Escherichia coli (E. coli)
Total Maximum Daily Load Report for the Lower Big Blue River Watershed

FINAL

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Prepared for

U.S. Environmental Protection Agency Region 5

Prepared by

Indiana Department of Environmental Management

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1.0 EXECUTIVE SUMMARY

The Lower Big Blue River watershed is located in east central Indiana and drains a total of 280 square miles. The two 10-digit hydrologic unit code (HUC) subwatersheds that make up the Lower Big Blue River are Little Blue River (0512020402) and Big Blue River (0512020408). The Lower Big Blue River Watershed originates in southern Henry County and then flows southwest through Hancock, Rush, Shelby and Johnson Counties, where it ultimately meets Sugar Creek to form Driftwood River near the Town of Edinburgh. Land use throughout the watershed is predominantly agricultural.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) impaired waters list. A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for regulated sources and load allocations (LAs) for unregulated sources. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly expressed, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

This TMDL has been developed for *E. coli* in the Lower Big Blue River watershed.

After the Indiana Department of Environmental Management (IDEM) identifies a waterbody as having an impairment and places the waterbody on Indiana's Section 303(d) list of impaired waters, IDEM implements a sampling plan to determine the extent and the magnitude of the impairment. The next task is to reassess the waterbodies using new sampling data and to examine the watershed as a whole. The reassessment data helps IDEM identify the area of concern for TMDL development. As a result of the reassessment for the Lower Big Blue River watershed, the pollutants and the impaired segments for which TMDLs were developed differ from the pollutants and impaired segments appearing on the Draft 2012 Section 303(d) list for the following reason:

- Sampling performed by IDEM in 2010 generated new water quality data that were not available at the time the Draft 2012 Section 303(d) list was developed.

Data used for the TMDL analysis were gathered from nineteen stream sites by IDEM between (9/20/2010-10/18/2010). There were also data analyzed from two sites that were sampled during the 2013 Probabilistic Monitoring in the basin between (7/16/2013-8/13/2013). The data indicate that 14 of the 21 sample sites violated the geometric mean for *E. coli*. Reductions needed to achieve water quality standards range from 0%-90%.

Determining the specific reasons for high *E. coli* counts in any given waterbody is challenging. There are many potential sources and *E. coli* counts are inherently variable. Within the Lower Big Blue River watershed, subwatersheds with regulated storm water and that are predominantly agricultural have the highest average *E. coli* counts. It is therefore possible that urban storm water and land application of manure in these subwatersheds is contributing to the elevated *E. coli* counts. However, other factors could also explain this correlation, such as such as leaking and failing septic sytems, and the fact that these subwatersheds tend to have smaller flows and thus have less dilution. Specific sources of *E. coli* to each impaired waterbody should be further evaluated during follow-up watershed planning and implementation activities.

An important step in the TMDL process is the allocation of the allowable loads of *E. coli* to individual point sources as well as to unregulated nonpoint sources. The Lower Big Blue River watershed TMDL includes these allocations, which are presented for each of the 38 Assessment Unit IDs (AUIDs) located in the twelve 12-digit hydrologic unit code (HUC) subwatersheds.

Potential point sources of *E. coli* in the watershed include five National Pollutant Discharge Elimination System (NPDES) permitted facilities that have limits for *E. coli* in their permits. These facilities are the Eastern Hancock Jr/Sr High School Waste Water Treatment Plant (WWTP), the Town of Shirley WWTP, the Town of Morristown WWTP, the City of Shelbyville WWTP, and the Town of Edinburgh WWTP. The facilities range in discharge from 0.029MGD (Million Gallons per Day) to 8.0 MGD. Although one facility has been found to be in violation of its permit limits for *E. coli*, the majority of the discharge effluent from these facilities meets water quality standards. Overall the five WWTPs are estimated to contribute about 0.88% of the overall *E. coli* load in the Lower Big Blue River watershed.

There are several types of nonpoint sources located in the Lower Big Blue River watershed, including small livestock operations, wildlife, livestock with direct access to streams, and straight piped, leaking or failing septic systems. Of these, small livestock operations, leaking and failing septic systems are found most often in eight subwatersheds with elevated levels of *E. coli*. Although Indiana does not have a permitting program for nonpoint sources, many are addressed through voluntary programs intended to reduce pollutant loads, minimize flow, and improve water quality, or, as with septic systems, are regulated by health departments.

This TMDL report identifies which areas of the watershed could most benefit from implementing water quality management measures and best management practices (BMPs). These areas in the Lower Big Blue River watershed are referred to as potential priority implementation areas (PPIAs). The report also provides recommendations on the types of management measures that key partners in the watershed can consider in order to achieve the pollutant load reductions calculated for each subwatershed. PPIAs are a starting point from which watershed stakeholders can continue the planning process to identify critical areas and select BMPs for the watershed. Table 1 presents the PPIAs and associated BMP recommendations likely to be most effective in achieving the *E. coli* load reductions allocated to sources in each subwatershed.

Table 1. PPIAs and Recommended BMPs to Achieve Pollutant Load Reductions by Subwatershed

Subwatershed	PPIA Rank	Implementation Action	Estimated Pollutant Load Reduction needed for *E. coli*
DePrez Ditch-Big Blue River	1	Outreach, education, and training	93.24% 42.76 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		storm water planning and management	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
Prairie Branch-Big Blue River	2	Outreach, education, and training	51.59% 22.43 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Anthony Creek-Six Mile Creek	3	Outreach, education, and training	64.69% 7.73 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Town of Rays Crossing-Little Blue River	4	Outreach, education, and training	72.07% 5.60 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		storm water planning and management	
		Cover crops	
		Grassed Waterways	
Nameless Creek	5	Outreach, education, and training	72.80% 4.39 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Conservation tillage/ residue management	
		Manure handling, storage, treatment, and disposal	
Manilla Branch-Little Blue River	6	Outreach, education, and training	45.17% 1.87 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Prescribed grazing	
		Grassed Waterways	
Beaver Meadow Creek	7	Outreach, education, and training	16.24% 0.32 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Headwaters Little Blue River	8	Outreach, education, and training	11.58% 0.22 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	

Subwatershed	PPIA Rank	Implementation Action	Estimated Pollutant Load Reduction needed for *E. coli*
Gilson Creek-Little Blue River	9	Outreach, education, and training	0*
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Headwaters Six Mile Creek	10	Outreach, education, and training	0*
		Stream fencing (animal exclusion)	
		Cover crops	
		Prescribed grazing	
		Grassed Waterways	
Shaw Ditch-Big Blue River	11	Outreach, education, and training	0*
		Stream fencing (animal exclusion)	
		Cover crops	
		Prescribed grazing	
		Grassed Waterways	
Foreman Branch-Big Blue River	12	Outreach, education, and training	0*
		Stream fencing (animal exclusion)	
		Storm water planning and management	
		Cover crops	
		Manure handling, storage, treatment, and disposal	

*Based on the samples collected no load reduction is needed during low flow conditions. Implementation actions and BMP installation are still recommended during mid to high flow conditions where sources may change.

Public participation is an important and required component of the TMDL development process. The following public meetings and public comment periods have been held to further develop this project:

- A Draft TMDL meeting was held May 7, 2014 at 2:30 PM. The meeting was held at the Shelby County Purdue Extension Office, 1600 East State Road 44, Suite C, Shelbyville IN, 46716

2.0 INTRODUCTION

This section of the Total Maximum Daily Load (TMDL) provides an overview of the Lower Big Blue River watershed location and the regulatory requirements that have led to the development of this TMDL to address impairments in the Lower Big Blue River watershed.

The Lower Big Blue River watershed, shown in Figure 1, is located in east central Indiana and drains a total of 280 square miles. The two 10-digit hydrologic unit code (HUC) subwatersheds that make up the Lower Big Blue River are Little Blue River (0512020402) and Big Blue River (0512020408). The Lower Big Blue River Watershed originates near southern Henry County and then flows southwest, where it ultimately meets Sugar Creek to form Driftwood River near Edinburgh. Land use throughout the watershed is predominantly agricultural.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop TMDLs for waters on the Section 303(d) lists. USEPA defines a TMDL as the sum of the individual wasteload allocations (WLA) for point sources and load allocations (LA) for nonpoint sources, and a margin of safety (MOS) such that the capacity of the waterbody to assimilate pollutant loadings is not exceeded.

The overall goals and objectives of the TMDL study for the Lower Big Blue River watershed are:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Determine current loads of pollutants to the impaired waterbodies.
- Use the best available science and available data to determine the total maximum daily load the waterbodies can receive while fully supporting the impaired designated use(s).
- If current loads exceed the maximum allowable loads, determine the load reduction that is needed.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Identify potential priority implementation areas (PPIAs) that watershed stakeholders can use to identify critical areas
- Recommend activities for purposes of TMDL implementation.
- Submit a final TMDL report to the U.S. Environmental Protection Agency (USEPA) for review and approval.

Watershed stakeholders and partners can use the final approved TMDL report to craft a watershed management plan (WMP) that meets both USEPA's nine minimum elements under the CWA Section 319 Nonpoint Source Program, as well as the additional requirements under IDEM's WMP Checklist. The USEPA's nine minimum elements can be found here: http://water.epa.gov/polwaste/nps/upload/319-guidelines-fy14.pdf. IDEM's WMP checklist can be found here: https://secure.in.gov/idem/nps/files/nps_compendium_wmp_checklist_2009.pdf

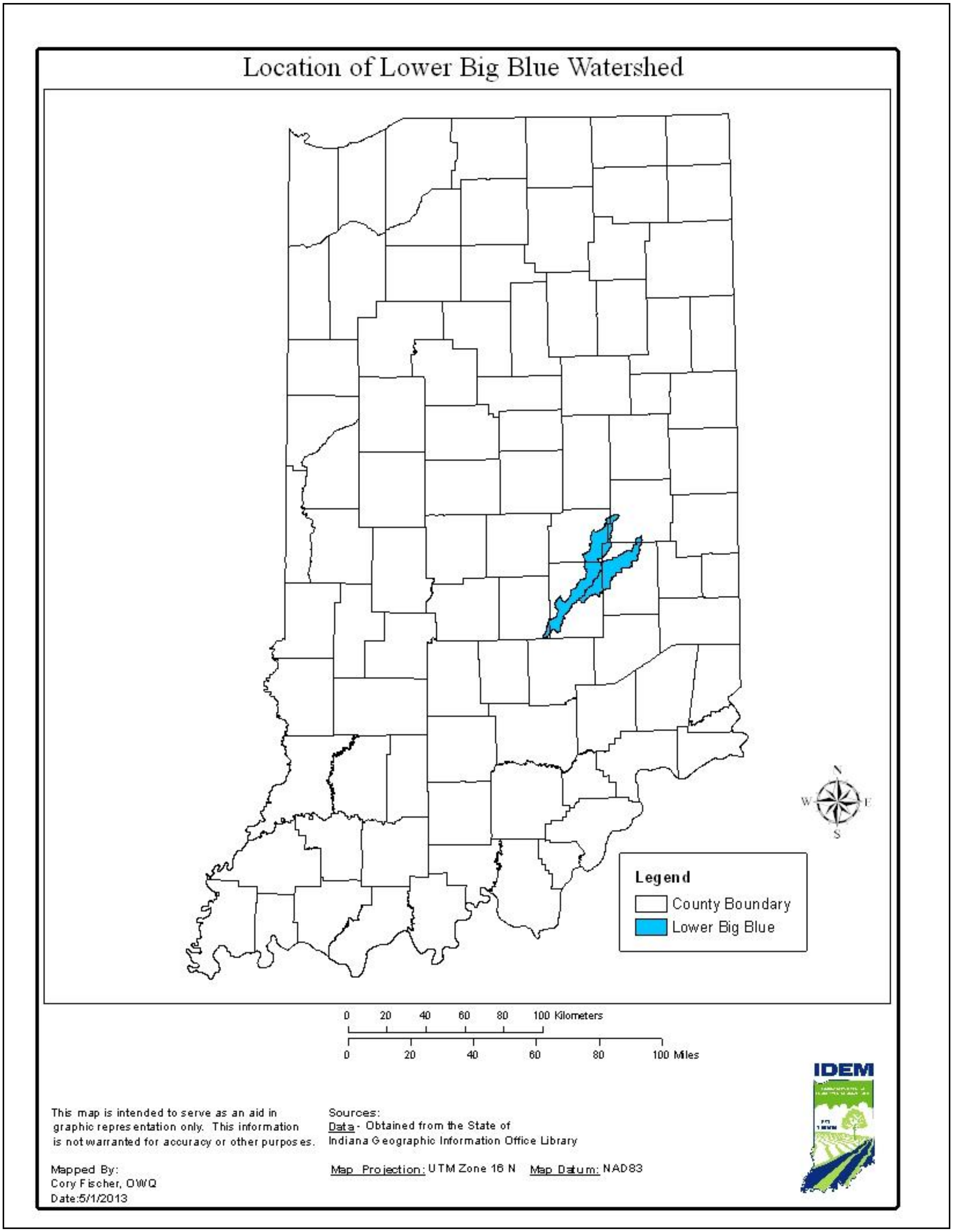


Figure 1. Location of Lower Big Blue River Watershed

2.1 Water Quality Standards

Under the CWA, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the CWA's goal of "swimmable/fishable" waters. Water quality standards consist of three different components:

- **Designated uses** reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and full body contact recreation. Every waterbody in Indiana has a designated use or uses; however, not all uses apply to all waters. The Lower Big Blue River Watershed TMDL focus on protecting the designated full body contact recreational uses of the waterbodies.
- Criteria express the condition of the water that is necessary to support the designated uses. **Numeric criteria** represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. **Narrative criteria** are the general water quality criteria that apply to all surface waters. Numeric criteria for *E. coli* were used as the basis of the Lower Big Blue River Watershed TMDL.
- Antidegradation policies protect existing uses and provide extra protection for high-quality or unique waters

The water quality standard in Indiana pertaining to *E. coli* is described below.

E. coli is an indicator of the possible presence of pathogenic organisms such as pathogenic bacteria, viruses, protozoa, and parasites which may cause human illness. The direct monitoring of these pathogens is difficult; therefore, *E. coli* is used as an indicator of potential fecal contamination. *E. coli* is a sub-group of fecal coliform, the presence of *E. coli* in a water sample indicates recent fecal contamination is likely. Concentrations are typically reported as the count of organisms in 100 milliliters of water (count/100 mL) and may vary at a particular site depending on the baseline *E. coli* level already in the river, inputs from other sources, dilution due to precipitation events, and die-off or multiplication of the organism within the river water and sediments.

The numeric *E. coli* criteria associated with protecting the recreational use are described below.

> *"The criteria in this subsection are to be used to evaluate waters for full body contact recreational uses, to establish wastewater treatment requirements, and to establish effluent limits during the recreational season, which is defined as the months of April through October, inclusive. E. coli bacteria, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period. . ."* [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

2.2 TMDL Target Values

Target values are needed for the calculation of daily loads when developing TMDLs. For parameters that have numeric criteria, such as *E. coli*, the target equals the numeric criteria. For parameters that do not have numeric criteria, target values must be identified from some other source. The target values used to develop the Lower Big Blue River Watershed TMDL are presented below.

2.2.1 *E. coli*

The target value used for the Lower Big Blue River Watershed TMDL was based on the 125 counts/100 mL geometric mean component of the standard (i.e., daily loading capacities were calculated by multiplying flows by 125 counts/100 mL). This approach ensures that both components of the standard will be met since a daily loading capacity based on 125 counts/100 mL will, by definition, meet the 235 counts/100 mL component of the standard. The use of the geometric mean component of the standard results in an added MOS (see Section 8.2 for more details).

2.3 Listing Information

There are a number of existing impairments in the Lower Big Blue River watershed from the approved Draft 2012 303(d) List of Impaired Waters (Figure 2). The listings and causes of impairment have been adjusted as a result of reassessment data collected at 21 sampling locations in the watershed (Figure 3). Within the Lower Big Blue River watershed a total of 25 assessment unit IDs (AUIDs) are cited as impaired for *E. coli*, (Figure 4). These impaired segments account for approximately 256 miles. Table 3 presents listing information for the Lower Big Blue River watershed, including a comparison of the updated listings with the 2012 listings and associated causes of impairments addressed by the TMDLs. The reassessment data used in updating the listings for the Lower Big Blue River watershed are available in Appendix B.

IDEM identifies the Lower Big Blue River watershed and its tributaries using a watershed numbering system developed by the United States Geological Survey (USGS), Natural Resource Conservation Service (NRCS), and the U.S. Water Resources Council referred to as hydrologic unit codes (HUCs). HUCs are a way of identifying watersheds in a nested arrangement from largest (i.e., those with shorter HUCs) to smallest (i.e., those with longer HUCs). (For more information on HUCs, go to http://www.in.gov/idem/nps/2422.htm.) Figure 5 shows the 12-digit HUCs located in the Lower Big Blue River watershed.

2.4 Priority Ranking Discussion

The Lower Big Blue River Watershed TMDL was prioritized to be completed at this time based on local interest in addressing water quality and on the IDEM rotating basin approach. In this approach available assessment resources are concentrated or targeted in defined watersheds for a specified period of time, thus allowing for water quality data to be collected and assessed in a spatially and temporally ‘focused’ manner. Over time, every portion of the state is targeted for monitoring and assessment.

IDEM utilizes a rotating basin approach to monitor water quality unless there is a significant reason to deviate from the rotating basin schedule. Deviations can lead to water bodies being upgraded or downgraded in priority depending on: the specified designated use and whether water quality standards are being met, the magnitude of the impairment, deviations to allow an appropriate amount of time for implementation practices to take hold, and instances where there is no water quality guidance available or guidance is currently being developed.

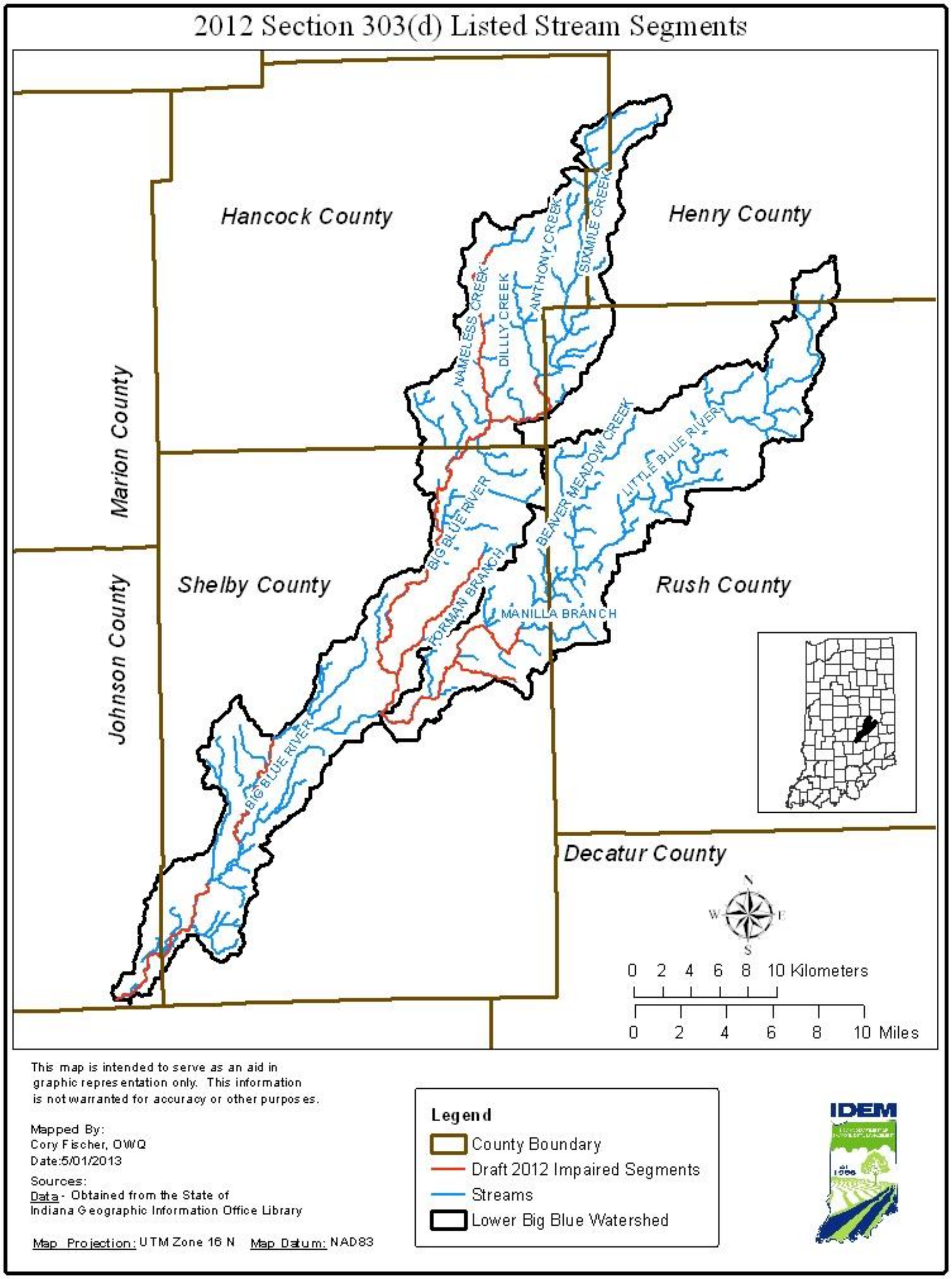


Figure 2. Streams Listed on the Draft 2012 Section 303(d) List in the Lower Big Blue River Watershed

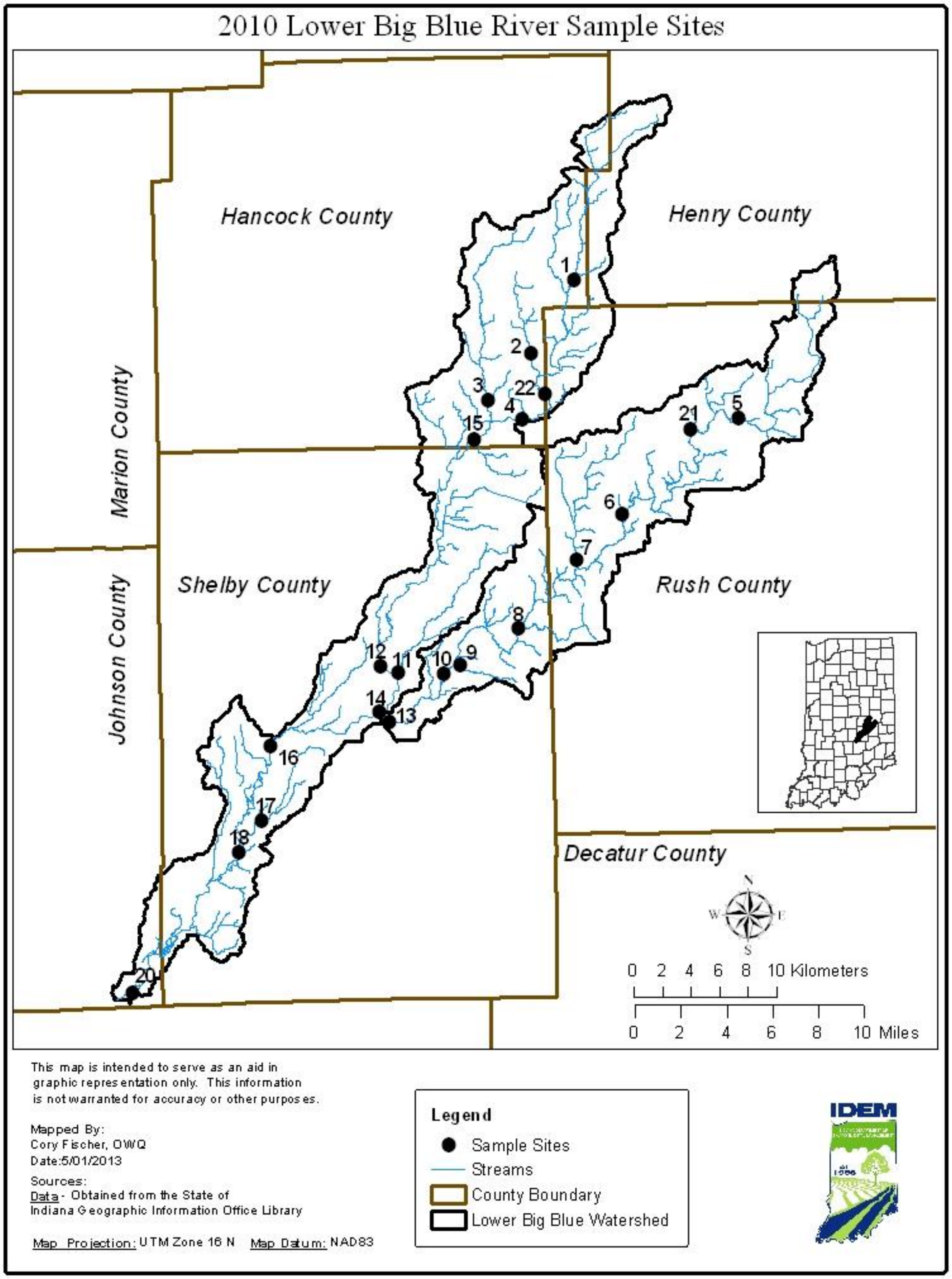


Figure 3. Sampling Locations in 2010 and 2013 Lower Big Blue Watershed TMDL

Table 2. Lower Big Blue River Sampling Site Information

Site #	L-Site #	Stream Name	Road Name	AUID 2012
1	WED020-0031	Six mile Creek	CR 1050 E	INW0481_01
2	WED020-0032	Dilly Creek	CR 200 S	INW0482_T1002
3	WED020-0033	Nameless Creek	CR 400 S	INW0483_01
4	WED020-0001	Six mile Creek	CR 800 E	INW0482_01
5	WED030-0029	Little Blue River	CR 150 W	INW0421_01
6	WED030-0030	Little Blue River	CR 300 N	INW0423_01
7	WED030-0031	Beaver Meadow Cr	CR 100 N	INW0422_01
8	WED030-0026	Little Blue River	CR 400 N	INW0425_01
9	WED030-0032	Tributary of Little Blue River	Union Rd	INW0425_T1001
10	WED030-0033	Little Blue River	CR 200 N	INW0425_01
11	WED020-0014	Foremans Branch	Knighthood Grove Rd	INW0485_T1002
12	WED020-0003	Big Blue River	Morristown Rd	INW0485_02
13	WED-02-0001	Little Blue River	Franklin St	INW0425_01
14	WED-08-0002	Big Blue River	Noble St	INW0486_01
15	WED-08-0003	Big Blue River	CR 575 E	INW0484_01
16	WED-08-0001	Big Blue River	CR 100 S	INW0486_02
17	WED050-0033	Howell Ditch	Manetta Rd	INW0486_T1003
18	WED050-0008	Big Blue River	CR 550 S	INW0487_01
20	WED050-0035	Big Blue River	SR 252	INW0487_01
21	WED-02-0003	Little Blue River	CR 400 W	INW0423_01
22	WED-08-0004	Six mile Creek	CR 900 E	INW0482_01

Understanding Table 2:

- *Column 1: Site #*. Lists the site number that corresponds to the site location in Figure 3.
- *Column 2: L-Site #* .Provides the Site Number in IDEMs Assessment Information Management System (AIMS)
- *Column 3: Stream Name*. Identifies the Stream Name that the site is located on.
- *Column 3: Road Name.* Identifies the Road Name that the site is located on
- *Column 4: AUID 2012.* Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2014 Section 303(d) listing assessment process.

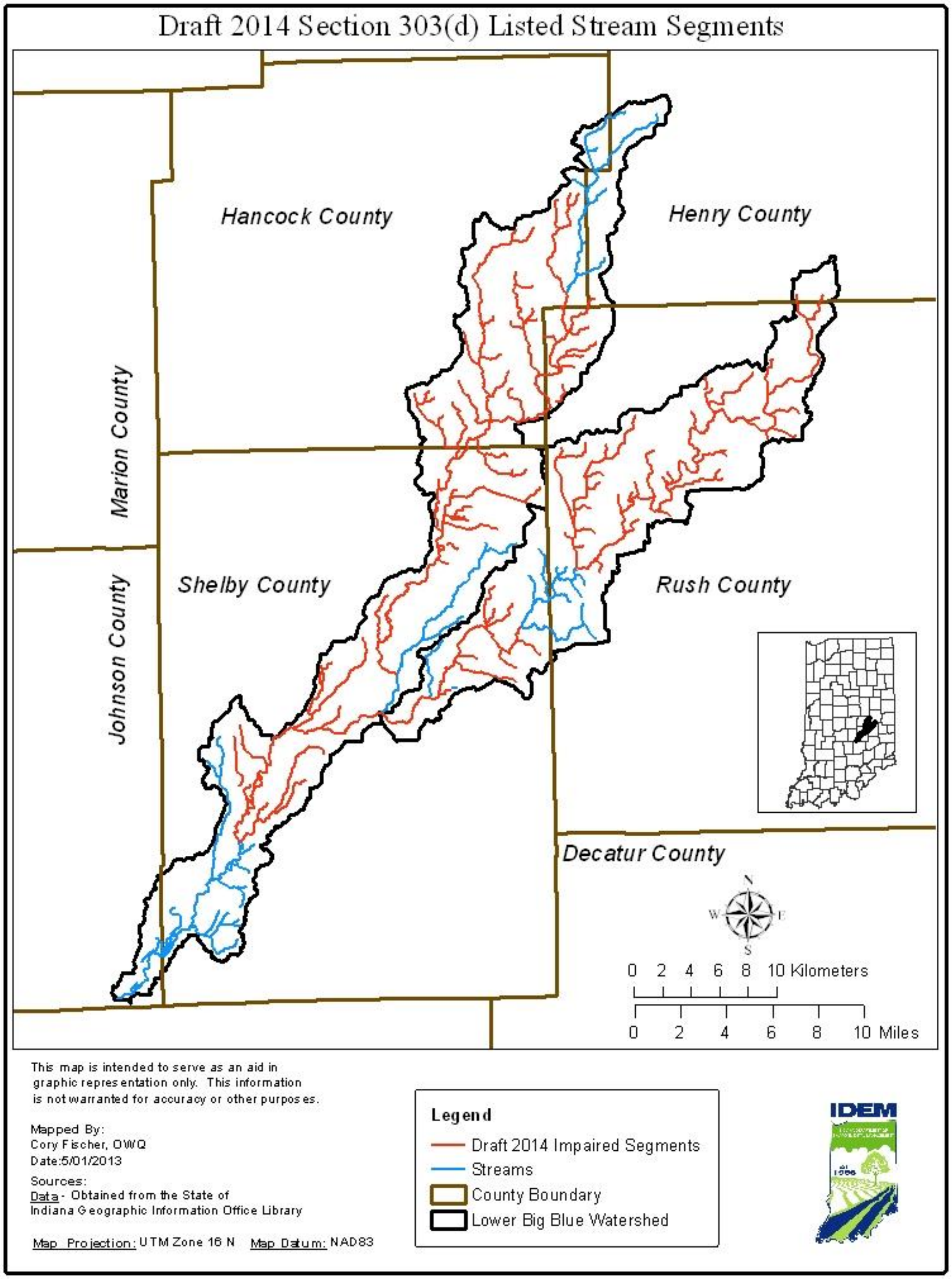


Figure 4. Streams Listed on the Draft 2014 Section 303(d) List in the Lower Big Blue River Watershed

Table 3. Section 303(d) List Information for the Lower Big Blue River Watershed for 2012 and 2014.

Watershed (10-digit HUC)	Subwatershed (12-digit HUC)	Previous AUID 2010	2012 Section 303(d) Listed Impairment	New AUID 2014	Updated Impairments to be Listed 2014
Little Blue River (0512020402)	Headwaters Little Blue River (051202040201)	INW0431_00		INW0421_01	*E. coli*
	Beaver Meadow Creek (051202040202)	INW0434_00		INW0422_01 INW0422_T1001	*E. coli* *E. coli*
	Gilson Creek-Little Blue River (051202040203)	INW0432_00 INW0433_00 INW0432_00		INW0423_01 INW0423_T1001 INW0423_T1001A	*E. coli* *E. coli* *E. coli*
	Manilla Branch-Little Blue River (051202040204)	INW0435_T1016 INW0435_00 INW0435_T1052		INW0424_01 INW0424_T1001 INW0424_T1002	
	Town of Rays Crossing- Little Blue River (051202040205)	INW0436_T1015 INW0436_00	*E. coli* *E. coli*	INW0425_01 INW0425_01A INW0425_T1001 INW0425_T1002	*E. coli* *E. coli*
Big Blue River (0512020408)	Headwaters Six Mile Creek (051202040801)	INW0421_00 INW0421_00		INW0481_01 INW0481_T1001	
	Anthony Creek-Six Mile Creek (051202040802)	INW0422_00 INW0423_00 INW0422_00 INW0423_T1001	 *E. coli*	INW0482_01 INW0482_01A INW0482_T1001 INW0482_T1002	*E. coli* *E. coli* *E. coli* *E. coli*
	Nameless Creek (051202040803)	INW0424_00	*E. coli*	INW0483_01	*E. coli*
	Prairie Branch-Big Blue River (051202040804)	INW0423_T1010 INW0425_T1011 INW0425_00 INW0425_00	 *E. coli*	INW0484_01 INW0484_T1001 INW0484_T1002 INW0484_T1003	*E. coli* *E. coli* *E. coli* *E. coli*
	Foreman Branch- Big Blue River (051202040805)	INW0426_T1012 INW0427_T1013 INW0428_T1014 INW0428_00	*E. coli* *E. coli* *E. coli* *E. coli*	INW0485_01 INW0485_02 INW0485_03 INW0485_T1001 INW0485_T1001A INW0485_T1002	*E. coli* *E. coli* *E. coli* *E. coli*
	DePrez Ditch-Big Blue River (051202040806)	INW0437_T1017 INW0451_T1018 INW0437_00 INW0452_00	 *E. coli*	INW0486_01 INW0486_02 INW0486_T1001 INW0486_T1002 INW0486_T1003	*E. coli* *E. coli* *E. coli* *E. coli*
	Shaw Ditch- Big Blue River (051202040807)	INW0453_T1019 INW0455_T1020 INW0454_00		INW0487_01 INW0487_T1001 INW0487_T1002	

Understanding Table 3:

- *Column 1: Watershed (10-digit HUC).* Lists the subwatersheds at the 10-digit HUC scale that were part of the initial assessment for the Lower Big Blue River watershed.

- *Column 2: Subwatershed (12-digit HUC).* Shows the name of the subwatershed at the 12-digit HUC scale. The subwatershed found in this second column is the appropriate scale for what the IDEM's WMP Checklist defines as a subwatershed for the purposes of watershed management planning.
- *Column 3: Previous AUID 2010.* Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2012 Section 303(d) listing assessment process.
- *Column 4:2012 Section 303(d) Listed Impairment.* Identifies the cause of impairment associated with the 2012 Section 303(d) listing.
- *Column 5: New AUID 2014.* Provides the updated AUIDs associated with each 12-digit HUC subwatershed. Look for these AUIDs used throughout this report to present detailed analysis of sources, load allocations, and recommended implementation activities in PPIAs.
- *Column 6: Updated Impairment to be Listed 2014.* Provides the updated causes of impairment if new data and information are available.

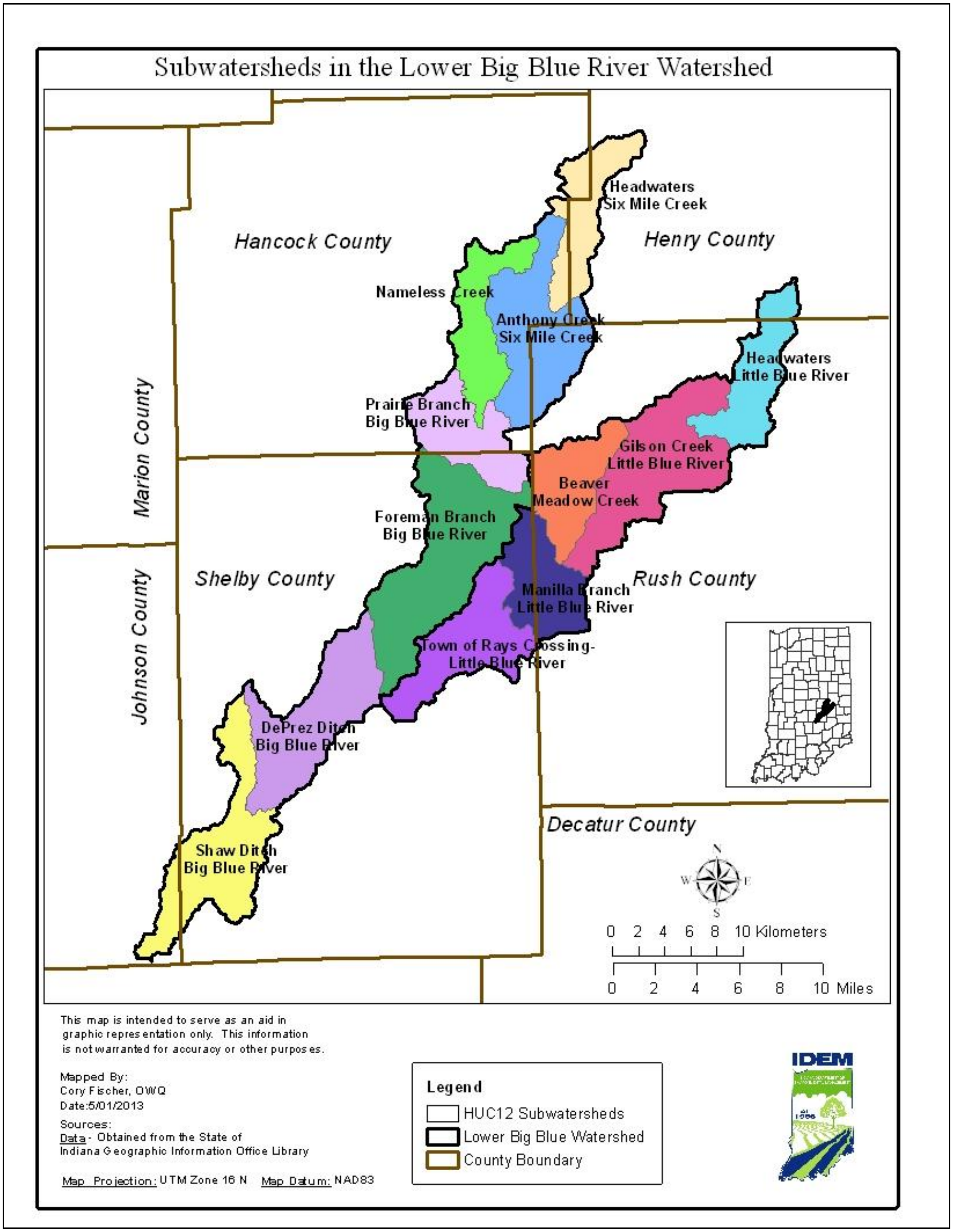


Figure 5. Subwatersheds (12-Digit HUCs) in the Lower Big Blue River Watershed

3.0 DESCRIPTION OF THE WATERSHED

This section of the TMDL report contains a brief characterization of the Lower Big Blue River watershed to provide a better understanding of the historic and current conditions of the watershed that affect water quality and contribute to the *E. coli* impairment. Understanding the natural and human factors affecting the watershed will assist in selecting and tailoring appropriate and feasible implementation activities to achieve water quality standards.

The Lower Big Blue River watershed has a diverse network of streams. Tributaries include the Anthony Creek, Beaver Meadow Creek, Cotton Run, Dilly Creek, Forman Branch, Gilson Creek, Howell Ditch, Linn Creek, Manilla Branch, Nameless Creek, Prairie Branch, Ridge Run, Shaw Ditch, Six mile Creek, and Smith Ditch among others. Many of these tributaries are shown in Figure 2 and subwatersheds are shown in Figure 5.

3.1 Land Use

Land use patterns provide important clues to the potential sources of *E. coli* in a watershed. Land use information for the Lower Big Blue River watershed is available from the Multi-Resolution Land Characteristics Consortium (MRLCC). These data categorize the land use for each 30 meter by 30 meter parcel of land in the watershed based on satellite imagery from circa 2006. Figure 6 displays the spatial distribution of the land uses and the data are summarized in Table 4.

Land use in the Lower Big Blue River watershed is primarily agricultural, comprising approximately 80 percent. Corn and soybean crops are not typically associated with high *E. coli* loads, unless they have been fertilized with manure. Approximately seven percent of the land is forested and eight percent is developed. Pasture/hay represents four percent of the watershed and indicates the presence of animal feedlots that can be significant sources of *E. coli*.

Table 4. Land Use of Lower Big Blue River Watershed

Land Use	Watershed		
	Area		
	Acres	Square Miles	Percent
Open Water	730.34	1.14	0.41
Developed Land	13,656.60	21.34	7.61
Forested Land	12,424.31	19.41	6.93
Grasslands and Shrubs	1,649.28	2.58	0.92
Pasture/Hay	6,789.05	10.61	3.79
Agricultural Lands	143,430.22	224.11	80.01
Wetlands	592.02	0.93	0.33
TOTAL	179,271.82	280.11	100.00

Understanding Table 4: The predominant land use types in the Lower Big Blue River watershed can indicate potential sources of *E. coli* loadings. Different types of land uses are characterized by different types of hydrology. For example, developed lands are characterized by impervious surfaces that increase the potential of storm water events during high flow periods delivering *E. coli* to downstream streams and rivers. Forested land and wetlands allow water to infiltrate slowly thus reducing the risks of polluted water running off into waterbodies. In addition to changes in hydrology, land use types are associated with different types of activities that could contribute *E. coli* to the watershed. Understanding types of land uses will help identify the type of implementation approaches that watershed stakeholders can use to achieve *E. coli* load reductions.

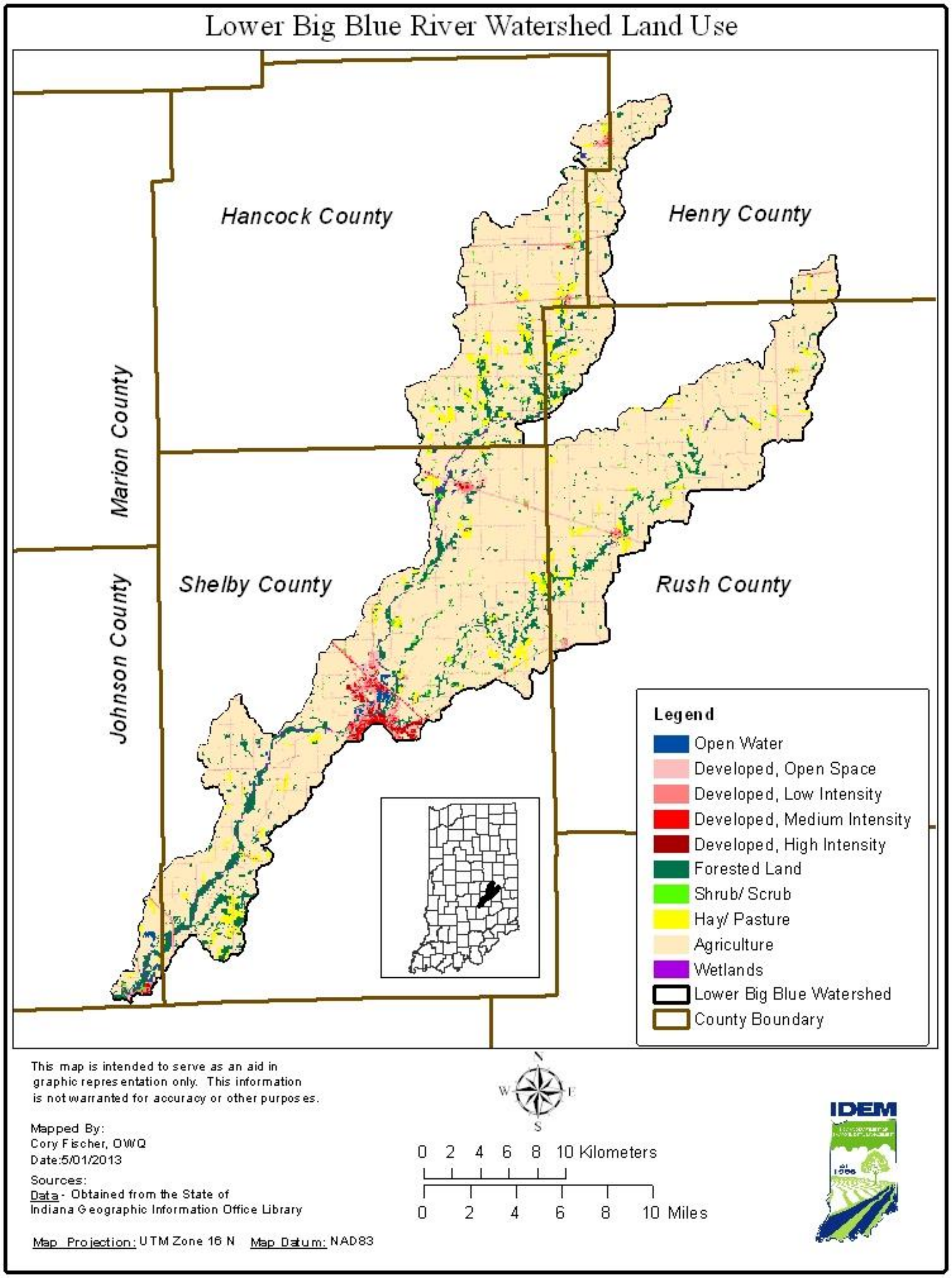


Figure 6. Land Use in the Lower Big Blue River Watershed

3.2 Cropland

Agricultural land use information for the Lower Big Blue River watershed is available from the USDA, National Agriculture Statistics Service (NASS), 2012 Indiana Cropland Data Layer. The purpose of the Cropland Data Layer Program is to use satellite imagery to provide acreage estimates to the Agricultural Statistics Board for the state's major commodities and to produce digital crop-specific, categorized geo-referenced output products. These data categorize the land use for each 30 meterby 30 meter parcel of land in the watershed based on satellite imagery from circa 2012. Figure 7 displays the spatial distribution of the crop land uses and the data are summarized in Table 5.

Land use in the Lower Big Blue River watershed is primarily agricultural, comprising approximately 80 percent of the Lower Big Blue River watershed. Corn and soybean crops are not typically associated with high *E. coli* loads, unless they have been fertilized with manure. Approximately 51 percent of the land is planted in corn and approximately 47 percent is planted in soybeans. Other cropland comprises approximately two percent of the watershed.

Table 5. 2012 Crop Land in the Lower Big Blue River Watershed

	Watershed		
	Area		
Crop Data	**Acres**	**Square Miles**	**Percent**
Corn	66,800.96	104.38	51.94
Soybean	60,841.89	95.07	47.31
Winter Wheat	882.69	1.38	0.69
Double Crop Winter Wheat/ Soybeans	74.28	0.12	0.06
TOTAL	**128,599.8**	**200.95**	**100.00**

Understanding Table 5: The predominant cropland types in the Lower Big Blue River watershed can indicate potential sources of *E. coli* loadings. Corn and soybean crops are not typically associated with high *E. coli* loads, unless they have been fertilized with manure. Understanding types of cropland will help watershed stakeholders to assess sources of manure application in order to identify the type of implementation approaches that they can use to achieve *E. coli* load reductions.

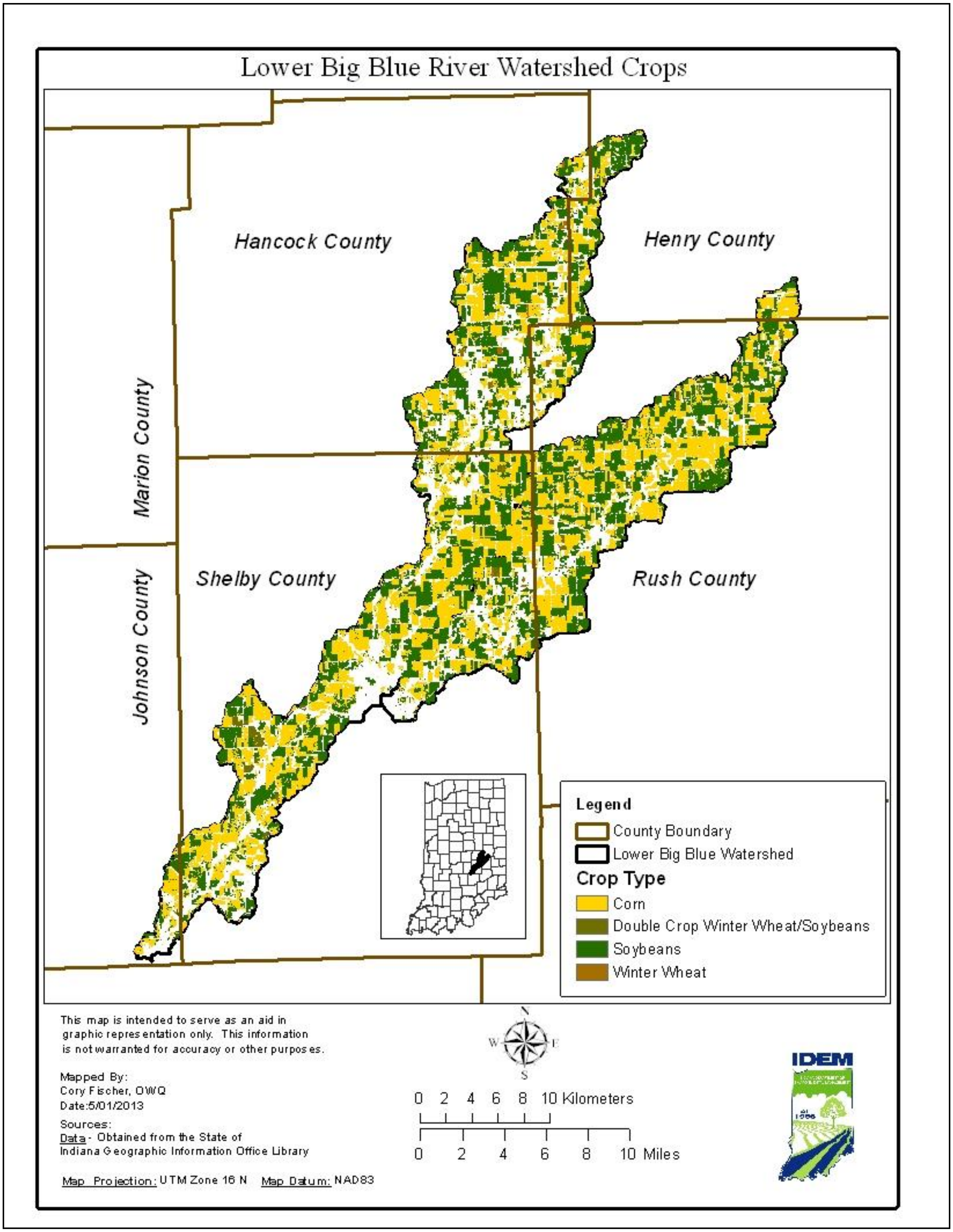


Figure 7. Crop Land in the Lower Big Blue River Watershed

3.3 Human Population

Counties with land located in the Lower Big Blue River watershed include Henry, Hancock, Rush, Shelby, and Johnson. Major cities and towns with jurisdiction at least partially within the Lower Big Blue River watershed include Edinburgh, Shelbyville, Morristown, and Shirley. U.S. Census data for each county during the past three decades are provided in Table 6.

Table 6. Population Data for Counties in the Lower Big Blue River Watershed

County	1990	2000	2010
Henry	48,139	48,508	49,462
Hancock	45,527	55,391	70,002
Rush	18,129	18,261	17,392
Shelby	40,307	43,445	44,436
Johnson	88,109	115,209	139,654
TOTAL	**240,211**	**280,814**	**320,946**

Source: U.S. Census Bureau.

Understanding Table 6: Water quality is linked to population growth because a growing population often leads to more development, translating into more houses, roads, and infrastructure to support more people. Table 6 provides information that shows how population has changed in each of the counties located in the Lower Big Blue River watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future and where action now could help prevent further water quality degradation. It is assumed that growth in Johnson and Hancock counties will continue to rise. This will continue the trend of converting ag land into urbanized landuses.

Estimates of population within Lower Big Blue River watershed are based on US Census data from 2010 and the percentage of the total county and urban area that is within the watershed (Table 7). Based on this analysis, the estimated population of the watershed is 27,373 with approximately 56 percent of the population classified as rural residents and 44 percent classified as urban residents. Figure 9 indicates population density within the Lower Big Blue River watershed.

Table 7. Estimated Population in the Lower Big Blue River Watershed

County	2010 Population	Total Estimated Watershed Population	Percent of Total Watershed Population	Non-urban Population	Urban Population
Henry	49,462	974	4	777	197
Hancock	70,002	4,306	16	3,679	687
Rush	17,392	2,942	11	2,942	0
Shelby	44,436	17,835	65	7,767	10,068
Johnson	139,654	1,316	5	351	965
TOTAL	**320,946**	**27,373**	**100**	**15,456**	**11,917**

Understanding Table 7: Understanding where the greatest population is concentrated within the Lower Big Blue River watershed will help watershed stakeholders understand where different types of water quality pressures might currently exist. In general, watersheds with large urban populations are more likely to have problems associated with lots of impervious surfaces, poor riparian habitat, flashy storm water flows, and large wastewater inputs. Alternatively, watersheds with mostly a non-urban population are more likely to suffer problems from failing septic systems, agricultural runoff, and other types of poor riparian habitat (e.g., channelized streams). Comparing the information in Table 6 with the information in

Table 7can provide an understanding of how population might change in the Lower Big Blue River watershed and which counties are experiencing the most growth and shifts in urban and non-urban population. Population change can serve as an indicator for changes in land uses. For example, growing populations might mean more development, resulting in increased impervious surfaces and more infrastructure (e.g., sanitary sewer and storm sewer). Declining population in areas of the Lower Big Blue River watershed might signify communities with under-utilized infrastructure and indicate opportunities to “rightsize” existing infrastructure and promote changes to land use that would benefit water quality (e.g., green infrastructure).

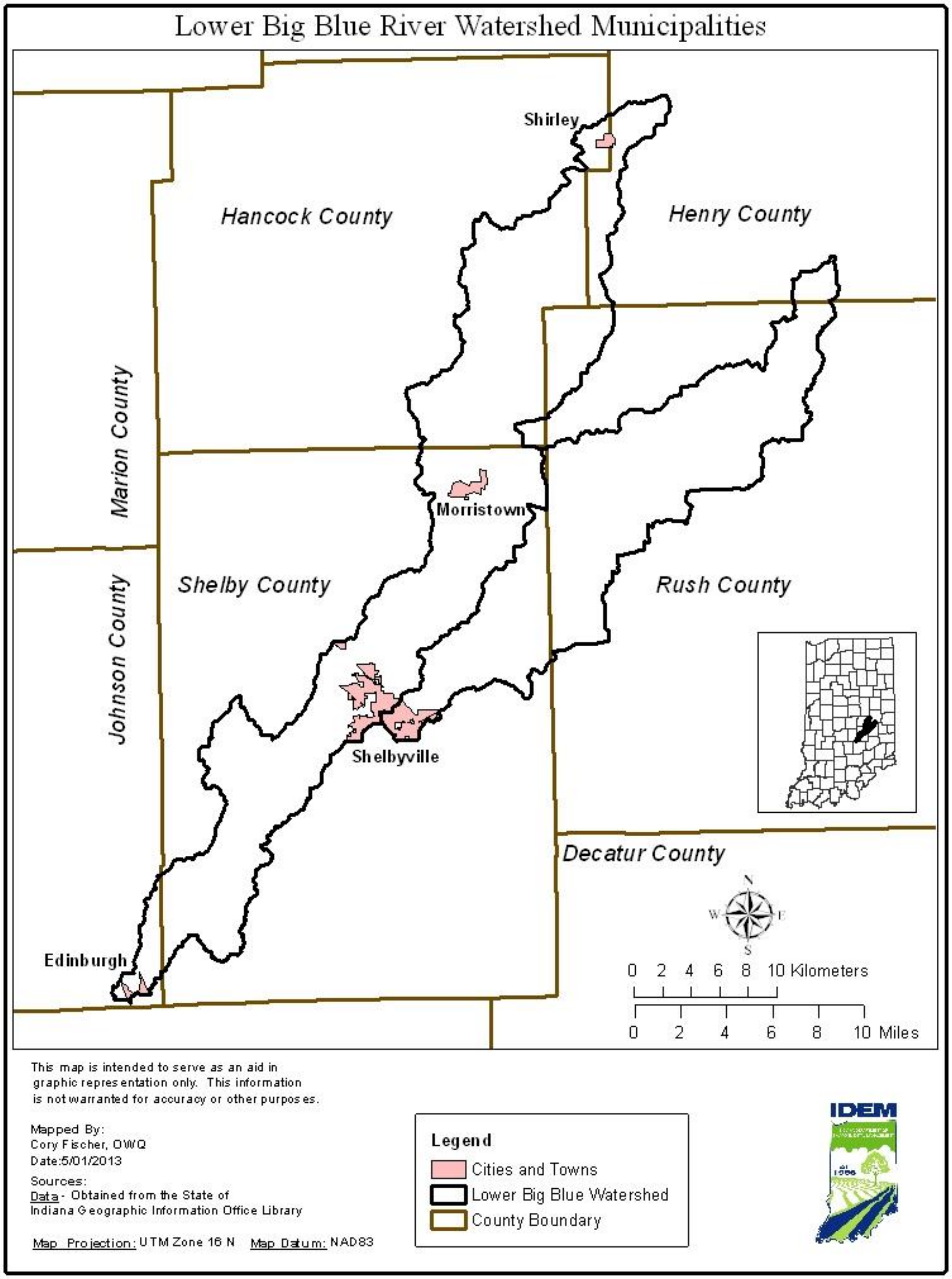


Figure 8. Cities and Towns in the Lower Big Blue River Watershed

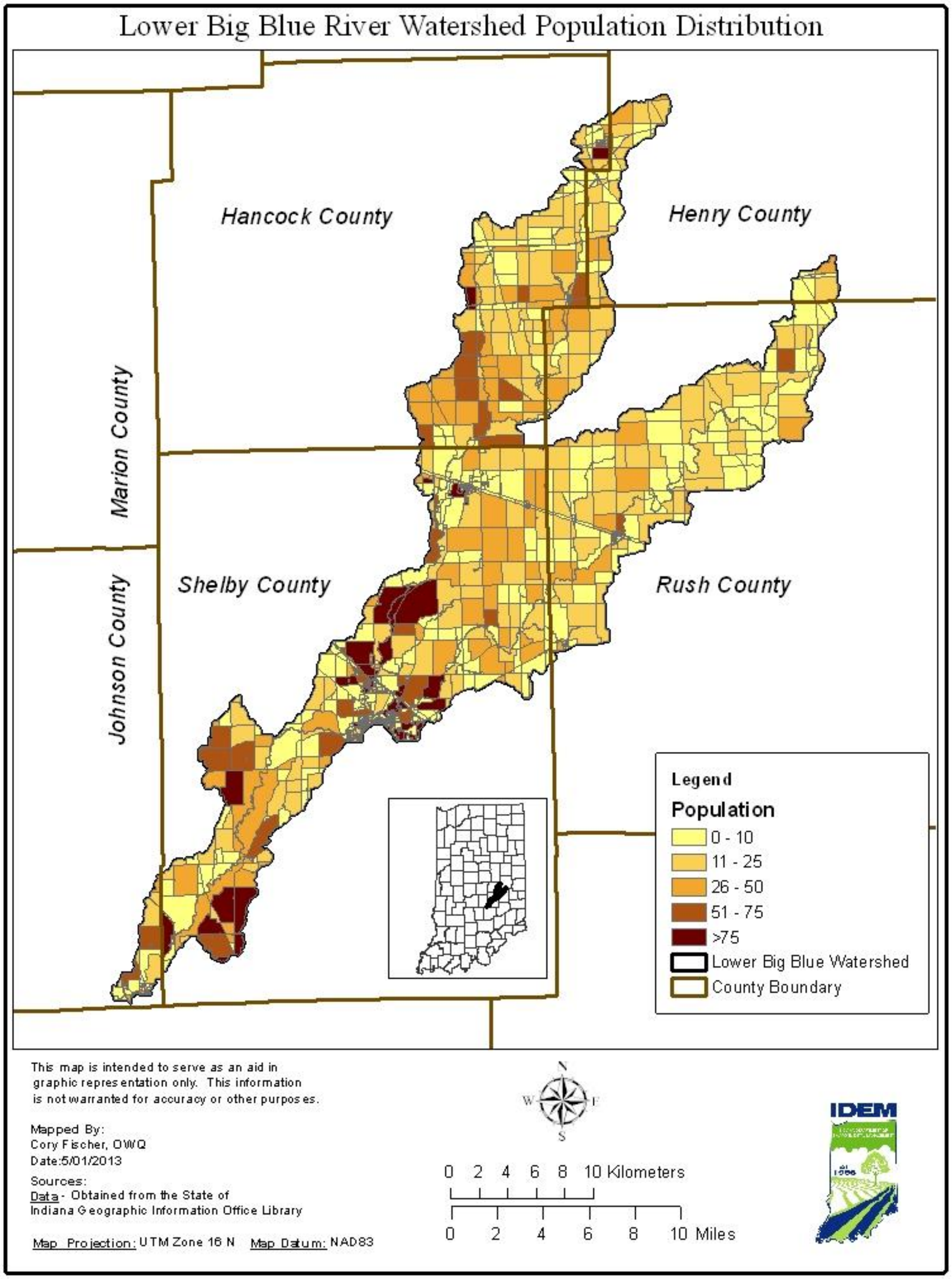


Figure 9. Population Density in the Lower Big Blue River Watershed

3.4 Topography and Geology

Topographic and geologic features of a watershed play a role in defining a watershed's drainage pattern. Information concerning the topography and geology within the Lower Big Blue River watershed is available from the Indiana Geologic Survey (IGS). The Lower Big Blue River watershed originates in Henry County and travels southwest through Hancock, Rush, Shelby, and Johnson Counties, eventually meeting Sugar Creek to form Driftwood River near Edinburgh .The Lower Big Blue River watershed is located in the New Castle Till Plains and Drainage Ways physiographic region which is characterized by a level to gently rolling till-plain, with broad bottomlands and associated terraces and meander scars along major river valleys having an average elevation of 731 feet. Figure 10 shows the topography of the Lower Big Blue River watershed. National Elevation Data (NED) is available from the USGS National Map seamless server (http://seamless.usgs.gov/website/seamless/viewer.htm). This map shows that the elevation is highest (1,070 feet) in Henry County, and gradually decreases to 680 feet in Johnson County. While the topography of the watershed can have an effect on hydrology, it is more likely that soil characteristics will play a greater role in affecting hydrologic processes.

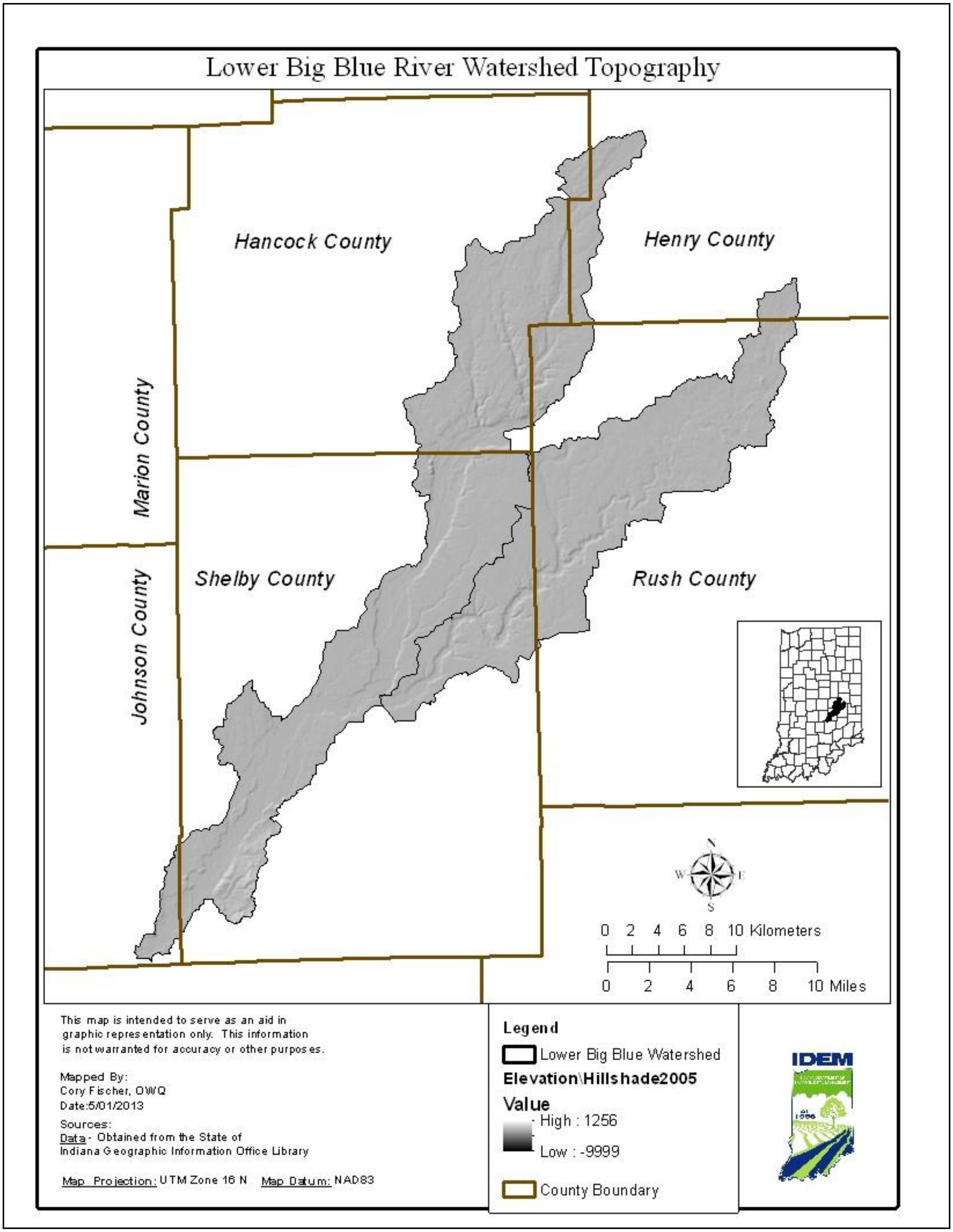


Figure 10. Topography of the Lower Big Blue River Watershed

3.5 Soils

There are different soil characteristics that can affect the health of the watershed. These characteristics include soil drainage, septic tank suitability, soil saturation, and soil erodibility.

3.5.1 Soil Drainage

The hydrologic soil group classification is a means for categorizing soils by similar infiltration and runoff characteristics during periods of prolonged wetting. The NRCS has defined four hydrologic groups for soils, described in Table 8 (NRCS, 2001). Data for the Lower Big Blue River watershed were obtained from the Soil Survey Geographic (SSURGO) database. Downloaded data were summarized based on the major hydrologic and are displayed in Figure 11.

The majority of the watershed is covered by group B soils (57%) followed by group C soils (42%), group A soils (0.1%) and group D soils (0.004%).

Table 8. Hydrologic Soil Groups

Hydrologic Soils Group	Description
A	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

Understanding Table 8: Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. Soil infiltration rates can affect *E. coli* loading within a watershed. During high flows, areas with low soil infiltration capacity can flood and therefore discharge high *E. coli* loads to nearby waterways. In contrast, soils with high infiltration rates can slow the movement of *E. coli* to streams.

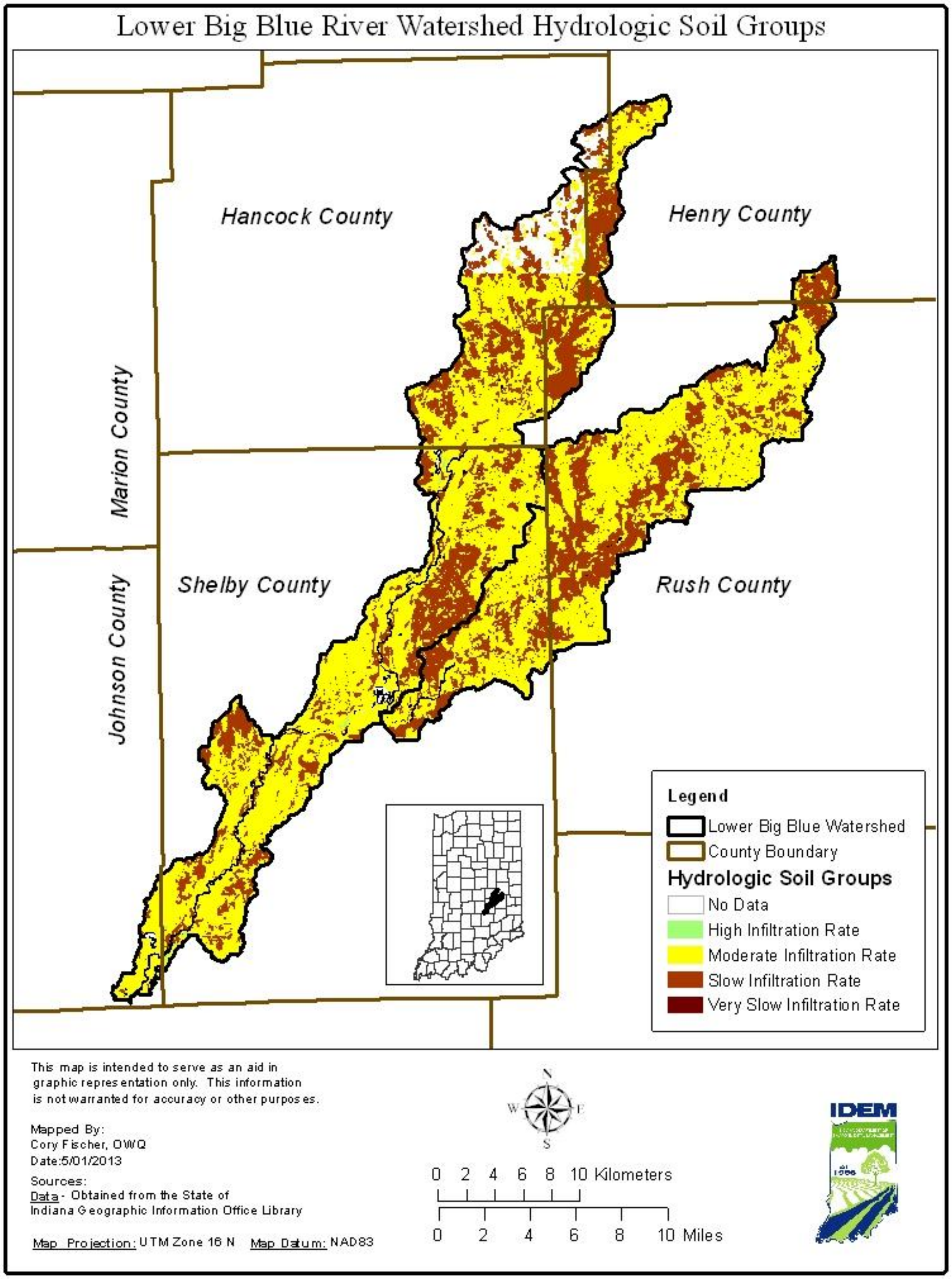


Figure 11. Hydrologic Soil Groups in the Lower Big Blue River Watershed

3.5.2 Septic Tank Suitability

Septic systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. Seasonal high water tables, shallow compact till and coarse soils present limitations for septic systems. While system design can often overcome these limitations (i.e., perimeter drains, mound systems or pressure distribution), sometimes the soil characteristics prove to be unsuitable for any type of traditional septic system.

Heavy clay soils require larger (and therefore more expensive) absorption fields; while sandier, well-drained soils are often suitable for smaller, more affordable gravity-flow trench systems.

The septic system is considered failing when the system exhibits one or more of the following:

1. The system refuses to accept sewage at the rate of design application thereby interfering with the normal use of plumbing fixtures

2. Effluent discharge exceeds the absorptive capacity of the soil, resulting in ponding, seepage, or other discharge of the effluent to the ground surface or to surface waters

3. Effluent is discharged from the system causing contamination of a potable water supply, ground water, or surface water.

Figure 12 shows ratings that indicate the extent to which the soils are suitable for septic systems within the Lower Big Blue River watershed. Only that part of the soil between depths of 24 and 60 inches is evaluated for septic system suitability. The ratings are based on the soil properties that affect absorption of the effluent, construction, maintenance of the system, and public health.

Soils labeled “very limited” indicate that the soil has at least one feature that is unfavorable for septic systems. Approximately 98.77 percent of the Lower Big Blue River watershed is considered “very limited” in terms of soil suitability for septic systems. Approximately 0.12 percent of the Lower Big Blue River watershed is considered “somewhat limited” in terms of soil suitability for septic systems. These limitations generally cannot be overcome without major soil reclamation or expensive installation designs. Approximately 1.11 percent of the soils within the Lower Big Blue River watershed are “not rated,” meaning these soils have not been assigned a rating class because it is not industry standard to install a septic system in these geographic locations. None of the soils in the Lower Big Blue River watershed are designated “not limited,” meaning that the soil type is suitable for septic systems.

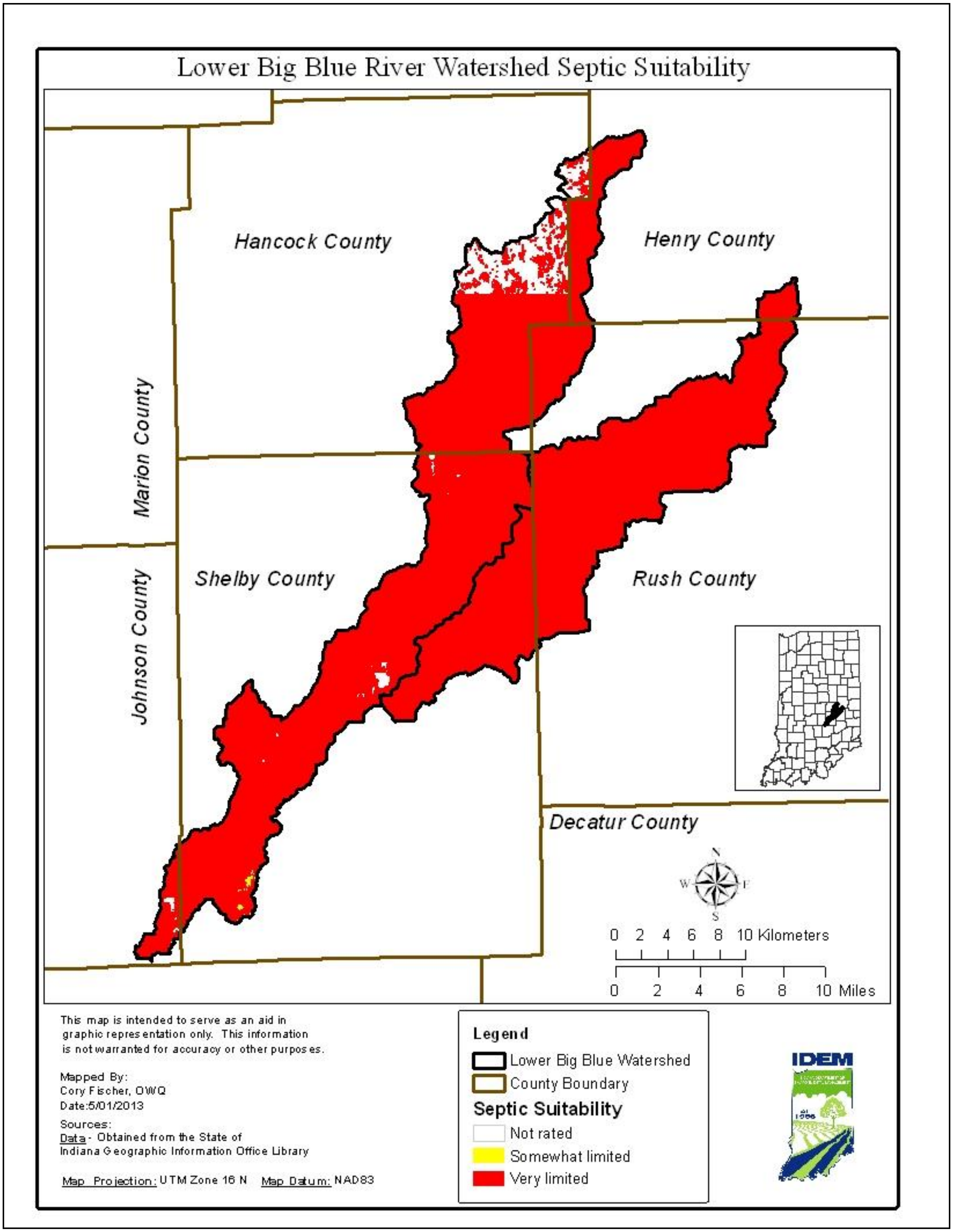


Figure 12. Suitability of Soils for Septic Systems in the Lower Big Blue River Watershed

3.5.3 Hydric Soils and Wetlands

Soils that remain saturated or inundated with water for a sufficient length of time become hydric through a series of chemical, physical, and biological processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. Hydric soils have been identified in the Lower Big Blue River watershed and are important in consideration of wetland restoration activities. Approximately 45,421.51 acres or approximately 25 percent of the Lower Big Blue River watershed area contains soils that are considered hydric, as shown in Table 9. However, a large majority of these soils have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soils, as shown in Figure 13, can be used to consider possible locations of wetland creation or enhancement. There are many components in addition to soil type that must be considered before moving forward with wetland design and creation.

