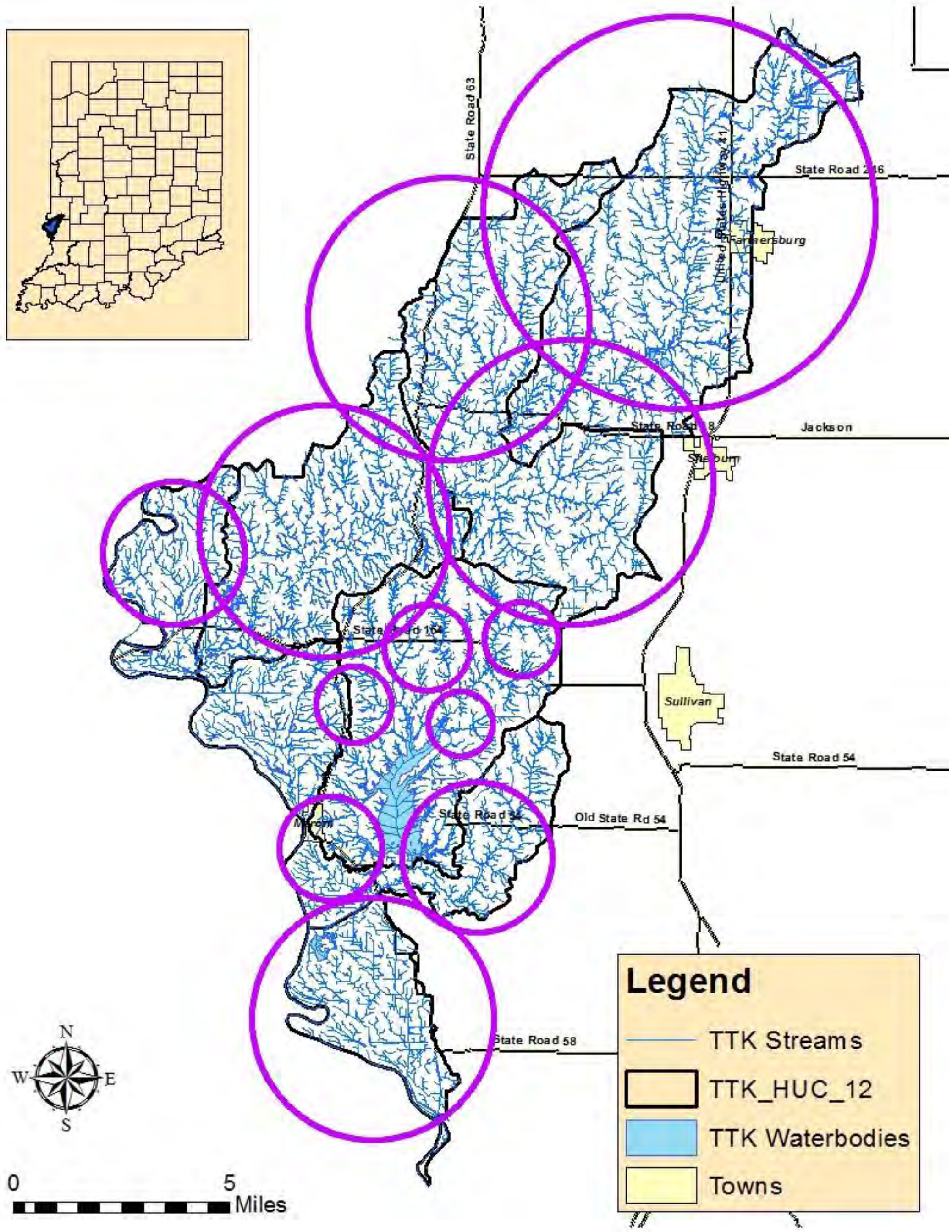


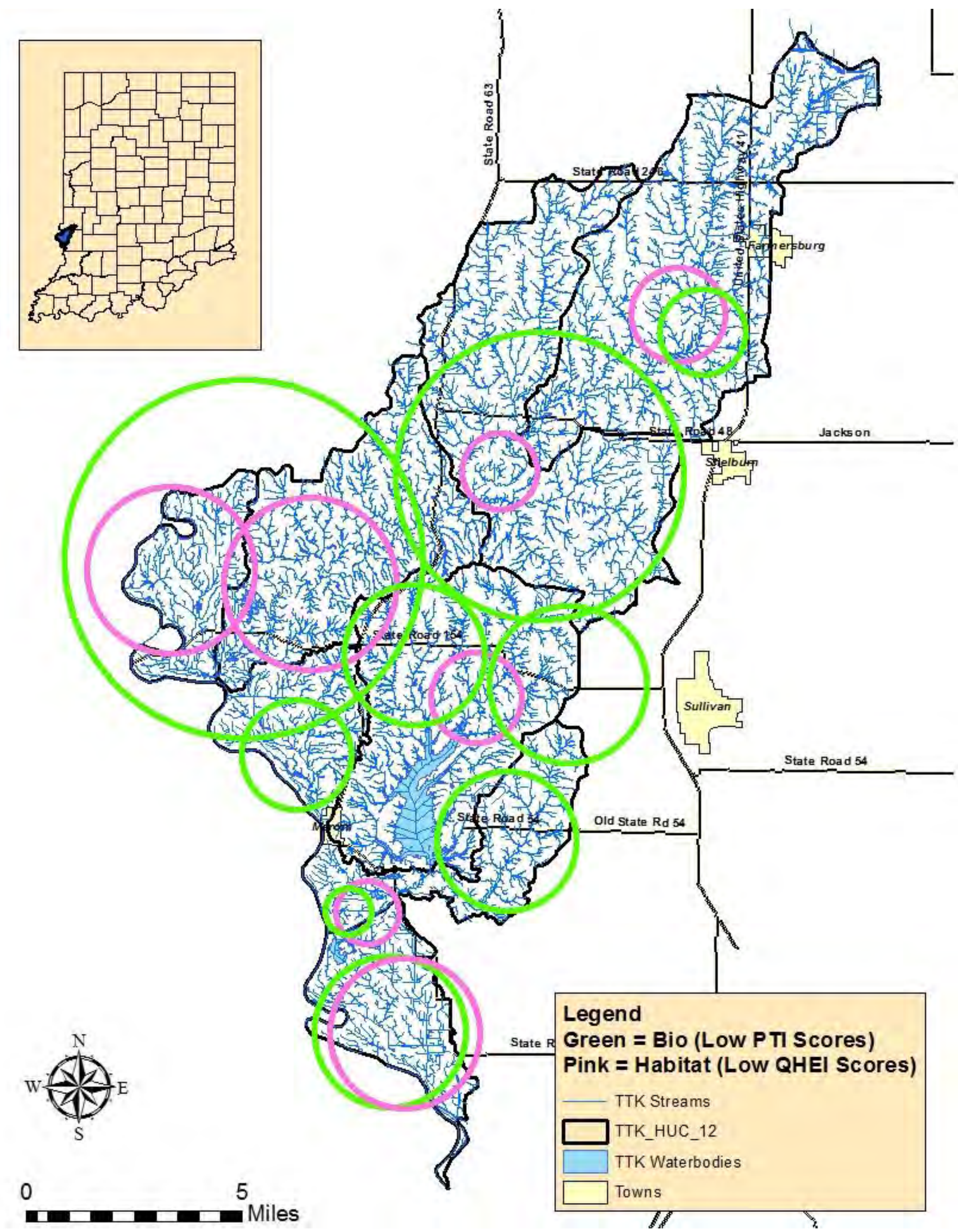
Figure 45 – TTK Total Phosphorus Pollutant Load Zones



Habitat/Macroinvertebrate Findings

Scores for Habitat (QHEI) and Macroinvertebrate PTI were alarmingly low throughout the TTK watershed. At some sites, not a single organism was collected, despite repeated attempts to locate macroinvertebrates in various substrates. Based on visual observations, it seems that in-stream habitat and macroinvertebrate populations are greatly impacted by the excess amounts of sediment and sand found covering cobble and embedding other features that would typically offer cover for spawning and hiding. In many cases, insufficient buffers (or none) were found along the stream banks, causing bank erosion, and little to no cover or shade. The monitoring sites were, in few cases, considered to be 'ideal' habitat for macroinvertebrates. On Figure 45 below is a map that illustrates areas where either (or both) scores were low for QHEI or macroinvertebrate PTI. In some cases there is overlap, indicating that these scores were altogether poor, though in a few cases, QHEI scores were acceptable, though macroinvertebrates were still not found in healthy populations. This could indicate that the water quality has more to do with the lack of macroinvertebrates than simply a lack of suitable habitat.

Figure 46 – TTK Habitat and Biological Impairment Zones



Turbidity

Turbidity data was collected during the 12 month monitoring project using the Hoosier Riverwatch turbidity tube method. In addition, TDS (Total Dissolved Solids) data was also collected monthly at each site using the YSI probe. These results typically mirrored the TSS lab data, with high levels reported during high flow events or after recent rainfall. For the purposes of the watershed management plan, emphasis was placed on TSS lab analysis data, due to its higher level of accuracy. For future monitoring events when funding for lab analysis is not available, turbidity will be monitored using the YSI probe and turbidity tube. Multiple methods were employed during this 12 month study for the purpose of establishing baseline turbidity data in a variety of formats. All methods of collecting turbidity data supported the concern that sediment in surface water is, in fact, a very serious problem in the TTK watershed. Complete data for the 12 month study is available in Appendix D.

4.2 Analysis of Stakeholder Concerns

The TTK Advisory Committee developed a list of concerns during the early phase of the TTK Planning and Implementation 319 grant. These concerns were voiced by a number of local stakeholders, producers, county officials, contractors, and conservation-minded interest groups. Many of these concerns were identified by landowners possessing an extensive knowledge of the historical and recent land uses, while other concerns were observed by the watershed coordinator during water monitoring events, tillage transects, and windshield surveys. Additionally, specific input regarding the Turtle Creek Reservoir was provided by representatives from Hoosier Energy based on internal studies and information collected during the Partnership for Turtle Creek Watershed Management Planning initiative in the early 2000s. The TTK Advisory Committee prioritized the concerns and indicated the ones on which they preferred to focus.

Table 40 - Analysis of Stakeholder Concerns

Concern	Supported by Data?	Evidence	Quantifiable?	Outside Scope of Project?	Group wants to focus on?
Sediment in streams	Yes	TSS data, windshield surveys	Yes	No	Yes
Erosion from agricultural fields	Yes	TSS data, tillage transects, windshield surveys	Yes	No	Yes
Nutrient loads from fertilizers, etc.	Yes	NO_2/NO_3 data, Total Phosphorus data	Yes	No	Yes

Table 40 (Cont.) - Analysis of Stakeholder Concerns

Concern	Supported by Data?	Evidence	Quantifiable?	Outside Scope of Project?	Group wants to focus on?
Trash, litter	Yes	Windshield surveys, observed during monitoring	Yes	Yes	No
Beavers	Yes	Stakeholder reports, observed during monitoring	No	Yes	No
Invasive Species	Yes	NRCS DC input, stakeholder reports, windshield surveys	Yes	Yes	No
Sheet and rill erosion	Yes	Tillage transects, windshield surveys, stakeholder reports	Yes	No	Yes
Livestock management	Yes	Windshield surveys, stakeholder reports	Yes	No	Yes
Soil health and quality	Yes	NRCS DC input, stakeholder reports	Yes	No	Yes
Improved habitat areas	Yes	QHEI scores, windshield surveys, stakeholder input	Yes	No	Yes
Conservation easements - acquire more	Yes	Stakeholder input, CRP program acres	Yes	Yes	No
Gas/oil well leaks	Yes	Observed during monitoring, stakeholder input	No	Yes	No
Historic mine activity (Northeast part of Turman Creek watershed)	Yes	Stakeholder input, data gathered from Cardno	Yes	Yes	No
Landfill proximity, pollutant leaching	No	Stakeholder input	No	Yes	No

Table 40 (Cont.) - Analysis of Stakeholder Concerns

Concern	Supported by Data?	Evidence	Quantifiable?	Outside Scope of Project?	Group wants to focus on?
Streambank/shoreline erosion	Yes	Windshield surveys, stakeholder input, TNC quantified	Yes	No	Yes
Large equipment difficult to maneuver on contoured land - need new solutions	No	Stakeholder input	No	Yes	No
Educating local students and citizens about resource concerns	Yes	Stakeholder and educator input, observations during public outreach	No	No (Adult Education Only)	Yes
Roadside ditch maintenance	Yes	Windshield surveys, stakeholder input	Yes	Yes	No
Improved waste disposal methods	No	Stakeholder input	No	Yes	No
Septic contributions to E.coli loads - educate public, promote new systems, loan programs	Yes	E.coli load calculations, windshield surveys, reports from Merom Town Council	Yes	No (Adult Education Only)	Yes
Keep water on land - prevent run-off, erosion, retain nutrients, save money	Yes	Windshield surveys, stakeholder input	Yes	No	Yes
Reduce pollutant inputs into reservoir (slow water, filter strips, buffers)	Yes	Hoosier Energy collected data, stakeholder input, windshield and desktop surveys	Yes	No	Yes
Purifying structures needed (wetlands, swales)	Yes	Desktop surveys (quantified wetland acreage), evidence of flooding, nutrient loading	Yes	No	Yes
Farmer compensation for conservation practices	Yes	Stakeholder input, conservation practice list (NRCS, CRP, LARE, etc.)	Yes	No	Yes

Table 40 (Cont.) - Analysis of Stakeholder Concerns

Concern	Supported by Data?	Evidence	Quantifiable?	Outside Scope of Project?	Group wants to focus on?
Promote cover crops	Yes	Cover crop tillage transect, windshield surveys, stakeholder input	Yes	No	Yes
Find sustainable ways to promote conservation practice (beyond the timeline of the grant)	n/a	Stakeholder input	No	No	Yes
Suggest tax breaks/other incentives for conservation	n/a	Stakeholder input	No	Yes	No
Fracking/Irrigation	Yes	Stakeholder input, windshield surveys	No	Yes	No
Additional studies of BMP (best management practice) effects in the watershed	n/a	Stakeholder input	No	Yes	No
Additional studies of pollutant leaching quantities through clay soils	n/a	Stakeholder input	No	Yes	No
Turtle Creek Reservoir					
15% lost volume	Yes	Hoosier Energy bathymetric survey	Yes	No	Yes
Excess sediment (8' recorded in places)	Yes	Hoosier Energy bathymetric survey	Yes	No	Yes
Algae-domination as a result of nutrient loading	Yes	Hoosier Energy stakeholder input	Yes	No	Yes

Table 40 (Cont.) - Analysis of Stakeholder Concerns

Concern	Supported by Data?	Evidence	Quantifiable?	Outside Scope of Project?	Group wants to focus on?
Fish kills	Yes	Hoosier Energy bathymetric survey	Yes	No (Water Quality)	Yes
Shoreline erosion	Yes	Hoosier Energy bathymetric survey	Yes	No	Yes
Ability to continue to use reservoir for power plant function	No	Stakeholder input	No	Yes	No
Develop a watershed management plan for areas surrounding reservoir	No	Stakeholder input	No	No	Yes

Even though certain concerns are supported by data (i.e., potential oil well leaks, roadside ditches in need of proper maintenance, invasive species, etc.), the Advisory Committee has chosen not to focus on them due to funding and time constraints. However, in some cases, even though the solutions lie outside of the boundaries of 319 cost-share parameters, continued education and outreach will be used as a method to initiate improvements throughout the watershed.

5.0 Identification of Problems and Causes

5.1 Focused Concerns

The TTK Advisory Committee identified specific problems relating to each concern on which the group wished to focus. Problems were defined as issues that exist due to a concern. Identified problems help clarify which contributing factors can be changed, improved upon, or investigated further. Featured below on Table 41 is an account of these concerns with corresponding 'problem' explanations.

Table 41 - Identification of Problems in Relation to Concerns

Concern(s)	***Problem***
- Sediment in streams - Erosion from agricultural fields - Sheet and rill erosion - Livestock management - Soil health and quality - [Need] improved habitat areas - Streambank/shoreline erosion - Prevent water run-off - Reduce pollutants entering reservoir - [Need] water purifying structures (i.e. wetlands, swales, buffers) - Lost volume of reservoir - Accumulated sediment in reservoir - Fish kills in reservoir - Develop a management plan for areas surrounding reservoir - Shoreline erosion along reservoir	• Large amounts of sediment transported into streams • High turbidity • Degraded habitat • Impaired biological populations • Water quality targets for TSS exceeded
- Nutrient loads from fertilizers, etc. - Algae-domination in reservoir - Livestock management - [Need] improved habitat areas - Soil health and quality - Prevent water run-off -Reduce pollutants entering reservoir - Develop a management plan for areas surrounding reservoir - [Need] water purifying structures (i.e. wetlands, swales, buffers) - Fish kills in reservoir	• Water quality targets for NO_2/NO_3 exceeded • Water quality targets for Total Phosphorus exceeded
- Septic contributions to E.coli loads - Livestock management - [Need] water purifying structures (i.e. wetlands, swales, buffers) - Reduce pollutants entering reservoir	• E.coli loads greatly exceed water quality targets for most streams throughout the watershed
- Septic contributions to E.coli loads - Livestock management - Erosion from agricultural fields - Promote more cover crops - [Promote] Farmer compensation for conservation practices - Promote more cover crops - Promote sustainable conservation practices - Educate citizens about resource concerns	• Lack of public awareness (i.e. the public may not be aware of current conservation practices and solutions for land management concerns)

Table 41 (Cont.) - Identification of Problems in Relation to Concerns

Concern(s)	*Problem*
- [Provide] farmer compensation for conservation practices - Promote more cover crops - Promote sustainable conservation practices - Educate citizens about resource concerns	• Outreach and public education does not reach a large enough number of stakeholders within the watershed • Conservation practices are seen as cost-prohibitive • Producers are concerned about risks/losses associated with changing management practices

5.2 Potential Causes

After identifying specific problems, the list was further refined by incorporating potential causes. Table 42 links stakeholder concerns to known water quality problems and their potential causes. For the purpose of the watershed management plan, a 'cause' is considered to be an event, agent, or series of actions that are capable of producing a problem.

Table 42 - Identification of Potential Causes in Relation to Problems

Problem	*Potential Cause(s)*
Large amounts of sediment transported into streams	Excess run-off occurs, transporting sediment into streams and reservoir, land and livestock management methods need improvement
High turbidity	Total Suspended Solids (TSS) water quality targets exceeded, soil erosion
Degraded habitat	Total Suspended Solids (TSS) water quality targets exceeded, lack of buffers, riparian areas, wetlands
Impaired biological populations	Total Suspended Solids (TSS) water quality targets exceeded, lack of buffers, riparian areas, wetlands
Water quality targets for TSS exceeded	Excess run-off occurs, transporting sediment into streams and reservoir, land management methods need improvement
Water quality targets for NO_2/NO_3 exceeded	Excess run-off occurs, transporting nutrients into streams and reservoir, land and livestock management methods need improvement, substandard septic systems
Water quality targets for Total Phosphorus exceeded	Excess run-off occurs, transporting nutrients into streams and reservoir, land and livestock management methods need improvement, substandard septic systems
E.coli loads greatly exceed water quality targets for most streams throughout the watershed	Excess untreated run-off occurs from unmaintained septic systems, land and livestock management methods need improvement, public lacks awareness

Table 42 (Cont.) - Identification of Potential Causes in Relation to Problems

Problem	Potential Cause(s)
Lack of public awareness (i.e. the public may not be aware of current conservation practices and solutions for land management concerns)	Information is not as available/visible as it could be at this time; funding for outreach is lacking,
Outreach and public education does not reach a large enough number of stakeholders within the watershed	Funding is lacking for widespread outreach, the preferred avenues for information dissemination are not being utilized
Conservation practices are seen as cost-prohibitive	This watershed exists within a county with one of the highest poverty rates in Indiana
Producers are concerned about risks/losses associated with changing management practices	The market prices of crops are volatile, fertilizer and equipment upgrades are expensive, there is some skepticism regarding emerging technology and soil health practices

6.0 Identification of Sources and Calculated Loads

6.1 Potential Pollutant Sources

In this section, the identified problems and causes are paired with potential sources and specific subwatersheds where these issues are most prevalent.

