Total Maximum Daily Load Report for the Lower Salt Creek Watershed

FINAL

August 20, 2018

Prepared by:

Indiana Department of Environmental Management

Table of Contents

Tables

Figures

1.0 EXECUTIVE SUMMARY

The Lower Salt Creek watershed (Hydrologic Unit Code 0512020808) is located in south central Indiana and drains a total of 636 square miles. The Lower Salt Creek watershed originates near Bloomington in southeast Monroe County, and then flows southwest, where it ultimately empties into the White River near Bedford, IN in Lawrence County. Land use throughout the watershed is predominantly forested with some urban and agricultural areas.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (U.S. EPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) List of Impaired Waters. 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 waste load allocations (WLAs) for regulated sources and load allocations (LAs) for sources that are not directly regulated. In addition, the TMDL must include a margin of safety (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:

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

This TMDL has been developed for *Escherichia coli* in the Lower Salt Creek watershed. This parameter will be referred to in this report as "the impairment."

After the Indiana Department of Environmental Management (IDEM) identifies a waterbody as having impairments 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 each waterbody using these new sampling data and to examine the watershed as a whole. The reassessment data helps IDEM identify the area of concern for TMDL development.

Both historical and recent data were used for the TMDL analysis. A preliminary survey of Lower Salt Creek watershed was conducted by IDEM in 1992 with additional surveys in 1995, 1997, 2000, 2001, 2002, 2007, and 2012 through the probabilistic, targeted, and fish tissue sampling programs. Recent data were sampled from November 2015 to October of 2016 by IDEM. The data indicates that 19 of the sample sites violated the geometric mean of 125 MPN/100mL and/or the secondary assessment methods as outlined in IDEM's 2016 Consolidated Assessment and Listing Methodology (CALM).

Reductions needed to achieve water quality standards range from 47-94 percent.

Potential sources of *E. coli* in the watershed include regulated point sources such as wastewater treatment plants (WWTPs) and Municipal Separate Storm Sewer Systems (MS4s). Point sources are regulated through the National Pollutant Discharge Elimination System (NPDES). Nonpoint sources such as unregulated storm water runoff and agricultural runoff are also potential sources, as well as leaking/failing septic systems.

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 Salt Creek watershed, subwatersheds with greater urban areas have high average *E. coli* counts. It is therefore possible that sanitary sewer overflows (SSO) and pet waste in these subwatersheds are contributing to the elevated *E. coli* levels. However, subwatersheds with large amounts of pastureland in the stream corridor also have high *E. coli* counts. Here, it is likely that field runoff and direct deposition from livestock, as well as wildlife, are contributing to elevated *E. coli* levels. Specific sources of *E. coli* to each impaired waterbody should be further evaluated during follow-up implementation activities.

An important step in the TMDL process is the allocation of the allowable loads to individual point sources, as well as sources that are not directly regulated. The Lower Salt Creek watershed TMDL includes these allocations, which are presented for each of the 43 impaired Assessment Unit IDs (AUIDs) located within the seven 12-digit HUC subwatersheds.

There are 19 NPDES permitted facilities located in the Lower Salt Creek watershed. Of these facilities, the eight WWTPs are the only potential contributors of *E. coli*. Of these eight facilities, only one was found to be in violation of its permit limits for *E. coli* in the last six years. Therefore, the majority of the time the discharge effluent from these facilities meets water quality standards.

There are several types of nonpoint sources of *E. coli* located in the Lower Salt Creek watershed, such as unregulated stormwater runoff (including pet waste), agricultural runoff, direct deposition from wildlife and from livestock on pastureland, illegal straight pipes, and leaking/failing septic systems. Although Indiana does not have a permitting program for nonpoint sources, many nonpoint sources are addressed through voluntary programs intended to reduce pollutant loads, minimize flow, and improve water quality.

This TMDL report identifies which locations could most benefit from focus on implementation activities. It also provides recommendations on the types of implementation activities, including best management practices (BMPs), that key implementation partners in the Lower Salt Creek watershed can consider to achieve the pollutant load reductions calculated for each subwatershed. Through the load duration curve approach it has been determined that load reductions for *E. coli* are needed for specific flow conditions. The critical conditions (the periods when the greatest reductions are required) vary by location and are summarized below in Table 1. After existing loading and percent reductions are calculated under each hydrologic condition class, the critical condition for each TMDL is identified as the flow condition requiring the largest percent reduction. The table indicates that critical conditions for *E. coli* for most locations occur during the moist and dry flow regimes, and therefore implementation of controls should be targeted for these conditions.

Table 1: Critical Conditions for TMDL Parameters

Parameter	Subwatershed (HUC)	Critical Condition				
		High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
E. coli	Jackson Creek (051202080801)	--	90%	90%	98%	--
	May Creek (051202080802)	--	47%	90%	98%	--
	Little Clear Creek (051202080803)	--	57%	83%	87%	--
	Hunter Creek (051202080804)	--	8%	NA	37%	--
	Knob Creek (051202080805)	--	74%	58%	82%	--
	Wolf Creek (051202080806)	--	84%	70%	93%	--
	Goose Creek (051202080807)	--	89%	NA	82%	--

Note: -- = No Data Collected in Flow Regime NA= No reduction needed

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:

- Two kickoff meetings were held at the Monroe County U.S. Department of Agriculture (USDA) Service Center on 11-17-2015, during which IDEM and the Monroe County SWCD described the TMDL program and provided a summary of the available data and the proposed modeling approach.
- A final public meeting was held at the Purdue Extension Office in Bedford, IN on 7-9-2018 during which IDEM described the TMDL program and provided an overview of the draft TMDL results.

2.0 INTRODUCTION

This section of the Total Maximum Daily Load (TMDL) report provides an overview of the Lower Salt Creek watershed. The location, characteristics, and the regulatory requirements that have led to the development of this TMDL are discussed below in order to address impairments in the Lower Salt Creek watershed.

The Lower Salt Creek watershed (Hydrologic Unit Code 0512020808), shown in Figure 1, is located in south central Indiana and drains a total of 636 square miles. The Lower Salt Creek watershed originates near Bloomington, and then flows southeast, where it ultimately empties into the East Fork White River near Bedford. Land use throughout the watershed is predominantly forested areas, with some larger areas of development and agricultural use.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (U.S. EPA) regulations require that states develop TMDLs for waters on the Section 303(d) List of Impaired Waters. U.S. EPA defines a TMDL as the sum of the individual waste load allocations (WLA) for point sources and load allocations (LA) for nonpoint sources, and a margin of safety (MOS) that addresses the uncertainty in the analysis.

The overall goals and objectives of the TMDL study for the Lower Salt Creek watershed are to:

- 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 TMDL 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 critical flow conditions 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. EPA 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 U.S. EPA's nine minimum elements under the CWA Section 319 Nonpoint Source Program, as well as the additional requirements under Indiana Department of Environmental Management's WMP Checklist.

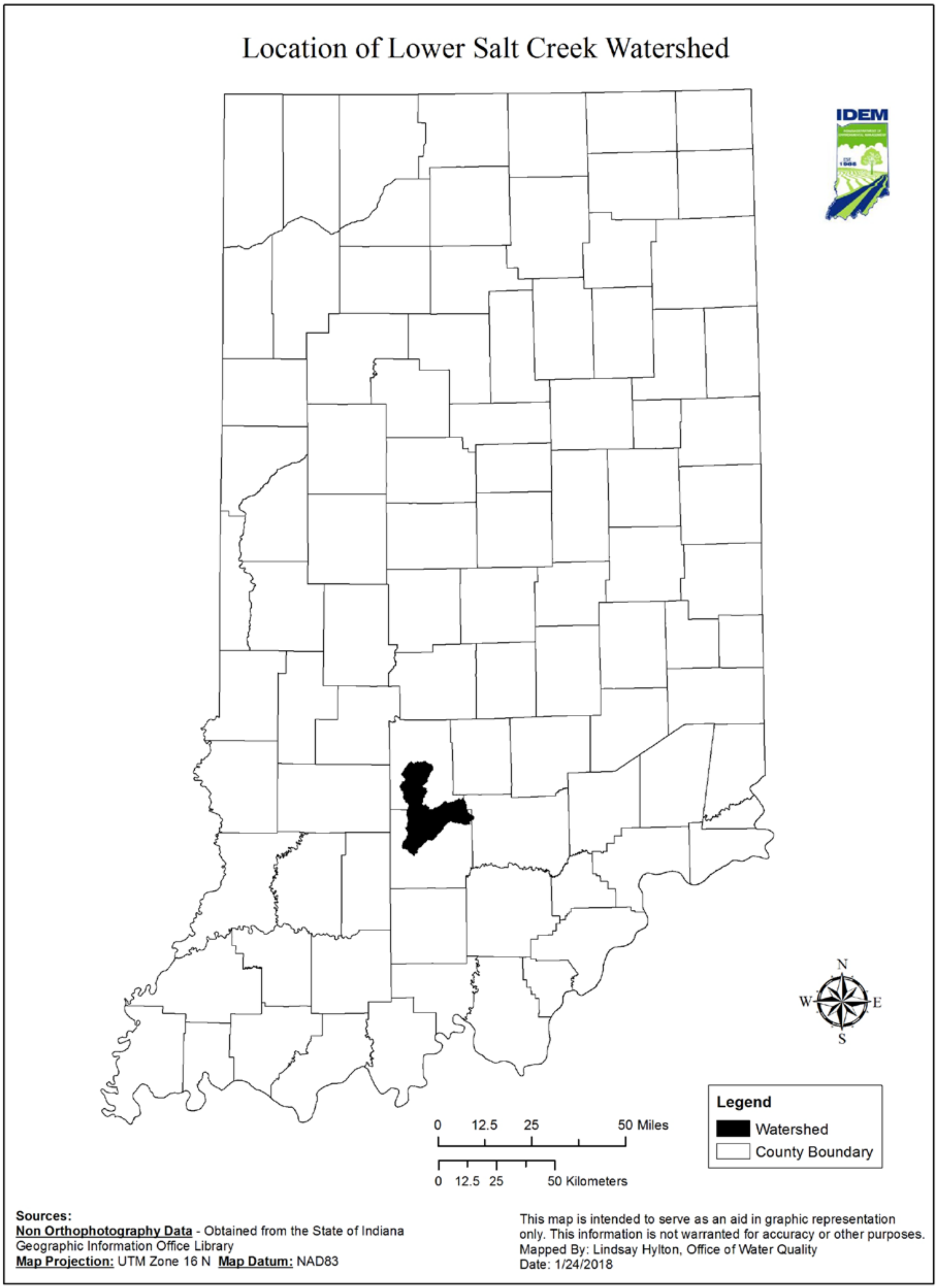


Figure 1: Location of Lower Salt Creek Watershed

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 Salt Creek Watershed TMDLs focus on protecting the designated aquatic life support and 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 ("free forms…") that apply to all surface waters. Numeric criteria for *E. coli* were used as the basis of the Lower Salt Creek Watershed TMDLs.
- **Antidegradation** policies provide protection of existing uses and extra protection for high-quality or unique waters.

The water quality standards in Indiana pertaining to *Escherichia coli* ("the impairment") are described below.

2.1.1 *E. coli*

E. coli is an indicator of the possible presence of pathogenic organisms (e.g., enterococcal *E. coli*, viruses, and protozoa) which may cause human illness. *E. coli* is a sub-group of fecal coliform and is used as an indicator of potential fecal contamination. Concentrations are typically reported as the count of organisms in 100 milliliters (mL) 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. . . However, a single sample shall be used for making beach notification and closure decisions." [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

2.2 Water Quality Targets

Target values are needed for the development of TMDLs because of the need to calculate allowable daily loads. 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 Salt Creek Watershed TMDL are presented below.

2.2.1 *E. coli* TMDLs

The target value used for the Lower Salt Creek Watershed TMDL was based on the 235 counts/100 mL single sample maximum component of the water quality standard (i.e., daily loading capacities were calculated by multiplying flows by 235 counts/100 mL). The EPA report, "*An Approach for Using Load Duration Curves in the Development of TMDLs*" (EPA 2007) [1] describes how the monthly geometric mean (125 counts/100mL) is likely to be met when the single sample maximum value (235 counts/100mL) is used to develop the loading capacity. The process calculates the daily maximum bacteria value that is possible to observe and still attain the monthly geometric mean. If the single sample maximum is set as a never-to-be surpassed value then it becomes the maximum value that can be observed, and all other bacteria values would have to be less than the maximum.

2.3 303(d) Listing Information

2.3.1 Understanding Subwatersheds and Assessment Units

This section presents information concerning IDEM's segmentation process as it applies to the Lower Salt Creek watershed. IDEM identifies the Lower Salt Creek watershed and its tributaries using a watershed numbering system developed by 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). Figure 2 shows the 12-digit HUCs located in the Lower Salt Creek watershed.

Within each 12-digit HUC subwatershed, IDEM has identified several Assessment Unit IDs (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 are defined by the aforementioned factors and 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 2 contains the AUIDs in the subwatersheds of the Lower Salt Creek Watershed. Subsequent sections of the TMDL report organize information by subwatershed (if applicable) and AUID.

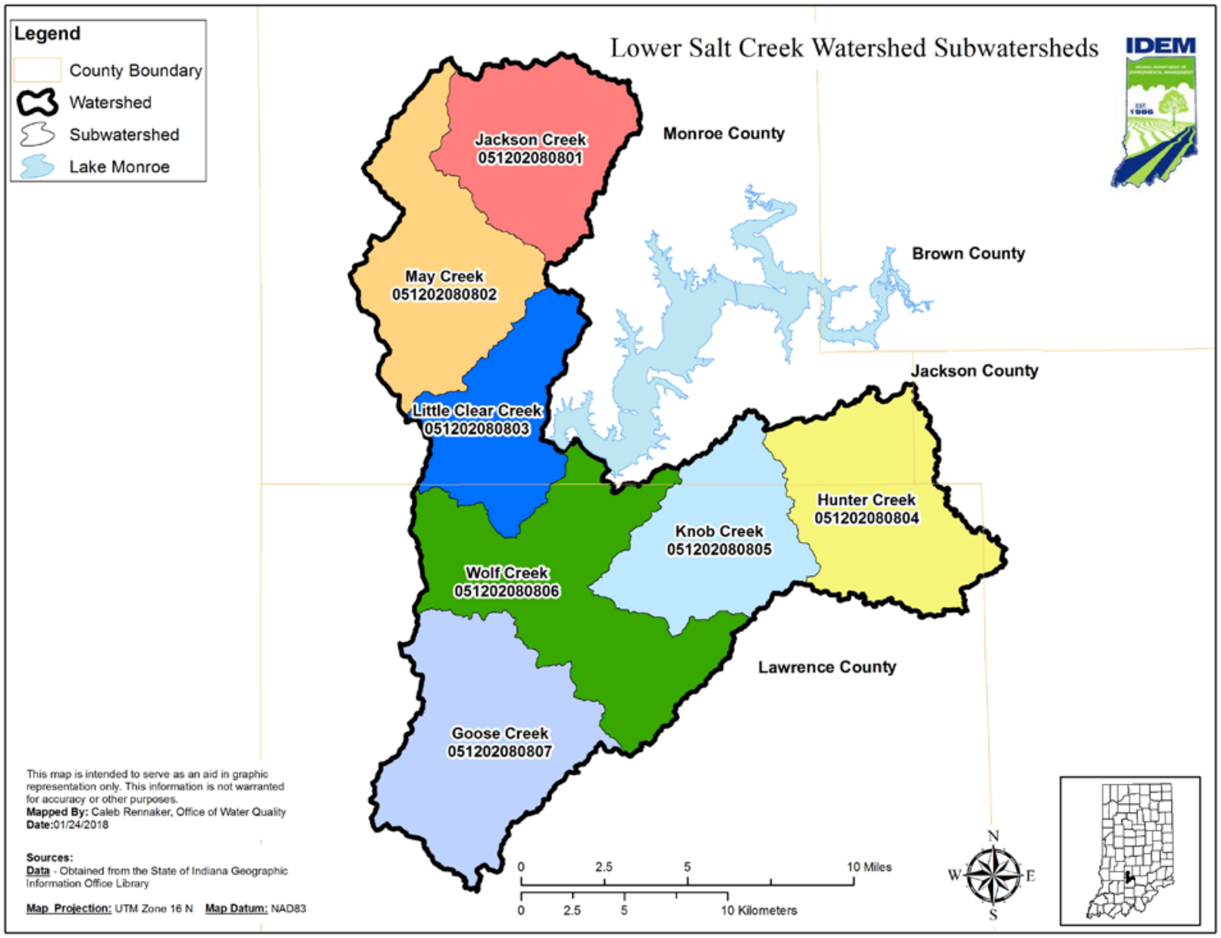


Figure 2: Subwatersheds (12-Digit HUCs) in the Lower Salt Creek Watershed

2.3.2 Understanding 303(d) Listing Information

There are a number of existing impairments in the Lower Salt Creek Watershed from the approved 2016 303(d) List of Impaired Waters (Table 2). Within the Lower Salt Creek watershed a total of two AUIDs are cited as impaired for ***E. coli***, 12 AUIDs are cited as impaired for ***Fish Tissue*** (***Mercury*** and/or ***PCB)*** impairments, and three AUIDs are cited as impaired for ***IBC*** on Indiana's 2016 303(d) List. Listings were based on historical sampling (1992, 1995, 1997, 2000, 2001, 2002, 2007, and 2012) and data collected in the Lower Salt Creek watershed. For historical sampling locations see Figure 3 below. With the collection of new data from November of 2015 to October 2016, the listings and causes of impairment have been adjusted as a result of reassessment data collected at 27 sampling locations in the watershed (Figure 4). There are now 43 AUIDs that will be listed on the draft 2018 303(d) list as impaired for *E. coli* (Figure 6). These impaired segments account for approximately 185 miles. Table 2 presents listing information for the Lower Salt Creek watershed, including a comparison of the updated 2018 listings with the 2016 listings and associated causes of impairment. The reassessment data used in updating the listings for the Lower Salt Creek watershed are available in Appendix B.

Table 2: Assessment Units and Section 303(d) Listed Impairments for the Lower Salt Creek Watershed

Subwatershed Name	12-digit HUC	2016 Assessment Unit ID	2016 Section 303(d) Listed Impairment	Final Assessment Unit ID	2018 303(d) Listed Impairment
Jackson Creek	51202080801	INW0881_01		INW0881_01	E. *coli*
		INW0881_01A		INW0881_01A	E. *coli*
		INW0881_02		INW0881_02	E. *coli*
		INW0881_03	PCBs (Fish Tissue)	INW0881_03	E. *coli,* IBC, PCBs (Fish Tissue)
		INW0881_04		INW0881_04	E. *coli,* IBC
		INW0881_T1001		INW0881_T1001	E. *coli*
		INW0881_T1002		INW0881_T1002	E. *coli*
		INW0881_T1003		INW0881_T1003	E. *coli*
		INW0881_T1005		INW0881_T1005	E. *coli*
		INW0881_T1006		INW0881_T1006	E. *coli*
		INW0881_T1007		INW0881_T1007	E. *coli*
		INW0881_05		INW0881_T1008	E. *coli*
		INW0881_06		INW0881_T1009	E. *coli,* IBC
		INW0881_T1004		INW0881_T1010	E. *coli,* IBC
May Creek	51202080802	INW0882_01	PCBs (Fish Tissue)	INW0882_02	E. *coli,* PCBs (Fish Tissue)
				INW0882_03	E. *coli*, Nutrients, PCBs (Fish Tissue)
		INW0882_T1001		INW0882_T1001	E. *coli*
		INW0882_T1002A		INW0882_T1002A	
		INW0882_T1003		INW0882_T1003	E. *coli*
		INW0882_T1004		INW0882_T1004	E. *coli,* IBC
		INW0882_T1005		INW0882_T1005	E. *coli*

Subwatershed Name	12-digit HUC	2016 Assessment Unit ID	2016 Section 303(d) Listed Impairment	Final Assessment Unit ID	2018 303(d) Listed Impairment
		INW0882_T1006		INW0882_T1006	E. *coli*
		INW0882_01	PCBs (Fish Tissue)	INW0882_T1007	E. *coli*, PCBs (Fish Tissue)
Little Clear Creek	51202080803	INW0883_01	E. *coli,* DO, PCBs (Fish Tissue)	INW0883_01	E. *coli*, PCBs (Fish Tissue)
		INW0883_02	E. *coli,* PCBs (Fish Tissue)	INW0883_02	E. *coli*, PCBs (Fish Tissue)
		INW0883_T1001		INW0883_T1001	E. *coli*
		INW0883_T1002		INW0883_T1002	E. *coli*
		INW0883_T1003		INW0883_T1003	E. *coli*
		INW0883_T1004		INW0883_T1004	E. *coli*
		INW0883_T1005		INW0883_T1005	E. *coli*
		INW0883_T1006		INW0883_T1006	
Hunter Creek	51202080804	INW0884_01		INW0884_02	
				INW0884_03	
				INW0884_04	
				INW0884_05	
				INW0884_T1003	
				INW0884_T1008	
				INW0884_T1009	
		INW0884_T1001		INW0884_T1004	
				INW0884_T1005	
				INW0884_T1006	
				INW0884_T1007	
		INW0884_T1002	IBC	INW0884_T1010	IBC

Subwatershed Name	12-digit HUC	2016 Assessment Unit ID	2016 Section 303(d) Listed Impairment	Final Assessment Unit ID	2018 303(d) Listed Impairment
				INW0884_T1011	
				INW0884_T1012	
				INW0884_T1013	
				INW0884_T1014	
				INW0884_T1015	
Knob Creek	51202080805	INW0885_02		INW0885_02	DO
		INW0885_01		INW0885_03	
				INW0885_04	
				INW0885_05	IBC
				INW0885_06	
		INW0885_T1001		INW0885_T1001	IBC
		INW0885_01		INW0885_T1003	
				INW0885_T1004	
				INW0885_T1005	
				INW0885_T1006	
		INW0885_T1002		INW0885_T1007	E. *coli*
				INW0885_T1008	E. *coli*
				INW0885_T1009	E. *coli*
Wolf Creek	51202080806	INW0886_01	Hg (Fish Tissue)	INW0886_01	E. *coli,* Hg (Fish Tissue)
		INW0886_02	PCBs (Fish Tissue), Hg (Fish Tissue)	INW0886_02	E. *coli,* PCBs (Fish Tissue), Hg (Fish Tissue)
		INW0886_03	PCBs (Fish Tissue), Hg (Fish Tissue)	INW0886_03	E. *coli,* PCBs (Fish Tissue), Hg (Fish Tissue)

Subwatershed Name	12-digit HUC	2016 Assessment Unit ID	2016 Section 303(d) Listed Impairment	Final Assessment Unit ID	2018 303(d) Listed Impairment
		INW0886_04	PCBs (Fish Tissue), Hg (Fish Tissue)	INW0886_04	E. *coli,* PCBs (Fish Tissue), Hg (Fish Tissue)
		INW0886_T1001		INW0886_T1001	
		INW0886_T1002		INW0886_T1002	
		INW0886_T1003		INW0886_T1003	
		INW0886_T1004	IBC	INW0886_T1004	IBC
		INW0886_T1005		INW0886_T1005	
		INW0886_T1006		INW0886_T1006	
		INW0886_T1008		INW0886_T1008	
		INW0886_T1009		INW0886_T1009	E. *coli,* IBC
		INW0886_P1001		INW0886_T1010	E. *coli*
		INW0886_T1010			
		INW0886_T1010A			
		INW0886_T1011		INW0886_T1011	E. *coli*
		INW0886_T1007	IBC, PCBs (Fish Tissue)	INW0886_T1012	PCBs (Fish Tissue)
				INW0886_T1013	IBC, PCBs (Fish Tissue)
Goose Creek	51202080807	INW0887_01	PCBs (Fish Tissue), Hg (Fish Tissue)	INW0887_02	E. *coli*, PCBs (Fish Tissue), Hg (Fish Tissue)
				INW0887_03	E. *coli*, PCBs (Fish Tissue), Hg (Fish Tissue)

Subwatershed Name	12-digit HUC	2016 Assessment Unit ID	2016 Section 303(d) Listed Impairment	Final Assessment Unit ID	2018 303(d) Listed Impairment
				INW0887_04	IBC, PCBs (Fish Tissue), Hg (Fish Tissue)
				INW0887_05	IBC, PCBs (Fish Tissue), Hg (Fish Tissue)
				INW0887_T1009	PCBs (Fish Tissue), Hg (Fish Tissue)
		INW0887_T1002A		INW0887_T1002A	
		INW0887_T1003B		INW0887_T1003B	
		INW0887_T1004		INW0887_T1004	
		INW0887_T1005C		INW0887_T1005C	
		INW0887_T1001		INW0887_T1006	E. *coli*
				INW0887_T1007	E. *coli*

Understanding Table 2:

- *Column 1: Subwatershed Name*. Identifies the name of the subwatershed at the 12-digit HUC scale
- *Column 2:12-digit HUC*. Subwatersheds of this scale are of the appropriate size for what IDEM's WMP Checklist defines as a subwatershed, for the purposes of watershed management planning.
- *Column 3: 2016 AUID.* Identifies the previous AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2016 Section 303(d) listing assessment process

- *Column 4: 2016 Section 303(d) Listed Impairment.* Identifies the cause of impairment associated with the 2016 Section 303(d) listing
- *Column 5: Final AUID.* Identifies the final AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2018 and future Section 303(d) listing assessment process
- *Column 6: 2018 303(d) Listed Impairment.* Identifies the cause of impairment associated with the 2018 Section 303(d) listing

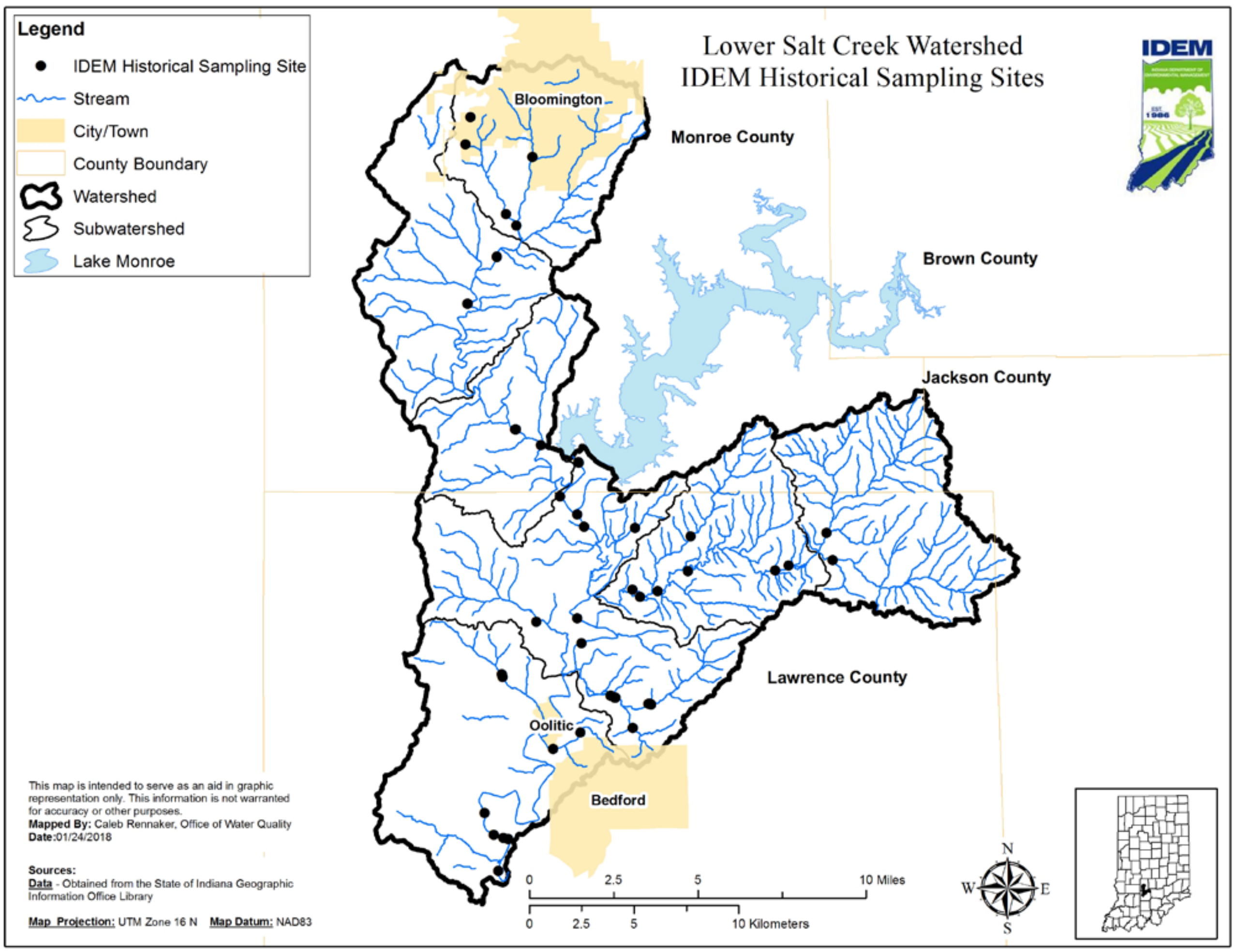


Figure 3: Location of Historical Sampling Sites in the Lower Salt Creek Watershed

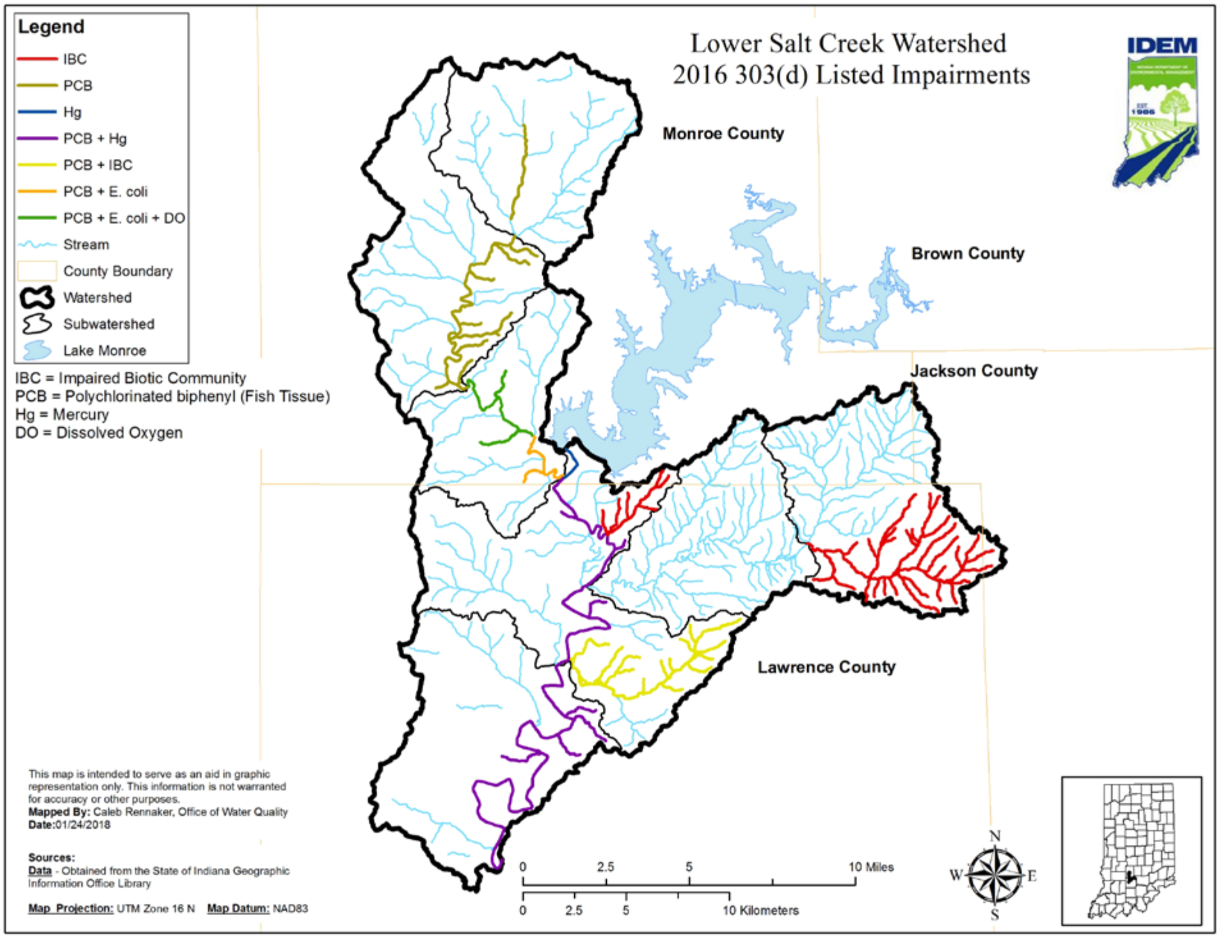


Figure 4: Streams Listed on the 2016 Section 303(d) List in the Lower Salt Creek Watershed

2.4 Water Quality Data

This section of the TMDL report contains a brief characterization of the Lower Salt Creek Watershed water quality information that was collected in development of this TMDL. 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. Below is an inventory of the available chemistry data for the Lower Salt Creek watershed.

2.4.1 Water Quality Data

Table 4 summarizes the water quality data within the Lower Salt Creek watershed by displaying the maximum concentrations (and geometric mean for *E. coli*) at all impaired sites, along with the reduction needed to meet the TMDL. Current data sampled in November 2015 through October 2016 by IDEM were used for the TMDL analysis. Table 3 and Figure 5 below show the sampling site locations and information.

The percent reductions were calculated as follows:

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

Appendix A shows the individual sample results and summaries of all the water quality data for all 28 monitoring stations.

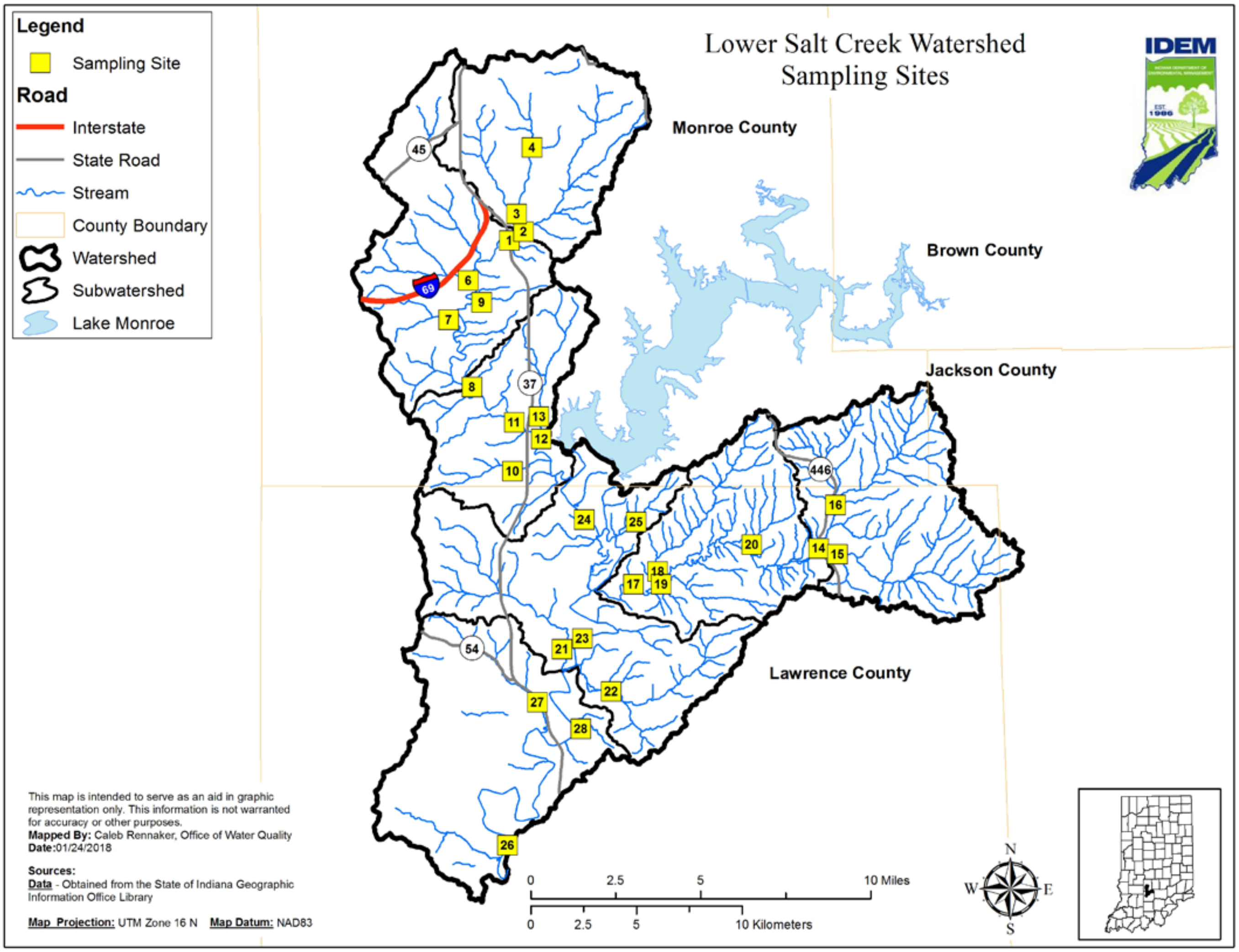


Figure 5: 2015-2016 Sampling Locations for the Lower Salt Creek TMDL

Table 3: Lower Salt Creek Sampling Site Information

Site #	Site ID #	Stream Name	Road Name	AUID
1	WEL-08-0005	Clear Creek	State Road 37	INW0882_02
2	WEL-08-0006	Jackson Creek	South Rogers Street	INW0881_T1009
3	WEL-08-0007	Clear Creek	W Church Lane	INW0881_T1010
4	WEL-08-0008	Clear Creek	W Country Club Drive	INW0881_03
6	WEL-08-0010	Tributary to Clear Creek	S Victor Pike	INW0882_T1003
7	WEL-08-0011	Tributary to Clear Creek	S Victor Pike	INW0882_T1005
8	WEL-08-0012	Clear Creek	S Ketcham Road	INW0882_03
9	WEL-08-0013	Tributary to Clear Creek	Will Flock Mill Road	INW0882_T1004
10	WEL-08-0014	Judah Branch	S Old State Road 37	INW0883_T1005
11	WEL-08-0015	Clear Creek	S Gore Road	INW0883_01
12	WEL-08-0016	Clear Creek	Depot Hill Road	INW0883_02
13	WEL-08-0017	Little Clear Creek	E Monroe Dam Road	INW0883_T1004
14	WEL-08-0018	Little Salt Creek	State Road 446	INW0885_06
15	WEL-08-0019	Henderson Creek	Humpback Ridge Road	INW0884_T1010
16	WEL-08-0035	Little Salt Creek	Hunter Creek Road	INW0884_04
17	WEL-08-0021	Little Salt Creek	Judah Legan Road	INW0885_02
18	WEL-08-0022	Knob Creek	Bat Hollow Road	INW0885_T1008
19	WEL-08-0023	Little Salt Creek	Bat Hollow Road	INW0885_05
20	WEL-08-0024	Tributary to Little Salt Creek	Heltonville/Bartlettsville Rd	INW0885_T1001

21	WEL-08-0025	Gulletts Creek	Peerless Road	INW0886_T1009
22	WEL-08-0026	Pleasant Run	Peerless Road	INW0886_T1012
23	WEL-08-0027	Salt Creek	Peerless Road	INW0886_03
24	WEL-08-0034	Salt Creek	Guthrie Road	INW0886_02
25	WEL-08-0029	Wolf Creek	Guthrie Road	INW0886_T1004
26	WEL-08-0033	Salt Creek	Old State Road 450	INW0887_04
27	WEL-08-0031	Goose Creek	Patton Hill Road	INW0887_T1007
28	WEL090-0003	Salt Creek	Oolitic Road	INW0887_03

Understanding Table 3:

- *Column 1: Site #.* Lists the site number that corresponds to the site location in Figure 5
- *Column 2: Site ID #.* Provides the IDEM site number corresponding to the AIMS database
- *Column 3: Stream Name*. Identifies the Stream Name that the site is located on
- *Column 4: Road Name.* Identifies the Road Name that the site is located on
- *Column 5: AUID.* Identifies the AUID given to waterbodies within the 12-digit HUC sub watershed for purposes of the 2018 Section 303(d) listing assessment process

2.4.2 *E. coli* Data

Table 4 provides a summary of pathogen data in the Lower Salt Creek watershed to show which AUIDs are impaired due to pathogens.

Table 4: Summary of Pathogen Data in Lower Salt Creek by Subwatersheds

Subwatershed	Final AUID	Period of Record	Station #	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
Jackson Creek	INW0881_03	4/18/16-10/17/16	WEL-08-0008	10	90%	90%	1,437.45	14,136	91.30%
	INW0881_T1009	4/18/17-10/17/16	WEL-08-0006	10	80%	70%	1,134.93	19,863	88.99%
	INW0881_T1010	4/18/16-10/17/16	WEL-08-0007	10	70%	70%	742.77	14,136	83.17%
May Creek	INW0882_02	11/16/15-10/17/16	WEL-08-0005	15	67%	53%	940.26	17,329	86.71%
	INW0882_03	11/16/15-10/17/16	WEL-08-0012	15	60%	47%	229.28	488.4	45.48%
	INW0882_T1003	4/18/16-10/17/16	WEL-08-0010	10	60%	30%	235.8	2,382	46.99%
	INW0882_T1004	4/18/16-10/17/16	WEL-08-0013	10	20%	10%	270.76	12,033	53.83%
	INW0882_T1005	4/18/16-10/17/16	WEL-08-0011	10	100%	70%	1,099.47	15,531	88.63%
Little Clear Creek	INW0883_01	4/18/16-10/17/16	WEL-08-0015	10	70%	20%	289.41	275.5	56.81%
	INW0883_02	11/16/15-10/17/16	WEL-08-0016	15	73%	33%	358.48	1,732.9	65.13%
	INW0883_T1004	4/18/16-10/17/16	WEL-08-0017	10	80%	17%	799.75	5,172	84.37%
	INW0883_T1005	4/18/16-10/17/16	WEL-08-0014	10	70%	40%	840.09	1,986.3	85.12%

Subwatershed	Final AUID	Period of Record	Station #	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
Hunter Creek	**INW0884_04**	4/19/16-10/18/16	**WEL-08-0035**	10	50%	20%	NA	461.1	*NA
	INW0884_T1010	4/19/16-10/18/16	**WEL-08-0019**	10	40%	30%	NA	365.4	*NA
Knob Creek	**INW0885_06**	11/16/15-10/18/16	**WEL-08-0018**	15	47%	13%	NA	980.4	*NA
	INW0885_05	4/19/16-10/18/16	**WEL-08-0023**	10	80%	60%	NA	613.1	*NA
	INW0885_02	11/16/15-10/18/16	**WEL-08-0021**	15	60%	47%	NA	>2,419.6	*NA
	INW0885_T1001	4/19/16-9/13/16	**WEL-08-0024**	5	60%	60%	NA	517.2	54.56% x x(Based on single sample max (235/100mL)
	INW0885_T1008	4/19/16-10/18/16	**WEL-08-0022**	10	80%	60%	NA	816.4	71.22% x x(Based on single sample max (235/100mL)
Wolf Creek	**INW0886_02**	4/19/16-10/18/16	**WEL-08-0034**	10	60%	40%	NA	4,352	94.60% x x(Based on single sample max (235/100mL)
	INW0886_03	4/20/16-10/19/16	**WEL-08-0027**	10	50%	40%	389.34	1,299.7	67.89%
	INW0886_T1004	4/19/16-10/18/16	**WEL-08- 0029**	10	30%	0%	NA	172.5	*NA
	INW0886_T1012	4/20/16-10/19/16	**WEL-08-0026**	10	20%	10%	28.07	325.5	NA
	INW0886_T1009	4/20/16-10/19/16	**WEL-08-0025**	10	80%	70%	904.54	613.1	86.18%

Subwatershed	Final AUID	Period of Record	Station #	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	**235**			
Goose Creek	**INW0887_04**	11/16/15-10/19/16	**WEL-08-0033**	15	13%	0%	70.66	178.5	NA
	INW0887_03	11/16/15-10/18/16	**WEL090-0003**	15	40%	27%	209.67	517.2	40.38%
	INW0887_T1007	4/20/16-10/19/16	**WEL-08-0031**	10	50%	30%	329.04	5,475	62.01%

Notes: Red = listed as impaired, Green = not listed as impaired, Blue = sample minimum not met for assessment. *Insufficient data to calculate geometric mean due to power outage during sample processing. Assessments were based on secondary methods as outlined in IDEM's 2016 Consolidated Assessment and Listing Methodology (CALM).

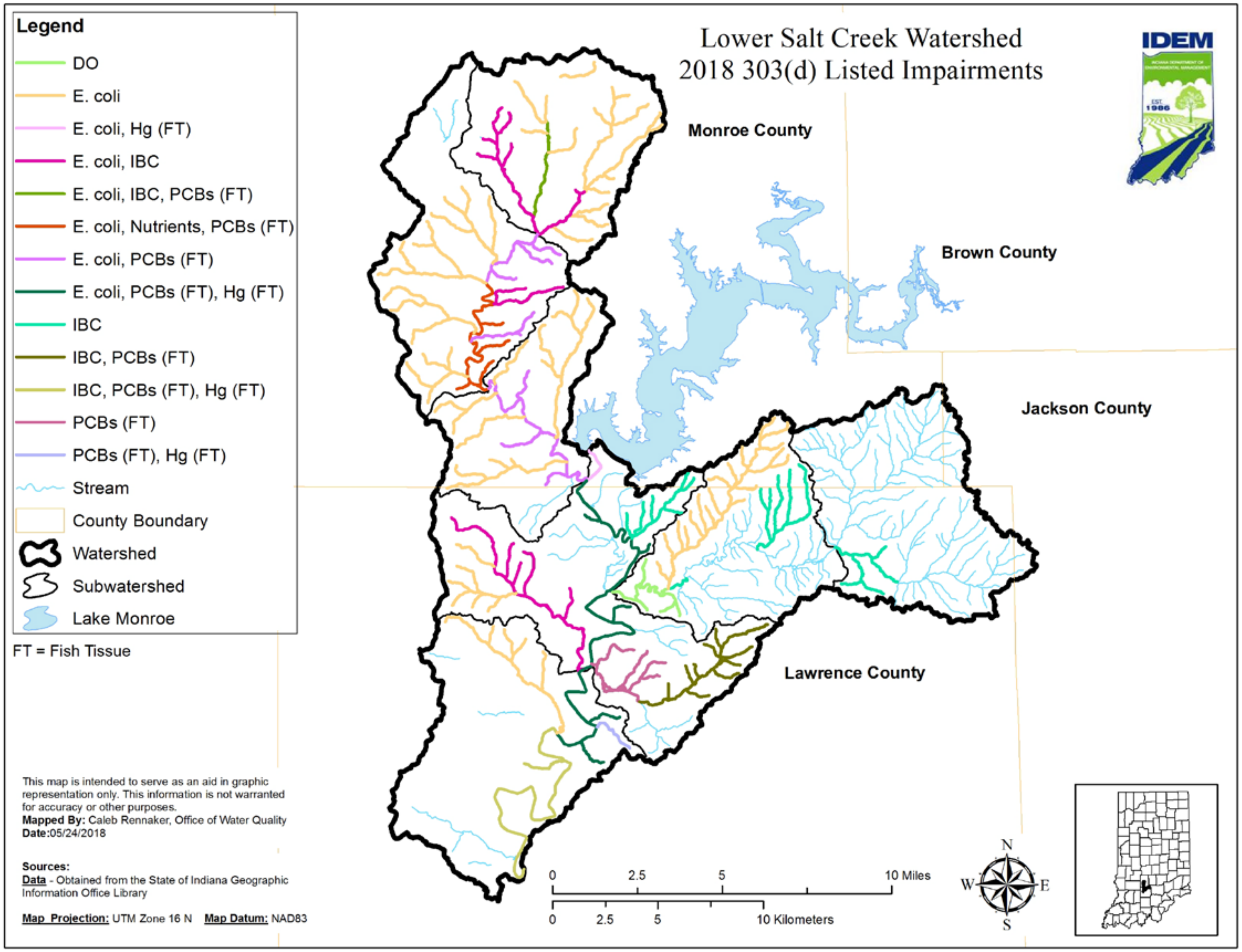


Figure 6: Streams Listed on the Draft 2018 Section 303(d) List in the Lower Salt Creek Watershed

3.0 DESCRIPTION OF THE WATERSHED AND SOURCE ASSESSMENT

This section of the TMDL report contains a brief characterization of the Lower Salt Creek 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* impairments. 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.

As discussed in Section 2.3, the Lower Salt Creek watershed contains seven 12-digit HUC subwatersheds. Examining subwatersheds enables a closer examination of key factors that affect water quality. The subwatersheds include (Figure 2):

- Jackson Creek – 051202080801
- May Creek – 051202080802
- Little Clear Creek – 051202080803
- Hunter Creek – 051202080804
- Knob Creek – 051202080805
- Wolf Creek – 051202080806
- Goose Creek - 051202080807

Table 5 contains the names of the seven subwatersheds of the Lower Salt Creek watershed and their associated drainage area.

Table 5: Lower Salt Creek Subwatershed Drainage Areas

Subwatershed	12-digit HUC	Drainage Area (sq mi)	Percent of Total Drainage Area
Jackson Creek	051202080801	25	4%
May Creek	051202080802	55	9%
Little Clear Creek	051202080803	76	12%
Hunter Creek	051202080804	30	5%
Knob Creek	051202080805	54	8%
Wolf Creek	051202080806	601	94%
Goose Creek	051202080807	636	100%

Understanding Table 5: Land area helps IDEM to define the pollutant load reductions needed for each AU in each 12-digit HUC subwatershed that comprises the Lower Salt Creek watershed. Information in each column is as follows:

- *Column 1: Name of Subwatershed.* Lists the name of the subwatersheds.
- *Column 2: 12-digit HUC.* Identifies the subwatershed's 12-digit HUC.
- *Column 3: Drainage Area.* Quantifies the area that the specific HUC 12 drains.
- *Column 4: Percent of Total Drainage Area.* Indicates the percent of the total drainage area of the Lower Salt Creek watershed. This provides a relative understanding of the drainage of each HUC 12 within the overall Lower Salt Creek watershed.

IDEM bases percent load reductions on the drainage area for each AUID in the 12-digit HUC subwatersheds. The information contained in Table 5 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 Salt Creek 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.

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: confined feeding operations (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 National Pollutant Discharge Elimination System (NPDES).

Nonpoint sources include all other categories not classified as point sources. In urban areas, nonpoint sources can include leaking or faulty septic systems, runoff from lawn fertilizer applications, 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 and inputs from streambank erosion, leaking or failing septic systems, and wildlife.

3.1 Land Use

Land use patterns provide important clues to the potential sources of impairments in a watershed. Land use information for the Lower Salt Creek watershed is available from the National Agricultural Statistics Service (NASS) cropland data layer. These data categorize the land use for each 30 meters by 30 meters parcel of land in the watershed based on satellite imagery from circa 2016. Figure 7 displays the spatial distribution of the land uses and the data are summarized in Table 6. Additionally, Table 7 displays the breakdown of land uses within each of the seven subwatersheds.

Land use in the Lower Salt Creek watershed is primarily forested, comprising 56 percent of the watershed. Approximately 23 percent of the land is hay and/or pasture and seven percent is agricultural. Pasture/hay may indicate the presence of animal feedlots that can be significant sources of *E. coli*. Another 14 percent of the watershed is developed lands from urban areas, like Bloomington, which are indicators of high amounts of impervious surfaces. These contribute to surface water runoff and contribute sources of pollutants impacting *E. coli* levels. The remaining land categories represent less than three percent of the total land area.

The Lower Salt Creek watershed has a diverse network of streams. Tributaries include Clear Creek, May Creek, Clifty Branch, Goose Creek, Pleasant Run, and Hunter Creek among others. The most northern portions of the watershed include the city of Bloomington, which accounts for the majority of all developed areas. Forested areas dominate both south of the city of Bloomington and on the western portions of the watershed, but slowly change to more hay and pasture dominated areas towards the Southwest regions. Many threatened and endangered species call this watershed home. Various species of mussels such as Wavyrayed Lampmussel (*Lampsilis fasciola*) and Round Hickorynut (*Obovaria subrotunda*) can be found in the watershed and surrounding counties and are dependent upon the health of the aquatic system. Additional information on state endangered, threatened and rare species can be found on the DNR website (http://www.in.gov/dnr/naturepreserve/4666.htm).

Table 6: Summary of Land Use of Lower Salt Creek Watershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Agricultural Lands	9,163.77	14.32	7.04%
Shrubland	78.95	0.12	0.06%
Forest Land	73,573.04	114.96	56.48%
Developed Land	17,697.28	27.65	13.59%
Wetlands	6.00	0.01	0.00%
Open Water	233.74	0.37	0.18%
Hay/Pasture Land	29,503.99	46.10	22.65%
TOTAL	**130,257**	**203.53**	**100%**

Understanding Table 6: 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 pollutants 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 differences in hydrology, land use types are associated with different types of activities that could contribute to dissolved oxygen impairments and impaired biotic communities within the watershed. Understanding different types of land uses will help identify the type of implementation approaches that watershed stakeholders can use to achieve *E. coli* reductions.