Table 9. Hydric Soils by County in the Lower Big Blue River Watershed

County	Map Symbol	Hydric Soil Type	Acres
Henry	Cy	Cyclone Silty Clay Loam	3,397.85
	Mx	Millgrove Loam	188.24
	Sn	Sloan Silty Clay Loam, Occasionally Flooded	29.00
	Wb	Washtenaw Silt Loam	1.37
	We	Westland Silt Loam	225.73
		Total	**3,842.19**
Hancock	Br	Brookston Silty Clay Loam	3,881.07
	Ko	Kokomo Silty Clay Loam	27.49
	Mr	Milford Silty Clay Loam	12.19
	Ps	Palms Muck	4.01
	Re	Rensselaer Silty Clay Loam	640.69
	So	Sloan Silty Clay Loam	543.81
	We	Westland Clay Loam	375.90
		Total	**5,485.16**
Rush	Cy	Cyclone Silty Clay Loam	32.70
	Pn	Patton Silty Clay Loam	390.25
	So	Sloan Silt Loam, Frequently Flooded	1742.33
	Tr	Treaty Silty Clay Loam	13,883.30
	We	Westland Clay Loam	1551.28
		Total	**17,599.86**
Shelby	Br	Brookston Silty Clay Loam	14,069.11
	Ko	Kokomo Silty Clay Loam	17.31
	Lm	Palms Muck, 0-1 percent slopes, drained	47.85
	Re	Rensselaer Clay Loam	262.18
	Sa	Saranac Silty Clay Loam	517.80
	Se	Sebewa Clay Loam	111.20
	We	Westland and Brookston loams. Overwash	113.00
	Wc	Westland Clay Loam	3,191.94
		Total	**18,330.39**
Johnson	Br	Brookston Silty Clay Loam	10.10
	Sn	Sloan Clay Loam	14.41
	We	Westland Clay Loam	139.40
		Total	**163.91**

Understanding Table 9: In the Lower Big Blue River watershed, areas with hydric soils contain opportunities for wetland restoration activities that could help address water quality impairments.

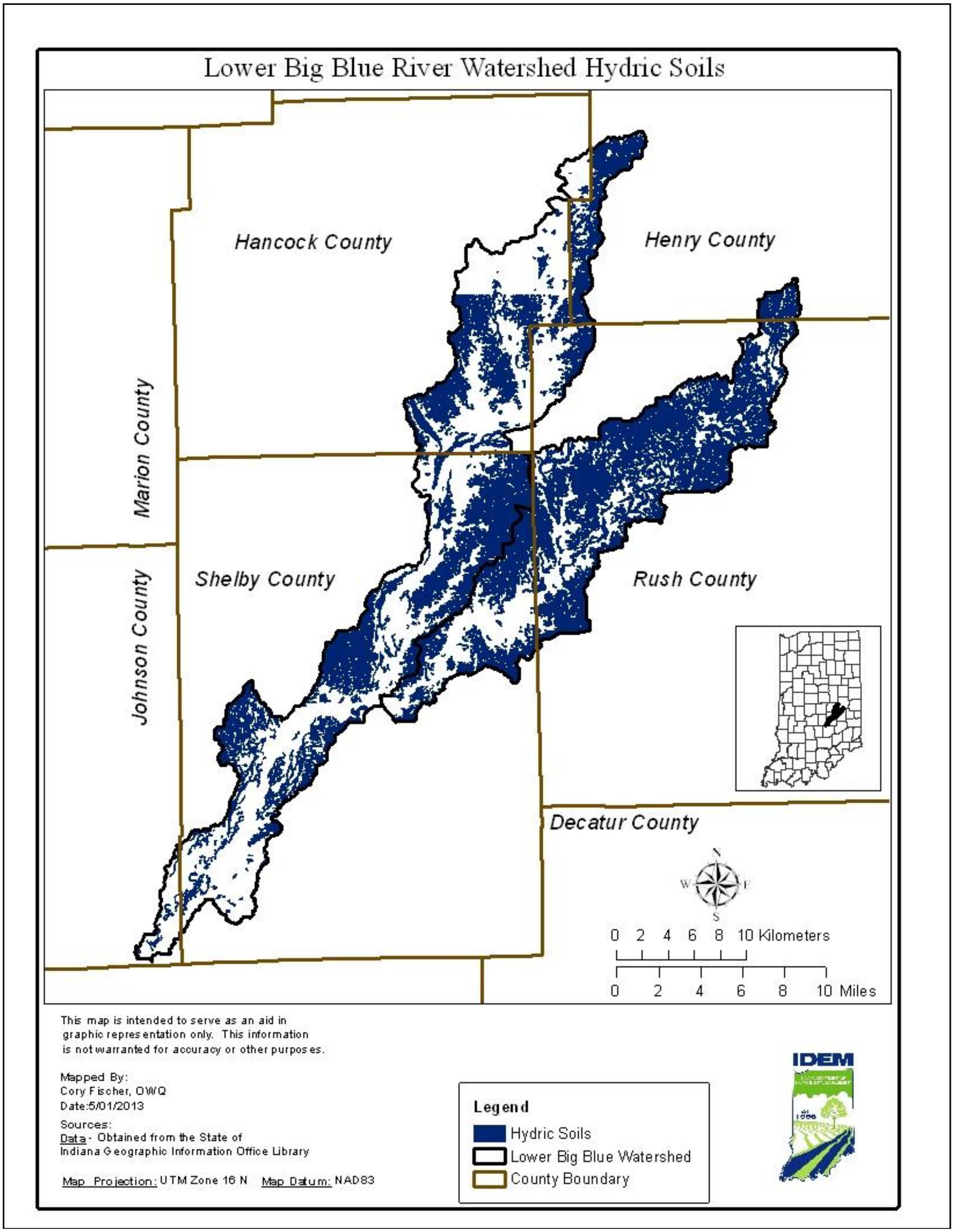


Figure 13. Hydric Soils in the Lower Big Blue River Watershed

[Data on hydric soils by county available from NRCS at http://soils.usda.gov/use/hydric/]
Agencies such as the USGS and U.S. Fish and Wildlife Service (USFWS) estimate that Indiana has lost approximately 85 percent of its original wetlands. (See http://www.in.gov/dnr/fishwild/files/partner.pdf and http://water.usgs.gov/nwsum/WSP2425/state_highlights_summary.html) Currently, the Lower Big Blue River watershed contains approximately 5,603 acres of wetlands or 3.13 percent of the total surface area (USFWS, 2003). Figure 14 shows estimated locations of wetlands as defined by the USFWS's National Wetland Inventory (NWI). Wetland data for Indiana is available from the U.S. Fish and Wildlife Service's NWI at <http://www.fws.gov/wetlands/Data/WebMapServices.html>.
Aerial photograph interpretation techniques were used to compile the NWI. The NWI was not intended to produce maps that show exact wetland boundaries comparable to boundaries derived from ground surveys, and boundaries are generalized in most cases. It should be noted that the estimate of the current extent of wetlands in the Lower Big Blue River watershed from the NWI may not agree with those listed in Section 3.1, which are based upon the MRLCC dataset. Wetland areas act to buffer wide variations in flow conditions that result from storm events. They also allow water to infiltrate slowly thus reducing the risks of contaminated water washed into waterbodies

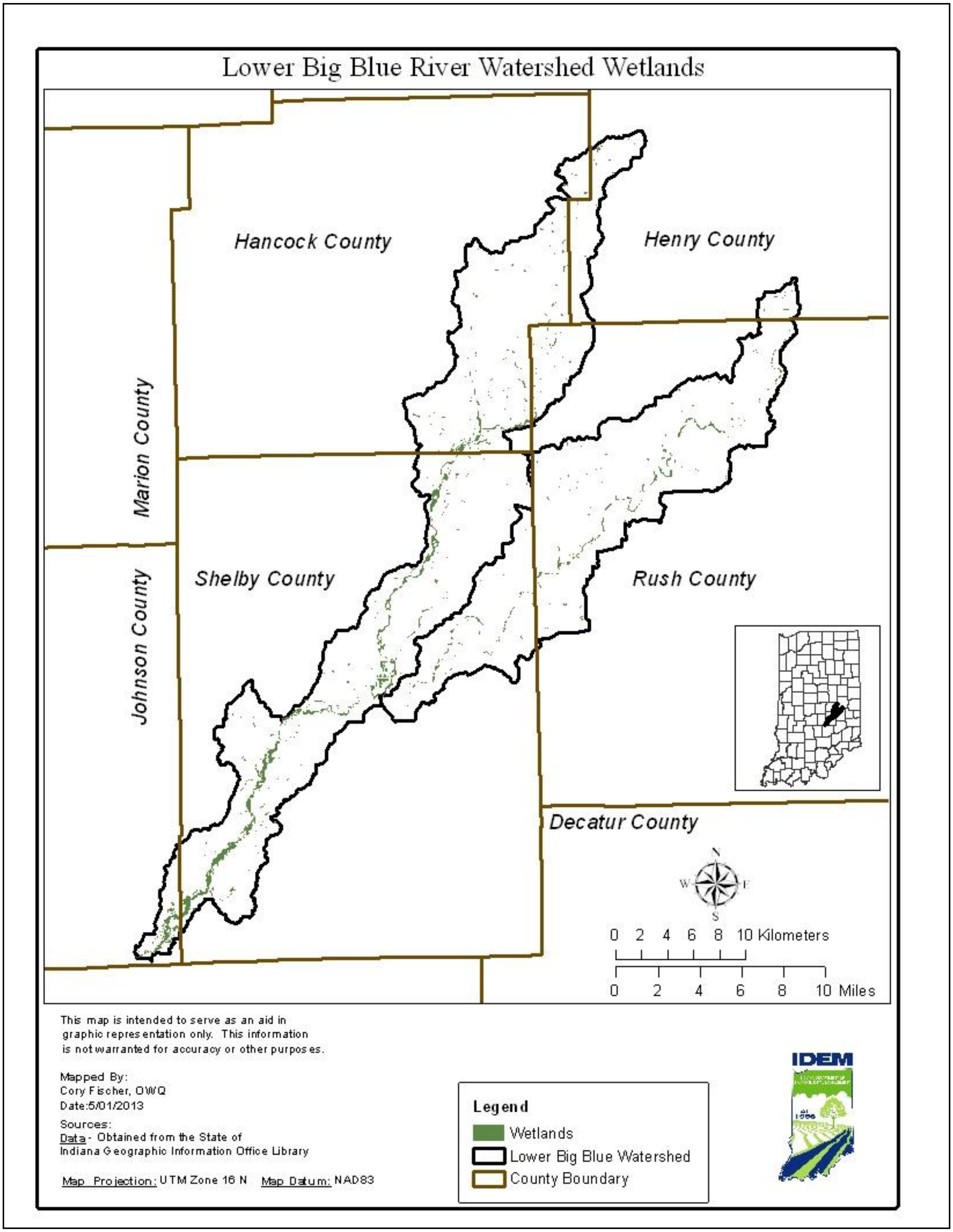


Figure 14. Locations of Wetlands in Lower Big Blue River Watershed

Changes to the natural drainage patterns of a watershed are referred to as hydromodification. Historically, drain tiles have been used throughout Indiana to drain marsh or wetlands and make it either habitable or tillable for agricultural purposes. While tile drainage is understood to be pervasive – estimated at thousands of miles in Indiana – it is extremely challenging to quantify on a watershed basis because these tiles were established by varying authorities including County Courts, County Commissioners, or County Drainage Boards (see http://boonecounty.in.gov/Default.aspx?tabid=167). Records were not kept by private landowners as to the location and quantity of these tiles. Since the landuse in this watershed is predominantly agriculturally based, it is expected that field tile drainage greatly influences conditions in local streams.

3.5.4 Soil Erodibility

Although erosion is a natural process within stream ecosystems, excessive erosion negatively impacts the health of watersheds. Erosion increases sedimentation of the streambeds, which impacts the quality of habitat for fish and other organisms. Erosion also impacts water quality as it increases nutrients and decreases water clarity. As water flows over land and enters the stream as runoff, it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms.

The NRCS maintains a list of highly erodible land (HEL) units for each county based upon the potential of soil units to erode from the land. Highly erodible lands are especially susceptible to the erosional forces of water. The classification for highly erodible lands is based upon an erodibility index for a soil, which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss tolerance (T) value, which is the maximum annual rate of erosion that could occur without causing a decline in long-term productivity. The soil types and acreages in the Lower Big Blue River watershed are listed by county in Table 10. Highly erodible land and potentially highly erodible lands in the Lower Big Blue River watershed are mapped in Figure 15. The data used to create Figure 15 was collected from the NRCS offices of Hancock, Henry, Shelby, Rush, and Johnson Counties. A total of 56,083 acres or 31 percent of the Lower Big Blue River watershed is considered highly erodible or potentially highly erodible. Rainfall within the Lower Big Blue River watershed is moderately heavy with an annual average of 40 inches. This rainfall and climate data specific to the watershed is available from the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/ncdc.html). Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

Table10. HEL/Potential HEL by County in the Lower Big Blue River Watershed

County	Map Symbol	HEL/Potential HEL Soil Types	Acres
Henry	CeB2	Celina silt loam, 1-6 percent slopes	865.86
	CrA	Crosby silt loam, 0-3 percent slopes	3,122.14
	ExC3	Eldean clay loam, 6 to 12 percent slopes	5.24
	LeB2	Losantville silt loam, 2 to 6 percent slopes	74.32
	LeC2	Losantville silt loam, 6 to 12 percent slopes	11.61
	LhC3	Losantville clay loam, 6 to 12 percent slopes	100.33
	MlB2	Miami silt loam, gravelly substratum, 2 to 6 percent slopes	13.09
	MmB2	Miamian silt loam, 2 to 6 percent slopes	938.15
		Total:	**5,130.74**
Hancock	MmB2	Miami silt loam, 2 to 6 percent slopes, eroded	4,517.75
	MmC2	Miami silt loam, 6 to 12 percent slopes, eroded	324.22
	MmD2	Miami silt loam, 12 to 18 percent slopes, eroded	564.34
	MpC3	Miami complex, 6 to 12 percent slopes, severely eroded	1,284.51

	MpD3	Miami complex, 12 to 18 percent slopes, severely eroded	409.83
	OcB2	Ockley silt loam, 2 to 6 percent slopes, eroded	407.34
	OkC2	Ockley complex, 6 to 12 percent slopes, eroded	165.11
		Total:	**7,673.10**
Rush	CeB2	Celina silt loam, 2 to 6 percent slopes, eroded	942.63
	CrA	Crosby silt loam, 0 to 3 percent slopes	19,302.19
	EdB2	Eldean loam, 2 to 6 percent slopes, eroded	384.76
	ElC3	Eldean clay loam, 6 to 12 percent slopes, severely eroded	140.27
	ElD3	Eldean clay loam, 12 to 18 percent slopes, severely eroded	55.56
	MmB2	Miami silt loam, 2 to 6 percent slopes, eroded	19.03
	MpB2	Miamian silt loam, 2 to 6 percent slopes, eroded	6,294.51
	MpC	Miamian silt loam, 6 to 12 percent slopes	58.93
	MpD	Miamian silt loam, 12 to 18 percent slopes	185.82
	MpE	Miamian silt loam, 18 to 35 percent slopes	273.78
	MuC3	Miamian clay loam, 6 to 12 percent slopes, severely eroded	1,280.15
	MuD3	Miamian clay loam, 12 to 18 percent slopes, severely eroded	732.33
	OcB2	Ockley silt loam, 2 to 6 percent slopes, eroded	83.85
		Total:	**29,753.81**
Shelby	CrB	Crosby silt loam, 2 to 4 percent slopes	2,114.29
	CsB	Crosby-Miami silt loams, 0 to 6 percent slopes	947.36
	FoC2	Fox loam, 6 to 12 percent slopes, eroded	81.76
	FoD2	Fox loam, 12 to 18 percent slopes, eroded	75.59
	FxB3	Fox clay loam, 2 to 6 percent slopes, severely eroded	64.45
	FxC3	Fox clay loam, 6 to 12 percent slopes, severely eroded	340.31
	Gp	Gravel pits	346.05
	HeE	Hennepin loam, 18 to 25 percent slopes	634.18
	HeF	Hennepin loam, 25 to 50 percent slopes	757.89
	MaB2	Martinsville loam, 2 to 6 percent sloes, eroded	198.69
	MlB2	Miami silt loam, 2 to 6 percent slopes, eroded	2,816.54
	MlC2	Miami silt loam, 6 to 12 percent slopes, eroded	563.95
	MlD2	Miami silt loam, 12 to 18 percent sloes, eroded	204.07
	MmC3	Miami clay loam, 6 to 12 percent slopes, severely eroded	2,161.51
	MmD3	Miami clay loam, 12 to 18 percent slopes, severely eroded	877.83
	MrB	Miami-Crosby silt loams, 0 to 6 percent slopes	449.74
	NeD2	Negley loam, 12 to 18 percent slopes, eroded	53.29
	NeE	Negley loam, 18 to 25 percent slopes	108.27
	PaC2	Parke silt loam, 6 to 12 percent slopes, eroded	129.01
	PrC	Princeton fine sandy loam, 6 to 12 percent slopes	104.83
	RoE	Rodman gravelly loam, 18 to 35 percent slopes	100.37
		Total:	**13,129.98**
Johnson	CsB2	Crosby-Miami silt loams, 2 to 4 percent slopes, eroded	11.36
	FoB2	Fox loam, 2 to 6 percent slopes, eroded	98.90
	FxC2	Fox complex, 6 to 12 percent slopes, eroded	118.14
	HeF	Hennepin loam, 25 to 50 percent slopes	5.22
	MnB2	Miami silt loam, 2 to 6 percent slopes, eroded	101.87
	MnC2	Miami silt loam, 6 to 12 percent slopes, eroded	6.25
	MnD2	Miami silt loam, 12 to 18 percent slopes, eroded	4.52

	MnE	Miami silt loam, 18 to 25 percent slopes	2.99
	MtC3	Miami clay loam, 6 to 12 percent slopes, severely eroded	25.54
	MtD3	Miami clay loam, 12 to 18 percent slopes, severely eroded	19.02
	OcB2	Ockley loam, 2 to 6 percent slopes, eroded	2.39
		Total:	**396.20**

Understanding Table 10: In the Lower Big Blue River watershed, areas with HEL can contribute to water quality impairments associated with excessive erosion, and therefore contain opportunities for restoration to decrease erosion.

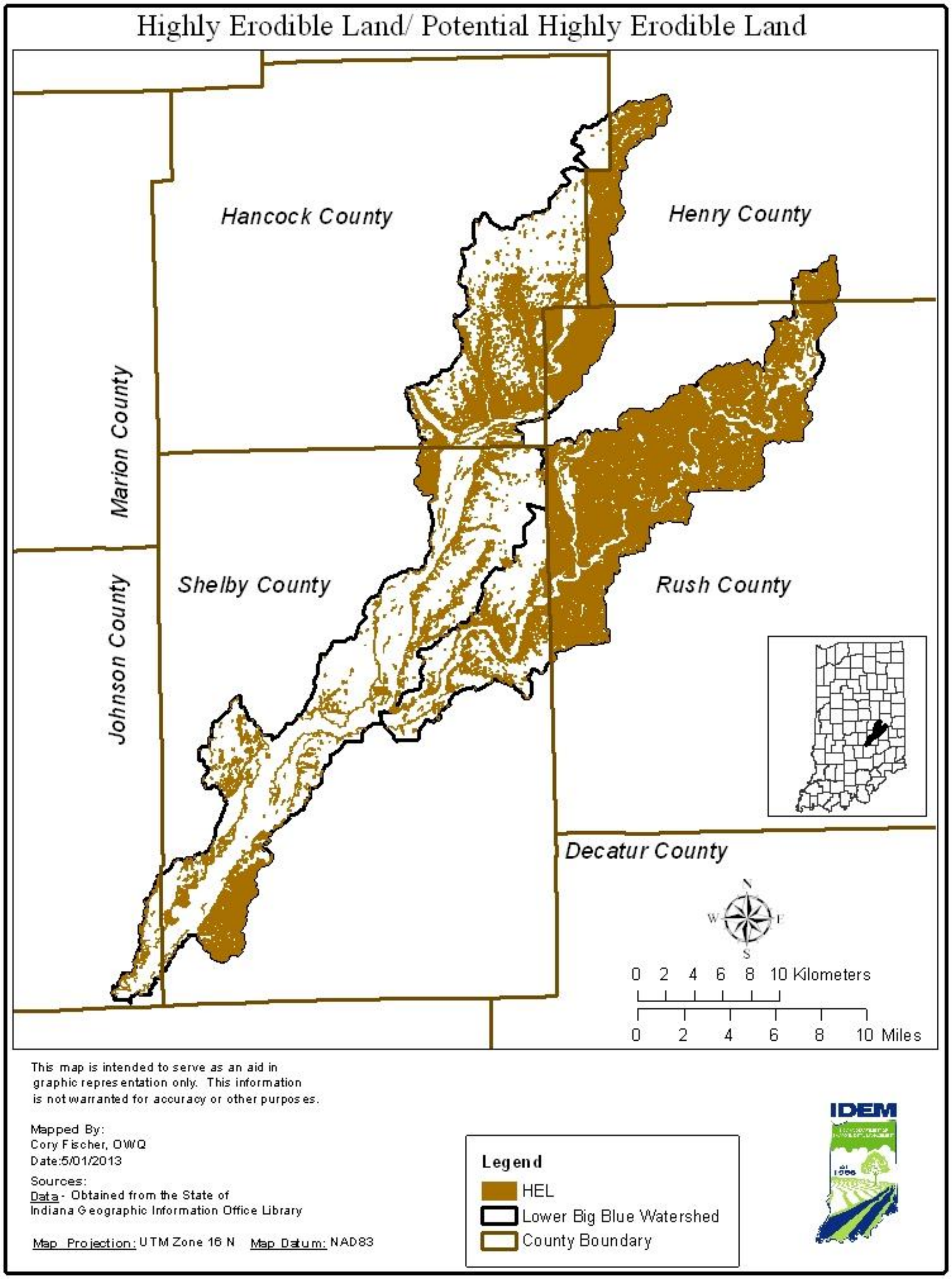


Figure 15. HEL/Potential HEL in the Lower Big Blue River Watershed

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropland through annual county tillage transects. Data collected (found at http://www.in.gov/isda/2383.htm) help determine adoption of conservation practices and estimate the average annual soil loss from Indiana's agricultural lands. The latest figures for the counties in the Lower Big Blue River watershed are shown in Table 11. Tillage practices captured in ISDA's tillage transect include No-Till, Mulch Till, and conventional tillage practices. ISDA defines No-Till as any direct seeding system including site preparation, with minimal soil disturbance. Mulch Till is any tillage system leaving greater than 30 percent residue cover after planting, excluding no-till. Reduced tillage is any tillage system leaving 16 percent to 30 percent residue cover after planting. Conventional tillage is any tillage system leaving less than 30 percent residue cover after planting.

Table 11. Tillage Transect Data for 2013 by County in the Lower Big Blue River Watershed

County	Tillage Practice 2013							
	No Till		Mulch Till		Reduced Till		Conventional Till	
	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Henry	56,900 ac. 70%	13,400 ac. 16%	17,900 ac. 22%	19,200 ac. 23%	4,100 ac. 5%	31,700 ac. 38%	2,400 ac. 3%	19,200 ac. 23%
Hancock	43,200 ac. 66%	15,900 ac. 23%	19,000 ac. 29%	11,000 ac. 16%	3,300 ac. 5%	40,000 ac. 58%	0 ac. 0%	2,100 ac. 3%
Rush	64,900 ac. 63%	20,900 ac. 19%	26,800 ac. 26%	44,000 ac. 40%	10,300 ac. 10%	38,500 ac. 35%	1,000 ac. 1%	6,600 ac. 6%
Shelby	68,400 ac. 75%	34,500 ac. 33%	11,900 ac. 13%	24,000 ac. 23%	10,900 ac. 12%	35,500 ac. 34%	900 ac. 1%	11,500 ac. 11%
Johnson	12,200 ac. 29%	4,400 ac. 8%	13,900 ac. 33%	3,900 ac. 7%	10,500 ac. 25%	14,400 ac. 26%	5,500 ac. 13%	32,700 ac. 59%

Understanding Table 11: According to Table 11, no-till soybean is the most predominant conservation tillage practice in the counties in the Lower Big Blue River watershed. The use of no-till is greatest in Shelby County. This county comprises approximately 45 percent of the entire Lower Big Blue River watershed.

3.6 Climate and Precipitation

Climate varies in Indiana depending on latitude, topography, soil types, and lakes. Information on Indiana's climate is available through sources including the Indiana State Climate Office at Purdue University (http://climate.agry.purdue.edu/climate/narrative.asp).

Climate data from Station 127999 Shelbyville Sewage Plant located in Shelbyville were used for climate analysis of the Lower Big Blue River watershed. Monthly data from 1992 - 2013 were available at the time of analysis. In general, the climate of the region is warm, humid summers and cold winters. From 1992 to 2013, the average winter temperature in Shelbyville was 30°F and the average summer temperature was 85°F. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 182 days.

Examination of precipitation patterns is also a key component of watershed characterization because of the impact of runoff on water quality. From 1992 to 2013, the annual average precipitation in Shelbyville at Station 127999 was approximately 40 inches, including approximately 14 inches of snowfall. More detailed discussions on precipitation data during sampling periods are presented in Section 6.0.

Rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of storm water on the Lower Big Blue River watershed. Using data from station

127999 during 1992 to 2013, 53 percent of the measureable precipitation events were very low intensity (i.e., less than 0.2 inches), while 8.22 percent of the measurable precipitation events were greater than one inch.

Knowing when precipitation events occur helps in the linkage analysis (Section 7.0), which correlates flow conditions to pollutant concentrations and loads. Data indicate that the wet weather season in the Lower Big Blue River watershed occurs between the months of March – May.

3.7 Summary

The information presented in Section 3.0 helps to provide a better understanding of the conditions and characteristics in the Lower Big Blue River watershed that, when coupled with the sources presented in Section 4, affect both water quality and water quantity. In summary, the predominant land use in the Lower Big Blue River watershed consists of agricultural and serves as an indicator as to the type of sources that are likely to contribute to water quality impairments. Human population, which is greatest in Shelby County in the Lower Big Blue River watershed, indicates where more infrastructure- related pressures on water quality might exist such as increased impervious surfaces and altered hydrology. The subsections on topography and geology, as well as soils and wetlands, provide information on the natural features that affect hydrology in the Lower Big Blue River watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the Lower Big Blue River watershed. Lastly, the subsection on climate and precipitation provides information on water quantity and the factors that influence flow, which ultimately affects the influence of storm water on the watershed. Collectively, this information plays an important role in understanding the sources that contribute to water quality impairment during TMDL development and crafting the linkage analysis that connects the observed water quality impairment to what has caused that impairment.

4.0 SOURCE ASSESSMENT

This section presents information concerning IDEM's stream segmentation process as it applies to the Lower Big Blue River watershed in order to present a source assessment specific to the watershed as well as summaries of significant sources of *E. coli* for each subwatershed within the Lower Big Blue River watershed.

4.1 Understanding Subwatersheds and Assessment Units

As briefly discussed in Section 2.3, the Lower Big Blue River watershed contains twelve 12-digit HUC subwatersheds. Examining subwatersheds enables a closer look at key factors that affect water quality. The subwatersheds include (Figure5):

- Headwaters Little Blue River:05120204201
- Beaver Meadow Creek: 05120204202
- Gilson Creek- Little Blue River: 05120204203
- Manilla Branch- Little Blue River: 05120204204
- Town of Rays Crossing- Little Blue River: 05120204205
- Headwaters Six Mile Creek: 051202040801
- Anthony Creek- Six Mile Creek: 051202040802
- Nameless Creek: 051202040803
- Prairie Branch- Big Blue River: 051202040804
- Foreman Branch- Big Blue River: 051202040805
- DePrez Ditch- Big Blue River: 051202040806
- Shaw Ditch- Big Blue River: 051202040807

Within each 12-digit HUC subwatershed, IDEM has identified several AUIDs, which represent individual stream segments. Through the process of segmenting subwatersheds into AUIDs, IDEM identifies streams reaches and stream networks that are representative for the purposes of assessment. In practice, this process leads to grouping tributary streams into smaller catchment basins of similar hydrology, land use, and other characteristics such that all tributaries within the catchment basin can be expected to have similar potential water quality impacts. Catchment basins, as defined by the aforementioned factors, are typically very small, which significantly reduces the variability in the water quality expected from one stream or stream reach to another. Given this, all tributaries within a catchment basin are assigned a single AUID. Grouping tributary systems into smaller catchment basins also allows for better characterization of the larger watershed and more localized recommendations for implementation activities. Variability within the larger watershed will be accounted for by the differing AUIDs assigned to the different catchment basins.

Table 12 contains the AUIDs and the associated drainage area in the subwatersheds of the Lower Big Blue River watershed. Subsequent sections of the TMDL report organize information by subwatershed (if applicable) and AUID.

Table 12. Assessment Units in Lower Big Blue River Watershed

Name of Subwatershed	12-digit HUC	Current AUID 2012	Length (mi)	Drainage area (sq. miles)	Percent of Total Drainage area
Little Blue River	Headwaters Little Blue River	INW0421_01	19.52	17.32	2.97
	Beaver Meadow Creek	INW0422_01	14.27	16.56	2.84
		INW0422_T1001	5.45	5.99	1.03
	Gilson Creek- Little Blue River	INW0423_01	32.75	49.66	8.51
		INW0423_T1001	4.61	3.72	0.64
		INW0423_T1001A	0.71	0.182	0.03
	Manilla Branch- Little Blue River	INW0424_01	10.42	62.22	10.67
		INW0424_T1001	2.61	4.95	0.85
		INW0424_T1002	5.91	3.81	0.65
	Town of Rays Crossing- Little Blue River	INW0425_01	21.56	88.31	15.14
		INW0425_01A	0.27	0.07	0.01
		INW0425_T1001	3.29	3.85	0.66
		INW0425_T1002	3.25	0.53	0.09
Big Blue River	Headwaters Six Mile Creek	INW0481_01	0.05	16.90	2.90
		INW0481_T1001	15.05	3.28	0.56
	Anthony Creek- Six Mile Creek	INW0482_01	4.60	45.56	7.81
		INW0482_01A	20.32	0.91	0.16
		INW0482_T1001	1.13	8.30	1.42
		INW0482_T1002	7.98	1.31	0.22
	Nameless Creek	INW0483_01	8.61	16.43	2.82
	Prairie Branch- Big Blue River	INW0484_01	17.80	269.42	46.19
		INW0484_T1001	4.09	2.46	0.42
		INW0484_T1002	2.97	4.44	0.76
		INW0484_T1003	5.37	6.51	1.12
	Foreman Branch- Big Blue River	INW0485_01	9.05	290.33	49.77
		INW0485_02	6.22	303.52	52.03
		INW0485_03	14.14	314.66	53.94
		INW0485_T1001	2.22	8.67	1.49
		INW0485_T1001A	12.77	9.43	1.62
		INW0485_T1002	2.47	433.34	74.29
	DePrez Ditch- Big Blue River	INW0486_01	12.82	547.43	93.85
		INW0486_02	7.65	7.50	1.29
		INW0486_T1001	9.89	2.81	0.48
		INW0486_T1002	10.04	6.55	1.12
		INW0486_T1003	2.67	583.32	100.00
	Shaw Ditch- Big Blue River	INW0487_01	10.36	7.43	1.27
		INW0487_T1001	26.68	1.133	0.19
		INW0487_T1002	8.41	3.46	0.59

Understanding Table 12: Land area helps IDEM to define the pollutant load reductions needed for each AU in each 12-digit HUC subwatershed that comprises the Lower Big Blue River watershed. Information in each column is as follows:

- *Column 1: Name of Subwatershed.* Lists the name of the 10-digit subwatersheds.
- *Column 2: 12-digit HUC.* Identifies the 12-digit subwatershed.
- *Column 3: Current AUID.* Provides the updated AUIDs associated with each subwatershed.
- *Column 4: Length of assessment unit in miles*
- *Column 5: Drainage Area.* Quantifies the area the specific AUID drains.
- *Column 6: Percent of Total Drainage Area.* Indicates the percent of the total drainage area, providing a relative understanding of the proportion of the AUID drainage area in the overall Lower Big Blue River watershed.

IDEM bases percent load reductions needed on the drainage area for each AUID in the 12-digit HUC subwatersheds. The information contained in this table is the foundation for the technical calculations found in Sections 5, 6, and 7 of this report. This table will help watershed stakeholders look at the smaller segments within the Lower Big Blue River watershed and understand the smaller areas contributing to the impaired waterbody, helping to quantify the geographic scale that influences source characterization and areas for implementation.

4.2 Source Assessment by Subwatershed

This section summarizes the available information on significant point and nonpoint sources of *E. coli* in the twelve subwatersheds of the Lower Big Blue River watershed.

The term "point source" refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a waterbody. It also includes vessels or other floating craft from which pollutants are or may be discharged. By law, the term "point source" also includes: concentrated animal feeding operations (CAFO)(which are places where animals are confined and fed); storm water runoff from Municipal Separate Storm Sewer Systems (MS4s); and illicitly connected "straight pipe" discharges of household waste. Permitted point sources are regulated through the NPDES program.

Nonpoint sources include all other categories not classified as point sources. In urban areas, nonpoint sources can include leaking or failing septic systems, pet waste, storm water runoff (outside of MS4 communities), and other sources. In rural areas, nonpoint sources can include runoff from cropland, pastures and animal feeding operations (Confined Feeding Operations CFO) and smaller animal operations) and inputs from streambank erosion, and wildlife.

4.2.1 Subwatershed Summary: Headwaters Little Blue River

This section of the report presents the available information on the sources of *E. coli* in the Headwaters Little Blue River subwatershed.

The Headwaters Little Blue River subwatershed is located in northeast portion of the Lower Big Blue River Watershed, covering nearly 17 square miles (Figure 16). The Headwaters Little Blue River drains portions of Henry and Rush Counties. Land use in the Headwaters Little Blue River is primarily Agriculture (87%) as shown in Table 13.

Table 13. Land Use in the Headwaters Little Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	38.25	0.06	0.35
Developed, Open Space	633.38	0.99	5.71
Developed, Low Intensity	70.05	0.11	0.63
Developed, Medium Intensity	7.12	0.01	0.06
Developed, High Intensity	1.11	0.00	0.02
Forested Land	294.90	0.46	2.66
Shrub/Scrub	89.85	0.14	0.81
Pasture/Hay	329.81	0.52	2.97
Agriculture	9,611.68	15.02	86.66
Wetlands	12.68	0.02	0.11
TOTAL	11,088.83	17.33	100

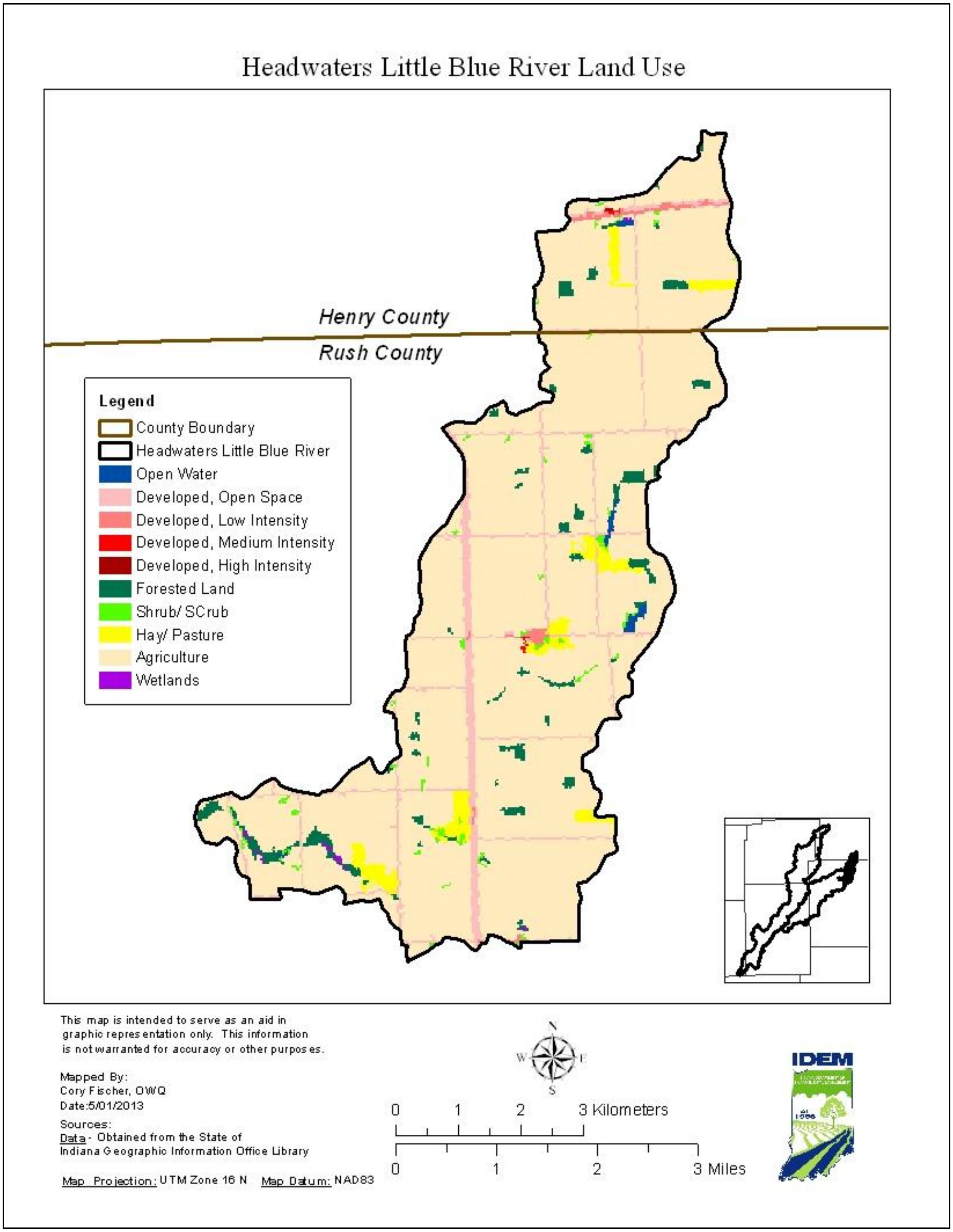


Figure 16. Land Use in the Headwaters Little Blue River Subwatershed

4.2.1.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Headwaters Little Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected “Straight Pipe” Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as “straight pipe” discharges). For more information regarding local straight pipe dischargers contact the county health department.

4.2.1.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Headwaters Little Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 87 percent of the land in the Headwaters Little Blue River subwatershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Headwaters Little Blue River Subwatershed is shown in Table 14 and Figure 17.

Table 14. 2012 Cropland in the Headwaters Little Blue River Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	4,628.26	7.23	52.03
Soybean	4,191.48	6.55	47.12
Winter Wheat	44.48	0.07	0.50
Double Crop Winter Wheat/ Soybeans	32.91	0.05	0.37
TOTAL	**8,897.13**	**13.90**	**100**

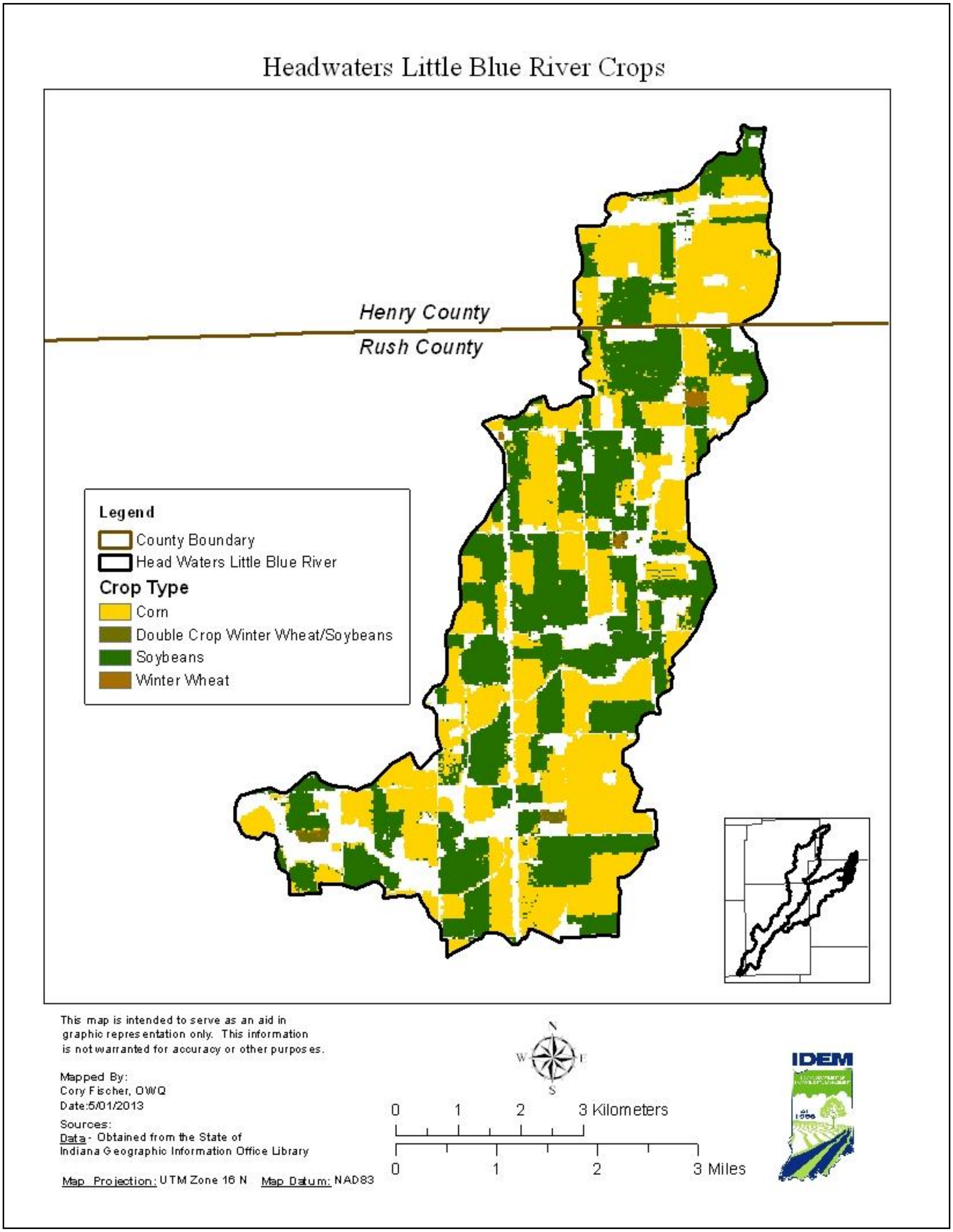


Figure 17. 2012 Cropland in the Headwaters Little Blue River Subwatershed

Pastures and Livestock Operations

In the Headwaters Little Blue River subwatershed, 3 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are a potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 16,145 animal units in the Headwaters Little Blue River subwatershed and the animal unit density is 932 animal units per square mile as shown in Table 15.

Table 15. Animal Unit Density in the Headwaters Little Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
17.32	Hogs and Pigs	26,237	2.5	10,495	932
	Cattle and Calves	4,045	1	4,045	
	Sheep and Lambs	385	10	39	
	Horses and Ponies	783	0.5	1,566	
			TOTAL	16,145	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of Total Suspended Solids (TSS), total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There is one CFO in the Headwaters Little Blue River Subwatershed as shown in Table 16 and Figure 18.

Table 16. CFOs in the Headwaters Little Blue River Subwatershed

CFO Permit ID	Operation Name	County	Animal Type and Units
6435	J&J Livestock LLC	Rush	8000 Finishers

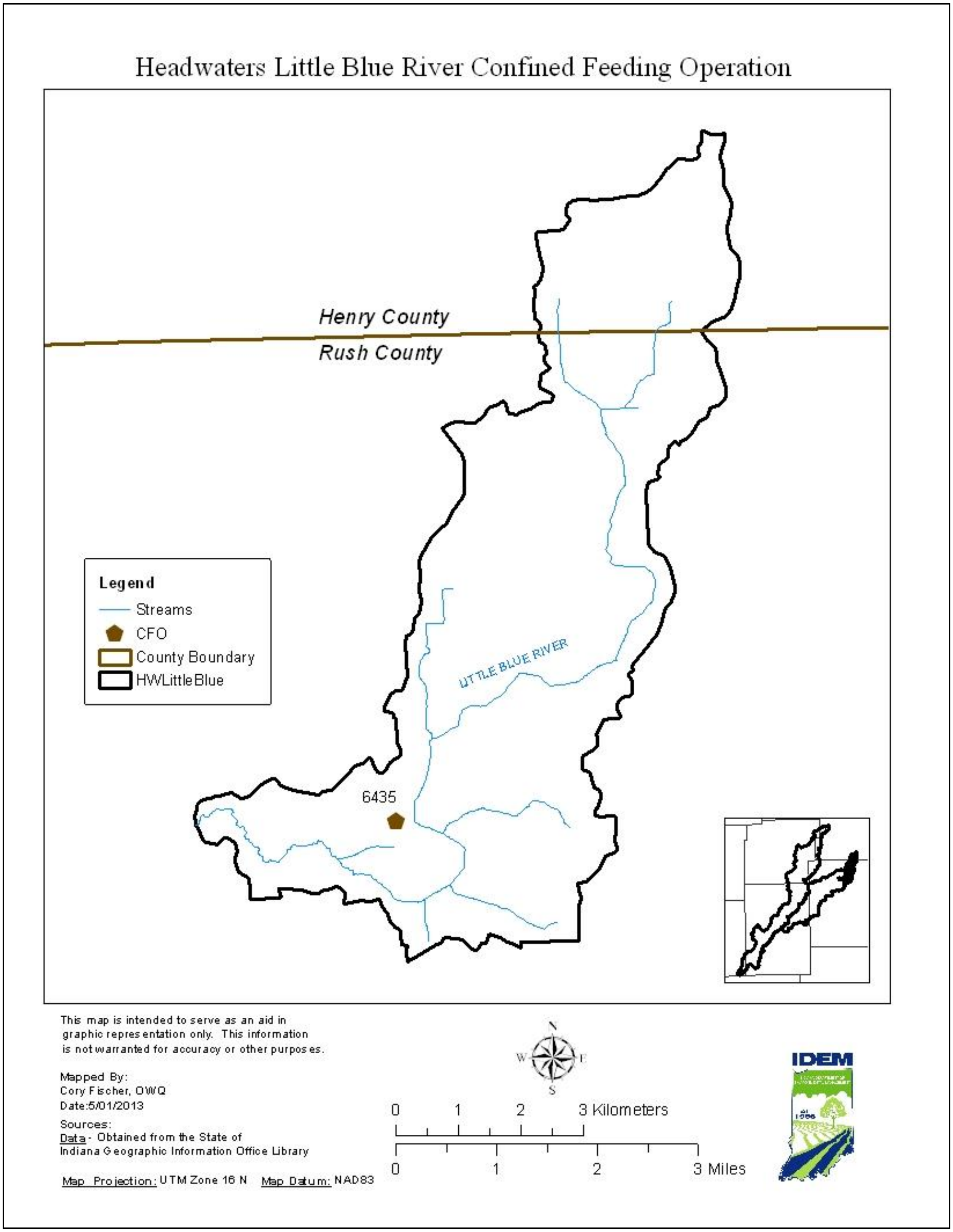


Figure 18. Confined Feeding Operations in the Headwaters Little Blue River Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and businesses and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Headwaters Little Blue River subwatershed is shown in Table 17, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 17. Rural Population Density in the Headwaters Little Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Henry	2.74	134	0	134	
Rush	14.58	508	0	508	37.07
TOTAL	17.32	642	0	642	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Headwaters Little Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Headwaters Little Blue River watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Headwaters Little Blue River subwatershed is dominated by agriculture. Potential sources of impairments include agricultural nonpoint source, failing septic systems, wildlife, one CAFO, and unregulated storm water. These characteristics are likely to affect the amount of *E. coli* loading found in the Headwaters Little Blue River subwatershed.

4.2.2 Subwatershed Summary: Beaver Meadow Creek

This section of the report presents the available information on the sources of *E. coli* in the Beaver Meadow Creek subwatershed.

The Beaver Meadow Creek subwatershed is located in the northeast portion of the Lower Big Blue River, covering nearly 16 square miles (Figure 19). The Beaver Meadow Creek drains portions of Rush and Shelby Counties. Land use in the Beaver Meadow Creek is primarily agriculture (89%) as shown in Table 18.

Table 18. Land Use in the Beaver Meadow Creek Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	3.11	0.00	0.04
Developed, Open Space	554.88	0.87	5.29
Developed, Low Intensity	16.01	0.03	0.15
Developed, Medium Intensity	NA	NA	NA
Developed, High Intensity	NA	NA	NA
Forested Land	153.45	0.24	1.46
Shrub/Scrub	92.07	0.14	0.88
Pasture/Hay	236.18	0.37	2.25
Agriculture	9,435.55	14.74	89.91
Wetlands	2.67	0.00	0.03
TOTAL	10,493.92	16.40	100

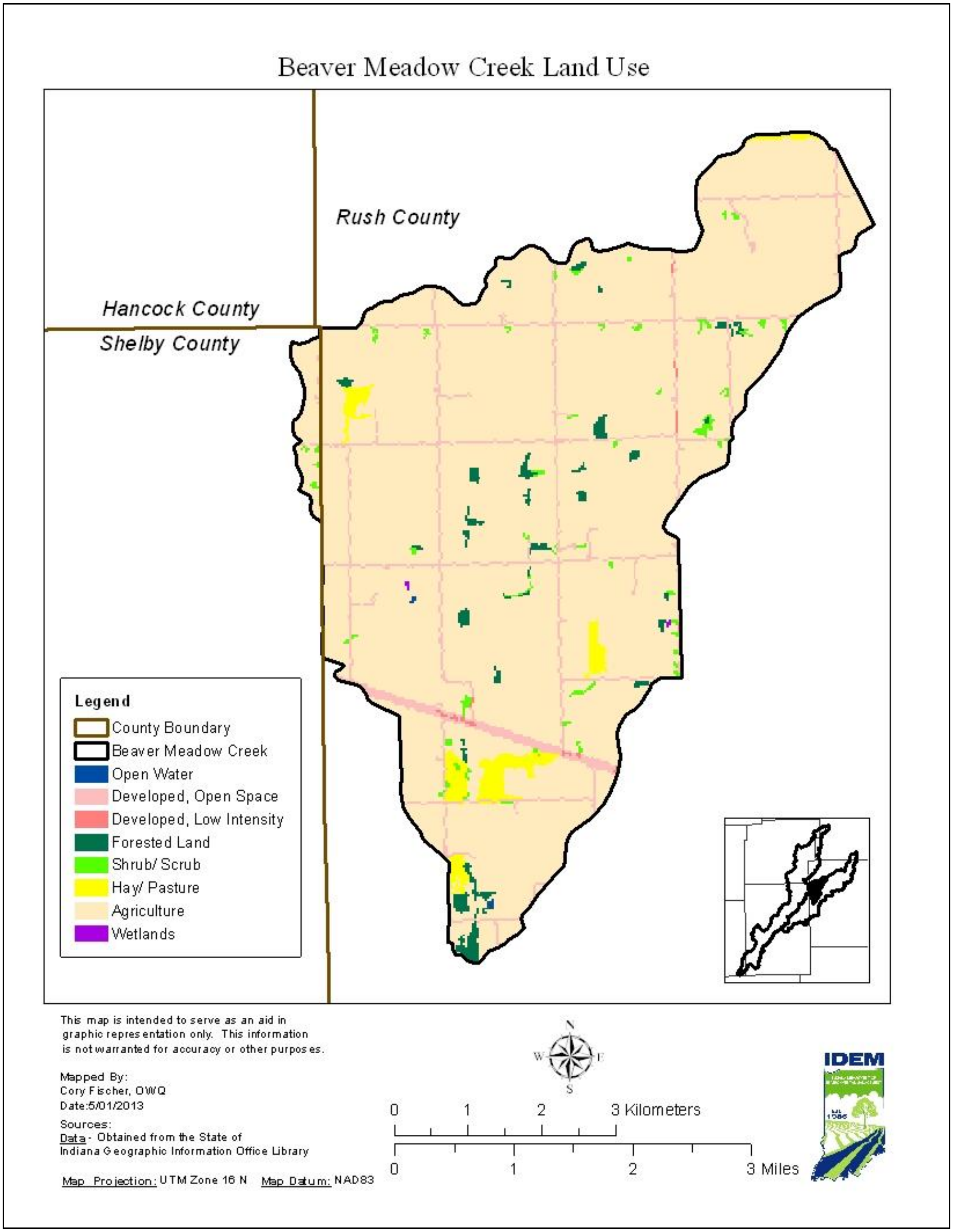


Figure 19. Land Use in the Beaver Meadow Creek Subwatershed

4.2.2.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Beaver Meadow Creek subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Beaver Meadow Creek subwatershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.2.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Beaver Meadow Creek subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 89 percent of the land in the Beaver Meadow Creek subwatershed is classified as row crops. Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Beaver Meadow Creek Subwatershed is shown in Table 19 and Figure 20.

Table 19. 2012 Cropland in the Beaver Meadow Creek Subwatershed

2012 Cropland	Area		Percent
	Acres	**Square Miles**	
Corn	4,515.73	7.06	50.11
Soybean	4,245.74	6.63	47.12
Winter Wheat	128.54	0.20	1.43
Double Crop Winter Wheat/ Soybeans	124.10	0.19	1.38
TOTAL	**9,014.11**	**14.08**	**100**

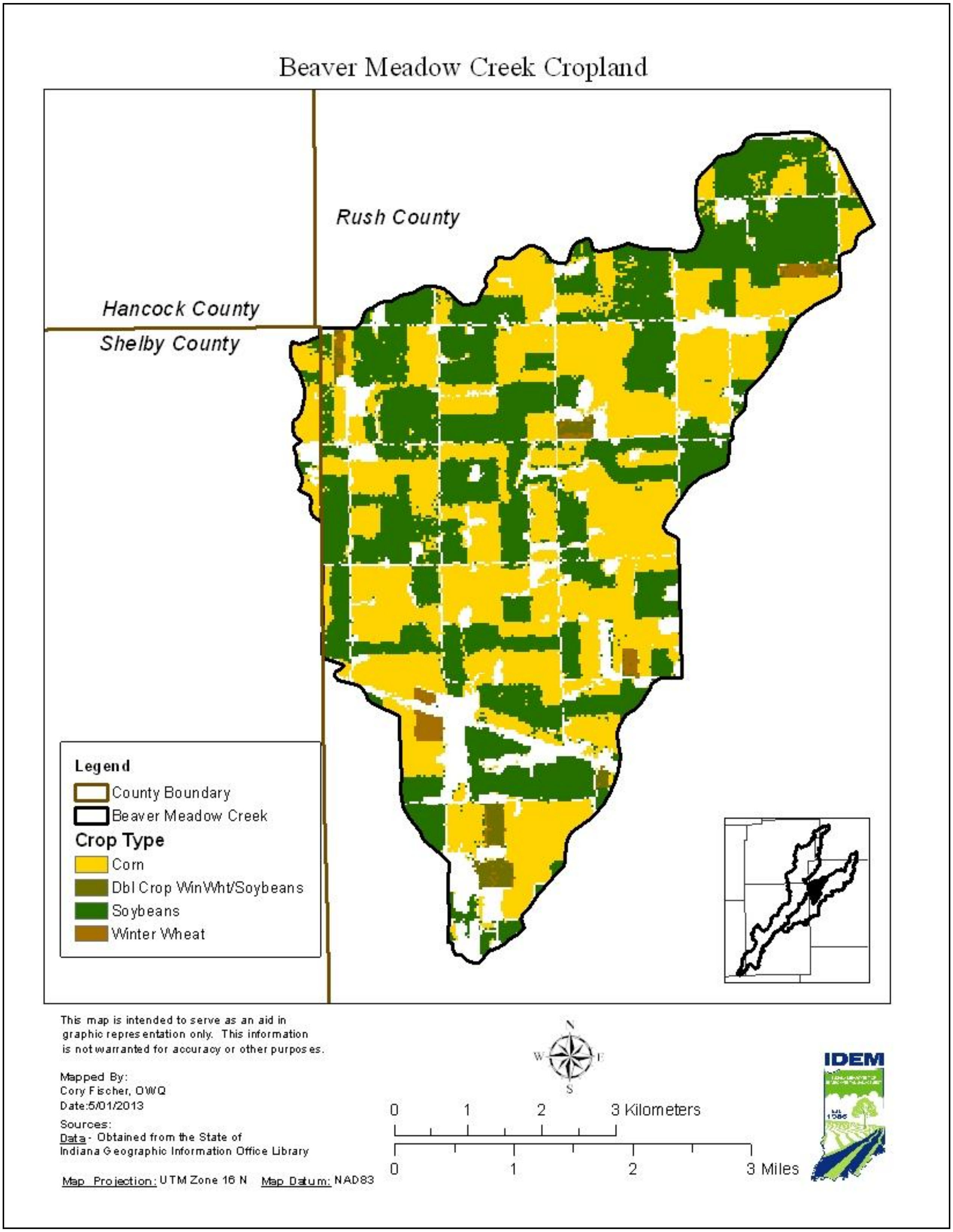


Figure 20. 2012 Cropland in the Beaver Meadow Creek Subwatershed

Pastures and Livestock Operations

In the Beaver Meadow Creek subwatershed, approximately 2 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are a potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 13,383 animal units in the Beaver Meadow Creek subwatershed and the animal unit density is 817 animal units per square mile as shown in Table 20.

Table 20. Animal Unit Density in the Beaver Meadow Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
16.39	Hogs and Pigs	26,170	2.5	10,468	817
	Cattle and Calves	2,298	1	2,298	
	Sheep and Lambs	229	10	23	
	Horses and Ponies	297	0.5	595	
			TOTAL	13,383	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There are two CFOs in the Beaver Meadow Creek subwatershed as shown in Table 21 and Figure 21

Table 21. CFOs in the Beaver Meadow Creek Subwatershed

CFO Permit ID	Operation Name	County	Animal Type and Units
184	David Vanosdol	Rush	1960 Finishers
2950	Ronald Sullivan	Rush	2000 Finishers

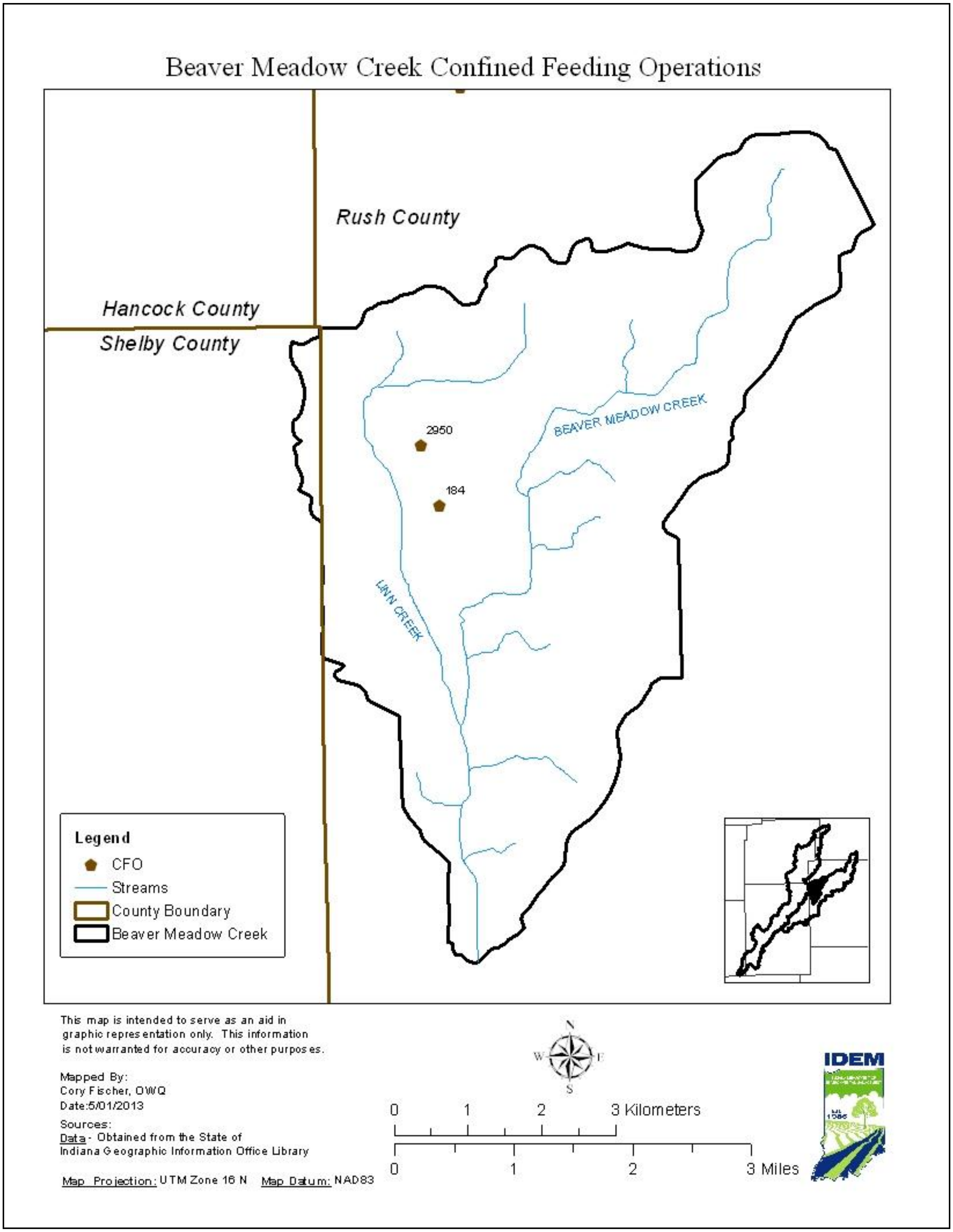


Figure 21. CFOs in the Beaver Meadow Creek Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Beaver Meadow Creek subwatershed is shown in Table 22, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 22. Rural Population Density in the Beaver Meadow Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Rush	16.12	577	0	577	38.38
Shelby	0.27	52	0	52	
TOTAL	16.39	629	0	629	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Beaver Meadow Creek watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations, which can provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Beaver Meadow Creek watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Beaver Meadow Creek subwatershed is dominated by agriculture. Sources of impairment include agricultural nonpoint source, wildlife, CFO, and unregulated storm water. These characteristics are likely to affect the amount of *E. coli* loading found in the Beaver Meadow Creek subwatershed.

4.2.3 Subwatershed Summary: Gilson Creek- Little Blue River

This section of the report presents the available information on the sources of *E. coli* in the Gilson Creek-Little Blue River subwatershed.

The Gilson Creek- Little Blue River subwatershed is located in northeast portion of Lower Big Blue River watershed , covering nearly 32 square miles (Figure 22). The Gilson Creek- Little Blue River drains portions of Rush County. Land use in the Gilson Creek- Little Blue River is primarily agriculture (85%) as shown in Table 23

Table 23. Land Use in the Gilson Creek- Little Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	27.58	0.04	0.13
Developed, Open Space	972.31	1.52	4.70
Developed, Low Intensity	75.61	0.12	0.37
Developed, Medium Intensity	7.56	0.01	0.04
Developed, High Intensity	NA	NA	NA
Forested Land	1,121.09	1.75	5.41
Shrub/Scrub	235.07	0.37	1.14
Pasture/Hay	469.48	0.73	2.27
Agriculture	17,772.24	27.77	85.84
Wetlands	20.02	0.03	0.11
TOTAL	20,700.96	32.35	100

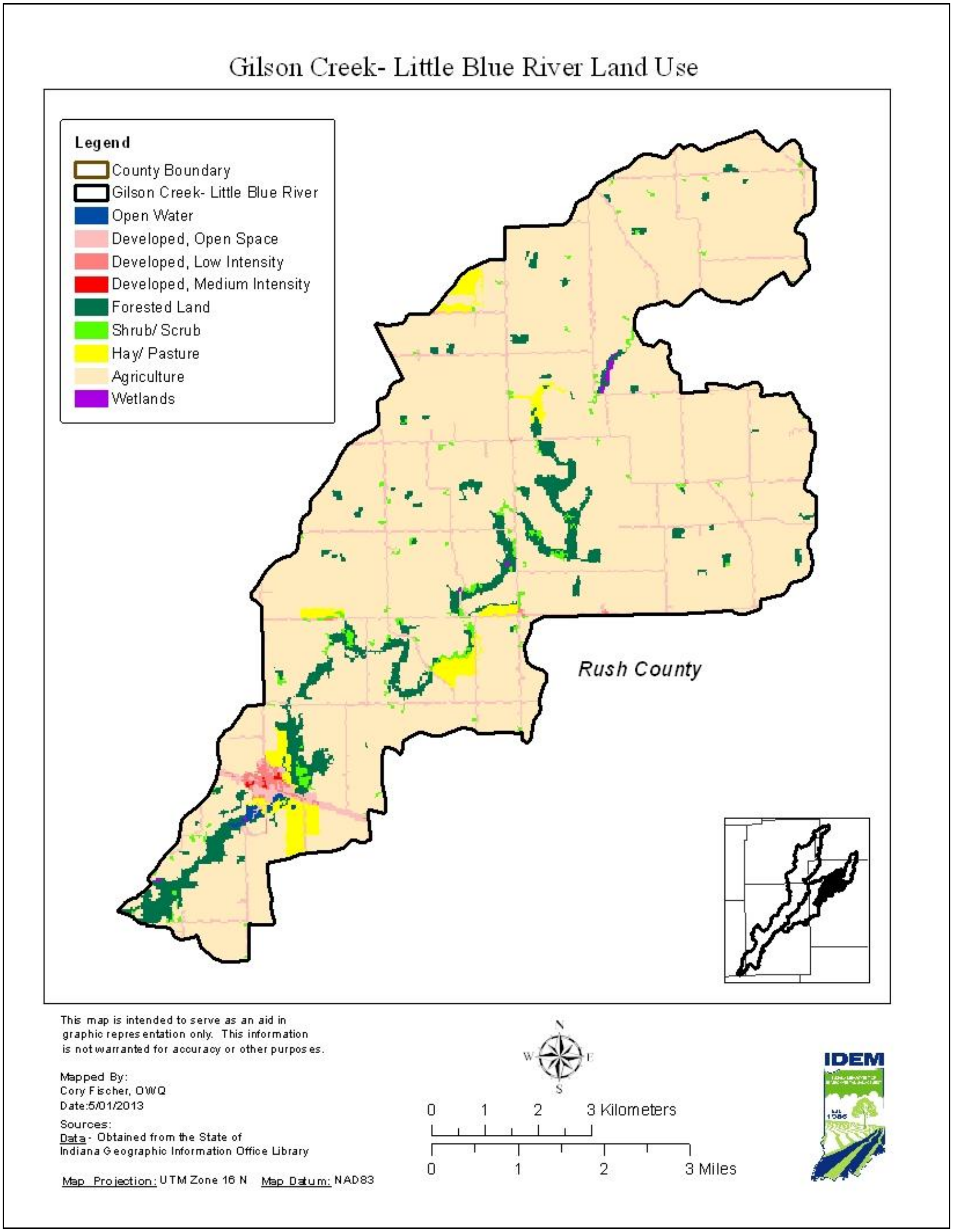


Figure 22. Land Use in the Gilson Creek- Little Blue River Subwatershed

4.2.3.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Gilson Creek- Little Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.3.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Gilson Creek- Little Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 86 percent of the land in the Gilson Creek- Little Blue River subwatershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Gilson Creek- Little Blue River Subwatershed os shown in Table 24 and Figure 23.

Table 24. 2012 Cropland in the Gilson Creek- Little Blue River Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	8,843.53	13.82	52.98
Soybean	7,662.84	11.97	45.91
Winter Wheat	72.72	0.11	0.44
Double Crop Winter Wheat/ Soybeans	111.42	0.17	0.67
TOTAL	**16,690.51**	**26.08**	**100**

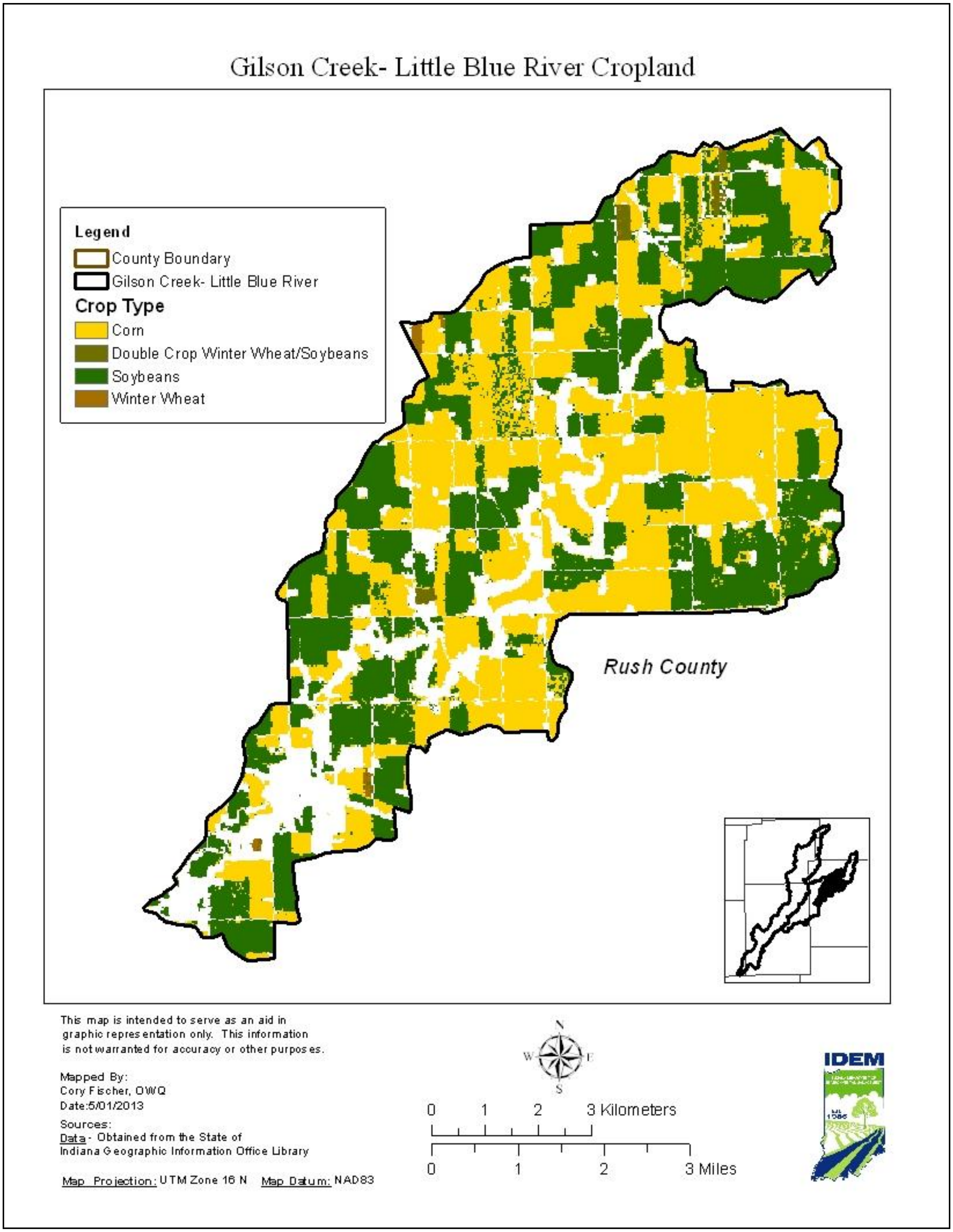


Figure 23. 2012 Cropland in the Gilson Creek- Little Blue River Subwatershed

Pastures and Livestock Operations

In the Gilson Creek- Little Blue River subwatershed, 2 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 26,755 animal units in the Gilson Creek- Little Blue River subwatershed and the animal unit density is 827 animal units per square mile as shown in Table 25.

Table 25. Animal Unit Density in the Gilson Creek- Little Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
32.34	Hogs and Pigs	52,354	2.5	20,942	827
	Cattle and Calves	4,591	1	4,591	
	Sheep and Lambs	457	10	46	
	Horses and Ponies	589	0.5	1,177	
			TOTAL	26,755	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There is one CFOs in the Gilson Creek- Little Blue River subwatershed.

Table 26. CFOs in the Gilson Creek- Little Blue River Subwatershed

CFO Permit ID	Operation Name	County	Animal Type and Units
4909	William Smith Farm 3	Rush	3800 Finishers

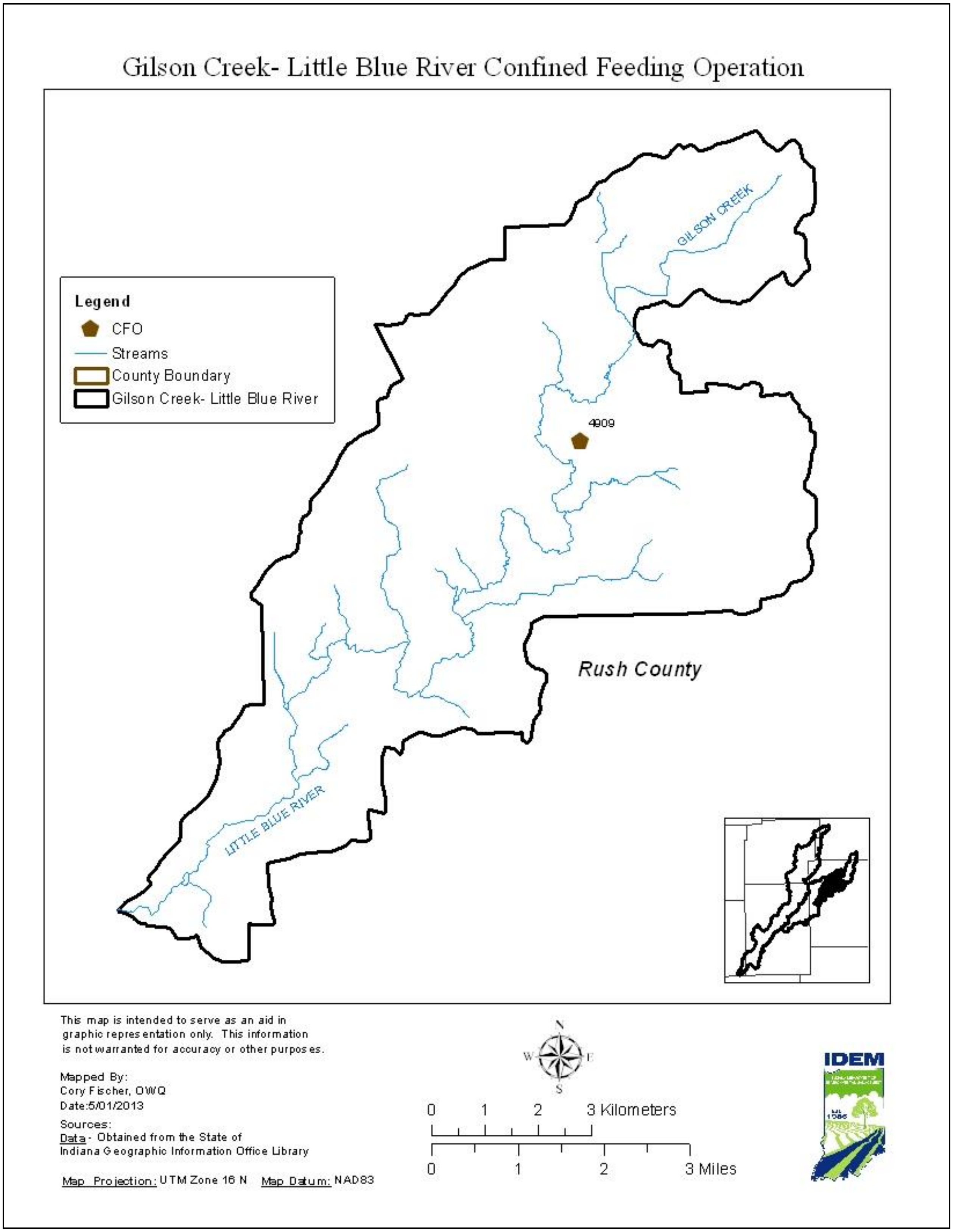


Figure 24. Confined Feeding Operations in the Gilson Creek- Little Blue River Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli* (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Gilson Creek- Little Blue River subwatershed is shown in Table 27, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 27. Rural Population Density in the Gilson Creek- Little Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Rush	32.34	1001	0	1001	30.95

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Gilson Creek- Little Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Gilson Creek- Little Blue River watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Gilson Creek- Little Blue River subwatershed is dominated by agriculture. Sources of impairment include wildlife, agricultural nonpoint source, CFO, and unregulated storm water. These characteristics are likely to affect the amount of *E. coli* loading found in the Gilson Creek- Little Blue River subwatershed.

4.2.4 Subwatershed Summary: Manilla Branch- Little Blue River

This section of the report presents the available information on the sources of *E. coli* in the Manilla Branch- Little Blue River subwatershed.

The Manilla Branch- Little Blue River subwatershed is located in the east central portion of Lower Big Blue River, covering nearly 17 square miles (Figure 25). The subwatershed drains portions of Rush and Shelby Counties. Land use in the Manilla Branch- Little Blue River is primarily agriculture (80%) as shown in Table 28.