Table 43 - Identification of Potential Sources Relating to Problems and Causes

Problem	Potential Cause(s)	Potential Source(s)	Watershed(s)
Large amounts of sediment transported into streams	Excess run-off occurs, transporting sediment into streams and reservoir, land and livestock management methods need improvement	52% agricultural land uses conventional tillage methods, roadside ditches not seeded after maintenance, removal of riparian areas, 46% streams lack sufficient buffers	All watersheds, most notably: Dodd's Bridge, West Turman, Thunderbird Pond, Little Turtle, Buzzard Pond
High turbidity	80% sites tested exceeded Total Suspended Solids (TSS) water quality targets, soil erosion	52% agricultural land uses conventional tillage methods, roadside ditches not seeded after maintenance, removal of riparian areas, 46% streams lack sufficient buffers	All watersheds, most notably: Dodd's Bridge, West Turman, Thunderbird Pond, Little Turtle, Buzzard Pond
Degraded habitat	80% sites tested exceeded Total Suspended Solids (TSS) water quality targets, lack of buffers, riparian areas, wetlands	Removal of riparian and wetland areas, embedded stream substrate (from excess sediment), 63% QHEI scores poor or very poor	All watersheds, most notably; West Turman, Dodd's Bridge, Kelley Bayou, Buzzard Pond, Little Turtle

Table 43 (Cont.) - Identification of Potential Sources Relating to Problems and Causes

Problem	Potential Cause(s)	Potential Source(s)	Watershed(s)
Impaired biological populations	80% sites exceeded Total Suspended Solids (TSS) water quality targets, lack of buffers, riparian areas, wetlands	Removal of riparian areas, embedded stream substrate, lack of shade/cover in-stream, 46% streams lack buffer, 83% sites tested showed poor macroinvertebrate scores	All watersheds, most notably; West Turman, Dodd's Bridge, Kelley Bayou, Buzzard Pond, Little Turtle
Water quality targets for TSS exceeded	Excess run-off occurs, transporting sediment into streams and reservoir, land management methods need improvement	52% of agricultural land uses conventional tillage methods, roadside ditches not seeded after maintenance, removal of riparian areas, streambank/shoreline erosion, 46% unbuffered streams	All watersheds, most notably: Dodd's Bridge, West Turman, Thunderbird Pond, Little Turtle, Buzzard Pond
Water quality targets for NO_2/NO_3 exceeded	Excess run-off occurs, transporting nutrients into streams and reservoir, land and livestock management methods need improvement	Agricultural fertilizer use without nutrient management plans, livestock permitted free access to streams in at least 24 pastures, non-functioning septic systems, lack of buffers on 46% of streams, 50% sites tested exceeded NO_2/NO_3 water quality target	All watersheds, most notably; Dodd's Bridge, northern portions of West Turman, Little Turtle, Buzzard Pond, western portions of Turtle Creek
Water quality targets for Total Phosphorus exceeded	Excess run-off occurs, transporting nutrients into streams and reservoir, land and livestock management methods need improvement	Agricultural fertilizer use without nutrient management plans, livestock permitted free access to streams in at least 24 pastures, non-functioning septic systems, lack of buffers on 46% of streams, 90% sites tested exceeded Total P water quality target	All watersheds, most notably; Dodd's Bridge, Thunderbird Pond, West Turman, Little Turtle, Buzzard Pond, southwest and northeast portions of Turtle Creek
E.coli loads greatly exceed water quality targets for most streams throughout the watershed	Excess untreated run-off occurs from unmaintained septic systems, land and livestock management methods need improvement, public lacks awareness	Manure used as fertilizer without nutrient management plans, livestock permitted free access to streams in at least 24 pastures, non-functioning septic systems, 76% sites tested exceeded E.coli water quality target, lack of buffers/swales/wetlands to filter water before it enters streams	All watersheds, most notably; Dodd's Bridge, Thunderbird Pond, northern portions of West Turman, Little Turtle between sites LT5 and LT4, southwest and northeast portions of Turtle Creek

Table 43 (Cont.) - Identification of Potential Sources Relating to Problems and Causes

Problem	*Potential Cause(s)*	*Potential Source(s)*	*Watershed(s)*
Lack of public awareness (i.e. the public may not be aware of current conservation practices and solutions for land management concerns)	Information is not as available/visible as it could be at this time	n/a	All watersheds

6.2 Current Pollutant Loads and Load Reduction Goals

Load calculations were determined for the following parameters: E.coli, TSS, NO_2/NO_3, and Total Phosphorus using two different methods: Average pollutant loads per each of the 30 monitoring sites and L-THIA pollutant loads for each of the seven 12 digit HUC subwatersheds.

As discussed previously, pollutant concentration data was collected monthly from 30 unique sites throughout the TTK watershed for the duration of one year. (See Sections 3.4 and 4.1) For each of the aforementioned parameters, the monthly concentrations were averaged for each site. In addition to concentration data, a flow measurement was also determined for each site, when possible. Once the yearly averages for concentration and flow were determined, the values were plugged into the IDEM Load Calculation Tool (Figure 21). This method was used to determine pollutant loads for each of the monitoring sites, as depicted throughout Section 3.5.

However, to gain a better understanding of each watershed in relation to land use and long-term average rainfall, the L-THIA modeling program was used. L-THIA stands for "Long Term Hydrologic Impact Analysis' and is a desktop modeling tool produced by Purdue University. Information regarding this tool can be found at the following website: https://engineering.purdue.edu/~lthia/. By inputting land use acreage and soil types, the program assessed various pollutant loads based on geographical topography, rainfall, and climate. The L-THIA program was used to calculate pollutant loads for Nitrogen, Suspended Solids, and Phosphorus for the seven 12 digit HUC subwatersheds using average flow data from the furthest downstream point in each subwatershed.

For the purpose of obtaining accurate conversions, the E.coli loads for each of the seven subwatersheds were determined using the WCIWA collected monitoring data and average flow data from the furthest downstream sites in each subwatershed. L-THIA estimates for E.coli did not provide units in a format that was easily convertible for the purposes of reduction calculations.

Overall, the load reduction calculations and goal statements are based on the worst case scenarios for pollutant loads. L-THIA provided a long-term assessment, however if at any time, the collected monitoring results yielded higher loads than the L-THIA estimates, this number was used instead for load reduction calculations. In this manner, the possibility of aiming 'too low' for goal achievement can be avoided. Aside from E.coli data, WCIWA data was used instead of L-THIA data, in the cases of Little Turtle TSS and Phosphorus, as well as Buzzard Pond Nitrogen. These substitutions are indicated on the tables below.

L-THIA Results

Determining load calculations for each monitoring site proved to be useful for detecting pollutant 'hot spots' within the watershed as demonstrated in Section 4.1. It also helped to gain a more detailed understanding of how surrounding land use can influence water quality on a smaller scale. However, to obtain a more comprehensive view of the entire TTK watershed over a period of longer than 12 months, L-THIA was utilized. By considering average rainfall for Sullivan County on soil types and slopes indicative of the area, a broader understanding was achieved.

Land use statistics for each of the seven subwatersheds were used to conduct L-THIA modeling and generate pollutant load estimates. The Nitrogen, Phosphorus, and Suspended Solids pollutant totals were converted to lbs/day so that target loads could be subtracted in order to calculate the percent reduction needed for each parameter. E.coli loads (current and target) were determined by using collected WCIWA monitoring data since L-THIA E.coli data was not provided in an easily convertible unit. The following tables will highlight pollutant load summaries and necessary reductions for each of the seven subwatersheds.

Table 44 – Thunderbird Pond L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	16,292.17	10,358.23	124,179.00	36,689.00	3,019,820.00
Forest	B	3,490.94	254.97	486.00	6.00	694.00
Low Density Residential	C	1,622.94	894.43	4,435.00	1,389.00	99,918.00
High Density Residential	C	108.22	127.99	634.00	198.00	14,298.00
Water/Wetlands	A	247.90	0.00	0.00	0.00	0.00
Grass/Pasture	B	955.59	122.93	234.00	3.00	334.00
Industrial	C	0.00	0.00	0.00	0.00	0.00
Commercial	C	108.22	24.03	87.00	20.00	3,634.00
TOTAL	**n/a**	**22,731.90**	**11,782.58**	**130,055.00**	**38,305.00**	**3,138,698.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	356.32	104.95	8,599.17	9.13E+13
Target Load	73.69	51.58	736.88	2.87E+13
Reduction Needed	**282.63 (79.3%)**	**53.37 (50.7%)**	**7,862.29 (91.4%)**	**6.26E+13 (68.6%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

Table 45 – West Turman L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	16,147.74	10,266.41	123,078.00	36,364.00	2,993,049.00
Forest	B	299.99	21.91	41.00	0.60	59.00
Low Density Residential	C	1,244.00	685.59	3,399.00	1,064.00	76,588.00
High Density Residential	C	14.70	17.38	86.00	27.00	1,942.00
Water/Wetlands	A	28.17	0.00	0.00	0.00	0.00
Grass/Pasture	B	483.80	62.24	118.00	1.00	169.00
Industrial	C	0.00	0.00	0.00	0.00	0.00
Commercial	C	0.00	0.00	0.00	0.00	0.00
TOTAL	**n/a**	**11,053.53**	**11,053.53**	**126,722.00**	**37,456.60**	**3,071,807.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	347.18	102.62	8,415.91	6.65E+13
Target Load	97.62	68.34	976.22	3.80E+13
Reduction Needed	**249.56 (71.9%)**	**34.28 (33.4%)**	**7,439.69 (88.4%)**	**2.85E+13 (42.9%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

Table 46 – Dodd's Bridge L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	8,603.32	5,469.81	65,574.00	19,374.00	1,594,660.00
Forest	B	4,268.53	311.77	594.00	8.00	849.00
Low Density Residential	C	744.35	410.22	2,034.00	637.00	45,826.00
High Density Residential	C	1.03	1.21	6.00	1.00	136.00
Water/Wetlands	A	117.85	0.00	0.00	0.00	0.00
Grass/Pasture	B	945.46	121.63	231.00	3.00	331.00
Industrial	C	0.00	0.00	0.00	0.00	0.00
Commercial	C	0.00	0.00	0.00	0.00	0.00
TOTAL	**n/a**	**14,680.54**	**6,314.64**	**68,439.00**	**20,023.00**	**1,641,802.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	187.50	54.86	4,498.09	1.87E+13
Target Load	37.68	26.38	376.79	1.47E+13
Reduction Needed	**149.82 (79.9%)**	**28.48 (51.9%)**	**4,121.3 (91.6%)**	**4.03E+12 (21.5%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

Table 47– Turtle Creek L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	11,020.70	7,006.74	84,000.00	24,818.00	2,042,731.00
Forest	B	2,747.10	200.64	382.00	5.00	546.00
Low Density Residential	C	1,047.23	577.14	2,862.00	896.00	66,473.00
High Density Residential	C	33.40	39.50	195.00	61.00	4,413.00
Water/Wetlands	A	1,671.52	0.00	0.00	0.00	0.00
Grass/Pasture	B	1,571.49	202.17	385.00	5.00	550.00
Industrial	C	21.57	27.10	93.00	20.00	4,468.00
Commercial	C	0.00	0.00	0.00	0.00	0.00
TOTAL	**n/a**	**18,113.01**	**8,053.29**	**87,917.00**	**25,805.00**	**2,119,181.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	240.87	70.70	5,805.98	2.30E+13
Target Load	246.61	172.63	2,466.14	9.60E+13
Reduction Needed	**-5.74 (-0.02%)**	**-10(-1.44%)**	**3,339.84 (57.5%)**	**-7.30E+13 (-317.6%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

Table 48 – Little Turtle Creek L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	8,086.73	5,141.38	616,637.00	18,211.00	1,498,908.00
Forest	B	2,919.04	213.20	406.00	5.00	580.00
Low Density Residential	C	802.92	442.50	2,194.00	687.00	49,432.00
High Density Residential	C	6.86	8.11	40.00	12.00	906.00
Water/Wetlands	A	1,101.50	0.00	0.00	0.00	0.00
Grass/Pasture	B	294.84	37.93	72.00	1.00	103.00
Industrial	C	0.00	0.00	0.00	0.00	0.00
Commercial	C	0.00	0.00	0.00	0.00	0.00
TOTAL	**n/a**	**13,211.89**	**5,843.12**	**619,349.00**	**18,916.00**	**1,549,929.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	1,696.85	57.97**	21,453.70**	7.02E+13
Target Load	144.95	10.15**	1,449.57**	5.64E+13
Reduction Needed	**1,551.9 (91.5%)**	**47.84 (82.5%)****	**20,003.84(93.2%)****	**1.38E+13 (19.6%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

***WCIWA Monitoring Data used*

Table 49 – Buzzard Pond L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	5,164.84	3,283.70	39,366.00	11,631.00	957,324.00
Forest	B	125.94	9.19	17.00	0.25	25.00
Low Density Residential	C	36.96	20.36	101.00	31.00	2,275.00
High Density Residential	C	7.38	8.72	43.00	13.00	975.00
Water/Wetlands	A	1,226.59	0.00	0.00	0.00	0.00
Grass/Pasture	B	151.71	19.51	37.00	0.53	53.00
Industrial	C	0.00	0.00	0.00	0.00	0.00
Commercial	C	0.00	0.00	0.00	0.00	0.00
TOTAL	**n/a**	**6,713.42**	**3,341.48**	**39,564.00**	**11,675.78**	**960,652.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	164.16**	31.99	2,631.92	2.00E+13
Target Load	50.36**	35.24	503.47	1.96E+13
Reduction Needed	**113.81(69.3%)****	**-3.25 (-10.2%)**	**2,128.45 (80.9%)**	**4.23E+11 (2.1%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

***WCIWA Monitoring Data used*

Table 50 – Kelley Bayou L-THIA Land Use Summary and Load Calculations

Land Use	Soil Class	Acres	Run-off (Acre/Ft)	Nitrogen (lbs/year)	Phosphorus (lbs/year)	Suspended Solids (lbs/year)
Agricultural	C	3,895.86	2,476.90	29,694.00	8,773.00	722,113.00
Forest	B	400.36	29.24	55.00	0.80	79.00
Low Density Residential	C	377.06	207.80	1,030.00	322.00	23,214.00
High Density Residential	C	0.66	0.78	3.00	1.00	87.00
Water/Wetlands	A	804.59	0.00	0.00	0.00	0.00
Grass/Pasture	B	170.83	21.97	41.00	0.60	59.00
Industrial	C	0.00	0.00	0.00	0.00	0.00
Commercial	C	0.00	0.00	0.00	0.00	0.00
TOTAL	**n/a**	**5,649.36**	**2,736.69**	**30,823.00**	**9,097.39**	**745,552.00**

	Nitrogen (lbs/day)	Phosphorus (lbs/day)	Suspended Solids (lbs/day)	E.coli* (cfu/year)
Current Load	84.45	24.92	2,042.61	6.78E+12
Target Load	18.54	12.98	185.43	7.21E+12
Reduction Needed	**65.91 (78.0%)**	**11.94 (47.9%)**	**1,857.18 (90.9%)**	**-4.39E+11 (-6.5%)**

**E.coli Loads calculated from WCIWA Monitoring Data (Section 3.5)*

7.0 Critical Areas and Statement of Goals

7.1 Goal Statements

Goals for the TTK watershed were formulated by the TTK Advisory Committee in the summer of 2014 and further refined in the summer of 2015. These goals were based on the list of Stakeholder Concerns (Table 2) created early in the project timeline, along with collected monitoring data and pollutant loads. Other Watershed Management Plans were also consulted for reference, including the Busseron Creek WMP and the Mill Creek-Blue River WMP.

The goals represented in this WMP reflect a comprehensive approach to load reductions throughout the entire TTK watershed, though each percentage goal can be applied to the target loads outlined in Section 6.2 and reflected on Tables 51 and 52 below. Load reductions will be calculated and compiled for each TTK project BMP completed (whether in a critical area or not). The TTK watershed goals are as follows:

Short-Term Goals

Table 51 - Short-Term (5 years) Load Reduction Goals for Each Subwatershed

	Sediment 15% (lb/day)	Nitrogen 15% (lb/day)	Phosphorus 15% (lb/day)	E.coli 4% (cfu/year)**
Thunderbird Pond	1,289.88	53.45	15.74	3.652E+12
West Turman	1,262.39	52.08	15.39	2.66E+12
Dodd's Bridge	674.71	28.13	8.23	7.48E+11
Turtle	870.90	36.13*	10.61*	9.2E+11*
Little Turtle	3,218.15**	254.53	8.70**	2.808E+12
Buzzard Pond	394.79	24.62**	4.80*	8.0E+11
Kelley Bayou	306.39	12.67	3.74	2.71E+11*
Total	**5,436.02**	**453.25**	**66.28**	**1.1857E+13**

*No load reduction required, though goal load reduction value is noted

**WCIWA Monitoring Data used

1. Reduce Sediment loads by at least 15% in each subwatershed within the next 5 years (992.07 t/yr)

2. Reduce Nitrogen loads by 15% in each subwatershed within the next 5 years (165,436.25 lbs/yr)

3. Reduce Phosphorus loads by 15% in each subwatershed within the next 5 years (24,192.2 lbs/yr)

4. Reduce E.coli loads by 4% in each subwatershed within the next 5 years (1.1857E+13 cfu/yr)

Long-Term Goals

Table 52 - Long-Term (20-30 years) Load Reduction Goals for Each Subwatershed

	25 Years Sediment 100% (lb/day)	*20 Years* Nitrogen 100% (lb/day)	*25 Years* Phosphorus 100% (lb/day)	*30 Years* E.coli 60% (cfu/year)**
Thunderbird Pond	8,599.17	356.32	104.95	5.47E+13
West Turman	8,415.91	347.18	102.62	3.99E+13
Dodd's Bridge	4,498.09	187.50	54.86	1.122E+13
Turtle	5,805.98	240.87*	70.70*	1.38E+13*
Little Turtle	21,453.71**	1,696.85	57.97**	4.212E+13
Buzzard Pond	2,631.92	164.16**	31.99*	1.2E+13
Kelley Bayou	2,042.61	84.45	24.92	4.068E+12*
Total	**36,240.06**	**3,021.56**	**441.86**	**1.77808E+14**

*No load reduction required, though goal load reduction value is noted

**WCIWA Monitoring Data used

5. Reduce TSS loads by 100% in each subwatershed within the next 25 years (6,613.81 t/yr)

6. Reduce Nitrogen loads by 100% in each subwatershed within the next 20 years (1,102,869.4 lbs/yr)

7. Reduce Phosphorus loads by 100% in each subwatershed within the next 25 years (161,278.9 lbs/yr)

8. Reduce E.coli loads 60% in each subwatershed within the next 30 years (1.77808E+14 cfu/year)

Habitat/Biological Goals

9. Continue to promote programs and conservation practices that establish riparian corridor, wetland habitat, field buffers, and filter strips.

10. Document significant QHEI and macroinvertebrate PTI score improvements on 70% of the 30 monitoring sites within the next 20 years.

Administrative Goals

11. Continue to pursue advantageous partnerships and additional funding sources in order to make improvements throughout TTK and surrounding watersheds in the future.

12. Continue to promote a variety of Best Management Practices (BMPs) that will help bring about long-term behavioral changes, better land management, and continued conservation throughout the region.

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7.2 Achievement Indicators

In order to accomplish these goals within the stated time frames, a number of objectives have been highlighted. These objectives will provide a clear outline for the best methods to be utilized in order to accomplish the previously stated goals. Success will be measured by monitoring the indicators listed in the tables below.