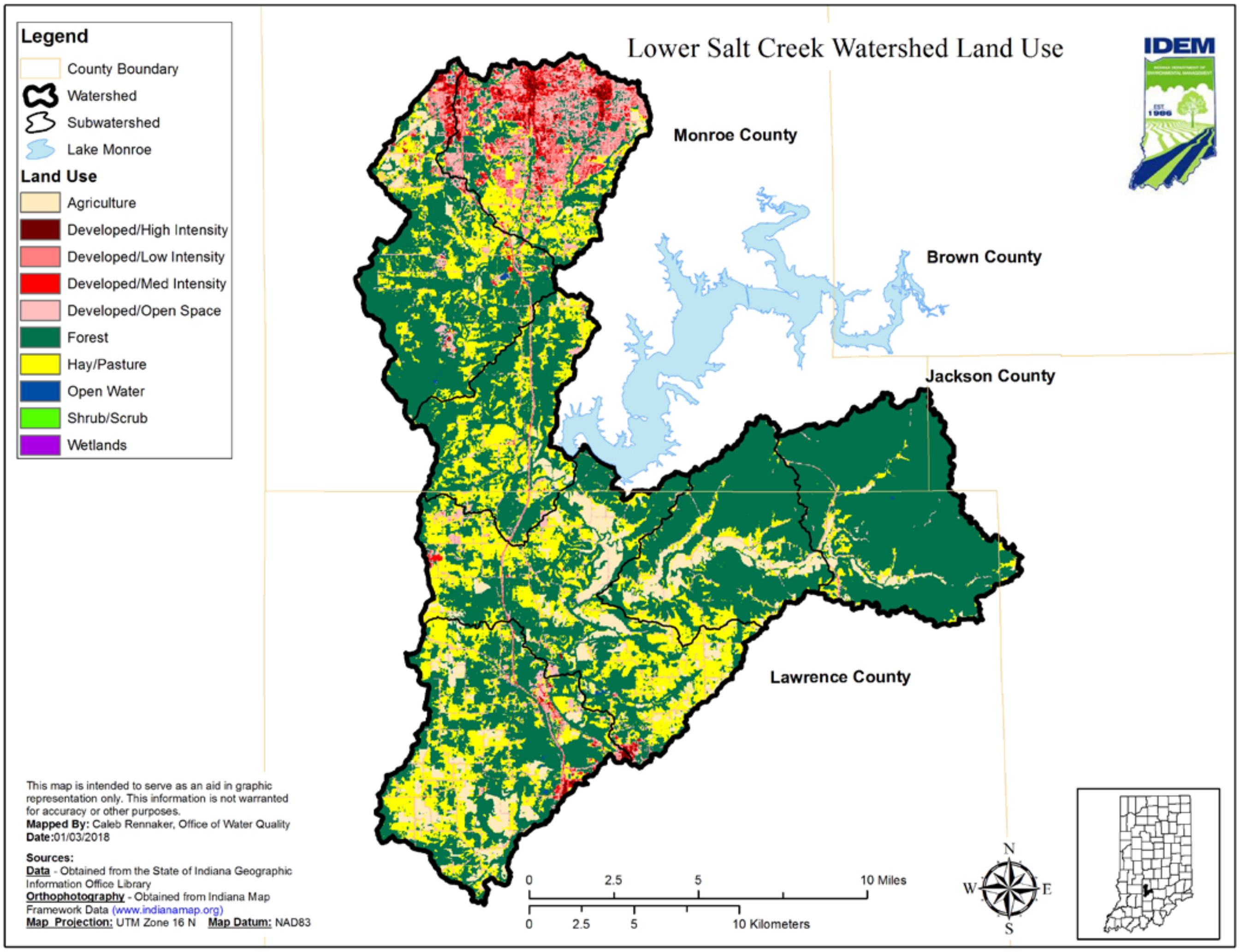


Figure 7: Land Use in the Lower Salt Creek Watershed

Table 7: Land Use in the Lower Salt Creek Subwatersheds

Subwatershed	Area	Land Use							Total
		Agriculture	Developed	Forest	Hay/ Pasture	Shrub/ Scrub	Open Water	Wetlands	
Jackson Creek (051202080801)	Acres	258.87	9,108.84	3,864.11	2,801.06	11.34	25.35	0.22	16,069.81
	Sq. Mi.	0.40	14.23	6.03	4.38	0.02	0.04	0.00	25.12
	Percent	**1.61%**	**56.68%**	**24.05%**	**17.43%**	**0.07%**	**0.16%**	**0.00%**	**100%**
May Creek (051202080802)	Acres	725.67	2,440.56	11,834.74	4,112.53	14.01	58.71	2.00	19,188.23
	Sq. Mi.	1.13	3.81	18.49	6.43	0.02	0.09	0.003	29.98
	Percent	**3.78%**	**12.72%**	**61.68%**	**21.43%**	**0.07%**	**0.31%**	**0.01%**	**100%**
Little Clear Creek (051202080803)	Acres	432.78	862.67	7,595.67	4,350.71	20.24	8.67	0	13,270.75
	Sq. Mi.	0.68	1.35	11.87	6.80	0.03	0.01	0	20.74
	Percent	**3.26%**	**6.50%**	**57.24%**	**32.78%**	**0.15%**	**0.07%**	**0.00%**	**100%**
Hunter Creek (051202080804)	Acres	614.03	433.67	17,067.92	865.12	2.89	7.56	0	18,997.19
	Sq. Mi.	0.96	0.68	26.67	1.35	0.00	0.01	0	29.67
	Percent	**3.23%**	**2.28%**	**89.87%**	**4.56%**	**0.02%**	**0.04%**	**0.00%**	**100%**
Knob Creek (051202080805)	Acres	1,735.12	472.14	11,052.13	2,158.79	4.45	5.56	0.44	15,428.64
	Sq. Mi.	2.71	0.74	17.27	3.73	0.01	0.01	0.00	24.12
	Percent	**11.25%**	**3.06%**	**71.63%**	**13.99%**	**0.03%**	**0.04%**	**0.00%**	**100%**
Wolf Creek (051202080806)	Acres	29,21.60	20,30.91	11,504.04	8,704.53	10.45	50.71	0.67	25,222.91
	Sq. Mi.	4.57	3.17	17.98	13.60	0.02	0.08	0.00	39.41
	Percent	**11.58%**	**8.05%**	**45.61%**	**34.51%**	**0.04%**	**0.20%**	**0.00%**	**100%**
Goose Creek (051202080807)	Acres	2,475.92	2,348.49	10,654.49	6,511.72	15.57	77.17	2.67	22,086.03
	Sq. Mi.	3.87	3.67	16.65	10.17	0.02	0.12	0.00	34.51
	Percent	**11.21%**	**10.63%**	**48.24%**	**29.48%**	**0.07%**	**0.35%**	**0.01%**	**100%**

3.1.1 Cropland

Croplands can be a source of *E. coli*. Accumulation of *E. coli* on cropland occurs from the application of manure fertilizers, wildlife excreta, irrigation water, and the application of waste products from municipal and industrial wastewater treatment facilities. Use of manure for nitrogen supplementation often results in excessive phosphorus loads relative to crop requirements (U.S. EPA, 2003).

Crop data was obtained from the U.S. Department of Agriculture's National Agricultural Statistic Service (NASS). The 2016 Cropland Data Layer (CDL) was used in the analysis to derive total acreage, as shown in Table 8 below. Figure 8 displays this information spatially.

Table 8: Major Cash Crop Acreage in the Lower Salt Creek watershed

Subwatershed	Crop	Total Acreage	% of Subwatershed Cash Crop Acreage
Jackson Creek	Corn	112.97	43.75%
	Soybean	145.22	56.25%
	Winter Wheat	0.00	0.00%
	Total	**258.19**	**100%**
May Creek	Corn	321.13	45.18%
	Soybean	373.17	52.50%
	Winter Wheat	16.45	2.32%
	Total	**710.75**	**100%**
Little Clear Creek	Corn	217.27	50.28%
	Soybean	213.27	49.36%
	Winter Wheat	1.55	0.36%
	Total	**432.09**	**100%**
Hunter Creek	Corn	152.56	24.88%
	Soybean	460.13	75.04%
	Winter Wheat	0.44	0.08%
	Total	**613.13**	**100%**
Knob Creek	Corn	638.94	36.83%
	Soybean	1095.96	63.17%
	Winter Wheat	0.00	0.00%
	Total	**1734.9**	**100%**
Wolf Creek	Corn	1074.83	36.93%
	Soybean	1817.85	62.46%
	Winter Wheat	17.56	0.61%
	Total	**2910.24**	**100%**
Goose Creek	Corn	1274.32	53.12%
	Soybean	1122.64	46.80%
	Winter Wheat	2.00	0.08%
	Total	**2398.96**	**100%**

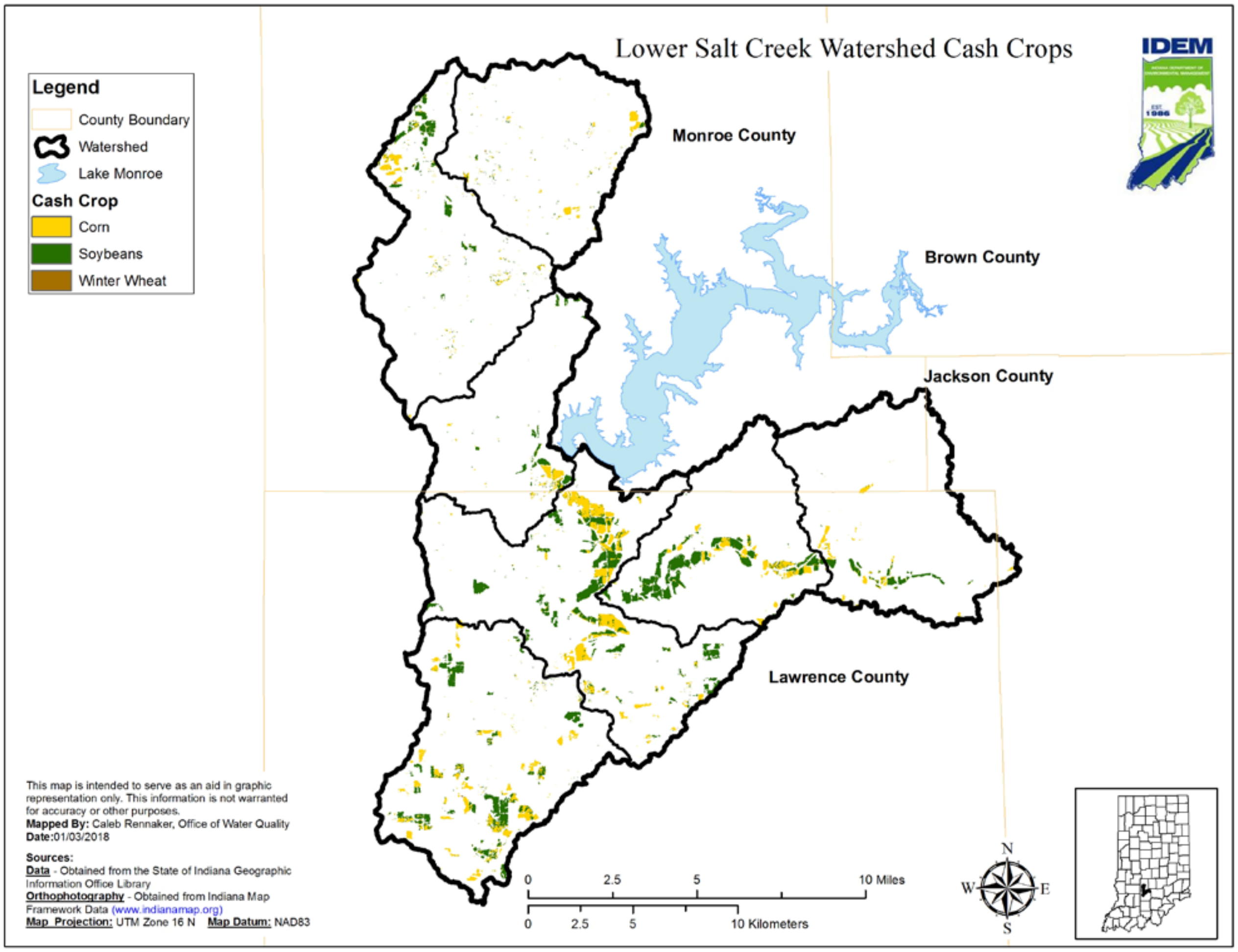


Figure 8: Cash Crop Acreage in the Lower Salt Creek Watershed

3.1.2 Pastureland

Runoff from pastures and livestock operations can be potential agricultural sources of pollutants. 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 NASS were downloaded and area weighted to estimate animal population in the subwatersheds. The area of the county within the subwatersheds is divided by the area of the entire county and multiplied by the total number of animals in the county based on the 2012 (*2007) NASS survey. This is done for each county in the subwatersheds and summed to get an area-weighted estimate of animals within the subwatersheds. There are an estimated 5,833 animal units in the Lower Salt Creek watershed, with the animal unit density being 28.7 animal units per square mile, as shown in Table 9. Figure 9 displays the location of the pastureland in the watershed.

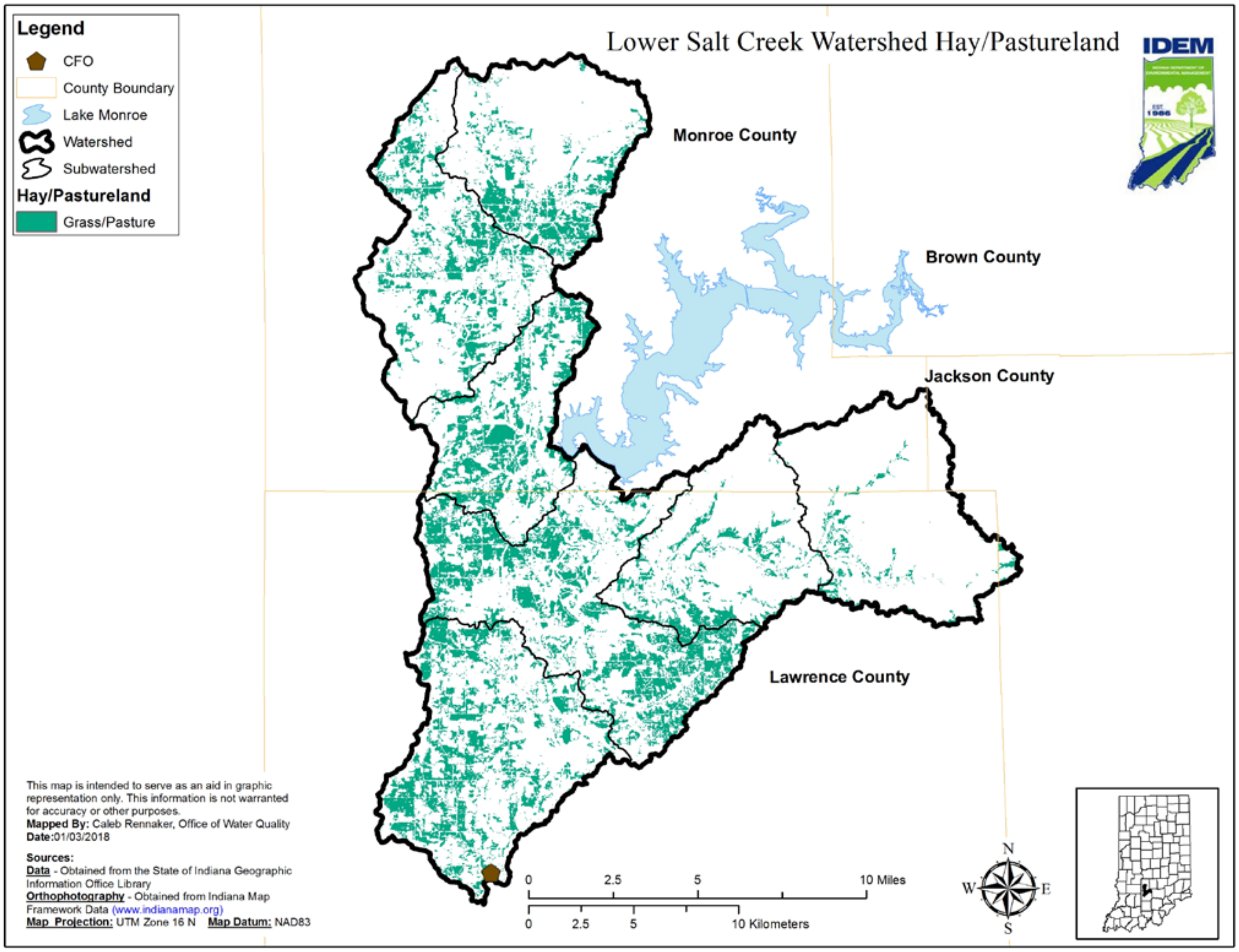


Figure 9: Hay/Pastureland in the Lower Salt Creek Watershed

Table 9: Animal Unit Density in the Lower Salt Creek Subwatersheds

Total Number of Animal Units in Subwatersheds							
	Jackson Creek	May Creek	Little Clear Creek	Hunter Creek	Knob Creek	Wolf Creek	Goose Creek
Hogs and Pigs	5	7	4	74	2	3	2
Cattle and Calves	321	383	320	732	684	1212	1090
Sheep and Goats	1	1	1	2	1	2	2
Horses and Ponies	137	163	110	137	110	175	152
Total	**464**	**554**	**435**	**945**	**797**	**1392**	**1246**
Animal Unit Density (animal units/mi²)	**18.48**	**18.48**	**20.97**	**31.82**	**33.07**	**35.31**	**36.08**

3.1.3 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
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over 50 percent of the lot or facility.
- The number of animals present meets the requirements for the state permitting action.

Confined feeding operations that are not classified as concentrated animal feeding operations (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 U.S. EPA. 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 CAFOs and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012. It should be noted that there are currently zero facilities in Indiana that have an NPDES permit under 15-16.

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 can also be a potential source of *E. coli* due to the following:

- 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 Lower Salt Creek watershed as shown below in Table 10 and in Figure 9 above.

Table 10: CFOs in the Lower Salt Creek Watershed

Subwatershed	CFO Permit ID	Operation Name	County	Animal Type and Permitted number
Goose Creek	6508	Kyle Hall Farm	Lawrence	Turkeys: 68,000

3.2 Topography and Geology

Topographic and geologic features of a watershed play a role in defining a watershed's drainage pattern. Figure 10 below displays the topography of the watershed. Information concerning the topography and geology within the Lower Salt Creek watershed is available from the Indiana Geologic Survey (IGS). The Lower Salt Creek watershed originates in Brown County, Monroe County, and Jackson County and flows southwest through Lawrence County, eventually discharging into the East Fork of the White River. The Lower Salt Creek watershed is located in The Sanders Group, which consists of a variety of carbonate rocks in complex facies relationships.

The entire bedrock surface of Indiana consists of sedimentary rocks. The major kinds of sedimentary rock in Indiana include limestone, dolomite, shale, sandstone, and siltstone. The northern two-thirds of Indiana are composed of glacial deposits containing groundwater. These glacial aquifers exist where sand and gravel bodies are present within clay-rich glacial till (sediment deposited by ice) or in alluvial, coastal, and glacial outwash deposits. Groundwater availability is much different in the southern unglaciated part of Indiana. There are few unconsolidated deposits above the bedrock surface, and the voids in bedrock (other than karst dissolution features) are seldom sufficiently interconnected to yield useful amounts of groundwater. Reservoirs, such as Monroe Lake and Patoka Lake, are used for water supply in lieu of water wells in southern Indiana. Therefore, surface water quality is even more important in these systems because water is treated directly from reservoirs for drinking use. The IGS website contains further information about the geology of Indiana (http://igs.indiana.edu/Groundwater/)

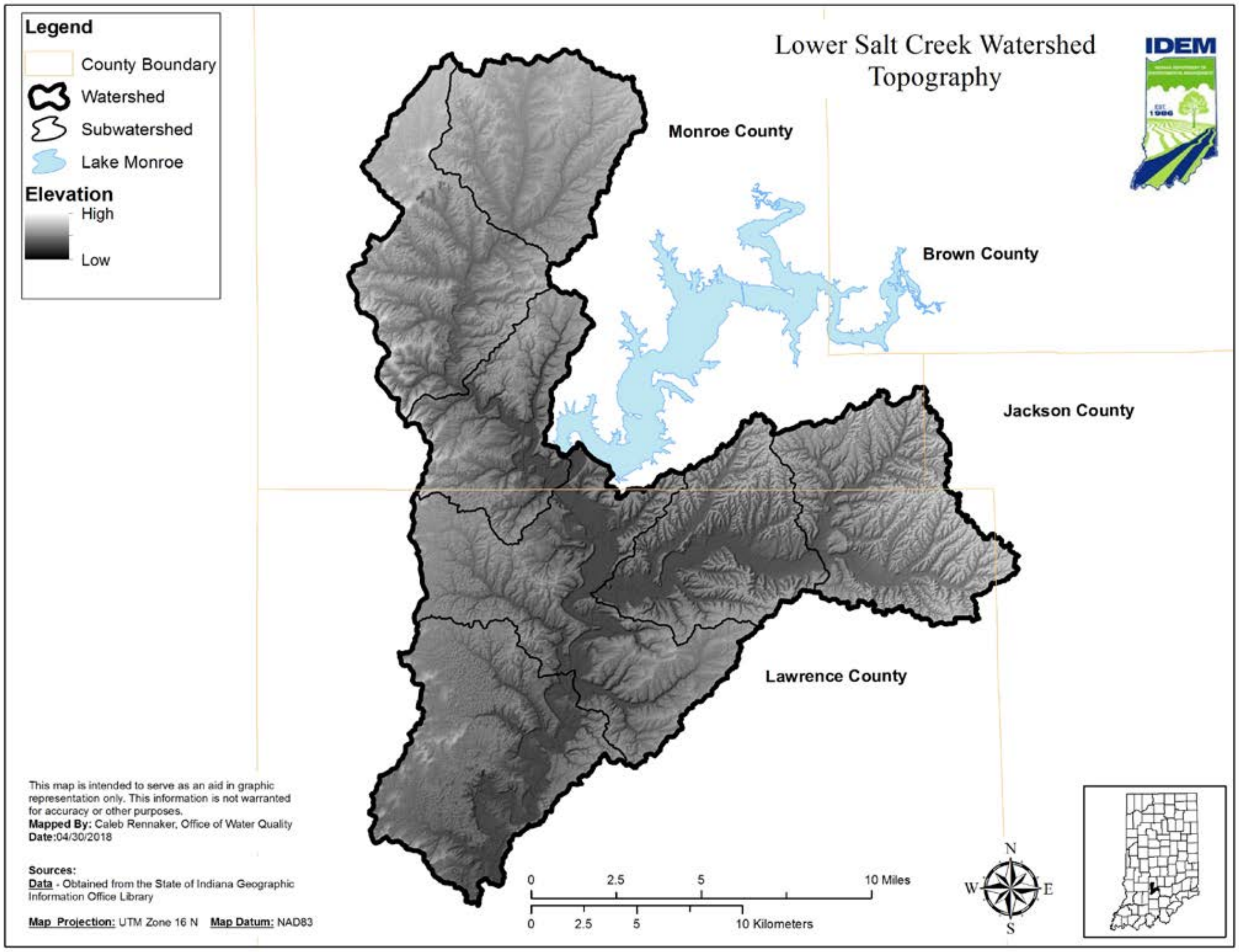


Figure 10: Topography of the Lower Salt Creek Watershed
National Elevation Data (NED) is available from the USGS National Map seamless server (http://seamless.usgs.gov/website/seamless/viewer.htm).

3.2.1 Karst Geology

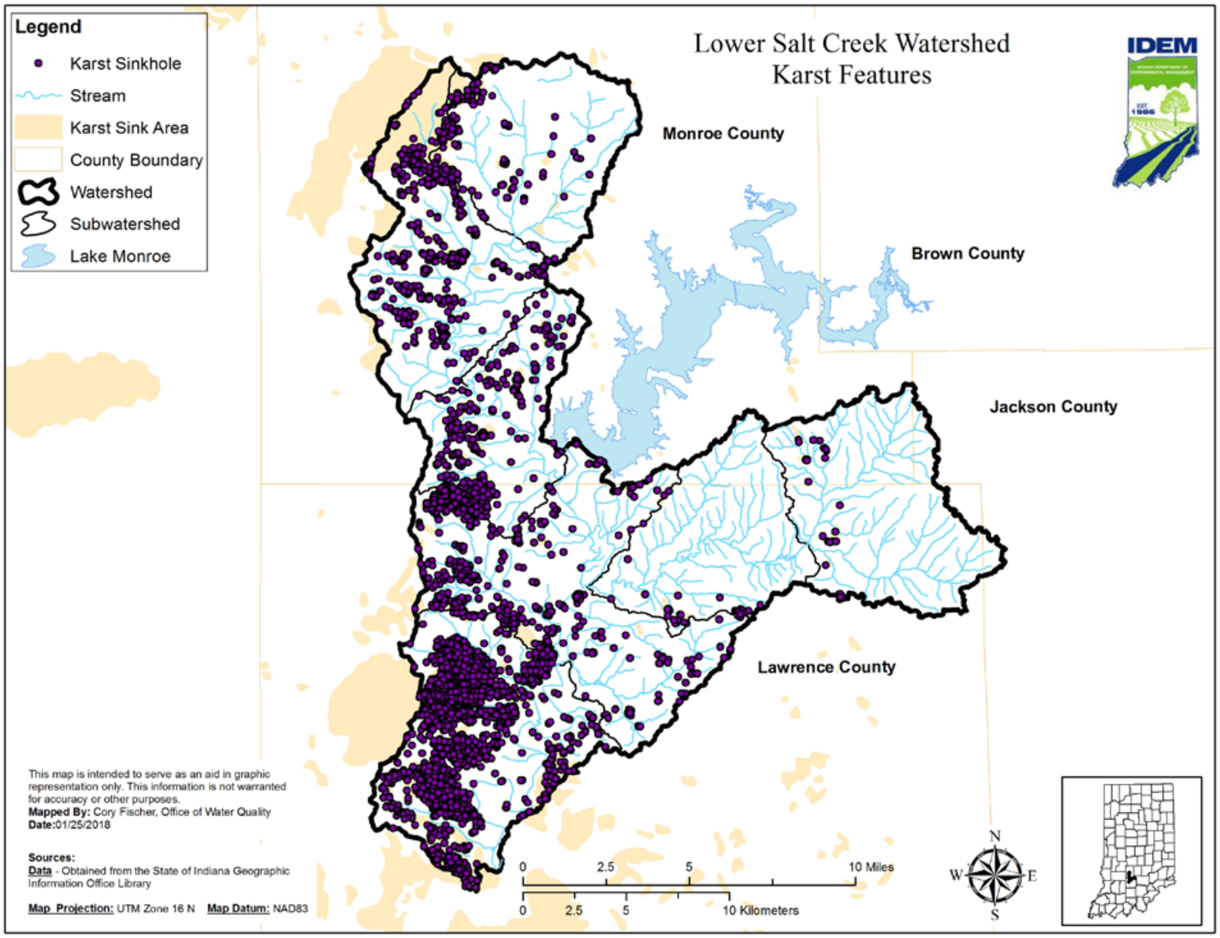


Figure 11: Karst Features in the Lower Salt Creek Watershed

Karst regions are characterized by the presence of limestone or other soluble rocks, where drainage has been largely diverted into subsurface routes. The topography of such areas is dominated by sinkholes, sinking streams, large springs, and caves. Many subsurface drainage networks in this area are fed by surface streams that sink into caves or swallow holes. Activities that impact the surface water quality can thus be expected to affect ground water as well. Due to the nature of conduit flow, impacts are likely to be ephemeral, and determination of exact directions of transport or affected conduits may be problematic in the absence of detailed dye-tracing studies. While the State of Indiana has performed dye-tracing studies in southern Indiana, none have been performed within the Lower Salt Creek Watershed (Atlas of hydrogeologic terrains and settings of Indiana, 1995). Figure 11, above, displays the location of the karst features of the watershed.

The Indiana Karst Conservancy is a 501(c)(3) non-profit organization dedicated to the preservation and conservation of Indiana's unique karst features. Unfortunately, many karst features are subject to incompatible or damaging uses. Most are on private land, occasionally with owners unware of their significance or apathetic to their preservation. The IKC provides protection and awareness of karst features and the unique habitat they provide. For more information regarding the IKC, visit their website at http://www.ikc.caves.org/.

3.3 Soils

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

3.3.1 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 11 (NRCS, 2001). Data for the Lower Salt Creek watershed were obtained from the USDA Soil Survey Geographic (SSURGO) database. Downloaded data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed below in Figure 12 and Table 12.

The majority of the watershed is covered by category B soils (48%) followed by category C soils (43%), category D soils (6%), and category A soils (3%). Category B soils are moderately deep and well drained, while Category C soils are finer and allow for slower infiltration. This means that regular flooding is likely not typical in much of this watershed, but could potentially occur on occasion and transport pollutants across the landscape.

Table 11: Summary of Hydrologic Soil Groups

Hydrologic Soils Group	Percentage of Watershed	Description
A	3%	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little runoff.
B	48%	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	43%	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	6 %	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

Understanding Table 11: 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 pollutant transport and in-stream loading within a watershed. During high flows, areas with low soil infiltration capacity can flood and therefore discharge high pollutant loads to nearby waterways. In contrast, soils with high infiltration rates can slow the movement of pollutants to streams.

Table 12: Hydrologic Soil Groups in the Lower Salt Creek Subwatersheds

Subwatershed	Hydrologic Soil Group			
	A	B	C	D
Jackson Creek	0%	81.7%	11.4%	6.9%
May Creek	0%	52.2%	34.0%	13.8%
Little Clear Creek	0%	59.5%	31.1%	9.4%
Hunter Creek	0%	31.4%	66.3%	2.3%
Knob Creek	0%	30.6%	64.3%	5.1%
Wolf Creek	0%	47.3%	48.5%	4.2%
Goose Creek	0.1%	52.5%	47.2%	0.2%

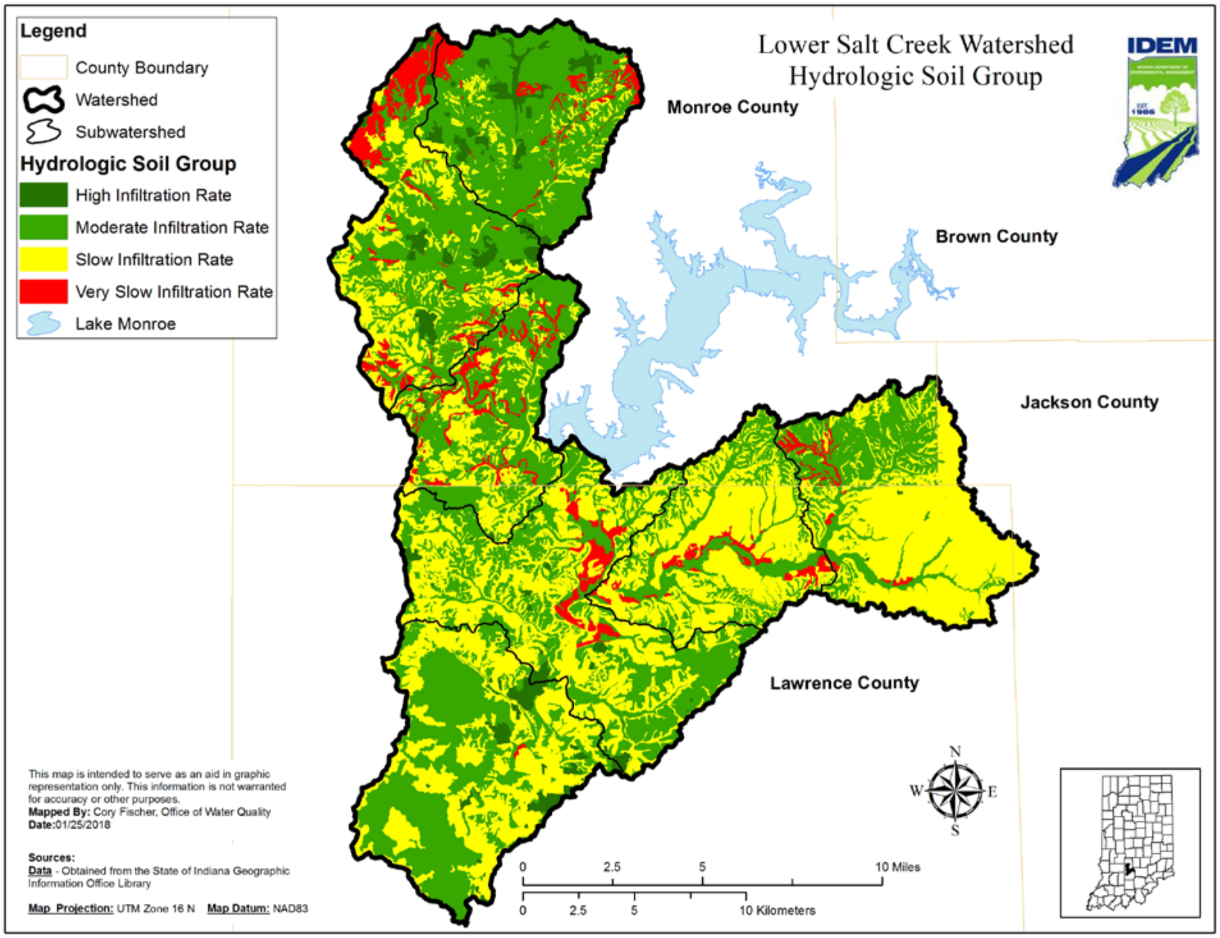


Figure 12: Hydrologic Soil Groups in the Lower Salt Creek Watershed

3.3.2 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 13 shows ratings that indicate the extent to which the soils are suitable for septic systems within the Lower Salt Creek 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 67 percent of the Lower Salt Creek watershed is considered “very limited” in terms of soil suitability for septic systems. These limitations generally cannot be overcome without major soil reclamation or expensive installation designs. Approximately less than five percent of the soils within the Lower Salt Creek 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. Approximately 28 percent of the soils in the Lower Salt Creek watershed are designated “somewhat limited,” meaning that the soil type is suitable for septic systems.

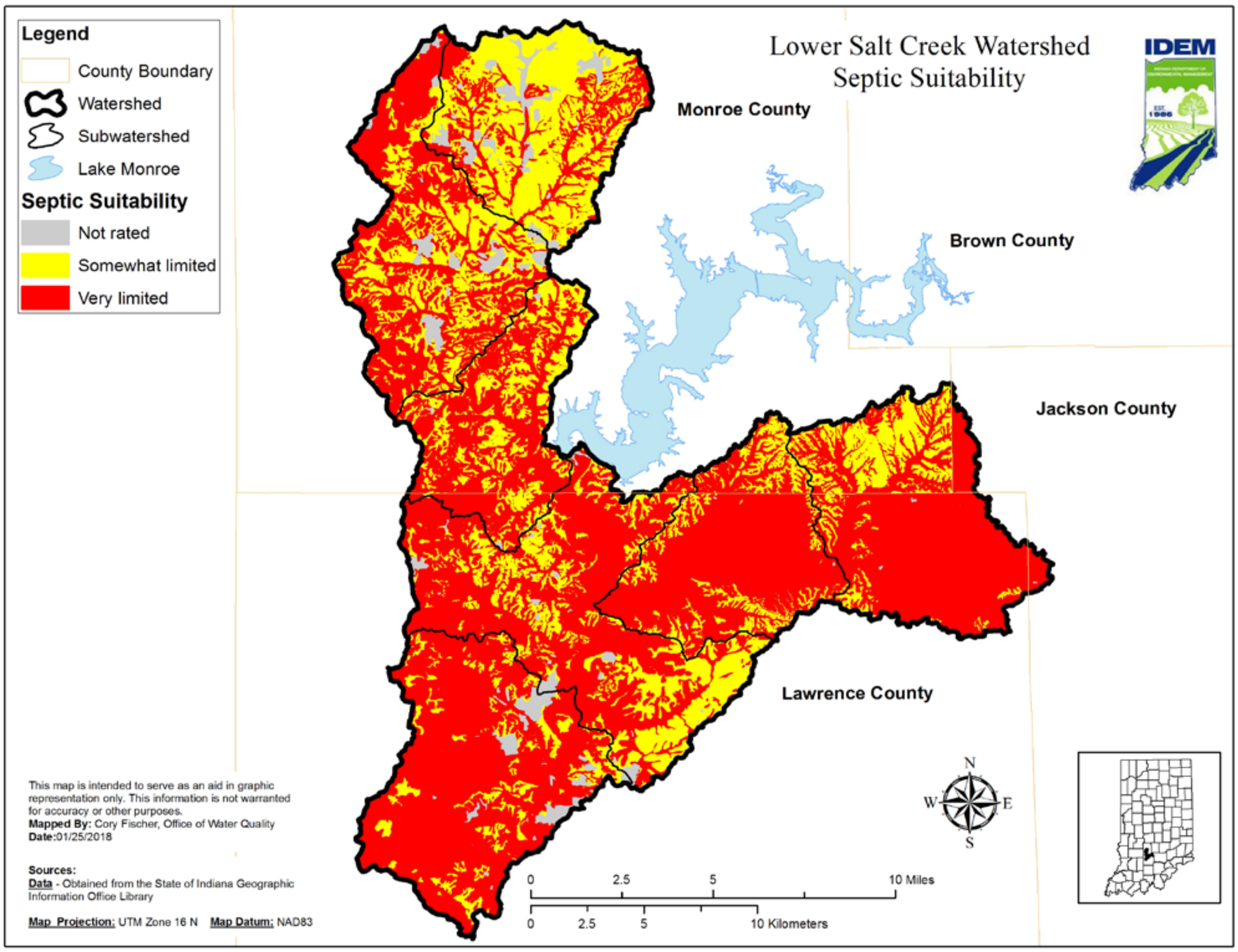


Figure 13: Suitability of Soils for Septic Systems in the Lower Salt Creek Watershed

Onsite Wastewater Treatment Systems
Onsite wastewater treatment systems (i.e., 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 high 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 and nutrients.

The Indiana State Department of Health (ISDH) regulates the residential onsite sewage disposal program (410 IAC 6-8.3) through the local health departments. Onsite sewage disposal systems (i.e., septic systems) are those which do not result in an off-lot discharge of treated effluent and typically consist of a septic tank to settle out and digest sewage solids, followed by a system of perforated piping to distribute the treated wastewater for absorption into the soil. More than 800,000 onsite sewage disposal systems are currently used in Indiana. Local health departments issue more than 15,000 permits per year for new systems, and about 6,000 permits for repairs.

410 IAC 6-8.3-52 General sewage disposal requirements
Sec. 52. (a) No person shall throw, run, drain, seep, or otherwise dispose into any of the surface waters or ground waters of this state, or cause, permit, or suffer to be thrown, run, drained, allowed to seep, or otherwise disposed into such waters, any organic or inorganic matter from a dwelling or residential onsite sewage system that would cause or contribute to a health hazard or water pollution.
(b) The: (1) design; (2) construction; (3) installation; (4) location; (5) maintenance; and (6) operation; of residential onsite sewage systems shall comply with the provisions of this rule.

410 IAC 6-8.3-55 Violations; permit denial and revocation
Sec. 55. (a) Should a residential onsite sewage system fail, the failure shall be corrected by the owner within the time limit set by the health officer. (b) If any component of a residential onsite sewage system is found to be: (1) defective; (2) malfunctioning; or (3) in need of service; the health officer may require the repair, replacement, or service of that component. The repair, replacement, or service shall be conducted within the time limit set by the health officer. (c) Any person found to be violating this rule may be served by the health officer with a written order stating the nature of the violation and providing a time limit for satisfactory correction thereof.

A comprehensive database of septic systems within the Lower Salt Creek watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The U.S. Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population was estimated using the 2010 U.S. Census Data. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural household density. An additional estimate of septic systems can be made using the 1990 U.S. Census, as that is the last Census that inventoried how household wastewater is disposed. The rural households in the Lower Salt Creek subwatersheds are shown below in Table 13, along with a calculated density (total rural households divided by total area). The rural household density can be used to compare the different subwatersheds within the Lower Salt Creek watershed.

It should also be noted that hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. Group C and D soils have slow infiltration rates with finer textures and slow water movement. Table 12 illustrates the hydrologic soil groups for the Lower Salt Creek subwatersheds.

Table 13: Rural Household Density in the Lower Salt Creek Subwatersheds

Subwatershed	County	Area of County in Subwatershed (mi^2)	County Households in Subwatershed	Urban Households	Rural Households	Rural Household Density (Houses/mi^2)	Urban Household Density (Houses/mi^2)
Jackson Creek	Monroe	25.11	29,453	22,085	7,368	**293.4**	**879.5**
	Total	**25.11**	**29,453**	**22,085**	**7,368**		
May Creek	Monroe	29.98	3,903	973	2,930	**97.7**	**32.5**
	Total	**29.98**	**3,903**	**973**	**2,930**		
Little Clear Creek	Monroe	17.81	993	0	993	**60.9**	**0.0**
	Lawrence	2.93	270	0	270		
	Total	**20.74**	**1,263**	**0**	**1,263**		
Hunter Creek	Monroe	9.79	25	0	25	**5.0**	**0.0**
	Lawrence	17.87	120	0	120		
	Jackson	2.00	29	0	29		
	Total	**29.66**	**149**	**0**	**149**		
Knob Creek	Monroe	4.17	53	0	53	**16.5**	**0.0**
	Lawrence	19.94	345	0	345		
	Total	**24.11**	**398**	**0**	**398**		
Wolf Creek	Monroe	1.72	69	0	69	**46.8**	**6.2**
	Lawrence	37.7	2,019	0	2,019		
	Total	**39.42**	**2,088**	**244**	**1,844**		
Goose Creek	Lawrence	34.5	2,647	956	1,691	**49.0**	**27.7**
	Total	**34.5**	**2,647**	**956**	**1,691**		

3.3.3 Soil Saturation 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 Salt Creek watershed and are important in consideration of wetland restoration activities. Approximately 14,470 acres, or 11 percent of the Lower Salt Creek watershed area, contains soils that are considered hydric, as shown below in Table 14. 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 14, 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. Additional information on wetlands can be found on the IDEM website (http://www.in.gov/idem/wetlands/).

Table 14: Hydric Soils by Subwatershed in the Lower Salt Creek Watershed

Subwatershed	Map Symbol	Hydric Soil Type	Acres
Jackson Creek	Ba	Bartle silt loam	17.52
	Hd	Haymond silt loam, frequently flooded	1,116.79
	IvA	Iva silt loam, 0 to 3 percent slopes	93.77
	PeB	Pekin silt loam, 2 to 6 percent slopes	7.38
	Wa	Wakeland silt loam, frequently flooded	291.61
	Wr	Wilbur silt loam, frequently flooded	15.02
		Total:	**152.09**
May Creek	Ba	Bartle silt loam	40.48
	Hd	Haymond silt loam, frequently flooded	1,785.67
	IvA	Iva silt loam, 0 to 3 percent slopes	158.88
	PeA	Pekin silt loam, 0 to 2 percent slopes	38.94
	PeB	Pekin silt loam, 2 to 6 percent slopes	20.12
	Po	Peoga silt loam	5.14
	St	Stendal silt loam, frequently flooded	108.09
	Wa	Wakeland silt loam, frequently flooded	57.45
	Wr	Wilbur silt loam, frequently flooded	0.51
		Total	**2,215.28**
Little Clear Creek	Ba	Bartle silt loam	46.52
	Bo	Bonnie silt loam, frequently flooded	7.65
	BodAH	Bonnie silt loam, 0 to 1 percent slopes, frequently flooded, brief duration	148.07
	CspB	Crider silt loam, 2 to 6 percent slopes	79.16
	Hd	Haymond silt loam, frequently flooded	1,010.01
	MwhA	Muren silt loam, 1 to 3 percent slopes	11.38
	PeA	Pekin silt loam, 0 to 2 percent slopes	8.34
	Po	Peoga silt loam	20.18
	Wa	Wakeland silt loam, frequently flooded	20.57
	WokAH	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded, brief duration	38.27
	Wr	Wilbur silt loam, frequently flooded	49.74
		Total	**1439.87**
Hunter Creek	BbhAQ	Bartle silt loam, 0 to 2 percent slopes, rarely flooded	337.15
	CspB	Crider silt loam, 2 to 6 percent slopes	13.70
	Hd	Haymond silt loam, frequently flooded	87.47
	MikAH	McGary silty clay loam, 0 to 2 percent slopes, frequently flooded, brief duration	15.08
	MwhA	Muren silt loam, 1 to 3 percent slopes	23.42
	PeA	Pekin silt loam, 0 to 2 percent slopes	5.07
	PeB	Pekin silt loam, 2 to 6 percent slopes	12.68
	StwAH	Stendal silt loam, clayey substratum, 0 to 2 percent slopes, frequently flooded, brief duration	201.69
	SvgA	Stoy silt loam, 0 to 2 percent slopes	76.68

Subwatershed	Map Symbol	Hydric Soil Type	Acres
	WokAH	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded, brief duration	6.04
		Total	**779.00**
Knob Creek	BbhAQ	Bartle silt loam, 0 to 2 percent slopes, rarely flooded	264.63
	BodAH	Bonnie silt loam, 0 to 1 percent slopes, frequently flooded, brief duration	110.60
	CspB	Crider silt loam, 2 to 6 percent slopes	328.74
	HnoA	Hoosierville silt loam, 0 to 1 percent slopes	26.60
	MikAH	McGary silty clay loam, 0 to 2 percent slopes, frequently flooded, brief duration	230.59
	MwhA	Muren silt loam, 1 to 3 percent slopes	8.76
	StwAH	Stendal silt loam, clayey substratum, 0 to 2 percent slopes, frequently flooded, brief duration	826.28
	WokAH	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded, brief duration	200.45
		Total	**1,996.64**
Wolf Creek	Ba	Bartle silt loam	25.36
	BbhAQ	Bartle silt loam, 0 to 2 percent slopes, rarely flooded	419.04
	Bo	Bonnie silt loam, frequently flooded	20.35
	BodAH	Bonnie silt loam, 0 to 1 percent slopes, frequently flooded, brief duration	184.06
	CspB	Crider silt loam, 2 to 6 percent slopes	1,194.56
	Hd	Haymond silt loam, frequently flooded	947.73
	HnoA	Hoosierville silt loam, 0 to 1 percent slopes	40.98
	MikAH	McGary silty clay loam, 0 to 2 percent slopes, frequently flooded, brief duration	266.78
	MwhA	Muren silt loam, 1 to 3 percent slopes	422.09
	NprAH	Nolin silt loam, 0 to 2 percent slopes, frequently flooded	91.20
	PeA	Pekin silt loam, 0 to 2 percent slopes	5.51
	PhfA	Peoga silt loam, clayey substratum, 0 to 1 percent slopes	13.53
	St	Stendal silt loam, frequently flooded	36.03
	StwAH	Stendal silt loam, clayey substratum, 0 to 2 percent slopes, frequently flooded, brief duration	1,100.80
	Wa	Wakeland silt loam, frequently flooded	9.83
	WokAH	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded, brief duration	566.20
	Wr	Wilbur silt loam, frequently flooded	53.26
		Total	**5,397.31**
	BbhAQ	Bartle silt loam, 0 to 2 percent slopes, rarely flooded	450.14
	BodAH	Bonnie silt loam, 0 to 1 percent slopes, frequently flooded, brief duration	23.09

Subwatershed	Map Symbol	Hydric Soil Type	Acres
Goose Creek	BuoA	Bromer silt loam, 0 to 2 percent slopes	18.38
	CspB	Crider silt loam, 2 to 6 percent slopes	624.76
	HnoA	Hoosierville silt loam, 0 to 1 percent slopes	9.79
	MikAH	McGary silty clay loam, 0 to 2 percent slopes, frequently flooded, brief duration	708.51
	MwhA	Muren silt loam, 1 to 3 percent slopes	304.38
	NbhAH	Newark silt loam, 0 to 2 percent slopes, frequently flooded	4.00
	PhfA	Peoga silt loam, clayey substratum, 0 to 1 percent slopes	22.03
	PkaAH	Petrolia silty clay loam, 0 to 1 percent slopes, frequently flooded, brief duration	5.14
	StwAH	Stendal silt loam, clayey substratum, 0 to 2 percent slopes, frequently flooded, brief duration	39.29
	WokAH	Wilbur silt loam, 0 to 2 percent slopes, frequently flooded, brief duration	283.22
		Total	**2,492.73**

Understanding Table 14: In the Lower Salt Creek watershed, the Wolf Creek Subwatershed has the most acreage of hydric soils. Areas within this subwatershed might contain opportunities for wetland restoration activities that could help address water quality impairments.

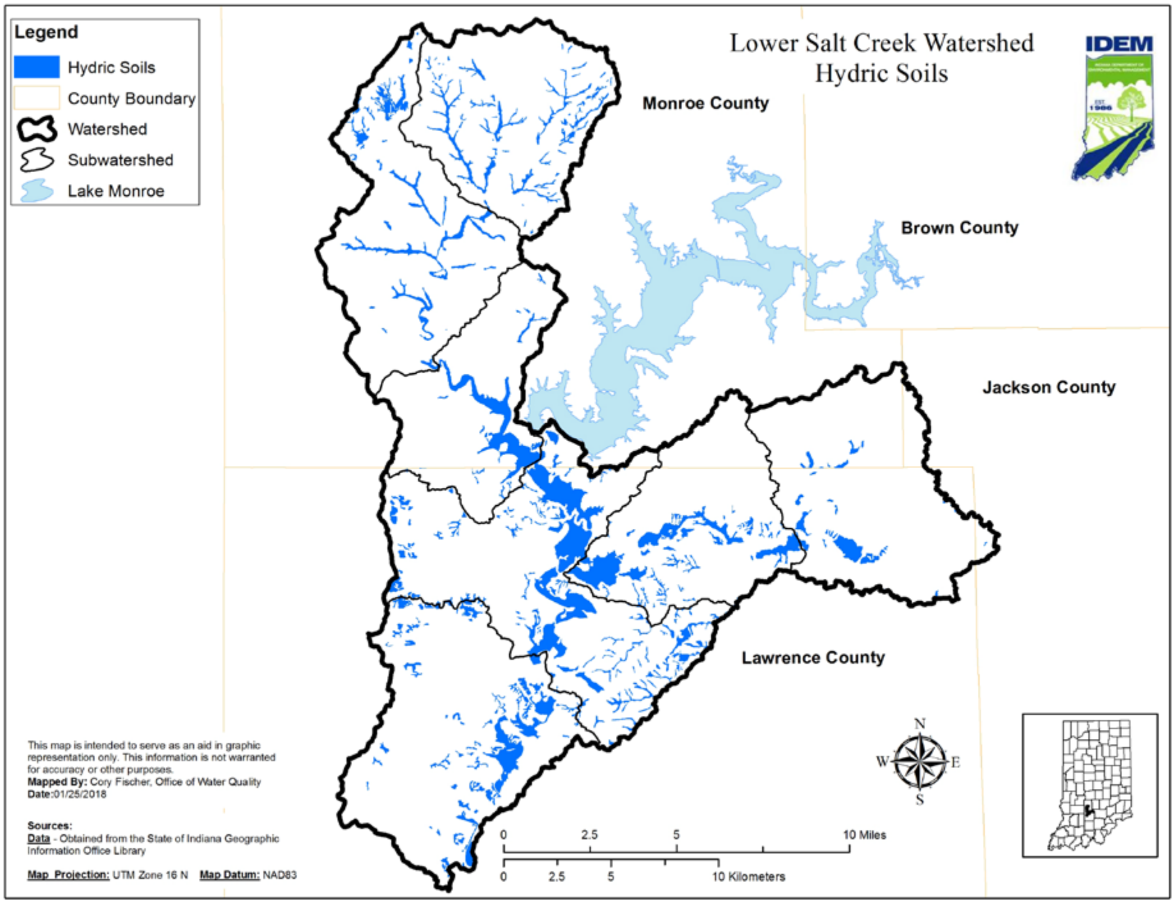


Figure 14: Hydric Soils in the Lower Salt Creek Watershed
(Data on hydric soils by county available from NRCS at
https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/)

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 runoff into waterbodies. Agencies such as the USGS and U.S. Fish and Wildlife Service (USFWS) estimate that Indiana has lost approximately 85 percent of the state's original wetlands. Currently, the Lower Salt Creek watershed contains approximately 344 acres of wetlands or 1.80 percent of the total surface area (USFWS, 2003). Figure 15 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/Web-Map-Services.html. 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. The USFWS's objective of mapping wetlands and deep-water habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology, and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis. The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data, and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems. Wetlands or other mapped features may have changed since the date of the imagery and/or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

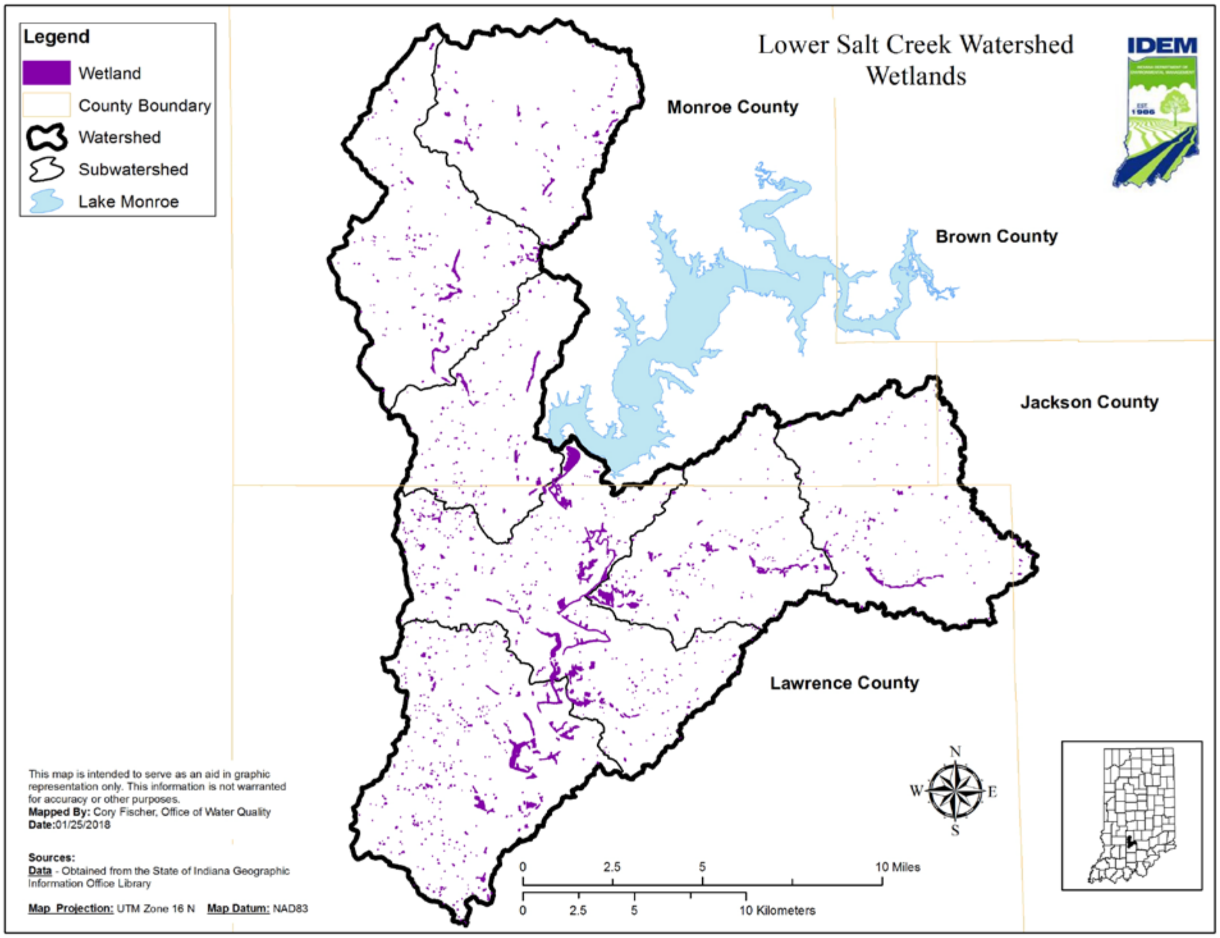


Figure 15: Locations of Wetlands in Lower Salt Creek Watershed

Changes to the natural drainage patterns of a watershed are referred to as hydromodifications. 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://www.co.monroe.in.us/tsd/Government/Infrastructure/HighwayDepartment/DrainageBoard.aspx and https://lawrencecounty.in.gov/government/surveyor).

