VFC Index - Watershed (Plan)

Program: Watershed

IDEM Document Type: Plan

Document Date: 11/8/2017

Security Group: Public

Project Name: South Fork Blue River WMP

Plan Type: Watershed Management Plan

HUC Code: 05140104 Blue-Sinking

Sponsor: Washington County SWCD

Contract #: 5-180

County: Washington

Cross Reference ID: 80004247; 80004247

Comments: Harrison, Clark, Floyd, Scott

Additional WMP Information

Checklist: 2009 Checklist

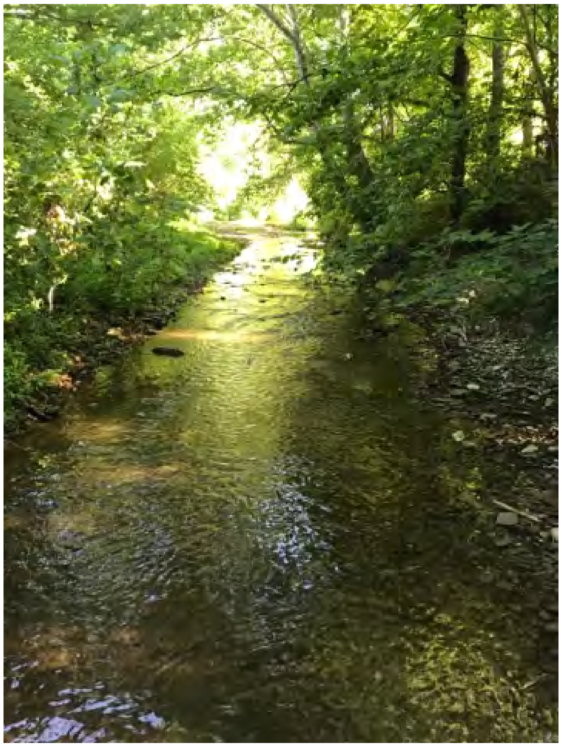
Grant type: 205j

Fiscal Year: 2014

IDEM Approval Date: 11/8/2017

EPA Approval Date: 11/8/2017

Project Manager: Kathleen Hagan



SOUTH FORK-BLUE RIVER WATERSHED MANAGEMENT PLAN

SOUTH FORK-BLUE RIVER WATERSHED PROJECT

A PROJECT OF THE WASHINGTON COUNTY SOIL AND WATER CONSERVATION DISTRICT

Hoehn, Jessica - NRCS, Salem, IN
801 Anson Street
Salem, IN 47167
(812)883-3704 ext. 3

June 29, 2017

Table of Contents

Index of Figures

Index of Tables

1.0 Introduction

A watershed is an area of land that drains into a specific point. This area can be as large as the area that drains into the Gulf of Mexico, or as small as the area that drains into a small farm pond. Each watershed is assigned a Hydrologic Unit Code (HUC), which is a set of unique digits specific to a watershed. As a watershed becomes smaller in acreage, the HUC becomes longer with additional digits. Indiana is divided into thirty-nine, 8-digit HUC watersheds. The 8-digit HUCs are then subdivided into 10-digit HUC watersheds. The South Fork-Blue River Watershed (SFBR) is a 10-digit watershed (0514010406) located on the northern portion of the 8-digit Blue-Sinking Watershed (05140104). The South Fork-Blue River Watershed stretches across the southeast corner of Washington County, northern Harrison County, northwestern Floyd County, western Clark County, and southwestern Scott County. Figure 1 shows the location of SFBR and its position within the Blue-Sinking Watershed.

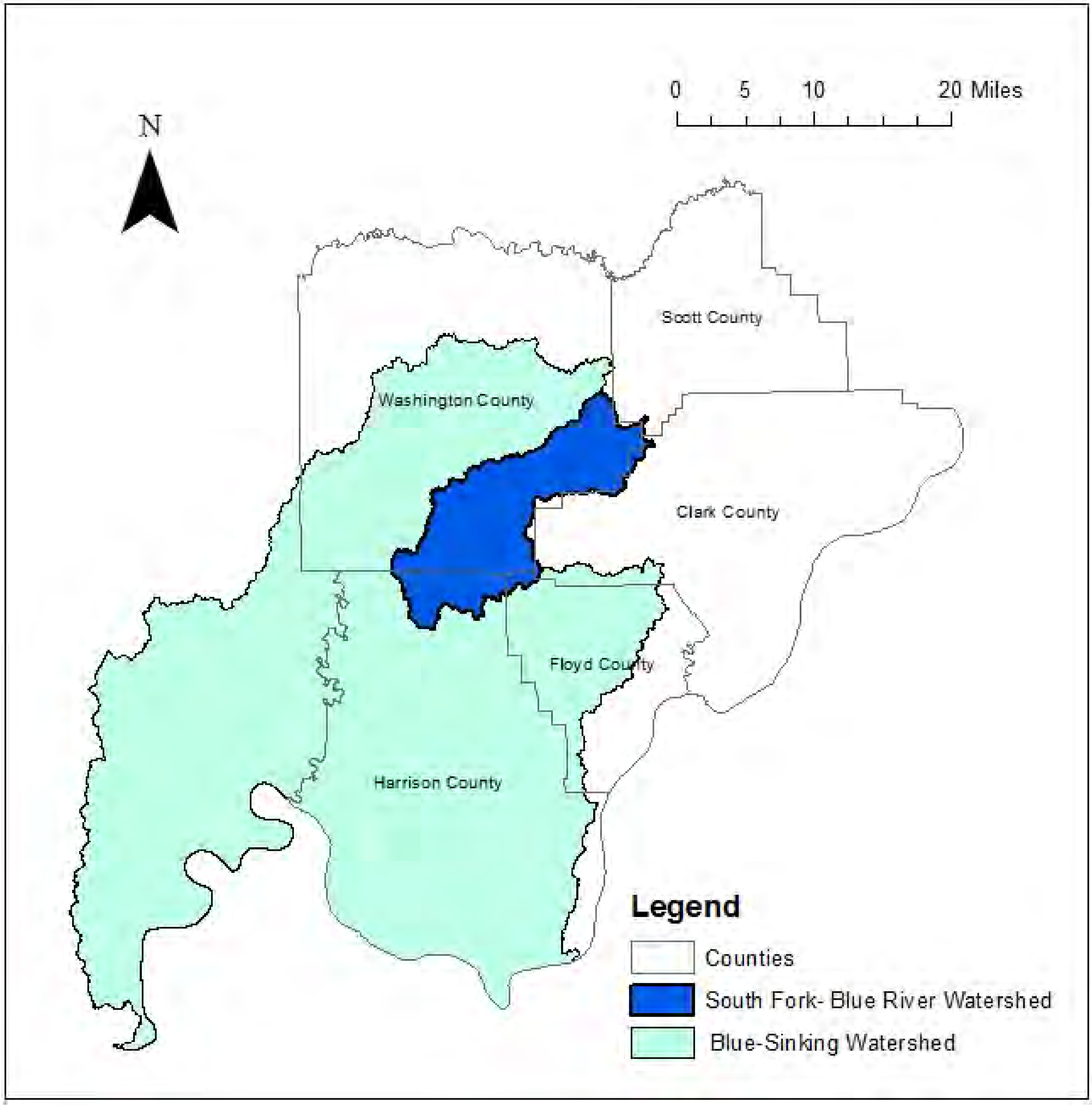


Figure 1: Blue Sinking and South Fork-Blue River Watershed Locations

The South Fork-Blue River (SFBR) watershed covers 80,699 acres and contains six 12-digit subwatersheds (Figure 2, Table 1).

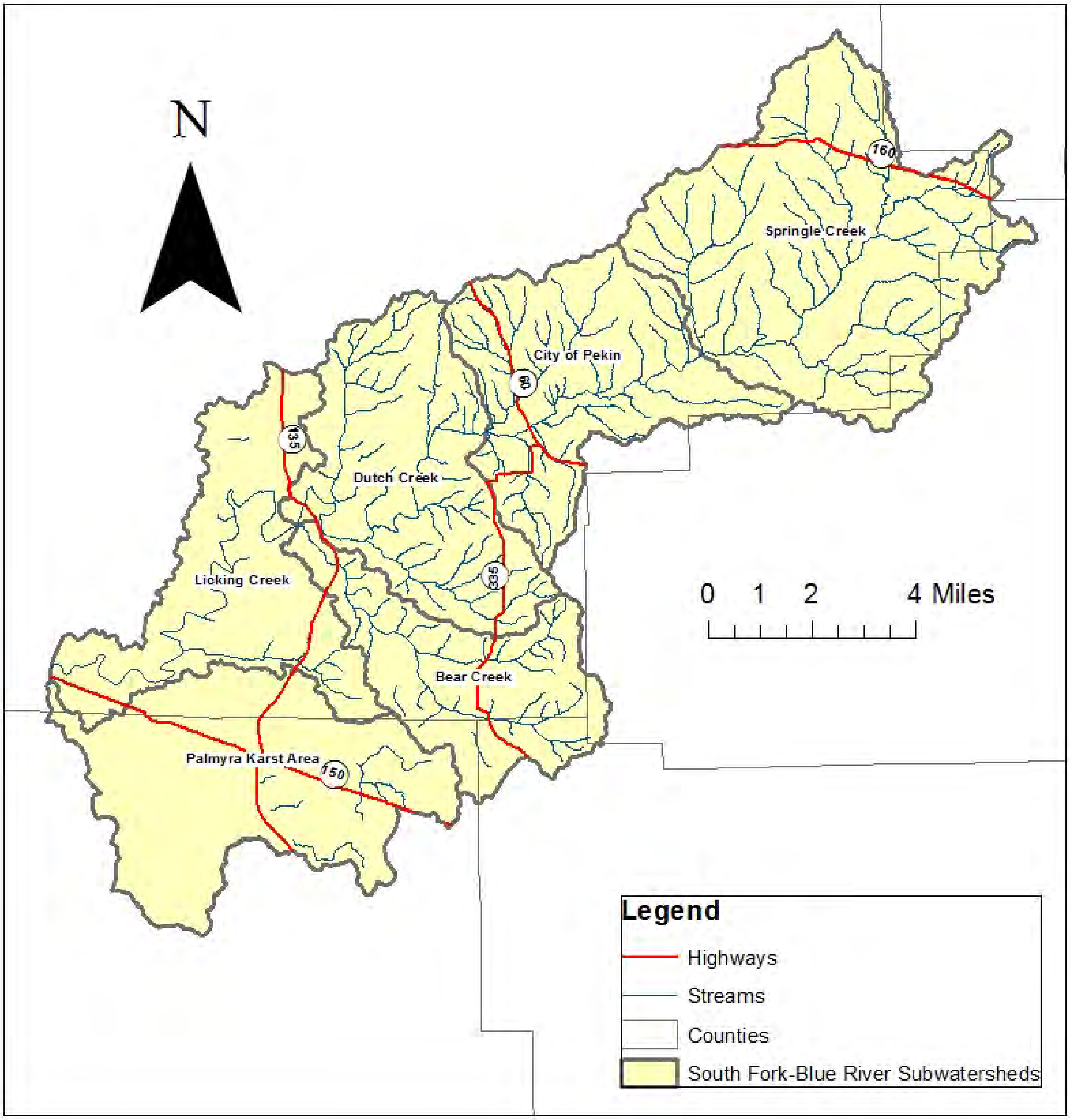


Figure 2: South Fork-Blue River Watershed with Subwatersheds

Name	HUC	Area (Acres)
Springle Creek	051401040601	20,938
City of Pekin	051401040602	12,092
Bear Creek	051401040603	8,930
Dutch Creek	051401040604	12,408
Palmyra Karst Area	051401040605	14,867
Licking Creek	051401040606	11,464

Table 1: 12-digit Subwatersheds in SFBR Watershed

1.1 Watershed Community Initiative

The mission statement of the Washington County Soil and Water Conservation District (SWCD) is "The conservation and development of our soil, water and related natural resources through education, public information, leadership, technical assistance, and development of innovative programs for Washington County."

Having seen success with the Mill Creek-Blue River Watershed Project, the Washington County SWCD decided to pursue an additional Indiana Department of Environmental Management (IDEM) 319 grant. Knowing of impaired biotic communities within the South Fork-Blue River Watershed and becoming aware of stakeholder water quality concerns, it only seemed appropriate that the Washington County SWCD apply for an Indiana Department of Environmental Management 319 Nonpoint Source Pollution grant for South Fork-Blue River.

The goal of the South Fork-Blue River Watershed Project is to assess the condition of streams in the watershed to facilitate informed decisions about appropriate best management practices in the South Fork-Blue River Watershed. A successful planning phase of the South Fork-Blue River Watershed Project would also lead the Washington County SWCD board to pursue the implementation phase to secure cost-share money to implement conservation practices within South Fork-Blue River. With more conservation practices implemented, an improvement in water quality could be detected.

After applying for an IDEM 319 grant in 2013, the application was ranked against dozens of applications across the state. Because of its high ranking, the application was chosen to be funded through the IDEM 205j grant program, which does not require local matching funds. Because of Washington County SWCD's strong local partnerships, previous work completed, and ability to leverage with IDEM sampling needs, the Washington County SWCD project was selected to be IDEM's Total Maximum Daily Load (TMDL)/watershed baseline project. Because of IDEM's TMDL/watershed baseline project with SFBR, IDEM completed the water quality monitoring for the SFBR Watershed Project.

1.2 South Fork-Blue River Stakeholder Involvement and Steering Committee

Stakeholder involvement was generated by word of mouth of the Washington County SWCD members, SWCD staff, Natural Resources Conservation Services (NRCS) District Conservationists, and Indiana State Department of Agriculture (ISDA) Resource Specialist. Articles were submitted to the following local papers: *The Salem Leader, The Corydon Democrat, The Banner Gazette,* and *The Clarion.* The articles invited stakeholders of the South Fork-Blue River watershed to voice any water quality concerns at a stakeholder meeting that was held on March 31st, 2014 at the Washington County Government Building from 5:30-6:30 p.m. The stakeholder meeting was also publicized on the Washington County Government website and to walk-in stakeholders of the Washington County USDA Service Center. Additional stakeholder questions and concerns were gathered by phone calls from concerned stakeholders who learned of the project through articles in local newspapers.

Stakeholder support was obtained and steering committee members were recruited by attending and presenting the South Fork-Blue River Watershed Project at the following meetings: Washington County Council, Washington County Commissioners, Washington County SWCD Annual Meeting, Harrison County SWCD Annual meeting, and Harrison County SWCD monthly meeting.

Table 2 lists SFBR steering committee members and their representation.

	Steering Committee Member	Group/Organization Represented
1	Scott Vannoy	Washington County SWCD

2	Todd Armstrong	Washington County SWCD
3	Ruth Hackman	Natural Resources Conservation Service
4	Kevin Baird	Indiana State Department of Agriculture
5	Jerome Jacobi	Washington and Harrison County Landowner
6	Mike Book	Washington and Harrison County Landowner
7	Scott Luttrell	Washington County Landowner
8	David Gottbrath	Washington County Landowner
9	Kimberly Simpson	Floyd County Resident
10	Ron Deisch	Washington County Landowner
11	Ken Armstrong	Washington County Landowner
12	Shelby Villier	The Nature Conservancy
13	Cameron Churchill	Harrison County SWCD
14	Gary Geswein	Harrison and Floyd County Landowner
15	John Churchman	Washington County Landowner/East Washington High School
16	Ophelia Davis	West Washington High School FFA

Table 2: South Fork-Blue River Steering Committee Members

1.3 Stakeholder Concerns

Through public meetings, the steering committee, and word-of-mouth, a list of water quality concerns was generated. Table 3 is a comprehensive list of concerns as expressed by stakeholders of the South Fork-Blue River Watershed.

Stakeholder Concerns
Trash dumped into streams
Trash accumulated on residential property and then washed into streams during heavy rainfalls
Log jams
Stream bank erosion
Lack of buffer zones in agriculture fields
Water quality
Protecting endangered species
Flooding
The railroad bridge in New Pekin- debris collects because of center support and also causes flooding in heavy rain
Septic Maintenance
Access of livestock to stream
Lawn care treatment/education
Application of litter/manure
Sediment accumulation into Jordan Lake

Table 3: Stakeholder Concerns in South Fork-Blue River

2.0 Watershed Inventory-Part I

If a person were to travel from the northern edge of Indiana to the southern region, a vast array of terrain would be witnessed. The landscape of Indiana was defined by multiple glaciers that occurred about 16,000 years ago. As the glaciers creeped south across the state, at a rate of about 1 foot per day, Indiana's land was shaped. The glaciers did not extend past the central part of the state. It was the floods created from the thawing of the glaciers that created that rivers and hills of southern Indiana. (Global Conservation Regions)

The characteristics of the South Fork-Blue River Watershed's geology/topography, hydrology, and soils can all be attributed to these glaciers. The type of geology/topography, hydrology, and soils in the watershed determine how the land is used and the planned efforts for that area.

2.1 Geology/Topography

The southwestern portion of SFBR is primarily made up of a distinctive type of landscape or topography known as karst. Karst topography typically forms where carbonate rocks (limestone and dolostone) lie beneath the surface. As slightly acidic rainwater and the water in the soil slowly dissolve the fractures in the limestone--sinkholes, caves, and other characteristic features of karst landscape are created. These characteristic karst features are considered sensitive because surface water flows directly into them instead of being filtered by soil and bedrock. (Indiana Geological Survey)

See Figure 3 for a diagram of a cross section of karst topography.

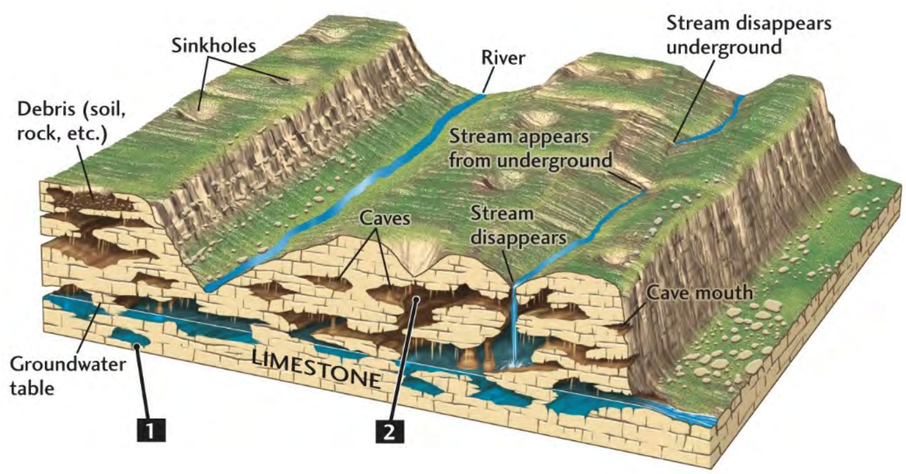


Figure 3: Karst Topography Diagram http://bc.outcrop.org/images/groundwater/press4e/figure-13-19.jpg

The northeastern portion of the watershed is underlined by chemically resistant sandstone, shale and siltstone. (Indiana Geological Survey) Its chemical resistance results in fewer sinkholes and caves.

The northeastern portion of the watershed also contains the watershed's highest elevations. This area contains a portion of the Clark State Forest. The watershed originates from the higher elevations of the northeast and flows to lower elevations of the southwest. The steepest topography can also be found in the northeast and along the river and creeks of the watershed. The Palmyra Karst Subwatershed contains the flattest topography of the watershed.

There are fewer perennial stream miles in the southwest portion of SFBR watershed due to the karst topography. Streams disappear underground in holes created by the karst topography. See Figure 4 for an illustration of locations of streams in SFBR. Because surface water can reach underground aquifers without filtering through soil and bedrock, water quality is very sensitive in karst topography.

Caves are very common in areas of karst. According to *The Nature Conservancy*, almost 25% of the groundwater is located in caves in karst regions. The protection and management of these vital water resources are critical to public health and to sustainable economic development. Once a cave is damaged, its formations and the creatures that live within it cannot be recovered. See Figure 5 for cave density in SFBR.

The Nature Conservancy states that 40% of our drinking water passes through cave and karst topography. Karst regions have unique features that control the movement and access to ground water and watersheds. Development in these areas is vulnerable to increased chances of contamination and lack of availability of quality drinking water in the future. See figure 6 for karst sinkholes in SFBR.

As seen in figure 6, sinkholes dominate the southwestern portion of the SFBR Watershed. Figure 6 depicts 3,555 sinkholes in the SFBR watershed with nearly all of those reported in the subwatersheds of Palmyra Karst Area, Licking Creek, Dutch Creek, and Bear Creek. This is an ever-changing number as sinkholes can form daily in karst regions. Water bypasses natural filtration by soil and can be directed straight into groundwater sources. Contaminants can then be diffused to wells and springs and lead to contamination of water from those sources. Karst areas and sinkholes are extremely sensitive and should be protected to avoid contamination to water sources.

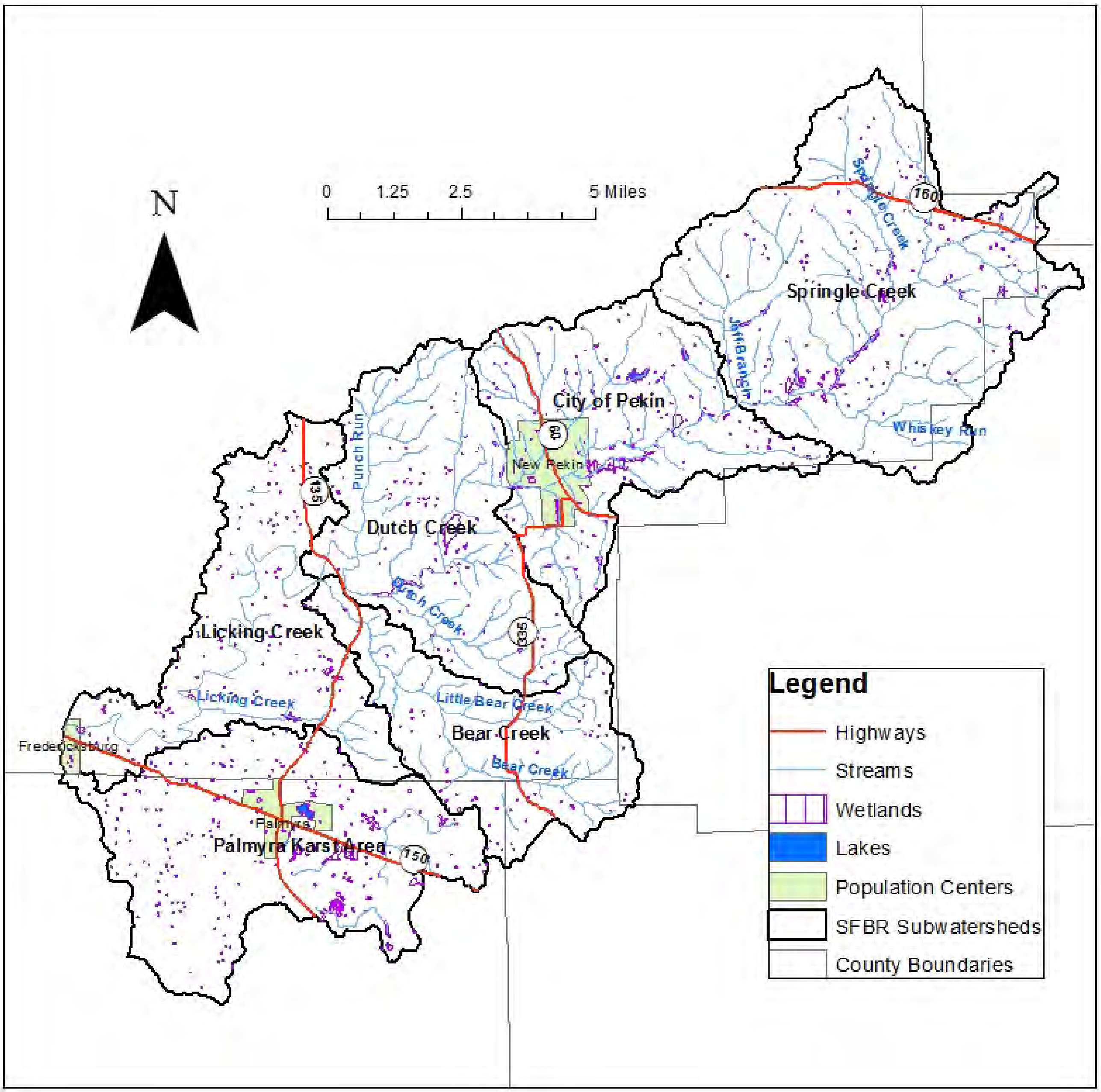


Figure 4: South Fork-Blue River Hydrology

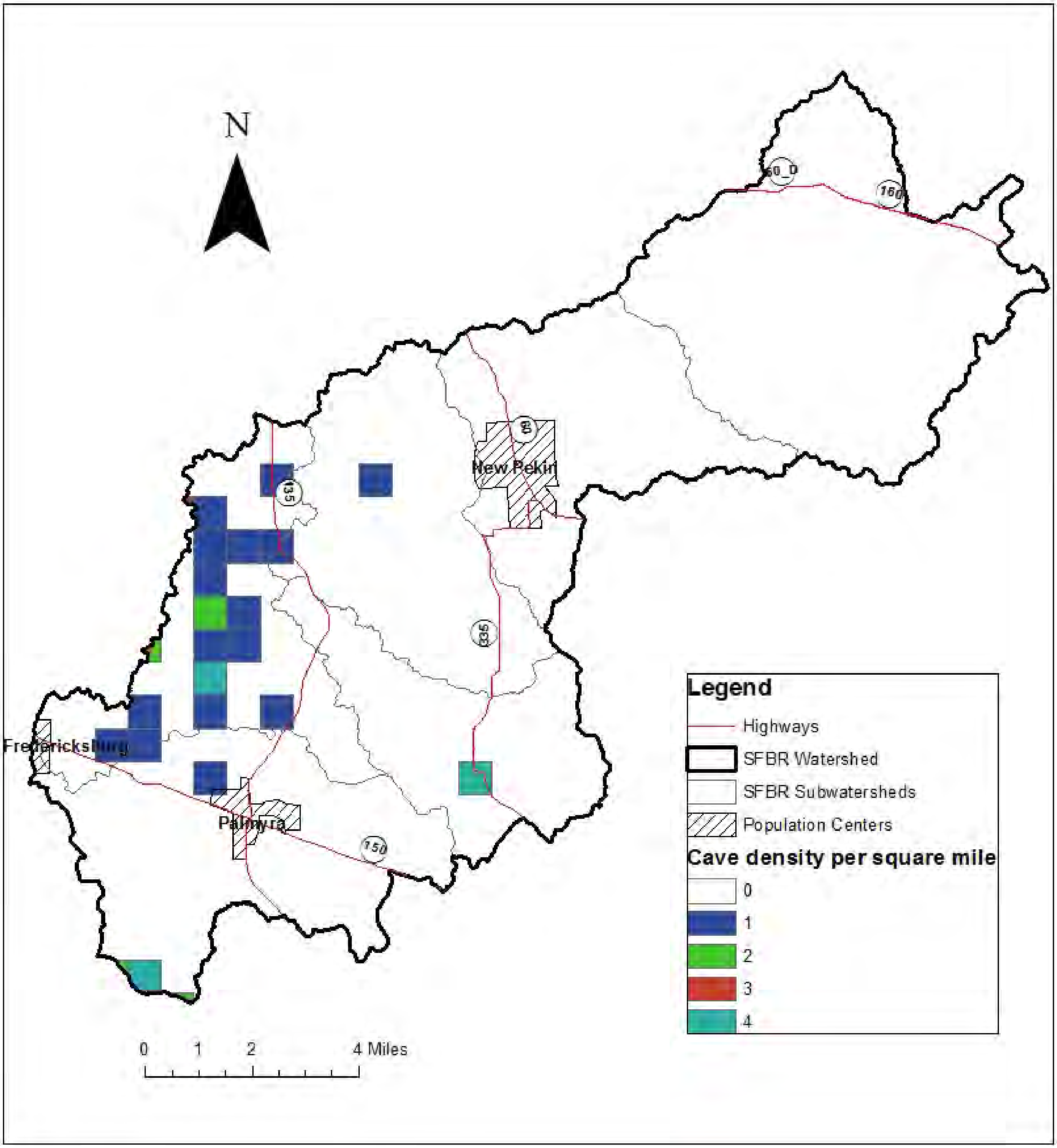


Figure 5: South Fork-Blue River Cave Density

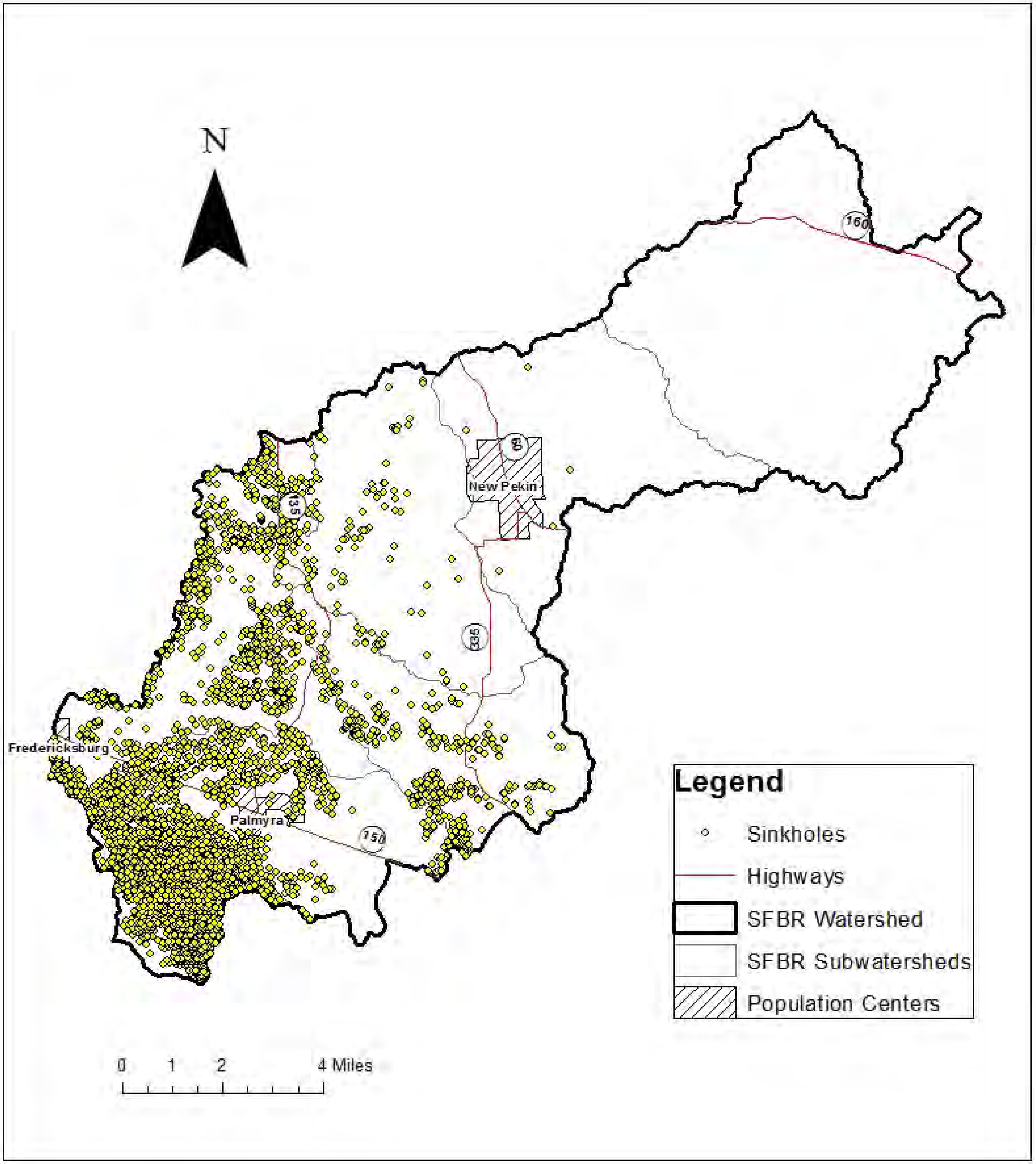


Figure 6: South Fork-Blue River Sinkholes

2.2 Hydrology

Watershed Streams

There are approximately 149 miles of stream in the SFBR watershed. This includes 5.3 miles of Bear Creek, 2.5 miles of Dutch Creek, 3.0 miles of Jeff Branch, 2.5 miles of Licking Creek, 2.3 miles of Little Bear Creek, 1.5 miles of Middle Poplar Branch, 1.7 miles of North Honey Run, 3.1 miles of Punch

Run, 19 miles of South Fork-Blue River, 2.2 miles of South Poplar Branch, 2.8 miles of Springle Creek, 2.1 miles of Whiskey Run, and 101.5 miles of unnamed tributaries of South Fork-Blue River (Figure 4).

Streams and rivers of the SFBR Watershed are used for various recreational activities including but not limited to fishing, swimming, wading, and viewing pleasure.

Waters of SFBR are also used for research of aquatic habitat, volunteer and professional water monitoring. Personnel completing research and results are discussed later in this WMP.

Watershed Lakes and Wetlands

According to the Environmental Protection Agency (EPA), "Wetlands have important filtering capabilities for intercepting surface water runoff from higher dry land before the runoff reaches open water. As the runoff water passes through, the wetlands retain excess nutrients and some pollutants, and reduce sediment that would clog waterways and affect fish and amphibian egg development. In performing this filtering function, wetlands save us a great deal of money."

The EPA also adds, "In addition to improving water quality through filtering, some wetlands maintain stream flow during dry periods, and many replenish groundwater. Many Americans depend on groundwater for drinking."

SFBR contains 1,048 acres of wetlands (Figure 4). This is approximately 1.3% of the SFBR watershed. Wetlands of the SFBR Watershed help to naturally filter and buffer water. They are also habitat to many species of animals.

SFBR is home to 701 ponds and lakes. These 701 ponds and lakes cover approximately 259 acres, both private and public. This is approximately .3% of the SFBR watershed. SFBR contains 3 major lakes: Buffalo Trace Lake, Palmyra Lake and Jordan Lake.

Buffalo Trace Lake is a 29-acre lake located approximately ½ mile east of the town of Palmyra and can be found within Buffalo Trace Park. It is a man-made lake constructed in 1971 and is maintained and operated by the Harrison County Parks and Recreation Department. Uses for the lake include fishing, boating, swimming, viewing pleasure by locals and tourists, and flood control.

Palmyra Lake is an 8.8-acre public lake located approximately 6.8 miles southwest of New Pekin or 2 miles north of Palmyra. Uses for the lake include fishing, boating, swimming, and viewing pleasure.

Lake Jordan is a private 15-acre lake owned by the members of the lake association. Lake Jordan is located in the town of New Pekin. Uses for the lake include fishing, boating, swimming, and viewing pleasure.

Watershed Stormwater and Storm Drains, Ditches, Legal Drains

Storm drains are located predominantly in the populated areas of Palmyra and New Pekin. The storm drains in New Pekin lead directly to South Fork-Blue River. This untreated water could be related to the stakeholder concerns of trash and debris washing off into streams as well as degrading habitat for endangered species.

There are approximately 10 miles of ditches in SFBR. Ditches are used to carry excess water from land to reduce flooding.

There are no legal drains in SFBR.

Watershed Dams
SFBR is home to six dams.

The Buffalo Trace Lake Dam is located within Buffalo Trace Park in Palmyra. It was completed in 1971. Its primary purpose is for flood control. It is owned by the Harrison County Park and Recreation Board.

The Palmyra Lake Dam is located approximately 2 miles north of Palmyra and 5 miles upstream of Fredericksburg. The dam was completed in 1938. Its primary purpose is for recreation. Palmyra Lake Dam is privately owned.

The Jordan Lake Dam is located in New Pekin. It was completed 1978. Its primary purpose is for recreation. Jordan Lake is privately owned by the Jordan Lake Association which is comprised of individuals that own land and homes surrounding the lake. Lake association members are concerned with sediment filling the lake that is believed to originate upstream. Stakeholders are concerned with flooding that is caused by accumulated sediment in the lake that will not allow for sufficient drainage. The lake was dredged approximately 15 years ago (2000).

The Peek-A-Boo Lake Dam is located approximately 2 miles upstream from New Pekin. The dam was completed in 1963. The dam is privately owned. The primary purpose is recreation.

The Chestnut Hill Tree Farm Dam is located approximately 4 miles up-stream from Pekin. The dam was completed in 1966. The primary purpose is recreation. Chestnut Hill Tree Farm Dam is privately owned.

2.3 Soil Characteristics

Highly Erodible Soils (HES)
Official lists of highly erodible and potential highly erodible soil map units are maintained in the NRCS-Field Office Technical Guide. HES are soils that are considered very susceptible to erosion.

SFBR contains approximately 48,571 acres of HES which equates to 60.2% of SFBR's total of 80,699 acres. (Table 4 and Figure 7)

Stakeholders of SFBR listed the concern of lack of buffer strips along agricultural fields. HES can be a major contributor to nonpoint source pollution (NPS) by increasing sediment that may also carry additional pollutants such as nutrients and chemicals to water bodies. According to NRCS online, buffer strips, also known as conservation buffers, "are small areas or strips of land in permanent vegetation, designed to intercept pollutants and manage other environmental concerns. Strategically placed buffer strips in the agricultural landscape can effectively mitigate the movement of sediment, nutrients, and pesticides within farm fields and from farm fields."

County	Acres of HES	% HES in SFBR
Clark	2,041	2.5
Floyd	1,289	1.6
Harrison	11,085	13.7
Scott	275	0.3
Washington	33,881	42.0
Total	**48,571**	**60.2**

Table 4: South Fork-Blue River HES

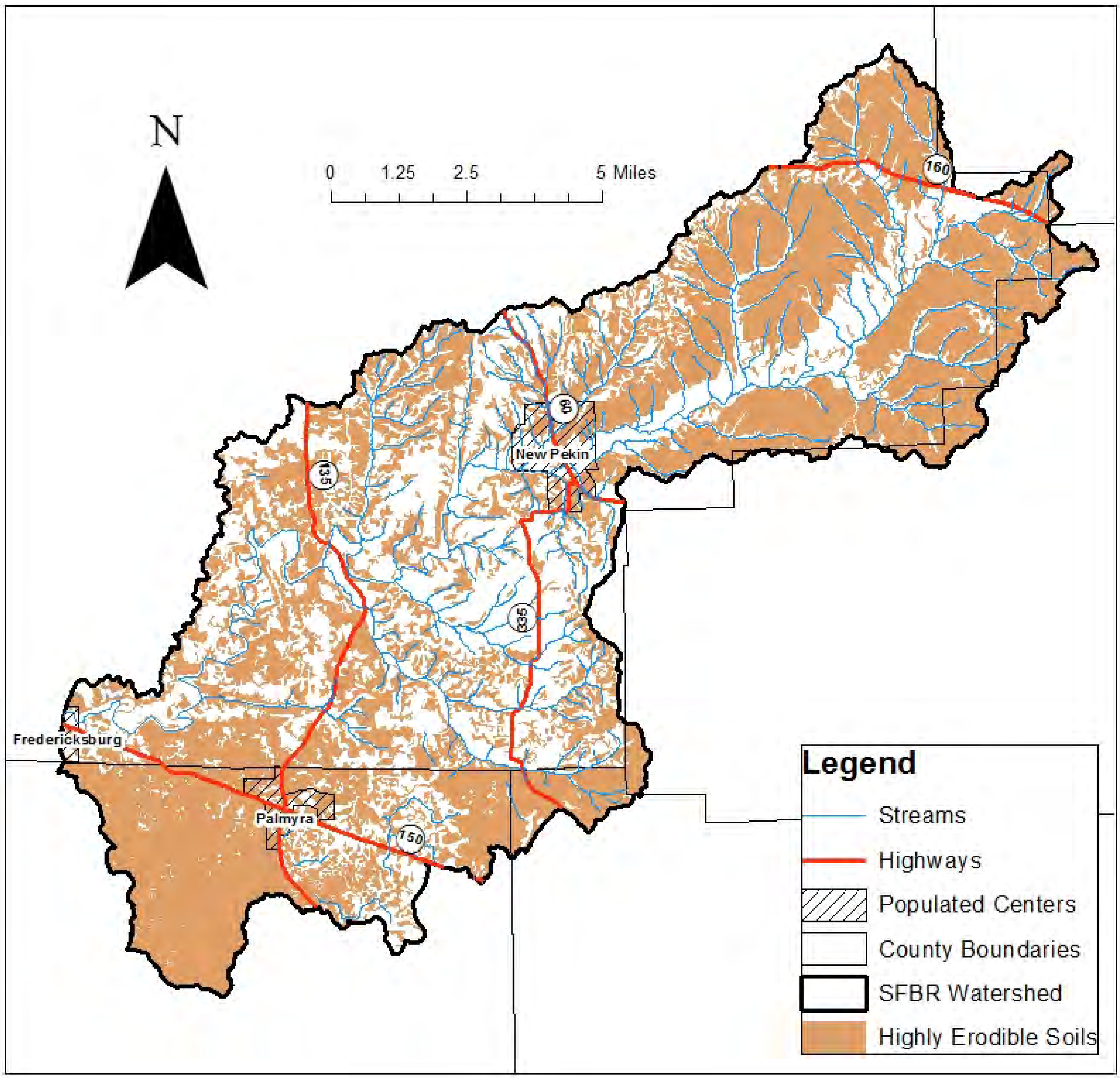


Figure 7: South Fork-Blue River Highly Erodible Soils

Hydric Soils

According to NRCS online, “The definition of a hydric soil is a soil that formed under conditions of saturation, flooding or ponding long enough during the growing season to develop anaerobic conditions in the upper part.” Even if a hydric soil is drained, it will always retain the characteristics of a hydric soil. Approximately 680 acres of the SFBR watershed consists of soils that are considered hydric (Table 5) and locations of these hydric soils can be found on the map of Figure 8. Identifying hydric soils within the watershed are important in the consideration of wetland creation or enhancement.

County	Acres of Hydric Soils	% Hydric Soils in SFBR
Clark	0	0
Floyd	0	0
Harrison	48.5	0.06
Scott	5.1	0.006
Washington	627.1	.8
Total	**680.7**	**0.866**

Table 5: South Fork-Blue River Hydric Soils

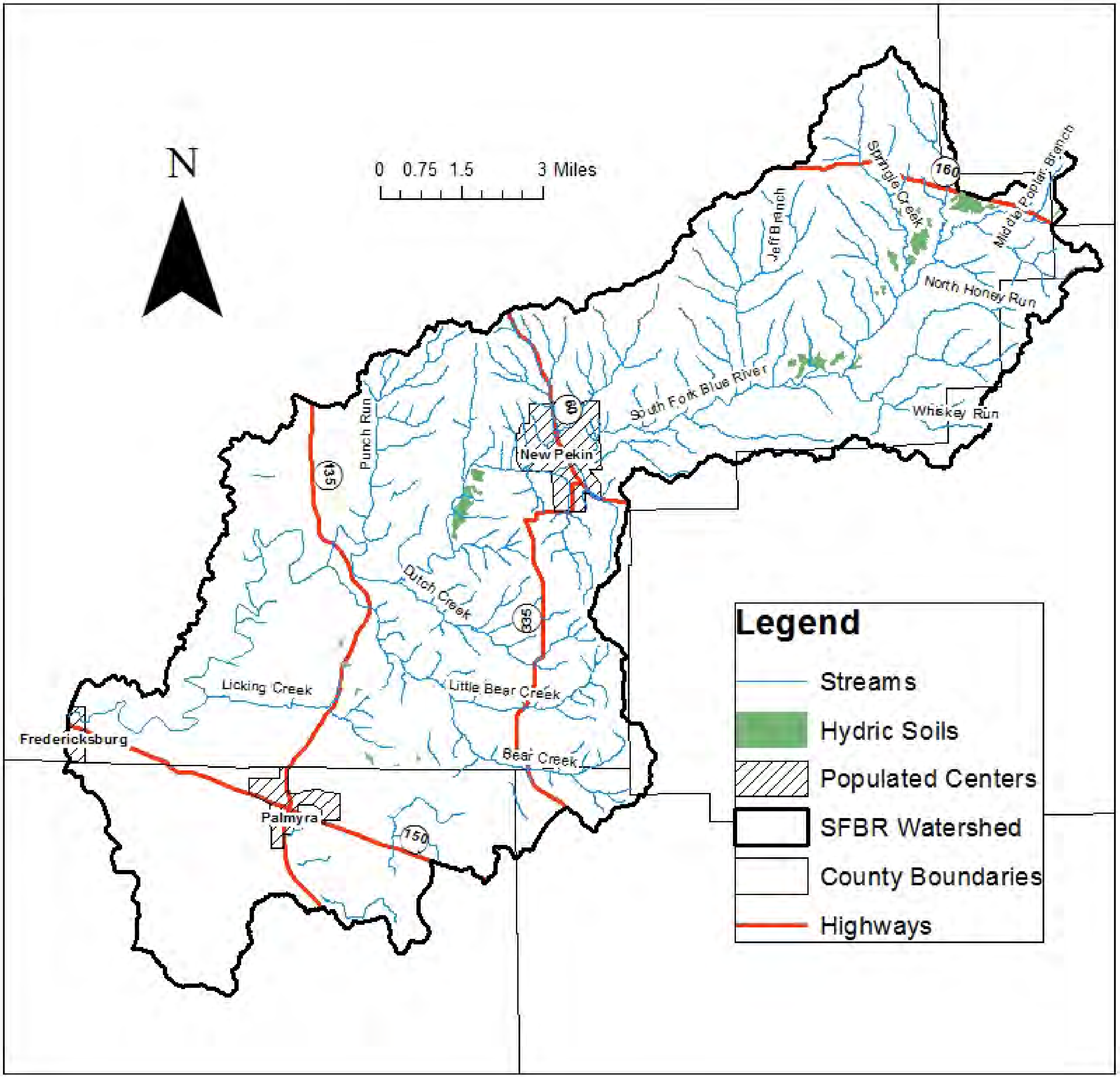


Figure 8: South Fork-Blue River Hydric Soils

Septic System Suitability

Septic system maintenance and failing septic systems are concerns of stakeholders throughout the SFBR Watershed. According to the Environmental Protection Agency (EPA), approximately 20% of homes in the United States use an on-site waste water treatment system, such as a septic system. The EPA estimated that 10-20% of those systems fail each year. Approximately 54,177 acres of SFBR soils are rated as Somewhat Limited Soils for septic system suitability (67.2 % of the SFBR watershed). Approximately 26,251.6 acres of SFBR soils are rated Very Limited Soils for septic system suitability (26.6 % of SFBR watershed). See Table 6 and Figure 9.