Table 53 –TSS Objectives and Indicators

Reduce TSS Loads by 15% in the Next 5 Years and 100% within 25 Years

<table>
<tr><th>Objectives</th><th>Indicators</th></tr>
<tr><td>Implement 319, LARE, and other cost-share programs to put erosion-reducing BMPs in place</td><td rowspan="6">Tabulate number of BMPs implemented using cost-share program
Measure sediment load reductions for each installed BMP using StepL or Region5 models
Continue monitoring turbidity at each site, quarterly in both high and low flow events, to track improvements
Continue annual Macroinvertebrate monitoring to track success
Conduct QHEI at each monitoring site no less than every 3 years to track improvements
Track number of event attendees, website traffic, social media followers
Tillage Transect will show increased acreage utilizing cover crops and/or no-till practices</td></tr>
<tr><td>Promote CRP, WRP, CREP and programs designed to establish buffers</td></tr>
<tr><td>Educate the public about the amount of soil that can be lost from land if reduced tillage is not practiced; promote conservation practices</td></tr>
<tr><td>Work with Hoosier Energy to develop land management methods for areas draining into Turtle Creek Reservoir</td></tr>
<tr><td>Continue to conduct annual Tillage Transect and Cover Crop Transect in Sullivan County</td></tr>
<tr><td>Work with partners to pool resources for BMP implementation, future monitoring, and/or widespread public education</td></tr>
</table>

Table 54 – NO_2/NO_3 Objectives and Indicators

Reduce NO_2/NO_3 Loads by 15% in the Next 5 Years and 100% within 20 Years

Objectives	*Indicators*
Implement 319, LARE, and other cost-share programs to put runoff-reducing BMPs in place	• Tabulate number of BMPs implemented using cost-share program • Measure Nitrogen load reductions for each installed BMP using StepL or Region5 models • Collect Nitrogen samples using Hoosier Riverwatch methods or lab analysis (if funds is available) to track improvements • Continue annual Macroinvertebrate monitoring to track success • Conduct QHEI at each monitoring site no less than every 3 years to track improvements • Track number of event attendees, website traffic, social media followers • Tillage Transect will show increased acreage utilizing cover crops and/or no-till practices
Promote CRP, WRP, CREP and programs designed to establish buffers	
Educate the public about nutrient management strategies; promote conservation practices and voluntary N analysis through programs such as INField Advantage	
Work with Hoosier Energy to develop land management methods for areas draining into Turtle Creek Reservoir	
Continue to conduct annual Tillage Transect and Cover Crop Transect in Sullivan County	
Work with partners to pool resources for BMP implementation, future monitoring, and/or widespread public education	

Table 55 - E.coli Objectives and Indicators

Reduce E.coli Loads by 4% in the Next 5 Years and 60% within 30 Years

Objectives	***Indicators***
Promote and (when possible) fund conservation practices that emphasize livestock management methods such as restricting access to streams and pasture improvements	• Tabulate number of BMPs implemented using cost-share program • More producers restricting livestock access to streams • Measure load reductions for each installed BMP when possible using recommended tools • Collect E.coli samples using Hoosier Riverwatch methods or lab analysis (if funds is available) to track improvements • Track number of event attendees, website traffic, social media followers • Number of residences upgrading on-site septic systems as indicated by permitting trends
Promote CRP, WRP, CREP and programs designed to establish buffers	
Work with local Health Department to promote education and awareness regarding septic system maintenance	
Work with Hoosier Energy to develop land management methods for areas draining into Turtle Creek Reservoir	
Work with partners to pool resources for BMP implementation, future monitoring, and/or widespread public education	

Table 56 - Total Phosphorus Objectives and Indicators

Reduce Total Phosphorus Loads by 15% in the Next 5 Years and 100% within 25 Years

Objectives	***Indicators***
Implement 319, LARE, and other cost-share programs to put runoff-reducing BMPs in place	• Tabulate number of BMPs implemented using cost-share program • Measure Phosphorus load reductions for each installed BMP using StepL or Region5 models • Continue annual Macroinvertebrate monitoring to track success • Conduct QHEI at each monitoring site no less than every 3 years to track improvements • Track number of event attendees, website traffic, social media followers • Tillage Transect will show increased acreage utilizing cover crops and/or no-till practices • Collect Total Phosphorus samples using Hoosier Riverwatch methods or lab analysis (if funds is available) to track improvements
Promote CRP, WRP, CREP and programs designed to establish buffers	
Educate the public about nutrient management strategies; promote conservation practices	
Work with Hoosier Energy to develop land management methods for areas draining into Turtle Creek Reservoir	
Continue to conduct annual Tillage Transect and Cover Crop Transect in Sullivan County	

Table 57 – Continued Promotion of BMPs that Establish Buffers and Enhance Habitat

Continue to Promote BMPs and Educate the Public about Buffers and Riparian Corridor

Objectives	*Indicators*
Promote CRP, WRP, CREP and programs designed to establish buffers	• Track participants in programs such as CRP, CREP, WRP • Track number of attendees at events and field days as well as social media and website traffic • Secure continued funding for increased BMP implementation • Calculate load reductions from BMPs installed as a result of WCIWA partnership/promotion by using StepL and Region5 tools
Educate the public about buffers, filter strips, and wetlands; promote conservation practices that enhance stream habitat	
Work with Hoosier Energy to develop land management methods for areas draining into Turtle Creek Reservoir	
Continue to maintain and update website, Twitter, Flickr, and other social media sites	

Table 58 – Habitat/Biological Objectives and Indicators

Improved QHEI and Macroinvertebrate Scores on 70% of Monitoring Sites in 20 years

Objectives	*Indicators*
Implement 319, LARE, and other cost-share programs to put erosion-reducing BMPs in place to reduce stream embeddedness	• Tabulate number of BMPs implemented using cost-share program • Continue annual Macroinvertebrate monitoring to track success • Conduct QHEI at each monitoring site no less than every 3 years to track improvements • Tillage Transect will show increased acreage utilizing cover crops and/or no-till practices • Conduct stream buffer desktop analysis in 10 years to gauge improvement
Promote CRP, WRP, CREP and programs designed to establish buffers	
Educate the public about reduced tillage strategies and streambank/shoreline protection; promote conservation practices that enhance stream habitat	
Work with Hoosier Energy to develop land management methods for areas draining into Turtle Creek Reservoir	
Continue to conduct annual Sullivan County Tillage and Cover Crop Transects	

Table 59 - Continued Partnerships and Funding: Objectives and Indicators

Continue to Pursue Partnerships and Additional Funding

Objectives	***Indicators***
Pursue continued 319 and other funding (CWI, LARE, private agency) when possible	• Track number of attendees at events and field days as well as social media and website traffic • Secure continued funding for increased BMP implementation • Calculate load reductions from BMPs installed as a result of WCIWA partnership/promotion
Keep TTK Watershed Management Plan updated and current	
Maintain existing partnerships and cultivate new alliances	
Continue to maintain and update website, Twitter, Flickr, and other social media sites	

Table 60 - Continued BMP Promotion and Public Education: Objectives and Indicators

Continue to Promote BMPs and Educate Public about Conservation

Objectives	***Indicators***
Keep TTK Watershed Management Plan updated and current	• Track number of attendees at events and field days as well as social media and website traffic • Secure continued funding for increased BMP implementation • Calculate load reductions from BMPs installed as a result of WCIWA partnership/promotion using StepL or Region5 spreadsheet models
Continue to maintain and update website, Twitter, Flickr, and other social media sites	
Work with partners to plan and promote local and regional conservation field days	
Maintain public visibility at local events, fairs, field days, planter clinics, etc.	

7.3 Critical Areas Defined

Based on the TTK monitoring data collected almost all of the seven subwatersheds exhibited pollutant loads exceeding water quality targets for at least one of the four pollutants for which the Advisory Committee chose to focus (TSS, Nitrates/Nitrites, Total Phosphorus, E.coli). Four critical areas were selected in total, however, to accommodate EPA's requirements for watershed management planning, only three were selected as primary critical areas (i.e. will be targeted for cost-share implementation). The primary critical areas selected and ranked for the TTK Watershed are as follows:

1. **West Turman subwatershed**
2. **Thunderbird Pond subwatershed**
3. **Dodd's Bridge subwatershed**

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4. ***Little Turtle Creek subwatershed***

Even though the Little Turtle Creek subwatershed ranked very high, the TTK Advisory Committee decided to prioritize other subwatersheds for cost-share due to the fact that Turtle Creek and Little Turtle Creek watersheds have already undergone watershed management planning and implementation during the Partnership for Turtle Creek grant in the early 2000s. 319 implementation funding will be utilized for the first three critical areas noted above, though other funding sources such as Clean Water Indiana and LARE will be sought in order to implement BMPs in the Little Turtle subwatershed, since it ranked very high according to the scoring method used.

Three ranking methods were undertaken to determine which areas were most critical overall. The ranking method used to select these top three critical areas was voted on by the Advisory Committee; Ranking Method 2 was preferred, though Little Turtle was removed from the top three, because it is a relatively small subwatershed and other conservation options through LARE and Clean Water Indiana are currently being pursued to help remediate its pollutant loads. The Advisory Committee also wanted to place emphasis on areas with listed 5A impairments according to IDEM's Office of Water Quality Assessment Branch data, and also the headwaters of Turman Creek.

Scores were based on 12 months of water monitoring lab data collected from April 2014-March 2015 during the TTK water monitoring study and calculated load scores for each monitoring site. All nutrient-related pollutant scores (Nitrates/Nitrites and Total Phosphorus) were added together and averaged to create a single, overall score for 'Nutrients'. Kelley Bayou was averaged based on two sites instead of three, because the TNC oxbow site (Kelley 3) has no flow and is anomalous.

To rank watersheds for each of the three methods, each of the three main pollutant types was scored separately (Sediment, E.coli, and Combined Nutrients). Watersheds were assigned a point total based on their high/low scores: For example: 1st place = 7 pts., 7th place = 1 pt. Then, each pollutant type was given an additional number of 'weighted' points based on its designated 'importance' and ability to be targeted within the scope of 319 grant parameters (as determined by Advisory Committee). For instance, TSS = 3 pts because it was deemed the number one concern by the Advisory Committee and will be the focus of most BMPs implemented. Nutrients = 2 points and E.coli = 1 point because it is the most difficult to remedy with BMPs and is of lower priority.

At this point, each watershed has been given a score for its rank (1st – 7th place) for each pollutant. Finally, all points were added together from all three pollutant parameters (TSS, Nutrients, and E.coli) to give each watershed a total overall score for each method, with the pollutant type scores weighted accordingly. Total scores are shown on the tables below according to the three different ways to rank them. The three methods are described as follows:

Method 1) According to Pollutant Load Reduction % Needed

Method 2) According to Pollutant Load Reduction Volumes Needed (either ton/year or cfu/year)

Method 3) Score Based on Number of 'Fails' per Watershed (i.e. Average number of times a site had a pollutant concentration that exceeded target levels and was considered 'impaired')

After carefully evaluating each method of ranking, the TTK Advisory Committee decided that Method 2, based on pollutant load reduction calculations provided the most accurate representation of which subwatersheds reflected the highest magnitude of pollution and warranted designation for critical areas. A more detailed break-down of the calculations used to produce these ranking method outcomes can be found attached in Appendix H.

Table 61 – Critical Area Ranking Method 1

Score Based on Average Pollutant Load Percent Reduction Needed

Overall Rank	**Subwatershed**	**(3 pts)**	**(Combined – 2 pts)**		**(1 pt.)**	**Total Points**
		TSS Avg. %	**Total P Avg. %**	**NO_2/NO_3 Avg. %**	**E.coli Avg. %**	
1	West Turman	91.1%	81.9%	43.36%	45.5%	25.5
2	Little Turtle	86.48%	68.54%	13.4%	37.24%	21
3	Dodd's Bridge	81.63%	73.26%	41.26%	36.93%	20.5
4	Thunderbird Pond	76.9%	61.94%	-101.26%	49.28%	19.5
5	Buzzard Pond	69.95%	72.45%	74%	3.7%	18
6	Kelley Bayou	21.5%	64.95%	6.5%	27.1%	11.5
7	Turtle Creek	9.92%	39.98%	-130.12%	-14.65%	10

(Not selected for use as ranking method for critical areas)

Table 62 – Critical Area Ranking Method 2

Score Based on Average Pollutant Load Reduction Needed (by volume)

Overall Rank	Subwatershed	(3 pts)	(Combined – 2 pts)		(1 pt.)	Total Points
		TSS Avg. tons/yr	Total P Avg. tons/yr	NO_2/NO_3 Avg. tons/yr	E.coli Avg. cfu/year	
1	West Turman	1,742.29	4.73	12.6	2.376E+13	26.5
2	Little Turtle	1,129.2	2.93	3.25	1.9748E+13	22
3	Thunderbird Pond	592.93	2.21	-0.52	2.09E+13	20
4	Dodd's Bridge	566.38	2.27	10.54	1.77E+13	19
5	Buzzard Pond	180.57	-1.28	18.25	4.66E+11	17
6	Kelley Bayou	12.95	0.39	0.43	-1.1095E+12	11
7	Turtle Creek	38.61	0.46	-4.40	-5.8067E+12	10.5

(Selected by Advisory Committee as preferred ranking method)

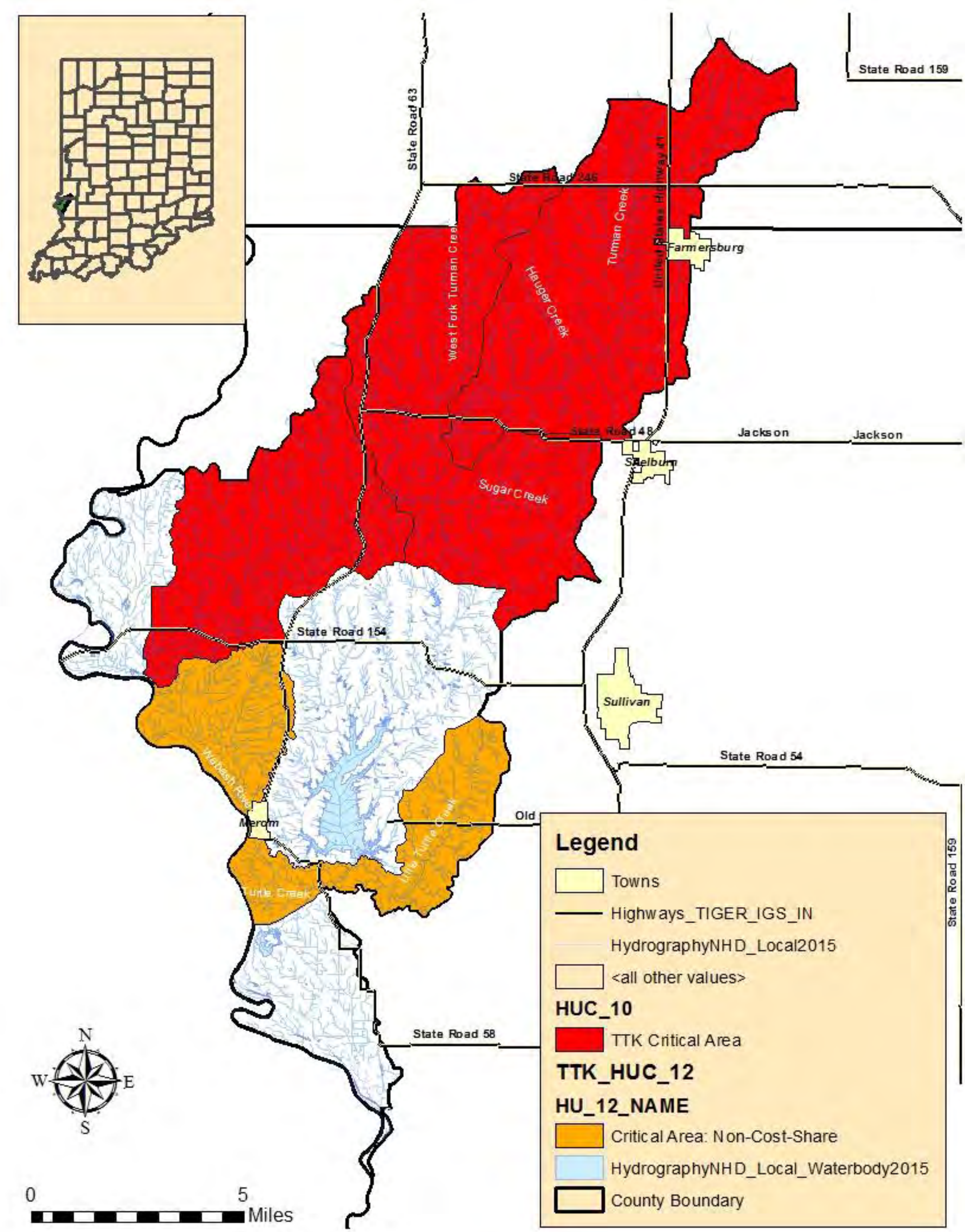
Table 63 – Critical Area Ranking Method 3

Score Based on Average Number of Failed Concentrations

Overall Rank	Subwatershed	(3 pts)	(Combined – 2 pts)		(1 pt.)	Total Points
		TSS Avg. # Fails	Total P Avg. # Fails	NO_2/NO_3 Avg. # Fails	E.coli Avg. # Fails	
1	Buzzard Pond	9.5	9	10.5	2	21
2	West Turman	5	9	7	7.6	20.5
2	Dodd's Bridge	6.33	8	6.6	6.33	20.5
4	Kelley Bayou	7	8	4	3	18.5
4	Thunderbird Pond	5.4	8	3.2	6.6	18.5
6	Little Turtle	6.6	7.8	6.4	6.2	18
7	Turtle Creek	5.33	6.4	3.3	5	12.5

(Not selected for use as ranking method for critical areas)

Figure 47 – Overview of TTK Critical Areas



8.0 Best Management Practices and Other Measures

The three critical areas chosen for cost-share implementation were prioritized based on an overall score that took all pollutant scores into account. A variety of BMPs can be implemented in order to achieve pollutant load reductions that will satisfy the goals of the WMP. In this case, numerous agricultural BMPs were selected as ideal conservation practices for the problems cited in these critical areas: Cover Crops, Critical Area Seeding, Nutrient Management, Exclusion Fence, Heavy Use Area Protection (HUAP), Prescribed Grazing, Filter Strip, Grassed Waterway, WASCOBs, Precision Agriculture upgrades, No-Till Planter upgrades, and several others that will be featured in the TTK Cost-Share Implementation plan. Many of these BMPs include secondary associated practices, such as subsurface drainage or underground outlets. These practices are also designed to be implemented in conjunction with other similar BMPs as a part of a comprehensive systems approach to conservation throughout the watershed. The NRCS practice numbers for these related practices are listed under the main BMP description. Detailed descriptions regarding specifications can be found in the NRCS FOTG (Field Office Technical Guide) for Sullivan, IN https://efotg.sc.egov.usda.gov/treemenuFS.aspx Practice standards for BMPs listed on Table 62 below.

BMP load reduction totals were estimated using the Region5 and StepL pollutant load tools, with minor adjustments made to more accurately reflect the soil loss estimated for the watershed area according to the NRCS RUSLE soil loss equation and current tillage transect data (Section 2.3) which estimates soil loss per acre to be in the range of 1.2 to 6.8 tons/acre/year, depending on land use. 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 tabulated into a comprehensive format 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.

Table 64- Best Management Practice Information

BMP or Measure [NRCS Practice #]	***Critical Area(s)***	***Water Quality Concern (Reason For Being Critical)***	***Estimated Load Reduction for BMP***			***Estimated Cost/Unit***
			Nitrogen lb/year	***Phosphorus lb/year***	***Sediment tons/year***	
Access Control/Fence (linear ft.) [472, 382]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, E.coli, Habitat/Bio	8.9	3.1	0.1	$2/ft.
Animal Trails and Walkways (linear ft.) [575, 578]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, E.coli, Habitat/Bio	8.9	3.1	0.1	$5-$10/ft.
Conservation Cover/Cover Crop (acre) [327, 340, 635]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	8.4	9.6	0.5	$40/ac
Critical Area Planting (acre) [342]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients Habitat/Bio	23.5	8.2	1.0	$500 - $2,000
Diversion (linear ft.) [362, 606]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	11.0	4.3	0.2	$4/ft.
Field Border/Filter Strip (linear ft.) [386, 393, 332]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	23.5	8.2	0.3	$600/ft.
Forage and Biomass Planting (acre) [512]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	13.0	7.0	0.5	$100-$250/ac.