In addition to tile drainage, regulated drains are another form of hydromodification. A regulated drain is a drain which was established through either a Circuit Court or Commissioners Court of the County prior to January 1, 1966, or by the County Drainage Board since that time. Regulated drains can be an open ditch, a tile drain, or a combination of both. The County Drainage Board can construct, maintain, reconstruct or vacate a regulated drain.

3.3.4 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 pollutants 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 lands (HEL) units for each county based upon the potential of soil units to erode from the land. HELs are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another. The classification for HELs 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 Salt Creek watershed are listed below in Table 15. HELs and potential HELs in the Lower Salt Creek watershed are mapped in Figure 16.

The data used to create Figure 16 were collected from the NRCS offices of Monroe, Lawrence, and Jackson Counties. A total of 94,896 acres, or 73 percent of the Lower Salt Creek watershed, is considered highly erodible or potentially highly erodible. Rainfall within the Lower Salt Creek watershed is moderately heavy with an annual average of 52 inches. This rainfall and climate data specific to the watershed is available from Midwestern Regional Climate Center (see Section 3.5 for more climate information). The 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.

Table 15: HEL/Potential HEL Total Acres in the Lower Salt Creek Watershed

Map Symbol	HEL/Potential HEL Soil Types	Acres
BdB	Bedford Silt Loam (2-6% slopes)	6424
BdyB	Bedford-Stoy Silt Loams (1-4% slopes)	191
BkF	Berks-Weikert Complex (25-75% slopes)	3212
BlrC	Bloomfield Loamy Sand (3-10% slopes)	32
Bu	Burnside Silt Loam	1699
CaD	Caneyville Silt Loam (12-18% slopes)	6259
Cb	Caneyville-Hagerstown Silt Loam	1516
CbpC2	Caneyville Silt Loam (6-12% slopes)	823
CbpD2	Caneyville Silt Loam (12-20% slopes)	5378
CbxG	Caneyville-Adyeville-Rock Outcrop	2882
CoF	Corydon Variant-Caneyville Variant	2502
CrB	Crider Silt Loam (2-6% slopes)	2614
CrC	Crider Silt Loam (6-12% slopes)	11703
CrD	Crider Silt Loam (12-18% slopes)	167
CsC	Crider-Caneyville Silt Loams (6-12%)	847
CspB	Crider Silt Loam (2-6% slopes)	1945
CspC2	Crider Silt Loam (6-12% slopes)	10678
CspD2	Crider Silt Loam (12-18% slopes)	357

CtB	Crider-Urban Land Complex (2-6% slopes)	1921
CtC	Crider-Urban Land Complex (6-12% slopes)	3046
CtxD2	Crider-Frederick Silt Loams, karst (6-20% slopes)	7565
CtzD2	Crider-Caneyville Silt Loam (12-18% slopes)	1240
FkhC2	Frederick Silt Loam (6-12% slopes)	152
FkhD2	Frederick Silt Loam (12-18% slopes)	3200
FklD5	Frederick Silty Clay Loam (10-18% slopes)	132
FknC2	Frederick-Crider Silt Loam, karst	1498
FkoD2	Frederick-Crider-Gilwood Silt Loam	53
GpD	Gilpin Silt Loam (12-18% slopes)	56
GrD	Gilpin-Gullied Land Complex	42
HaC	Hagerstown Silt Loam (6-12% slopes)	923
HaD	Hagerstown Silt Loam (12-18% slopes)	3003
HaE	Hagerstown Silt Loam (18-25%)	156
HbD3	Hagerstown Silty Clay Loam (12-22% slopes)	160
HoA	Hosmer Silt Loam (0-2% slopes)	257
HoB	Hosmer Silt Loam (2-6% slopes)	1113
HoC	Hosmer Silt Loam (6-12% slopes)	357
HsaB2	Hosmer Silt Loam (2-6% slopes) eroded	255
HtB	Hosmer-Urban Land Complex (2-12% slopes)	813
MwhA	Muren Silt Loam (1-3% slopes)	552
PcrB	Pekin Silt Loam (2-6% slopes), eroded	465
PcrC2	Pekin Silt Loam (6-12% slopes), eroded	645
PeB	Pekin Silt Loam (2-6% slopes)	40
PeC	Pekin Silt Loam (6-12% slopes)	50
Ua	Udorthents, Loamy	1357
Uas	Udorthents-Pits, Quarries Complex	1075
UcuA	Udorthents, Loamy	565
Ud	Udorthents-Pits Complex	1267
WeC	Wellston Silt Loam (6-12% slopes)	423
WmC	Wellston-Gilpin Silt Loam (6-20% slopes)	3286
	Total	**94,896**

Understanding Table 15: In the Lower Salt Creek watershed HEL/potential HEL soils make up the majority of the land area. HEL soils might contribute to water quality impairments associated with excessive erosion and may contain opportunities for restoration to decrease erosion.

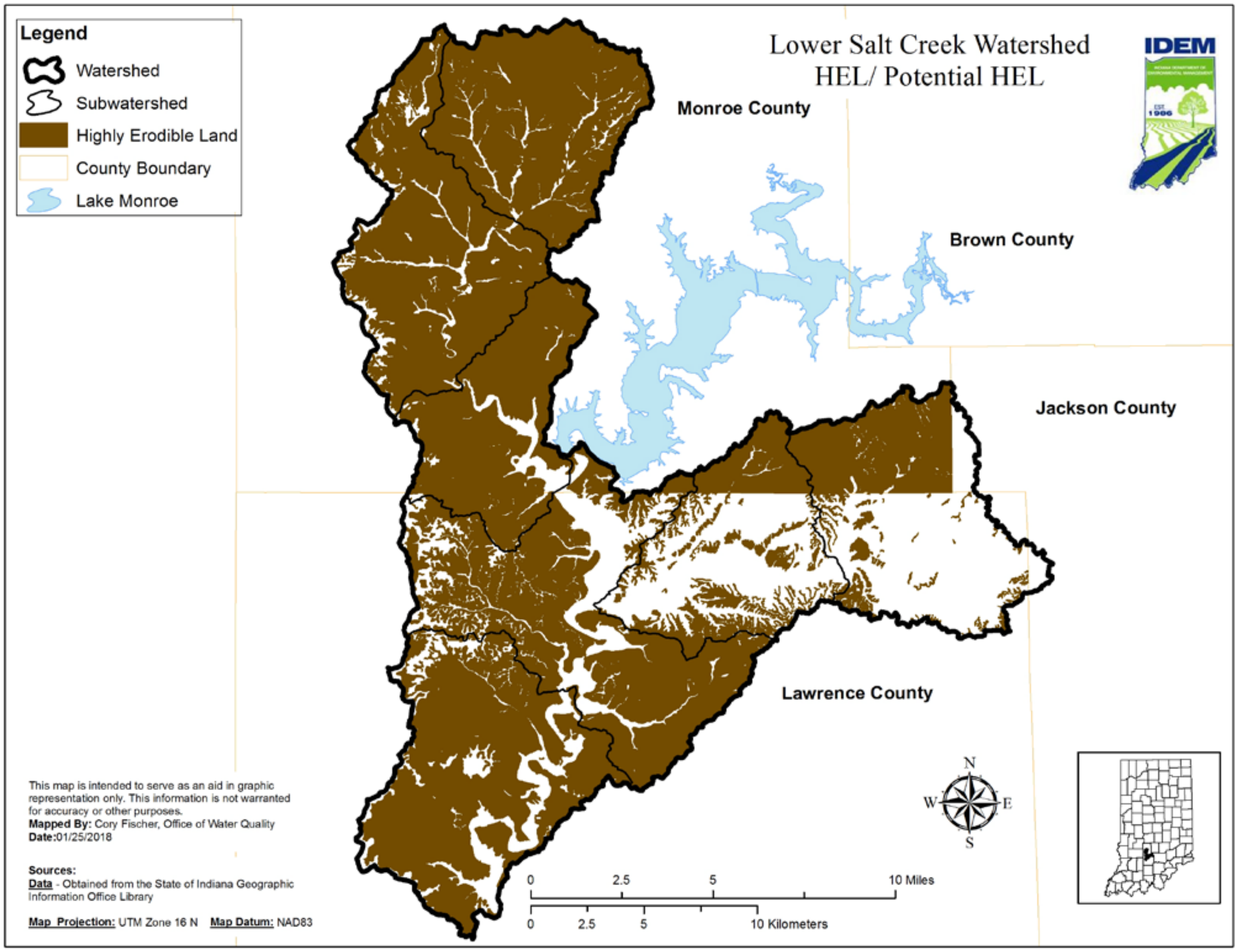


Figure 16: HEL/Potential HEL Soils in the Lower Salt Creek Watershed

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropland through annual county tillage transects. Data collected through the tillage transect (county data found at http://www.in.gov/isda/2370.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 Salt Creek watershed are shown below in Table 16. 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 16 percent residue cover after planting.

Table 16: Tillage Transect Data for 2015 by County in the Lower Salt Creek Watershed

	Tillage Practice 2015							
	No Till		Mulch Till		Reduced Till		Conventional Till	
County	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Monroe	3,700 ac. 54%	4,200 ac. 58%	1,200 ac. 17%	200 ac. 3%	600 ac. 9%	1,100 ac. 15%	1,400 ac. 20%	1,800 ac. 24%
Jackson	47,600 ac. 71%	50,200 ac. 76%	10,100 ac. 15%	4,600 ac. 7%	4,000 ac. 6%	5,300 ac. 8%	4,700 ac. 7%	2,100 10%
Lawrence	18,300 ac. 86%	13,600 ac. 64%	1,100 ac. 5%	3,000 ac. 14%	1,900 ac. 9%	2,500 ac. 12%	0 ac. 0%	5,900 ac. 9%

Understanding Table 16: According to Table 16, No-Till is predominant in all counties in the Lower Salt Creek watershed. The use of No-Till is greatest in Jackson and Lawrence counties. These counties comprise about half of the entire Lower Salt Creek watershed.

Streambank Erosion

Streambank erosion is potentially a significant source of pollutants in the Lower Salt Creek watershed. Streambank erosion is a natural process but can be accelerated due to a variety of human activities. Vegetation located adjacent to streams flowing through crop or pasture fields is often removed to promote drainage or cattle access to water. The loss of vegetation makes the streambanks more susceptible to erosion due to the loss of plant roots. Extensive areas of agricultural tiles promote much quicker delivery of rainfall into streams than would occur without subsurface drainage, which could potentially contribute to streambank erosion, due to high velocities and shear stress. The creation of impervious surfaces (e.g., streets, rooftops, driveways, parking lots) can also lead to rapid runoff of rainfall and higher stream velocities that might cause streambank erosion.

3.4 Wildlife and Classified Lands

3.4.1 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*. Little information exists surrounding feces depositional patterns of wildlife and a direct inventory of wildlife populations is generally not available. However, based on the *Bacteria Source Load Calculator* developed by the Center for TMDL and Watershed Studies, bacteria production by animal type is estimated, as well as their preferred habitat. Higher concentrations of wildlife in the habitats described below, in Table 17, could contribute *E. coli* to the watershed, particularly during high flow conditions or flooding events.

Table 17: Bacteria Source Load by Species

Wildlife Type	*E. coli* Production Rate (cfu/day – animal)	Habitat
Deer	1.86×10^{8}	Entire Watershed
Raccoon	2.65×10^{7}	Low density on forests in rural areas; high density on forest near a permanent water source or near cropland
Muskrat	1.33×10^{7}	Near ditch, medium sized stream, pond or lake edge
Goose	4.25×10^{8}	Near main streams and impoundments
Duck	1.27×10^{9}	Near main streams and impoundments
Beaver	2.00×10^{5}	Near streams and impoundments in forest and pastures

3.4.2 Classified Lands

Managed lands, shown in Table 18 below, include natural and recreation areas which are owned or managed by the Indiana Department of Natural Resources, federal agencies, local agencies, non-profit organizations, and conservation easements. Classified lands are public or private lands containing areas supporting growth of native or planted trees, native or planted grasses, wetlands or other acceptable types of cover that have been set aside for managed production of timber, wildlife habitat and watershed protection. Natural areas provide ideal habitat for wildlife. Some of the more common wildlife often found in natural areas include white-tailed deer, raccoon, muskrat, fowl and beaver. While wildlife is known to contribute *E.coli* to surface waters, natural areas provide economic, ecological and social benefits and should be preserved and protected. Management practices such as reducing impervious surfaces, native vegetation plantings, wetland creation and riparian buffers will help in reducing storm water runoff transporting pollutants to the streams. Table 18 and Figure 17 show the managed lands within the Lower Salt Creek watershed. Table 19 and Figure 17 show the classified lands within Lower Salt Creek watershed.

Table 18: Managed Lands within the Lower Salt Creek Watershed

Unit Name	Manager	Area (acres)
Allison – Jukebox Community Center	Bloomington Parks and Recreation Department	0
Avoca State Fish Hatchery	DNR Fish and Wildlife	39
Banneker Center	Bloomington Parks and Recreation Department	0
Bloomington Rail Trail	Bloomington Parks and Recreation Department	2
Broadview Park	Bloomington Parks and Recreation Department	1
Brown Woods	Bloomington Parks and Recreation Department	25
Bryan Park	Bloomington Parks and Recreation Department	35
Building and Trades Park	Bloomington Parks and Recreation Department	3
Cedar Bluffs Nature Preserve	The Nature Conservancy	23
Cedar Bluff Nature Preserve (Cons Easement)	DNR Nature Preserves	29
Clear Creek Trail	Bloomington Parks and Recreation Department	3
County Farm (Karst) Park	Monroe County Park Board	142
Farmers Market	Bloomington Parks and Recreation Department	1
Frank Southern Ice Area	Bloomington Parks and Recreation Department	1
Goat Farm Park	Bloomington Parks and Recreation Department	33
Henke Preserve	Sycamore Land Trust	0
Hoosier National Forest	U.S Forest System	14,979
Latimer Woods	Bloomington Parks and Recreation Department	10
Leonard Springs Park	Bloomington Parks and Recreation Department	84
McDoel Switchyard Park	Bloomington Parks and Recreation Department	59
Mills Pool	Bloomington Parks and Recreation Department	2
Monroe Lake	DNR State Parks	198
Olcott Park	Bloomington Parks and Recreation Department	42
Park Ridge Park	Bloomington Parks and Recreation Department	1
Park Square Park	Bloomington Parks and Recreation Department	6
People's Park	Bloomington Parks and Recreation Department	0
RCA Community Park	Bloomington Parks and Recreation Department	48
Reverend Ernest D Butler Park	Bloomington Parks and Recreation Department	9
Rose Hill Cemetery	Bloomington Parks and Recreation Department	26
Schmalz Farm Park	Bloomington Parks and Recreation Department	6
Seminary Park	Bloomington Parks and Recreation Department	1
Sherwood Oaks Park	Bloomington Parks and Recreation Department	16
Southeast Park	Bloomington Parks and Recreation Department	9
The Cedars Preserve	Sycamore Land Trust	40
Third Street Park	Bloomington Parks and Recreation Department	2
Twin Lakes Recreation Center	Bloomington Parks and Recreation Department	10
Twin Lakes Sport Park	Bloomington Parks and Recreation Department	50
Wapehani Mountain Bike Park	Bloomington Parks and Recreation Department	47
Wayne's Woods	Sycamore Land Trust	13
White Oak Cemetery	Bloomington Parks and Recreation Department	4
Winslow Sport Complex and Trail	Bloomington Parks and Recreation Department	36
Winslow Woods Park	Bloomington Parks and Recreation Department	39
	Total	**16,071**

Table 19: Classified Lands within the Lower Salt Creek Watershed

Classified Lands (Acres)						
Subwatershed	**Grassland**	**Woodland**	**Shrubland**	**Wetland**	**Other**	**Total**
Jackson Creek	1	27	1	0	22	**51**
May Creek	12	897	2	0	37	**948**
Little Clear Creek	9	584	12	0	95	**700**
Hunter Creek	5	885	20	0	17	**927**
Knob Creek	11	1,174	7	0	116	**1,308**
Wolf Creek	3	343	3	0	57	**406**
Goose Creek	0	626	1	2	45	**674**

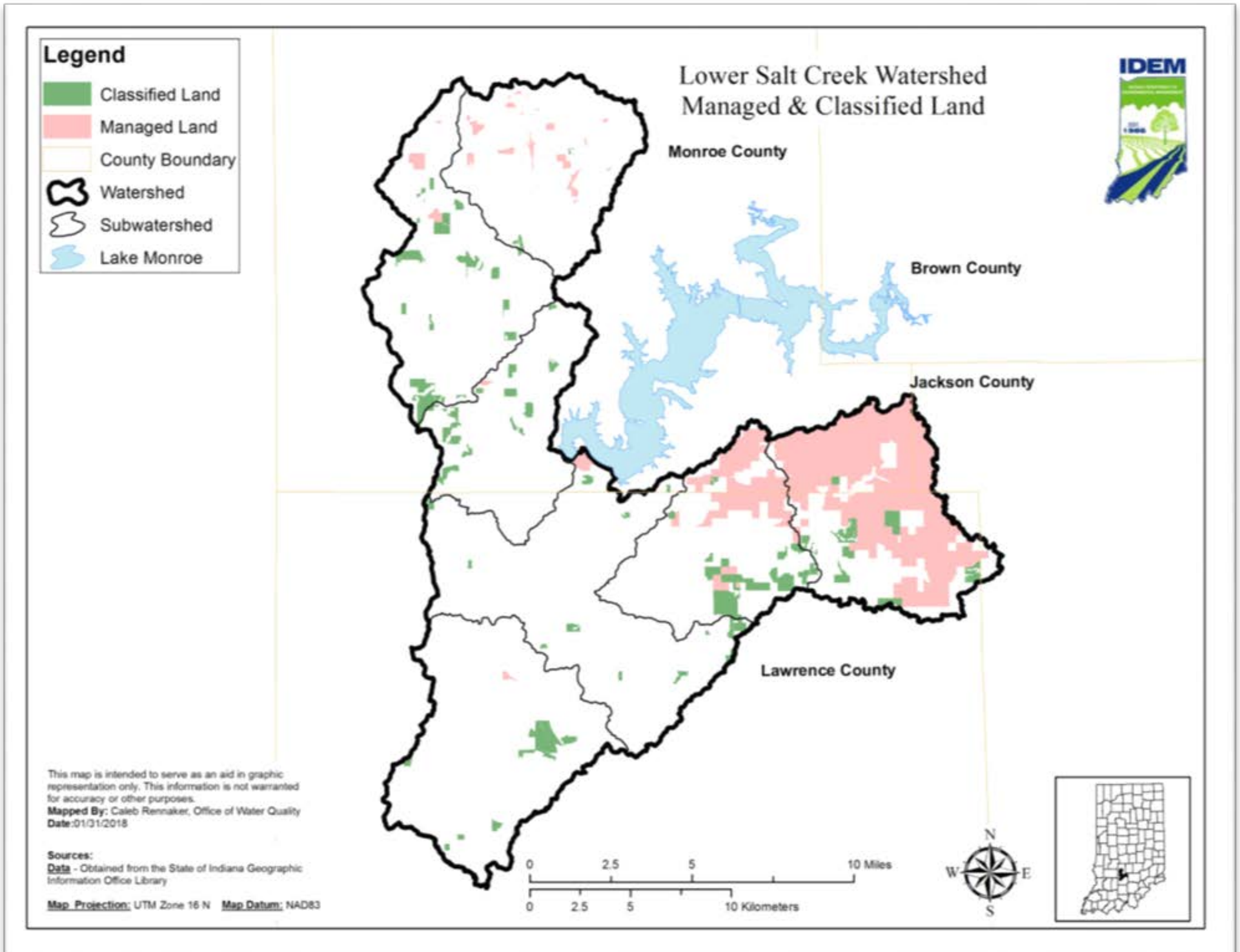


Figure 17**:** Managed and Classified Lands within the Lower Salt Creek Watershed

3.5 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 Midwestern Regional Climate Center (http://mrcc.isws.illinois.edu/CLIMATE/).

Climate data from Station USC00120784 located in Bloomington was used for climate analysis of the Lower Salt Creek watershed. Monthly data from 1895 - 2016 were available at the time of analysis and data from 2006 to 2016 was utilized. In general, the climate of the region is continental with hot, humid summers and cold winters. From 2006 to 2016, the average winter temperature in Bloomington was 33.0 °F and the average summer temperature was 73.4 °F. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 205 days.

Examination of precipitation patterns is also a key component of watershed characterization because of the impact of runoff on water quality. From 2006 to 2016, the annual average precipitation in Bloomington at Station USC00120784 was approximately 52 inches, including approximately 17.4 inches on average of total annual Lower Salt Creek snowfall.

Rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of storm water on the Lower Salt Creek watershed. Using data from USC00120784 during 2006 to 2016, 74% percent of the measureable precipitation events were very low intensity (i.e., less than 0.2 inches), while 0.04% percent of the measurable precipitation events were greater than one inch.

Understanding when precipitation events occur helps in the linkage analysis Section 5.0, which correlates flow conditions to pollutant concentrations and loads. Data indicates that the wet weather season in the Lower Salt Creek watershed occurs between the months of March and July.

3.6 Human Population

Counties with land located in the Lower Salt Creek watershed include Monroe, Jackson, and Lawrence. Major government units with jurisdiction at least partially within the Lower Salt Creek watershed include Bloomington, Bedford, and Oolitic. U.S. Census data for each county during the past three decades are provided in Table 20. As the table displays, each county's population shows trending growth between 1990 and 2010, which is likely continuing into the present. This is especially true for Monroe County, which is home to the growing city of Bloomington and Indiana University. Increasing urban sprawl and development can add additional sources of pollutants like *E. coli* and sediment into the watershed.

Table 20: Population Data for Counties in the Lower Salt Creek Watershed

County	1990	2000	2010
Monroe	108,978	120,563	137,974
Jackson	37,730	41,335	42,376
Lawrence	42,836	45,922	46,134
TOTAL	**189,544**	**204,820**	**226,484**

Source: U.S. Census Bureau 2010

Understanding Table 20: 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 20 provides information that shows how population has changed in each of the counties located in the Lower Salt Creek watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future and where action in Lower Salt Creek could help prevent further water quality degradation.

Estimates of population within Lower Salt Creek watershed are based on U.S. Census data (2010) and the percentage of the Total County and urban area that is within the watershed (Table 21). Based on this analysis, the estimated population of the watershed is 94,697 with approximately 37 percent of the population classified as rural residents and 63 percent classified as urban residents. With most of the watershed's population focused in the urban areas of Monroe County, urban stormwater and pollutants will likely need to be addressed. Figure 18 below indicates population density within the Lower Salt Creek watershed.

Table 21: Estimated Population in the Lower Salt Creek Watershed

County	2010 Population	Total Estimated Watershed Population	Total Estimated Watershed Urban Population	Total Estimated Watershed Rural Population	Percent of Total Watershed Population
Monroe	137,974	82,532	56,684	25,848	87%
Jackson	42,376	60	0	60	<1%
Lawrence	46,134	12,105	2,531	9,574	13%
TOTAL	**226,484**	**94,697**	**59,215**	**35,482**	**100%**

Understanding Table 21: Understanding where the greatest population is concentrated within the Lower Salt Creek 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 impervious surfaces, poor riparian habitat, flashy stormwater flows, and large wastewater inputs. Alternatively, watersheds with mostly 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 20 with the information in Table 21 can provide an understanding of how population might change in the Lower Salt Creek 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 Salt Creek 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).

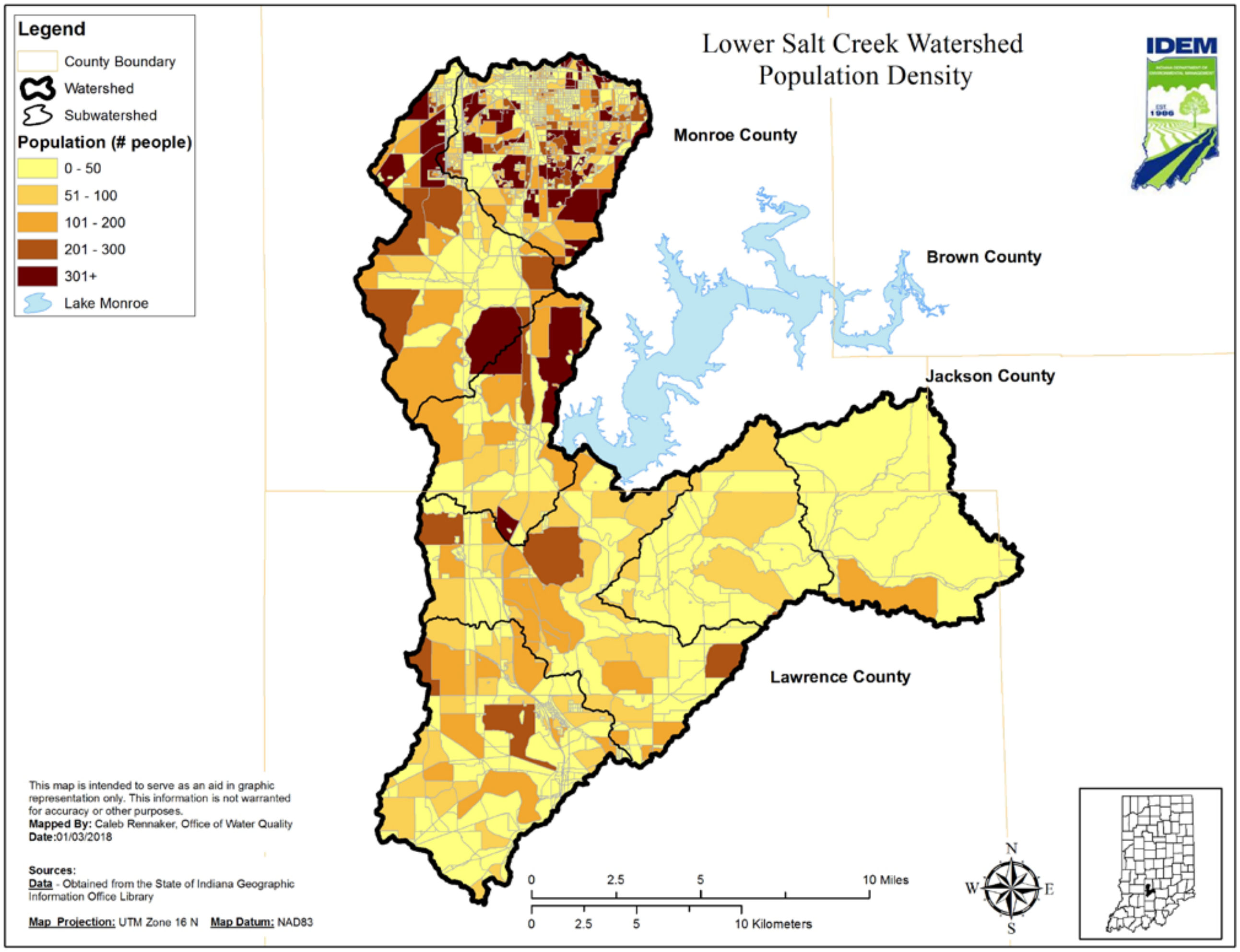


Figure 18: Population Density in the Lower Salt Creek Watershed

In addition to human population, the household pet population within a watershed can also impact water quality, due to the bacteria in pet waste being transported to waterways during precipitation events. Dog and cat populations were estimated for the Lower Salt Creek subwatersheds using statistics reported in the *2012 U.S. Pet Ownership & Demographics Sourcebook*[1]. Specifically, the *Sourcebook* reports that on average 36.5 percent of households own dogs and 30.4 percent of households own cats. Typically, the average number of pets per household is 1.6 dogs and 2.1 cats. Pets are likely a significant source of *E. coli* and pollutants in population centers (i.e., cities and towns). The estimates of domestic pets in cities and towns in the watershed are presented in Table 22 and are based on the average number of pets per household multiplied by the households in the urban areas of the subwatersheds. Figure 19 below shows the location of the municipalities within Lower Salt Creek.

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

Table 22: Estimated Pet Populations in the Cities and Towns in the Lower Salt Creek Watershed

Subwatershed	City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Jackson Creek	Bloomington	28,103	59,016	44,965
Goose Creek	Oolitic	767	1,611	1,227
	Bedford	1,084	2,276	1,734
TOTAL		**29,954**	**62,903**	**47,926**

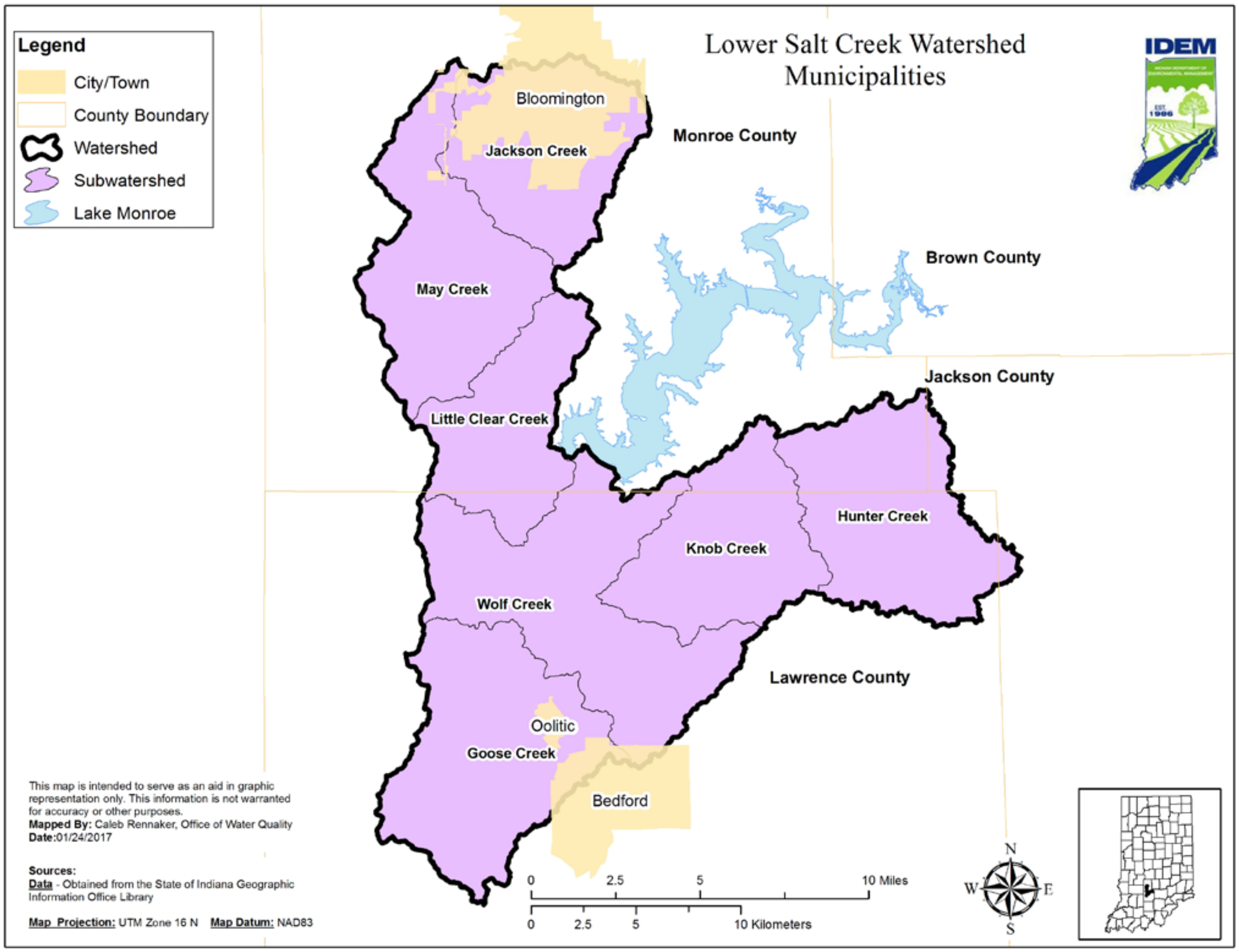


Figure 19: Municipalities in the Lower Salt Creek Watershed (only municipalities with population greater than 1,000 are labeled)

3.7 Point Sources

This section summarizes the potential point sources of *E. coli* in the Lower Salt Creek watershed, as regulated through the NPDES Program.

3.7.1 Wastewater Treatment Plants (WWTPs)

Wastewater treatment facilities have NPDES permits to discharge wastewater within the Lower Salt Creek watershed. There are eight active WWTPs that discharge wastewater containing pollutants within the Lower Salt Creek watershed (Table 23 and Figure 20). As authorized by the CWA, the NPDES permit program controls water pollution by regulating WWTPs that discharge pollutants into waters of the United States. Municipal facilities in the Lower Salt Creek Watershed are required to disinfect their effluent for *E. coli* during the recreational season (April 1 to October 31) in accordance with 327 IAC 5-10-6. Table 23 contains the maximum design flow for these active facilities.

The City of Bloomington (Dillman Road) currently operates a Class IV, 15.0 MGD (million gallons per day) wastewater treatment facility (Publicly Owned Treatment Works) with a peak design flow of 30.0 MGD. Flow equalization is accomplished via a 43 million gallon capacity flow equalization basin with four floating aeration units. Flows to the equalization basin are controlled by a plant pump station. Return of flows to the plant are controlled by a drain using an electronic flow control valve with a flow meter. The facility also has influent and effluent flow measurement, two aerated rectangular grit chambers, two mechanically cleaned bar screens, six single-stage aeration units with step feed capability and coarse bubble diffusers, six circular center feed secondary clarifiers, four mixed media filters, a backwash tank, phosphorus removal equipment, and sodium hypochlorite disinfection and sodium bisulfite dechlorination. Solids handling includes two aerobic digesters, two gravity belt thickeners, two belt filter presses, seventeen sludge drying beds, one covered storage pad, a sludge monofill, and two solids storage lagoons. The collection system is comprised of 100% separate sanitary sewers by design with eleven Sanitary Sewer Overflow (SSO) points.

The South Central Regional Sewer District currently operates the Caslon Wastewater Treatment Plant (Semipublic facility), a Class II, 0.3 MGD extended aeration treatment facility consisting of three package type extended aeration units with a 1.0 million gallon equalization basin, post aeration, ultraviolet light disinfection, and effluent flow measurement. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points.

Briarwood Subdivision currently operates a Class I, 0.037 MGD extended aeration treatment facility (Publicly Owned Treatment Works) consisting of an aeration tank, an effluent clarifier, an ultraviolet light disinfection unit, post aeration, and an effluent flow meter. Final solids are hauled off-site by a licensed contractor. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points.

The Pedigo Bay Wastewater Treatment Plant operates a Class I, 0.022 MGD extended aeration package-type treatment facility (Semipublic facility) consisting of a surge tank, an aeration chamber, clarifiers, a sludge holding tank and return system, ultraviolet light disinfection, and post aeration. Biosolids are hauled off site. The collection system is comprised of 100% separate sanitary sewers by design, with no overflow or bypass points.

Stone Crest Golf Community Wastewater Treatment Plants currently operates a Class I, 0.04 MGD extended aeration treatment facility (Semipublic facility) consisting of a flow equalization tank, a comminutor, a sludge holding tank, an aeration basin, two secondary clarifiers, ultraviolet light disinfection, post aeration, and a flow meter. Final solids are hauled off-site by a contract hauler. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points.

The Town of Oolitic currently operates a Class I, 0.35 MGD extended aeration treatment facility (Publicly Owned Treatment Works) consisting of an influent splitter box, two bar screens, two activated sludge treatment units with anoxic zones, two secondary clarifiers, ultraviolet light disinfection, and an effluent flow meter. Bio-solids are stored in an aerobic digester prior to disposal. The collection system is comprised of 100% separate sanitary sewers by design with one Sanitary Sewer Overflow (SSO).

Camp Indi-Co-So currently operates a Class I, 0.010 MGD extended aeration treatment facility (Semipublic facility) with a bar screen, aerobic digestion, settling, effluent chlorination, a terminal lagoon, and an effluent flow meter. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points.

Needmore Elementary School operates a Class I, 0.009 MGD extended aeration package treatment facility (Semipublic facility) consisting of a bar screen, a 6,000 gallon flow equalization basin, a 12,000 gallon aeration basin, a 900 gallon sludge holding tank, a 1,500 gallon secondary clarifier tank, ultraviolet lights and intensity meter, a flow meter, two 9,000 gallon polishing tanks and a lift station to Outfall 001. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points.

Table 23: NPDES Permitted Wastewater Treatment Plants Discharging within the Lower Salt Creek Subwatersheds

Subwatershed	Facility Name	Permit Number	Receiving Stream	Design Flow (MGD)
May Creek	Bloomington S. Dillman Rd. WWTP	IN0035718	OR/E FK White/ Salt Creek/ Clear Creek	15
Little Clear Creek	South Central RSD Caslon WWTP	IN0045187	Salt Creek VIA Clear Creek	0.3
	Briarwood Subdivision WWTP	IN0038920	Clifty Branch VIA unnamed tributary	0.037
Wolf Creek	Pedigo Bay WWTP	IN0062154	Unnamed tributary to Salt Creek	0.022
	Camp INDI CO SO	IN0042617	Salt Creek/ Gullets Creek/ Unnamed Trib	0.010
	Stone Crest Golf Community WWTP	IN0061093	OR/E FK White/Salt/ Gullets – Unnamed Trib	0.04
Goose Creek	Oolitic WWTP	IN0023981	Salt Creek VIA Goose Creek	0.35
	Needmore Elementary School	IN0053741	Salt Creek/Goose Greek/ Unamed Trib	0.009

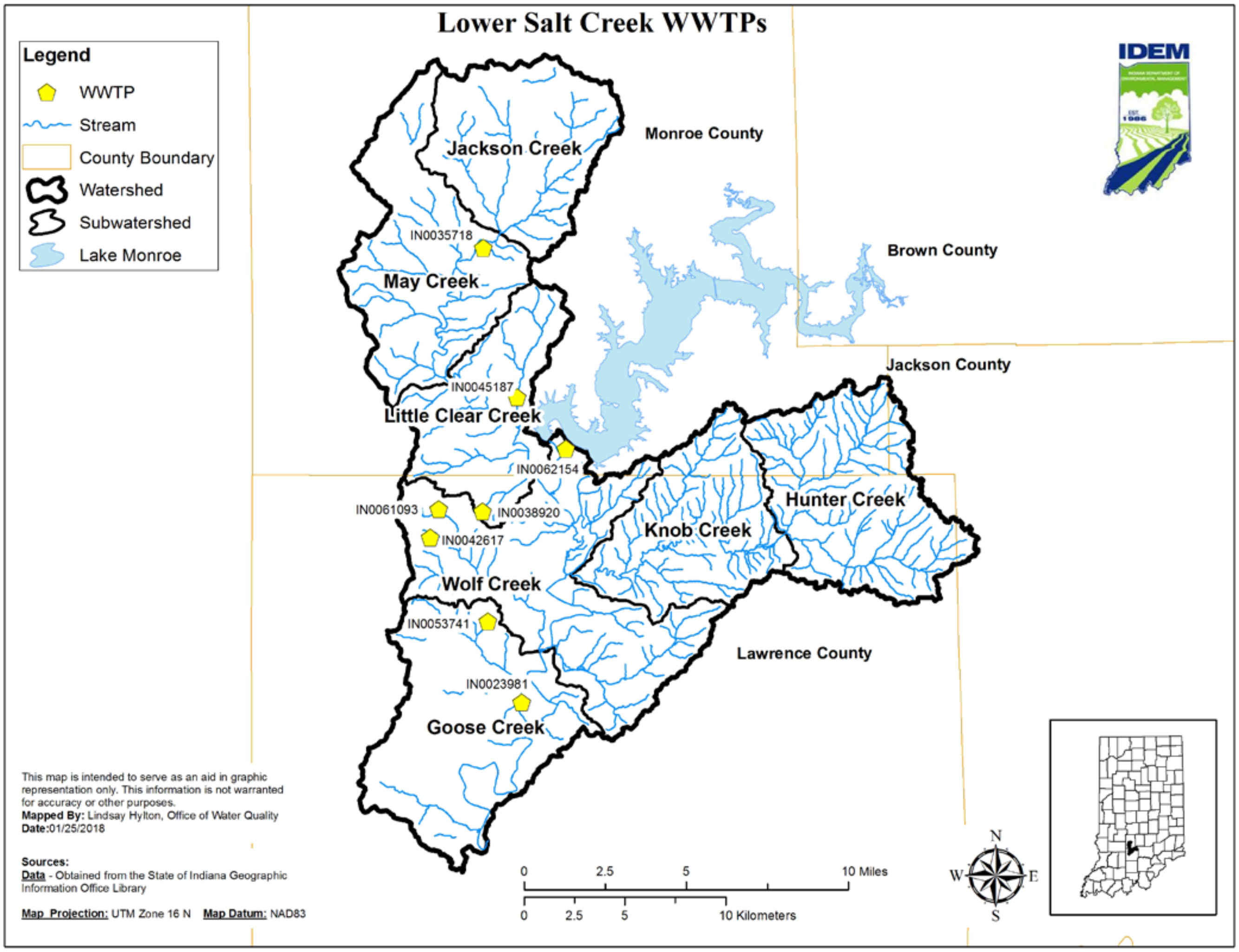


Figure 20: NPDES Permitted Wastewater Treatment Plants Discharging within the Lower Salt Creek Subwatersheds

3.7.1.1 Combined Sewer Overflows (CSOs)

CSO systems are sewers that are designed to collect rainwater runoff, domestic sewage, and industrial wastewater into the same pipe. Most of the time, combined sewer systems transport all of their wastewater to a sewage treatment plant, where it is treated and then discharged to a waterbody. During periods of heavy rainfall or snowmelt, the wastewater volume in a combined sewer system can exceed the capacity of the sewer system or treatment plant. For this reason, combined sewer systems are designed to overflow occasionally and discharge excess wastewater directly to nearby streams, rivers, or other water bodies. These overflows, called CSOs, can contain both storm water and untreated human and industrial waste, including pollutants such as *E. coli*, total nitrogen, total phosphorus, and TSS. Because they are associated with wet weather events, CSOs typically discharge for short periods of time at random intervals. IDEM regulates CSOs in Indiana through the state's NPDES program and they are point sources subject to both technology-based and water quality based requirements of the CWA and state law. The permitee is authorized to have wet weather discharges from outfalls listed in their permit. One key component of this program is locating all CSO outfalls for tracking purposes. There are no combined sewer systems in the Lower Salt Creek watershed, meaning there are zero associated CSO outfalls contributing discharge.

3.7.1.2 Sanitary Sewer Overflows (SSOs)

According to U.S. EPA, sanitary sewer systems collect and transport domestic, commercial, and industrial wastewater and limited amounts of stormwater and infiltrated ground water to treatment facilities for appropriate treatment. Sanitary sewers are different than combined sewers, which are designed to collect large volumes of stormwater in addition to sewage and industrial wastewater. Occasionally, sanitary sewers will release raw sewage. EPA estimates there are at least 23,000 - 75,000 SSOs per year (not including sewage backups into buildings) in the U.S. (For more information, visit https://www.epa.gov/npdes/sanitary-sewer-overflows-ssos).

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

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

Overflows in the sanitary sewer system or in a sanitary portion of a combined sewer system are expressly prohibited from discharging at any time. Should any release from the sanitary sewer system occur, the permitee is required to notify the Compliance Data Section of the Office of Water Quality orally within 24 hours and in writing within 5 days of the event, in accordance with the requirements in Part II.C.2.b of the permit. The correspondence should include the duration and cause of discharge, as well as the remediation action taken to eliminate it. Below, Table 24 and Figure 21 show the 15 SSO points in the Lower Salt Creek watershed.

The Town of Oolitic operates the Town of Oolitic Wastewater Treatment Plant. The collection system is comprised of 100% separate sanitary sewers by design with one Sanitary Sewer Overflow (SSO) point. Attachment A of the permit identifies the location of the SSO and states that it is prohibited from discharging at any time. Should a release occur, the permittee is required to notify the Office of Water Quality within 24 hours.

The City of Bloomington operates a sewer collection system. The City transports wastewater to the City of Bloomington-Dillman Road WWTP. The collection system is comprised of 100% separate sanitary sewers by design with eleven SSO points. The SSO locations have been identified and prohibited in Attachment A of the permit.

The City developed an Agreed Order in 2005, which aims in part to address SSOs. According to the Agreed Order, an SSO Elimination Plan will identify corrective actions necessary to eliminate sanitary sewer overflows from the wastewater collection system and create a schedule for the completion of such actions. The SSO Elimination Plan scope will include:

- Attending meetings with the City of Bloomington Utilities (CBU) and IDEM to discuss the proposed Project Plan that will become the basis for the development of the SSO Elimination Plan
- Reviewing and summarizing previous relevant studies and sewer work performed to date for inclusion into the Plan, in addition to summarizing the historical SSO data and showing trends versus precipitation
- Using hydraulic sewer modeling software to estimate collection system hydraulic capacity. Tabulating wet weather SSO frequency, duration, and estimated volume for multiple levels of control
- Meeting with CBU staff to prepare an agenda to set and meet goals for public participation
- Coordinating with CBU's financial and rate consultant regarding financing for corrective action projects
- Preparing a draft report summarizing findings and recommendations

The City of Bedford operates the City of Bedford WWTP. The collection system is comprised of 100% separate sanitary sewers by design with nineteen SSO points. While this facility and main outfall are located outside of the Lower Salt Creek watershed, three of the SSO points fall within the watershed.

In 2014 the City developed a Sewer Master Plan that aims at addressing SSOs. The proposed projects are divided between two major sewersheds referred to as the Westside System and the Eastside System. According to the Sewer Master Plan, when considering SSO, stormwater, and unsewered area issues collectively, the financial capability analysis demonstrates that Bedford will be in the "High Burden" category. EPA guidance allows up to 20 years to complete improvements when a community's financial burden is in the "High" category. Therefore, Bedford has put a plan together that would take approximately 20 years to complete. This plan allows for phased construction of the SSO improvements. The City of Bedford intends to continue the existing monitoring effort that has provided good information with regard to the magnitude of the SSO volumes. The City will also be expanding the monitoring program to include newly discovered overflows to better understand the behavior of the system during wet weather.

The Westside System project includes the following phases:

Phase I

1. Installation of in-system flow monitors and permanent flow monitors in all existing SSO points (Spider Creek pump station, SSO 011, SSO 012, SSO 013, SSO 014 and SSO 015).
2. Installation of 24-inch gravity sewer line between U Street and Spider Creek pump station.

Phase II

1. Installation of 24-inch gravity line between U Street and intersection of 5th Lincoln.
2. Installation of 18-inch line from 6th L intersection to 24 -inch line at Jim Williams Road.

Phase III
1. Installation of 36-inch gravity sewer between Spider Creek pump station and Broadview pump station.
2. Construction of new Broadview pump station (15" and 24 ") rated at 17.5 MGD and dual force mains to the WWTP.

Phase IV
1. Construction of a new 2.2 MG flow equalization tank at the WWTP.

The Eastside System project includes the following phases:

Phase I
1. Installation of in-system flow monitors and permanent flow monitors in all existing SSO points (Blue Hole pump station, SSO 016).
2. Installation of 12 -inch gravity sewer feeding Riley Blvd lift station.
3. Increase the Bedford Heights lift station and its force main size from 4-in to 6-in.

Phase II
1. Construction of new Blue Hole lift station rated at 400 gpm and installation of 6-inch force main to the 18-inch gravity line feeding the 22nd and M pump station.

Phase III
1. Construction of new 22nd and F lift station rated at 800 gpm and installation of 8-inch force main directly to 22" and M pump station.

Phase IV
1. Construction of new 22nd and M pump station rated at 4,300 gpm and installation of 18-inch force main discharging to 36-inch gravity sewer feeding the WWTP.