The only sewered areas of the SFBR watershed are the Town of Palmyra (640 acres) and the Town of New Pekin (1515 acres). The remaining 78,544 acres are unsewered which equates to 97.3% of SFBR. (Figure 10) There are 15 unsewered housing developments in the watershed.

It is important to discern which areas of the watershed are suitable for septic systems. Approximately 97% of the watershed is considered rural and septic systems are typically the only option for homes and businesses in these rural locations. However, not all areas may be suitable for septic systems.

The Harrison County Health Department has a record of 14 leaking septic systems in the South Fork-Blue River watershed of the county. Thirteen of the 14 systems have been recorded as repaired successfully.

The Washington County Health Department estimates that the failure rate for septic systems is approximately 50% and about 20% of septic systems are running on a "homemade" system from before 1975. They also report that not all households have an on-site septic system and some outlet raw sewage into nearby drainage.

County	**Somewhat Limited Soils (Acres / % of watershed)**	**Very Limited Soils (Acres / % of watershed)**
Clark	2,123.0 / 2.6	0 / 0
Floyd	1,419.0 / 1.8	0 / 0
Harrison	8,866.6 / 11.0	4,815.1 / 6.0
Scott	313.1 / 0.4	0 / 0
Washington	41,455.3 / 51.4	21,436.5 / 26.6
Total	**54,177.0 / 67.2**	**26,251.6 / 32.6**

Table 6: South Fork-Blue River Septic System Suitability

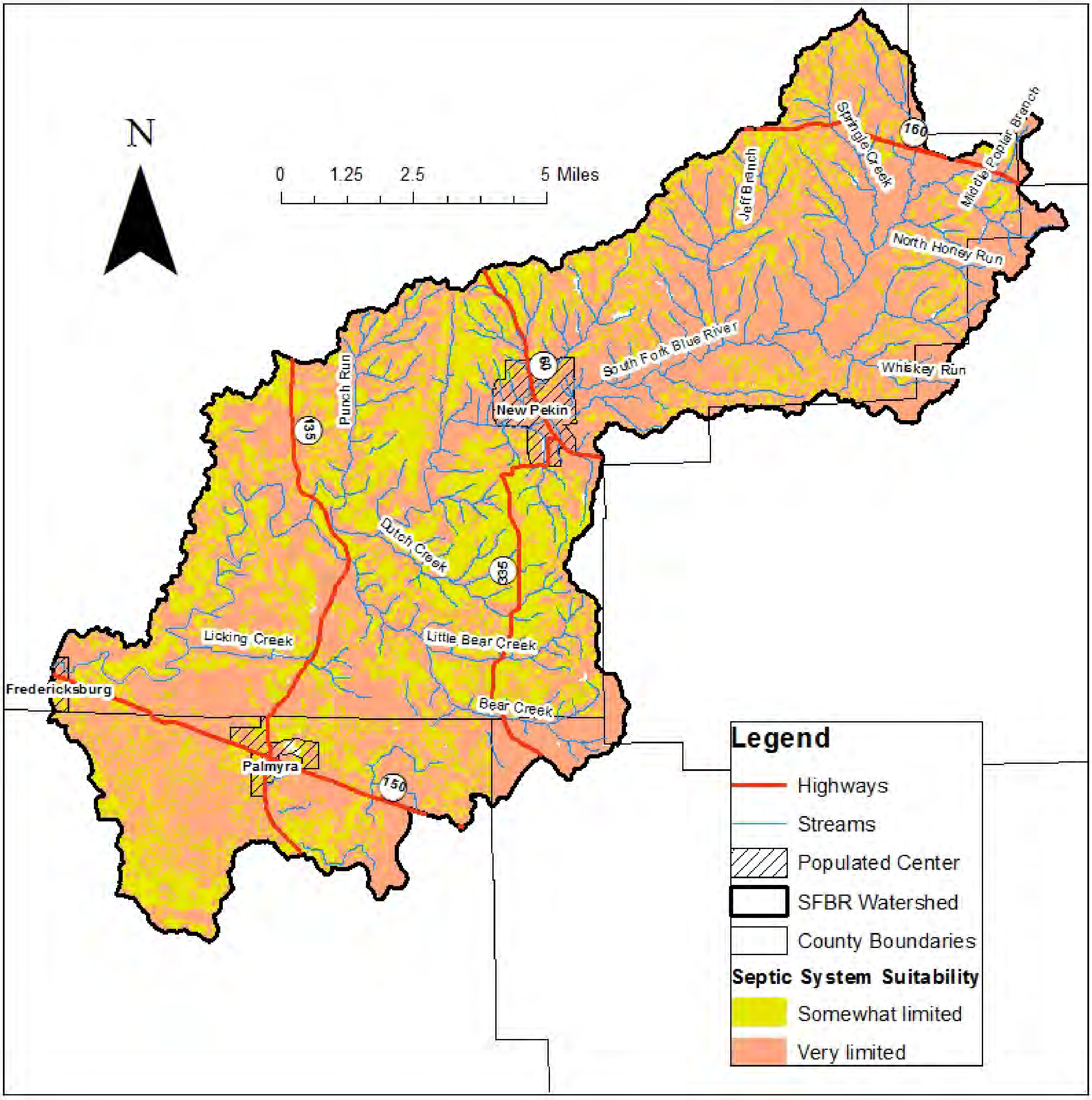


Figure 9: South Fork-Blue River Septic Suitability

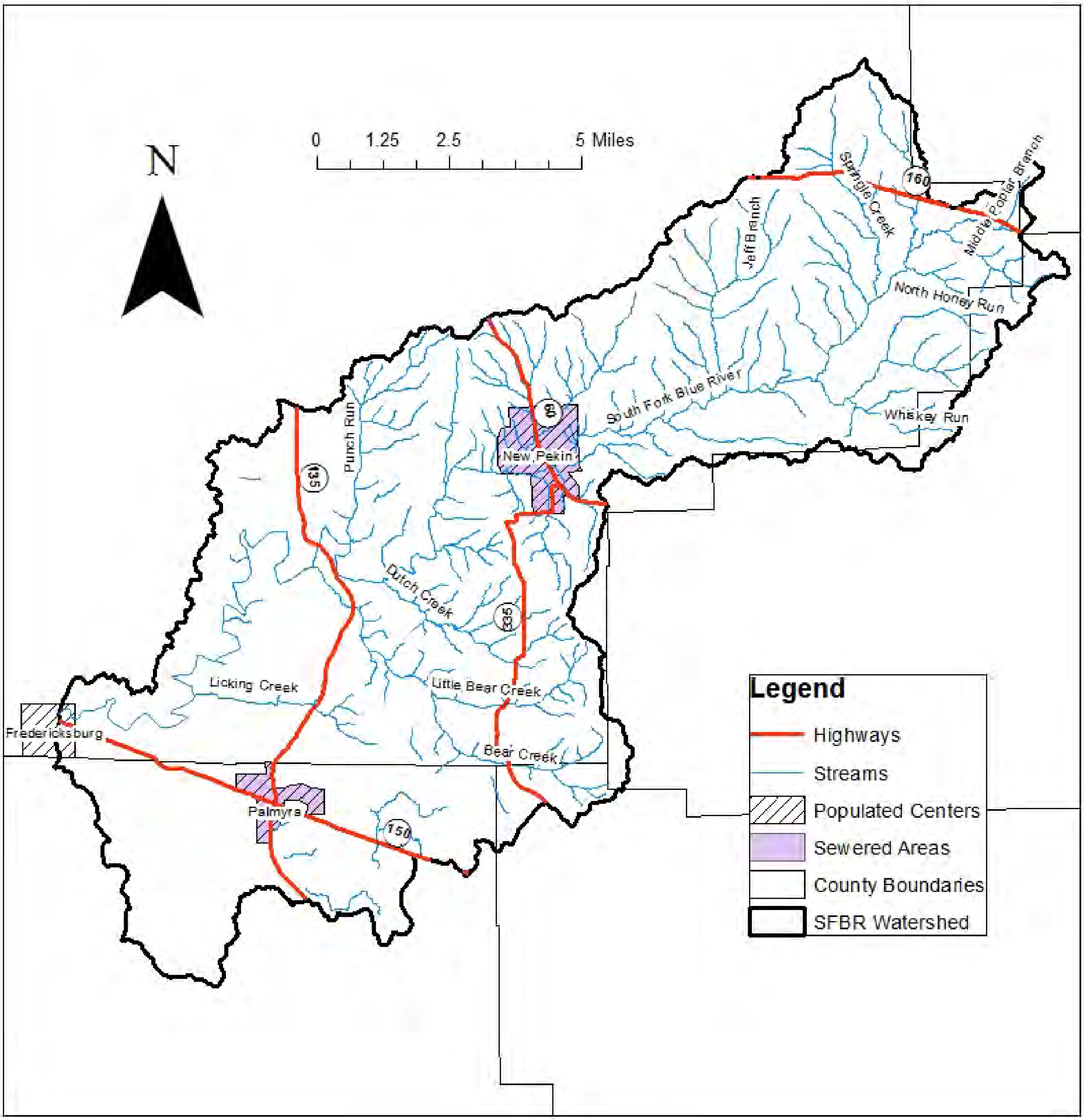


Figure 10: South Fork-Blue River Sewered Areas

Tillage Transect

Tillage transect information data for Washington, Scott, Clark, Floyd and Harrison Counties was updated for 2015. As reported by ISDA, members of Indiana's Conservation Partnership (ICP) conduct a field survey of tillage methods. A tillage transect is an on-the-ground survey that identifies the types of tillage systems farmers are using and long-term trends of conservation tillage adoption using GPS technology, plus a statistically reliable model for estimating farm management and related annual trends.

Table 7 provides the number of acres and percent of acres from each county of each of the four categories of till (no-till, mulch-till, reduced-till, and conventional-till) for 2015. Table 8 provides number of acres and percent of acres from each county from each of the four categories of till (no-till, mulch-till, reduced-till, and conventional-till) for 2013.

The dominant form of tillage in both years has been no-till for all counties of the watershed. However, when comparing years 2013 and 2015, both Washington and Harrison Counties (counties within the South Fork-Blue River watershed with the most tillable ground) have seen a decrease in the acres and percent of acres of no-till soybean and corn fields. A decreasing trend in no-till can contribute to negative water quality effects. No-till decreases the amount of soil erosion and allows for more water infiltration into the soil and less water runoff. This, in turn, keeps sediment and nutrients in the field and out of water sources such as streams and rivers.

The different types of tillage defined by ISDA are as follows:

No-till: any direct seeding system, including site preparation, with minimal soil disturbance (includes strip and ridge till).
Mulch-till: Any tillage system leaving 30%-75% residue cover after planting, excluding no-till.
Reduced-till: Any tillage system leaving 16%-30% residue cover after planting.
Conventional-till: Any tillage system leaving less than 15% residue cover after planting.

County	No-Till		Mulch-Till		Reduced-Till		Conventional-Till	
	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Washington	39,100 ac. 86%	44,400 ac. 81%	2,700 ac. 6%	2,600 ac. 5%	900 ac. 2%	1,000 ac. 2%	2,300 ac. 5%	5,100 ac. 10%
Scott	17,800 ac. 85%	13,100 ac. 95%	1,000 ac. 5%	300 ac. 2%	800 ac. 4%	0 ac. 0%	1,300 ac. 6%	300 ac. 2%
Clark	23,800 ac. 75%	15,100 ac. 81%	3,500 ac. 11%	1,100 ac. 6%	600 ac. 2%	600 ac. 3%	3,500 ac. 11%	1,100 ac. 6%
Floyd	2,900 ac. 93%	3,100 ac. 100%	0 ac. 0%	0 ac. 0%	0 ac. 0%	0 ac. 0%	200 ac. 7%	0 ac. 0%
Harrison	23,800 ac. 90%	19,300 ac. 70 %	1,600 ac. 6%	2,500 ac. 9%	300 ac. 1%	2,200 ac. 8%	500 ac. 2%	3,900 ac. 14%

Table 7: Cropland Tillage Data for Corn and Soybeans-Year 2015

County	No Till		Mulch Till		Reduced Till		Conventional Till	
	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Washington	39,600 ac. 87%	44,400 ac. 87%	1,400 ac. 3%	1,000 ac. 2%	900 ac. 2%	500 ac. 1%	3,600 ac. 8%	5,100 ac. 10%
Scott	16,500 ac. 79%	10,000 ac. 73%	2,100 ac. 10%	1,500 ac. 11%	0 ac. 0%	1,000 ac. 7%	2,100 ac. 10%	1,200 ac. 9%
Clark	25,400 ac. 80%	14,200 ac. 76%	600 ac. 2%	600 ac. 3%	300 ac. 1%	600 ac. 3%	5,400 ac. 17%	3,400 ac. 18%
Floyd	2,500 ac. 81%	2,300 ac. 75%	200 ac. 7%	100 ac. 4%	0 ac. 0%	0 ac. 0%	300 ac. 11%	700 ac. 21%
Harrison	24,800 ac. 94%	23,000 ac. 86%	0 ac. 0%	600 ac. 2%	1,100 ac. 4%	1,700 ac. 6%	500 ac. 2%	1,700 ac. 6%

Table 8: Cropland Tillage Data for Corn and Soybeans-Year 2013

2.4 Land Use

Current Land Use
Land use has a direct impact on water quality. While cultivating crops is a necessity of human life, this land use has a high potential to erode sediment which can also carry nutrients into water resources. Sediment and unwanted nutrients affect aquatic plants and animals. Livestock operations can also contribute to erosion and unwanted nutrients entering water sources as well as bacteria through improperly stored manure or livestock with access to water sources. Industrial/Developed areas are also often threats to water quality due to increased impervious surfaces as well as failing septic systems. Obtaining knowledge of land use to determine the best remediation for pollution sources is imperative for the SFBR Watershed Project.

Table 9 outlines the current land uses in the SFBR Watershed. Forest (45.5%), Hay/Pasture (28.8%), and Cultivated Crops (19.8%) combine to cover over 94% of the watershed. (Figure 11)

Water quality concerns in direct relation to agriculture land use (Cultivated Crops and Hay/Pasture) of SFBR stakeholders include lack of buffer strips between agricultural fields and water resources, access of livestock to streams, and application of litter/manure.

Land Use	Acres	% of SFBR Watershed
Cultivated Crops	15,980.0	19.8
Developed Land	3,879.2	4.8
Forest	36,719.6	45.5
Hay/Pasture	23,243.4	28.8
Open Water	264.4	.3
Shrub/Scrub	660.7	.8
Total	**80,847.3**	**100**

Table 9: Current Land Use in the SFBR Watershed

Fertilizer Use

The use of fertilizer is predominantly for agriculture production in SFBR. Agriculture commodities such as hay, corn, soybeans, and wheat are grown as a feed source for livestock as well as to sell as a commodity. Fertilizers are used to increase quantity and quality of the crop. The watershed contains numerous permitted and unpermitted livestock facilities/farms. Although it is not a documented concern, the over or improper application of manure is a suspected issue in the watershed.

Home and business owners also commonly use fertilizers for lawns and gardens. Home and business owners often use fertilizers on lawns to improve plant growth as well as brighten the green grass color. Similar to agriculture production, fertilizer use on gardens is used to increase quality and quantity of the crop; however, on a much smaller scale.

Lawn care education (including fertilizer use) and application of litter/manure are listed SFBR stakeholder concern.

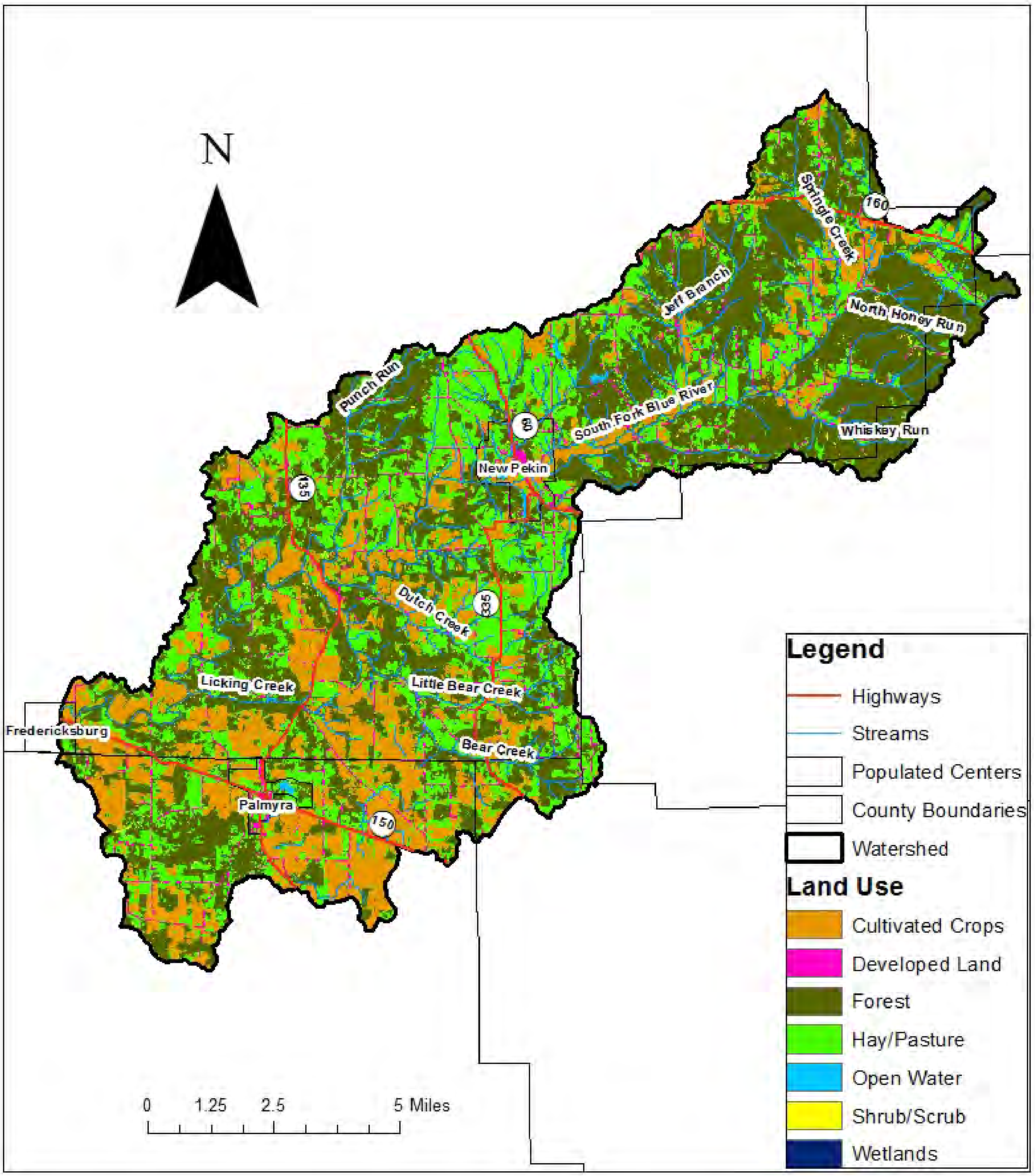


Figure 11: South Fork-Blue River Land Use

Managed Lands

Managed lands are those that show natural and recreation areas that are owned and managed by federal agencies, state agencies, local agencies, non-profit organizations, and conservation easements.

SFBR Watershed consists of approximately 3,872 acres in managed lands which is about 4.8% of the watershed. Managed lands include Big Spring Farm Forest Legacy Area, Big Spring Nature Preserve, Buffalo Trace Park, Charles Spring, Clark State Forest, and Dr. Clapp Barrens. The largest area of managed lands is located in the Springle Creek subwatershed and consists of approximately 3,419 acres (Figure 12).

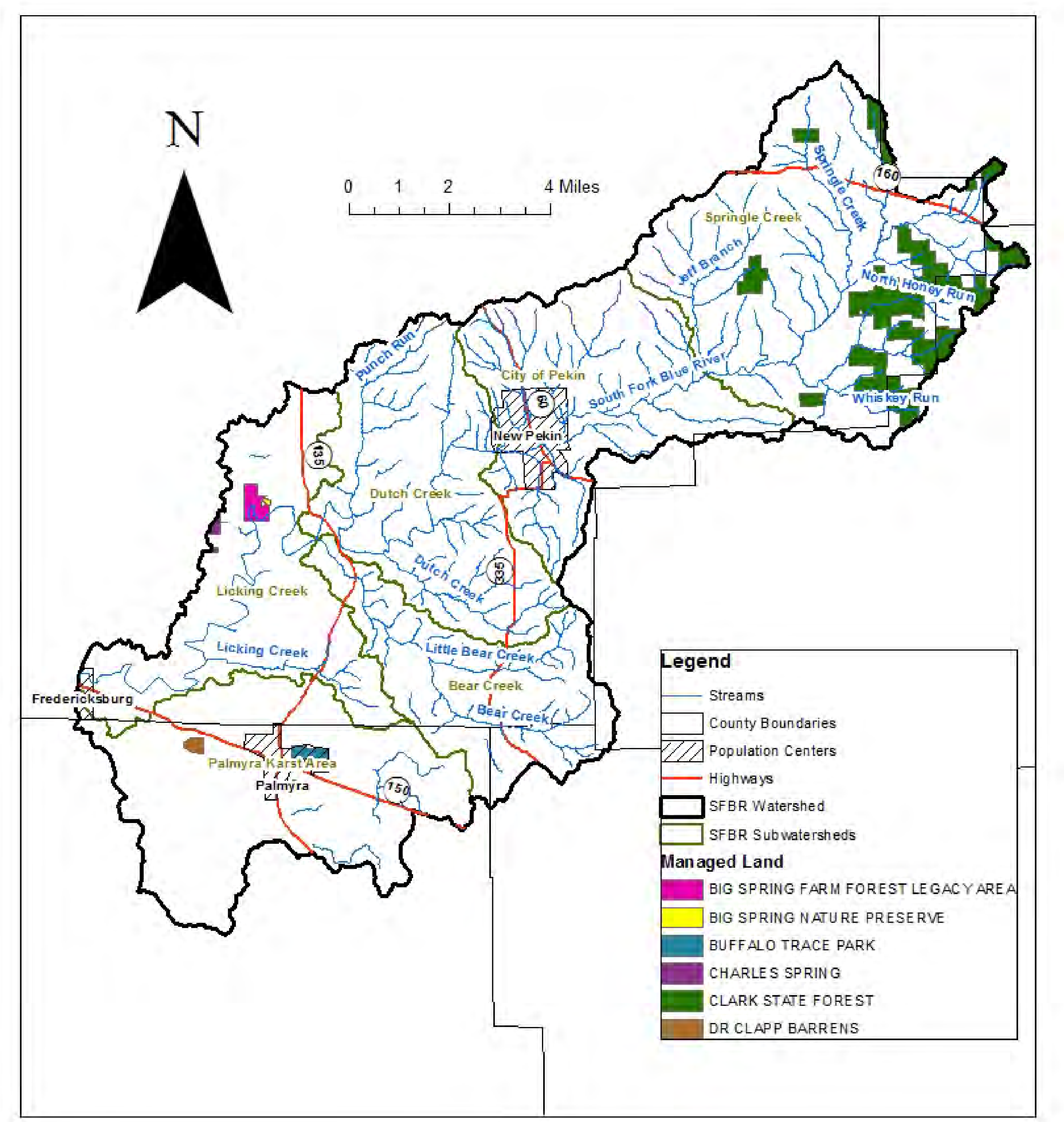


Figure 12: South Fork-Blue River Managed Lands

Pet and Wildlife Waste

Excess nutrients and pathogens can be carried by pet and wildlife waste and degrade water quality if it enters a water resource.

This waste is more likely to enter water resources in populated areas where there is more impervious surface and the waste can be washed into storm drains that outlet untreated water into water resources. The towns of Palmyra and New Pekin are populated centers with storm drains.

Buffalo Trace Park in Palmyra is also known to contain a concentrated population of ducks and geese. The waste is known to be a nuisance to park users and could be a contributor to pollution of water resources in the watershed. Park users often use the walking trail to exercise their dogs. If dog owners do not clean up and dispose of pet waste properly, this could lead to pollution of water resources.

Other common wildlife species include large population of white tail deer, turkeys, and geese. Genetic *E.coli* testing was performed by The Nature Conservancy in the SFBR watershed at four locations. Ruminants, which include deer, cattle, sheep, and goats, were a marker tested for. Ruminant markers were detected at 50% of testing occurrences. More detailed results of water monitoring can be found in Section 3.3 of the WMP.

2.5 Planning Efforts

Washington County

Washington County's last comprehensive plan was published in 2010. Within the plan, it is stated that future growth is expected along Hwy 60 near New Pekin and also possibly along U.S. Highway 150 in Fredericksburg. These areas are expected to develop because they are direct routes to the Louisville metro area. Although the Washington County comprehensive plan states it is less likely, it notes the possibility of redevelopment of the Fredericksburg area. Fredericksburg's development was inhibited when local business properties were bought by the federal government because of their location in a floodplain. Future redevelopment would be outside of the floodplain.

Washington County's comprehensive plan also acknowledges much of the county is covered in sensitive karst landscape and protection of sensitive karst areas may need to be addressed in new zoning ordinances.

Fredericksburg contains floodplains, karst topography, highly erodible soils, and soils that have a very limited soil suitability for septic systems. If this area were to be redeveloped, these sensitive areas would need to be taken into consideration to not degrade water quality.

Other natural resource recommendations found in the Washington County comprehensive plan include:

- Protect Washington County's watersheds by preventing flooding, erosion, and polluted water. Additional storm water control structures could reduce flooding.
- Protect Washington County's natural areas by carefully scrutinizing development in floodplains, wetlands, karst areas and areas of steep slope.
- Protect the county's water assets by discouraging development below dams.
- Special care should be given to Lake John Hay to improve the quality of its water, and thereby the drinking water for the City of Salem. This may include additional land preservation or modification of farming and logging practices.
- Use of existing parks and state forests should be maximized. Private forests should remain in sustainable production as much as possible, preserving jobs and the tax base.
- Protect Washington County's cultural and historic resources by clustering development, allowing prime farmland and associated rural development to remain intact.

- CFO and CAFO development in karst areas should be monitored and allowed with proper design and construction of manure storage structures.

These recommendations indicate that Washington County will take sensitive landscape into consideration in the event of future development.

Harrison County

The 2009 Harrison County Comprehensive Plan also indicates that there will be little expected development in the South Fork-Blue River Watershed portion of the county, with Palmyra being the only population center of SFBR located in Harrison County.

The fourth goal of the Harrison County Comprehensive plan is to "Preserve and protect the natural resources of Harrison County for the use and enjoyment of future generations." The objectives that accompany this goal are as follows:

1. Develop regulations on reclamation of limestone and sand mining sites.
2. Protect the karst areas within the county.
3. Preserve existing mineral reserves for future production and protect them from residential encroachment.
4. Explore the creation of agricultural preservation districts.
5. Limit development in areas containing large concentrations of natural resources.
6. Discourage development within the floodplains and on shorelines.

This goal and associated objectives indicate that Harrison County will take sensitive landscape into consideration in the event of future development, which does not appear to be likely in the SFBR Watershed of Harrison County.

Floyd County

The *Floyd County Comprehensive Land Use Plan Update* makes no indication that there are any future plans for the portion of SFBR Watershed located in Floyd County.

Prior to publishing the *Floyd County Comprehensive Land Use Plan Update*, a survey was sent to 2,500 residents of Floyd County. Response rate of the survey was thirty-seven percent. Sixty-three percent of respondents indicated that they would be willing to consider a modest fee or tax to assist in preserving the natural resources of the county. Fifty-eight percent indicated that they were willing to consider a fee or tax program to protect agricultural lands. One can conclude that majority of the survey respondents are conscious of the need to preserve the rural character of Floyd County and also preserve the county's natural resources.

The Floyd County Comprehensive Plan listed the ten guiding principles of smart growth. One of the chosen principles for Floyd County to meet the stated community values and manage anticipated growth over the next 10 years include "Preserving Open Space, farmland, and critical environmental areas." One theme that emerged from the aforementioned survey indicated that residents want to maintain the rural character and development of the county. Land use of SFBR Watershed in Floyd County is cultivated crops, forest, or hay/pasture. There are no future plans for development in the SFBR Watershed in Floyd County.

Clark County
The *Clark County Transportation Plan Final Report* reports that most of future growth will occur around existing cities and towns. There were no findings of future plans in the Clark County area of the SFBR Watershed.

Scott County
There are no future plans for development for the SFBR portion of the county.

IDEM Total Maximum Daily Load Report
IDEM is developing a Total Maximum Daily Load (TMDL) report for the South Fork-Blue River watershed (HUC 0514010406).   The SFBR TMDL's focus is on protecting the designated uses of aquatic life support and full body contact recreational uses of the waterbodies. The TMDL is being developed for *E.coli*. Data used for the TMDL analysis were collected from 21 stream sites by IDEM between November 2014 and October 2015. This data was used in the development of this watershed management plan and can be found in more detail in the water quality data section.

Rule 5/Unmanaged Urban Sprawl
The South Fork-Blue River Watershed has no areas that are in need of Rule 5 enforcement. Also, there are no areas of unmanaged construction/sprawl.

2.6 Threatened and Endangered Species

The Indiana Natural Heritage Data Center is part of the Indiana Department of Natural Resources. "The Indiana Natural Heritage Data Center maintains the most comprehensive and up-to-date information about federal and state endangered, threatened, and rare species, high quality natural communities, and significant natural areas in Indiana." (DNR, 2015)

Table 10 displays a list of endangered, threatened and rare species documented by the Indiana Natural Heritage Data Center in the SFBR Watershed. Habitat descriptions are also included in the table.

Many of the species listed in Table 10, such as the spotted darter, are sensitive to changes in water quality. For example, the spotted darter is particularly sensitive to siltation. When siltation increases, the pore space around substrate is decreased. Pore spaces are used for reproduction as well as for protection from larger predators.

The Eastern Hellbender is listed on Indiana's endangered species list and is declining. Hellbenders are very sensitive to water quality. They prefer cool, shallow rivers where rocks are not embedded in sediment or silted in. Clean water is also important for Hellbenders because they obtain most of their oxygen from the water by "breathing" through their skin. One of the explanations for the decline in the Eastern Hellbender population is likely caused by human influences such as habitat degradation and destruction. The stream-bottom habitat of hellbenders can be degraded by sediment from eroded banks and fields and destroyed when streams are dammed or dredged.

Through personal correspondence with Nick Burgmeier, a research biologist and extension wildlife specialist with Purdue University, South Fork-Blue River was on the list of possible streams to release the hellbender in. However, due to the amount of siltation, South Fork-Blue River was removed from the list.

Nick's comments about his findings in South Fork-Blue River are as follows: "South Fork was on our list of five streams we were considering for a future hellbender release. South Fork is a historic hellbender stream and might even still have them. The last sighting that I'm aware of was in 2007. I evaluated South Fork from this starting point (38.544496, -85.898443) to its confluence with the Blue River. I "floated" the entire stretch and ranked habitat based on flow type, substrate, and boulder size/abundance."

"Unfortunately, and to my disappointment, we removed South Fork from the list after evaluation. There is a lot of hellbender habitat in South Fork, but it's much siltier than we would be comfortable releasing hellbenders into. A lot of the gravel and boulders have significant silt buildup and the interstitial spaces that larval hellbenders need are absent. Silt is also thought to cause egg failure."

"So right now, South Fork is not currently being considered. We would certainly like to see hellbenders back in there at some point, but I think that's a ways off."

A section in the lower part of Blue River, downstream from South Fork-Blue River, has been identified as a location to release Eastern Hellbenders.

Protecting endangered species is a listed SFBR stakeholder concern.

Scientific Name	**Common Name**	**Type**	**Habitat**
Cryptobranchus alleganiensis alleganiensis	Eastern Hellbender	Amphibian	Cool, clear streams and rivers with many large rocks
Aimophila aestivalis	Bachman's Sparrow	Bird	Pine woodlands with more open understory and grassy conditions
Wilsonia citrina	Hooded Warbler	Bird	Dense understories in mature forest
Notropis ariommus	Popeye Shiner	Fish	Clear, gravel-bottomed, flowing pools and runs of creeks and small to medium rivers
Etheostoma maculatum	Spotted Darter	Fish	Large rubble and boulder areas, adjacent to or in swift deep riffles, in small to medium, clear rivers
Dryobius sexnotatus	Six-banded Longhorn Beetle	Insect Coleoptera	Mature hardwood forests with large, overmature trees
Pseudanophthalmus tenuis	Cave Beetle	Insect Coleoptera	Riparian microhabitat on mudbanks, gravel or rocks, usually immediately adjacent to a cave stream
Taxidea taxus	American Badger	Mammal	Grasslands, parklands, farms, and other treeless areas w/ friable soil
Fusconaia subrotunda	Longsolid	Mollusk	Relatively silt-free substrates of sand, gravel, and cobble in good flows of smaller streams.
Obovaria subrotunda	Round Hickorynut	Mollusk	Medium to large sized rivers in gravel substrates of moderate current
Simpsonaias ambigua	Salamander Mussel	Mollusk	Medium to large sized rivers often under large flat stones

Scientific Name	Common Name	Type	Habitat
Ptychobranchus fasciolaris	Kidneyshell	Mollusk	Small to medium rivers, usually in areas with fairly good flow. Substrate-sand and/or gravel.
Villosa lienosa	Little Spectaclecase	Mollusk	Small creeks to medium-sized rivers, usually along the banks in slower currents
Ligumia recta	Black Sandshell	Mollusk	Rivers, lakes, and large streams, usually in riffles or raceways with good current. Substrates-sandy mud, firm sand, or gravel.
Tragia cordata	Heart-leaved Noseburn	Vascular Plant	Bottoms, rocky open woods, thickets, glades
Stenanthium gramineum	Eastern Featherbells	Vascular Plant	Moist meadows, bogs, deciduous forests
Ranunculus pusillus	Pursh Buttercup	Vascular Plant	Low wet ground, swamps, and shallow pools
Bacopa rotundifolia	Roundleaf Water-hyssop	Vascular Plant	Small rainwater pools on bedrock outcrops, and occasionally along the margins of shallow ponds
Carex gigantea	Large Sedge	Vascular Plant	River birch-silver maple-sweet gum swamp forest
Carex decomposita	Cypress-knee Sedge	Vascular Plant	Swamps, wet woods, and wooded floodplains, often in dense shade
Ophioglossum engelmannii	Limestone Adder's-tongue	Vascular Plant	Soil over limestone in open fields, pastures, and cedar glades
Polygala incarnata	Pink Milkwort	Vascular Plant	Dry sand to wet peaty soils, prairie remnants, lake margins, and meadows.
Magnolia acuminata	Cucumber Magnolia	Vascular Plant	Cool moist sites mostly in the mountains
Woodwardia areolata	Netted Chainfern	Vascular Plant	Shaded swamps, wet woods; can grow in slightly brackish water
Isoetes engelmannii	Appalachian Quillwort	Vascular Plant	Intermittent wetlands and soft water lakes in lake plain landscapes
Rhynchospora corniculata var. interior	Short-bristle Horned-rush	Vascular Plant	Swamps, marshes, and shallows, mostly in basic to circumneutral, silty or muddy open sites
Carex straminea	Straw Sedge	Vascular Plant	Low ground, marshes, and swamps
Hypericum denticulatum	Coppery St. John's-wort	Vascular Plant	Sandy soils, pine barrens
Lathyrus venosus	Smooth Veiny Pea	Vascular Plant	Dry sandy soil in open upland woods and prairies

Table 10: Endangered, Threatened and Rare Species in SFBR Watershed

2.7 Review of Relevant Relationships

Topography, Soils, Septic Suitability, and Hydrology

Much of the topography and terrain characteristics have a direct correlation to water quality.

Approximately 60.2% of SFBR contains Highly Erodible Soils. HES are very susceptible to erosion. Nutrients such as phosphorus also commonly erode with soil. Sediments and nutrients that reach creeks, streams and rivers are likely to degrade water quality. HES that are used for animal and/or cropland are more susceptible to soil erosion. If adequate best management practices are not implemented with land use, such as row cropping HES, degradation of water quality is likely.

The southwestern half of the SFBR watershed is composed mostly of karst topography. Karst topography is sensitive to water quality degradation due to the fact that water passes directly into groundwater sources without using soil’s natural filtration to remove nutrients, chemicals, pathogens, and sediment.

Most of the soils in the watershed are rated either somewhat limited or very limited for septic system suitability. Only a small portion of the watershed consists of homes utilizing sewers. Therefore, most homes in the watershed utilize septic systems. This is a concern because adequate filtration may not occur and this water may easily reach water sources and groundwater. Any species utilizing the water sources may be affected or even harmed if contamination levels become too high. To complicate the use of septic systems in areas of somewhat limited and very limited septic suitability, much of these areas containing septic systems also are located in karst areas as well. With a lack of natural filtration of septic fields to groundwater in karst areas, degradation of water quality is likely if septic systems are not maintained. Septic maintenance is a concern of SFBR stakeholders.

Areas with hydric soil are areas that can be considered for locations of wetland creation or enhancement. Wetlands can help address water quality impairments by reducing flooding and also filtering nitrogen, phosphorus, and pesticides from water runoff. With hydric soils contributing to less than 1% of soils in the watershed and most of those acres being located in Washington County, it is not expected to have a major water quality impact.

Because of the karst topography in the southwest portion of the watershed, there are fewer stream miles in this area. With no perennial streams in the Palmyra-Karst Watershed, there is no surface water monitoring data.

Land Use and Planning Efforts

SFBR consists of approximately 45% forested area and nearly 48% agriculture (row crops and hay/pasture). It has been noted that in recent years, the price of corn has increased and this has prompted some hay/pasture ground to be converted to row crops, such as corn and soybeans. Row cropped soil is more susceptible to erosion and typically indicates more fertilizer/chemical use. These are possible pollutants for water sources. Comprehensive plans do not indicate substantial change in land use in the watershed.

With majority of SFBR Watershed consisting of HES, no-till is an important conservation practice on cropland with HES. Tillage transect data for 2015 reports that majority of row cropland is no-till, with Washington County reporting 86% soybean no-till and 81% corn no-till. Harrison County reported 90% soybean no-till and 70% corn no-till. Conventional tillage in soybeans was reported at 5% in Washington County and 2% in Harrison County. Conventional tillage in corn was reported at 10% in Washington County and 14% in Harrison County. Refer to Table 7 for a complete listing of tillage types, acres, and percentages for 2015.

Threatened and Endangered Species
With HES, very limited and somewhat limited septic suitability and karst topography, the habitat for many animals are subject to degradation and sensitive to water quality. Many of the species listed in the threatened and endangered section rely on high water quality in caves, which are very common in karst topography.

South Fork-Blue River was on a list of five streams that were being considered for future hellbender release. After Nick Burgmeier, research biologist and extension wildlife specialist for Purdue University, evaluated the entire stretch of South Fork-Blue River, it was removed from the list due to the significant amount of silt buildup and the lack of interstitial spaces needed for the larval hellbenders. Silt is thought to be a cause of egg failure.

3.0 Watershed Inventory–Part II

3.1 Water Quality Data and Targets

A large portion of the SFBR Watershed Project is to gather historical data and collect new water quality data of the watershed and make it available to stakeholders. Past water monitoring has been completed in SFBR by IDEM.

Numerous target levels are used for different water uses. For this watershed, targets that allow for a thriving aquatic habitat and that SFBR stakeholders can safely recreate whether swimming, fishing, canoeing, etc. are desired. Water quality targets for the SFBR Watershed can be found in Table 11.

Data was also collected by the steering committee, stakeholders and watershed coordinator via windshield and desktop surveys. Windshield surveys were completed by traveling the watershed and noting the location of any potential negative water quality influence as well as identifying the potential negative influence. Desktop surveys were conducted using internet and ArcGIS to evaluate the watershed using aerial imagery.

Parameter	Target	Reference
pH	6.0 to 9.0	Indiana Administrative Code

Parameter	Target	Reference
Dissolved Oxygen	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code
Temperature	Monthly Standard	Indiana Administrative Code
E.coli	<235 colonies/100mL Geometric mean < 125 cfu/100mL	Indiana Administrative Code
Nitrate-Nitrite	1.2 mg/L	Dodds et al. (1998)
Nitrogen-Ammonia	Between 0.0 and 0.21 mg/L depending on temperature and pH	Indiana Administrative Code
Total Kjehldahl Nitrogen (TKN)	<0.591 mg/L	U.S. EPA recommendation
Total Suspended Solids (TSS)	<25 mg/L	Waters T.F. (1995)
Turbidity	10.4 NTU	U.S. EPA recommendation
Total Phosphorus	Max: .076 mg/L	U.S. EPA recommendation
Citizens Qualitative Habitat Evaluation Index (CQHEI)	>60 points	Hoosier Riverwatch
IDEM Qualitative Habitat Evaluation Index (QHEI)	>51 points	IDEM's Consolidated Assessment and Listing Methodology (CALM)
Fish Index of Biotic Integrity (IBI)	>35 points	IDEM's CALM
Macroinvertebrate Index of Biotic Integrity (mIBI)	>35 points	IDEM's CALM
Pollution Tolerance Index (PTI)	>16 points	Hoosier Riverwatch

Table 11: Water Quality Targets for Measured Parameters

3.2 Historical Water Quality Data

IDEM has completed historical water quality monitoring in the South Fork-Blue River Watershed. A summary of these results can be found in this section. Locations of historical sampling sites can be found in Figure 13.

IDEM sampled water chemistry at 5 locations in the South Fork-Blue River watershed. Sampling occurred in South Fork-Blue River at 4 different locations and 1 location on Bear Creek. In 2000, 3 sites on South Fork-Blue River were tested. In 2005, a site in Bear Creek was tested. In 2010, a site on South Fork-Blue River was sampled.