Table 28. Land Use in the Manilla Branch- Little Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	3.11	0.00	0.03
Developed, Open Space	619.59	0.97	5.85
Developed, Low Intensity	53.819552	0.08	0.51
Developed, Medium Intensity	3.11	0.00	0.03
Developed, High Intensity	NA	NA	NA
Forested Land	714.11	1.12	6.74
Shrub/Scrub	90.07	0.14	0.85
Pasture/Hay	554.65	0.87	5.23
Agriculture	8,555.97	13.37	80.73
Wetlands	4.45	0.01	0.04
TOTAL	10,598.89	16.56	100.00

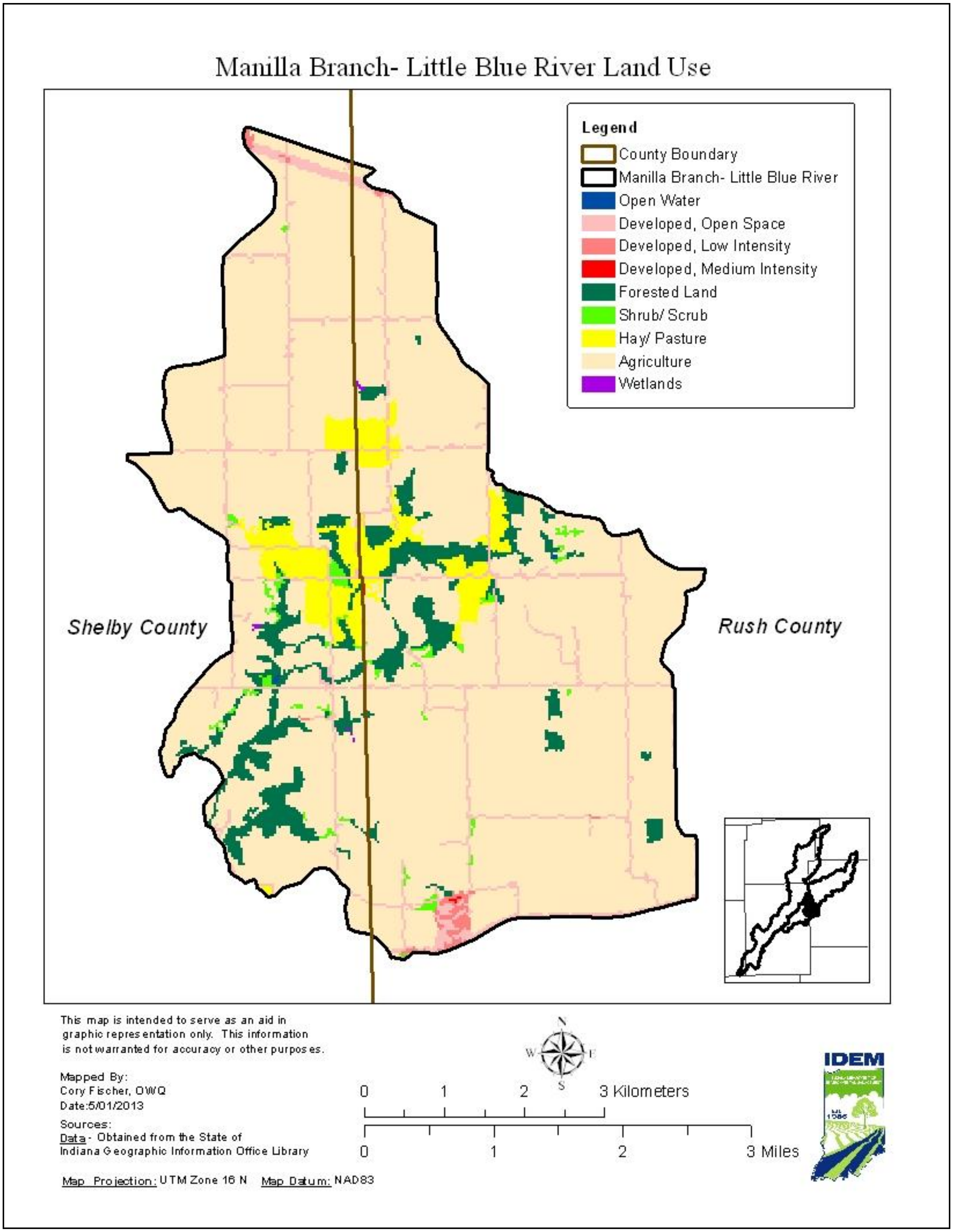


Figure 25. Land Use in the Manilla Branch- Little Blue River Subwatershed

4.2.4.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Manilla Branch- Little Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.4.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Manilla Branch- Little Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 81 percent of the land in the Manilla Branch- Lower Big Blue River watershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Manilla Branch- Lower Big Blue River Subwatershed is shown in Table 29 and Figure 26.

Table 29. 2012 Cropland in the Manilla Branch- Lower Big Blue River Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	4,256.86	6.65	54.03
Soybean	3,573.66	5.58	45.36
Winter Wheat	34.47	0.05	0.44
Double Crop Winter Wheat/ Soybeans	12.45	0.02	0.16
TOTAL	**7,877.45**	**12.31**	**100**

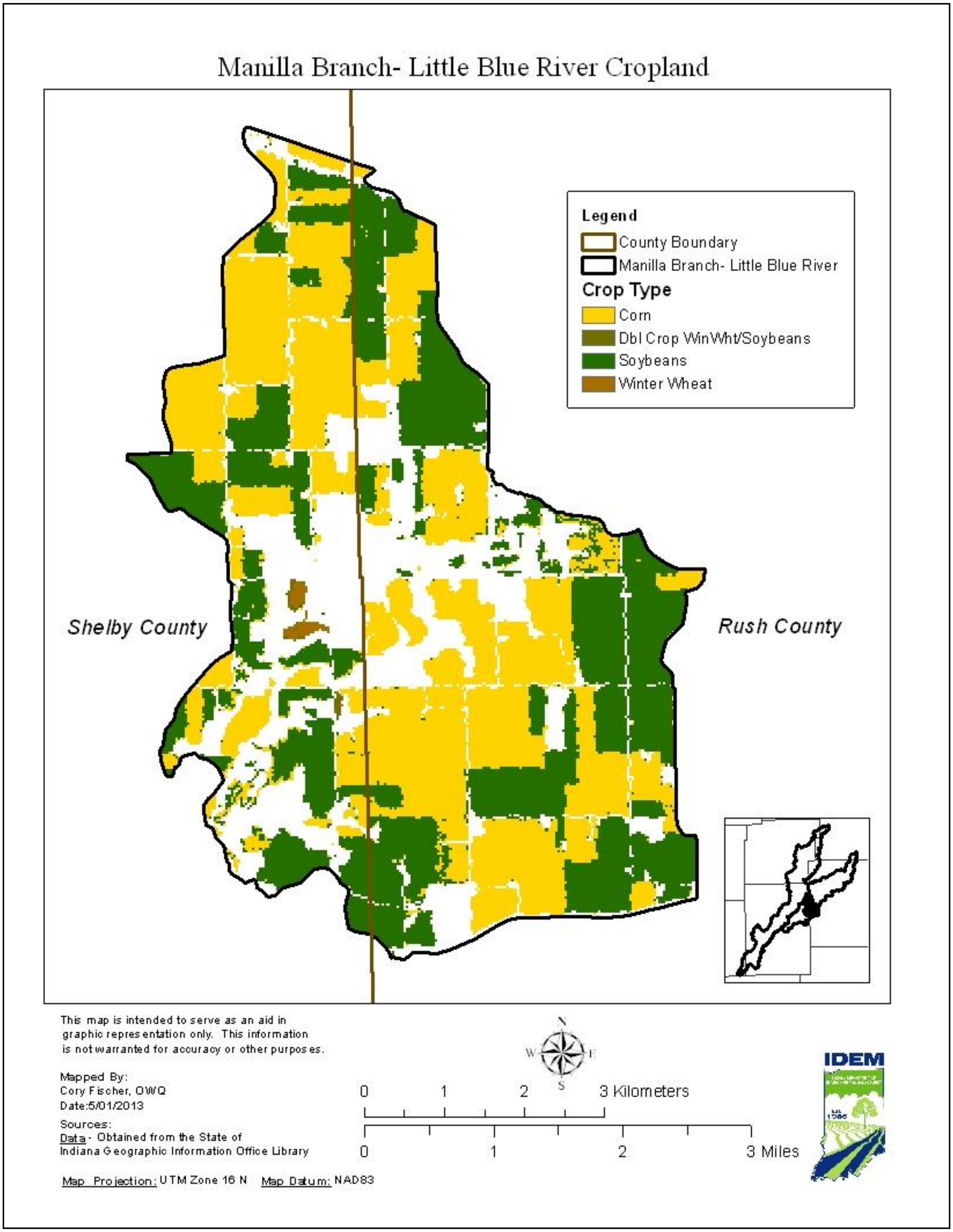


Figure 26. 2012 Cropland in the Manilla Branch- Lower Big Blue River Subwatershed

Pastures and Livestock Operations

In the Manilla Branch- Little Blue River subwatershed, 1 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 9,322 animal units in the Manilla Branch- Little Blue River subwatershed and the animal unit density is 563 animal units per square mile as shown in Table 30.

Table 30. Animal Unit Density in the Manilla Branch- Little Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
16.56	Hogs and Pigs	17,781	2.5	7,112	563
	Cattle and Calves	1,640	1	1,640	
	Sheep and Lambs	176	10	18	
	Horses and Ponies	276	0.5	552	
			TOTAL	9,322	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There are no CFOs in the Manilla Branch- Little Blue River subwatershed.

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Manilla Branch- Little Blue River subwatershed is shown in Table 31, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 31. Rural Population Density in the Manilla Branch- Little Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Rush	9.85	652	0	652	69.69
Shelby	6.71	502	0	502	
TOTAL	16.56	1,154	0	1,154	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants

originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Manilla Branch- Little Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Manilla Branch- Little Blue River watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Manilla Branch- Little Blue River subwatershed is dominated by agriculture. Sources of impairment include agricultural nonpoint source, wildlife, and unregulated storm water. These characteristics are likely to affect the amount of *E. coli* loading found in the Manilla Branch- Little Blue River subwatershed.

4.2.5 Subwatershed Summary: Town of Rays Crossing- Little Blue River

This section of the report presents the available information on the sources of *E. coli* in the Town of Rays Crossing- Little Blue River subwatershed.

The Town of Rays Crossing- Little Blue River subwatershed is located in east central portion of Lower Big Blue River, covering nearly 22 square miles (Figure 27). The Town of Rays Crossing- Little Blue River drains portions of Rush and Shelby Counties. The Town of Rays Crossing- Little Blue River includes the City of Shelbyville. Land use in the Town of Rays Crossing- Little Blue River is primarily agriculture (75%) as shown in Table 32.

Table 32. Land Use in the Town of Rays Crossing- Little Blue River Subwatershed

Land Use	Area		Percent
	Acres	**Square Miles**	
Open Water	12.68	0.02	0.09
Developed, Open Space	944.51	1.48	6.68
Developed, Low Intensity	329.14437	0.51	2.33
Developed, Medium Intensity	244.63	0.38	1.73
Developed, High Intensity	153.01	0.24	1.08
Forested Land	1,085.73	1.70	7.68
Shrub/Scrub	169.24	0.26	1.20
Pasture/Hay	520.85	0.81	3.68
Agriculture	10,675.40	16.68	75.51
Wetlands	2.45	0.00	0.02
TOTAL	14,137.64	22.09	100

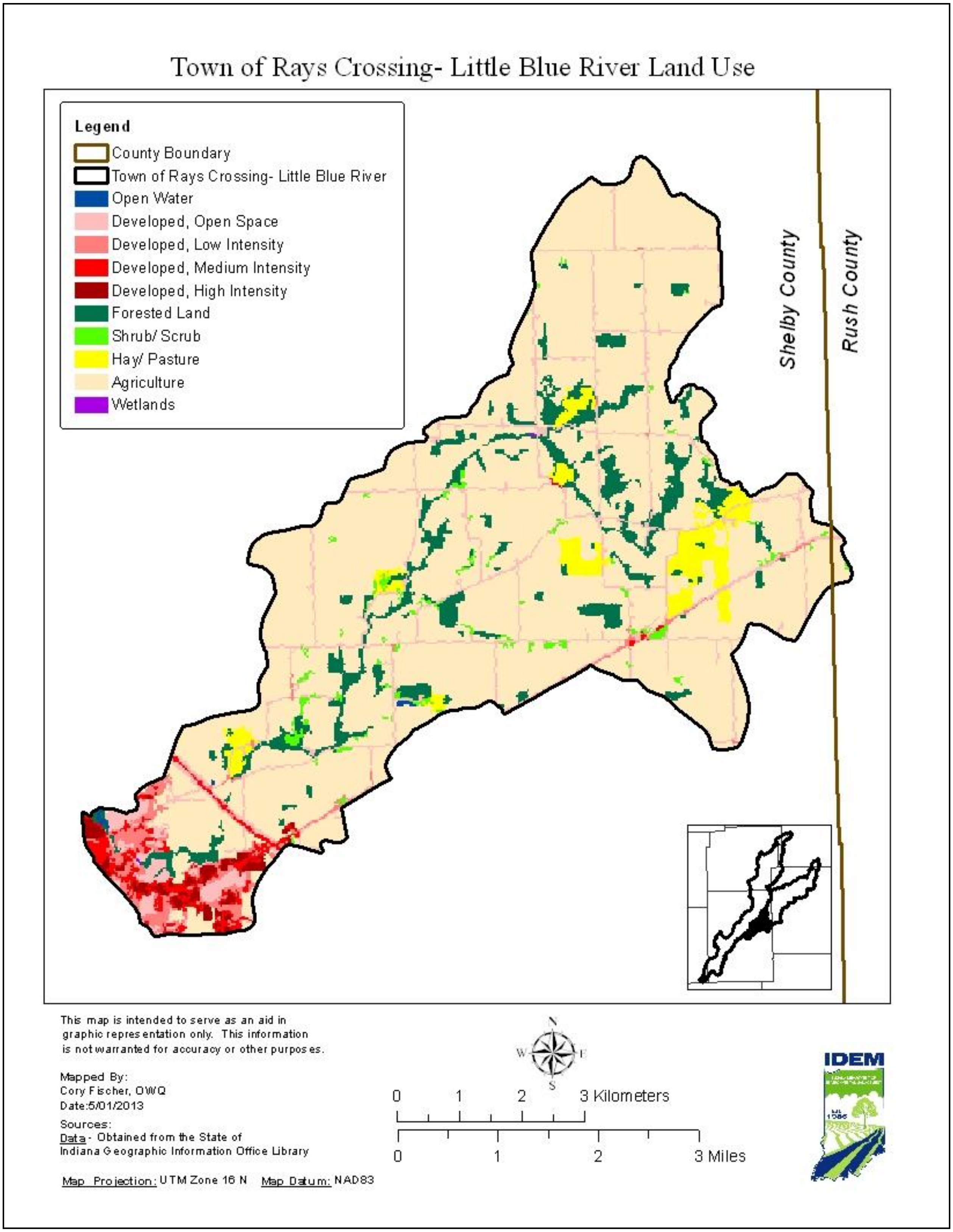


Figure 27. Land Use in the Town of Rays Crossing- Little Blue River Subwatershed

4.2.5.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Town of Rays Crossing- Little Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, failing septic systems, construction, and streambank erosion from hydrologic modifications. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. There is one MS4 community in the Town of Rays Crossing- Little Blue River subwatershed as shown in Table 33 and Figure 28.

Table 33. Town of Rays Crossing- Little Blue River MS4 Communities

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040051	Shelbyville	2.27

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Figure 28 shows the MS4 boundaries in the Town of Rays Crossing- Little Blue River subwatershed. The City of Shelbyville MS4 uses the incorportated area as its jurisdictional boundary. The City of Shelbyville MS4 is only being assigned a wasteload allocation for the developed area within its jurisdictional boundary. The Shelbyville MS4 Coordinator provided the boundary area that was used in this TMDL.

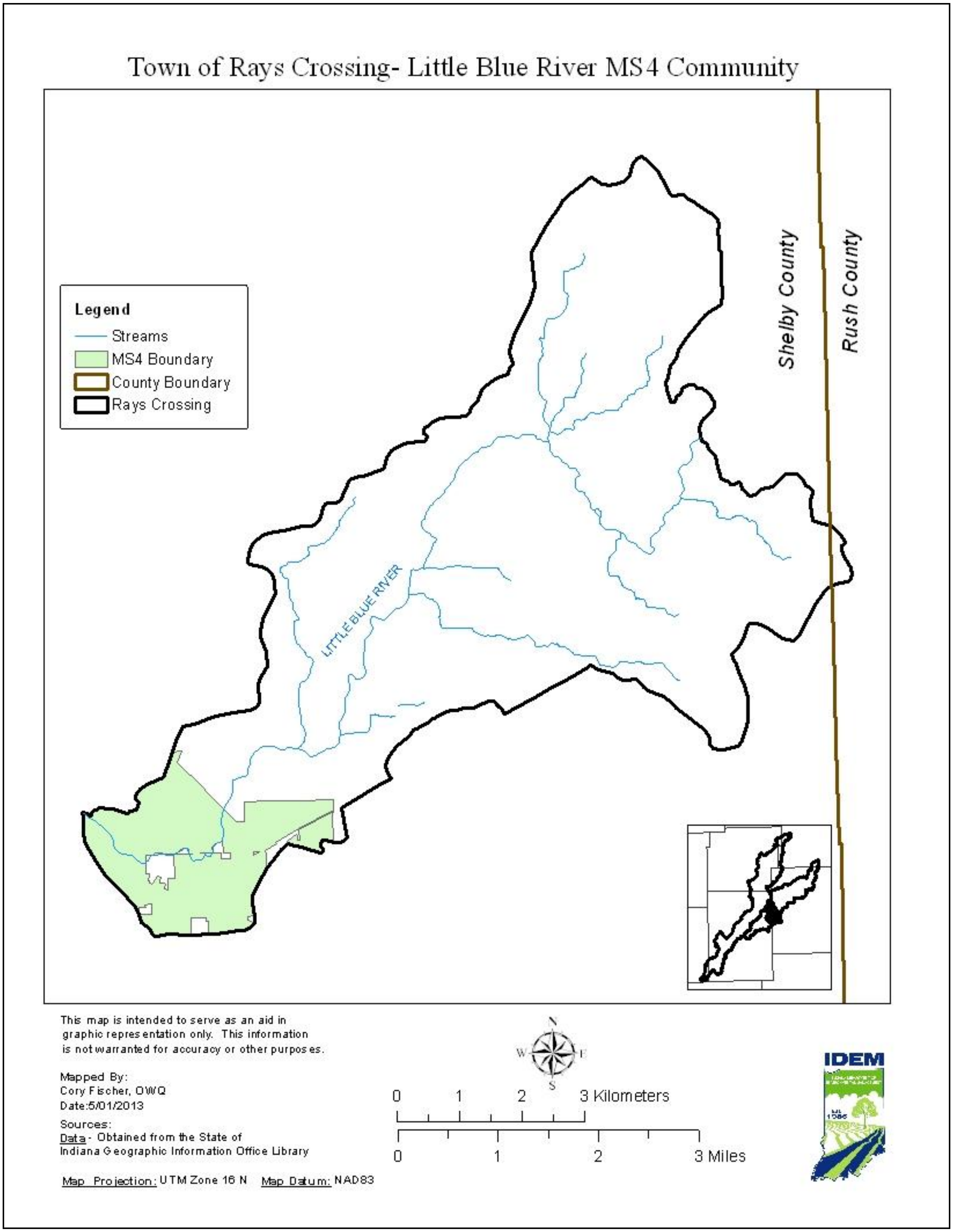


Figure 28. Map of MS4 Boundaries in the Town of Rays Crossing- Little Blue River Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.5.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Town of Rays Crossing- Little Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 76 percent of the land in the Town of Ray's Crossing Subwatershed is classified as row crops. Accumulation on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities.

Table 34. 2012 Cropland in the Town of Ray's Crossing Subwatershed

Cropland	Area		Percent
	Acres	**Square Miles**	
Corn	4,463.91	6.97	49.64
Soybean	4,339.81	6.78	48.25
Winter Wheat	78.51	0.12	0.86
Double Crop Winter Wheat/ Soybeans	112.75	0.18	1.24
TOTAL	**8,994.98**	**14.05**	**100**

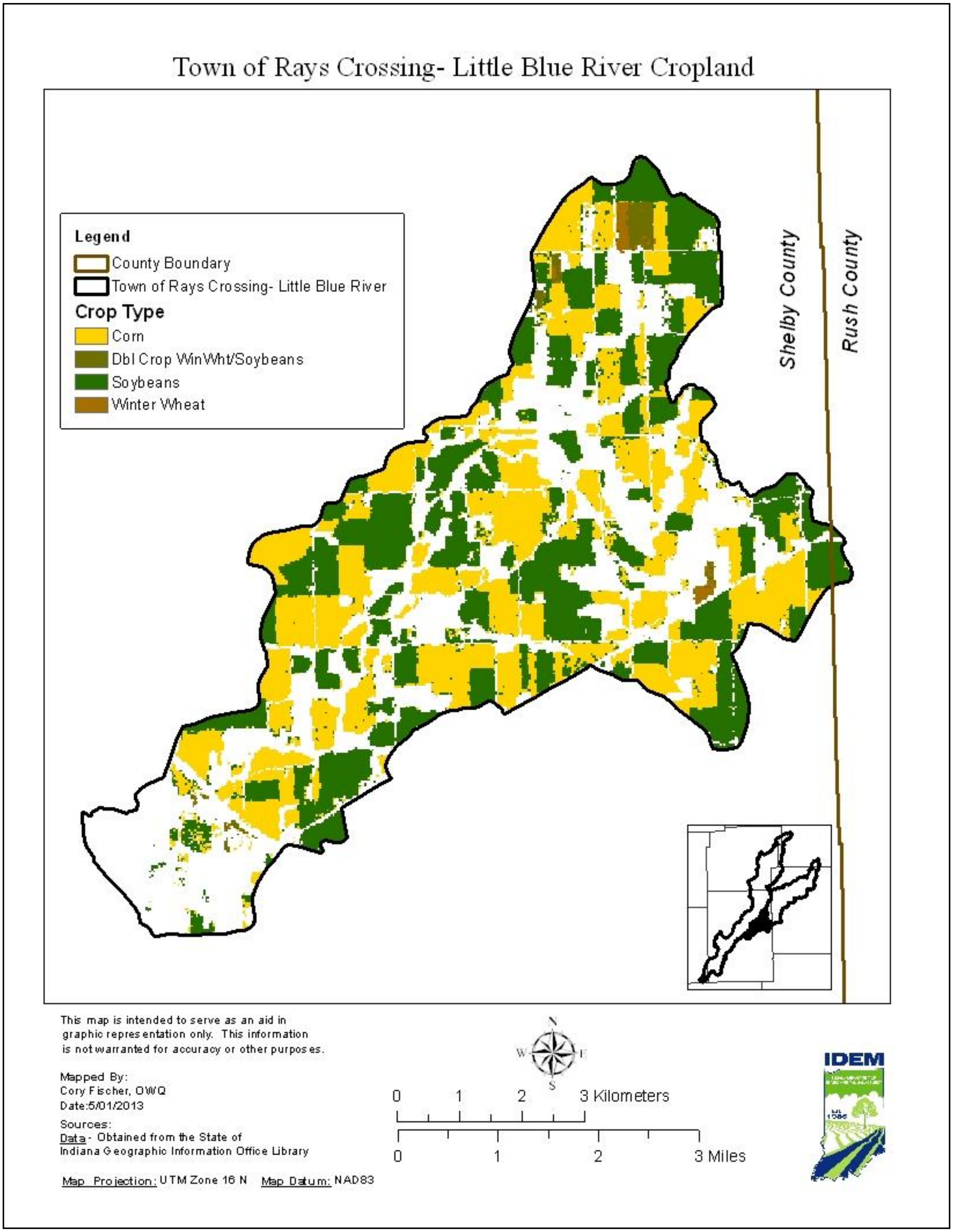


Figure 29. 2012 Cropland in the Town of Ray's Crossing-Little Blue River Subwatershed

Pastures and Livestock Operations

In the Town of Rays Crossing- Little Blue River subwatershed, 4 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 3,911 animal units in the Town of Rays Crossing- Little Blue River subwatershed and the animal unit density is 177 animal units per square mile as shown in Table 35.

Table 35. Animal Unit Density in the Town of Rays Crossing- Little Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
22.08	Hogs and Pigs	6,142	2.5	2,457	177
	Cattle and Calves	805	1	805	
	Sheep and Lambs	122	10	12	
	Horses and Ponies	319	0.5	638	
			TOTAL	3,911	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There are no CFOs in the Town of Rays Crossing- Little Blue River subwatershed.

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli*, nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Town of Rays Crossing- Little Blue River subwatershed is shown in Table 36, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 36. Rural Population Density in the Town of Rays Crossing- Little Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Shelby	22.00	5,525	3,394	2,131	
Rush	0.08	2	0	2	96.60
TOTAL	22.08	5,527	3,394	2,133	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants

originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Town of Rays Crossing- Little Blue River subwatershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Town of Rays Crossing- Little Blue River subwatershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Town of Rays Crossing- Little Blue River subwatershed is dominated by agriculture, but also includes more urban area than the other subwatersheds. Sources of impairment include the Shelbyville MS4, unregulated storm water, agricultural nonpoint source, and wildlife. These characteristics are likely to affect the amount of *E. coli* loading found in the Town of Rays Crossing- Little Blue River subwatershed.

4.2.6 Subwatershed Summary: Headwaters Six Mile Creek

This section of the report presents the available information on the sources of *E. coli* in the Headwaters Six Mile Creek subwatershed.

The Headwaters Six Mile Creek subwatershed is located in the northwest corner of the Lower Big Blue River Watershed, covering nearly 17 square miles (Figure 30). The Headwaters Six Mile Creek subwatershed drains portions of Hancock and Henry Counties. The Headwaters Six Mile Creek subwatershed includes the Town of Shirley. Land use in the Headwaters Six Mile Creek subwatershed is primarily agriculture as shown in Table 37.

Table 37. Land Use in the Headwaters Six Mile Creek Subwatershed

Land Use	Area		Percent
	Acres	**Square Miles**	
Open Water	48.93	0.08	0.44
Developed, Open Space	660.51	1.03	6.11
Developed, Low Intensity	200.60	0.31	1.85
Developed, Medium Intensity	30.69	0.05	0.28
Developed, High Intensity	5.34	0.01	0.05
Forested Land	495.50	0.77	4.58
Shrub/Scrub	181.47	0.28	1.68
Pasture/Hay	270.21	0.42	2.50
Agriculture	8,914.47	13.93	82.42
Wetlands	9.12	0.01	0.08
TOTAL	10,816.84	16.90	100

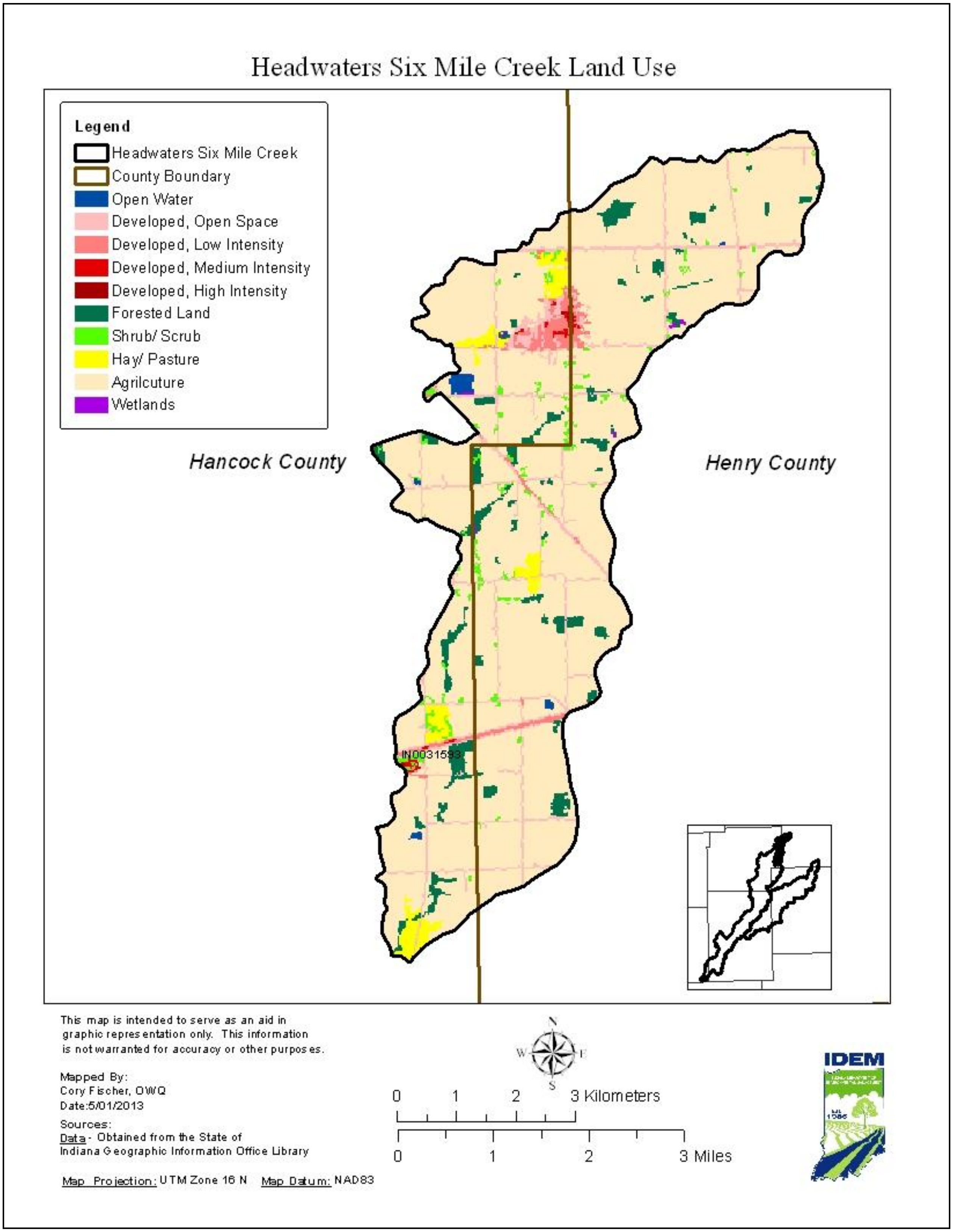


Figure 30. Land Use in the Headwaters Six Mile Creek Subwatershed

4.2.6.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Headwaters Six Mile Creek subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Wastewater Treatment Plants (WWTPs) and Industrial Facilities

Facilities with NPDES permits to discharge wastewater within the Lower Big Blue River watershed include municipal wastewater treatment plants (WWTPs) and industrial facilities. There are two active WWTPs that discharge wastewater containing *E. coli* within the Headwaters Six Mile Creek subwatershed (Table 40 and Figure 31). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States.

Table 40. NPDES Permitted Wastewater Dischargers within the Headwaters Six Mile Creek Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Eastern Hancock Jr/Sr High School	IN0031593	INW0481_01	Six Mile Creek	0.029
Shirley WWTP	IN0024503	INW0481_T1001	Smith Ditch	0.155

The Eastern Hancock Jr/Sr High School currently operates a Class I, 0.029 MGD extended aeration treatment facility consisting of a grinder, a raw surge tank, a splitter box, an aeration tank, a secondary clarifier, chlorination, an effluent meter, and two (2) two-day polishing ponds. Bio-soilds are stored within a sludge holding tank and hauled off- site. The collection system is comprised of 100% sanitary sewers by design with no overflow or bypass points. Table 39 shows the Eastern Hancock Jr/Sr High School WWTP's effluent characterisitics for the past five years.

Table 38. Eastern Hancock Jr/Sr High School *E. coli* Effluent Characteristics

Year	Average *E. coli* Concentration (per 100mL)	Maximum *E. coli* Concentration (per 100mL)	Average Daily Flow (MGD)	Total Annual Flow (MG)
2007	11.29	36.90	0.01	13.25
2008	4.06	12.40	0.01	9.19
2009	1.74	6.20	0.01	8.48
2010	3.50	13.50	0.01	9.03
2011	2.60	6.80	0.01	10.56

The Shirley WWTP currently operates a Class I-SP, 0.155 MGD controlled discharge waste stabilization lagoon treatment facility consisting of two treatment lagoons totaling 31.6 million gallons in storage capacity, one storage/ polishing lagoon totaling 38.3 million gallons in storage capacity, influent and effluent flow meters and stream gage. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. Table 39 shows the Shirley WWTP's effluent characterisitics for the past five years.

Table 39. Shirley WWTP *E. coli* Effluent Characteristics

Year	Average *E. coli* Concentration (per 100mL)	Maximum *E. coli* Concentration (per 100mL)	Average Daily Flow (MGD)	Total Annual Flow (MG)
2007	42.14	66.00	0.28	307
2008	57.43	126	0.33	357
2009	47.00	98.00	0.22	244

2010	32.67	65.00	0.19	210
2011	22.86	41.00	0.33	358

Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31). IDEM does not require disinfection for waste-stabilization lagoons as long as *E. coli* limits from the permit are met utilizing the lagoon's retention time. Table 40 contains the maximum design flow for the active facilities. Of the two facilities in Headwaters Six Mile Creek, the Shirley WWTP uses waste stabilization lagoons that have a 90 day detention time. Waste stabilization lagoons discharge at a 10:1 dilution ratio.

Table 40. NPDES Permitted Wastewater Dischargers within the Headwaters Six Mile Creek Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Eastern Hancock Jr/Sr High School	IN0031593	INW0481_01	Six Mile Creek	0.029
Shirley WWTP	IN0024503	INW0481_T1001	Smith Ditch	0.155

Table 41 presents a summary of permit compliance for both NPDES facilities in the Headwaters Six Mile Creek subwatershed for the five year period between 2008 and 2013. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation). The table also presents the total number of violations in the five year period for *E. coli*. According to Table 41, there have been 11 NPDES facility inspections in the five year period. Overall, there are a total of 0 permit violations for *E. coli* in the Headwaters Six Mile Creek subwatershed.

Table 41. Summary of Inspections and Permit Compliance in the Headwaters Six Mile Creek Subwatershed for the Five Year Period Ending March 2013

Facility Name	Permit Number	AUID	Date of Last Inspection and Findings	Violations from July 2009 through December 2013
Eastern Hancock Jr/Sr High School	IN0031593	INW0481_01	10/30/2008: Violations were observed 12/15/2009: No violations observed 12/22/2010: No violations observed 02/21/2013: No violations observed 10/28/2013: No violations observed	0 *E. coli* violations
Shirley WWTP	IN0024503	INW0481_T1001	08/06/2008: Violations were observed 11/06/2009: Violations were observed 03/08/2010: Violations were observed 12/07/2010: No violations observed 08/18/2012: Potential Problems were Observed 03/28/2013: Violations were observed	0 *E. coli* violations

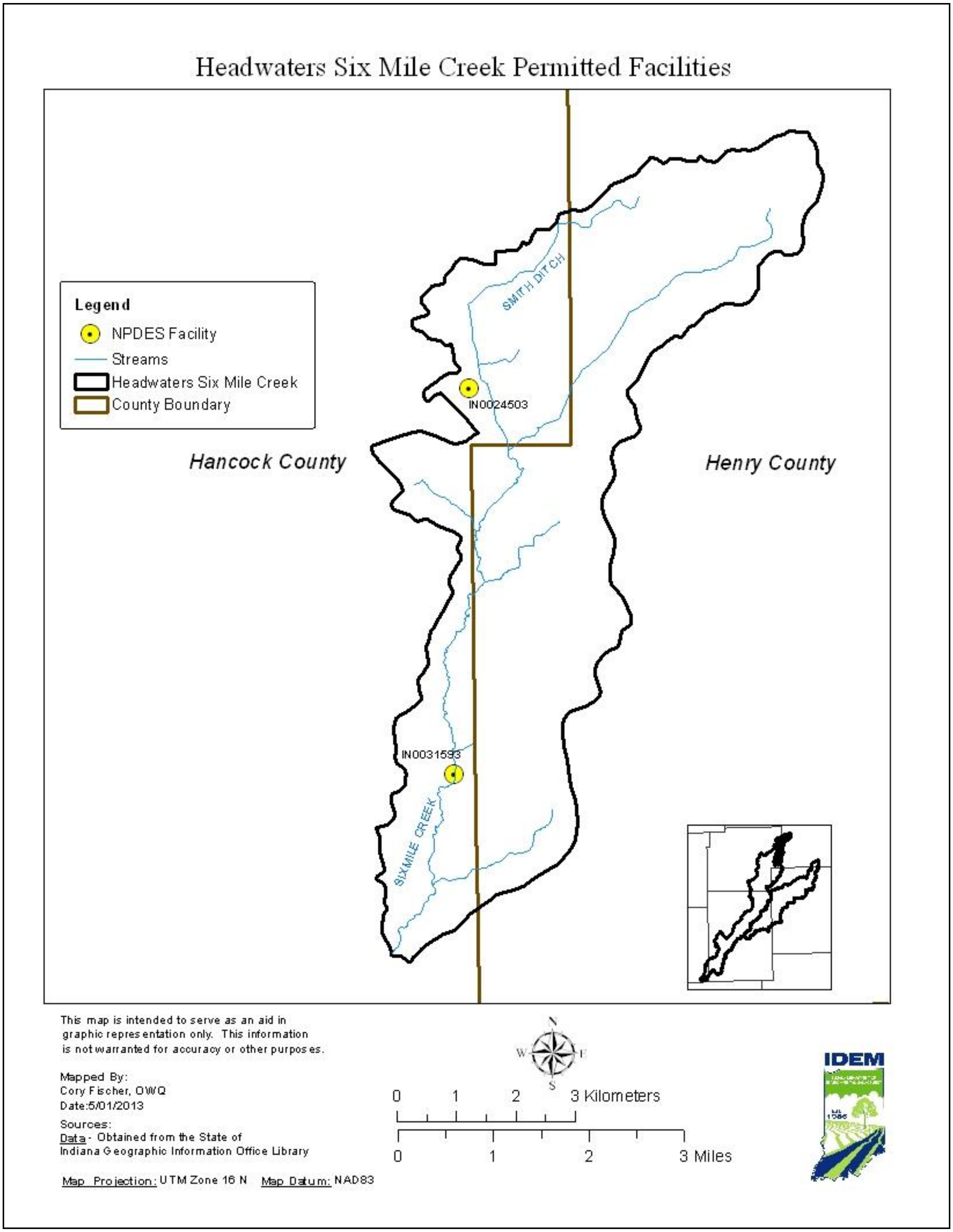


Figure 31. NPDES Facilities in the Headwaters Six Mile Creek Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.6.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Headwaters Six Mile Creek subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 82 percent of the land in the Headwaters Six Mile Creek subwatershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Headwaters Six Mile Creek Subwatershed are shown in Table 42 and Figure 32.

Table 42. 2012 Cropland in the Headwaters Six Mile Creek Subwatershed

Cropland	Area		Percent
	Acres	Square Miles	
Corn	3,404.20	5.32	43.10
Soybean	4,418.76	6.90	55.95
Winter Wheat	75.17	0.12	0.94
Double Crop Winter Wheat/ Soybeans	0.22	0.00	0.00
TOTAL	**7,898.35**	**12.34**	**100**

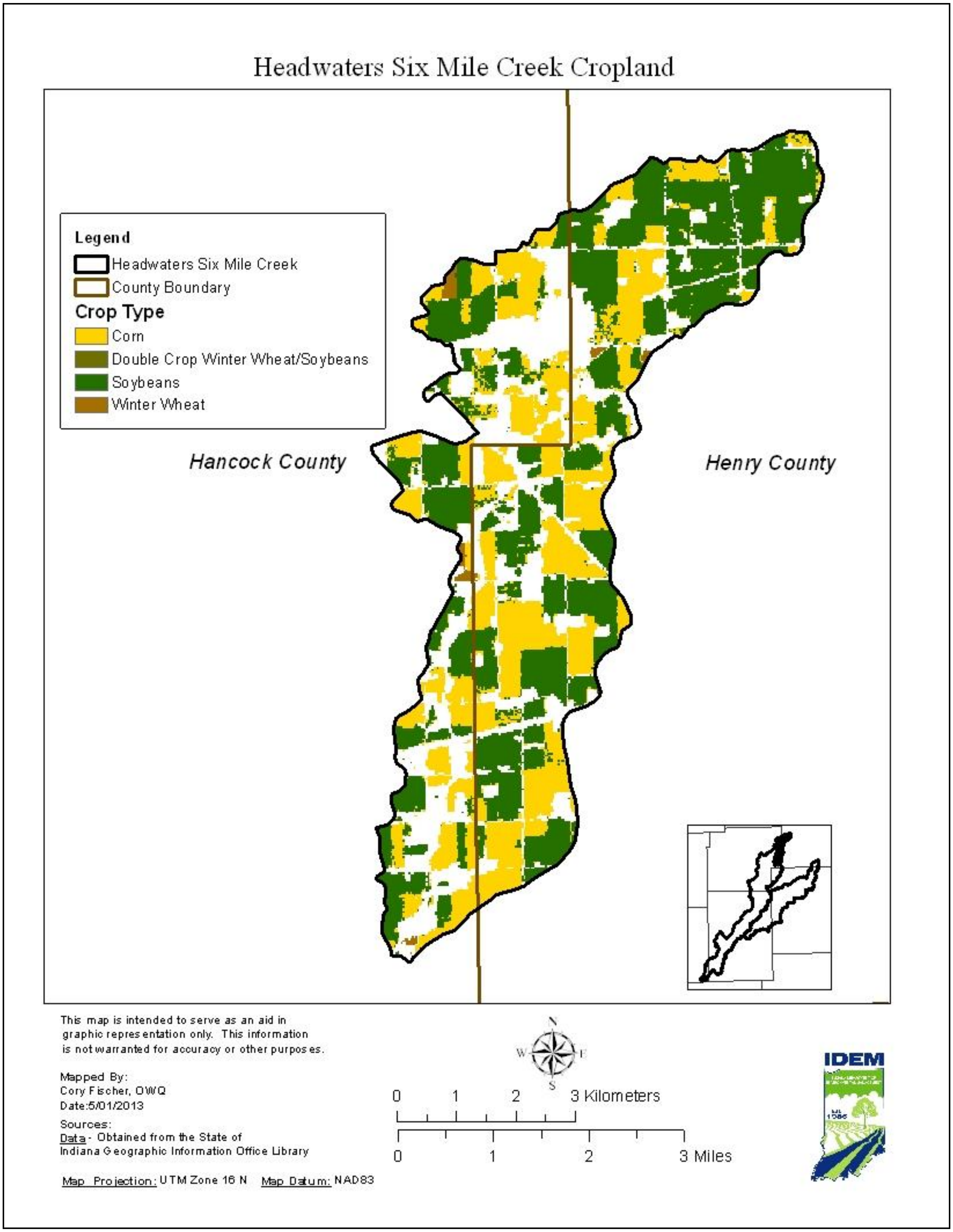


Figure 32. 2012 Cropland in the Headwaters Six Mile Creek Subwatershed

Pastures and Livestock Operations

In the Headwaters Six Mile Creek subwatershed, 2.5 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 19,647 animal units in the Headwaters Six Mile Creek subwatershed and the animal unit density is 1,163 animal units per square mile as shown in Table 43.

Table 43. Animal Unit Density in the Headwaters Six Mile Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
16.90	Hogs and Pigs	18,427	2.5	7,371	1,163
	Cattle and Calves	7,928	1	7,928	
	Sheep and Lambs	919	10	92	
	Horses and Ponies	2,128	0.5	4,255	
			TOTAL	19,647	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There are no CFOs in the Headwaters Six Mile Creek subwatershed.

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Headwaters Six Mile Creek subwatershed is shown in Table 44, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 44. Rural Population Density in the Headwaters Six Mile Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Henry	10.50	778	185	593	80
Hancock	6.40	1,452	699	753	
TOTAL	16.90	2,230	884	1,346	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Headwaters Six Mile Creek watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Headwaters Six Mile Creek watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Headwaters Six Mile Creek subwatershed is dominated by agriculture. Sources of impairment include NPDES Facilities, unregulated storm water, wildlife, and agricultural nonpoint sources. Specifically, Headwaters Six Mile Creek is characterized by two WWTPs with no permit violations for *E. coli*. These characteristics are likely to affect the amount of *E. coli* loading found in the Headwaters Six Mile Creek subwatershed.

4.2.7 Subwatershed Summary: Anthony Creek- Six Mile Creek

This section of the report presents the available information on the sources of *E. coli* in the Anthony Creek- Six Mile Creek subwatershed.

The Anthony Creek- Six Mile Creek subwatershed is located in the northwest portion of Lower Big Blue River, covering nearly 29 square miles (Figure 33). The Anthony Creek- Six Mile Creek subwatershed drains portions of Hancock, Henry, and Rush Counties. Land use in the Anthony Creek- Six Mile Creek subwatershed is primarily agriculture (77%) as shown in Table 45.

Table 45. Land Use in the Anthony Creek- Six Mile Creek Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	24.69	0.04	0.12
Developed, Open Space	976.09	1.53	5.32
Developed, Low Intensity	170.35	0.27	0.93
Developed, Medium Intensity	12.90	0.02	0.07
Developed, High Intensity	5.34	0.01	0.03
Forested Land	1,577.89	2.47	8.60
Shrub/Scrub	156.34	0.24	0.85
Pasture/Hay	1,263.65	1.97	6.89
Agriculture	14,143.42	22.10	77.11
Wetlands	12.68	0.02	0.07
TOTAL	18,343.35	28.66	100

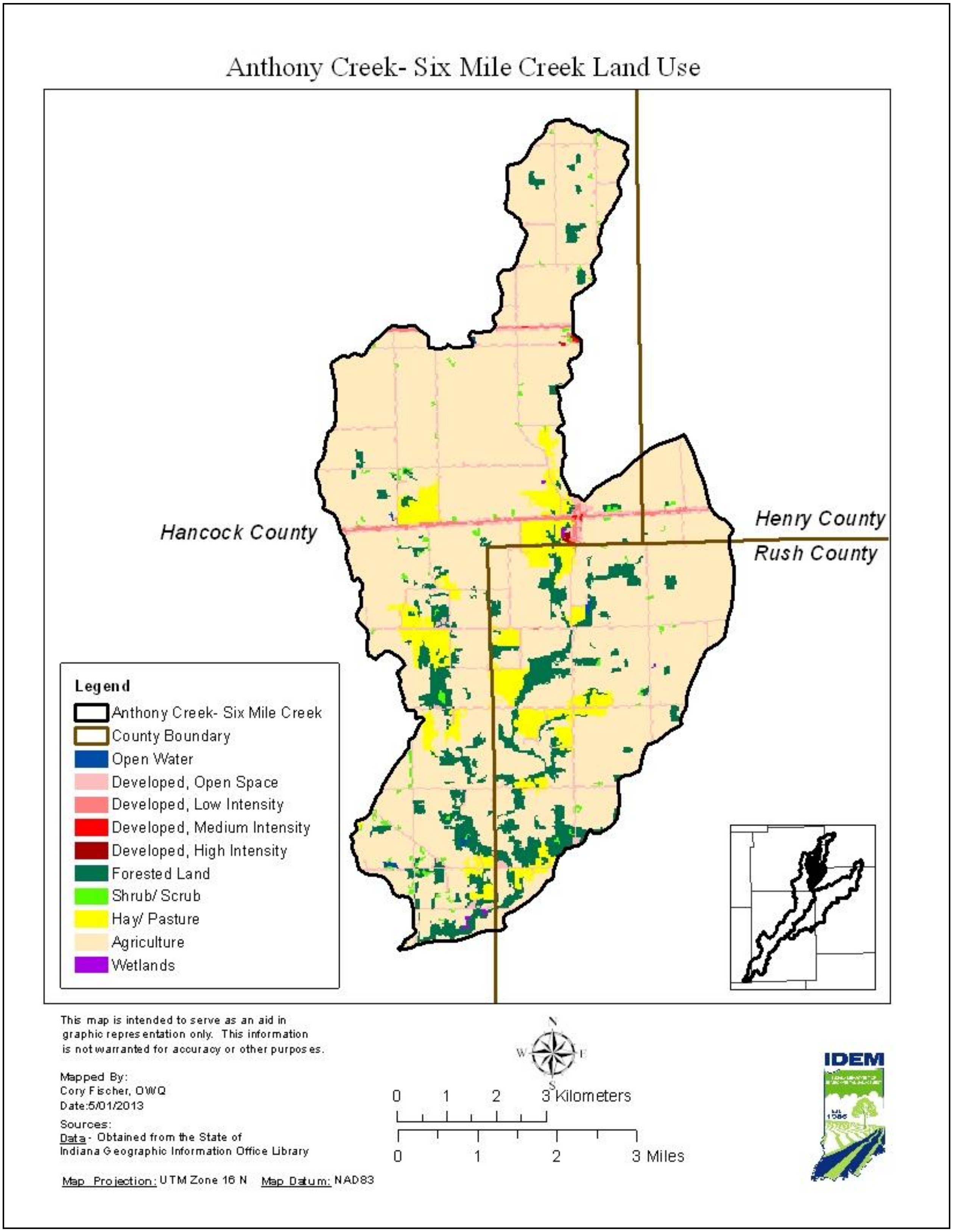


Figure 33. Land Use in the Anthony Creek- Six Mile Creek Subwatershed

4.2.7.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Anthony Creek- Six Mile Creek subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.7.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Anthony Creek- Six Mile Creek subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 77 percent of the land in the Anthony Creek- Six Mile Creek subwatershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Anthony Creek- Six Mile Creek Subwatershed are shown in Table 46 and Figure 34.

Table 46. 2012 Cropland in the Anthony Creek- Six Mile Creek Subwatershed

Cropland	Area		Percent
	Acres	Square Miles	
Corn	5,825.86	9.10	48.72
Soybean	5,917.48	9.25	49.50
Winter Wheat	205.72	0.32	1.71
Double Crop Winter Wheat/ Soybeans	8.23	0.01	0.07
TOTAL	**11,957.28**	**18.68**	100

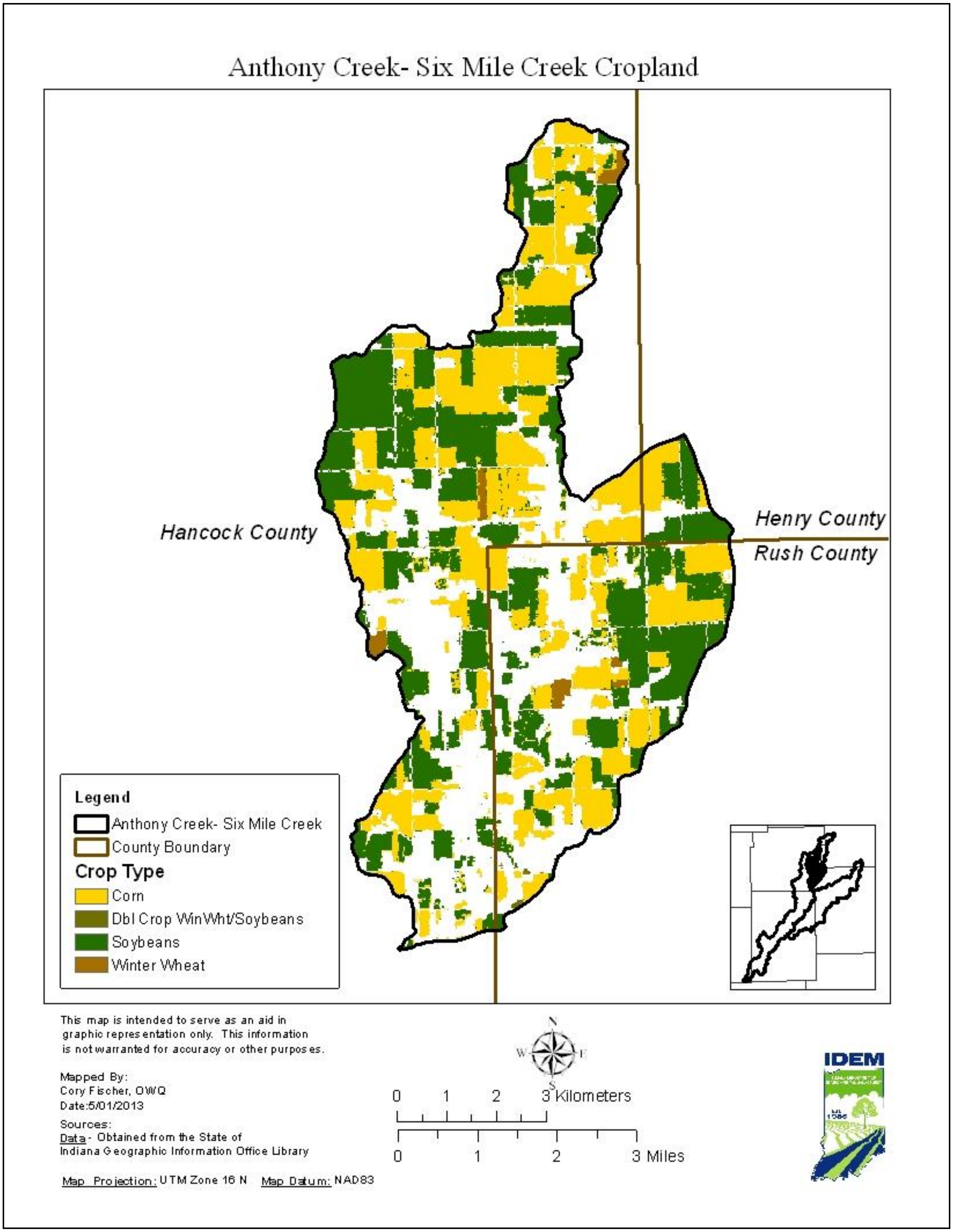


Figure 34. 2012 Cropland in the Anthony Creek- Six Mile Creek Subwatershed

Pastures and Livestock Operations

In the Anthony Creek- Six Mile Creek subwatershed, 7 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 20,714 animal units in the Anthony Creek- Six Mile Creek subwatershed and the animal unit density is 723 animal units per square mile as shown in Table 47.

Table 47. Animal Unit Density in the Anthony Creek- Six Mile Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
28.65	Hogs and Pigs	39,950	2.5	15,980	723
	Cattle and Calves	3,101	1	3,101	
	Sheep and Lambs	859	10	86	
	Horses and Ponies	773	0.5	1,547	
			TOTAL	20,714	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified by IDEM as CFOs are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There are four CFOs in the Anthony Creek- Six Mile Creek subwatershed as shown in Table 48 and Figure35.

Table 48. CFOs in the Anthony Creek- Six Mile Creek Subwatershed

Farm ID	Operation Name	County	Animal Type and Units
4448	Jeff & Bruce Muegge	Hancock	Nursery Pigs: 320 Finishers: 800 Sows: 185
4623	Bob White Farm	Rush	Nursery Pigs: 500 Finishers: 1000
2581	Lewis Pork Farm LLC	Hancock	Nursery Pigs: 3,200 Finishers: 6,500
6582	Pork in Blue River LLC	Hancock	Finishers: 8,000

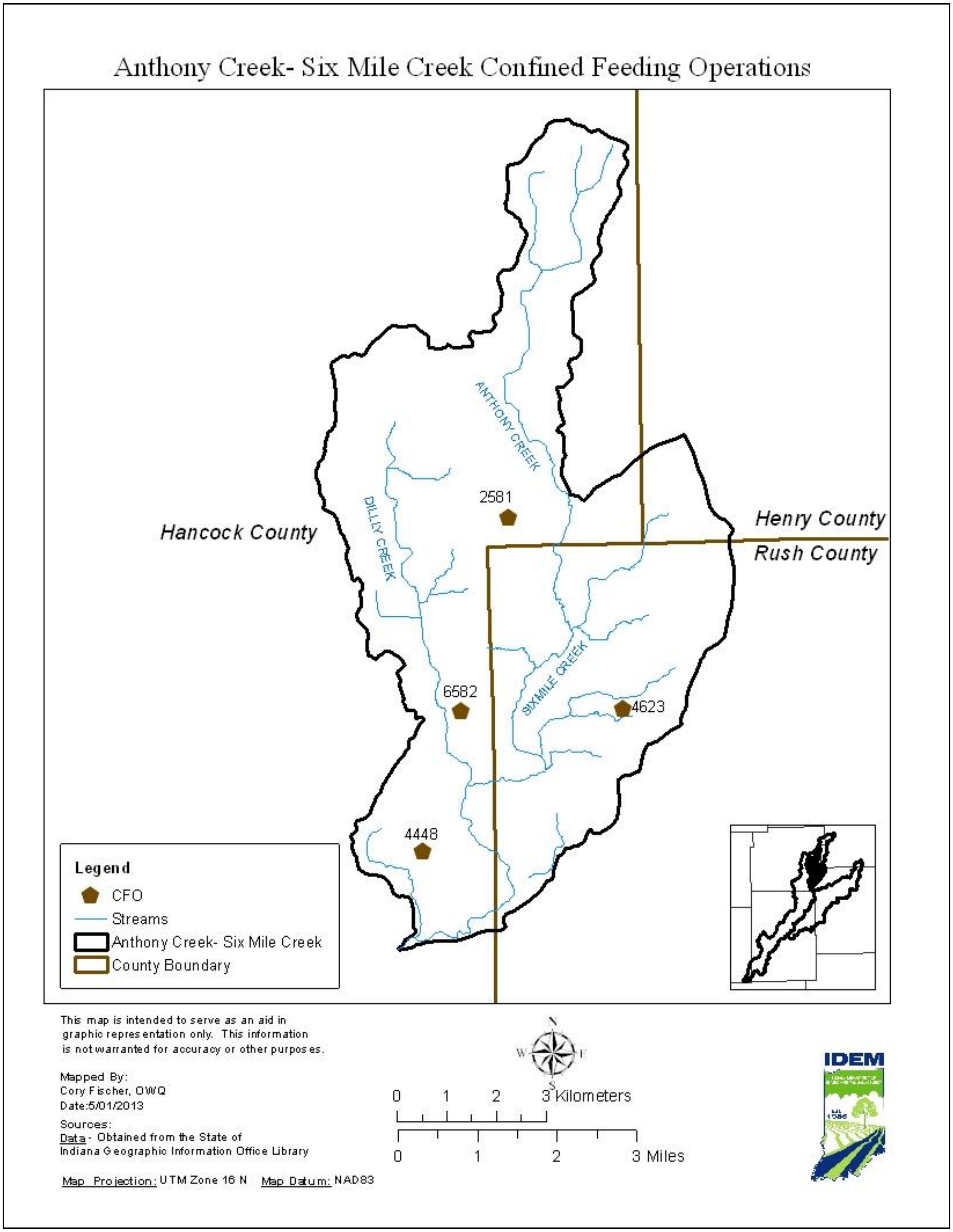


Figure 35. Confined Feeding Operations in the Anthony Creek- Six Mile Creek Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: [410 IAC 6-8.1-31]

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Anthony Creek- Six Mile Creek subwatershed is shown in Table 49, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 49. Rural Population Density in the Anthony Creek- Six Mile Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Henry	1.03	96	0	96	67
Hancock	18.17	1,356	0	1,356	
Rush	9.45	460	0	460	
TOTAL	28.65	1,912	0	1,912	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Anthony Creek- Six Mile Creek watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Anthony Creek- Six Mile Creek watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Anthony Creek- Six Mile Creek subwatershed is dominated by agriculture. Sources of impairment include,CFO, wildlife, unregulated storm water, and agricultural nonpoint source. These characteristics are likely to affect the amount of *E. coli* loading found in the Anthony Creek- Six Mile Creek subwatershed.

4.2.8 Subwatershed Summary: Nameless Creek

This section of the report presents the available information on the sources of *E. coli* in the Nameless Creek subwatershed.

The Nameless Creek subwatershed is located in the northwest portion of the Lower Big Blue River Watershed, covering nearly 16 square miles (Figure 36). The Nameless Creek subwatershed drains portions of Hancock County. Land use in the Nameless Creek subwatershed is primarily agriculture (82%) as shown in Table 50.

Table 50. Land Use in the Nameless Creek Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	22.91	0.04	0.21
Developed, Open Space	599.58	0.94	5.70
Developed, Low Intensity	100.97	0.16	0.96
Developed, Medium Intensity	2.22	0.00	0.02
Developed, High Intensity	NA	NA	NA
Forested Land	568.44	0.89	5.41
Shrub/Scrub	88.51	0.14	0.84
Pasture/Hay	528.63	0.83	5.03
Agriculture	8,602.23	13.44	81.80
Wetlands	3.78	0.01	0.04
TOTAL	10,517.27	16.43	100

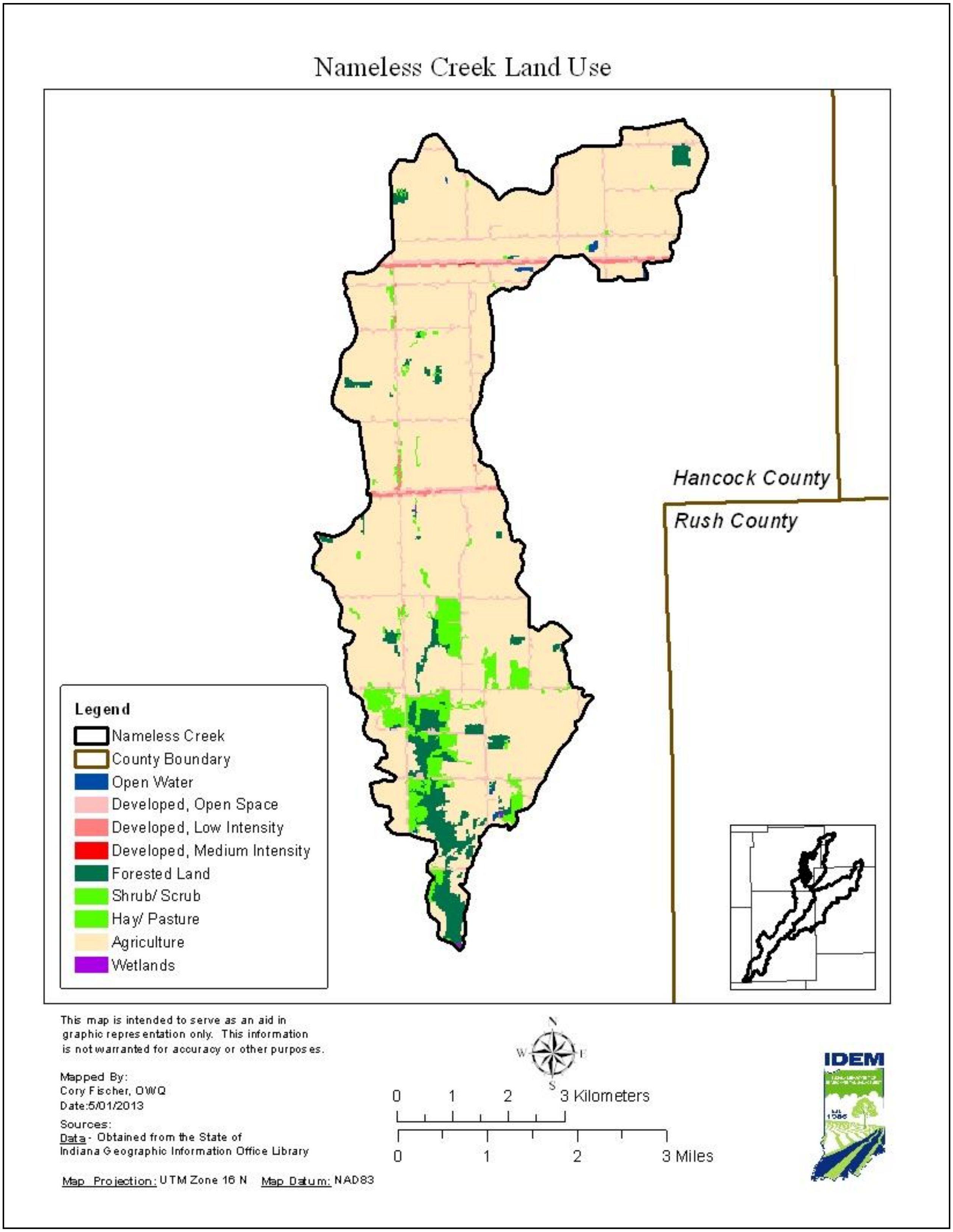


Figure 36. Land Use in the Nameless Creek Subwatershed

4.2.8.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Nameless Creek subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.8.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Nameless Creek subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 82 percent of the land in the Nameless Creek subwatershed is classified as row crops. Accumulation of E. coli on cropland occurs from decomposition of residual crop material, fertilization with manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in the Nameless Creek Subwatershed is shown in Table 51 and Figure 37.

Table 51. 2012 Cropland in the Nameless Creek Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	3,354.83	5.24	44.05
Soybean	4,124.76	6.44	54.16
Winter Wheat	108.53	0.17	1.43
Double Crop Winter Wheat/ Soybeans	27.35	0.04	0.36
TOTAL	**7,615.47**	**11.90**	**100**

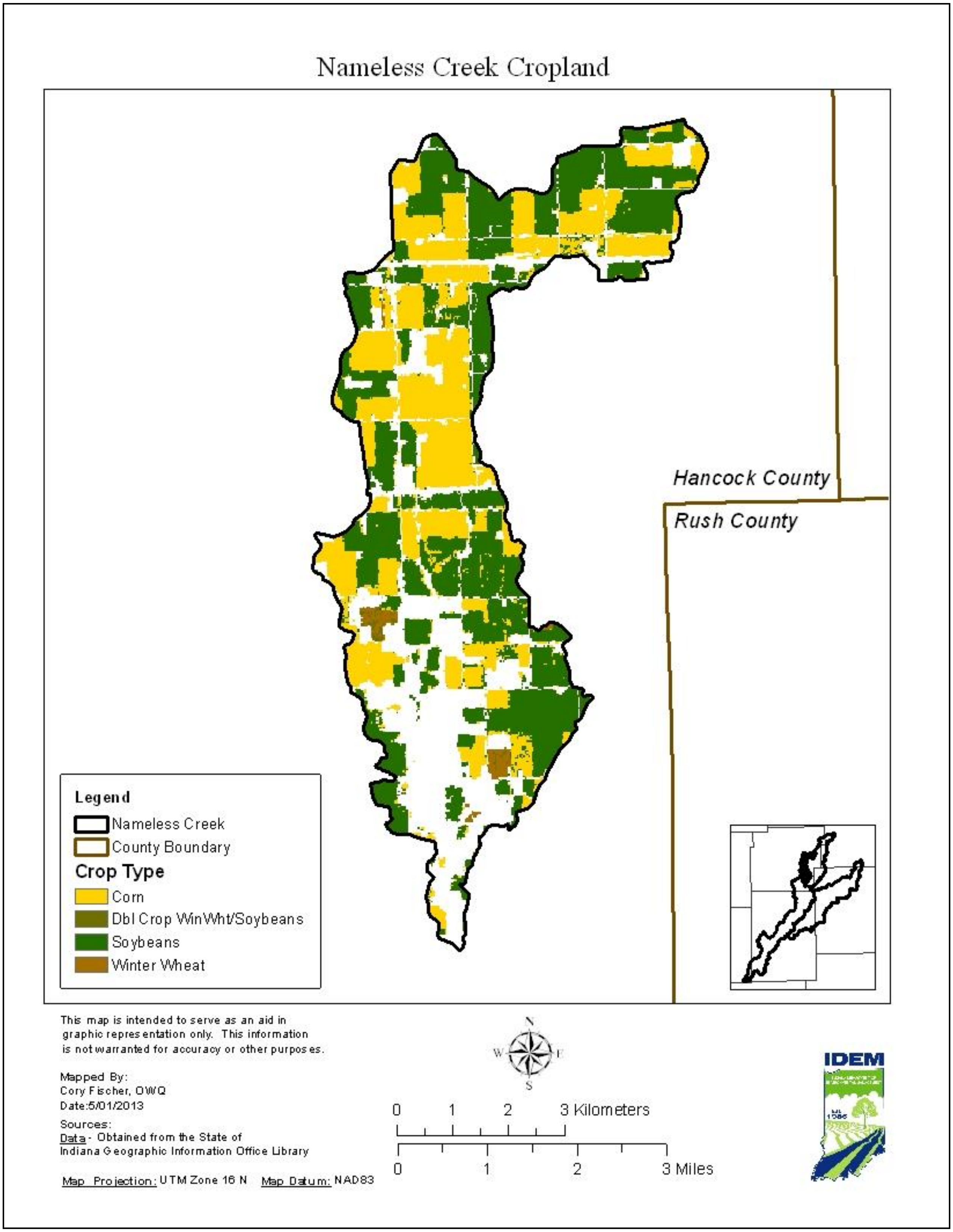


Figure 37. 2012 Cropland in the Nameless Creek Subwatershed

Pastures and Livestock Operations

In the Nameless Creek subwatershed, 5 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 10,273 animal units in the Nameless Creek subwatershed and the animal unit density is 625 animal units per square mile as shown in Table 52.

Table 52. Animal Unit Density in the Nameless Creek Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
16.43	Hogs and Pigs	21,396	2.5	8,558	625
	Cattle and Calves	919	1	919	
	Sheep and Lambs	595	10	59	
	Horses and Ponies	368	0.5	736	
			TOTAL	10,273	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified by IDEM as CFOs are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There is one CFO in the Nameless Creek subwatershed as shown in Table 53 and Figure 38.

Table 53. CFOs in the Nameless Creek Subwatershed

Operation Name	Farm ID	Animal Type and Unit
SSZ Enterprises	1901	Nursery Pigs: 975 Finishers: 325 Sows: 118

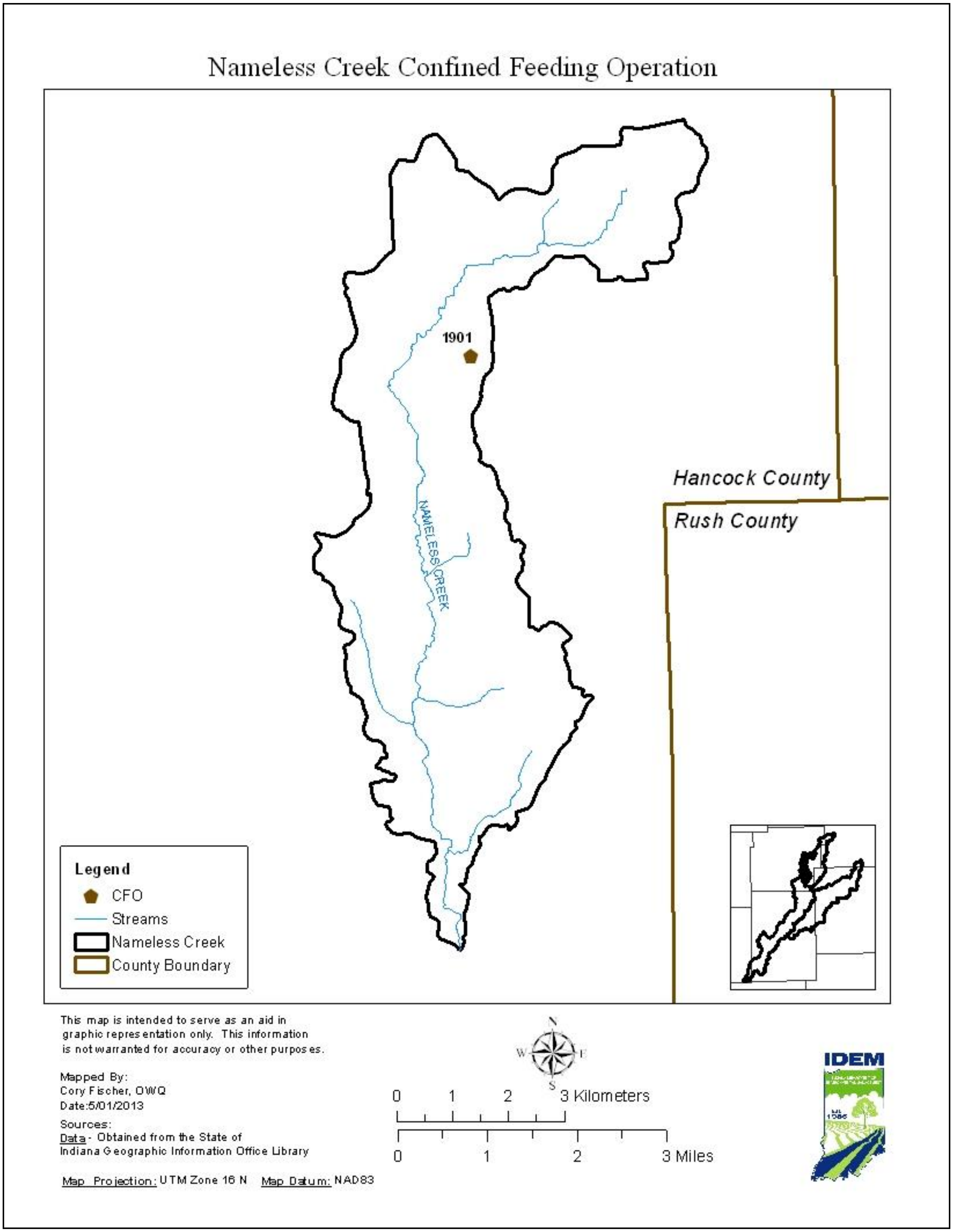


Figure 38. Confined Feeding Operation in the Nameless Creek Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Nameless Creek subwatershed is shown in Table 54, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 54. Rural Population Density in the Nameless Creek Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Hancock	16.43	1,133	0	1,133	68.96

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Nameless Creek watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Nameless Creek watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Nameless Creek subwatershed is dominated by agriculture. Sources of impairment include a CFO, unregulated storm water, wildlife, and agricultural nonpoint source. These characteristics are likely to affect the amount of *E. coli* loading found in the Nameless Creek subwatershed.

4.2.9 Subwatershed Summary: Prairie Branch- Big Blue River

This section of the report presents the available information on the sources of *E. coli* in the Prairie Branch- Big Blue River subwatershed.

The Prairie Branch- Big Blue River subwatershed is located in the west central portion of the Lower Big Blue River Watershed, covering nearly 17 square miles (Figure 39). The Prairie Branch- Big Blue River subwatershed drains portions of Hancock and Shelby Counties. Land use in the Prairie Branch- Big Blue River subwatershed is primarily agriculture (82%) as shown in Table 55.

Table 55. Land Use in the Prairie Branch- Big Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	3.56	0.01	0.03
Developed, Open Space	493.94	0.77	4.43
Developed, Low Intensity	NA	NA	NA
Developed, Medium Intensity	NA	NA	NA
Developed, High Intensity	NA	NA	NA
Forested Land	733.68	1.15	6.58
Shrub/Scrub	147.67	0.23	1.33
Pasture/Hay	608.69	0.95	5.46
Agriculture	9,092.39	14.21	81.58
Wetlands	65.16	0.10	0.58
TOTAL	11,145.10	17.41	100

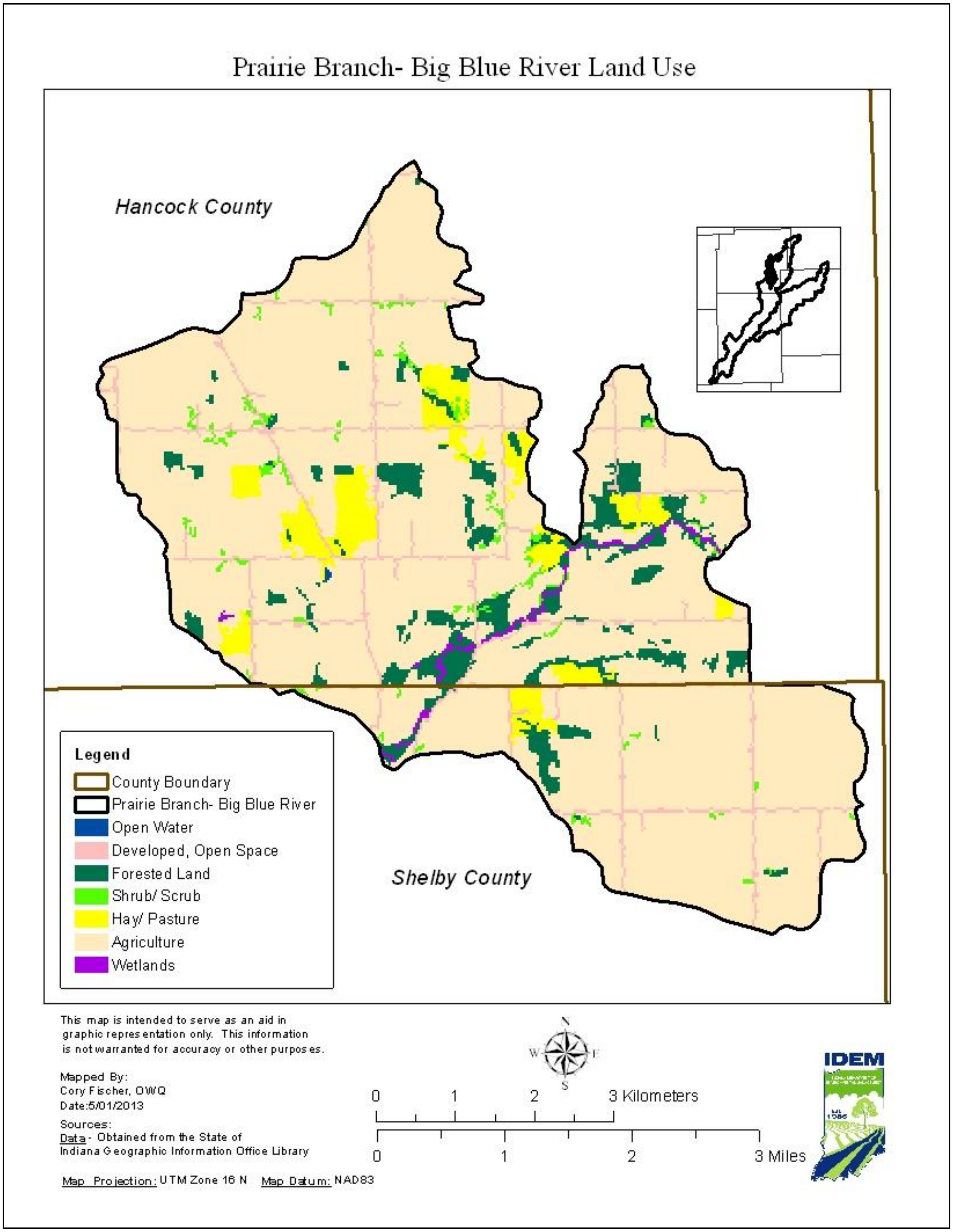


Figure 39. Land Use in the Prairie Branch- Big Blue River Subwatershed

4.2.9.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Prairie Branch- Big Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.9.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Prairie Branch- Big Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 82 percent of the land in the Prairie Branch- Big Blue River subwatershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, fertilization with manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in Prairie Branch- Big Blue River Subwatershed are shown in Table 56 and Figure 40.