Table 24: Sanitary Sewer Overflows in the Lower Salt Creek Subwatersheds

Subwatershed	Facility Name	Permit #	Type	Outfall #	AUID
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	004	INW0881_T1001
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	014	INW0881_T1007
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	019	INW0881_03
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	064	INW0881_03
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	068	INW0881_05
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	069	INW0881_05
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	072	INW0881_T1001
Jackson Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	073	INW0881_01A
May Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	035	INW0882_01
May Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	002	INW0882_01
May Creek	Bloomington-Dillman Rd. WWTP	IN0035718	Man hole	066	INW0882_01

Subwatershed	Facility Name	Permit #	Type	Outfall #	AUID
Little Clear Creek	NA	NA	NA	NA	NA
Wolf Creek	Bedford WWTP	IN0025623	Lift station	002	INW0886_T1008
Wolf Creek	Bedford WWTP	IN0025623	Lift station	008	INW0886_T1008
Goose Creek	Oolitic WWTP	IN0023981	Lift station	002	INW0887_T1001
Goose Creek	Bedford WWTP	IN0025623	Lift station	009	INW0887_01
Knob Creek	NA	NA	NA	NA	NA
Hunter Creek	NA	NA	NA	NA	NA

Note: NA = No sanitary sewer overflows located within the subwatershed

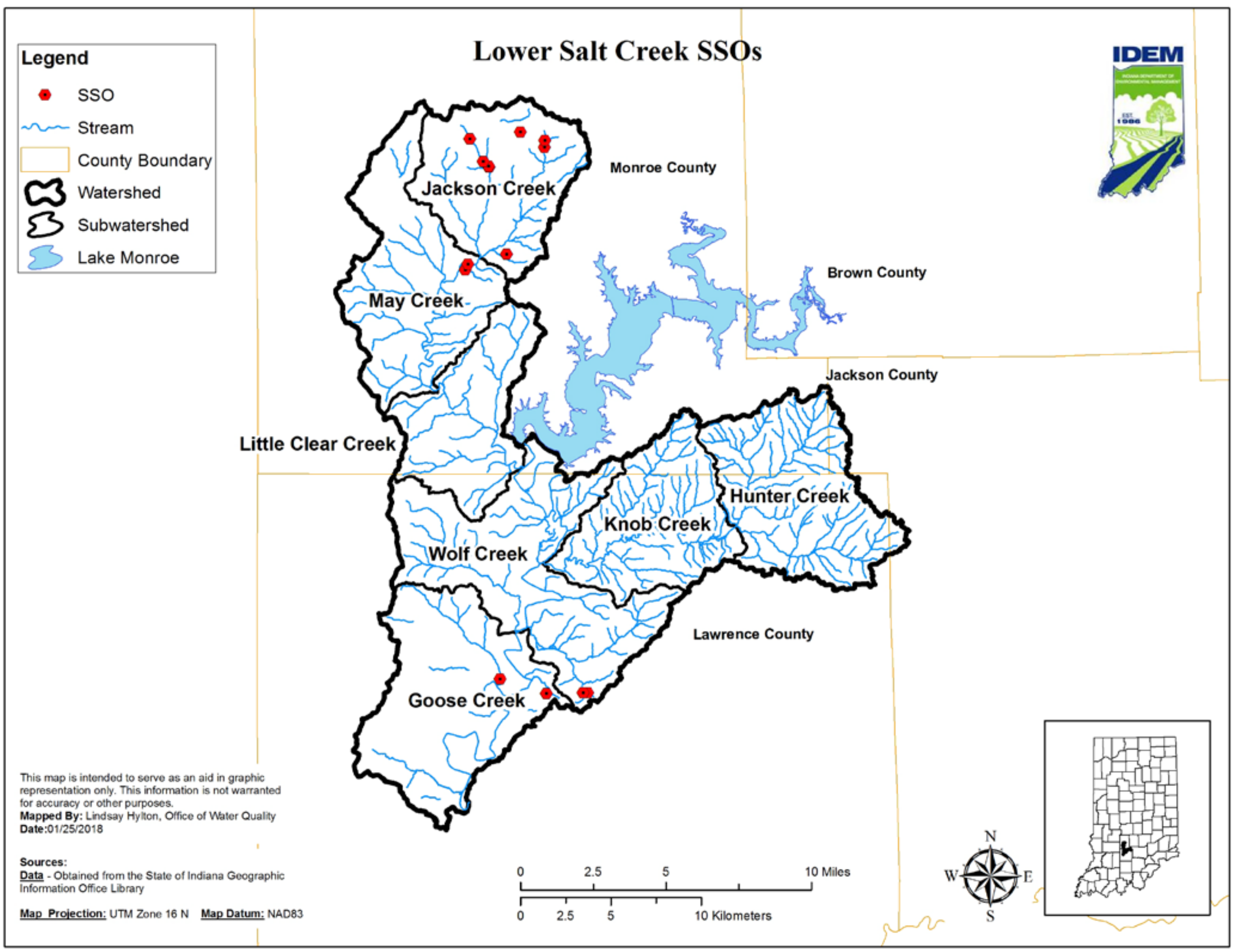


Figure 21: Sanitary Sewer Overflows in the Lower Salt Creek Subwatersheds

3.7.1.3 Compliance and Inspections

Table 25 presents a summary of permit compliance for NPDES facilities in the Lower Salt Creek watershed for the six-year period of 2012 to 2017.

Table 25: Summary of Inspections and Permit Compliance in the Lower Salt Creek Watershed

Subwatershed	Facility Name	Permit Number	Stream	Date of Inspection for the Last Five Years	Water Quality Violations for the Last six Years				
					Month	Year	Parameter	Type	# violations
Jackson Creek	NA	NA	NA	NA	NA				
May Creek	Bloomington S. Dillman Rd. WWTP	IN0035718	Salt Creek/ Clear Creek	8/7/2013: Potential Violation 4/15/2014: In Violation 10/20/2014: In Violation 11/18/2014: In Violation 8/15/2016: In Violation 6/19/2017: In Violation	Feb. Feb. Feb.	2016 2016 2016	Chlorine Chlorine TSS	Mo. Avg Daily Mx Mx Wk Avg	1 1 1
Little Clear Creek	South Central RSD Caslon WWTP/ Monroe County Reg. Waste Dist.	IN0045187	Salt Creek VIA Clear Creek	9/4/2013: Potential Violations 12/31/2013: No Violations 3/2/2015: No Violations 11/19/2015: No Violations 4/6/2017: Potential Violations	July April July Oct. Jan. Apr. July Oct.	2013 2014 2014 2014 2015 2015 2015 2015	TSS TSS TSS TSS TSS TSS TSS TSS	Mo. Avg. Mo. Avg. Mo. Avg. Mo. Avg. Mo. Avg. Mo. Avg. Mo. Avg. Mo. Avg.	1 1 1 1 1 1 1 1
	Briarwood Subdivision WWTP	IN0038920	Clifty Branch VIA unnamed tributary	4/4/2013: No Violations 8/27/2014: Potential Violations 5/25/2017: No Violations 10/5/2017: No Violations	Dec	2013	NH3-N	Mx. Wk. Avg.	1
Hunter Creek	NA	NA	NA	NA	NA				
Knob Creek	NA	NA	NA	NA	NA				
Wolf Creek	Pedigo Bay WWTP	IN0062154	Monroe Reservoir	4/2/2014: No Violations 3/23/2015: Potential Violations 3/14/2016: No Violations	NA				
	Stone Crest Golf Community WWTP	IN0061093	Salt/ Gullets – Unnamed Trib	4/2/2013: No Violations 8/22/2014: No Violations 4/15/2015: No Violations 9/16/2015: No Violations 7/20/2017: In Violation	Jan. March April May May	2017 2017 2017 2017 2017	TSS TSS TSS TSS E. coli	Mo. Avg Min Mo. Avg Min Mo. Avg Min Mo. Avg Min Daily Mx	1 1 1 1 1

	Camp INDI CO SO	IN0042617	Salt Creek/ Gullets Creek/ Unnamed Trib	4/22/2013: In Violation 5/12/2014: In Violation 4/9/2015: In Violation 2/18/2016: In Violation 5/25/2017: In Violation 11/28/2017: Potential Violations	April	2012	NH3-N	Mx Wk. Avg.	
					April	2012	NH3-N	Mo. Avg.	1
					April	2012	NH3-N	Mx Wk. Avg.	1
					April	2012	TSS	Mo. Avg.	1
					May	2012	TSS	Mo. Avg.	1
					May	2012	TSS	Mx Wk. Avg.	1
					June	2012	DO	Daily Min.	1
					June	2012	TSS	Mo. Avg.	1
					June	2012	Chlorine	Daily Mx.	1
					June	2012	NH3-N	Mx Wk. Avg.	1
					June	2012	NH3-N	Mx Wk. Avg.	1
					June	2012	TSS	Mx Wk. Avg.	1
					Feb	2013	TSS	Mo. Avg.	1
					Feb	2013	TSS	Mx Wk. Avg.	1
					Feb	2013	TSS	Mx Wk. Avg.	1
					Feb	2013	TSS	Mo. Avg.	1
					March	2013	pH	Daily Mx.	1
					April	2013	Chlorine	Mo. Avg.	1
					April	2013	Chlorine	Daily Mx.	1
					April	2013	pH	Daily Mx.	8
					May	2013	Chlorine	Mo. Avg.	1
					May	2013	Chlorine	Daily Mx.	1
					June	2013	Chlorine	Mo. Avg.	8
					June	2013	Chlorine	Daily Mx.	1
					June	2013	DO	Daily Min	9
					July	2013	DO	Daily Min	2
					July	2013	Chlorine	Mo. Avg.	8
					July	2013	Chlorine	Daily Mx.	1
					Oct	2013	NH3-N	Mo. Avg.	11
					Oct	2013	Chlorine	Mo. Avg.	1
					Oct	2013	Chlorine	Daily Mx.	1
					Nov	2013	NH3-N	Mo. Avg.	1
					Nov	2013	NH3-N	Mx Wk. Avg.	1
					Nov	2013	NH3-N	Mx Wk. Avg.	3
					Dec	2013	DO	Daily Min.	1
					Mar	2014	DO	Daily Min.	1
					April	2014	pH	Daily Mx	1
					April	2014	Chlorine	Daily Min.	9
					April	2014	NH3-N	Mx. Wk. Avg.	1
					April	2014	NH3-N	Mx Wk. Avg.	1
					April	2014	NH3-N	Mo. Avg.	1
					April	2014	TSS	Mx Wk. Avg.	1
					May	2014	Chlorine	Mo. Avg.	1
					May	2014	Chlorine	Daily Mx	8

					June	2014	Chlorine	Mo. Avg.	1
					June	2014	Chlorine	Daily Mx.	6
					July	2014	Chlorine	Mo. Avg.	1
					July	2014	DO	Daily Mx.	3
					July	2014	Chlorine	Daily Mx.	3
					July	2014	NH3-N	Mo. Avg.	1
					July	2014	NH3-N	Mx. Wk. Avg.	4
					July	2014	NH3-N	Mx. Wk. Avg.	3
					Aug	2014	DO	Daily Min.	1
					Aug	2014	Chlorine	Mo. Avg.	1
					Aug	2014	Chlorine	Daily Mx.	3
					March	2015	Chlorine	Daily Mx.	9
					March	2015	CBOD	Mx. Wk. Avg.	1
					March	2015	TSS	Mx Wk. Avg.	1
					March	2015	pH	Daily Mx.	4
					May	2016	DO	Daily Min.	1
					May	2016	NH3-N	Mx. Wk. Avg.	1
					May	2016	NH3-N	Mx. Wk. Avg.	1
					June	2016	DO	Daily Min.	2
					July	2016	NH3-N	Mx. Wk. Avg.	2
					July	2016	NH3-N	Mx. Wk. Avg.	1
					July	2016	NH3-N	Mo. Avg.	1
					Aug	2016	TSS	Mx. Wk. Avg.	1
					Sep	2016	TSS	Mo. Avg.	1
					Nov	2016	TSS % Rem.	Mo. Avg. Min.	1
Goose Creek	Needmore Elementary School	IN0053741	Salt Creek VIA Goose Creek VIA Unnamed Trib	12/17/2013: No Violations 10/31/2014: No Violations 11/20/2015: No Violations 10/4/2016: Potential Violations 10/19/2017: No Violations	NA				
	Oolitic WWTP/ Oolitic Municipal STP	IN0023981	Salt Creek VIA Goose Creek	3/17/2014: In Violation 2/20/2015: Potential Violation 4/14/2016: No Violations 4/19/2017: In Violation	NA				

The table presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation for facility maintenance). It also presents the total number of violations in the six-year period for the NPDES permitted parameters. According to Table 25, there have been 13 NPDES facility inspections resulting in violations in the six-year period. Overall, there are a total of 171 permit violations for the NPDES permitted parameters in the Lower Salt Creek watershed during this time.

3.7.2 Storm Water

3.7.2.1 Municipal Separate Storm Sewer Systems (MS4)

327 IAC 15-13 regulates Municipal Separate Storm Sewer Systems (MS4s). 327 IAC 15-13 (Rule 13) is a storm water general permit rule. MS4s are defined as a conveyance or system of conveyances owned by a state, city, town, or other public entity that discharges to waters of the United States and is designed or used for collecting or conveying storm water. Regulated conveyance systems include roads with drains, municipal streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels and conduits. It does not include CSOs and publicly owned treatment works.

The CWA requires storm water discharges from certain types of urbanized areas to be permitted under the NPDES program. In 1990, Phase I of these requirements became effective, and municipalities with a population served by an MS4 of 100,000, or more, were regulated. Under Phase I federal storm water regulations, regulated MS4 entities were required to obtain individual permits. In 1999, Phase II became effective and any entity responsible for an MS4 conveyance, regardless of population size, could potentially be regulated. IDEM foresees that the vast majority, if not all, of the Phase II MS4 entities in Indiana will be covered under general permits. A general permit is a single permit that is written to cover multiple permittees with similar characteristics. No written draft permit is issued to the permittee under a general permit. Under 327 IAC 15-2-9(b) an individual NPDES permit is required when water quality standards are not being met under the general permit, technology or regulatory change has occurred that causes the implementation of specific controls or limitations not expressed in the general permit, or a general permit is no longer appropriate based on permittee changes. If any of these situations occur, MS4 entities covered under this general permit rule may be required to terminate coverage and apply for an individual MS4 permit

MS4 conveyances within urbanized areas have one of the greatest potentials for polluted storm water runoff. The Federal Register Final Rule explains the reason as: “urbanization alters the natural infiltration capacity of the land and generates...pollutants...causing an increase in storm water runoff volumes and pollutant loadings.” Based on increased population and proportionally higher pollutant sources, urbanization results, “in a greater concentration of pollutants that can be mobilized by, or disposed into, storm water discharges.” MS4s can be significant sources of *E. coli*, nutrients, and sediment 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.

There are four MS4 entities in the Lower Salt Creek Watershed subwatersheds as shown in Table 26 and Figure 22. 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 22 shows the MS4 boundaries in the subwatersheds of the Lower Salt Creek Watershed. The MS4 WLAs are developed at High and Moist flow regimes; it is not expected that the MS4 will have non stormwater discharges. The MS4 operator shall develop a stormwater quality management plan (SWQMP) that includes a commitment to develop and implement a strategy to detect and eliminate illicit discharges to the MS4 conveyance.

In areas not covered under the NPDES MS4 program, storm water runoff from developed areas is not regulated under a permit and is therefore a nonpoint source. Runoff from urban areas can carry a variety of pollutants originating from a variety of sources. Typically, urban sources of nutrients are fertilizer application to lawns and pet waste, which is also a source of *E. coli*. Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. However, inputs from urban sources are difficult to quantify. 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 pollutants in the Lower Salt Creek watershed.

Table 26: MS4 Communities in the Lower Salt Creek Watershed

Subwatershed	MS4 Community	Permit ID	Area in Drainage (Acres)	Percentage of Subwatershed
Jackson Creek	Monroe County	INR040089	6325.25	39.36%
	IU Bloomington	INR040123	954.38	5.94%
	Bloomington	INR040136	8,657.22	53.88%
May Creek	Bloomington	INR040136	347.01	1.81%
	Monroe County	INR040089	6,996.94	36.47%
Little Clear Creek	NA	NA	NA	NA
Hunter Creek	NA	NA	NA	NA
Knob Creek	NA	NA	NA	NA
Wolf Creek	Bedford	INR040027	315.78	1.25%
Goose Creek	Bedford	INR040027	1,217.11	5.51%

Note: NA = No MS4 communities within the subwatershed

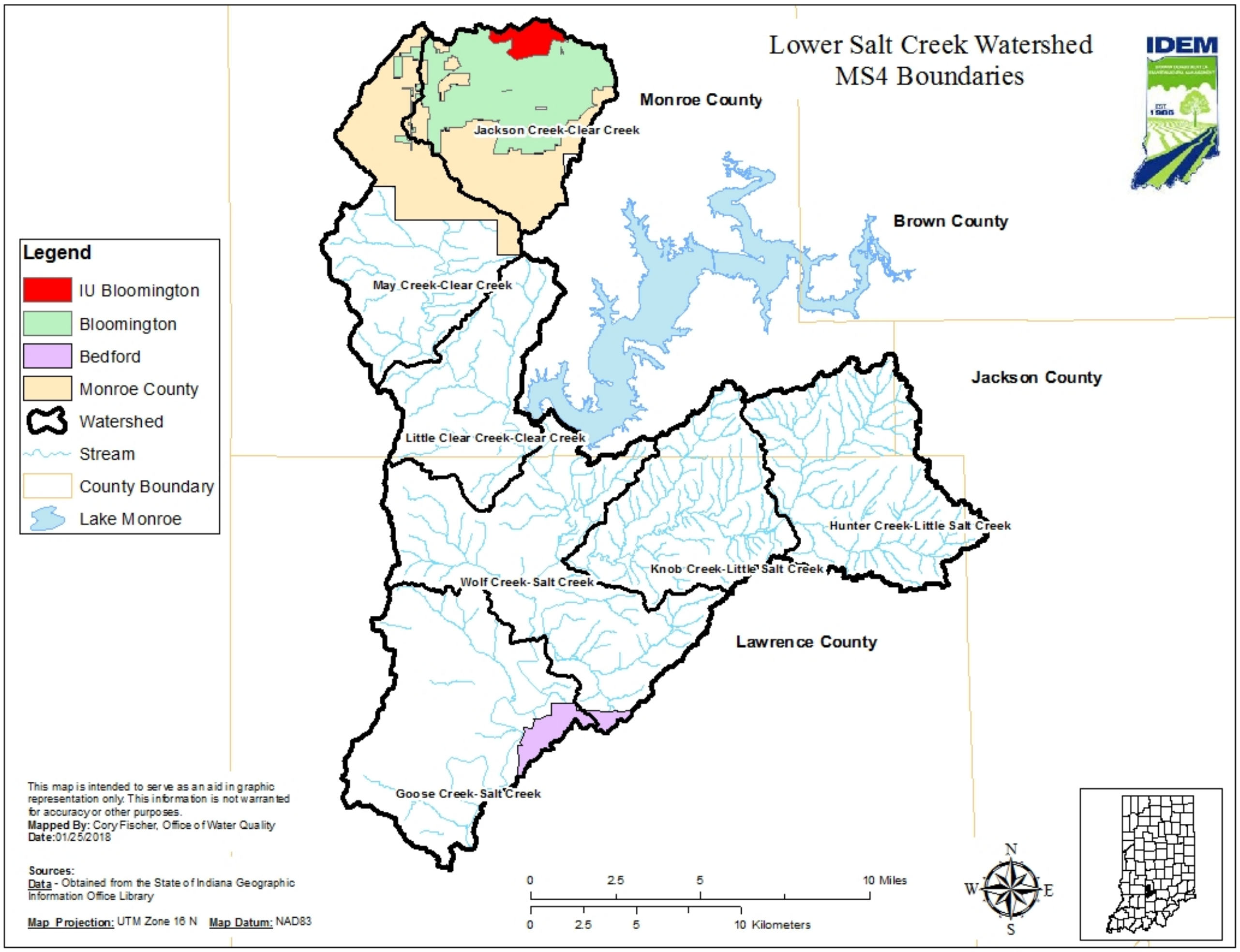


Figure 22: MS4 boundaries in the Lower Salt Creek Watershed

3.8 Summary

The information presented in Section 3 helps to provide a better comprehensive understanding of the conditions and characteristics in the Lower Salt Creek watershed that, when coupled with the sources presented in the next sections, affect both water quality and water quantity. In summary, the predominant land uses of forest and agriculture in the Lower Salt Creek watershed serve as indicators of the type of pollutant sources that are likely to contribute to water quality impairments in the watershed. Human population, which is greatest in Monroe County, indicates where more infrastructure-related pressures on water quality might exist, such as the influence of WWTP facilities and related SSO events. The subsections on topography and geology, as well as soils, provide information on the natural features that affect hydrology in the Lower Salt Creek watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the Lower Salt Creek 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 stormwater on the watershed. Collectively, this information plays an important role in understanding the sources that contribute to water quality impairment during TMDL development, and in crafting the linkage analysis that connects the observed water quality impairment to what has caused that impairment.

4.0 TECHNICAL APPROACH

Previous sections of the report have provided a description of the Lower Salt Creek 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.

4.1.1 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 with the 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., MPN/100 mL for *E. coli*) to loads (e.g., MPN/day for *E. coli*) with the following factors used for this TMDL:
- [for *E. coli*] Flow (cfs) x TMDL Concentration Target (MPN/100mL) x Conversion Factor (24,465,758.4) = Load (MPN/day)
- To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the estimated 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 U.S. EPA'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" (U.S. EPA, 2007):

- *High Flows:* Flows in this range 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.
- *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 27 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 27: Relationship Between Load Duration Curve Zones and Contributing Sources

	Duration Curve Zone				
Contributing Source Area	**High**	**Moist**	**Mid-Range**	**Dry**	**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)

4.1.2 Stream Flow Estimates

Previous sections of the report have provided a description of the Lower Salt Creek watershed and summarized the applicable water quality standards, water quality data, and identified the potential sources of pollutants 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 pollutants in each subwatershed. This section focuses on describing the methodology and is helpful in understanding subsequent sections of the TMDL report.

Daily stream flows are necessary to implement the load duration curve approach. Load duration assessment locations in the Lower Salt Creek 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 does not operate any stream flow gaging stations in the Lower Salt Creek watershed. Since there are no continuous flow data for the Lower Salt Creek watershed, flow data were estimated for the Lower Salt Creek watershed using flow data from a neighboring "surrogate" watershed. This is a standard practice when developing TMDLs for ungaged watersheds and is appropriate when the two watersheds are located close to one another and have similar land use and soil characteristics.

The Lick Creek watershed was chosen as a "surrogate" due to its proximity to the Lower Salt Creek watershed and its similar hydrologic characteristics. Both watersheds are located in the south central portion of the state and the centers of each watershed are approximately 30 miles from one another. Land use in both watersheds is mostly agriculture and forest. The location of the Lick Creek Watershed near Paoli USGS Gage (03373610) watershed flow gage is shown in Figure 23 and the period of record is from 2010 to current. Figure 24 displays the average daily flows at this gage, which are believed to be representative of the trends that would be observed in the Lower Salt Creek watershed. Flows are highest during March and April, and lowest during September and October.

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. Additional flows were added to certain locations to account for wastewater treatment plants that discharge upstream and are not directly accounted for using the drainage area weighting method.

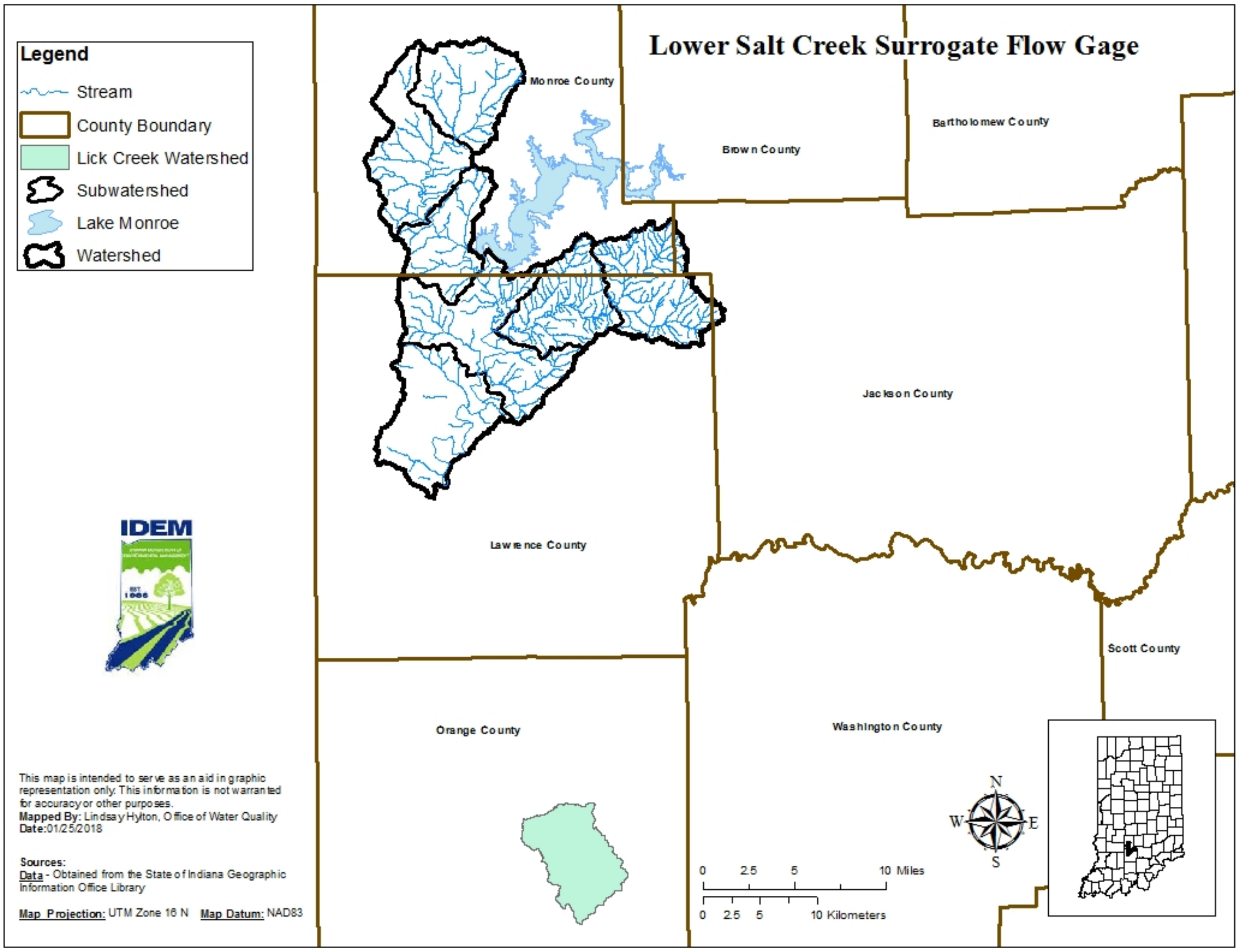


Figure 23: Location of Surrogate Flow Gage in the Lick Creek Watershed

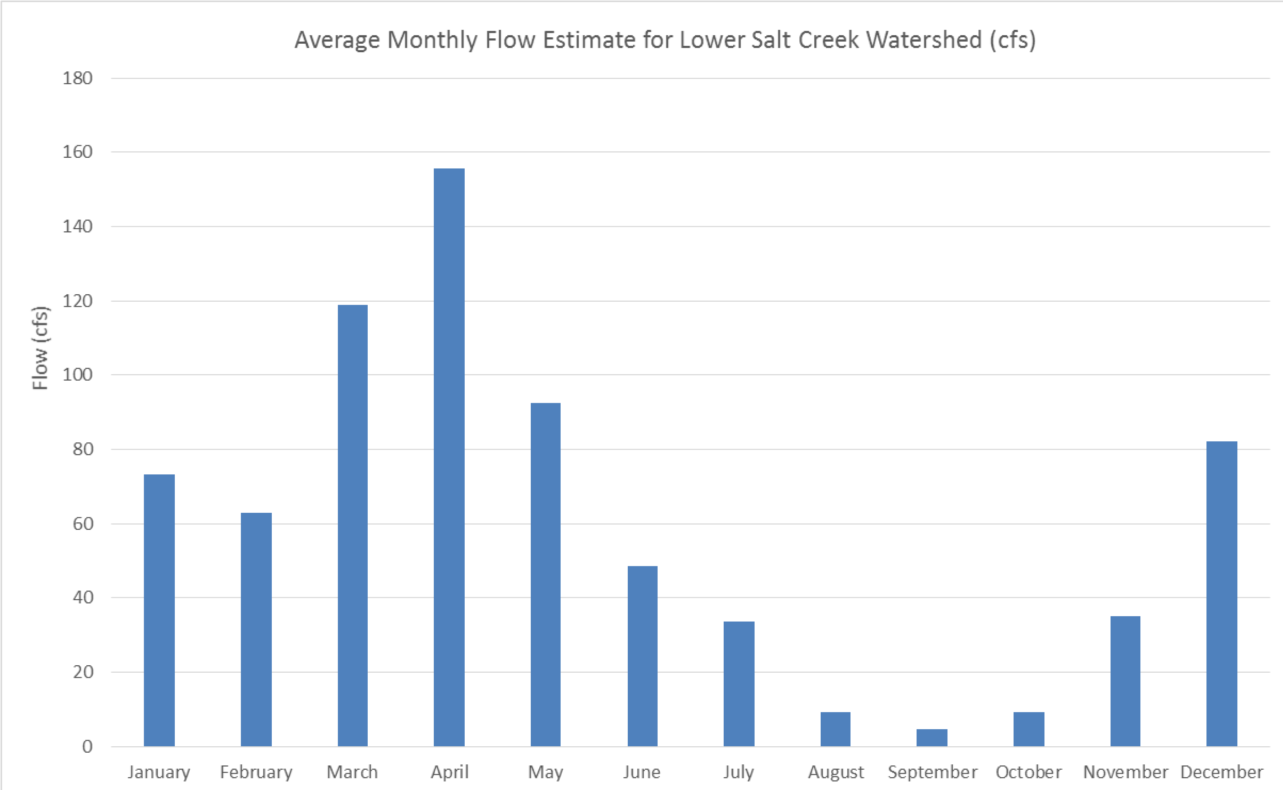


Figure 24: Average Monthly Flow Estimate for the Lower Salt Creek Watershed

4.1.3 Margin of Safety (MOS)

Section 303(d) of the CWA and U.S. EPA 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 standards with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between limitations and water quality." U.S. EPA 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 few conservative assumptions. A moderate 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.
- An additional implicit MOS for *E. coli* is included because the load duration analysis does not address die-off of pathogens.

4.1.4 Future Growth Calculations

Population trends are indicating that this watershed has been growing over the past two decades, and uncertainty in future populations in the Lower Salt Creek watershed have led IDEM to choose to allocate 5% of the loading capacity toward future growth. IDEM anticipates that land uses will likely be changing in the watershed in the future, and in anticipation of those land use changes, has set aside 5% of the loading capacity to address increased pollutant loads from those future contributors.

5.0 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 3.0 and water quality data within the Lower Salt Creek watershed are discussed in Section 2.0. 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.

5.1 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 Salt Creek watershed that were sampled by IDEM in the 2016 recreation season (April 1- October 31). The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Section 4.1.1 summarizes the load duration curve approach. This section discusses the load duration curves and the linkage between the potential sources in the Lower Salt Creek 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 Bloomington managed by the Midwestern Regional Climate Center.

E. coli sources typically associated with high flow and moist conditions include failing onsite wastewater systems, urban storm water/CSOs, 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.

Linkage Analysis by Subwatershed

Water quality duration curves, load duration curves, and precipitation graphs were created for all the sampling sites in the Lower Salt Creek watershed. Flow data used to develop the load duration curves is summarized in Section 4.1.2. The following sections discuss these graphs and the linkage of sources to the water quality exceedances for each subwatershed in the Lower Salt Creek watershed.

5.1.1 Jackson Creek Subwatershed

The Jackson Creek subwatershed drains approximately 25 square miles. The subwatershed is located in the northernmost portion of the Lower Salt Creek watershed and encompasses the majority of the city of Bloomington, including Indiana University. The land use is primarily developed (57%) followed by forested land (24%) and hay/pasture (17%) (Figure 25). There are no wastewater treatment facilities in the subwatershed but there are three MS4 communities: Monroe County, IU Bloomington, and the City of Bloomington. Over half of the subwatershed is urban or developed, indicating that the remaining homes likely pump to on-site septic systems. Based on the septic suitability of the soil, this subwatershed is primarily limited, with portions also being very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. Additionally, Jackson Creek subwatershed contains significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as land from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential locations for wetland restoration. With a land use of approximately 17 percent pasture land, a minimal presence of pasture animals is expected. There are no permitted CFO/CAFOs in the subwatershed, with a total animal density of 18.48 animals/square mile. This is lower than the median concentration when compared to other subwatersheds in the Lower Salt Creek watershed.

There are three sampling sites located in the Jackson Creek Subwatershed: two located on Clear Creek WEL-08-0008 (4) and WEL-08-0007 (3), and one located on Jackson Creek WEL-08-0006 (2). In 2015-2016 this watershed was sampled monthly, resulting in sites failing the WQS for *E. coli.* No sites in this subwatershed were fully supporting for recreational use. These stream reaches will be placed on the Draft 2018 303(d) List of Impaired Waters.

The *E. coli* geometric mean (geomean) for Site 2 was 1,134.93 MPN with 7/10 samples in exceedance of the single sample max, Site 3 had a geomean of 742.77 with 7/10 samples in exceedance of the single sample max, and Site 4 had a geomean of 1,437.45 with 9/10 samples in exceedance of the single sample max. The geomean from all sites in the watershed were taken on the same day for five consecutive weeks.

There are approximately 34 miles of streams in the subwatershed. Based on IDEM data collected in 2015-2016, all 34 stream miles will be impaired for *E. coli* on the Draft 2018 303(d) List of Impaired Waters. To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events can indicate contributions due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station USC00120784 located in Bloomington, IN. Figure 26 illustrates water quality standards violations during all flow ranges that occurred during sampling events. Table 28 provides a summary of the Jackson creek subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*.

Evaluating the load duration curves and precipitation graphs (Figures 27 & 28) with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations. 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 could include urban stormwater, small animal operations, wildlife, pasture animals with direct access to streams, straight pipes, and leaking/failing septic systems. To achieve necessary load reductions for *E.coli* impairments, implementation in Jackson Creek Subwatershed should focus on BMPs that have an impact throughout moist, mid-range, and dry flow regimes. These include septic system outreach and education, proper pet waste disposal, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 and Table 37 for additional information regarding critical conditions and suitable BMP selection for the Lower Salt Creek watershed.

Table 28: Summary of Jackson Creek Subwatershed Characteristics

Jackson Creek (051202080801)					
Drainage Area	25 square miles				
TMDL Sample Site	WEL-08-0006, WEL-08-0007, WEL-08-0008				
Listed Segments	INW0881_01 INW0881_01A INW0881_02 INW0881_03 INW0881_04 INW0881_T1001 INW0881_T1002 INW0881_T1003 INW0881_T1005 INW0881_T1006 INW0881_T1007 INW0881_T1008 INW0881_T1009 INW0881_T1010				
Land Use	Agricultural Land: 1.61% Forested Land: 24.05% Developed Land: 56.68% Open Water: 0.16% Pasture/Hay: 17.43% Grassland/Shrubs: 0.07% Wetland: 0.00%				
Industrial stormwater facilities	Fell Iron & Metal Inc. (INRM00763) JB's Salvage Incorporated West Side Auto Parts (INRM00427) (NOT A SOURCE OF E. COLI)				
Industrial wastewater facilities	N/A				
Permitted construction sites (average annual acreage)	43.3 (NOT A SOURCE OF E. COLI)				
WWTP Facilities	N/A				
MS4 Communities	Monroe County (INR040089), IU Bloomington (INR040123), Bloomington (INR040136)				
CSO Communities	N/A				
CAFOs	N/A				
CFOs	N/A				
Flow Regine TMDL analysis for *E. coli* (MPN/day)					
Allocation Category **Duration Level**	**High** 5%	**Moist** 25%	**Mid-range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**1.75E+12**	**3.12E+11**	**1.14E+11**	**2.85E+10**	**9.10E+09**
Upstream Drainage	N/A	N/A	N/A	N/A	N/A
LA	1.22E+10	2.17E+09	9.73E+10	2.42E+10	7.74E+09
Monroe Co. MS4 WLA	5.85E+11	1.04E+11	N/A	N/A	N/A
IU Bloomington MS4 WLA	9.E+10	2.E+10	N/A	N/A	N/A
City of Bloomington MS4 WLA	8.00E+11	1.43E+11	N/A	N/A	N/A
Total WLA	1.47E+12	2.63E+11	N/A	N/A	N/A
MOS (10%)	1.75E+11	3.12E+10	1.14E+10	2.85E+09	9.10E+08
Future Growth (5%)	8.74E+10	1.56E+10	5.72E+09	1.43E+09	4.55E+08

Note: LA= Load Allocation, WLA= Waste Load Allocation, MOS= Margin of Safety
*For MS4s, N/A is listed for Mid-range, Dry, and Low flow regimes because those regimes are unlikely to result in significant runoff

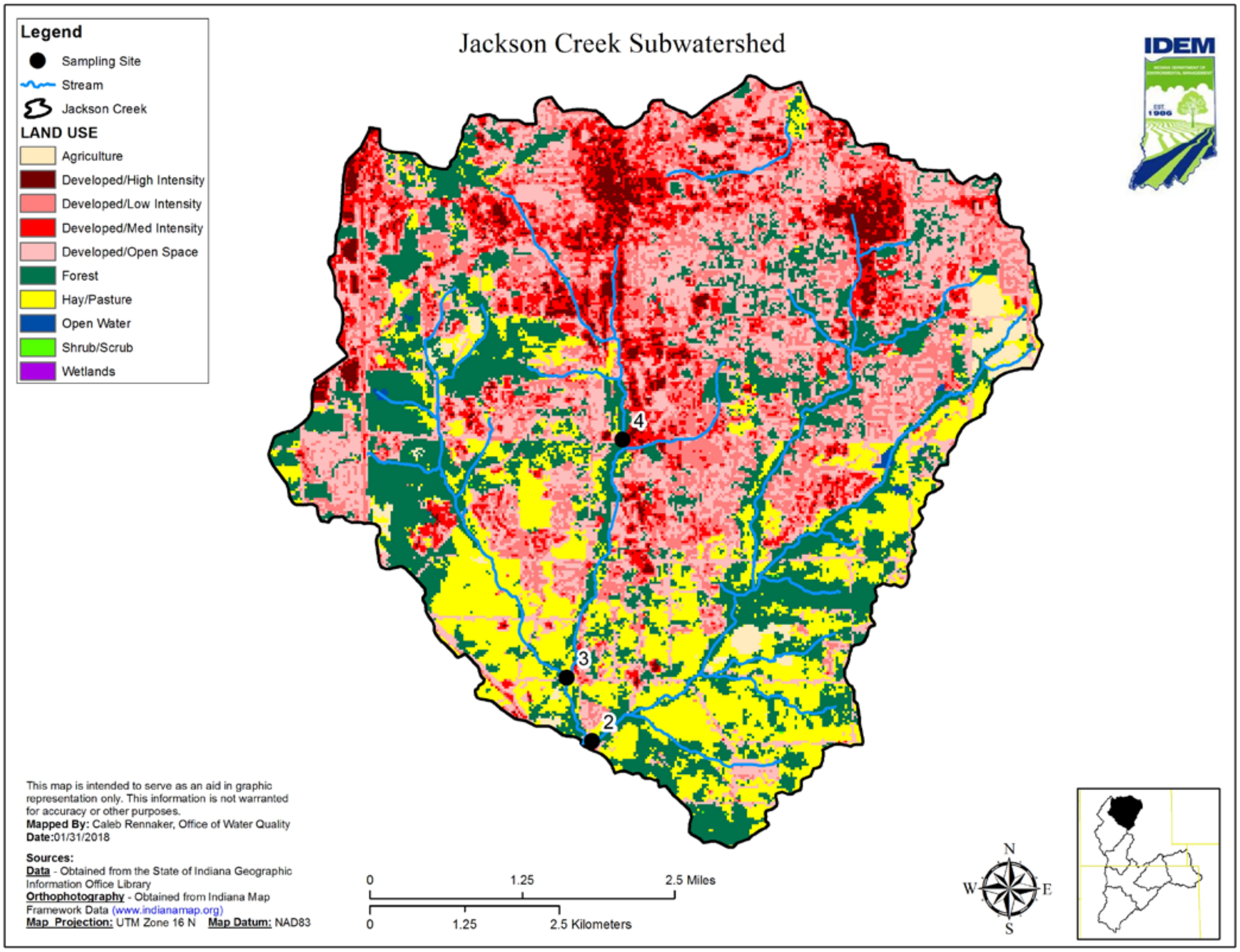


Figure 25: Sampling Sites in Jackson Creek Subwatershed

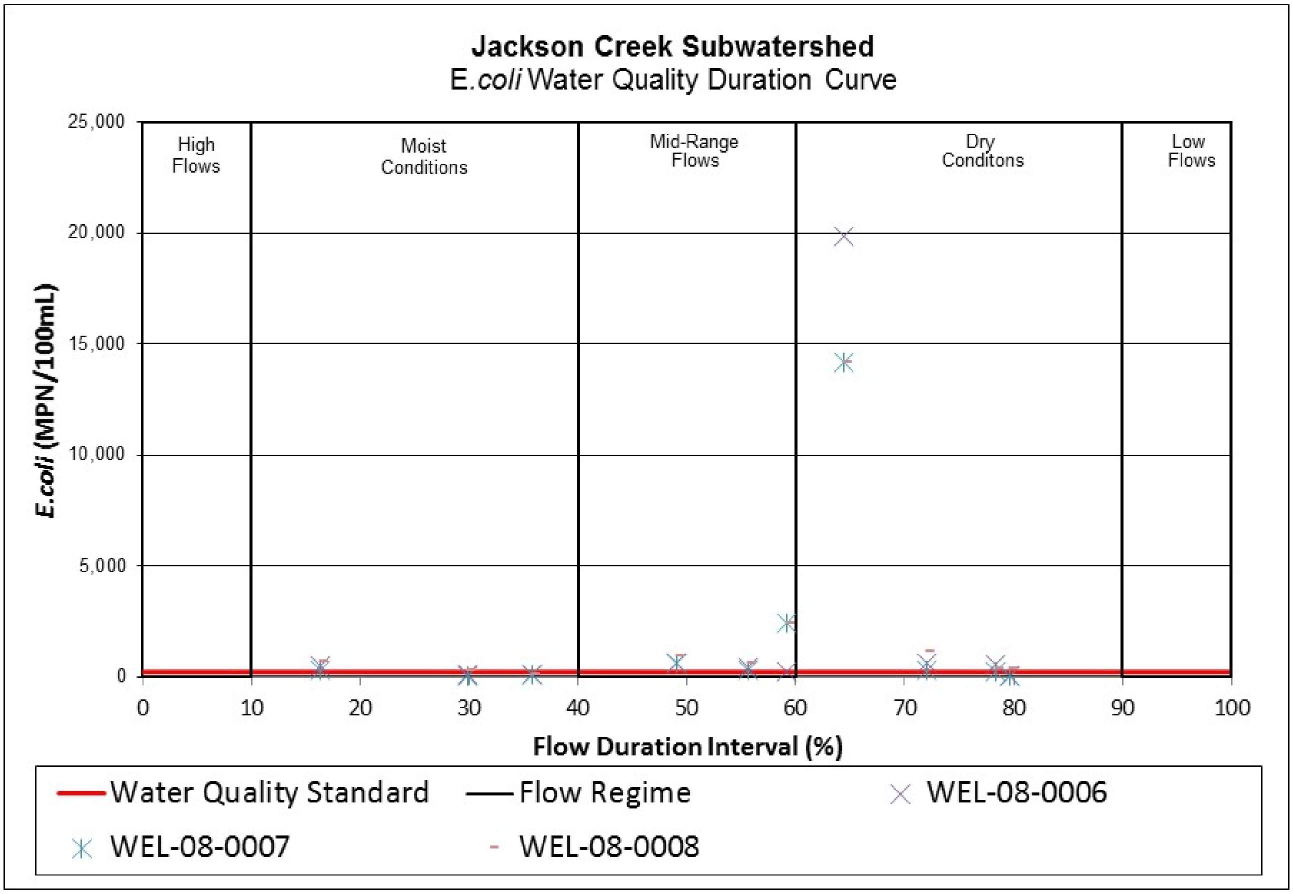


Figure 26: *E. coli* Water Quality Duration Curve for all Sampling Sites in the Jackson Creek Subwatershed

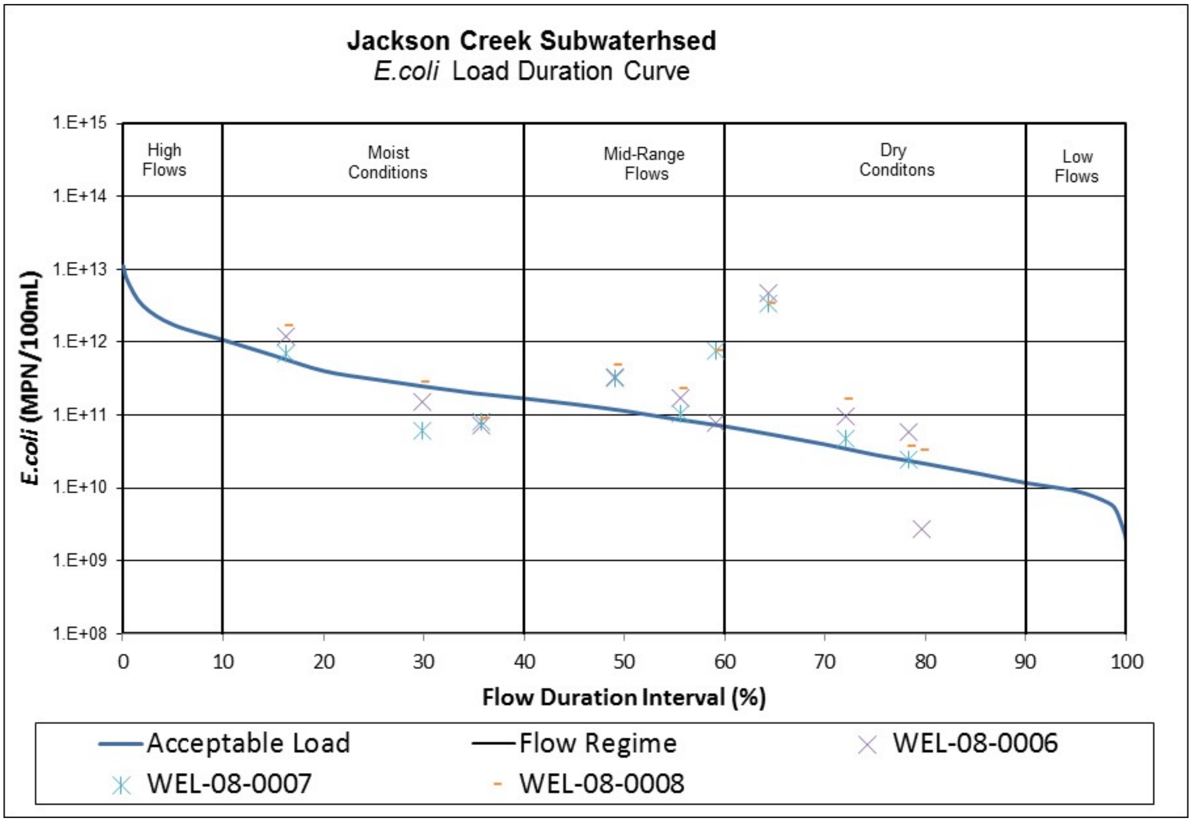


Figure 27: *E. coli* Load Duration Curve for all Sampling Sites in the Jackson Creek Subwatershed

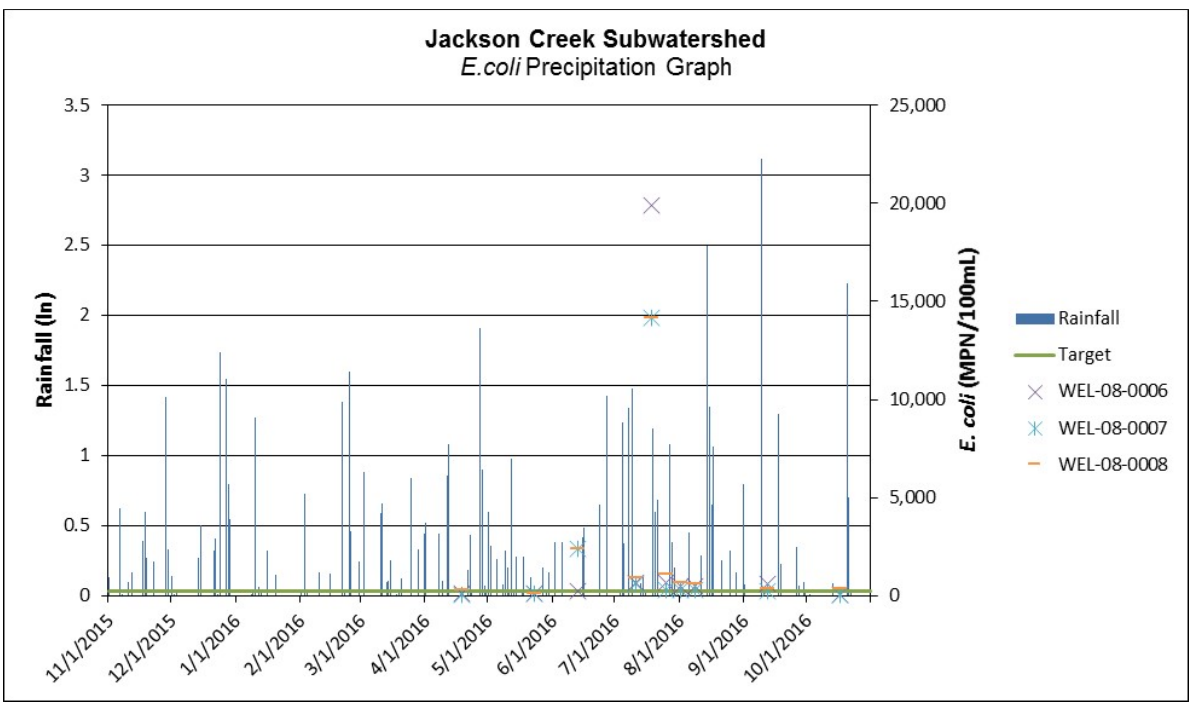


Figure 28: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the Jackson Creek Subwatershed

5.1.2 May Creek Subwatershed

The May Creek subwatershed drains approximately 55 square miles. The subwatershed sits in the upper portion of the Lower Salt Creek watershed, within Monroe County. The land use is primarily forested (62%) followed by hay and pasture land (21%) and developed land (13%) (Figure 29). There is one wastewater treatment facility within the watershed, the Bloomington S. Dillman Rd. WWTP, and two MS4 communities, Monroe County and the City of Bloomington. This is a high-capacity wastewater treatment plant which contributes around 87 percent of the flow to Clear Creek during periods of low flow in the stream. The majority of the subwatershed is forested rural land, indicating many homes pump to on-site septic systems. Based on the septic suitability of the soil, most of the subwatershed is very limited or somewhat limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. With its hilly nature, the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration. With a land use of approximately 21 percent pasture land, a presence of pasture animals is expected, many of which could have direct access to the stream corridor. There are no permitted CFO/CAFOs in the subwatershed, with a total animal density of 18.48 animals/square mile. This is lower than the median concentration when compared to other subwatersheds in the Lower Salt Creek watershed.

There are five sampling sites located in the May Creek Subwatershed: two located on Clear Creek WEL-08-0005 (1) and WEL-08-0012 (8), and three located on tributaries to Clear Creek, WEL-06-0010 (6) and WEL-08-0013 (9), and WEL-08-0011 (7). In 2015-2016 this watershed was sampled monthly resulting in sites failing the water quality standard for *E. coli*. None of the sites in this subwatershed were fully supporting for recreational use. These stream reaches will be placed on the Draft 2018 303(d) List of Impaired Waters.

The *E. coli* geomean for Site 1 was 940.26 MPN with 8/15 samples in exceedance of the single sample max, Site 8 had a geomean of 229.28 MPN with 7/15 samples in exceedance, Site 6 had a geomean of 235.8 MPN with 3/10 samples in exceedance, Site 9 had a geomean of 270.76 MPN with 1/10 samples in exceedance, and Site 7 had a geomean of 1,099.47 MPN with 7/10 samples in exceedance of the single sample max. The geomean from all sites in the watershed were taken on the same day for five consecutive weeks.

There are approximately 50 miles of streams in the subwatershed. Based on IDEM data collected in 2015-2016 there will be approximately 47 stream miles impaired for *E. coli* on the Draft 2018 303(d) List of Impaired Waters. To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events can indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station USC00120784 located in Bloomington, IN. Figure 30 illustrates water quality standards violations during all flow ranges that occurred during sampling events. Table 29 provides a summary of the May Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*.

Evaluating the load duration curves and precipitation graphs (Figures 31 & 32) with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations. 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 wildlife, pasture animals with direct access to streams, urban stormwater, straight pipes, and leaking and failing septic systems. To achieve necessary load reductions for *E.coli* impairments, implementation in the May Creek Subwaterhsed should primarily focus on BMPs that have an impact throughout moist, mid-range and dry flow regimes. These include septic system outreach and education, stormwater reduction, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 and Table 37 for additional information regarding critical conditions and suitable BMP selection for the Lower Salt Creek watershed.

Table 29: Summary of May Creek Subwatershed Characteristics

May Creek (051202080802)					
Drainage Area	55 square miles				
TMDL Sample Site	WEL-08-0005, WEL-08-0012, WEL-08-0010, WEL-08-0013, WEL-08-0011				
Listed Segments	INW0882_02 INW0882_03 INW0882_T1001 INW0882_T1003 INW0882_T1004 INW0882_T1005 INW0882_T1006 INW0882_T1007				
Land Use	Agricultural Land: 3.78% Forested Land: 61.68% Developed Land: 12.72% Open Water: 0.31% Pasture/Hay: 21.43% Grassland/Shrubs: 0.07% Wetland: 0.01%				
Industrial stormwater facilities	Hoosier Disposal & Recycling (INRM01182) GEA Bloomington Productions Operations LLC (INRM01894) United Parcel Service, Bloomington (INRM00246) (NOT A SOURCE OF E. COLI)				
Industrial wastewater facilities	Dimension Stone Operation (INDIANA LIMESTONE ACQUISITION - CROWN QUARRY) (ING490142), Sawing & Surfacing Limestone (INDIANA LIMESTONE CO INC – CENTRAL) (ING490094) (NOT A SOURCE OF E. COLI)				
Permitted construction sites (average annual acreage)	219.7 (NOT A SOURCE OF E. COLI)				
WWTP Facilities	Bloomington S. Dillman Rd. (IN0035718)				
MS4 Communities	Bloomington (INR040136), Monroe County (INR040089)				
CSO Communities	N/A				
CAFOs	N/A				
CFOs	N/A				
Flow Regime TMDL analysis for *E. coli* (MPN/day)					
Allocation Category **Duration Level**	**High** 5%	**Moist** 25%	**Mid-range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**3.92E+12**	**8.10E+11**	**3.82E+11**	**1.95E+11**	**1.53E+11**
Upstream Drainage Input (Jackson Creek)	1.75E+12	3.12E+11	1.14E+11	2.85E+10	9.10E+09
LA	1.07E+12	1.91E+11	1.14E+11	2.83E+10	9.04E+09
Monroe County MS4 WLA	6.33E+11	1.13E+11	N/A	N/A	N/A

City of Bloomington MS4 WLA	3.14E+10	5.61E+09	N/A	N/A	N/A
Bloomington S. Dillman Rd. WWTP WLA	1.33E+11	1.33E+11	1.33E+11	1.33E+11	1.33E+11
Total WLA	7.98E+11	2.52E+11	1.33E+11	1.33E+11	1.33E+11
MOS (10%)	2.04E+11	3.65E+10	1.34E+10	3.33E+09	1.06E+09
Future Growth (5%)	1.02E+11	1.82E+10	6.69E+09	1.67E+09	5.32E+08

Note: LA= Load Allocation, WLA= Waste Load Allocation, MOS= Margin of Safety

*For MS4s, N/A is listed for Mid-range, Dry, and Low flow regimes because those regimes are unlikely to result in significant runoff

*Due to the Dillman Road WWTP facility discharge, flow in this watershed is largely effluent driven at low flows. To support loading capacity, the MOS and Future Growth for May Creek subwatershed were calculated based on the TMDL less upstream contributions and the WLA from the Dillman WWTP. Due to implicit assumptions of loadings coming from this facility, the resulting values are still believed to result in protection of water quality standards.