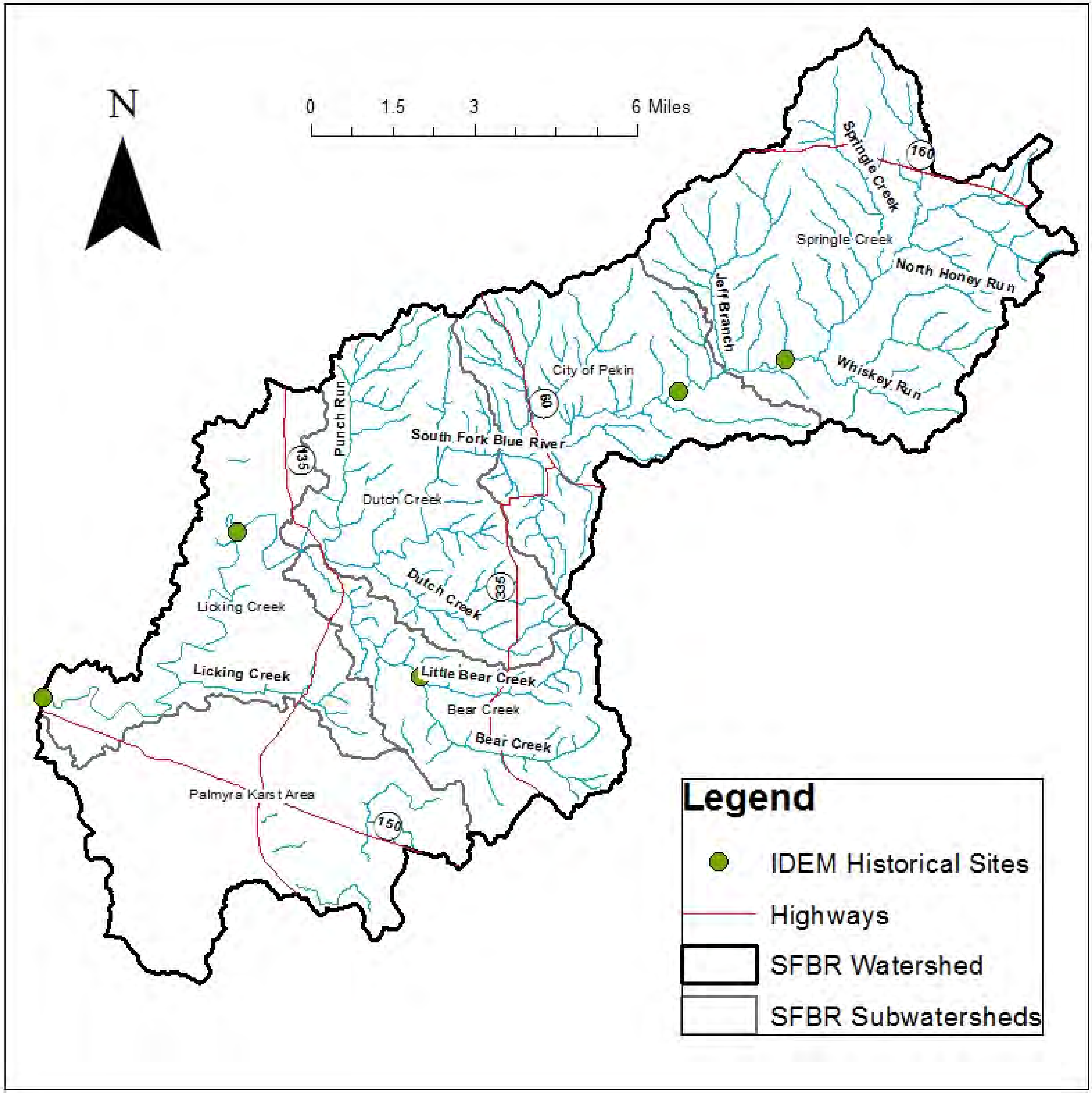


Figure 13: IDEM Historical Water Monitoring Sites

Springle Creek Subwatershed-051401040601

The Springle Creek subwatershed contains one historical water monitoring site (IDEM site # OBS130-0009) located near Misty Hollow Road on South Fork-Blue River. Monitoring events occurred on 6-16-10, 8-2-10, and 9-9-10. TKN was the only water quality parameter that did not meet project targets. Table 12 summarizes water monitoring results for the historical monitoring at the specified location.

	pH	DO (mg/L)	Temp (°C)	Nitrate+ Nitrite (mg/L)	TKN (mg/L)	TSS (mg/L)	Turbidity (NTU)	Total Phosphorus (mg/L)
Average	7.42	6.9	22.44	.24	.85	1.67	-	0
Minimum	7.29	3.55	15.57	0	.31	-1	-	0
Maximum	7.48	9.61	27.24	.67	1.4	3	-	0
# of results	3	3	3	3	3	3	-	3
# times exceeded targets	0	0	0	0	2	0	-	0

Table 12: Historical Water Monitoring Results-Misty Hollow

City of Pekin Subwatershed-051401040602

IDEM site # OBS130-0001 is a historical water monitoring site located in the City of Pekin Subwatershed located near Blue River Road on South Fork-Blue River. Monitoring occurred on 5-24-00, 7-25-00, and 9-12-00. Parameters exceeding targets include TKN, TSS, Turbidity, and Total Phosphorus. Table 13 summarizes water monitoring results for the historical water monitoring at the specified location.

	pH	DO (mg/L)	Temp (°C)	Nitrate+ Nitrite (mg/L)	TKN (mg/L)	TSS (mg/L)	Turbidity (NTU)	Total Phosphorus (mg/L)
Average	7.58	7.49	20.9	.41	.765	20.3	60.3	.114
Minimum	7.03	6.04	19.18	.21	.33	4	4.69	.03
Maximum	7.94	9.23	22.46	.68	1.2	50	116	.25
# of results	3	3	3	3	2	3	2	3
# times exceeded targets	0	0	0	0	1	1	1	1

Table 13: Historical Water Monitoring Results-Lockenour Road

IDEM Fish Community Assessment

There is one historical monitoring report for site # OBS130-0001 located on South Fork-Blue River in City of Pekin Subwatershed. The sampling event occurred at a location on Blue River Road of South Fork-Blue River on 7/25/00. Total IBI score of the sampling event was 44. This score meets SFBR water quality targets. The QHEI score of the sampling event was 63 which also meets the SFBR water quality target.

OWQ/WAPB Macroinvertebrate Community Assessment

A sampling event occurred on 7/25/00 on South Fork-Blue River at a location on Blue River Road in City of Pekin Subwatershed. The mIBI metric score for this event was 4.2, which equates to fully supporting.

Bear Creek Subwatershed-051401040603

IDEM site # OBS130-0007 is a historical water monitoring site located in the Bear Creek Subwatershed near Martinsburg Road on Bear Creek. *E.coli* testing occurred on 6-7-05, 6-14-05, 6-21-05, 6-28-05, and 7-6-05. Chemical water monitoring occurred on 5-31-05, 6-21-05, 7-11-05, 8-09-05, and 9-13-05. Parameters exceeding targets include Nitrate+Nitrite, TSS, Turbidity and *E.coli*. Table 14 summarizes water monitoring results for the historical water monitoring at the specified location.

	pH	DO (mg/L)	Temp (°C)	Nitrate +Nitrite (mg/L)	TKN (mg/L)	TSS (mg/L)	Turbidity (NTU)	Total Phosphorus (mg/L)	*E.coli* (MPN/ 100mL)
Average	7.89	9.16	21.72	1.97	.41	13	2.67	0	781.9
Minimum	7.6	7.31	16.4	1.8	.38	3	0	0	172.3
Maximum	8.5	11.22	28.45	2.2	.43	32	15	0	2419.2
# of results	10	10	10	3	2	3	10	3	5
# times exceeded targets	0	0	0	3	0	1	1	0	4

Table 14: Historical Water Monitoring Results-Martinsburg Road

OWQ/WAPB Macroinvertebrate Community Assessment

A sampling event occurred on 8/9/05 on Bear Creek at site # OBS130-007 on Martinsburg Fire Road in the Bear Creek Subwatershed. The mIBI score for this event was 36. This meets the SFBR water quality target. The QHEI score for the sampling event was 66 which meets the SFBR water quality target.

Licking Creek Subwatershed-051401040606

The Licking Creek subwatershed contains two historical water monitoring sites, one located near Fredericksburg Road and the other located near Big Springs Road. Both of these sampling sites were located on the main stem of South Fork-Blue River. Table 15 summarizes results from water monitoring events held at the Fredericksburg Road (IDEM site # OBS130-0002) on 8-16-13 and Table 16 displays results from events occurring on 7-24-00 and 9-13-00. Parameters exceeding targets include turbidity, TKN, TSS, and Total Phosphorus. Due to the 13 year gap between testing dates, results were displayed in separate tables.

IDEM Site # OBS130-0002	pH	DO (mg/L)	Temp (° C)	Turbidity (NTU)
Average	7.83	7.49	22.72	59.3
Minimum	7.82	7.44	22.71	N/A
Maximum	7.84	7.54	22.74	N/A
# of results	2	2	2	1
# times exceeded targets	0	0	0	1

Table 15: 2013 Historical Water Monitoring Results-Fredericksburg Road

	pH	DO (mg/L)	Temp (° C)	Nitrate+ Nitrite (mg/L)	TKN (mg/L)	TSS (mg/L)	Turbidity (NTU)	Total Phosphorus (mg/L)
Average	8.18	7.8	21.03	1.35	1	32.5	47.75	.201
Minimum	8.11	7.08	19.76	1.3	1	21	17	.092
Maximum	8.25	8.51	22.29	1.4	1	44	78.5	.31
# of results	2	2	2	2	1	2	2	2
# times exceeded targets	0	0	0	0	1	1	2	2

Table 16: 2000 Historical Water Monitoring Results-Fredericksburg Road

IDEM site # OBS130-0003 is in South Fork-Blue River on Big Springs Road. This location is upstream from IDEM site # OBS130-0002. Table 17 summarizes results at the Big Springs Road location from testing performed on 5-17-00, 8-1-00, and 9-26-00. Parameters exceeding targets include Nitrate+Nitrite, TKN, TSS, Turbidity, and Total Phosphorus.

	pH	DO (mg/L)	Temp (° C)	Nitrate+ Nitrite (mg/L)	TKN (mg/L)	TSS (mg/L)	Turbidity (NTU)	Total Phosphorus (mg/L)
Average	7.6	11.25	18.13	1.34	.77	16.3	18.76	.109
Minimum	7.5	6.45	14.53	.73	.33	5	5.69	.045
Maximum	7.9	9.49	22.51	1.8	1.6	38	36.7	.22
# of results	3	3	3	3	3	3	3	3
# times exceeded targets	0	0	0	2	1	1	2	1

Table 17: 2000 Historical Water Monitoring Results-Big Springs Road

OWQ/WAPB Macroinvertebrate Community Assessment

There are two historical monitoring reports for a sampling location on South Fork-Blue River in Licking Creek Subwatershed. A sampling event on 7/24/00 at site # OBS130-002 on South Fork-Blue River in Licking Creek Subwatershed reported that the mIBI metric score was 2.4 which equates to moderately impaired. The QHEI score for the sampling event was 50 which does not meet the SFBR water quality target. A sampling event at the same site on 8/6/13 reported an mIBI Metric Score of 34 which does not meet the SFBR water quality target. The QHEI score for the sampling event was 64 which meets the SFBR water quality target

IDEM Fish Community Assessment

There are three historical monitoring reports for a sampling location on South Fork-Blue River in Licking Creek Subwatershed. The sampling events occurred at site # OBS130-002 near Fredericksburg Road of South Fork-Blue River on 7/24/00, 9/6/00 and 8/6/13 and total IBI scores of all 3 sampling events were 36, 36, and 44 respectively. These scores meet SFBR water quality targets. The QHEI score for the event on 7/24/00 was 50, which does not meet SFBR water quality targets. The QHEI score for the event on 9/6/00 was 59 and the score for the event on 8/6/13 was 69, which both meet SFBR water quality targets.

Discussion of Historical Data

IDEM historical water monitoring data indicates that SFBR targets have been exceeded in the Licking Creek and Bear Creek subwatersheds for Nitrate+Nitrite for a total of 5 sampling events (36%) in 2000 and 2005.

Targets were exceeded for TKN in subwatersheds of Licking Creek, City of Pekin, and Springle Creek for a total of 5 sampling events (45%). The most recent data recorded with an exceedance for TKN occurred in the Springle Creek Watershed in 2010.

TSS targets were exceeded in subwatersheds of Licking Creek, Bear Creek, and City of Pekin for a total of 4 events (29%). All exceedances occurred in 2000 and 2005.

Turbidity targets were exceeded at 7 sampling events (39%) in Licking Creek, Bear Creek, and City of Pekin Subwatershed. The Licking Creek Subwatershed exceedance was the only recent of the recorded exceedances, which occurred in 2013.

Total phosphorus target was exceeded at 4 (29%) sampling events in the Licking Creek and City of Pekin subwatersheds occurring in 2000.

Bear Creek was the only subwatershed with *E.coli* historical monitoring occurring in 2005. Out of a total of 5 sampling events, 4 received results that exceeded the SFBR water quality targets.

Chemical water monitoring data collected from years 2000 and 2005 may not be considered relevant due to age of the data.

Biological data was collected from sampling events ranging from 2000 to 2013. A sampling event in 2013 at IDEM site # OBS130-0003 in the Licking Creek Subwatershed did not meet water quality targets established for mIBI. At the same site also in 2013, a fish IBI score was obtained that met water quality targets.

In 2005, a sampling event on IDEM site # OBS130-0007 in the Bear Creek Subwatershed resulted in a mIBI score that met the water quality target. Biological water monitoring data from years 2000 and 2005 may not be considered relevant due to age of the data.

Overall, there is minimal historical water quality data to be considered for the entire South Fork-Blue River Watershed.

3.3 Current Water Quality Data

IDEM 303(d) list of Impaired Waterbodies
According to the 2014 303(d) list of impaired waterbodies, SFBR contains approximately 38 miles of impaired waters. Bear Creek is listed as impaired for 20.4 miles, Little Bear Creek is listed as impaired for 10.8 miles and South Fork-Blue River for 6.4 miles.

The segments of South Fork-Blue River contain impaired biotic communities (IBC) and are impaired for dissolved oxygen (DO). Little Bear Creek and Bear Creek are impaired for *E.coli*.

The following are descriptions of impairments found in SFBR Watershed

Impaired Biotic Communities: “Biological communities – the fish and aquatic invertebrates, such as insects, in stream – are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana’s 303(d) list, means IDEM’s monitoring data shows one or both of the aquatic communities are not as healthy as they should be. Although an IBC is a direct measure of aquatic life use impairment, often the sources of these impairments are unknown.” (IDEM, 2015)

Dissolved Oxygen: “The amount of DO in surface waters is important. Aquatic organisms depend on DO in the water to breathe. A DO listing on Indiana’s 303(d) list means IDEM’s monitoring data shows the concentrations of DO is lower than needed to support the aquatic communities. IDEM evaluates DO data in two ways for the purpose of making water quality assessments. Low DO concentrations are evaluated against the state’s Water Quality Standards (WQS) for DO to determine whether the waterbody in question is capable of supporting aquatic life. DO results are also evaluated in combination with other parameters to determine the degree to which nutrient enrichment may be impacting the waterbody.” (IDEM, 2015)

E.coli: “E. coli is a bacteria present in the feces of warm-blooded animals. E. coli in surface waters indicates the presences of pathogens that can cause illness in humans. An E. coli listing on Indiana’s 303(d) list means IDEM’s monitoring data shows the concentration of E. coli is higher than allowed in the state’s WQS.” (IDEM, 2015)

Impairments are divided into one of four impairment categories. These categories include recreational use impairment, aquatic life use impairment, drinking water use impairment, and fish consumption use impairment.

E.coli is designated as a recreational use impairment. “Recreational use impairments indicate that a waterbody is not fully supporting recreational uses such as swimming, fishing and boating – uses that involve bodily contact with the water.” (IDEM, 2015)

Dissolved Oxygen and impaired biotic communities are designated as an aquatic life use impairment. “Aquatic Life Use Impairments include both direct and indirect evidence of impairment to the aquatic ecosystem. Direct measures include impairment of one or more aquatic communities including fish and/or macroinvertebrates. Indirect measures are those indicating impairment resulting from chemical and/or other conditions that have the potential to negatively impact the ability of a waterbody to support a healthy aquatic community.” (IDEM, 2015)

The 2018 Draft 303(d) list has had several miles of impairments added due to additional TMDL sampling and reassessment for a total of 143.54 miles. Impairments include *E.coli*, IBC, and *E.coli* + IBC. DO was removed from the list. See Figure 14 for a map of the impairments.

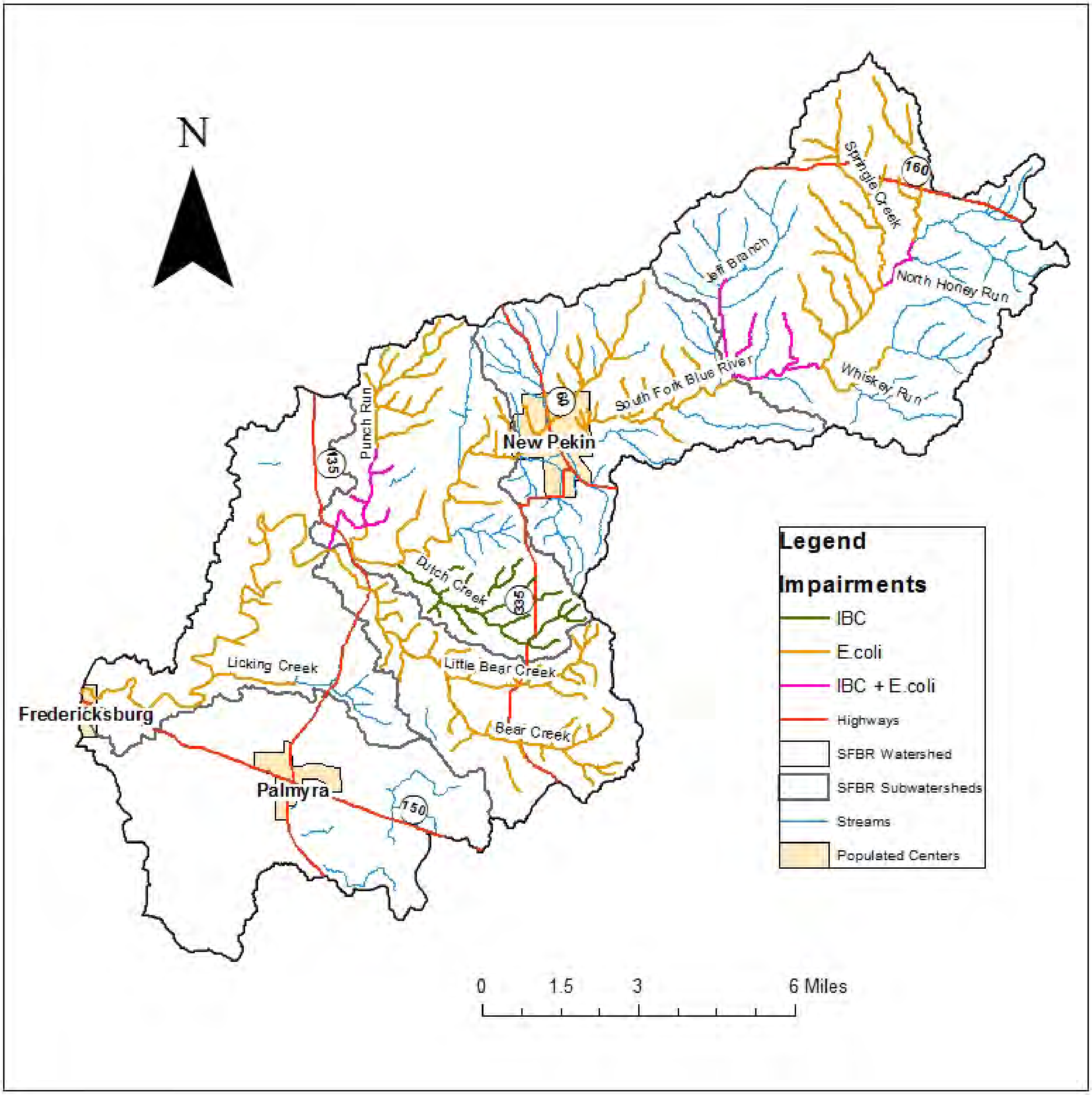


Figure 14: 2018 Draft 303(d) Impaired Segments

Current Water Monitoring Locations

Twenty-three different sites were monitored within the SFBR watershed. Twenty-one of the sites were chosen by IDEM for the TMDL sampling. Pour point sites were sampled monthly for 12 months and target sites were sampled monthly from April-October. Four sites were chosen for volunteer monitoring. Sampling occurred by both IDEM and volunteers at 2 sites. The sites are listed in Table 18 and shown graphically in Figure 15.

Site #	IDEM (IDEM # or Volunteer)	Location Description	Stream Name	Coordinates (Latitude Longitude)	IDEM Site Type (Pour point vs target
1	IDEM	Fredericksburg Road	South Fork-Blue River	38.434 -86.183	pour point
2	IDEM	Palmyra Road	South Fork-Blue River	38.448 -86.135	target
3	IDEM	Palmyra Road	Licking Creek	38.437 -86.129	target
4	IDEM	Wetzel Road	Bear Creek	38.427 -86.050	target
5	IDEM	Martinsburg Fire Road	Bear Creek	38.440 -86.057	target
6	IDEM	State Road 135	Bear Creek	38.461 -86.081	pour point
7	IDEM	Dutch Creek Road	Dutch Creek	38.463 -86.066	target
8	IDEM	State Road 135	Bear Creek	38.478 -86.093	pour point
9	IDEM/ Volunteer	Big Springs Road	South Fork-Blue River	38.480 -86.112	target
10	IDEM	Shorts Corner Road-Punch Run	Punch Run	38.500 -86.079	target
11	IDEM	Martinsburg Road	South Fork-Blue River	38.498 -86.036	target
12	IDEM	Shorts Corner Road	Tributary of South Fork-Blue River	38.505 -86.020	target
13	IDEM/ Volunteer	Mahuron Road	Tributary of South Fork-Blue River	38.508 -86.015	target
14	IDEM	Main Street-Pekin	South Fork-Blue River	38.500 -86.009	target
15	IDEM	Lockenour Road	South Fork-Blue River	38.512 -85.975	pour point
16	IDEM	E Blue River Road	Jeff Branch	38.524 -85.953	target
17	IDEM	Bowers Knob Road	South Fork-Blue River	38.520 -85.939	pour point
18	IDEM	Bethel Road	Jeff Branch	38.538 -85.956	target
19	IDEM	North Honey Run Road	Honey Run	38.525 -85.898	target
20	IDEM	Blue River Road	Springle Creek	38.5464 -85.898	target
21	IDEM	Casey Hollow Road	Poplar Branch	38.552 -85.888	target
22	Volunteer	Lisa Lane	South Fork-Blue River	38.480 -86.151	-
23	Volunteer	Shorts Corner Road-Pekin UMC Church	Tributary of South Fork-Blue River	38.507 -86.018	-

Table 18: Volunteer and IDEM Water Monitoring Sites

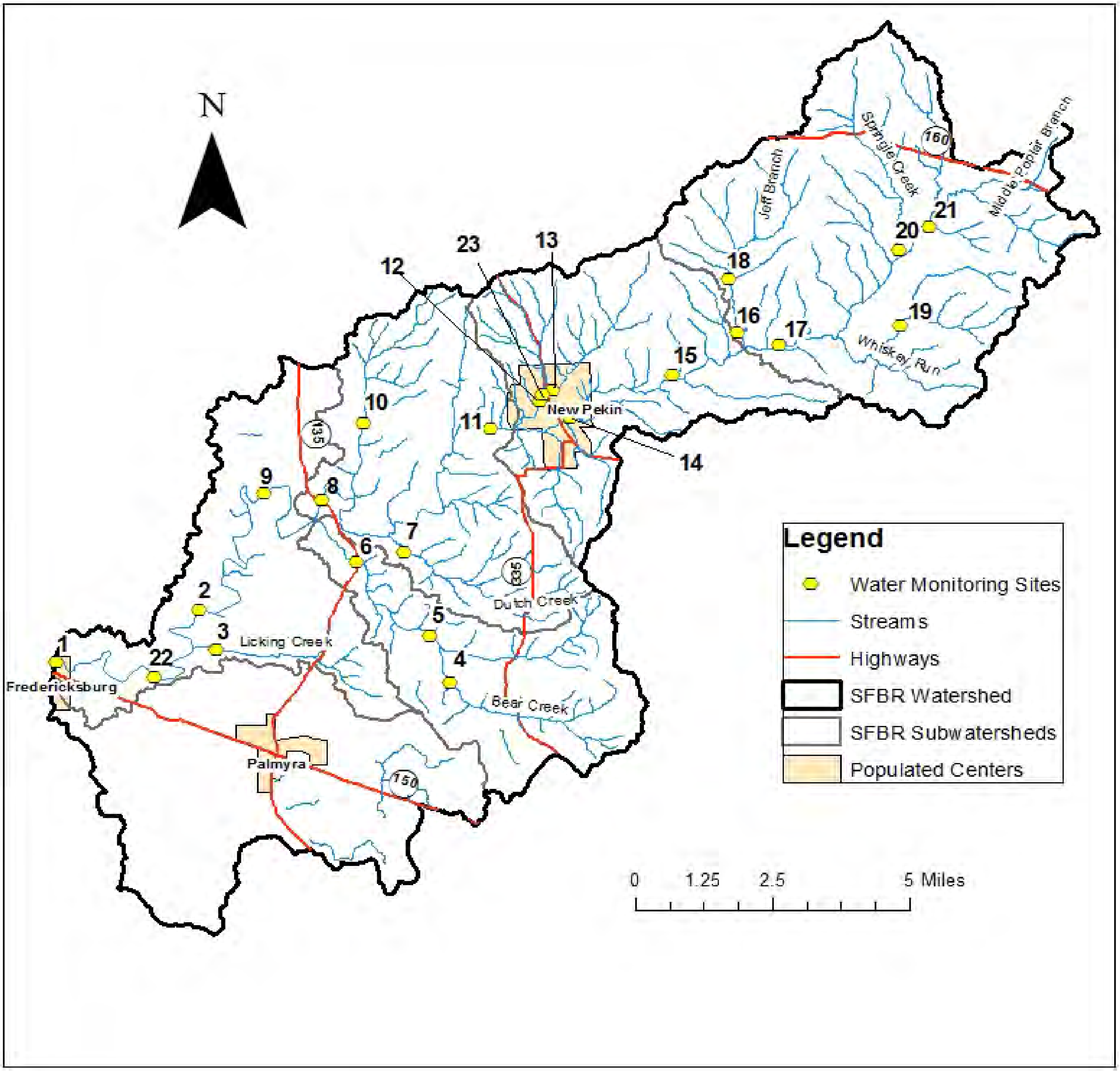


Figure 15: Water Monitoring Locations

Volunteer Water Monitoring

Volunteers from the West Washington FFA and East Washington FFA completed water monitoring at 4 sites (site #'s 9, 13, 22, and 23) within the SFBR watershed using Hoosier Riverwatch methods. Locations were determined by proximity to volunteers, stream access permission granted, and variations of up-stream land use. Volunteer water monitoring is an excellent way to involve and educate stakeholders.

Each sampling session included chemical monitoring and stream flow calculation when conditions allowed. Habitat evaluation and biological monitoring occurred approximately once per year. Sampling protocol followed Hoosier Riverwatch procedures found in the handbook "Volunteer Stream Monitoring Training Manual" (IDEM, Hoosier Riverwatch, 2015). Chemical parameters included the following: dissolved oxygen, biological oxygen demand (five (5) day), *E.coli* bacteria, pH, temperature and temperature change, orthophosphate, nitrate, nitrite, and turbidity.

Sampling dates occurred approximately once per month, depending on flow and availability of volunteers. Dissolved oxygen, pH, temperature and temperature change, orthophosphate, nitrate, nitrite, and turbidity were collected and analyzed by Riverwatch Volunteers at the site using Riverwatch methods. The biological oxygen demand (five (5) day) and *E.coli* bacteria samples were then collected by the coordinator and/or a volunteer who conducted the *E.coli* and BOD 5 day tests off site. Macroinvertebrate sampling was completed once between the months of May-October at the testing sites, except for the site on Big Springs Road, which has no access to the stream other than from the bridge.

The sampling dates will not correspond to rainfall-runoff events due to high flow, which is not a safe condition for volunteers using Hoosier Riverwatch techniques to calculate stream flow or sample the macroinvertebrate community. If there is a high flow on the chosen testing day, testing will be re-scheduled for the next week if available.

IDEM Water Monitoring
Methods:

Water Chemistry

The following parameters were measured for each of the 21 sites: pH, dissolved oxygen, temperature, nitrate-nitrite, Total Kjehldahl Nitrogen (TKN), total suspended solids (TSS), turbidity, and total phosphorus. Pour points are an outlet of a subwatershed or common point where all the water flows out of any given subwatershed. Pour point sites were chosen at the nearest bridge to the pour point. Targeted sites are sites that are intentionally selected based on specific monitoring objectives or decisions to be made.

During the months of November through March, only sites at the pour point of each 12 digit HUC were sampled monthly. The first sampling event was conducted in November of 2014 and the study concluded in October 2015.

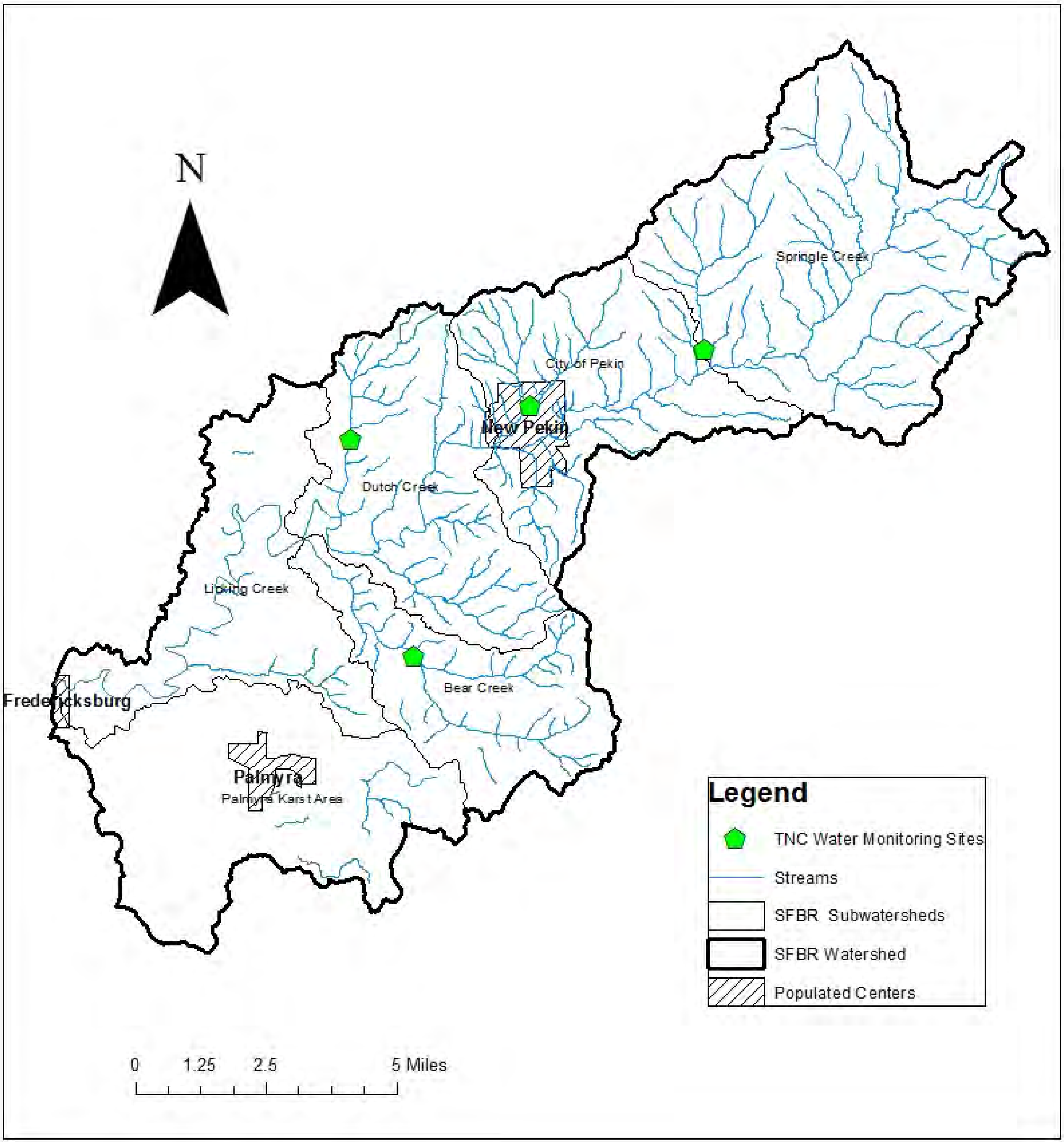
Escherichia coli (E.coli) testing took place monthly from April through October 2015 at all sites in the watershed. In addition, *E.coli* samples were collected five times for each site at equally spaced intervals over a 30-day period during the recreational season of April to October 2015 to determine a geometric mean.

Data results from IDEM water monitoring for chemical and biological parameters can be found in Section 4.0 as part of subwatershed discussions.

Microbial Source Tracking
TNC partnered with the South Fork-Blue River Watershed Project to sample four locations within the watershed to narrow down possible hosts that contribute to fecal pollution in streams. Connecting the *E.coli* found in streams of the watershed to its source could be a great benefit in determining the best way to remediate the concern. Sites chosen were upstream from any point sources such as waste treatment plants so that TNC results would not be influenced by point sources. With a limited amount of funds, not all possible sources could be tested for. Sources chosen to test for were human, ruminant, and chicken/turkey. The steering committee, TNC and watershed coordinator discussed possible sites and markers to test for and felt with land use and windshield surveys of the watershed, these would be

the most likely sources of *E.coli*. Figure 16 shows graphically where the monitoring locations are located.

Figure 16: TNC Microbial Source Tracking Monitoring Locations



The Nature Conservancy *E.coli* DNA-Blue River Road Springle Creek Subwatershed		
	November 2015	April 2016 (Turkey markers included)
Human	Trace	Trace
Chicken	Not Detected	Not Detected
Ruminant	Not Detected	Low Concentration
The Nature Conservancy *E.coli* DNA-Mahuron Road City of Pekin Subwatershed		
	November 2015	April 2016 (Turkey markers included)
Human	Low Concentration	Trace
Chicken	Not Detected	Not Detected
Ruminant	Not Detected	Low Concentration
The Nature Conservancy *E.coli* DNA-Shorts Corner Road Dutch Creek Subwatershed		
	November 2015	April 2016 (Turkey markers included)
Human	Trace	Low Concentration
Chicken	Not Detected	Not Detected
Ruminant	Not Detected	Not Detected
The Nature Conservancy *E.coli* DNA-M-burg Fire Road Bear Creek Subwatershed		
	November 2015	April 2016 (Turkey markers included)
Human	Trace	Trace
Chicken	Not Detected	Not Detected
Ruminant	Low Concentration	Low Concentration

Table 19: TNC E.coli Microbial Source Tracking Results

Table 19 above summarizes the finding of the water monitoring completed. After the first round of sampling was completed in November of 2015, the lab requested a local turkey fecal sample to ensure the turkey marker was able to be picked up in the testing. No *E.coli* originating from chicken or turkey was identified with any samples. Ruminant *E.coli* was detected at least once at sites on Blue River Road, Mahuron Road, and Martinsburg Fire Road. Human *E.coli* was detected at all sites and all testing events.

3.4 Land Use Information

SFBR Watershed is mostly rural with only 3 populated cites/towns. The watershed is mostly used for agriculture and forests. Land use trends are not projected to change significantly. Some land uses and potential pollution sources are discussed below.

Brownfield Sites

According to the IDEM website found at http://www.in.gov/ifa/brownfields/2362.htm, "Generally, a brownfield is a property where redevelopment is complicated due to actual or potential environmental contamination. Indiana defines a brownfield as:

- 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." (IDEM, 2015)

SFBR has 4 sites identified as brownfield sites. The sites are as follows: Green Gas Station, Main Gas Station, Coleman Motors, and Eastside Grocery. All four are located in the Palmyra Karst subwatershed. The first three mentioned are located within the Town of Palmyra limits.

See Figures 17, 18, and 19 below for SFBR Brownfield site locations.

Leaking Underground Storage Tank (LUST) Sites
"An Underground Storage Tank (UST) is a tank or combination of tanks which hold regulated substances and have at least ten percent of their volume underground, including underground piping connected to the tank. USTs that contain petroleum or hazardous substances are regulated by IDEM."

"A release "priority" is assigned to every release reported to IDEM. Priority rankings are assigned by IDEM based on information submitted by the responsible party and/or their consultant. Priority rankings are used by IDEM to determine resource needs.
"High" – Sites with one of the following conditions:

  - measureable free product;
  - drinking water impacts;
  - surface impacts; or
  - vapors in buildings or utilities.

- "Medium" – Ground water contamination is present.
- "Low" – Only Soil Contamination is present.
- "Unknown" – Inadequate information is available to make a priority determination." (IDEM, 2015)

According to the IDEM "UST Branch Report" at http://www.in.gov/idem/landquality/2367.htm, there are eleven locations identified as LUST sites with 14 incidents. The reported incidents reports were ranked as 7 low priority, 2 medium priority, 3 high priority, 1 spill, and 1 unknown.

See Figures 17, 18, and 19 below for SFBR LUST site locations.

National Pollution Discharge Elimination System (NPDES) Facilities and Permit Compliance
"The State of Indiana's efforts to control the direct discharge of pollutants to waters of the State were inaugurated by the passage of the Stream Pollution Control Law of 1943. The vehicle currently used to control direct discharges to waters of the State is the NPDES (National Pollutant Discharge Elimination System) Permit Program."

"These permits place limits on the amount of pollutants that may be discharged to waters of the State by each discharger. These limits are set at levels protective of both the aquatic life in the waters which receive the discharge and protective of human health." (IDEM 2015)

In SFBR, there are two locations where NPDES facilities are permitted to discharge in compliance with the Clean Water Act. One facility is the Palmyra Municipal Wastewater Treatment Plant located in the Palmyra Karst Area Subwatershed and discharges into an unnamed sinkhole. The other facility is the New Pekin Wastewater Treatment Plant located in the City of Pekin Subwatershed and discharges into

South Fork-Blue River. Both facilities are in compliance with the NPDES permit. See Figures 17, 18, and 19 below for facility and site locations.

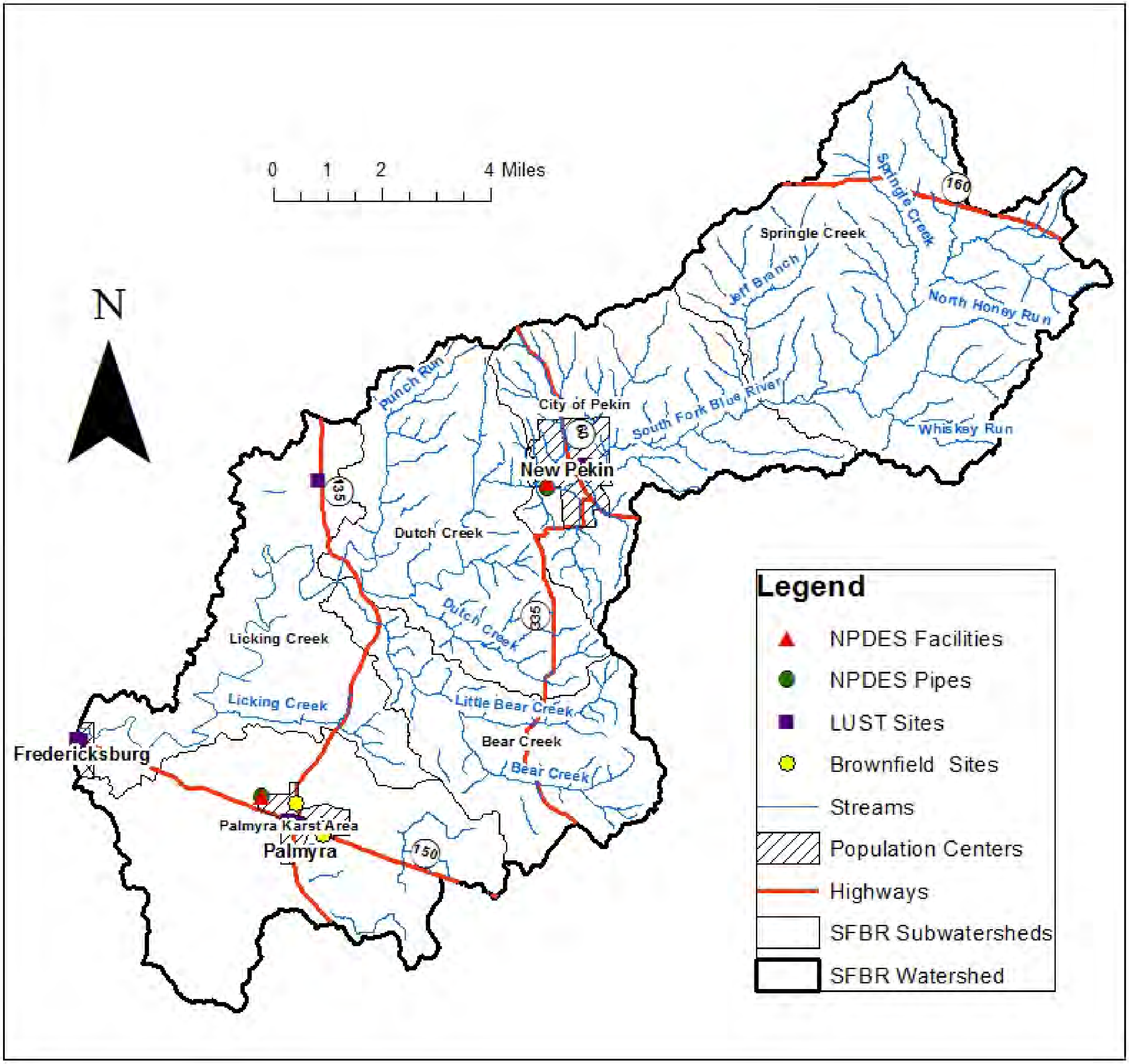


Figure 17: NPDES Facilities, NPDES Pipes, LUST Sites and Brownfield Sites

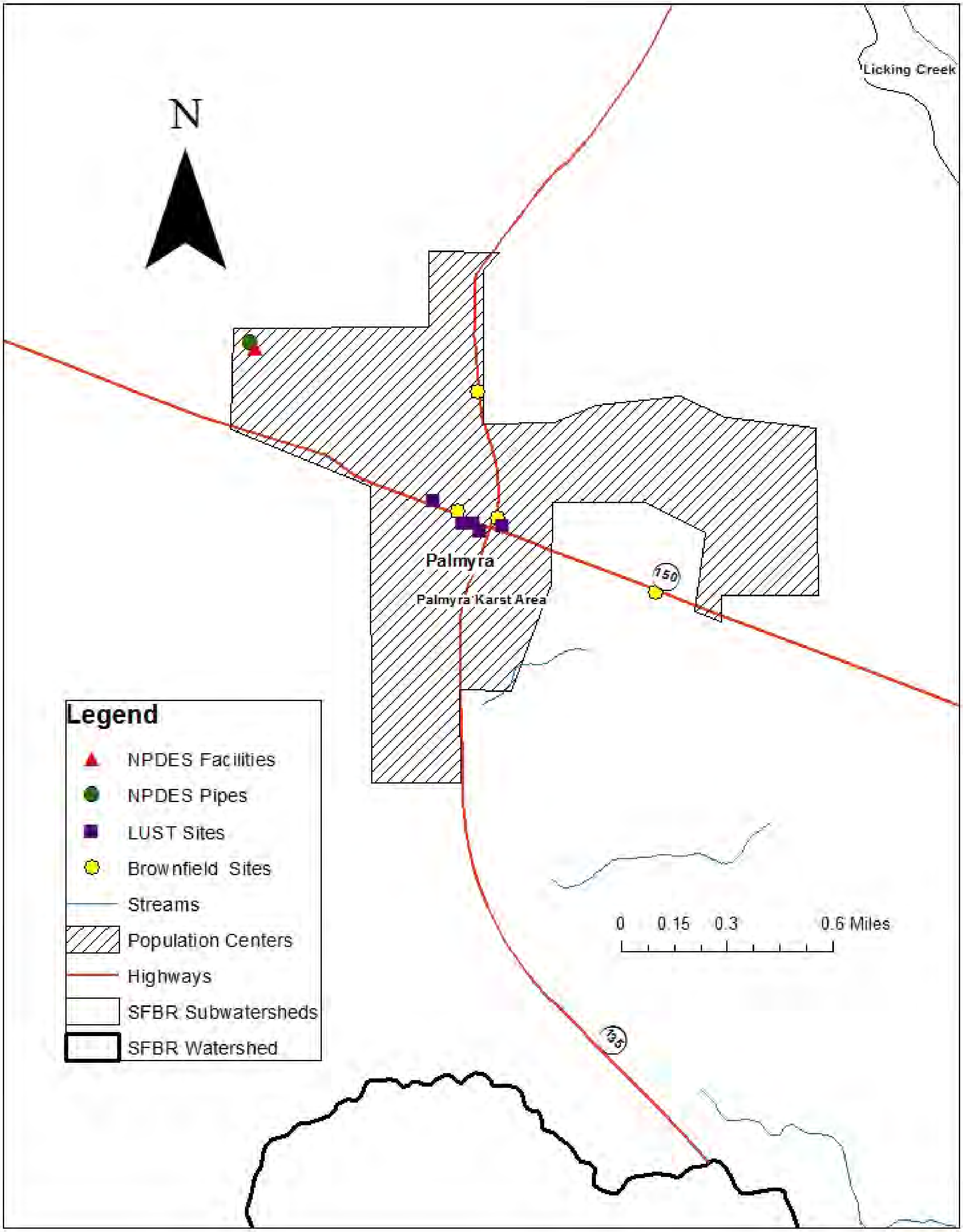


Figure 18: NPDES Facilities and Pipes, LUST Sites, and Brownfield Sites, w/in Palmyra

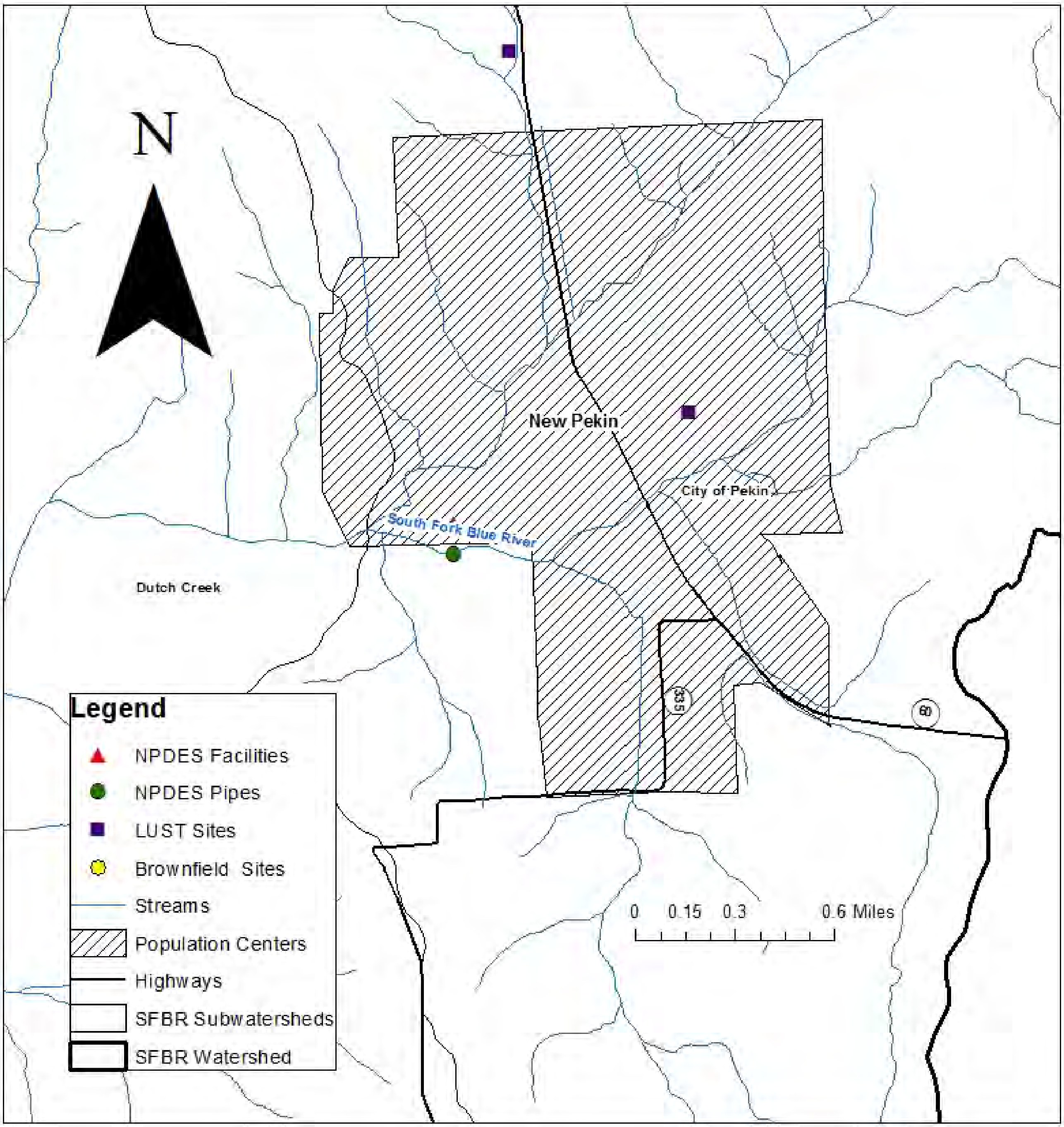


Figure 19: NPDES Facilities and Pipes, LUST Sites, and Brownfield Sites, w/in New Pekin

Animal Feeding Operations, Confined Feeding Operations (CFOs) and Concentrated Animal Feeding Operations (CAFOs)

According to the EPA, "Animal Feeding Operations (AFOs) are agricultural operations where animals are kept and raised in confined situations. AFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land." (EPA, 2015)

Regulated AFOs are divided into 2 categories, Concentrated Animal Feeding Operations (CAFOs) and Confined Feeding Operations (CFOs).