Table 64 - (Cont.) Best Management Practice Information

BMP or Measure [NRCS Practice #]	*Critical Area(s)*	*Water Quality Concern (Reason For Being Critical)*	*Estimated Load Reduction for BMP*			*Estimated Cost/Unit*
			Nitrogen lb/year	*Phosphorus lb/year*	*Sediment tons/year*	
Grade Stabilization Structure (linear ft.) [410]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	2.0	1.0	1.0	$50-$600 (single structure)
Grassed Waterways (linear ft.) [412]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	0.1	0.1	0.1	$6/ft.
HUAP/Access Protection (sq. ft.) [561, 560]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, E.coli, Habitat/Bio	4.0	2.0	0.05	$500 - $2,500 (single structure)
Nutrient Management (single plan, per acre) [590]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	Nutrients, Habitat/Bio	12	n/a	n/a	$11 - $30/acre
Pasture Seeding, Prescribed Grazing (acre) [528, 516, 558]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, E.coli	40	30	0.6	$26/acre
Residue and Tillage Management (Mulch, No-Till, Strip-Till) (acre) [345, 329, 585]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	10.1	3.4	0.8	$40/ac

Table 64 - (Cont.) Best Management Practice Information

BMP or Measure [NRCS Practice #]	*Critical Area(s)*	*Water Quality Concern (Reason For Being Critical)*	*Estimated Load Reduction for BMP*			*Estimated Cost/Unit*
			Nitrogen lb/year	*Phosphorus lb/year*	*Sediment tons/year*	
Riparian Buffer, Forest, Herbaceous (linear ft.) [391, 390, 395]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	11.4	4.4	0.5	$700-$2,000/ac
Streambank and Shoreline Protection (linear ft.) [580]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Habitat/Bio	8.9	3.1	0.2	$50/ft.
Structure for Water Control (single structure) [587]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	Nutrients, TSS, Habitat/Bio	0.52	0.41	0.96	$2,000
Terrace (linear ft.) [600, 606, 620]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	26.5	10.4	0.2	$3.00/ft
Tree and Shrub Establishment (acre) [612, 338]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Nutrients, Habitat/Bio	11.4	4.4	0.5	$700/acre
WASCOB (linear ft.) [638, 606, 620]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, Habitat/Bio	0.1	0.1	0.1	$1,500 - $4,000 (single structure)

Table 64 - (Cont.) Best Management Practice Information

BMP or Measure [NRCS Practice #]	*Critical Area(s)*	*Water Quality Concern (Reason For Being Critical)*	*Estimated Load Reduction for BMP*			*Estimated Cost/Unit*
			Nitrogen lb/year	*Phosphorus lb/year*	*Sediment tons/year*	
Watering Facility (single structure) [614, 533]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	TSS, E.coli, Nutrients, Habitat/Bio	340	60	1.35	$1,500-$3,000
Wetland Creation, Enhancement, Restoration (acre) [656, 658, 659, 657]	(All) West Turman, Thunderbird Pond, Dodd's Bridge	Nutrients, TSS, Habitat/Bio	1.0	0.5	10.0	$400-$5,000/ac.

Short-term and long-term goals were outlined in Section 7.1, along with the pollutant loads needed to achieve these goals for each of the seven subwatersheds. Table *** and Table *** depict a series of strategies for implementing combinations of the aforementioned BMPs in order to achieve short and long-term goals within the watershed. For the short-term goals, each of the four critical areas will be the outlined, with proposed combinations of BMPs needed to remedy the pollutant loads. For long-term goals, the entire TTK watershed will be considered (i.e. all pollutant loads will be added together) in order to determine a proposed combination of BMPs needed in order to achieve success.

All load reductions and cost-estimates were collected and calculated using the best approved methods and tools. At this time, there is no approved tool for accurately calculating E.coli load reductions resulting from BMP installation, so reduction goals for E.coli loads could not be generated. StepL and Region5 do include reduction efficiencies for septic system maintenance, livestock access restriction, or pasture management. It is possible that applicable tools for estimating and calculating E.coli load reductions will be available in the future, in which case, this WMP should be reevaluated and updated accordingly.

The BMP s proposed for achieving load reductions are not required to be implemented exactly as the quantities suggest. These totals are simply proposed solutions for achieving short and long-term goals and will act as a guideline. These BMPs were chosen based on the likelihood of adoption as well as current stakeholder interest, the TTK Cost-Share Implementation wait list, and local expertise. Practices such as cover crops, no-till planter upgrades, nutrient management, and WASCOBs have been adopted by local producers in past 319 programs in adjacent watersheds and continue to generate interest throughout the TTK watershed. These suggested BMPs are designed to achieve load reduction goals via a conservation 'systems approach' and will be promoted as such. Several practices, such as cover crops, can be implemented on the same acreage year after year, though for the purposes of these estimates, will only be counted singly. BMP adoption and success is closely tied to the participation of local producers. Continued promotion and conservation planning with a 'systems approach' will be necessary for the successful installation of load-reducing BMPs in the future.

Table 65 - Suggested BMPs for Short Term Load Reductions in Critical Areas

Short Term Goals: Reduce Nitrogen, Phosphorus, Sediment loads 15% in 5 years

Critical Area	Thunderbird Pond			
Suggested BMP	**Unit**	**Nitrogen Reduction (lbs/day)**	**Phosphorus Reduction (lbs/day)**	**Sediment Reduction (lbs/day)**
Cover Crops	300 acres	6.9	7.8	822
WASCOBs	5 structures	0.00135	0.00135	2.75
Tillage Management/Upgrades	200 acres	5.4	1.8	876
Grade Stabilization Structure	2 structures	0.01	0.004	10.96
Pasture/Grazing Management	100 acres	11	8	329
Nutrient Management	1,000 acres	33	n/a	n/a
BMP Reduction Total	**n/a**	**56.3**	**17.6**	**2,040.71**
Calculated Goal Total	**n/a**	**53.45**	**15.74**	**1,289.88**

Critical Area	West Turman			
Suggested BMP	**Unit**	**Nitrogen Reduction (lbs/day)**	**Phosphorus Reduction (lbs/day)**	**Sediment Reduction (lbs/day)**
Cover Crops	400 acres	9.2	10.4	1,096
Pasture/Grazing Management	100 acres	11	8	329
Livestock Watering Facility	2 units	1.86	0.32	14.78
WASCOBs	3 structures	0.00081	0.00081	1.65
Tillage Management/Upgrades	100 acres	2.7	0.9	438
Nutrient Management	500 acres	16.5	n/a	n/a
Filter Strip	300 ft.	18	6	492
BMP Reduction Total	**n/a**	**58.56**		**2,371.43**
Calculated Goal Total	**n/a**	**52.08**	**15.39**	**1,263.39**

Critical Area	Dodd's Bridge			
Suggested BMP	**Unit**	**Nitrogen Reduction (lbs/day)**	**Phosphorus Reduction (lbs/day)**	**Sediment Reduction (lbs/day)**
Cover Crops	200 acres	4.6	5.2	548
Livestock Watering Facility	2 units	1.86	0.48	14.78
Livestock HUAP	2400 ft^2	24	12	120
Access Control/Fence	300 ft.	6	2.4	165
Forage and Biomass Planting	100 acres	3.5	1.9	274
Filter Strip	100 ft.	6	2	164
WASCOBs	5 structures	0.00135	0.00135	2.75
BMP Reduction Total	**n/a**	**45.96**	**23.98**	**1,288.53**
Calculated Goal Total	**n/a**	**28.13**	**8.23**	**674.71**

Critical Area	Little Turtle Creek			
Suggested BMP	**Unit**	**Nitrogen Reduction (lbs/day)**	**Phosphorus Reduction (lbs/day)**	**Sediment Reduction (lbs/day)**
Cover Crops	500 acres	11.5	13	1,370
Tillage Management/Upgrades	1,000 acres	27	9	4,380
Nutrient Management	1,500 acres	49.5	n/a	n/a
Filter Strip	1,000 ft.	60	20	1,640
Terrace	500 ft.	35	14	545
Forage and Biomass Planting	300 acres	10.5	5.7	822
Riparian Buffer Establishment	1,000 ft.	30	12	2,740
Streambank/Shoreline Protection	1,000 ft.	20	8	1,090
Pasture/Grazing Management	50 acres	5.5	4	164.5
Livestock HUAP	1600 ft^2	16	8	80
BMP Reduction Total	**n/a**	**265.0**	**93.7**	**12,831.5**
Calculated Goal Total	**n/a**	**254.53**	**8.70**	**3,218.15**

Table 66 - Suggested BMPs for Long Term Load Reductions in TTK

Long Term Goals: Reduce Nitrogen, Phosphorus, Sediment loads 100% in 20-25 years

TTK Watershed Entire				
Suggested BMP	Unit	*20 years*	*25 years*	*25 years*
		Nitrogen Reduction (lbs/day)	**Phosphorus Reduction (lbs/day)**	**Sediment Reduction (lbs/day)**
Streambank/Shoreline Protection	5,000 ft.	100	40	5,450
Pasture/Grazing Management	1,000 acres	110	80	3,290
WASCOBs	30 structures	0.0081	0.0081	16.5
Filter Strip	8,500 ft.	510	170	13,940
Critical Area Seeding	100 acres	6	2.2	548
Nutrient Management	20,000 acres	660	n/a	n/a
Cover Crops	25,000 acres	575	650	68,500
Livestock Watering Facility	5 units	4.65	0.8	36.95
Access Control/Fence	500 ft.	10	4	275
Livestock HUAP	4,000 ft^2	40	20	200
Terrace	2,000 ft.	140	56	2,180
Diversion	1,000 ft.	180	72	6,540
Tillage Management/Upgrades	20,000 acres	540	180	87,600
Tree/Shrub Establishment	100 acres	7	2.8	274
Forage and Biomass Planting	1,000 acres	35	19	2,740
Riparian Buffer Establishment	4,000 ft.	120	48	10,960
BMP Reduction Total	**n/a**	**3,037.66**	**1,344.81**	**202,550.45**
Calculated Goal Total	**n/a**	**3,021.56**	**441.86**	**36,240.06**

Long-term strategies for BMP implementation throughout the TTK watershed are highly dependent on continued promotion of conservation practices in the future. A comprehensive systems approach will need to be applied, starting with critical areas first. Initial implementation efforts during the first five years of the project will also help encourage widespread continuous adoption of many beneficial cropping practices such as cover crops, no-till, filter strips, and nutrient management. In this expansive manner, goals can realistically be achieved, though may be difficult to track with exactitude. Future water monitoring may be necessary to verify the extent to which pollutant loads have been reduced.

9.0 Action Register and Schedule

Goals and actions will be grouped accordingly and listed below, with a corresponding set of instructions meant to provide a detailed outline for measurable success in the future. The TTK Advisory Committee and other interested parties can use this Action Register as a tool to track progress. It will also serve as a reference document to periodically consult throughout the project in an effort to ensure that all goals will be met in a timely fashion.

Organizations and partners listed below are not technically obligated to fulfill requirements as stated. This list is intended to serve as a guideline for current and future Advisory Committee members and other project associates. This Action Register is based on the likelihood of a partnership as well as the group's current interest and involvement at the time of this writing.

Goals

Short-Term Goals

1. Reduce TSS loads by 15% in the next 5 years.

2. Reduce Nitrate/Nitrite loads by 15% in the next 5 years.

3. Reduce Total Phosphorus loads by 15% in the next 5 years

4. Reduce E.coli loads by 4% in the next 5 years.

Long-Term Goals

5. Reduce TSS loads by 100% within the next 25 years.

6. Reduce Nitrate/Nitrite loads by 100% within the next 20 years.

7. Reduce Total Phosphorus loads by 100% within the next 25 years.

8. Reduce E.coli loads 60% within the next 30 years.

Habitat/Biological Goals

9. Continue to promote programs and conservation practices that establish riparian corridor, wetland habitat, field buffers, and filter strips.

10. Document significant QHEI and macroinvertebrate PTI score improvement s on 70% of the 30 monitoring sites within the next 20 years.

Administrative Goals

11. Continue to pursue advantageous partnerships and additional funding sources in order to make improvements throughout TTK and surrounding watersheds in the future.

12. Continue to promote a variety of Best Management Practices (BMPs) that will help bring about long-term behavioral changes, better land management, and continued conservation throughout the region.

Table 67 - TTK Action Register

Goals 1 and 5 – Reduce TSS by 15% in the next 5 years and 100% within the next 25 years					
Problem Statement: TSS pollutant loads exceed water quality targets.					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Implement 319, LARE, CWI, and other cost-share programs to put erosion-reducing BMPs in place (See Tables 65 and 66)	Landowners, Stakeholders, Agricultural Producers, General Public	Within 3 months, develop a cost-share program and establish a Cost-Share Interest list for potential participants	$2,000 (promote) $200,000+ (BMPs)	PP = Advisory Committee, seed and implement dealers, DNR, ISDA, Hoosier Energy, TNC, IN American Water TA = NRCS, ISDA, TNC, local agronomists, Purdue Extension, Hoosier Riverwatch personnel	Tabulate number of BMPs implemented through 319 and other watershed initiatives; track number of customers and participating producers
		Achieve short-term load reduction goal for critical areas - 15% in 5 years (Table 51)			Track sediment load reductions for each BMP using StepL or Region 5 in order to determine when milestone has been achieved
		Achieve long-term load reduction goal 100% in 25 years – all watersheds (36,240.06 lbs/day)			Continued quarterly turbidity monitoring will reflect improvements within 5 years; long-term monitoring will be conducted to verify 25 year goal achieved; Macroinvertebrate and QHEI scores will improve within 5 years
Pursue and promote alternative funding sources such as LARE, CWI, CREP, CRP, EQIP, WRP; promote buffer establishment		Acquire new funding and match sources through continued grant submittal and cross-promotion of programs	$100-$500/ac	PP = Advisory Committee; TA = NRCS, ISDA, TNC, local agronomist, Purdue Extension	Increased numbers of BMPs implemented throughout watershed; increased load reductions tabulated towards goal achievement
Continue to conduct annual Tillage and Cover Crop Transects throughout watershed		Each year, record tillage data in early summer on 200+ predetermined sites; record cover crop/tillage data in late fall on same field sites	$500	TA = NRCS, ISDA	Transects will reflect increased cover crop acreage, fewer conventionally tilled acres

(Cont.) Goals 1 and 5 – Reduce TSS by 15% in the next 5 years and 100% within the next 25 years					
Problem Statement: TSS pollutant loads exceed water quality targets.					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Educate the public about soil erosion, increase awareness about applicable conservation practices, BMPs and cost-share opportunities	Landowners, Stakeholders, Agricultural Producers, General Public	Release 4 newsletters per year, update website monthly, distribute brochures advertising cost-share program after WMP is complete and approved	$2,500	PP = Landowners, Hoosier Energy (printing), TNC, IN American Water, Public library, Purdue Extension, local seed and implement dealers	# of publications distributed, # of individuals on contact list, increased website traffic, increased media coverage
Work with partners to pool resources for BMPs, monitoring, and public education		Hold 1 regional field day in the first year highlighting BMPs; assist with partner field days; acquire additional grant funding through partnerships	$1,500	PP = Other SWCDs, DNR, ISDA, ; TA = NRCS, TNC, ISDA, DNR	Track # of attendees at each event, record # media releases, observe increased social media traffic; acquire additional funding through CWI, LARE and other sources

Goals 2 and 6 – Reduce NO_2/NO_3 loads by 15% in the next 5 years and 100% within the next 20 years					
Problem Statement: Nitrate/Nitrite pollutant loads exceed water quality targets .					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Implement 319, LARE, CWI, and other cost-share programs to put runoff-reducing BMPs in place (See Tables 65 and 66)	Landowners, Stakeholders, Agricultural Producers, General Public	Within 3 months, develop a cost-share program and establish a Cost-Share Interest list for potential participants	$2,000 (promote) $200,000+ (BMPs)	PP = Advisory Committee, seed and implement dealers, DNR, ISDA, Hoosier Energy, TNC, IN American Water TA = NRCS, ISDA, TNC, local agronomists, Purdue Extension, Hoosier Riverwatch personnel	Tabulate number of BMPs implemented through 319 and other watershed initiatives; track number of customers and participating producers
		Achieve short-term load reduction goal for critical areas - 15% in 5 years (Table 51)			Track nitrogen load reductions for each BMP using StepL or Region 5 in order to determine when milestone has been achieved
		Achieve long-term load reduction goal 100% in 20 years – all watersheds (3,021.56 lbs/day)			Continued quarterly monitoring will reflect improvements within 5 years; long-term monitoring will be conducted to verify 20 year goal achieved; Macroinvertebrate and QHEI scores will improve within 5 years
Pursue and promote alternative funding sources such as LARE, CWI, CREP, CRP, EQIP, WRP; promote buffer establishment		Acquire new funding and match sources through continued grant submittal and cross-promotion of programs	$100-$500/ac	PP = Advisory Committee; TA = NRCS, ISDA, TNC, local agronomist PP = Willing landowners, Advisory Committee	Increased numbers of BMPs implemented throughout watershed; increased load reductions tabulated towards goal achievement
Continue to conduct annual Tillage and Cover Crop Transects throughout watershed		Each year, record tillage data in early summer on 200+ predetermined sites; record cover crop/tillage data in late fall on same field sites	$500	PP = Advisory Committee; TA = NRCS, ISDA, TNC, local agronomist, Purdue Extension	Transects will reflect increased cover crop acreage, fewer conventionally tilled acres

(Cont.) Goals 2 and 6 – Reduce NO_2/NO_3 loads by 15% in the next 5 years and 100% within the next 20 years

Problem Statement: Nitrate/Nitrite pollutant loads exceed water quality targets

Objective(s)	Target Audience	Milestone(s)	Cost	Potential Partner (PP) and necessary Technical Assistance (TA)	Goal Indicator(s)
Educate the public about run-off, increase awareness about applicable conservation practices, BMPs and cost-share opportunities	Landowners, Stakeholders, Agricultural Producers, General Public	Release 4 newsletters per year, update website monthly, distribute brochures advertising cost-share program after WMP is complete and approved	$2,500	PP = Landowners, Hoosier Energy (printing), TNC, IN American Water, Public library, Purdue Extension, local seed and implement dealers	# of publications distributed, # of individuals on contact list, increased website traffic, increased media coverage
Work with partners to pool resources for BMPs, monitoring, and public education		Hold 1 regional field day in the first year highlighting BMPs; assist with partner field days; acquire additional grant funding through partnerships	$1,500	PP = Other SWCDs, DNR, ISDA, ; TA = NRCS, TNC, ISDA, DNR	Track # of attendees at each event, record # media releases, observe increased social media traffic; acquire additional funding through CWI, LARE and other sources

Goals 3 and 7 – Reduce Phosphorus loads by 15% in the next 5 years and 100% within the next 25 years					
Problem Statement: Total Phosphorus pollutant loads exceed water quality targets					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Implement 319, LARE, CWI, and other cost-share programs to put runoff-reducing BMPs in place (See Tables 65 and 66)	Landowners, Stakeholders, Agricultural Producers, General Public	Within 3 months, develop a cost-share program and establish a Cost-Share Interest list for potential participants	$2,000 (promote) $200,000+ (BMPs)	PP = Advisory Committee, seed and implement dealers, DNR, ISDA, Hoosier Energy, TNC, IN American Water TA = NRCS, ISDA, TNC, local agronomists, Purdue Extension, Hoosier Riverwatch personnel	Tabulate number of BMPs implemented through 319 and other watershed initiatives; track number of customers and participating producers
		Achieve short-term load reduction goal for critical areas - 15% in 5 years (Table 51)			Track phosphorus load reductions for each BMP using StepL or Region 5 in order to determine when milestone has been achieved
		Achieve long-term load reduction goal 100% in 25 years – all watersheds (441.86 lbs/day)			Continued quarterly monitoring will reflect improvements within 5 years; long-term monitoring will be conducted to verify 25 year goal achieved; Macroinvertebrate and QHEI scores will improve within 5 years
Pursue and promote alternative funding sources such as LARE, CWI, CREP, CRP, EQIP, WRP; promote buffer establishment		Acquire new funding and match sources through continued grant submittal and cross-promotion of programs	$100-$500/ac	PP = Advisory Committee; TA = NRCS, ISDA, TNC, local agronomist PP = Willing landowners, Advisory Committee	Increased numbers of BMPs implemented throughout watershed; increased load reductions tabulated towards goal achievement
Continue to conduct annual Tillage and Cover Crop Transects throughout watershed		Each year, record tillage data in early summer on 200+ predetermined sites; record cover crop/tillage data in late fall on same field sites	$500	PP = Advisory Committee; TA = NRCS, ISDA, TNC, local agronomist, Purdue Extension	Transects will reflect increased cover crop acreage, fewer conventionally tilled acres