Table 56. 2012 Cropland in Prairie Branch- Big Blue River Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	4,071.60	6.36	50.90
Soybean	3,816.07	5.96	47.71
Winter Wheat	45.59	0.07	0.58
Double Crop Winter Wheat/ Soybeans	64.27	0.10	0.81
TOTAL	**7,997.54**	**12.50**	**100**

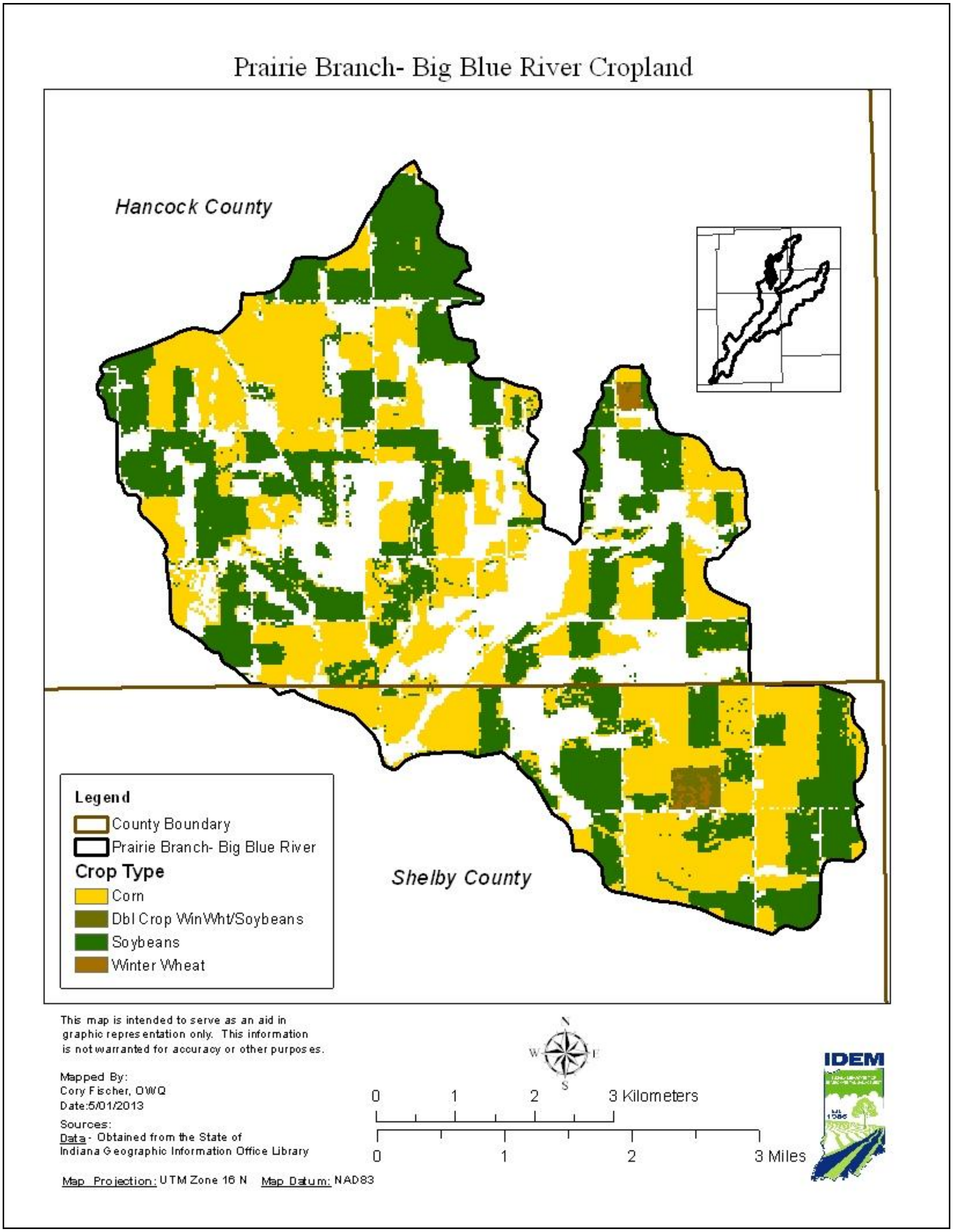


Figure 40. 2012 Cropland in the Prairie Branch- Big Blue River Subwatershed

Pastures and Livestock Operations

In the Prairie Branch- Big Blue River subwatershed, 6 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 8,670 animal units in the Prairie Branch- Big Blue River subwatershed and the animal unit density is 498 animal units per square mile as shown in Table 57.

Table 57. Animal Unit Density in the Prairie Branch- Big Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in Subwatershed	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
17.41	Hogs and Pigs	17,611	2.5	7,044	498
	Cattle and Calves	876	1	876	
	Sheep and Lambs	479	10	48	
	Horses and Ponies	351	0.5	701	
			TOTAL	8,670	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified by IDEM as CFOs are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There is one CFO in the Prairie Branch- Big Blue River subwatershed as shown in Table 58 and Figure 41.

Table 58. CFOs in the Prairie Branch- Big Blue River Subwatershed

Operation Name	Farm ID	AUID	Animal Type and Units
Janes Brothers	637	INW0484_T1003	Nursery Pigs: 300 Finishers: 300 Sows: 40

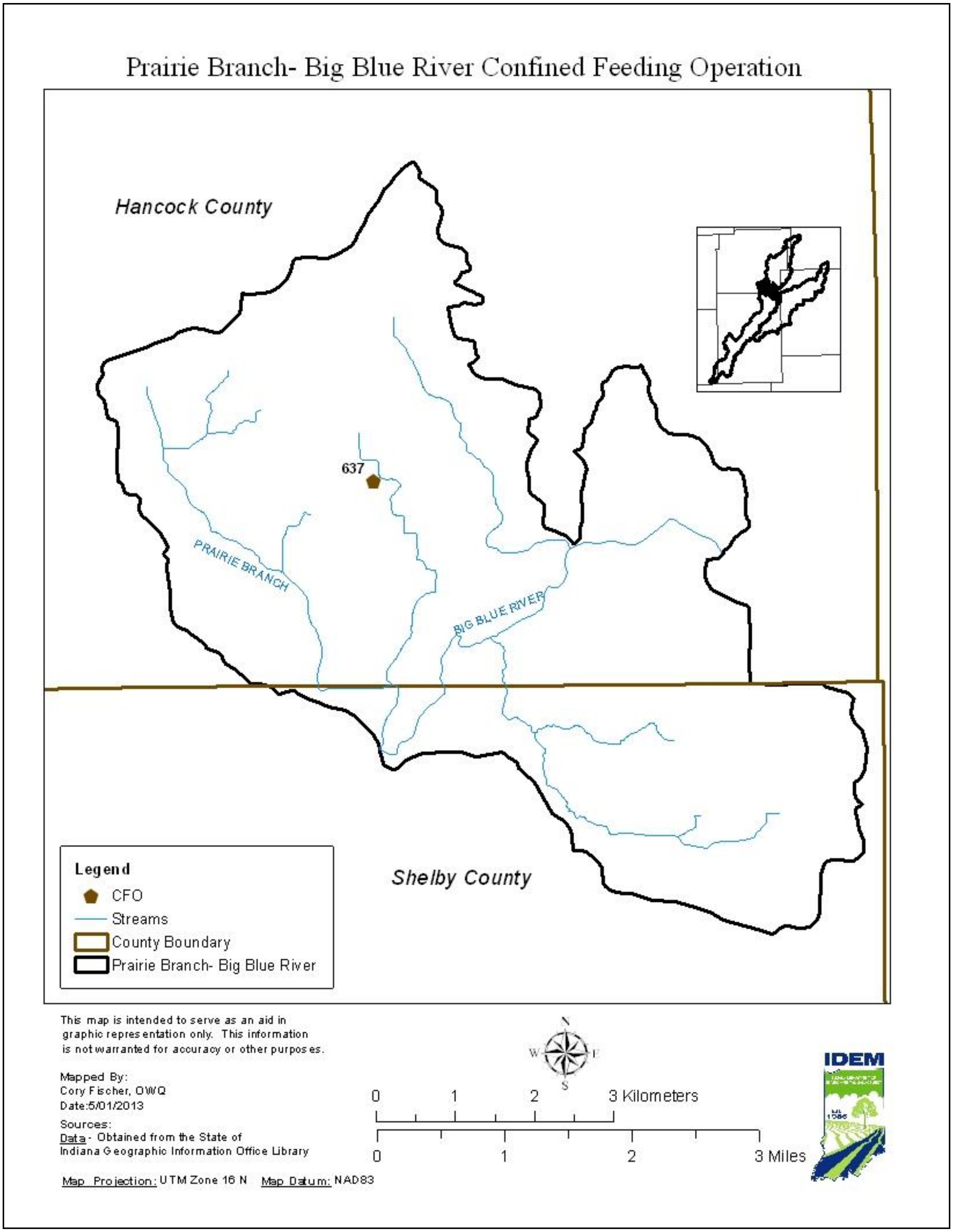


Figure 41. Confined Feeding Operations in the Prairie Branch- Big Blue River Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Prairie Branch- Big Blue River subwatershed is shown in Table 59, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 59. Rural Population Density in the Prairie Branch- Big Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Hancock	12.49	1,046	0	1,046	71.5
Shelby	4.92	139	0	139	
TOTAL	17.41	1,245	0	1,245	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Prairie Branch- Big Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Prairie Branch- Big Blue River watershed.

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Prairie Branch- Big Blue River subwatershed is dominated by agriculture. Sources of impairment include a CFO, wildlife, unregulated storm water, and agricultural nonpoint source. These characteristics are likely to affect the amount of *E. coli* loading found in the Prairie Branch- Big Blue River subwatershed.

4.2.10 Subwatershed Summary: Foreman Branch- Big Blue River

This section of the report presents the available information on the sources of *E. coli* in the Foreman Branch- Big Blue River subwatershed.

The Foreman Branch- Big Blue River subwatershed is located in central portion of the Lower Big Blue River Watershed, covering nearly 39 square miles (Figure 42). The Foreman Branch- Big Blue River subwatershed drains portions of Hancock and Shelby Counties. The subwatershed includes Morristown and the City of Shelbyville. Land use in the Foreman Branch- Big Blue River subwatershed is primarily agriculture (80%) as shown in Table 60.

Table 60. Land Use in the Foreman Branch- Big Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	213.28	0.33	0.86
Developed, Open Space	1,522.52	2.38	6.14
Developed, Low Intensity	352.94	0.55	1.42
Developed, Medium Intensity	91.63	0.14	0.37
Developed, High Intensity	63.83	0.10	0.26
Forested Land	1,695.54	2.65	6.84
Shrub/Scrub	309.57	0.48	1.25
Pasture/Hay	568.00	0.89	2.29
Agriculture	19,810.04	30.95	79.92
Wetlands	159.90	0.25	0.65
TOTAL	24,787.24	38.73	100

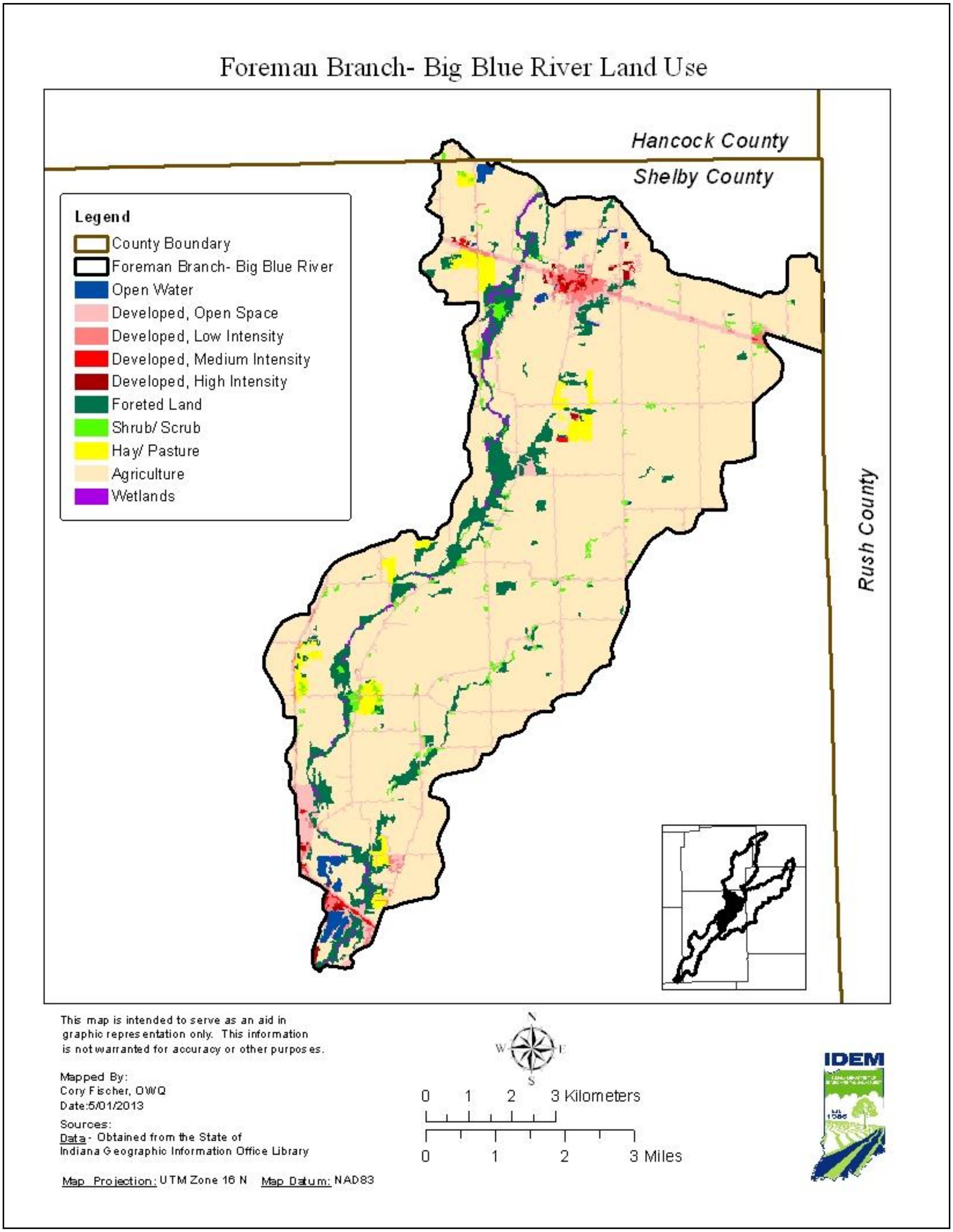


Figure 42. Land Use in the Foreman Branch- Big Blue River Subwatershed

4.2.10.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Foreman Branch- Big Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Wastewater Treatment Plants (WWTPs) and Industrial Facilities

Facilities with NPDES permits to discharge wastewater within the Lower Big Blue River watershed include municipal WWTPs and industrial facilities. There is one active WWTP that discharges wastewater containing *E. coli* within the Foreman Branch- Big Blue River subwatershed (Table 61 and Figure 43). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States. Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31). Table 64 contains the maximum design flow for the active facilities.

Table 61. NPDES Permitted Wastewater Dischargers within the Foreman Branch- Big Blue River Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Morristown WWTP	IN0023841	INW0485_01	Big Blue River	0.6

The Morristown WWTP currently operates a class II, 0.6 MGD activated sludge oxidation ditch-type treatment facility consisting of aerated primary lagoon, primary flow metering, two manual grit removal channels, a mechanical fine screen, a two-ring extended aeration oxidation ditch, two secondary clarifiers, a chlorine contact tank with dechlorination, and an effluent flow meter. The collection system is comprised of 100% separate sanitary sewers be design with no overflow or bypass points. Table 62 shows the average effluent charactersistics for the Morristown WWTP for the past five years.

Table 62. Morristown WWTP *E. coli* Effluent Characteristics

Year	Average *E. coli* Concentration (per 100mL)	Maximum *E. coli* Concentration (per 100mL)	Average Daily Flow (MGD)	Total Annual Flow (MG)
2007	46.00	46.00	0.28	414
2008	2.43	9.00	0.30	503
2009	9.57	43.00	0.30	498
2010	31.14	88.00	0.36	617
2011	21.43	48.00	0.41	701

Table 63 presents a summary of permit compliance for all NPDES facilities in the Foreman Branch- Big Blue River subwatershed for the five year period between 2008 and 2013. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation). The table also presents the total number of violations in the five year period for *E. coli* and other parameters. According to Table 65, there have been nine NPDES facility inspections resulting in no *E. coli* violations in the five year period. Overall, there were no permit violations for *E. coli* in the Foreman Branch- Big Blue River subwatershed.

Table 63. Summary of Inspections and Permit Compliance in the Foreman Branch- Big Blue River Subwatershed for the Five Year Period Ending March 2013

Facility Name	Permit Number	AUID	Date of Last Inspection and Findings	Violations from April 2008 through March 2013
Morristown WWTP	IN0023841	INW0485_01	04/01/2008: No Violations were observed 07/09/2008: Potential Problems Discovered 02/12/2009: Potential Problems Discovered 05/11/2009: No Violations were observed 08/12/2009: Potential Problems Discovered 02/22/2010: Potential Problems Discovered 04/07/2010:No Violations were observed 04/02/2012:Violations were observed 02/19/2013:Potential Problems Discovered	0 *E. coli* violations

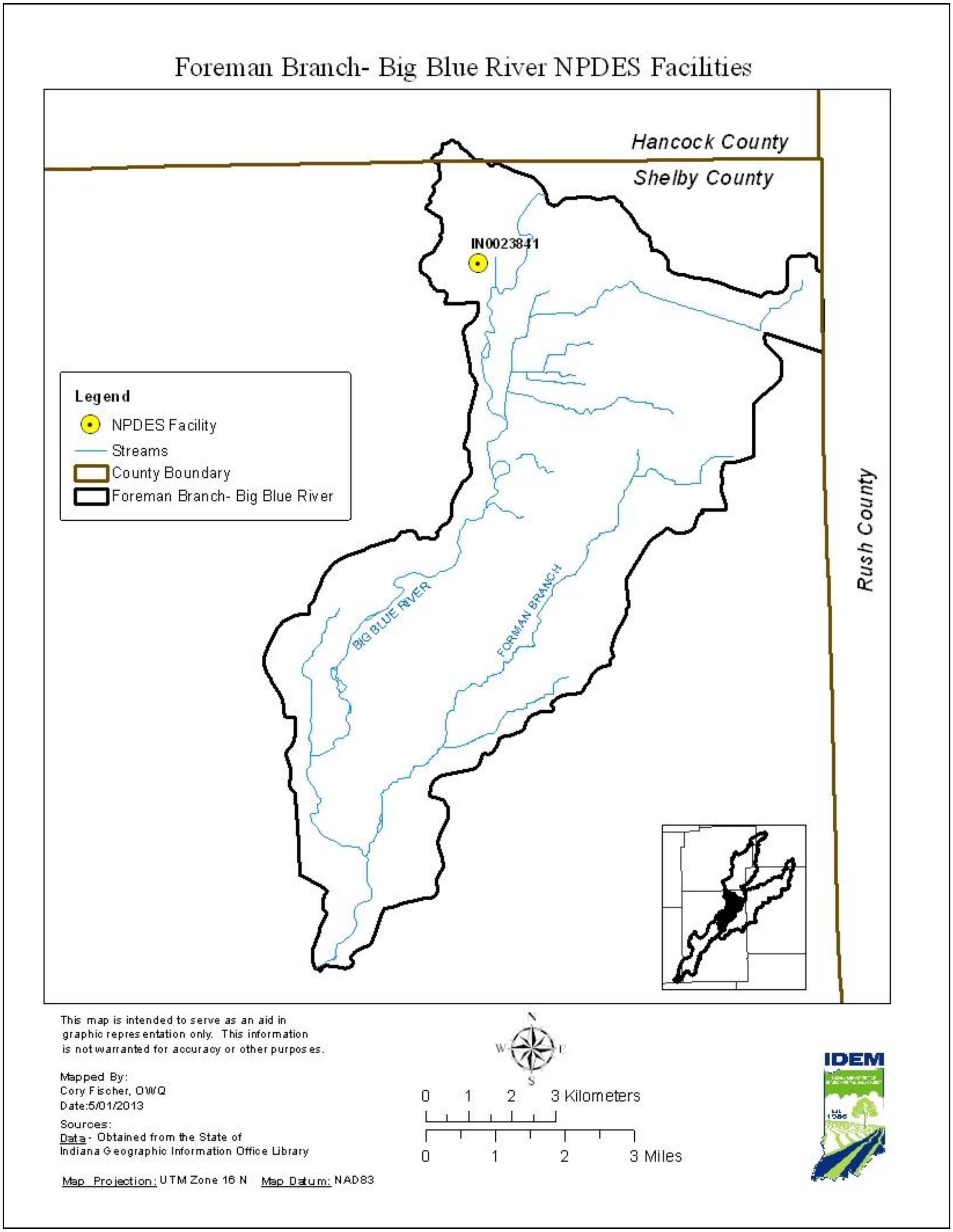


Figure 43. NPDES Facilities in the Foreman Branch- Big Blue River Subwatershed

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections, failing septic systems, fertilizer, construction, and streambank erosion from hydrologic modifications. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. There is one MS4 community in the Foreman Branch- Big Blue River subwatershed as shown in Table 64.

Table 64. Foreman Branch- Big Blue River MS4 Communities

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040051	City of Shelbyville	0.16

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Figure 44 shows the MS4 boundaries in the Foreman Branch- Big Blue River subwatershed. The City of Shelbyville MS4 uses the incorportated area as its jurisdictional boundary. The City of Shelbyville MS4 is only being allocated for the developed area within their jurisdictional boundary. The Shelbyville MS4 Coordinator provided the boundary area that was used in this TMDL.

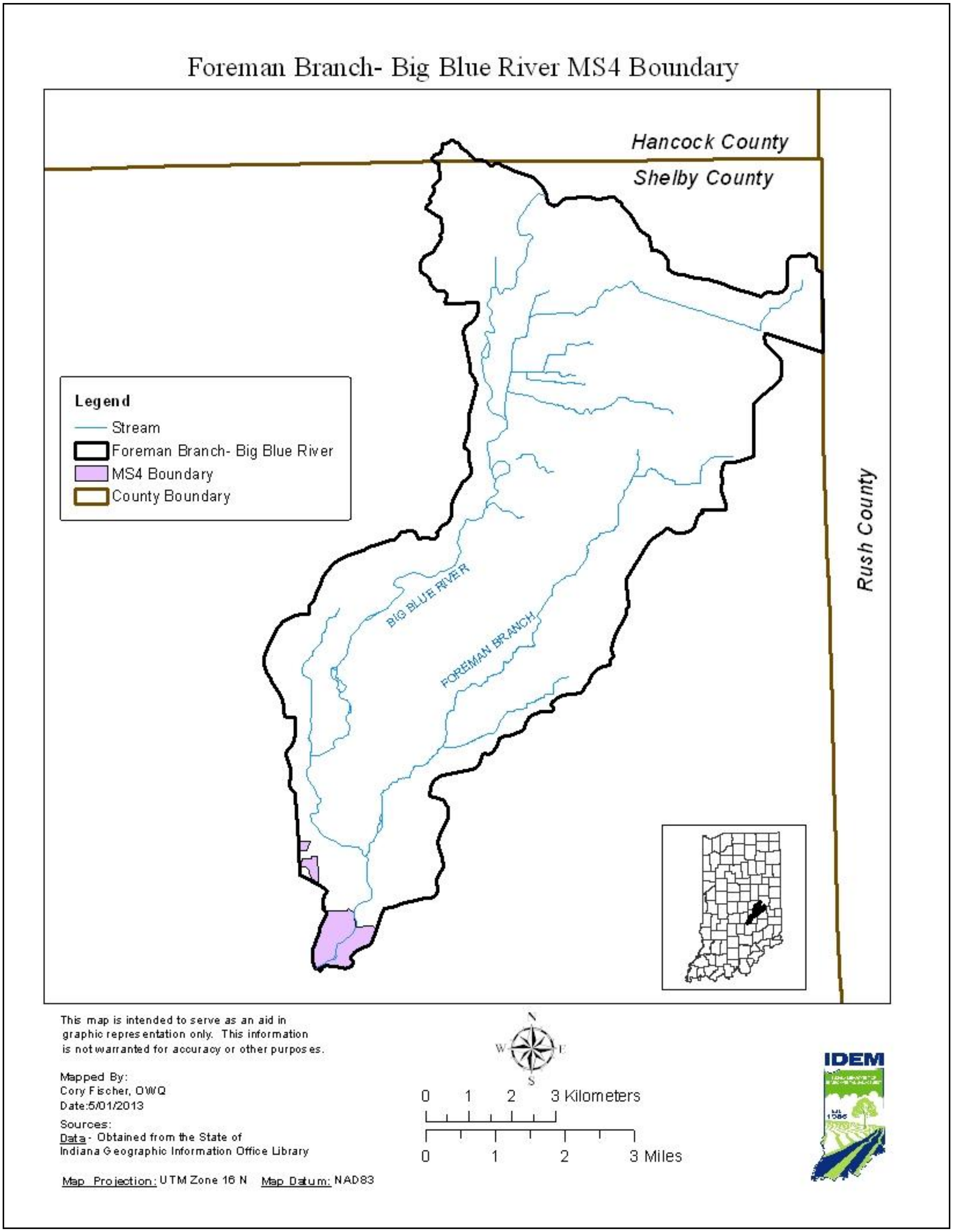


Figure 44. Map of MS4 Boundaries in the Foreman Branch- Big Blue River Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.10.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Foreman Branch- Big Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 80 percent of the land in the Foreman Branch- Big Blue River subwatershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, fertilization with manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in Foreman Branch- Big Blue River Subwatershed is showin in Table 65 and Figure 45.

Table 65. 2012 Cropland in Foreman Branch- Big Blue River Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	9,500.71	14.84	52.96
Soybean	8,357.82	13.06	46.59
Winter Wheat	43.37	0.07	0.24
Double Crop Winter Wheat/ Soybeans	39.36	0.06	0.21
TOTAL	**17,941.26**	**28.03**	**100**

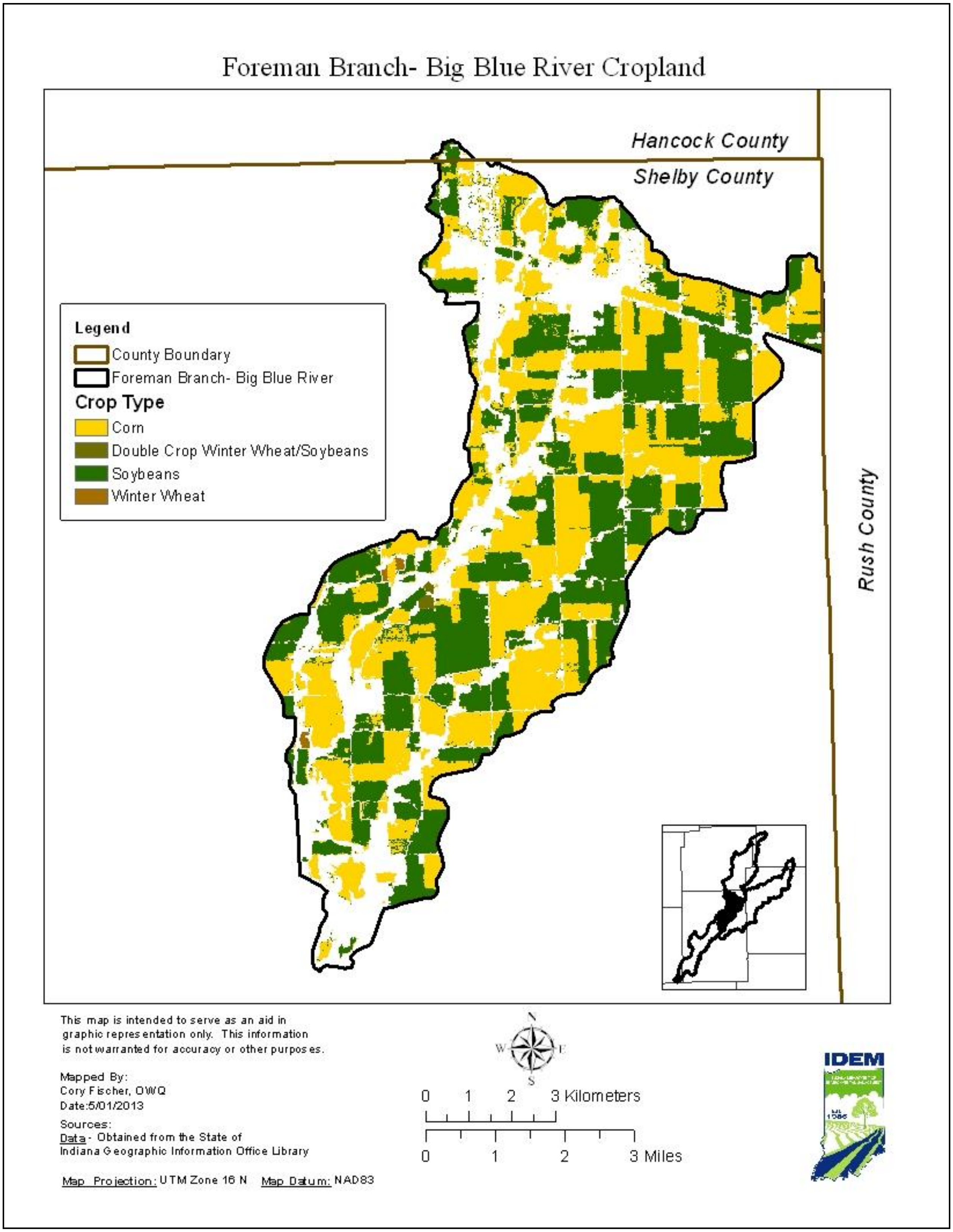


Figure 45. 2012 Cropland in the Foreman Branch- Big Blue River Subwatershed

Pastures and Livestock Operations

In the Foreman Branch- Big Blue River subwatershed, 2 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 6,822 animal units in the Foreman Branch- Big Blue River subwatershed and the animal unit density is 392 animal units per square mile as shown in Table 66.

Table 66. Animal Unit Density in the Foreman Branch- Big Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
17.41	Hogs and Pigs	10,704	2.5	4,282	392
	Cattle and Calves	1,399	1	1,399	
	Sheep and Lambs	216	10	22	
	Horses and Ponies	560	0.5	1,119	
			TOTAL	6,822	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified by IDEM as CFOs are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

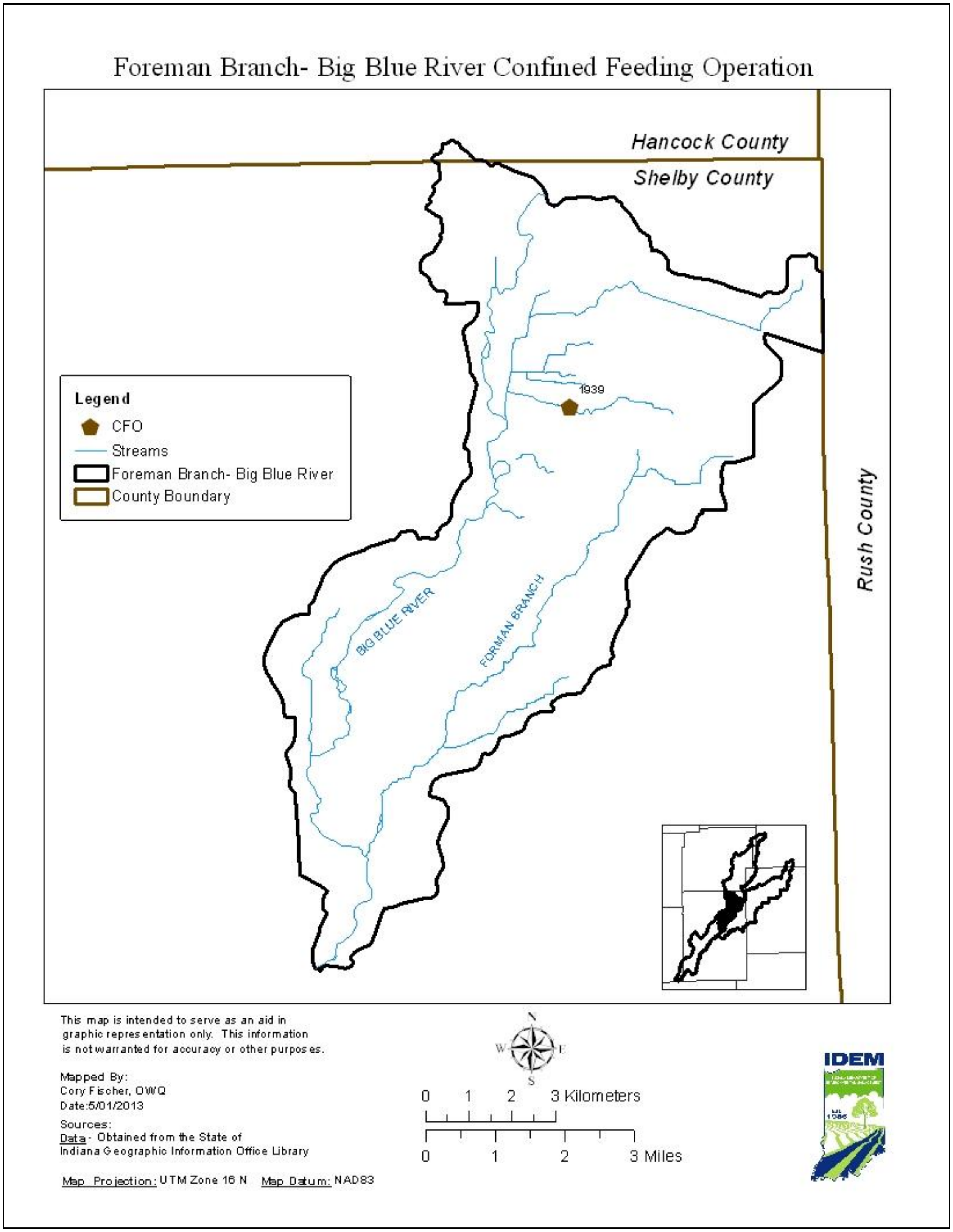
Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure over application or improper application can adversely impact soil productivity.

There is one CFO in the Foreman Branch- Big Blue River Subwatershed.

Table 67. CFOs in the Foreman Branch- Big Blue River Subwatershed

NPDES Permit ID	Operation Name	County	Animal Type and Units
1939	Signature Farms	Shelby	5,970 Sows



46. Confined Feeding Operations in the Foreman Branch- Big Blue River Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Foreman Branch- Big Blue River subwatershed is shown in Table 68, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 68. Rural Population Density in the Foreman Branch- Big Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Hancock	0.1109	60	0	60	77.2
Rush	0.0017	8	0	8	
Shelby	38.61	4,762	1,841	2,921	
TOTAL	38.72	4,830	1,841	3,057	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Foreman Branch- Big Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Foreman Branch- Big Blue River watershed.

Dog and cat populations were estimated for the Foreman Branch- Big Blue River watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are

[1] http://www.avma.org/reference/marketstats/sourcebook.asp

likely only a significant source of *E. coli* in population centers (i.e., cities and towns). The estimates of domestic pets in cities and towns in the watershed are presented in Table 69 and are based on the average number of pets per household multiplied by the households of the watershed.

Table 69. Estimated Pet Populations in the Cities and Towns in the Foreman Branch- Big Blue River Watershed

City/Town	Households 2010	Estimated Number of Cats	Estimated Number of Dogs
Morristown	532	1,171	905
Shelbyville	399	878	679
Total	931	2,049	1,584

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Foreman Branch- Big Blue River subwatershed is dominated by agriculture. Sources of impairment include WWTP, MS4, unregulated storm water, agricultural nonpoint source, and wildlife. Specifically, Foreman Branch- Big Blue River is characterized by one small WWTP with no permit violations, one MS4 community, one CFO, and predominately agricultural land use. These characteristics are likely to affect the amount of *E. coli* loading found in the Foreman Branch- Big Blue River subwatershed.

4.2.11 Subwatershed Summary: DePrez Ditch- Big Blue River

This section of the report presents the available information on the sources of *E. coli* in the DePrez Ditch- Big Blue River subwatershed.

The DePrez Ditch- Big Blue River subwatershed is located in southern portion of the Lower Big Blue Watershed, covering nearly 28 square miles (Figure 47). The DePrez Ditch- Big Blue River subwatershed drains portions of Shelby County. The DePrez Ditch- Big Blue River includes The City of Shelbyville. Land use in the DePrez Ditch- Big Blue River subwatershed is primarily agriculture (75%) as shown in Table 70.

Table 70. Land Use in the DePrez Ditch- Big Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	172.58	0.27	0.96
Developed, Open Space	1,173.13	1.83	6.56
Developed, Low Intensity	717.89	1.12	4.01
Developed, Medium Intensity	490.60	0.77	2.74
Developed, High Intensity	174.36	0.27	0.97
Forested Land	1,260.76	1.97	7.05
Shrub/Scrub	26.91	0.04	0.15
Pasture/Hay	280.44	0.44	1.57
Agriculture	13,459.78	21.03	75.21
Wetlands	139.66	0.22	0.78
TOTAL	17,896.11	27.96	100

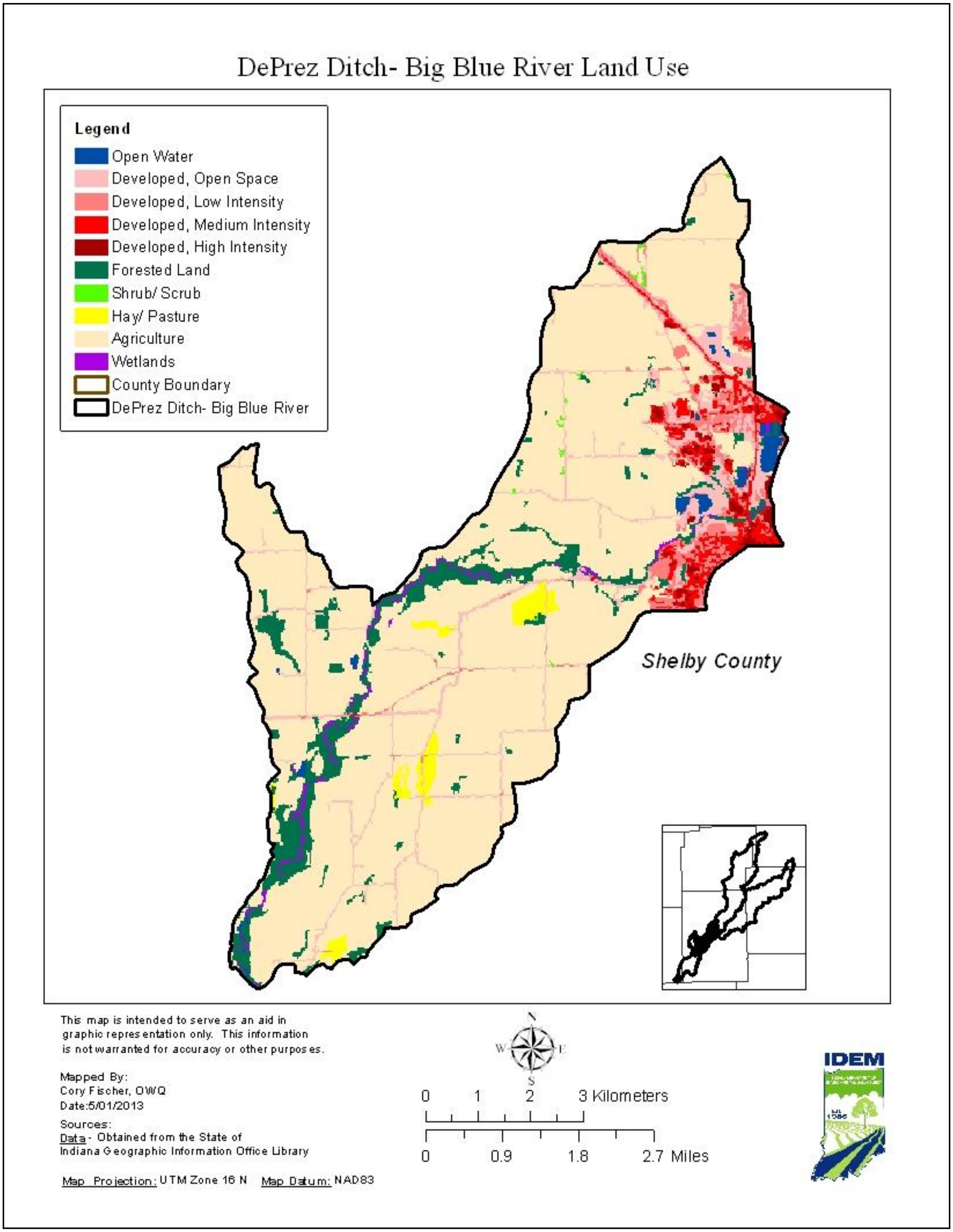


Figure 47. Land Use in the DePrez Ditch- Big Blue River Subwatershed

4.2.11.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the DePrez Ditch- Big Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Wastewater Treatment Plants (WWTPs) and Industrial Facilities

Facilities with NPDES permits to discharge wastewater within the Lower Big Blue River watershed include municipal WWTPs and industrial facilities. There is one active WWTP that discharges wastewater containing *E. coli* within the DePrez Ditch- Big Blue River subwatershed (Table 71 and Figure 48). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States. Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31).

Table 71. NPDES Permitted Wastewater Dischargers within the DePrez Ditch- Big Blue River Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Shelbyville WWTP	IN0032867	INW0486_01	Big Blue River	8.0

The Shelbyville WWTP currently operates a class IV, 8.0 MGD trickling filter/ solids contact treatment facility consisting of an influent flow meter, grit removal, three primary clarifiers, three trickling filters, two solids contact tanks, three secondary clarifiers, ultraviolet light disinfection, and effluent flow measurement. Sludge is digested, belt pressed, and is either land applied or landfilled. The collection system is comprised of 100% sanitary sewers by design with one Sanitary Sewer Overflow (SSO) point. Table 72 shows the effluent characteristics for the Shelbyville WWTP for the past five years.

Sanitary sewer overflows (SSOs) are unintentional and illegal discharges of raw sewage from municipal sanitary sewers. SSOs discharge *E. coli* to waterbodies and may occur due to:

- Vandalism
- Severe weather resulting in of excessive runoff of storm water into sewer lines
- Improper operation and maintenance
- Malfunction of lift stations
- Electrical power failures

Table 72. Shelbyville WWTP *E. coli* Effluent Characteristics

Year	Average *E. coli* Concentration (per 100mL)	Maximum *E. coli* Concentration (per 100mL)	Average Daily Flow (MGD)	Total Annual Flow (MG)
2007	29.29	47.00	5.56	11,805
2008	25.96	42.35	6.10	13,112
2009	55.12	98.78	5.47	11,619
2010	50.97	177	4.86	10,406
2011	26.89	62.10	6.00	10,646

Table 73 presents a summary of permit compliance for all NPDES facilities in the DePrez Ditch- Big Blue River subwatershed for the five year period between 2008 and 2013. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation). The table also presents the total number of violations in the five year period for *E. coli*. According to Table 73 there have been five NPDES facility inspections resulting in three violations in the five year period. Overall, there are a total of 11 permit violations for *E. coli* in the DePrez Ditch- Big Blue River subwatershed.

Table 73. Summary of Inspections and Permit Compliance in the DePrez Ditch- Big Blue River Subwatershed for the Five Year Period Ending March 2013

Facility Name	Permit Number	AUID	Date of Last Inspection and Findings	Violations from July 2009 through March 2013
Shelbyville WWTP	IN0032867	INW0486_01	06/03/2008: No violations Oberved 03/03/2009: Potential Problems Observed 08/05/2009: Violations were observed 08/29/2011: Violations were observed 03/07/2013: Violations were observed	11 *E. coli* violations

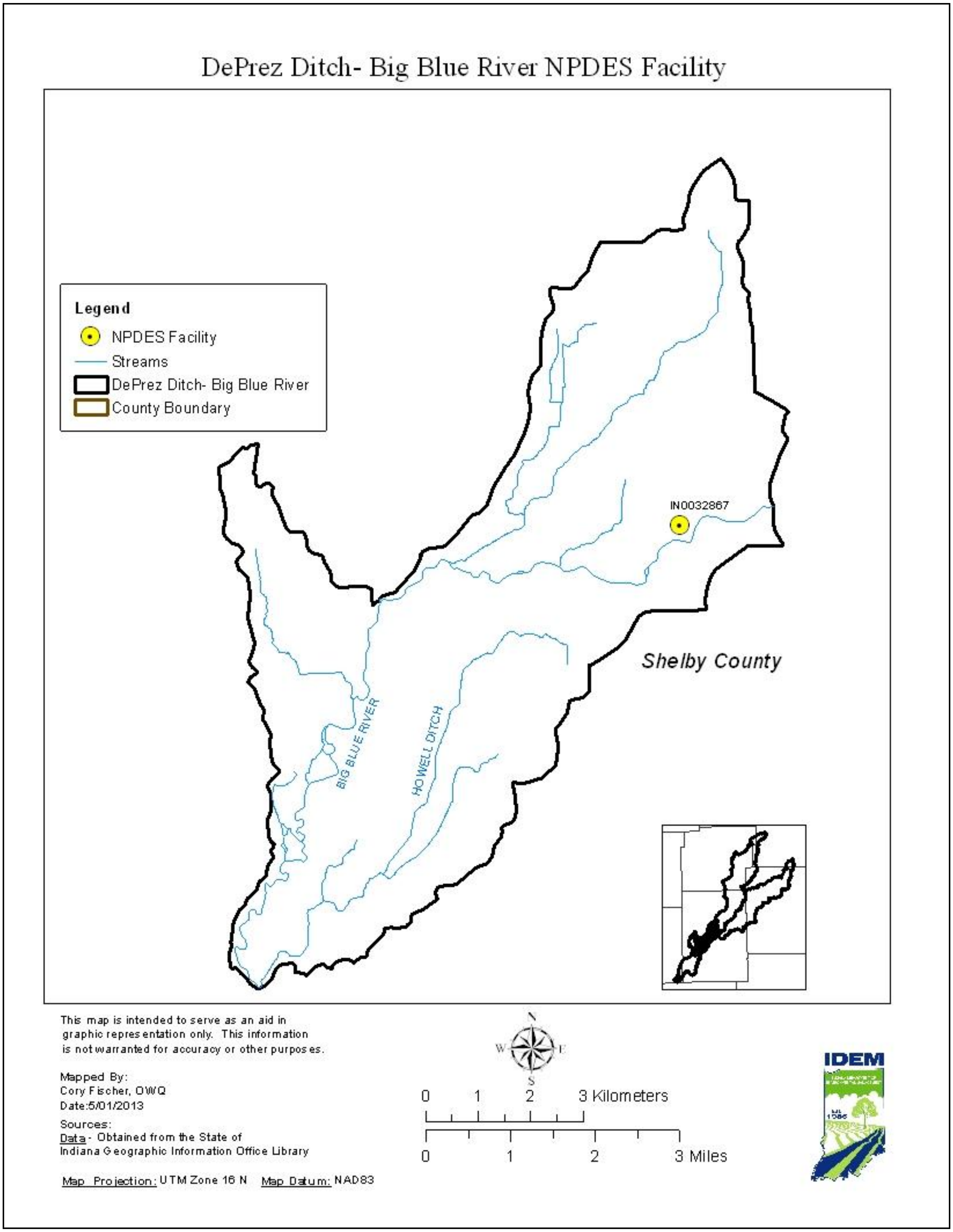


Figure 48. NPDES Facilities in the DePrez Ditch- Big Blue River Subwatershed

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections, failing septic systems, fertilizer, construction, and streambank erosion from hydrologic modifications. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. There is one MS4 community in the DePrez Ditch- Big Blue River subwatershed as shown in Table 74.

Table 74. DePrez Ditch- Big Blue River MS4 Communities

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040051	City of Shelbyville	2.93

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Figure 49 shows the MS4 boundaries in the DePrez Ditch- Big Blue River subwatershed. The City of Shelbyville MS4 uses the incorportated area as its jurisdictional boundary. The City of Shelbyville MS4 is only being allocated for the developed area within their jurisdictional boundary. The Shelbyville MS4 Coordinator provided the boundary area that was used in this TMDL.

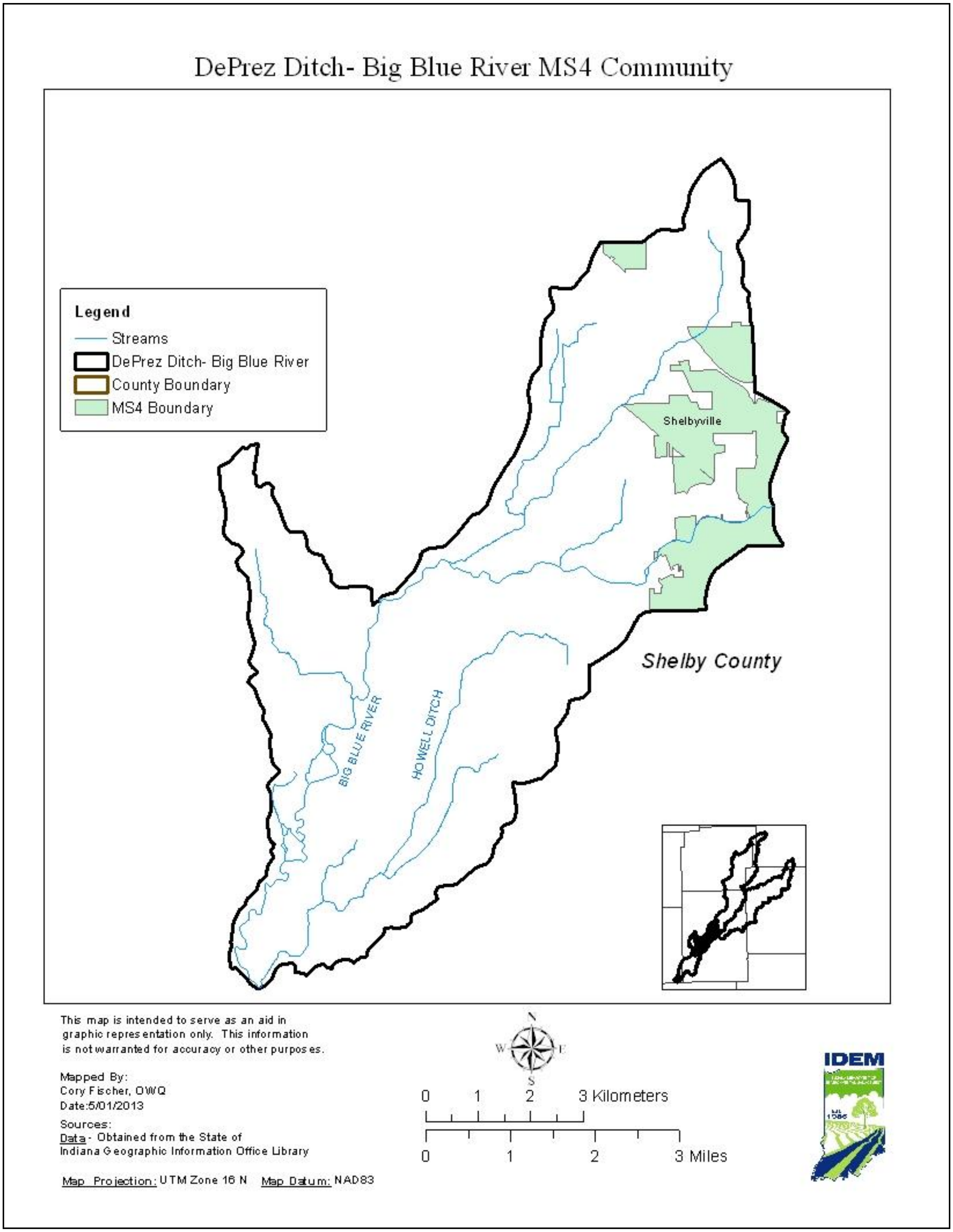


Figure 49. Map of MS4 Boundaries in the DePrez Ditch- Big Blue River Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.11.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the DePrez Ditch- Big Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately 75 percent of the land in the subwatershed is classified as row crops. Accumulation of *E. coli* on cropland occurs from decomposition of residual crop material, fertilization with chemical (e.g., anyhdrous ammonia) and manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Cropland in DePrez Ditch- Big Blue River Subwatershed is shown in Table 75 and Figure 50.

Table 75. 2012 Cropland in DePrez Ditch- Big Blue River Subwatershed

Cropland	Area		Percent
	Acres	Square Miles	
Corn	6,875.78	10.74	54.93
Soybean	5,283.88	8.26	42.22
Winter Wheat	28.24	0.04	0.23
Double Crop Winter Wheat/ Soybeans	327.81	0.51	2.62
TOTAL	**12,515.71**	**19.55**	**100**

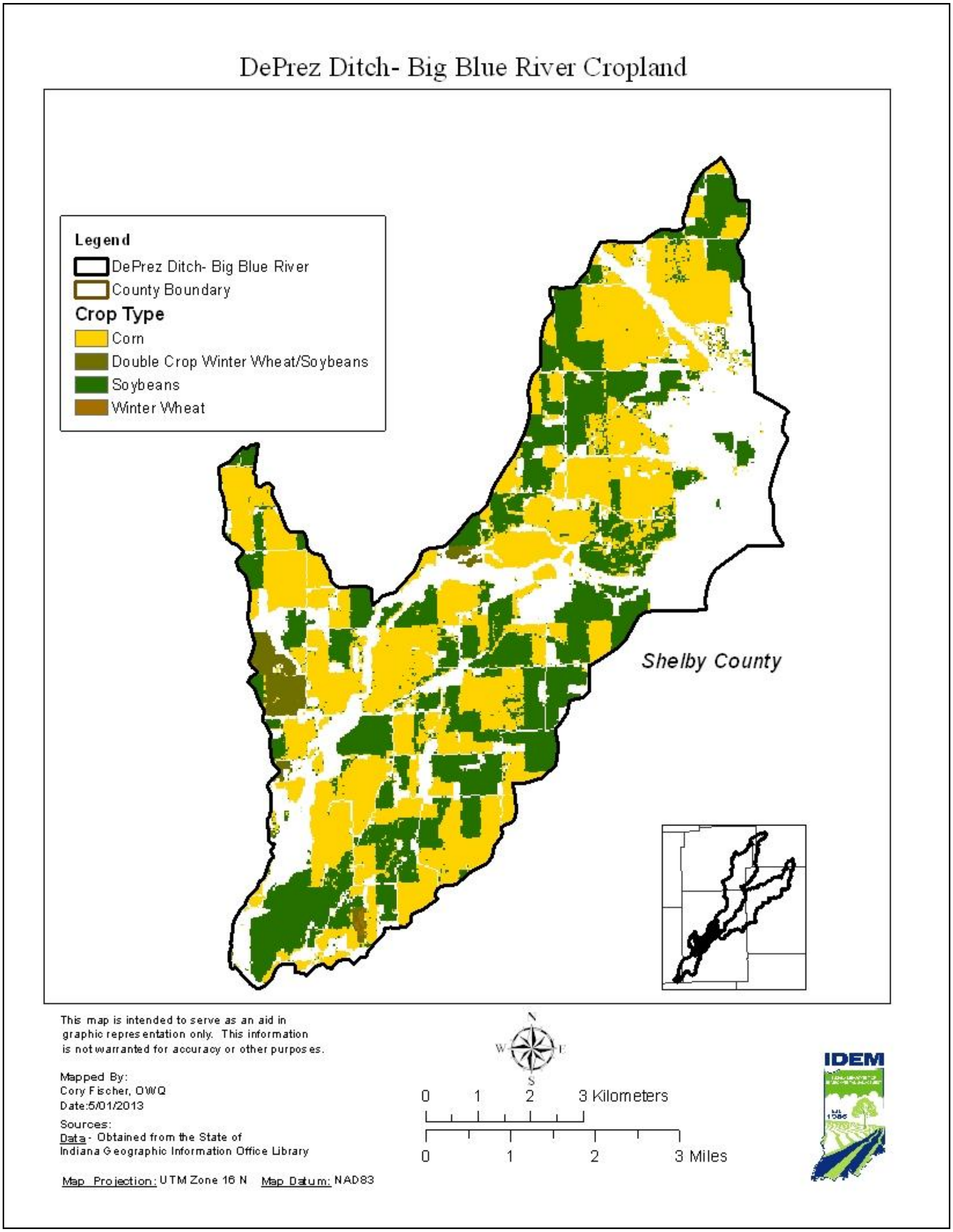


Figure 50. 2012 Cropland in the DePrez Ditch- Big Blue River Subwatershed

Pastures and Livestock Operations

In the DePrez Ditch- Big Blue River subwatershed, 2 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 4,891 animal units in the DePrez Ditch- Big Blue River subwatershed and the animal unit density is 175 animal units per square mile as shown in Table 76.

Table 76. Animal Unit Density in the DePrez Ditch- Big Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
27.97	Hogs and Pigs	7,648	2.5	3,059	175
	Cattle and Calves	1,009	1	1,009	
	Sheep and Lambs	154	10	15	
	Horses and Ponies	404	0.5	807	
			TOTAL	4,891	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified by IDEM as CFOs are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There is one CFO in the DePrez Ditch- Big Blue River subwatershed as shown in Table 77 and Figure 51.

Table 77. CFOs in the DePrez Ditch- Big Blue River Subwatershed

Operation Name	Farm ID	Animal Type and Unit	County
Jarrod Law and Michael Pauszek	2208	600 Nursery Pigs 280 Sows	Shelby

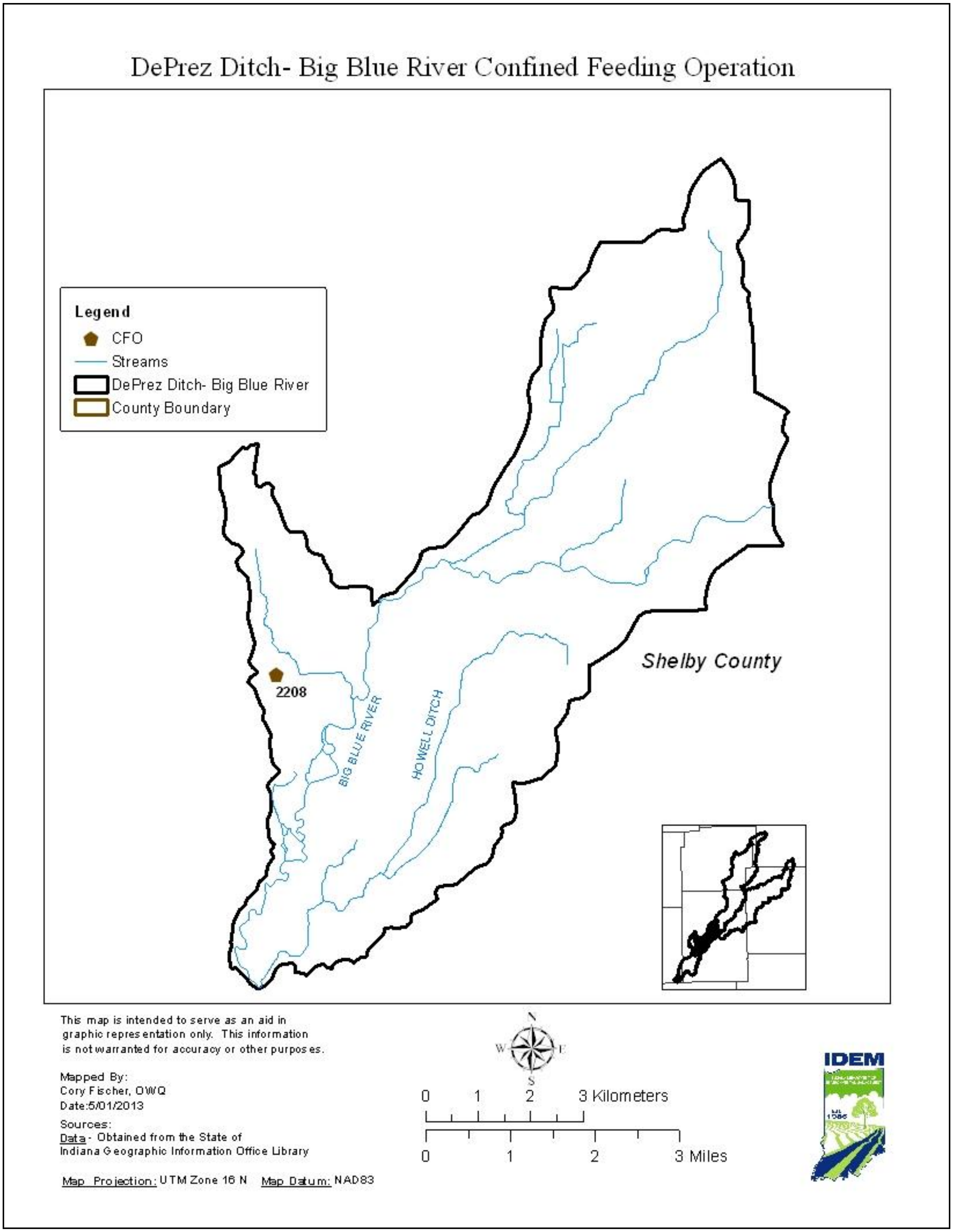


Figure 51. Confined Feeding Operation in the DePrez Ditch- Big Blue River Subwatershed

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: [410 IAC 6-8.1-31]

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the DePrez Ditch- Big Blue River subwatershed is shown in Table 78, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 78. Rural Population Density in the DePrez Ditch- Big Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	2010 County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Shelby	27.97	7,401	5622	1779	63.6

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the DePrez Ditch- Big Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the DePrez Ditch- Big Blue River watershed.

Dog and cat populations were estimated for the DePrez Ditch- Big Blue River watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* in population centers (i.e., cities and towns). The estimates of domestic

[1] http://www.avma.org/reference/marketstats/sourcebook.asp

pets in cities and towns in the watershed are presented in Table 79 and is based on the average number of pets per household multiplied by the households of the watershed.

Table 79. Estimated Pet Populations in the Cities and Towns in the DePrez Ditch- Big Blue River Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Shelbyville	2,934	6,555	4,988

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the DePrez Ditch- Big Blue River subwatershed is dominated by agriculture. Sources of impairment include the WWTP, the MS4, one CFO, agricultural nonpoint source, and wildlife, which are likely to affect the amount of *E. coli* loading found in subwatershed.

4.2.12 Subwatershed Summary: Shaw Ditch- Big Blue River

This section of the report presents the available information on the sources of *E. coli* in the Shaw Ditch- Big Blue River subwatershed.

The Shaw Ditch- Big Blue River subwatershed is located in the southern most portion of the Lower Big Blue Watershed, covering nearly 29 square miles (Figure 52). The Shaw Ditch- Big Blue River drains portions of Johnson and Shelby Counties. The Shaw Ditch- Big Blue River includes a portion of the Town of Edinburgh. Land use in the Shaw Ditch- Big Blue River is primarily agriculture (71%) as shown in Table 80.

Table 80. Land Use in the Shaw Ditch- Big Blue River Subwatershed

Land Use	Area		Percent
	Acres	Square Miles	
Open Water	161.01	0.25	0.86
Developed, Open Space	862.45	1.35	4.60
Developed, Low Intensity	235.07	0.37	1.25
Developed, Medium Intensity	51.82	0.08	0.28
Developed, High Intensity	24.02	0.04	0.13
Forested Land	2,723.22	4.26	14.51
Shrub/Scrub	62.05	0.10	0.33
Pasture/Hay	1,157.34	1.81	6.17
Agriculture	13,327.68	20.82	71.02
Wetlands	160.35	0.25	0.85
TOTAL	18,765.01	29.32	100

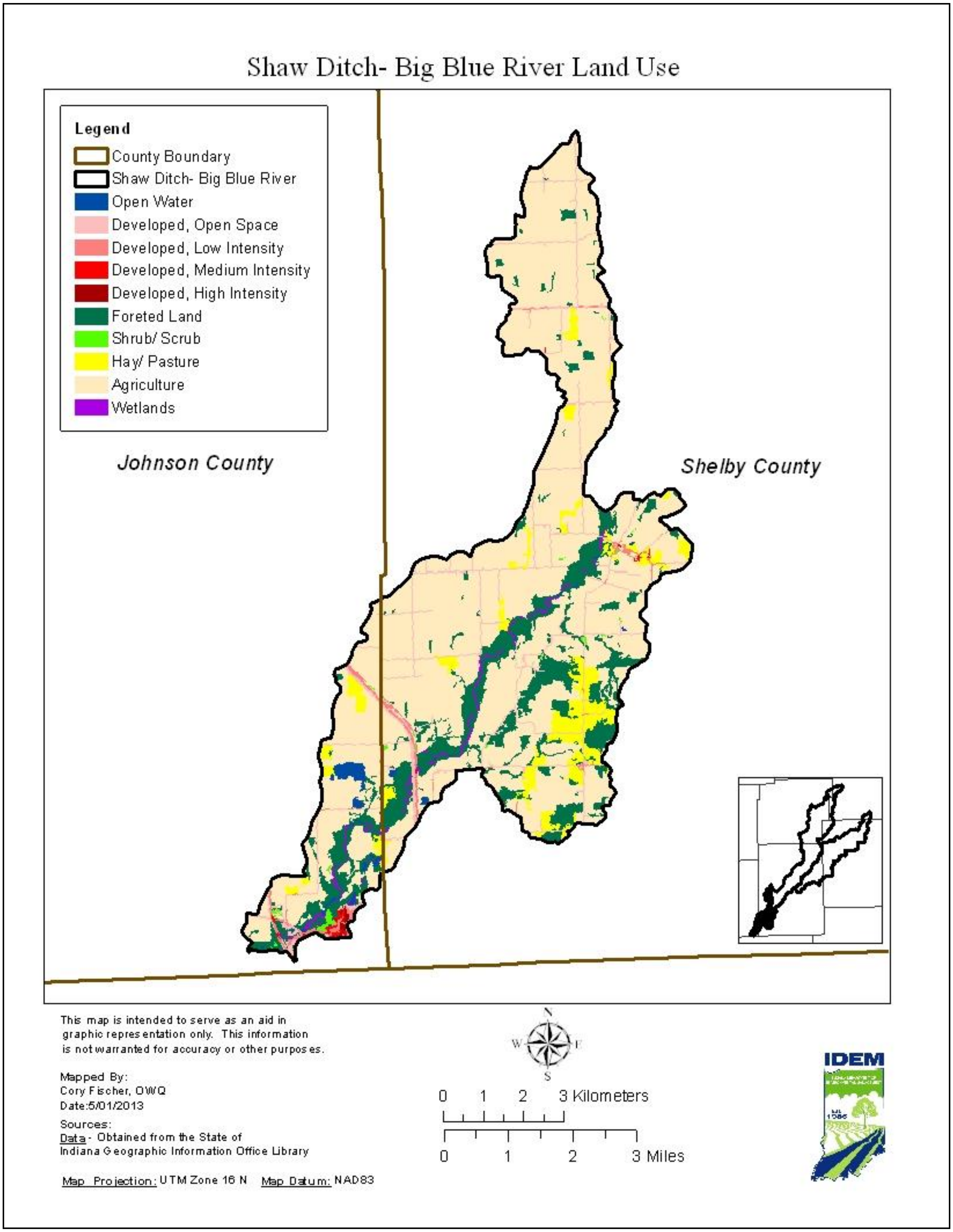


Figure 52. Land Use in the Shaw Ditch- Big Blue River Subwatershed

4.2.12.1 Point Sources

This section summarizes the potential point sources of *E. coli* in the Shaw Ditch- Big Blue River subwatershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Wastewater Treatment Plants (WWTPs) and Industrial Facilities

Facilities with NPDES permits to discharge wastewater within the Lower Big Blue River watershed include municipal WWTPs and industrial facilities. There is one active WWTP that discharges wastewater containing *E. coli* within the Shaw Ditch- Big Blue River subwatershed (Table 83 and Figure 53). As authorized by the Clean Water Act, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States. Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31).

Table 82. NPDES Permitted Wastewater Dischargers within the Shaw Ditch- Big Blue River Subwatershed

Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Edinburgh WWTP	IN0020184	INW0487_01	Big Blue River	1.5

The Edinburgh WWTP currently operates a class III, 1.5 MGD extended aeration treatment facility consisting of two (2) vertical loop reactors, an in-channel grinder, grit/fine screening, two (2) secondary clarifiers, ultra-violet light disinfection, influent/effluent flow meters, a 9.0 MGD two- celled surge lagoon and a cascade post aeration. The collection system is comprised of sanitary and storm sewers with no known overflow or bypasses points. The combined sewers have been permitted with provisions. The collections system is comprised of combined sanitary and storm sewers with no known overflow or bypass points. Any discharge from any portion of the POTW, including the collections system, with the exception of outfall 001 (treated water outfall), is expressly prohibited. Based on our review of the Town of Edinburgh's NPDES permit renewal application, IDEM does not consider the Town to have any active CSO outfalls. Therefore, there is no need for Edinburgh to develop a Long Term Control Plant (LTCP). However, because the collection system contains combined sewers, it is necessary to develop and submit a CSO Operational Plan. Table 81 show the Edinburgh WWTP's effluent characteristics over the past five years.

Table 81. Edinburgh WWTP *E. coli* Effluent Characteristics

Year	Average *E. coli* Concentration (per 100mL)	Maximum *E. coli* Concentration (per 100mL)	Average Daily Flow (MGD)	Total Annual Flow (MG)
2007	0.79	1.00	0.67	955
2008	1.29	3.00	0.87	1,122
2009	1.29	4.00	0.55	710
2010	0.86	1.00	0.59	754
2011	1.14	2.00	0.84	1,073

Table 83 presents a summary of permit compliance for all NPDES facilities in the Shaw Ditch- Big Blue River subwatershed for the five year period between 2008 and 2013. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation). The table also presents the total number of violations in the five year period for *E. coli* and other parameters. According to Table 84 there have been 5five NPDES facility inspections resulting in no violations in the five year period.

Table 83. Summary of Inspections and Permit Compliance in the Shaw Ditch- Big Blue River Subwatershed for the Five Year Period Ending August 2013

Facility Name	Permit Number	AUID	Date of Last Inspection and Findings	Violations from July 2008 through August 2013
Edinburgh WWTP	IN0020184	INW0487_01	07/09/2008: No Violations Obeserved 03/16/2010: No Violations Obeserved 06/22/2011: No Violations Obeserved 10/29/2012: No Violations Obeserved 08/20/2013: No Violations Obeserved	0 *E. coli* violations

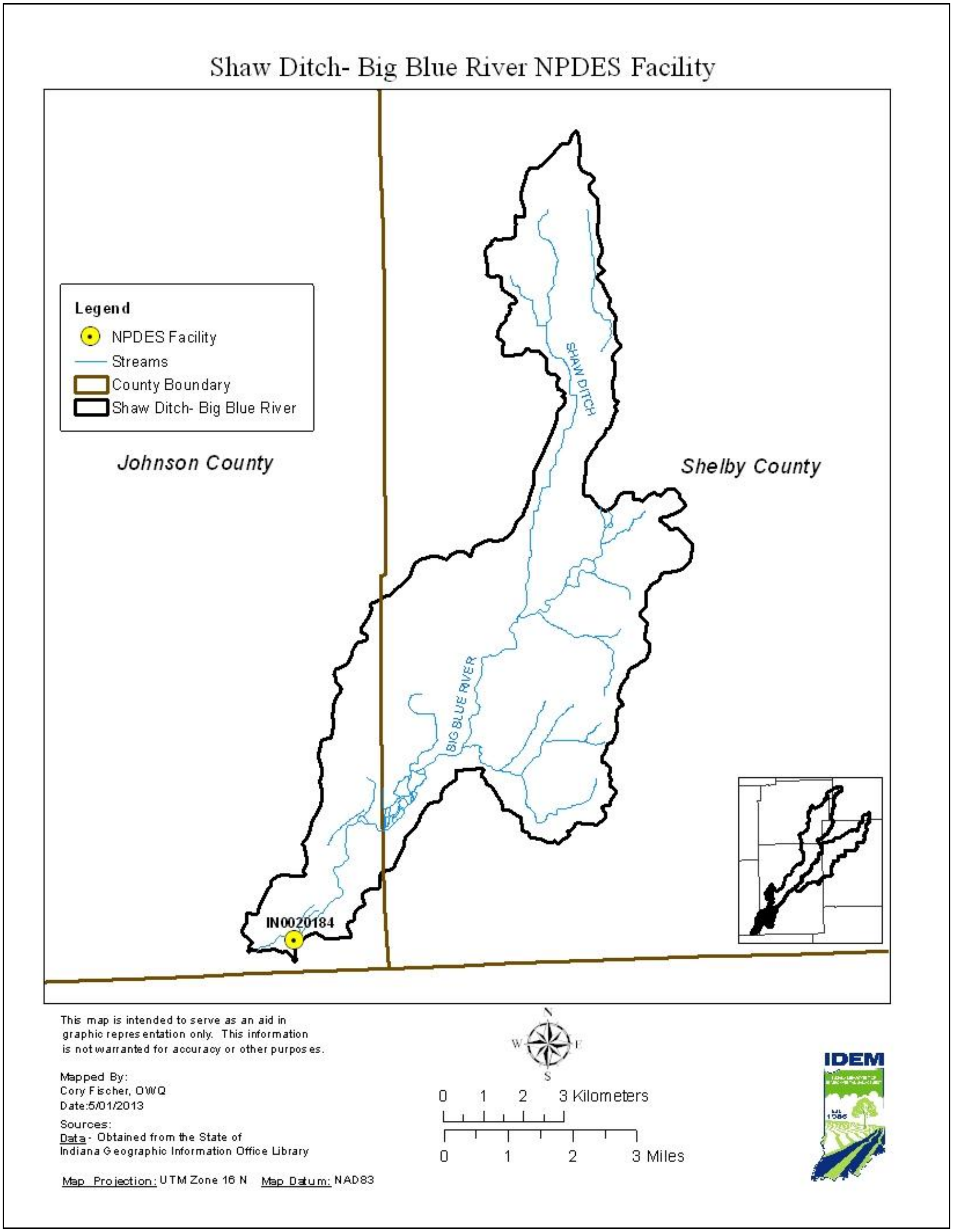


Figure 53. NPDES Facilities in the Shaw Ditch- Big Blue River Subwatershed

Regulated Storm water Sources – Municipal Separate Storm Sewer Systems (MS4s)

MS4s are, in general, public storm sewer systems (including roads with drainage systems and municipal streets) that are owned or operated by a public body and not part of a combined sewer (i.e., storm and sanitary sewers combined). MS4s can be significant sources of *E. coli* because they transport urban runoff that can be affected by pet waste, illicit sewer connections, failing septic systems, fertilizer, construction, and streambank erosion from hydrologic modifications. Large and medium MS4s serve populations of more than 100,000 people. Regulated small MS4s are identified according to the U.S. Census Bureau definition of urbanized area as established every 10 years in its decennial census. Populations served by these regulated small MS4s range from several hundred to tens of thousands of people, but in most instances these systems serve fewer than about 30,000–50,000 people. There is one MS4 community in the Shaw Ditch- Big Blue River subwatershed as shown in Figure 54.

Table 84. Shaw Ditch- Big Blue River River MS4 Communities

MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
INR040026	Town of Edinburgh	0.57

Municipal boundaries and MS4 boundaries are not always the same, but are often used to delineate the regulated MS4 area if a system map is not readily available. Table 66 shows the MS4 boundaries in the Foreman Branch- Big Blue River subwatershed. The City of Shelbyville MS4 uses the incorportated area as its jurisdictional boundary. The Town of Edinburgh MS4 is only being allocated for the developed area within their jurisdictional boundary.

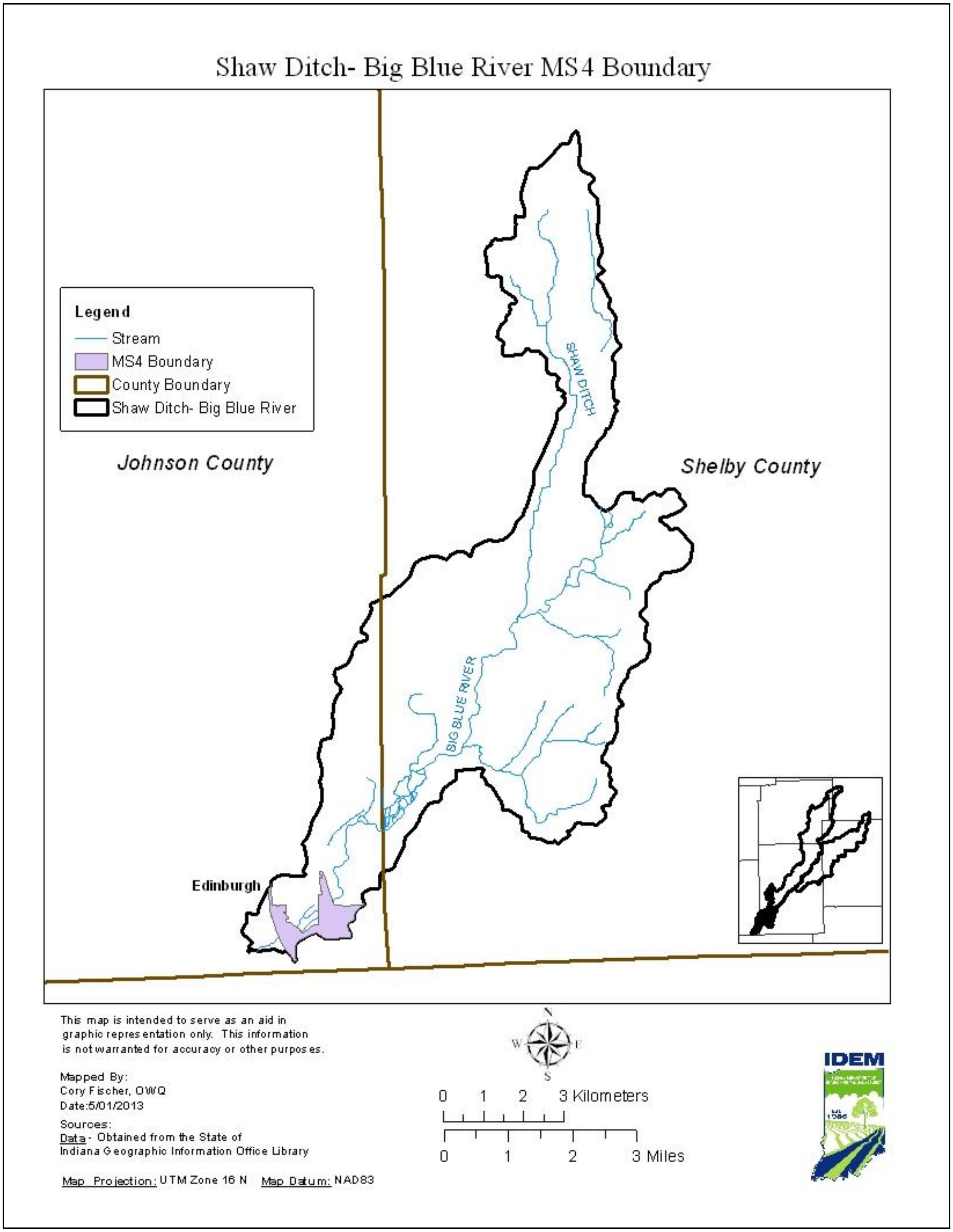


Figure 54. Map of MS4 Boundaries in the Shaw Ditch- Big Blue River Subwatershed

Illicitly Connected "Straight Pipe" Systems

Some household wastes within Indiana and potentially within the Lower Big Blue River watershed directly discharge to a stream or are illegally connected directly to tile-drainage pipes in agricultural watersheds, providing a direct source of pollutants such as *E. coli* to the stream (these systems are sometimes referred to as "straight pipe" discharges).