"In Indiana, an animal feeding operation with 300 or more cattle, 600 or more swine or sheep, 30,000 or more poultry, or 500 horses in confinement is a CFO. A person must request and receive IDEM approval before starting construction of a CFO, or starting expansion of a CFO to increase animal population or manure storage capacity." (IDEM, 2015)

"The terms CFO and CAFO relate to the size of the CFO. A Concentrated Animal Feeding Operation (CAFO) is a CFO that meets the threshold animal numbers for a large CAFO in the chart below. Many of the program's requirements apply to CFOs of all sizes. Some requirements apply only to CAFOs.

CAFO Threshold Numbers:

- 700 mature dairy cows
- 1,000 veal calves
- 1,000 cattle other than mature dairy cows
- 2,500 swine above 55 pounds
- 10,000 swine less than 55 pounds
- 500 horses
- 10,000 sheep or lambs
- 55,000 turkeys
- 30,000 laying hens or broilers with a liquid manure handling system
- 125,000 broilers with a solid manure handling system
- 82,000 laying hens with a solid manure handling system
- 30,000 ducks with a solid manure handling system
- 5,000 ducks with a liquid manure handling system" (IDEM, 2015)

SFBR currently contains 7 permitted CFOs and 4 permitted CAFOs. See Figure 20 below for locations of CFOs and CAFOs within the SFBR Watershed. Ten of these 11 operations are located on or near a river, stream, or tributary of SFBR. In addition, the watershed contains a large number of livestock operations, including cattle and poultry that are not of CFO/CAFO size. These unpermitted farms have the potential to impact water quality.

Access of livestock to streams and application of manure/litter are water quality concerns of stakeholders. According to *Indiana Agricultural Statistics 2013-2014*, Washington County ranks 1st in beef cattle production (7th all cattle), 7th in chicken production, and 7th in turkey production. Harrison County ranks 2nd in beef cattle production (6th all cattle) and 17th in chicken production. Run-off from manure/litter application to land, erosion/run-off from overgrazed pastures, direct deposit of feces from livestock with access to streams, run-off from decomposing livestock, and streambank erosion from animal with access to streams are all potential sources of non-point source pollution in relation to livestock.

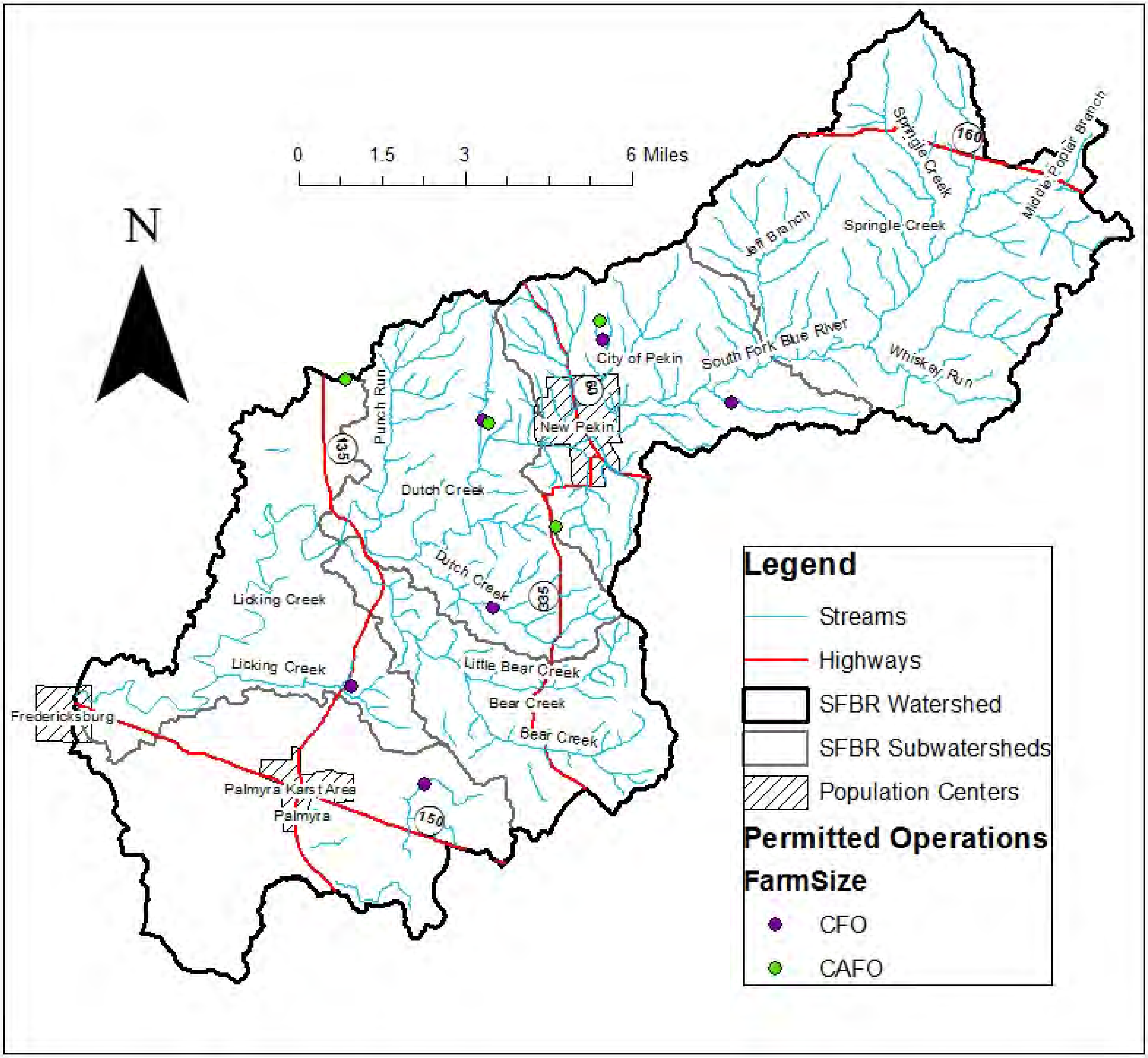


Figure 20: SFBR Permitted Livestock Operations

Fertilizer Use on Non-Urban/Suburban Land Use

SFBR Watershed contains 45.5% forests and 48.6% used for agriculture. Agriculture use consists of cultivated crops, hay and pasture.

Both manure and commercial fertilizers are used in this watershed on agricultural land. According to the Office of Indiana State Chemist, in 2014 a total of 27,514.79 tons of fertilizer was applied on Harrison and Washington County land. Clark, Scott, and Floyd County fertilizer rates were not included due to the minimal amount of agricultural land in the watershed. (Table 20)

County	Total Fertilizer Applied (tons)	Total Nitrogen (N) applied (tons)	Total Phosphorus (P_2O_5) Applied (tons)	Total Potassium (K_2O) Applied (tons)
Harrison	16,409.93	3,219.98	1,877.88	2,698.59
Washington	11,104.86	2,269.59	1,329.12	1,609.72
Total	**27,514.79**	**5,489.57**	**3,207.0**	**4,308.31**

Table 20: Fertilizer Use in Washington and Harrison Counties (totals for entire counties)

Streambank Needing Stabilization and Stream Miles Needing Buffers

Desktop and windshield surveys were conducted by stakeholders, steering committee members, and the watershed coordinator to determine the need for stabilization of streambanks and stream miles needing buffers in the watershed.

Figure 21 illustrates locations in the watershed where approximately 20 feet or less of stream buffer was identified by windshield survey. Figure 22 illustrates stream locations where buffers are estimated to be < 20 feet by desktop survey. Blue segments were determined to have a buffer of more than 20 feet.

Figure 21 also illustrates locations identifed with active streambank erosion. Because not all private land could be accessed for the windshield survey, a number of locations in the watershed could not be evaluated for streambank erosion.

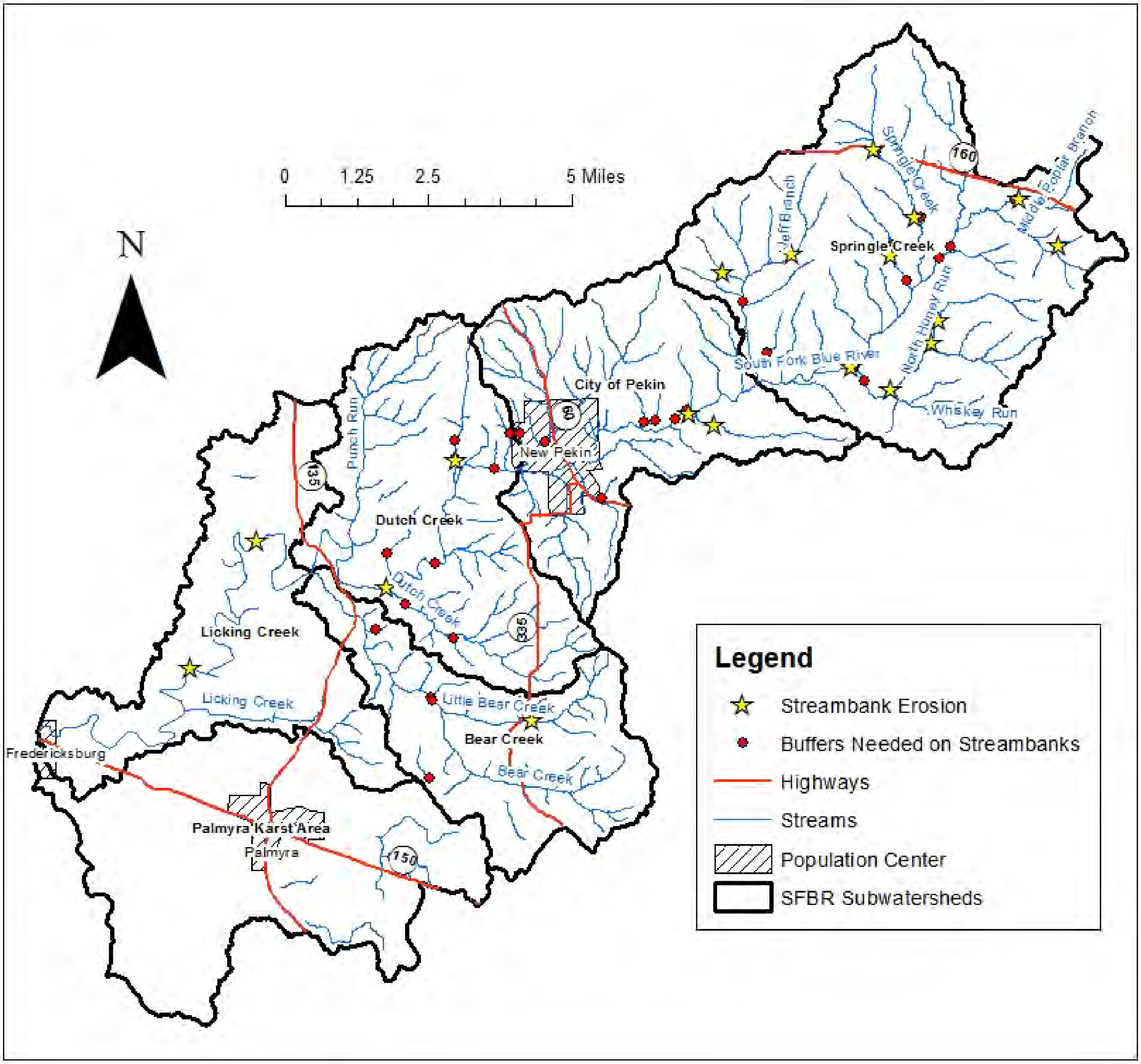


Figure 21: SFBR Streambank Erosion and Buffers <20 Feet by Windshield Survey

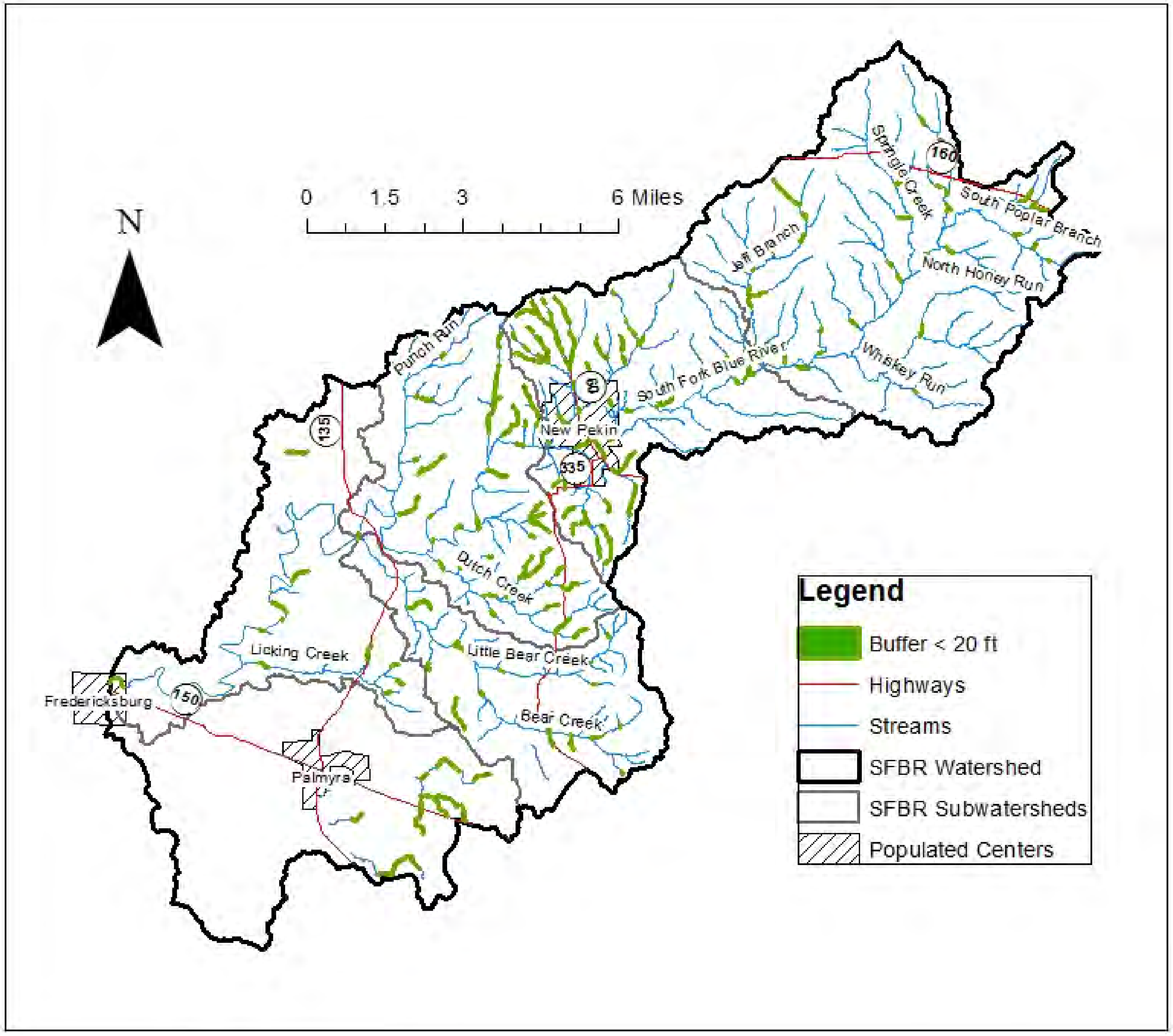


Figure 22: SFBR Stream Buffers < 20 Feet by Desktop Survey

Watershed Inventory–Part III

Land use information
The South Fork-Blue River Watershed consists of six subwatersheds. Each subwatershed has its own set of unique characteristics, as well as characteristics that are similar to the other subwatersheds. Each subwatershed is discussed more in depth in this section as well.

4.1 Springle Creek- HUC 051401040601

The Springle Creek Subwatershed is located on the northeastern portion of the SFBR Watershed and contains 20,937 acres. Springle Creek is located mainly in Washington County with a small acreage reaching Scott and Clark Counties. South Fork-Blue River originates and is the main stream that runs through the Springle Creek subwatershed. The Springle Creek subwatershed is also comprised of Jeff Branch, Whiskey Run, Springle Creek, South Poplar Branch, and many unnamed tributaries.

Information from the land use data shows this watershed consists of cultivated crops (2,029.8 acres, 9.7%), developed land (828.4 acres, 3.9%), Forest (13,553.6 acres, 64.7%), Hay/Pasture (4,306.2 acres, 20.6%), Open Water (59.8 acres, 0.3%), Shrub/Scrub (174.8 acres, .8%), and Wetlands (.2 acres, <.1%). The Springle Creek subwatershed has the largest number of acres and largest percentage of acres of forest in the SFBR Watershed. Cultivated crops and hay/pasture ground are concentrated along the streams where the topography is not as steep. (Figure 23)

There is one CFO-sized permitted operation in the subwatershed. (Figure 24) The majority of the watershed is comprised of highly erodible soils, with most of the not highly erodible soil located on the main stem of South Fork-Blue River. (Figure 7) Soils of the subwatershed are labeled very limited or somewhat limited for septic suitability. (Figure 9) With no sewered areas, the entire subwatershed is serviced by septic systems.

Table 21 summarizes windshield survey findings from windshield surveys conducted in the fall of 2015. Most often occuring potential water quality influences were overgrazing of pastures, livestock with access to streams, active stream bank erosion and row crops within 20 feet of a stream. (Figure 24)

Potential Water Quality Influence	# of times identified in subwatershed	Observer
Overgrazing of pasture	13	Steering Committee
Gully erosion in crop field	3	Steering Committee
Livestock with access to stream	9	Steering Committee
Active Stream Bank Erosion	14	Steering Committee
Row crop within 20 feet of stream	11	Steering Committee
Possible Timber Stand Improvement (TSI) needed	1	Steering Committee
Log Jam	2	Steering Committee

Table 21: Springle Creek Subwatershed Windshield Surveys

A total of 35.51 miles of streams in the Springle Creek subwatershed are listed on the Draft 2018 303(d) list. 27.53 miles are impaired for *E.coli* and 7.98 miles are listed for *E.coli* and IBC impairments (Figure 24).

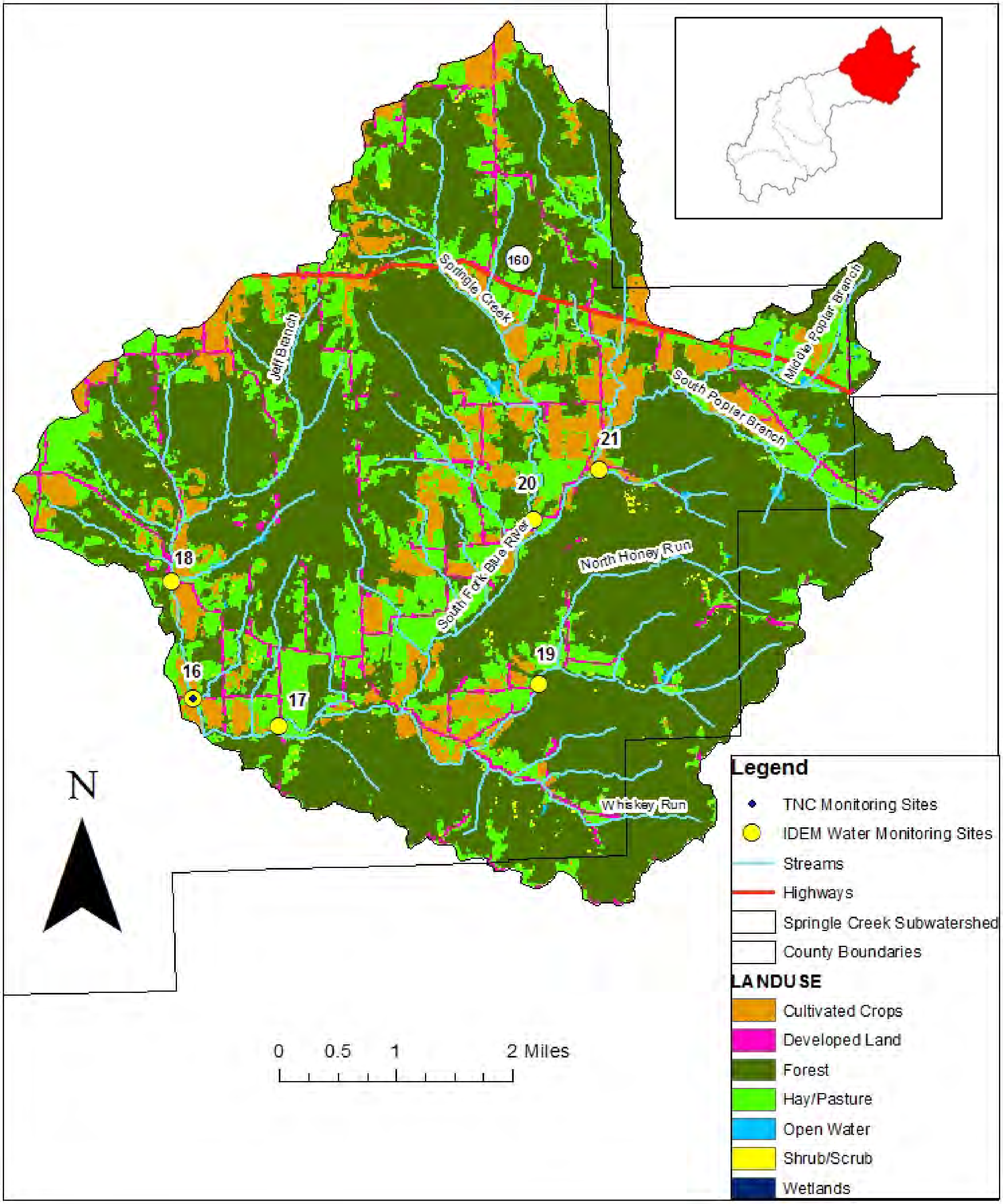


Figure 23: Springle Creek Land Use

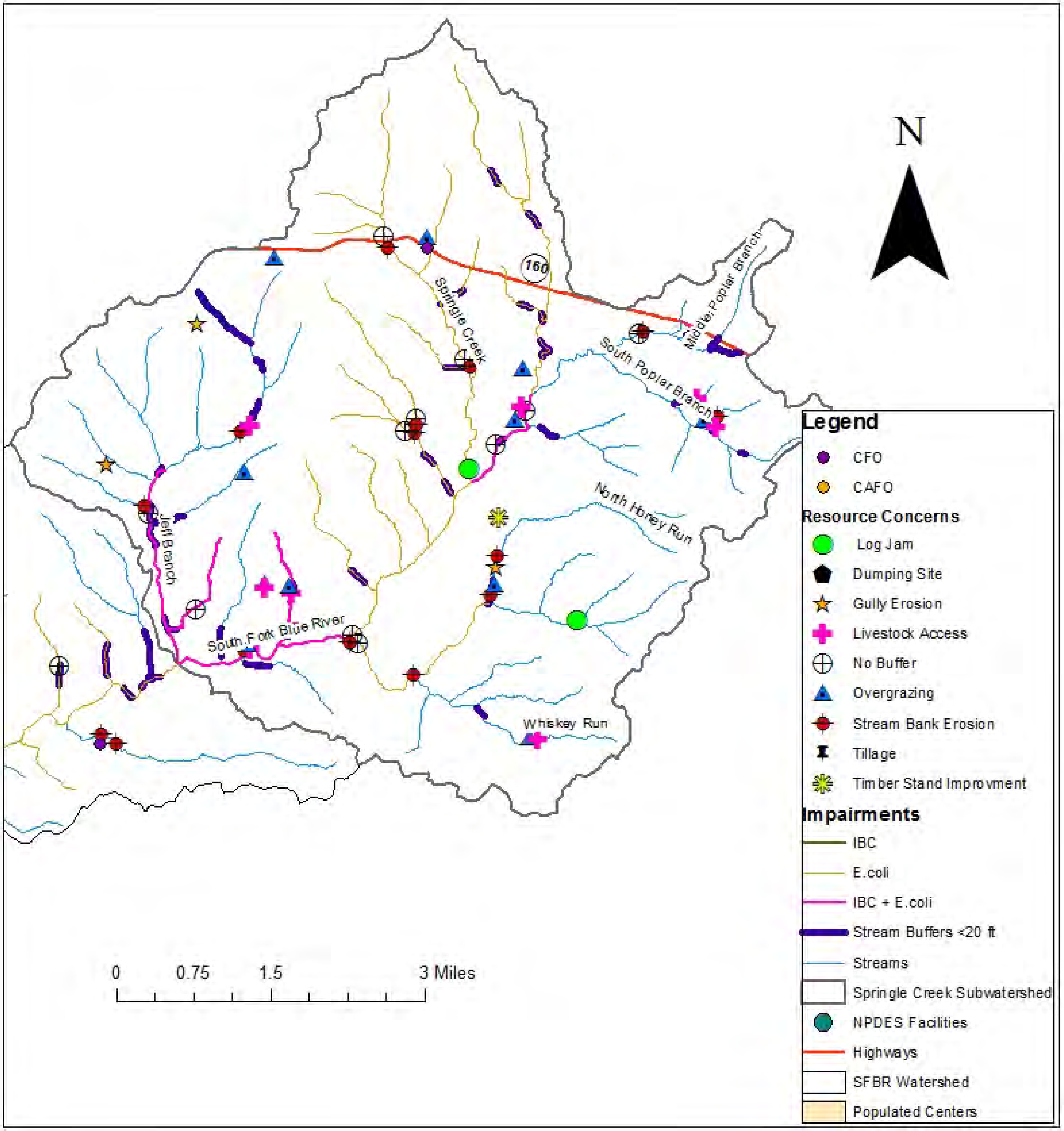


Figure 24: Springle Creek Survey Summary

Water Quality and Habitat Data Summary
IDEM completed water testing at six sites within the Springle Creek Subwatershed.

At site 17 (IDEM OBS-06-0002), which is located on South Fork-Blue River at Bowers Knob Road, the geometric mean for *E.coli* was 403.37. Throughout the sampling season, the *E.coli* target was not met on 7/15 occurrences. Other parameters that did not meet project targets include dissolved oxygen on 5/17 occurrences, Nitrate+Nitrite on 1/12 occurrences, TKN on 3/12 occurrences, TSS on 2/12 occurrences, turbidity on 3/17 occurrences, total phosphorus on 2/12 occurrences. Fish IBI and QHEI (IBI) also did not meet project targets. Site 17 failed both aquatic life use as well as recreational use and these stream reaches will be placed on the 2018 303(d) list of impaired waters. For a summary of water quality analysis at site 17, see Table 22.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.74	SU	0/17	0%
Dissolved Oxygen	10.89	mg/L	5/17	29%
Temp	13.96	Celsius	0/17	0%
Nitrate+Nitrite	.616	mg/L	1/12	8%
TKN	.496	mg/L	3/12	25%
TSS	87.6	mg/L	2/12	17%
Turbidity	45.22	NTU	3/17	18%
Total Phosphorus	.077	mg/L	2/12	17%
E.coli	754.08	Colonies/100 mL	7/15	47%
Fish IBI	32	-	1/1	100%
QHEI(IBI)	48	-	1/1	100%
mIBI	40	-	0/1	0%
QHEI(mIBI)	43	-	1/1	100%

Table 22: Site 17 Water Quality Analysis-Springle Creek Subwatershed

Site 16 (IDEM OBS-06-0003), which is located on Jeff Branch at Blue River Road, had a geometric mean for *E.coli* of 398.75. Throughout the sampling season, the target for *E.coli* was exceeded on 7/10 occurrences. Other parameters that exceeded the project targets include Nitrate+Nitrite on 1/7 occurrences, TKN on 2/7 occurrences, TSS on 2/7 occurrences, turbidity on 2/12 occurrences, and total phosphorus on 2/7 occurrences. The mIBI scores did not meet project targets on 1/2 occasions as well. For a summary of the water quality analysis for Site 16 see Table 23.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.35	SU	0/12	0%
Dissolved Oxygen	7.08	mg/L	0/12	0%
Temp	18.27	Celsius	0/12	0%
Nitrate+Nitrite	.65	mg/L	1/7	14%
TKN	.46	mg/L	2/7	29%
TSS	84.3	mg/L	2/7	29%
Turbidity	36.37	NTU	2/12	17%
Total Phosphorus	.082	mg/L	2/7	29%
E.coli	864	Colonies/100 mL	7/10	70%
Fish IBI	38	-	0/1	0%
QHEI(IBI)	65	-	0/1	0%
mIBI	34/36	-	1/2	50%
QHEI(mIBI)	44	-	0/1	100%

Table 23: Site 16 Water Quality Analysis: Springle Creek Watershed

At testing site 20 (OBS-06-0005), which is located on Springle Creek at Blue River Road, the *E.coli* geometric mean was 627.37. Throughout the sampling season, *E.coli* did not meet the project target on 5/9 occurrences. Other parameters that did not meet the project target include TKN on 1/6 occurrences, TSS on 2/6 occurrences, turbidity on 2/11 occurrences, and total phosphorus on 1/6 occurrences. The mIBI score also did not meet project target as well. For a summary of water quality analysis of site 20, see Table 24.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.31	SU	0/11	0%
Dissolved Oxygen	7.16	mg/L	0/11	0%
Temp	18.59	Celsius	0/11	0%
Nitrate+Nitrite	.767	mg/L	0/6	0%
TKN	.5	mg/L	1/6	17%
TSS	129.8	mg/L	2/6	33%
Turbidity	24.65	NTU	2/11	18%
Total Phosphorus	.087	mg/L	1/6	17%
E.coli	1353.4	Colonies/100 mL	5/9	56%
Fish IBI	44	-	0/1	0%
QHEI(IBI)	56	-	0/1	0%
mIBI	36	-	0/1	0%
QHEI(mIBI)	43	-	0/1	0%

Table 24: Site 20 Water Quality Analysis-Springle Creek Subwatershed

At testing site 21 (IDEM OBS-06-0010), which is located on South Fork-Blue River at Casey Hollow Road, the geometric mean for *E.coli* was 457.16. Throughout the sampling season, *E.coli* did not meet project targets on 3/10 occurrences. Other parameters that did not meet project targets include TKN on 2/7 occurrences, TSS on 2/7 occurrences, turbidity on 2/12 occurrences, and total phosphorus on 2/7 occurrences. Scores for fish IBI, QHEI (IBI), and mIBI, and QHEI (mIBI) also did not meet targets for the project. Site 21 failed both aquatic life use as well as recreational use and these stream reaches will be placed on the 2018 303(d) list of impaired waters. For a summary of water quality analysis of site 21, please see Table 25.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.71	SU	0/12	0%
Dissolved Oxygen	6.76	mg/L	0/12	0%
Temp	18.79	Celsius	0/12	0%
Nitrate+Nitrite	.45	mg/L	0/7	0%
TKN	.46	mg/L	2/7	29%
TSS	103.9	mg/L	2/7	29%
Turbidity	47.58	NTU	2/12	17%
Total Phosphorus	.079	mg/L	2/7	29%
E.coli	753.14	Colonies/100 mL	3/10	30%
Fish IBI	30/32	-	2/2	100%
QHEI(IBI)	50/47	-	2/2	0%
mIBI	36	-	0/1	0%
QHEI(mIBI)	44	-	1/1	100%

Table 25: Site 21 Water Quality Analysis-Springle Creek Subwatershed

At testing site 18 (IDEM OBS-06-0019), which is located on Jeff Branch at Bethel Road, the geometric mean for *E.coli* was 42.7. Throughout the sampling season, *E.coli* did not meet project targets on 3/9 occurrences. Other parameters that did not meet project targets include Nitrate+Nitrite on 1/6 occurrences, TKN 2/6 occurrences, TSS on 2/6 occurrences, turbidity on 2/11 occurrences, and total phosphorus on 2/6 occurrences. Scores for mIBI, and QHEI (mIBI) also did not meet project targets. Although the mIBI score for site 18 did not meet the target, IDEM assessed the site as fully supporting for aquatic life use based on best professional judgement. For a summary of water quality analysis for Site 18, see Table 26.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.55	SU	0/11	0%
Dissolved Oxygen	8.71	mg/L	0/11	0%
Temp	18.58	Celsius	0/11	0%
Nitrate+Nitrite	.85	mg/L	1/6	17%
TKN	.43	mg/L	2/6	33%
TSS	55.7	mg/L	2/6	33%
Turbidity	35.43	NTU	2/11	18%
Total Phosphorus	.067	mg/L	2/6	33%
E.coli	495.5	Colonies/100 mL	3/9	33%

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
Fish IBI	42	-	0/1	0%
QHEI(IBI)	62	-	0/1	0%
mIBI	32	-	1/1	100%
QHEI(mIBI)	44	-	1/1	100%

Table 26: Site 18 Water Quality Analysis-Springle Creek Subwatershed

At testing site 19 (IDEM OBS-06-0011), which is located on Honey Run at North Honey Run Road, the geometric mean for *E.coli* was 277.13. Throughout the sampling season, *E.coli* did not meet project targets on 6/10 occurrences. Other parameters that did not meet project targets include TKN on 2/7 occurrences, TSS on 2/7 occurrences, turbidity on 1/12 occurrences, and total phosphorus on 2/7 occurrences. All biological results met project targets. For a summary of water quality analysis for Site 19, see Table 27.

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
pH	7.53	SU	0/12	0%
Dissolved Oxygen	7.38	mg/L	0/12	0%
Temp	17.86	Celsius	0/12	0%
Nitrate+Nitrite	.43	mg/L	0/7	0%
TKN	.51	mg/L	2/7	29%
TSS	97	mg/L	2/7	29%
Turbidity	54.88	NTU	1/12	8%
Total Phosphorus	.079	mg/L	2/7	29%
E.coli	457.9	Colonies/100 mL	6/10	60%
Fish IBI	44	-	0/1	0%
QHEI(IBI)	56	-	0/1	0%
mIBI	36	-	0/1	0%
QHEI(mIBI)	43	-	0/1	0%

Table 27: Site 19 Water Quality Analysis-Springle Creek Subwatershed

4.2 City of Pekin- HUC 051401040602

City of Pekin Subwatershed is located in the central portion of the SFBR watershed (upstream of the Dutch Creek Subwatershed) and contains 12,091 acres. City of Pekin Subwatershed is mainly located in Washington County with a sliver extending into Clark County. SFBR is the main stream that runs through the subwatershed. There are also many unnamed tributaries in the City of Pekin Subwatershed.

Information from the land use data shows this watershed consists of cultivated crops 1,420.7 acres (11.7%), developed land 909.1 acres (7.5%), Forest 4,820 acres (39.9%), Hay/Pasture 4,841.1 acres (40%), Open Water 131 acres (1.1%), Shrub/scrub 93.1 acres (.8%), and Wetlands 1.3 acres (<.1%). (Figure 25) Resource concerns were taken from personal testimonies of stakeholders as well as collected through windshield surveys

Highly erodible soils are found in the subwatershed (Figure 7). Septic suitability for soils is rated either somewhat limited or very limited for nearly the entire watershed (Figure 9). While the Town of New Pekin is sewered (Figure 10), a large portion of the watershed utilizes septic systems. Failing septic systems are a concern throughout the South Fork-Blue River Watershed. The City of Pekin subwatershed contains 1 NPDES facility and 1 NPDES pipe that discharges into the South Fork-Blue River (Figure 19 and 26). There are 2 LUST sites located within the subwatershed as well. (Figure 19)

There are three permitted livestock operations, two which are CFO-sized and one that is CAFO sized. (Figure 26)

Table 28 and Figure 26 summarize findings from windshield surveys conducted by the watershed coordinator and stakeholders in late 2015. The most frequently noted potential water quality influences were livestock with access to streams and row crops within 20 feet of a stream.

Potential Water Quality Influence	# of times identified in subwatershed	Observer
Overgrazing of pasture	3	Coordinator/Steering Committee
Gully erosion in crop field	1	Coordinator/Steering Committee
Livestock with access to stream	5	Coordinator/Steering Committee
Stream Bank Erosion	2	Coordinator/Steering Committee
Row crop within 20 feet of stream	7	Coordinator/Steering Committee

Table 28: City of Pekin Subwatershed Windshield Surveys

Approximately 21 miles of streams in the City of Pekin Subwatershed are listed on the Draft 2018 IDEM 303(d) list for Impaired Waterbodies for *E.coli* (Figure 26). Possible sources of *E.coli* according to windshield surveys, stakeholder concerns and TNC water monitoring suggest livestock with access to streams, overgrazing, manure applied to cropland, and failing septic systems.

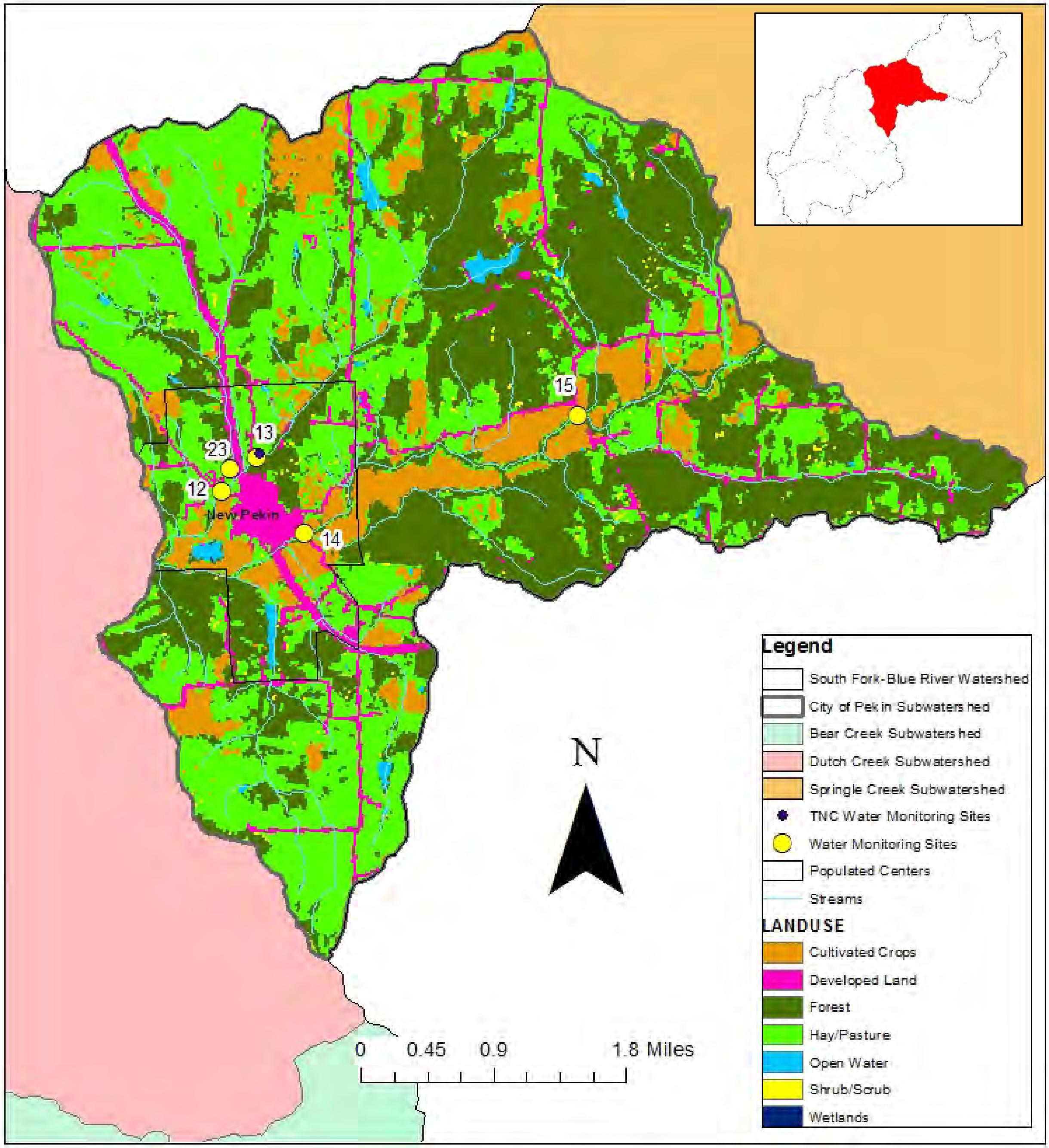


Figure 25: City of Pekin Subwatershed Land Use

Water Quality and Habitat Data Summary

IDEM completed monthly water sampling in 2015 at four sites within the City of Pekin Subwatershed. Two sites are located on Tributaries of South Fork-Blue River and two sites are located on South Fork-Blue River. The sampling resulted in sites failing WQS for *E.coli*. The watershed had only slight to moderate impairment with geometric means ranging from 171-467 MPN/100mL.