(Cont.) Goals 3 and 7 – Reduce Phosphorus loads by 15% in the next 5 years and 100% in the next 20 years					
Problem Statement: Total Phosphorus pollutant loads exceed water quality targets					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Educate the public about runoff, increase awareness about applicable conservation practices, BMPs and cost-share opportunities	Landowners, Stakeholders, Agricultural Producers, General Public	Release 4 newsletters per year, update website monthly, distribute brochures advertising cost-share program after WMP is complete and approved	$2,500	PP = Landowners, Hoosier Energy (printing), TNC, IN American Water, Public library, Purdue Extension, local seed and implement dealers	# of publications distributed, # of individuals on contact list, increased website traffic, increased media coverage
Work with partners to pool resources for BMPs, monitoring, and public education		Hold 1 regional field day in the first year highlighting BMPs; assist with partner field days; acquire additional grant funding through partnerships	$1,500	PP = Other SWCDs, DNR, ISDA, ; TA = NRCS, TNC, ISDA, DNR	Track # of attendees at each event, record # media releases, observe increased social media traffic; acquire additional funding through CWI, LARE and other sources

Goals 4 and 8 – Reduce E.coli loads by 4% in the next 5 years and 60% within the next 30 years					
Problem Statement: E.coli pollutant loads exceed water quality targets					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Promote and (when possible) fund conservation practices that emphasize livestock management methods such as access control, grazing management, and pasture improvement; Implement suggested BMPs when possible (See Tables 65 and 66)	Landowners, Stakeholders, Agricultural Producers, General Public	Within 3 months, develop a cost-share program and establish a Cost-Share Interest list for potential participants	$2,000 (promote) $100,000+ (BMPs)	PP = Advisory Committee, seed and implement dealers, DNR, ISDA, Hoosier Energy, TNC, IN American Water TA = NRCS, ISDA, TNC, local agronomists, Purdue Extension, Hoosier Riverwatch personnel	Tabulate number of BMPs implemented through 319 and other watershed initiatives; track number of customers and participating producers; more producers restricting livestock access to streams
		Achieve short-term load reduction goal for critical areas - 4% in 5 years (Table 51)			When possible, track E.coli load reductions for each BMP using approved methods in order to determine when milestone has been achieved
		Achieve long-term load reduction goal 600% in 30 years – all watersheds (1.77808E+14 cfu/yr)			Continued quarterly monitoring will reflect improvements within 5 years; long-term monitoring will be conducted to verify 30 year goal achieved
Pursue and promote alternative funding sources such as LARE, CWI, CREP, CRP, EQIP, WRP; promote buffer establishment		Acquire new funding and match sources through continued grant submittal and cross-promotion of programs	$100-$500/ac	PP = Advisory Committee; TA = NRCS, ISDA, TNC, local agronomist PP = Willing landowners, Advisory Committee	Increased numbers of BMPs implemented throughout watershed; increased load reductions tabulated towards goal achievement
Work with local contractors and Health Department to promote education and awareness regarding septic system installation and maintenance		Produce and distribute septic maintenance brochure at local events, field days, county fairs; offer cost-share incentives to producers proving voluntary septic maintenance	$500	PP = Health Dept., local contractors TA = Soil Scientists (NRCS), local contractors, Health Dept. personnel	Increased number of residences upgrading on-site septic systems as indicated by permitting trends

(Cont.) Goals 4 and 8 – Reduce E.coli loads by 4% in the next 5 years and 60% within the next 30 years					
Problem Statement: E.coli pollutant loads exceed water quality targets					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Educate stakeholders and landowners about pasture management, increase awareness about applicable conservation practices, BMPs and cost-share opportunities	Landowners, Stakeholders, Agricultural Producers, General Public	Release 4 newsletters per year, update website monthly, distribute brochures advertising cost-share program after WMP is complete and approved	$2,500	PP = Landowners, Hoosier Energy (printing), TNC, IN American Water, Public library, Purdue Extension, local seed and implement dealers	# of publications distributed, # of individuals on contact list, increased website traffic, increased media coverage
Work with partners to pool resources for BMPs, monitoring, and public education		Hold 1 regional field day in the first year highlighting BMPs; assist with partner field days; acquire additional grant funding through partnerships	$1,500	PP = Other SWCDs, DNR, ISDA, ; TA = NRCS, TNC, ISDA, DNR	Track # of attendees at each event, record # media releases, observe increased social media traffic; acquire additional funding through CWI, LARE and other sources

Goal 9 – Continue to promote programs and conservation practices that establish riparian corridor, wetland habitat, field buffers, and filter strips					
Problem Statement: Lack of widespread conservation BMPs has resulted in decreased water quality and poor stream habitat					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Promote CRP, WRP, CREP and other cost-share implementation programs designed to establish buffers and riparian corridor	Landowners, Stakeholders, Agricultural Producers, General Public, county officials	New landowners enroll in buffer programs; implement over 2000' new filter strip in watershed	$1,000	PP = Advisory Committee, DNR, Wabash Healthy Rivers Initiative, TNC, ISDA TA = NRCS, ISDA, TNC, DNR personnel	Calculate sediment load reductions as a result of installed BMPs; continue to monitor macroinvertebrates annually to track improvement; conduct QHEI assessment every three years on all 30 sites to track improvement
Educate public about buffers, filter strips, wetlands, and proper streambank management; promote conservation practices that enhance stream habitat		Distribute brochures and information regarding buffers and riparian corridor at local field days, county fairs, and events; offer on-site inventory and evaluation	$500	PP = Advisory Committee, DNR, Wabash Healthy Rivers Initiative, TNC, ISDA TA = NRCS, ISDA, TNC, DNR personnel	Increased traffic on website and social media; public interest in land management solutions
Pursue mutually beneficial partnerships with local organizations to secure funding and increase BMP implementation for enhanced stream habitat		Recruit new Advisory Committee members to offer input; Hold 1 regional field day in the first year highlighting BMPs; assist with partner field days; acquire additional grant funding through partnerships	$1,000	PP = Advisory Committee, Hoosier Energy, DNR, Wabash Healthy Rivers Initiative, TNC, ISDA TA = NRCS, ISDA, TNC, DNR personnel	New BMPs installed, pollutant load reductions tabulated, new farmers adopt wider buffers and reduced tillage practices (as will be evidenced in Tillage Transect, future windshield/desktop buffer surveys)
Continue to maintain and update website at least monthly, Twitter, Flickr, and other social media sites		Increased social media traffic, website visits; new Advisory Committee members, new program participants	$200	PP = Advisory Committee TA = website assistance	Track number of website visits, social media 'shares', contributions from stakeholders, increased participation

Goal 10 – Document significant QHEI and macroinvertebrate PTI score improvements on 70% of the 30 monitoring sites within the next 20 years

Problem Statement: QHEI and Macroinvertebrate scores fall below water quality targets for most sites

Objective(s)	Target Audience	Milestone(s)	Cost	Potential Partner (PP) and necessary Technical Assistance (TA)	Goal Indicator(s)
Implement 319, LARE, CWI, and other cost-share programs to put erosion-reducing BMPs in place, as well as streambank protection, wetland establishment, riparian corridor plantings (See Tables 65 and 66)	Landowners, Stakeholders, Agricultural Producers, General Public	Within 3 months, develop a cost-share program and establish a Cost-Share Interest list for potential participants	$2,000 (promote) $100,000+ (BMPs)	PP = Advisory Committee, seed and implement dealers, DNR, ISDA, Hoosier Energy, Healthy Rivers Initiative, TNC, IN American Water TA = NRCS, ISDA, TNC, local agronomists, Purdue Extension, Hoosier Riverwatch personnel	Tabulate number of BMPs implemented through 319 and other watershed initiatives; track number of customers and participating producers; load reduction tracking for sediment will reflect decreased turbidity
		Achieve goal for habitat improvement: Significantly improved QHEI and macroinvertebrate scores on 70% of the 30 water monitoring sites within the next 20 years			Continued annual macroinvertebrate monitoring will reflect improvements within 20 years; QHEI assessments conducted every 3 years will show improvement within 20 year, meeting water quality targets for healthy PTI and habitat scores
Pursue and promote alternative funding sources such as LARE, CWI, CREP, CRP, EQIP, WRP; promote buffer establishment		Acquire new funding and match sources through continued grant submittal and cross-promotion of programs	$100-$500/ac	PP = Advisory Committee; TA = NRCS, ISDA, TNC, DNR, local agronomist, Purdue Extension	Increased numbers of BMPs implemented throughout watershed; increased load reductions tabulated towards goal achievement
Continue to conduct annual Tillage and Cover Crop Transects throughout watershed		Each year, record tillage data in early summer on 200+ predetermined sites; record cover crop/tillage data in late fall on same field sites	$500	TA = NRCS, ISDA	Transects will reflect increased cover crop acreage, fewer conventionally tilled acres, more buffers and filter strips established

Goal 10 – Document significant QHEI and macroinvertebrate PTI score improvements on 70% of the 30 monitoring sites within the next 20 years					
Problem Statement: QHEI and Macroinvertebrate scores fall below water quality targets for most sites					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Educate the public about streambank/shoreline erosion, increase awareness about applicable conservation practices, BMPs and cost-share opportunities	Landowners, Stakeholders, Agricultural Producers, General Public	Release 4 newsletters per year, update website monthly, distribute brochures advertising cost-share program after WMP is complete and approved	$2,500	PP = Landowners, Hoosier Energy (printing), TNC, IN American Water, Healthy Rivers Initiative, Public library, Purdue Extension, local seed and implement dealers	# of publications distributed, # of individuals on contact list, increased website traffic, increased media coverage
Work with partners to pool resources for BMPs, monitoring, and public education		Hold 1 regional field day in the first year highlighting BMPs; assist with partner field days; acquire additional grant funding through partnerships	$1,500	PP = Other SWCDs, DNR, ISDA, ; TA = NRCS, TNC, ISDA, DNR	Track # of attendees at each event, record # media releases, observe increased social media traffic; acquire additional funding through CWI, LARE and other sources

Goal 11 – Continue to pursue advantageous partnerships and additional funding sources in order to make improvements throughout TTK and surrounding watersheds in the future.					
Problem Statement: Ongoing efforts will be needed in order to continue funding BMPs, promoting conservation practices, and educating local stakeholders about resource concerns in order to reduce pollutant loads in the TTK watershed.					
Objective(s)	**Target Audience**	**Milestone(s)**	**Cost**	**Potential Partner (PP) and necessary Technical Assistance (TA)**	**Goal Indicator(s)**
Improve water quality through better habitat and land management; target non-point sources	Landowners, Stakeholders, Agricultural Producers, General Public, county officials	Update social media and website with information and statistics at least quarterly; encourage stakeholders to 'follow' online	$250	PP = Advisory Committee, SWCD Board, local producers (spread the word); TA = volunteer web developer, as needed	Increased traffic on website and social media; public interest in land management solutions
Encourage new producers to enroll in cost-share program		Promote cost-share program and conservation practices at annual Planter Clinics	$200	PP = Pigg Implement, SWCD, NRCS, agronomist, Advisory Committee	New BMPs installed, pollutant load reductions tabulated, new farmers develop new land management habits
Pursue mutually beneficial partnerships with local organizations		Recruit new Advisory Committee members to offer input	$250	PP = Advisory Committee, SWCD, NRCS	New members attending meetings

Goal 12 – Continue to promote a variety of BMPs that will help bring about long-term behavioral changes, better land management, and continued conservation throughout the region.

Problem Statement: Lack of awareness regarding BMP implementation and land management in the TTK watershed has resulted in pollutant loads exceeding water quality targets.

Objective(s)	Target Audience	Milestone(s)	Cost	Potential Partner (PP) and necessary Technical Assistance (TA)	Goal Indicator(s)
Install BMPs in critical areas and educate producers about the benefits	Landowners, Stakeholders, Agricultural Producers, General Public, county officials	Organize a small group meeting of producers to discuss BMPs, challenges, and new technology	$2,000 (promote) $100,000+ (BMPs)	PP = Advisory Committee, SWCD Board, local producers (spread the word); TA = NRCS DC, agronomist	# of participants at meeting
Encourage new producers to enroll in cost-share program		Promote cost-share program and conservation practices at annual Planter Clinics	$500	PP = Pigg Implement, SWCD, NRCS, agronomist, Advisory Committee	New BMPs installed, pollutant load reductions tabulated, new farmers develop new land management habits
Pursue mutually beneficial partnerships with local organizations		Recruit new Advisory Committee members to offer input	$250	PP = Advisory Committee, SWCD, NRCS	New members attending meetings

10.0 Tracking Effectiveness

In order to determine the overall success and effectiveness of the TTK Watershed Management Plan over time, milestones must be recorded for future reference. Listed below are some of the main methods with which to track overall effectiveness.

Tracking Effectiveness of BMPs

In order to tabulate total load reductions in critical areas over time, each BMP associated with 319 funding or target watershed initiatives will be tracked and evaluated. Depending on the type of BMP installed, a load reduction calculation will be determined using programs such as StepL, Region5, or another approved option. The Watershed Coordinator will be responsible for calculating and recording the load reductions for each installed BMP as well as overall load reductions for each critical area as time passes. Typically, load reduction summaries will be provided in annual updates at the local Advisory Committee and SWCD Annual Meetings, as well as being presented in 319 final reports. Additionally, copies of the load reductions for each installed BMP will be provided to participating producers in order to better educate them about the benefits of an adopted conservation practice.

Tables 64, 65, and 66 provide information regarding the cost per unit for implementing each BMP as well as the calculable load reduction for each practice. Additionally, a suite of suggested BMPs has been provided in order to offer guidance when working towards reducing pollutant loads in the critical areas (short-term) as well as throughout the entire TTK watershed (long-term). The Watershed Coordinator will oversee the cost-share aspect of the 319 Implementation grant, though the NRCS District Conservationist, NRCS Conservation Implementation Team, ISDA Resource Specialists, and other partner personnel may assist with conservation planning, inventory and evaluation, engineering designs, and verification of proper installation. The Sullivan County Soil and Water Conservation District Coordinator/Educator will issue payments and track financial records accordingly.

Water Quality Monitoring

Funding for ongoing water monitoring involving laboratory analysis is often cost-prohibitive. Efforts will be made to partner with agencies such as Hoosier Energy, The Nature Conservancy, and Indiana American Water to share lab facilities and equipment, and/or to obtain additional funding for periodic lab analyses of water samples collected.

In the case of limited funding, Hoosier Riverwatch methods can be utilized on a regular basis to track macroinvertebrate populations, QHEI scores, turbidity levels, flow, fecal coliform, nutrients, and other changes in-stream. A Watershed Coordinator, a representative from the local SWCD, or a volunteer group may be responsible for continued quarterly monitoring of the 30 sites chosen for the TTK Watershed project for up to 5 years. Beyond the scope of the 319 project requirements, monitoring can continue for the foreseeable future, as long as there are dedicated and trained individuals available to carry out the testing. If monitoring ceases for a period of time, it can be resumed again, with comparisons being drawn from the baseline data collected as a part of the TTK watershed management planning efforts. Additionally, other agencies may be monitoring in the area, and partnerships can be cultivated that will result in the sharing of mutually beneficial data.

Social Indicators

Social indicators are often difficult to ascertain as they are sometimes very gradual and vague in nature. However, stakeholders in the TTK watershed are very observant and committed to fostering positive changes when it comes to conservation. Tangible ways to observe social indicators may be through periodic windshield surveys and tillage transects, to record land-use changes and improved conservation methods. Widespread adoption of new BMPs can often be observed during windshield surveys as well.

Attendance will be tracked for all conservation field days, events, fair booths, planter clinics, and annual meetings. Interest can also be gauged by the amount of newspaper and media articles that are released. Social media and online activity can also be observed by tracking website 'hits' as well as the number of 'followers' on Facebook, Twitter, and Flickr. A comprehensive database of contacts will also be maintained and periodic email updates may be sent. Traffic and inquiries in the USDA office will also be noted when it comes to specific inquiries related to TTK watershed resource concerns.

Tracking of Administrative Successes

Successes, both administrative and BMP-related can be scheduled according to the Action Register on Table 67. Goals are clearly outlined along with milestones for tracking success. The Watershed Coordinator, TTK Advisory Committee, and Sullivan County Soil and Water Conservation District Board can use the Action Register as a guideline when devising strategies for achieving the stated TTK watershed goals.

The Watershed Coordinator will be chiefly responsible for tracking and reporting all administrative successes, including load reductions, number of BMPs successfully installed, match/in-kind contributions, database of contacts, online media, and event participation/attendance. A comprehensive final report will be issued at the conclusion of each 319 grant, though the Watershed Coordinator and/or Advisory Committee may choose to maintain records for future watershed planning efforts and reporting purposes.

11.0 Future Activities

This WMP is intended to be a resource for interested parties, now and in the future. Data collected via monitoring is funding-dependent; the data collected for the TTK Water Monitoring study from 2014-2015 was conducted to establish baseline pollutant loads that would allow the TTK Advisory Committee to prioritize critical areas and make decisions regarding the most efficient courses of action. Monitoring using Hoosier Riverwatch will be conducted on the 30 chosen sites on a quarterly basis, along with an annual macroinvertebrate assessment and QHEI update every three years. Additional monitoring may take place in the future, if funding permits.

At this time, the TTK 319 Planning and Implementation grant is underway; this Watershed Management Plan was completed at the conclusion of the second year of the three year grant. After the WMP has been approved, the first round of TTK Implementation will begin in critical areas. An additional round of 319-funded implementation was applied for an awarded. The second round of TTK Implementation will tentatively commence in 2016 and conclude in 2018. Other funding sources are currently being pursued through LARE Watershed Land Treatment grant applications, as well as Clean Water Indiana funds.

This plan is designed to provide a comprehensive overview of the resource concerns observed within the TTK watershed at the time of this writing. It may be adapted as future needs require and should be revised when critical areas, load reductions, and/or land uses are believed to have changed significantly in any way. This WMP should be reevaluated every three years and revised after a maximum of 10 years have elapsed. The WCIWA Watershed Coordinator and/or the Sullivan County Soil and Water Conservation District Board will be responsible for revisions of this Watershed Management Plan. Any questions regarding this document may be directed to:

Sullivan Soil and Water Conservation District (West Central Indiana Watershed Alliance)

2316 North Section Street
Sullivan, IN 47882
(812) 268-5157 ext. 3

12.0 WMP Collected References, Guidance, and Derived Definitions

Indiana Map website http://indianamap.org/, Indiana Geographic Information Council and Indiana Geological Survey

Hoosier Riverwatch Manual (2015), Retrieved from http://www.in.gov/idem/riverwatch/files/volunteer_monitoring_manual.pdf

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Indiana Department of Environmental Management Virtual File Cabinet (2015), Retrieved from http://www.in.gov/idem/6953.htm/

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USDA-NRCS Definition of Prime Farmland, Retrieved from http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/pr/soils/?cid=nrcs141p2_037285

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Indiana Census Data (2010), Retrieved from http://www.stats.indiana.edu/topic/census.asp

Tools/Literature/Technical References:

USDA/NRCS Soil Survey 1971 Sullivan County, Indiana, Retrieved from http://www.nrcs.usda.gov/Internet/FSE_MANUSCRIPTS/indiana/sullivanIN1971/sullivan.pdf

Natural Resources Conservation Service. Field Office Technical Guide (FOTG) Indiana Standards. Retrieved from Section IV https://efotg.sc.egov.usda.gov/treemenuFS.aspx

Natural Resources Conservation Service, Field Office Technical Guide (FOTG), Definitions of Hydric and Highly Erodible Soils, Retrieved from Section II https://efotg.sc.egov.usda.gov/treemenuFS.aspx

Indiana Department of Environmental Management (2015). Water Quality Targets. Retrieved from http://www.in.gov/idem/nps/3484.htm

United States Environmental Protection Agency, Region5 and StepL Pollutant Load Reduction Model guidance, Retrieved from http://it.tetratech-ffx.com/steplweb/

Purdue University L-THIA (Long Term Hydrologic Impact Assessment) tool, Retrieved from https://engineering.purdue.edu/mapserve/LTHIA7/lthianew/lidIntro.php

Natural Resources Conservation Service, Web Soil Survey http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

Other WMPs consulted:

Partnership for Turtle Creek (2001), Turtle Creek and Little Turtle Creek Watershed Management Plan, Retrieved Sept. 2014 from http://www.in.gov/idem/nps/3191.htm

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Mill Creek-Blue River Watershed Management Plan (2013), Retrieved Feb. 2015 from http://www.in.gov/idem/nps/3905.htm

Plummer Creek Watershed DRAFT Management Plan (2014); copy requested from Greene County Soil and Watershed Conservation District, July 2014

Lost River Watershed Management Plan (2012), Retrieved July 2015 from http://www.in.gov/idem/nps/3903.htm

Big Pine Watershed Management Plan (2015), Retrieved Nov. 2015 from http://www.in.gov/idem/nps/3957.htm

Mapping/GIS Resources/Metadata:

The following geographic information systems (GIS) data sources were used to create one or more of the maps in the TTK Watershed Management Plan; most data was obtained from Indianamap.org and metadata is described according below:

- Confined Feeding Operation Facilities, 2015 - Shows swine, chicken, turkey, beef or dairy agribusinesses that have large enough numbers of animals that IDEM regulates for environmental concerns, as defined by IC 13-18-10 of the Indiana Code. Provided by personnel of the Indiana Department of Environmental Management, Office of Land Quality on February 25, 2015
- Brownfields, 2015 - A brownfield site is a parcel of real estate that is abandoned or inactive, or may not be operated at its appropriate use, and on which expansion, redevelopment, or reuse is complicated because of the presence or potential presence of a hazardous substance, a contaminant, petroleum, or a petroleum product that poses a risk to human health and the environment. Provided by personnel of the Indiana Department of Environmental Management, Office of Land Quality. Data are current as of February 25, 2015.