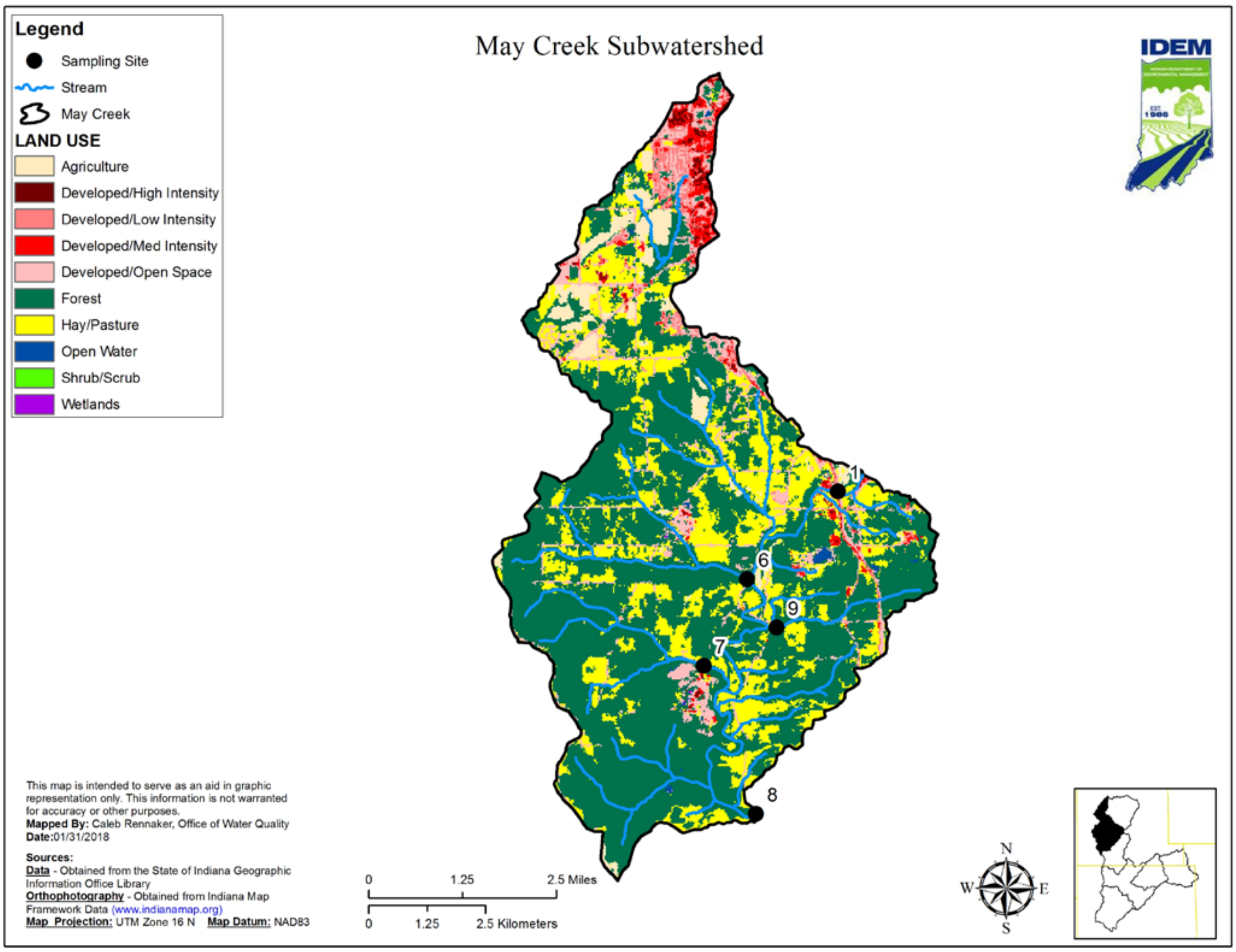


Figure 29: Sampling Sites in May Creek Subwatershed

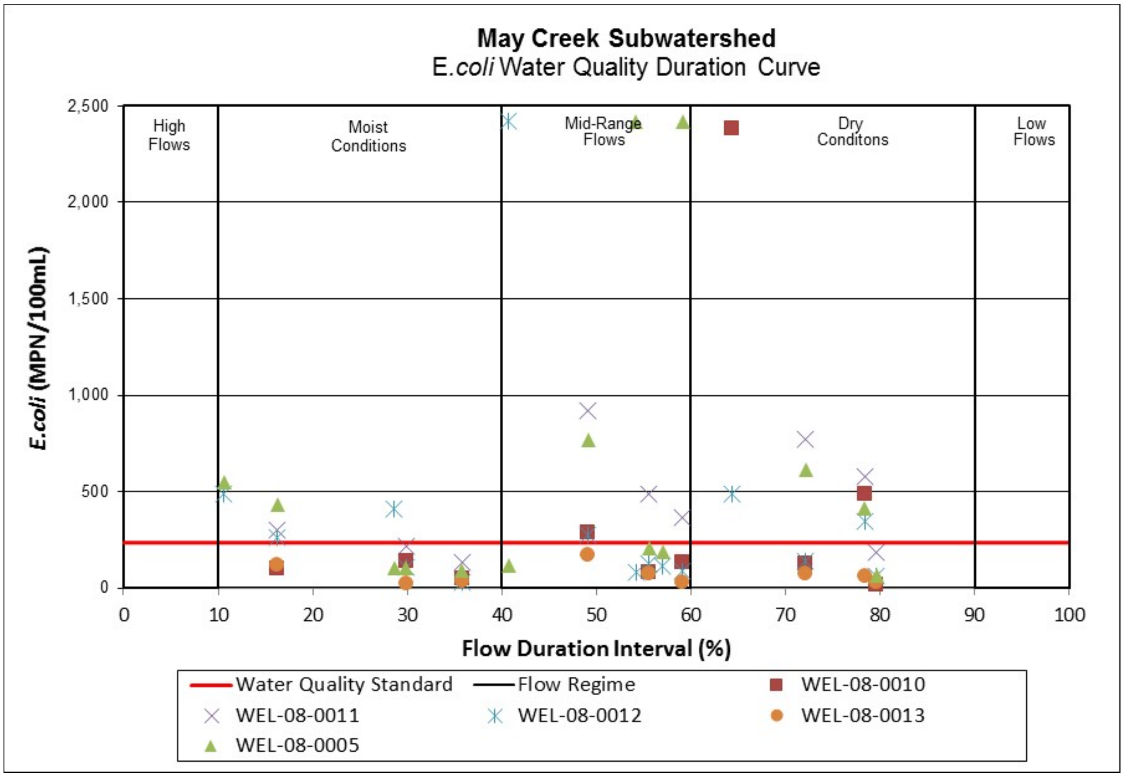


Figure 30: *E. coli* Water Quality Duration Curve for all Sampling Sites in the May Creek Subwatershed

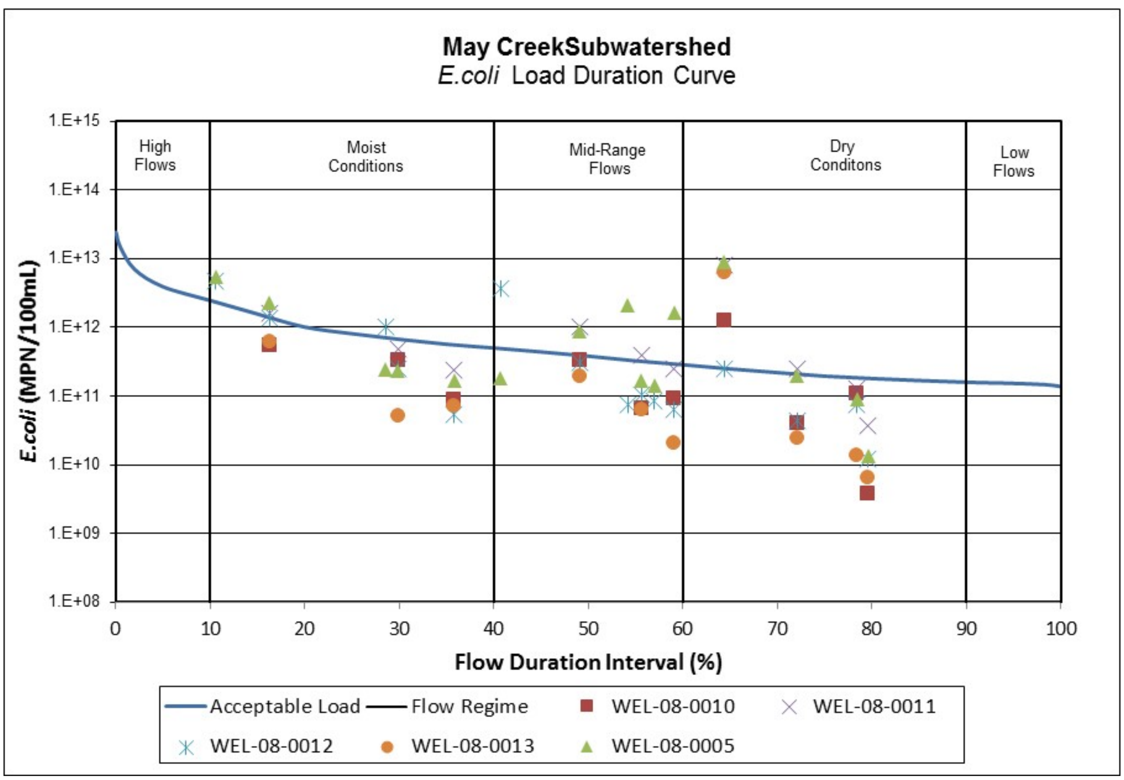


Figure 31: *E. coli* Load Duration Curve for all Sampling Sites in the May Creek Subwatershed

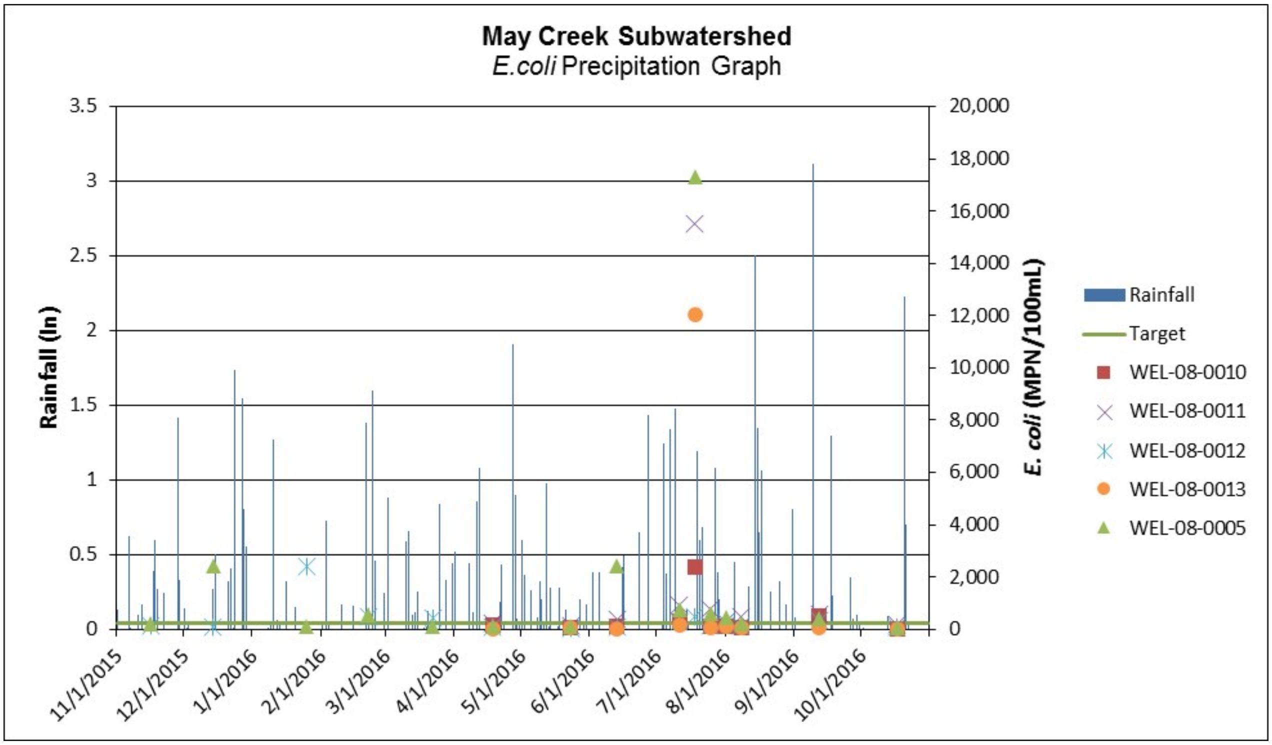


Figure 32: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the May Creek Subwatershed

5.1.3 Little Clear Creek Subwatershed

The Little Clear Creek subwatershed drains approximately 76 square miles. The subwatershed forms the northern middle portion of the watershed. The land use is primarily forested (57%) followed by hay and pasture land (33%) and developed land (7%) (Figure 33). There are two wastewater treatment facilities in the subwatershed, the South Central RSD Caslon WWTP and the Briarwood Subdivision WWTP. Monroe County is the only MS4 community within the subwatershed. The majority of the subwatershed is forested and rural, indicating many homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is either somewhat limited or very limited. For this reason, maintenance and inspections of septic systems in the area is important to ensure proper function and capacity.

With its hilly nature, this subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes. Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration. With a land use of approximately 33 percent pasture land, a moderate presence of pasture animals is expected, many of which could have direct access to the stream corridor. There are no permitted CFO/CAFOs in this subwatershed, which has a total animal density of 20.97 animals/square mile. This is lower than the median concentration when compared to other subwatersheds in the Lower Salt Creek watershed.

There are four sampling sites located in the Little Clear Creek Subwatershed: two located on Clear Creek, WEL-08-0015 (11) and WEL-08-0016 (12), one located on Little Clear Creek, WEL-08-0017 (13), and one located on Judah Branch, WEL-08-0014 (10). In 2015-2016 this watershed was sampled monthly resulting in sites failing the water quality standard for *E. coli*. None of the sites were fully supporting for recreational use. These stream reaches will be placed on the Draft 2018 303(d) List of Impaired Waters.

The *E. coli* geomean for Site 11 was 289.41 MPN with 2/10 samples in exceedance of the single sample max; Site 12 had a geomean of 358.48 MPN with 5/15 samples in exceedance; Site 13 had a geomean of 799.75 MPN with 2/10 samples in exceedance; Site 10 had a geomean of 840.09 MPN with 4/10 samples in exceedance of the single sample max. The geomean from all sites in the watershed were taken on the same day for five consecutive weeks.

There are approximately 36 miles of streams in the subwatershed. Based on IDEM data collected in 2015-2016 there will be approximately 33 stream miles impaired for *E. coli* on the Draft 2018 303(d) List of Impaired Waters. To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events can indicate contributions due to runoff. Precipitation data was taken from a National Weather Service Co-operative Station USC00120784 located in Bloomington, IN. Figure 34 illustrates water quality standards violations during all flow ranges that occurred during sampling events. Table 30 provides a summary of the Little Clear Creek subwatershed, including impaired segment AUIDs, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*.

Evaluating the load duration curves and precipitation graphs (Figures 35 & 36) with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations. 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 wildlife, pasture animals with direct access to streams, straight pipes, and leaking and failing septic systems. To achieve necessary load reductions for *E.coli* impairments, implementation in the Little Clear Creek subwatershed should focus on BMPs that have an impact throughout moist, mid-range, and dry flow regimes. These include septic system outreach and education, stormwater reduction, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 and Table 37 for additional information regarding critical conditions and suitable BMP selection for the Lower Salt Creek watershed.

Table 30: Summary of Little Clear Creek Subwatershed Characteristics

Little Clear Creek (051202080803)					
Drainage Area	76 square miles				
TMDL Sample Site	WEL-08-0015, WEL-08-0016, WEL-08-0017, WEL-08-0014				
Listed Segments	INW0883_01 INW0883_02 INW0883_T1001 INW0883_T1002 INW0883_T1003 INW0883_T1004 INW0883_T1005				
Land Use	Agricultural Land: 3.26% Forested Land: 57.24% Developed Land: 6.50% Open Water: 0.07% Pasture/Hay: 32.78% Grassland/Shrubs: 0.15% Wetland: 0.00%				
Industrial stormwater facilities	Ben's Quarry LLC (INRM01594) (NOT A SOURCE OF E. COLI)				
Industrial wastewater facilities	N/A				
Permitted construction sites (average annual acreage)	8.3 (NOT A SOURCE OF E. COLI)				
WWTP Facilities	South Central RSD Caslon (IN0045187), Briarwood Subdivision (IN0038920)				
MS4 Communities	N/A				
CSO Communities	N/A				
CAFOs	N/A				
CFOs	N/A				
Flow Regime TMDL analysis for *E. coli* (MPN/day)					
Allocation Category **Duration Level**	**High** 5%	**Moist** 25%	**Mid-Range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**5.36E+12**	**1.07E+12**	**4.79E+11**	**2.22E+11**	**1.64E+11**
Upstream Drainage Input (May Creek)	3.92E+12	8.10E+11	3.82E+11	1.95E+11	1.53E+11
LA	1.22E+12	2.18E+11	7.96E+10	1.95E+10	5.91E+09
South Central RSD Caslon WWTP WLA	2.67E+09	2.67E+09	2.67E+09	2.67E+09	2.67E+09
Briarwood Subdivision WWTP WLA	3.29E+08	3.29E+08	3.29E+08	3.29E+08	3.29E+08
Total WLA	**3.00E+09**	**3.00E+09**	**3.00E+09**	**3.00E+09**	**3.00E+09**
MOS (10%)	1.44E+11	2.60E+10	9.71E+09	2.64E+09	1.05E+09
Future Growth (5%)	7.20E+10	1.30E+10	4.86E+09	1.32E+09	5.24E+08

Note: LA= Load Allocation, WLA= Waste Load Allocation, MOS= Margin of Safety

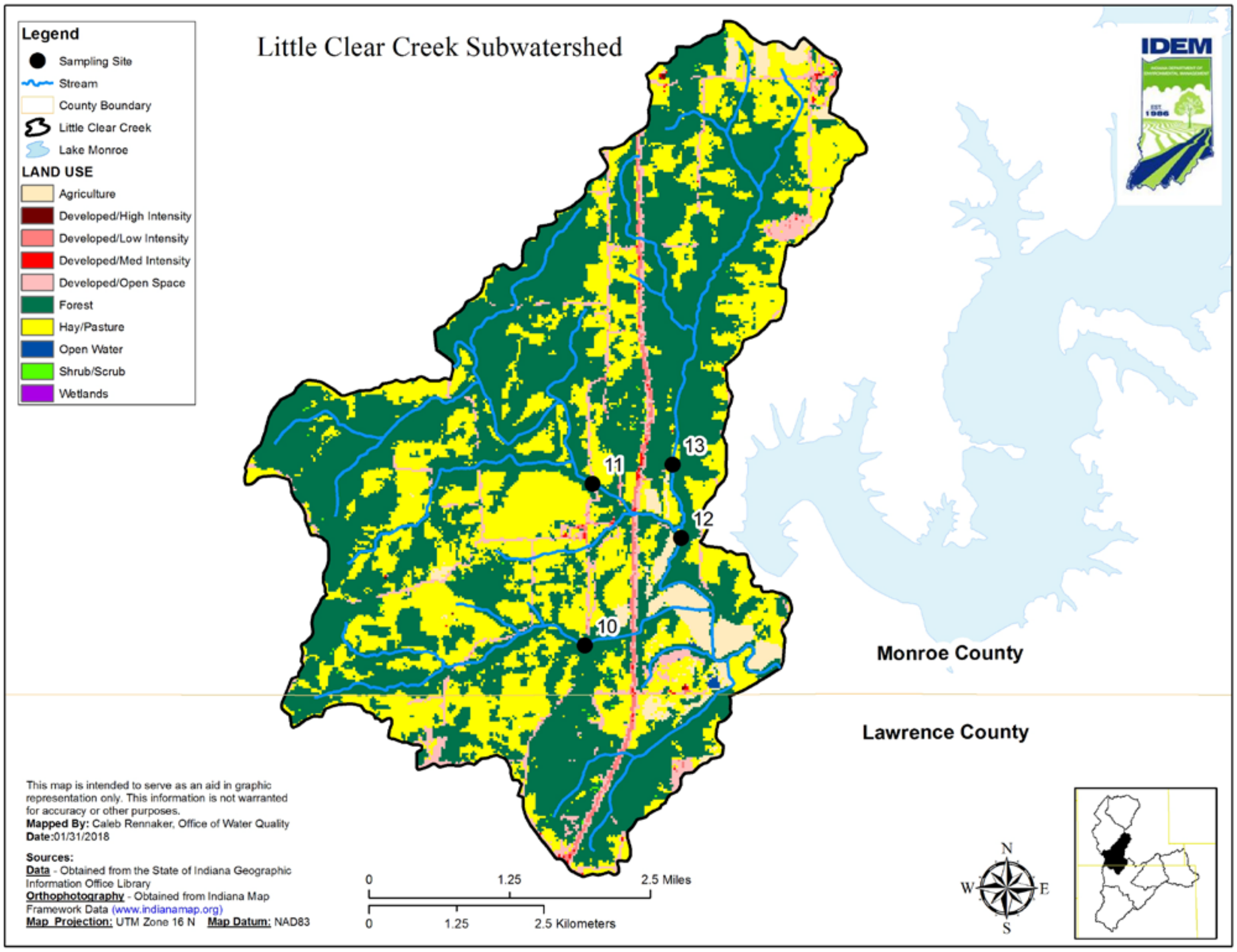


Figure 33: Sampling Sites in Little Clear Creek Subwatershed

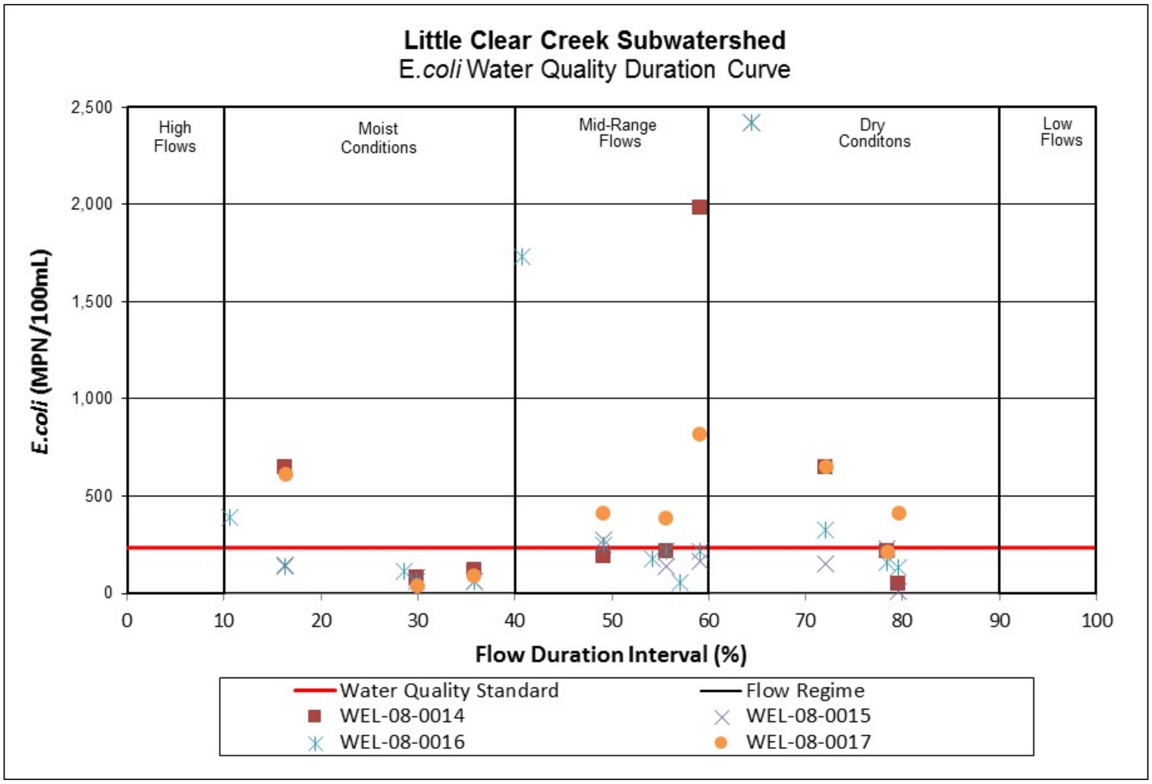


Figure 34: *E. coli* Water Quality Duration Curve for all Sampling Sites in the Little Clear Creek Subwatershed

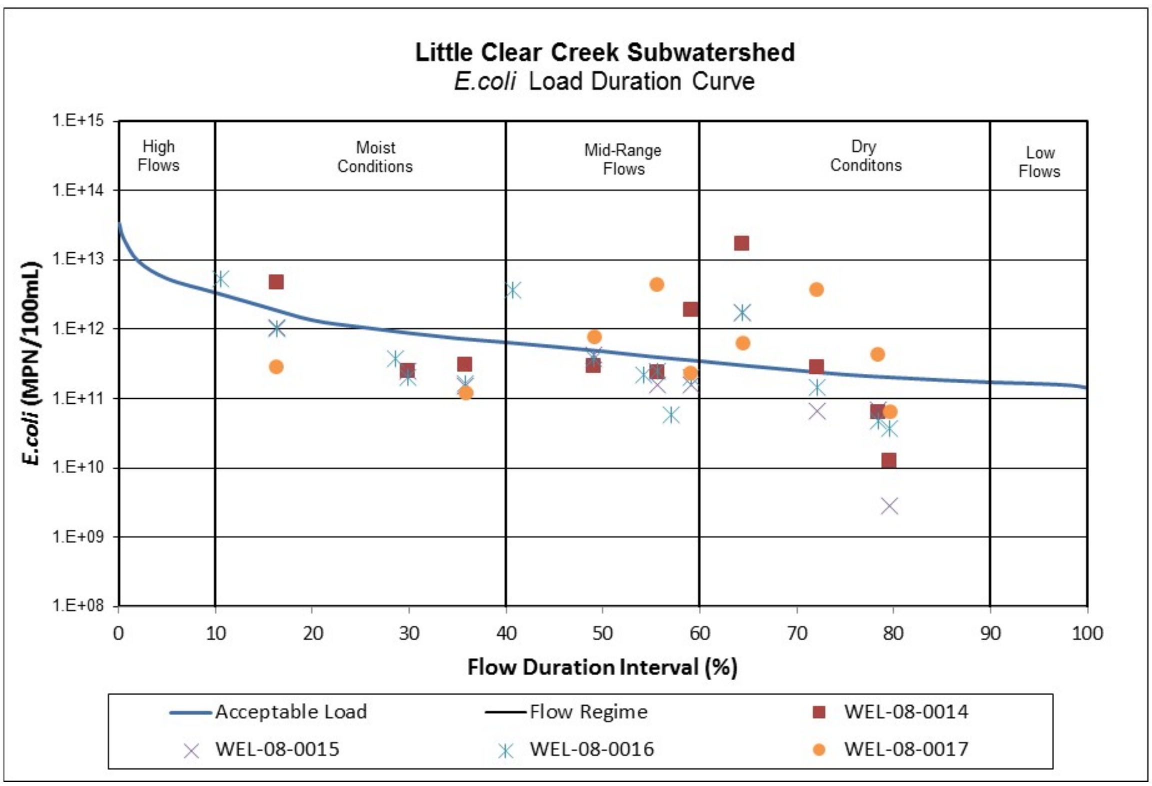


Figure 35: *E. coli* Load Duration Curve for all Sampling Sites in the Little Clear Creek Subwatershed

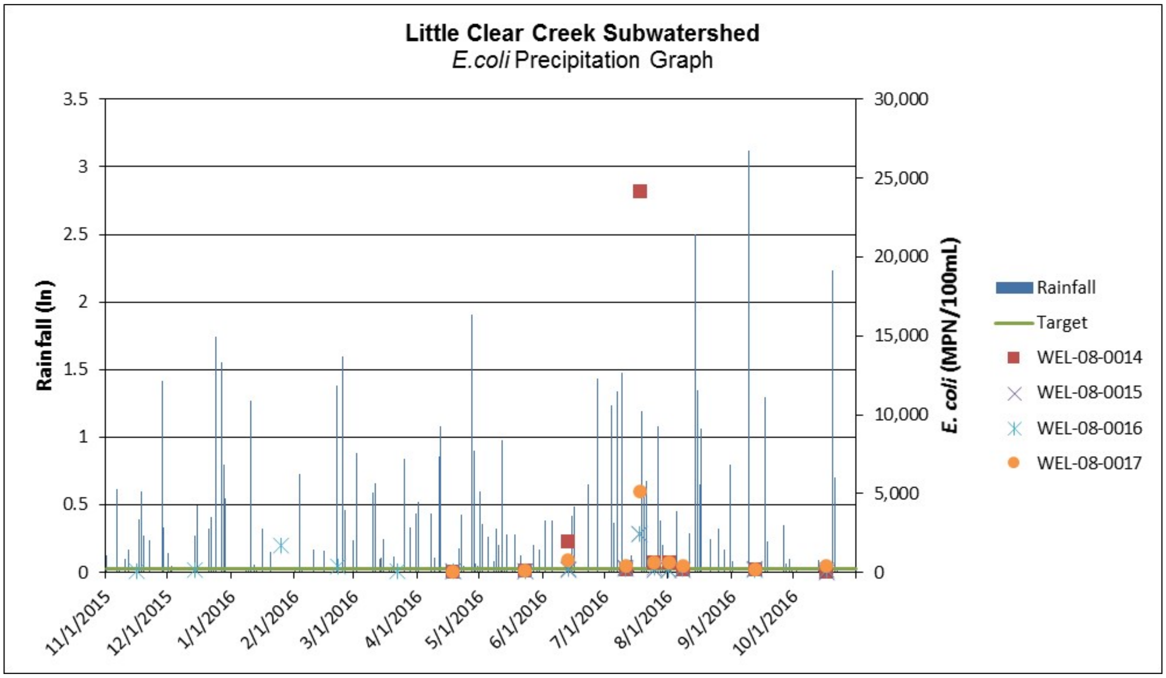


Figure 36: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the Little Clear Creek Subwatershed

5.1.4 Hunter Creek Subwatershed

Although there are no *E. coli* reductions needed for this subwatershed and TMDLs are not being developed for it, the information below (Figures 38, 39, & 40) can be useful during the watershed management plan development process.

The Hunter Creek subwatershed drains approximately 30 square miles. The subwatershed forms the easternmost portion of the watershed, within Monroe, Lawrence, and Jackson Counties. The land use is primarily forested (90%), followed by hay and pasture land (5%) and agricultural uses (3%) (Figure 37). There are no permitted WWTP facilities in the subwatershed or MS4 communities. The majority of the subwatershed is heavily forested and rural, with Hoosier National Forest covering much of the subwatershed. Homes would pump to on-site septic systems, and based on the septic suitability of the soil, the majority of the subwatershed is very limited. For this reason, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

Despite its hilly nature, this subwatershed contains significantly less areas with highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes. To a lesser extent than the other subwatersheds, some of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration. And with a land use of approximately 90 percent forested land, a significant presence of wildlife is expected, many of which will utilize the stream corridor.

There are two sampling sites located in the Hunter Creek Subwatershed: one located on Little Salt Creek, WEL-08-0035 (16), and one located on Henderson Creek, WEL-08-0019 (15). Both sites were fully supporting for recreational use. There was insufficient data for these sites to calculate a geometric mean due to a power outage during sample processing. Assessments were based on secondary methods as outlined in IDEM's 2016 Consolidated Assessment and Listing Methodology (CALM).

Table 31: Summary of Hunter Creek Subwatershed Characteristics

Hunter Creek (051202080804)					
Drainage Area	30 square miles				
TMDL Sample Site	WEL-08-0035, WEL-08-0019				
Listed Segments	N/A				
Land Use	Agricultural Land: 3.23% Forested Land: 89.87% Developed Land: 2.28% Open Water: 0.04% Pasture/Hay: 4.56% Grassland/Shrubs: 0.02% Wetland: 0.00%				
Industrial stormwater facilities	N/A (NOT A SOURCE OF E. COLI)				
Industrial wastewater facilities	N/A				
Permitted construction sites (average annual acreage)	0.73 (NOT A SOURCE OF E. COLI)				
WWTP Facilities	N/A				
MS4 Communities	N/A				
CSO Communities	N/A				
CAFOs	N/A				
CFOs	N/A				
Flow Regine TMDL analysis for *E. coli* (MPN/day)					
Allocation Category **Duration Level**	**High** 5%	**Moist** 25%	**Mid-range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**2.04E+12**	**3.65E+11**	**1.34E+11**	**3.33E+10**	**1.06E+10**
Upstream Drainage	N/A	N/A	N/A	N/A	N/A
LA	1.74E+12	3.10E+11	1.14E+11	2.83E+10	9.04E+09
Total WLA	N/A	N/A	N/A	N/A	N/A
MOS (10%)	2.04E+11	3.65E+10	1.34E+10	3.33E+09	1.06E+09
Future Growth (5%)	1.02E+11	1.82E+10	6.69E+09	1.67E+09	5.32E+08

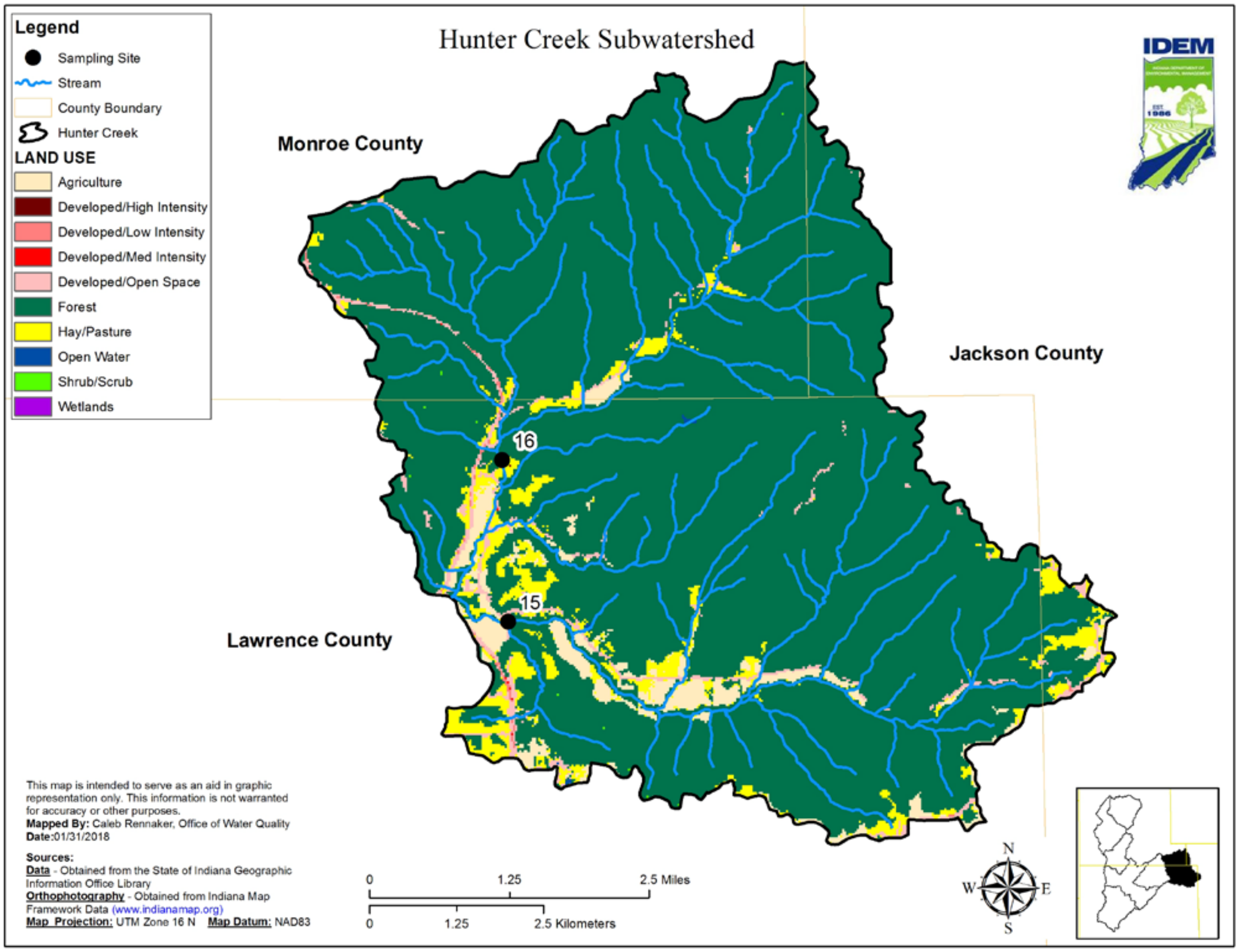


Figure 37: Sampling Sites in the Hunter Creek Subwatershed

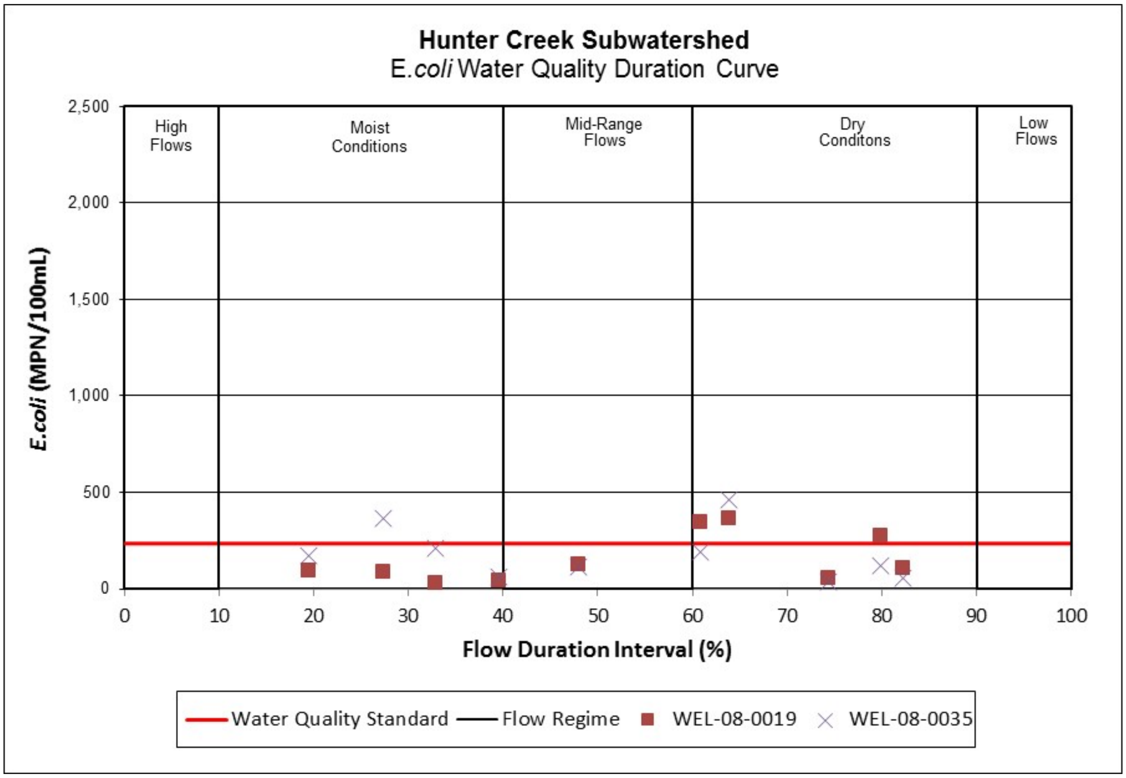


Figure 38: *E. coli* Water Quality Duration Curve for all Sampling Sites in the Hunter Creek Subwatershed

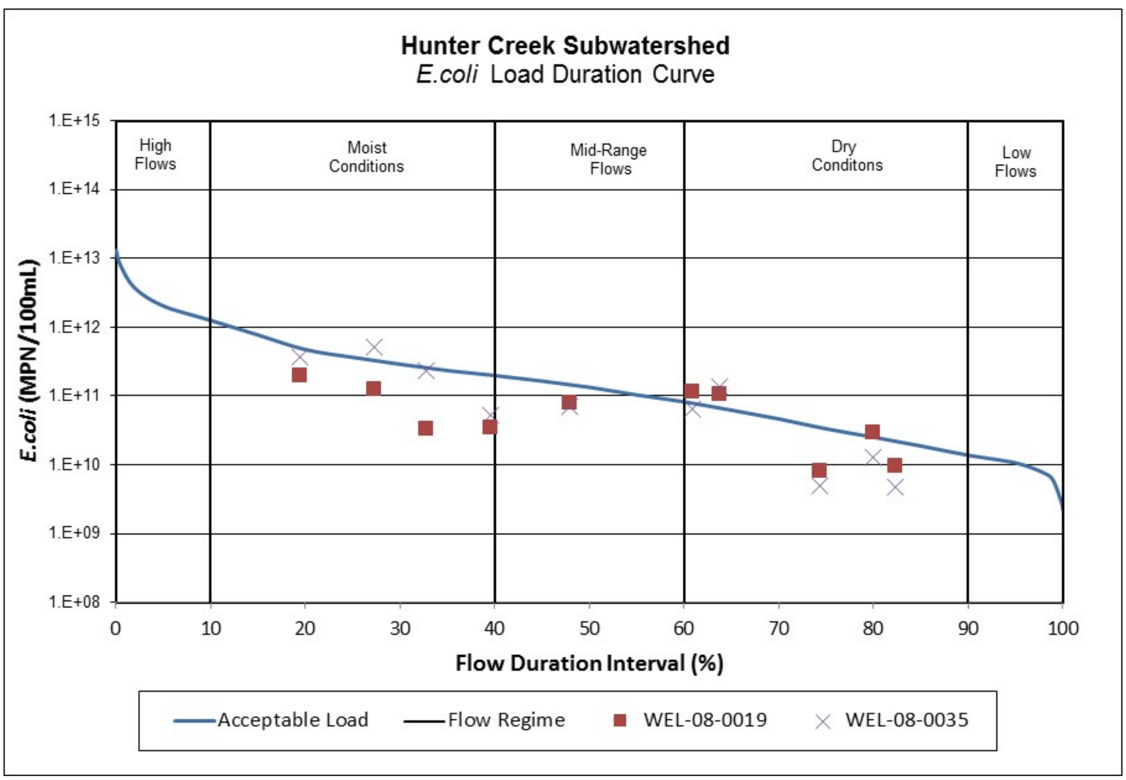


Figure 39: *E. coli* Load Duration Curve for all Sampling Sites in the Hunter Creek Subwatershed

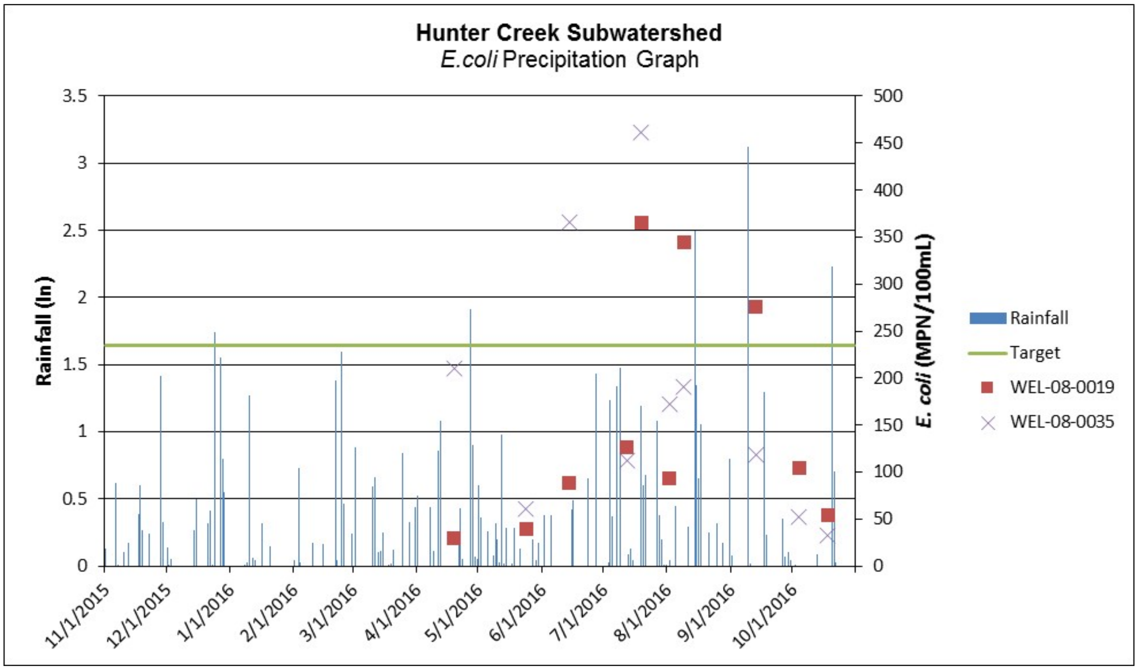


Figure 40: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the Hunter Creek Subwatershed

5.1.5 Knob Creek Subwatershed

The Knob Creek subwatershed drains approximately 54 square miles. Located in Lawrence and Monroe Counties, the subwatershed contains the second largest area of managed and classified lands in the Lower Salt Creek watershed. The land use is primarily forested (72%), followed by hay and pasture land (14%) and agricultural uses (11%) (Figure 41). There are no permitted industrial facilities, WWTPs, or MS4 communities in the subwatershed. The entire subwatershed is rural, indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. For this reason, maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. While less than the other subwatersheds in Lower Salt Creek, Knob Creek subwatershed contains a fair amount of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes. Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration. With a land use of approximately 14 percent pasture land, a minimal presence of pasture animals is expected. With 72 percent of the land being forested, an even greater presence of wildlife is expected, many of which will utilize the stream corridor. There are no permitted CFO/CAFOs in this subwatershed, which has a total animal density of 33.07 animals/square mile. This is higher than the median concentration when compared to other subwatersheds in the Lower Salt Creek watershed.

There are five sampling sites located in the Knob Creek Subwatershed, one located on Knob Creek WEL-08-0022 (18), one located on tributary of Little Salt Creek WEL-08-0024 (20) and three located on Little Salt Creek, WEL-08-0018 (14), WEL-08-0021 (17), and WEL-08-0023 (19). In 2015-2016 this watershed was sampled monthly, resulting in one site, WEL-08-0022 (18), failing the WQS for *E. coli*. This stream reach will be placed on the Draft 2018 303(d) List of Impaired Waters. All other sites were all found to be fully supporting for recreational use.

The *E. coli* geomean was unable to be calculated for all five sites due to a power outage during sample processing. Therefore, assessments were based on secondary methods as outlined in IDEM's 2016 CALM. However, Site 18 exceeded the single sample max in 8/10 samples, with a max sample value of 816.4 MPN.

There are approximately 77 miles of streams in the subwatershed. Based on IDEM data collected in 2015-2016 there will be approximately 22 stream miles impaired for *E. coli* on the Draft 2018 303(d) List of Impaired Waters. To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events can indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station USC00120784, located in Bloomington, IN. Figure 42 illustrates water quality standards violations during all flow ranges that occurred during sampling events. Table 32 provides a summary of the Knob Creek subwatershed, including impaired segment AUID, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*.

Evaluating the load duration curves and precipitation graphs (Figures 43 & 44) with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations. 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 wildlife, pasture animals with direct access to streams, straight pipes, and leaking and failing septic systems. To achieve necessary load reductions for *E.coli* impairments, implementation in Knob Creek Subwatershed should focus on BMPs that have an impact throughout moist, mid-range, and dry flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 and Table 37 for additional information regarding critical conditions and suitable BMP selection for the Lower Salt Creek watershed.