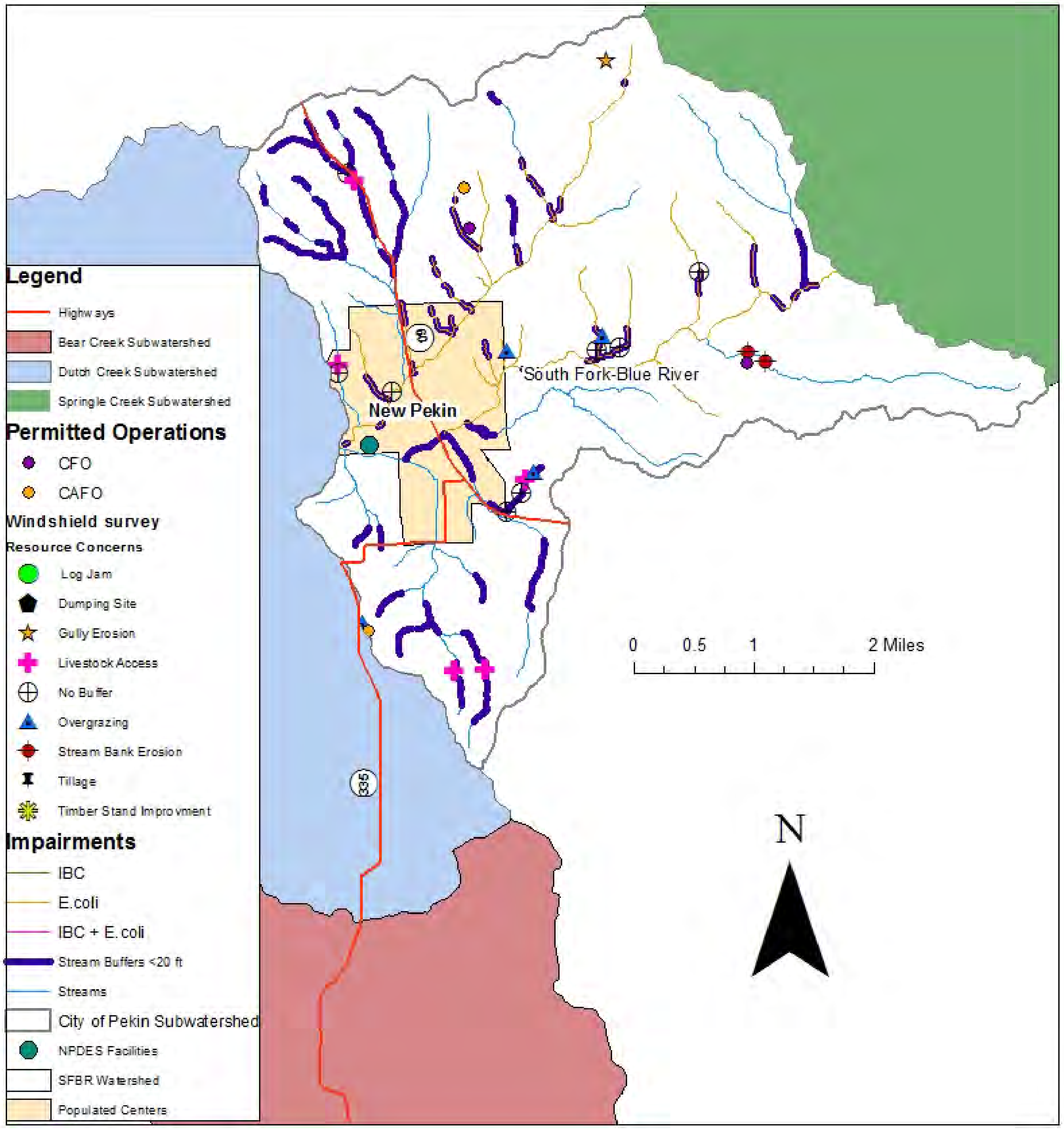


Figure 26: City of Pekin Subwatershed Survey

At testing site 12 (IDEM OBS-06-0006), which is located on an unnamed tributary at Shorts Corner Road, the geometric mean for *E.coli* was 171.46. Throughout the sampling season, *E.coli* exceeded the project target on 5/10 occurrences. Other parameters that exceeded the project targets include Nitrate+Nitrite on 2/7 occurrences and turbidity on 1/12 occurrences. Surrounding and upstream land use includes hay/pasture as well as some forest and cultivated crops. For a complete summary of water quality analysis of site 12, see Table 29.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.87	SU	0/12	0%
Dissolved Oxygen	8.6	mg/L	0/12	0%
Temp	19.98	Celsius	0/12	0%
Nitrate+Nitrite	.9	mg/L	2/7	29%
TKN	.23	mg/L	0/7	0%
TSS	3.1	mg/L	0/7	0%
Turbidity	3.72	NTU	1/12	8%
Total Phosphorus	.031	mg/L	0/7	0%
E.coli	493.92	Colonies/100 mL	5/10	50%
Fish IBI	42	-	0/1	0%
QHEI(IBI)	60	-	0/1	0%
mIBI	44	-	0/1	0%
QHEI(mIBI)	63	-	0/1	0%

Table 29: Sites 12 Water Quality Analysis-City of Pekin Subwatershed

At testing site 15 (IDEM OBS-06-0022), which is located on South Fork-Blue River on Lockenour Road, the geometric mean for *E.coli* was 240.8. Throughout the sampling season, the *E.coli* exceeded project targets on 6/17 occurrences. Other parameters that exceed project targets include dissolved oxygen on 4/17 occurrences, Nitrate+Nitrite on 2/12 occurrences, TKN on 2/12 occurrences, TSS on 2/12 occurrences and turbidity on 1/17 occurrences. Both the QHEI (IBI) and QHEI (mIBI) did not meet project targets. For a complete water quality summary of site 15, see Table 30.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.39	SU	0/17	0%
Dissolved Oxygen	9.5	mg/L	4/17	24%
Temp	14.28	Celsius	0/17	0%
Nitrate+Nitrite	.75	mg/L	2/12	17%
TKN	.97	mg/L	2/12	17%
TSS	405.6	mg/L	2/12	17%
Turbidity	29.31	NTU	1/17	6%
Total Phosphorus	.186	mg/L	2/12	17%
E.coli	779.59	Colonies/100 mL	6/17	35%
Fish IBI	40	-	0/1	0%
QHEI(IBI)	48	-	1/1	100%
mIBI	40	-	0/1	0%
QHEI(mIBI)	42	-	1/1	100%

Table 30: Site 15 Water Quality Analysis-City of Pekin Subwatershed

At testing site 13 (IDEM OBS-06-0012), which is located on a tributary of South Fork-Blue River at Mahuron Road, the *E.coli* geometric mean of 467.69. Throughout the sampling season, *E.coli* exceeded the project target on 7/10 occurrences. Other parameters that exceeded the project targets include, TKN on 2/7 occurrences, TSS on 2/7 occurrences, turbidity on 1/12 occurrences and total phosphorus on 2/7 occurrences. For biological and habitat, targets were not met on 1/2 occurrences for QHEI (IBI). Project targets for QHEI (mIBI) were not met. Project target for mIBI was met. For a complete water quality summary of site 13, see Table 31.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.65	SU	0/12	0%
Dissolved Oxygen	8.09	mg/L	0/12	0%
Temp	18.44	Celsius	0/12	0%
Nitrate+Nitrite	.5	mg/L	0/7	0%
TKN	1.04	mg/L	2/7	0%
TSS	262.2	mg/L	2/7	29%
Turbidity	6.17	NTU	1/12	8%
Total Phosphorus	.218	mg/L	2/7	29%
E.coli	709.17	Colonies/100 mL	7/10	70%
Fish IBI	36/38	-	0/2	0%
QHEI(IBI)	46/63	-	1/2	50%
mIBI	36	-	0/1	0%
QHEI(mIBI)	50	-	1/1	100%

Table 31: Site 13 Water Quality Analysis-City of Pekin Subwatershed

At testing site 14 (IDEM OBS-06-0018), which is located on South Fork-Blue River at Main Street in Pekin, the *E.coli* geometric mean was 255.4. Throughout the sampling season, *E.coli* exceeded the project target on 4/10 occurrences. Other parameters that exceeded project targets include Nitrate+Nitrite on 1/7 occurrences, TKN on 2/7 occurrences, TSS on 2/7 occurrences, turbidity on 2/12 occurrences and total phosphorus on 2/7 occurrences. For a complete water quality analysis summary for site 14, see Table 32.

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
pH	7.28	SU	0/12	0%
Dissolved Oxygen	6.95	mg/L	0/12	0%
Temp	19.98	Celsius	0/12	0%
Nitrate+Nitrite	.55	mg/L	1/7	14%
TKN	1	mg/L	2/7	29%
TSS	258	mg/L	2/7	29%
Turbidity	131.2	NTU	2/12	17%
Total Phosphorus	.171	mg/L	2/7	29%
E.coli	1065.29	Colonies/100 mL	4/10	40%
Fish IBI	40	-	0/1	0%
QHEI(IBI)	55	-	0/1	0%
mIBI	42	-	0/1	0%
QHEI(mIBI)	57	-	0/1	0%

Table 32: Site 14 Water Quality Analysis-City of Pekin Subwatershed

Hoosier Riverwatch volunteers from East Washington FFA conducted volunteer water monitoring at sites 13 and 23 in the City of Pekin Subwatershed (Figure 25). Site 13 is located near the East Washington Ball Park on Mahuron Road and Site 33 is located near the Pekin Methodist Church. Both streams are unnamed tributaries of South Fork-Blue River. Table 33 summarizes the results of parameters monitored that also have targets for the SFBR Project. Sampling events occurred approximately monthly from May 2015 through June 2017. Sampling did not occur when water levels were too low for sampling or during high water levels that are unsafe for volunteers. Volunteer water monitoring is an excellent way to get the community involved and provide education on water quality.

Site 13-Mahuron Road	pH	DO	Temp	Turbidity	*E.coli*
Average	6.11	7.69	17.19	15.56	183.3
Min./Max	6/6.5	7.47/11.84	18/25.2	15/20	100/550
# of results	9	9	9	9	3
# times exceeded targets	0	0	0	9	1
Site 23-Pekin Methodist Church	**pH**	**DO**	**Temp**	**Turbidity**	***E.coli***
Average	6.39	9.02	18.14	15	516.7
Min./Max	6/7	6.36/14.56	3.9/25.8	15/15	0/550
# of results	9	9	9	9	3
# times exceeded targets	0	1	0	9	3

Table 33: Volunteer Water Monitoring Results-City of Pekin Subwatershed

4.3 Bear Creek- South Fork-Blue River-HUC 051401040603

Bear Creek Subwatershed is located on the southeast side of the SFBR Watershed and includes 8,930 acres. Bear Creek Subwatershed is located mostly in Washington County, but also extends in to portions of Harrison, Floyd and Clark County. The main stream in this subwatershed is Bear Creek. Little Bear Creek and tributaries are also included.

Information from the land use data shows this watershed consists of cultivated crops 1,759.8 (19.7%), developed land 403.4 (4.5%), forest 3,974 acres (44.5%), hay/pasture 2,712.8 acres (30.4%), open water 9.1 acres (.1%), shrub/scrub 74.7 acres (.8%), and wetlands .2 acres (<.1%) (Figure 27).

Bear Creek subwatershed is comprised of karst topography with many sinkholes, although less than Licking Creek and Palmyra Karst subwatershed (See Figure 6). There are also few caves found in the subwatershed (Figure 5).

Highly erodible soils are found throughout the entire watershed and with most coverage in the southernmost portion of the watershed (Figure 7) Septic suitability is rated somewhat limited or very limited throughout the sub watershed (Figure 9). There are no sewered communities in Bear Creek, therefore, all are serviced by septic systems. Failing septic systems have been a concern of stakeholders.

There are no permitted CFOs or CAFOs, but many small livestock farms are found throughout the watershed.

Windshield surveys completed from October 2015 through June 2016 found water quality concerns which are outlined in Table 34. Most occurring potential water quality influences identified were overgrazing of pastures, gully erosion in crop fields, row crop within 20 feet of stream, and tillage.

Potential Water Quality Influence	# of times identified in subwatershed	Observer
Overgrazing of pasture	3	Coordinator/Stakeholder
Gully erosion in crop field	4	Coordinator/Stakeholder
Livestock with access to stream	2	Coordinator/Stakeholder
Stream Bank Erosion	1	Coordinator/Stakeholder
Row crop within 20 ft of stream	5	Coordinator/Stakeholder
Log Jam	1	Coordinator/Stakeholder
Tillage	3	Coordinator/Stakeholder

Table 34: Bear Creek Subwatershed Windshield Surveys

Approximately 29 miles of Bear Creek, Little Bear Creek and unnamed tributaries in the subwatershed of Bear Creek are listed on the Draft 2018 IDEM 303(d) list for Impaired Waterbodies for *E.coli* (Figure 28). Possible sources of *E.coli* according to windshield surveys, stakeholder concerns and TNC water monitoring suggest livestock with access to streams, overgrazing, manure applied to cropland, and failing septic systems.

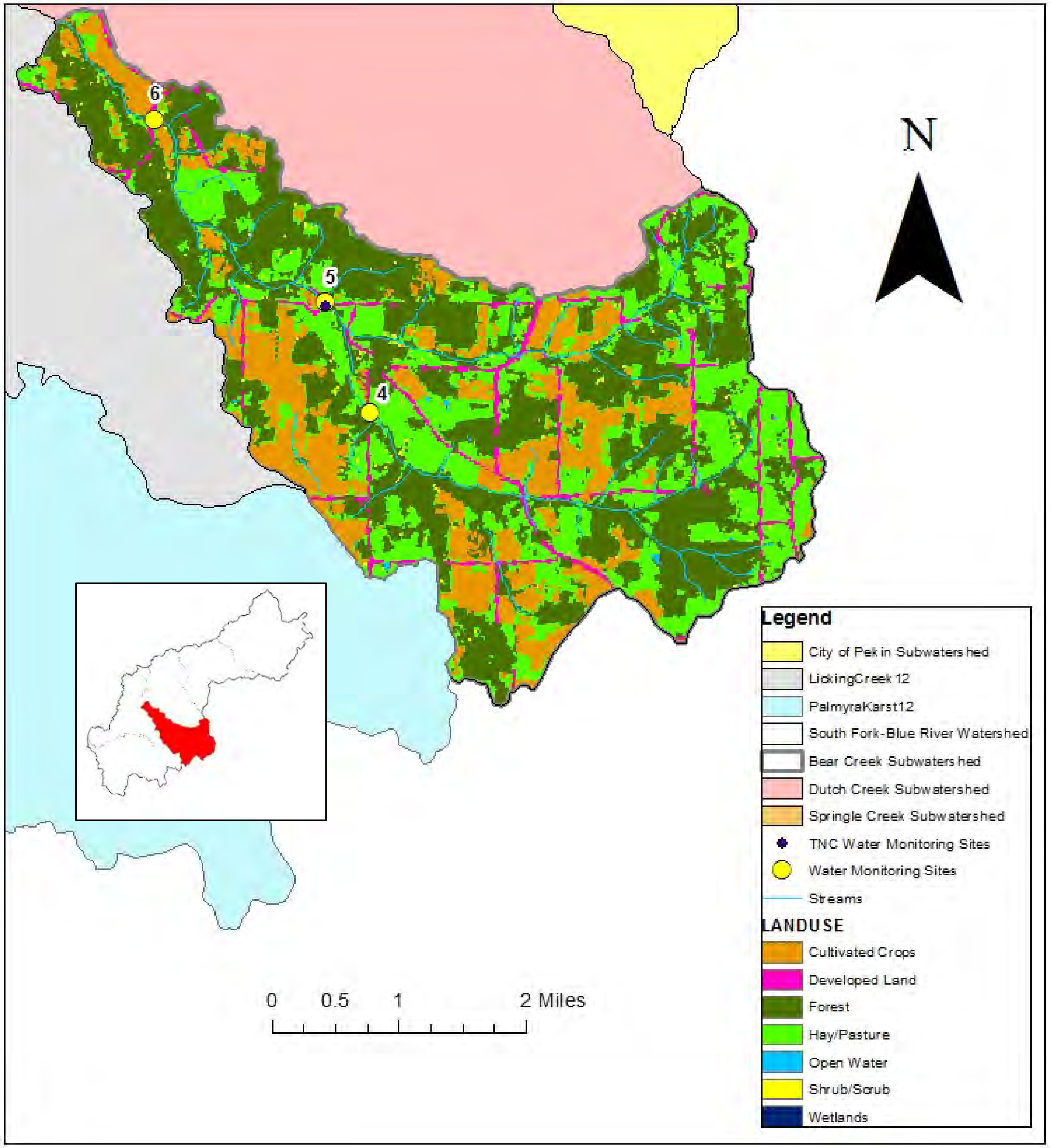


Figure 27: Bear Creek Land Use

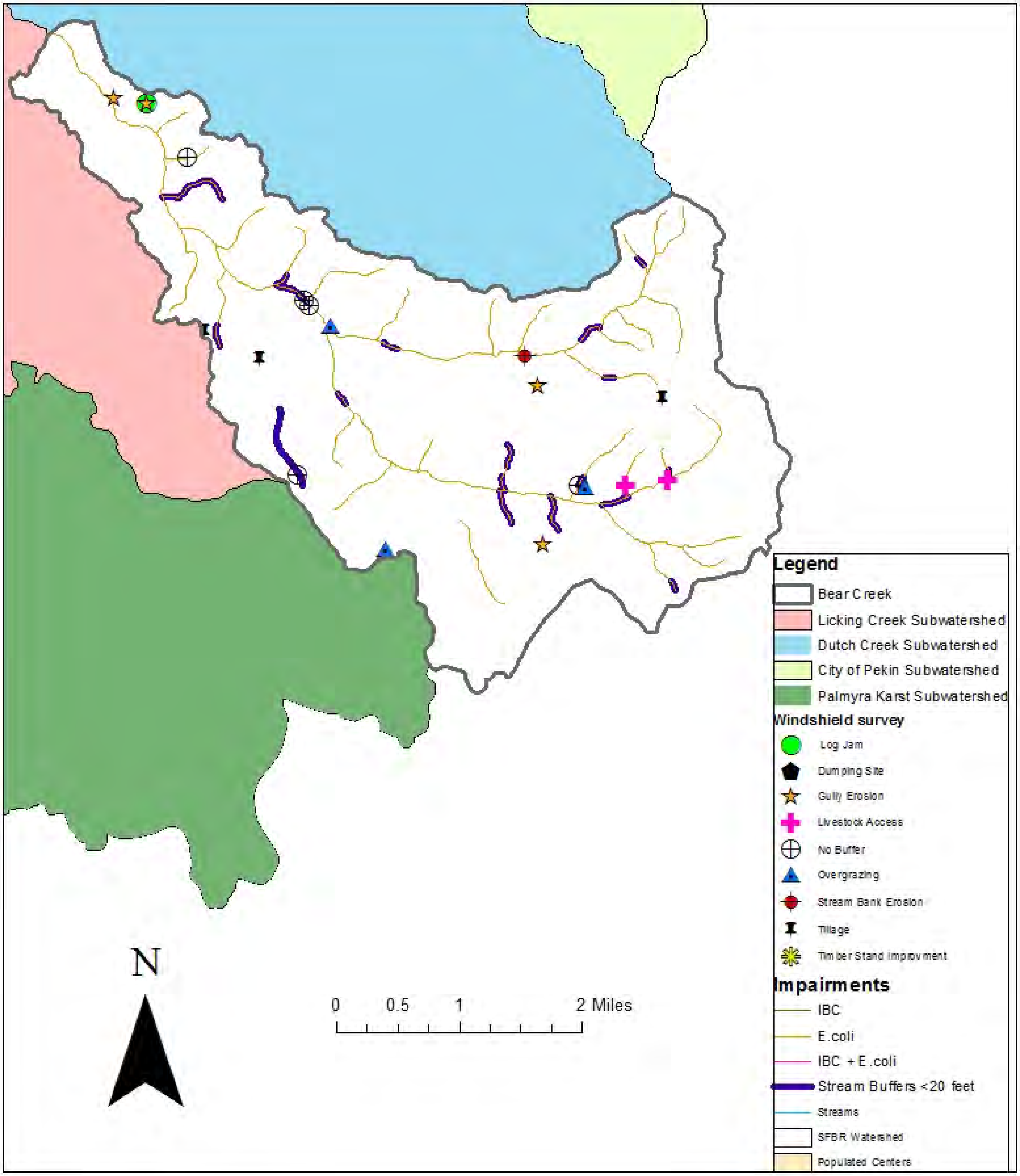


Figure 28: Bear Creek Subwatershed Survey

Water Quality and Habitat Data Summary
IDEM completed monthly water sampling at three sites in the Bear Creek Subwatershed in 2015. The monthly sampling resulted in all three sites failing the WQS for *E.coli*. The subwatershed had moderate impairments with geometric means ranging from 350-901 MPN/100mL.

At site 6 (IDEM OBS-06-0013), which is located at State Road 135 on Bear Creek, the geometric mean for *E.coli* was 678.22. Throughout the sampling season, *E.coli* exceeded the project target on 11/15 occurrences. Other parameters that exceeded targets include dissolved oxygen on 3/17 occurrences, Nitrate+Nitrite on 11/12 occurrences, and turbidity on 4/17 occurrences. Surrounding and upstream land use of site 6 includes mostly hay/pasture and forests with some cultivated cropland as well. For a complete summary of water quality data of site 6, see Table 35.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.1	SU	0/17	0%
Dissolved Oxygen	10.8	mg/L	3/17	18%
Temp	15.4	Celsius	0/17	0%
Nitrate+Nitrite	2.5	mg/L	11/12	92%
TKN	.3	mg/L	0/12	0%
TSS	5.2	mg/L	0/12	0%
Turbidity	9.11	NTU	4/17	24%
Total Phosphorus	.024	mg/L	0/12	0%
E.coli	446.6	Colonies/100 mL	11/15	73%
Fish IBI	48	-	0/1	0%
QHEI (IBI)	71	-	0/1	0%
mIBI	38	-	0/1	0%
QHEI(mIBI)	67	-	0/1	0%

Table 35: Site 6 Water Quality Analysis-Bear Creek Subwatershed

At site 5 (IDEM OBS-06-0014), which is located at Martinsburg Fire Road on Bear Creek, the geometric mean for *E.coli* was 901.78. Throughout the sampling season, *E.coli* exceeded the project target on 9/10 occurrences. Other parameters exceeding target include Nitrate+Nitrite on 6/7 occurrences and turbidity on 4/12 occurrences. Surrounding and upstream land use of site 5 includes hay/pasture, forests, and cultivated cropland. For a complete summary of water quality data of site 5, see Table 36.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.04	SU	0/12	0%
Dissolved Oxygen	8.72	mg/L	0/12	0%
Temp	19.06	Celsius	0/12	0%
Nitrate+Nitrite	2.1	mg/L	6/7	86%
TKN	.31	mg/L	1/7	14%
TSS	7	mg/L	0/7	0%
Turbidity	10.7	NTU	4/12	33%
Total Phosphorus	.024	mg/L	0/7	0%
E.coli	834.3	Colonies/100 mL	9/10	90%
Fish IBI	40/46	-	0/2	0%
QHEI(IBI)	72/68	-	0/2	0%
mIBI	40	-	0/1	0%
QHEI(mIBI)	56	-	0/1	0%

Table 36: Site 5 Water Quality Analysis-Bear Creek Subwatershed

At site 4 (OBS-06-0021), which is located at Wetzel Road on Bear Creek, the geometric mean for *E.coli* was 350.09. Throughout the sampling season, *E.coli* exceeded the project target on 8/10 occurrences. Other parameters that exceeded the project target include Nitrate+Nitrite on 7/7 occurrences and turbidity on 1/12 occurrences. The fish IBI score was 34, which is two points from meeting the project target. For a complete summary of water quality data of site 13, see Table 37.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.21	SU	0/12	0%
Dissolved Oxygen	10.2	mg/L	0/12	0%
Temp	18.9	Celsius	0/12	0%
Nitrate+Nitrite	2.2	mg/L	7/7	100%
TKN	.19	mg/L	0/7	0%
TSS	4.4	mg/L	0/7	0%
Turbidity	7.80	NTU	1/12	8%
Total Phosphorus	.024	mg/L	0/7	0%
E.coli	355.1	Colonies/100 mL	8/10	80%
Fish IBI	34	-	1/1	100%
QHEI(IBI)	64	-	0/1	0%
mIBI	46	-	0/1	0%
QHEI(mIBI)	47	-	0/1	100%

Table 37: Site 4 Water Quality Analysis-Bear Creek Subwatershed

4.4 Dutch Creek-South Fork Blue River- HUC 051401040604

Dutch Creek Subwatershed is located on the central portion of the SFBR Watershed and includes 12,408 acres. Dutch Creek Subwatershed is located solely in Washington County. The main stream in this subwatershed is the SFBR. Punch Run, Dutch Creek, and unnamed tributaries are also found in the subwatershed.

Information from the land use data shows this watershed consists of cultivated crops 2,171.2 (17.5%), developed land 482.4 acres (3.9%), forest 5,209.6 acres (42%), hay/pasture 4,450.1 acres (35.9%), open water 5.1 acres (<.1%), and shrub/scrub 101 acres (.8%) (Figure 29).

When assessing the South Fork-Blue River watershed, the density of sinkholes decreases when moving from the southwest to northeast. The Dutch Creek subwatershed still has numerous sinkholes, although not as many as Palmyra Karst, Licking Creek, and Bear Creek Subwatersheds (Figure 6). Much of the soils are Highly Erodible Soils as well (Figure 7).

The subwatershed contains three permitted livestock operations, two CFO-sized operations and one CAFO-sized operation (Figure 30).

Windshields surveys completed in the fall of 2015 found overgrazed pastures, livestock with access to streams, and row crops within 20 feet of stream to be the most prevalent potential water quality influences. See Table 38 and Figure 30 for a full summary of windshield survey findings.

Potential Water Quality Influence	# of times identified in subwatershed	Observer
Overgrazing of pasture	7	Coordinator/Stakeholder
Gully erosion in crop field	3	Coordinator/Stakeholder
Livestock with access to stream	8	Coordinator/Stakeholder
Stream Bank Erosion	2	Coordinator/Stakeholder
Row crop within 20 ft of stream	7	Coordinator/Stakeholder
Possible log jam	2	Coordinator/Stakeholder
Dumping Site	1	Coordinator/Stakeholder

Table 38: Dutch Creek Subwatershed Windshield Survey Summary

Approximately 42 miles of streams are listed on the 2018 Draft IDEM 303(d) List for Impaired Waters. Roughly 23 miles are impaired for *E.coli*, 14 miles impaired for IBC and 5 miles are impaired for *E.coli*+IBC (Figure 30). Possible sources of *E.coli* according to windshield surveys, stakeholder concerns and TNC water monitoring suggest livestock with access to streams, overgrazing, manure applied to cropland, and failing septic systems.

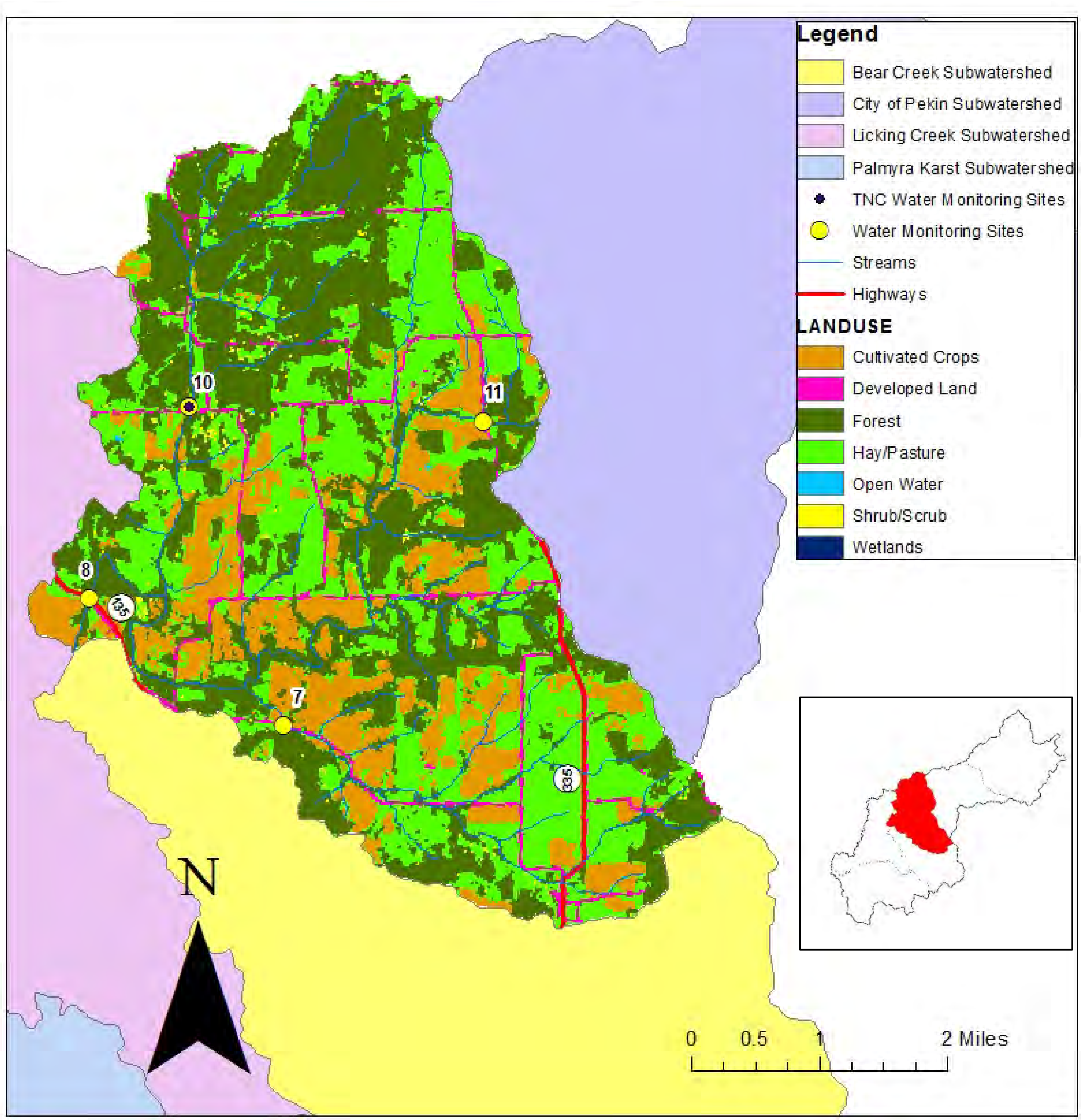


Figure 29: Dutch Creek Land Use

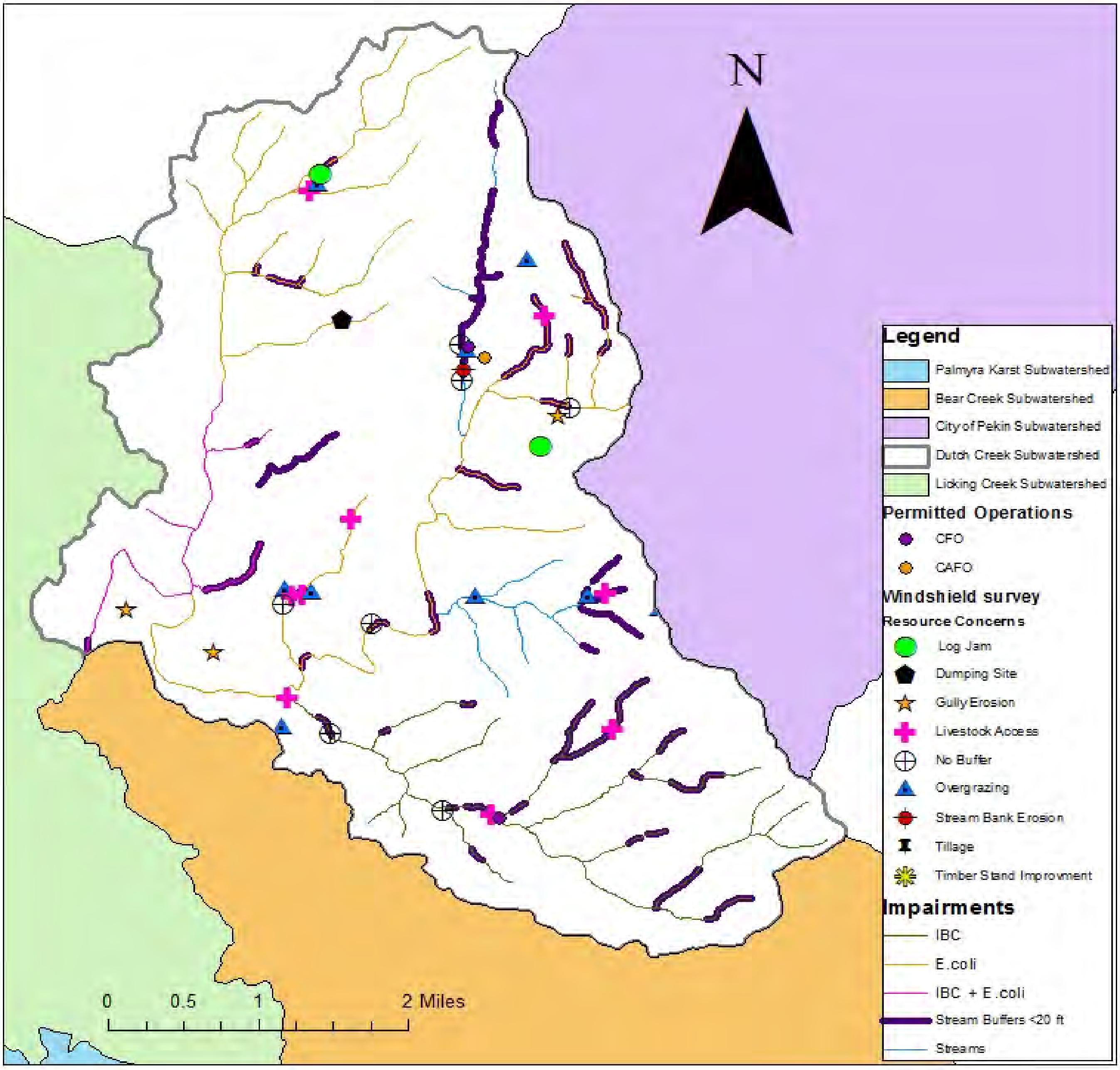


Figure 30: Dutch Creek Subwatershed Survey

Water Quality and Habitat Data Summary

In 2015, IDEM completed monthly water sampling at four sites within the Dutch Creek Subwatershed. The sampling resulted in three of the four sites failing the WQS for *E.coli*. The subwatershed had moderate impairment with geometric means ranging from 42-654 MPN/100mL.

At site 11 (IDEM OBS-06-0004), which is located on South Fork-Blue River at Martinsburg Road, the geometric mean for *E.coli* was 654.77. Throughout the sampling season, *E.coli* exceeded project targets on 11/16 occurrences. Other parameters that exceeded project targets include dissolved oxygen on 5/16 occurrences, Nitrate+Nitrite on 3/12 occurrences, TKN on 1/12 occurrences, and turbidity on 7/16 occurrences. Surrounding and upstream land use for site 11 includes hay/pasture, forest and cultivated cropland. Site 11 is also downstream from the New Pekin Waste Water Treatment Plant. For a complete summary of water quality data of site 11, see Table 39.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.04	SU	0/16	0%
Dissolved Oxygen	9.89	mg/L	5/16	31%
Temp	16.52	Celsius	0/16	0%
Nitrate+Nitrite	.86	mg/L	3/12	25%
TKN	.35	mg/L	1/12	8%
TSS	7.25	mg/L	0/12	0%
Turbidity	10.93	NTU	7/16	44%
Total Phosphorus	.033	mg/L	1/12	8%
E.coli	502.8	Colonies/100 mL	11/16	69%
Fish IBI	52	-	0/1	0%
QHEI(IBI)	58	-	0/1	0%
mIBI	42	-	0/1	0%
QHEI(mIBI)	61	-	0/1	0%

Table 39: Site 11 Water Quality Analysis-Dutch Creek Subwatershed

At site 8 (IDEM OBS-06-0008), which is located on South Fork-Blue River at State Road 135, the geometric mean for *E.coli* was 162.71. Throughout the sampling season, *E.coli* exceeded project targets on 7/15 occurrences. Other parameters that exceeded project targets include dissolved oxygen on 3/16 occurrences, Nitrate+Nitrite on 4/12 occurrences, TKN on 1/12 occurrences, TSS on 1/12 occurrences, turbidity on 5/16 occurrences, and mIBI on 1/1 occurence. Land use surrounding and upstream from site 8 includes hay/pasture, forest, and cultivated crops. For a complete summary of water quality data of site 8, see Table 40.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.21	SU	0/16	0%
Dissolved Oxygen	8.68	mg/L	3/16	19%
Temp	16.52	Celsius	0/16	0%
Nitrate+Nitrite	1.03	mg/L	4/12	33%
TKN	.36	mg/L	1/12	8%
TSS	9.58	mg/L	1/12	8%
Turbidity	10.10	NTU	5/16	31%
Total Phosphorus	.034	mg/L	1/12	8%
E.coli	364.9	Colonies/100 mL	7/15	47%
Fish IBI	52	-	0/1	0%
QHEI(IBI)	67	-	0/1	0%
mIBI	26	-	1/1	100%
QHEI(mIBI)	60	-	0/1	0%

Table 40: Site 8 Water Quality Analysis-Dutch Creek Subwatershed

At testing site 7, (IDEM OBS-06-0007) which is located on Dutch Creek at Dutch Creek Road, the geometric mean for *E.coli* was 42.72. Throughout the sampling season, *E.coli* exceeded project targets on 3/10 occurrences. Other parameters that exceeded project targets include dissolved oxygen on 3/11 occurrences, Nitrate+Nitrite on 3/7 occurrences, turbidity on 1/11 occurrences. The fish IBI was 34, which does not meet the project target. Surrounding and upstream land use of site 7 include mainly hay/pasture and cultivated crops with a small amount of forested acres. For a complete summary of water quality data for site 7, see Table 41.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.1	SU	0/11	0%
Dissolved Oxygen	10.9	mg/L	3/11	27%
Temp	20.61	Celsius	0/11	0%
Nitrate+Nitrite	1.4	mg/L	3/7	43%
TKN	.33	mg/L	0/7	0%
TSS	4.85	mg/L	0/7	0%
Turbidity	4.92	NTU	1/11	9%
Total Phosphorus	.019	mg/L	0/7	0%
E.coli	147.9	Colonies/100 mL	3/10	30%
Fish IBI	34	-	1/1	100%
QHEI(IBI)	60	-	0/1	0%
mIBI	Dry	-	-	-
QHEI(mIBI)	Dry	-	-	-

Table 41: Site 7 Water Quality Analysis-Dutch Creek Subwatershed

At testing site 10 (IDEM OBS-06-0009), which is located on Punch Run at Shorts Corner Road, the *E.coli* geometric mean was 392.18. Throughout the sampling season, *E.coli* exceeded the project target on 7/9 occurrences. Other parameters that exceeded project targets were Nitrate+Nitrite on 4/6 occurrences, and the fish IBI was 24, which does not meet the project standards. The surrounding and upstream land use consists mostly of hay/pasture and forest. For a complete summary of water quality data for site 10, see Table 42.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.83	SU	0/10	0%
Dissolved Oxygen	8.1	mg/L	0/10	0%
Temp	18.16	Celsius	0/10	0%
Nitrate+Nitrite	1.2	mg/L	46	67%
TKN	.15	mg/L	0/6	0%
TSS	2.5	mg/L	0/6	0%
Turbidity	3.2	NTU	0/6	0%
Total Phosphorus	.0155	mg/L	0/6	0%
E.coli	612	Colonies/100 mL	7/9	78%
Fish IBI	24	-	1/1	100%
QHEI(IBI)	62	-	0/1	0%
mIBI	Dry	-	-	-
QHEI(mIBI)	Dry	-	-	-

Table 42: Site 10 Water Quality Analysis-Dutch Creek Subwatershed

4.5 Palmyra Karst Area-South Fork Blue River Subwatershed- HUC 051401040605

Palmyra Karst Area subwatershed is located in the most southwest portion of the SFBR Watershed and includes a total of 14,866 acres and approximately 8.2 miles of intermittent streams. The majority of the subwatershed is located in northern Harrison County and includes the Town of Palmyra.

Information from the land use data shows this watershed consists of cultivated crops 5,544.3 acres (37.3%), developed 883.6 acres (5.9%), forest 4,570.4 (30.7%), hay/pasture 3,728.9 (25.1%), open water 43.1 acres (.3%), shrub/scrub 109.4 acres (.7%) and wetlands 900 acres (6.1%) (Figure 31).

Resource concerns were taken from personal testimonies of stakeholders as well as collected through windshield surveys. Table 43 and Figure 32 illustrate findings from windshield surveys conducted by the watershed coordinator, steering committee, and stakeholders in late 2015. The most frequently noted potential water quality influences were overgrazing of pastures and gully erosion in crop fields. The majority of the subwatershed contains Highly Erodible Soils (Figure 7). Highly Erodible Soils are more susceptible to soil loss due to erosion.

The Town of Palmyra is the only sewered area of the subwatershed, suggesting the majority of the subwatershed utilizes septic systems. The soils in the subwatershed are rated as very limited and somewhat limited for septic system suitability (Figure 9). This is a major resource concern because of the area's karst topography. Poorly maintained septic systems could leach directly into the karst topography and negatively impact water quality and aquatic life.

The Palmyra Karst subwatershed contains 1 NPDES facility and 1 NPDES pipe that discharges into an unnamed sinkhole (Figure 18). There are also 4 brownfield sites and 5 LUST sites in or near the city limits of Palmyra (Figure 18). The subwatershed has one permitted confined feeding operation with numerous small farms. (Figure 32)

The sensitive karst topography of the Palmyra Karst Subwatershed contains numerous sinkholes (Figure 6). Many stakeholders have shared that unnatural debris is routinely dumped into these sensitive areas.