- Soil Survey Geographic (SSURGO) Database, 20150126 (1:12,000) - Shows the most detailed level of soil geographic data available for Indiana, and provides information about the kinds and distribution of soils on the landscape. Attributes include soil map-units ('MAPUNIT_NA'), hydric rating ('HYDCLPRS'), drainage class ('DRCLASSDCD'), potential erosion hazard ('FORPEHRTDC'), and more. Data were obtained by personnel of the Indiana Geological Survey (IGS) from personnel of the National Resources Conservation Service (NRCS), U.S. Department of Agriculture (USDA). NOTE: This layer is based on data that were obtained from the NRCS in 20150126. However data and metadata for selected counties possibly have been revised by personnel of the NRCS. For the most current data, users should refer to the Indiana Soils Program Web page of the NRCS.
- Prime Farmland and Hydric Soils, 1994 (1:250,000) - Shows the percentage of prime farmland or hydric soils occurring within soil map units. The actual boundary of specific prime farmland or hydric soils is NOT shown. Derived from the State Soil Geographic (STATSGO) database, which is a digital general soil association map developed by the National Cooperative Soil Survey, U.S. Department of Agriculture. The soil maps for STATSGO are compiled by generalizing more detailed soil survey maps.
- Underground Storage Tanks, 2015 - Shows regulated underground storage tank locations, including leaking underground storage tanks. Regulated underground storage tanks are those that have 10 percent or more of the tank and piping buried beneath the ground and contain a regulated substance. This data set generally contains the location of access points to managed sites, along with a unique identifier for each location. Provided by personnel of Indiana Department of Environmental Management, Office of Land Quality. Data are current as of February 25, 2015.
- Facilities - National Pollutant Discharge Elimination System, 2013 - Shows state-permitted wastewater facilities and provides associated information such as the name of the facility, contacts, and a variety of mailing addresses. Extracted from the national EPA Integrated Compliance Information System (ICIS) database, this layer includes all available records listed in Indiana associated with active surface-water discharge facilities. There are 1792 facilities in this data layer, but only 1441 records have locational information as UTM values and are spatially displayed. Provided by personnel of the Indiana Department of Environmental Management (IDEM), Office of Water Quality on October 8, 2013.
- Pipe Locations - National Pollutant Discharge Elimination System, 2013 - Shows National Pollutant Discharge Elimination System (NPDES) Program pipe locations. Extracted from the national EPA Integrated Compliance Information System (ICIS) database, this layer focuses on active state-regulated wastewater facility permit discharge points discharging into surface water bodies in Indiana. There are a total of 10,187 records in this data layer, but only 4,999 records are spatially displayed, and for which locational information exists as UTM values. Provided by personnel of the Indiana Department of Environmental Management (IDEM), Office of Water Quality on October 8, 2013.
- Land Cover, 2006 (30-meter Grid) Shows fifteen categories of land use in Indiana. This grid is a subset of the 2006 National Land Cover Database (NLCD 2006), version 1.0 was released on February 14, 2011, and was produced through a cooperative project conducted by the USGS Multi-Resolution Land Characteristics (MRLC) Consortium. The land cover classification was achieved by using a combination of Landsat imagery and ancillary data.
- Bedrock Geology, 1987 (1:500,000) - Shows systems and selected groups, formations, and other stratigraphic units. Generalized lithologic characterizations are also provided, as well as hyperlinks to the Compendium of Paleozoic Rock-Unit Stratigraphy in Indiana. Digitized from the following published paper map: Indiana Geological Survey Miscellaneous Map 48.
- Underground Coal Mines, 2010 (1:24,000) - Shows the locations and extents of underground coal mines. Includes locations for all documented underground mines that operated in Indiana since the late 1800s. Mines can be differentiated based on mine type, mine number, source information, and dates of mining. Original source information includes company mine maps, field maps and notes of IGS geologists, IGS publications, and Indiana State Mine Inspector Reports.
- Surface Coal Mines, 2010 (1:24,000) - Shows the locations and extents of surface coal mines for the period from the early 1900s through 2009. Mines can be differentiated based on mine type, mine number, source information, and dates of mining. Original source information includes company mine maps, field maps and notes of IGS geologists, IGS publications, Indiana State Mine Inspector Reports, several series of aerial photographs, and U.S. Geological Survey 7.5-minute quadrangle maps. NOTE: AML data privately developed and distributed by Department of Reclamation upon request.
- Floodplains - Flood Rate Insurance Maps (FIRM), 20150519 (1:12,000) - Shows floodplains and flood hazard areas, derived from FEMA Flood Rate Insurance Maps (FIRM). The FIRM are the basis for floodplain management, mitigation, and insurance activities for the National Flood Insurance Program (NFIP). The Digital Flood Insurance Rate Map (DFIRM) Database is derived from Flood Insurance Studies (FIS), previously published Flood Insurance Rate Maps (FIRM), flood hazard analyses performed in support of the FIS's and FIRM's, and new mapping data, where available. This database is an interim version of the DFIRM Database and does not fully meet all DFIRM specifications. Updated data were supplied by Indiana Department of Natural Resources (IDNR) personnel on May 19, 2015.

- Streamflow Gauging Stations in Indiana, 2008 - This layer shows locations of 179 streamflow gauges maintained by the United States Geological Survey (USGS) in Indiana. The gauges are part of a real-time national streamflow network. Attributes include station name, station reference number, and a URL link to real-time hydrologic data for each station
- Lakes, Ponds, Reservoirs, Swamps, and Marshes, 20150921 (1:2,400) - Shows lakes, ponds, reservoirs, swamps and marshes in watersheds in Indiana. This layer is derived from the local-resolution National Hydrography Dataset (NHD), and provides currently available data as of September 21, 2015. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. Also, high-resolution NHD, generally developed at 1:24,000 to 1:12,000 scale, adds detail to the original 1:100,000-scale NHD. The local resolution NHD is developed at 1:2,400 scale, and adds even more detail to the NHD. This dataset is currently incomplete but includes data for the following thirty-one HUC08 subbasins in Indiana: Auglaize (0410007), Blue-Sinking (05140104), Driftwood (05120204), Eel (05120104), Eel (05120203), Flatrock-Haw (05120205), Highland-Pigeon (05140202), Iroquois (07120002), Lower East Fork White (05120208), Lower Great Miami (05080002), Lower Ohio-Little Pigeon (05140201), Lower Wabash (05120113), Lower White (05120202), Middle Wabash-Busseron (05120111), Middle Wabash-Deer (05120105), Middle Ohio-Laughery (05090203), Mississinewa (05120103), Muscatatuck (05120207), Patoka (05120209), Salamonie (05120102), St. Joseph (04050001), St. Joseph-Maumee (04100003), St. Mary's (04100004), Sugar (05120110), Upper East Fork White (05120206), Upper Great Miami (05080001), Upper Maumee (04100005), Upper White (05120201), Vermillion (05120109), Whitewater (05080003), Wildcat (05120107).
- Streams, Rivers, Canals, Ditches, Artificial Paths, Coastlines, Connectors, and Pipelines, 20150921 (1:2,400) - Shows streams, rivers, canals, ditches, artificial paths, coastlines, connectors and pipelines in Indiana. This layer is derived from the local-resolution National Hydrography Dataset (NHD), and provides currently available data as of September 21, 2015. NHD data was originally developed at 1:100,000-scale and exists at that scale for the whole country. Also, high-resolution NHD, generally developed at 1:24,000 to 1:12,000 scale, adds detail to the original 1:100,000-scale NHD. The local resolution NHD is developed at 1:2,400 scale, and adds even more detail to the NHD. This dataset is currently incomplete but includes data for the following thirty-one HUC08 subbasins in Indiana: Auglaize (0410007), Blue-Sinking (05140104), Driftwood (05120204), Eel (05120104), Eel (05120203), Flatrock-Haw (05120205), Highland-Pigeon (05140202), Iroquois (07120002), Lower East Fork White (05120208), Lower Great Miami (05080002), Lower Ohio-Little Pigeon (05140201), Lower Wabash (05120113), Lower White (05120202), Middle Wabash-Busseron (05120111), Middle Wabash-Deer (05120105), Middle Ohio-Laughery (05090203), Mississinewa (05120103), Muscatatuck (05120207), Patoka (05120209), Salamonie (05120102), St. Joseph (04050001), St. Joseph-Maumee (04100003), St. Mary's (04100004), Sugar (05120110), Upper East Fork White (05120206), Upper Great Miami (05080001), Upper Maumee (04100005), Upper White (05120201), Vermillion (05120109), Whitewater (05080003), Wildcat (05120107).
- Wetlands of Indiana from the National Wetland Inventory (NWI, 2014) - Shows the extent, approximate location, and type of wetlands and deepwater habitats in Indiana, as provided by the National Wetland Inventory (NWI) of the U.S. Fish and Wildlife Service (USFWS). These data delineate the areal extent of wetlands and surface waters as defined by Cowardin et al. (1979). Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and near shore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery. By policy, the Service also excludes certain types of "farmed wetlands" as may be defined by the Food Security Act or that do not coincide with the Cowardin et al. definition. Contact the Service's Regional Wetland Coordinator for additional information on what types of farmed wetlands are included on wetland maps. Digital wetlands data are intended for use with base maps and digital aerial photography at a scale of 1:12,000 or smaller. Due to the scale, the primary intended use is for regional and watershed data display and analysis, rather than specific project data analysis. The map products were neither designed nor intended to represent legal or regulatory products. Questions or comments regarding the interpretation or classification of wetlands or deepwater habitats can be addressed by visiting http://www.fws.gov/wetlands/FAQs.html.
- Watershed Boundary Dataset (WBD) - Ten-Digit Watershed Boundaries for Indiana, 2009 (1:24,000) - Shows the most recent revision of watershed boundaries of 10-digit hydrologic accounting units. This data set, part of the Watershed Boundary Data set (WBD), is a complete digital hydrologic unit boundary layer to the Watershed (10-digit) 5th level for the NRCS business areas in and around the state of Indiana. Polygons are attributed with hydrologic unit codes for 4th level sub-basins, 5th level watersheds, name, size, downstream hydrologic unit, type of watershed, noncontributing areas and flow modification. The Watershed and Subwatershed hydrologic unit boundaries provide a uniquely identified and uniform method of subdividing large drainage areas. The smaller sized 6th level sub-watersheds (up to 250,000 acres) are useful for numerous application programs supported by a variety of local, State, and Federal Agencies. This data set is intended to be used as a tool for water-resource management and planning activities, particularly for site-specific and localized studies requiring a level of detail provided by large-scale map information.

Funding and support for the Watershed Boundary data set (WBD) were provided by the Natural Resources Conservation Service, the Environmental Protection Agency, and the United States Geological Survey.

- Watershed Boundary Dataset (WBD) - Twelve-Digit Subwatershed Boundaries for Indiana, 2009 (1:24,000) - Shows the most recent revision of watershed boundaries of 12-digit hydrologic accounting units. This data set, part of the Watershed Boundary Data set (WBD), is a complete digital hydrologic unit boundary layer to the Subwatershed (12-digit) 6th level in and around the state of Indiana. Polygons are attributed with hydrologic unit codes for 4th level subbasins, 5th level watersheds, 6th level subwatersheds, name, size, downstream hydrologic unit, type of watershed, noncontributing areas and flow modification. The Watershed and Subwatershed hydrologic unit boundaries provide a uniquely identified and uniform method of subdividing large drainage areas. The smaller sized 6th level sub-watersheds (up to 250,000 acres) are useful for numerous application programs supported by a variety of local, State, and Federal Agencies. This data set is intended to be used as a tool for water-resource management and planning activities, particularly for site-specific and localized studies requiring a level of detail provided by large-scale map information. Funding and support for the Watershed Boundary data set (WBD) were provided by the Natural Resources Conservation Service, the Environmental Protection Agency, and the United States Geological Survey. USGS Topographic Maps, 1996 (1:24,000) - Shows the digital color imagery (Digital Raster Graphics, referred to as DRGs) of topographic quadrangle maps of the U.S. Geological Survey. See the following URL for a basic description of the creation of these data: http://topomaps.usgs.gov/drg/drg_overview
- Natural Gas, Crude Oil, and Refined Oil Pipelines, 1988 (1:63,360) - Shows the locations and extents of known natural gas, crude oil, and refined products pipelines. Digitized from data compiled for the creation of the following published map: Indiana Geological Survey Miscellaneous Map 53.
- Highways (INDOT), 2004 (1:24,000) - Shows Interstate, U.S., and State Highways. Attributes include route numbers and the number of lanes. Obtained from the Indiana Department of Transportation. The highways that are shown are a subset of the Indiana Statewide Travel Demand Model (version 4) and duplicate general traffic patterns, so that detailed networks at interchanges and ramps are not represented.
- Roadways (INDOT), 2012 (1:24,000) - Shows the Federal Highway Administration functional classification of roadways in the Indiana Statewide Travel Demand Model (ISTDM). Functional classification generally is the process by which streets and highways are grouped into classes, or systems, according to the character of the service they are intended to provide year to year. Attributes include route numbers, number of lanes, and functional classification (i.e., character of service). Data are current as of June 26, 2012.
- Boundaries of Incorporated Cities and Towns, 2001 - Shows incorporated area boundaries for all cities and towns. Provided by personnel of the Indiana Department of Transportation, Graphics Engineering.
- LiDAR Color Hillshade (2011 - 2013) - This custom hillshade was created by personnel of the Indiana Geological Survey from the 1.5m DEMs. Image cache was created by using the colorized DEM, hillshade, and slope data. It was last updated on February 14, 2014. The State of Indiana has completed a 3-year program (began in 2011) to acquire 1-foot resolution orthophotography (RGBI) and elevation data for the entire state (counties may elect to buy-up to 6-inch or 3-inch resolution imagery). The program includes new USGS-compliant light detection and ranging (LiDAR) data at either 1.0 meter or 1.5 meter average post spacing, as well as DEM products with 5-foot post spacing. The project is divided into three acquisition areas: center (2011), east (2012), and west (2013). Classified LiDAR point cloud data (in LAS file format, version 1.2) and bare-earth DEMs (with hydroflattening, in ERDAS IMAGINE format of *.IMG) are available for download from the Indiana Spatial Data Portal (ISDP), University Information Technology Services (UITS), Indiana University.
- County Boundaries, 1998 (1:24,000) - County boundaries in polygon format, derived from the 7.5-Minute digital raster graphic (DRG) series maps of the U.S. Geological Survey (USGS). The county boundaries are part of the Congressional Survey system, also known as the Public Land Survey system. Digitized by personnel of the Indiana Geological Survey.
- State Boundary, 1998 (1:24,000) - Shows the state boundary, as a polygon, derived from the 7.5-Minute digital raster graphic (DRG) series maps of the U.S. Geological Survey (USGS). The state boundary is part of the Congressional Survey system, also known as the Public Land Survey system. Digitized by personnel of the Indiana Geological Survey.

Additional GIS Data:

- Stream Buffer layer data created by The Nature Conservancy exclusively for the TTK Watershed Project; data available upon direct request
- TTK monitoring sites, merged watershed boundaries created exclusively for the TTK Watershed Project by WCIWA personnel; data available upon request
- IDEM Assessment Branch information on Turman Creek 5A Designations provided on request, though a mapping tool is currently being developed http://www.in.gov/idem/nps/3474.htm

Appendix A: Acronyms & Abbreviations

AFO	Animal Feeding Operation
AML	Abandoned Mine Lands
BMP	Best Management Practice
BDL	Below Detection Limit
CAFO	Concentrated Animal Feeding Operation
CFO	Confined Feeding Operation
CFU	Colony Forming Units
CIT	Conservation Implementation Team (NRCS)
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CWI	Clean Water Indiana (ISDA)
DNR	Department of Natural Resources
D.O.	Dissolved Oxygen
EQIP	Environmental Quality Incentives Program (NRCS)
FOTG	Field Office Technical Guide (NRCS)
FSA	Farm Service Agency
HEL/HES	Highly Erodible Land, Highly Erodible Soil
HUAP	Heavy Use Area Protection
HUC	Hydrologic Unit Code
IDEM	Indiana Department of Environmental Management
ISDA	Indiana State Department of Agriculture
EPA	Environmental Protection Agency
LARE	Lake and River Enhancement (DNR)
LUST	Leaking Underground Storage Tank
MRBI	Mississippi River Basin Initiative
NRCS	Natural Resources Conservation Service
NPDES	National Pollutant Discharge Elimination System
PTI	Pollution Tolerance Index
QAPP	Quality Assurance Project Plan
QHEI	Qualitative Habitat Evaluation Index
SOP	Standard Operating Procedure
SWCD	Soil and Water Conservation District

TDS	Total Dissolved Solids
TNC	The Nature Conservancy
TTK	Turtle Creek, Turman Creek, Kelley Bayou (watersheds)
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WASCOB	Water And Sediment Control Basin
WRP	Wetlands Reserve Program
WWTP	Wastewater Treatment Plant

Appendix B: DNR Endangered Species Lists (Sullivan/Vigo)