Table 32: Summary of Knob Creek Subwatershed Characteristics

Knob Creek (051202080805)					
Drainage Area	54 square miles				
TMDL Sample Sites	WEL-08-0018, WEL-08-0021, WEL-08-0022, WEL-08-0023, WEL-08-0024				
Listed Segments	INW0885_T1007 INW0885_T1008 INW0885_T1009				
Land Use	Agricultural Land: 11% Forested Land: 72% Developed Land: 3% Open Water: <1% Pasture/Hay: 14% Grassland/Shrubs: <1% Wetland: 0%				
Industrial stormwater facilities	N/A				
Industrial wastewater facilities	N/A				
Permitted construction sites (average annual acreage)	N/A				
WWTP Facilities	N/A				
MS4 Communities	N/A				
CSO Communities	N/A				
CAFOs	N/A				
CFOs	N/A				
Flow Regime TMDL analysis for *E. coli* (MPN/Day)					
Allocation Category **Duration Interval**	**High** 5%	**Moist** 25%	**Mid-range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**3.71E+12**	**6.63E+11**	**2.43E+11**	**6.05E+10**	**1.93E+10**
Upstream Drainage Input (Hunter Creek)	2.04E+12	3.65E+11	1.34E+11	3.33E+10	1.06E+10
LA	1.42E+12	2.53E+11	9.27E+10	2.31E+10	7.37E+09
WLA	N/A	N/A	N/A	N/A	N/A
MOS (10%)	1.67E+11	2.98E+10	1.09E+10	2.72E+09	8.68E+08
FG (5%)	8.33E+10	1.49E+10	5.45E+09	1.36E+09	4.34E+08

Note: LA= Load Allocation, WLA= Waste Load Allocation, MOS= Margin of Safety

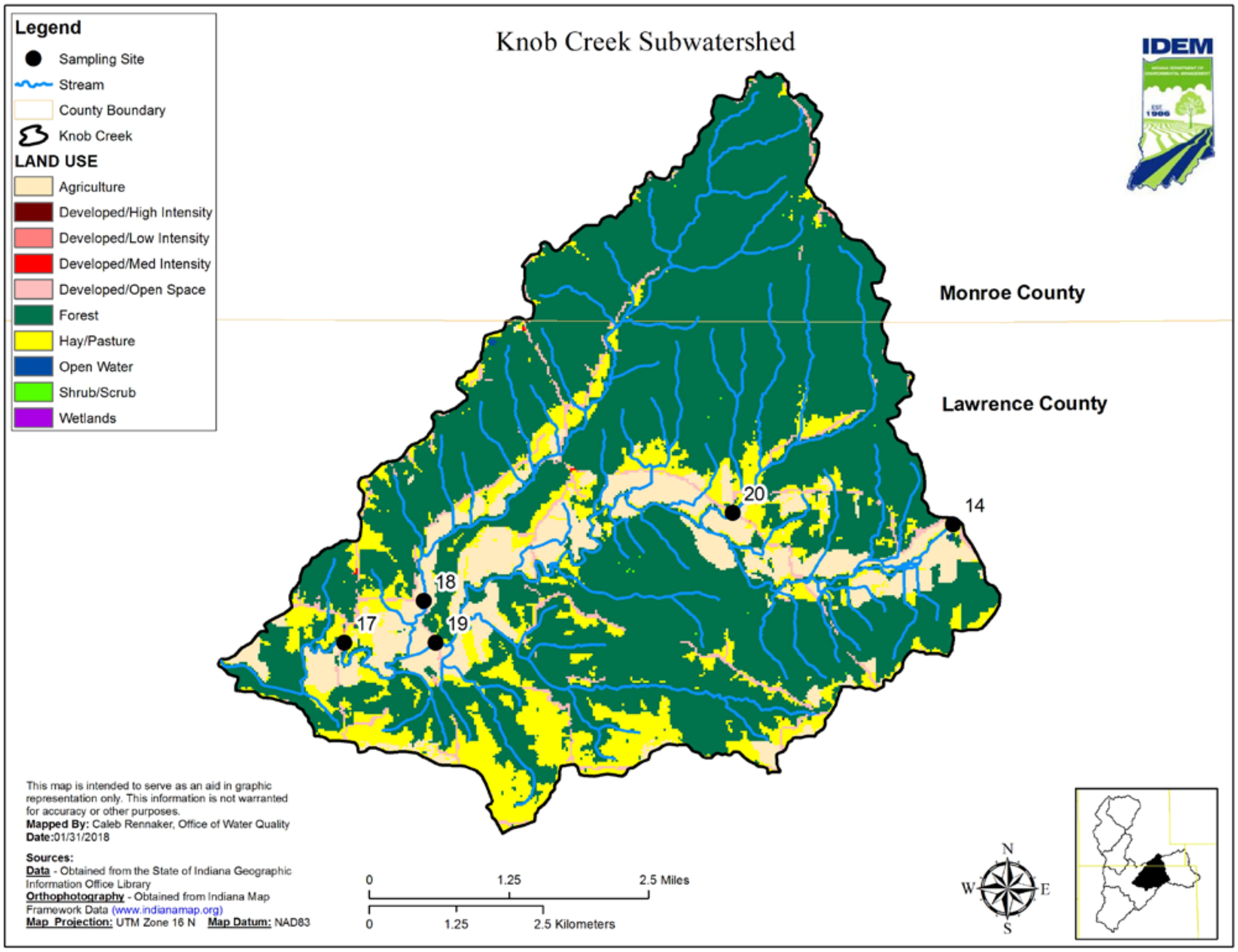


Figure 41: Sampling Sites in Knob Creek Subwatershed

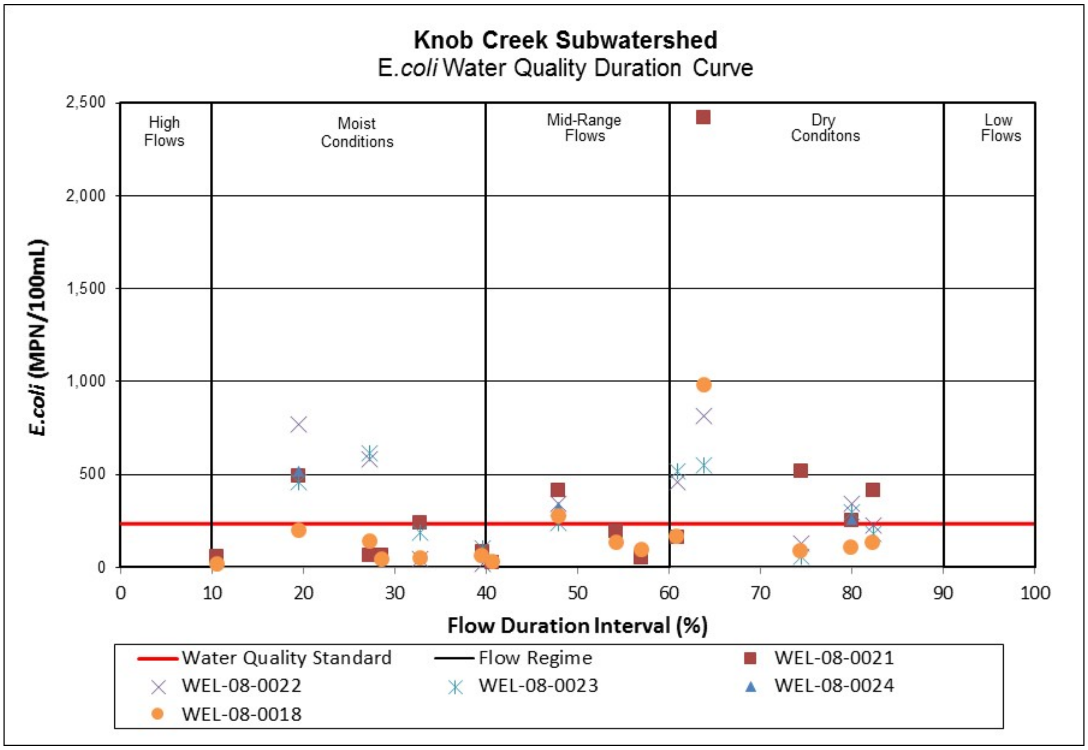


Figure 42: *E. coli* Water Quality Duration Curve for all Sampling Sites in the Knob Creek Subwatershed

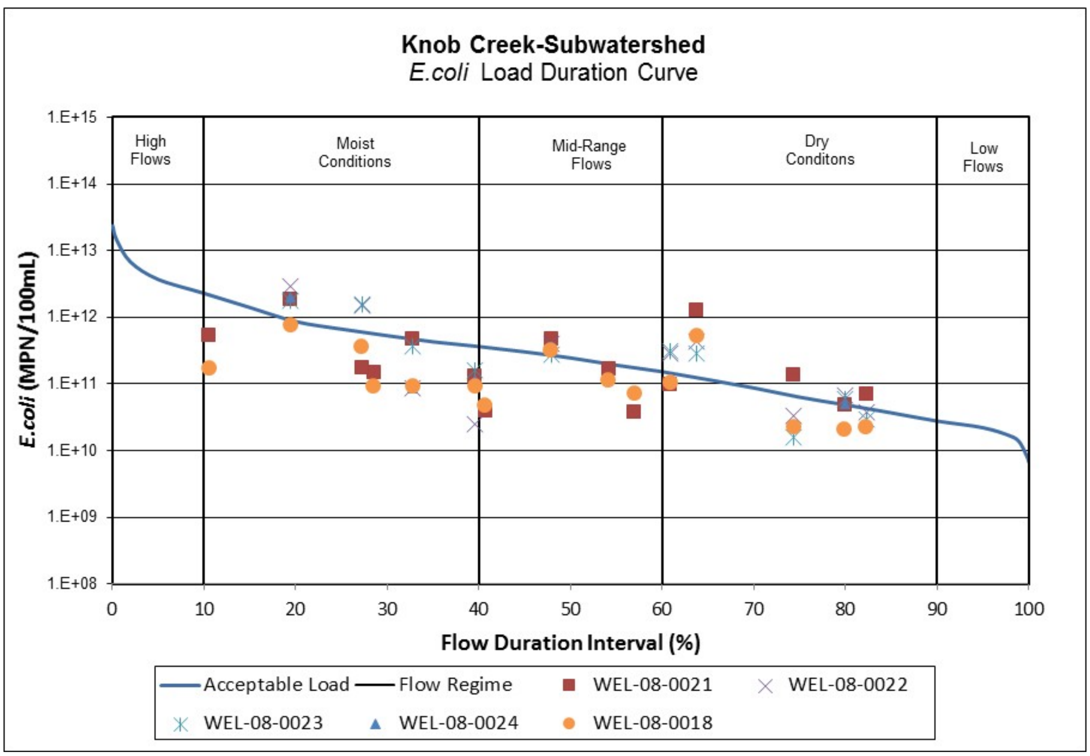


Figure 43: *E. coli* Load Duration Curve for all Sampling Sites in the Knob Creek Subwatershed

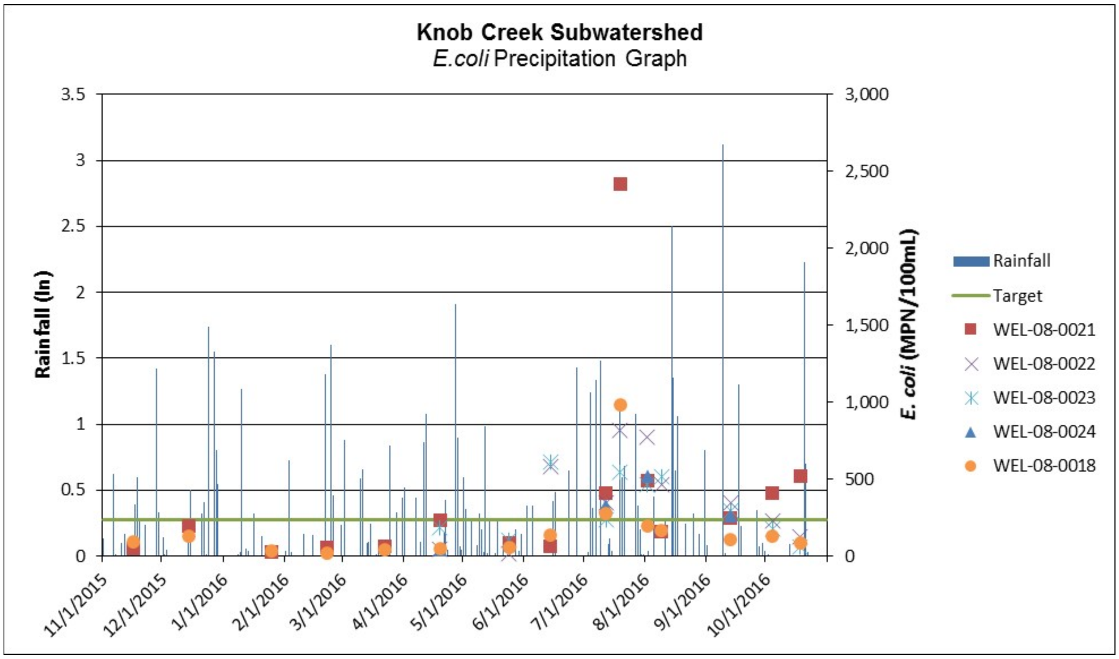


Figure 44: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the Knob Creek Subwatershed

5.1.6 Wolf Creek Subwatershed

The Wolf Creek subwatershed drains approximately 601 square miles, including Monroe Lake, and is located primarily in Lawrence County, with the northern portion within Monroe County. The land use is primarily forested (45%) followed by hay and pasture land (34%) and agricultural uses (12%) (Figure 45). There are two permitted WWTP facilities in the subwatershed; the Pedigo Bay WWTP, which discharges into an unnamed tributary of Salt Creek, and the Stone Crest Golf Community WWTP, which discharges into Salt Creek. The City of Bedford is a regulated MS4 community and occupies 1.25% of the subwatershed by land area. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited or somewhat limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes. Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration. With a land use of approximately 34 percent pasture land, a notable presence of pasture animals is expected, many of which could have direct access to the stream corridor. There are no permitted CAFOs or CFOs in the subwatershed, which has a total animal density of 35.31animals/square mile. This is higher than the median concentration when compared to the other subwatersheds in the Lower Salt Creek watershed.

There are five sampling sites located in the Wolf Creek subwatershed, one located on Gullets Creek WEL-08-0025 (21), one located on Pleasant Run WEL-08-0026 (22), one located on Wolf Creek WEL-08-0029 (25), and two sites on Salt Creek WEL-08-0027 (23) and WEL-08-0034 (24). In 2015-2016 this watershed was sampled monthly resulting in sites failing the water quality standard for *E. coli*. Sites WEL-08-0034 (24), WEL-08-0027 (23), and WEL-08-0025 (21) failed for recreational use. These stream reaches will be placed on the Draft 2018 303(d) List of Impaired Waters.

The *E. coli* geomean for sites 24 and 23 were unable to be calculated, however 6/10 and 5/10 samples exceeded the single sample max respectively, with a maximum sample value of 4,352 and 1,299.7 MPN respectively. Site 21 exceeded the single sample max for 8/10 samples with a maximum sample of 613.1 MPN.

There are approximately 81 miles of streams in the subwatershed. Based on IDEM data collected in 2015-2016, there will be approximately 33 stream miles impaired for *E. coli* on the Draft 2018 303(d) List of Impaired Waters. To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events can indicate contribution due to runoff. Precipitation data was taken from a National Weather Service Co-operative Station USC00120784 located in Bloomington, IN. Figure 46 illustrates water quality standards violations during all flow ranges that occurred during sampling events. Table 33 provides a summary of the Wolf Creek subwatershed, including impaired segment AUIDs, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*.

Evaluating the load duration curves and precipitation graphs (Figures 47 & 48) with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations. 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, pasture animals with direct access to streams, straight pipes, leaking and failing septic systems, and some urban stormwater. To achieve necessary load reductions for *E.coli* impairments, implementation in Wolf Creek subwatershed should focus on BMPs that have an impact throughout moist, mid-range, and dry flow regimes. These include septic system outreach and education, fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, and vegetated filter strips. See Section 6.2 and Table 37 for additional information regarding critical conditions and suitable BMP selection for the Lower Salt Creek watershed.

Table 33: Summary of Wolf Creek Subwatershed Characteristics

Wolf Creek (051202080806)					
Drainage Area	601 square miles				
TMDL Sample Site	WEL-08-0034, WEL-08-0027, WEL-08-0029, WEL-08-0026, WEL-08-0025				
Listed Segments	INW0886_01 INW0886_02 INW0886_03 INW0886_04 INW0886_T1009 INW0886_T1010 INW0886_T1011				
Land Use	Agricultural Land: 11% Forested Land: 46% Developed Land: 8% Open Water: <1% Pasture/Hay: 34% Grassland/Shrubs: <1% Wetland: 0%				
Industrial stormwater facilities	Newco Metals Processing Inc. (INRM00172) (NOT A SOURCE OF E. COLI)				
Industrial wastewater facilities	General Motors LLC Bedford (IN0003573) (NOT A SOURCE OF E. COLI)				
Permitted construction sites (average annual acreage)	4.9 (NOT A SOURCE OF E. COLI)				
WWTP Facilities	Pedigo Bay WWTP (IN0062154), Stone Crest Golf Community WWTP (IN0061093), Camp INDI CO SO (IN0042617)				
MS4 Communities	City of Bedford (INR040027)				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
Flow Regime TMDL analysis for *E. coli* (MPN/Day)					
Allocation Category **Duration Interval**	**High** 5%	**Moist** 25%	**Mid-range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**4.17E+13**	**7.56E+12**	**2.86E+12**	**8.15E+11**	**3.53E+11**
Upstream Drainage Input (Little Clear Creek, Knob Creek, Lake Monroe)	3.89E+13	7.06E+12	2.67E+12	7.69E+11	3.38E+11
LA	2.33E+12	4.17E+11	1.55E+11	3.85E+10	1.22E+10
Pedigo Bay WWTP	1.96E+08	1.96E+08	1.96E+08	1.96E+08	1.96E+08
Stone Crest Golf Community WWTP	3.56E+08	3.56E+08	3.56E+08	3.56E+08	3.56E+08
Camp INDI CO SO WWTP	8.89E+07	8.89E+07	8.89E+07	8.89E+07	8.89E+07
City of Bedford MS4	2.96E+10	5.29E+09	N/A	N/A	N/A
Total WLA	3.02E+10	5.93E+09	6.40E+08	6.40E+08	6.40E+08
MOS (10%)	2.78E+11	4.98E+10	1.83E+10	4.60E+09	1.51E+09
FG (5%)	1.39E+11	2.49E+10	9.14E+09	2.30E+09	7.56E+08

Note: LA= Load Allocation, WLA= Waste Load Allocation, MOS= Margin of Safety
*For MS4s, N/A is listed for Mid-range, Dry, and Low flow regimes because those regimes are unlikely to result in significant runoff

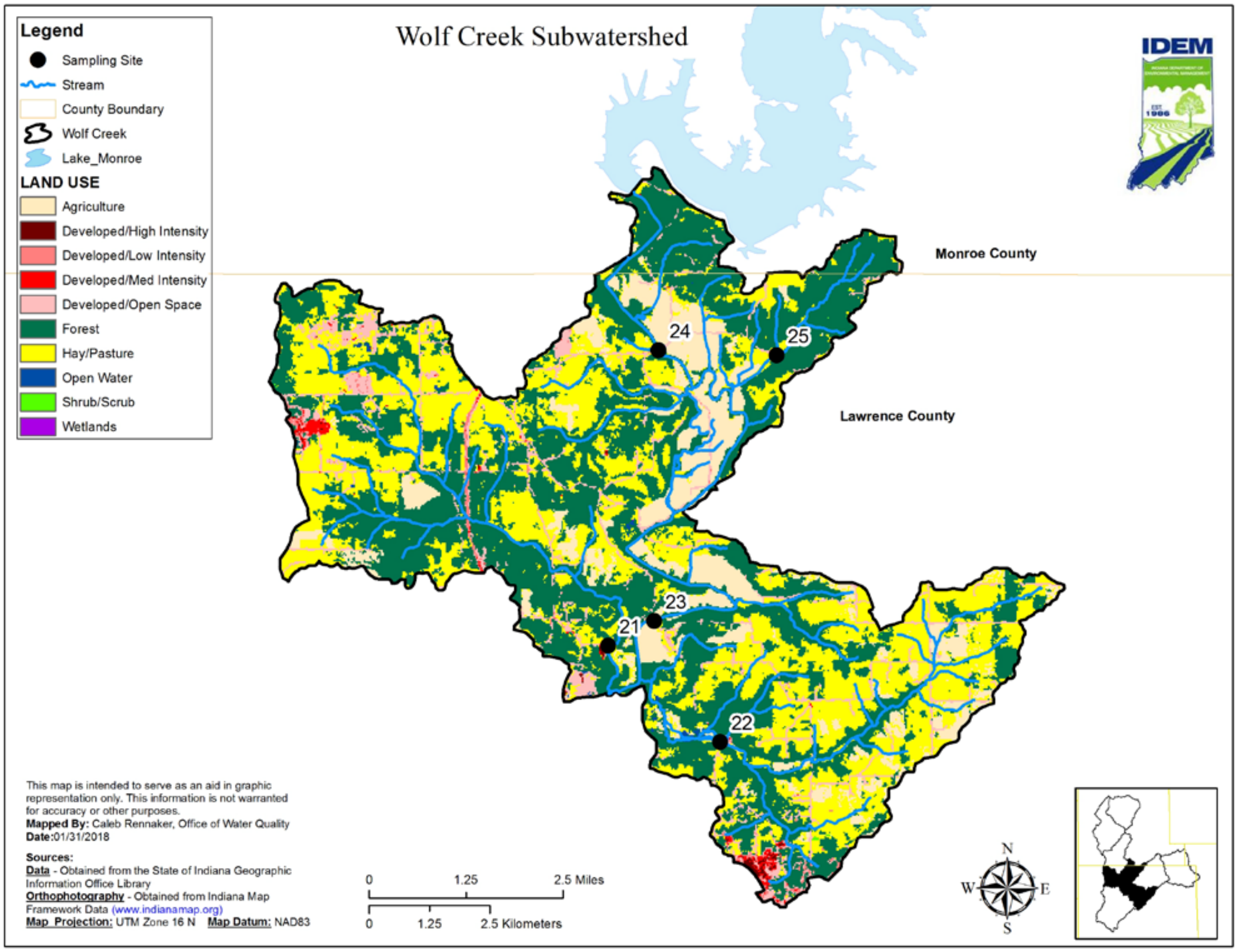


Figure 45: Sampling Sites in the Wolf Creek Subwatershed

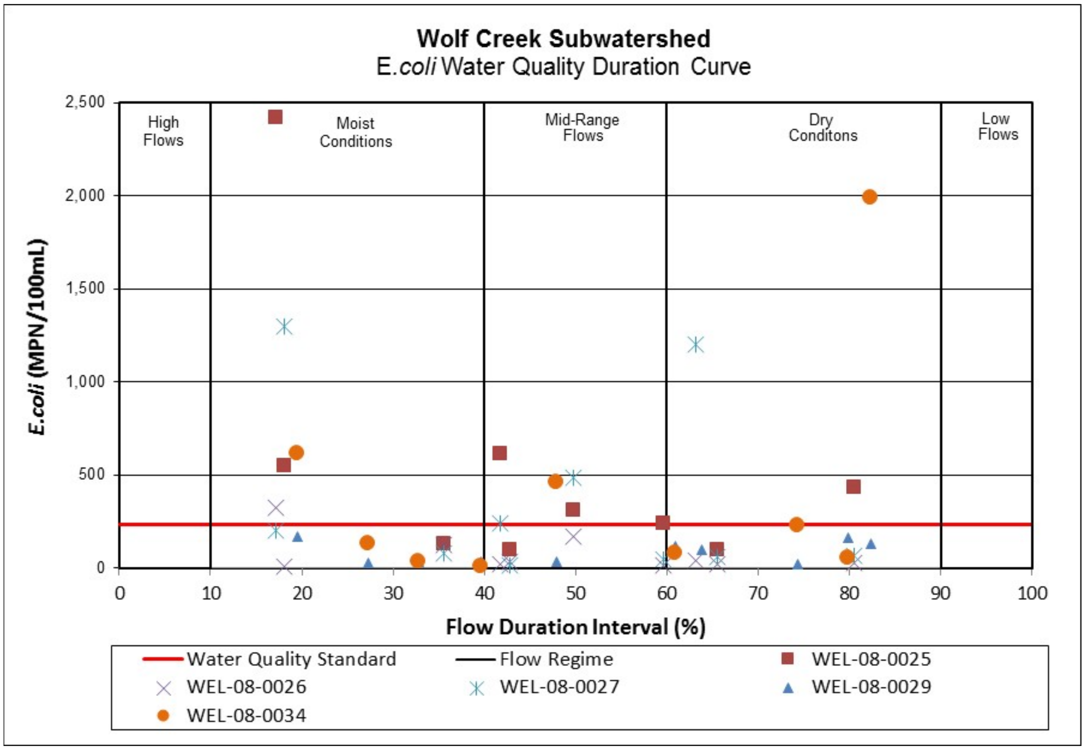


Figure 46: *E. coli* Water Quality Duration Curve for all Sampling Sites in the Wolf Creek Subwatershed

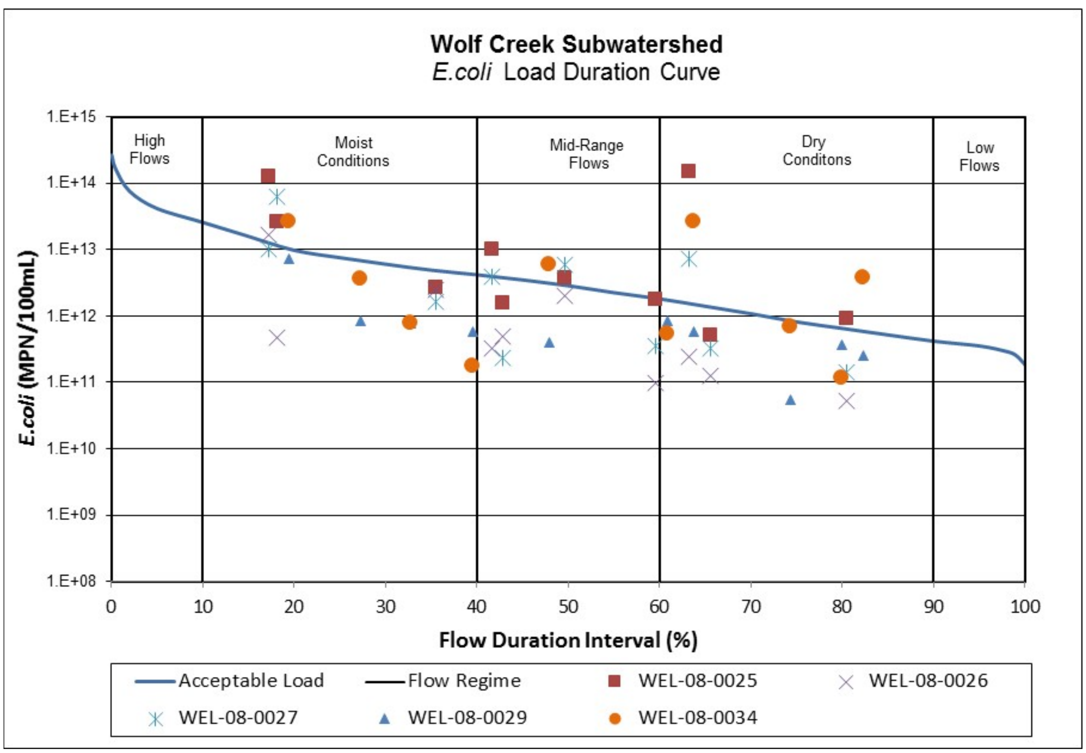


Figure 47: *E. coli* Load Duration Curve for all sampling Sites in the Wolf Creek Subwatershed

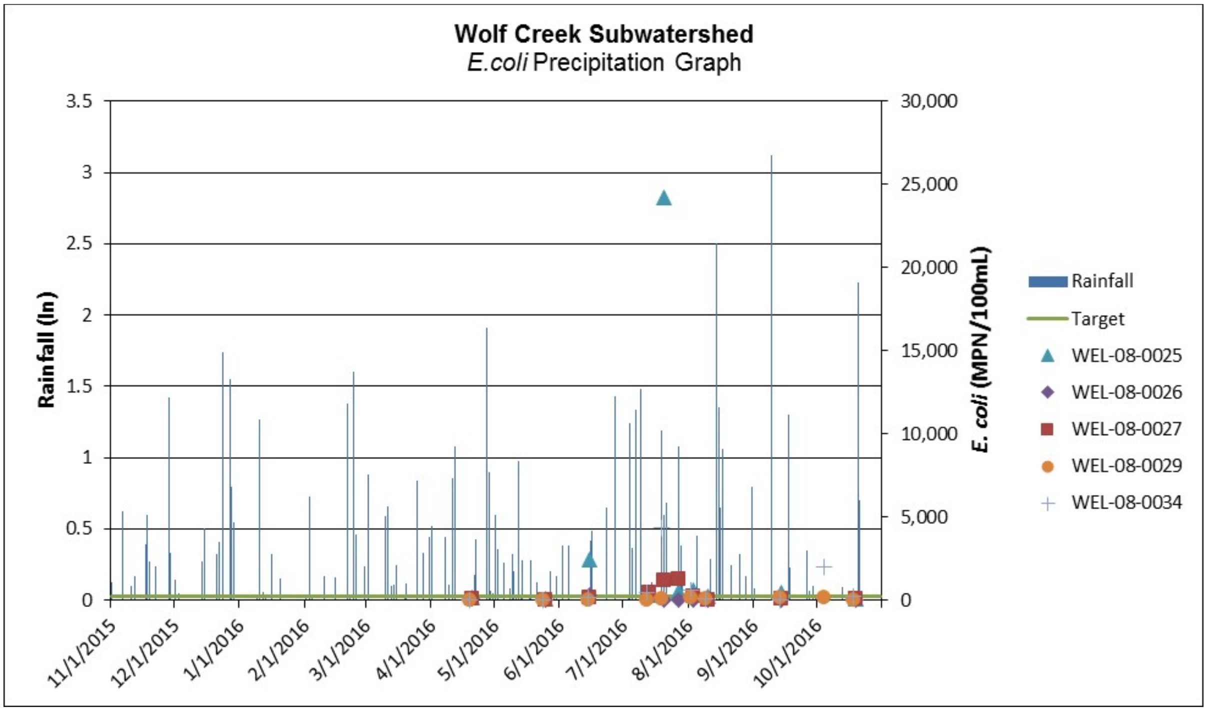


Figure 48: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the Wolf Creek Subwatershed

5.1.7 Goose Creek Subwatershed

The Goose Creek subwatershed drains approximately 636 square miles. The subwatershed includes the lowest drainage point for the Lower Salt Creek watershed and accepts all upstream contributions. The land use is primarily forested (48%) followed by hay and pasture land (29%) and agricultural uses (11%) (Figure 49). There is one permitted wastewater treatment facility in the subwatershed, Oolitic WWTP, which discharges into Goose Creek. The City of Bedford is a regulated MS4 community and occupies 5.51% of the subwatershed by land area. The majority of the subwatershed is rural, indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, the majority of the subwatershed is very limited. Therefore, maintenance and inspections of septic systems in the area are important to ensure proper function and capacity.

The subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from high gradient slopes. Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential places for wetland restoration. With a land use of approximately 29 percent pasture land, a significant presence of pasture animals is expected, many of which could have direct access to the stream corridor. There is also one permitted CFO in the subwatershed, Kyle Hall Farm, which may be land applying manure. This could possibly contribute to high levels of *E. coli*. The subwatershed has a total animal density of 36.08 animals/square mile, the highest amount of all of the subwatersheds in Lower Salt Creek.

There are three sampling sites located in the Goose Creek subwatershed, one located on Goose Creek WEL-08-0031 (27), and two sites on Salt Creek, WEL-08-0033 (26) and WEL090-0003 (28). In 2015-2016 this watershed was sampled monthly, resulting in sites failing the water quality standard for *E. coli*. Sites WEL-08-0033 (26) and WEL-08-0031 (27) failed for recreational use. These stream reaches will be placed on the Draft 2018 303(d) List of Impaired Waters.

The *E. coli* geomean for site 27 was 329.04 MPN with 5/10 samples in exceedance of the single sample max, with the highest being 5,475 MPN. Site 28 had a geomean of 209.67 MPN with 6/15 samples in exceedance of the single sample max, with the highest being 517.2 MPN. Although site 26 passed based on value with a geomean of 70.66 MPN, it was located on the same AUID (INW0887_01) as site 28, and, therefore, the entire AUID still failed for *E. coli*. The geomean from all sites in the watershed were taken on the same day for five consecutive weeks.

There are approximately 42 miles of streams in the subwatershed. Based on IDEM data collected in 2015-2016, there will be approximately 16 stream miles listed as impaired for *E. coli* on the Draft 2018 303(d) List of Impaired Waters. To further investigate sources, water quality data precipitation graphs have been created. Elevated levels of contaminants during rain events can indicate contribution due to runoff. The precipitation data was taken from a National Weather Service Co-operative Station USC00120784 located in Bloomington, IN. Figure 50 illustrates water quality standards violations during all flow ranges that occurred during sampling events. Table 34 provides a summary of the Goose Creek subwatershed, including impaired segment AUIDs, drainage area, sampling sites, land use, NPDES facilities, and CFOs, as well as LAs, WLAs, and MOS values for *E. coli*.

Evaluating the load duration curves and precipitation graphs (Figures 51 & 52) with consideration of these watershed characteristics allows for identification of potential nonpoint sources that are contributing to elevated *E. coli* concentrations. 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, pasture animals with direct access to streams, straight pipes, leaking and failing septic systems, and some urban stormwater. To achieve necessary load reductions for *E.coli* impairments, implementation in Goose Creek Subwatershed should focus on BMPs that have an impact primarily throughout moist flow regimes. These include fencing and livestock exclusion systems, alternative livestock watering systems, comprehensive nutrient management planning, vegetated filter strips, and septic system outreach and education. See Section 6.2 and Table 37 for additional information regarding critical conditions and suitable BMP selection for the Lower Salt Creek watershed.

Table 34: Summary of Goose Creek Subwatershed Characteristics

Goose Creek (051202080807)					
Drainage Area	34.51 square miles				
TMDL Sample Site	WEL-08-0033, WEL-08-0031, WEL090-0003				
Listed Segments	INW0887_02 INW0887_03 INW0887_T1006 INW0887_T1007				
Land Use	Agricultural Land: 11% Forested Land: 48% Developed Land: 11% Open Water: <1% Pasture/Hay: 29% Grassland/Shrubs: <1% Wetland: <1%				
Industrial stormwater facilities	N/A				
Industrial wastewater facilities	Indiana Limestone Co. Inc.- Empire (ING490057) (NOT A SOURCE OF E. COLI)				
Permitted construction sites (average annual acreage)	7.4 (NOT A SOURCE OF E. COLI)				
WWTP facilities	Oolitic WWTP (IN0023981), Needmore Elementary School (IN0053741)				
MS4 Communities	City of Bedford (INR040027)				
CSO Communities	N/A				
CAFOs	N/A				
CFOs	Kyle Hall Farm (6508)				
Flow Regime TMDL analysis for *E. coli* (MPN/Day)					
Allocation Category **Duration Interval**	**High** 5%	**Moist** 25%	**Mid-range** 50%	**Dry** 75%	**Low** 95%
TMDL= LA+WLA+MOS	**4.40E+13**	**7.99E+12**	**3.02E+12**	**8.57E+11**	**3.69E+11**
Upstream Drainage Input (Wolf Creek)	4.17E+13	7.56E+12	2.86E+12	8.15E+11	3.53E+11
LA	1.92E+12	3.42E+11	1.32E+11	3.26E+10	1.01E+10
Oolitic WWTP	3.11E+09	3.11E+09	3.11E+09	3.11E+09	3.11E+09
Needmore Elementary School WWTP	8.00E+07	8.00E+07	8.00E+07	8.00E+07	8.00E+07
City of Bedford MS4	1.12E+11	2.00E+10	N/A	N/A	N/A
Total WLA	1.15E+11	2.31E+10	3.19E+09	3.19E+09	3.19E+09
MOS (10%)	2.39E+11	4.30E+10	1.60E+10	4.21E+09	1.56E+09
FG (5%)	1.20E+11	2.15E+10	7.98E+09	2.11E+09	7.81E+08

Note: LA= Load Allocation, WLA= Waste Load Allocation, MOS= Margin of Safety
*For MS4s, N/A is listed for Mid-range, Dry, and Low flow regimes because those regimes are unlikely to result in significant runoff

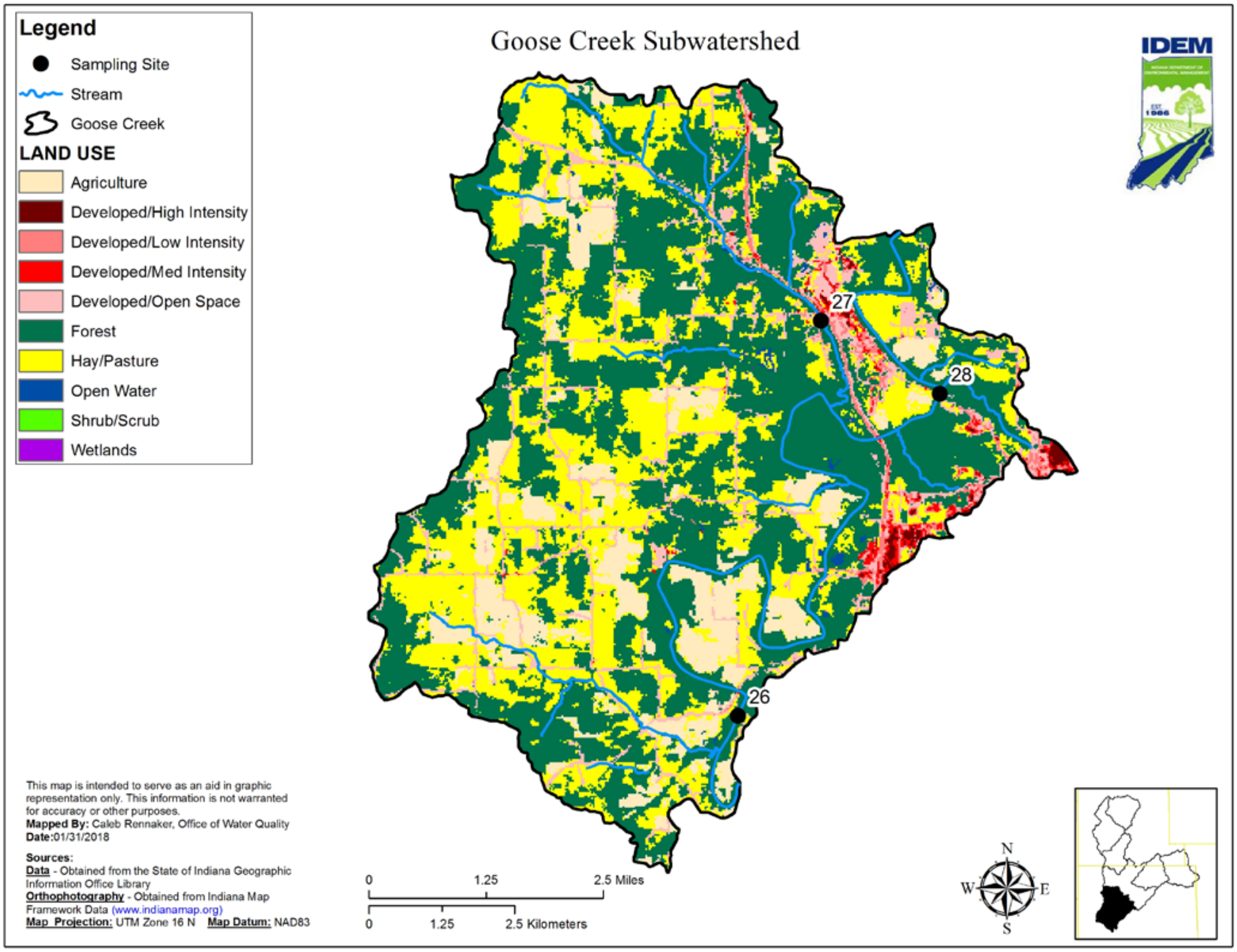


Figure 49: Sampling Sites in the Goose Creek Subwatershed

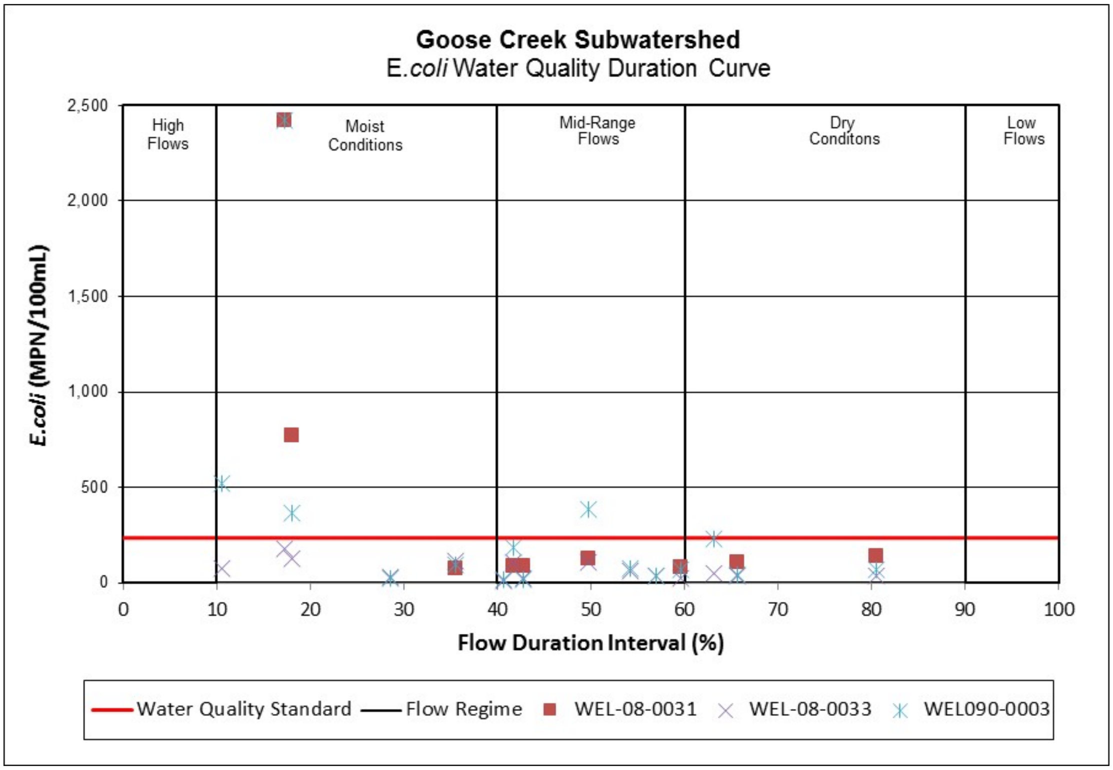


Figure 50: *E. coli* Water Quality Duration Curve for all Sampling Sites in the Goose Creek Subwatershed

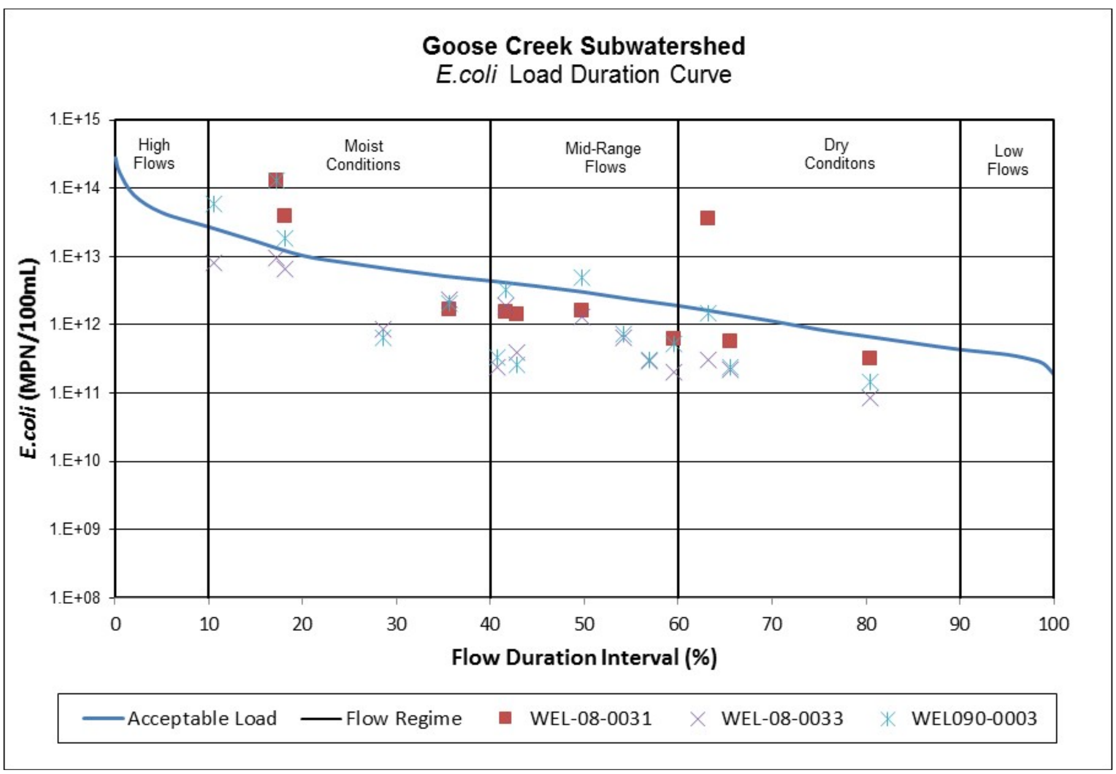


Figure 51: *E. coli* Load Duration Curve for all Sampling Sites in the Wolf Creek Subwatershed

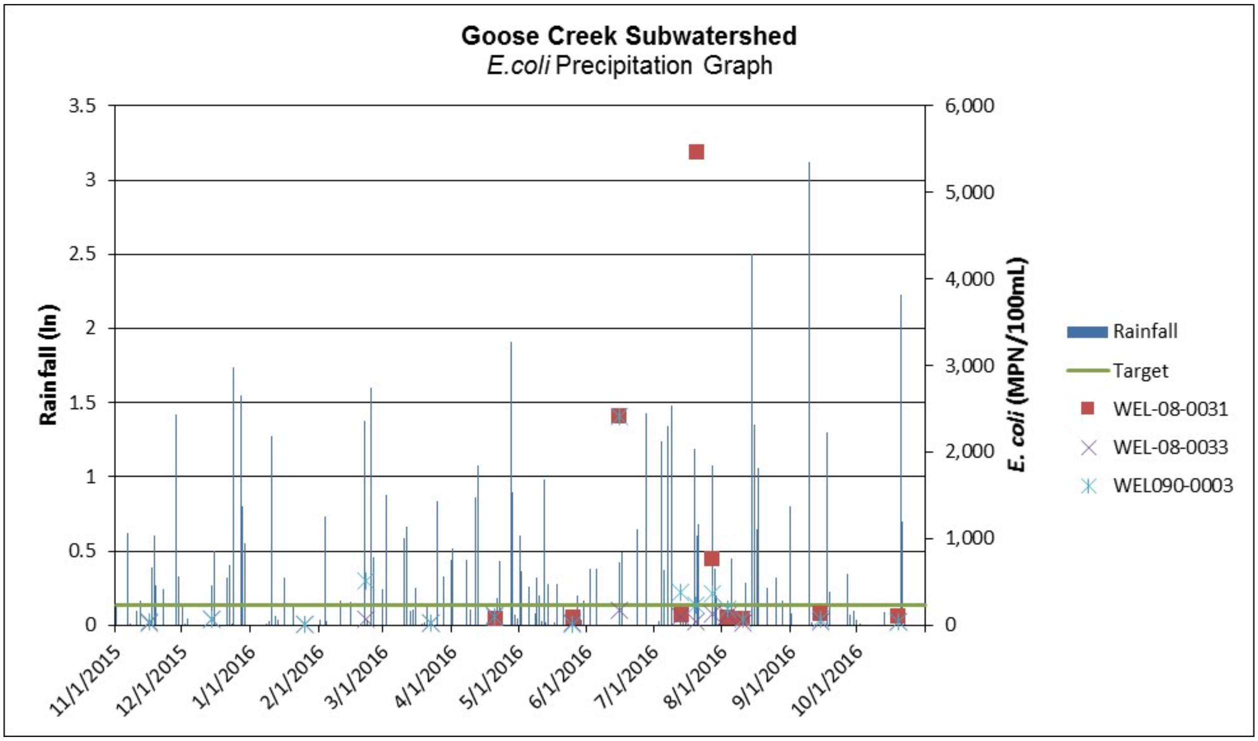


Figure 52: Graph of Precipitation and *E. coli* Data for all Sampling Sites in the Goose Creek Subwatershed

6.0 ALLOCATIONS

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 WLAs for regulated sources and LAs for sources not directly regulated by a permit. 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:

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

6.1 Individual WLAs for NPDES Facilities

The following sections present the allowable *E. coli* WLAs and associated allocations for each of the NPDES permits in the Lower Salt Creek watershed. Table 35 presents the individual WLAs for NPDES facilities in the Lower Salt Creek watershed by subwatershed. The WWTP WLAs were established based on the design flow multiplied by the TMDL target value of 235 MPN/100 mL for *E. coli*. The MS4 allocations, in Table 36, are based on the percentage of overall area the MS4 has jurisdiction over in the subwatershed.

Table 35: Individual WLAs for NPDES Facilities in the Lower Salt Creek Watershed

Subwatershed	Facility Name	Permit Number	AUID	Design Flow (MGD)	E.coli WLA (count/day)
May Creek	Bloomington S. Dillman Rd. WWTP	IN0035718	INW0882_01	15	1.33E+11
Little Clear Creek	South Central RSD Caslon WWTP	IN0045187	INW0883_T1004	0.3	2.67E+09
	Briarwood Subdivision WWTP	IN0038920	INW0883_T1006	0.037	3.29E+08
Wolf Creek	Pedigo Bay WWTP	IN0062154	INW0886_01	0.022	1.96E+08
	Camp INDI CO SO	IN0042617	INW0886_T1010	0.010	8.89E+07
	Stone Crest Golf Community WWTP	IN0061093	INW0886_T1009	0.04	3.56E+08
Goose Creek	Oolitic WWTP	IN0023981	INW0887_T1001	0.35	3.11E+09
	Needmore Elementary School	IN0053741	INW0887_T1001	0.009	8.00E+07

Table 36: Individual WLAs for MS4 Communities in the Lower Salt Creek Watershed

Subwatershed	MS4 Community	Permit ID	Area in Drainage (Acres)	Percentage of Subwatershed	High Flow Regime WLA	Moist Flow Regime WLA
Jackson Creek	Monroe County	INR040089	6325.25	39.36%	5.85E+11	1.04E+11
	IU Bloomington	INR040123	954.38	5.94%	8.82E+10	1.58E+10
	Bloomington	INR040136	8,657.22	53.88%	8.00E+11	1.43E+11
May Creek	Bloomington	INR040136	347.01	1.81%	3.14E+10	5.61E+09
	Monroe County	INR040089	6,996.94	36.47%	6.33E+11	1.13E+11
Little Clear Creek	NA	NA	NA	NA	NA	NA
Hunter Creek	NA	NA	NA	NA	NA	NA
Knob Creek	NA	NA	NA	NA	NA	NA
Wolf Creek	Bedford	INR040027	315.78	1.25%	4.73E+10	8.45E+09
Goose Creek	Bedford	INR040027	1,217.11	5.51%	1.12E+11	2.00E+10

6.2 Critical Conditions

The CWA requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. 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 sources (e.g., wastewater treatment facilities, livestock in the stream). Table 37 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). Existing loading is calculated as the 90th percentile of measured *E. coli* concentrations under each hydrologic condition class multiplied by the flow at the middle of the flow exceedance percentile. For example, in calculating the existing loading under dry conditions (flow exceedance percentile = 60-90 percent), the 75th percentile exceedance flow is *multiplied* by the 90th percentile of *E. coli* concentrations measured under 60-90th percentile flows. Table 37 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. Through the load duration curve approach it has been determined that load reductions for *E. coli* are needed for specific flow conditions. The critical conditions (the periods when the greatest reductions are required) vary by location and are summarized in Table 38. After existing loading and percent reductions are calculated under each hydrologic condition class, the critical condition for each TMDL is identified as the flow condition requiring the largest percent reduction. The table indicates that critical conditions for *E. coli* for most locations occur during the moist and dry flow regimes, and therefore implementation of controls should be targeted for these conditions.

Table 37: Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High (0%-10%)	**Moist (10%-40%)**	**Mid-Range (40%-60%)**	**Dry (60%-90%)**	**Low (90%-100%)**
Wastewater treatment plants			L	M	H
Livestock direct access to streams			L	M	H
Wildlife direct access to streams			L	M	H
Pasture management	H	H	M		
On-site wastewater systems/Unsewered areas	L	M	H	H	H
Riparian buffer areas	H	H	M	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	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)
(Modified from *EPA, 2007 An Approach for Using Load Duration Curves in the Development of TMDLs*)

Table 38: Critical Conditions for TMDL Parameters

Parameter	Subwatershed (HUC)	Critical Condition				
		High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
E. coli	Jackson Creek (051202080801)	--	90%	90%	98%	--
	May Creek (051202080802)	--	47%	90%	98%	--
	Little Clear Creek (051202080803)	--	57%	83%	87%	--
	Hunter Creek (051202080804)	--	8%	NA	37%	--
	Knob Creek (051202080805)	--	74%	58%	82%	--
	Wolf Creek (051202080806)	--	84%	70%	93%	--
	Goose Creek (051202080807)	--	89%	NA	82%	--

Note: -- = No Data Collected in Flow Regime NA= No reduction needed

Tables 37 and 38 provide the foundation necessary to identify subwatersheds that are in need of the most significant pollutant reductions to achieve water quality standards in the Lower Salt Creek watershed. Using these two tables, along with the Linkage Analysis in Section 5.0, 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 Salt Creek watershed for implementation. The tables above focus on the information and data collected and analyzed through the TMDL development process for percent reduction purposes, whereas critical areas take into account other factors for consideration (e.g., political, social, economic) to help determine implementation feasibility that will affect progress toward pollutant load reductions and, ultimately, attainment of water quality standards. This information can be key to watershed organizations in the process of identifying and selecting critical areas and implementation activities for the purposes of watershed management plan development. IDEM recommends that watershed organizations take the percent reductions into consideration when selecting critical areas for purposes of watershed management planning. By also taking into account different flow regimes, watershed groups will be able to prioritize practices that give them the most efficient load reductions for each critical area that is chosen.

7.0 REASONABLE ASSURANCES/IMPLEMENTATION

This section of the Lower Salt Creek watershed TMDL focuses on implementation activities that have the potential to achieve the WLAs and LAs presented in Section 6.0. The focus of this section is to identify and select the most appropriate structural and non-structural BMPs and control technologies to reduce *E. coli* loads from sources throughout the Lower Salt Creek watershed, particularly in the critical flow conditions identified in Section 6.0. 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 current ongoing activities in the Lower Salt Creek watershed at the local level that will play a key role in successful TMDL implementation.

To select appropriate BMPs and control technologies, it is important to review the significant sources in the Lower Salt Creek watershed.

Point Sources

- WWTPs
- SSOs
- Regulated storm water sources (MS4s)
- Illicitly connected straight pipe systems

Nonpoint Sources

- Cropland
- Pastures and livestock operations
- CFO
- Streambank erosion
- On-site wastewater treatment systems (Septics)
- Wildlife/domestic pets
- Urban nonpoint source runoff

7.1 Implementation Activity Options for Sources in the Lower Salt Creek Watershed

Keeping the list of significant sources in the Lower Salt Creek watershed in mind, it is possible to review the types of BMPs that are most appropriate for the existing *E. coli* impairments and their sources. Table 39 provides a list of implementation activities that are potentially suitable for the Lower Salt Creek watershed. The implementation activities 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 may depend on a number of factors (including socioeconomic, political and ecological factors). The recommendations in Table 39 are not intended to be prescriptive. Any number or combination of implementation activities might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or at other locations where sources contribute indirectly to the water quality impairment.