Potential Water Quality Influence	# of times identified in subwatershed	Observer
Overgrazing of pasture	5	Coordinator/Stakeholder
Gully erosion in crop field	8	Coordinator/Stakeholder
Livestock with access to stream	1	Coordinator/Stakeholder
Row crop within 20 ft of stream	1	Coordinator/Stakeholder

Table 43: Palmyra Karst Subwatershed Windshield Survey

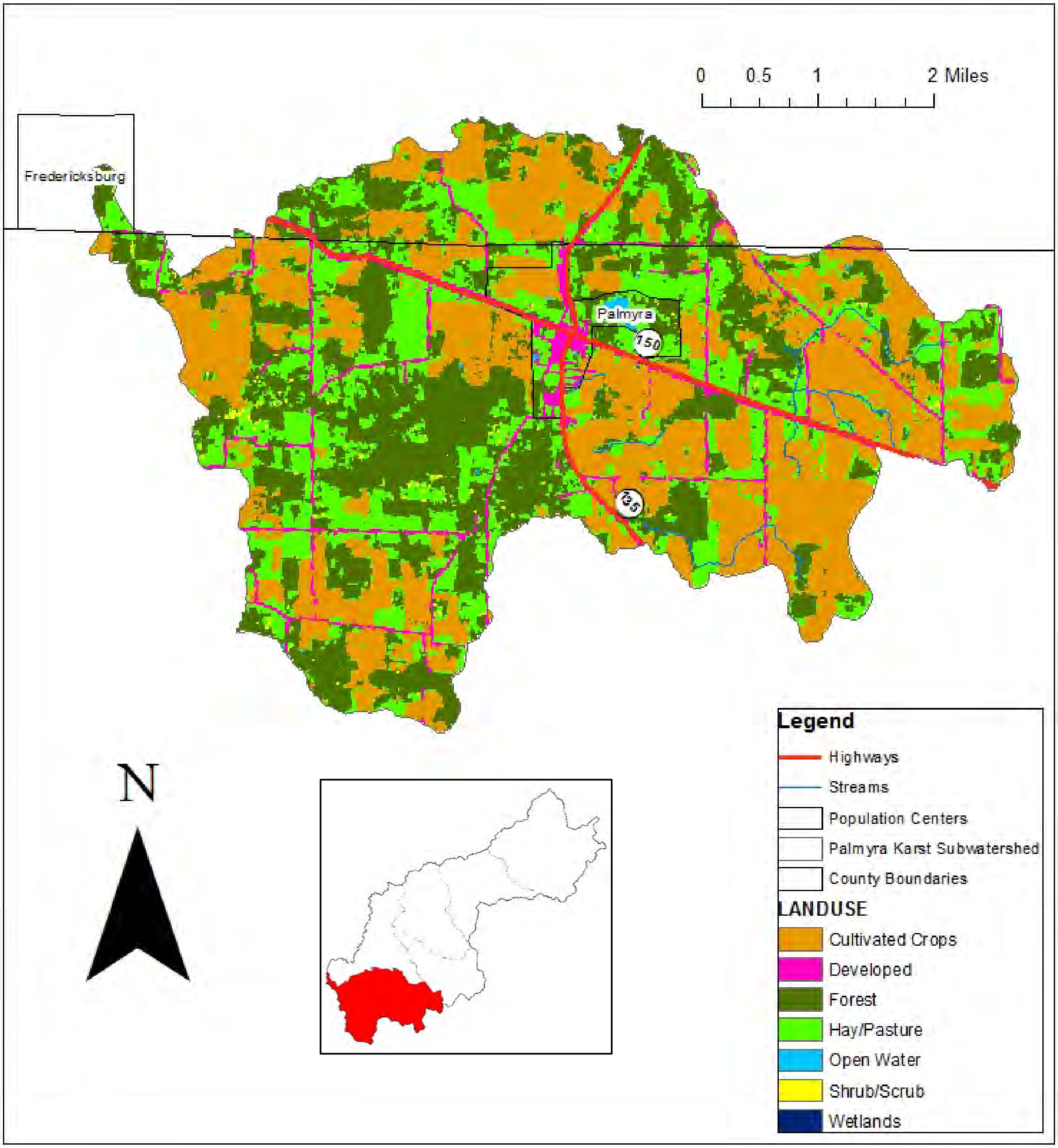


Figure 31: Palmyra Karst Subwatershed Land Use

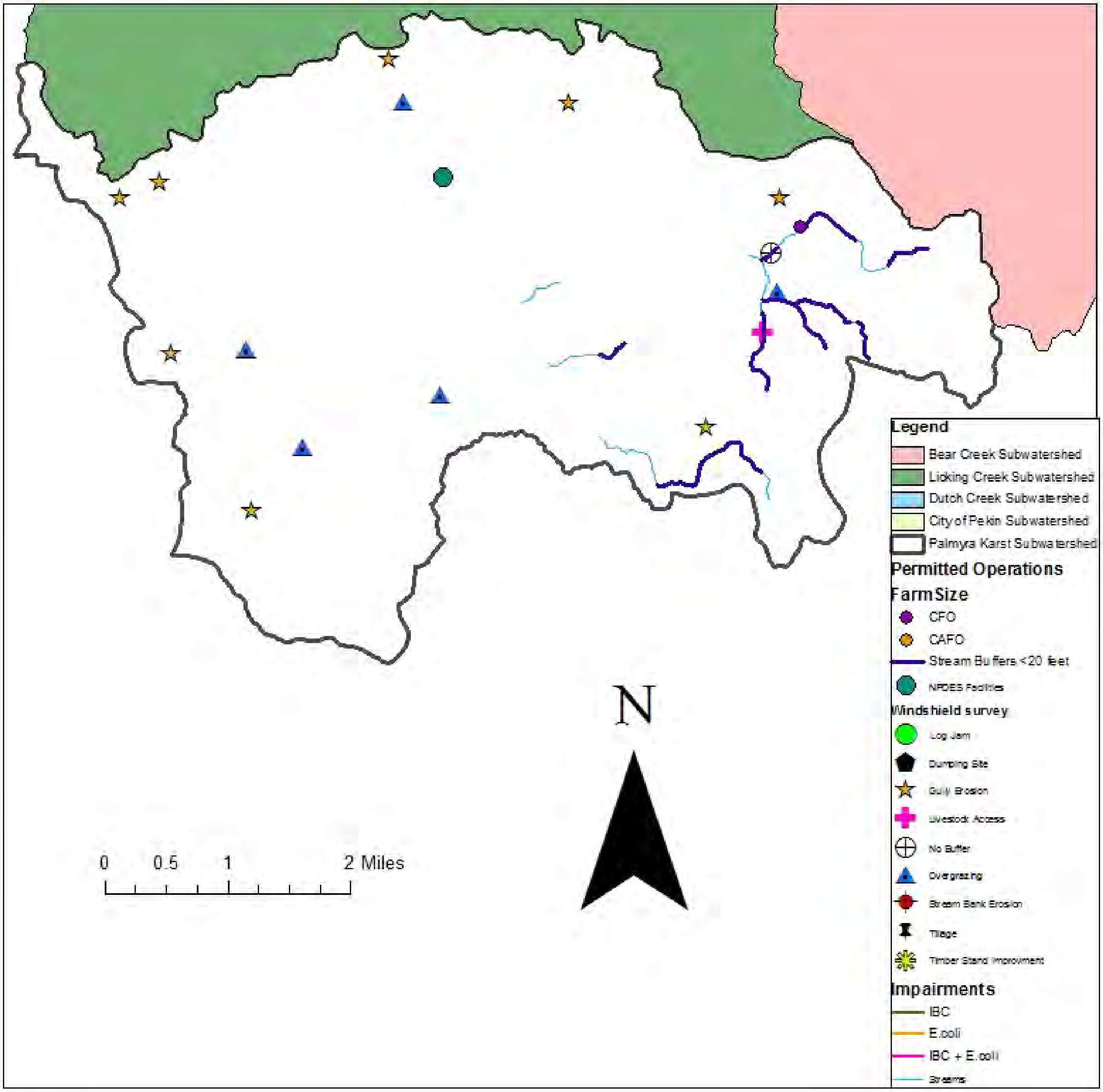


Figure 32: Palmyra Karst Subwatershed Survey

Palmyra Karst Water Quality and Habitat Data Summary.
Due to the subwatershed's unique karst topography all streams are intermittent and do not have sufficient flow for water monitoring. Therefore, there were no water monitoring sites and water quality data.

4.6 Licking Creek-South Fork Blue River-Subwatershed-HUC 051401040606

Licking Creek Subwatershed is located on the southwest side of the SFBR Watershed and includes 11,464 acres. Licking Creek is located mostly in Washington County but also slightly extends into Harrison County. The main stream in the watershed is South Fork-Blue River. Licking Creek is also located in the subwatershed as well as a limited amount of smaller tributaries. There are approximately 21.8 stream miles in the subwatershed.

Information from the land use data shows this watershed consists of cultivated crops 3,082.8 acres (26.9%), developed 482.8 acres (4.2%), forest 4,568.7 acres (39.9%), hay/pasture 3,216.5 acres (28.1%), open water 16.2 acres (.1%), and shrub/scrub 106.7 acres (.9%) (Figure 33).

Much like the Palmyra Karst Subwatershed, the Licking Creek subwatershed is comprised of karst topography with many sinkholes (Figure 6) and the highest density of caves (Figure 5) in the watershed. Highly erodible soils are prevalent in the subwatershed (Figure 7).

Licking Creek subwatershed contains two LUST sites, one within the Town of Fredericksburg and one located along Highway 135 on the northern end of the subwatershed (Figure 17). The subwatershed contains two permitted operations, one CFO size and one CAFO size (Figure 34).

Windshield surveys conducted in the fall of 2015 revealed potential water quality influences of gully erosion in crop fields at three locations, overgrazing of pastures and stream bank erosion at two locations and livestock with access to streams were identified at one location within the subwatershed. Table 44 and Figure 34 summarize these findings.

Potential Water Quality Influence	# of times identified in subwatershed	Observer
Overgrazing of pasture	2	Coordinator/Stakeholder
Gully erosion in crop field	3	Coordinator/Stakeholder
Livestock with access to stream	1	Coordinator/Stakeholder
Stream Bank Erosion	3	Coordinator/Stakeholder
Logjam	1	Coordinator/Stakeholder
Tillage	3	Coordinator/Stakeholder

Table 44: Licking Creek Subwatershed Windshield Survey

Approximately 9 miles of streams in Licking Creek subwatershed are listed on the 2018 Draft IDEM 303(d) list for impaired waterbodies for *E.coli* (Figure 34). Land use surrounding this stretch of impaired waters includes cultivated crops, forest, and hay/pasture. There are also a small number of houses and a small housing development located adjacent to the impaired segment.

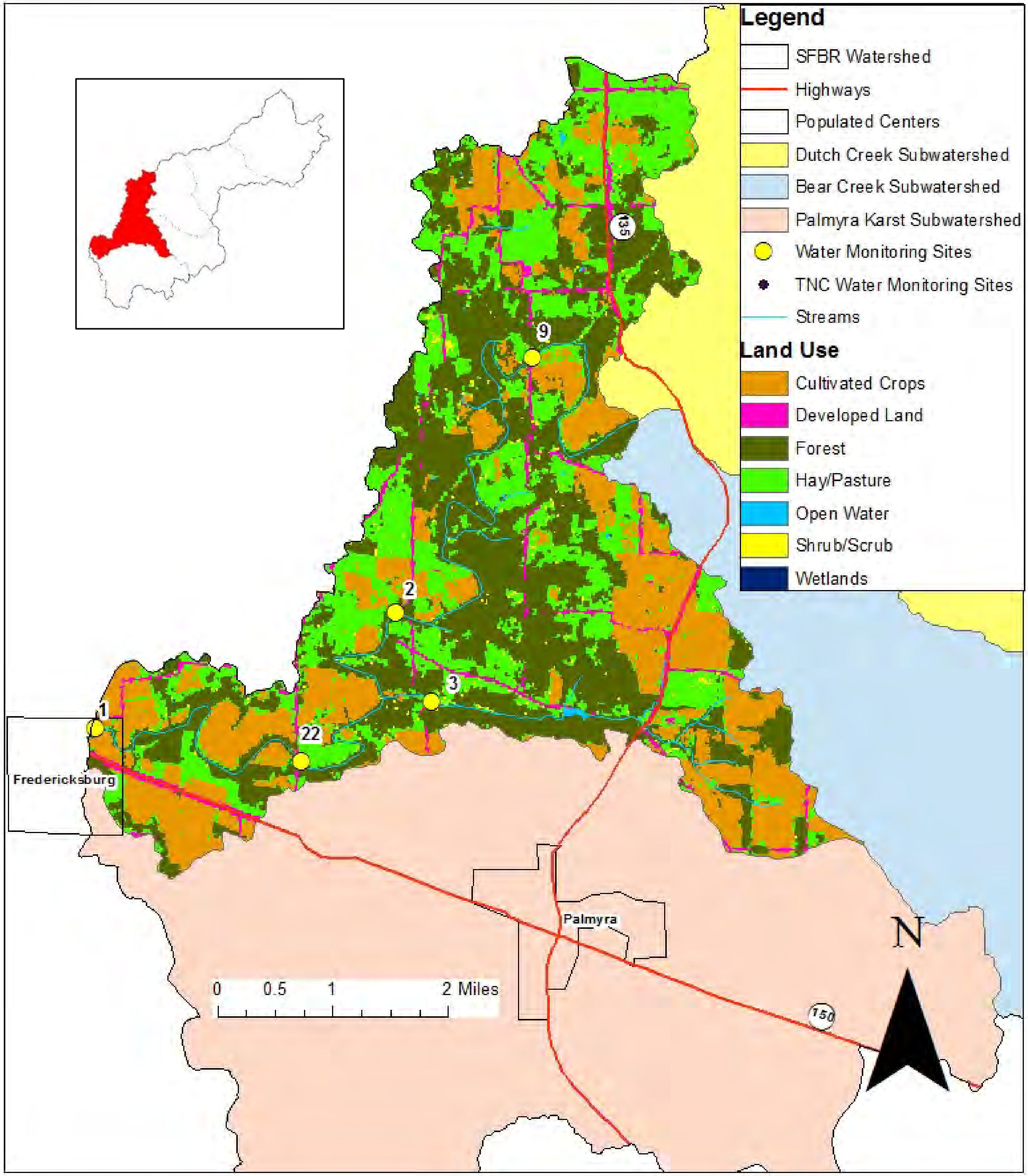


Figure 33: Licking Creek Subwatershed Landuse

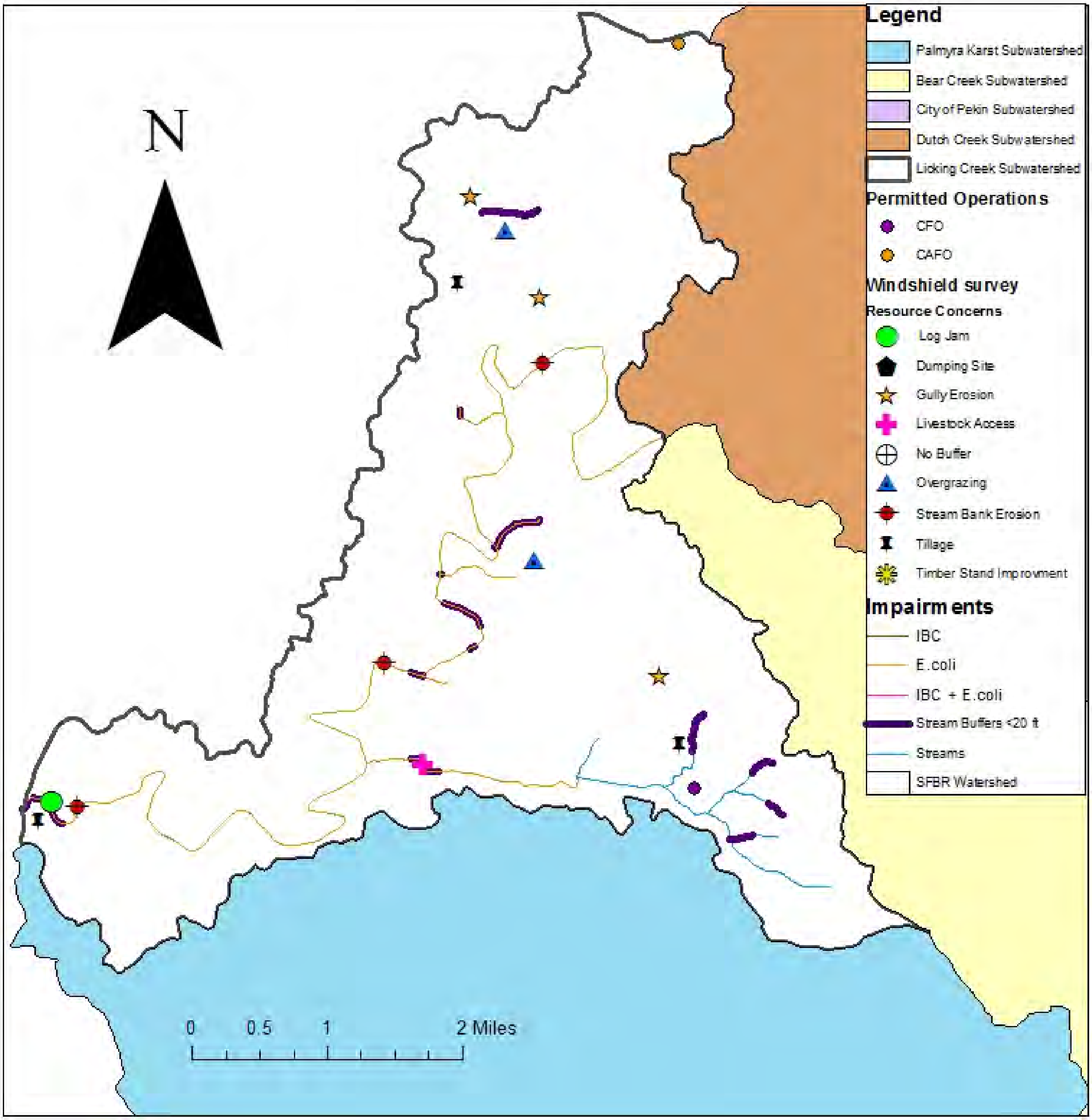


Figure 34: Licking Creek Subwatershed Survey

Water Quality and Habitat Data Summary

In 2015, IDEM completed monthly water sampling at four sites in the Licking Creek Subwatershed. The sampling resulted in all four sites failing WQS for *E.coli*. The watershed had moderate impairment with geometric means ranging from 173-1089 MPN/100mL.

At testing site 3 (IDEM OBS-06-0015), which is located on Licking Creek, the geometric mean for *E.coli* was 291.46. Throughout the sampling year, the *E.coli* numbers exceeded the single sample target 5 of 10 times. Nitrate+Nitrite exceeded the project targets on 5/7 occurrences. Both TKN and Total Phosphorus exceeded the target on 2/7 occurrences. TSS exceeded the project target on 1/7 occurrences. All other chemical and biological parameters met project targets. For a complete summary of water quality monitoring data at site 3 see Table 45.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	8.18	SU	0/12	0%
Dissolved Oxygen	8.92	mg/L	0/7	0%
Temp	18.22	Celsius	0/12	0%
Nitrate+Nitrite	1.61	mg/L	5/7	71%
TKN	.44	mg/L	2/7	29%
TSS	10.14	mg/L	1/7	14%
Turbidity	13.66	NTU	2/12	17%
Total Phosphorus	.102	mg/L	2/7	29%
E.coli	311.09	Colonies/100 mL	5/10	50%
Fish IBI	46	-	0/1	0%
QHEI(IBI)	60	-	0/1	0%
mIBI	44	-	0/1	0%
QHEI(mIBI)	66	-	0/1	0%

Table 45: Site 3 Water Quality Analysis-Licking Creek Subwatershed

At testing site 2 (OBS-06-0016), which is located on Palmyra Road on South Fork-Blue River, the geometric mean for *E.coli* was 1089.14. Throughout the sampling year, the *E.coli* numbers exceeded the single sample target on 9/10 occurrences. Surrounding land use to the testing site includes a small dairy farm and poultry barns as well as a mixture of cultivated crops, pasture, and forested acres. Additional target exceedances include Nitrate+Nitrite (4/7), TKN (1/7), TSS (2/7), and turbidity (2/10). All other chemical and biological data met project targets. For a complete summary of water quality monitoring data at site 2, see Table 46.

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
pH	8.30	SU	1/11	9%
Dissolved Oxygen	6.48	mg/L	0/11	0%
Temp	21.71	Celsius	0/11	0%
Nitrate+Nitrite	1.26	mg/L	4/7	57%
TKN	.393	mg/L	1/7	14%
TSS	12.85	mg/L	2/7	29%
Turbidity	13.15	NTU	2/10	20%
Total Phosphorus	.047	mg/L	0/7	0%
E.coli	1517.59	Colonies/100 mL	9/10	90%
Fish IBI	48	-	0/1	0%
QHEI(IBI)	59	-	0/1	0%
mIBI	42	-	0/1	0%
QHEI(mIBI)	62	-	0/1	0%

Table 46: Site 2 Water Quality Analysis-Licking Creek Subwatershed

At testing site 9 (IDEM OBS-06-0020), which is located on South Fork-Blue River on Big Springs Road, the geometric mean for *E.coli* was 173.2. Throughout the sampling year, the *E.coli* numbers exceeded the single sample target on 4/10 occurrences. Land use surrounding and upstream from the testing site includes cultivated crops, some hay/pasture, and a limited amount of forested acres, as well as a number of small farms. Additional parameters exceeding targets include Nitrate+Nitrite (2/7), TSS (1/7), turbidity (2/12) and Total Phosphorus (1/7). All other chemical and biological parameters met project targets. For a complete summary of water quality monitoring data at site 9, see Table 47.

Parameter	Mean/Score	Unit	# of Times Does Not Meet Target	% Does Not Meet Target
pH	7.83	SU	0/12	0%
Dissolved Oxygen	7.99	mg/L	0/12	0%
Temp	19.94	Celsius	0/12	0%
Nitrate+Nitrite	1.23	mg/L	2/7	29%
TKN	.329	mg/L	0/7	0%
TSS	10.71	mg/L	1/7	14%
Turbidity	8.41	NTU	2/12	8%
Total Phosphorus	.037	mg/L	1/7	14%
E.coli	318.23	Colonies/100 mL	4/10	40%
Fish IBI	52	-	0/1	0%
QHEI(IBI)	70	-	0/1	0%
mIBI	44/46	-	0/2	0%
QHEI(mIBI)	70/71	-	0/2	0%

Table 47: Site 9 Water Quality Analysis-Licking Creek Subwatershed

At testing site 1 (IDEM OBS130-0002), which is located on South Fork-Blue River off of Fredericksburg Road, the geometric mean for *E.coli* was 330.55. Throughout the sampling year, the *E.coli* numbers exceeded the single sample target on 12/14 occurrences. Land use surrounding the site includes cultivated crops with upstream land use consisting of cultivated crops, hay/pasture, and limited forested acres. There are several parameters that exceeded targets. Nitrate+Nitrite exceeded targets on

10/12 occurrences. TKN exceeded target on 4/12 occurrences. TSS exceeded target on 5/12 occurrences. Turbidity exceeded target on 5/15 occurrences. Total phosphorus exceeded the target on 4/12 occurrences. Possible sources of nitrogen and phosphorus could be animal waste from small farms, poultry litter spread on crop fields, fertilizer runoff from surrounding crop fields and failing septic systems. A category four logjam is located upstream of the testing site. Over two acres of land has eroded away as a result of the logjam. The logjam along with agriculture practices could be potential sources of elevated TSS and Turbidity levels. For a complete summary of water quality monitoring data at site 1, see Table 48.

Parameter	**Mean/Score**	**Unit**	**# of Times Does Not Meet Target**	**% Does Not Meet Target**
pH	7.68	SU	0/16	0%
Dissolved Oxygen	8.6	mg/L	2/16	13%
Temp	15.51	Celsius	0/12	0%
Nitrate+Nitrite	2	mg/L	10/12	83%
TKN	0.49	mg/L	4/12	33%
TSS	68	mg/L	5/12	42%
Turbidity	27.15	NTU	5/15	33%
Total Phosphorus	.098	mg/L	4/12	33%
E.coli	548.65	Colonies/100 mL	12/14	86%
Fish IBI	48	-	0/1	0%
QHEI(IBI)	69	-	0/1	0%
mIBI	44	-	0/1	0%
QHEI(mIBI)	64	-	0/1	0%

Table 48: Site 1 Water Quality Analysis-Licking Creek Subwatershed

Hoosier Riverwatch volunteers from West Washington FFA conducted volunteer water monitoring at sites 9 and 22 in the Licking Creek Subwatershed (Figure 33). Site 9 is located on Big Springs Road and Site 33 is located near the intersection of Lisa Lane and Horners Chapel Road. Both sites sample the main stem of South Fork-Blue River. Table 49 summarizes the results of parameters monitored that also have targets for the SFBR project. Sampling events occurred approximately monthly from May 2015 through April 2017. Sampling did not occur when water levels were too low for sampling or during high water levels that are unsafe for volunteers. Volunteer water monitoring is an excellent way to get the community involved and provide education on water quality.

Site 9-Big Springs Road	**pH**	**DO**	**Temp**	**Turbidity**	***E.coli***
Average	6.63	6.72	19.22	37.78	1900
Minimum/Maximum	6/7	4/12	12/24	15/60	1400/2300
# of results	8	9	9	9	9
# times exceeded targets	0	0	0	9	3
Site 22-Lisa Lane	**pH**	**DO**	**Temp**	**Turbidity**	***E.coli***
Average	6.87	6.54	16.76	49.23	24.42
Minimum/Maximum	5.5/7.85	4/9	12/24	15/60	10/40
# of results	13	13	13	13	6
# times exceeded targets	0	0	0	13	0

Table 49: Volunteer Water Monitoring Results-Licking Creek Subwatershed

5.0 Watershed Inventory Part IV

5.1 Watershed Inventory Summary

The South Fork-Blue River Watershed is mostly rural with the largest percentage of land use being forest (45.5%) followed by hay/pasture (28.8%), cultivated crops (19.8%) and developed land (4.8%) (Figure 11). The watershed contains two small towns, Palmyra with a population of just under 1,000 and New Pekin with a population of approximately 1,400.

The watershed is made of sensitive karst topography, with a high density of sinkholes in the lower portion of the watershed, which does not support perennial streams. The watershed is also home to several endangered plant and animal species on both the state and federal level known to live in some of the watershed's sensitive habitat.

Table 50 and Figure 35 illustrate a summary of the data that highlights the windshield data, draft 2018 list of impaired streams, NPDES facilities, and CAFO/CFOs for the South Fork-Blue River Watershed. Water quality issues identified include E. coli, impaired biotic communities, nutrients, and sediment. The Draft 2018 303(d) List of Impaired Waters includes 143.54 miles of stream segments within the SFBR watershed (116.67 miles for *E.coli* impairment, 14.29 miles for IBC impairment, and 12.58 miles for *E.coli* + IBC impairment). Site averages that do not meet targets set for the project include: *E.coli* Geometric mean (19 of 21 sites; all subwatersheds), Total Phosphorus (9 of 21 sites; Springle Creek, City of Pekin, and Licking Creek subwatersheds), Nitrate+Nitrite (9 of 21 sites; Bear Creek, Dutch Creek, and Licking Creek subwatersheds), and TSS (9 of 21 sites; Springle Creek and City of Pekin subwatersheds).

TNC microbial source tracking monitoring completed by TNC revealed human *E.coli* was present on both sampling events at all four testing sites. Ruminant *E.coli* was detected at least once at sites on Blue River Road, Mahuron Road, and Martinsburg Fire Road. Poultry *E.coli* was not detected at any sites. Failing or unmaintained septic systems and livestock are potential sources. Based on soils, 99.8% of the watershed has either very limited or somewhat limited soil capabilities. Livestock with access to streams and overgrazed pastures were noted in each subwatershed. Possible improper application of manure applied as fertilizer is also a potential source. There is no current data available but the potential problem does exist with the amount of livestock present in the watershed.

The windshield survey revealed a total of 147 areas of concern. Some of the most common concerns documented were: overgrazing of pastures-31 areas, gully erosion in crop fields-22 areas, livestock with access to streams-26 areas, stream bank erosion-22 areas, and row cropping within 20 feet of a stream-31 areas. All of these are potential sources for sediment and nutrients and most are also potential sources for *E.coli*. There are 11 permitted feeding operations facilities throughout the watershed and many unpermitted operations. The watershed also contains 2 NPDES sites, neither of which have permit compliance issues.

Subwatershed	Land Use (%)				2018 Draft IDEM 303(d) List (stream miles)			Sites Exceeding Project Targets			Primary Resource Concerns (Windshield Survey)			
	Cultivated Crops	Hay/Pasture	Forest	Developed Land	IBC	*E.coli*	*E.coli*, IBC	Total Phosphorus	Nitrogen	TSS	Overgrazing of pasture	Gully Erosion in Crop Field	Livestock With Access to Stream	Row Crop Within 20 ft. of Stream
Springle Creek -01	9.7	20.6	64.7	3.9	7.98	35.51		x		x	x	x	x	x
City of Pekin -02	11.7	40	39.9	7.5		20.7		x		x	x	x	x	x
Bear Creek -03	19.7	30.2	44.5	4.5		28.66			x		x	x	x	x
Dutch Creek -04	17.5	35.9	42	3.9	18.89	27.81	4.6		x		x	x	x	x
Palmyra Karst Area -05	37.3	25.1	30.7	5.9							x	x	x	x
Licking Creek -06	26.9	28.1	39.9	4.2		9.18		x	x		x	x	x	

Table 50: Subwatershed Summary Data

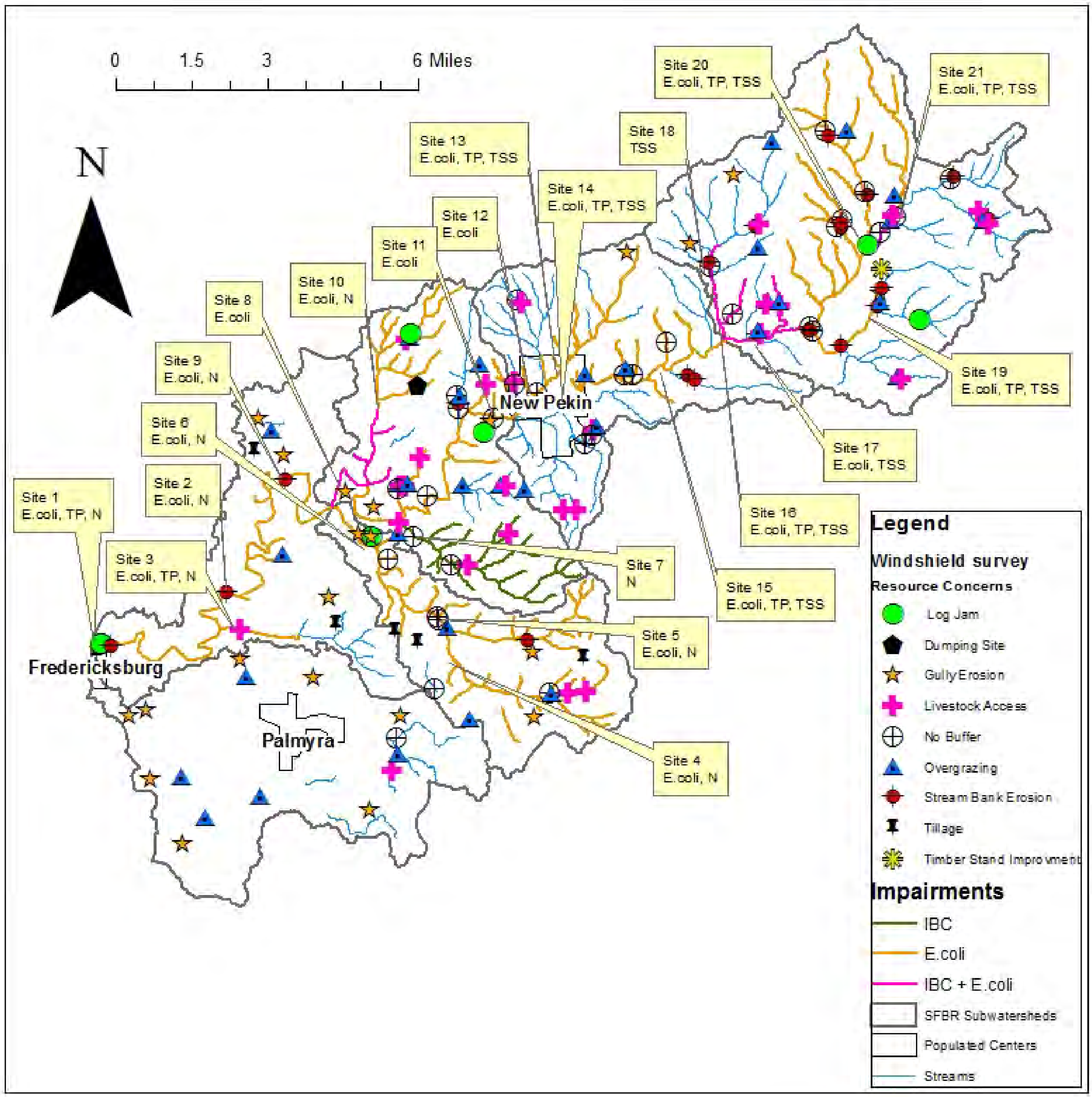


Figure 35: South Fork-Blue River Watershed Survey Results and Sites Not Meeting Water Quality Standards

5.2 Summary and Analysis of Stakeholder Concerns

Stakeholder concerns were collected by stakeholder meetings, steering committee meetings, discussions with stakeholders and/or windshields surveys. These concerns are outlined in Table 51 as to whether the concerns are supported by the collected data, quantifiable, outside the scope of this project, and whether or not the group would like to focus efforts on the concern in the WMP.

Concern	Supported by our data?	Evidence	Quantifiable?	Outside Scope?	Group wants to focus on?
Trash Dumped (streams, roadsides, etc.)	Yes	Sighting by stakeholders	Yes	No	Yes, with clean-up days, education, signs
Trash accumulated on residential property and then washed into streams during heavy rainfalls	Yes	2 areas on windshield survey Sightings by stakeholders	Yes	No	Yes, with clean-up days, education
Log jams	Yes	6 areas on windshield survey Stakeholder and Steering committee member sightings	Yes	No	Yes, education, technician to seek other funds
Streambank Erosion	Yes	22 areas on windshield survey Sightings by stakeholders	Yes	No	Yes
Lack of buffer zones in agriculture fields	Yes	31 areas on windshield survey Desktop survey-46.1 miles lacking buffers indentified	Yes	No	Yes
Water Quality	Yes	IDEM, Hoosier Riverwatch, and TNC water monitoring results 303d list	Yes	No	Yes
Protecting Endangered Species	Yes	DNR and FWS Endangered Species List	Yes	No	Yes, education
Flooding	Yes	Discussions with public/stakeholders	Yes	No	Yes, education
Debris collecting behind center support of bridge and causing flooding during heavy rains	Yes	Conversation with stakeholder	No	Yes	No
Septic Maintenance	Yes	Historical and current *E.coli* water monitoring data Current TNC *E.coli* water monitoring-	Yes	No	Yes

Concern	Supported by our data?	Evidence	Quantifiable?	Outside Scope?	Group wants to focus on?
		Human sources detected at all sampling occurrences Health Dept. Records- 14 leaking septic systems recorded, estimated 50% failing rate			
Access of livestock to streams	Yes	26 areas on windshield Survey Stakeholder sightings	Yes	No	Yes
Lawn Care Treatment/ Education	No	Possible improper application of lawn care products. 4.8% of watershed is developed-excessive fertilizer use is potential problem but no current data is available.	Yes	No	Yes, education
Improper Application of litter/manure	Suspected	Watershed Inventory -11 permitted livestock operation -numerous unpermitted small farms Water Quality Monitoring -10/21 sites had an *E.coli* geometric mean exceeding state standards -TNC *E.coli* monitoring indicates *E.coli* from ruminants detected at 4/24 sampling events	Yes	No	Yes
Sediment in water bodies	Yes	Stakeholder sightings -Jordan Lake sediment accumulation -siltation noted in hellbender survey of SFBR Water Quality Data	No	No	Yes

Concern	Supported by our data?	Evidence	Quantifiable?	Outside Scope?	Group wants to focus on?
		-13/21 sites exceed project target turbidity			
Overgrazing in pasture	Yes	31 areas on windshield survey	Yes	No	Yes
Gully erosion in crops fields	Yes	22 areas on windshield survey	Yes	No	Yes
Timber Stand Improvement Needed	Yes	1 area on windshield survey	No	Yes	No

Table 51: Analysis of Stakeholder Concerns

Although needed timber stand improvement is a concern supported by the project data, the steering committee decided to not focus on this concern because of the minimal impact it will have on water quality improvement.

Also, the steering committee has chosen to not focus on the concern of debris collecting behind center support of bridge and causing flooding during heavy rains because of the minimal impact it will have on water quality improvement.

6.0 Identification of Problems and Causes

The steering committee identified specific problems relating to each resource concern on which the group wished to focus. Problems were defined as issues that exist due to a concern. Identified problems build upon concerns by identifying a condition or actions that need to be changed, improved or investigated in great depth. Specific problems were then consolidated into problem categories. Table 52 links stakeholder concerns to specific water quality problems and generalized water quality problem categories.

6.1 Problems of Group's Focus

Concerns	Specific Problems	Problem Category
Trash Dumped into Streams	May contain hazardous materials; maintains behavior of community that trash on the street/roadside and dumping foreign material in storm drains is acceptable	Trash Degraded Habitat Decrease in Biodiversity
Trash accumulated on residential property and then washed into streams during heavy rainfalls	May contain hazardous materials; reinforces public perception that trash in natural areas is acceptable	Trash Degraded Habitat Decrease in Biodiversity
Log jams	Poor drainage and causes backup of materials; streambank erosion; damage to structures (specifically bridges)	Sedimentation High nutrient levels
Streambank Erosion	Sediment and nutrient inputs	Sedimentation High nutrient levels

Concerns	Specific Problems	Problem Category
Lack of buffer zones in agriculture fields	Buffer areas provide a natural filter for water before entering the stream. Without buffers, streams can have high nutrient levels, higher *E.coli* levels, and overall degraded habitat. Buffers also help bank stabilization.	High *E.coli* levels High nutrient levels Degraded habitat Sedimentation
Water Quality	Water quality targets are exceeded; streams within SFBR watershed are listed on the 303(d) list	High *E.coli* levels High nutrient levels Degraded Habitat Decrease in biodiversity Sedimentation
Protecting Endangered Species	Decrease in biodiversity	Decrease in biodiversity
Flooding	Runoff from flooded areas can increase nutrient, *E.coli* and sediment levels.	High *E.coli* levels High nutrient levels Sedimentation
Septic Maintenance	Failing septic systems increase the amount of *E.coli* and nutrients in streams and degrade habitat	High *E.coli* levels High nutrient levels Degraded habitat
Access of livestock to streams	Streambank erosion; degraded stream habitat; nutrient and *E.coli* inputs	High nutrient levels High *E.coli* levels Sedimentation Degraded habitat
Application of litter/manure	Nutrient inputs; *E.coli* levels; poor aquatic habitat	High nutrient levels High *E.coli* levels Degraded habitat
Overgrazing in pastures	Runoff from poorly managed pastureland can cause increased *E.coli* and nutrient levels in stream. Erosion causes increased sedimentation which degrades the stream's habitat	High *E.coli* levels High nutrient levels Sedimentation Degraded Habitat
Gully erosion in crop fields	Runoff that forms gully erosion carries sediment and potentially nutrients	High nutrient levels Sedimentation Degraded Habitat
Sediment in water bodies	Sediment that accumulates in water bodies such as lakes, ponds and rivers. This reduces the water volume the water body is able to accept and the sediment settles into rock bedding, reducing spawning habitats and water quality	Degraded Habitat Flooding Sedimentation
Lawn Care Treatment	Increase in nutrient input of water bodies and degrades habitat	High Nutrient Levels Degraded Habitat

Table 52: Identification of Problems and Causes

7.0 Identifying Potential Causes and Sources

7.1 Potential Sources for Each Pollution Problem

The steering committee linked identified water quality problem categories to potential causes and potential sources for those problems to sources based on windshield survey data and other observations made in the watershed (Table 53). Sources can be the results of any nonpoint source pollution.

Problem Category	Potential Causes	Potential Sources
Degraded Habitat	TSS, Turbidity, and Sedimentation	-Overgrazing of pastures by livestock (5x-Palmyra Karst, 2x-Licking Creek, 3x-Bear Creek, 7x-Dutch Creek, 1x-City of Pekin, 13x-Springle Creek) -Eroded sediment from stream banks (2x Licking Creek, 1x-Bear Creek, 2x-Dutch Creek, 2x-City of Pekin, 14x-Springle Creek) -Row Cropping within 20 feet of stream (1x-Palmyra Karst, 5x-Bear Creek, 7x-Bear Creek, 7x-City of Pekin, 11x-Springle Creek, 7x Dutch Creek) -Livestock with access to streams (1x-Licking Creek, 1x-Palmyra Karst, 2x-Bear Creek, 8x-Dutch Creek, 5x-City of Pekin, 9x-Spingle Creek) -Gully erosion in crop fields (8x-Palmyra Karst, 3x-Licking Creek, 4x-Bear Creek, 3x-Dutch Creek, 1x-City of Pekin, 3x-Springle Creek) -Highly erodible soils (48,571 acres-60.2% of SFBR Watershed) -Lack of riparian buffers-desktop survey (5.0 miles-Palmyra Karst, 2.9 miles-Licking Creek, 3.9 miles-Bear Creek, 11.9 miles-Dutch Creek, 16.0 miles- City of Pekin, 6.4 miles- Springle Creek) -Tillage-windshield survey (3x-Licking Creek, 3x Bear Creek) -Tillage transect data-conventional tillage (7,400 acres Washington County, 4,400 acres Harrison County)

Problem Category	Potential Causes	Potential Sources
	Nutrient	-Failing and unmaintained septic systems (all subwatersheds). 14 recorded failing systems in Harrison County SFBR Watershed, estimated 50% failing rate in Washington County. -67.2% of watershed with somewhat limited soil and 32.6% of watershed with very limited soil for septic suitability -Possible improper application (source, rate, timing, location) of manure applied as fertilizer (all subwatersheds). 39,223.4 acres cultivated crops/hay/pasture. No current data available but the potential problem does exist with the amount of livestock present. -Possible improper application of lawn care products. 4.8% is developed-excessive fertilizer use is a potential problem but no current data is available. - Possible fertilizer leaching and/or runoff from agriculture land (all subwatersheds) -Sources listed above for sediment could also be potential sources for nutrients.
	Lack of riparian vegetation	-Lack of riparian buffers (5.0 miles- Palmyra Karst, 2.9 miles-Licking Creek, 3.9 miles-Bear Creek, 11.9 miles-Dutch Creek, 16.0 miles- City of Pekin, 6.4 miles-Springle Creek)
	Dumping Sites	-Dumping site (2x-Dutch Creek)
Sedimentation	TSS and turbidity levels exceed project targets	-Overgrazing of pastures by livestock (5x-Palmyra Karst, 2x-Licking Creek, 3x-Bear Creek, 7x-Dutch Creek, 1x-City of Pekin, 13x-Springle Creek) -Eroded sediment from stream banks (2x Licking Creek, 1x-Bear Creek, 2x-Dutch Creek, 2x-City of Pekin, 14x-Springle Creek) -Row Cropping within 20 feet of stream (1x-Palmyra Karst, 5x-Bear Creek, 7x-Bear Creek, 7x-City of Pekin, 11x-Springle Creek, 7x Dutch Creek) -Gully erosion in crop fields (8x-Palmyra Karst, 3x-Licking Creek, 4x-Bear Creek, 3x-Dutch Creek, 1x-City of Pekin, 3x-Springle Creek) -Lack of riparian buffers-desktop survey (5.0 miles-Palmyra Karst, 2.9 miles-Licking Creek, 3.9 miles-Bear Creek, 11.9 miles-Dutch Creek, 16.0 miles- City of Pekin, 6.4 miles- Springle Creek)

Problem Category	Potential Causes	Potential Sources
		-Tillage-windshield survey (3x-Licking Creek, 3x Bear Creek) -Tillage transect data-conventional tillage (7,400 acres Washington County, 4,400 acres Harrison County) -Logjams (1x-Licking Creek, 2x-Dutch Creek, 2x-Springle Creek, 1x-Bear Creek) -Highly erodible soils (48,571 acres-60.2% of SFBR Watershed) -Storm water runoff (all subwatersheds) (2,797 acres of developed area in City of Pekin, Licking Creek and Palmyra Karst subwatersheds)
High *E.coli* Levels	*E.coli* levels exceed project water quality targets; Lack of understanding of *E.coli* sources	-Livestock with access to streams (1x-Licking Creek, 1x-Palmyra Karst, 2x-Bear Creek, 8x-Dutch Creek, 5x-City of Pekin, 9x-Spingle Creek) -Failing and unmaintained septic systems (all subwatersheds) 14 recorded failing systems in Harrison County SFBR Watershed, estimated 50% failing rate in Washington County. -67.2% of watershed with somewhat limited soil and 32.6% of watershed with very limited soil for septic suitability -Overgrazing of pastures by livestock (5x-Palmyra Karst, 2x-Licking Creek, 3x-Bear Creek, 7x-Dutch Creek, 1x-City of Pekin, 13x-Springle Creek) -Possible improper application (source, rate, timing, location) of manure applied as fertilizer (all subwatersheds). No current data available but the potential problem does exist with the amount of livestock present. -Lack of riparian buffers (5.0 miles- Palmyra Karst, 2.9 miles-Licking Creek, 3.9 miles-Bear Creek, 11.9 miles-Dutch Creek, 16.0 miles- City of Pekin, 6.4 miles-Springle Creek)
High Nutrient Levels	Nutrient levels exceed water quality target; Lack of public understanding of nutrient sources	-Livestock with access to streams (1x-Licking Creek, 1x-Palmyra Karst, 2x-Bear Creek, 8x-Dutch Creek, 5x-City of Pekin, 9x-Spingle Creek) -Failing and unmaintained septic systems (all subwatersheds) 14 recorded failing systems in Harrison County SFBR Watershed, estimated 50% failing rate in Washington County. -67.2% of watershed with somewhat limited soil and 32.6% of watershed with very limited soil for septic suitability

Problem Category	Potential Causes	Potential Sources
		- Possible fertilizer leaching and/or runoff from agriculture land (all subwatersheds) -Lack of riparian buffers (5.0 miles- Palmyra Karst, 2.9 miles-Licking Creek, 3.9 miles-Bear Creek, 11.9 miles-Dutch Creek, 16.0 miles- City of Pekin, 6.4 miles-Springle Creek) -Possible improper application of lawn care products. 4.8% is developed-excessive fertilizer use is a potential problem but no current data is available -Overgrazing of pastures by livestock (5x-Palmyra Karst, 2x-Licking Creek, 3x-Bear Creek, 7x-Dutch Creek, 1x-City of Pekin, 13x-Springle Creek) -Eroded sediment from stream banks (2x Licking Creek, 1x-Bear Creek, 2x-Dutch Creek, 2x-City of Pekin, 14x-Springle Creek) -Row Cropping within 20 feet of stream (1x-Palmyra Karst, 5x-Bear Creek, 7x-Bear Creek, 7x-City of Pekin, 11x-Springle Creek, 7x Dutch Creek) -Gully erosion in crop fields (8x-Palmyra Karst, 3x-Licking Creek, 4x-Bear Creek, 3x-Dutch Creek, 1x-City of Pekin, 3x-Springle Creek) -Tillage-windshield survey (3x-Licking Creek, 3x Bear Creek) -Tillage transect data-conventional tillage (7,400 acres Washington County, 4,400 acres Harrison County) -Logjams (1x-Licking Creek, 2x-Dutch Creek, 2x-Springle Creek, 1x-Bear Creek) -Highly erodible soils (48,571 acres-60.2% of SFBR Watershed) -Storm water runoff (all subwatersheds) (2,797 acres of developed area in City of Pekin, Licking Creek and Palmyra Karst subwatersheds)
Decrease in biodiversity	High nutrient, sediment, and *E.coli* levels exceed water quality targets resulting from insufficient public understanding of pollution sources	-Overgrazing of pastures by livestock (5x-Palmyra Karst, 2x-Licking Creek, 3x-Bear Creek, 7x-Dutch Creek, 1x-City of Pekin, 13x-Springle Creek) -Eroded sediment from stream banks (2x Licking Creek, 1x-Bear Creek, 2x-Dutch Creek, 2x-City of Pekin, 14x-Springle Creek)

Problem Category	Potential Causes	Potential Sources
		-Row Cropping within 20 feet of stream (1x-Palmyra Karst, 5x-Bear Creek, 7x-Bear Creek, 7x-City of Pekin, 11x-Springle Creek, 7x Dutch Creek) -Livestock with access to streams (1x-Licking Creek, 1x-Palmyra Karst, 2x-Bear Creek, 9x-Dutch Creek, 5x-City of Pekin, 8x-Spingle Creek) -Failing and unmaintained septic systems (all subwatersheds) 14 recorded failing systems in Harrison County SFBR Watershed, estimated 50% failing rate in Washington County. -67.2% of watershed with somewhat limited soil and 32.6% of watershed with very limited soil for septic suitability -Lack of riparian buffers-desktop survey (5.0 miles-Palmyra Karst, 2.9 miles-Licking Creek, 3.9 miles-Bear Creek, 11.9 miles-Dutch Creek, 16.0 miles- City of Pekin, 6.4 miles- Springle Creek) -Gully erosion in crop fields (8x-Palmyra Karst, 3x-Licking Creek, 4x-Bear Creek, 3x-Dutch Creek, 1x-City of Pekin, 3x-Springle Creek) -Tillage-windshield survey (3x-Licking Creek, 3x Bear Creek) -Tillage transect data-conventional tillage (7,400 acres Washington County, 4,400 acres Harrison County) -Logjams (1x-Licking Creek, 2x-Dutch Creek, 2x-Springle Creek, 1x-Bear Creek) -Highly erodible soils (48,571 acres-60.2% of SFBR Watershed) -Storm water runoff (all subwatersheds) (2,797 acres of developed area in City of Pekin, Licking Creek and Palmyra Karst subwatersheds) -Possible improper application (source, rate, timing, location) of manure applied as fertilizer (all subwatersheds). No current data available but the potential problem does exist with the amount of livestock present. -Possible improper application of lawn care products. 4.8% is developed-excessive fertilizer use is a potential problem but no current data is available - Possible fertilizer leaching and/or runoff from agriculture land (all subwatersheds)

Problem Category	Potential Causes	Potential Sources
Trash	Lack of public understanding of pollution consequences; Lack of funds to properly dispose of trash	-Dumping of trash/debris (2x-Dutch Creek)

Table 53: Potential Pollutant Source per Problem Category

7.2 Calculating Loads

A very useful tool in determining how much reduction in pollutants is needed to attain water quality standards or targets is load estimation. With many variables involved, this is often a difficult task. Load is defined as the amount of a pollutant (usually in pounds, kilograms, or tons) that passes through a point on a stream or river in a certain amount of time (often in one day or one year). In order to estimate load on a particular day (instantaneous load), two things are needed:

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

The *Web-based Load Calculation using LOADEST* was the tool used to calculate the loads for the South Fork-Blue River Watershed. This tool is based on the USGS LOADEST model and was developed by the Agricultural and Biological Engineering Department at Purdue University. The model is based on the assumption that concentration varies with flow and uses regression equations to estimate loads for a specified time period. Stream flow data from the USGS gage on Blue River at Fredericksburg and project water quality data from Site T01 (the site closest to the watershed outlet) were used to calculate annual loads for nutrients and sediment (Table 54-56). E. coli reductions required for the project were obtained from the South Fork Blue River TMDL (Table 57).