Indiana County Endangered, Threatened and Rare Species List

County: Sullivan

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Cyprogenia stegaria	Eastern Fanshell Pearlymussel	LE	SE	G1Q	S1
Epioblasma propinqua	Tennessee Riffleshell		SX	GX	SX
Epioblasma torulosa torulosa	Tubercled Blossom	LE	SE	G2TX	SX
Epioblasma triquetra	Snuffbox	LE	SE	G3	S1
Fusconaia subrotunda	Longsolid		SE	G3	SX
Lampsilis ovata	Pocketbook			G5	S2
Obovaria retusa	Ring Pink	LE	SX	G1	SX
Pleurobema clava	Clubshell	LE	SE	G2	S1
Pleurobema cordatum	Ohio Pigtoe		SSC	G4	S2
Pleurobema plenum	Rough Pigtoe	LE	SE	G1	S1
Pleurobema rubrum	Pyramid Pigtoe		SE	G2G3	SX
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Quadrula cylindrica cylindrica	Rabbitsfoot	C	SE	G3G4T3	S1
Insect: Odonata (Dragonflies & Damselflies)					
Enallagma divagans	Turquoise Bluet		SR	G5	S3
Fish					
Etheostoma squamiceps	Spottail Darter			G4G5	S2S3
Amphibian					
Acris crepitans blanchardi	Northern Cricket Frog		SSC	G5	S4
Rana areolata circulosa	Northern Crawfish Frog		SE	G4T4	S2
Scaphiopus holbrookii	Eastern Spadefoot			G5	S2
Reptile					
Emydoidea blandingii	Blanding's Turtle		SE	G4	S2
Sistrurus catenatus catenatus	Eastern Massasauga	C	SE	G3G4T3T4Q	S2
Terrapene carolina carolina	Eastern Box Turtle		SSC	G5T5	S3
Bird					
Ammodramus henslowii	Henslow's Sparrow		SE	G4	S3B
Ardea herodias	Great Blue Heron			G5	S4B
Asio flammeus	Short-eared Owl		SE	G5	S2
Botaurus lentiginosus	American Bittern		SE	G4	S2B
Circus cyaneus	Northern Harrier		SE	G5	S2
Haliaeetus leucocephalus	Bald Eagle	LT,PDL	SSC	G5	S2
Ixobrychus exilis	Least Bittern		SE	G5	S3B
Lanius ludovicianus	Loggerhead Shrike	No Status	SE	G4	S3B
Nyctanassa violacea	Yellow-crowned Night-heron		SE	G5	S2B
Pandion haliaetus	Osprey		SE	G5	S1B
Rallus elegans	King Rail		SE	G4	S1B
Rallus limicola	Virginia Rail		SE	G5	S3B
Tyto alba	Barn Owl		SE	G5	S2

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GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank
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Indiana County Endangered, Threatened and Rare Species List

County: Sullivan

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mammal					
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Nycticeius humeralis	Evening Bat		SE	G5	S1
Taxidea taxus	American Badger		SSC	G5	S2
Vascular Plant					
Armoracia aquatica	Lake Cress		SE	G4?	S1
Carex gravida	Heavy Sedge		SE	G5	S1
Carex sparganioides var. cephaloidea	Thinleaf Sedge		SE	G5	S1
Chelone obliqua var. speciosa	Rose Turtlehead		WL	G4T3	S3
Chrysopsis villosa	Hairy Golden-aster		ST	G5	S2
Juncus secundus	Secund Rush		SE	G5?	S1
Lemna minima	Least Duckweed		SE	GNR	S1
Orobanche riparia	Bottomland Broomrape		SE	G5	S2
Potamogeton pulcher	Spotted Pondweed		SE	G5	S1
Silene regia	Royal Catchfly		ST	G3	S2
Sparganium androcladum	Branching Bur-reed		ST	G4G5	S2
Strophostyles leiosperma	Slick-seed Wild-bean		ST	G5	S2
High Quality Natural Community					
Barrens - sand	Sand Barrens		SG	G3	S2
Forest - floodplain wet-mesic	Wet-mesic Floodplain Forest		SG	G3?	S3

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Indiana County Endangered, Threatened and Rare Species List

County: Vigo

Species Name	Common Name	FED	STATE	GRANK	SRANK
Mollusk: Bivalvia (Mussels)					
Cyprogenia stegaria	Eastern Fanshell Pearlymussel	LE	SE	G1Q	S1
Epioblasma flexuosa	Leafshell		SX	GX	SX
Epioblasma propinqua	Tennessee Riffleshell		SX	GX	SX
Epioblasma sampsonii	Wabash Riffleshell		SX	GX	SX
Epioblasma torulosa rangiana	Northern Riffleshell	LE	SE	G2T2	SX
Epioblasma torulosa torulosa	Tubercled Blossom	LE	SE	G2TX	SX
Fusconaia subrotunda	Longsolid		SE	G3	SX
Lampsilis abrupta	Pink Mucket	LE	SE	G2	SX
Lampsilis ovata	Pocketbook			G5	S2
Leptodea leptodon	Scaleshell	LE	SX	G1G2	SX
Ligumia recta	Black Sandshell			G5	S2
Obovaria retusa	Ring Pink	LE	SX	G1	SX
Obovaria subrotunda	Round Hickorynut		SSC	G4	S1
Plethobasus cicatricosus	White Wartyback	LE	SE	G1	SX
Plethobasus cyphyus	Sheepnose	LE	SE	G3	S1
Pleurobema clava	Clubshell	LE	SE	G2	S1
Pleurobema cordatum	Ohio Pigtoe		SSC	G4	S2
Pleurobema plenum	Rough Pigtoe	LE	SE	G1	S1
Pleurobema rubrum	Pyramid Pigtoe		SE	G2G3	SX
Ptychobranchus fasciolaris	Kidneyshell		SSC	G4G5	S2
Quadrula cylindrica cylindrica	Rabbitsfoot	C	SE	G3G4T3	S1
Fish					
Acipenser fulvescens	Lake Sturgeon		SE	G3G4	S1
Ichthyomyzon bdellium	Ohio Lamprey			G3G4	S2
Moxostoma valenciennesi	Greater Redhorse		SE	G4	S2
Amphibian					
Acris crepitans blanchardi	Northern Cricket Frog		SSC	G5	S4
Cryptobranchus alleganiensis alleganiensis	Eastern Hellbender		SE	G3G4T3T4	S1
Rana areolata circulosa	Northern Crawfish Frog		SE	G4T4	S2
Rana pipiens	Northern Leopard Frog		SSC	G5	S2
Scaphiopus holbrookii	Eastern Spadefoot			G5	S2
Reptile					
Clonophis kirtlandii	Kirtland's Snake		SE	G2	S2
Bird					
Accipiter striatus	Sharp-shinned Hawk	No Status	SSC	G5	S2B
Ammodramus henslowii	Henslow's Sparrow		SE	G4	S3B
Ardea herodias	Great Blue Heron			G5	S4B
Bartramia longicauda	Upland Sandpiper		SE	G5	S3B
Botaurus lentiginosus	American Bittern		SE	G4	S2B

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Indiana County Endangered, Threatened and Rare Species List

County: Vigo

Species Name	Common Name	FED	STATE	GRANK	SRANK
Circus cyaneus	Northern Harrier		SE	G5	S2
Cistothorus palustris	Marsh Wren		SE	G5	S3B
Falco peregrinus	Peregrine Falcon	No Status	SE	G4	S2B
Haliaeetus leucocephalus	Bald Eagle	LT,PDL	SSC	G5	S2
Ixobrychus exilis	Least Bittern		SE	G5	S3B
Lanius ludovicianus	Loggerhead Shrike	No Status	SE	G4	S3B
Lophodytes cucullatus	Hooded Merganser			G5	S2S3B
Nyctanassa violacea	Yellow-crowned Night-heron		SE	G5	S2B
Tyto alba	Barn Owl		SE	G5	S2
Mammal					
Lasiurus borealis	Eastern Red Bat		SSC	G5	S4
Mustela nivalis	Least Weasel		SSC	G5	S2?
Myotis lucifugus	Little Brown Bat		SSC	G5	S4
Myotis septentrionalis	Northern Myotis		SSC	G4	S3
Myotis sodalis	Indiana Bat or Social Myotis	LE	SE	G2	S1
Nycticeius humeralis	Evening Bat		SE	G5	S1
Pipistrellus subflavus	Eastern Pipistrelle		SSC	G5	S4
Taxidea taxus	American Badger		SSC	G5	S2
Vascular Plant					
Anemone caroliniana	Carolina Anemone		SX	G5	SX
Armoracia aquatica	Lake Cress		SE	G4?	S1
Carex conoidea	Prairie Gray Sedge		ST	G5	S1
Carex gravida	Heavy Sedge		SE	G5	S1
Chelone obliqua var. speciosa	Rose Turtlehead		WL	G4T3	S3
Cuscuta cuspidata	Cusp Dodder		SE	G5	S1
Didiplis diandra	Water-purslane		SE	G5	S2
Gaura filipes	Slender-stalked Gaura		ST	G5	S2
Hymenopappus scabiosaeus	Carolina Woollywhite		SE	G4G5	S1
Liatris pycnostachya	Cattail Gay-feather		ST	G5	S2
Lithospermum incisum	Narrow-leaved Puccoon		SE	G5	S1
Onosmodium hispidissimum	Shaggy False-gromwell		SE	G4	S1
Sanguisorba canadensis	Canada Burnet		SE	G5	S1
Silene regia	Royal Catchfly		ST	G3	S2
Trautvetteria caroliniensis	Carolina Tassel-rue		SX	G5	SX
Trifolium reflexum var. glabrum	Buffalo Clover		SE	G5T2T4Q	S1
High Quality Natural Community					
Barrens - sand	Sand Barrens		SG	G3	S2
Forest - floodplain wet	Wet Floodplain Forest		SG	G3?	S3
Forest - upland mesic	Mesic Upland Forest		SG	G3?	S3
Wetland - marsh	Marsh		SG	GU	S4

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Indiana County Endangered, Threatened and Rare Species List

County: Vigo

Species Name	Common Name	FED	STATE	GRANK	SRANK
Wetland - swamp forest	Forested Swamp		SG	G2?	S2
Wetland - swamp shrub	Shrub Swamp		SG	GU	S2
Other Significant Feature					
Freshwater Mussel Concentration Area	Mussel Bed		SG	G3	SNR

Fed: LE = Endangered; LT = Threatened; C = candidate; PDL = proposed for delisting

State: SE = state endangered; ST = state threatened; SR = state rare; SSC = state species of special concern; SX = state extirpated; SG = state significant; WL = watch list

GRANK: Global Heritage Rank: G1 = critically imperiled globally; G2 = imperiled globally; G3 = rare or uncommon globally; G4 = widespread and abundant globally but with long term concerns; G5 = widespread and abundant globally; G? = unranked; GX = extinct; Q = uncertain rank; T = taxonomic subunit rank

SRANK: State Heritage Rank: S1 = critically imperiled in state; S2 = imperiled in state; S3 = rare or uncommon in state; G4 = widespread and abundant in state but with long term concern; SG = state significant; SH = historical in state; SX = state extirpated; B = breeding status; S? = unranked; SNR = unranked; SNA = nonbreeding status unranked

Appendix C: TTK Monitoring QAPP

(Attached as a Separate File)

Appendix D: TTK Monitoring Data (Complete)

(Attached as a Separate File)

Appendix E: QHEI Score Sheet

OWQ Biological QHEI (Qualitative Habitat Evaluation Index)

IDEM

Sample #	bioSample #	Stream Name	Location

Surveyor	Sample Date	County	Macro Sample Type	☐ Habitat Complete	**QHEI Score:**

1] *SUBSTRATE* Check ONLY Two predominant substrate TYPE BOXES; estimate % and check every type present

BEST TYPES — PREDOMINANT P/G R/R — PRESENT P/G R/R — TOTAL %

- ☐☐ BLDR/SLABS [10] ☐☐ ____
- ☐☐ BOULDER [9] ☐☐ ____
- ☐☐ COBBLE [8] ☐☐ ____
- ☐☐ GRAVEL [7] ☐☐ ____
- ☐☐ SAND [6] ☐☐ ____
- ☐☐ BEDROCK [5] ☐☐ ____

OTHER TYPES — PREDOMINANT P/G R/R — PRESENT P/G R/R — TOTAL %

- ☐☐ HARDPAN [4] ☐☐ ____
- ☐☐ DETRITUS [3] ☐☐ ____
- ☐☐ MUCK [2] ☐☐ ____
- ☐☐ SILT [2] ☐☐ ____
- ☐☐ ARTIFICIAL [0] ☐☐ ____

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

Check ONE (Or 2 & average)

ORIGIN

- ☐ LIMESTONE [1]
- ☐ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTRINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate ☐ Maximum 20

Comments

2] *INSTREAM COVER* Indicate presence 0 to 3 and estimate percent: **0**–Absent; **1**–Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed root wad in deep/fast water, or deep, well-defined, functional pools.)

% Amount
- ____ UNDERCUT BANKS [1]
- ____ OVERHANGING VEGETATION [1]
- ____ SHALLOWS (IN SLOW WATER) [1]
- ____ ROOTMATS [1]

% Amount
- ____ POOLS > 70cm [2]
- ____ ROOTWADS [1]
- ____ BOULDERS [1]

% Amount
- ____ OXBOWS, BACKWATERS [1]
- ____ AQUATIC MACROPHYTES [1]
- ____ LOGS OR WOODY DEBRIS [1]

AMOUNT

Check ONE (Or 2 & average)
- ☐ EXTENSIVE > 75% [11]
- ☐ MODERATE 25 - 75% [7]
- ☐ SPARSE 5 - < 25% [3]
- ☐ NEARLY ABSENT < 5% [1]

Cover ☐ Maximum 20

Comments

3] *CHANNEL MORPHOLOGY* Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☐ MODERATE [3]
- ☐ LOW [2]
- ☐ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☐ GOOD [5]
- ☐ FAIR [3]
- ☐ POOR [1]

CHANNELIZATION
- ☐ NONE [6]
- ☐ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☐ HIGH [3]
- ☐ MODERATE [2]
- ☐ LOW [1]

Channel ☐ Maximum 20

Comments

4] *BANK EROSION AND RIPARIAN ZONE* Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☐☐ NONE/LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY/SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☐ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☐ VERY NARROW [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☐ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]

(L R)
- ☐☐ CONSERVATION TILLAGE [1]
- ☐☐ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING /CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Riparian ☐ Maximum 10

Comments

5] *POOL/GLIDE AND RIFFLE/RUN QUALITY*

MAXIMUM DEPTH

Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7 - < 1m [4]
- ☐ 0.4 - < 0.7m [2]
- ☐ 0.2 - < 0.4m [1]
- ☐ < 0.2m [0] [metric = 0]

CHANNEL WIDTH

Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY

Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☐ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach – pools and riffles.

Recreation Potential (Circle one and comment on back)
- ☐ Primary Contact
- ☐ Secondary Contact

Pool/ Current ☐ Maximum 12

Comments

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

Check ONE (Or 2 & average) ☐ NO RIFFLE [metric = 0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5 - 10cm [1]
- ☐ BEST AREAS < 5 cm [metric = 0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE/RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE/RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Riffle/ Run ☐ Maximum 8

Comments

6] *GRADIENT* (ft/mi)

DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2–4]
- ☐ MODERATE [6 - 10]
- ☐ HIGH - VERY HIGH [10 - 6]

%POOL: ☐ %GLIDE: ☐

%RUN: ☐ %RIFFLE: ☐

Gradient ☐ Maximum 10

IDEM 11/15/12

OWQ Biological QHEI (Qualitative Habitat Evaluation Index)

COMMENT ______________________________

A-CANOPY
- ☐ >85% - Open
- ☐ 55% - <85%
- ☐ 30% - <55%
- ☐ 10% - <30%
- ☐ <10% - Closed

B-AESTHETICS
- ☐ Nuisance algae
- ☐ Invasive macrophytes
- ☐ Excess turbidity
- ☐ Discoloration
- ☐ Foam/Scum
- ☐ Oil sheen
- ☐ Trash/Litter
- ☐ Nuisance odor
- ☐ Sludge deposits
- ☐ CSOs/SSOs/Outfalls

C-RECREATION

	Area	Depth
Pool:	☐ > 100 ft^2	☐ > 3 ft

D-MAINTENANCE
- ☐ Public ☐ Private
- ☐ Active ☐ Historic
- Succession: ☐ Young ☐ Old
- ☐ Spray ☐ Islands ☐ Scoured
- Snag: ☐ Removed ☐ Modified
- Leveed: ☐ One sided ☐ Both banks
- ☐ Relocated ☐ Cutoffs
- Bedload: ☐ Moving ☐ Stable
- ☐ Armoured ☐ Slumps
- ☐ Impounded ☐ Desiccated
- ☐ Flood control ☐ Drainage

E-ISSUES
- ☐ WWTP ☐ CSO ☐ NPDES
- ☐ Industry ☐ Urban
- ☐ Hardened ☐ Dirt & Grime
- ☐ Contaminated ☐ Landfill
- BMPs: ☐ Construction ☐ Sediment
- ☐ Logging ☐ Irrigation ☐ Cooling
- Erosion: ☐ Bank ☐ Surface
- ☐ False bank ☐ Manure ☐ Lagoon
- ☐ Wash H_2O ☐ Tile ☐ H_2O Table
- Mine: ☐ Acid ☐ Quarry
- Flow: ☐ Natural ☐ Stagnant
- ☐ Wetland ☐ Park ☐ Golf
- ☐ Lawn ☐ Home
- ☐ Atmospheric deposition
- ☐ Agriculture ☐ Livestock

Looking upstream (> 10m, 3 readings; ≤ 10m, 1 reading in middle); **Round to the nearest whole percent**

	Right	Middle	Left	Total Average
% open	___ %	___ %	___ %	___ %
	X	X	X	

Stream Drawing:

Appendix F: MRBI Field Sheet

BIOLOGICAL MONITORING DATA SHEET

Date ___/___/___ (MM DD YY)

Begin Time ____:____ (am/pm) # Adults ______________

End Time ____:____ (am/pm) # Students ______________

Certified Monitors' Names ______________________________ Volunteer ID ______________

Organization Name ____

Watershed Name ______________________________ Watershed # _ _ _ _ _ _ _ _

Stream/River Name ______________________________ Site ID ______________

(Please do not abbreviate.) (Above ID numbers are required.)

Check Methods Used

- ☐ Kick Seine Net (3 times)
- ☐ D-Net (20 jabs or scoops)

Check Habitats Sampled

- ☐ Riffles
- ☐ Undercut Banks
- ☐ Sediment
- ☐ Leaf Packs
- ☐ Snags/Vegetation
- ☐ Other

POLLUTION TOLERANCE INDEX (PTI)

PT GROUP 1 *Intolerant*		PT GROUP 2 *Moderately Intolerant*		PT GROUP 3 *Fairly Tolerant*		PT GROUP 4 *Very Tolerant*	
Stonefly Nymph	____	Damselfly Nymph	____	Midges	____	Left-Handed Snail	____
Mayfly Nymph	____	Dragonfly Nymph	____	Black Fly Larvae	____	Aquatic Worms	____
Caddis Fly Larvae	____	Sowbug	____	Planaria	____	Blood Midge	____
Dobsonfly Larvae	____	Scud	____	Leech	____	Rat-tailed Maggot	____
Riffle Beetle	____	Crane Fly Larvae	____				
Water Penny	____	Clams/Mussels	____				
Right-Handed Snail	____	Crayfish	____				
# Of TAXA	____	**# Of TAXA**	____	**# Of TAXA**	____	**# Of TAXA**	____
Weighting Factors: **(x 4)**	____	**(x 3)**	____	**(x 2)**	____	**(x 1)**	____

23 or More	**Excellent**
17 - 22	**Good**
11 - 16	**Fair**
10 or Less	**Poor**

POLLUTION TOLERANCE INDEX RATING
(Add the final index values for each group.)