4.2.12.2 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli* in the Shaw Ditch- Big Blue River subwatershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

Cropland

Approximately71 percent of the land in the Shaw Ditch- Big Blue River subwatershed is classified as row crops. Accumulation on cropland occurs from decomposition of residual crop material, fertilization with manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities.

Table 85. 2012 Cropland in Shaw Ditch- Big Blue River Subwatershed

2012 Cropland	Area		Percent
	Acres	Square Miles	
Corn	7,040.35	11.00	58.61
Soybean	4,929.83	7.70	41.04
Winter Wheat	20.46	0.03	0.17
Double Crop Winter Wheat/ Soybeans	349.16	0.03	0.18
TOTAL	**12,339.80**	**18.77**	**100**

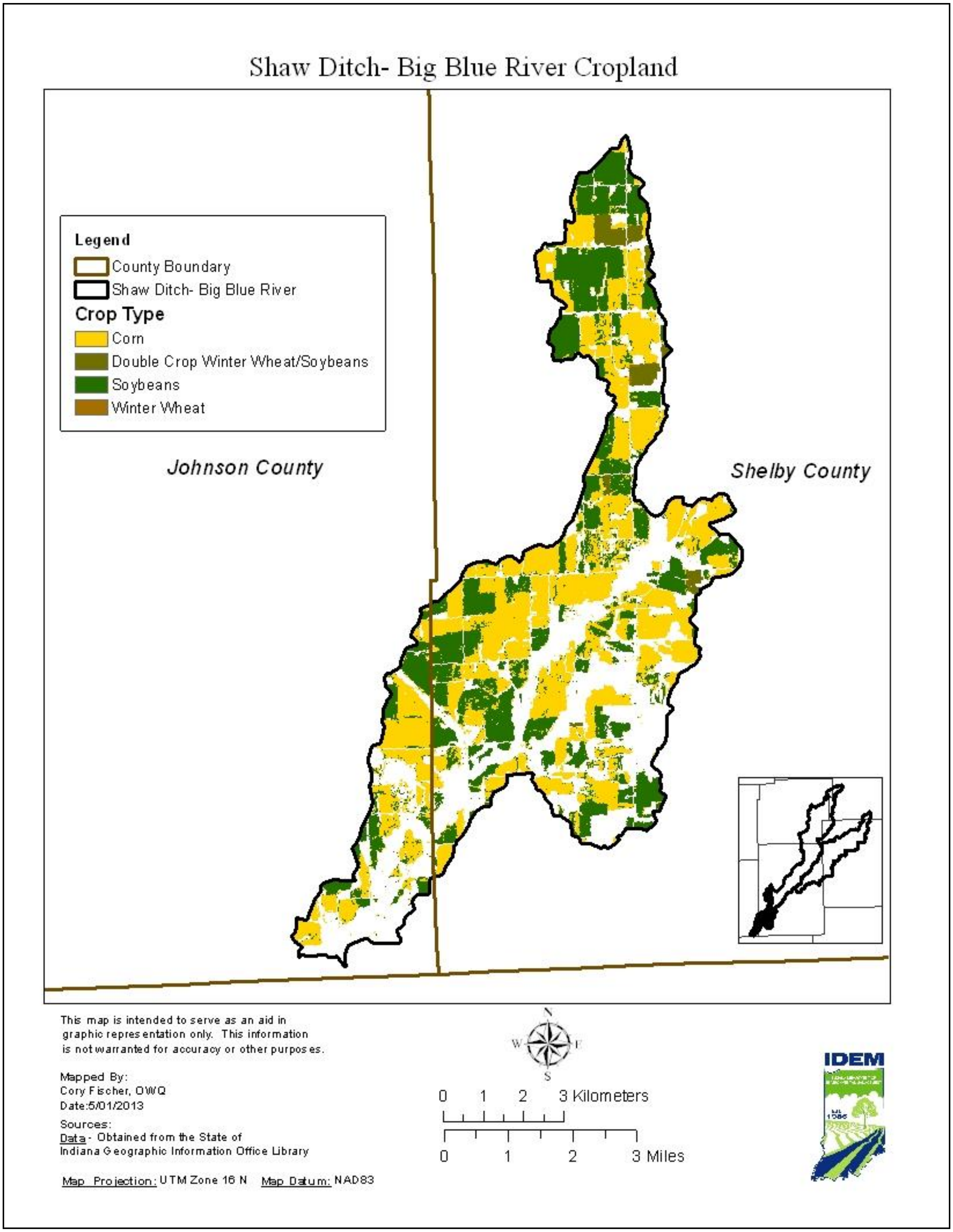


Figure 54. 2012 Cropland in the Shaw Ditch- Big Blue River Subwatershed

Pastures and Livestock Operations

In the Shaw Ditch- Big Blue River subwatershed, 6 percent of land use is pasture and grasslands. Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated runoff during a storm event.

Livestock are potential source of *E. coli* to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the watershed. The area of the county within the watershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the watershed and summed to get an area weighted estimate of animals within the watershed. There are an estimated 22,005 animal units in the Shaw Ditch- Big Blue River subwatershed and the animal unit density is 751 animal units per square mile as shown in Table 86.

Table 86. Animal Unit Density in the Shaw Ditch- Big Blue River Subwatershed

Subwatershed Area (sq. miles)	Animal	Total Number of Head in County	Number of Animals in One Animal Unit	Number of Animal Units	Animal Unit Density (animal units/mi^2)
29.33	Hogs and Pigs	21,726	2.5	8,690	751
	Cattle and Calves	7,981	1	7,981	
	Sheep and Lambs	298	10	30	
	Horses and Ponies	2,652	0.5	5,304	
			TOTAL	22,005	

Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period, and
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over any portion of the lot or facility.
- The number of animal present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations identified by IDEM as CFOs are considered nonpoint sources by USEPA. Indiana's CFOs have state-issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations "not cause or contribute to an impairment of surface waters of the state". IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which

regulates concentrated animal feeding operations and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012.

Like CAFOs, the animals raised in CFOs produce manure that is stored in pits, lagoons, tanks and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer. CFOs, however, can also be potential sources of TSS, total nitrogen, total phosphorus, and *E. coli* due to the following:

- Manure can leak or spill from storage pits, lagoons, tanks, etc.
- Improper application of manure can contaminate surface or ground water.
- Manure overapplication or improper application can adversely impact soil productivity.

There are no CFOs in the Shaw Ditch- Big Blue River subwatershed.

Onsite Wastewater Treatment Systems

Onsite wastewater treatment systems (e.g., septic systems) that are properly designed and maintained should not serve as a source of contamination to surface waters. However, onsite systems do fail for a variety of reasons. Common soil-type limitations which contribute to failure are: seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeologically (inadequate soil filtration) there can be adverse effects to surface waters due to *E. coli,* nitrate + nitrite, and total phosphorus (Horsely and Witten, 1996). Septic systems contain all the water discharged from homes and business and can be significant sources of pathogens.

All counties follow State Code: 410 IAC 6-8.1-31

A comprehensive database of septic systems within the Lower Big Blue River watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural population in the Shaw Ditch- Big Blue River subwatershed is shown in Table 87, along with a calculated density (total rural population divided by total area). The rural population density can be used to compare the different subwatersheds within the Lower Big Blue River watershed.

Table 87. Rural Population Density in the Shaw Ditch- Big Blue River Subwatershed

County	Area of County in Subwatershed (mi^2)	County Population	Urban Population	Rural Population	Rural Population Density (persons/mi^2)
Shelby	24.26	1,840	0	1840	74.7
Johnson	5.07	1,316	965	351	
TOTAL	29.32	3,156	965	2191	

Unregulated Urban Storm Water

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is unregulated and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants

originating from a variety of sources. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Shaw Ditch- Big Blue River watershed is discussed in Section 4.2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of *E. coli* in the Shaw Ditch- Big Blue River watershed.

Dog and cat populations were estimated for the Shaw Ditch- Big Blue River watershed using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* in population centers (i.e., cities and towns). The estimates of domestic pets in cities and towns in the watershed are presented in Table 88 and are based on the average number of pets per household multiplied by the households in the watershed.

Table 88. Estimated Pet Populations in the Cities and Towns in the Shaw Ditch- Big Blue River Watershed

City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Edinburgh	488	1,074	830

Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, geese, ducks, etc. can be sources of *E. coli*. Population estimates for types of wildlife are generally not available.

In summary, the Shaw Ditch- Big Blue River subwatershed is dominated by agriculture. Sources of impairment include the WWTP, agricultural nonpoint source, unregulated storm water, and wildlife, which are likely to affect the amount of *E. coli* loading found in the subwatershed.

[1] http://www.avma.org/reference/marketstats/sourcebook.asp

5.0 INVENTORY AND ASSESSMENT OF WATER QUALITY INFORMATION

Below is an inventory and assessment of the available data for the Lower Big Blue River watershed related to *E. coli*. Table 89 reiterates the TMDL target values presented in Section 1.0. These are the target values IDEM uses to assess water quality data collected in the Lower Big Blue River watershed.

Table 89. Target Values Used for Development of the Lower Big Blue River Watershed TMDLs

Parameter	Target Value
E. coli	No value should exceed 125 counts/100 mL (geometric mean)

5.1 Water Chemistry Data

Table 90 summarizes the *E. coli* data within the Lower Big Blue River watershed by displaying the maximum concentrations (and geometric mean for *E. coli*) at all sampling stations with water quality impairments, along with the load reductions needed to meet the TMDL. Data collected in 2010 by IDEM were used for the TMDL analysis.

The percent reductions were calculated as follows:

$$\%\ \text{Reduction} = \frac{(\text{Target Value or WQS} - \text{Observed Geomean})}{\text{Observed Geomean}}$$

Appendix A shows the individual sample results and summaries of all the water quality data for all 21 monitoring stations.

5.2 *E. coli* Data

For *E. coli*, the AUIDs in Headwaters Little Blue River were assessed with data from 2009 and 2013. Table 89 provides a summary of *E. coli* data in the Lower Big Blue River watershed to show which sampling stations correspond to each AUID per subwatershed.

Table 90. Summary of *E. coli* Data in Lower Big Blue River Watershed

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Number 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			
Headwaters Little Blue River	WED030-0029	INW0421_01	9/20/2010-10/18/2010	5	2	1	141.12	1986.3	11.42
Beaver Meadow Creek	WED030-0031	INW0422_01	9/20/2010-10/18/2010	5	2	1	148.73	435.2	15.96
Gilson Creek-Little Blue River	WED030-0030 WED-02-0003	INW0423_01 INW0423_01	9/20/2010-10/18/2010 7/16/2013-8/13/2013	10	8	7	> 1215.77	> 2419.6	
Manilla Branch-Little Blue River									
Town of Rays Crossing-Little Blue River	WED030-0026 WED030-0033 WED030-0032 WED-02-0001	INW0425_01 INW0425_01 INW0425_T1001 INW0425_01	9/20/2010-10/18/2010	20	12	6	360.57	1553.1	65.33
Headwaters Six Mile Creek	WED020-0031	INW0481_01	9/20/2010-10/18/2010	5	0	0	30.16	77.6	0
Anthony Creek-Six Mile Creek	WED020-0032 WED020-0001 WED-08-0004	INW0482_T1002 INW0482_01 INW0482_01	9/20/2010-10/18/2010 7/16/2013-8/13/2013	15	13	10	380.65	1732.9	62.51
Nameless Creek	WED020-0033	INW0483_01	9/20/2010-10/18/2010	5	4	3	> 460.27	> 2419.6	72.84
Prairie Branch-Big Blue River	WED-08-0003	INW0484_01	9/20/2010-10/18/2010	5	5	3	281.24	435.2	55.55

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Number 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			
Foreman Branch-Big Blue River	WED020-0003 WED020-0014	INW0485_02 INW0485_T1002	9/20/2010-10/18/2010	10	6	2	191.56	1119.9	34.75
DePrez Ditch-Big Blue River	WED-08-0002 WED-08-0001 WED050-0033	INW0486_01 INW0486_02 INW0486_T1003	9/20/2010-10/18/2010	15	10	0	130.92	214.2	4.52
Shaw Ditch-Big Blue River	WED050-0008 WED050-0035	INW0487_01 INW0487_01	9/20/2010-10/18/2010	10	2	0	114.21	146.7	0

Understanding Table 90: *E. coli* data for the Lower Big Blue River watershed indicates the following:

- Reductions of 11.42 percent or greater are needed to meet the TMDL target values for *E. coli* in Headwaters Little Blue River.
- Reductions of 15.96 percent or greater are needed to meet the TMDL target values for *E. coli* in Beaver Meadow Creek.
- No reductions are needed to meet the TMDL target values for *E. coli* in Gilson Creek- Little Blue River.
- No reductions are needed to meet the TMDL target values for *E. coli* in Manilla Branch- Little Blue River.
- Reductions of 65.33 percent or greater are needed to meet the TMDL target values for *E. coli* in Town of Rays Crossing-Little Blue River
- No reductions are needed to meet the TMDL target values for *E. coli* in Headwaters Six Mile Creek
- Reductions of 62.51 percent or greater are needed to meet the TMDL target values for *E. coli* in Anthony Creek-Six Mile Creek
- Reductions of 72.84 percent or greater are needed to meet the TMDL target values for *E. coli* in Nameless Creek
- Reductions of 55.55 percent or greater are needed to meet the TMDL target values for *E. coli* in Prairie Branch-Big Blue River
- Reductions of 34.75 percent or greater are needed to meet the TMDL target values for *E. coli* in Foreman Branch-Big Blue River
- Reductions of 4.52 percent or greater are needed to meet the TMDL target values for *E. coli* in DePrez Ditch-Big Blue River
- No reductions are needed to meet the TMDL target values for *E. coli* in Shaw Ditch-Big Blue River

6.0 TECHNICAL APPROACH

Previous sections of the report have provided a description of the Lower Big Blue River watershed and summarized the applicable water quality standards, water quality data, and identified the potential sources of *E. coli* for assessment units in each subwatershed. This section presents IDEM's technical approach for using water quality sampling data and flow data for each subwatershed as described in Section 4.0 to estimate the current allowable loads of *E. coli* in each subwatershed. This section focuses on describing the methodology and is helpful in understanding subsequent sections of the TMDL report.

6.1.1 Load Duration Curves

To determine allowable loads for the TMDL, IDEM uses a load duration curve approach. This approach helps to characterize water quality problems across flow conditions and provide a visual display that assists in determining whether loadings originate from point or nonpoint sources. Load duration curves present the frequency and magnitude of water quality violations in relation to the allowable loads, communicating the magnitude of the needed load reductions.

Developing a load duration curve is a multi-step process. To calculate the allowable loadings of a pollutant at different flow regimes, the load duration curve approach involves multiplying each flow by the TMDL target value or Water Quality Standard and an appropriate conversion factor. The steps are as follows:

- A flow duration curve for the stream is developed by generating a flow frequency table and plotting the observed flows in order from highest (left portion of curve) to lowest (right portion of curve).
- The flow curve is translated into a load duration (or TMDL) curve. To accomplish this, each flow value is multiplied by the TMDL target value or Water Quality Standard with the appropriate conversion factor and the resulting points are graphed. Conversion factors are used to convert the units of the target (e.g., #/100 mL for *E. coli*) to loads (e.g., G-org/day for *E. coli* [G-org=1E+09 organisms]) with the following factors used for this TMDL:
- *E. coli:* Flow (cfs) x TMDL Concentration Target (#/100mL) x Conversion Factor (0.024463) = Load (G-org/day)
- To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected and the appropriate conversion factor. Then, the existing individual loads are plotted on the TMDL graph with the curve.
- Points plotting above the curve represent violations of the applicable water quality standard or exceedances of the applicable target and the daily allowable load. Those points plotting below the curve represent compliance with standards and the daily allowable load.
- The area beneath the load duration curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions above the curve is the load that must be reduced to meet water quality standards.

The load duration curve approach can consider seasonal variation in TMDL development as required by the CWA and USEPA's implementing regulations. Because the load duration curve approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions.

The stream flows displayed on water quality or load duration curves may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into the following five "hydrologic zones" (USEPA, 2007):

- Very High Flows: Flows in this represent flooding or near flooding stages of a stream. These flows are exceeded 0 – 10 percent of the time.
- Moist Zone: Flows in this range are related to wet weather conditions. These flows are exceeded 10 – 40 percent of the time.
- Mid-Range Zone: Flows in this range represent median stream flow conditions. These flows are exceeded 40 – 60 percent of the time.
- Dry Zone: Flows in this range are related to dry weather flows. These flows are exceeded 60 -90 percent of the time.
- Very Low Flows: Flows in this range are seen in drought-like conditions. These flows are exceeded 90 -100 percent of the time.

The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources. Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated storm water discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point source sources (e.g., wastewater treatment facilities, livestock in the stream). Table 91 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). For example, the table indicates that impacts from wastewater treatment plants are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur.

Table 91. Relationship between Load Duration Curve Zones and Contributing Sources

	Duration Curve Zone				
Contributing Source Area	**Very High**	**Moist**	**Mid-Range**	**Dry**	**Very Low**
Wastewater treatment plants				M	H
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H
On-site wastewater systems/Unsewered Areas	M	M-H	H	H	H
Riparian areas		H	H	M	
Storm water: Impervious		H	H	H	
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)

6.1.2 Stream Flow Estimates

Daily stream flows are necessary to implement the load duration curve approach. Load duration assessment locations in the Lower Big Blue River watershed were chosen based on the location of the impaired stream segments and the availability of water quality samples to estimate existing loads.

The USGS gage for the Big Blue River at Shelbyville 03361500 located at the downstream end of the Big Blue River watershed was used for the development of the *E. coli* load duration curve analysis for the Lower Big Blue River watershed TMDL. USGS gage 03361500 is located on the Big Blue River in Shelby County.

Since the load duration approach requires a stream flow time series for each site included in the analysis, stream flows were extrapolated from USGS gage 03361500 for each assessment location by using a multiplier based upon the ratio of the upstream drainage area for a given location to the drainage area of the Lower Big Blue River watershed.

Flows were estimated using the following equation:

$$Q_{ungaged} = \frac{A_{ungaged}}{A_{gaged}} \times Q_{gaged}$$

Where,

$Q_{ungaged}$:	Flow at the ungaged location
Q_{gaged}:	Flow at surrogate USGS gage station
$A_{ungaged}$:	Drainage area of the ungaged location
A_{gaged}:	Drainage area of the gaged location

In this procedure, the drainage area of each of the load duration stations was divided by the drainage area of the surrogate USGS gage. The flows for each of the stations were then calculated by multiplying the flows at the surrogate gage by the drainage area ratios.

7.0 LINKAGE ANALYSIS

A linkage analysis connects the observed water quality impairment to what has caused that impairment. An essential component of developing a TMDL is establishing a relationship between the source loadings and the resulting water quality. Potential point and nonpoint sources are inventoried in Section 4.0 and water quality data within the Lower Big Blue River watershed are discussed in Section 5.0. The purpose of this section of the report is to evaluate which of the various potential sources is most likely to be contributing to the observed water quality impairments.

7.1 Linkage Analysis for *E. coli*

Establishing a linkage analysis for *E. coli* is challenging because there are so many potential sources and *E. coli* counts have a high degree of variability. While it is difficult to perform a site-specific assessment of the causes of high *E. coli* for each location in a watershed, it is reasonable to expect that general patterns and trends can be used to provide some perspective on the most significant sources.

Load duration curves were created for the sampling sites in the Lower Big Blue River watershed that were sampled by IDEM in 2010, and 2013. The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Section 6.1.1 summarizes the load duration curve approach. This section discusses the load duration curves and the linkage between the potential sources in the Lower Big Blue River watershed and the observed water quality impairment.

To further investigate sources, *E. coli* precipitation graphs have been created. Elevated levels of *E. coli* during rain events indicate *E. coli* contribution due to runoff. The precipitation data was taken from a weather station in Shelbyville and managed by the Indiana State Climate Office at Purdue University.

E. coli sources typically associated with high flow and moist conditions include failing onsite wastewater systems, urban storm water, runoff from agricultural areas, and bacterial re-suspension from the streambed. *E. coli* sources typically associated with low flow conditions include a large number of homes on failing or illicitly connected septic systems that would provide a constant source. Elevated *E. coli* levels at low flow could also result from inadequate disinfection at wastewater treatment plants or animals with direct access to streams.

The following sections discuss the load duration curves, precipitation graphs and linkage of sources to the water quality exceedances for each subwatershed.

7.1.1 Headwaters Little Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Appendix C) in the Headwaters Little Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 92.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 93 provides a summary of the Headwaters Little Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 92. USGS Site Assignments for Development of Load Duration Curves in the Headwaters Little Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 93. Summary of Headwaters Little Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	17.33 square miles				
TMDL Sample Site	WED030-0029				
AUID Segments	INW0421_01				
Land Use	Agricultural Land: 86.66% Forested Land: 2.66% Developed Land: 6.42% Open Water: 0.35% Pasture/Hay: 2.97% Grassland/Shrubs: 0.81% Wetland: 0.11%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	6435: J&J Livestock (8,000 Finishers)				
TMDL *E. coli* Allocations (billion MPN/day)]					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**“Normal” Flows**	**Lower Flow Conditions**	**Low Flows**
LA	279.03	82.65	36.85	15.98	2.98
WLA	NA	NA	NA	NA	NA
MOS (10%)	31.0	9.18	4.09	1.78	0.33
TMDL = LA+WLA+MOS	310.0	91.83	40.94	17.75	3.31

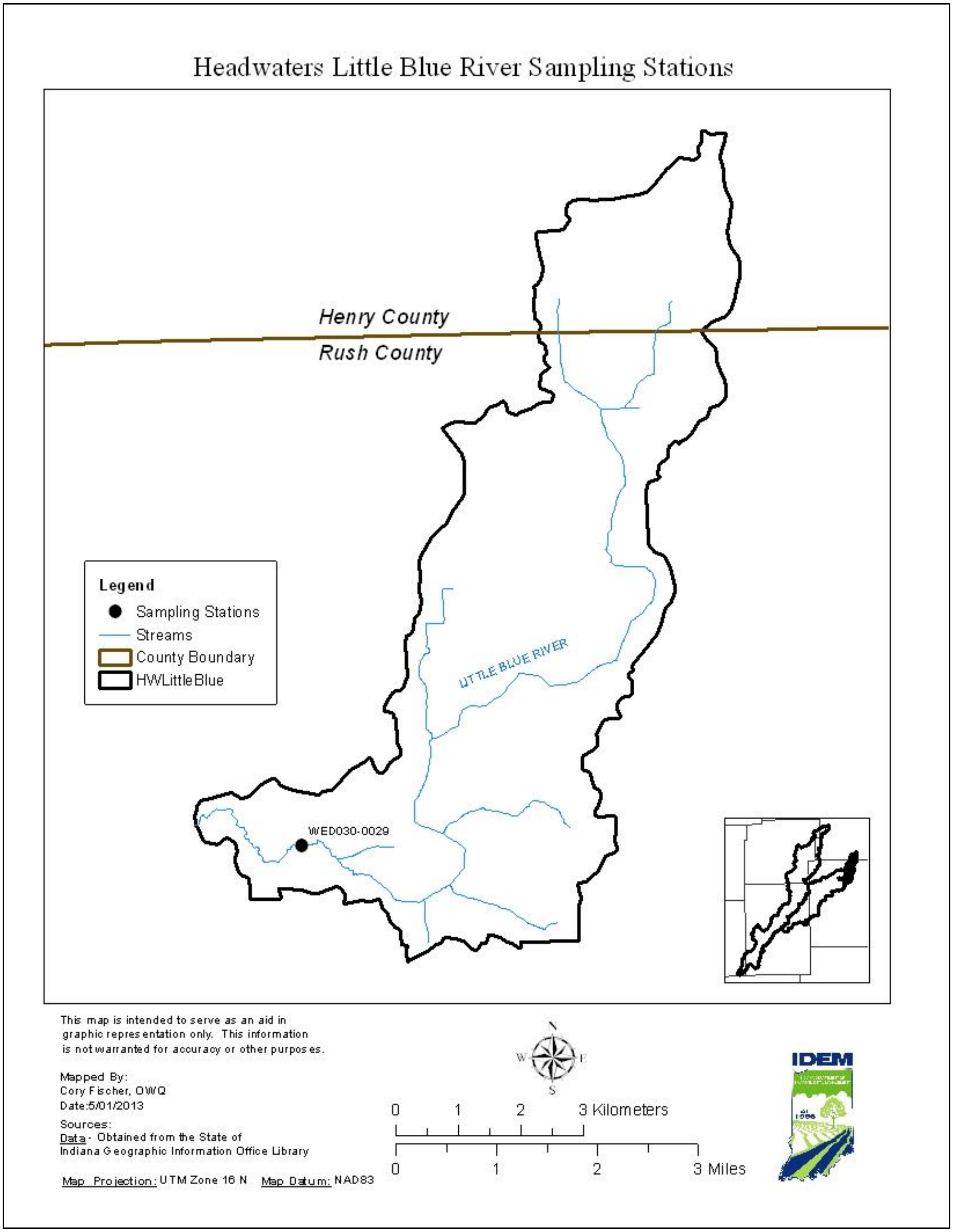


Figure 55. Sampling Stations in Headwaters Little Blue River Subwatershed

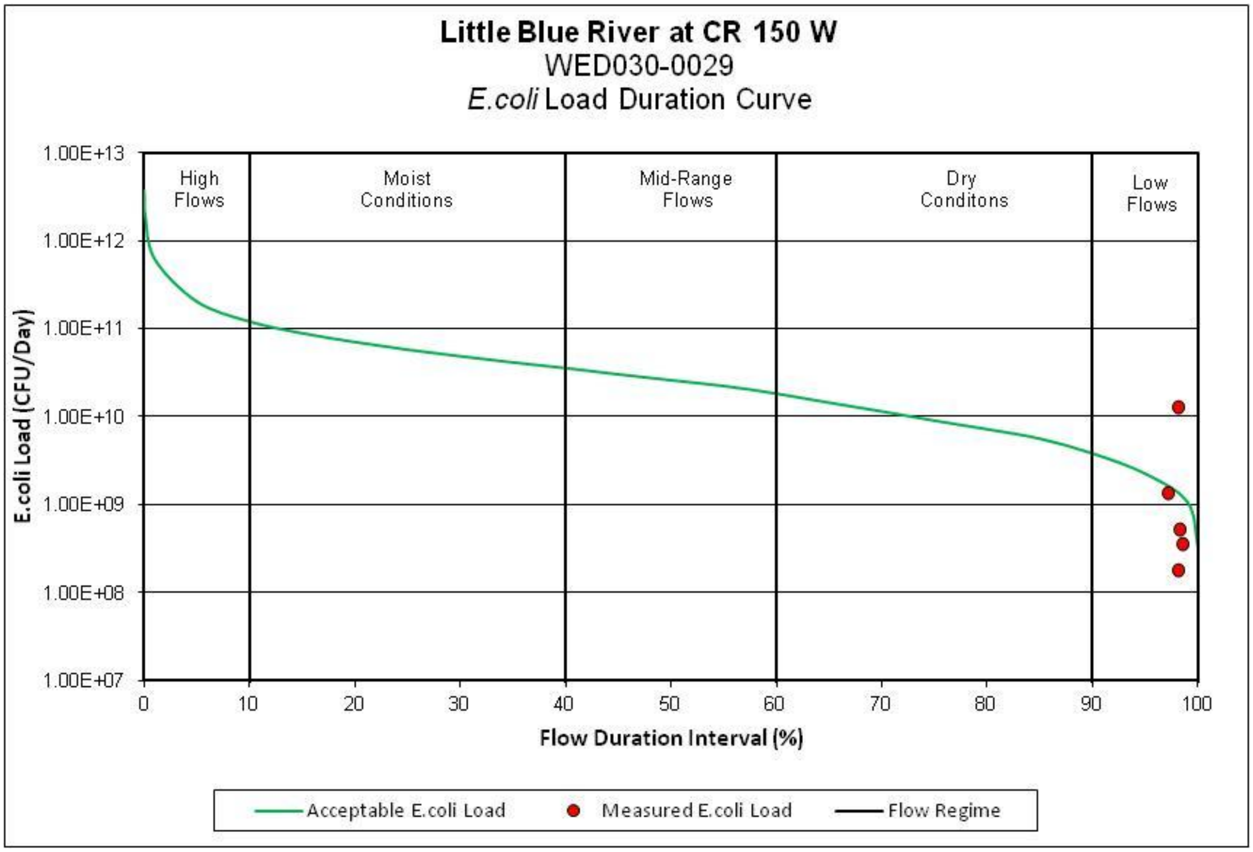


Figure 56. Load Duration Curve for Most Representative Site in the Headwaters Little Blue River Subwatershed

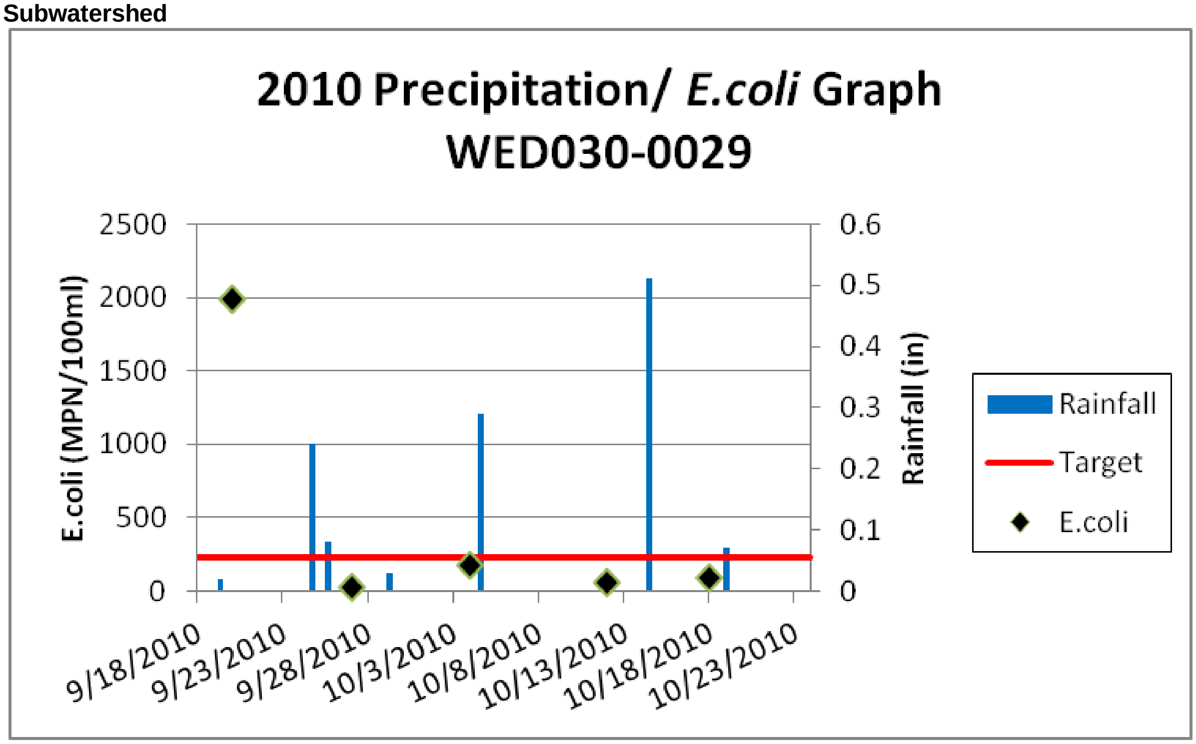


Figure 57. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Headwaters Little Blue River Subwatershed

Site WED030-0029 is located at CR 150 W on Little Blue River. The geometric mean value for site WED030-0029 is 141.12MPN/100mL. Load duration curves are presented in Figure 56 and Appendix C. The load duration curve shows one exceedance of the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Figure 57 and Appendix A. This indicates a consistent loading since rain events do not seem to have a significant effect on the *E. coli*. But due to sampling only during dry flow regime and looking at the landuse for the area we believe wet weather sources are also an issue that may not have been captured by the sampling. The stream is consistently at or below water quality criterias even during drier conditions on the chart. If animals have direct access upstream of WED030-0029 this could contribute to *E. coli* violations at dry and wet conditions. Also, high values in the absence of rain events suggest septic system failure, or straight pipe discharges in the watershed.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 20% of the time and an average geometric mean violation 100 % of the time. There is no NPDES permit with an open enforcement case and there are no CFOs in the watershed. There are no MS4 communities in the subwatershed considered to be a source of *E. coli*. There are no CSO communities in the watershed considered to be a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.2 Beaver Meadow Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 58) in the Beaver Meadow Creek subwatershed. Flow data used to develop the load duration curves is summarized in Table 94.

Figures 59 and 60 illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 95 provides a summary of the Beaver Meadow Creek subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 94. USGS Site Assignments for Development of Load Duration Curves in the Beaver Meadow Creek Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 95. Summary of Beaver Meadow Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	16.39 square miles				
TMDL Sample Site	WED030-0031				
AUID Segments	INW0422_01, INW0422_T1001				
Land Use	Agricultural Land: 89.91% Forested Land: 1.46% Developed Land: 5.44% Open Water: 0.04% Pasture/Hay: 2.25% Grassland/Shrubs: 0.88% Wetland: 0.03%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	184: David Vanosdol (960 Finishers) 2950: Ronald Sullivan (2000 Finishers)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	263.90	78.16	34.85	15.11	2.82
WLA	NA	NA	NA	NA	NA
MOS (10%)	29.3	8.68	3.87	1.68	0.31
TMDL = LA+WLA+MOS	293.2	86.85	38.72	16.79	3.13

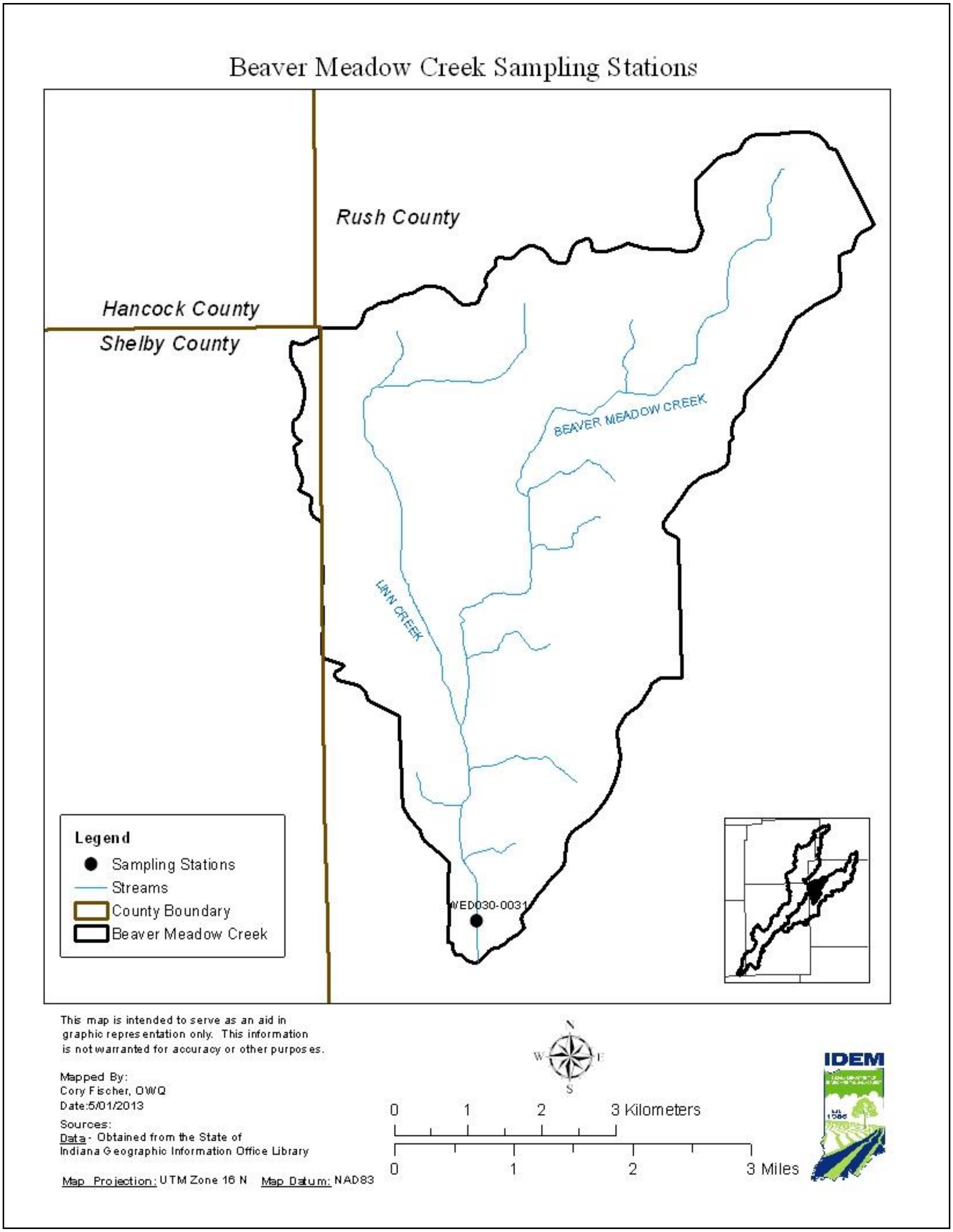


Figure 58. Sampling Stations in Beaver Meadow Creek Subwatershed

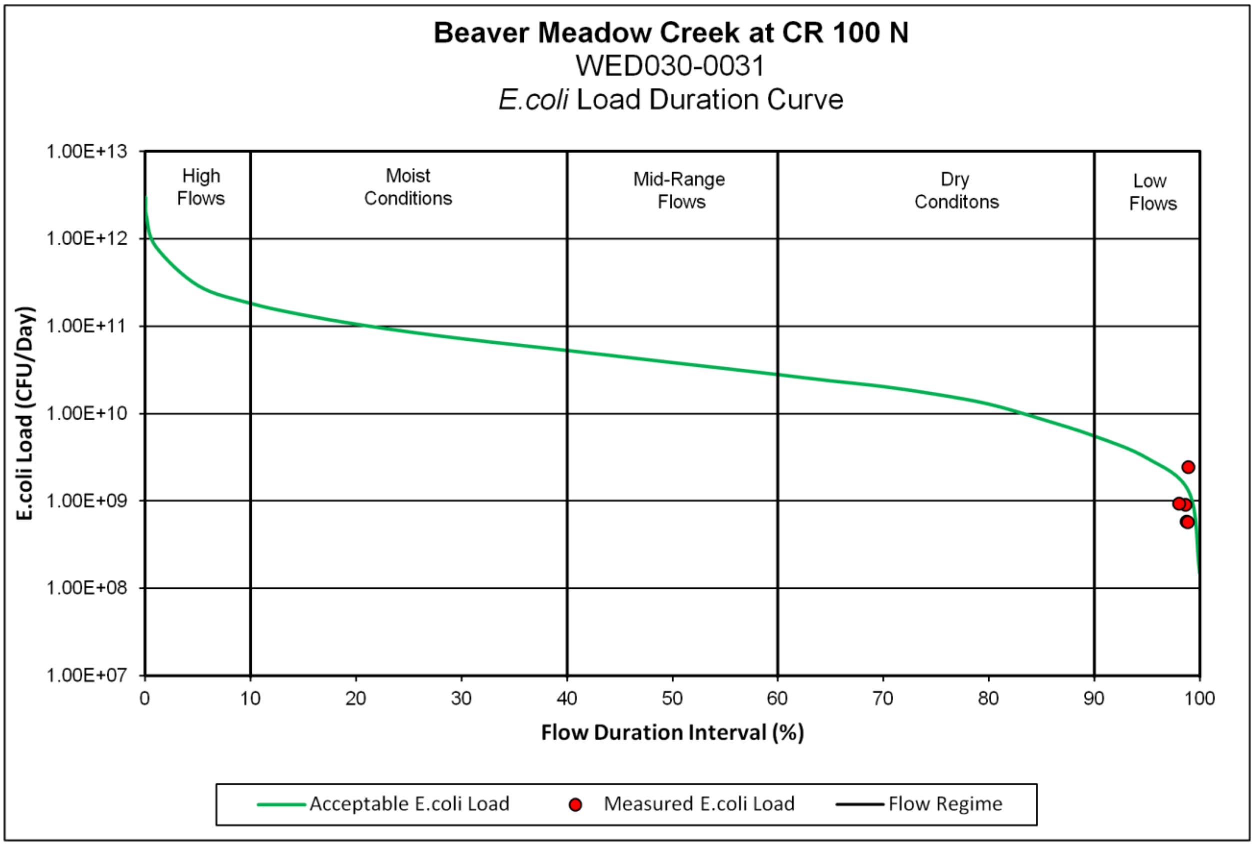


Figure 59. Load Duration Curve for Most Representative Site in the Beaver Meadow Creek Subwatershed

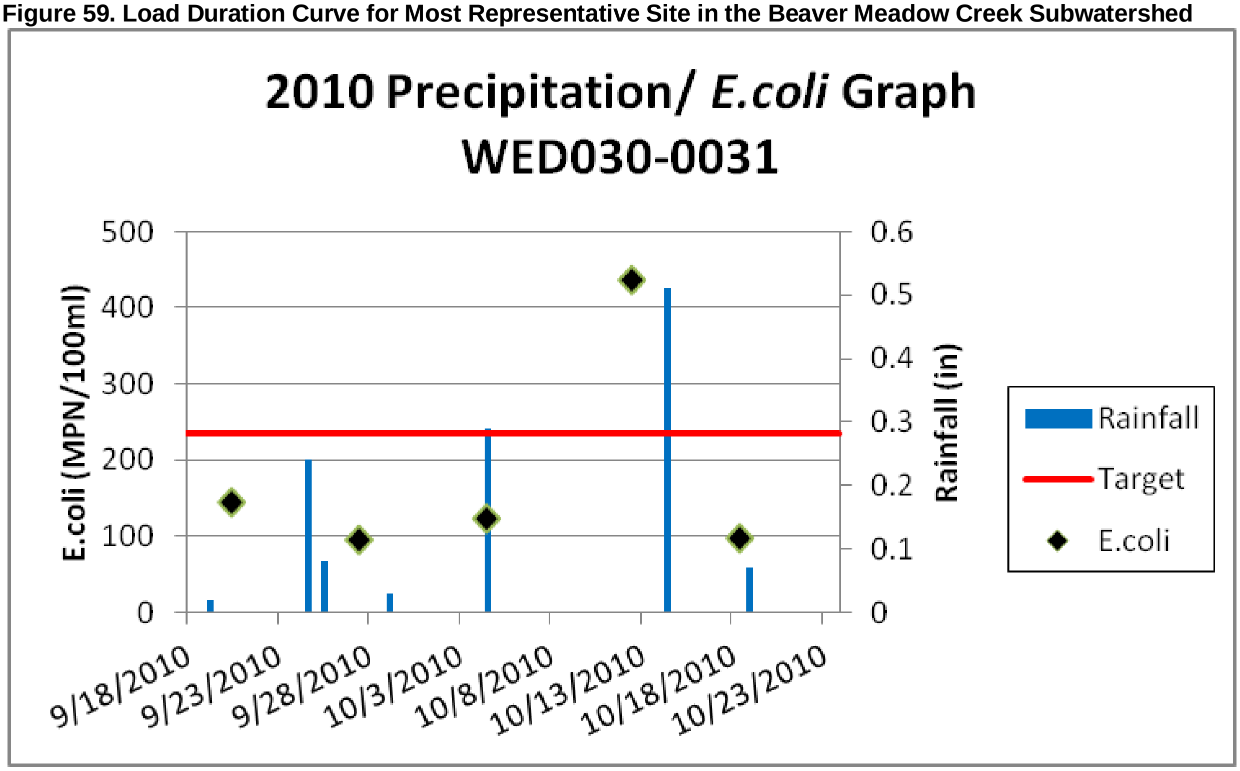


Figure 60. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Beaver Meadow Creek Subwatershed

Site WED030-0031 is located at CR 100 N on Beaver Meadow Creek.The geometric mean value for site WED030-0031 is 148.73 MPN/100mL. Load duration curves are presented in Figure 59 Appendix C. The load duration curve shows one exceedance of the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Figure 60 Appendix A. These indicate a consistent loading since rain events do not seem to have a significant effect on the *E. coli*. But, due to sampling only during dry flow regime and looking at the landuse for the area, we believe wet weather sources are also an issue that may not have been captured by the sampling. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates that point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED030-0031, this could contribute to *E. coli* violations during dry and wet conditions.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 20% of the time and an average geometric mean violation 100 % of the time. There are no NPDES permits with an enforcement case open and there are no CFO or CAFO permit violations. There is no MS4 community considered to be a source of *E. coli*. There are no CSO communities in the watershed considered to be a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.3 Gilson Creek- Little Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 61) in the Gilson Creek- Little Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 96.

Figures 62 and 63 illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 97 provides a summary of the Gilson Creek- Little Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 96. USGS Site Assignments for Development of Load Duration Curves in the Gilson Creek- Little Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 97. Summary of Gilson Creek- Little Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	49.66 square miles				
TMDL Sample Site	WED030-0030; WED-02-0003				
AUID Segments	INW0423_01, INW0423_T1001, INW0423_T1001A				
Land Use	Agricultural Land: 85.84% Forested Land: 5.41% Developed Land: 5.11% Open Water: 0.13% Pasture/Hay: 2.27% Grassland/Shrubs: 1.14% Wetland: 0.11%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	4909: William Smith Farm 3 (3,800 Finishers)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	799.59	236.82	105.59	45.78	8.55
WLA	NA	NA	NA	NA	NA
MOS (10%)	88.8	26.31	11.73	5.09	0.95
TMDL = LA+WLA+MOS	888.4	263.14	117.33	50.86	9.49

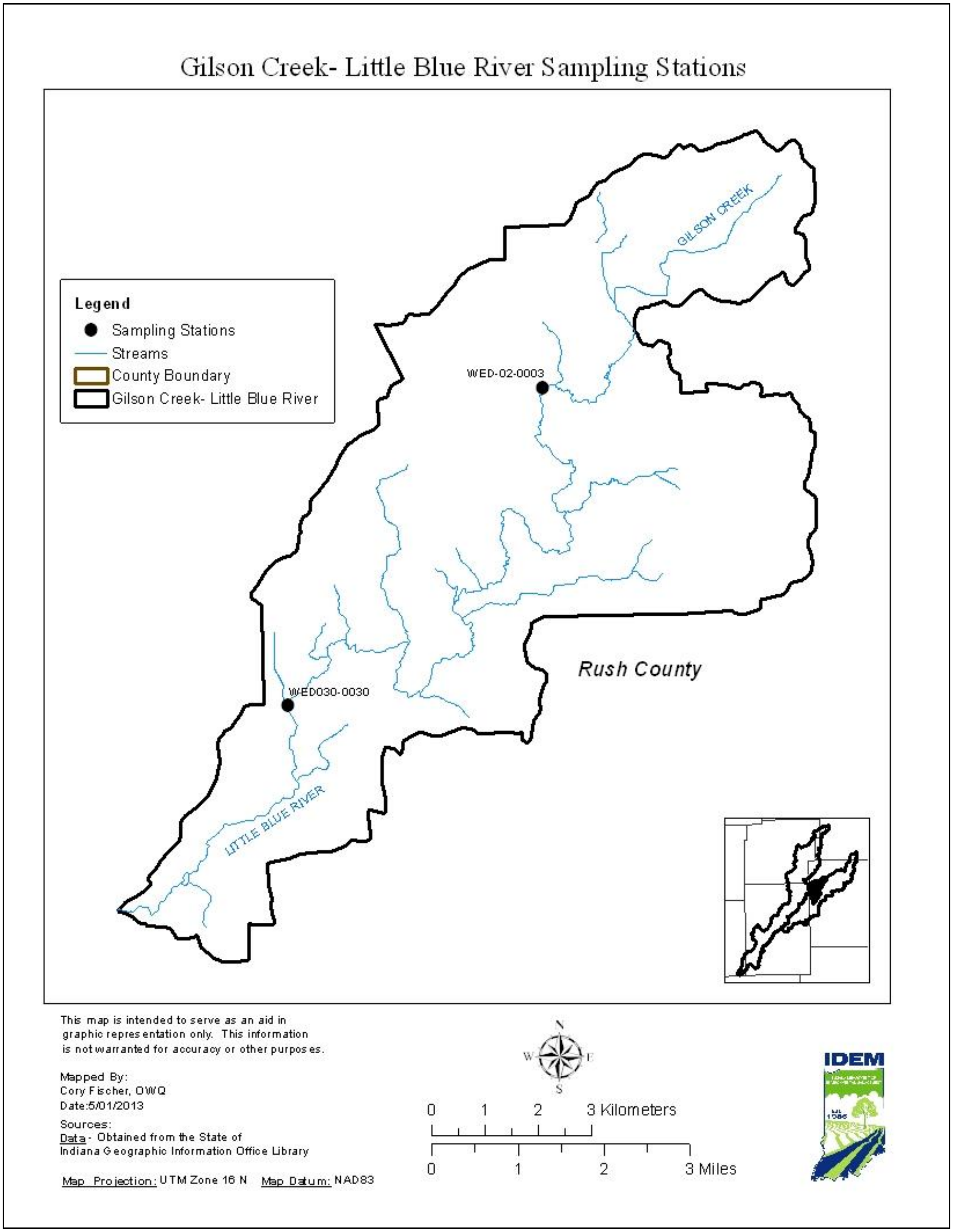


Figure 61. Sampling Stations in Gilson Creek- Little Blue River Subwatershed

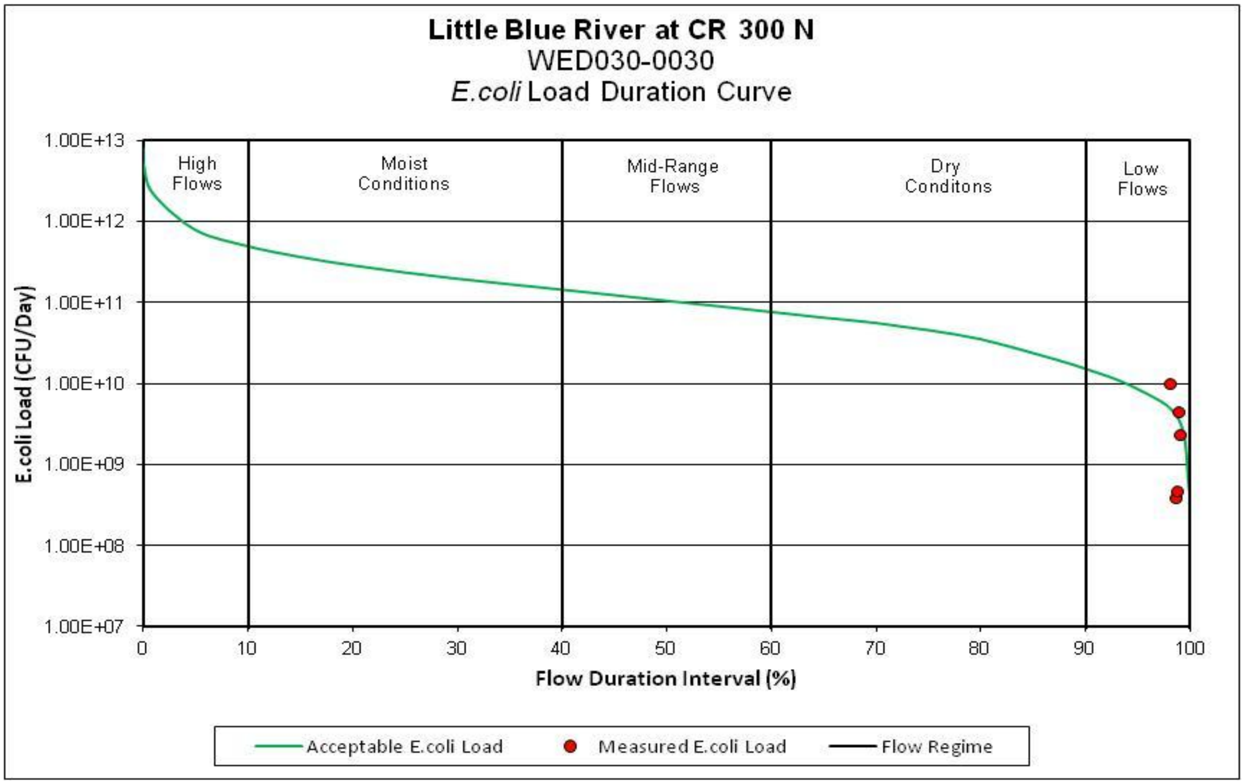


Figure 62. Load Duration Curve for Most Representative Site in the Gilson Creek- Little Blue River Subwatershed

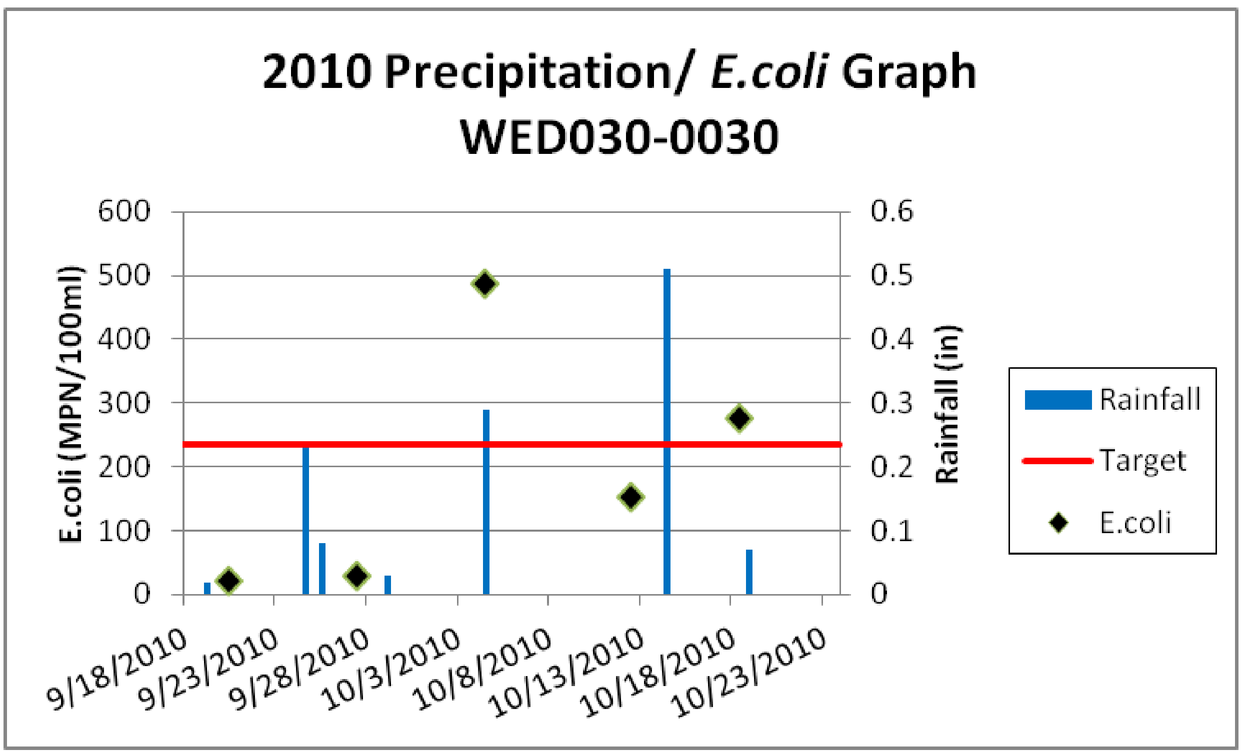


Figure 63. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Gilson Creek- Little Blue River Subwatershed

Site WED030-0030 is located at CR 300 N on Little Blue River.The geometric mean value for site WED030-0030 is 105.79 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows two exceedances of the single sample maximum with three samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.3 inch rain event. It is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing along with nonpoint sources. If animals have direct access upstream of WED030-0030 this could contribute to *E. coli* violations at dry and wet conditions.

Site WED-02-0003 is located at CR 400 W on Little Blue River was sampled in 2013 as part of the IDEM probabilistic monitoring program. The geometric mean value for site WED-02-0003 is >1215.77 MPN/100mL. Load duration curves are presented in Appendix D. The load duration curve shows five exceedances of the single sample with no samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.4 inch rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently above water quality criterias even during drier conditions on the chart. This indicates that point sources may be contributing to increase levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED-02-0003 this could contribute to *E. coli* violations during dry and wet conditions.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 70% of the time and an average geometric mean violation 50 % of the time. There are no NPDES facilities or MS4 permits in the watershed. There are no CSO communities in the watershed considered to be a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.4 Manilla Branch- Little Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 64) in the Manilla Branch- Little Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 98. The most representative site for Manilla Branch- Little Blue River was captured just downstream of the pour point of the watershed at the nearest bridge.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 99 provides a summary of the Manilla Branch- Little Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 98. USGS Site Assignments for Development of Load Duration Curves in the Manilla Branch- Little Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 99. Summary of Manilla Branch- Little Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	83.05 square miles				
TMDL Sample Site	NA*				
AUID Segments	INW0424_01, INW0424_T1001, INW0424_T1002				
Land Use	Agricultural Land: 80.73% Forested Land: 6.74% Developed Land: 6.39% Open Water: 0.03% Pasture/Hay: 5.23% Grassland/Shrubs: 0.85% Wetland: 0.04%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	1337.20	396.06	176.59	76.56	14.29
WLA	NA	NA	NA	NA	NA
MOS (10%)	148.6	44.01	19.62	8.51	1.59
TMDL = LA+WLA+MOS	1485.8	440.06	196.21	85.06	15.88

*The most representative site (WED030-0026) for Manilla Branch- Little Blue River was captured just downstream of the pour point of the watershed at the nearest bridge.

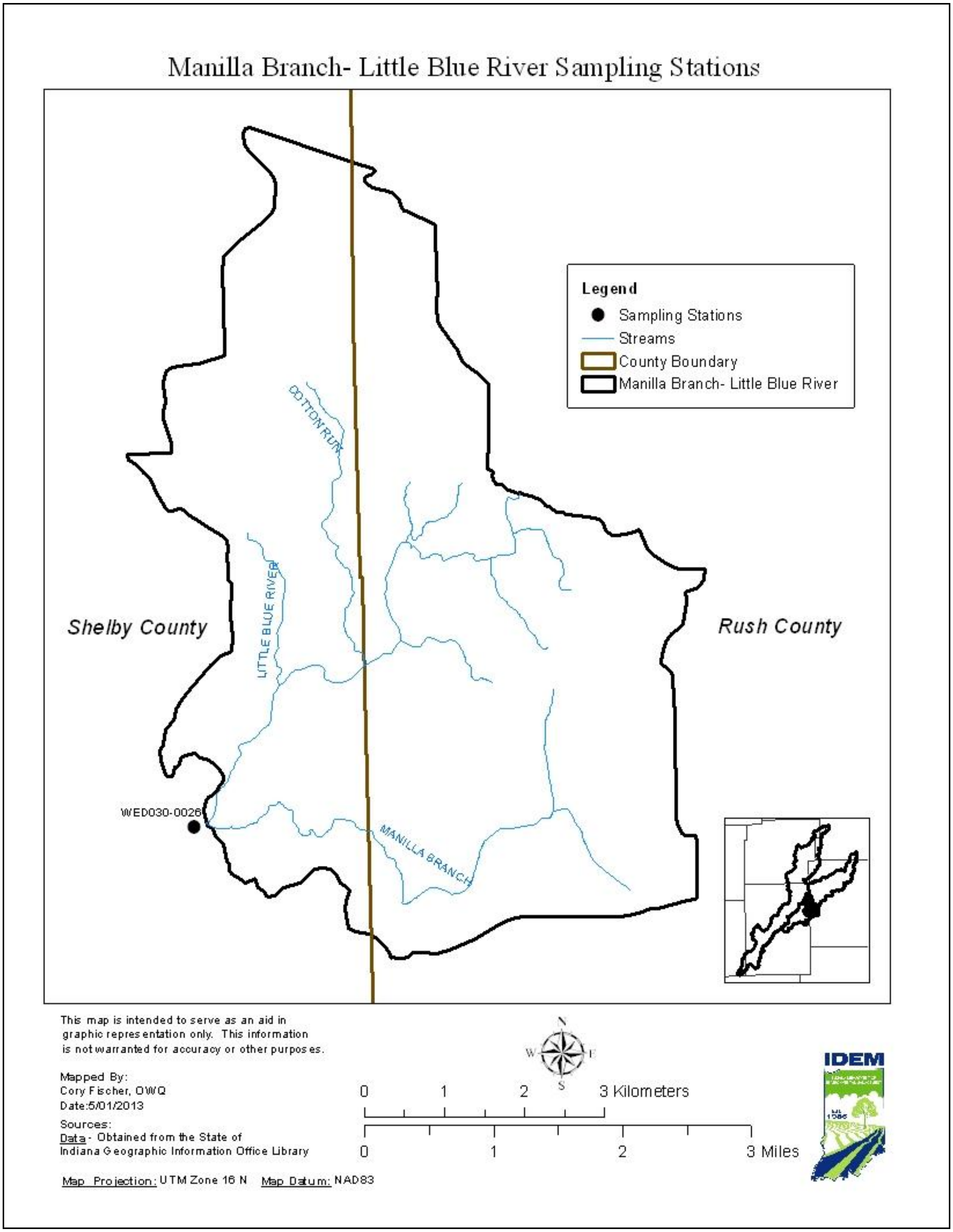


Figure 64. Sampling Station in Manilla Branch- Little Blue River Subwatershed

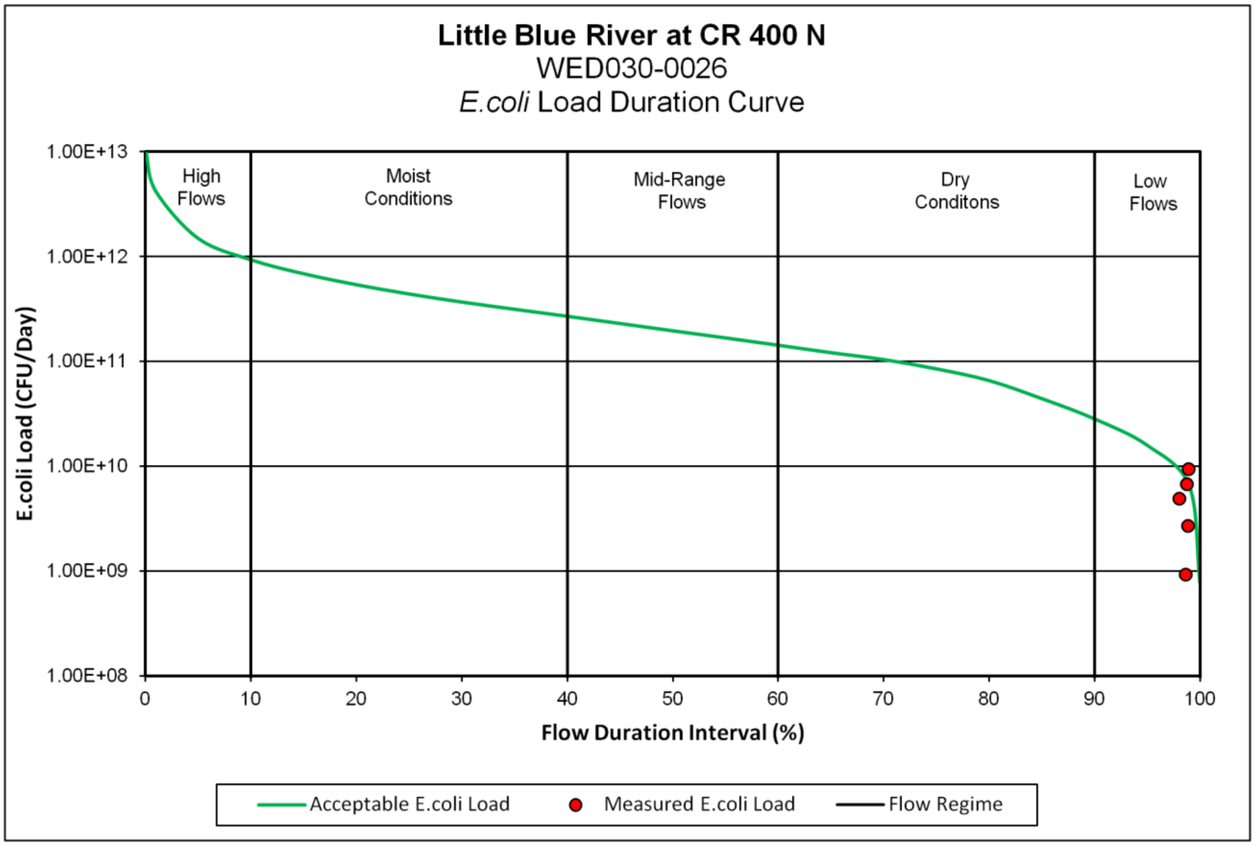


Figure 65. Load Duration Curve for Most Representative Site in the Manilla Branch- Little Blue River Subwatershed

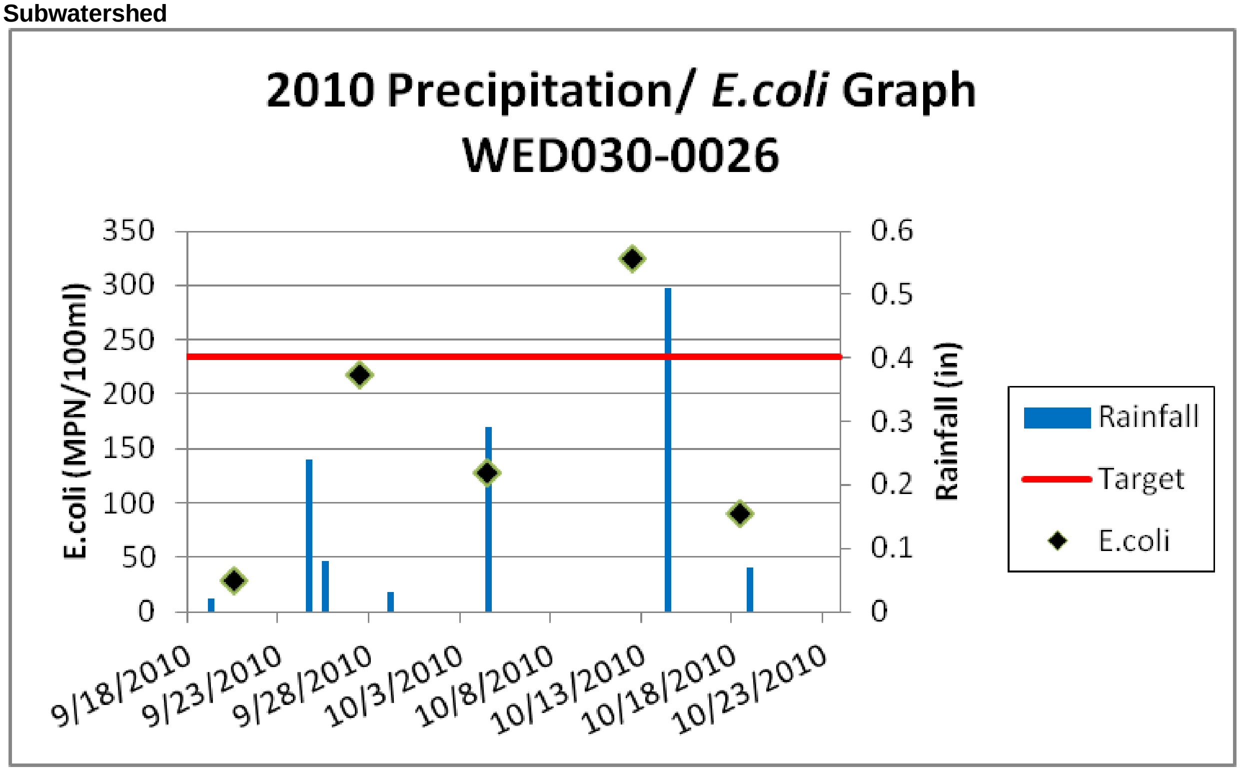


Figure 66. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Manilla Branch- Little Blue River Subwatershed

Site WED030-0026 is located at CR 400 N on Little Blue River. The geometric mean value for site WED030-0026 is 118.93 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows one exceedance of the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The stream has one violation of water quality criteria even during drier conditions on the chart. This indicates that point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED030-0026 this could contribute to *E. coli* violations during dry and wet conditions. There are no NPDES facility, CFO, or MS4 permits in the watershed. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.5 Town of Rays Crossing- Little Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 65) in the Town of Rays Crossing- Little Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 100.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 101 provides a summary of the Town of Rays Crossing- Little Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 100. USGS Site Assignments for Development of Load Duration Curves in the Town of Rays Crossing- Little Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 101. Summary of Town of Rays Crossing- Little Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	104.71 square miles				
TMDL Sample Site	WED030-0026, WED030-0033, WED-02-0001, WED030-0032				
AUID Segments	INW0425_01, INW0425_01A, INW0425_T1001, INW0425_T1002				
Land Use	Agricultural Land: 75.51% Forested Land: 7.68% Developed Land: 11.82% Open Water: 0.09% Pasture/Hay: 3.68% Grassland/Shrubs: 1.20% Wetland: 0.02%				
NPDES Facilities	NA				
MS4 Communities	INR040051: Shelbyville (1.29 sq. miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	1,645.36	487.33	222.65	96.52	18.02
WLA: Shelbyville MS4	36.53	10.82	NA	NA	NA
MOS (10%)	187.3	55.48	24.74	10.72	2.00
TMDL = LA+WLA+MOS	1,896.19	553.63	247.39	107.25	20.02

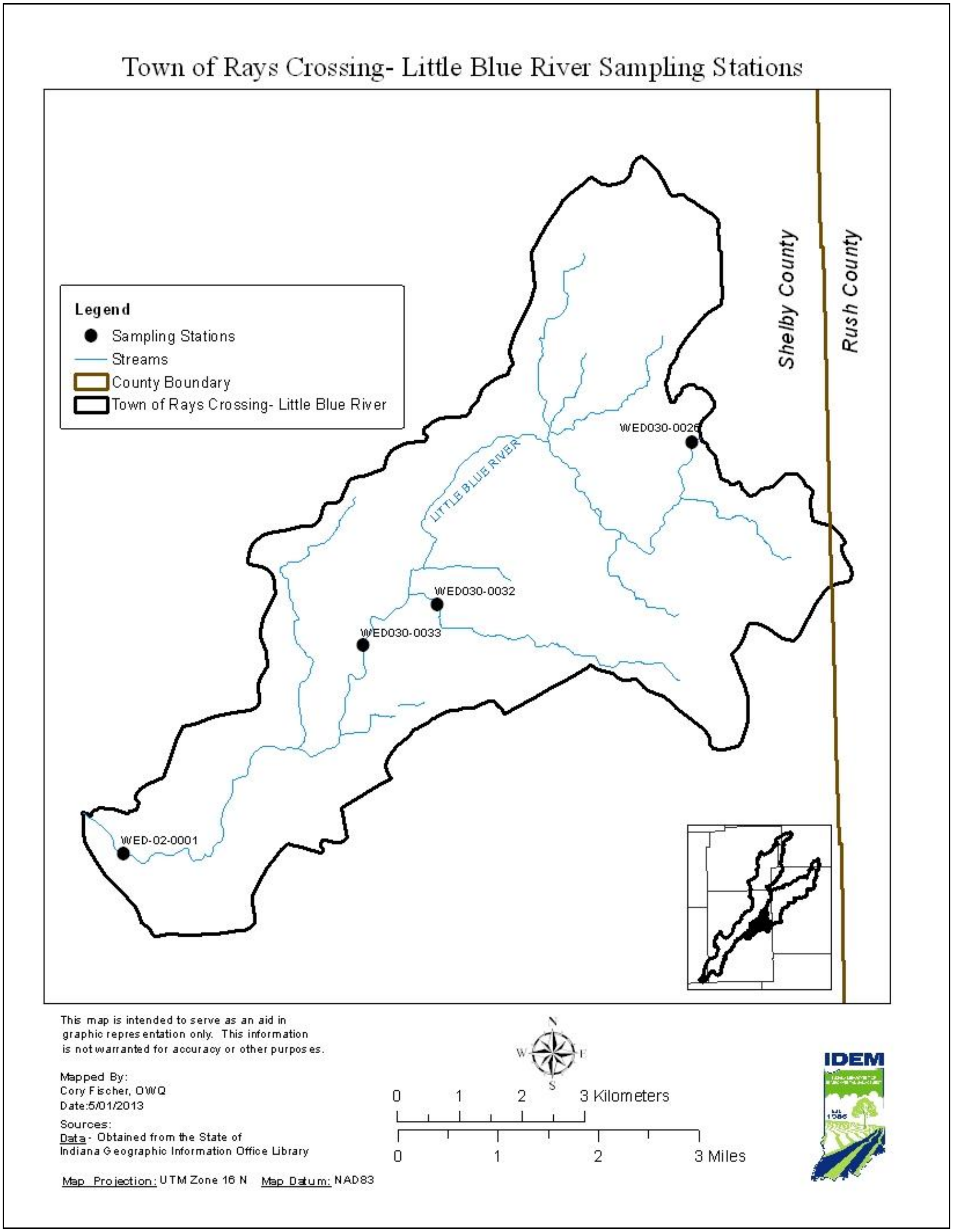


Figure 67. Sampling Stations in Town of Rays Crossing- Little Blue River Subwatershed

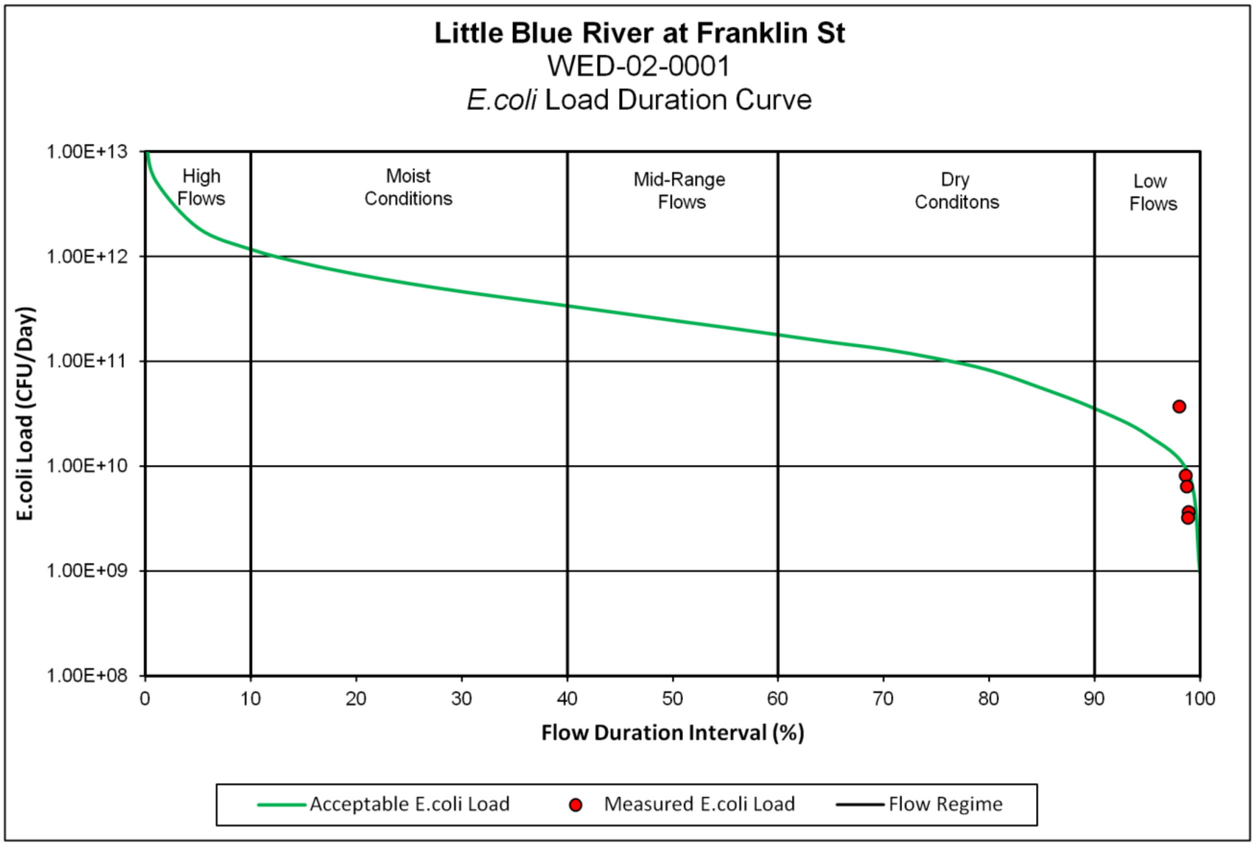


Figure 68. Load Duration Curve for Most Representative Site in the Town of Rays Crossing- Little Blue River Subwatershed

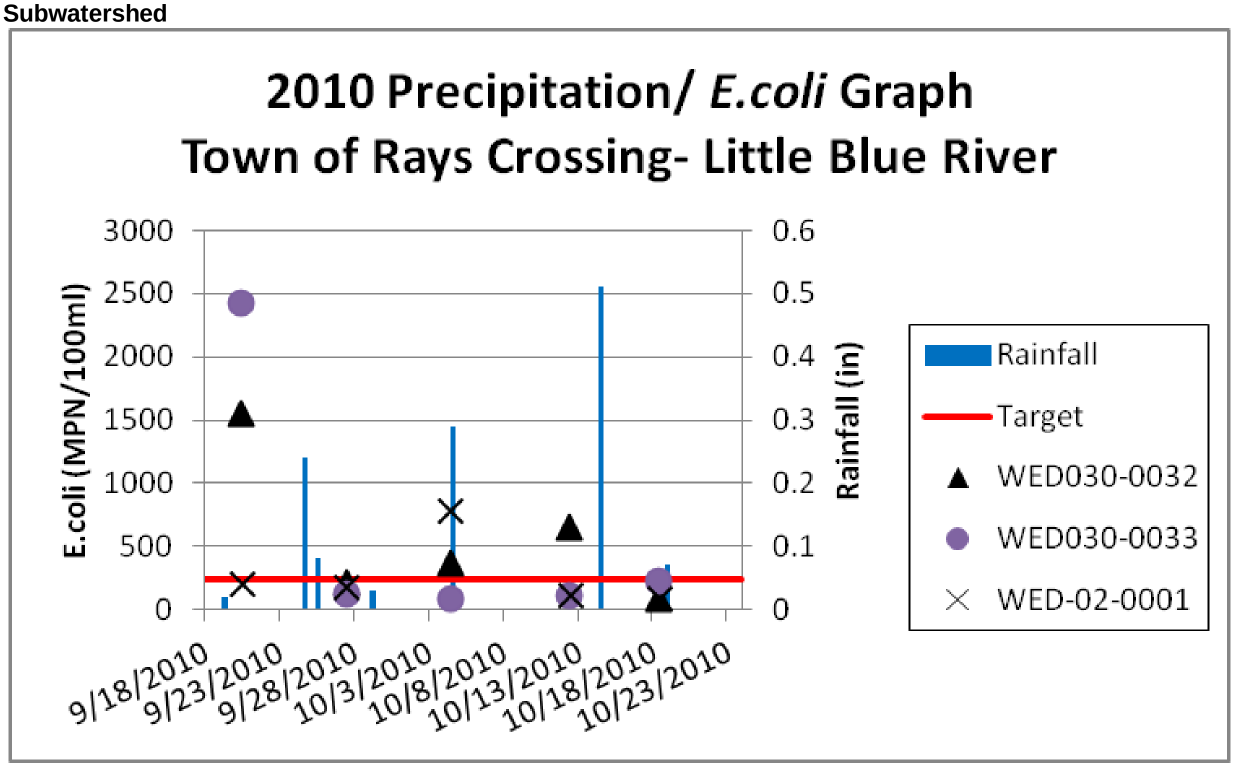


Figure 69. Graph of Precipitation and *E. coli* Data in the Town of Rays Crossing- Little Blue River Subwatershed

Site WED030-0032 is located at Union Rd on Tributary of Little Blue River. The geometric mean value for site WED030-0032 is 360.57 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows three exceedances of the single sample maximum with two samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of from run-off *E. coli*during a 0.3 inch rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. This indicates that point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED030-0032 this could contribute to *E. coli* violations during dry and wet conditions.