The South Fork Blue River Watershed has an estimated current load of nitrate-nitrite of 1,218,005 lbs. per year. In order to meet the watershed's nitrate-nitrite target of 1.2 mg/L, the watershed needs to reduce its nitrate-nitrite load by 707,310 lbs. per year, which is a 58% reduction.

NO3-NO2 (T01)	Total (lb/yr)	Per acre (lb/ac/yr)
Estimated Annual Load :	**1,218,005**	**15.1**
Maximum Annual Load to Meet Target :	**510,695**	**6.3**
Load Reduction Needed to Meet Target :	**707,310**	**8.8**

Table 54: Load Reduction Required to Meet Nitrate-Nitrite Goal

The South Fork-Blue River Watershed has an estimated current load of total phosphorus of 357,335 pounds per year. In order to meet the watershed's total phosphorus target of 0.076 mg/L, the watershed needs to reduce its total phosphorus load by 324,991 pounds per year, which is a 91% reduction.

Total Phosphorus (T01)	Total (lb/yr)	Per acre (lb/ac/yr)
Estimated Annual Load :	**357,335**	**4.4**
Maximum Annual Load to Meet Target :	**32,344**	**0.4**
Load Reduction Needed to Meet Target :	**324,991**	**4**

Table 55: Load Reduction Required to Meet Total Phosphorus Goal

The South Fork-Blue River Watershed has an estimated current load of total suspended solids (TSS) of 253,250 tons per year. To meet the watershed's TSS target of 25 mg/L, the watershed needs to reduce its TSS load by 247,930 per year, which is a 98% reduction.

TSS (T01)	Total (lb/yr)	Per acre (lb/ac/yr)	Total (tons/yr)	Per acre (tons/ac/yr)
Estimated Annual Load :	**506,499,915**	**6,277**	**253,250**	**3.1**
Maximum Annual Load to Meet Target :	**10,639,495**	**131.9**	**5,320**	**0.1**
Load Reduction Needed to Meet Target :	**495,860,420**	**6,145.10**	**247,930**	**3.1**

Table 56: Load Reduction Required to Meet Total Suspended Solids (TSS) Goal

Table 57 provides a summary of E. coli data in the South Fork Blue River subwatersheds to show which are impaired due to pathogens. It shows the total of number of samples taken and the % of time that target value was exceeded. The percent reductions are based the geomean value for each site.

Subwatershed	**Station #**	**AUID**	**Period of Record**	**Total # of Samples**	**Percent of Samples Exceeding *E. coli* WQS (#/100 mL)**		**Geomean (#/ 100 mL)**	**Single Sample Maximum (#/ 100 mL)**	**Percent Reduction Based on Geomean (125/ 100mL)**
					125	**235**			
Springle Creek	OBS-06-0010 (T21)	INN0461_02	4/7/2015-10/6/2015	10	90%	50%	457.16	5,794	52.95%
	OBS-06-0002 (T17)	INN0461_04	11/12/2014-10/6/2015	15	67%	53%	403.37	5,475	69.01%
	OBS-06-0005 (T20)	INN0461_T106	4/7/2015-9/14/2015	9	22%	33%	627.37	4,611	80.07%
	OBS-06-0011 (T19)	INN0461_T1012	4/7/2015-9/14/2015	10	90%	70%	277.13	>2419.6	54.89%
	OBS-06-003 (T16)	INN0461_T1018	4/7/2015-9/14/2015	10	70%	70%	398.75	1,986.3	69%
	OBS-06-0010 (T18)	INN0461_T1018	4/7/2015-9/14/2015	9	67%	44%	42.7	>2419.6	NA
City Of Pekin	OBS-06-0022 (T15)	INN0462_02	11/12/2015-10/6/2015	15	73%	47%	240.8	7,701	48.09%

Subwatershed	Station #	AUID	Period of Record	Total # of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
	OBS-06-0018 (T14)	INN0462_02	4/7/2015-10/6/2015	10	70%	50%	255.4	8,664	51.06%
	OBS-06-0012 (T13)	INN0462_T1009	4/7/2015-10/6/2015	10	90%	80%	467.69	3,448	73.27
	OBS-06-0006 (T12)	INN0462_T1013	4/6/2015 – 10/5/2015	10	70%	50%	171.76	1,986.3	27.22%
Bear Creek	OBS-06-0021 (T04)	INN0463_02	4/6/2015 – 10/5/2015	10	90%	80%	350.09	816.4	64.30%
	OBS-06-0014 (T05)	INN0463_03	4/6/2015 – 10/5/2015	10	90%	90%	901.78	2,100.3	86.14%
	OBS-06-0013 (T06)	INN0463_04	11/12/2015 -10/5/2015	15	87%	73%	678.22	1,046.2	81.57%
Dutch Creek	OBS-06-0004 (T11)	INN0464_01	11/12/2015 -10/5/2015	15	93%	73%	654.77	1203.3	80.91%
	OBS-06-0008 (T08)	INN0464_03	11/12/2015 -10/5/2015	15	60%	47%	162.71	2,040.7	23.18%
	OBS-06-0007 (T07)	INN0464_T1004	4/6/2015 – 10/5/2015	10	40%	20%	42.72	410.6	NA
	OBS-06-0009 (T10)	INN0464_T1006	4/6/2015 – 9/1/2015	9	89%	78%	392.18	1,912.6	68.13%
Palmyra Karst	NA	NA	NA	NA	NA	NA	NA	NA	NA
Licking Creek	OBS-06-0020 (T09)	INN0466_01	4/6/2015 – 10/5/2015	10	80%	40%	173.2	1,119.9	27.83%
	OBS-06-0016 (T02)	INN0466_03	4/6/2015 – 10/5/2015	10	90%	90%	1,089.14	4,611	88.52%
	OBS-06-0002 (T01)	INN0466_08	11/12/2015 -10/5/2015	15	87%	80%	330.5	1,059.4	62.18%
	OBS-06-0015 (T03)	INN0466_T1004	4/6/2015 – 10/5/2015	10	100 %	70%	291.46	866.4	57.11%

Table 57: Percent Reduction Required to Meet E.coli Goal

8.0 South Fork-Blue River Goals and Indicators

Goals were developed by the steering committee to address the problems and concerns of the watershed. Many of the goals address more than one problem category. The goals selected are not listed in particular order of importance.

Goal #1: The steering committee would like to reduce the nutrients in the watershed. The current estimated annual load for nitrate-nitrogen and total phosphorus respectively is 1,218,005 lbs/year and 357,335 lb/year. To meet the project water quality targets, the steering committee would like to reduce nitrate-nitrogen by 58% (707,310 lbs/year) and Total Phosphorus by 91% (324,991 lbs/year).

5 year goal: 15% reduction for nitrate-nitrogen (182,701 lbs/year) and 23% reduction for total phosphorus (81,248 lbs/year).

10 year goal: 30% for nitrate-nitrogen (365,402 lbs/year) and 46% for total phosphorus (162,496 lbs/year).

15 year goal: 44% reduction for nitrate-nitrogen (535,922 lbs/year) and 69% reduction for total phosphorus (243,744 lbs/year).

20 year goal: 58% reduction for nitrate-nitrogen (707,310 lbs/year) and 91% reduction for total phosphorus (324,991 lbs/year).

Indicators of Progress:

1. Number of acres/best management practices implemented and calculated load reductions for each.
2. Improved results for nitrate-nitrogen and total phosphorus results in future IDEM samplings.
3. Number of people attending field days and other educational events.

Goal #2: The steering committee would like to reduce soil erosion and sedimentation in the watershed. The current estimated annual load for TSS is 253,250 tons/year. To meet the project water quality targets, the steering committee would like to reduce the current load of total suspended solids (TSS) by 98% (247,930 tons/year).

5 year goal: 25% reduction (61,983 tons/year) of sediment

10 year goal: 49% reduction (123,965 tons/year) of sediment

15 year goal: 74% reduction (185,948 tons/year) of sediment

20 year goal: 98% reduction (247,930 tons/year) of sediment

Indicators of progress:

1. Number of acres/best management practices implemented and calculated load reductions for each.
2. Improved results for TSS in future IDEM samplings.
3. Number of people attending field days and other education events.

Goal #3: The steering committee would like to reduce E. coli so that all streams in SFBR meet the State water quality standard (235 colonies/100mL grab sample; 125/100mL in geometric sample). Approximately 126 miles of streams are on the 303(d) list for E. coli and 19 sites exceeded the geometric mean standard.

5 year goal: Eliminate at least 2 problem areas where livestock access streams; apply nutrient management to 2,000 acres

10 year goal: Eliminate at least 4 problem areas where livestock access streams; apply nutrient management to 4,000 acres

15 year goal: Eliminate at least 7 problem areas where livestock access streams; apply nutrient management to 6,000 acres

20 year goal: Eliminate at least 10 problem areas where livestock access streams; apply nutrient management to 8,000 acres. Streams in SFBR Watershed should meet geometric mean of 235 colonies/100mL grab sample; 125 colonies/100mL in geometric samples.

Indicators of progress:

1. Reduce number of livestock access areas.
2. Number of Best Management Practices installed and calculated load reductions for each.
3. Number of acres addressed by nutrient management.
4. Improved results for *E.coli* in future IDEM samplings.
5. Number of people attending field days and other education events.

Goal #4: The steering committee would like to increase partnerships with county and state agencies to utilize South Fork-Blue River in public areas for recreational use as well as increase public awareness and provide public education on the impact individual choices and activities have on the watershed.

5 year goal: Help organize annual stream/road clean-ups.
Host annual education events for youth and adults.
Install at least 2 signs that discourages litter.

10 year goal: Help organize annual stream/road clean-ups.
Host annual education events for youth and adults.
Install at least 4 signs that discourages litter.

15 year goal: Help organize annual stream/road clean-ups.
Host annual education events for youth and adults.

20 year goal: Increase public access areas by 2 sites.
Help organize annual stream/road clean-ups.
Host annual education events for youth and adults.
Install at least 8 signs that discourages litter.

Indicators of progress:

1. Number of youth attending youth education events. (Youth can take information back to families)
2. Number of attendees at field days and education events.
3. Distribute surveys at education events to gauge increase in knowledge.
4. Decrease amount of trash at stream/road clean-ups.
5. Increase signage that discourages litter.
6. Number of inquiries for information to NRCS/SWCD office.
7. One public access area in 10 years.

Goal #5: The steering committee would like to protect and enhance critical habitat and unique natural areas of the South Fork-Blue River, its tributaries, and the entire watershed including threatened, endangered, and rare species.

Indicators of progress:

1. Increase in macroinvertebrate populations and diversity in the next 20 years (mIBI scores >35).
2. Increase in fish populations and diversity in the next 20 years (Fish mIBI scores >35).
3. Delist the stream segments from the IDEM 303(d) list for impaired biotic communities.
4. Number of Best Management Practices installed and calculated load reductions for each.

A prescriptive schedule of implementation for the 5-year, 10-year and 20-year goals can be found in Tables 69-71 and are also referenced in the Action Register (Table 72).

9.0 South Fork-Blue River Critical Areas

After the steering committee set goals for the project, they then developed a ranking system to determine the critical areas to determine where and how implementation should occur to best meet the set goals. Further defined, a critical area is an area for watershed management planning where implementation of watershed management plan guidance can remediate nonpoint source pollution in order to improve water quality or mitigate future pollutant sources to protect water quality.

9.1 Critical Area Factors

Critical areas for the watershed were determined by ranking the following factors:

- *E.coli* impairments
- IBC impairments
- IDEM Water Chemistry Results
- Number of livestock operations
- Number of livestock access areas
- Number of unsewered housing developments
- Agricultural land acreage
- Number of overgrazed pastures
- Number of row crop fields within 20 feet of stream
- Number of gully erosion in crop field
- Karst/sinkholes

The following section gives a brief description of the factors included in the ranking systems as well as the points assigned.

E.coli Impairments: Each subwatershed with a stream segment that was on the draft 2018 303(d) List of Impairments for *E.coli* was given 2 points. The factor was weighted by 2 given it is a widespread impairment across the watershed.

Impaired Biotic Communities: Each subwatershed with a stream segment that was on the draft 2018 303(d) List of Impairments for Impaired Biotic Communities was given a score of 4. Because the IBC impairment includes both fish and aquatic invertebrate communities and the impairment could be caused by many different sources, the subwatershed with these impaired streamed segments were given scores weighted by 4.

Exceedance > 20% for nitrate-nitrite, TKN, Total Phosphorus, and TSS: Subwatersheds with results that exceeded the targets more than 20% of the time for the mentioned parameters were given a point.

Average above project standard for nitrate-nitrite, TKN, Total Phosphorus, and TSS: Subwatersheds that had monitoring results that were above the project standards for the mentioned parameters were assigned a point.

Number of livestock operations: The number of livestock operations in each subwatershed was estimated by using windshield surveys as well as knowledge of the steering committee. Subwatersheds with less than 10 operations were assigned 1 point, 13 to 15 operations were assigned 2 points, 16 to 18 operations were assigned 3 points, and 19 or more operations were assigned 4 points. The number of livestock operations within each subwatershed are found in the chart below.

SUBWATERSHED	# of livestock operations (approx.)	Points Assigned
Springle Creek	23	4
City of Pekin	14	2
Dutch Creek	16	3
Bear Creek	7	1
Palmyra Karst	13	2
Licking Creek	14	2

Table 58: Ranking points assigned to # of livestock operations

Number of livestock access areas: The number of livestock with access to streams and/or sensitive areas were documented through windshields surveys. Subwatersheds with 1 to 3 points of access were assigned 1 point, 4 to 6 were assigned 2 points, 7 to 9 were assigned 3 points, and 10 or more were assigned 4 points. The number of documented livestock access areas for each subwatershed can be found in the chart below.

SUBWATERSHED	# of livestock access areas (approx.)	Points Assigned
Springle Creek	9	3
City of Pekin	5	2
Dutch Creek	8	3
Bear Creek	2	1
Palmyra Karst	1	1
Licking Creek	1	1

Table 59: Ranking points assigned to # of livestock access areas

Number of un-sewered housing developments: The watershed has a number of unsewered housing developments. Improperly working septic systems are known to be a source of *E.coli* and nutrients. A total number of failing septic systems is undocumented for the majority of the watershed. The number of unsewered housing developments in each subwatershed was estimated by using windshield surveys as well as knowledge of the steering committee. Each subwatershed was given a point for each unsewered housing development. The chart below indicated the number of unsewered housing developments.

SUBWATERSHED	# of unsewered housing developments	Points Assigned

Springle Creek	0	0
City of Pekin	3	3
Dutch Creek	1	1
Bear Creek	3	3
Palmyra Karst	4	4
Licking Creek	4	4

Table 60: Ranking points assigned to # of un-sewered housing developments

Total Agriculture Acres: Acres of cultivated cropland and hay/pasture were added together to come up with total agriculture acres. This category was given the most weight because agriculture is a leading source of nonpoint source pollution. It is impossible to see all resource concerns from the road during windshield surveys and the heavy weighting of this category will help adjust for this shortcoming. Also, fertilizers, both commercial and manure, are on all agriculture land. The steering committee took into consideration that water testing data is not available for all subwatersheds. Yet, looking at our windshield survey results and noted areas of resource concerns made by the steering committee, ranking numbers were raised for this component of the ranking concerns to offset the lack of water testing data for all subwatersheds. Not all subwatersheds have water testing data due to karst topography. The sensitivity of the karst topography was also discussed at the steering committee meeting. Subwatersheds with less than 5,000 acres of agriculture land were given 2 points, 5,001-7,999 acres were give 4 points, and >8,000 acres were given 8 points. Springle Creek, City of Pekin, Dutch Creek, and Licking Creek were similar in the number of agriculture acres, therefore these subwatersheds received the same number of points. Palmyra Karst contains the highest number of agriculture acres by far, and received the highest score. See the chart below for number of agriculture acres in each subwatershed.

SUBWATERSHED	Agricultural Land Acreage	Points Assigned
Springle Creek	6,336	4
City of Pekin	6,262	4
Dutch Creek	6,621	4
Bear Creek	4,473	2
Palmyra Karst	9,273	8
Licking Creek	6,300	4

Table 61: Ranking points assigned to agricultural land acreage

Number of overgrazed pastures: Overgrazed pastures were noted during windshield surveys of the watershed. Subwatersheds with 1 to 3 documented overgrazed pastures were given 1 point, 4 to 6 were given 2 points, 7 to 9 were given 3 points and 10 or more overgrazed pastures were given 4 points. The chart below illustrates the number of overgrazed pastures in each subwatershed.

SUBWATERSHED	# of Overgrazed Pastures	Points Assigned
Springle Creek	13	4
City of Pekin	3	1
Dutch Creek	8	3
Bear Creek	3	1
Palmyra Karst	2	2
Licking Creek	5	1

Table 62: Ranking points assigned to # of overgrazed pastures

Number of row crops within 20 feet of stream: Row crop fields that were within 20 feet of a stream were documented during windshields surveys. Subwatersheds with 1 to 3 were given 1 point, 4 to 6 were given 2 points, 7 to 9 were given 3 points, and 10 or more were given 4 points. The chart below illustrates the number of fields with row crops within 20 feet of a stream within each subwatershed.

SUBWATERSHED	# of Row Crop fields within 20 ft of Stream	Points Assigned
Springle Creek	11	4
City of Pekin	7	3
Dutch Creek	7	3
Bear Creek	5	2
Palmyra Karst	1	1
Licking Creek	0	0

Table 63: Ranking points assigned to # of row crop fields within 20 feet of stream

Number of gully erosion in crop field: Crop fields where gully erosion was identified in the watershed were identified through windshield surveys. Subwatersheds with 1 to 2 fields noted with gully erosion were given 1 point, 3 to 4 were given 2 points, and 5 or more fields with gully erosion were given 3 points. The chart below illustrates the number of fields within each subwatershed with gully erosion.

SUBWATERSHED	# of Gully Erosion in crop field	Points Assigned
Springle Creek	3	2
City of Pekin	1	1
Dutch Creek	3	1
Bear Creek	4	1
Palmyra Karst	8	3
Licking Creek	3	2

Table 64: Ranking points assigned to # of gully erosion identified in crop fields

Number of karst/sinkholes: Karst topography contains sinkholes. The more sinkholes in an area, the more sensitive the landscape is to non-point source pollution because those sinkholes are direct conduits to groundwater. The ArcGIS layer was used to calculate an approximate total number of sinkholes in each subwatershed. Subwatersheds with 1-250 sinkholes were given 1 point, 251-500 sinkholes were given 2 points, 501-750 sinkholes were given 3 points, 751-1000 were given 4 points, and 1001+ were given 5 points. The chart below illustrates the number of sinkholes within each subwatershed.

SUBWATERSHED	# of Sinkholes	Points Assigned
Springle Creek	0	0
City of Pekin	5	1
Dutch Creek	119	1
Bear Creek	302	2
Palmyra Karst	2048	5
Licking Creek	834	4

Table 65: Ranking points assigned to # of sinkholes

Table 66 below depicts the points assigned for each of the watershed in regards to each of the factors.

	Springle Creek	City of Pekin	Dutch Creek	Bear Creek	Palmyra Karst	Licking Creek
Impaired waterbody locations						
Streams with E. coli impairments	2	2	2	2		2
Streams with IBC impairments	4	0	4	0		0
Monitoring samples exceeding targets						
Nitrate-nitrite exceedance >20%	0	0	1	1		1
Nitrate-nitrite average > 1.2 mg/L	0	0	1	0		1
TKN exceedance % >20%	1	0	0	0		1
TKN average > 0.591 mg/L	0	1	0	0		0
Total Phosphorus exceedance % >20%	1	0	0	0		1
Total Phosphorus average > 0.076 mg/L	1	1	0	0		0
TSS exceedance % >20%	1	0	0	0		1
TSS average >25 mg/L	1	1	0	0		1
Potential sources/conditions						
Number of livestock operations (<10=1 pt, 13-15=2 pts, 16-18=3 pts, 19+=4 pts)	4	2	3	1	2	2
Number of livestock access areas (1-3=1 pt, 4-6= 2pt, 7-9=3pt, 10+=4 pt)	3	2	3	1	1	1
Number of unsewered housing developments (1=1 pt, 2= 2pt, 3=3pt, 4=4 pt)	0	3	1	3	4	4
Agricultural land acreage (<5,000 acres = 2 points, 5,001-7,999 acres = 4 points, >8,000 acres = 8 points)	4	4	4	2	8	4
Number of overgrazed pastures (1-3=1 pt, 4-6=2 pts, 7-9=3 pts, 10+=4 pts)	4	1	3	1	2	1
Number of row crops within 20 feet of stream (1-3=1 pt, 4-6=2 pts, 7-9=3 pts, 10+=4 pts)	4	3	3	2	1	0
Number of gully erosion in crop field (1-2=1 pt, 3-4=2 pts, 5+=3 pts)	2	1	1	1	3	2
Karst/sinkholes(1-250=1 pt, 251-500=2 pts, 501-750=3 pts, 751-1000= 4pts, 1001+=5 pts)	0	1	1	2	5	4
TOTAL	**32**	**22**	**27**	**16**	**26**	**26**

Table 66: Summary of ranking points assigned per watershed

9.2 Critical Area Rankings

The points for each watershed for each of the factors represented in Table 66 were then added up to give each watershed a total score. The chart below illustrates the total points for each subwatershed as well as the rank. Both Palmyra Karst and Licking Creek received 26 points; therefore they tied for third rank. Bear Creek, having the lowest score of 16, ranked last and received no priority. Springle Creek, City of Pekin, Dutch Creek, Palmyra Karst, and Licking Creek will all be critical areas of the South Fork-Blue River Watershed.

South Fork-Blue River Critical Area Rankings		
SUBWATERSHED	**Total Points**	**Rank**
Springle Creek	32	1
City of Pekin	22	5
Dutch Creek	27	2
Bear Creek	16	6
Palmyra Karst	26	3
Licking Creek	26	3

Table 67: South Fork-Blue River critical area rankings

The breaks presented by the ranking system were analyzed by the steering committee. The steering committee placed high priority on the subwatersheds of Springle Creek, Dutch Creek, Licking Creek, and Palmyra Karst Area. These areas were the top 3 ranked subwatersheds (with a two-way tie for 3rd ranked). Point ranges for the high priority areas range from 32-26. The City of Pekin Subwatershed received medium priority with a ranking score of 22. The largest break between ranking scores was a difference of 6 points. The lowest ranking subwatershed was Bear Creek with a score of 16. This subwatershed received no priority.

Figure 36 below illustrates the critical areas of the South Fork-Blue River Watershed, as well the priority areas of the watershed.

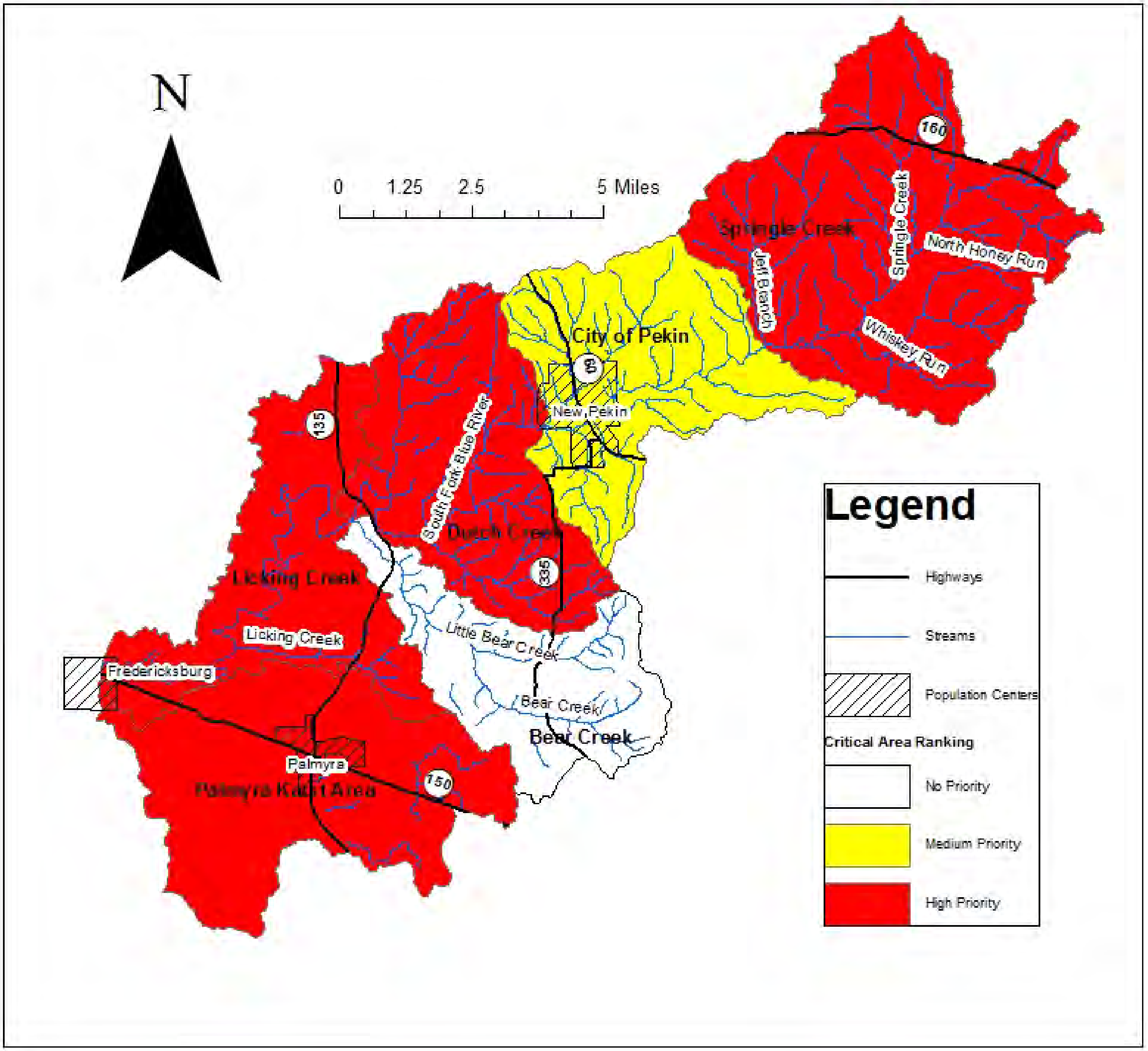


Figure 36: South Fork-Blue River Watershed Critical Area Rankings and Priority Areas

10.0 Applying Improvement Measures: Best Management Practices

Best Management Practices (BMPs) are conservation practices implemented on land to improve water quality. BMPs have been proven to help prevent and/or reduce non-point source pollution such as sediment, nutrients, and *E.coli* and to maintain and/or improve habitat.

10.1 Potential Water Quality Improving BMPs

A list of potential BMPs were reviewed by the technical committee. The SFBR technical committee is comprised of individuals that are very familiar with the watershed land use, producers and/or landowners/, and topography. Members include Washington County NRSC District Conservationist, ISDA Resource Specialist, TNC staff, SWCD board member, and Purdue Extension Agriculture and Natural Resource Educator. Identified resource concerns, watershed land use, and project goals were taken into consideration, and a list of BMPs most appropriate to remediate the sources of pollution in the watershed was developed. The committee would like to note that no practice list is exhaustive and that additional techniques may be both possible and necessary to reach water quality goals. It is also important to note that no single practice will address all issues; but, it will be necessary to implement a combination of practices, or conservation system, to make lasting change in the South Fork-Blue River Watershed.

The South Fork-Blue River Watershed is rural with only 2 small, incorporated towns. Agriculture (row crop and pasture/hay land) makes up the largest land use of the watershed. The committee chose to focus on agriculture BMPs. Selected practices are appropriate for all critical areas since they all contain agriculture land use and pasture, and crop resource concerns were identified in all subwatersheds. It was also taken into consideration that only a small percentage of the watershed can be seen during windshield surveys. Selected practices with descriptions are listed below. Table 68 provides the goals addressed by each BMP and the targeted sub-watersheds. As the table indicates, many of the BMPs address multiple goals. All BMPs will address the goal of protecting or enhancing critical habitat. If water quality is improved, this will simultaneously improve habitat for many threatened, endangered and rare species.

Access Control- The temporary or permanent exclusion of animals, people, vehicles, and/or equipment from an area. Access control is used to achieve and maintain desired resource conditions by monitoring and managing the intensity of use by animals, people, vehicles, and/or equipment in coordination with the application schedule of practices, measures and activities specified in the conservation plan. (NRCS Code 472)

Access Road- An access road is an established route for equipment and vehicles. An access road is used to provide a fixed route for vehicular travel for resource activities involving the management of timber, livestock, agriculture, wildlife habitat, and other conservation enterprises. (NRCS Code 560)

Agrichemical Handling Facility-A facility with an impervious surface to provide an environmentally safe area for handling of on-farm agrichemicals. To provide an environmentally-safe facility to: store, mix, load, and clean-up agrichemicals; retain incidental spillage or leakage; and reduce pollution to surface water, ground water, air and/or soil. (NRCS Code 309)

Amending Soil Properties with Gypsum Products- Using gypsum (calcium sulfate dehydrate-derived products) to change the physical and chemical properties of the soil. This practice is used to improve soil health by improving physical/chemical properties and increasing infiltration of the soil; improve surface water quality by reducing dissolved phosphorus concentrations in surface runoff and subsurface drainage; improve soil health by ameliorating subsoil aluminum toxicity; and improve water quality by reducing the potential for pathogens and other contaminants transported from areas of manure and bio solids application (NRCS Code 333)

Animal Mortality Facility- An on-farm facility for the treatment and disposal of livestock and poultry carcasses for routine and catastrophic mortality events. This practices supports one or more of the following purposes: reduce impacts to surface and groundwater resources; reduce the impact of odors; and decrease the spread of pathogens. (NRCS Code 316)

Conservation Cover- Establishing and maintaining permanent vegetative cover. The purposes for this practice include: reduce sheet, rill, and wind erosion; reduce ground and surface water quality degradation by nutrients and surface water quality degradation by sediment; reduce emissions of particulate matter (PM), PM precursors, and greenhouse gases; improve soil health; and enhance wildlife, pollinator and beneficial organism habitat. (NRCS Code 327)

> **Firebreak** (A component of conservation cover)- A permanent or temporary strip of bare or vegetated land planned to retard fire. This purposes of this practice are to reduce the spread of wildfire and contain prescribed burns. (NRCS Code 394)

Conservation Crop Rotation- A planned sequence of crops grown on the same ground over a period of time (i.e. the rotation) This practice is applied to support one or more of the following purposes: reduce sheet, rill and wind erosion; maintain or increase soil health and organic matter content; reduce water quality degradation due to excess nutrients; improve soil moisture efficiency; reduce the concentration of salts and other chemicals from saline seeps; reduce plant pest pressures; provide feed and forage for domestic livestock; and provide food and cover habitat for wildlife, including pollinator forage and nesting. (NRCS Code 328)

Composting Facility- A structure or device to contain and facilitate the controlled aerobic decomposition of manure or other organic material by micro-organisms into a biologically stable organic material that is suitable for use as a soil amendment. To reduce the pollution potential and improve the handling characteristics of organic waste solids; and produce a soil amendment that adds organic matter and beneficial organisms, provides slow-release plant-available nutrients, and improves soil condition. (NRCS Code 317)

Cover Crop- Grasses legumes, and forbs planted for seasonal vegetative cover. Purposes include: reduces erosion from wind and water; maintain or increase soil health and organic matter content; reduces water quality degradation by utilizing excessive soil nutrients; suppresses excessive weed pressures and break pest cycles; improves soil moisture use efficiency; and minimizes soil compaction. Manure/litter runoff is also reduce when applied to fields that are seeded in cover crops. (NRCS Code 340)

Critical Area Planting- Establishing permanent vegetation on sites that have, or are expected to have, high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices. This practice supports one or more of the following purposes: stabilize stream and channel banks, pond and other shorelines-Resource concern (Soil Erosion-excessive bank erosion from streams shorelines or water conveyance channels); stabilize areas with existing or expected high rates of soil erosion by wind or water-Resource concern (Soil Erosion-concentrated flow erosion and/or soil erosion- sheet, rill and wind erosion and or Soil Quality Degradation-concentration of salts and other chemicals); and stabilize areas, such as sand dunes and riparian areas-Resource concern (Soil Erosion-Concentrated flow erosion and/or soil erosion-sheet, rill and wind erosion). (NRCS Code 342)

Diversion- A channel generally constructed across the slope with a supporting ridge on the lower side. The practice may be applied to support one or more of the following purposes: break up concentrations of water on long slopes, on undulating land surfaces, and on land that is generally considered too flat or irregular for terracing; divert water away from farmsteads, agricultural waste systems, and other improvements; collect or direct water for storage, water-spreading or water-harvesting systems; protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above; intercept surface and shallow subsurface flow; reduce runoff damages from upland runoff damages from upland runoff; reduce erosion and runoff on urban and developing areas and at construction or mining sites; divert water away from active gullies or critically eroding areas; and supplement water management on conservation cropping or stripcropping systems. (NRCS Code 362)

Drainage Water Management- The process of managing water discharges from surface and/or subsurface agricultural drainage systems. The purpose of this practice is to reduce nutrient, pathogen, and/or pesticide loading from drainage systems into downstream receiving waters; improve productivity, health, and vigor of plants; reduce oxidation of organic matter in soils; reduce wind erosion or particulate matter (dust) emissions; and provide seasonal wildlife habitat. (NRCS Code 554)

Fence- A constructed barrier to animal or people. This practice facilitates the accomplishment of conservation objectives by providing a means to control movement of animals and people, including vehicles. Fencing would allow rotational grazing systems to be set-up and reduce the amount of overgrazing in the watershed. (NRCS Code 382)

Field Border- A strip of permanent vegetation established at the edge or around the perimeter of a field. This practice may be applied to accomplish one or more of the following: reduce erosion from wind and water-Resource Concern (Soil Erosion-sheet, rill and wind erosion); protect soil and water quality-Resource Concerns (Soil Quality Degradation-Compaction and Water Quality Degradation-Excess nutrients in surface and ground waters); provide wildlife food and cover and pollinator or other beneficial organism habitat-Resource Concern (Inadequate Habitat for Fish and Wildlife-Habitat degradation); increase carbon storage-Resource Concern (Soil Quality Degradation-Organic matter depletion); improve air quality-Resource Concern (Air Quality Impacts-Emissions of Particulate Matter-PM- and PM precursors). (NRCS Code 386)

Filter Strip- A strip or area of herbaceous vegetation that removes contaminants from overland flow. The practice supports one or more of the following purposes: reduce suspended solids and associated contaminants in runoff-Resource concerns (Water Quality Degradation-Excess nutrients in surface and ground waters, pesticides transported to surface and ground waters, excess pathogens and chemicals from manure, bio-solids or compost applications, and excessive sediment in surface waters); reduce dissolved contaminant loadings in runoff-Resource concerns (Water Quality Degradation-Excess pathogens and chemicals from manure, bio-solids or compost applications); and reduce suspended solids and associated contaminants in irrigation tail water-Resource concern (Water Quality Degradation-Excess nutrients in surface and ground waters, pesticides transported to surface and ground waters, excess pathogens and chemicals from manure, bio-solids or compost applications, and excessive sediment in surface waters). (NRCS Code 393)

Forage and Biomass Planting- Establishing adapted and/or compatible species, varieties, or cultivars of herbaceous species suitable for pasture, hay or biomass production. Purposes include: Improve or maintain livestock nutrition and/or health; provide or increase forage supply during periods of low forage production; reduce soil erosion; improve soil and water quality; produce feedstock for biofuel or energy production. (NRCS Code 512)

Grade Stabilization Structure- A grade stabilization structure is used to control the grade in natural or constructed channels. The purpose of a grade stabilization structure is to: stabilize grade; reduce erosion; and improve water quality. (NRCS Code 410)

Grassed Waterway- A shaped or graded channel that is established with suitable vegetation to convey surface water at a non-erosive velocity using a broad and shallow cross section to a stable outlet. Purposes include: to convey runoff from terraces, diversion, or other water concentrations without causing erosion or flooding; to prevent gully formation, and to protect/improve water quality. (NRCS Code 412)

> **Subsurface Drain** (A component of grassed waterway)- A conduit installed beneath the ground surface to collect and/or convey excess water. This practice may be applied as part of a resource management system to achieve one or more of the following purposes: remove or distribute excessive soil water and remove salts and other contaminants from the soil profile. (NRCS Code 606)
>
> **Underground Outlet** (A component of grassed waterway) **-** A conduit or system of conduits installed beneath the surface of the ground to convey surface water to a suitable outlet. The purpose of this practice is to carry water to a suitable outlet from terraces, water and sediment control basins, other similar practices or flow concentrations without causing damage by erosion or flooding. (NRCS Code 620)

Heavy Use Area Protection (HUAP)- HUAP is used to stabilize a ground surface that is frequently used by people, animals, or vehicles and to protect water quality. (NRCS Code 561)

Integrated Pest Management (IPM)- A site-specific combination of pest prevention, pest avoidance, pest monitoring, and pest suppression strategies. Purposes for this practice includes: prevent or mitigate off-site pesticide risks to water quality from leaching, solution runoff and adsorbed runoff losses; prevent or mitigate off-site pesticide risks to soil, water air, plants, animals and humans from drift and volatilization losses; prevent or mitigate on-site pesticide risks to pollinators and other beneficial species through direct contact; and prevent or mitigate cultural, mechanical and biological pest suppression risks to soil, water, air, plants, animals and humans. (NRCS Code 595)

Lined Waterway or Outlet- A waterway or outlet having an erosion-resistant lining of concrete, stone, synthetic turf reinforcement fabrics, or other permanent material. This practice may be applied as part of a resource management system to support one or more of the following purposes: provide for safe conveyance of runoff from conservation structures or other water concentrations without causing erosion or flooding; stabilize existing and prevent future gully erosion; and protect and improve water quality. (NRCS Code 468)

Livestock Pipeline- A pipeline and appurtenances installed to convey water for livestock or wildlife. This practice may be applied as part of a resource management system to achieve one or more of the following purposes: convey water to points of use for livestock or wildlife; reduce energy use, and development renewable energy systems. (NRCS Code 516)

Mulching- Applying plant residues or other suitable material produced off site, to the land surface. The practice supports one or more of the following purposes: conserve soil moisture-Resource Concern (Insufficient Water-Inefficient moisture management); reduce energy use associated with irrigation-Resource concern (Inefficient Energy Use-Farming/ranching practices and field operations and Insufficient Water-Inefficient moisture management); provide erosion control-Resource concern (Soil Erosion-Excessive bank erosion from streams shorelines or water conveyance channels; and/or Soil Erosion-Concentrated flow erosion, and/or Soil Erosion-Sheet, rill, and wind erosion); facilitate the establishment of vegetative cover-Resource concern (Degraded Plant Condition-Undesirable plant productivity and health); improve soil health-Resource concern (Soil Quality Degradation-organic matter depletion); and reduce airborne particulates-Resource concern (Air Quality Impacts-Emissions or Particulate Matter-PM- and PM Precursors). (NRCS Code 590)

Nutrient Management- Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments. Purposes for this practice include: to budget, supply and conserve nutrients for plant production; to minimize agricultural nonpoint source pollution of surface and groundwater resources; to properly utilize manure or organic by-products as a plant nutrient source; to protect air quality by reducing odors, nitrogen emissions (ammonia, oxides of nitrogen), and the formation of atmospheric particulates; and to maintain or improve the physical, chemical, and biological condition of soil. (NRCS Code 590)

Pond- A water impoundment made by constructing an embankment or by excavating a pit or dugout. The purpose of this practice is to provide water for livestock, fish, and wildlife, recreation, fire control, develop renewable energy systems, and other related uses, and to maintain or improve water quality. (NRCS Code 378)

Prescribed Grazing- Managing the harvest of vegetation with grazing and/or browsing animals. This practice may be applied as part of a conservation management system to achieve one or more of the following: Improve or maintain desired species composition and vigor of plant communities; improve or maintain quantity and quality of forage for grazing and browsing animals' health and productivity; improve or maintain surface and/or subsurface water quality and quantity; improve or maintain riparian and watershed function; reduce accelerated soil erosion, and maintain or improve soil condition; improve or maintain the quantity and quality of food and/or cover available for wildlife; and manage fine fuel loads to achieve desired conditions. (NRCS Code 528)

Pumping Plant- A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy sources(s), and protective structures. This practice may be applied as a part of a resource management system to achieve one or more of the following: delivery of water for irrigation, watering facilities, wetland, or fire protection; removal of excessive subsurface or surface water; provide efficient use of water on irrigated land; transfer of animal waste as part of a manure transfer system; improvement of air quality; and reduce energy use. (NRCS 533)

Residue and Tillage Management- Limiting soil disturbance to manage the amount, orientation, and distribution of crop and plant residue on the soil surface year around. This practice may be applied as part of a conservation management system to support one or more of the following purposes: reduce sheet, rill and wind erosion-Resource Concern (Soil Erosion-Sheet, rill and wind erosion); reduce tillage-induced particulate emissions- Resource Concern (Air Quality Impacts- Emissions of Particulate Matter – PM and PM Precursors); maintain or increase soil quality and organic matter content- Resource concern (Soil Quality Degradation-Organic matter depletion); reduce energy use – Resource Concern (Inefficient Energy Use – Farming/ranching practices and field operations); increase plant-available moisture-Resource Concern (Insufficient Water – Inefficient moisture management); and provide food and escape cover for wildlife – Resource Concern (Inadequate Habitat For Fish and Wildlife – Habitat Degradation). (NRCS Code 329) Windshield surveys identified conventional tillage 6 times. Tillage transect data reports that 7,400 acres in Washington County and 4,400 acres in Harrison County are conventionally tilled.