Other Biological Indicators

- ☐ Native Mussels
- ☐ Zebra Mussels
- ☐ Rusty Crayfish
- ☐ Aquatic Plants
- ______ % Algae Cover
- ______ Diversity Index

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Appendix G:

Merom Generating Station Land Management Recommendations

(Attached as a Separate File)

Appendix H:

Critical Area Ranking Method Calculations

Ranking Method 1 - Percent Reduction Needed

E.coli		
Buzzard 1	5.30%	
Buzzard 2	2.10%	
Total	7.40%	÷ 2 = 3.7%
Dodds 1	42.90%	
Dodds 2	46.40%	
Dodds 3	21.50%	
Total	110.80%	÷ 3 = 36.93 %
Kelley 1	-47.70%	
Kelley 2	-6.50%	
~~Kelley 3~~	n/a	
Total	-54.20%	÷ 2 = -27.1%
LT1	15.80%	
LT2	19.60%	
LT3	57.10%	
LT4	61.10%	
LT5	32.60%	
Total	186.20%	÷ 5 = 37.24%
Tbird 1	19.30%	
Tbird 2	55.90%	
Tbird 3	54.60%	
Tbird 4	48.00%	
Tbird 5	68.60%	
Total	246.40%	÷ 5 = 49.28%
Turtle 1	-20.80%	
Turtle 2	31.60%	
Turtle 3	-40.10%	
Turtle 4	0.00%	
Turtle 5	53.50%	
Turtle 6	41.00%	
Turtle 7	58.50%	
Turtle 8	62.00%	
Turtle 9	-317.60%	
Total	-131.90%	÷ 9 = -14.65%
West 1	45.30%	
West 2	28.50%	
West 3	62.90%	
Total	136.70%	÷ 3 = 45.5%

TSS		
Buzzard 1	64.30%	
Buzzard 2	75.60%	
Total	139.90%	69.95%
Dodds 1	81.40%	
Dodds 2	83.90%	
Dodds 3	79.60%	
Total	244.90%	÷ 3 = 81.63 %
Kelley 1	53.10%	
Kelley 2	-11.10%	
~~Kelley 3~~	n/a	
Total	43.00%	÷ 2 = 14%
LT1	90.10%	
LT2	93.20%	
LT3	90.40%	
LT4	79.80%	
LT5	78.70%	
Total	432.40%	÷ 5 = 86.48%
Tbird 1	35.50%	
Tbird 2	84.70%	
Tbird 3	86.80%	
Tbird 4	83.90%	
Tbird 5	93.60%	
Total	384.50%	÷ 5 = 76.9%
Turtle 1	-23.30%	
Turtle 2	18.70%	
Turtle 3	-63.40%	
Turtle 4	0.00%	
Turtle 5	-3.50%	
Turtle 6	13.90%	
Turtle 7	46.60%	
Turtle 8	60.00%	
Turtle 9	40.30%	
Total	89.30%	÷ 9 = 9.92%
West 1	87.60%	
West 2	93.50%	
West 3	92.20%	
Total	273.30%	÷ 3 = 91.1%

Total P		
Buzzard 1	70.80%	
Buzzard 2	74.10%	
Total	144.90%	÷ 2 = 72.45%
Dodds 1	70.80%	
Dodds 2	75.90%	
Dodds 3	73.10%	
Total	219.80%	÷ 3 = 73.26 %
Kelley 1	63.20%	
Kelley 2	66.70%	
~~Kelley 3~~	n/a	
Total	129.90%	÷ 2 = 43.3%
LT1	58.80%	
LT2	82.50%	
LT3	73.10%	
LT4	75.00%	
LT5	53.30%	
Total	342.70%	÷ 5 = 68.54%
Tbird 1	0.00%	
Tbird 2	72.00%	
Tbird 3	79.40%	
Tbird 4	69.60%	
Tbird 5	88.70%	
Total	309.70%	÷ 5 = 61.94%
Turtle 1	22.20%	
Turtle 2	58.80%	
Turtle 3	12.50%	
Turtle 4	0.00%	
Turtle 5	30.00%	
Turtle 6	68.20%	
Turtle 7	58.80%	
Turtle 8	63.20%	
Turtle 9	46.20%	
Total	359.90%	÷ 9 = 39.98%
West 1	78.80%	
West 2	83.70%	
West 3	83.30%	
Total	245.80%	÷ 3 = 81.9%

Nitrate/Nitrite		
Buzzard 1	78.70%	
Buzzard 2	69.30%	
Total	148.00%	÷ 2 = 74%
Dodds 1	55.90%	
Dodds 2	29.60%	
Dodds 3	38.30%	
Total	123.80%	÷ 3 = 41.26%
Kelley 1	-12.40%	
Kelley 2	25.40%	
~~Kelley 3~~	n/a	
Total	13.00%	÷ 2 = 6.5%
LT1	-5.30%	
LT2	-44.90%	
LT3	61.70%	
LT4	44.80%	
LT5	10.70%	
Total	67.00%	÷ 5 = 13.4%
Tbird 1	-376.20%	
Tbird 2	-122.20%	
Tbird 3	-16.30%	
Tbird 4	45.40%	
Tbird 5	-37.00%	
Total	-506.30%	÷ 5 = -101.26%
Turtle 1	18.00%	
Turtle 2	-212.50%	
Turtle 3	-300.00%	
Turtle 4	0.00%	
Turtle 5	-78.60%	
Turtle 6	-23.50%	
Turtle 7	-19.00%	
Turtle 8	58.80%	
Turtle 9	-614.30%	
Total	-1171.10%	÷ 9 = -130.12%
West 1	27.50%	
West 2	35.50%	
West 3	67.10%	
Total	130.00%	÷ 3 =43.36%

Ranking	Points	Total
1st = Tbird	7 + 1	8
2nd = West	6 + 1	7
3rd = LT	5 + 1	6
4th = Dodds	4 + 1	5
5th = Buzzard	3 + 1	4
6th = Turtle	2 + 1	3
7th = Kelley	1 + 1	2

Ranking	Points	Total
1st = West	7 + 3	10
2nd = LT	6 + 3	9
3rd = Dodds	5 + 3	8
4th = Tbird	4 + 3	7
5th = Buzzard	3 + 3	6
6th = Kelley	2 + 3	5
7th = Turtle	1 + 3	4

Ranking	Points	Total
1st = West	7 + 2	9
2nd = Dodds	6 + 2	8
3rd = Buzzard	5 + 2	7
4th = LT	4 + 2	6
5th = Tbird	3 + 2	5
6th = Kelley	2 + 2	4
7th = Turtle	1 + 2	3

Ranking	Points	Total
1st = Buzzard	7 + 2	9
2nd = West	6 + 2	8
3rd = Dodds	5 + 2	7
4th = LT	4 + 2	6
5th = Kelley	3 + 2	5
6th = Tbird	2 + 2	4
7th = Turtle	1 + 2	3

Average Total P and Nitrate/Nitrite Scores

Overall Nutrient Score

1st = West (8.5 pts)
2nd = Buzzard (8 pts)
3rd = Dodds (7.5 pts)
4th = LT (6 pts)
5th = Kelley (4.5 pts.)
5th = Tbird (4.5 pts)
7th = Turtle (3 pts)

Key	
1st = 7 pts	Sediment = 3 pts
2nd = 6 pts	Nutrients = 2 pts
3rd = 5 pts	E.coli = 1 pt.
4th = 4 pts	
5th = 3 pts	
6th = 2 pts	
7th = 1 pt.	

Ranking Method 1 (Percent Reduction Needed) - Overall Scores for Each Subwatershed

1st = West (7 + 10 + 8.5 = 25.5)
2nd = LT (6 + 9 + 6 = 21)
3rd = Dodds (5 + 8 + 7.5 = 20.5)
4th = Tbird (8 + 7 + 4.5 = 19.5)
5th = Buzzard (4 + 6 + 8 = 18)
6th = Kelley (2 + 5 + 4.5 = 11.5)
7th = Turtle (3 + 4 + 3 = 10)

Ranking Method 2 - Load Reduction Needed

E.coli		
Buzzard 1	5.08E+11	
Buzzard 2	4.24E+11	
Total	9.32E+09	÷ 2 = 4.66E+11
Dodds 1	2.85E+13	
Dodds 2	2.08E+13	
Dodds 3	4.03E+12	
Total	5.33E+13	÷ 3 = 1.77E+13
Kelley 1	-1.78E+12	
Kelley 2	-4.39E+11	
~~Kelley 3~~	n/a	
Total	-2.22E+12	÷ 2 = -1.1095E+12
LT1	2.47E+12	
LT2	1.38E+13	
LT3	1.65E+13	
LT4	6.16E+13	
LT5	4.37E+12	
Total	9.87E+13	÷ 5 = 1.97748E+13
Tbird 1	1.61E+12	
Tbird 2	1.22E+13	
Tbird 3	2.26E+13	
Tbird 4	5.39E+12	
Tbird 5	6.27E+13	
Total	1.05E+14	÷ 5 = 2.09E+13
Turtle 1	-4.98E+11	
Turtle 2	1.02E+12	
Turtle 3	-1.40E+12	
Turtle 4	0.00E+00	
Turtle 5	4.61E+11	
Turtle 6	8.93E+12	
Turtle 7	5.09E+12	
Turtle 8	6.65E+12	
Turtle 9	-7.30E+13	
Total	-5.27E+13	÷ 9 = -5.8607E+12
West 1	1.13E+13	
West 2	2.06E+13	
West 3	3.94E+13	
Total	7.13E+13	÷ 3 = 2.376E+13

TSS	(t/yr)	
Buzzard 1	76.80	
Buzzard 2	284.34	
Total	361.14	÷ 2 = 180.57
Dodds 1	779.23	
Dodds 2	651.47	
Dodds 3	268.45	
Total	1,699.15	÷ 3 = 566.38
Kelley 1	29.29	
Kelley 2	-3.39	
~~Kelley 3~~	n/a	
Total	25.90	÷ 2 = 12.95
LT1	562.95	
LT2	3,650.75	
LT3	549.11	
LT4	726.84	
LT5	156.42	
Total	5,646.07	÷ 5 = 1,129.2
Tbird 1	17.34	
Tbird 2	250.44	
Tbird 3	577.57	
Tbird 4	143.21	
Tbird 5	1,976.11	
Total	2,964.70	÷ 5 = 592.93
Turtle 1	-2.57	
Turtle 2	2.39	
Turtle 3	-8.89	
Turtle 4	0.00	
Turtle 5	-0.06	
Turtle 6	9.70	
Turtle 7	14.78	
Turtle 8	28.64	
Turtle 9	303.38	
Total	347.49	÷ 9 = 38.61
West 1	448.70	
West 2	3,495.77	
West 3	1,282.42	
Total	5,226.89	÷ 3 = 1,742.296

Total P	(t/yr)	
Buzzard 1	0.72	
Buzzard 2	1.84	
Total	2.56	÷ 2 = 1.28
Dodds 1	3.03	
Dodds 2	2.48	
Dodds 3	1.31	
Total	6.82	÷ 3 = 2.27
Kelley 1	0.31	
Kelley 2	0.47	
~~Kelley 3~~	n/a	
Total	0.78	÷ 2 = 0.39
LT1	0.62	
LT2	8.73	
LT3	1.10	
LT4	3.86	
LT5	0.34	
Total	14.65	÷ 5 = 2.93
Tbird 1	0.00	
Tbird 2	0.81	
Tbird 3	2.38	
Tbird 4	0.44	
Tbird 5	7.40	
Total	11.03	÷ 5 = 2.206
Turtle 1	0.03	
Turtle 2	0.10	
Turtle 3	0.02	
Turtle 4	0.00	
Turtle 5	0.01	
Turtle 6	0.90	
Turtle 7	0.17	
Turtle 8	0.23	
Turtle 9	2.70	
Total	4.16	÷ 9 = 0.46
West 1	1.66	
West 2	8.71	
West 3	3.82	
Total	14.19	÷ 3 = 4.73

Nitrate/Nitrite	(t/yr)	
Buzzard 1	15.73	
Buzzard 2	20.77	
Total	36.50	÷ 2 = 18.25
Dodds 1	22.62	
Dodds 2	4.73	
Dodds 3	4.27	
Total	316.20	÷ 3 = 10.54
Kelley 1	-0.29	
Kelley 2	1.15	
~~Kelley 3~~	n/a	
Total	0.86	÷ 2 = 0.43
LT1	-0.31	
LT2	-8.20	
LT3	9.36	
LT4	14.89	
LT5	0.51	
Total	16.25	÷ 5 = 3.25
Tbird 1	-2.49	
Tbird 2	2.48	
Tbird 3	-1.23	
Tbird 4	2.27	
Tbird 5	-3.63	
Total	-2.60	÷ 5 = -.52
Turtle 1	0.30	
Turtle 2	-0.71	
Turtle 3	-1.72	
Turtle 4	0.00	
Turtle 5	-0.08	
Turtle 6	-1.15	
Turtle 7	-0.27	
Turtle 8	2.73	
Turtle 9	-38.71	
Total	-39.61	÷ 9 = -4.40
West 1	2.42	
West 2	13.31	
West 3	22.27	
Total	38.00	÷ 3 =12.6

Ranking	Points	Total
1st = West	7 + 1	8
2nd = Tbird	6 + 1	7
3rd = LT	5 + 1	6
4th = Dodds	4 + 1	5
5th = Buzz	3 + 1	4
6th = Kelley	2 + 1	3
7th = Turtle	1 + 1	2

Ranking	Points	Total
1st = West	7 + 3	10
2nd = LT	6 + 3	9
3rd = Tbird	5 + 3	8
4th = Dodds	4 + 3	7
5th = Buzz	3 + 3	6
6th = Turtle	2 + 3	5
7th = Kelley	1 + 3	4

Ranking	Points	Total
1st = West	7 + 2	9
2nd = LT	6 + 2	8
3rd = Dodds	5 + 2	7
4th = Tbird	4 + 2	6
5th = Buzz	3 + 2	5
6th = Turtle	2 + 2	4
7th = Kelley	1 + 2	3

Ranking	Points	Total
1st = Buzz	7 + 2	9
2nd = West	6 + 2	8
3rd = Dodds	5 + 2	7
4th = LT	4 + 2	6
5th = Kelley	3 + 2	5
6th = Tbird	2 + 2	4
7th = Turtle	1 + 2	3

Average Total P and Nitrate/Nitrite Scores

Overall Nutrient Score

1st = West (8.5 pts)
2nd = Buzzard (7 pts)
2nd = Dodds (7 pts)
2nd = LT (7 pts)
5th = Tbird (5 pts.)
6th = Kelley (4 pts)
7th = Turtle (3.5 pts)

Key	
1st = 7 pts	Sediment = 3 pts
2nd = 6 pts	Nutrients = 2 pts
3rd = 5 pts	E.coli = 1 pt.
4th = 4 pts	
5th = 3 pts	
6th = 2 pts	
7th = 1 pt.	

Ranking Method 2 (Load Reduction Needed) - Overall Scores for Each Subwatershed

1st = West (8 + 10 + 8.5 = 26.5)
2nd = LT (6 + 9 + 7 = 22)
3rd = Tbird (7 + 8 + 5 = 20)
4th = Dodds (5 + 7 + 7 = 19)
5th = Buzzard (4 + 6 + 8.5 = 18.5)
6th = Kelley (3 + 4 + 4 = 11)
7th = Turtle (2 + 5 + 3.5 = 10.5)

Ranking Method 3 - Number of Monthly Water Quality Target Fails

E.coli		
Buzzard 1	3	
Buzzard 2	4	
Total	4	÷ 2 = 2
Dodds 1	7	
Dodds 2	8	
Dodds 3	4	
Total	19	÷ 3 = 6.33
Kelley 1	2	
Kelley 2	4	
~~Kelley 3~~	n/a	
Total	6	÷ 2 =3
LT1	5	
LT2	5	
LT3	7	
LT4	8	
LT5	6	
Total	31	÷ 5 = 6.2
Tbird 1	3	
Tbird 2	7	
Tbird 3	10	
Tbird 4	5	
Tbird 5	8	
Total	33	÷ 5 = 6.6
Turtle 1	5	
Turtle 2	4	
Turtle 3	3	
Turtle 4	5	
Turtle 5	6	
Turtle 6	7	
Turtle 7	7	
Turtle 8	7	
Turtle 9	1	
Total	45	÷ 9 = 5
West 1	7	
West 2	8	
West 3	8	
Total	23	÷ 3 = 7.6

TSS		
Buzzard 1	9	
Buzzard 2	10	
Total	19	÷ 2 = 9.5
Dodds 1	4	
Dodds 2	8	
Dodds 3	7	
Total	19	÷ 3 = 6.33
Kelley 1	5	
Kelley 2	3	
~~Kelley 3~~	n/a	
Total	14	÷ 2 = 7
LT1	5	
LT2	7	
LT3	7	
LT4	9	
LT5	5	
Total	33	÷ 5 = 6.6
Tbird 1	5	
Tbird 2	5	
Tbird 3	5	
Tbird 4	3	
Tbird 5	9	
Total	27	÷ 5 = 5.4
Turtle 1	2	
Turtle 2	4	
Turtle 3	3	
Turtle 4	8	
Turtle 5	5	
Turtle 6	4	
Turtle 7	7	
Turtle 8	4	
Turtle 9	11	
Total	48	÷ 9 = 5.33
West 1	4	
West 2	6	
West 3	5	
Total	15	÷ 3 = 5

Total P		
Buzzard 1	8	
Buzzard 2	10	
Total	18	÷ 2 = 9
Dodds 1	7	
Dodds 2	8	
Dodds 3	9	
Total	24	÷ 3 = 8
Kelley 1	9	
Kelley 2	7	
~~Kelley 3~~	n/a	
Total	16	÷ 2 = 8
LT1	6	
LT2	9	
LT3	9	
LT4	9	
LT5	6	
Total	39	÷ 5 = 7.8
Tbird 1	4	
Tbird 2	11	
Tbird 3	11	
Tbird 4	5	
Tbird 5	9	
Total	40	÷ 5 = 8
Turtle 1	6	
Turtle 2	2	
Turtle 3	4	
Turtle 4	7	
Turtle 5	5	
Turtle 6	8	
Turtle 7	9	
Turtle 8	7	
Turtle 9	10	
Total	58	÷ 9 = 6.4
West 1	10	
West 2	9	
West 3	8	
Total	27	÷ 3 = 9

Nitrate/Nitrite		
Buzzard 1	11	
Buzzard 2	10	
Total	21	÷ 2 = 10.5
Dodds 1	8	
Dodds 2	6	
Dodds 3	6	
Total	20	÷ 3 = 6.6
Kelley 1	4	
Kelley 2	4	
~~Kelley 3~~	n/a	
Total	8	÷ 2 = 4
LT1	5	
LT2	2	
LT3	11	
LT4	8	
LT5	6	
Total	32	÷ 5 = 6.4
Tbird 1	1	
Tbird 2	2	
Tbird 3	3	
Tbird 4	6	
Tbird 5	4	
Total	16	÷ 5 = 3.2
Turtle 1	6	
Turtle 2	1	
Turtle 3	1	
Turtle 4	5	
Turtle 5	1	
Turtle 6	4	
Turtle 7	5	
Turtle 8	7	
Turtle 9	0	
Total	30	÷ 9 = 3.3
West 1	5	
West 2	7	
West 3	9	
Total	21	÷ 3 =7

Ranking	Points	Total	Ranking	Points	Total	Ranking	Points	Total	Ranking	Points	Total
1st = West	7 + 1	8	1st = Buzz	7 + 3	10	1st = Buzz	7 + 2	9	1st = Buzz	7 + 2	9
2nd = Tbird	6 + 1	7	2nd = Kelley	6 + 3	9	1st = West	7 + 2	9	2nd = West	6 + 2	8
3rd = Dodds	5 + 1	6	3rd = LT	5 + 3	8	2nd = Tbird	6 + 2	8	3rd = Dodds	5 + 2	7
4th = LT	4 + 1	5	4th = Dodds	4 + 3	7	2nd = Dodds	6 + 2	8	4th = LT	4 + 2	6
5th = Turtle	3 + 1	4	5th = Tbird	3 + 3	6	2nd = Kelley	6 + 2	8	5th = Kelley	3 + 2	5
6th = Kelley	2 + 1	3	6th = Turtle	2 + 3	5	6th = LT	2 + 2	4	6th = Turtle	2 + 2	4
7th = Buzz	1 + 1	2	7th = West	1 + 3	4	7th = Turtle	1 + 2	3	7th = Tbird	1 + 2	3

Key	
1st = 7 pts	Sediment = 3 pts
2nd = 6 pts	Nutrients = 2 pts
3rd = 5 pts	E.coli = 1 pt.
4th = 4 pts	
5th = 3 pts	
6th = 2 pts	
7th = 1 pt.	

Average Total P and Nitrate/Nitrite Scores

Overall Nutrient Score

1st = Buzzard (9 pts)
2nd = West (8.5 pts)
3rd = Dodds (7.5 pts)
4th= Kelley (6.5 pts)
5th = Tbird (5.5 pts.)
6th = LT (5 pts)
7th = Turtle (3.5 pts)

Ranking Method 3 (Number of Monthly Water Quality Target Fails) - Overall Scores for Each Subwatershed

1st = Buzzard (2 + 10 + 9 = 21)
2nd = West (8 + 4 + 8.5 = 20.5)
2nd = Dodds (6 + 7 + 7.5 = 20.5)
4th = Kelley (3 + 9 + 6.5 = 18.5)
4th = Tbird (7 + 6 + 5.5 = 18.5)
6th = LT (5 + 8 + 5 = 18)
7th = Turtle (4 + 5 + 3.5 = 12.5)