Site WED030-0033 is located at CR 200 N on Little Blue River. The geometric mean value for site WED030-0033 is 223.93 MPN/100mL. Load duration curves are presented in Appendix D. The load duration curve shows one exceedance of the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.3 inch rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates that point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED030-0033 this could contribute to *E. coli* violations during dry and wet conditions.

Site WED-02-0001 is located at Franklin Street on Little Blue River.The geometric mean value for site WED-02-0001 is 186.20 MPN/100mL. Load duration curves are presented in Appendix D. The load duration curve shows one exceedanceof the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off *E. coli*during a 0.3 inch rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates that point sources may be to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED-02-0001this could contribute to *E. coli* violations during dry and wet conditions.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 33% of the time and an average geometric mean violation 33 % of the time. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. The City of Shelbyville, an MS4 community, is considered a source of *E. coli*. There are no CSO communities in the watershed considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.6 Headwaters Six Mile Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 70) in the Headwaters Six Mile Creek subwatershed. Flow data used to develop the load duration curves is summarized in Table 102.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 103 provides a summary of the Headwaters Six Mile Creek subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communityies, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 102. USGS Site Assignments for Development of Load Duration Curves in the Headwaters Six Mile Creek Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 103. Summary of Headwaters Six Mile Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	16.90 square miles				
TMDL Sample Site	WED020-0031				
AUID Segments	INW0481_01, INW0481_T1001				
Land Use	Agricultural Land: 82.42% Forested Land: 4.58% Developed Land: 8.29% Open Water: 0.44% Pasture/Hay: 2.50% Grassland/Shrubs: 1.68% Wetland: 0.08%				
NPDES Facilities	IN0031593: Eastern Hancock Jr/Sr High School (0.029 MGD) IN0024503: Shirley WWTP (0.155)				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	1685.27	498.67	221.97	95.84	17.33
WLA: IN0031593 IN0024503 Total:	 0.11 0.58 0.69	 0.11 0.58 0.69	 0.11 0.58 0.69	 0.11 0.58 0.69	 0.11 0.58 0.69
MOS (10%)	187.3	55.48	24.74	10.72	2.00
TMDL = LA+WLA+MOS	1873.3	554.84	247.39	107.25	20.02

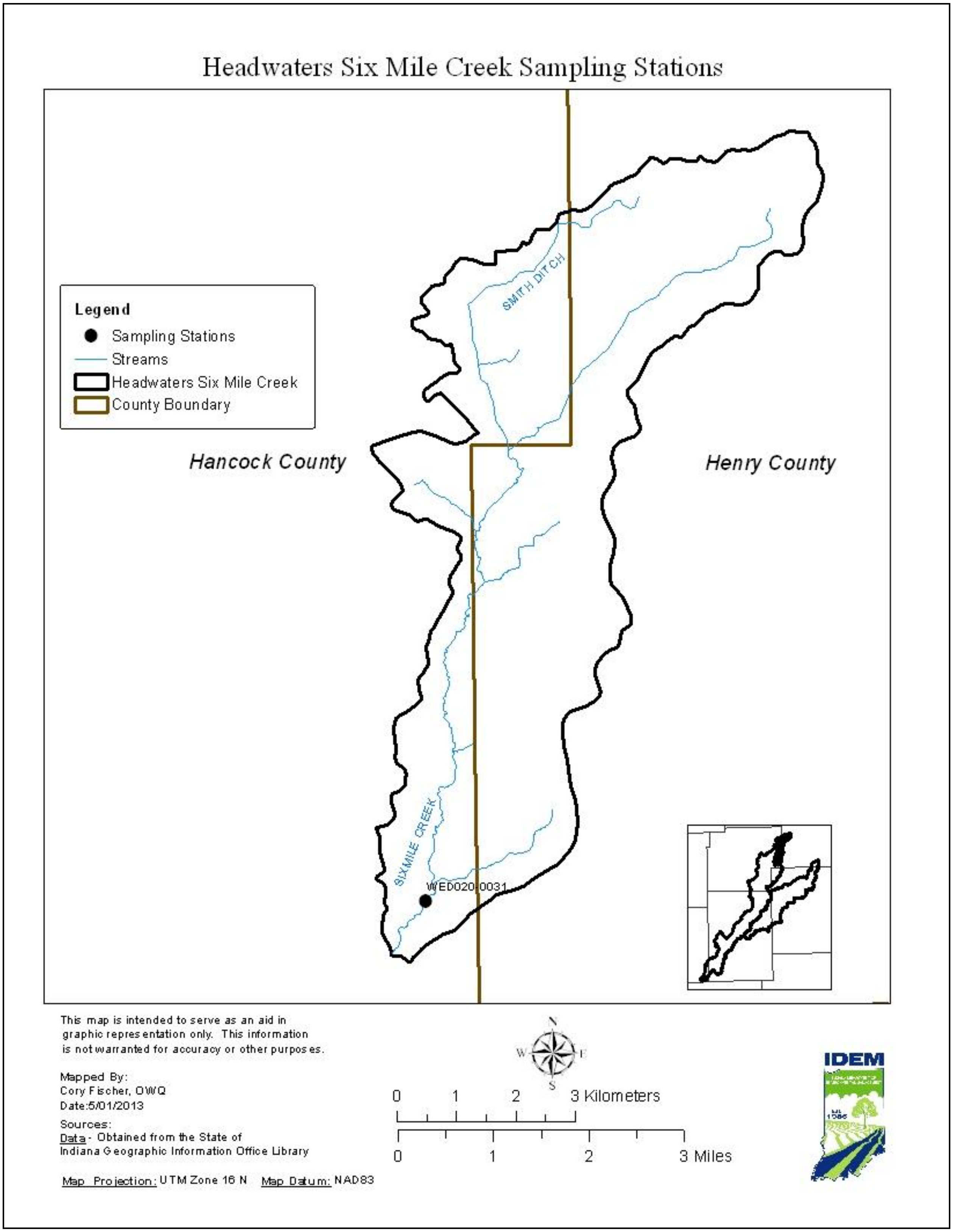


Figure 70. Sampling Stations in Headwaters Six Mile Creek Subwatershed

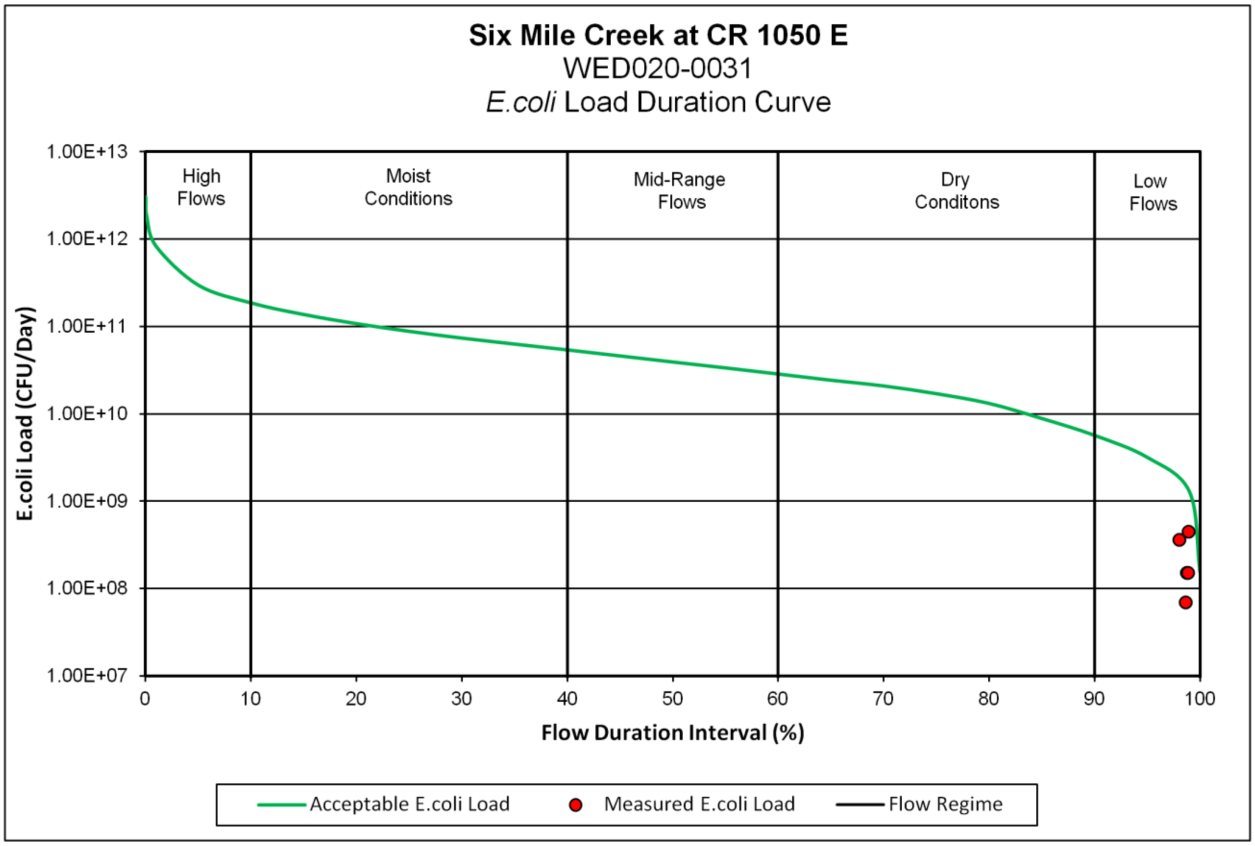


Figure 71. Load Duration Curve for Most Representative Site in the Headwaters Six Mile Creek Subwatershed

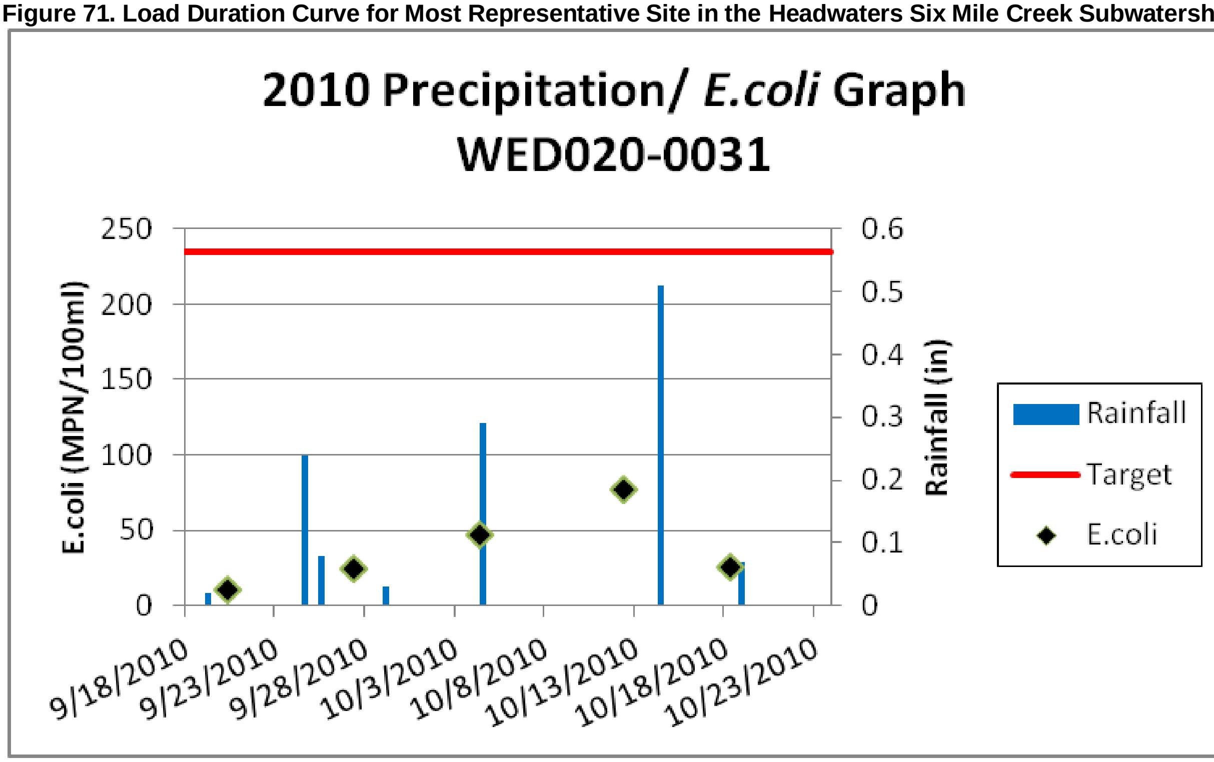


Figure 72. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Headwaters Six Mile Creek Subwatershed

Site WED020-0031 is located at CR 1050 E on Six Mile Creek.The geometric mean value for site WED020-0031 is 30.16 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows no exceedances of the single sample maximum with five samples below the water quality criteria during low flow. Precipitation graphs are presented in Appendix C. The stream is consistently below water quality criteria even during drier conditions on the chart.. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. There are no MS4 communties considered a source of *E. coli*. There are no CSO communities in the watershed and they are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.7 Anthony Creek- Six Mile Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 73) in the Anthony Creek- Six Mile Creek subwatershed. Flow data used to develop the load duration curves is summarized in Table 104.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 105 provides a summary of the Anthony Creek- Six Mile Creek subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 104. USGS Site Assignments for Development of Load Duration Curves in the Anthony Creek- Six Mile Creek Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 105. Summary of Anthony Creek- Six Mile Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	45.57 square miles				
TMDL Sample Site	WED020-0032, WED020-0001, WED08-0004				
ASUID Segments	INW0482_01, INW0482_01A, INW0482_T1001, INW0482_T1002				
Land Use	Agricultural Land: 77.11% Forested Land: 8.60% Developed Land: 6.35% Open Water: 0.12% Pasture/Hay: 6.89% Grassland/Shrubs: 0.85% Wetland: 0.07%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	4448: Jeff and Bruce Muegge (320 Nursery Pigs, 800 Finishers, 185 sows) 4623: Bob White Farm (500 Nursery Pigs, 1,000 Finishers) 2581: Lewis Pork Farm LLC (3,200 Nursery Pigs, 6,500 Finishers) 6582: Pork in Blue River LLC (8,000 Finishers)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	733.73	217.32	96.90	42.01	7.84
WLA	NA	NA	NA	NA	NA
MOS (10%)	81.5	24.15	10.77	4.67	0.87
TMDL = LA+WLA+MOS	815.3	241.47	107.66	46.68	8.71

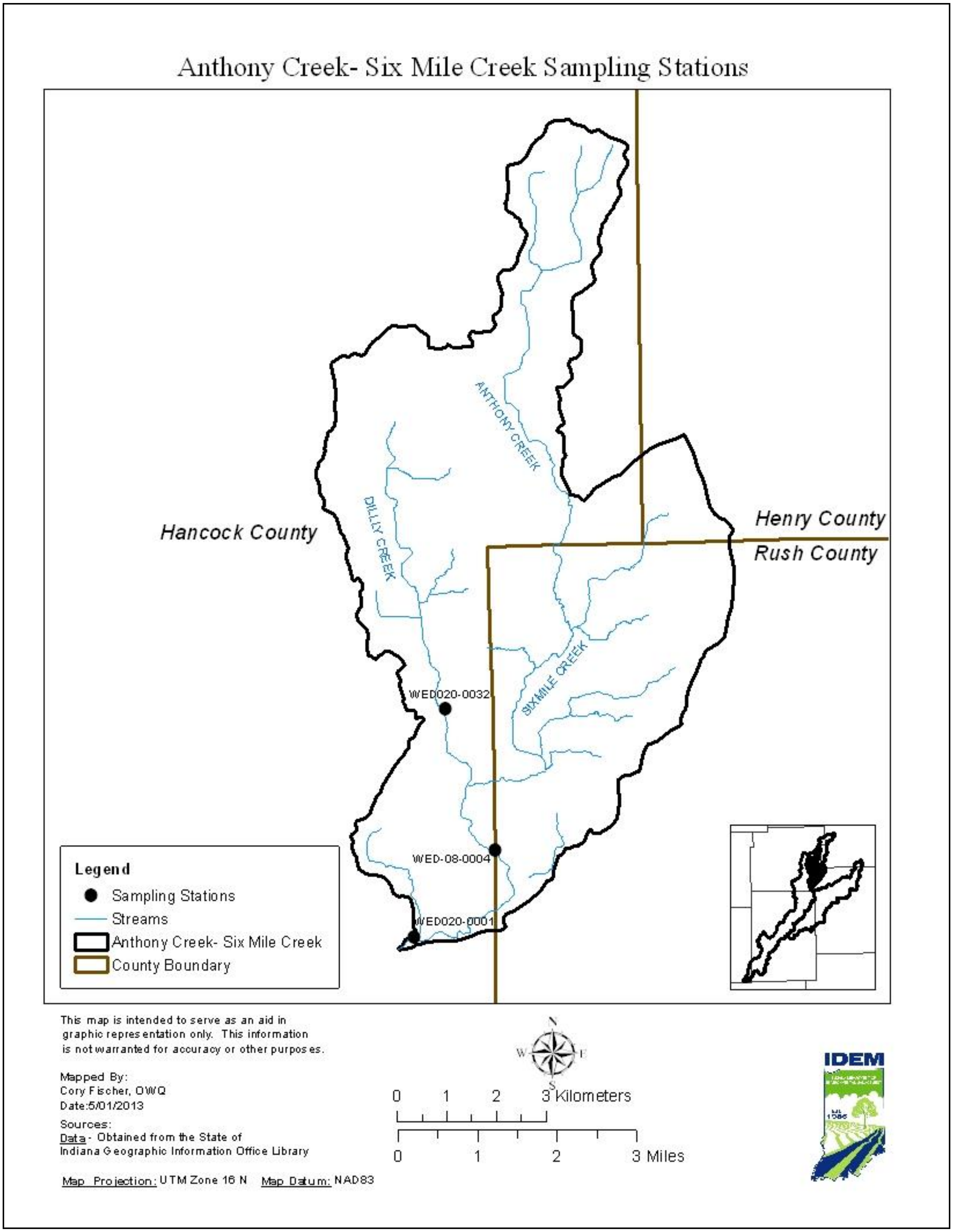


Figure 73. Sampling Stations in Anthony Creek- Six Mile Creek Subwatershed

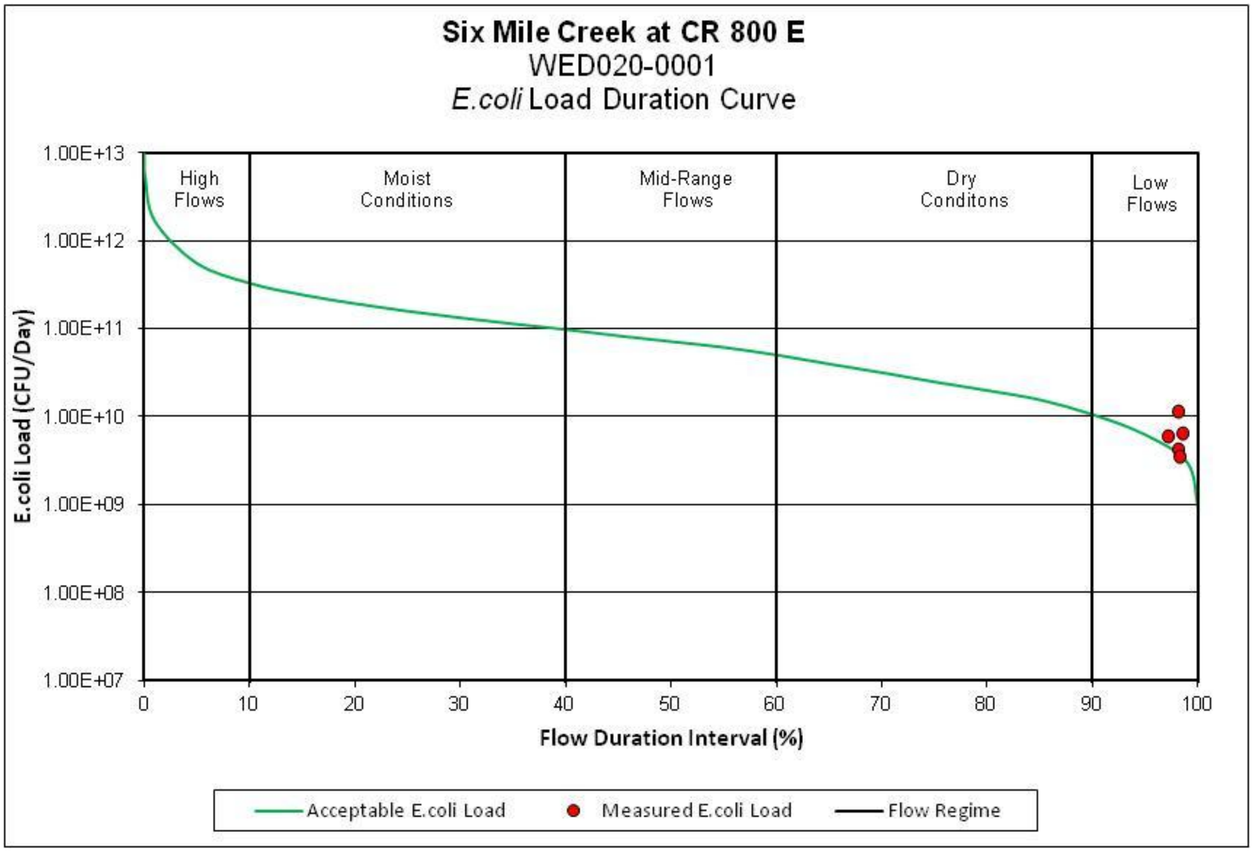


Figure 74. Load Duration Curve for Most Representative Site in the Anthony Creek- Six Mile Creek Subwatershed

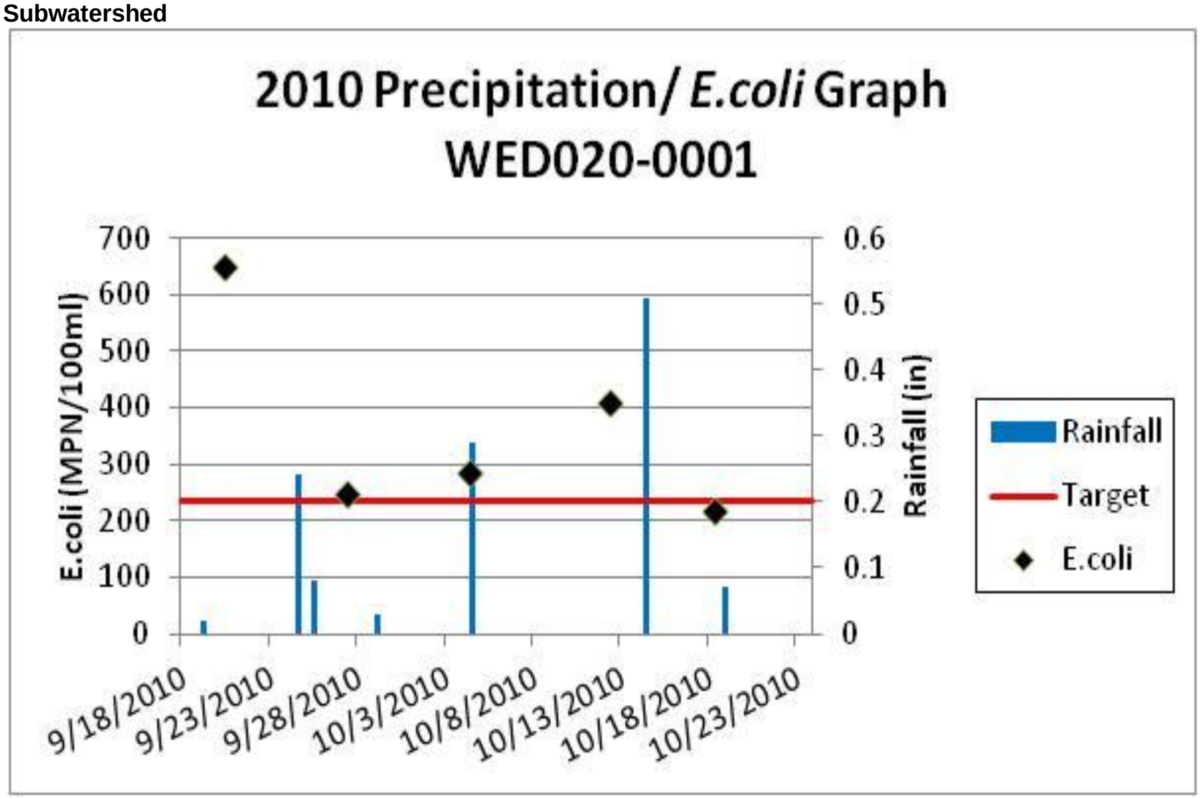


Figure 75. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Anthony Creek- Six Mile Creek Subwatershed

Site WED020-0032is located at CR 200 S on Dilly Creek. The geometric mean value for site WED020-0032 is 270.83 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows two exceedances of the single sample maximum with three samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off after a rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates that point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED020-0032 this could contribute to *E. coli* violations during dry and wet conditions.

Site WED020-0001 is located at CR 800 E on Six Mile Creek.The geometric mean value for site WED020-0001 is 333.43 MPN/100mL. Load duration curves are presented in Figure 74 Appendix C. The load duration curve shows four exceedances of the single sample with one sample below the water quality criteria. Precipitation graphs are presented in Figure 75 and Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off after a rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently in violation of water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing along with nonpoint sources. If animals have direct access upstream of WED020-0001 this could contribute to *E. coli* violations at dry and wet conditions.

Site WED-08-0004 is located at CR 900 E on Six Mile Creek.The geometric mean value for site WED-08-0004 is 380.65 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows five exceedances of the single sample with no samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off after a rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently in violation of water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing along with nonpoint sources. If animals have direct access upstream of WED-08-0004 this could contribute to *E. coli* violations at dry and wet conditions.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 73% of the time and an average geometric mean violation 100 % of the time. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. There are no MS4 communities considered a source of *E. coli*. There are no CSO communities in the watershed that are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.8 Nameless Creek

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 76) in the Nameless Creek subwatershed. Flow data used to develop the load duration curves is summarized in Table 106.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 107 provides a summary of the Nameless Creek subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 106. USGS Site Assignments for Development of Load Duration Curves in the Nameless Creek Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 107. Summary of Nameless Creek Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	16.43 square miles				
TMDL Sample Site	WED020-0033				
AUID Segments	INW0483_01				
Land Use	Agricultural Land: 81.80% Forested Land: 5.41% Developed Land: 6.68% Open Water: 0.21% Pasture/Hay: 5.03% Grassland/Shrubs: 0.84% Wetland: 0.04%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	1901: SSZ Enterprises (975 Nursery Pigs, 325 Finishers, 118 Sows)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	264.54	78.35	34.94	15.15	2.83
WLA	NA	NA	NA	NA	NA
MOS (10%)	29.4	8.71	3.88	1.68	0.31
TMDL = LA+WLA+MOS	293.9	87.06	38.82	16.83	3.14

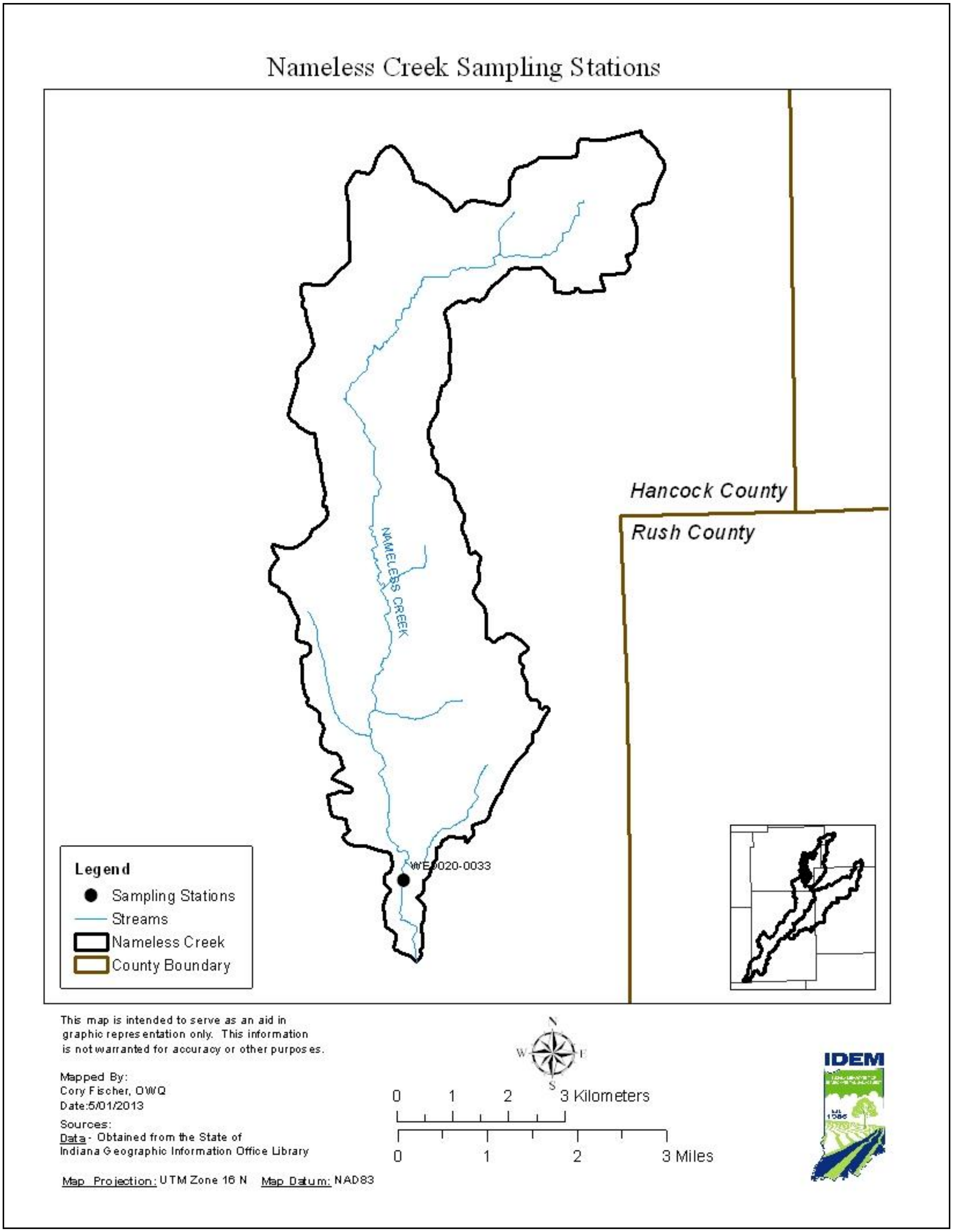


Figure 76. Sampling Stations in Nameless Creek Subwatershed

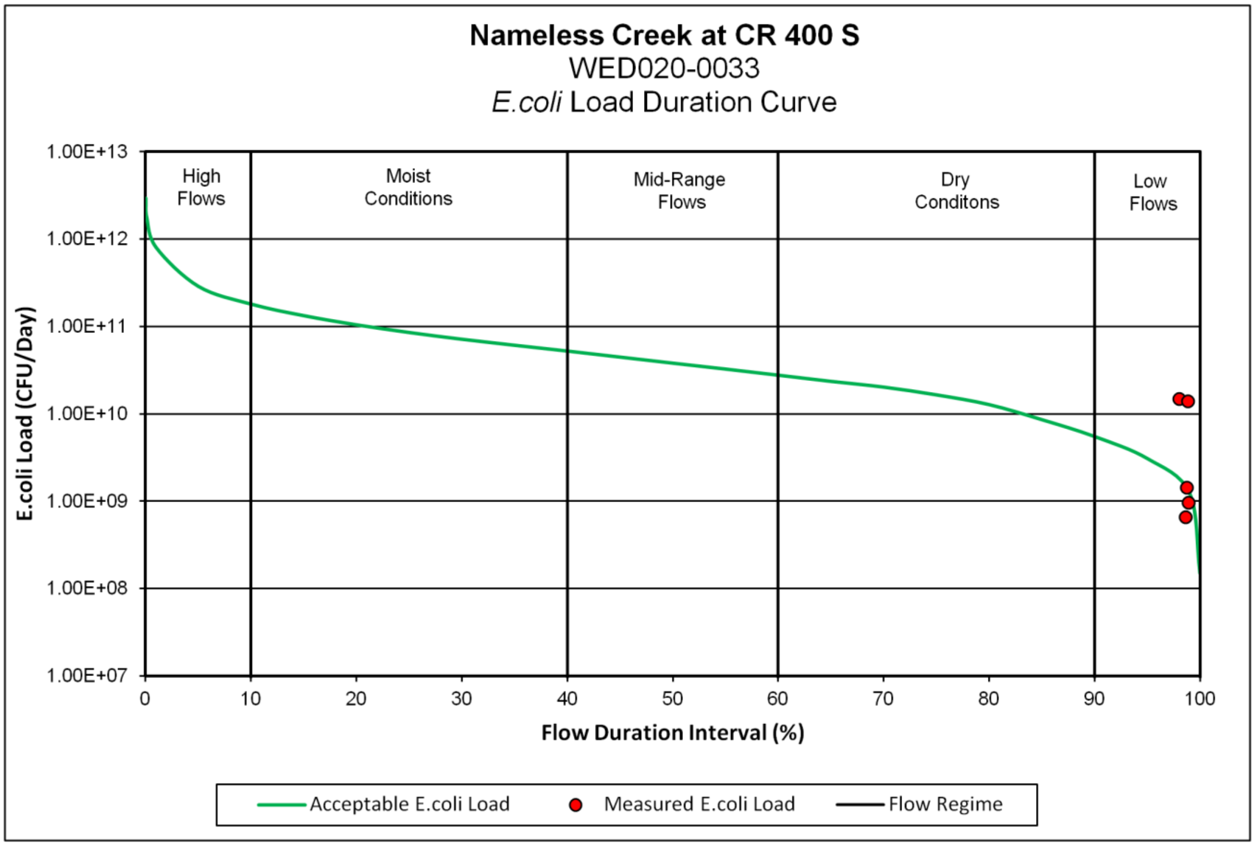


Figure 77. Load Duration Curve for Most Representative Site in the Nameless Creek Subwatershed

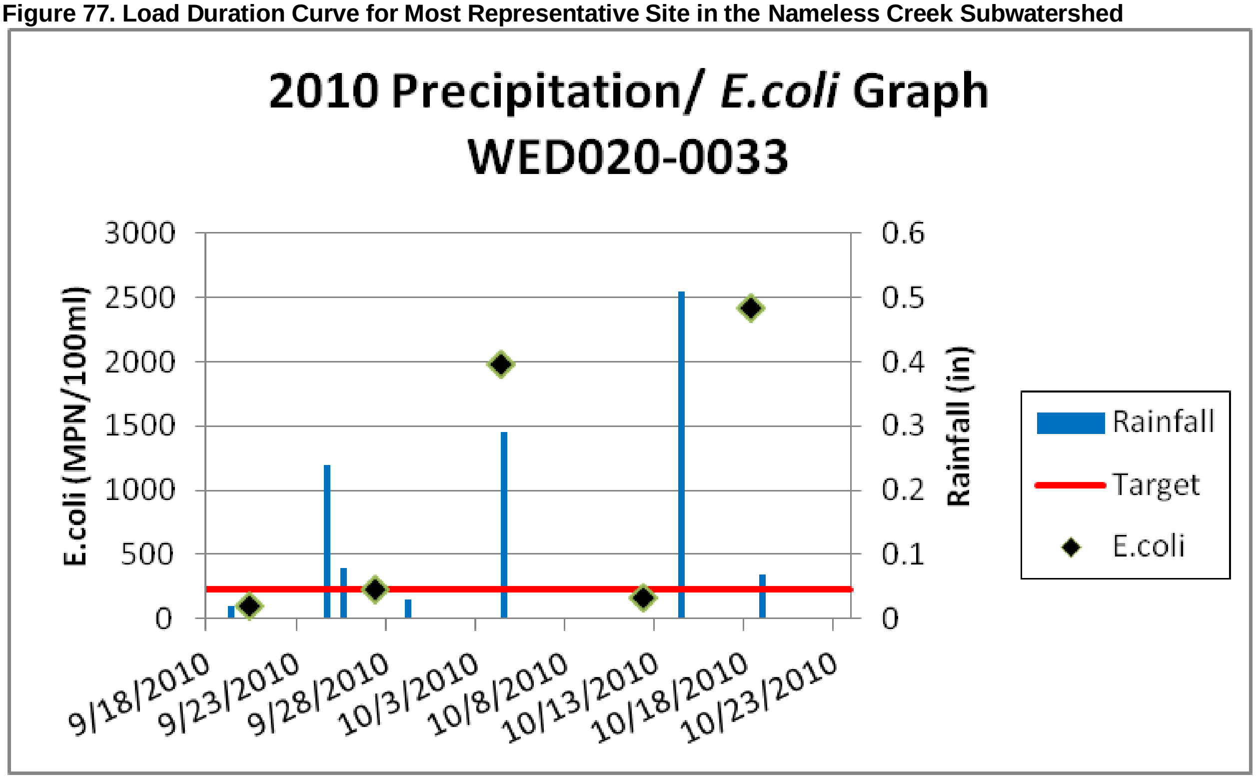


Figure 78. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Nameless Creek Subwatershed

Site WED020-0033 is located at CR 400 S on Nameless Creek. The geometric mean value for site WED020-0033 is 460.27 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows three exceedances of the single sample maximum with two samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.3 inch rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently in violation of water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing along with nonpoint sources. If animals have direct access upstream of WED020-0033 this could contribute to *E. coli* violations at dry and wet conditions. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. There are no CSO communities in the watershed that are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.9 Prairie Branch- Big Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 79) in the Prairie Branch- Big Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 108.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 109 provides a summary of the Prairie Branch- Big Blue Riverr subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 108. USGS Site Assignments for Development of Load Duration Curves in the Prairie Branch- Big Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 109. Summary of Prairie Branch- Big Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	275.93 square miles				
TMDL Sample Site	WED-08-0003				
AUID Segments	INW0484_01, INW0484_T1001, INW0484_T1002, INW0484_T1003				
Land Use	Agricultural Land: 81.58% Forested Land: 6.58% Developed Land: 4.43% Open Water: 0.03% Pasture/Hay: 5.46% Grassland/Shrubs: 1.33% Wetland: 0.58%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	637: Janes Brothers (300 Nursery Pigs, 300 Finishers, 40 sows)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	4,442.80	1,315.88	586.72	254.36	47.48
WLA	NA	NA	NA	NA	NA
MOS (10%)	493.64	146.21	65.19	28.26	5.28
TMDL = LA+WLA+MOS	4,936.45	1,462.09	651.91	282.62	52.76

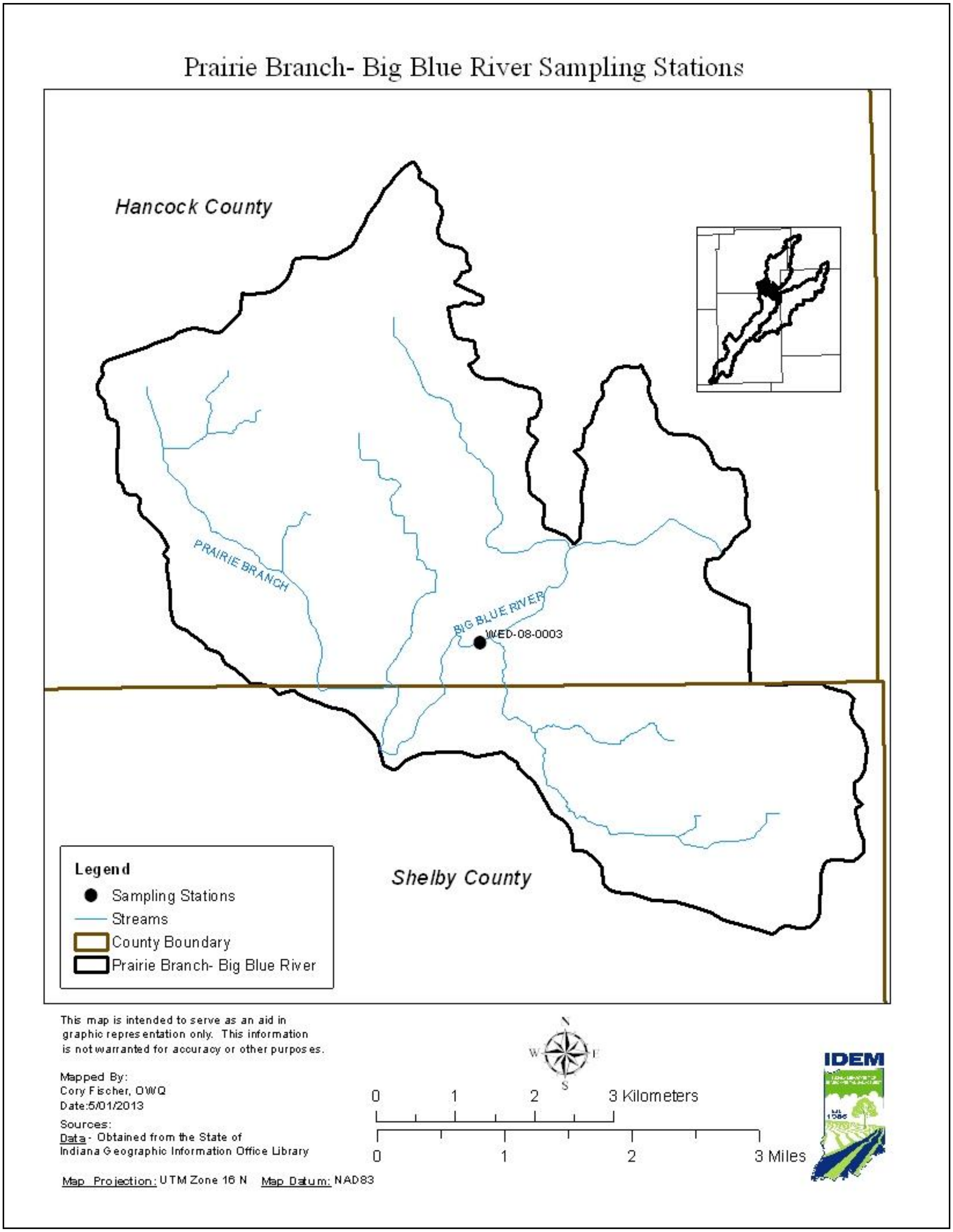


Figure 79. Sampling Stations in Prairie Branch- Big Blue River Subwatershed

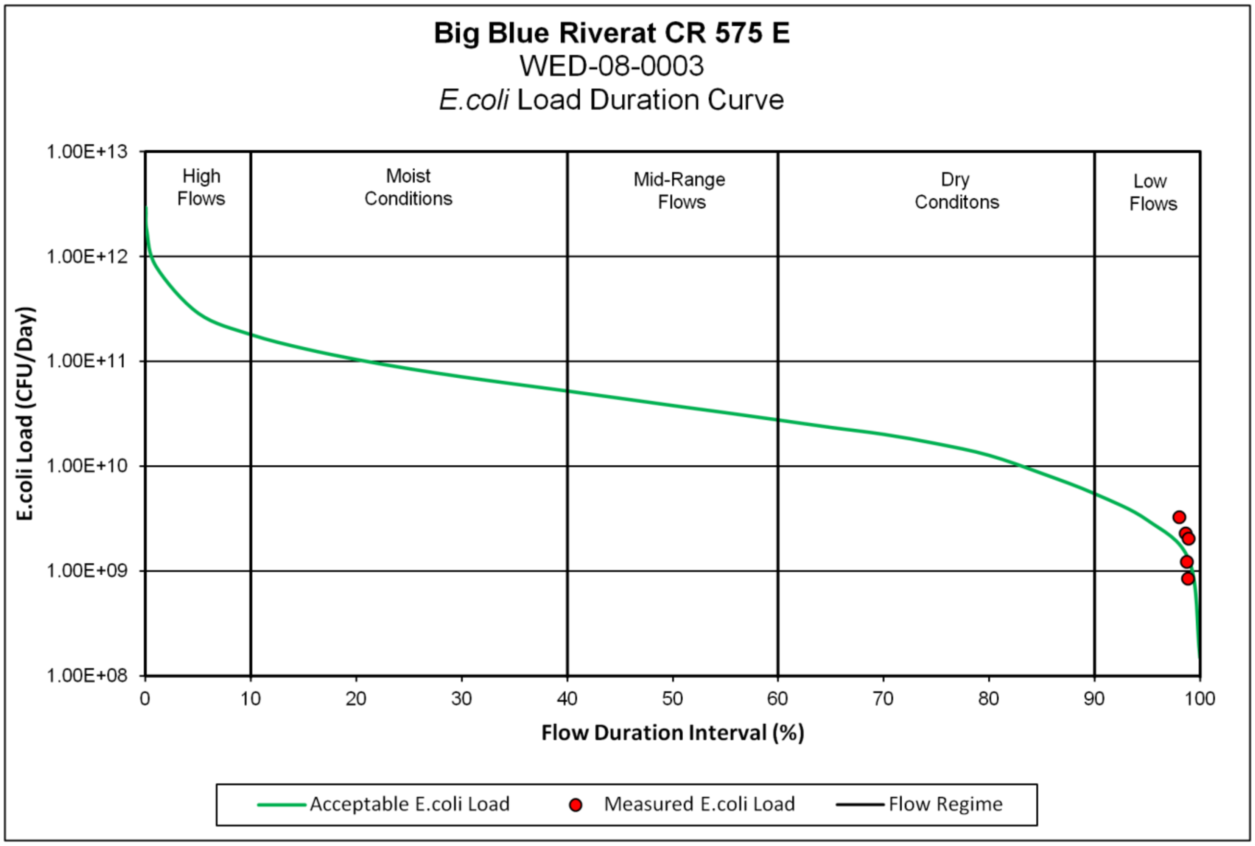


Figure 80. Load Duration Curve for Most Representative Site in the Prairie Branch- Big Blue River Subwatershed

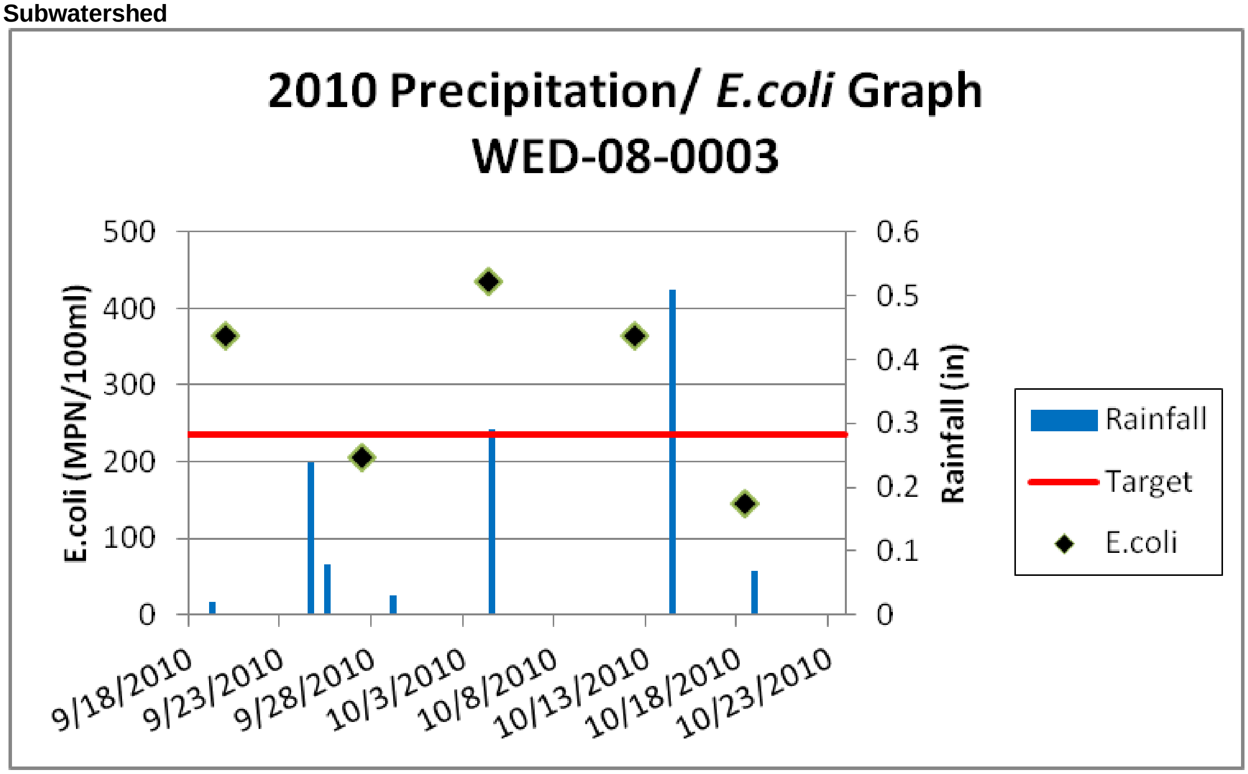


Figure 81. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Prairie Branch- Big Blue River Subwatershed

Site WED-08-0003 is located at CR 575 E on Big Blue River. The geometric mean value for site WED-08-0003 is 281.24 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows three exceedances of the single sample maximum with two samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.3 inch rain event. This is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently in violation of water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing along with nonpoint sources. If animals have direct access upstream of WED-08-0003this could contribute to *E. coli* violations at dry and wet conditions. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. There are no MS4 communities considered a source of *E. coli*. There are no CSO communities in the watershed that are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.10 Foreman Branch- Big Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 82) in the Foreman Branch- Big Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 110.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 111 provides a summary of the Foreman Branch- Big Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communityies, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 110. USGS Site Assignments for Development of Load Duration Curves in the Foreman Branch- Big Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 111. Summary of Foreman Branch- Big Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	314.36 square miles				
TMDL Sample Site	WED020-0003, WED020-0014				
AUID Segments	INW0485_01, INW0485_02, INW0485_03, INW0485_T1001, INW0485_T1001A, INW0485_T1002				
Land Use	Agricultural Land: 79.92% Forested Land: 6.84% Developed Land: 8.19% Open Water: 0.86% Pasture/Hay: 2.29% Grassland/Shrubs: 1.25% Wetland: 0.65%				
NPDES Facilities	IN0023841: Morristown WWTP (0.6 MGD)				
MS4 Communities	INR040051: City of Shelbyville (0.16 sq. miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	1939: Signature Farms Morristown (5,970 Sows)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**“Normal” Flows**	**Lower Flow Conditions**	**Low Flows**
LA	5,049.85	1,494.11	666.21	287.56	51.86
WLA: City of Shelbyville MS4 Morristown WWTP Total:	 9.50 2.23 11.73	 2.81 2.23 5.04	 NA 2.23 2.23	 NA 2.23 2.23	 NA 2.23 2.23
MOS (10%)	562.40	166.57	74.27	32.20	6.01
TMDL = LA+WLA+MOS	5,623.97	1,665.73	742.71	321.98	60.10

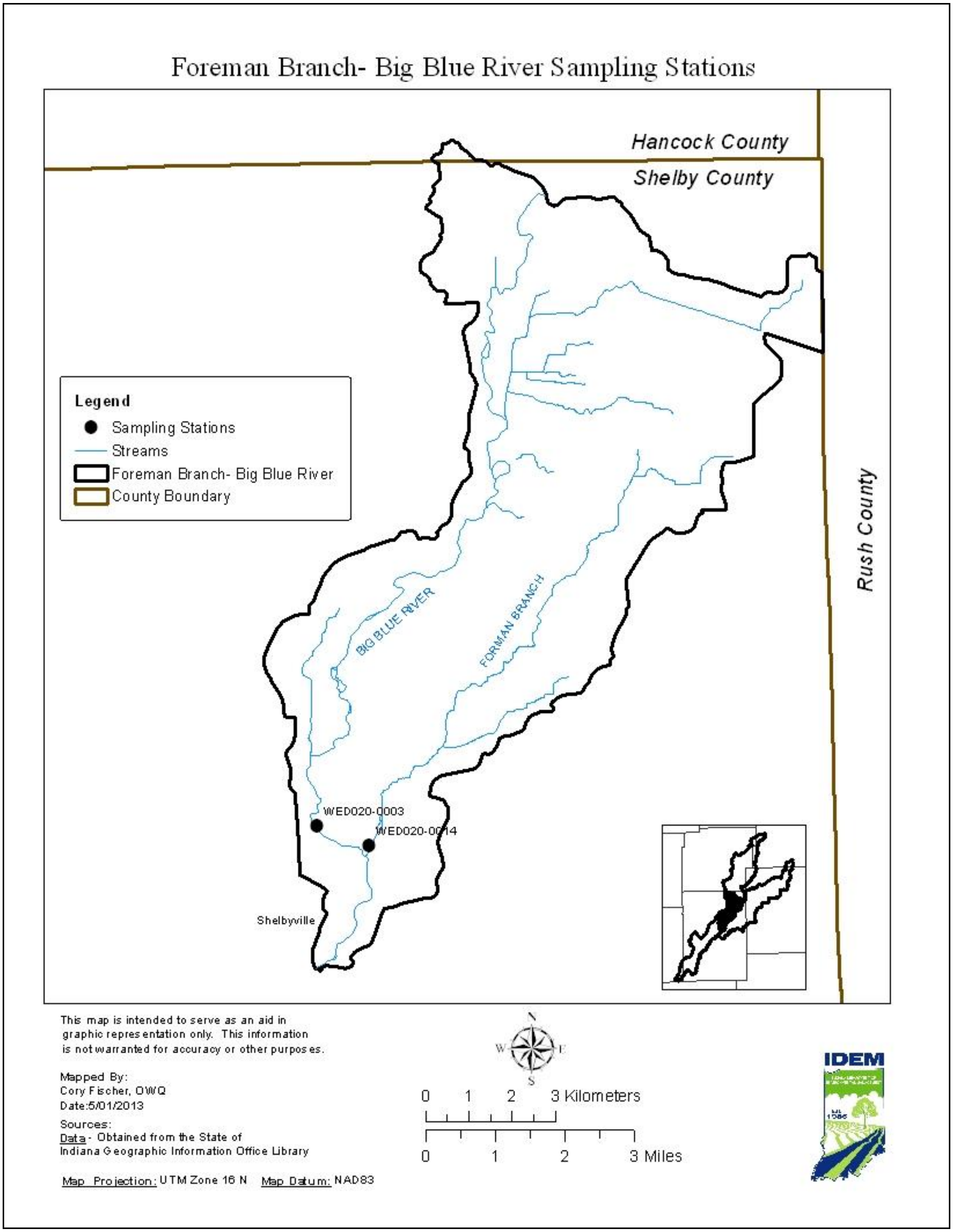


Figure 82. Sampling Stations in Foreman Branch- Big Blue River Subwatershed

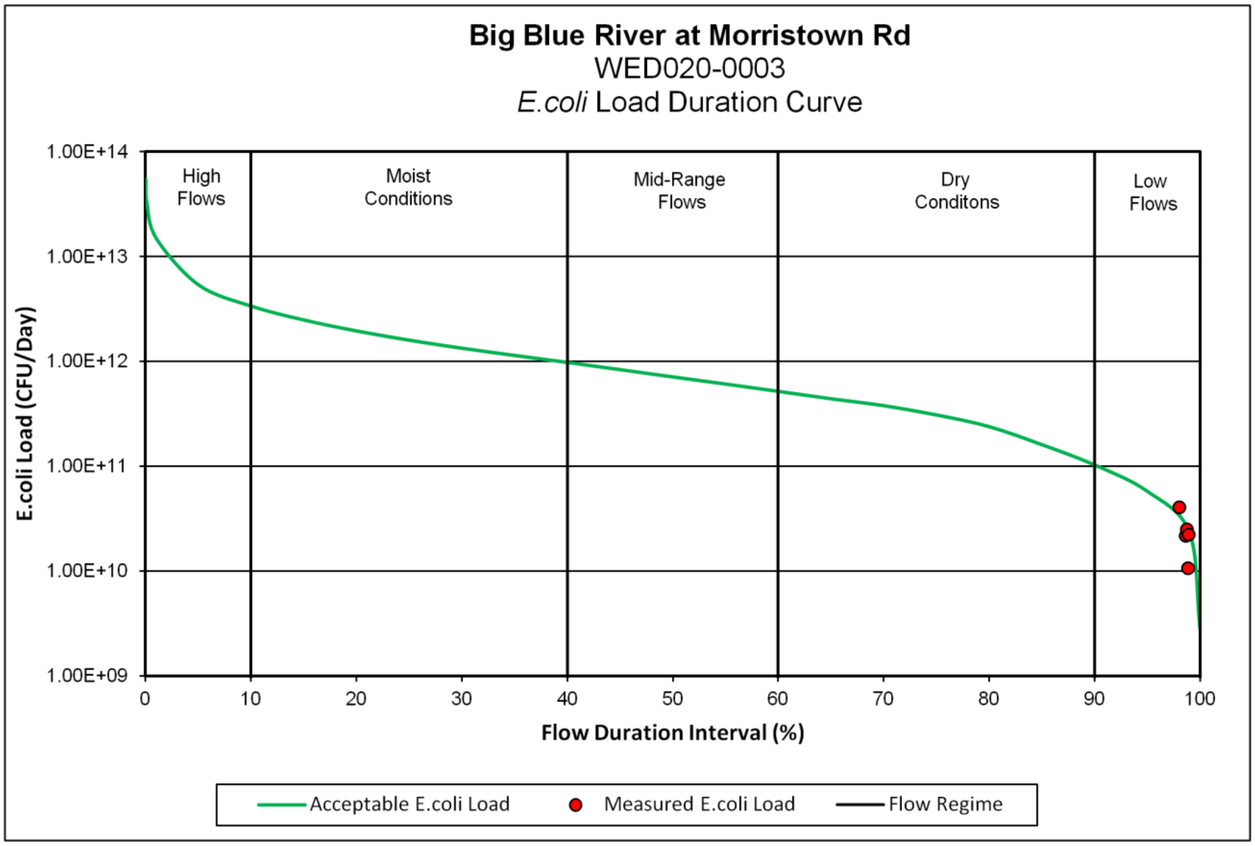


Figure83. Load Duration Curve for Most Representative Site in the Foreman Branch- Big Blue River Subwatershed

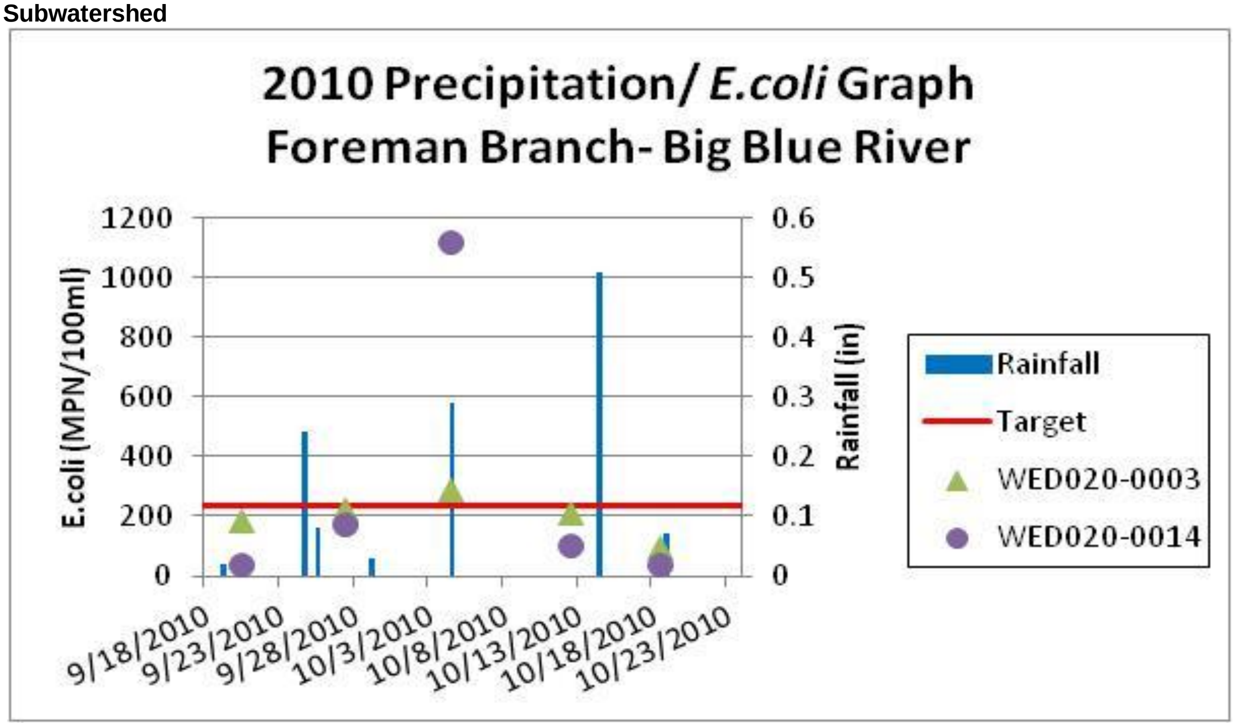


Figure 84. Graph of Precipitation and *E. coli* Data at all Sites in the Foreman Branch- Big Blue River Subwatershed

Site WED020-0003 is located at Morristown Road on Big Blue River. The geometric mean value for site WED020-0003 is 191.56 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows one exceedance of the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.3 inch rain event. It is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED020-0003this could contribute to *E. coli* violations at dry and wet conditions.

Site WED020-0014 is located at Knighthood Grove Rd. on Foremans Branch.The geometric mean value for site WED020-0014 is 123.51 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows one exceedance of the single sample maximum with four samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The precipitation graph for this site shows the stream is susceptible to high loads of *E. coli* from run-off during a 0.3 inch rain event. It is evident that a small amount of rain can cause a considerable effect on the watershed. The stream is consistently at or below water quality criteria even during drier conditions on the chart. This indicates point sources may be contributing to increased levels of *E. coli* in addition to nonpoint sources. If animals have direct access upstream of WED020-0014 this could contribute to *E. coli* violations at dry and wet conditions.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 20% of the time and an average geometric mean violation 50 % of the time. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. The City of Shelbyville, an MS4 community, is considered a source of *E. coli*. There are no CSO communities in the watershed that are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.11 DePrez Ditch- Big Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 85) in the DePrez Ditch- Big Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 112.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 113 provides a summary of the DePrez Ditch- Big Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 112. USGS Site Assignments for Development of Load Duration Curves in the DePrez Ditch- Big Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as "surrogate," AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 113. Summary of DePrez Ditch- Big Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	553.98 square miles				
TMDL Sample Site	WED-08-0001; WED050-0033; WED-08-0002				
AUID Segments	INW0486_01, INW0486_02, INW0486_T1001, INW0486_T1002, INW0486_T1003				
Land Use	Agricultural Land: 75.21% Forested Land: 7.05% Developed Land: 14.28% Open Water: 0.96% Pasture/Hay: 1.57% Grassland/Shrubs: 0.15% Wetland: 0.78%				
NPDES Facilities	IN0032867: Shelbyville WWTP (8.0 MGD)				
MS4 Communities	INR040051: City of Shelbyville (1.99 sq.miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	2208: Jarrod Law and Michael Pauszek (600 Nursery Pigs, 280 Sows)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
LA	8,761.23	2,574.02	1,148.24	480.96	65.61
WLA: City of Shelbyville MS4 Shelbyville WWTP Total:	 128.80 29.71 158.51	 38.15 29.71 67.86	 NA 29.71 29.71	 NA 29.71 29.71	 NA 29.71 29.71
MOS (10%)	991.08	293.54	130.88	56.74	10.59
TMDL = LA+WLA+MOS	9,910.82	2,935.42	1,308.83	567.41	105.92

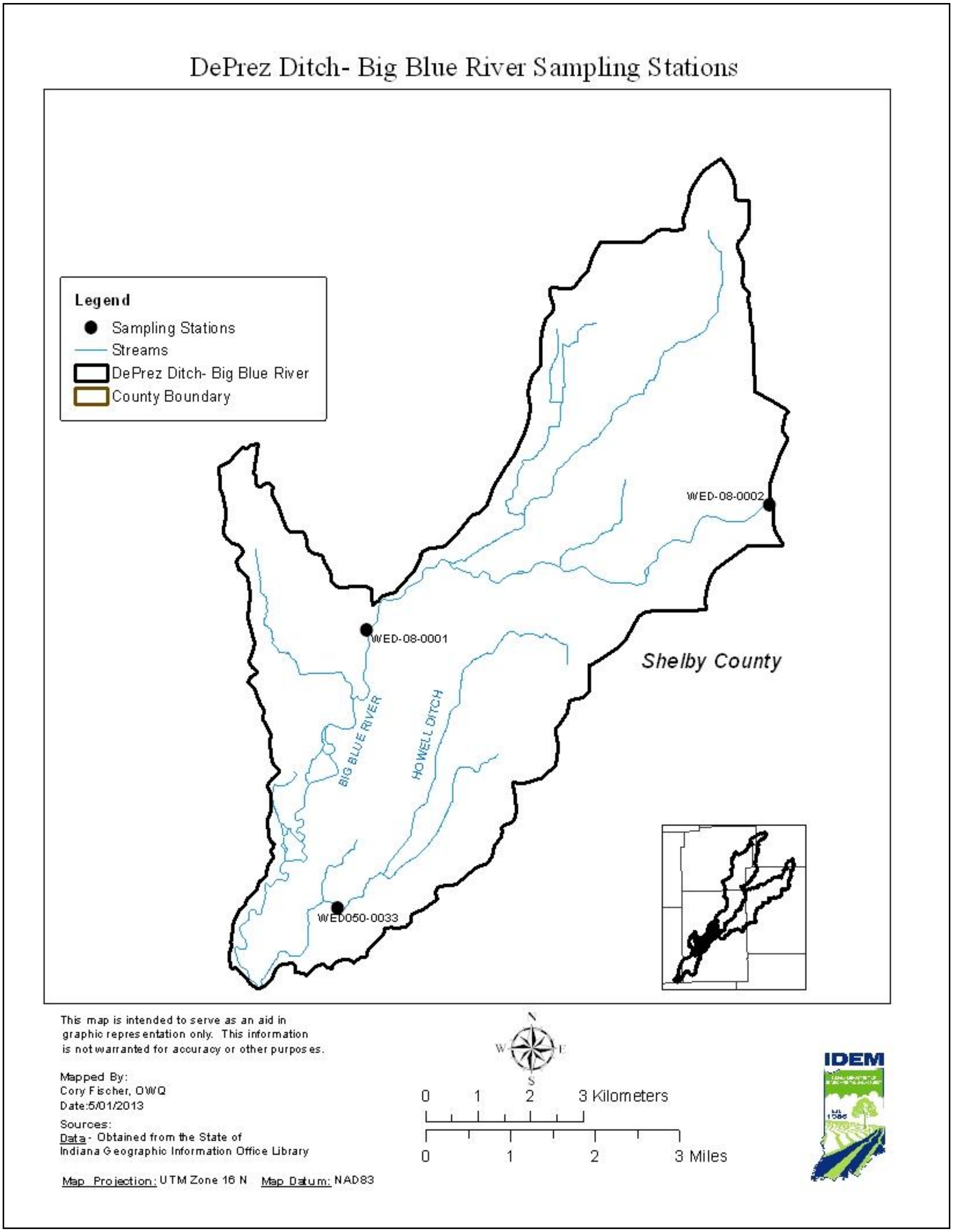


Figure 85. Sampling Stations in DePrez Ditch- Big Blue River Subwatershed

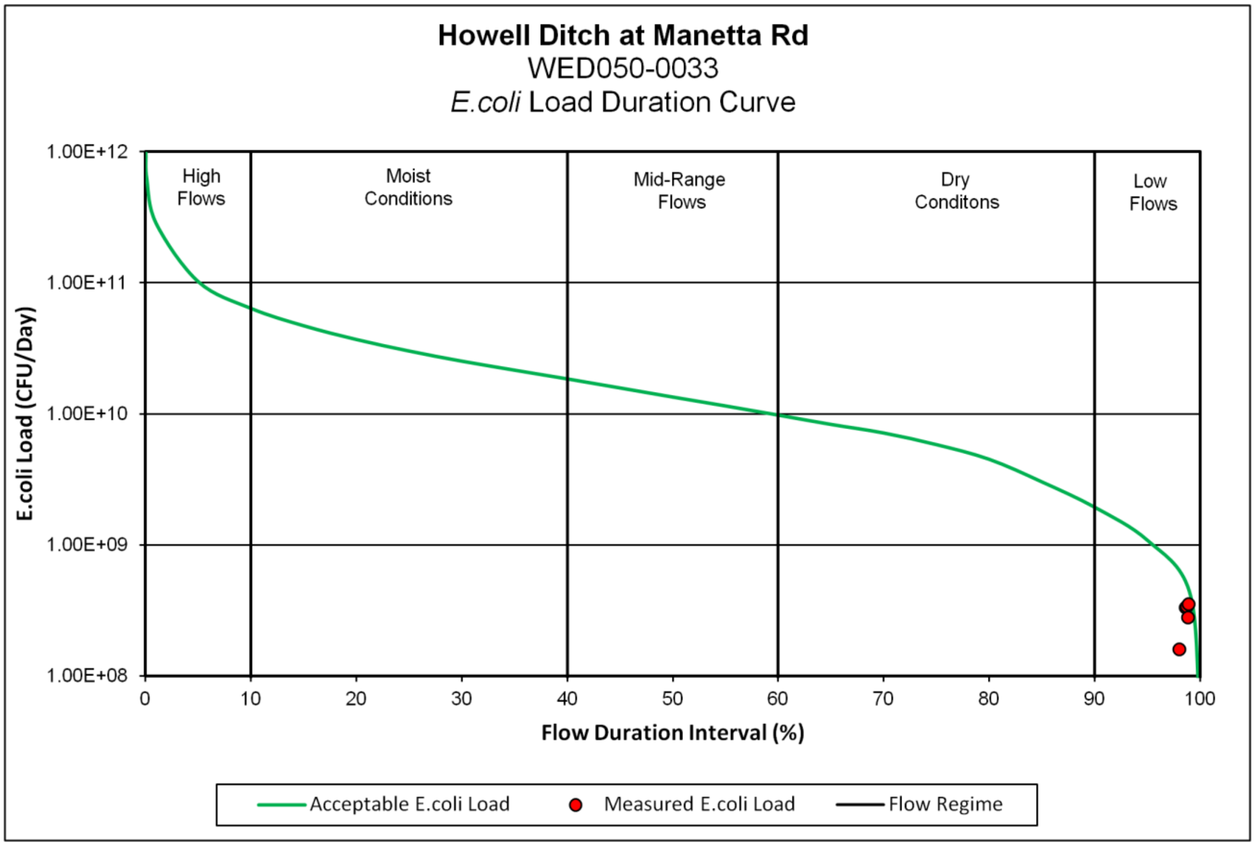


Figure 86. Load Duration Curve for Most Representative Site in the DePrez Ditch- Big Blue River Subwatershed

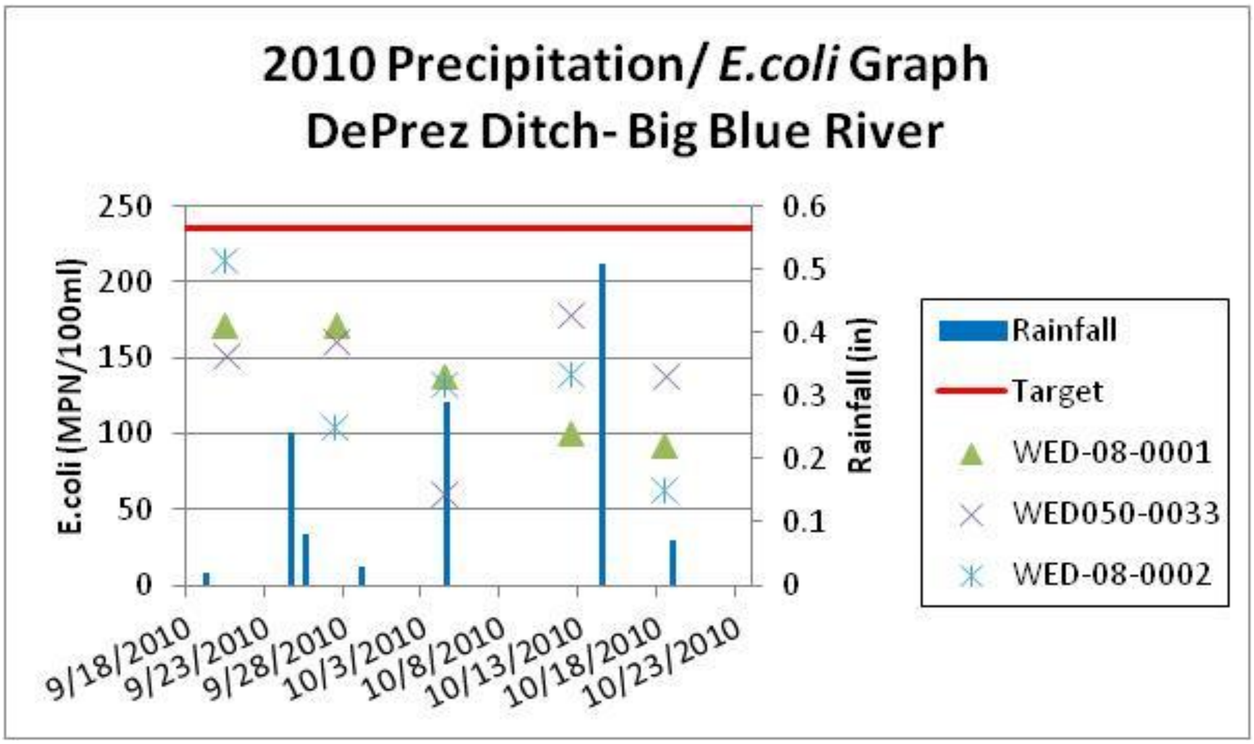


Figure 87. Graph of Precipitation and *E. coli* Data at Most Representative Site in the DePrez Ditch- Big Blue River Subwatershed

Site WED-08-0001 is located at CR 100 S on Big Blue River. The geometric mean value for site WED-08-0001 is 130.92 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows no exceedances of the single sample maximum with five samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The stream is consistently under water quality criteria even during drier conditions on the chart.

Site WED050-0033 is located at Howell Ditch on Manetta Rd.The geometric mean value for site WED050-0033 is 129.50 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows no exceedances of the single sample maximum with five samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The stream is consistently under water quality criteria even during drier conditions on the chart.

Site WED080-0002 is located at Big Blue Rover on Noble Street.The geometric mean value for site WED080-0002 is 121.19 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows no exceedances of the single sample maximum with five samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The stream is consistently under water quality criteria even during drier conditions on the chart.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 0% of the time and an average geometric mean violation 66 % of the time. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. The City of Shelbyville, an MS4 community, is considered a source of *E. coli*. There are no CSO communities in the watershed that are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

7.1.12 Shaw Ditch- Big Blue River

Load duration curves and precipitation graphs were created for all the sampling sites (Figure 88) in the Shaw Ditch- Big Blue River subwatershed. Flow data used to develop the load duration curves is summarized in Table 114.