Table 39: List of Potentially Suitable BMPs for the Lower Salt Creek Watershed

	Point Sources			Nonpoint Sources						
Implementation Activities	**WWTPs and Industrial Facilities**	**Regulated Stormwater Sources**	**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		
Outreach and education and training	X	X	X	X	X	X	X	X	X	X
System replacement			X					X		
Conservation tillage/residue management				X						
Cover crops				X			X			
Filter strips		X		X	X	X	X			
Grassed waterways				X		X	X			
Riparian forested/herbaceous buffers				X	X	X	X		X	
Manure handling, storage, treatment, and disposal						X				
Composting		X								X
Alternative watering systems					X	X	X			
Stream fencing (animal exclusion)					X		X			
Prescribed grazing					X		X			
Conservation easements										
Two-stage ditches										
Rain barrel		X					X			X
Rain garden		X					X			X
Street rain garden		X					X			X
Block bioretention		X					X			X
Regional bioretention		X					X			X
Porous pavement		X					X			X
Green alley							X			X
Green roof		X					X			X
Dam modification or removal							X			
Levee or dike modification or removal										
Stormwater planning and management	X	X					X	X	X	X
Comprehensive Nutrient Management Plan				X		X				
Constructed Wetland	X		X	X					X	X
Critical Area Planting					X		X			
Drainage Water Management				X			X			
Heavy Use Area Pad					X					
Nutrient Management Plan				X			X			
Terrace				X						
Land Reconstruction of Mined Land							X			

	Point Sources			Nonpoint Sources						
Implementation Activities	**WWTPs and Industrial Facilities**	**Regulated Stormwater Sources**	**Illicitly Connected "Straight Pipe" Systems**	**Cropland**	**Pastures and Livestock Operations**	**CFOs**	**Streambank Erosion**	**Onsite Wastewater Treatment Systems**	**Wildlife/Domestic Pets**	**Urban NPS Runoff**
Sediment Basin		X								X
Pasture and Hay Planting				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	
Waste Treatment Lagoon					X	X				
Conservation Crop Rotation				X			X			

The information provided in Section 6.1 assisted in the development of Table 39, which provides a more refined suite of recommended implementation activities targeted to the critical flow condition identified in Section 6.2. Watershed stakeholders can use the implementation activities identified in Table 39 for each critical flow condition and select activities that are most feasible in the Lower Salt Creek watershed. This table can also help watershed stakeholders to identify implementation activities for critical areas that they select through the watershed management planning process.

7.2 Implementation Goals and Indicators

For each impairment in the Lower Salt Creek 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 waterbodies (or streams) in the Lower Salt Creek watershed should meet the 125 colonies/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.

7.3 Summary of Programs

There are a number of federal, state, and local programs that either require or can assist with the implementation activities recommended for the Lower Salt Creek watershed in Section 7.1. A description of these programs is provided in this section. The following section discusses how some of these programs relate to the various sources in the Lower Salt Creek watershed.

7.3.1 Federal Programs

Clean Water Act Section 319(h) Grants

Section 319 of the federal CWA contains provisions for the control of nonpoint source pollution. The Section 319 program provides for various voluntary projects throughout the state to prevent water pollution and also provides for assessment and management plans related to waterbodies in Indiana impacted by nonpoint source pollution. The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the Office of Water Quality at IDEM administers the Section 319 program for the nonpoint source-related projects.

U.S. EPA offers CWA 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 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 invited to submit Section 319(h) proposals to the Office of Water Quality.

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 standards;
- 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.

USDA's Conservation Stewardship Program (CSP)

The Conservation Stewardship Program (CSP) helps landowners build on their existing conservation efforts while strengthening their operation. Whether they are looking to improve grazing conditions, increase crop yields, or develop wildlife habitat, NRCS can custom design a CSP plan to help them meet those goals. NRCS can help landowners schedule timely planting of cover crops, develop a grazing plan that will improve the forage base, implement no-till to reduce erosion or manage forested areas in a way that benefits wildlife habitat. If landowners are already taking steps to improve the condition of the land, chances are CSP can help them find new ways to meet their goals.

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.

USDA's Conservation Reserve Enhancement Program (CREP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Conservation Reserve Enhancement Program (CREP), an offshoot of CRP, targets high-priority conservation concerns identified by a State, and federal funds are supplemented with non-federal funds to address those concerns. In exchange for removing environmentally sensitive land from production and establishing permanent resource conserving plant species, farmers and ranchers are paid an annual rental rate along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary, and the contract period is typically 10–15 years.

USDA's Farmable Wetlands Program (FWP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. Plant cover may include plants that are partially submerged or specific types of trees.

By restoring farmable wetlands, FWP improves groundwater quality, helps trap and break down pollutants, prevents soil erosion, reduces downstream flood damage, and provides habitat for water birds and other wildlife. Wetlands can also be used to treat sewage and are found to be as effective as "high tech" methods.

The Farm Service Agency runs the program through the Conservation Reserve Program (CRP) with assistance from other government agencies and local conservation groups.

USDA's Conservation Technical Assistance (CTA)

The purpose of the CTA program is to assist land users, 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 land users, 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 land users 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 land users 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.

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 cost-effective 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.

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.

Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and non-governmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands.

Agricultural Land Easements protect the long-term viability of the nation's food supply by preventing conversion of productive working lands to non-agricultural uses. Land protected by agricultural land easements provides additional public benefits, including environmental quality, historic preservation, wildlife habitat, and protection of open space.

Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity, and provide opportunities for educational, scientific and limited recreational activities.

NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agricultural use and conservation values of eligible land. In the case of working farms, the program helps farmers and ranchers keep their land in agriculture. The program also protects grazing uses and related conservation values by conserving grassland, including rangeland, pastureland and shrubland. Eligible partners include American Indian tribes, state and local governments and non-governmental organizations that have farmland, rangeland, or grassland protection programs.

Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife and related natural resources on regional or watershed scales. Through the program, NRCS and its partners help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

Healthy Forests Reserve Program (HFRP)

The Healthy Forests Reserve Program (HFRP) helps landowners restore, enhance and protect forestland resources on private lands through easements and financial assistance. HRFP aids the recovery of endangered and threatened species under the Endangered Species Act, improves plant and animal biodiversity, and enhances carbon sequestration.

HFRP provides landowners with 10-year restoration agreements and 30-year or permanent easements for specific conservation actions. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Some landowners may avoid regulatory restrictions under the Endangered Species Act by restoring or improving habitat on their land for a specified period of time.

Conservation Innovation Grants (CIG)

Conservation Innovation Grants (CIG) are competitive grants that drive public and private sector innovation in resource conservation. Authorized by the 2002 Farm Bill, CIG uses EQIP funds to award competitive grants to non-Federal governmental or nongovernmental organizations, American Indian Tribes, or individuals. Producers involved in CIG funded projects must be EQIP eligible.

Through the NRCS CIG program, public and private grantees develop the tools, technologies, and strategies to support next-generation conservation efforts on working lands and develop market-based solutions to resource challenges. Grantees leverage the federal investment by at least matching it.

The NRCS understands the importance of supporting historically underserved, new and beginning, and military veteran producers in farming and ranching because these producers are critical to the fabric of American agriculture and to our rural communities. Annually, approximately 10% of CIG funding is set aside to support these farmers and ranchers.

CIG projects inspire creative problem-solving that boosts production on farms, ranches, and private forests - ultimately they improve water quality, soil health, and wildlife habitat.

Voluntary Public Access and Habitat Incentive Program (VPA-HIP)

The Voluntary Public Access and Habitat Incentive Program (VPA-HIP) is a competitive grants program that helps state and tribal governments increase public access to private lands for wildlife-dependent recreation, such as hunting, fishing, nature watching, or hiking.

State and tribal governments may submit proposals for VPA-HIP block grants from NRCS. These governments provide the funds to participating private landowners to initiate new or expand existing public access programs that enhance public access to areas previously unavailable for wildlife-dependent recreation. Nothing in VPA-HIP preempts liability laws that may apply to activities on any property related to grants made in this programs.

7.3.2 State Programs

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 standards. 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.

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 U.S. EPA, with U.S. EPA reserving the right to make final changes to the list. Actual funding depends on approval from U.S. EPA 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.

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 also includes the 92 soil and water conservation districts (SWCDs), the USDA Natural Resources Conservation Service, the Purdue University Cooperative Extension Service, IDNR, IDEM, FSA, and the State Soil Conservation Board. 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 land users. The Division staff includes field-based resource specialists who work closely with land users, to assist in the selection, design, and installation of practices to reduce soil erosion on agricultural land.

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 standards. 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.

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 nonpoint source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

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 on 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.

7.3.3 Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Partners such as the Monroe County SWCD and Lawrence County SWCD are instrumental to bringing grant funding into the Lower Salt Creek watershed to support local protection and restoration projects. This section provides a brief summary of the local programs taking place in the Lower Salt Creek watershed that will help to reduce *E. coli* loads, as well as to provide ancillary benefits to the Lower Salt Creek watershed. County level information on conservation investments made with local, state, and federal funding was obtained from the Indiana Conservation Partnership's accomplishments website.

Lawrence County

Lawrence County received the following funding to improve water quality in 2016:

- Local funding from non-state and non-federal sources - $74,720
- Clean Water Indiana (CWI) - $85,000
- Game Bird Habitat Development Program - $1,240
- Wildlife Habitat Cost-Share Program - $2,269
- Conservation Reserve Program and Conservation Reserve Enhancement Program- $729,918
- Conservation Stewardship Program - $24,788
- Environmental Quality Incentives Program - $435,378
- Grassland Reserve Program - $5,552

Lawrence and Washington County SWCDs were awarded a 2017 CWI grant to implement a nutrient management systems cost-share program. The objective of nutrient management is to ensure that commercial fertilizers and organic fertilizers such as manure and litter are applied with the right placement, in the right amount, at the right time, and from the right source to optimize profitability and to minimize nutrient losses to plant, soil, air, and water resources. The cost-share programs developed will provide a whole system approach to address *E. coli*, nutrient, and sediment water quality resource concerns.

Monroe County

Monroe County received the following funding to improve water quality in 2016:

- Local funding from non-state and non-federal sources - $41,096
- Clean Water Indiana (CWI) - $10,000
- Conservation Reserve Program and Conservation Reserve Enhancement Program - $148,999
- Environmental Quality Incentives Program - $82,388

Monroe County SWCD offers a mini grant program for county residents to address soil, water, and/or natural resource concerns on their property. The grants are made possible through a partnership with the Monroe County Stormwater Utility Board.

Monroe, Brown, Owen, and Green County SWCDs were awarded a 2017 CWI grant to implement *Remove*, *Replant*, *and Restore*: a project designed to manage the threat that non-native invasive plants pose to wildlife habitat, soil health, and water quality.

7.4 Implementation Programs by Source

Section 7.3 identified a number of federal, state, and local programs that can support implementation of the recommended management or restoration activities for the Lower Salt Creek watershed. Table 40 and the following sections identify which programs are relevant to the various sources in the Lower Salt Creek watershed.

Table 40: Summary of Programs Relevant to Sources in the Lower Salt Creek 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	USDA's Conservation Stewardship Program	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 Farmable Wetlands Program	USDA's Conservation Innovation Grant	USDA's Healthy Forests Program
WWTPs and Industrial Facilities	X			X											
Regulated Storm water Sources	X			X											
Illicitly Connected "Straight Pipe" Systems	X	X		X											
Cropland		X	X	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		X	
CFOs	X			X			X							X	
Streambank Erosion		X	X	X	X	X	X	X	X	X	X	X		X	X
Onsite Wastewater Treatment Systems		X		X											
Wildlife/Domestic Pets		X	X												X
In-stream Habitat		X	X											X	X

7.4.1 Point Source Programs

7.4.1.1 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.

7.4.1.2 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.

7.4.1.3 Regulated storm water sources

Regulated MS4s are required to obtain permits covered under IDEM's MS4 general permit that requires a storm water quality management program to address six minimum control measures. There are two MS4s in the Lower Salt Creek watershed that have coverage under IDEM's MS4 general permit. The storm water quality management program for each of these MS4s describes best management practices implemented to fulfill the six minimum control measure requirements.

7.4.1.4 Illegal straight pipes

Local health departments are responsible for locating and eliminating illicit discharges and illegal connections to the sewer system.

7.4.2 Nonpoint Source Programs

7.4.2.1 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:

- CWA Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs (CWI)
- 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

7.4.2.2 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 (CWI)

- 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

7.4.2.3 CFOs

While CAFOs are regulated by federal law, CFOs are not. However, Indiana has CFO regulations 327 IAC 16 and 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.

7.4.2.4 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:

- CWA Section 319 program
- Indiana Department of Natural Resources Division of Soil Conservation (CWI)
- 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
- Mitigation Funds

7.4.2.5 On-site 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.

The website for the Monroe County Health Department discusses how homeowners in the county can care for septic systems. (http://www.co.monroe.in.us/tsd/Community/HealthDepartment/WastewaterSanitation/SepticSystemMaintenance.aspx).

7.4.2.6 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.

7.5 Potential Implementation Partners and Technical Assistance Resources

Agencies and organizations at the federal, state, and local levels will play a critical role in implementation to achieve the WLAs and LAs assigned under this TMDL. Table 41 identifies key potential implementation partners and the type of technical assistance they can provide to watershed stakeholders.

Table 41: Potential Implementation Partners in the Lower Salt Creek Watershed

Potential Implementation 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	Wildlife Habitat Incentives Program
USEPA	Section 319 program grants
USEPA	Section 205(j) program grants
State	
ISDA	Division of Soil Conservation (CWI)
IDNR	Division of Fish and Wildlife Lake and River Enhancement program
IDEM	Section 319 program grants
IDEM	Section 205(j) program grants
Local	
Indiana University Bloomington	
Soil and Water Conservation Districts	
Indiana Karst Conservancy (IKC)	

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 .

8.0 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:

- Two kickoff public meetings were held at the Monroe County USDA Service Center on November 17, 2015 to introduce the project and solicit public input. IDEM explained the TMDL process during these meetings, presented initial information regarding the Lower Salt Creek watershed, and answered questions from the public. Information was also solicited from stakeholders in the area.
- A Draft TMDL public meeting was held in the watershed at the Purdue Extension Office in Bedford, IN on July 9th of 2018. The draft findings of the TMDL were presented at this meeting and the public had the opportunity ask questions and provide information to be included in the final TMDL report. There was a public comment period from July 2 - August 2, 2018.

9.0 WORKS CITED

AMVA. 2007. U.S. *Pet Ownership & Demographics Sourcebook.* 2012. American Veterinary Medical Association. Washington D.C.

Flemming, A. H., Bonneau, P. Brown, S.E., et al. 1995. Atlas of Hydrogeologic Terrains and Settings of Indiana. Indiana Geological Survey. Bloomington, Indiana

IDEM (Indiana Department of Environmental Management). 2006. Fish Community Sampling Program. B-004-OWQ-A-BS-06-0-R5. Indianapolis, Indiana.

IDEM (Indiana Department of Environmental Management). 2005. Summary of Protocols: Probability Based Site Assessment. 32/03/002/1999. Indianapolis, Indiana

IDEM (Indiana Department of Environmental Management). 2014. Consolidated Assessment and Listing Methodology (CALM): IDEM, 2014. Web. 2 Feb. 2016. < https://secure.in.gov/idem/nps/2639.htm>

NRCS (National Resources Conservation Service). 2009. Hydrologic Soil Groups. USDA Hydrology National Engineering Handbook. Washington D.C.

OEPA (Ohio Environmental Protection Agency). 1999. Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams. OEPA Technical Bulletin MAS/1999-1-1. Columbus, Ohio.

Patwardhan, A.S., Donlglan Jr, A.S. 1997. Assessment of Nitrogen Loads to Aquatic Systems. USEPA (United States Environmental Protection Agency) Athens, Georgia

Sims, G.K., D.D. Buhler, and R.F. Turco. 1994. Residue management impacts on the environment, in Managing Agricultural Residues. P.W. Unger, editor. CRC Press, Inc., Boca Raton, FL, 77-98.

US Census Bureau. 2012. Population Estimates. https://www.census.gov/popest/data/historical/. Washington D.C.

U.S. EPA (U.S. Environmental Protection Agency). 2010. Five-Year Review Report: First Five-Year Review Report for Little Mississinewa River Site, Union City, Randolph County, Indiana.

U.S. EPA (U.S. Environmental Protection Agency). 2016. Region 5 Cleanup Sites: Little Mississinewa River. U.S. EPA, 2013. http://www3.epa.gov/region5/cleanup/mississinewa/index.html

USEPA (U. S. Environmental Protection Agency). 2007 An Approach for Using Load Duration Curves in the Development of TMDLs. EPA 841-B-07-006. Washington, DC.

USGS (United States Geological Survey). 1999. National Water Summary on Wetland Resources. http://water.usgs.gov/nwsum/WSP2425/state_highlights_summary.html.

Zeckoski, R. W., Benham, B. L., Shah, S. B., Wolfe, M. L., Brannan, K. M., Al-Smadi, M., Heatwole, C. D. 2005. Bslc: A Tool For Bacteria Source Characterization For Watershed Management. Applied Engineering in Agriculture, 21(5), 879-889.

APPENDIX A. WATER QUALITY DATA FOR THE LOWER SALT CREEK WATERSHED TMDL

APPENDIX B. REASSESSMENT NOTES FOR THE LOWER SALT CREEK WATERSHED TMDL

APPENDIX C. SAMPLING AND ANALYSIS WORK PLAN FOR THE LOWER SALT CREEK WATERSHED TMDL

Subwatershed (12-digit HUC)	AUID	Waterbody	Station	TMDL Site	Location	Date	Comments	% Saturation	Alkalinity (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Coliforms (Total)	DO (mg/L)	E. coli	Hardness (mg/L)	Magnesium (mg/L)	Ammonia Nitrogen (mg/L)	Nitrogen, Nitrate+Nitrite (mg/L)	pH (SU)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Total Solids (mg/L)	Total Dissolved Solids (mg/L)	Specific Conductance (mg/L)	Sulfate (mg/L)	Temperature (°C)	TKN (mg/L)	TOC (mg/L)	Turbidity (NTU)
Jackson Creek-Clear Creek	INW0881_01																												
	INW0881_01A																												
	INW0881_02																												
	INW0881_03	Clear Creek	WEL-08-0008	16T-004	W Country Club Dr	4/18/2016		99.6	200	107	118	>2419.6	10.52	272.3	334	11	<0.10	1.1	7.77	0.022	<6	564	532	886	42	12.78	<0.30	2.3	4.84
						5/23/2016		92.4	227	105	136	180.7	9.38	103.6	317	11	<0.10	1.1	7.93	0.015	<6	582	544	904	38	14.55	<0.30	2.2	8.04
						6/13/2016		62.7	152	65.7	82	>2419.6	5.59	>2419.6	202	6.62	<0.10	0.6	7.59	0.044	<6	388	371	631	25	20.89	0.5	7.5	9.95
						7/11/2016		92.3	239	100	119	24196	8.5	920.8	323	9.65	<0.10	1.4	7.99	0.029	<6	581	540	924	40	19.2	<0.30	1.4	6.7
						7/18/2016	Near bankfull, recent heavy rain.	91.2				>2419.6	7.99	14136					8.07					202		21.87			96.1
						7/25/2016		95				>2419.6	8.04	1119.9					8.08					883		23.52			7.52
						8/1/2016		94.2				>2419.6	8.26	686.7					7.9					900		21.7			6.93
						8/8/2016		87.4	218	93.5	130	>2419.6	7.76	613.1	297	9.45	<0.10	1	7.89	0.013	<6	574	541	867	41	21.1	<0.30	2.1	2.39
						8/25/2016		111					9.08						7.76					711		24.25			3.68
						8/29/2016		122.8					10.16						7.51					817		23.88			4.3
						9/12/2016		88.7	256	103	98	>2419.6	8.44	365.4	317	9.86	<0.10	1.6	7.77	0.027	<6	536	514	857	40	17.65	<0.30	1.7	3.69
						10/17/2016		77.3	223	90.1	108	>2419.6	7.43	344.8	291	9.43	<0.10	0.7	7.83	0.043	<6	498	486	792	36	17.14	<0.30	2.9	4.29
	INW0881_04																												
	INW0881_05																												
	INW0881_06	Jackson Creek	WEL-08-0006	16T-002	S Rogers St	4/18/2016		112	170	72.4	44	1732.9	11.79	141.4	231	8.76	<0.10	0.9	8	0.012	<6	320	314	549	27	12.96	<0.30	2.2	4.43
						5/23/2016		102.6	197	80.1	50	180.7	10.56	86.2	244	9.6	<0.10	0.8	8.15	0.006	<6	358	339	584	24	14.05	<0.30	1.8	4.36
						6/13/2016		86.1	168	67	54	>2419.6	7.65	248.9	227	8.77	<0.10	0.4	7.89	0.02	<6	342	334	557	27	21.11	<0.30	2	2.38
						7/11/2016		94.9	199	73.2	54	>2419.6	8.67	648.8	230	8.31	<0.10	1	8.11	0.008	<6	367	349	620	26	19.7	<0.30	1.4	6.08
						7/18/2016	Muddy from recent rain event	92.3				>2419.6	8.14	19863					7.98					192		21.55			148
						7/25/2016		93.2				>2419.6	7.84	648.8					8.1					570		23.95			6.86
						8/1/2016		95.6				>2419.6	8.42	488.4					8.04					531		21.58			6.84
						8/8/2016		93.4	186	66.3	51	>2419.6	8.29	461.1	222	8.73	<0.10	0.6	8.03	<0.03	<6	334	324	561	27	21.12	<0.30	2.6	4.38
						8/24/2016		95.8					8.59						7.86					532		19.71			6.62
						8/29/2016		115.2					9.32						7.49					487		25.12			4.62
						9/12/2016		92.6	209	77.7	47	>2419.6	8.9	579.4	245	9.2	<0.10	1.2	7.96	0.019	<6	360	341	579	25	17.14	<0.30	2.4	1.81
						10/17/2016		83.4	198	70.6	48	2419.6	7.9	29.4	211	9.81	<0.10	0.1	8	0.011	<6	338	324	567	29	17.08	<0.30	2.8	3.14
	INW0881_T1001																												
	INW0881_T1002																												
	INW0881_T1003																												
	INW0881_T1004	Clear Creek	WEL-08-0007	16T-003	W Church Ln	4/18/2016		111.4	182	85	42	1732.9	11.56	58.3	283	10.1	<0.10	0.4	7.86	0.008	<6	388	366	622	38	13.54	<0.30	2.3	6.63
						5/23/2016		96.7	213	90.1	48	180.7	9.82	95.8	284	11.1	<0.10	0.5	8.06	0.014	6	399	372	633	44	14.58	<0.30	2.8	9.71
						6/13/2016		82.6	213	91	51	>2419.6	7.46	2419.6	280	11	<0.10	0.7	7.95	0.032	19	460	396	658	46	20.33	0.3	2.6	21.6
						7/11/2016		92.9	205	80.1	38	24196	8.42	613.1	247	8.76	<0.10	0.7	8.05	0.017	10	371	340	601	34	20.05	<0.30	1.7	16.4
						7/18/2016	Muddy due to recent heavy rain.	89.7				>2419.6	7.81	14136					7.96					469		22.19			312
						7/25/2016		91.6				>2419.6	7.74	325.5					8.11					602		23.74			12.9
						8/1/2016		92.4				>2419.6	8.1	290.9					7.95					585		21.8			11.4
						8/8/2016		89.7	207	77.6	46	>2419.6	8	275.5	254	9.33	<0.10	0.5	8.01	0.009	<6	377	356	597	39	20.88	<0.30	3.5	5.17
						8/23/2016		103.9					9.16						8.08					534		20.29			5.23
						8/29/2016		105.6					8.61						7.67					517		24.75			5.45
						9/12/2016		92.8	201	85.1	28	>2419.6	8.85	248.9	277	10.1	<0.10	0.7	7.82	0.027	<6	386	353	580	64	17.56	<0.30	2.8	6.31
						10/17/2016		81.7	239	91.4	42	>2419.6	8	57.3	297	11.2	<0.10	0.2	8.01	0.016	<6	411	394	640	49	16.2	<0.30	3.8	4.19
	INW0881_T1005																												
	INW0881_T1006																												
	INW0881_T1007																												
May Creek-Clear Creek	INW0882_01	Clear Creek	WEL-08-0005	16T-001	State Road 37	11/16/2015		90.7	227	89	76	2419.6	11.21	186	288	9.69	<0.10	0.4	7.47	<0.03	<6	450	418	723	37	6.22	<0.30	1.7	1.63
						12/14/2015		88.2	183	93.1	96	>2419.6	9.2	>2419.6	283	9.18	<0.10	0.9	8.07	0.019	10	464	430	735	38	13.33	<0.30	1.9	13.4
						1/25/2016		93.6	237	97	97	517.2	13.03	117.2	291	9.64	<0.10	1.7	8.02	0.023	<6	488	472	856	32	1.64	<0.30	1.3	6.03
						2/22/2016		95.1	185	87.6	140	>2419.6	11.4	547.5	265	8.63	<0.10	1.5	8.02	0.022	11	518	479	853	25	7.35	<0.30		19.6
						3/22/2016		94.3	215	93.8	71	920.8	11.36	101.4	290	10.2	<0.10	1.1	8.01	<0.03	<6	450	423	709	32	7.2	<0.30	1.2	5.73
						4/18/2016		113.7	187	84	59	1299.7	11.94	101.7	274	9.02	<0.10	0.9	7.94	0.011	<6	392	369	654	38	13.01	<0.30	2.5	5.08
						5/23/2016		108.6	215	91.3	65	180.7	11.02	93.4	278	10.1	<0.10	0.8	8.16	0.009	<6	415	389	673	34	14.55	<0.30	2.3	6.09
						6/13/2016		80.5	188	79.9	86	>2419.6	7.13	>2419.6	260	8.91	<0.10	0.9	7.8	0.03	<6	445	426	696	37	21.17	0.3	4.9	4.15
						7/11/2016		96.9	218	85.3	68	24196	8.79	770.1	273	8.79	<0.10	1.1	8.1	0.012	<6	430	415	706	32	20.01	<0.30	1.5	11.2
						7/18/2016	Muddy due to recent rain event	90.7				>2419.6	7.97	17329					7.98					218		21.76			196
						7/25/2016		95.9				>2419.6	8.02	613.1					8.08					645		24.2			7.68
						8/1/2016		95.1				>2419.6	8.34	435.2					7.98					670		21.74			6.89
						8/8/2016		92.7	203	78.3	70	>2419.6	8.19	206.4	258	9.17	<0.10	0.7	7.97	0.017	<6	409	397	653	34	21.44	<0.30	3.3	2.88
						8/25/2016		102					8.54						7.86					476		23.08			11
						8/29/2016		98.3					7.8						7.5					576		22.61			4.75
						9/12/2016		94	227	90.5	54	>2419.6	8.98	410.6	288	9.55	<0.10	1.2	7.94	0.023	<6	421	391	658	41	17.45	<0.30	2.9	3.9
						10/17/2016		83.1	231	88.1	64	>2419.6	8.04	65.7	279	10.3	<0.10	0.3	7.96	0.014	<6	425	408	662	39	16.84	<0.30	3.4	4.22
			WEL-08-0012	16T-008	S Ketcham Road	11/16/2015		95.5	139	65.8	61	1986.3	11.39	113.7	216	8.43	<0.10	8.1	8.08	0.682	<6	414	379	650	53	7.61	0.5	3.5	5.32
						12/14/2015		89.3	172	75.4	58	1732.9	9.25	83.9	236	8.94	<0.10	5.6	8.08	0.6	<6	390	368	616	49	13.7	0.5	2.9	6.14
						1/25/2016		92.9	194	83	74	>2419.6	12.74	>2419.6	262	9	<0.10	4.9	8.11	0.394	<6	429	407	753	38	2.22	0.4	2.1	7.02
						2/22/2016		94.9	170	84.4	92	>2419.6	11.29	488.4	238	8.33	<0.10	1.6	8.09	0.086	14	422	380	700	28	7.75	0.5		23.9
						3/22/2016		95.1	177	76.9	53	2419.6	11.21	410.6	242	9.14	<0.10	3.1	7.89	0.456	<6	395	368	613	42	8.15	0.3	2.1	6.36
						4/18/2016		137.5	191	78.3	42	1413.6	13.58	107.6	243	8.9	0.1	2	8.27	0.253	<6	362	365	578	38	15.82	0.6	2.9	5.9
						5/23/2016		135.7	174	74.1	50	176.9	13.01	29.8	231	9.28	<0.10	3.6	8.48	0.041	<6	369	347	592	39	17.29	<0.30	2.9	6.95
						6/13/2016		118.7	137	59.9	70	>2419.6	9.97	90.8	207	8.03	<0.10	8.5	8.35	0.131	<6	420	398	646	45	23.93	<0.30	3.8	2.96
						7/11/2016		97.3	181	74.2	60	>2419.6	8.45	275.5	232	8.08	<0.10	4.7	8.15	0.132	6	425	389	670	42	22.19	0.4	2.6	10.7
						7/18/2016		91.8				>2419.6	7.78	488.4					8.11					630		23.6			10.5
						7/25/2016		97				>2419.6	7.88	139.6					8.18					649		25.8			9.99
						8/1/2016		93.1				>2419.6	7.92	260.3					8.06					636		23.35			9.39
						8/8/2016		101.7	158	67	60	>2419.6	8.57	129.6	211	8.31	<0.10	6.2	8.09	0.124	<6	408	378	626	52	23.8	0.4	3.6	5.06
						8/24/2016		107.8					9.1						8.01					599		22.57			5.2
						9/7/2016		103.3					8.42						8.27					545		24.6			5
						9/12/2016		95.2	187	72.7	55	>2419.6	8.71	344.8	224	7.88	<0.10	5	8.04	0.053	<6	399	372	614	43	19.59	<0.30	3.3	3.75
						10/17/2016		92.8	148	60.6	61	>2419.6	8.8	60.9	186	8.52	<0.10	9.3	8.1	0.232	<6	406	385	624	46	17.79	0.5	4.4	4.99
	INW0882_T1001																												
	INW0882_T1002A																												
	INW0882_T1003	Tributary to Clear Creek	WEL-08-0010	16T-006	S Victor Pike	4/18/2016		120.5	156	84.9	5.5	1553.1	12.39	142.1	268	10.2	<0.10	0.2	8.09	0.01	<6	318	301	440	54	13.97	<0.30	1.4	5.54
						5/23/2016		105.4	180	86.4	5.6	180.7	10.68	48.7	274	12.6	<0.10	0.3	8.24	0.007	<6	349	349	530	79	14.68	<0.30	2.5	6.83
						6/13/2016		95	181	93.4	8.1	>2419.6	8.48	131.4	350	14.5	<0.10	0.5	8.05	0.018	<6	426	400	451	105	20.9	<0.30	1.8	4.3
						7/11/2016		98.9	179	92.5	8.2	>2419.6	9.02	290.9	302	14	<0.10	0.4	8.12	0.021	6	443	405	625	129	19.76	<0.30	1.5	8.97
						7/18/2016	Stream muddy due to recent rain.	92.1				>2419.6	8.17	2382					8.03					430		21.27			190
						7/25/2016		96.9				>2419.6	8.26	127.4					8.13					587		23.22			8.67
						8/1/2016		93.9				>2419.6	8.2	101.2					8.02					584		21.95			7.58
						8/8/2016		96	200	101	11	>2419.6	8.37	81.6	335	15.1	<0.10	0.5	8.05	<0.03	<6	466	436	636	134	21.56	<0.30	2.9	4.85
						8/23/2016		101.1					9.2						8.1					495		18.73			6.81
						9/7/2016		97.2					8.43						8.15					527		21.61			5.9
						9/12/2016		98.3	216	96.3	6.2	>2419.6	9.49	488.4	294	11.9	<0.10	0.5	8.01	0.02	<6	395	373	562	82	16.95	<0.30	2.9	5.41
						10/17/2016		88.5	232	108	7.3	1732.9	8.66	18.7	348	16	<0.10	<0.10	8.08	0.011	<6	466	438	642	117	16.33	<0.30	3.3	4.14
	INW0882_T1004	Tributary to Clear Creek	WEL-08-0013	16T-009	Will Flock Mill Road	4/18/2016		104.9	181	87.7	11	1046.2	10.84	22.8	265	8.74	<0.10	<0.10	7.92	0.008	<6	304	291	522	26	13.78	<0.30	1.6	5.46
						5/23/2016		96	224	86.8	12	176.9	9.92	39.3	256	8.94	<0.10	0.2	8.02	0.005	<6	320	295	522	21	13.82	<0.30	1.4	4.85
						6/13/2016		56.8	209	79.4	15	>2419.6	5.4	30.1	251	7.89	<0.10	0.3	7.36	0.019	9	302	287	498	21	17.8	<0.30	2.1	8.92
						7/11/2016		91.2	232	83	18	>2419.6	8.41	172.3	262	8.03	<0.10	0.2	8.04	0.005	<6	327	315	565	26	19.16	<0.30	1.3	6.39
						7/18/2016	Muddy due to recent rain.	94.8				>2419.6	8.49	12033					8.01					310		20.74			103
						7/25/2016		87				>2419.6	7.47	76.7					7.94					522		22.9			6.29
						8/1/2016		84.7				>2419.6	7.57	118.7					7.79					505		20.86			6.73
						8/8/2016	Very low flow. Stream nearly pooled.	87.4	214	76.8	22	>2419.6	7.89	77.1	234	8.2	<0.10	0.2	7.88	<0.03	<6	299	292	513	23	20.32	<0.30	2.7	2.82
						8/23/2016		97.7					9.08						8.04					502		17.33			5.46
						9/12/2016		90.7	244	86.4	17	>2419.6	8.78	63.7	255	8.34	<0.10	0.2	7.85	0.015	<6	325	314	512	23	16.8	<0.30	2.5	2.49
						9/21/2016		94.9					8.48						7.7					516.1		19.63			2.53
						10/17/2016		79	239	82.8	16	>2419.6	7.69	32.7	250	8.44	<0.10	<0.10	7.92	0.008	<6	314	308	529	23	16.29	<0.30	3.1	3.68
	INW0882_T1005	Tributary to Clear Creek	WEL-08-0011	16T-007	S Victor Pike	4/18/2016		131.3	158	78.5	5.5	866.4	13.47	214.3	242	9.28	<0.10	0.2	8.16	0.008	<6	280	270	466	35	14.08	<0.30	2.3	6.01
						5/23/2016		113.9	198	86.5	6.3	180.7	11.48	130.8	295	10.8	<0.10	0.4	8.27	0.01	<6	318	302	512	39	14.94	<0.30	1.3	10.1
						6/13/2016		101	191	84.2	9	>2419.6	9.04	365.4	296	12.1	<0.10	0.6	8.1	0.033	12	381	352	543	68	20.7	<0.30	1.6	11.9
						7/11/2016		105.1	216	95.4	9.2	>2419.6	9.59	920.8	295	12	<0.10	0.6	8.18	0.015	7	391	352	584	68	19.72	<0.30	1.4	13.3
						7/18/2016	Muddy due to recent rain.	93.9				>2419.6	8.39	15531					8.07					468		20.8			347
						7/25/2016		100.9				>2419.6	8.67	770.1					8.14					566		22.8			12.22
						8/1/2016		95.2				>2419.6	8.45	298.7					8.01					570		21.8			95.2
						8/8/2016		103.1	224	97.2	10	>2419.6	9.12	488.4	308	12.8	<0.10	0.4	7.99	0.005	<6	423	406	597	78	21.31	<0.30	2.9	7.81
						8/22/2016		101					9.21						8.08					464		18.54			6.58
						9/7/2016		102.2					8.78						8.19					475		22.37			6
						9/12/2016		104.7	218	91.1	8.6	>2419.6	10.1	579.4	290	12.3	<0.10	0.6	8.06	0.02	<6	405	384	574	78	17	<0.30	2	4.45
						10/17/2016		88.5	245	96.4	8.4	1732.9	8.75	186	322	14.4	<0.10	<0.10	8.07	0.012	<6	413	392	597	78	15.74	<0.30	3.3	5.7
	INW0882_T1006																												
	INW0883_01	Clear Creek	WEL-08-0015	16T-011	S Gore Road	4/18/2016		126.3	192	77.4	39	1553.1	12.37	79.4	234	8.77	<0.10	1.5	8.18	0.108	<6	346	328	563	40	16.21	0.4	2.7	6.98
						5/23/2016		116.7	183	76	47	176.9	11.16	59.4	234	9.31	<0.10	3	8.28	0.034	<6	368	345	588	42	17.41	<0.30	2.6	6.83
						6/13/2016		93.7	142	62.6	69	>2419.6	7.8	167.4	225	8.14	<0.10	8.2	8.01	0.146	7	431	403	655	47	24.51	0.5	3.5	5.95
						7/11/2016		95.4	187	77	61	>2419.6	8.23	275.5	224	8.2	<0.10	4.2	8.12	0.116	8	423	389	671	41	22.65	0.3	2.4	12.7
						7/18/2016		87.5				>2419.6	7.41	>2419.6					7.96					630		23.6			20.7
						7/25/2016		96				>2419.6	7.73	149.7					8.14					632		26.28			10.9
						8/1/2016		90				>2419.6	7.64	143.9					8.05					625		23.48			7.98
						8/8/2016		98.4	167	69.5	54	>2419.6	8.32	141.4	229	8.4	<0.10	5.6	8.01	0.125	<6	397	373	617	51	23.75	<0.30	3.4	6.33
						8/24/2016		96.8					8.34						7.97					553		21.34			4.87
						9/12/2016		92.7	189	75.5	52	>2419.6	8.47	231	226	8.08	<0.10	4.8	8.02	0.052	<6	398	373	611	42	19.7	<0.30	2.8	4.57
						9/20/2016		96					8.23						8.22					578		21.57			2.92
						10/17/2016		90	152	61.5	62	2419.6	8.58	10	191	8.41	<0.10	9.2	8.04	0.206	<6	412	389	630	48	17.16	0.4	4.4	5
	INW0883_02	Clear Creek	WEL-08-0016	16T-012	Depot Hill Road	11/16/2015		93.4	144	68.2	66	>2419.6	11.26	57.3	218	8.47	<0.10	8.6	8.11	0.626	<6	402	371	652	52	7.22	0.7	3.5	4.82
						12/14/2015		85.7	174	76	56	2419.6	8.94	178.5	239	8.8	<0.10	6	7.97	0.629	<6	395	369	625	50	13.39	0.5	2.7	5.59
						1/25/2016		92.1	209	88.9	63	>2419.6	12.61	1732.9	273	9.19	<0.10	3.6	8.14	0.275	6	419	401	743	35	2.07	0.3	2.1	7.84
						2/22/2016		93.6	174	75.9	88	>2419.6	11.08	387.3	226	7.43	<0.10	1.5	8.11	0.109	25	416	364	673	27	7.94	0.4		28.9
						3/22/2016		91.4	191	82.1	45	1986.3	10.67	111.9	248	9.11	<0.10	2.2	7.98	0.256	<6	388	359	605	36	8.53	<0.30	1.9	5.29
						4/18/2016		125.4	188	75.5	37	1119.9	12.23	63.8	246	8.44	<0.10	1.5	8.1	0.075	<6	355	319	557	24	16.5	0.4	2.8	7.6
						5/23/2016		92.8	183	75.8	42	176.9	8.86	64	234	9.09	<0.10	2.5	8.12	0.05	<6	369	340	580	36	17.42	0.3	2	8.84
						6/13/2016		89.7	145	64.6	64	>2419.6	7.44	214.2	202	8.27	<0.10	7.4	7.97	0.149	9	426	398	650	42	24.71	0.6	3.3	5.6
						7/11/2016		95.4	188	78.6	59	>2419.6	8.14	248.1	241	8.22	<0.10	3.9	8.14	0.109	9	423	387	661	38	23.15	0.4	2.3	11.7
						7/18/2016		87.3				>2419.6	7.37	>2419.6					7.99					610		23.82			31.7
						7/25/2016		94.2				>2419.6	7.56	328.2					8.14					626		26.55			10.8
						8/1/2016		90.3				>2419.6	7.66	137.4					8.05					619		23.5			10.2
						8/8/2016		96.7	169	70.4	53	>2419.6	8.12	218.7	227	8.32	<0.10	5.6	8.03	0.117	<6	402	378	614	47	24.05	<0.30	3.4	6.84
						8/24/2016		91.4					7.96						7.84					583		21.08			8.12
						9/12/2016		93.4	196	75.2	52	>2419.6	8.43	158.5	228	7.97	<0.10	4.6	8.01	0.067	6	402	370	612	40	20.28	0.4	2.8	5.78

Little Clear Creek-Clear Creek						9/20/2016		89.1					7.78						8.14					571		20.87			3.76
						10/17/2016		85.3	157	64.2	60	>2419.6	8.15	131.7	201	8.62	<0.10	8.8	8	0.258	<6	433	399	627	44	17.47	0.4	3.9	5.79
	INW0883_T1001																												
	INW0883_T1002																												
	INW0883_T1003																												
	INW0883_T1004	Little Clear Creek	WEL-08-0017	16T-013	E Monroe Dam Road	4/18/2016		121.8	181	77.2	9.2	365.4	12.14	38.4	251	7.3	<0.10	0.2	8.02	0.016	7	275	264	475	36	15.5	<0.30	1.9	5.63
						5/23/2016		104.7	214	84	11	176.9	10.48	91.3	270	7.9	<0.10	0.3	8.07	0.01	<6	306	286	500	25	15.29	<0.30	1.1	5.62
						6/13/2016		85.2	224	84.3	14	>2419.6	7.53	816.4	263	6.81	<0.10	0.2	7.82	0.021	<6	325	313	537	24	21.38	<0.30	1.3	5.05
						7/11/2016		92.1	240	89.6	15	>2419.6	8.33	410.6	241	7.37	<0.10	0.4	7.96	0.005	<6	340	310	570	23	20.17	<0.30	1	6.79
						7/18/2016	Muddy	82.2				>2419.6	7.28	5172					7.9					477		21.25			48.3
						7/25/2016		92.7				>2419.6	7.93	648.8					7.97					499		22.98			6.23
						8/1/2016		84.2				>2419.6	7.46	613.1					7.76					530		21.23			7.02
						8/8/2016		94.4	245	91.9	15	>2419.6	8.39	387.3	282	7.83	<0.10	0.3	7.86	<0.03	<6	348	326	426	24	21.09	<0.30	1.7	6.54
						8/22/2016		94.3					8.68						7.87					465		18.18			4.26
						9/12/2016		86.8	245	89.7	15	>2419.6	8.1	214.2	296	7.54	<0.10	0.2	7.81	0.02	<6	329	315	543	22	18.66	<0.30	2.4	3.19
						9/20/2016		71.9					6.57						7.94					499		19.52			3.72
						10/17/2016		71.2	260	96.5	16	>2419.6	6.84	410.6	294	7.92	<0.10	<0.10	7.87	0.011	<6	348	336	570	21	16.95	<0.30	2.2	5.23
	INW0883_T1005	Judah Branch	WEL-08-0014	16T-010	S Old State Road 37	4/18/2016		118	161	61.8	<5	770.1	10.82	79.4	202	8.79	<0.10	0.4	8.25	0.018	<6	226	215	396	35	19.55	<0.30	1.9	7.39
						5/23/2016		102	199	75.6	5.7	176.9	9.76	119.4	240	11	<0.10	0.6	8.24	0.013	6	271	255	457	16	17.37	<0.30	1.1	10.2
						6/13/2016		94.7	210	72.9	7	>2419.6	8.32	1986.3	248	11.8	<0.10	1	8.11	0.032	6	332	280	462	22	21.68	<0.30	1.6	5.65
						7/11/2016		95.2	213	74.7	6.6	>2419.6	8.48	191.8	224	10.1	<0.10	0.9	8.21	0.027	7	306	274	492	15	20.97	<0.30	1.8	12.7
						7/18/2016	Muddy due to recent rain	93.3				>2419.6	8.3	>2419.6					8.07					404		21.08			191
						7/25/2016		93.5				>2419.6	8.05	648.8					8.18					482		22.75			13.1
						8/1/2016		95.9				>2419.6	8.86	648.8					8.02					476		19.09			11.9
						8/8/2016		95	212	72	5.2	>2419.6	8.31	214.2	248	10.9	<0.10	0.9	8.1	0.011	<6	282	266	466	16	21.91	<0.30	2.7	13.3
						8/22/2016		104					9.65						7.98					430		16			9.87
						9/12/2016	Missing turbidity data.	95.3	237	83.1	7.2	>2419.6	8.97	214.2	247	11	<0.10	0.9	8.09	0.027	6	311	292	504	17	18.19	<0.30	2.7	
						9/20/2016		91.3					8.6						8.03					447		17.91			3.47
						10/17/2016		92	254	83	7.9	1299.7	8.77	45.7	286	13.5	<0.10	0.5	8.13	0.019	<6	328	312	530	25	17.6	<0.30	3	4.37
	INW0883_T1006																												
Hunter Creek-Little Salt Creek	INW0884_01	Little Salt Creek	WEL-08-0035	16T-016	Unnamed County Rd off of Hunter Creek Rd	4/19/2016		104.7	59	22.1	<5	1553.1	11.02	209.8	82	4.71	<0.10	<0.10	7.36	0.017	<6	112	102	214	23	13.02	<0.30	<1	4.73
						5/24/2016		100.8	65	26.4	<5	169.4	10.47	60.8	95	5.61	<0.10	<0.10	7.82	0.009	<6	135	121	245	23	13.6	<0.30	<1	4.77
						6/14/2016		100.4	92	36.7	6	>2419.6	9.01	365.4	120	7.18	<0.10	0.2	7.87	0.012	<6	165	154	312	26	20.63	<0.30	<1	3.48
						7/12/2016		98.4	92	35.8	6.3	2419.6	8.84	111.9	108	7.09	<0.10	0.2	7.85	0.009	<6	155	149	283	25	20.52	<0.30	1	4.36
						7/19/2016	Very low flow	94.8				>2419.6	8.57	461.1					7.74					289		20.26			5.79
						7/26/2016		94					7.98						7.77					306		23.39			6.67
						8/2/2016		103.8				>2419.6	9.19	172.3					7.91					275		21.18			5.38
						8/9/2016		104.7	122	41.1	5.4	>2419.6	9.33	190.4	135	7.18	<0.10	0.1	7.9	0.007	<6	175	169	310	19	20.63	<0.30	<1	1.4
						8/22/2016		96.6					8.86						8.09					192		18.28			3.03
						9/7/2016		127.8					10.02						8.58					223		26.27			1.38
						9/13/2016		96.7	97	33.7	<5	>2419.6	9.38	118.2	108	6.69	<0.10	0.1	7.76	0.015	<6	153	144	286	20	16.88	<0.30	1.1	1.12
						10/4/2016		102				1413.6	10.19	52					7.81					303		15.44			3.71
						10/18/2016		79.3	117	42.3	6.8	2419.6	7.51	33.1	126	8.12	<0.10	<0.10	7.67	0.014	<6	179	172	327	24	18	<0.30	2	4.53
	INW0884_T1001																												
	INW0884_T1002	Henderson Creek	WEL-08-0019	16T-015	Humback Ridge Road	4/19/2016		105	47	18.5	<5	770.1	10.85	30.1	71	4.22	<0.10	0.6	7.31	0.01	<6	100	93	202	24	13.83	<0.30	<1	3.75
						5/24/2016		98.6	57	20.3	<5	165.7	10.03	39.7	78	4.5	<0.10	0.4	7.45	0.004	<6	114	107	203	18	14.57	<0.30	<1	3.72
						6/14/2016		68.2	62	25.3	<5	>2419.6	6	88.4	81	4.92	<0.10	0.4	7.25	0.009	<6	113	113	174	18	21.72	<0.30	<1	4.72
						7/12/2016		88.2	65	24.9	<5	>2419.6	7.86	125.9	81	5.66	<0.10	0.6	7.71	0.006	<6	120	117	232	19	21	<0.30	<1	4.96
						7/19/2016		86.5				>2419.6	7.66	365.4					7.56					221		21.26			11
						7/26/2016		73.5					6.13						7.61					241		24.47			5.23
						8/2/2016		86.8				>2419.6	7.54	93.3					7.52					226		22.31			4.95
						8/9/2016		75.5	73	26	5.7	>2419.6	6.59	344.8	80	5.46	<0.10	0.2	7.47	0.043	<6	123	117	222	16	22.18	<0.30	<1	1.76
						8/22/2016		92.7					8.21						8.07					161		20.04			3.2
						9/7/2016		90.3					7.39						7.63					187		24.31			2.85
						9/13/2016		83	69	26.5	<5	>2419.6	7.86	275.5	88	5.42	<0.10	0.3	7.42	<0.03	<6	124	118	234	18	17.98	<0.30	1.1	1.17
						10/4/2016		74.7				>2419.6	7.38	104.6					7.51					251		15.88			4.11
						10/18/2016		57.3	88	30.1	6.1	>2419.6	5.41	54.6	89	5.31	<0.10	<0.10	7.34	0.013	<6	133	127	252	17	18.06	<0.30	1.5	4.96
Knob Creek-Little Salt Creek	INW0885_01	Little Salt Creek	WEL-08-0018	16T-014	State Road 446	11/16/2015		109.1	89	37.7	8.4	2419.6	12.61	96	125	6.41	<0.10	0.2	7.85	<0.03	<6	166	156	296	29	8.95	<0.30	<1	3.42
						12/14/2015		110	81	35.9	8.3	1986.3	11.7	131.7	113	5.89	<0.10	0.8	8.05	<0.03	<6	151	142	269	23	12.57	<0.30	1	3.41
						1/25/2016		101.3	60	26.2	<5	260.3	13.84	31.5	82	4.94	<0.10	0.7	7.72	0.013	<6	120	117	252	24	2.42	<0.30	<1	4.15
						2/22/2016		107.2	48	23.1	5.1	224.7	13.01	17.5	74	5.04	<0.10	0.3	7.89	0.008	<6	110	102	231	26	6.94	<0.30		5.22
						3/22/2016		105.8	52	22.5	<5	261.3	12.46	38.9	83	4.56	<0.10	0.7	7.66	0.011	<6	126	118	224	24	8.11	<0.30	1.2	6.76
						4/19/2016		108	64	24.8	<5	1203.3	11.08	45.7	86	4.73	<0.10	0.4	7.62	0.009	<6	116	111	228	25	14.19	<0.30	<1	3.62
						5/24/2016		104.6	71	28	<5	176.9	10.53	58.6	106	5	<0.10	0.4	7.73	<0.03	<6	130	125	248	20	15.04	<0.30	<1	4.72
						6/14/2016		95.8	96	39.5	7.3	>2419.6	8.29	139.6	120	5.96	<0.10	0.4	7.59	0.01	<6	155	157	299	22	22.47	<0.30	<1	4.6
						7/12/2016		97.3	93	35.1	6.4	>2419.6	8.55	275.5	105	6.08	<0.10	0.5	7.75	0.006	<6	159	147	292	23	21.72	<0.30	<1	5.26
						7/19/2016		93.4				>2419.6	8.24	980.4					7.67					278		21.49			7.53
						7/26/2016		84.9					7.01						7.66					304		25.01			5.9
						8/2/2016		97.7				>2419.6	8.43	198.9					7.63					278		22.62			5.99
						8/9/2016		93.9	116	41.3	6.6	>2419.6	8.12	166.4	129	6.8	<0.10	0.2	7.66	0.005	<6	169	163	304	19	22.54	<0.30	1.1	2.07
						9/8/2016		75					6.36						7.58					254		22.77			1.52
						9/13/2016		94.1	102	36.6	6	>2419.6	8.83	104.6	112	6.29	<0.10	0.2	7.61	0.011	<6	157	148	288	19	18.31	<0.30	1.4	1.64
						10/4/2016		91				1986.3	8.88	133.3					7.64					297		16.44			6.83
						10/18/2016		78.8	122	43.8	8.4	>2419.6	7.31	83.6	128	6.3	<0.10	<0.10	7.61	0.009	<6	175	167	324	21	18.89	<0.30	1.6	4.17
						12/22/2016		102.6					8.7						8.32					197		22.09			2.79
			WEL-08-0023	16T-019	Bat Hollow Road	4/19/2016		97.2	65	24.1	<5	2419.6	9.4	184.2	84	4.51	<0.10	0.3	7.39	0.009	<6	122	109	227	23	16.9	<0.30	1.1	8.42
						5/24/2016		90	70	27.4	<5	173.1	8.59	100.5	102	4.99	<0.10	0.3	7.55	0.007	6	132	123	244	18	17.53	<0.30	1.2	10.5
						6/14/2016		54	82	30.9	5.9	>2419.6	4.55	613.1	99	5.39	<0.10	0.2	7.19	0.039	10	144	130	263	14	23.97	0.4	1.6	21.2
						7/12/2016		76.3	88	33.8	6	>2419.6	6.52	238.2	103	5.7	<0.10	0.5	7.85	0.034	12	154	138	279	17	23.2	0.3	1.5	18.9
						7/19/2016		74.1				>2419.6	6.29	547.5					7.54					271		23.54			21.2
						7/26/2016		60.5					4.94						7.66					282		25.8			20.1
						8/2/2016		74.7				>2419.6	6.32	461.1					7.61					264		23.72			23.5
						8/9/2016		66.6	96	33.3	<5	>2419.6	5.64	517.2	104	5.63	<0.10	0.2	7.51	0.023	15	156	138	264	12	23.68	<0.30	2.6	19.6
						8/22/2016		80.5					7.04						7.53					204		20.91			11.2
						9/13/2016		75.3	90	32.4	<5	>2419.6	6.84	298.7	98	5.66	<0.10	0.3	7.38	0.025	11	159	145	266	15	20.1	<0.30	2.2	13.6
						9/20/2016		67.1					5.85						7.77					222		21.19			10.8
						10/4/2016		59.9				>2419.6	5.81	178.5					7.17					257		16.67			19.1
						10/18/2016		38.3	99	33.6	6.9	2419.6	3.59	58.1	101	5.72	<0.10	0.1	7.22	0.026	<6	148	140	273	14	18.36	0.3	2.8	14.1
	INW0885_02	Little Salt Creek	WEL-08-0021	16T-017	Judah Legan Road	11/16/2015		71.3	79	32.4	8	1299.7	8.6	50.4	109	6.03	<0.10	0.1	7.31	0.011	<6	147	145	276	23	7.18	<0.30	1.4	7.86
						12/14/2015		77.3	82	32.2	8.2	>2419.6	8.19	193.5	105	5.78	<0.10	0.6	7.41	0.012	<6	147	136	256	23	12.71	<0.30	1.1	12.7
						1/25/2016		92.2	60	25.4	5.2	488.4	12.94	25.6	84	4.8	<0.10	0.9	7.7	0.015	<6	121	118	256	21	1.38	<0.30	<1	6.79
						2/22/2016		94.7	47	23.3	6.7	1413.6	11.04	56.3	85	4.82	<0.10	0.4	7.89	0.029	13	128	104	240	25	8.62	<0.30		18.8
						3/22/2016		91.9	52	22.6	<5	613.1	10.72	63.1	75	4.5	<0.10	0.7	7.72	0.01	7	130	121	230	24	8.57	<0.30	1.2	9.05
						4/19/2016		91.6	61	23.9	<5	2419.6	8.95	235.9	85	4.56	<0.10	0.4	7.34	0.009	13	128	106	221	21	16.47	<0.30	1.1	11.6
						5/24/2016		82.7	65	25.5	<5	180.7	7.68	82.9	98	4.76	<0.10	0.4	7.44	0.011	8	132	118	234	18	18.93	<0.30	1.1	15.4
						6/14/2016		41.3	88	32	5.8	>2419.6	3.45	67	100	5.52	<0.10	<0.10	7.15	0.048	8	144	132	262	11	24.46	0.4	2.4	16.5
						7/12/2016		69.8	86	31	6	>2419.6	5.94	410.6	95	5.36	<0.10	0.5	7.53	0.022	13	155	135	267	16	23.53	<0.30	1.7	20.5
						7/19/2016		66.6				>2419.6	5.68	2419.6					7.64					281		23.33			25.6
						7/26/2016		48.7					3.92						7.38					270		26.63			19.2
						8/2/2016		66.8				>2419.6	5.63	488.4					7.36					248		23.93			18.7
						8/9/2016		58.5	85	29.1	<5	>2419.6	4.87	161.6	91	5.15	<0.10	0.2	7.31	0.032	8	141	128	241	12	24.64	0.4	2.8	16.9
						8/22/2016		79					6.91						8.02					196		20.96			11.1
						9/13/2016		65	89	32.3	5	>2419.6	5.87	248.9	95	5.7	<0.10	0.3	7.25	0.029	10	151	136	253	15	20.36	0.3	2.5	14.4
						9/20/2016		59.2					5.13						7.72					217		22.13			10.3
						10/4/2016		61.4				>2419.6	5.9	410.6					7.24					275		17.45			16.1
						10/18/2016		38	93	30.5	6.7	>2419.6	3.54	517.2	94	5.37	<0.10	<0.10	7.25	0.032	6	140	132	260	12	18.34	0.4	2.8	15.8
	INW0885_T1001	Tributary to Little Salt Creek	WEL-08-0024	16T-020	Heltonville Bartlettsville Road	4/19/2016		96.4	26	10.9	<5	1732.9	9.91	43.1	45	3.71	<0.10	<0.10	7.07	0.008	<6	82	74	163	26	14.13	<0.30	1.1	4.5
						5/24/2016		80	34	13.7	<5	176.9	7.98	74.3	58	4.18	<0.10	<0.10	6.95	<0.03	<6	87	83	179	20	15.41	<0.30	<1	4.07
						7/12/2016		64.4	50	16.7	<5	>2419.6	5.73	325.5	67	5.03	<0.10	<0.10	7.45	0.006	<6	96	94	193	20	21.11	<0.30	<1	4.05
						7/26/2016	Very low flow	55.1					4.78						7.02					161		22.63			3.96
						8/2/2016	Very low flow	66				>2419.6	5.74	517.2					6.98					196		22.2			4.22
						8/23/2016		68.6					6						7.9					130		20.61			
						9/13/2016		66.4	53	17.1	<5	>2419.6	6.07	261.3	64	5.25	<0.10	<0.10	6.88	0.01	<6	99	93	167	18	19.7	<0.30	1.1	1.13
	INW0885_T1002	Knob Creek	WEL-08-0022	16T-018	Bat Hollow Road	4/19/2016		101.9	27	11.1	<5	1413.6	10.29	42.8	45	3.17	<0.10	0.4	7.05	0.007	<6	81	72	147	22	14.9	<0.30	<1	4.51
						5/24/2016		102.1	28	12.4	<5	176.9	9.87	16	51	3.42	<0.10	0.6	7.02	<0.03	<6	88	76	170	16	16.98	<0.30	<1	6.86
						6/14/2016		86.9	37	15.8	5.3	>2419.6	7.18	579.4	56	3.88	<0.10	0.3	6.99	0.011	7	93	87	182	15	24.96	<0.30	<1	12
						7/12/2016		96.2	37	15.6	5.3	>2419.6	8.34	344.8	61	4.1	<0.10	0.8	7.62	0.007	<6	121	110	184	17	22.41	<0.30	<1	8.29
						7/19/2016		90.4				>2419.6	7.72	816.4					7.36					190		23.18			8.02
						7/26/2016		76.8					6.41						7.36					184		24.46			10.9
						8/2/2016		93.5				>2419.6	8.08	770.1					7.26					175		22.58			6.76
						8/9/2016		86.4	40	14.3	<5	>2419.6	7.47	461.1	52	3.86	<0.10	0.5	7.25	0.004	<6	96	87	174	16	22.57	<0.30	<1	5.73
						8/23/2016		89.7					7.85						8.22					114		20.7			3.77
						9/13/2016		83.2	38	14.7	<5	>2419.6	7.53	344.1	55	4.03	<0.10	0.4	7.02	0.012	<6	92	84	168	15	20.23	<0.30	1.1	6.55
						9/21/2016		66					5.81						6.79					1439		20.42			28.1
						10/4/2016		84.1				>2419.6	8.13	228.2					7.25					183		16.91			10.9
						10/18/2016		69.9	46	16.2	5.2	>2419.6	6.45	125.9	54	3.95	<0.10	0.2	7.27	0.024	15	110	89	186	14	19.1	<0.30	1.5	36.6
	INW0886_01																												
	INW0886_02	Salt Creek	WEL-08-0034	16T-024	Guthrie Road	4/19/2016		104.3	32	13	<5	285.1	10.72	34.5	50	3.63	<0.10	0.3	7.68	0.016	11	100	83	175	19	13.96	<0.30	2.7	15.1
						5/24/2016		103.8	31	12.3	<5	132.2	9.67	9.8	56	3.56	<0.10	0.2	7.58	0.009	6	91	81	172	14	18.68	<0.30	2.6	7.17
						6/14/2016		72.7	90	40.2	33	>2419.6	6.1	128.1	118	6.3	<0.10	3	7.53	0.072	9	244	224	391	29	24.11	0.4	2.9	11.6
						7/12/2016		79.8	127	53.1	34	>2419.6	6.81	461.1	153	6.94	<0.10	2.2	7.73	0.089	28	302	259	448	29	23.24	0.4	2.5	27.6
						7/19/2016	Muddy	83.5				>2419.6	7.15	4352					7.7					352		22.97			44.6
						7/26/2016		81.6					6.97						7.44					254		23.18			22.9
						8/2/2016		85.3				>2419.6	7.31	613.1					7.44					307		23.02			23.8
						8/9/2016		82.2	69	21.7	10	>2419.6	7.03	79.4	76	4.72	0.1	0.6	7.29	0.084	24	154	146	232	17	23.14	0.6	3.5	19.6
						8/23/2016		83.3					7.05						7.81					271		22.48			14.7
						9/13/2016		90.5	62	22.2	9.4	>2419.6	7.53	52.1	72	4.9	0.1	0.5	7.52	0.034	16	140	117	224	16	24.58	0.5	4	13.4
						9/21/2016		71.8					6.11						7.42					415		22.08			15.7
						10/4/2016		77.6				>2419.6	7.1	1986.3					7.7					408		19.52			25.3
						10/18/2016		75.3	89	33.1	22	>2419.6	6.88	228.2	99	5.6	0.1	2.8	7.73	0.096	14	203	184	334	23	20.21	0.8	4	19
	INW0886_03	Salt Creek	WEL-08-0027	16T-023	Peerless Road	4/20/2016		99.3	36	15.4	5.3	1046.2	10.22	82	59	3.91	<0.10	0.3	7.58	0.037	31	128	89	189	18	14.02	0.4	2.7	21.1
						5/25/2016		99	30	12.8	<5	148.3	9.18	14.8	54	3.72	<0.10	0.2	7.52	0.017	25	114	81	169	16	19	0.4	2.6	16
						6/15/2016		67	92	40.4	30	>2419.6	5.74	198.9	127	6.38	<0.10	2.8	7.44	0.07	12	230	209	383	26	23.09	0.5	3	17.6
						7/13/2016		77.6	103	42	22	>2419.6	6.66	488.4	118	6.12	<0.10	1.2	7.74	0.076	50	261	204	358	24	23.01	0.4	2.8	38.1
						7/20/2016	Muddy	75.3				11199	6.41	1203.3					7.69					349		23.47			41
						7/27/2016		79.4				>2419.6	6.63	1299.7					7.72					442		24.51			43.3
						8/3/2016		80.1				>2419.6	6.85	240					7.59					276		23.15			30.5
						8/10/2016		76.7	64	23.1	11	>2419.6	6.45	48.8	82	4.77	<0.10	0.6	7.47	0.068	34	165	124	233	16	24.12	0.4	3.3	26.3
						8/23/2016		74.1					6.4						7.71					281		21.63			18