Riparian Forest Buffer- An area predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies. Purposes for this practice include: create shade to lower or maintain water temperatures to improve habitat for aquatic organisms; create or improve riparian habitat and provide a source of detritus and large woody debris; reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow; reduce pesticide drift entering the water body; restore riparian plant communities; and increase carbon storage in plant biomass and soils. (NRCS Code 391)

Riparian Herbaceous Cover- Grasses, sedges, rushes, ferns, legumes, and forbs tolerant of intermittent flooding or saturated soils, established or managed as the dominant vegetation in the transitional zone between upland and aquatic habitats. This practice may be applied as part of a conservation management system to accomplish one or more of the following purposes: provide or improve food and cover for fish, wildlife and livestock; improve and maintain water quality; establish and maintain habitat corridors; increase water storage on floodplains; reduce erosion and improve stability to stream banks and shorelines; increase net carbon storage in biomass and soil; enhance pollen, nectar, and nesting habitat of pollinators; restore, improve or maintain the desired plant communities; dissipate stream energy and trap sediment; and enhance stream bank protection as part of stream bank soil bioengineering practices. (NRCS Code 390)

Roof Runoff Structure- A structure that will collect, control and convey precipitation runoff from a roof. This practice is applied to achieve one or more of the following purposes: protect surface water quality by excluding roof runoff from contaminated areas; protect a structure foundation from water damage or soil erosion from excess water runoff; increase infiltration of runoff water; and capture water for other uses. (NRCS Code 558)

Roofs and Covers- A rigid, semi-rigid, or flexible manufactured membrane, composite material, or roof structure placed over a waste management facility. Purposes for this practice includes providing a roof or cover for: water quality improvement; diversion of clean water from animal management areas (i.e. barnyard, feedlot or exercise area) and/or waste storage facilities; capture of biogas for energy production; reducing net effect of greenhouse gas emissions; and air quality improvement and odor reduction. (NRCS Code 367)

Sediment Basin- A basin constructed with an engineered outlet, formed by an embankment or excavation or a combination of the two. The purpose of this practice is to capture and detain sediment laden runoff, or other debris for a sufficient length of time to allow it to settle out in the basin. (NRCS Code 350)

Spring Development- Collection of water from springs or seeps to provide for livestock and wildlife. This practice applies where spring or seep will provide a dependable supply of suitable water for planned use. (NRCS Code 574)

Stream Crossing- A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles. The purposes of this practice include: improving water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream; reduce streambank and streambed erosion; and provide crossing for access to another land unit. (NRCS Code 578)

Structure for Water Control- A structure in a water management system that conveys water, controls the direction or rate of flow, maintains a desired water surface elevation or measures water. The practice may be applied as a management component of a water management system to control the stage, discharge, distribution, delivery or direction of water flow. (NRCS Code 587)

Terrace- An earth embankment, or a combination ridge and channel, constructed across the field slope. This practice may be applied as part of a resource management system to support one or both of the following: reduce soil erosion by reducing slope length and retain runoff for moisture conservation. (NRCS Code 600)

Trails and Walkways-A trail is a constructed path with a vegetated or earthen surface. A walkway is a constructed path with an artificial surface. A trail/walkway is used to facilitate the movement of animals, people, or off-road vehicles. A trail/walkway is used to accomplish one or more of the following purposes: provide or improve animal access to forage, water, working/handling facilities, or shelter; facilitate improved grazing efficiency and distribution; protect ecologically sensitive, erosive, or potentially erosive sites; and provide pedestrian or off-road vehicle access to agricultural, construction, or maintenance operations. (NRCS Code 575)

Tree/Shrub Establishment-Establishing woody plants by planting seedling or cuttings, direct seeding, or natural regeneration. The purpose of this practice is to establish woody plants for: forest products such as timber, pulpwood, etc.; wildlife habitat; long-term erosion control and improvement of water quality; treating waste; storing carbon in biomass; reduce energy use; develop renewable energy systems; improving or restoring natural diversity; and enhancing aesthetics. (NRCS Code 612)

Waste Storage Facility-A waste storage impoundment made by constructing an embankment and/or excavating a pit or dugout, or by fabricating a structure. The purpose of this practice is to temporarily stores wastes such as manure, wastewater, and contaminated runoff as a storage function component of an agricultural waste management system. (NRCS Code 313)

Water and Sediment Control Basin- An earth embankment or a combination ridge and channel constructed across the slope of minor watercourses to form a sediment trap and water detention basin with a stable outlet. This practice may be applied as part of a resource management system for one or more of the following purposes: to reduce watercourse and gully erosion; to trap sediment; and to reduce and manage onsite and downstream runoff. (NRCS Code 638)

Waste Transfer-A system using structures, pipes or conduits installed to convey wastes or waste byproducts from the agriculture production site to storage/treatment or application. To transfer agriculture waste material associated with production, processing, and harvesting to: a storage facility; a treatment facility; a handling or loading area; and agricultural land for agronomic application. (NRCS Code 634)

Watering Facility- A watering facility is a means of providing drinking water to livestock or wildlife. The purposes of this practice include to provide designated access to drinking water for livestock or wildlife to: supply daily water requirements; improve animal distribution; and provide a water source that is an alternative to a sensitive resource. By providing alternative watering sources, nutrients, *E.coli*, and sediment loading will be reduced. Also by providing watering facilities, rotational grazing systems may be implemented to also address the overgrazing noted in the watershed. (NRCS Code 614)

Water Well- A hole drilled, dug, driven, bored, jetted, or otherwise constructed into an aquifer for water supply. The purpose of this practice is to provide access to a groundwater supply suitable for livestock watering, fire control, wildlife, and other agricultural uses. (NRCS Code 642)

Windbreak/Shelterbelt Establishment- Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations. The purposes of this practice include: reduce soil erosion from wind; protect plants from wind related damage; alter microenvironment for enhancing plant growth; manage snow deposition; provide shelter for structures, animals, and people; enhance wildlife habitat; provide noise screens; provide visual screens; improve air quality by reducing and intercepting air born particulate matter, chemicals, and odors; delineate property and field boundaries; improve irrigation efficiency; increase carbon storage in biomass and soils; and reduce energy use. (NRCS Code 380)

Windbreak/Shelterbelt Renovation- Replacing, releasing and/or removing selected trees and shrubs or rows within an existing windbreak or shelterbelt, adding rows to the windbreak or shelterbelt or removing selected tree and shrub branches. The purpose of this practice is restoring or enhancing the original planned function of existing windbreaks or shelterbelts. (NRCS Code 650)

	Goals Addressed				
Suggested BMPs	**Nutrients**	**Sediment**	***E. coli***	**Habitat**	**Targeted Sub-watersheds**
Cover Crop (340)	x	x	x	x	High Priority- Springle Creek Dutch Creek Licking Creek Palmyra Karst Area Medium Priority- City of Pekin
Forage and Biomass Planting (512)	x	x	x	x	
Access Road (560)	x	x	x	x	
Critical Area Planting (342)	x	x		x	
Grassed Waterway (412)	x	x	x	x	
Lined waterway or outlet (468)	x	x	x	x	
Fence (382)	x	x	x	x	
Livestock Pipeline (516)	x	x	x	x	
Filter Strip (393)	x	x	x	x	
Waste Storage Facility (313)	x		x	x	
Heavy Use Area Protection (561)	x	x	x	x	
Access Control (472)	x	x	x	x	
Agrichemical Handling Facility (309)				x	
Amending Soil Properties with Gypsum Products (333)	x	x	x	x	
Animal Mortality Facility (316)			x	x	
Conservation Cover (327)	x	x		x	
Firebreak(a component of Conservation Cover) (394)	x	x		x	
Conservation Crop Rotation (327)	x	x		x	
Composting Facility (317)	x		x	x	
Diversion (362)	x	x	x	x	
Drainage Water Management (554)	x	x	x	x	
Field Border (386)	x	x	x	x	

Suggested BMPs	Goals Addressed				Targeted Sub-watersheds
	Nutrients	Sediment	*E. coli*	Habitat	
Grade Stabilization Structure (410)	x	x		x	High Priority- Springle Creek Dutch Creek Licking Creek Palmyra Karst Area Medium Priority- City of Pekin
Subsurface Drain (component of waterway) (606)	x	x	x	x	
Underground Outlet (component of various BMPs) (620)	x	x	x	x	
Integrated Pest Management (595)				x	
Mulching (484)	x	x		x	
Nutrient Management (590)	x	x	x	x	
Pond (378)	x	x	x	x	
Prescribed Grazing (528)	x	x	x	x	
Pumping Plant (533)	x	x	x	x	
Residue and Tillage Management (329)	x	x	x	x	
Riparian Forest Buffer (391)	x	x	x	x	
Riparian Herbaceous Cover (390)	x	x	x	x	
Roof Runoff Structure (558)	x	x	x	x	
Roofs and Covers (367)	x	x	x	x	
Sediment Basin (350)	x	x		x	
Spring Development (574)	x	x	x	x	
Stream Crossing (578)	x	x	x	x	
Structure for Water Control (587)	x	x	x	x	
Terrace (600)	x	x		x	
Trails and Walkways (575)	x	x	x	x	
Tree/shrub Establishment (612)	x	x	x	x	
Water and Sediment Control Basin (638)	x	x		x	
Waste Transfer (634)	x		x	x	
Watering Facility (614)	x	x	x	x	
Water Well	x	x	x	x	
Windbreak/shelterbelt Establishment (380)	x	x	x	x	
Windbreak/Shelterbelt Renovation (650)	x	x	x	x	

Table 68: Goals Addressed by Suggested BMPs and Targeted Sub-watersheds

10.2 BMP Load Reductions, Targets and Estimated Costs

Table 69 below outlines the suggested BMPs, the estimated load reduction for nutrients and sediment (if available, the target amount of BMP for the project and estimated costs per BMP for implementation. Suggested BMPs, BMP targets and estimated costs were developed by the technical committee. The Region V model was used to estimate the approximate load reductions for BMPs. BMPs with dashes (-) do not have load reductions available using the Region V Model.

Suggested BMPs	BMP load reduction efficiency per unit of BMP			Unit	BMP Targets	Estimated Cost (per unit)	Total Estimated Cost	Targeted Sub-watersheds
	Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)					
Cover Crop (340)	15	7	7	acre	8,000 Ac	$25-$40	$200,000-$320,000	High Priority- Springle Creek Dutch Creek Licking Creek Palmyra Karst Area Medium Priority- City of Pekin
Forage and Biomass Planting (512)	23	11	10	acre	2,325 Ac	$75-$300	$174,375-$697,500	
Access Road (560)	.013	.006	.008	feet	10,000 ft	$7	$70,000	
Critical Area Planting (342)	23	11	10	acre	10 Ac	$650	$6,500	
Grassed Waterway (412)	232.9	116.4	101.3	acre	10 Ac	$5,000	$50,000	
Lined waterway or outlet (468)	.5	.2	.2	feet	200 Ft	$2.50	$500	
Fence (382)	.4	.4	.4	feet	52,000 Ft	$1.00 temp./ $3.00 perm.	$52,000-$156,000	
Livestock Pipeline (516)	-	-	-	feet	8,000 Ft	$1.00-$2.50	$8,000-$20,000	
Filter Strip (393)	24	12	10	acre	20 Ac	$75-$300	$1,500-$6,000	
Waste Storage Facility (313)	-	-	-	unit	1 Unit	$125,000	$125,000	
Heavy Use Area Protection (561)	0.0014463	0.000712	0.000941	Ft^2	130,680 Ft^2	$1.25 gravel/ $3.00 concrete	$163,350-$392,040	
Access Control (472)	-	-	-	acre	40	$42	$1,680	
Agrichemical Handling Facility (309)	-	-	-	unit	3	$20,000	$60,000	
Amending Soil Properties with Gypsum Products (333)	-	-	-	acre	100 Ac	$35	$3,500	
Animal Mortality Facility (316)	-	-	-	unit	1	$35,000	$35,000	High Priority- Springle Creek Dutch Creek Licking Creek Palmyra Karst Area Medium Priority- City of Pekin
Conservation Cover (327)	23	11	10	acre	5 Ac	$75-$300	$375-$1,500	
Firebreak(a component of Cons. Cover) (394)	23	11	10	acre	1 Ac	$75-$300	$75-$300	
Conservation Crop Rotation (327)	-	-	-	acre	1600 Ac	$25	$40,000	
Composting Facility (317)	-	-	-	unit	5	$30,000	$150,000	
Diversion (362)	.4	.2	.2	feet	1,000 Ft	$3.00	$3,000	
Drainage Water Management (554)	-	-	-	acre	200 Ac	$50	$10,000	
Field Border (386)	23	11	10	acre	5 Ac	$75-$300	$375-$1,500	
Grade Stabilization Structure (410)	69.9	34.9	30.4	unit	10	$2,500	$25,000	
Subsurface Drain (component of waterway) (606)	-	-	-	feet	8,000 Ft	$2.00	$16,000	
Underground Outlet (component of various BMPs) (620)	-	-	-	feet	5,000 Ft	$4.00	$20,000	

Suggested BMPs	BMP load reduction efficiency per unit of BMP			Unit	BMP Targets	Estimated Cost (per unit)	Total Estimated Cost	Targeted Sub-watersheds
	Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)					
Integrated Pest Management (595)	-	-	-	acre	100	$3.00	$300.00	High Priority- Springle Creek Dutch Creek Licking Creek Palmyra Karst Area Medium Priority- City of Pekin
Mulching (484)	-	-	-	acre	8 Ac	$300	$2,400	
Nutrient Management (590)	-	-	-	Acre	8,000 Ac	$ 4 basic; $15 precision; TSP Pay @ 90% cost	$120,000	
Pond (378)	3687.2	1843.6	1603.1	unit	1	$12,500	$12,500	
Prescribed Grazing (528)	17	9	8	acre	400	$15.00	$6,000	
Pumping Plant (533)	-	-	-	unit	1	$1,500	$1,500	
Residue and Tillage Management (329)	21	10	11	acres	8,000	$15	$120,000	
Riparian Forest Buffer (391)	10	5	5	acres	5 Ac	$400	$2,000	
Riparian Herbaceous Cover (390)	23	11	10	acres	5 Ac	$350	$1,750	
Roof Runoff Structure (558)	-	-	-	unit	10,000 Ft	$7	$70,000	
Roofs and Covers (367)	-	-	-	unit	1	$5,000	$5,000	
Sediment Basin (350)	166.9	83.4	72.6	unit	1	$5,000	$5,000	
Spring Development (574)	31	15	18	unit	5	$2,600	$13,000	
Stream Crossing (578)	2.8	1.4	1.2	unit	10	$4,000	$40,000	
Structure for Water Control (587)	-	-	-	unit	5	$2,000	$10,000	
Terrace (600)	.5	.2	.2	feet	1,000 Ft	$3.00	$3,000	
Trails and Walkways (575)	22	11	14	Ft (.5 ac units)	1,000 Ft	$1.25 gravel/ $3.00 concrete	$163,350-$392,040	
Tree/shrub Establishment (612)	10	5	5	acre	5 Ac	$450	$2,250	
Water and Sediment Control Basin (638)	129.8	64.9	56.4	unit	10	$2,500	$25,000	
Waste Transfer (634)	-	-	-	feet	800	$3.00/ concrete	$2,400	
Watering Facility (614)	34	17	23	unit	20	Portable-$200 Ball/Fountain-$1,000	$4,000-$20,000	
Water Well	-	-	-	unit	1 (100’)	$18.00	$1,800	
Windbreak/shelterbelt Establishment (380)	10	5	5	feet	3,000	$.75	$2,250	
Windbreak/Shelterbelt Renovation (650)	10	5	5	feet	1,000	$.50	$500	

Table 69: Suggested BMPs, Estimated Load Reductions, BMP Targets and Estimated Costs

Tables 70, 71, and 72 below estimate available load reductions for each of the BMPs with available load reductions in relation to 20 year goals, 5 year goals, and 10 year goals.

BMP	BMP Targets	Estimated 20 Year Load Reduction for BMP Targets		
		Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)
Cover Crop (340)	8,000 acres	120,000	56,000	56,000
Forage and Biomass Planting (512)	2,325 acres	53,475	25,575	23,250
Access Road (560)	10,000 feet	110	55	80
Critical Area Planting (342)	10 acre	230	110	100
Grassed Waterway (412)	10 acre	2,329	1,164	1,013
Lined waterway or outlet (468)	200 feet	100	40	40
Fence (382)	52,000 feet	20,800	20,800	20,800
Filter Strip (393)	20 acre	480	240	200
Heavy Use Area Protection (561)	130,680 $feet^2$	189	93	123
Conservation Cover (327)	5 acre	115	55	50
Firebreak(a component of Conservation Cover) (394)	1 acre	23	11	10
Diversion (362)	1,000 feet	400	200	200
Field Border (386)	5 acre	115	55	50
Grade Stabilization Structure (410)	10 unit	699	349	304
Pond (378)	1 unit	3687.2	1843.6	1603.1
Prescribed Grazing (528)	400 acres	6,800	3,600	3,200
Residue and Tillage Management (329)	8,000 acres	168,000	80,000	88,000
Riparian Forest Buffer (391)	5 acres	50	25	25
Riparian Herbaceous Cover (390)	5 acres	230	55	50
Sediment Basin (350)	1 unit	166.9	83.4	72.6
Spring Development (574)	5 units	155	75	90
Stream Crossing (578)	10 units	28	14	12
Terrace (600)	1,000 feet	495.9	248	215.6
Trails and Walkways (575)	1,000 feet	22,000	11,000	14,000
Tree/shrub Establishment (612)	5 acres	50	25	25
Water and Sediment Control Basin (638)	10 acres	1,298	649	564
Watering Facility (614)	20 units	680	340	460
Windbreak/shelterbelt Establishment (380)	3,000 feet	30,000	15,000	15,000
Windbreak/Shelterbelt Renovation (650)	1,000 feet	10,000	5,000	5,000
Total Load Reduction from Target Amount of BMPs		**442,706**	**222,705**	**230,512.3**
Load Reduction needed to meet water quality goals		**707,310**	**324,991**	**247,930**
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		**264,604 still required to meet target**	**102,286 still required to meet target**	**17,417.7 still required to meet target**

Table 70: Estimated 20-year Load Reduction for BMP Targets

BMP	5-year BMP Targets	Load Reduction for Target Amount		
		Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)
Cover Crop	2800 Acres	42,000	19,600	19,600
Forage and Biomass Planting	814 Acres	18,722	8,954	8,140
Access Road	3,500 Feet	38.5	19.25	28
Critical Area Planting	3.5 Acres	80.5	38.5	30.5
Grassed Waterway	3.5 Acres	815.15	407.4	354.55
Lined Waterway or Outlet	70 Feet	35	14	14
Fence	18,200	7,280	7,280	7,280
Filter Strip	7 Acres	168	84	70
Heavy Use Area Protection	1 Acres	63	31	41
Conservation Cover	1.75 Acres	40.25	19.25	17.5
Firebreak	.35 Acres	8.05	3.85	3.5
Diversion	250 Feet	100	50	50
Field Border	1.75 Acres	40.25	19.25	17.5
Grade Stabilization Structure	3.5 Units	244.65	122.15	106.4
Pond	1 Pond	3687.2	1843.6	1603.1
Prescribed Grazing	140 Acres	2,380	1,260	1,120
Residue and Tillage Management	2,800 Acres	58,800	28,000	30,800
Riparian Forest Buffer	1.75 Acres	17.5	8.75	8.75
Riparian Herbaceous Cover	1.75 Acres	40.25	19.25	17.5
Sediment Basin	1 Basin	166.9	83.4	72.6
Spring Development	2 Units	62	30	36
Stream Crossing	4 Crossings	11.2	5.6	4.8
Terrace	350 Feet	173.6	86.8	75.5
Trails and Walkways	350 Feet	7,700	3,850	4,900
Tree/Shrub Establishment	1.75 Acres	17.5	8.75	8.75
Water and Sediment Control Basin	5 Basins	649	324.5	282
Watering Facility	7 Facilities	238	119	161
Windbreak/shelterbelt Establishment	1,050 Feet	10,500	5,250	5,250
Windbreak/shelterbelt Renovation	350 Feet	3,500	1,750	1,750
Total Load Reduction from Target Amount of BMPs		**157,578.5**	**79,282.3**	**81,842.95**
Load Reduction needed to meet 5-year water quality goals		**182,701**	**81,248**	**61,983**
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		**25,122.5 still required to meet target**	**1,965.7 still required to meet target**	**Exceeds**

Table 71: Estimated 5-year Load Reduction for BMP Targets

BMP	10-year BMP Targets	Load Reduction for BMP Targets		
		Nitrogen (lb/year)	Phosphorus (lb/year)	Sediment (T/year)
Cover Crop	4,800 Acres	72,000	33,600	33,600
Forage and Biomass Planting	1,395 Acres	32,085	15,345	13,950
Access Road	6,000 Feet	66	33	48
Critical Area Planting	6 Acres	138	66	60
Grassed Waterway	6 Acres	1,397.4	698.4	607.8
Lined Waterway or Outlet	120 Feet	60	24	24
Fence	31,200 Feet	12,480	12,480	12,480
Filter Strip	12 Acres	288	144	120
Heavy Use Area Protection	2 Acres	126	62	82
Conservation Cover	3 Acres	69	33	30
Firebreak	.6 Acres	13.8	6.6	6
Diversion	500 Feet	200	100	100
Field Border	3 Acres	69	33	30
Grade Stabilization Structure	6 Structures	419.4	209.4	182.4
Pond	1 Pond	3687.2	1843.6	1603.1
Prescribed Grazing	240 Acres	4,080	2,160	1,920
Residue and Tillage Management	4,800 Acres	100,800	48,000	52,800
Riparian Forest Buffer	3 Acres	30	15	15
Riparian Herbaceous Cover	3 Acres	69	33	30
Sediment Basin	1 Basin	166.9	83.4	72.6
Spring Development	3 Units	93	45	54
Stream Crossing	6 Crossings	16.8	8.4	7.2
Terrace	600 Feet	297.5	148.8	129.4
Trails and Walkways	600 Feet	13,200	6,600	8,400
Tree/shrub Establishment	3 Acres	30	15	15
Water and Sediment Control Basin	8 Basins	1,038.4	519.2	451.2
Watering Facility	12 Facilities	408	3,468	276
Windbreak/shelterbelt Establishment	1,800 Feet	18,000	9,000	9,000
Windbreak/shelterbelt Renovation	600 Feet	6,000	3,000	3,000
Total Load Reduction from Target Amount of BMPs		**267,328.4**	**137,773.8**	**139,093.7**
Load Reduction needed to meet 10-year water quality goals		**365,402**	**243,744**	**123,965**
Expected Load Reduction for Targeted Installation of BMPs vs Load Reduction Needed		**98,073.6 still required to meet target**	**105,970.2 still required to meet target**	**Exceeds**

Table 72: Estimated 10-year Load Reduction for BMP Targets

The target amount of BMPs proposed to be installed are not required to be implemented as the quantities suggest. These targets are simply guidelines for achieving goals. The technical committee chose the BMPs based on land use, windshield survey concerns identified, and water quality data. Estimates for load reductions were calculated using the Region V model. Load reductions solely using this model do not meet the project targets for nitrogen and phosphorus for the 5- 10- and 20-year goals, and the target for sediment reduction was not met for the 20-year goal. The steering committee realizes that the model's calculations are only an estimate, and actual reductions could be beyond the model's estimation. The Region V model does not provide estimated reductions for all suggested BMPs; therefore, those load reductions are not accounted for. Also, there are currently practices contracted for the next few years with other funding sources such as the NRCS Environmental Quality Incentives Program within the SFBR Watershed. BMPs implemented through other funding sources and without any assistance may not be tracked and could account for additional load reduction.

The steering committee acknowledges that they have set the bar high by establishing ambitious and strenuous water quality targets that will be difficult to obtain. The group is committed to improve water quality the best that they can, even in the event that the original load reduction goals are not met.

The South Fork-Blue River Committee met to develop an action register to facilitate implementation of the goals and objectives of the watershed management plan. It includes specific and measureable objectives that the project wishes to carry out to improve water quality. Table 73 below illustrates the action register for the South Fork-Blue River Watershed Project by stating the goals, objectives, target audiences, measurable milestones, cost estimates for the objectives, potential partners and sources of technical assistance.

The Washington County SWCD will ultimately be responsible for checking at interim intervals to identify whether interim goals are being met.

Goal	Objective	Target Audience	Milestones	Cost (includes BMPs, staff and supplies)	Potential Partners/ Technical Assistance
The current estimated annual load for nitrate-nitrogen and total phosphorus respectively is 1,218,005 lb/year and 357,335 lb/year. The load reduction needed to meet target levels for nitrate-nitrogen by 58% is 707,310 lb/year and Total Phosphorus by 91% is 324,991 lb/year.	Educate and promote installation of BMPs through field days/workshops	Agriculture Producers Landowners Residents Stakeholders General Public	Host at least 1 field day/workshop annually*	$1,602,450	SWCD NRCS Purdue Extension ISDA US Fish & Wildlife IDEM
	Education through publications/press releases		Develop 4 publications/ press releases/articles annually for first 3 years and 1 publication per year through year 20		
			Host a booth at Home and Garden Show annually and provide lawn care treatment information		
	Implement 319, CWI, LARE and other cost-share programs to put nutrient-reducing BMPs in place		Achieve 5 year interim BMP target and load reduction goal-15% (nitrate-nitrogen) and 23% (phosphorus) reduction (Table 71)		
			Achieve 10 year interim BMP target and load reduction goal-30% (nitrate-nitrogen) & 46% (phosphorus) reduction (Table 72)		
			Achieve 20 year BMP target and load reduction goal-58% (nitrate-nitrogen) & 91%		

Goal	Objective	Target Audience	Milestones	Cost (includes BMPs, staff and supplies)	Potential Partners/ Technical Assistance
			(phosphorus) reduction (Table 70)		
Reduce soil erosion and sedimentation in the watershed. The current estimated annual load for TSS is 253,250 tons/year. The load reduction needed to meet target levels for TSS by 98% is 247,930 tons/year).	Educate and promote installation of BMPs through field days/workshops	Agriculture Producers Landowners Residents Stakeholders General Public	Host at least 1 field day/workshop annually*	$1,456,730	SWCD NRCS Purdue Extension ISDA US Fish & Wildlife IDEM
	Education through publications/press releases		Develop 4 publications/ press releases/articles annually for 1st 3 years and 1 publication per year through year 20-topics including log jams, effects of sedimentation on threatened and endangered species		
	Implement 319, CWI, LARE and other cost-share programs to put erosion-reducing BMPs in place		Achieve 5 year BMP target and load reduction goal-25% reduction (Table 71)		
			Achieve 10 year BMP target and load reduction goal-49% reduction (Table 72)		
			Achieve 20 year BMP target and load reduction goal-98% reduction (Table 70)		
Reduce *E.coli* to meet the State water quality standard (235 colonies/100 mL grab sample; 125 colonies/100 mL in geometric samples).	Educate and promote installation of BMPs through field days/workshops	Agriculture Producers Landowners Residents Stakeholders General Public	Host at least 1 field day/workshop annually*	$1,589,700	SWCD NRCS Purdue Extension ISDA US Fish & Wildlife IDEM TNC
	Education through publications/press releases		Develop 4 publications/ press releases/articles annually for first 3 years and 1 publication through year 20		
	Implement 319, CWI, LARE and other cost-share programs to put *E.coli*-reducing BMPs in place		Implement at least 12 BMPs annually that will reduce *E.coli*		
			Exclude 20 head of livestock annually from sensitive areas		

Goal	Objective	Target Audience	Milestones	Cost (includes BMPs, staff and supplies)	Potential Partners/ Technical Assistance
	Educate and promote proper septic maintenance		Develop publication by end of year 1, host septic system maintenance education workshop by end of year 2.		Health Departments Local Contractors
			Host a booth at Home and Garden Show annually and provide septic maintenance information		
			Educational mailing to 15 un-sewered communities by end of year 3		
	Pursue a septic cost-share program using funds from TNC		Pursue funds in year 1, develop cost-share guidelines for year 2.		
Increase partnerships with county and state agencies to utilize South Fork-Blue River in public areas for recreational use as well as increase public awareness and provide public education on how the impact of individual choices and activities have on the watershed.	Increase recreational use of watershed	Agriculture Producers Landowners Residents General Public	Develop 1 new public access site by year 10 and 2 by year 20.	$22,100	SWCD NRCS Purdue Extension ISDA US Fish & Wildlife IDEM TNC IDNR Environmental Groups Government Agencies FFA
	Increase stakeholder participation in watershed		Host annual stream/road clean-up		
	Increase youth water quality education so that they can take the message back to adults		Host at least 2 classroom lessons annually		
			Complete volunteer water monitoring at a minimum of one location at least once annually.		
	Increase signage that discourages litter		Install 2 signs by year 5, 4 signs by year 10 and 8 signs by year 20.		
Protect and enhance critical habitat and unique natural area of the South Fork-Blue River, its tributaries,	Provide financial assistance to install BMPs to improve water quality and habitat	Agriculture Producers Landowners	See milestones for sediment, nutrient, and *E.coli* goals	$1,768,550	SWCD NRCS

Goal	Objective	Target Audience	Milestones	Cost (includes BMPs, staff and supplies)	Potential Partners/ Technical Assistance
and the entire watershed including threatened, endangered, and rare species.	Monitor changes in populations and habitat	Residents County agencies	Delist stream segments from IDEM 303(d) list for IBC within 20 years		Purdue Extension ISDA US Fish & Wildlife IDEM TNC
			Increase in macroinvertebrate and fish populations and diversity in the next 20 years (mIBI scores >35)		
			Complete volunteer water monitoring at a minimum of one location at least once annually.		

*The same field day may address 1 of more of the goals

Table 73: 5, 10 and 20 Year Action Plan and Strategies for the South Fork-Blue River Watershed Project

12.0 Future Activities

The next steps for the project include starting implementation of this management plan for the South Fork-Blue River Watershed. The Washington County Soil and Water Conservation District along with the steering committee and many other partners have submitted a grant application for implementation, which would provide funds for a cost-share program to install BMPs and an education and outreach program. If the grant is awarded, the steering committee will develop a cost-share program that will include steps to meeting the goals and management strategies of this plan. The anticipated cost-share program will use a ranking system to fund applications that will have the most impact in improving water quality. Factors such as location within watershed (priority areas), distance from streams, number of resource concerns addressed, and number of practices planned will be considered as part of the ranking process to further prioritize BMPs.

In order to track the project's progress of reaching goals and improving water quality, information and data will need to be continually collected during implementation.

Tracking Strategy	Frequency	Total Estimated Cost (Staff Time Included)	Partners/Technical Assistance
BMP Load Reductions	Continuous	$2,000	SWCDs, NRCS, ISDA
Attendance at Workshops/Field Days	Yearly	N/A	N/A
Post Workshop Surveys for Effectiveness	Yearly	$1,000	SWCD, NRCS, Purdue Extension
Number of Educational Programs/students reached	Yearly	N/A	N/A
Windshield Surveys	Every 4-5 years	$2,000	SWCDs, Committee, ISDA
Tillage/Cover Crop Transects	Yearly	$20,000	SWCDs, NRCS, ISDA, Staff, Committee, Earth Team Volunteers

Tracking Strategy	Frequency	Total Estimated Cost (Staff Time Included)	Partners/Technical Assistance
Volunteer Water Monitoring	Yearly	$1,000	Volunteers, SWCD, FFA students, Earth Team Volunteers, TNC
# of educational publications/press releases	Yearly	$1,000	SWCD
IDEM Performance Monitoring	To be determined	N/A (IDEM provides staff and funding)	IDEM
IDEM Probabilistic Monitoring	Every 9 years2019	N/A (IDEM provides staff and funding)	IDEM

Table 74: Strategies for Tracking Goals and Effectiveness of Implementation

The tracking strategies illustrated in Table 74 will be used to document changes and aid in the plan re-evaluation. Work completed towards each goal/objective documented will include scheduled and completed activities, numbers of individuals attending or efforts completed toward each objective, and load calculations for each goal, objective, and strategy. Overall, project progress will be tracked by measureable items such as workshops held, BMPs installed, meetings held, number of attendees, etc. Load reductions will be calculated for each BMP installed. These values and associated project details including BMP type, location, dimensions, load reductions, and more will be tracked over time and documented on the Indiana State Department of Agriculture Conservation Tracking sheet. Individual landowner contacts and information will be tracked for both identified and installed BMPs. Volunteer water monitoring results will be documented on the Hoosier Riverwatch website. The South Fork-Blue River Watershed Coordinator is responsible for keeping the mentioned records. The Washington County SWCD will be responsible for the long-term housing of records.

It is anticipated that additional water quality monitoring will be completed by IDEM's Watershed Assessment and Planning Branch through their Performance Monitoring program. Performance monitoring is conducted to identify changes in areas where there is reason to believe improvements may have occurred as a result of activities that may have a mitigating effect on water quality impairments identified on the state's 303(d) List of Impaired Waters. Generally, study areas are selected based on where watershed management plans have been implemented and where best management practices applied are most likely to have had sufficient time to have a measurable effect on water quality. The specific parameters to be monitored and the number of sampling sites will vary depending on the type and spatial extent of the original impairment.

Additional data could potentially be provided through the Probabilistic Monitoring program if sites within the SFBR watershed are selected for sampling. The Probabilistic Monitoring Program samples at least 38 randomly selected sites in a given basin and is the primary source of data used in IDEM's Integrated Report assessments. This program is designed to characterize the overall water quality in each major river basin and to identify specific waterbodies within each basin that are not fully supporting their beneficial designated uses. The state is divided into nine basins and one basin is sampled each year. The Ohio River Tributaries basin, which contains the SFBR watershed, is scheduled for monitoring in 2019.

Due to the uncertainty of the watershed management planning, an adaptive management strategy will be implemented to improve the project's success. While much thought and expertise has been put into the planning process, not all scenarios can be foreseen. Often times there are changes such as a shift in community attitude/behavior, changes in resource concerns, development of new information or accomplishing a goal sooner or later than expected. By implementing an adaptive management strategy, the Washington County SWCD and Steering Committee can adjust the watershed management plan to ensure project success. A four step adaptive management strategy has been outlined for the South Fork-Blue River Watershed Project and can be found below.

Step 1: Planning- The planning process developed the SFBR WMP that follows the IDEM's 2009 Watershed Management Checklist. The watershed coordinator, guided by the SFBR Steering Committee, developed the WMP using knowledge of the watershed, inputs from stakeholders, new data from water monitoring and windshield surveys, and historical data. This plan includes goals, action register, and schedule outlining how and when to achieve the defined goals.

Step 2: Implementation- The action register and schedule will then be implemented to achieve the goals of the SFBR project objectives and goals. Partnering agencies such as NRCS, SWCD, ISDA, and IDEM will carry out the implementation. Implementation will include a cost-share program and education events, both for youth and adults. Practices implemented through the cost-share program will follow the NRCS Field Office Technical Guide (FOTG) Practice Standards and will include, but not limited to, practices such as cover crops, heavy use area protection, pipeline, watering facilities, fencing, filter strips, grassed waterways, and nutrient management plans. Cost-share funding will be implemented in priority areas, addressing high priority areas before the medium priority area. A ranking system will be used to prioritize applications that will have the greatest impact on water quality improvement.

Step 3: Evaluate & Learn- Evaluations will occur often to check the progress being made toward the project goals. The steering committee will annually review progress and determine if the project is on track to meet interim and project end goals outlined in the Action Plan (Table 73) and goals (Section 8.0) Factors evaluated will include, but are not limited to, numbers of BMPs installed, calculated/estimated load reductions of installed BMPs, number of individuals reach through outreach, etc. The evaluations will be conducted by the SFBR Steering Committee. The group will then provide recommendations that will improve project success.

Step 4: Alter Strategy- The project's implementation and management strategy will be adjusted to improve the project's success. If progress is not made proportionate to the time into the project (i.e. at the end of year 3, approximately 60% (3/5) of 5 year goals should be met), the steering committee will have the opportunity to alter their strategy in order to meet the goals of the project. Adjustments will be based off of recommendations from the Evaluate and Learn step. Once the adjustments are agreed upon by the steering committee, the project will revert back to Implementation (Step 2) to continue with the Adaptive Management strategy (steps 2-4) until all goals have been met or all conservation opportunities have been exhausted.

The Washington County SWCD is responsible for maintaining records for the project.
Washington County SWCD contact information:
801 Anson Street
Salem, IN 47167
812-883-3704 ext. 3

References

About Indiana's Karst Caves | The Nature Conservancy. Retrieved September 4, 2015.

Animal Diversity Web. *Ligumia recta. http://animaldiversity.org/accounts/Ligumia_recta/*, retrieved October 27, 2015.

Ohio Department of Natural Resources. *Carex Decompositat Muhl. Cypress-knee Sedge. https://naturepreserves.ohiodnr.gov/portals/dnap/pdf/Rare_Plant_Abstracts/Carex_decomposita.pdf*. Retrieved on October 27, 2015.

Ohio Department of Natural Resources. *Carex gigantea* Rudge. http://naturepreserves.ohiodnr.gov/portals/dnap/pdf/Rare_Plant_Abstracts/Carex%20gigantea%202015%20Final.pdf, retrieved on October 27, 2015.

Central Hardwoods Joint Venture. Hooded Warbler (*Wilsonia citrina)* http://www.lmvjv.org/hsi_model/species/howa/s_howa.aspx, retrieved October 27, 2015.

Clark County Transportation Plan Final Report. http://www.kipda.org/files/PDF/Transportation_Division/Information/ClarkCounty/Clark_County_Final_Report.pdf, Retrieved October 16, 2015.

Connecticut Botanical Society. *Netted Chain Fern. http://www.ct-botanical-society.org/Plants/view/1061*, retrieved October 27, 2015.

Envionmental Protection Agency. *Animal Feeding Operations Overview. http://water.epa.gov/polwaste/npdes/afo/index.cfm*, retrieved November 5, 2015.

Etheostoma maculatum. http://www.iucnredlist.org/details/8118/0 , retrieved on October 27, 2015.

Fischer, Cory E., *2015 SAMPLING AND ANALYSIS WORKPLAN FOR BASELINE MONITORING OF THE SOUTH FORK BLUE RIVER. November 13, 2014.*

Flora of North America. *Ophioglossum engelmannii Prantl*, *Ber. Deutsch. Bot. Ges. 1: 351. 1883.* http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=233500833, retrieved October 27, 2015.

Flora of North America. *Rhynchospora corniculata*. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=242357871, retrieved on October 27, 2015.

Floyd County Comprehensive Land Use Plan Update. Retrieved October 16, 2015.

Global Conservation Regions | The Nature Conservancy. Retrieved July 22, 2015.

Harrison County Comprehensive Plan 2009. Retrieved October 16, 2015.

Indian Department of Environmental Management. *About Brownfields. http://www.in.gov/ifa/brownfields/2362.htm,* retrieved October 21, 2015.

Indiana Department of Environmental Management. *Confined Feeding Operations (CFOs). http://www.in.gov/idem/landquality/2349.htm*, retrieved November 5, 2015.

Indiana Department of Environmental Management. *Impairments (And Other Contstituents) Considered In Assessing Indiana Waters. http://www.in.gov/idem/nps/3365.htm#ibc*, retrieved on November 5, 2015.

Indiana Department of Environmental Management. *IDEM Permit Guide.* http://www.in.gov/idem/5894.htm, retrieved October 20, 2015.

Indiana Department of Environmental Management. *National Pollutant Discharge Elimination System (NPDES).* http://in.gov/idem/cleanwater/2429.htm, retrieved October 20, 2015.

Indiana Geological Survey. Retrieved July 22, 2015.

Indiana Soils: Evaluation and Conservation Online Manual. Retrieved October 13, 2015.

Indiana State Department of Agriculture. Retrieved October 9, 2015.

Lewis, Julian J. *USDA Forest Service, Eastern Region. (October 2002). http://www.fs.usda.gov /Internet/FSE_DOCUMENTS/fsm91_054266.pdf*, retrieved on October 27, 2015.

Magnolia acuminata L. http://www.na.fs.fed.us/pubs/silvics_manual/volume_2/magnolia/ accuminata.htm, retrieved on October 27, 2015.

Michigan Natural Features Inventory. *Carex straminea Straw sedge. http://mnfi.anr.msu. edu/explorer/species.cfm?id=15259*, retrieved on October 27, 2015.

Michigan Natural Features Inventory. *Dryobius sexnotatus Si-banded longhorn beetle. http://mnfi.anr.msu.edu/explorer/species.cfm?id=11551*, retrieved on October 27, 2015.

Michigan Natural Features Inventory. *Isoetes engelmannii Englemann's quilwort. http://mnfi.anr.msu.edu/explorer/species.cfm?id=15925*, retrieved on October 27, 2015.

Michigan Natural Features Inventory. *Polygala incarnate Pink milkwort. http://mnfi.anr.msu.edu/explorer/species.cfm?id=14504*, retrieved on October 27, 2015.

Minnesota Department of Natural Resources. *Bacopa rotundifolia (Michx.)Wettst. Water-hyssop. http://www.dnr.state.mn.us/rsg/profile.html?action=elementDetail&selected Element=PDSCR06080*

Mussel CWCS Species (46 species). http://fw.ky.gov/WAP/Documents/MUSSEL%20 CWCS%20SPECIE.pdf, retrieved on October 27, 2015.

Natural Resources Conservation Service. Retrieved October 2, 2015.

Notropis ariommus (Cope, 1891) Popeye shiner. *http://www.fishbase.org/summary/2822*, retrieved October 27, 2015.

NC State University At&T State University Cooperative Extension. *Stenanthium gramineum. https://plants.ces.ncsu.edu/plants/all/stenanthium-gramineum/*, retrieved October 27, 2015.

Office of Indiana State Chemist. *Fertilizer Section Annual Reports. http://www.oisc.purdue.edu/ fertilizer/annual_reports.html,* retrieved October 21, 2015.

Ohio Department of Natural Resources. Lathyrus venosus Muhl. Wild Pea. https://naturepreserves.ohiodnr.gov/portals/dnap/pdf/Rare_Plant_Abstracts/Lathyrus_venosus.pdf, retrieved on October 27, 2015.

Ohio Department of Natural Resources. *Ranunculus Pusillus Poiret Low Spearwort. https://naturepreserves.ohiodnr.gov/portals/dnap/pdf/Rare_Plant_Abstracts/Ranunculus_pusillus.pdf, retrieved October 27, 2015.*

Plants of Southern New Jersey. https://cumauriceriver.org/botany/hyde2.html, retrieved on October 27, 2015.

Purdue Extension Help the Hellbenders. (n.d.). Retrieved March 14, 2016, from https://ag.purdue.edu/extension/hellbender/Pages/default.aspx.

Tragia cordata Michx. http://www.missouriplants.com/Greenalt/Tragia_cordata_page.html, retrieved on October 27, 2015.

Roe, Kevin J. *Conservation Assessment for The Round Hickorynut (Obovaria subrotunda) Rafinesque, 1820. (2003) http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_ 054190.pdf*, retrieved October 27, 2015.

Roe, Kevin J. *Conservation Assessment for The Salamander Mussel (Simpsonaias ambigua) Say, 1825. http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_054186.pdf, retrieved October 27, 2015.*

Simon, Thomas P. *Conservation Assessment for the Spotted Darter (Etheostoma maculatum). http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsm91_054380.pdf*, retrieved October 27, 2015.

University of Michigan. *Ptychobranchus fasciolaris. http://animaldiversity.org/accounts/ Ptychobranchus_fasciolaris/*, retrieved October 27, 2015.

USDA Forest Service. *Wildlife Species: Taxidea taxus. http://www.fws.gov/midwest/endangered /amphibians/ozhe/ozheFactSheet.html*, retrieved, October 27, 2015.

U.S. Fish & Wildlife Service. *Ozark Hellbender (Cryptobranchus alleganiensis bishopi). http://www.fws.gov/midwest/endangered/amphibians/ozhe/ozheFactSheet.html*

U.S. Fish and Wildlife Service. *Species Profile for Finerayed pigtoe (Fusconaia cuneolus). http://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=F00O*, retrieved October 27, 2015.

U.S. Fish & Wildlife Service. *Species Profile for Bachman's sparrow (Aimophila aestivalis). https://ecos.fws.gov/tess_public/profile/speciesProfile.action?spcode=B07F*, retrieved October 27, 2015.

Washington County Comprehensive Plan November 2010. Retrieved October 16, 2015.

Water Quality and Hydrology. Retrieved September 14, 2015.

Whitewater River Watershed Watershed Management Plan. September 20, 2016.