The figures illustrate water quality criteria violations during all flow ranges that occurred during sampling events. A discussion of key sampling sites in the subwatershed is included following the figures. Table 115 provides a summary of the Shaw Ditch- Big Blue River subwatershed, including drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 communities, CSO communities, CAFOs and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated *E. coli* concentrations.

Table 114. USGS Site Assignments for Development of Load Duration Curves in the Shaw Ditch- Big Blue River Subwatershed

Gage Location	Gage ID	Period of Record	Watershed Relationship[1]
Big Blue River at Shelbyville	03361500	1/1/1990- 12/06/2013	Surrogate

1. Where denoted as “surrogate,” AUID watersheds are ungaged, and flows for the segment were estimated using flows from the noted UGSG gage in a surrogate watershed.

Table 115. Summary of Shaw Ditch- Big Blue River Subwatershed Characteristics

Upstream Characteristics					
Drainage Area	583.32 square miles				
TMDL Sample Site	WED050-0008, WED050-0035				
AUID Segments	INW0487_01, INW0487_T1001, INW0487_T1002				
Land Use	Agricultural Land: 71.02% Forested Land: 14.51% Developed Land: 6.26% Open Water: 0.86% Pasture/Hay: 6.17% Grassland/Shrubs: 0.33% Wetland: 0.85%				
NPDES Facilities	IN0020184: Edinburgh WWTP (1.5 MGD)				
MS4 Communities	INR040026: Town of Edinburgh (0.29 Sq. Miles)				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**“Normal” Flows**	**Lower Flow Conditions**	**Low Flows**
LA	8,918.59	2,632.15	1,226.99	524.38	87.04
WLA: Edinburgh WWTP Edinburg MS4 Sum:	 13.34 460.22 **473.56**	 13.34 136.31 **149.65**	 13.34 NA **13.34**	 13.34 NA **13.34**	 13.34 NA **13.34**
MOS (10%)	1,043.57	309.09	137.82	59.75	11.15
TMDL = LA+WLA+MOS	10,435.72	3,090.89	1,378.15	597.47	111.53

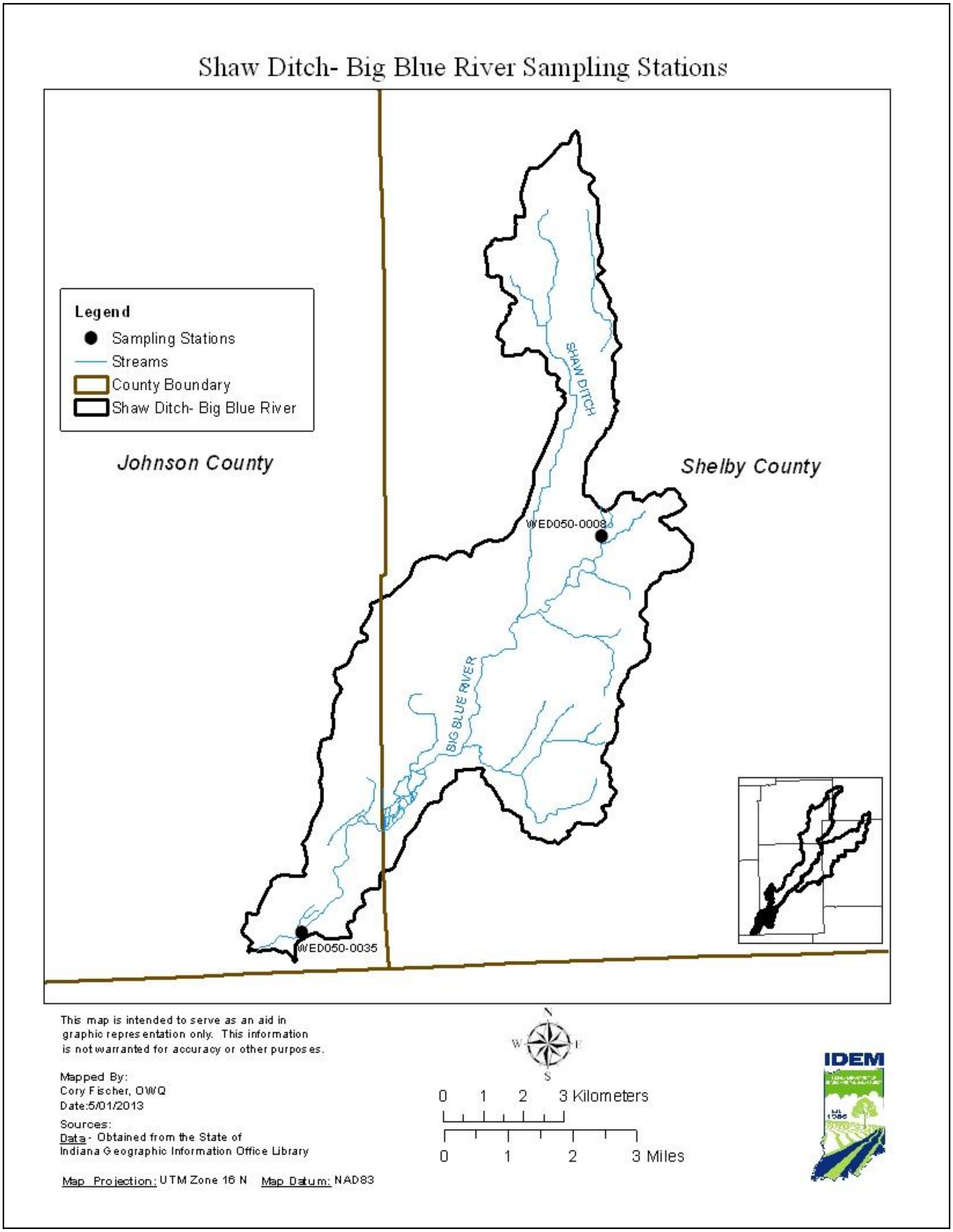


Figure 88. Sampling Stations in Shaw Ditch- Big Blue River Subwatershed

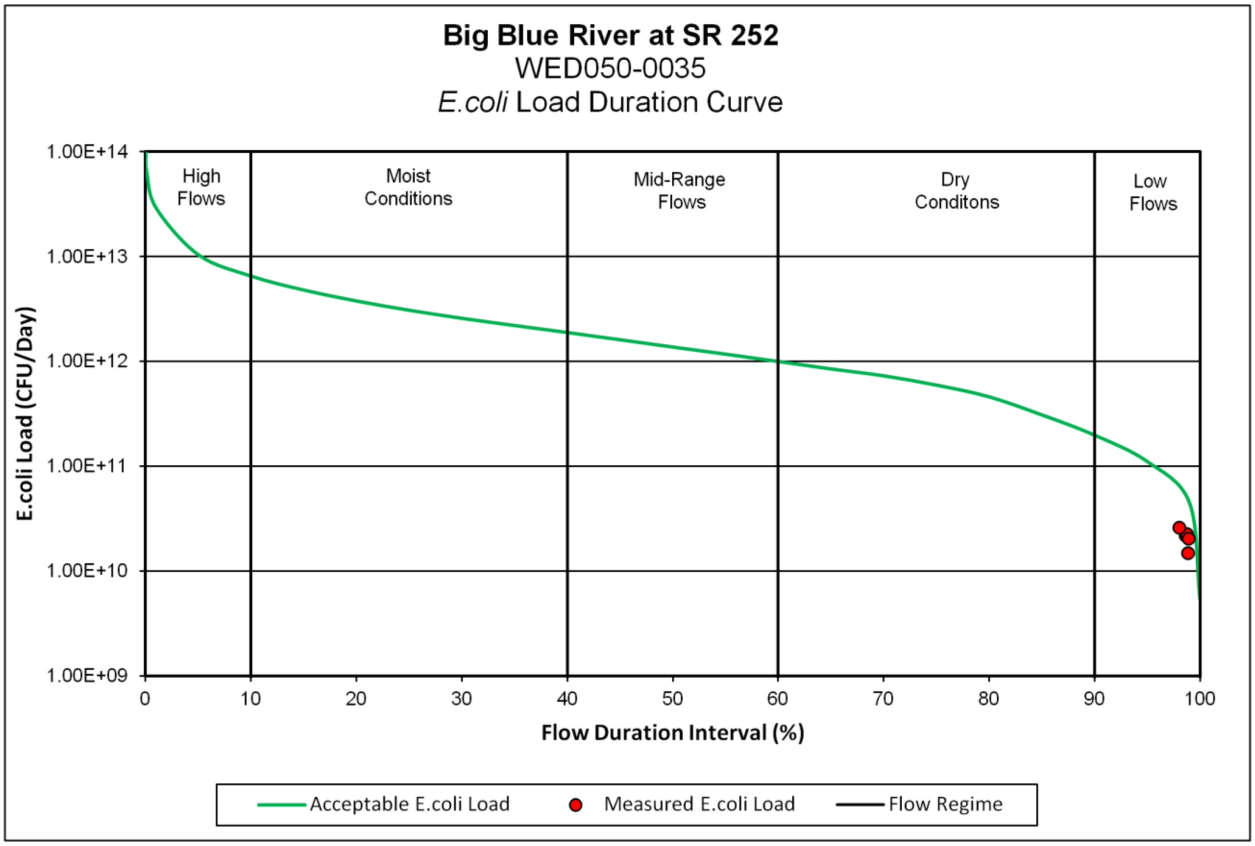


Figure 89. Load Duration Curve for Most Representative Site in the DePrez Ditch- Big Blue River Subwatershed

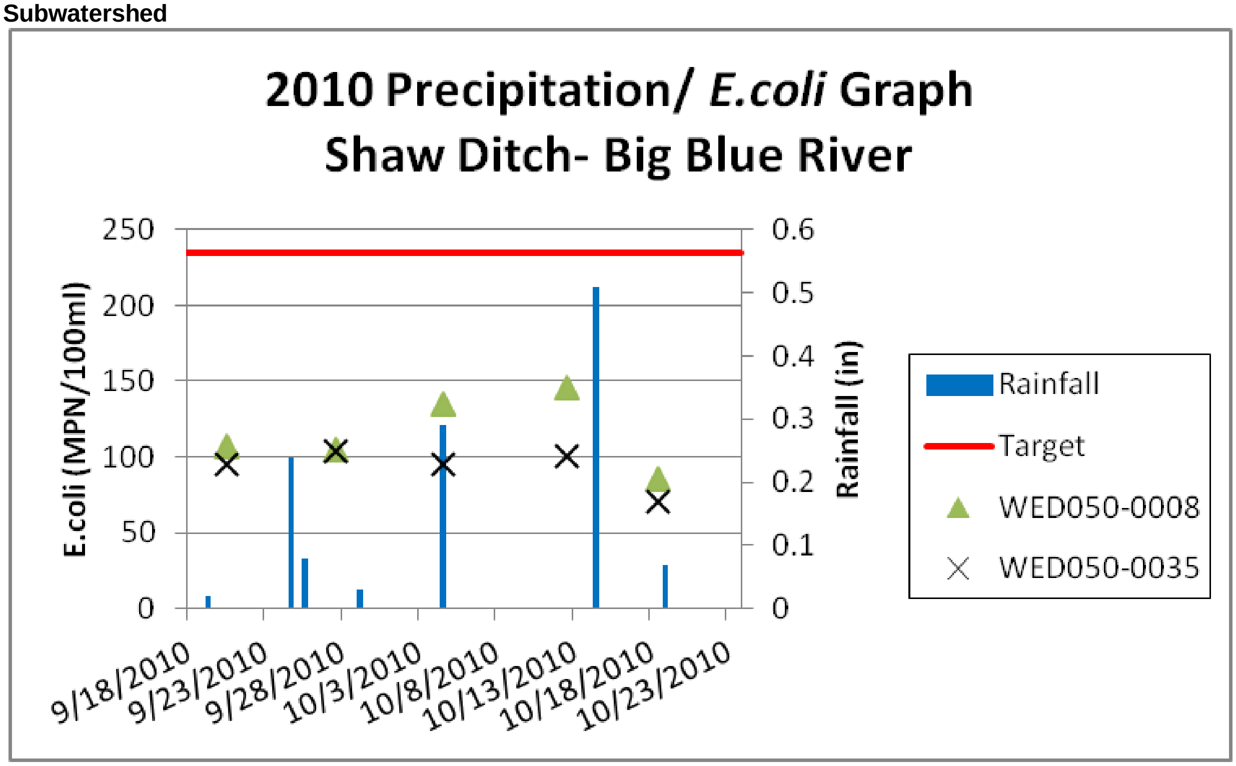


Figure 90. Graph of Precipitation and *E. coli* Data at Most Representative Site in the Shaw Ditch- Big Blue River Subwatershed

Site WED050-0008 is located at CR 550 S on Big Blue River. The geometric mean value for site WED050-0008 is 114.21 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows no exceedances of the single sample maximum with five samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The stream is consistently under water quality criteria even during drier conditions on the chart.

Site WED050-0035 is located at SR 252 on Big Blue River. The geometric mean value for site WED050-0035 is 92.93 MPN/100mL. Load duration curves are presented in Appendix C. The load duration curve shows no exceedances of the single sample maximum with five samples below the water quality criteria. Precipitation graphs are presented in Appendix A. The stream is consistently below water quality criteria even during drier conditions on the chart.

The combined *E. coli* data for the subwatershed have an average single sample maximum violation 0% of the time and an average geometric mean violation 0 % of the time. There is no NPDES permit with an enforcement case open and there are no CFO or CAFO permit violations. There are no MS4 communities considered a source of *E. coli*. There are no CSO communities in the watershed that are considered a source of *E. coli*. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are nonpoint sources that include small animal operations, wildlife, animals with direct access to streams, straight piped, leaking and failing septic systems.

8.0 ALLOCATIONS

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality criteria. TMDLs are composed of the sum of individual WLAs for regulated sources and LAs for unregulated sources. In addition, the TMDL must include a MOS, either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

8.1 Results by Assessment Location

The following sections present the allowable *E. coli* loads and associated allocations for each of the subwatersheds and associated assessment units in the Lower Big Blue River watershed. Allocations were calculated for each 12-digit HUC. WLAs were calculated based on the design flow of the facility and the TMDL Target.

Table 116 presents the individual WLAs for NPDES facilities in the Lower Big Blue River watershed by subwatershed.

The 5 WWTPs are estimated to contribute about 0.88 percent of the *E. coli* load in the Lower Big Blue River watershed.] The WWTP WLAs were established based on the design flow multiplied by the TMDL target value of [for bacteria: 125#/100 mL for *E. coli*]

Table 116. Individual WLAs for NPDES Facilities in the Lower Big Blue River Watershed

Subwatershed	Facility Name	Permit ID	AUID	Design Flow (MGD)	*E. coli* WLA (Billion/ day)
Headwaters Little Blue River	NA	NA	NA	NA	NA
Beaver Meadow Creek	NA	NA	NA	NA	NA
Gilson Creek-Little Blue River	NA	NA	NA	NA	NA
Manilla Branch-Little Blue River	NA	NA	NA	NA	NA
Town of Rays Crossing-Little Blue River	NA	NA	NA	NA	NA
Headwaters Six Mile Creek	Eastern Hancock Jr/Sr High School	IN0031593	INW0481_01	0.029	0.26
	Shirley WWTP	IN0024503	INW0481_T1001	0.155	1.38
Anthony Creek-Six Mile Creek	NA	NA	NA	NA	NA
Nameless Creek	NA	NA	NA	NA	NA
Prairie Branch-Big Blue River	NA	NA	NA	NA	NA
Foreman Branch-Big Blue River	Morristown WWTP	IN0023841	INW0485_01	0.6	5.34
DePrez Ditch-Big Blue River	Shelbyville WWTP	IN0032867	INW0486_01	8.0	71.16
Shaw Ditch-Big Blue River	Edinburgh WWTP	IN0020184	INW0487_01	1.5	13.34

There are no CSO communities in the Lower Big Blue River watershed as shown in Table 117.

Table 117. Individual WLAs for CSO Communities in the Lower Big Blue River Watershed TMDL

Subwatershed	Facility	Permit #	AUID	*E. coli* WLA [Billion/day]
Headwaters Little Blue River	NA	NA	NA	NA
Beaver Meadow Creek	NA	NA	NA	NA
Gilson Creek-Little Blue River	NA	NA	NA	NA
Manilla Branch-Little Blue River	NA	NA	NA	NA
Town of Rays Crossing-Little Blue River	NA	NA	NA	NA
Headwaters Six Mile Creek	NA	NA	NA	NA
Anthony Creek-Six Mile Creek	NA	NA	NA	NA
Nameless Creek	NA	NA	NA	NA
Prairie Branch-Big Blue River	NA	NA	NA	NA
Foreman Branch-Big Blue River	NA	NA	NA	NA
DePrez Ditch-Big Blue River	NA	NA	NA	NA
Shaw Ditch-Big Blue River	NA	NA	NA	NA

Table 118 presents the individual WLAs for MS4 communities in the Lower Big Blue River watershed by subwatershed.

Different WLAs were established for each MS4 depending on the area of the MS4 upstream of the each assessment location. The jurisdictional areas of townships, municipalities, and urbanized areas were used as surrogates for the regulated area of each MS4. These areas were then used to calculate WLAs based on the proportion of the upstream drainage area located within the MS4 boundaries by multiplying that proportional area by the loading capacity of the assessment location. The MS4 WLAs therefore are equal to the estimated flows from the MS4 multiplied by the TMDL target value of for bacteria: 125#/100 mL for *E. coli*.

Table 118. Individual WLAs for MS4 Communities in the Lower Big Blue River watershed TMDLs

Subwatershed	MS4 Community	Permit ID	AUID	Area in Drainage (sq miles)	*E. coli* WLA [Billion/day]	
					Very High	***Higher***
Headwaters Little Blue River	NA	NA	NA	NA	NA	
Beaver Meadow Creek	NA	NA	NA	NA	NA	
Gilson Creek-Little Blue River	NA	NA	NA	NA	NA	
Manilla Branch-Little Blue River	NA	NA	NA	NA	NA	
Town of Rays Crossing-Little Blue River	Shelbyville	INR040051	INW0425_01	2.27	36.53	10.82
Headwaters Six Mile Creek	NA	NA	NA	NA	NA	
Anthony Creek-Six Mile Creek	NA	NA	NA	NA	NA	
Nameless Creek	NA	NA	NA	NA	NA	
Prairie Branch-Big Blue River	NA	NA	NA	NA	NA	
Foreman Branch-Big Blue River	Shelbyville	INR040051	INW0485_03	0.59	9.50	2.89
DePrez Ditch-Big Blue River	Shelbyville	INR040051	INW0486_01	2.93	128.80	38.15
Shaw Ditch-Big Blue River	Edinburgh	INR040026	INW0487_01	0.29		

Table 119 presents the individual WLAs for CFO/CAFOs in the Lower Big Blue River watershed by subwatershed. IDEM has identified 12 CFO/CAFOs in the Lower Big Blue River watershed and the

WLAs for each is set to zero. The zero allocation is based on the Effluent Limitations Guidelines and New Source Performance Criteria requiring, in general, zero discharge from these areas. This limit on load is reasonable due to the requirement for the proper design, construction, operation, and maintenance of the structures to contain all manure, litter, and process wastewater including the runoff and direct precipitation from a 25 year, 24-hour rainfall event. Further, the allocation is based on the conditions of the NPDES general permit providing that water quality criteria shall not be exceeded in the event of an overflow from production areas.

Table 119. Individual WLAs for CFO/CAFOs in the Lower Big Blue River watershed

Subwatershed	Operation Name	FARM ID	AUID	*E. coli* WLA [Billion/day]
Headwaters Little Blue River	J & J Livestock LLC	6435	INW0421_01	0
Beaver Meadow Creek	David Vanosdol Ronald Sullivan	184 2950	INW0422_T1001 INW0422_T1001	0 0
Gilson Creek-Little Blue River	William E Smith Farm 3	4909	INW0423_01	0
Manilla Branch-Little Blue River	NA	NA	NA	NA
Town of Rays Crossing-Little Blue River	NA	NA	NA	NA
Headwaters Six Mile Creek	NA	NA	NA	NA
Anthony Creek-Six Mile Creek	Lewis Pork Farm LLC Jeff &Bruce Muegge Bob White Farm Pork in Blue River LLC	2581 4448 4623 6582	INW0482_01 INW0482_01 INW0482_01 INW0482_T1002	0 0 0 0
Nameless Creek	SSZ Enterprises	1901	INW0483_01	0
Prairie Branch-Big Blue River	Janes Brothers	637	INW0484_T1003	0
Foreman Branch-Big Blue River	Signature Farms Morristown	1939	INW0485_T1001	0
DePrez Ditch-Big Blue River	Jarrod Law&Michael Pauszek	2208	INW0486_T1001	0
Shaw Ditch-Big Blue River	NA	NA	NA	NA

8.2 Margin of Safety (MOS)

Section 303(d) of the Clean Water Act and USEPA regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality criteria with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between limitations and water quality." USEPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). This TMDL uses both an implicit and explicit MOS. An implicit MOS was used by applying a couple of conservative assumptions. A moderately explicit MOS has been applied by reserving ten percent of the allowable load. Ten percent was considered an appropriate MOS based on the following considerations:

- The use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the nearest downstream USGS gage.
- The *E. coli* TMDLs include an implicit MOS in that they were based on the geometric mean component of the criteria rather than the single sample maximum criteria. Using the single sample maximum criteria would have resulted in larger loading capacities.
- An additional implicit MOS for *E. coli* is included because the load duration analysis does not address die-off of pathogens.

8.3 Critical Conditions

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it has been determined that load reductions for the parameters of concern are needed for specific flow conditions; the critical conditions (the periods when the greatest reductions are required) vary by parameter and location and are summarized in Table 120. The table indicates that critical conditions for most *E. coli* for most locations occur during low flow and therefore implementation of controls should be targeted for these conditions. Based on the samples collected during lower and low flows load reductions are needed during each flow conditions. We did not sample during high flow conditions, therefore implementation actions and BMP installation are still recommended during mid to high flow conditions where sources may change.

Table 120. Critical Conditions for TMDL Parameters

Parameter	Station ID	Critical Condition				
		Very High	Higher	Normal	Lower	Low
E. coli (counts/mL)	WED-02-0001					X
	WED-08-0001					X
	WED-08-0002					X
	WED-08-0003					X
	WED020-0001					X
	WED020-0003					X
	WED020-0014					X
	WED020-0031					X
	WED020-0032					X
	WED020-0033					X
	WED030-0026					X
	WED030-0029					X
	WED030-0030					X
	WED030-0031					X
	WED030-0032					X
	WED030-0033					X
	WED050-0008					X
	WED050-0033					X
	WED050-0035					X
	WED-02-0003				X	
	WED-08-0004				X	

8.4 Potential Priority Implementation Areas (PPIAs)

The information in Section 6 and the allocations presented in this section provide the foundation necessary to identify subwatersheds that are in need of the most significant *E. coli* reductions to meet water quality criteria in the Lower Big Blue River watershed. The areas in need of the most significant *E. coli* reductions during low flow conditions (as shown in Table 119) are considered PPIAs. Using the PPIA rankings, watershed organizations will gain a better understanding of which subwatersheds require the most pollutant load reductions. This can assist in future efforts to identify critical areas in the Lower Big Blue River watershed for implementation of management measures/BMPs. PPIAs differ from critical areas in that PPIAs focus on the information and data collected and analyzed through the TMDL development process for ranking purposes, whereas critical areas per the IDEM 2009 Watershed Management Plan Checklist take into account other factors into consideration (e.g., political, social, economic) to help determine management measures that will affect progress toward pollutant load reductions and, ultimately, attainment of water quality criteria.

8.4.1 PPIAs for *E. coli*

Table 121 ranks subwatersheds in the Lower Big Blue River watershed according to *E. coli* load reductions needed to meet water quality criteria, from highest pollutant load reduction to least pollutant load reduction, with the associated flow regime (e.g., very high, higher, normal, lower, low).

Table 121. PPIA Ranking for Subwatersheds in the Lower Big Blue River Watershed

PPIA Ranking	Subwatershed	Percent Load Reduction Needed	Pollutant Load Reduction Needed [Billion/day]	Associated Flow Category
1	DePrez Ditch-Big Blue River	93.24%	42.76	Low
2	Prairie Branch-Big Blue River	51.59%	22.43	Low
3	Anthony Creek-Six Mile Creek	64.69%	7.73	Low
4	Town of Rays Crossing-Little Blue River	72.07%	5.60	Low
5	Nameless Creek	72.80%	4.39	Low
6	Manilla Branch-Little Blue River	45.17%	1.87	Low
7	Beaver Meadow Creek	16.24%	0.32	Low
8	Headwaters Little Blue River	11.58%	0.22	Low
9	Gilson Creek-Little Blue River	0%	0*	Low
10	Headwaters Six Mile Creek	0%	0*	Low
11	Shaw Ditch-Big Blue River	0%	0*	Low
12	Foreman Branch-Big Blue River	0%	0*	Low

* Based on the samples collected no load reduction is needed during low flow conditions. We did not sample during high flow conditions, therefore implementation actions and BMP installation are still recommended during mid to high flow conditions where sources may change.

Understanding Table 120: According to this table, DePrez Ditch-Big Blue River has the highest PPIA ranking under low flow conditions with a 93.24 percent load reduction needed for *E. coli*. Typically significant pollutant load reductions needed under high flow conditions are indicators of wet weather sources and significant pollutant load reductions needed under low flow conditions are indicators of WWTP and other point sources with more constant discharges as well as dry weather low flow nonpoint sources. Therefore, implementation activities for the highest ranked PPIAs in Table 121 should likely focus on livestock with direct access to streams, on-site wastewater systems/ unsewered areas, impervious surfaces, storm water, field drainage tile systems.

Section 9 identifies recommended management measures for each subwatershed and shows the associated PPIA rankings. This information can be key to watershed organizations in the process of identifying and selecting critical areas and management measures for the purposes of watershed management plan development. While PPIAs are not intended to dictate those critical areas for watershed organizations, IDEM anticipates that watershed organizations will take the PPIA rankings into consideration when selecting critical areas for purposes of watershed management planning.

9.0 REASONABLE ASSURANCE

This section of the Lower Big Blue River watershed TMDL focuses on management measures that have the potential to achieve the WLAs and LAs presented in Section 7.1.12. The focus of this section is to identify and select the most appropriate structural and non-structural best management practices (BMPs), management measures and control technologies to reduce *E. coli* loads from sources throughout the Lower Big Blue River watershed, particularly in the PPIAs identified in Section 7.1.12. This section also addresses the programs that are available to facilitate implementation of structural and non-structural BMPs to achieve the allocations, as well as ongoing activities in the Lower Big Blue River watershed at the local level that will play a key role in successful TMDL implementation.

To select appropriate BMPs, management measures and control technologies, it is important to review the significant sources in the Lower Big Blue River watershed.

<u>Point Sources</u>

- WWTPs
- Regulated storm water sources
- CAFOs
- Illicitly connected straight pipe systems

<u>Nonpoint Sources</u>

- Cropland
- Pastures and livestock operations
- CFOs and AFOs
- Streambank erosion
- Onsite wastewater treatment systems
- Wildlife/domestic pets
- Urban nonpoint source runoff

9.1 Implementation Activity Options for Sources in the Lower Big Blue River Watershed

Keeping the list of significant sources in the Lower Big Blue River watershed in mind, it is possible to review the types of BMPs that are most appropriate to reduce *E. coli* from various sources. Table 122 provides a list of management measures that are potentially suitable for the Lower Big Blue River watershed based on the *E. coli* and the types of sources. The measures are a combination of structural and non-structural BMPs to achieve the assigned WLAs and LAs. IDEM recognizes that actions taken in any individual subwatershed depend on a number of factors (including socioeconomic, political and ecological factors). The recommendations in Table 122 are not intended to be prescriptive. Any number or combination of management measures might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or other locations where sources contribute indirectly to the water quality impairment.

Table 122. List of Potential Management Measures for the Lower Big Blue River Watershed

Management Measures	Pollutant	Point Sources				Nonpoint Sources						
	Bacteria	**WWTPs and Industrial Facilities**	**Regulated storm water Sources**	**CAFOs**	**Illicitly Connected "Straight Pipe" Systems**	**Cropland**	**Pastures and Livestock Operations**	**CFOs**	**Streambank Erosion**	**Onsite Wastewater Treatment Systems**	**Wildlife/Domestic Pets**	**Urban NPS Runoff**
Inspection and maintenance	X	X	X	X						X		
Outreach and education and training	X	X	X	X	X	X	X	X	X	X	X	
System replacement	X				X					X		
Conservation tillage/residue management	X					X						
Cover crops	X					X			X			
Filter strips	X		X	X		X	X	X	X			
Grassed waterways	X			X		X		X	X			
Riparian forested/herbaceous buffers	X			X		X	X	X	X		X	
Manure handling, storage, treatment, and disposal	X			X				X				
Composting	X		X									
Alternative watering systems	X			X			X	X	X			
Stream fencing (animal exclusion)	X			X			X		X			
Prescribed grazing	X						X		X			
Conservation easements	X											
Rain barrel			X									
Rain garden			X									
Street rain garden			X									
Block bioretention			X									
Regional bioretention			X									
Porous pavement			X									
Green alley												
Green roof			X									
Dam modification or removal												
Levee or dike modification or removal												

	Pollutant	Point Sources				Nonpoint Sources						
Management Measures	**Bacteria**	**WWTPs and Industrial Facilities**	**Regulated storm water Sources**	**CAFOs**	**Illicitly Connected "Straight Pipe" Systems**	**Cropland**	**Pastures and Livestock Operations**	**CFOs**	**Streambank Erosion**	**Onsite Wastewater Treatment Systems**	**Wildlife/Domestic Pets**	**Urban NPS Runoff**
Storm water planning and management	X	X	X						X	X	X	
Comprehensive Nutrient Management Plan	X					X		X				
Constructed Wetland	X	X			X	X					X	
Critical Area Planting							X		X			
Drainage Water Management						X						
Heavy Use Area Pad	X						X					
Nutrient Management Plan	X					X						
Sediment Basin												X
Pasture and Hay Planting	X					X	X	X	X		X	
Streambank and Shoreline Protection						X	X	X	X		X	
Conservation Crop Rotation						X	X	X				
Field Border	X					X	X	X			X	
Waste Treatment Lagoon	X			X			X	X				

The information provided in Table 122 assisted in the development of Table 122, which provides a more refined suite of recommended implementation activities targeted to the PPIAs identified in Section 8.4.

Watershed stakeholders can use the management measures identified in Table 122 for each PPIA and select activities that are most feasible in the Lower Big Blue River watershed. This table can also help watershed stakeholders to determine critical areas through the watershed management planning process.

Table 123. PPIAs and Recommended Management Measures to Achieve Pollutant Load Reductions by Subwatershed

Subwatershed	PPIA Rank	Management Measure	Estimated Pollutant Load Reduction needed for *E. coli*
DePrez Ditch-Big Blue River	1	Outreach, education, and training	93.24% 42.76 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		storm water planning and management	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
Prairie Branch-Big Blue River	2	Outreach, education, and training	51.59% 22.43 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Anthony Creek-Six Mile Creek	3	Outreach, education, and training	64.69% 7.73 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Town of Rays Crossing-Little Blue River	4	Outreach, education, and training	72.07% 5.60 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		storm water planning and management	
		Cover crops	
		Grassed Waterways	
Nameless Creek	5	Outreach, education, and training	72.80% 4.39 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Conservation tillage/ residue management	
		Manure handling, storage, treatment, and disposal	
Manilla Branch-Little Blue River	6	Outreach, education, and training	45.17% 1.87 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Prescribed grazing	
		Grassed Waterways	
Beaver Meadow Creek	7	Outreach, education, and training	16.24% 0.32 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	
Headwaters Little Blue River	8	Outreach, education, and training	11.58% 0.22 Billion MPN/ Day
		Stream fencing (animal exclusion)	
		Cover crops	
		Manure handling, storage, treatment, and disposal	
		Conservation tillage/ residue management	

<table>
<tr><th>Subwatershed</th><th>PPIA Rank</th><th>Management Measure</th><th>Estimated Pollutant Load Reduction needed for E. coli</th></tr>
<tr><td rowspan="5">Gilson Creek-Little Blue River</td><td rowspan="5">9</td><td>Outreach, education, and training</td><td rowspan="5">0</td></tr>
<tr><td>Stream fencing (animal exclusion)</td></tr>
<tr><td>Cover crops</td></tr>
<tr><td>Manure handling, storage, treatment, and disposal</td></tr>
<tr><td>Conservation tillage/ residue management</td></tr>
<tr><td rowspan="5">Headwaters Six Mile Creek</td><td rowspan="5">10</td><td>Outreach, education, and training</td><td rowspan="5">0</td></tr>
<tr><td>Stream fencing (animal exclusion)</td></tr>
<tr><td>Cover crops</td></tr>
<tr><td>Prescribed grazing</td></tr>
<tr><td>Grassed Waterways</td></tr>
<tr><td rowspan="5">Shaw Ditch-Big Blue River</td><td rowspan="5">11</td><td>Outreach, education, and training</td><td rowspan="5">0</td></tr>
<tr><td>Stream fencing (animal exclusion)</td></tr>
<tr><td>Cover crops</td></tr>
<tr><td>Prescribed grazing</td></tr>
<tr><td>Grassed Waterways</td></tr>
<tr><td rowspan="5">Foreman Branch-Big Blue River</td><td rowspan="5">12</td><td>Outreach, education, and training</td><td rowspan="5">0</td></tr>
<tr><td>Stream fencing (animal exclusion)</td></tr>
<tr><td>storm water planning and management</td></tr>
<tr><td>Cover crops</td></tr>
<tr><td>Manure handling, storage, treatment, and disposal</td></tr>
</table>

9.2 Implementation Goals and Indicators

For each *E. coli* load reduction in the Lower Big Blue River watershed, IDEM has identified broad goal statements and indicators. This information is to help watershed stakeholders determine how to track implementation progress over time and also provides the information necessary to complete a watershed management plan.

***E. coli* Goal Statement:** The AUIDs in the Lower Big Blue River watershed should meet the 125 counts/100 mL (geometric mean) TMDL target value.

***E. coli* Indicator:** Water quality monitoring by IDEM will serve as the environmental indicator to determine progress toward the *E. coli* target value. IDEM will have the potential to test the Lower Big Blue River in 2022 during its Probabilistic Monitoring Program.

9.3 Summary of Programs

There are a number of federal, state, and local programs that either require or can assist with the management measures recommended for the Lower Big Blue River watershed. See Tables 123 and 124 and the following descriptions of these programs. Section 9.4 discusses how some of these programs relate to the various sources in the Lower Big Blue River watershed.

9.3.1 Federal Programs

9.3.1.1 Clean Water Act Section 319(h) Grants

Section 319 of the federal Clean Water Act contains provisions for the control of nonpoint source pollution. The Section 319 program provides funding for developing and implementing watershed management plans (WMPs). The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the Office of Water Quality administers the Section 319 program.USEPA offers Clean Water Act Section 319(h) grant monies to the state on an annual basis. These grants must be used to fund projects that address nonpoint source pollution issues. Some projects which the Office of Water Quality has funded with this money in the past include developing and implementing Watershed Management Plans (WMPs), BMP demonstrations, data management, educational programs, modeling, stream restoration, and riparian buffer establishment. Projects are usually two to three years in length. Section 319(h) grants are intended to be used for project start-up, not as a continuous funding source. Units of government, nonprofit groups, and universities in the state that have expertise in nonpoint source pollution problems are eligible for funding. (http://www.in.gov/idem/nps/2524.htm)

9.3.1.2 Clean Water Action Section 205(j) Grants

Section 205(j) provides for planning activities relating to the improvement of water quality from nonpoint and point sources by making funding available to municipal and county governments, regional planning commissions, and other public organizations. For-profit entities, non-profit organizations, private associations, universities and individuals are not eligible for funding through Section 205(j). The CWA states that the grants are to be used for water quality management and planning, including, but not limited to:

- Identifying most cost effective and locally acceptable facility and non-point source measures to meet and maintain water quality criteria;
- Developing an implementation plan to obtain state and local financial and regulatory commitments to implement measures developed under subparagraph A;
- Determining the nature, extent, and cause of water quality problems in various areas of the state.

The Section 205(j) program provides for projects that gather and map information on nonpoint and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and develop watershed management plans.

9.3.1.3 USDA's Conservation of Private Grazing Land Initiative (CPGL)

The Conservation of Private Grazing Land initiative will ensure that technical, educational, and related assistance is provided to those who own private grazing lands. It is not a cost-share program. This technical assistance will offer opportunities for: better grazing land management; protecting soil from erosive wind and water; using more energy efficient ways to produce food and fiber; conserving water; providing habitat for wildlife; sustaining forage and grazing plants; using plants to sequester greenhouse gases and increase soil organic matter; and using grazing lands as a source of biomass energy and raw materials for industrial products.

9.3.1.4 USDA's Conservation Reserve Program (CRP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Conservation Reserve Program reduces soil erosion, protects the Nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost-share funding is provided to establish the vegetative cover practices.

9.3.1.5 USDA's Conservation Technical Assistance (CTA)

The purpose of the CTA program is to assist landusers, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. The purpose of the conservation systems is to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands.

One objective of the program is to assist individual landusers, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals in complying with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the Memorandum of Understanding signed by the Secretary of Agriculture, the Governor of the State, and the conservation district. Assistance is provided to landusers voluntarily applying conservation practices and to those who must comply with local or State laws and regulations.

Another objective is to provide assistance to agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.), the Federal Agriculture Improvement and Reform Act of 1996, and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps landusers develop and implement conservation plans to comply with the law. The program also provides technical assistance to participants in USDA cost-share and conservation incentive programs.

NRCS collects, analyzes, interprets, displays, and disseminates information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. They also develop effective science-based technologies for natural resource assessment, management, and conservation.

9.3.1.6 USDA's Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and costeffective manner. The program provides assistance to farmers and ranchers in complying with Federal, State, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan, which includes structural, vegetative, and land management practices on eligible land. Five to ten year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management.

Fifty percent of the funding available for the program is targeted at natural resource concerns relating to livestock production. The program is carried out primarily in priority areas that may be watersheds, regions, or multi-state areas, and for significant statewide natural resource concerns that are outside of geographic priority areas.

9.3.1.7 USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)

The Small Watershed Program works through local government sponsors and helps participants solve natural resource and related economic problems on a watershed basis. Projects include watershed protection, flood prevention, erosion and sediment control, water supply, water quality, fish and wildlife habitat enhancement, wetlands creation and restoration, and public recreation in watersheds of 250,000 or fewer acres. Both technical and financial assistance are available.

9.3.1.8 USDA's Watershed Surveys and Planning

The Watershed and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 U.S.C. 1001-1008) authorized this program. Prior to fiscal year 1996, small watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled the Watershed Surveys and Planning program. Activities under both programs are continuing under this authority.

The purpose of the program is to assist Federal, State, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. Resource concerns addressed by the program include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries.

Types of surveys and plans include watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance. The focus of these plans is to identify solutions that use land treatment and non-structural measures to solve resource problems.

9.3.1.9 USDA's Wetlands Reserve Program (WRP)

The Wetlands Reserve Program is a voluntary program to restore wetlands. Participating landowners can establish conservation easements of either permanent or 30 year duration, or can enter into restoration cost-share agreements where no easement is involved. In exchange for establishing a permanent easement, the landowner receives payment up to the agricultural value of the land and 100 percent of the restoration costs for restoring the wetlands. The 30 year easement payment is 75 percent of what would be provided for a permanent easement on the same site and 75 percent of the restoration cost. The voluntary agreements are for a minimum 10 year duration and provide for 75 percent of the cost of restoring the involved wetlands. Easements and restoration cost-share agreements establish wetland protection and restoration as the primary land use for the duration of the easement or agreement. In all instances, landowners continue to control access to their land.

9.3.1.10 USDA's Wildlife Habitat Incentives Program (WHIP)

The Wildlife Habitat Incentives Program provides financial incentives to develop habitat for fish and wildlife on private lands. Participants agree to implement a wildlife habitat development plan and USDA agrees to provide cost-share assistance for the initial implementation of wildlife habitat development practices. USDA and program participants enter into a cost-share agreement for wildlife habitat development. This agreement generally lasts a minimum of 10 years from the date that the contract is signed.

9.3.2 State Programs

9.3.2.1 State Point Source Control Program

The purpose of the NPDES permit is to control the point source discharge of pollutants into the waters of the State such that the quality of the water of the State is maintained in accordance with applicable water quality criteria. NPDES permit requirements ensure that the minimum amount of control is imposed upon any new or existing point source through the application of technology-based treatment requirements. Control of discharges from WWTPs, industrial facilities and CSOs consistent with WLAs is implemented through the NPDES program. The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

9.3.2.2 State Nonpoint Source Control Program

The state's Nonpoint Source Program, administered by the IDEM Office of Water Quality's Watershed Planning and Restoration Section, focuses on the assessment and prevention of nonpoint source water pollution. The program also provides for education and outreach to improve the way land is managed. Through the use of federal funding for the installation of BMPs, the development of watershed management plans, and the implementation of watershed restoration pollution prevention activities, the program reaches out to citizens so that land is managed in such a way that less pollution is generated.

Nonpoint source projects funded through the Office of Water Quality are a combination of local, regional, and statewide efforts sponsored by various public and not-for-profit organizations. The emphasis of these projects has been on the local, voluntary implementation of nonpoint source water pollution controls. The Watershed Planning and Restoration Section administers the Section 319 funding for nonpoint source-related projects, as well as Section 205(j) grants.

To award 319 grants, Watershed Planning and Restoration Section staff review proposals for minimum 319(h) eligibility criteria and rank each proposal. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; strength of local partnerships; and competence/reliability of contracting agency. They then convene to discuss individual project merits and pool all rankings to arrive at final rankings for the projects. All proposals that rank above the funding target are included in the annual grant application to USEPA, with USEPA reserving the right to make final changes to the list. Actual funding depends on approval from USEPA and yearly congressional appropriations.

Section 205(j) projects are administered through grant agreements that define the tasks, schedule, and budget for the project. IDEM project managers work closely with the project sponsors to help ensure that the project runs smoothly and the tasks of the grant agreement are fulfilled. Site visits are conducted at least quarterly to touch base on the project, provide guidance and technical assistance as needed, and to work with the grantee on any issues that arise to ensure a successful project closeout.

9.3.2.3 Indiana State Department of Agriculture Division of Soil Conservation

The Division of Soil Conservation's mission is to ensure the protection, wise use, and enhancement of Indiana's soil and water resources. The Division's employees are part of Indiana's Conservation Partnership, which includes the 92 soil and water conservation districts (SWCDs), the USDA Natural Resources Conservation Service, and the Purdue University Cooperative Extension Service. Working together, the partnership provides technical, educational, and financial assistance to citizens to solve erosion and sediment-related problems occurring on the land or impacting public waters.

The Division administers the Clean Water Indiana soil conservation and water quality protection program under guidelines established by the State Soil Conservation Board, primarily through the local SWCDs in direct service to landusers. The Division staff includes field-based resource specialists who work closely with landusers, assisting in the selection, design, and installation of practices to reduce soil erosion on agricultural land. The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

9.3.2.4 Indiana Department of Natural Resources, Division of Fish and Wildlife

The Lake and River Enhancement (LARE) program utilizes a watershed approach to reduce nonpoint source sediment and nutrient pollution of Indiana's and adjacent states' surface waters to a level that meets or surpasses state water quality criteria. To accomplish this goal, LARE provides technical and financial assistance to local entities for qualifying projects that improve and maintain water quality in public access lakes, rivers, and streams.

9.3.2.5 State Revolving Fund (SRF) Loan Program

The SRF is a fixed rate, 20-year loan administered by the Indiana Finance Authority. The SRF provides low-interest loans to Indiana communities for projects that improve wastewater and drinking water infrastructure. The Program's mission is to provide eligible entities with the lowest interest rates possible on the financing of such projects while protecting public health and the environment. SRF also funds non-point source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

9.3.2.6 Hoosier Riverwatch

Hoosier Riverwatch, administered by the IDEM OWQ Watershed Assessment and Planning Branch,is a water quality monitoring initiative which aims to increase public awareness of water quality issues and concerns through hands-on training of volunteers in-stream monitoring and cleanup activities. Hoosier Riverwatch collaborates with agencies and volunteers to educate local communities about the relationship between land use and water quality and to provide water quality information to citizens and governmental agencies working to protect Indiana's rivers and streams.

9.3.3 Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Partners are instrumental to bringing grant funding into the Lower Big Blue River watershed to support local protection and restoration projects. This section provides a brief summary of the local programs taking place in the Lower Big Blue River watershed that will help to reduce *E. coli* loads, as well as provide ancillary benefits to the Lower Big Blue River watershed.

Hancock County

Hancock County received the following funding to improve water quality in 2012:

- Local: $36,637
- CWI: $10,000
- CRP/CREP: $159,712
- CSP: $123,292
- EQIP: $43,390

Henry County:
Henry County received the following funding to improve water quality in 2012:

Local: $31,308
CWI: $12, 671
WHCP: $2,820
CRP/CREP: $217,772
EQIP: $623,231
WRP/WREP: $55,253

Johnson County:
Johnson County received the following funding to improve water quality in 2012:

Local: $122,397
CWI: $57,250
CRP/CREP: $505,194
CSP: $160,000
EQIP: $37,715

Rush County:
Rush County received the following funding to improve water quality in 2012:

Local: $50,946
CWI: $10,000
CRP/CREP: $264,940
CSP: $157,878
EQIP: $26,099

Shelby County:
Shelby County received the following funding to improve water quality in 2012:

Local: $72,185
CWI: $10,000
CRP/CREP: $169,417
CSP: $218,386
EQIP: $54,060

9.4 Implementation Programs by Source

Section 9.3 identified a number of federal, state, and local programs that can support implementation of the recommended management measures for the Lower Big Blue River watershed. Table 124 and the following sub-sections identify which programs are relevant to the various *E. coli* sources in the Lower Big Blue River watershed.

Table 124. Summary of Programs Relevant to *E. coli* Sources in the Lower Big Blue River Watershed

Source	State NPDES program	Local agencies/programs	Section 319 program	Section 205(j) program	ISDA Division of Soil Conservation	IDNR Division of Fish and Wildlife (LARE)	USDA's Conservation of Private Grazing Land Initiative	USDA's Conservation Reserve Program	USDA's Conservation Technical Assistance	USDA's Environmental Quality Incentives Program	USDA's Small Watershed Program and Flood Prevention Program	USDA's Watershed Surveys and Planning	USDA's Wetlands Reserve Program	USDA's Wildlife Habitat Incentives Program
WWTPs and Industrial Facilities	X			X										
Regulated storm water Sources	X			X										
CAFOs	X			X										
Illicitly Connected "Straight Pipe" Systems	X	X		X										
Cropland		X	X	X	X	X		X	X	X	X	X	X	
Pastures and Livestock Operations		X	X	X	X	X	X	X	X	X	X	X		
CFOs	X			X		X								
Streambank Erosion		X	X	X	X	X	X		X	X	X	X		
Onsite Wastewater Treatment Systems		X		X										
Wildlife/Domestic Pets	X	X	X	X										
In-stream Habitat	X	X	X	X										X

9.4.1 Point Source Programs

9.4.1.1 WWTPs

Discharges from WWTPs are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

9.4.1.2 Industrial facilities

As with discharges from WWTPs, industrial discharges are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

9.4.1.3 Regulated storm water sources

Regulated MS4s are required to obtain permit covered under IDEM's MS4 general permit that requires a storm water quality management program (SWQMP) to address six minimum control measures. There is one MS4s in the Lower Big Blue River watershed that has coverage under IDEM's MS4 general permit. The SWQMPs for each of these MS4s describes best management practices implemented to fulfill the six minimum control measure requirements. The Shelbyville MS4 designed a storm water website as well as a Facebook page that allows for easy tracking of users and can transmit information to users in a quick and timely manner. The MS4 has also worked with the SWCD and Boy Scout groups on a storm drain marking program where they successfully marked 99% of the drains. The MS4 has worked with Hoosier Riverwatch to provide training, as well as river clean-up opportunities and completed a stream bank stabilization project. The MS4 has also actively tried to engage stakeholders by publishing bi-monthly newspaper articles highlighting BMPs, participated in numerous outreach events, visited schools to discuss and educate on storm water, and attended builders association meetings to raise awareness.

9.4.1.4 CAFOs

CAFOs are point sources regulated through the NPDES Program. Indiana regulations for CAFOs can be found in 327 IAC 15-15 and federal regulations for all CAFOs can be found in 40 CFR Parts 9, 122, and 412. The Effluent Limitations Guidelines and New Source Performance Standards for CAFOs require, in general, zero discharge from these areas and require proper design, construction, operation, and maintenance of the structures to contain all manure, litter, and process wastewater including the runoff and direct precipitation from a 25-year, 24-hour rainfall event. The NPDES general permit also requires that water quality standards shall not be exceeded in the event of an overflow from production areas.

Examples of requirements for CAFO operators include

- weekly inspections of their waste storage facilities
- develop a Soil Conservation Practice Plan for all manure application sites controlled by the CAFO
- develop a Storm Water Pollution Prevention Plan for the area immediately around the production barns
- submit an annual report to IDEM
- adjust land application rates based on nitrogen and phosphorus

9.4.1.5 Illegal straight pipes

Local health departments are responsible for locating and eliminating illicit discharges and illegal connections to the sewer system.

9.4.2 Nonpoint Sources Programs

9.4.2.1 Cropland

Nonpoint source pollution from cropland areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of cropland BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)

- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA’s Conservation Reserve Program (CRP)
- USDA’s Conservation Technical Assistance (CTA)
- USDA’s Environmental Quality Incentives Program (EQIP)
- USDA’s Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA’s Watershed Surveys and Planning
- USDA’s Wetlands Reserve Program (WRP)
- USDA’s Wildlife Habitat Incentives Program (WHIP)

9.4.2.2 Pastures and livestock operations

Nonpoint source pollution from pasture and livestock areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of pasture and grazing BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA’s Conservation of Private Grazing Land Initiative (CPGL)
- USDA’s Conservation Reserve Program (CRP)
- USDA’s Conservation Technical Assistance (CTA)
- USDA’s Environmental Quality Incentives Program (EQIP)
- USDA’s Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA’s Watershed Surveys and Planning
- USDA’s Wildlife Habitat Incentives Program (WHIP)

9.4.2.3 CFOs

While CAFOs are regulated by federal law, CFOs are not. However, Indiana has CFO regulations 327 IAC 16, 327 IAC 15 that require that operations manage manure, litter, and process wastewater in a manner that “does not cause or contribute to an impairment of surface waters of the state.” IDEM regulates CFOs under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 16, which implement the statute regulating CFOs, were effective on March 10, 2002. IDEM's Office of Land Quality administers the regulatory program, which includes permitting, compliance monitoring and enforcement activities.

9.4.2.4 Streambank erosion

Streambank erosion can be the result of changes in the physical structure of the immediate bank from activities such as removal of riparian vegetation or frequent use by livestock, or it can be the result of increased flow volumes and velocities resulting from increased surface runoff throughout the upstream watershed. Therefore, streambank erosion might be addressed through BMPs and restoration targeted to the specific stream reach, and further degradation could be addressed through the use of BMPs implemented to address storm water issues throughout the watershed. Programs available to support implementation of BMPs to address streambank erosion, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Soil Conservation
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA's Watershed Surveys and Planning
- USDA's Wildlife Habitat Incentives Program (WHIP)

9.4.2.5 Onsite wastewater treatment systems

Indiana State Department of Health (ISDH) Rule 410 IAC 6-8.1 outlines regulations for septic systems, including a series of regulatory constraints on the location and design of current septic systems in an effort to prevent system failures. The rule prohibits failing systems, requiring that:

- No system will contaminate ground water.
- No system will discharge untreated effluent to the surface.

9.4.2.6 Wildlife/domestic pets

Addressing pollutant contributions from wildlife and domestic pets is typically done at the local level through education and outreach efforts. For wildlife, educational programs focus on proper maintenance of riparian areas and discouraging the public from feeding wildlife. For domestic pets, education programs focus on responsible pet waste maintenance (e.g., scoop the poop campaigns) coupled with local ordinances.

9.5 Potential Partners and Technical Assistance Resources

Agencies and organizations at the federal, state, and local levels will play a critical role in watershed planning and implementation to achieve the WLAs and LAs assigned under this TMDL. Table 125 identifies key potential partners and the type of technical assistance they can provide to watershed stakeholders.

Table 125. Potential Partners in the Lower Big Blue River Watershed

Potential Partner	Funding Source
Federal	
USDA	Conservation of Private Grazing Land Initiative (technical and education assistance only)
USDA	Conservation Reserve Program
USDA	Conservation Technical Assistance (technical assistance only)
USDA	Environmental Quality Incentives Program
USDA	Small Watershed Program and Flood Prevention Program
USDA	Watershed Surveys and Planning
USDA	Wetlands Reserve Program
USDA	Wildlife Habitat Incentives Program

Potential Partner	Funding Source
State	
ISDA	Division of Soil Conservation soil and water conservation districts
IDNR	Division of Fish and Wildlife Lake and River Enhancement program
IDEM	Section 319 program grants
IDEM	Section 205(j) program grants

IDEM has compiled a matrix of public and private grants and other funding resources available to fund watershed implementation activities. The matrix is available on IDEM's website at http://www.in.gov/idem/nps/3439.htm .

10.0 PUBLIC PARTICIPATION

Public participation is an important and required component of the TMDL development process. The following public meetings were held in the watershed to discuss this project:

- A Draft TMDL meeting was held May 7, 2014 at 2:30 PM. The meeting was held at the Shelby County Purdue Extension Office, 1600 East State Road 44, Suite C, Shelbyville IN, 46716

Appendix A: *E.coli* data for Lower Big Blue Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
1	2010 Lower Big Blue Watershed TMDL	WED020-0031	Sixmile Creek	CR 1050 E	AA61772	9/20/2010	10.8	30.16
					AA61794	9/27/2010	24.6	
					AA61816	10/4/2010	47.3	
					AA61838	10/12/2010	77.6	
					AA61860	10/18/2010	25.6	
2	2010 Lower Big Blue Watershed TMDL	WED020-0032	Dilly Creek	CR 200 S	AA61774	9/20/2010	201.4	270.83
					AA61796	9/27/2010	79.4	
					AA61818	10/4/2010	57.1	
					AA61840	10/12/2010	1732.9	
					AA61862	10/18/2010	920.8	
3	2010 Lower Big Blue Watershed TMDL	WED020-0033	Nameless Creek	CR 400 S	AA61775	9/20/2010	104.6	460.27
					AA61797	9/27/2010	238.2	
					AA61819	10/4/2010	1986.3	
					AA61841	10/12/2010	172.5	
					AA61863	10/18/2010	2419.6	
4	2010 Lower Big Blue Watershed TMDL	WED020-0001	Sixmile Creek	CR 800 E	AA61776	9/20/2010	648.8	333.43
					AA61798	9/27/2010	248.1	
					AA61820	10/4/2010	285.1	
					AA61842	10/12/2010	410.6	
					AA61864	10/18/2010	218.7	
5	2010 Lower Big Blue Watershed TMDL	WED030-0029	Little Blue River	CR 150 W	AA61777	9/20/2010	1986.3	141.12
					AA61799	9/27/2010	29.2	
					AA61821	10/4/2010	178.9	
					AA61843	10/12/2010	61.3	
					AA61865	10/18/2010	88	

Appendix A: *E.coli* data for Lower Big Blue Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
6	2010 Lower Big Blue Watershed TMDL	WED030-0030	Little Blue River	CR 300 N	AA61778	9/20/2010	22.6	105.79
					AA61800	9/27/2010	28.5	
					AA61822	10/4/2010	488.4	
					AA61844	10/12/2010	152.9	
					AA61866	10/18/2010	275.5	
7	2010 Lower Big Blue Watershed TMDL	WED030-0031	Beaver Meadow Creek	CR 100 N	AA61779	9/20/2010	143.9	148.73
					AA61801	9/27/2010	95.9	
					AA61823	10/4/2010	123.4	
					AA61845	10/12/2010	435.2	
					AA61867	10/18/2010	98.2	
8	2010 Lower Big Blue Watershed TMDL	WED030-0026	Little Blue River	CR 400 N	AA61780	9/20/2010	28.8	118.93
					AA61802	9/27/2010	218.7	
					AA61824	10/4/2010	128.1	
					AA61846	10/12/2010	325.5	
					AA61868	10/18/2010	90.6	
9	2010 Lower Big Blue Watershed TMDL	WED030-0032	Tributary of Little Blue River	Union Rd	AA61781	9/20/2010	1553.1	360.57
					AA61803	9/27/2010	209.8	
					AA61825	10/4/2010	365.4	
					AA61847	10/12/2010	648.8	
					AA61869	10/18/2010	78.9	
10	2010 Lower Big Blue Watershed TMDL	WED030-0033	Little Blue River	CR 200 N	AA61782	9/20/2010	2419.6	223.93
					AA61805	9/27/2010	123.6	
					AA61826	10/4/2010	82.3	
					AA61848	10/12/2010	104.6	
					AA61871	10/18/2010	218.7	

Appendix A: *E.coli* data for Lower Big Blue Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
11	2010 Lower Big Blue Watershed TMDL	WED020-0014	Foremans Branch	Knighthood Grove Rd	AA61783	9/20/2010	38.8	123.51
					AA61806	9/27/2010	172.5	
					AA61827	10/4/2010	1119.9	
					AA61849	10/12/2010	101.7	
					AA61872	10/18/2010	37.7	
12	2010 Lower Big Blue Watershed TMDL	WED020-0003	Big Blue River	Morristown Rd	AA61784	9/20/2010	186	191.56
					AA61807	9/27/2010	224.7	
					AA61828	10/4/2010	290.9	
					AA61850	10/12/2010	214.3	
					AA61873	10/18/2010	99	
13	2010 Lower Big Blue Watershed TMDL	WED-02-0001	Little Blue River	Franklin St	AB01196	9/20/2010	201.4	186.20
					AB01201	9/27/2010	166.4	
					AB01205	10/4/2010	770.1	
					AB01209	10/12/2010	101.2	
					AB01214	10/18/2010	85.7	
14	2010 Lower Big Blue Watershed TMDL	WED-08-0002	Big Blue River	Noble St	AB01197	9/20/2010	214.2	121.19
					AB01202	9/27/2010	104.6	
					AB01206	10/4/2010	133.3	
					AB01210	10/12/2010	139.6	
					AB01215	10/18/2010	62.7	
					AB01197	9/20/2010	214.2	
15	2010 Lower Big Blue Watershed TMDL	WED-08-0003	Big Blue River	CR 575 E	AB01198	9/20/2010	365.4	281.24
					AB01203	9/27/2010	206.4	
					AB01207	10/4/2010	435.2	
					AB01212	10/12/2010	365.4	
					AB01216	10/18/2010	146.7	

Appendix A: *E.coli* data for Lower Big Blue Watershed

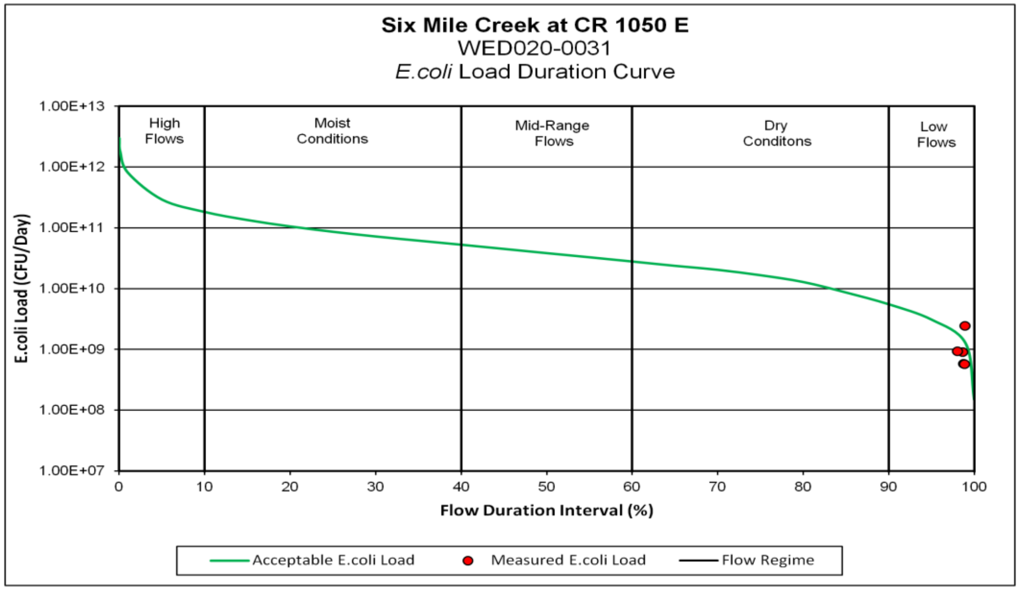
Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
16	2010 Lower Big Blue Watershed TMDL	WED-08-0001	Big Blue River	CR 100 S	AB01199	9/20/2010	172	130.92
					AB01204	9/27/2010	172.3	
					AB01208	10/4/2010	137.6	
					AB01213	10/12/2010	101.2	
					AB01217	10/18/2010	93.2	
17	2010 Lower Big Blue Watershed TMDL	WED050-0033	Howell Ditch	Manetta Rd	AA61790	9/20/2010	151.5	129.50
					AA61812	9/27/2010	160.7	
					AA61833	10/4/2010	60.9	
					AA61856	10/12/2010	178.5	
					AA61878	10/18/2010	137.6	
18	2010 Lower Big Blue Watershed TMDL	WED050-0008	Big Blue River	CR 550 S	AA61791	9/20/2010	108.1	114.21
					AA61813	9/27/2010	105	
					AA61835	10/4/2010	135.4	
					AA61857	10/12/2010	146.7	
					AA61879	10/18/2010	86.2	
20	2010 Lower Big Blue Watershed TMDL	WED050-0035	Big Blue River	SR 252	AA61793	9/20/2010	95.9	92.93
					AA61815	9/27/2010	104.6	
					AA61837	10/4/2010	95.9	
					AA61859	10/12/2010	101.2	
					AA61881	10/18/2010	71.2	

Appendix A: *E.coli* data for Lower Big Blue Watershed

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100mL)	Geometric Mean
21	2013 Corvallis	WED-02-0003	Little Blue River	CR 400 W	AB12673	7/16/2013	344.8	> 1215.77
					AB12690	7/23/2013	1299.7	
					AB12707	7/30/2013	1413.6	
					AB12724	8/6/2013	> 2419.6	
					AB12741	8/13/2013	1732.9	
22	2013 Corvallis	WED-08-0004	Sixmile Creek	CR 900 E	AB12660	7/16/2013	410.6	380.65
					AB12677	7/23/2013	579.4	
					AB12694	7/30/2013	260.3	
					AB12711	8/6/2013	517.2	
					AB12728	8/13/2013	249.5	

10 HUC	12 HUC	2010 AUID	2012 AUID	Project ID	L-Site #	Stream Name	Description	Sample #	Date	E.coli (MPN/ 100mL)	GEOMEAN	Notes
512020402 Little Blue River	51202040201 Headwaters Little Blue River	INW0431_00	INW0421_01	2010 Lower Big Blue TMDL	WED030-0029	Little Blue River	CR 150 W	AA61777	9/20/2010 11:05	1986.3	141.12	Slightly impaired. One CFO in the WS w/almost all row crop ag throughout. Very sparse rural development. Land app of CFO waste is most likely potential source.
								AA61799	9/27/2010 11:10	29.2		
								AA61821	10/4/2010 10:55	178.9		
								AA61843	10/12/2010 11:00	61.3		
								AA61865	10/18/2010 10:50	88		
	51202040202 Beaver Meadow Creek	INW0434_00	INW0422_01	2010 Lower Big Blue TMDL	WED030-0031	Beaver Meadow Creek	CR 100 N	AA61779	9/20/2010 11:40	143.9	148.73	Slightly impaired. Two CFOs in the WS w/almost all row crop ag throughout. Very sparse rural development. Land app of CFO waste is most likely potential source. Site located Beaver Meadow Creek below confluence with Linn Creek. Results considered representative of conditions in Linn Creek based on homogenous land uses throughout the WS.
								AA61801	9/27/2010 11:45	95.9		
								AA61823	10/4/2010 11:35	123.4		
								AA61845	10/12/2010 11:50	435.2		
								AA61867	10/18/2010 11:25	98.2		
			INW0422_T1001			Linn Creek						WED030-0031 was used to impair this segment
	51202040203 Gilson Creek-Little Blue River	INW0432_00 INW0433_00	INW0423_01	2010 Lower Big Blue TMDL	WED030-0030	Little Blue River	CR 300 N	AA61778	9/20/2010 11:30	22.6	105.79	2010 TMDL data indicates no issue but more recent Corvallis data collected in 2013 indicate high impairment. Corvallis site located further US in the WS than the TMDL site. in the vicinity of the only CFO in the WS. Land use in this area and most of the rest of the WS is almost all row crop ag w/little to no buffer along streams. Arlington, IN which is an unsewered community is located in the lower part of the WS. But, there is no evidence that failing septics and/or straight pipe discharges are contributing to this impairment. Based on magnitude of impairment, land uses throughout the WS, and the US location of the site relative to the other assessment units in this WS, the assessment is applied to streams throughout.
								AA61800	9/27/2010 11:30	28.5		
								AA61822	10/4/2010 11:20	488.4		
								AA61844	10/12/2010 11:35	152.9		
								AA61866	10/18/2010 11:15	275.5		
				2013 Corvallis	WED-02-0003	Little Blue River	CR 400 W	AB12673	7/16/2013 9:10	344.8	> 1215.77	
								AB12690	7/23/2013 9:00	1299.7		
								AB12707	7/30/2013 9:45	1413.6		
								AB12724	8/6/2013 9:30	> 2419.6		
								AB12741	8/13/2013 9:00	1732.9		
		INW0432_00	INW0423_T1001			GILSON CREEK						WED-02-0003 was used to impair this segment
			INW0423_T1001A			Tributary of Gilson Creek						WED-02-0003 was used to impair this segment
	51202040204 Manilla Branch-Little Blue River	INW0435_T1016 INW0435_00	INW0424_01			Little Blue River						Not impaired due to WED030-0026 used as pour point of HUC 12
		INW0435_00	INW0424_T1001			COTTON RUN						Not impaired due to WED030-0026 used as pour point of HUC 12
		INW0435_T1052	INW0424_T1002			MANILLA BRANCH						Not impaired due to WED030-0026 used as pour point of HUC 12
	51202040205 Town of Rays Crossing- Little Blue River	INW0436_T1015	INW0425_01	2010 Lower Big Blue TMDL	WED030-0026	LITTLE BLUE RIVER	CR 400 N	AA61780	9/20/2010 12:00	28.8	118.93	Three sites cover most of the Little Blue River in this WS. Results from the two sites lower in the WS indicate slight impairment. The site at the upper end does not. The impairment appears to begin somewhere between the uppermost site in the WS and site 0033, which is DS of the confluence with an unnamed tributary. This tributary was sampled and found to be impaired and as such is likely contributing to the MS impairment. Shelbyville (an MS4) is located in the lower end of this WS. US of Shelbyville, land use is almost all row crop ag w/nonexistent buffer and very sparse rural development. No CFOs in the WS. No readily apparent sources. Impairment attributed to generalized ag and possibly failing septics. Assessment applied to both tributaries to Little Blue River in this WS.
								AA61802	9/27/2010 12:10	218.7		
								AA61824	10/4/2010 11:50	128.1		
								AA61846	10/12/2010 12:10	325.5		
								AA61868	10/18/2010 11:45	90.6		
				2010 Lower Big Blue TMDL	WED030-0033	LITTLE BLUE RIVER	CR 200 N	AA61782	9/20/2010 12:20	> 2419.6	> 223.93	
								AA61805	9/27/2010 12:30	123.6		
								AA61826	10/4/2010 12:15	82.3		
								AA61848	10/12/2010 12:30	104.6		
								AA61871	10/18/2010 12:15	218.7		
				2010 Lower Big Blue TMDL	WED-02-0001	LITTLE BLUE RIVER	Franklin St	AB01196	9/20/2010 13:10	201.4	186.20	
								AB01201	9/27/2010 13:15	166.4		
								AB01205	10/4/2010 12:50	770.1		
								AB01209	10/12/2010 13:05	101.2		
								AB01214	10/18/2010 12:50	85.7		
			INW0425_01A			Tributary of Little Blue River						Not Assessed
		INW0436_00	INW0425_T1001	2010 Lower Big Blue TMDL	WED030-0032	Tributary of Little Blue River	Union Rd	AA61781	9/20/2010 12:10	1553.1	360.57	Results from samples collected on this tributary indicate impairment, which is likely contributing to the MS Little Blue River impairment in this WS. Land use is almost all row crop ag w/nonexistent buffer and very sparse rural development. No CFOs in the WS. No readily apparent sources. Impairment attributed to generalized ag and possibly failing septics.
								AA61803	9/27/2010 12:25	209.8		
								AA61825	10/4/2010 12:10	365.4		
								AA61847	10/12/2010 12:20	648.8		
								AA61869	10/18/2010 12:05	78.9		
			INW0425_T1002			Tributary of Little Blue River						WED030-0033 was used to impair this segment
	51202040801 Headwaters Six Mile Creek	INW0421_00	INW0481_01	2010 Lower Big Blue TMDL	WED020-0031	SIXMILE CREEK	CR 1050 E	AA61772	9/20/2010 9:30	10.8	30.16	Fully Supporting
								AA61794	9/27/2010 9:40	24.6		
								AA61816	10/4/2010 9:20	47.3		
								AA61838	10/12/2010 9:20	77.6		
								AA61860	10/18/2010 9:20	25.6		
		INW0421_00	INW0481_T1001			SMITH DITCH						Fully Supporting
	51202040802 Anthony Creek-Six Mile Creek	INW0422_00 INW0423_00	INW0482_01	2010 Lower Big Blue TMDL	WED020-0001	SIXMILE CREEK	CR 800 E	AA61776	9/20/2010 10:15	648.8	333.43	Sixmile Creek was sampled in 2010 with results indicating impairment. Most recent Corvallis data from site just US of 0001 supports the assessment of impairment. Four CFOs in the WS and row crop ag throughout.
								AA61798	9/27/2010 10:20	248.1		
								AA61820	10/4/2010 9:55	285.1		
								AA61842	10/12/2010 10:00	410.6		
								AA61864	10/18/2010 10:00	218.7		
				2013 Corvallis	WED-08-0004	SIXMILE CREEK	CR 900E	AB12660	7/16/2013 9:40	410.6	380.65	
								AB12677	7/23/2013 9:35	579.4		
								AB12694	7/30/2013 10:20	260.3		
								AB12711	8/6/2013 10:10	517.2		
								AB12728	8/13/2013 9:30	249.5		
			INW0482_01A			RIDGE RUN						WED020-0001; WED-08-0004 were used to impair this segment
		INW0422_00	INW0482_T1001			ANTHONY CREEK						WED020-0001; WED-08-0004 were used to impair this segment
		INW0423_T1001	INW0482_T1002	2010 Lower Big Blue TMDL	WED020-0032	DILLLY CREEK	CR 200 S	AA61774	9/20/2010 9:50	201.4	270.83	Data indicate that Dilly Creek is impaired. Land use throughout this WS is almost all row crop ag with four CFOs suggesting land app of CFO waste is driving impairment.
								AA61796	9/27/2010 9:55	79.4		
								AA61818	10/4/2010 9:35	57.1		
								AA61840	10/12/2010 9:35	1732.9		
								AA61862	10/18/2010 9:35	920.8		
	51202040803 Nameless Creek	INW0424_00	INW0483_01	2010 Lower Big Blue TMDL	WED020-0033	NAMELESS CREEK	CR 400 S	AA61775	9/20/2010 10:00	104.6	> 460.27	Better buffers in the lower part of WS. But magnitude of impairment suggests that it probably extends DS. This is a small WS. One CFO in the upper reaches of this catchment. Entire WS is row crop ag. Land app of CFO waste is most likely source.
								AA61797	9/27/2010 10:05	238.2		
								AA61819	10/4/2010 9:45	1986.3		
								AA61841	10/12/2010 9:45	172.5		
								AA61863	10/18/2010 9:45	> 2419.6		
	51202040804 Prairie Branch-Big Blue River	INW0425_T1011 INW0423_T1010	INW0484_01	2010 Lower Big Blue TMDL	WED-08-0003	BIG BLUE RIVER	CR 575 E	AB01198	9/20/2010 10:40	365.4	281.24	Results indicate impairment. Both main trib systems flowing into Big Blue from surrounding WS are also impaired with similar land uses. Land use throughout this WS is almost all row crop ag with one CFO suggesting land app of CFO waste, along with US sources are driving impairment.
								AB01203	9/27/2010 10:45	206.4		
								AB01207	10/4/2010 10:30	435.2		
								AB01212	10/12/2010 10:35	365.4		
								AB01216	10/18/2010 10:25	146.7		
			INW0484_T1001			BIG BLUE RIVER - UNNAMED TRIBUTARY						WED-08-0003 was used as a rational to impair this segement
		INW0425_00	INW0484_T1002			BIG BLUE RIVER - UNNAMED TRIBUTARY						WED-08-0003 was used as a rational to impair this segement
		INW0425_00	INW0484_T1003			PRAIRIE BRANCH						WED-08-0003 was used as a rational to impair this segement
		INW0426_T1012	INW0485_01			BIG BLUE RIVER						Impaired based on WED-08-0003 impairment

0512020408 Big Blue River	51202040805 Foreman Branch- Big Blue River	INW0427_T1013	INW0485_02	2010 Lower Big Blue TMDL	WED020-0003	BIG BLUE RIVER	Morristown Rd	AA61784	9/20/2010 12:45	186	191.56	Sites located on Big Blue River in WS immediately US and on the reach immediately DS in this WS indicate NS. Results are considered representative of conditions on this reach. Morristown is located on this reach and is a potential source along with US sources.
								AA61807	9/27/2010 12:45	224.7		
								AA61828	10/4/2010 12:30	290.9		
								AA61850	10/12/2010 12:45	214.3		
								AA61873	10/18/2010 12:30	99		
		INW0428_T1014	INW0485_03			BIG BLUE RIVER						Fully Supporting, based on WED-08-0002
			INW0485_T1001			BIG BLUE RIVER - UNNAMED TRIBUTARY						This tributary assessed as impaired based on the impairment of Big Blue River into which it flows and homogenous land uses in the upper WS. Other than in Morristown proper, land app of CFO waste is a likely source throughout.
		INW0428_00	INW0485_T1002	2010 Lower Big Blue TMDL	WED020-0014	FORMAN BRANCH	Knighthood Grove Rd	AA61783	9/20/2010 12:30	38.8	123.51	Fully Suporting
								AA61806	9/27/2010 12:35	172.5		
								AA61827	10/4/2010 12:25	1119.9		
								AA61849	10/12/2010 12:40	101.7		
								AA61872	10/18/2010 12:20	37.7		
	51202040806 DePrez Ditch- Big Blue River	INW0437_T1017	INW0486_01	2010 Lower Big Blue TMDL	WED-08-0002	BIG BLUE RIVER	Noble St	AB01197	9/20/2010 13:00	214.2	121.19	Results from all sites in this WS taken together suggest very slight impairment throughout. Although results from 0002 indicate FS, the site is located on the upper WS boundary, and results from site 0001 DS indicate slight impairment. Shelbyville WWTP is located at the upper end of this WS and may be mitigating impairment to some degree. Results from site 0003 on Howell Ditch, a tributary to the Big Blue River in this WS, also indicate slight impairment. Other than Shelbyville, the land use in this WS is almost entirely row crop ag with a forested buffer on much of the Big Blue. One CFO in the WS. So land app of CFO waste is a likely source. Assessment of NS is applied to entire WS.
								AB01202	9/27/2010 13:00	104.6		
								AB01206	10/4/2010 12:40	133.3		
								AB01215	10/18/2010 12:40	62.7		
		INW0451_T1018	INW0486_02	2010 Lower Big Blue TMDL	WED-08-0001	BIG BLUE RIVER	CR 100 S	AB01199	9/20/2010 13:45	172	130.92	
								AB01204	9/27/2010 13:40	172.3		
								AB01208	10/4/2010 13:10	137.6		
								AB01213	10/12/2010 13:30	101.2		
								AB01217	10/18/2010 13:10	93.2		
		INW0437_00	INW0486_T1001			BIG BLUE RIVER - UNNAMED TRIBUTARY						
			INW0486_T1002			BIG BLUE RIVER - UNNAMED TRIBUTARY						
		INW0452_00	INW0486_T1003	2010 Lower Big Blue TMDL	WED050-0033	HOWELL DITCH	Manetta Rd	AA61790	9/20/2010 14:00	151.5	129.50	
								AA61812	9/27/2010 13:50	160.7		
								AA61833	10/4/2010 13:25	60.9		
								AA61856	10/12/2010 13:40	178.5		
								AA61878	10/18/2010 13:25	137.6		
	51202040807 Shaw Ditch- Big Blue River	INW0453_T1019 INW0455_T1020	INW0487_01	2010 Lower Big Blue TMDL	WED050-0008	BIG BLUE RIVER	CR 550 S	AA61791	9/20/2010 14:05	108.1	114.21	Fully Support
								AA61813	9/27/2010 14:00	105		
								AA61835	10/4/2010 13:35	135.4		
								AA61857	10/12/2010 13:55	146.7		
								AA61879	10/18/2010 13:35	86.2		
					WED050-0035	BIG BLUE RIVER	SR 252	AA61793	9/20/2010 14:30	95.9	92.93	Fully Support
								AA61815	9/27/2010 14:20	104.6		
								AA61837	10/4/2010 13:55	95.9		
								AA61859	10/12/2010 14:15	101.2		
								AA61881	10/18/2010 13:55	71.2		
		INW0454_00	INW0487_T1001			SHAW DITCH						Fully Support
			INW0487_T1001A			SHAW DITCH - UNNAMED TRIBUTARY						Fully Support
			INW0487_T1002			BIG BLUE RIVER - UNNAMED TRIBUTARY						Fully Support



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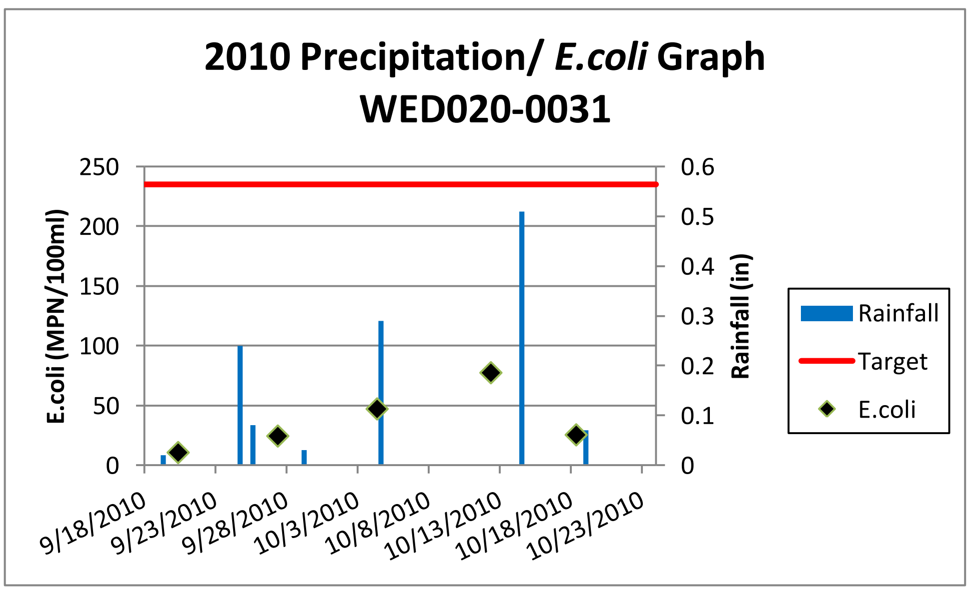
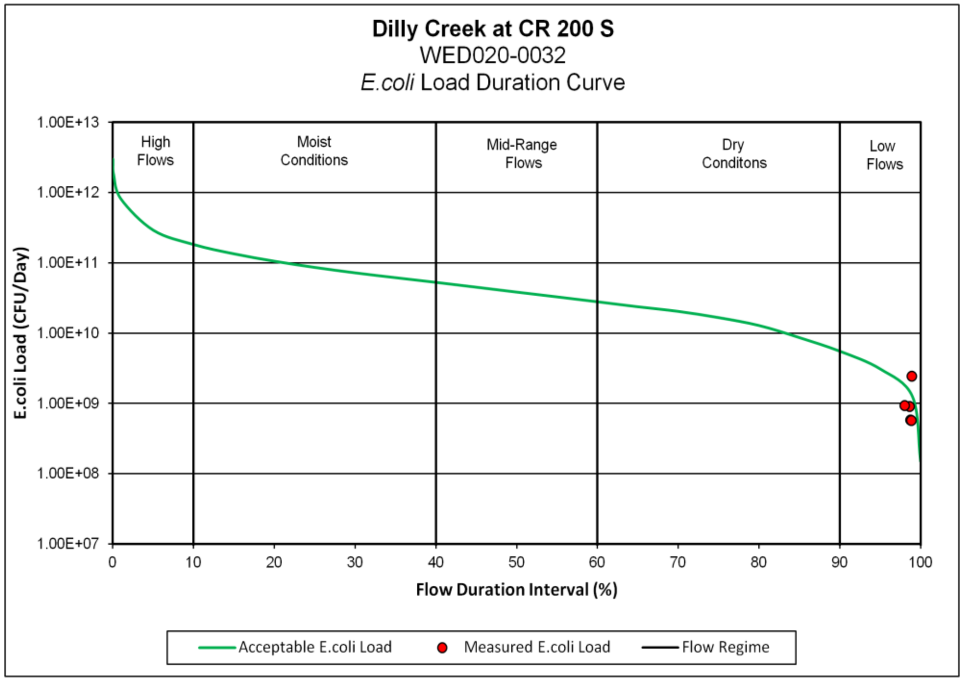
Downstream





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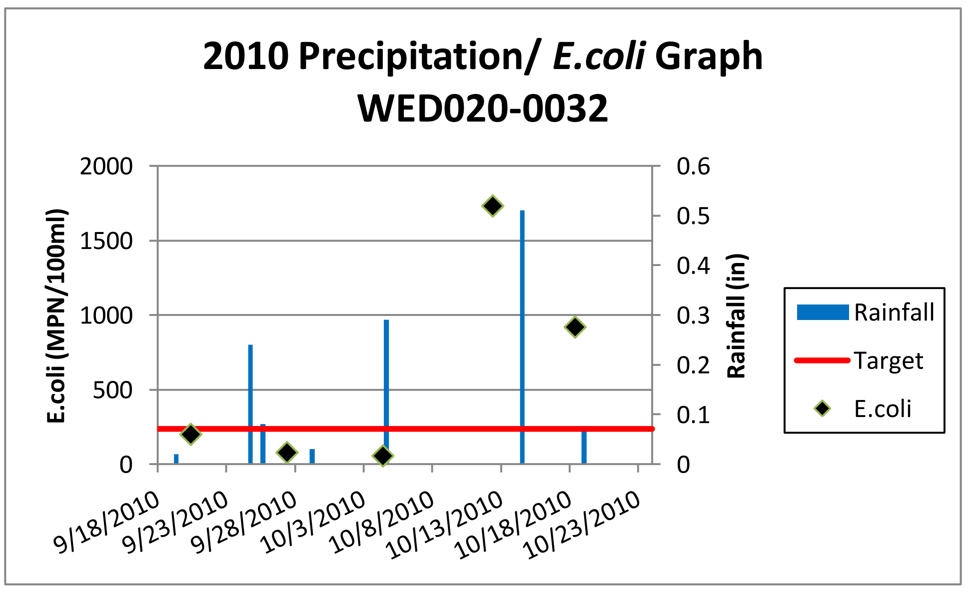

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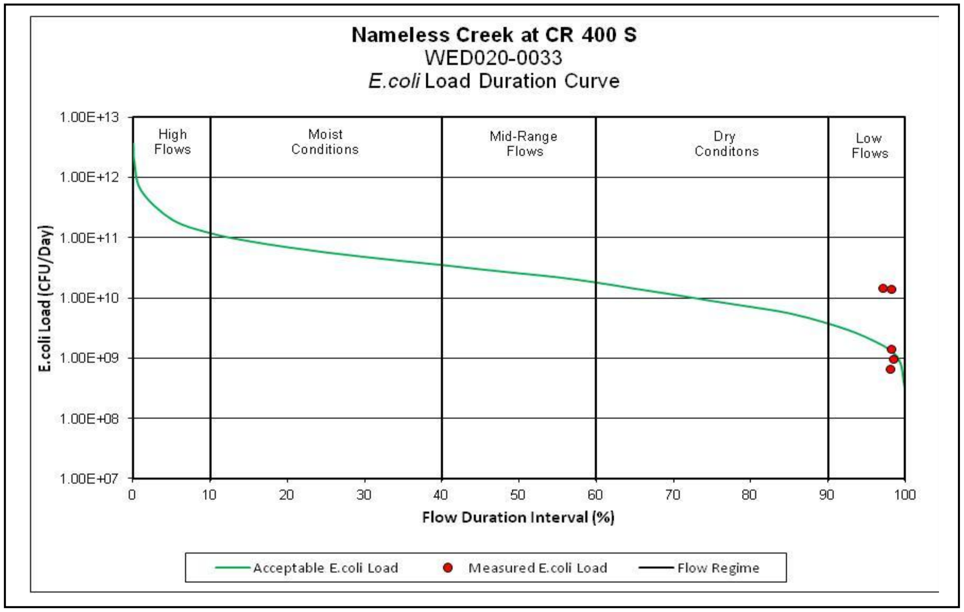

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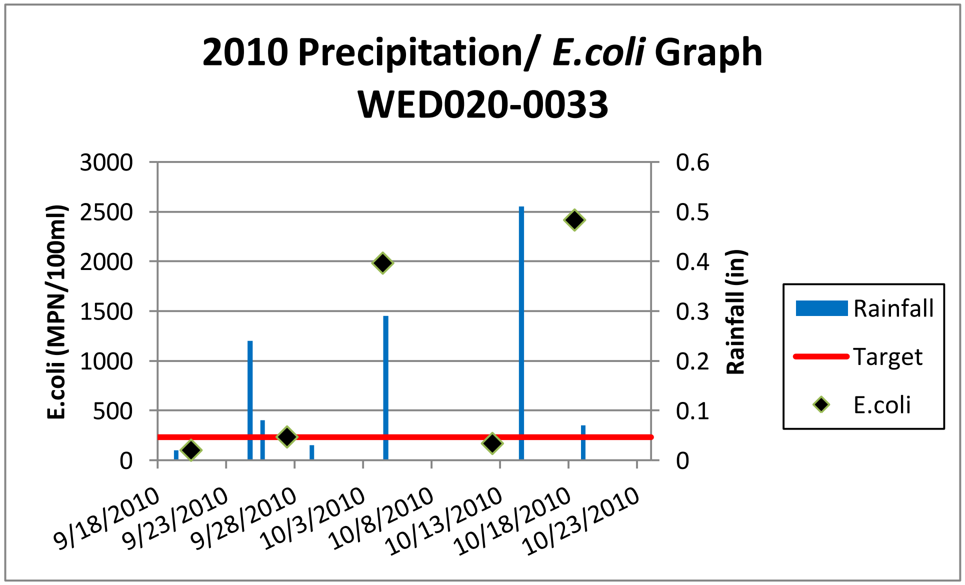

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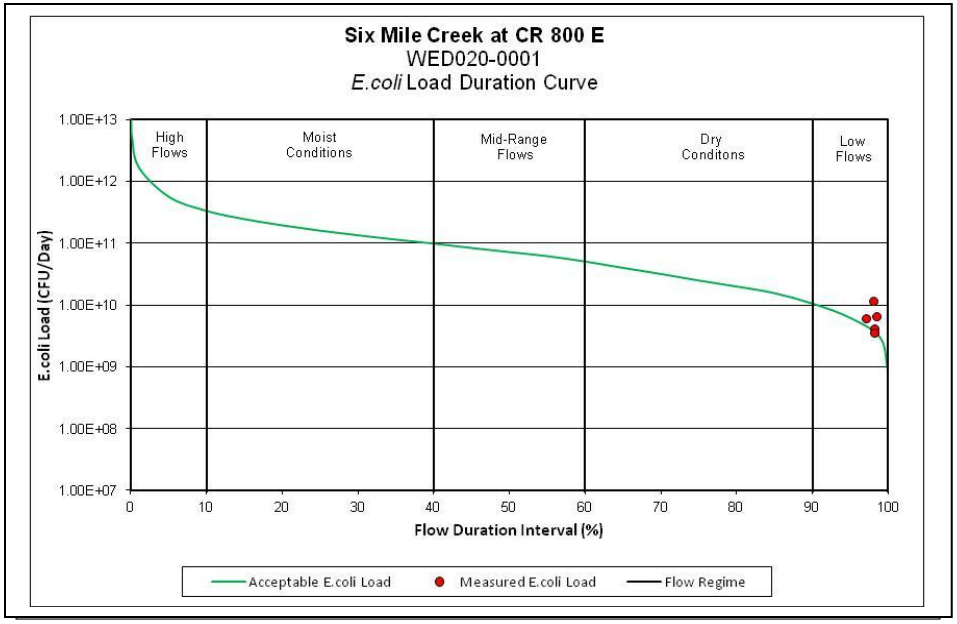

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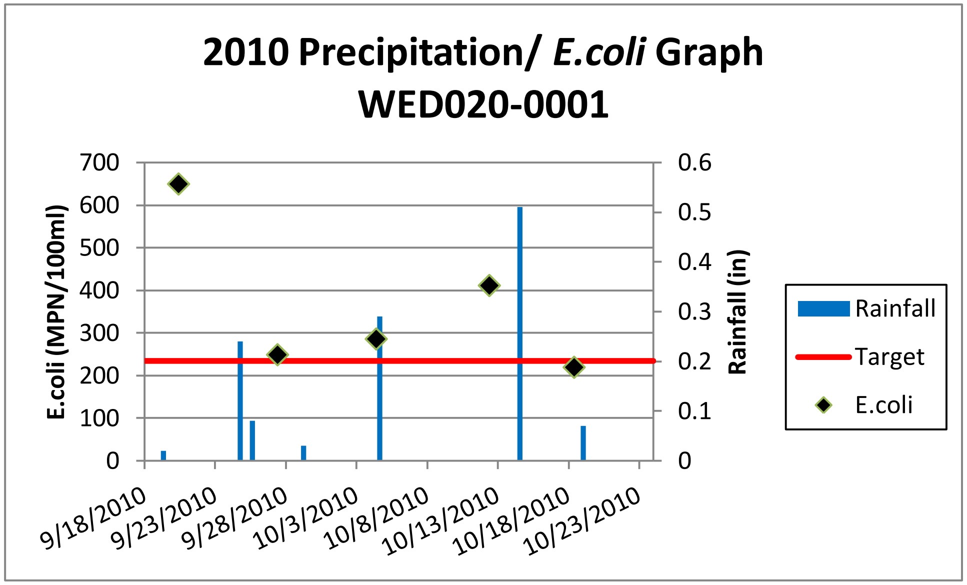

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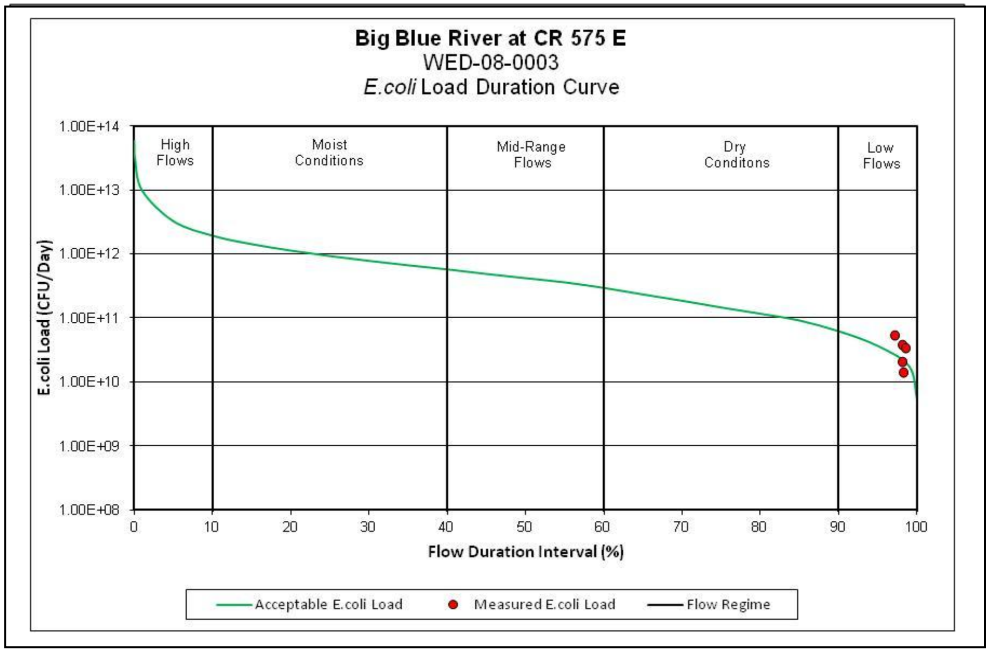

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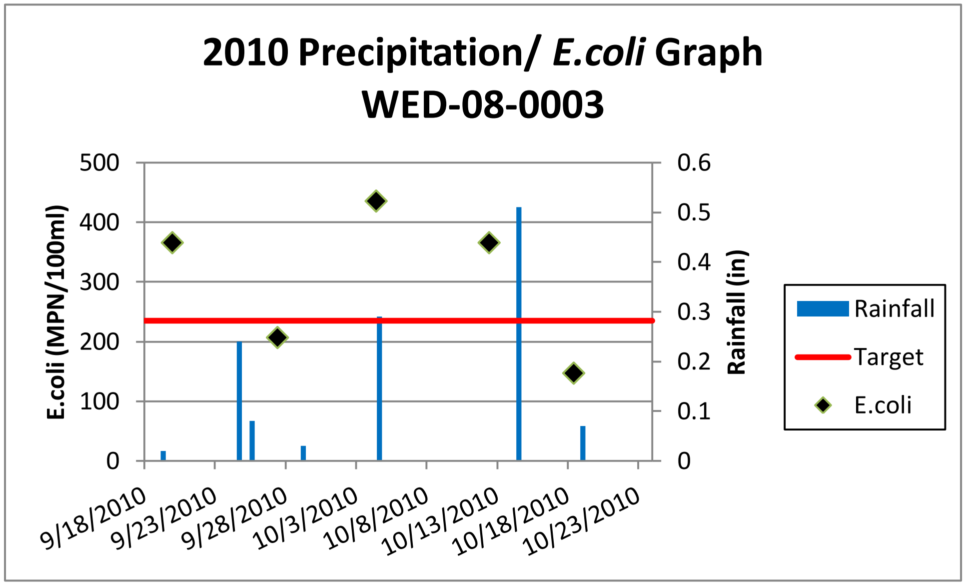

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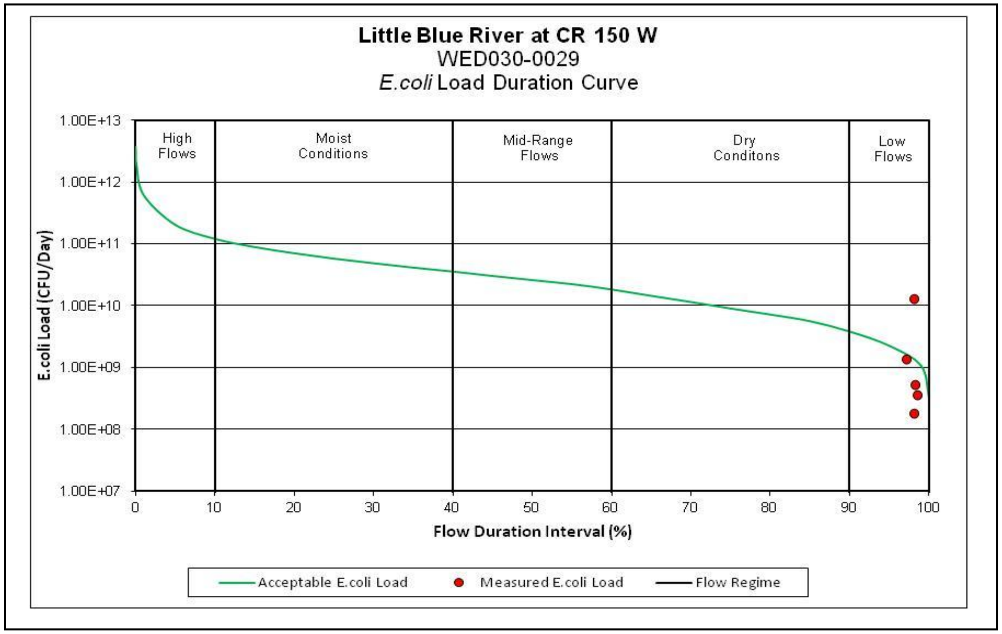

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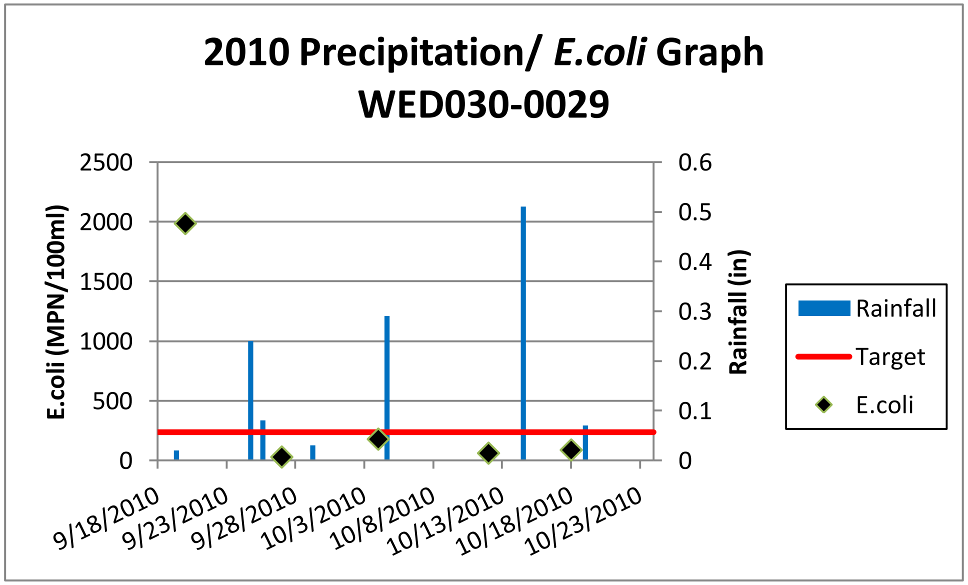

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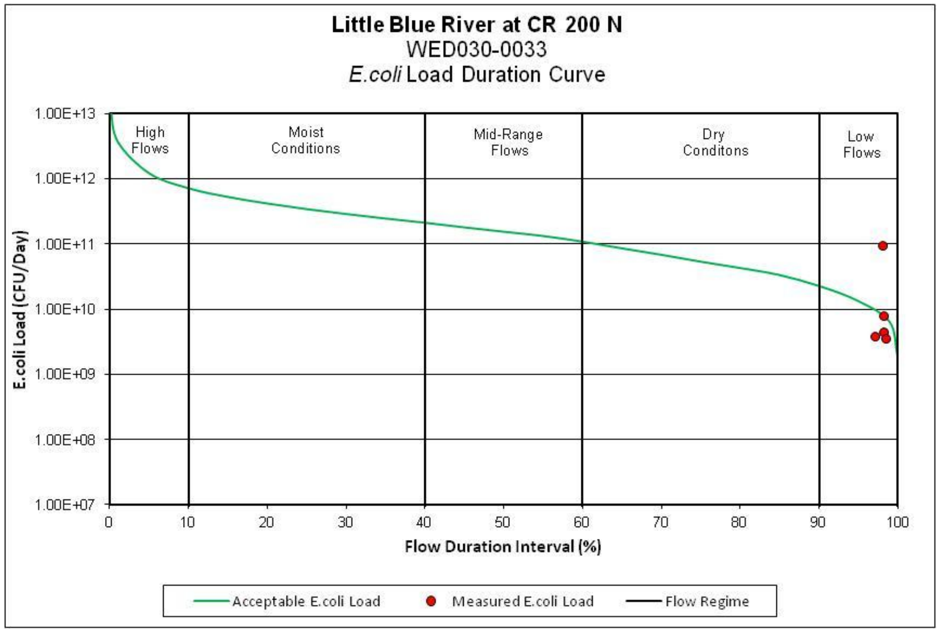

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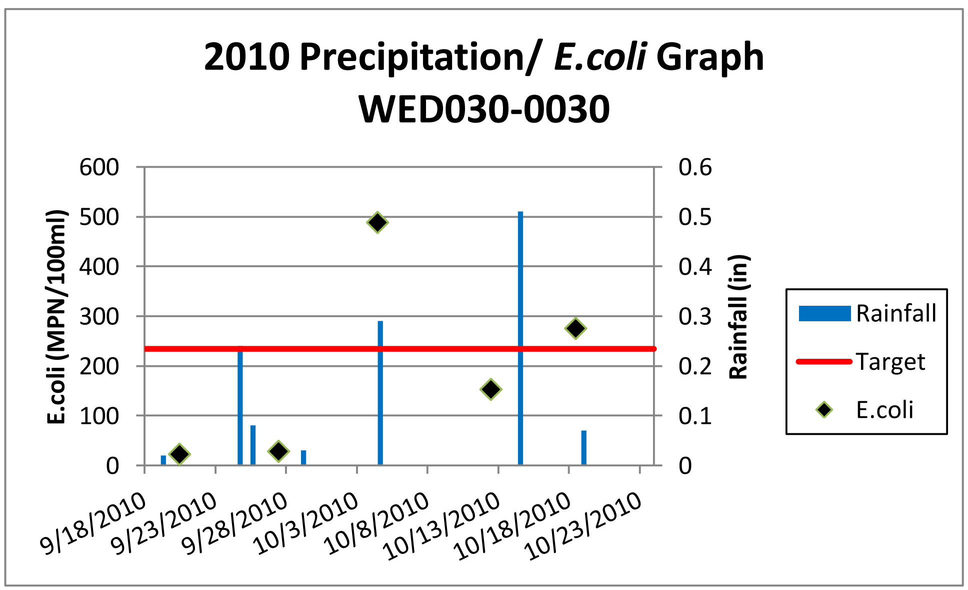

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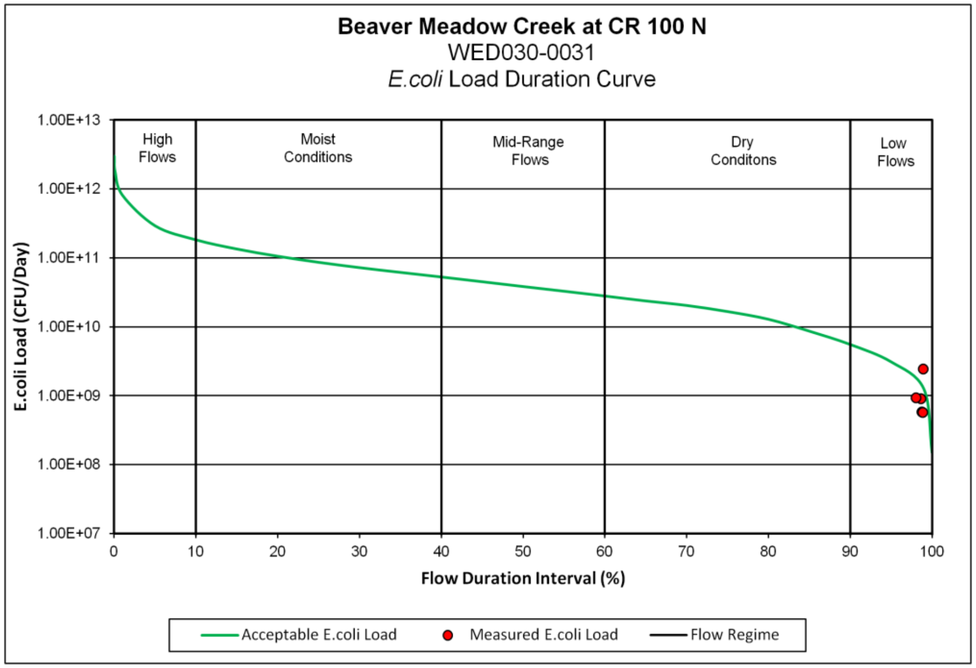

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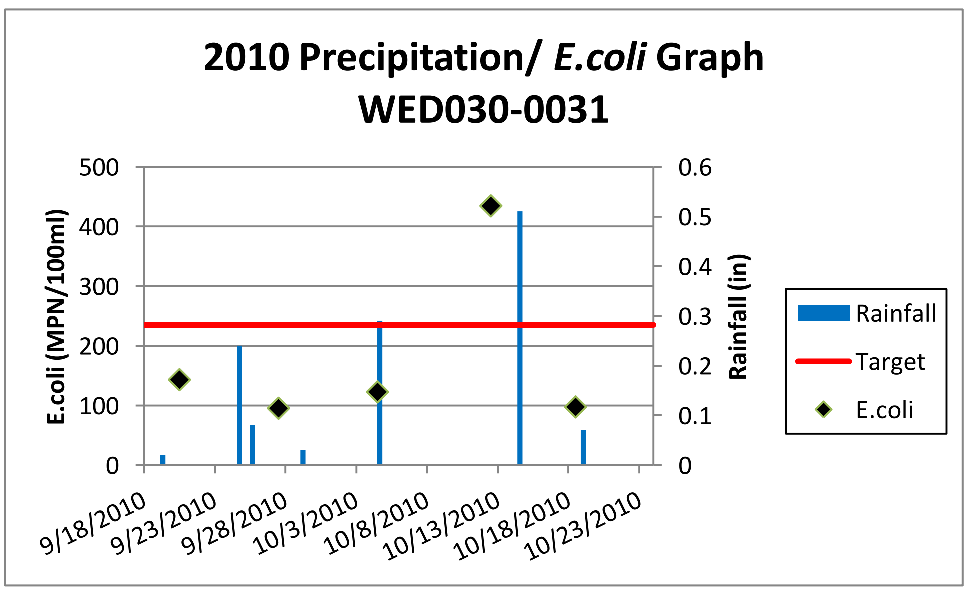

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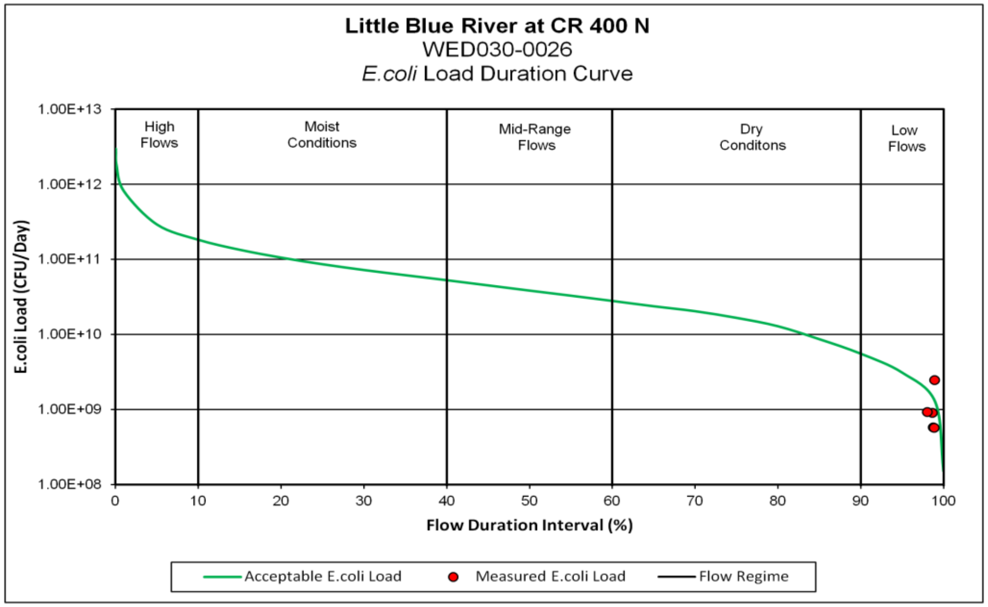

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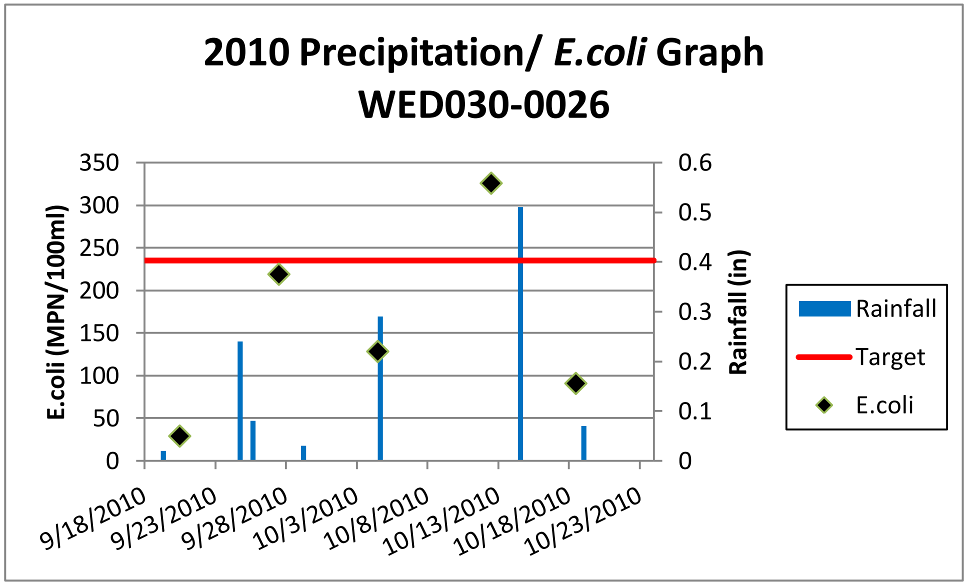

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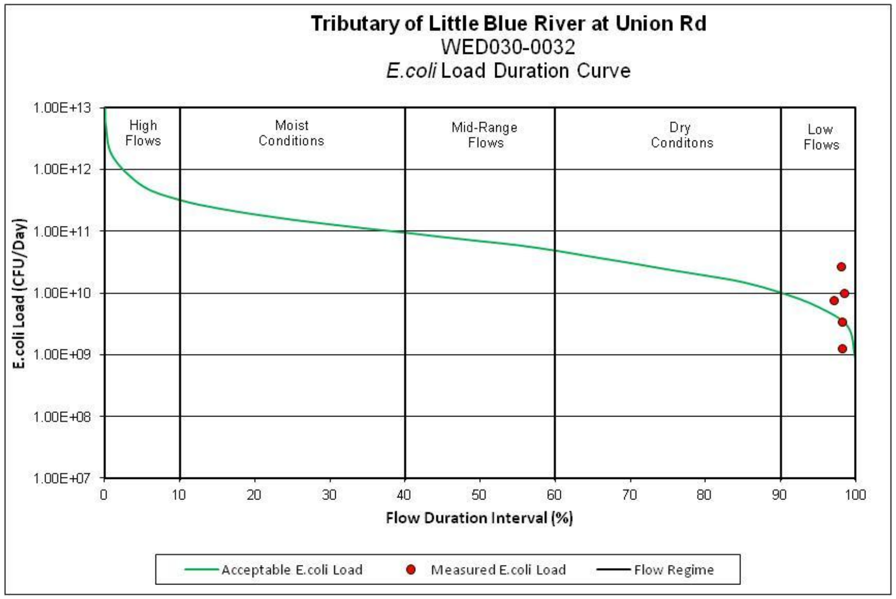

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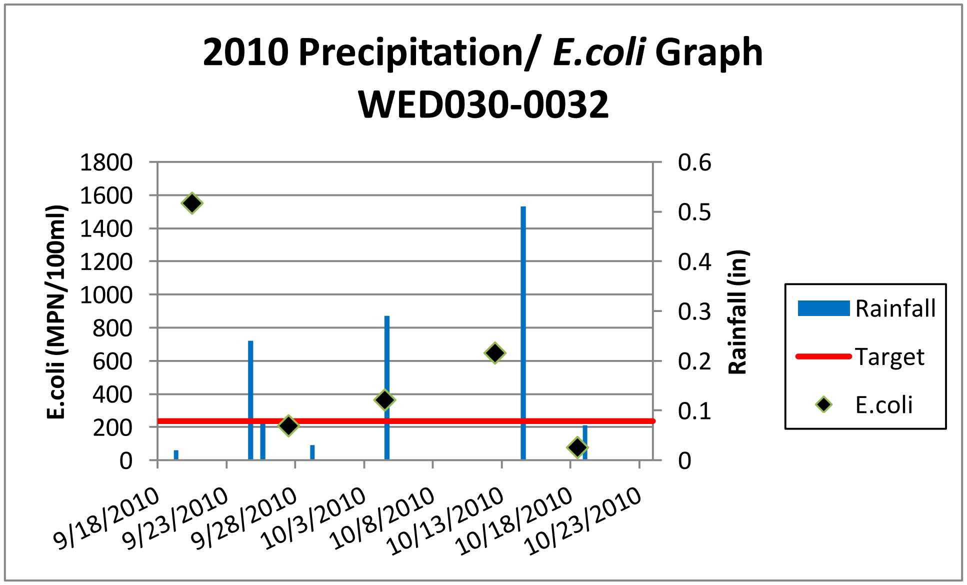

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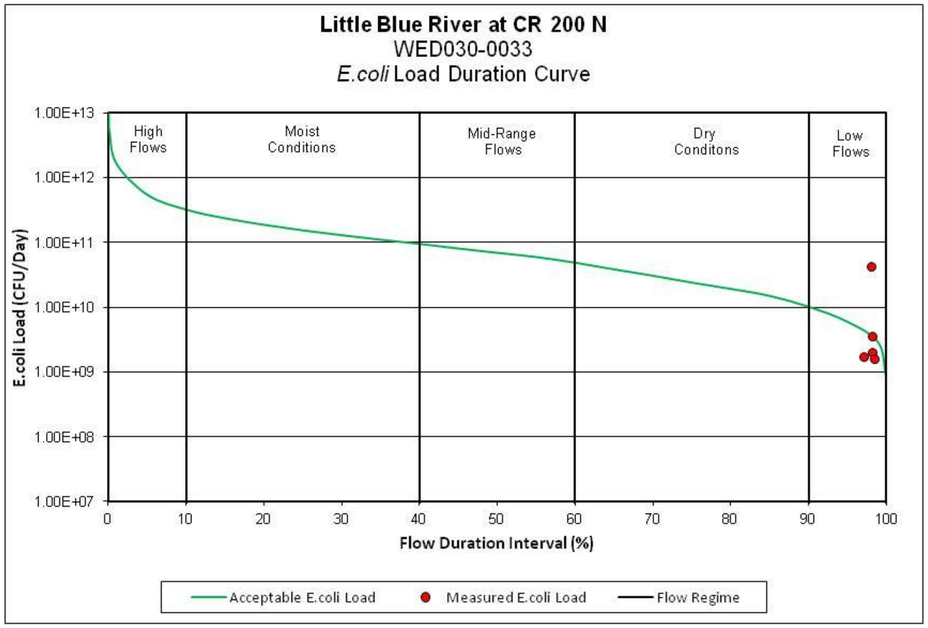

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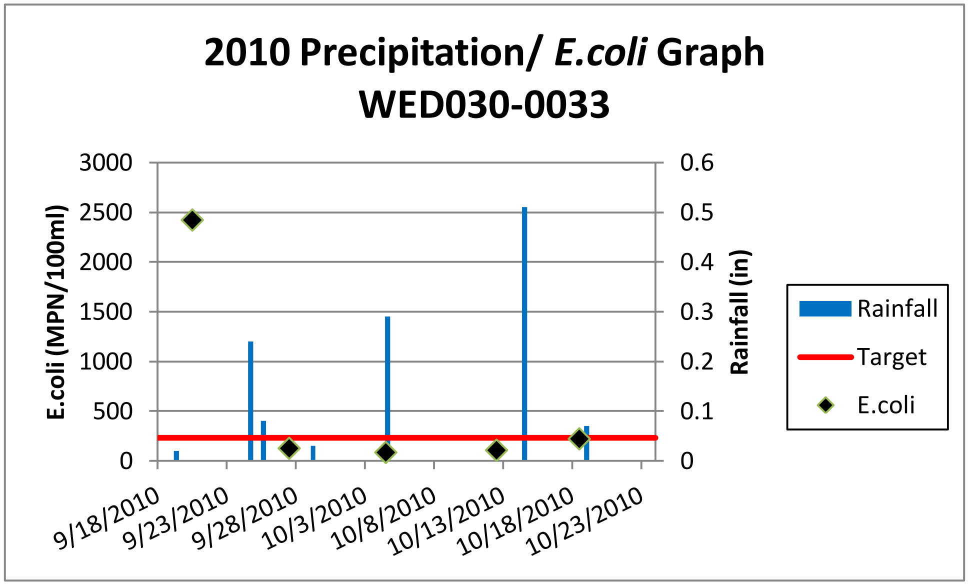

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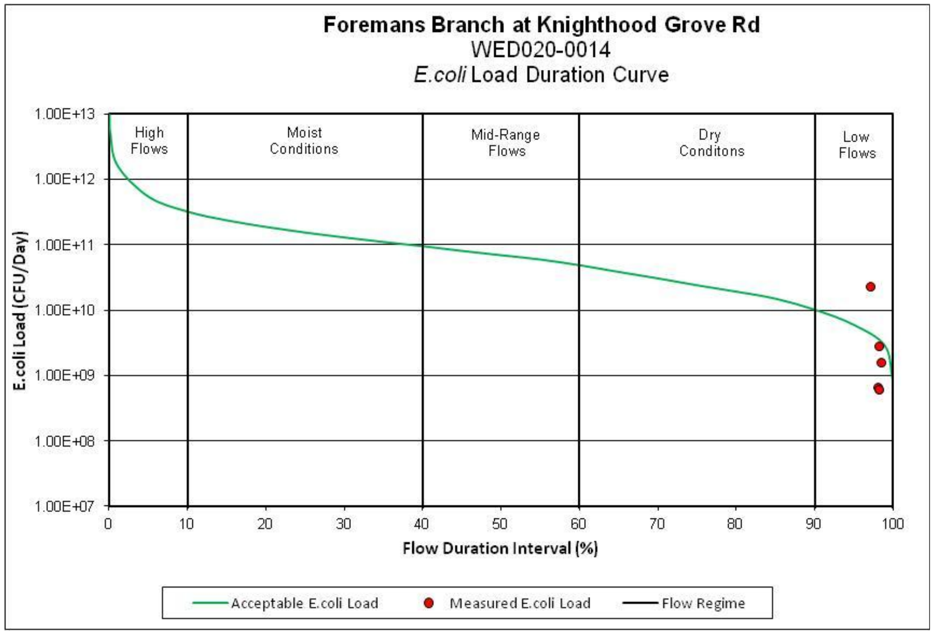

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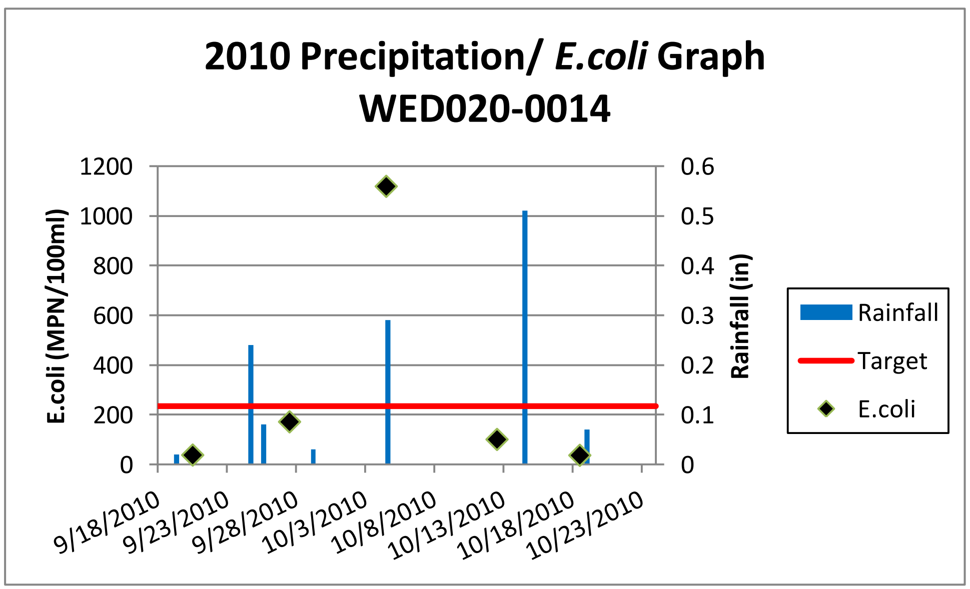

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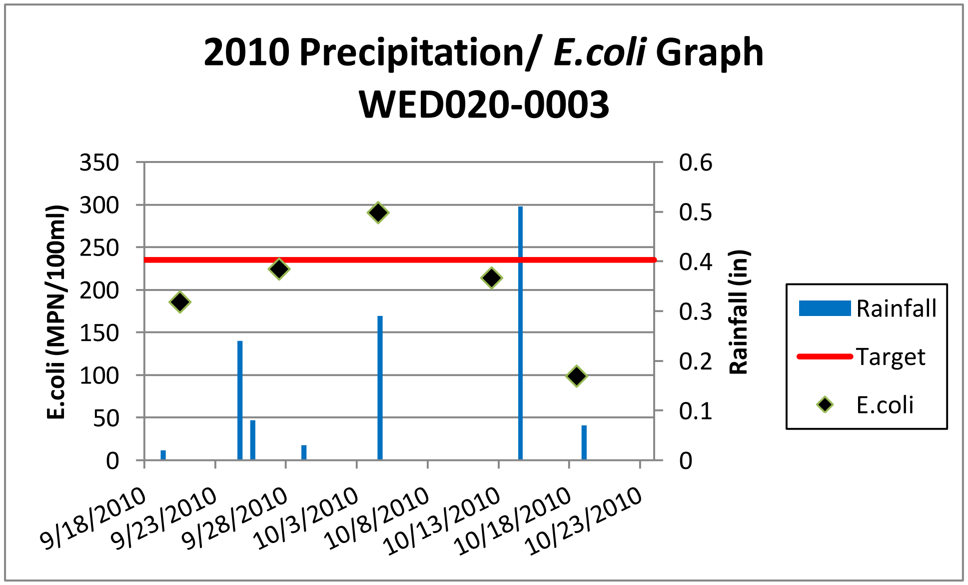

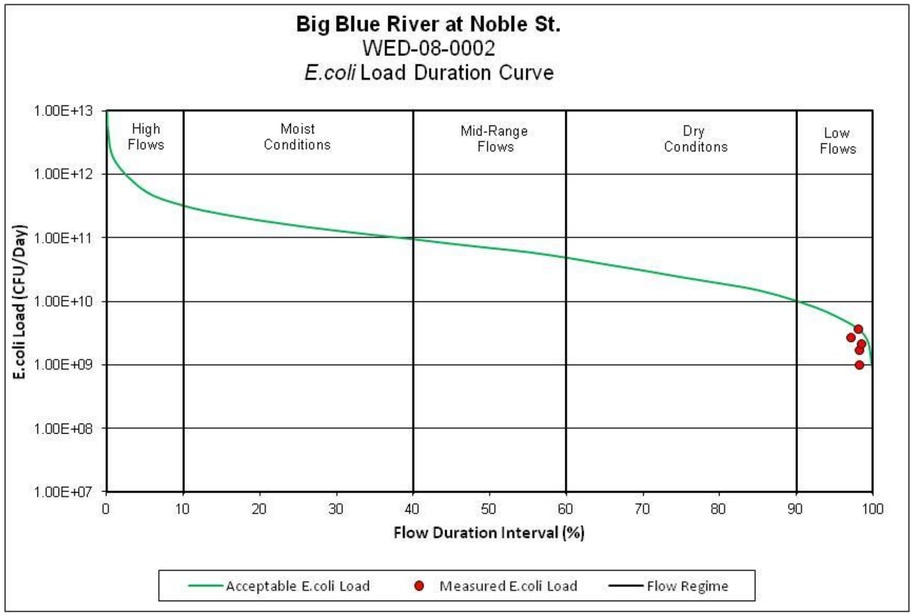

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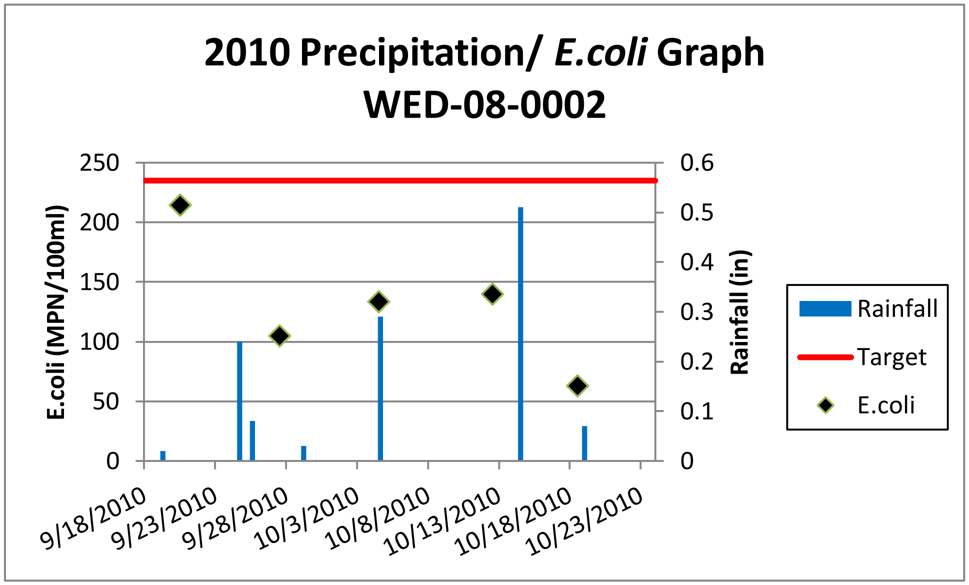

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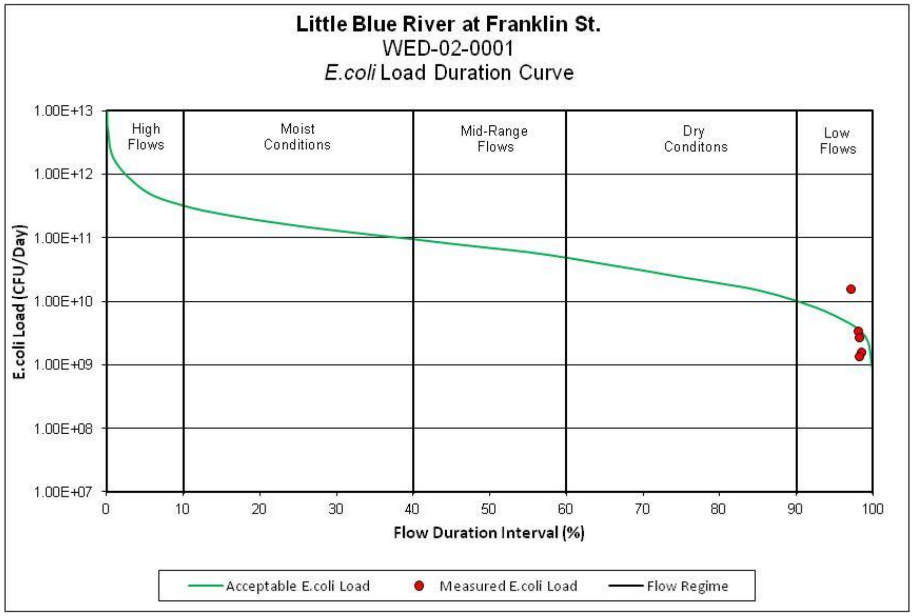

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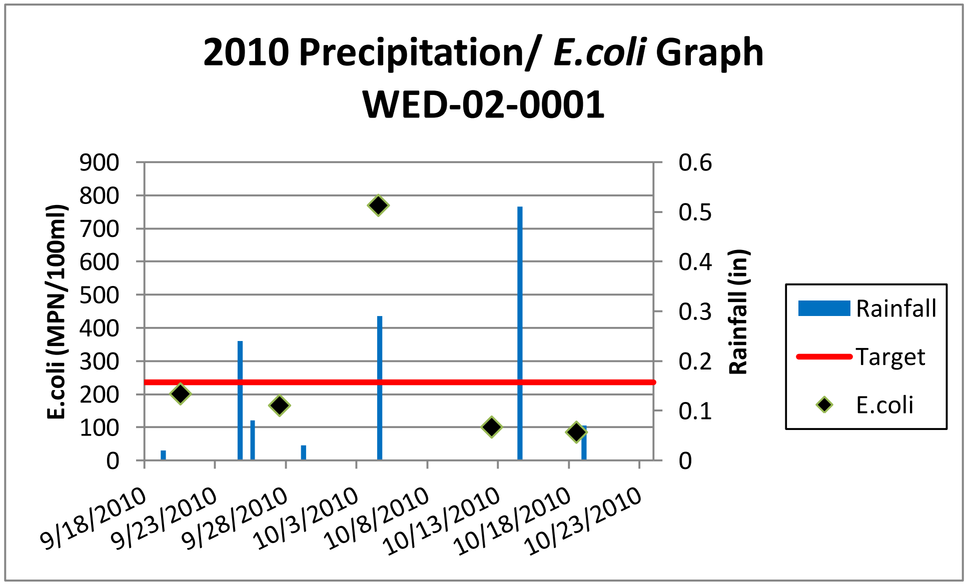

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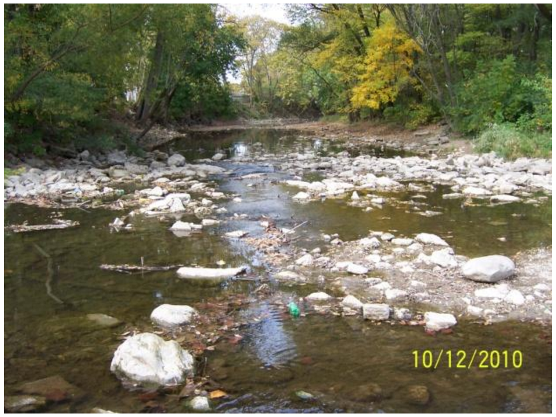

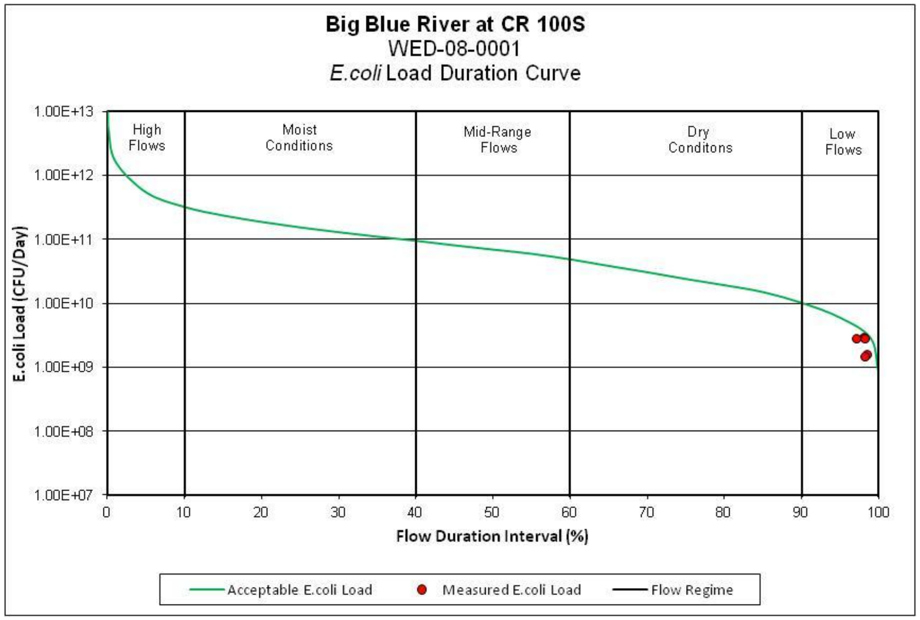

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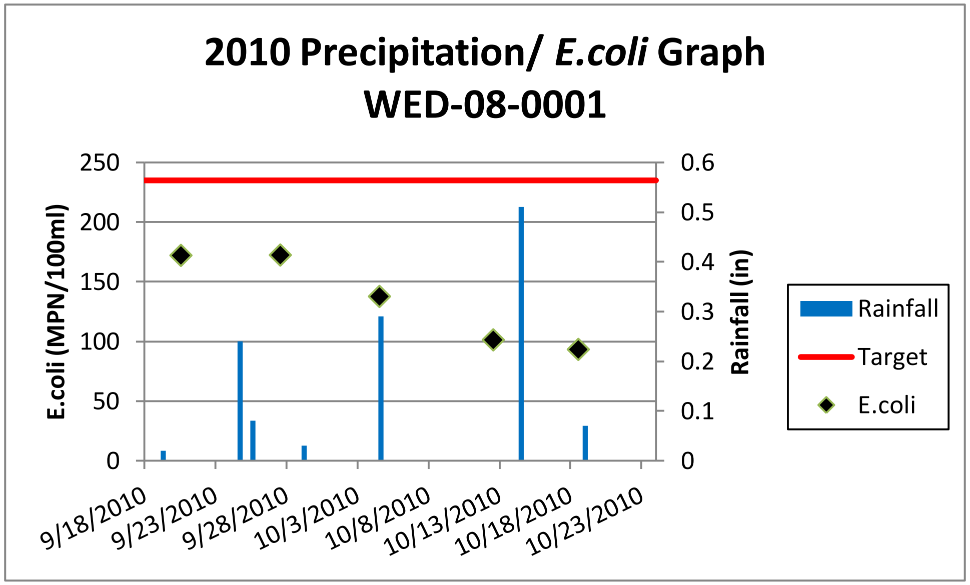

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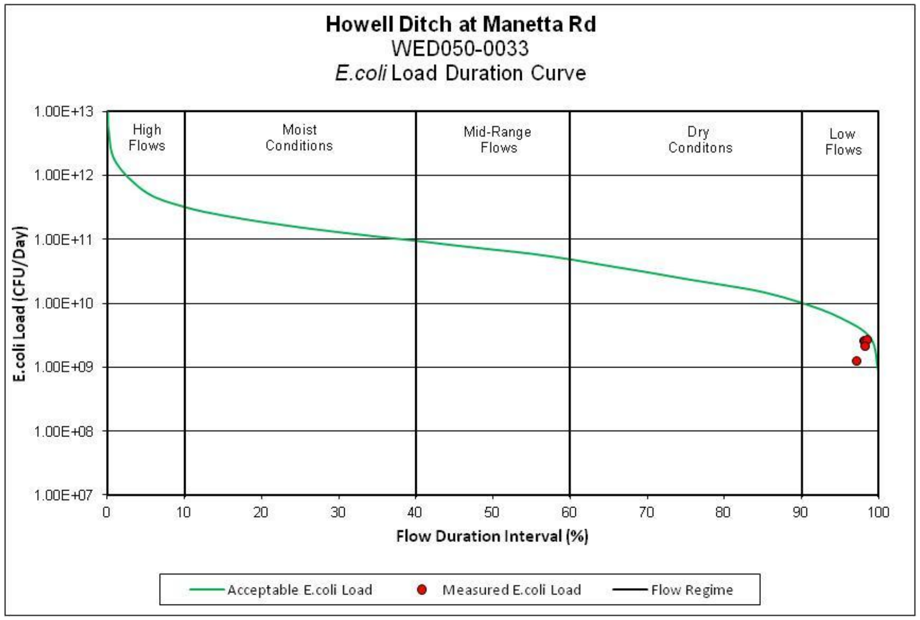

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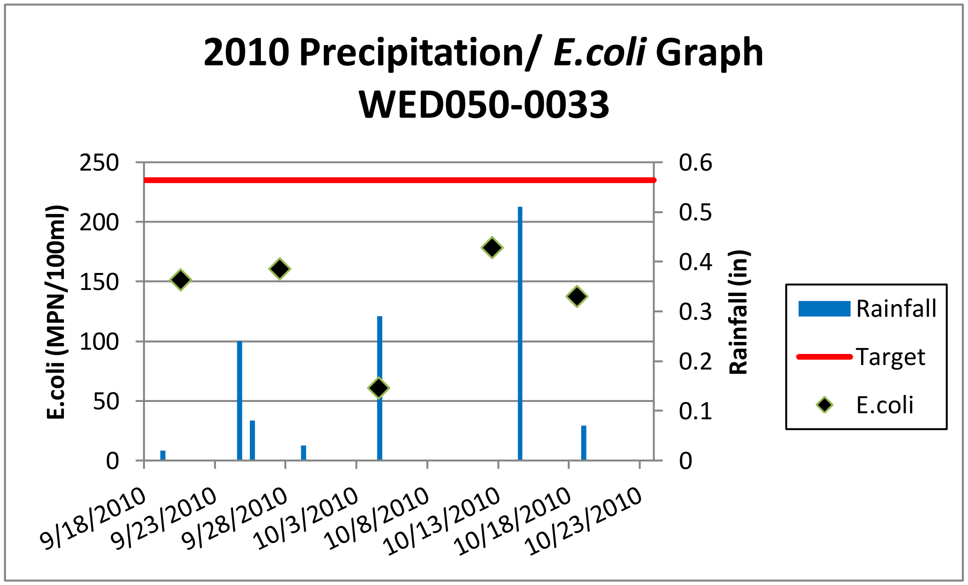

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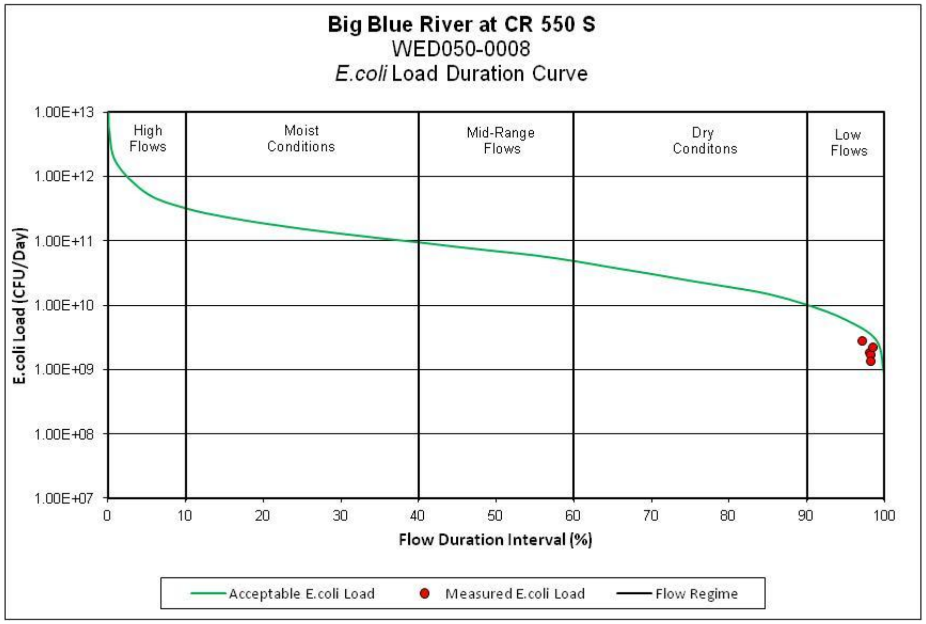

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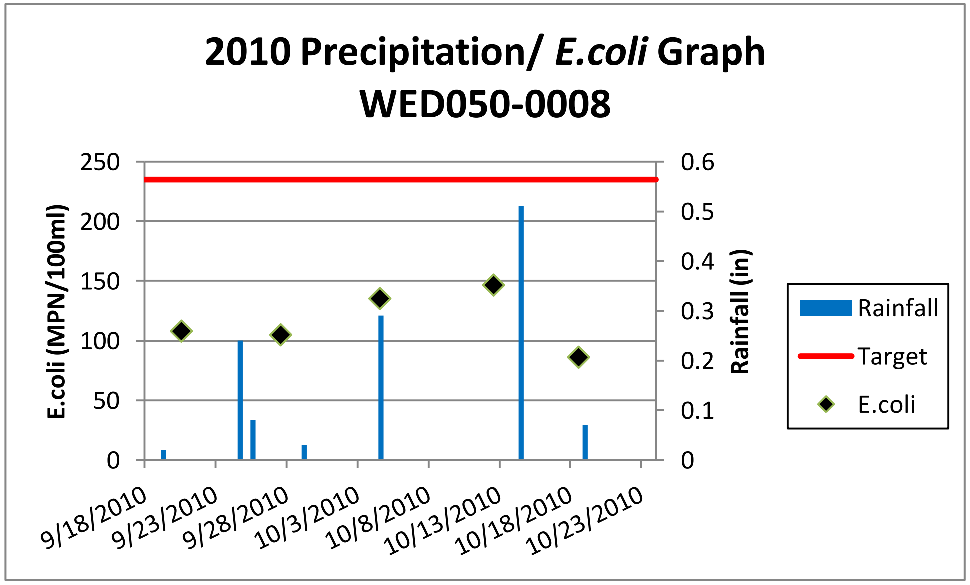

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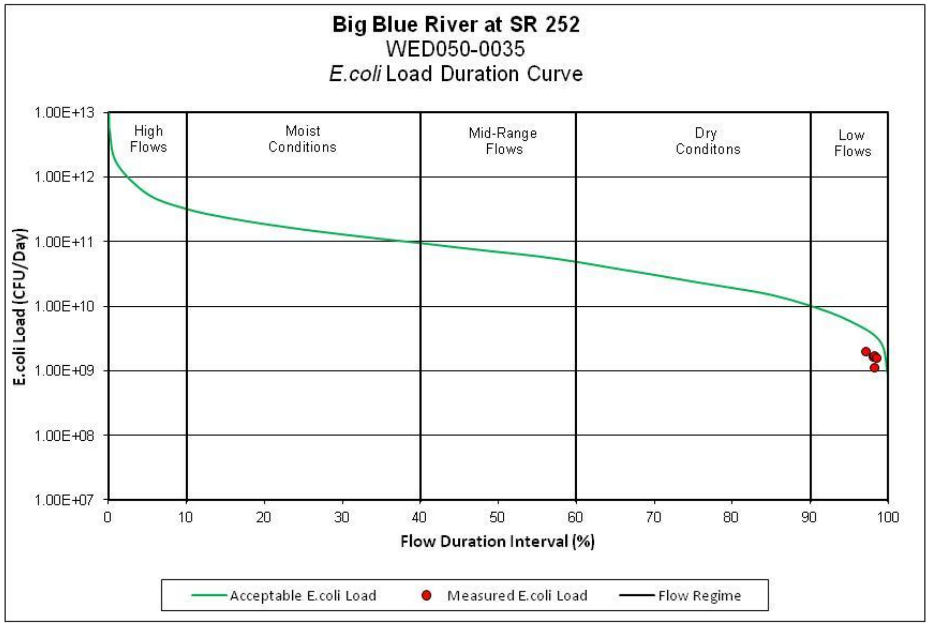

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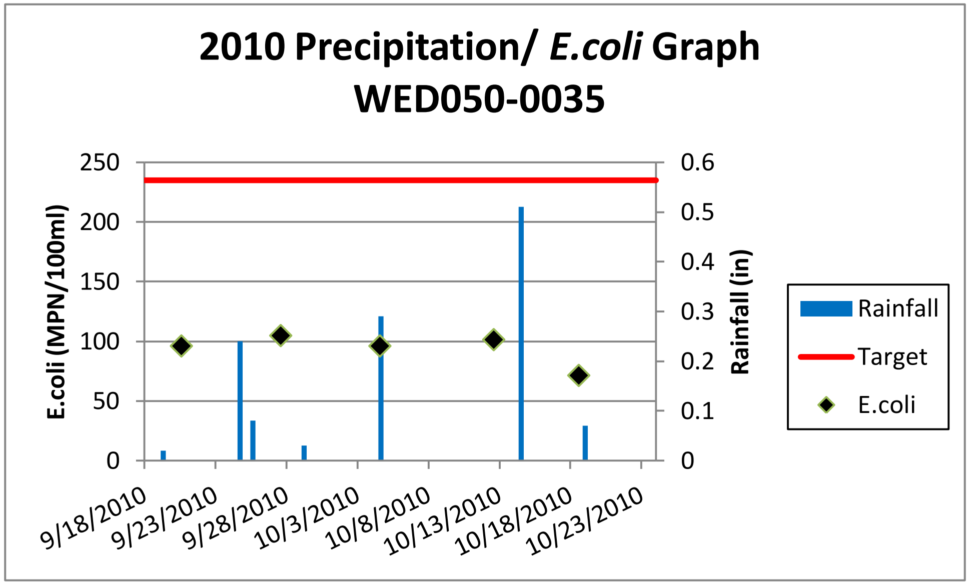

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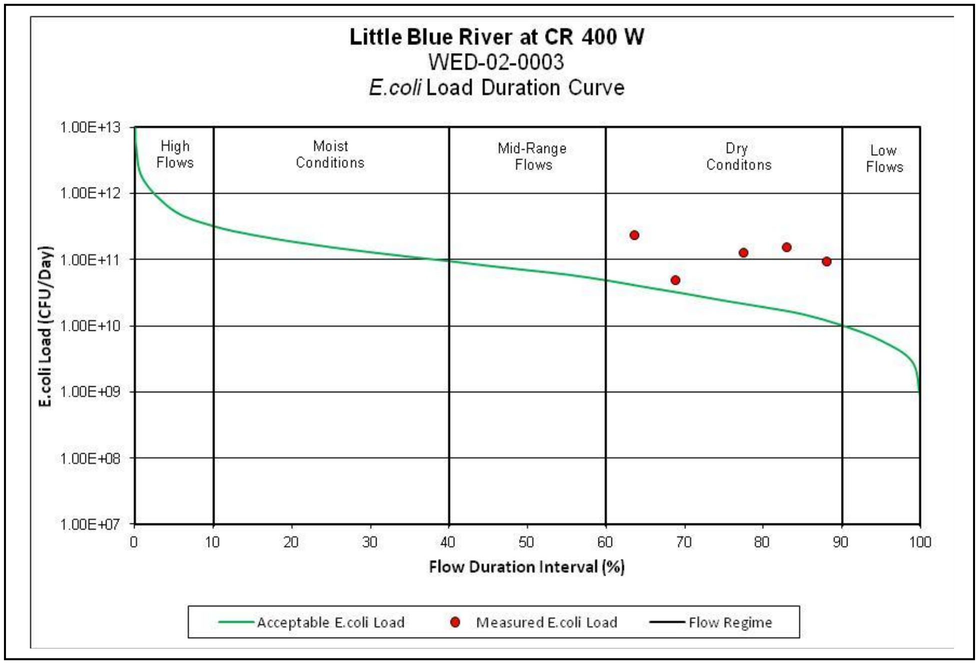

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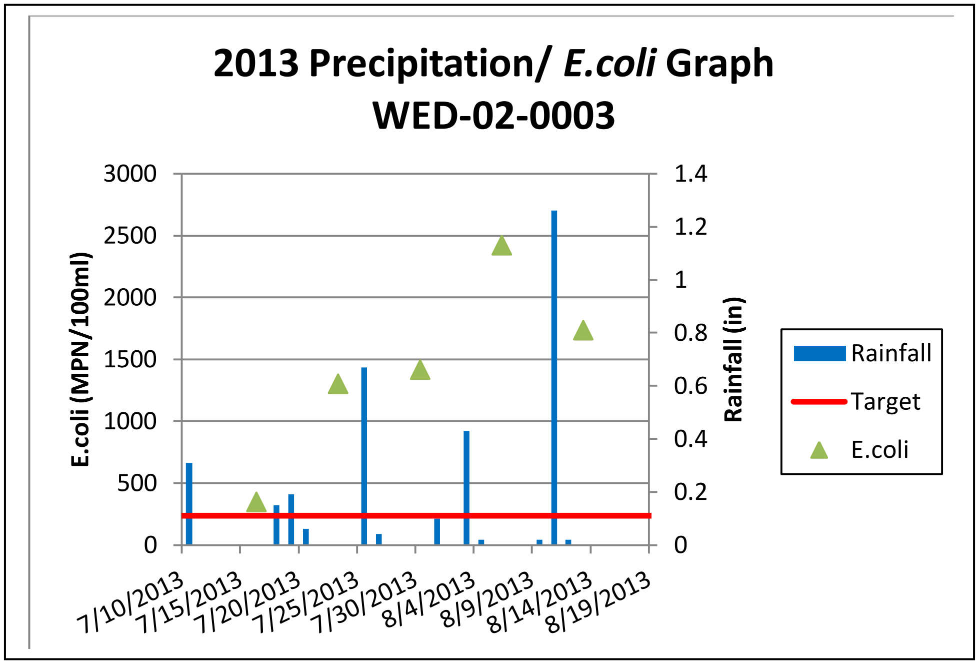

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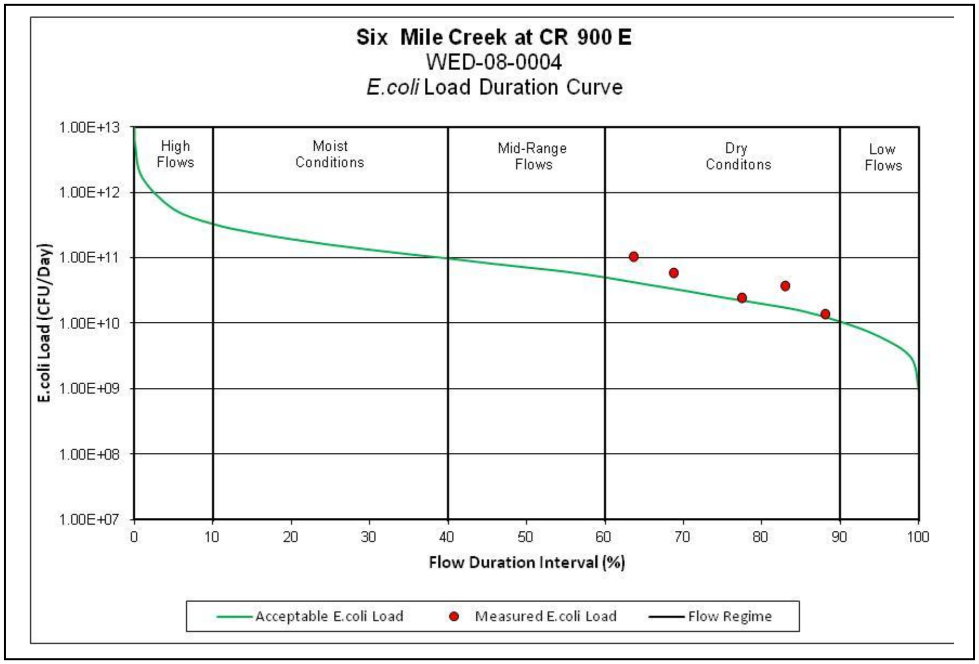

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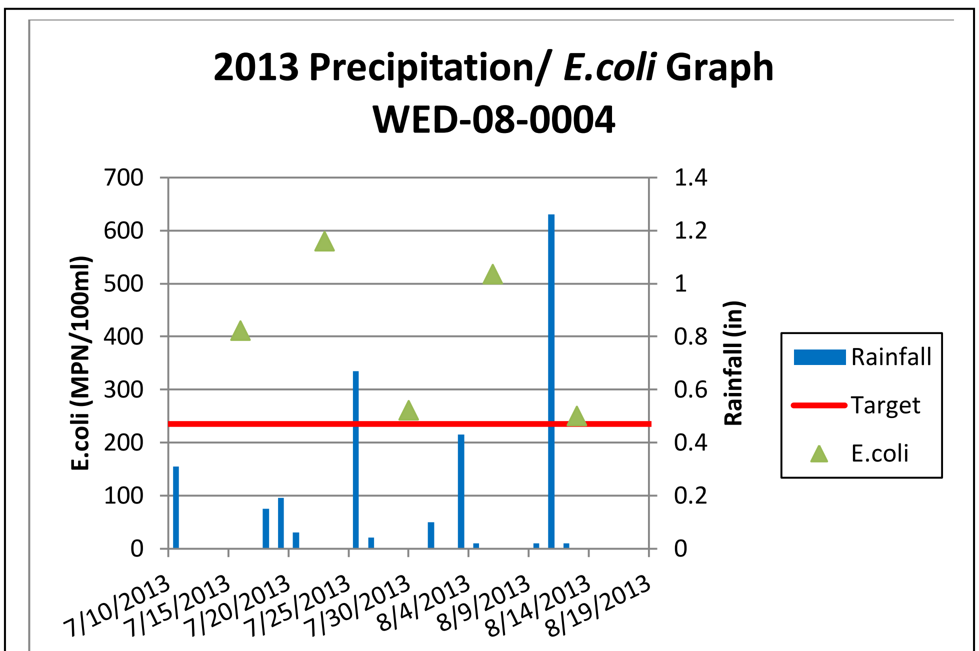

Downstream

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Number 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			
Headwaters Little Blue River	WED030-0029	INW0421_01	9/20/2010-10/18/2010	5	2	1	141.12	1986.3	11.42
Beaver Meadow Creek	WED030-0031	INW0422_01	9/20/2010-10/18/2010	5	2	1	148.73	435.2	15.96
Gilson Creek-Little Blue River	WED030-0030	INW0423_01	9/20/2010-10/18/2010	5	3	2	105.79	488.4	0
	WED-02-0003	INW0423_01	7/16/2013-8/13/2013	5	5	5	1215.77	2419.6	89.72
Manilla Branch-Little Blue River	WED030-0026	INW0425_01	9/20/2010-10/18/2010	5	3	1	118.93	325.5	0
Town of Rays Crossing-Little Blue River	WED030-0033	INW0425_01	9/20/2010-10/18/2010	5	2	1	223.93	2419.6	44.18
	WED030-0032	INW0425_T1001		5	4	3	360.57	1553.1	65.33
	WED-02-0001	INW0425_01		5	3	1	186.20	770.1	32.87
Headwaters Six Mile Creek	WED020-0031	INW0481_01	9/20/2010-10/18/2010	5	0	0	30.16	77.6	0
Anthony Creek-Six Mile Creek	WED020-0032	INW0482_T1002	9/20/2010-10/18/2010	5	3	2	270.83	1732.9	53.84
	WED020-0001			5	5	4	333.43	648.8	62.51
	WED-08-0004	INW0482_01	7/16/2013-8/13/2013	5	5	5	380.65	579.4	67.16
Nameless Creek	WED020-0033	INW0482_01	9/20/2010-10/18/2010	5	4	3	460.27	2419.6	72.84
Prairie Branch-Big Blue River	WED-08-0003	INW0484_01	9/20/2010-10/18/2010	5	5	3	281.24	435.2	55.55
Foreman Branch-Big Blue River	WED020-0003	INW0485_02	9/20/2010-10/18/2010	5	4	1	191.56	290.9	34.75
	WED020-0014	INW0485_T1002		5	2	1	123.51	1119.9	0
	WED-08-0002	INW0486_01		5	3	0	121.19	214.2	0
DePrez Ditch-Big Blue River	WED-08-0001	INW0486_02	9/20/2010-10/18/2010	5	3	0	130.92	172.3	4.52
	WED050-0033	INW0486_T1003		5	4	0	129.50	178.5	3.47
Shaw Ditch-Big Blue River	WED050-0008	INW0487_01	9/20/2010-10/18/2010	5	2	0	114.21	146.7	0
	WED050-0035	INW0487_01		5	0	0	92.93	104.6	0