Wolf Creek-Salt Creek						9/14/2016		73.6	88	35.8	16	>2419.6	6.3	67.6	101	6.32	<0.10	1.1	7.47	0.036	20	189	162	297	20	23.27	0.5	3.7	16.1
						9/20/2016		61.6					5.2						7.29					399.4		22.75			11.5
						10/19/2016		71.5	99	36.2	24	2419.6	6.55	63.1	110	5.83	<0.10	2.8	7.74	0.073	11	210	192	356	24	19.69	0.4	3.9	17.2
	INW0886_04																												
	INW0886_P1001																												
	INW0886_T1001																												
	INW0886_T1002																												
	INW0886_T1003																												
	INW0886_T1004	Wolf Creek	WEL-08-0029	16T-025	Guthrie Road	4/19/2016		107	89	33.1	<5	1413.6	10.74	35	104	4.88	<0.10	0.1	7.44	0.007	<6	140	132	260	21	15.14	<0.30	<1	4.95
						5/24/2016		102	93	36.1	<5	165.7	9.98	33.6	123	5.34	<0.10	0.2	7.55	0.005	<6	145	141	271	17	16.34	<0.30	<1	3.78
						6/14/2016		79.8	99	37.7	5.7	2419.6	7.03	29.9	109	5.19	<0.10	0.2	7.2	0.019	11	165	147	278	16	21.55	<0.30	<1	4.63
						7/12/2016		79.3	116	41	5.7	>2419.6	6.97	30.9	118	6.17	<0.10	0.3	7.41	0.011	<6	165	160	307	18	21.67	<0.30	1.1	4.56
						7/19/2016		91				>2419.6	7.82	96					7.53					289		22.86			4.56
						7/26/2016		78.2					6.61						7.37					323		23.82			5.73
						8/2/2016		90				>2419.6	7.74	172.5					7.38					305		22.79			6.21
						8/9/2016		82.5	128	43.5	5.8	>2419.6	7.12	121.1	129	6.6	<0.10	0.4	7.41	0.007	<6	178	172	315	14	22.7	<0.30	1.2	2.71
						8/23/2016		89.6					7.78						8.47					230		21.02			2.15
						9/8/2016		75.3					6.36						7.47					246		22.82			2.22
						9/13/2016		88.1	118	43.6	6.6	>2419.6	8	165.8	115	6.73	<0.10	0.3	7.26	0.016	<6	171	164	302	15	20.08	<0.30	1.2	2.16
						10/4/2016		86.7				>2419.6	8.34	133.4					7.35					323		17.18			4.49
						10/18/2016		63.4	122	40.5	6.2	>2419.6	5.87	18.5	117	5.71	<0.10	0.1	7.3	0.013	<6	166	159	305	15	18.85	<0.30	1.4	4.63
	INW0886_T1005																												
	INW0886_T1006																												
	INW0886_T1007	Pleasant Run	WEL-08-0026	16T-022	Peerless Road	4/20/2016		110.7	192	76.9	11	>2419.6	10.71	123.6	279	7.12	<0.10	0.5	7.77	0.023	<6	379	352	579	99	16.78	<0.30	2.9	6.2
						5/25/2016		154.2	196	76.3	14	180.7	13.82	31.3	248	7.34	<0.10	<0.10	8.3	0.012	<6	388	372	585	85	20.62	0.4	3.6	8.01
						6/15/2016		72.9	203	76.9	35	>2419.6	6.04	325.5	250	9.61	<0.10	<0.10	7.72	0.167	<6	808	785	1100	341	24.73	0.4	9.5	6.63
						7/13/2016		190	213	79.3	12	>2419.6	16.15	166.4	241	6.52	<0.10	0.7	8.34	0.018	<6	357	350	570	74	23.28	<0.30	3	5.15
						7/20/2016	Thick mats of algae. Water is clear.	97.6				>2419.6	8.19	40.2					7.93					607		24.01			6.69
						7/27/2016	Thick algae mats observed.	58.3				>2419.6	4.69	9.7					7.64					748		26.31			4.81
						8/3/2016	Thick algae mats observed.	136.8				>2419.6	11.44	19.9					8.01					596		24.29			5.87
						8/10/2016	Lots of algae mats observed.	58.7	211	65.4	32	>2419.6	4.76	13.5	236	9.08	<0.10	<0.10	7.61	0.021	<6	777	755	1068	330	25.77	0.4	8.4	1.66
						8/22/2016		218.3					18.13						8.11					463		23.61			4.16
						9/14/2016	Thick algae mats	84.6	223	79.5	20	>2419.6	7.64	25	238	8.32	<0.10	<0.10	7.72	0.022	<6	478	465	720	152	20.21	0.3	4.1	2.01
						9/20/2016	Excessive Filamentous Algae on substrate	109.3					9.5						7.87					758		21.07			2.13
						10/19/2016	Algae mats observed.	44.4	225	79.3	48	>2419.6	4.1	24.3	266	9.93	<0.10	<0.10	7.71	0.033	<6	667	643	955	247	19.1	0.3	4.2	4.18
	INW0886_T1008																												
	INW0886_T1009	Gulletts Creek	WEL-08-0025	16T-021	Peerless Road	4/20/2016		82.9	214	81.6	14	>2419.6	8.36	133.3	277	9.4	<0.10	0.7	7.55	0.01	<6	311	292	516	32	14.95	<0.30	1.3	6.64
						5/25/2016		80.3	215	88.2	18	180.7	7.8	101	280	10.5	<0.10	1	7.84	0.009	<6	346	322	540	35	16.69	<0.30	1.1	11.2
						6/15/2016		84.5	159	67	14	>2419.6	8.01	>2419.6	218	7.72	<0.10	2.9	7.69	0.085	41	326	275	440	20	17.93	0.6	5	57
						7/13/2016		79.7	232	91.8	21	>2419.6	7.22	313	284	10.4	<0.10	1.2	7.77	0.021	7	375	349	574	38	20.13	<0.30	1.5	10.4
						7/20/2016	Muddy due to recent rain.	88.8				>2419.6	7.98	>2419.6					7.61					249		20.59			331
						7/27/2016		77				>2419.6	6.65	547.5					7.91					560		22.66			13.1
						8/3/2016		52.3				>2419.6	7.32	613.1					7.83					528		21.05			13
						8/10/2016		74.6	212	82.6	23	>2419.6	6.43	238.2	274	10.6	<0.10	0.9	7.77	0.008	6	380	358	662	42	22.73	<0.30	1.5	6.91
						8/22/2016	Use Revisit (AB26888) for assessments.	97.5					8.96						7.84					468		18.39			7.69
						9/14/2016		79.7	224	96.6	24	>2419.6	7.46	435.2	280	12	<0.10	0.9	7.83	0.021	6	370	344	567	42	18.48	<0.30	1.9	7.53
						9/20/2016	Use for assessments.	86.1					7.6						7.52					575		20.37			7.69
						9/20/2016		85.9					7.55						7.54					568		20.22			
						10/19/2016		51.7	250	94.7	25	>2419.6	4.88	98.8	315	12.4	<0.10	0.3	7.77	0.025	<6	396	376	625	59	18.1	0.3	3.5	6.27
	INW0886_T1010																												
	INW0886_T1010A																												
	INW0886_T1011																												
Goose Creek-Salt Creek	INW0887_01	Salt Creek	WEL-08-0033	16T-026	Old State Road 450	11/16/2015		72.5	105	44.5	23	686.7	8.22	34.1	144	6.75	<0.10	1	7.79	0.063	<6	222	208	387	36	9.66	<0.30	3.2	6.75
						12/14/2015		83.4	127	52.4	26	410.6	9.52	63.8	164	7.33	<0.10	1.8	7.81	0.073	<6	249	235	417	37	9.56	0.3	2.6	8.71
						1/25/2016		97.8	43	17.7	6.9	228.2	13.33	13.2	63	4.44	<0.10	0.3	7.72	0.037	24	124	103	214	18	2.49	<0.30	3	18.7
						2/22/2016		94.2	82	36.7	24	980.4	11.25	72.8	104	5.85	<0.10	0.9	7.77	0.117	10	192	170	342	24	7.55	<0.30		17.8
						3/22/2016		104.1	50	19.5	6.3	410.6	11.74	30.9	73	4.26	<0.10	0.4	8.03	0.047	49	174	122	221	18	10.08	0.4	3	33.9
						4/20/2016		97.5	36	15.3	<5	866.4	9.95	110.6	60	3.83	<0.10	0.3	7.67	0.038	43	137	89	184	20	14.34	0.4	2.8	27.4
						5/25/2016		94.7	35	14.3	<5	155.1	8.83	24.3	60	3.81	<0.10	0.2	7.54	0.026	62	151	87	176	16	18.72	0.3	2.5	39.9
						6/15/2016		100.6	65	27.4	11	>2419.6	8.16	178.5	87	5.4	<0.10	0.7	7.88	0.064	11	151	136	262	20	25.82	0.5	3	15
						7/13/2016		57.9	147	58.2	18	>2419.6	4.87	104.6	167	6.72	<0.10	1.4	7.58	0.039	14	261	237	420	27	23.98	0.4	2.4	23
						7/20/2016	Slightly Muddy	57.8				1732.9	4.8	46.4					7.6					411		24.75			16.1
						7/27/2016		62.4				>2419.6	5.18	127.4					7.69					299		24.79			26.2
						8/3/2016		65.9				5794	5.57	110					7.53					296		23.72			26.9
						8/10/2016		63.2	81	29.2	11	2419.6	5.23	25.9	94	5.15	<0.10	0.7	7.43	0.052	14	170	145	264	19	24.97	0.4	3.4	15.5
						9/14/2016		72.5	62	23.3	7.8	>2419.6	6.02	37.3	74	5.04	<0.10	0.3	7.41	0.036	19	140	113	217	16	24.22	0.5	3.5	20.4
						9/19/2016		35.4					2.91						7.35					268		23.77			7.86
						9/19/2016		35.4					2.93						7.25					268		23.76			7.86
						10/19/2016		57.1	128	49.5	28	770.1	5.37	39.3	148	7.34	<0.10	2.5	7.62	0.043	<6	255	242	430	36	18.39	0.4	3.7	11.2
		Salt Creek	WEL090-0003	16T-028	Oolitic Road	11/16/2015		84.2	92	38.7	28	648.8	9.7	35.9	136	6.25	<0.10	2.3	7.85	0.059	<6	219	206	388	35	9.09	<0.30	3.3	5.7
						11/30/2015		89.8	137		18		10.3		177		<0.10	1.4	7.91	0.055	13	246	231	410	30	9.21	0.3	2.6	19.9
						12/14/2015		88	110		25		9.62		150		<0.10	2	7.93	0.179	6	239	222	428	35	11.73	0.4	2.6	11.6
						12/14/2015		83.2	112	46.7	25	920.8	9.03	73.3	156	6.88	<0.10	1.9	7.71	0.162	<6	236	220	389	35	11.6	0.3	2.7	10
						1/7/2016		97.3	55		6.8		12.39		70		<0.10	0.3	8.23	0.048	28	136	107	224	16	5.09	0.3	2.9	11.4
						1/25/2016		97.6	40	16.9	6.9	214.3	13.42	18.5	65	4.37	<0.10	0.3	7.72	0.074	17	118	101	212	18	2.14	0.5	3.2	26.2
						2/4/2016		95.2	80		13		11.95		108		<0.10	0.8	7.81	0.07	24	197	162	253	18	5.52	0.4		41.6
						2/22/2016		90.8	93	45	42	2419.6	10.57	517.2	131	5.67	<0.10	0.7	7.81	0.054	17	249	218	406	22	8.65	0.4		43
						3/22/2016		99.9	44	18.6	6.4	613.1	11.62	23.1	68	4.34	<0.10	0.4	7.51	0.064	62	174	118	208	19	8.71	0.3	3	40.2
						3/23/2016		100.3	44		6.4		11.29		68		<0.10	0.4	7.83	0.044	43	142	95	197	19	10.06	0.4	3	19.9
						4/6/2016		99.7	45		6.6		10.81		66		<0.10	0.4	7.78	0.034	19	128	101	187	16	11.57	<0.30	2.8	19.5
						4/20/2016		99.1	38	16.1	5.2	1553.1	10.27	95.9	65	3.96	<0.10	0.3	7.41	0.043	53	152	91	188	20	13.72	0.4	2.7	28.7
						5/25/2016		97.3	32	13.4	<5	155.1	9.12	16	60	3.79	<0.10	0.2	7.46	0.02	48	132	84	171	16	18.44	0.4	2.5	20.8
						5/31/2016		95.9	37		5.8		8.54		64		<0.10	0.2	7.75	0.029	32	124	88	163	15	20.98	<0.30	2.6	10.2
						6/15/2016		51.7	96	43.8	23	>2419.6	4.52	>2419.6	135	6.37	0.1	1.2	7.34	0.071	46	274	224	394	36	21.97	0.9	4	77.2
						6/29/2016		80.9	88		16		6.85		110		<0.10	0.9	7.72	0.075	19	195	167	246	22	23.52	0.4	3.1	33.6
						7/13/2016		87.1	135		29		7.4		158		<0.10	1.6	7.87	0.066	32	294	248	410	31	23.49	0.3	2.5	16.4
						7/13/2016		67.1	133	53.4	29	12997	5.69	387.3	160	6.87	<0.10	1.6	7.63	0.058	40	299	251	437	31	23.49	0.4	2.6	42.2
						7/20/2016	Slightly muddy	61.4				15531	5.18	231					7.57					346		23.82			49.2
						7/27/2016		72.2				>2419.6	6.12	365.4					7.48					266		23.62			45
						8/3/2016		72.7				>2419.6	6.2	185					7.44					322		23.31			36.5
						8/10/2016		68.7	69	25.2	10	>2419.6	5.77	67	87	4.84	<0.10	0.7	7.32	0.073	33	171	134	244	20	24.2	0.5	3.4	27.3
						8/23/2016		72.3					6.24						7.68					300		21.6			14.1
						8/29/2016		87.5	51		5.5		7.14		70		<0.10	0.2	7.95	0.049	89	183	93	207	15	25.73	0.6	3.8	36.1
						9/14/2016		65.3	71	27.4	9.6	>2419.6	5.47	65.7	87	5.46	<0.10	0.5	7.28	0.048	31	168	133	243	18	24.28	0.5	3.6	28.8
						9/20/2016		50.3					4.27						7.46					394.4		22.44			12.7
						9/26/2016		75.2	113		27		6.63		153		<0.10	2.7	8.03	0.036	12	261	239	462	28	21.39	0.4	3.8	14.8
						10/10/2016		83.1	140		28		8.02		165		<0.10	2.5	7.38	0.054	9	272	255	484	39	16.94	0.3	4.1	10.6
						10/19/2016		57.6	106	38.1	25	2419.6	5.31	43.7	115	6.06	<0.10	2.1	7.58	0.059	9	228	199	364	26	19.29	0.5	4	13.9
	INW0887_T1001	Goose Creek	WEL-08-0031	16T-027	Patton Hill Road	4/20/2016		112.7	195	82.7	9.6	1119.9	11.65	78	282	11.6	<0.10	0.9	8.06	0.009	27	338	331	514	56	13.77	<0.30	<1	9.32
						5/25/2016		108.1	174	75.6	11	169.4	10.55	86.7	251	10.9	<0.10	1	8.2	0.007	7	317	294	475	47	16.46	<0.30	1	14.8
						6/15/2016		97.3	156	70.7	12	>2419.6	9.38	>2419.6	221	8.82	<0.10	1.7	7.89	0.04	22	312	276	429	34	17.03	0.6	3.5	60.3
						7/13/2016		99.6	178	76.1	12	7270	9.12	127.4	274	11.2	<0.10	1.3	8.04	0.016	10	362	338	523	67	19.54	<0.30	1.4	22.3
						7/20/2016	Muddy	95.4				>2419.6	8.75	5475					8.04					505		19.47			52.9
						7/27/2016		95				>2419.6	8.55	770.1					7.99					535		20.45			17.8
						8/3/2016	Fine whitish floc in the creek.	97.8				9208	8.49	88					7.92					460		22.29			34.6
						8/10/2016	Water is whitish in color	96.8	147	63.8	14	>2419.6	8.18	81.6	237	10.2	<0.10	0.8	7.97	0.087	7	308	277	440	55	23.81	<0.30	1.7	21.3
						8/23/2016	Weird Limestone color.	104.8					9.79						7.94					473		17.5			13.8
						9/14/2016	Slight white floc observed in the creek	97.3	169	80.6	12	>2419.6	8.85	142.1	235	12.3	<0.10	0.8	7.98	0.016	9	329	301	470	56	19.94	<0.30	1.9	18.3
						9/20/2016	Water is grey, likely from rock quarry activity	104.6					9.17						7.74					458.9		20.49			16.3
						10/19/2016	loc observed in stream and white sediment on su	91.8	179	72.4	22	>2419.6	8.61	104.3	235	10.5	<0.10	1.6	7.99	0.019	17	336	296	502	52	18.43	<0.30	2.5	38.3
	INW0887_T1002A																												
	INW0887_T1003B																												
	INW0887_T1004																												
	INW0887_T1005C																												

Subwatershed	HUC12	AUID	Sampling Site	AUNAME	Results_ECOLI	RECR_2018	RECR Cause	RECR Methods	RECR Sources	Results_BIO	Results_CHEM	ALUS_2018	ALUS Cause	ALUS Sources	ALUS Methods	Assessment Notes
Jackson Creek	51202080801	INW0881_01	WEL-08-0008	CLEAR CREEK	1437 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_01A	WEL-08-0008	CLEAR CREEK	1437 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA		226	It appears that this stream goes underground at its downstream end. Although it's impossible to know for certain, but this reach is probably connected to INW0881_01. There is clearly a pipe on the US end of INW0881_01, and based on the catchment, this is the most likely source of the water flowing into it. Land uses are no different for this stream as they are in the lower WS. Therefore, based on the magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment.
Jackson Creek	51202080801	INW0881_02	WEL-08-0008	CLEAR CREEK	1437 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_03	WEL-08-0008	CLEAR CREEK	1437 cfu/100 mL	NS	E. coli	421	23	IBI 40, QHEI 53. mIBI 34, QHEI 41.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Site is located in what appears to be a constructed wetland; Sampled a week after some signifcant rains. Possible scouring event. Cinder blocks line the stream bed. Ground water might be influencing the stream (recharge). A lot of stormwater influence. Very flashy. First day site had a lot of rain. SSO outfalls within the WS. HIghly urbanized area.
Jackson Creek	51202080801	INW0881_04	WEL-08-0008; WEL-08-0005	CLEAR CREEK	1437, 940 cfu/100 mL	NS	E. coli	421	23	IBI 40, 46, QHEI 53, 88. mIBI 34, 34, QHEI 41, 75.	Chem OK. See additional worksheets for individual results.	NA	IBC	140	226; 323; 332; 920	Based on magnitude of impairment at site 0008 and homogeneity of land uses throughout this catchment, results extrapolated downstream through this reach. Upstream sources apply. Chemistry results from 0008 are likely representative given the proximity of the site located at the US end of this reach and the homogeneity of land uses. Biological results from 0005 on Clear Creek DS are likely more representative of conditions and stressors on this US reach than DS where land uses become far less urbanized (see notes for INW0882_02). Macroinvertebrate scores are marginal at both sites and indicate impairment.
Jackson Creek	51202080801	INW0881_T1001	WEL-08-0008	CLEAR CREEK - UNNAMED TRIBUTARY	1437 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.

Jackson Creek	51202080801	INW0881_T1002	WEL-08-0008	CLEAR CREEK - UNNAMED TRIBUTARY	1437 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_T1003	WEL-08-0008	CLEAR CREEK - UNNAMED TRIBUTARY	1437 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_T1005	WEL-08-0006	JACKSON CREEK - UNNAMED TRIBUTARY	1135 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_T1006	WEL-08-0006	JACKSON CREEK - UNNAMED TRIBUTARY	1135 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_T1007	WEL-08-0006	JACKSON CREEK - UNNAMED TRIBUTARY	1135 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_T1008	WEL-08-0006	JACKSON CREEK	1135 cfu/100 mL	NS	E. coli	421	23	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226	Magnitude of impairment at site 0008 downstream and homogeneity of land uses throughout this catchment indicate E. coli impairment throughout the catchment. Same sources as those applied to INW0881_03 apply to this reach. Biological results not extrapolated but chemistry results likely representative given the location of the sampling site downstream and homogeneity of land uses.
Jackson Creek	51202080801	INW0881_T1009	WEL-08-0006	JACKSON CREEK	1135 cfu/100 mL	NS	E. coli	421	23	IBI 44, QHEI 77. mIBI 34, QHEI 67.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	May have been a scouring event but taxa counts indicated that the stream had recolonized but the diversity wasn't there. Stream is heavily impacted by urbanization. Five SSOs up in the HW.
Jackson Creek	51202080801	INW0881_T1010	WEL-08-0007	CLEAR CREEK - UNNAMED TRIBUTARY	743 cfu/100 mL	NS	E. coli	421	133; 134; 136	IBI 44, QHEI 68. mIBI 32, QHEI 65.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	No SSOs in this catchment to explain E. coli. Urban stormwater. Mostly wooded with apratment complexes tucked in. Wildlife a likely source as domesticated pets. Golf course. Macros have a good assemblage.

May Creek	51202080802	INW0882_02	WEL-08-0005	CLEAR CREEK	940 cfu/100 mL	NS	E. coli	421	23; 85	IBI 46, QHEI 88. mIBI 34, QHEI 75.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Macro results are mixed between this site and 0012 located at the lower end of the WS. Taken as a whole, the biological data indicates conditions are pretty good. The macro impairment at this site is really more representative of conditions US than on this stream (see notes for INW0881_04). This reach assessed as FS for biology (BPJ). One high DO value but all other chem OK. E.coli changes dramatically US to DS along Clear Creek in this WS. TB says the difference is a function of the hydrograph. Dillman WWTP and two SSOs are possible sources for E. coli impairment on this reach, while on the DS reach, the E. coli impairment is likely more influenced by pasture and row crop ag.
May Creek	51202080802	INW0882_03	WEL-08-0012	CLEAR CREEK	229 cfu/100 mL	NS	E. coli	421	143, 156	IBI 54; QHEI 88. mIBI 44; QHEI 69.	Data indicate impairment. See additional worksheets for individual results.	NS	Nutrients	23; 85	226; 323; 332; 910	Macro results are mixed. However taken as a whole, the biological data indicates conditions are pretty good. Impairing site is really more representative of conditions US than this stream. No IBC (BPJ) High DO was likely the result of high temperatures at time of sampling. Several high TP values, one co-occurring with a high DO value. Per TB, TP has a point source signature. Dillman WWTP and two SSOs arelocated US. E. coli changes dramatically US to DS along Clear Creek in this WS. TB says the difference is a function of the hydrograph. Dillman WWTP and two SSOs are possible sources for E. coli impairment on US reach, while on this one, the E. coli impairment is likely more influenced by pasture and row crop ag.
May Creek	51202080802	INW0882_T1001	WEL-08-0005; WEL-08-0012; WEL-08-0011; WEL-08-0013; WEL-08-0010	CLEAR CREEK - UNNAMED TRIBUTARY	940; 229; 1099; 271; 236 cfu/100 mL	NS	E. coli	421	134; 136; 141, 143, 168	No Data	No Data	NA	NA	NA	NA	No data collected on this tributary. However, results from other tributaries sampled indicate impairment and are considered representative of this reach (BPJ). Clear Creek sites 0005 and 0012 indicate impairment from one end to the other in this WS, suggesting loadings from the tributaries. Although only about half the tributaries in this WS were sampled (0010, 1011, and 0013), all indicate impairment, and south of Bloomington, land uses along the all the tributaries in this WS are very similar -- sparse rural development mixed with patches of ag (mostly pastures) and woodlands. Assessment of E. coli impairment applies to all tributaries in this WS (BPJ). However, chemistry and biological results collected on the tributaries in this WS were applied only to the reaches sampled and were not likewise extrapolated.
May Creek	51202080802	INW0882_T1002A	No Data	CLEAR CREEK - UNNAMED TRIBUTARY	No Data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Steam appears on aerial photos to termine in a forested wetland. No data to support any kind of an assessment.
May Creek	51202080802	INW0882_T1003	WEL-08-0010	Tributary of Clear Creek	236 cfu/100 Ml	NS	E. coli	421	143, 168	IBI 42, QHEI 66. mIBI 36, QHEI 67.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	E. coli sources include sparse rural development (septic) but mostly pasture.
May Creek	51202080802	INW0882_T1004	WEL-08-0013	CLEAR CREEK - UNNAMED TRIBUTARY	271 cfu/100 mL.	NS	E. coli	421	143, 168	IBI 36, QHEI 53. mIBI 28, QHEI 64.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Stream goes mostly dry. Cloudy water likely the result of runoff from stone cutting facility US, but TSS and turbidty were both very low during most sampling events. E. coli sources include sparse rural development (septic) but mostly pasture.
May Creek	51202080802	INW0882_T1005	WEL-08-0011	CLEAR CREEK - UNNAMED TRIBUTARY	1099 cfu/100 mL.	NS	E. coli	421	143, 168	IBI 40, QHEI 56. mIBI 32, QHEI 59.	Chem OK. See additional worksheets for individual results.	FS (BPJ)	NA	NA	226; 323; 332	Always fairly low flow during. Pasture located US of E.coli sampling location. Clusters of homes make septics a possibility, too. Bedrock substrate limits the macros. Found a stonefly, which is a highly intolerant species. Not impairing for macros (BPJ)

May Creek	51202080802	INW0882_T1006	WEL-08-0005; WEL-08-0012; WEL-08-0011; WEL-08-0013; WEL-08-0010	MAY CREEK	940; 229; 1099; 271; 236 cfu/100 mL	NS	E. coli	421	134; 136; 141, 143, 168	No Data	No Data	NA	NA	NA	NA	No data collected on this tributary. However, results from other tributaries sampled indicate impairment and are considered representative of this reach (BPJ). Clear Creek sites 0005 and 0012 indicate impairment from one end to the other in this WS, suggesting loadings from the tributaries. Although only about half the tributaries in this WS were sampled (0010, 1011, and 0013), all indicate impairment, and south of Bloomington, land uses along the all the tributaries in this WS are very similar -- sparse rural development mixed with patches of ag (mostly pastures) and woodlands. Assessment of E. coli impairment applies to all tributaries in this WS (BPJ). However, chemistry and biological results collected on the tributaries in this WS were applied only to the reaches sampled.
May Creek	51202080802	INW0882_T1007	WEL-08-0005; WEL-08-0012; WEL-08-0011; WEL-08-0013; WEL-08-0010	CLEAR CREEK - UNNAMED TRIBUTARY	940; 229; 1099; 271; 236 cfu/100 mL	NS	E. coli	421	134; 136; 141; 143; 168	No Data	No Data	NA	NA	NA	NA	No data collected on this tributary. However, results from other tributaries sampled indicate impairment and are considered representative of this reach (BPJ). Clear Creek sites 0005 and 0012 indicate impairment from one end to the other in this WS, suggesting loadings from the tributaries. Although only about half the tributaries in this WS were sampled (0010, 1011, and 0013), all indicate impairment, and south of Bloomington, land uses along the all the tributaries in this WS are very similar -- sparse rural development mixed with patches of ag (mostly pastures) and woodlands. Assessment of E. coli impairment applies to all tributaries in this WS (BPJ). However, chemistry and biological results collected on the tributaries in this WS were applied only to the reaches sampled.
Little Clear Creek	51202080803	INW0883_01	WEL-08-0015	CLEAR CREEK	289 cfu/100 mL.	NS	E. coli	421	134; 136; 143; 168	IBI 56, QHEI 77. mIBI 36, QHEI 68.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Pasture US of E.coli sampling location. Clusters of homes make septics a possibility, too. Site located in a walnut grove. Wildlife a potential source for E. coli impairment.
Little Clear Creek	51202080803	INW0883_02	WEL-08-0016	CLEAR CREEK	358 cfu/100 mL.	NS	E. coli	421	134; 136; 143; 168	IBI 52, QHEI 77. mIBI 36, QHEI 57.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Pasture US of E.coli sampling location. Clusters of homes make septics a possibility, too. Site located in a walnut grove. Wildlife a potential source for E. coli impairment.
Little Clear Creek	51202080803	INW0883_T1001	WEL-08-0012; WEL-08-0015	CLEAR CREEK - UNNAMED TRIBUTARY	229; 289 cfu/100 mL	NS	E. coli	421	134; 136; 141; 143, 168	No Data	No Data	NA	NA	NA	NA	No data collected on this tributary. However, results from sites on Clear Creek US and DS of its confluence with this tributary and others suggesting consistent, low-level inputs from the tributaries in the upper subwatershed that flow into Clear Creek between these sites. Land uses along all the tributaries between these two sites are the same -- sparse rural development mixed with patches of ag (mostly pastures) and woodlands. E. coli results are considered representative of this reach (BPJ). However, chemistry and biological results were applied only to Clear Creek.

Little Clear Creek	51202080803	INW0883_T1002	WEL-08-0012; WEL-08-0015	CLEAR CREEK - UNNAMED TRIBUTARY	229; 289 cfu/100 mL	NS	E. coli	421	134; 136; 141; 143, 168	No Data	No Data	NA	NA	NA	NA	No data collected on this tributary. However, results from sites on Clear Creek US and DS of its confluence with this tributary and others suggesting consistent, low-level inputs from the tributaries in the upper subwatershed that flow into Clear Creek between these sites. Land uses along all the tributaries between these two sites are the same -- sparse rural development mixed with patches of ag (mostly pastures) and woodlands. E. coli results are considered representative of this reach (BPJ). However, chemistry and biological results were applied only to Clear Creek.
Little Clear Creek	51202080803	INW0883_T1003	WEL-08-0012; WEL-08-0015	CLEAR CREEK - UNNAMED TRIBUTARY	229; 289 cfu/100 mL	NS	E. coli	421	134; 136; 141; 143, 168	No Data	No Data	NA	NA	NA	NA	No data collected on this tributary. However, results from sites on Clear Creek US and DS of its confluence with this tributary and others suggesting consistent, low-level inputs from the tributaries in the upper subwatershed that flow into Clear Creek between these sites. Land uses along all the tributaries between these two sites are the same -- sparse rural development mixed with patches of ag (mostly pastures) and woodlands. E. coli results are considered representative of this reach (BPJ). However, chemistry and biological results were applied only to Clear Creek.
Little Clear Creek	51202080803	INW0883_T1004	WEL-08-0017	LITTLE CLEAR CREEK	800 cfu/100 mL.	NS	E. coli	421	143; 168	IBI 26, 40. QHEI 59. mIBI 36, QHEI 70.	Chem OK. See additional worksheets for individual results.	FS (BPJ)	NA	NA	226; 323; 332	Revisit yielded an IBI score of 40. Communities were similar but numbers were different (BPJ). E. coli is likely being driven by pasture but also rural development around Lake Monroe. Sewer likely doesn't extend. Lot of mound systems and Presby systems.
Little Clear Creek	51202080803	INW0883_T1005	WEL-08-0014	JUDAH BRANCH	840 cfu/100 mL.	NS	E. coli	421	143; 174	IBI 38, QHEI 67. mIBI 32, QHEI 73.	Chem OK. See additional worksheets for individual results.	FS (BPJ)	NA	NA	226; 323; 332	Cattle access and pasture in this area. Stonefly rule. Other bugs that we don't see often. Different feeding groups were pretty low + half the taxa were non-insect taxa. Not impaired for IBC (BPJ).
Little Clear Creek	51202080803	INW0883_T1006	No Data	CLIFTY BRANCH	No data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Data collected in this WS indicate impairment throughout Clear Creek and its tributaries in this WS. This reach is likely impaired as well but the lack of additional data DS of its confluence with Clear Creek prevents assessment with any confidence.
Hunter Creek	51202080804	INW0884_02	WEL-08-0035	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_03	WEL-08-0035	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_04	WEL-08-0035	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	IBI 38, QHEI 64. mIBI 24, QHEI 41.	Chem OK. See additional worksheets for individual results.	FS (BPJ)	NA	NA	226; 323; 332	Surprised the stream didn't go dry - almost interstitial. Entire drainage is Hoosier National Forest. Bedrock stream. Not impairing for IBC (BPJ).

Hunter Creek	51202080804	INW0884_05	WEL-08-0035	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1003	WEL-08-0035	TANYARD BRANCH - UNNAMED TRIBUTARY	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1004	WEL-08-0035	HUNTER CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1005	WEL-08-0035	TANYARD BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1006	WEL-08-0035	HUNTER CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1007	WEL-08-0035	HUNTER CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. Results collected on Little Salt Creek DS indicate FS and were considered representative of conditions in this stream and all others US of the site. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.

Hunter Creek	51202080804	INW0884_T1008	WEL-08-0035; WEL-08-0018	LITTLE SLAT CREEK - UNNAMED TRIBUTARY	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Results collected on Little Salt Creek US and DS of its confluence with this catchment indicate FS. Results are considered representative. Almost entire WS is forested with only very small pockets of ag land and rural homes. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1009	WEL-08-0035; WEL-08-0018	MCPIKE BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Results collected on Little Salt Creek US and DS of its confluence with this catchment indicate FS. Results are considered representative. Almost entire WS is forested with only very small pockets of ag land and rural homes. Biological and chemistry results are probably also representative of conditions in this stream but cannot be applied with the same confidence as pathogen data. Biological and chemistry results were applied only to the reaches sampled.
Hunter Creek	51202080804	INW0884_T1010	WEL-08-0019	HENDERSON CREEK	Assessed using secondary criteria	FS	NA	422	NA	IBI 34, QHEI 82. mIBI 46, QHEI 65.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Almost the entire WS is forested with only very small pockets of ag land and rural homes. E. coli results collected on Henderson Creek DS indicate FS and were considered representative of RECR conditions in this stream and all others US of the site. This reach is currently listed for IBC. Mostly private land but very similar to Hoosier National Forest -- All wooded with very few human influences. DELTs brought the score down. USFW was sampling at this site, too, for potential dam removal. Overlapping sampling may impact total numbers. Need to look at original impairing data to see if results might otherwise suggest FS but would still need additional sampling to know for sure.
Hunter Creek	51202080804	INW0884_T1011	WEL-08-0019	HENDERSON CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. E. coli results collected on Henderson Creek DS indicate FS and were considered representative of RECR conditions in this stream and all others US of the site. Biological and chemistry results cannot be applied with the same confidence as pathogen data and were applied only to the reach sampled.
Hunter Creek	51202080804	INW0884_T1012	WEL-08-0019	JACKIE BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. E. coli results collected on Henderson Creek DS indicate FS and were considered representative of RECR conditions in this stream and all others US of the site. Biological and chemistry results cannot be applied with the same confidence as pathogen data and were applied only to the reach sampled.
Hunter Creek	51202080804	INW0884_T1013	WEL-08-0019	BRANNAMAN BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. E. coli results collected on Henderson Creek DS indicate FS and were considered representative of RECR conditions in this stream and all others US of the site. Biological and chemistry results cannot be applied with the same confidence as pathogen data and were applied only to the reach sampled.

Hunter Creek	51202080804	INW0884_T1014	WEL-08-0019	BRANNAMAN BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. E. coli results collected on Henderson Creek DS indicate FS and were considered representative of RECR conditions in this stream and all others US of the site. Biological and chemistry results cannot be applied with the same confidence as pathogen data and were applied only to the reach sampled.
Hunter Creek	51202080804	INW0884_T1015	WEL-08-0019	TERRILL BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Almost the entire WS is forested with only very small pockets of ag land and rural homes. E. coli results collected on Henderson Creek DS indicate FS and were considered representative of RECR conditions in this stream and all others US of the site. Biological and chemistry results cannot be applied with the same confidence as pathogen data and were applied only to the reach sampled.
Knob Creek	51202080805	INW0885_02	WEL-08-0021	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	IBI 42, QHEI 45. mIBI 36, QHEI 41.	Data indicate impairment. See additional worksheets for individual results.	NS	DO	155; 174	226; 323; 332; 910	3/18 DO Low. Low gradient, highly channelized stream. Heavy bank erosion; Cattle have access. DO is a flow-dirven issue. Predominantly forested WS.
Knob Creek	51202080805	INW0885_03	WEL-08-0018; WEL-08-0023	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Little Salt Creek though this WS is well forested along many of its tributaries in their mid to upper reaches. Land uses along the Little Salt Creek and in the lower reaches of its tributaries is mostly agriculture with sparse rural development. E. coli at both sites indicate full support of RECR uses Assessment applied to entire mainstem of Little Salt Creek in this WS. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_04	WEL-08-0018; WEL-08-0023	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Little Salt Creek though this WS is well forested along many of its tributaries in their mid to upper reaches. Land uses along the Little Salt Creek and in the lower reaches of its tributaries is mostly agriculture with sparse rural development. E. coli at both sites indicate full support of RECR uses Assessment applied to entire mainstem of Little Salt Creek in this WS. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_05	WEL-08-0023	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	IBC 50; QHEI 46. mIBI 28; QHEI 36.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Site is located at the lower WS boundary. Results indicate biological impairment. E. coli results indicate FS.
Knob Creek	51202080805	INW0885_06	WEL-08-0018	LITTLE SALT CREEK	Assessed using secondary criteria	FS	NA	422	NA	IBC 48; QHEI 77. mIBI 38; QHEI 51.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Site is located at the upper WS boundary. Biological and chemistry results indicate FS. E. coli results also indicate FS.
Knob Creek	51202080805	INW0885_T1001	WEL-08-0024	LITTLE SALT CREEK - UNNAMED TRIBUTARY	No Data	NA	NA	NA	NA	IBI 30, QHEI 71.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 332; 920	Drainage area is very small, only about three square miles. Stream went dry for macros and was too dry to sample for E.coli. With stream dry just two weeks prior to sampling fish, it's likely there had not been sufficient time for the fish to re-colonize. Low number of individuals.
Knob Creek	51202080805	INW0885_T1003	WEL-08-0018; WEL-08-0023	LITTLE SALT CREEK - UNNAMED TRIBUTARY	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Results from sites located on Little Salt Creek US and DS of its confluence with this reach indicate FS for RECR suggesting little/no inputs from this stream. Given these results and the lack of potential sources in this WS, the assessment of FS is applied to this and other tributaries to Little Salt Creek in this WS. Biological and chemistry results were applied only to the reaches sampled.

Knob Creek	51202080805	INW0885_T1004	WEL-08-0018; WEL-08-0023	LITTLE SALT CREEK - UNNAMED TRIBUTARY	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Results from sites located on Little Salt Creek US and DS of its confluence with this reach indicate FS for RECR suggesting little/no inputs from this stream, which is almost entirely forested. Given these results and the lack of potential sources in this WS, the assessment of FS is applied to this and other tributaries to Little Salt Creek in this WS. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_T1005	WEL-08-0018; WEL-08-0023	BREWER BRANCH	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Site 0023 is located on Little Salt Creek just DS of its confluence. Results from this and site 0018 located US indicate FS for RECR. Togther, these results suggest little/no inputs from this catchment, which is pretty heavily forested thorughout most of its streams. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_T1006	WEL-08-0018; WEL-08-0023	LITTLE SALT CREEK - UNNAMED TRIBUTARY	Assessed using secondary criteria	FS	NA	422	NA	No Data	No Data	NA	NA	NA	NA	Site 0023 is located on Little Salt Creek just DS of its confluence. Results from this and site 0018 located US indicate FS for RECR. Togther, these results suggest little/no inputs from this catchment, which is pretty heavily forested thorughout most of its streams. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_T1007	WEL-08-0022	KNOB CREEK	Assessed using secondary criteria	NS	E. coli	422	143; 174	No Data	No Data	NA	NA	NA	NA	Tributaries to Knob Creek in this catchment are forested, while Knob Creek itself lacks much of a riparian buffer and has a fair amount of pasture and rural development in the floodplain. The site was located in a very channelized reach of Knob Creek. Wildlife from the forested tribs may be impacting to a lesser degree. Given nearly identical land uses throughout this catchment, bacteria results were applied throughout. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_T1008	WEL-08-0022	KNOB CREEK	Assessed using secondary criteria	NS	E. coli	422	143; 174	IBI 46, QHEI 67. mIBI 36, QHEI 49.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Tributaries to Knob Creek in this catchment are forested, while Knob Creek itself lacks much of a riparian buffer and has a fair amount of pasture and rural development in the floodplain. The site was located in a very channelized reach of Knob Creek. Wildlife from the forested tribs may be impacting to a lesser degree. Given nearly identical land uses throughout this catchment, bacteria results were applied throughout. Biological and chemistry results were applied only to the reaches sampled.
Knob Creek	51202080805	INW0885_T1009	WEL-08-0022	KNOB CREEK	Assessed using secondary criteria	NS	E. coli	422	143; 174	No Data	No Data	NA	NA	NA	NA	Tributaries to Knob Creek in this catchment are forested, while Knob Creek itself lacks much of a riparian buffer and has a fair amount of pasture and rural development in the floodplain. The site was located in a very channelized reach of Knob Creek. Wildlife from the forested tribs may be impacting to a lesser degree. Given nearly identical land uses throughout this catchment, bacteria results were applied throughout. Biological and chemistry results were applied only to the reaches sampled.
Wolf Creek	51202080806	INW0886_01	WEL-08-0034	SALT CREEK	Assessed using secondary criteria	NS	E. coli	422	85	No Data	No Data	NA	NA	NA	NA	This reach of Salt Creek is located at the outlet of the reservoir. RECR assessment from the site located just DS was applied to this one based on similarity of land use and proximity. Pedigo Bay WWTP is a potential source. Biological and chemistry results were applied only to the reaches sampled.

Wolf Creek	51202080806	INW0886_02	WEL-08-0034	SALT CREEK	Assessed using secondary criteria	NS	E. coli	422	154	IBI 44, QHEI 36. mIBI 36, QHEI 35.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	30% of E. coli results were greater than 576 cfu/100 mL. However most are low, suggesting the reservior may be mitigating loads to some degree. Mostly row crop ag but no CFOs. US sources apply.
Wolf Creek	51202080806	INW0886_03	WEL-08-0027	SALT CREEK	389 cfu/100 mL.	NS	E. coli	421	154; 168	IBI 44, QHEI 37. mIBI 38, QHEI 30.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	The magnitude of the GM result at this site combined with the high individual results at the site US suggest that US sources may be driving this impairment. Most of the land use along this reach is row crop ag and rural development. In the vicinity of the sampling site, there are few other readily apparent sources other than possibly septic systems. Although these land uses are similar in the tributaries to this reach, the assessment was limited to the main stem of Salt Creek based on the likelihood that US sources are driving the impairment far more than any tributary loadings may be.
Wolf Creek	51202080806	INW0886_04	WEL-08-0027	SALT CREEK	389 cfu/100 mL.	NS	E. coli	422	85	No Data	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	This reach of Salt Creek is located at the pore point of this subWS. RECR assessment from the US was applied to this one based on similarity of land use and proximity. Chemistry results were also applied based on such close proximity. Biological data applied only to the reach sampled because it looked like the habitat at the sampling site might be quite different than that along this reach (one is more forested with a bit more buffer).
Wolf Creek	51202080806	INW0886_T1001	No Data	SALT CREEK - UNNAMED TRIBUTARY	No Data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	No data collected for this tributary. Although land uses are similar in the tributaries to Salt Creek in this area, the assessment was limited to the main stem of Salt Creek based on the likelihood that US sources, as opposed to any tributary loadings, are driving the impairment.
Wolf Creek	51202080806	INW0886_T1002	No Data	SALT CREEK - UNNAMED TRIBUTARY	No Data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	No data collected for this tributary. Although land uses are similar in the tributaries to Salt Creek in this area, the assessment was limited to the main stem of Salt Creek based on the likelihood that US sources, as opposed to any tributary loadings, are driving the impairment.
Wolf Creek	51202080806	INW0886_T1003	No Data	SALT CREEK - UNNAMED TRIBUTARY	No Data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	No data collected for this tributary. Although land uses are similar in the tributaries to Salt Creek in this area, the assessment was limited to the main stem of Salt Creek based on the likelihood that US sources, as opposed to any tributary loadings, are driving the impairment.
Wolf Creek	51202080806	INW0886_T1004	WEL-08-0029	WOLF CREEK	Assessed using secondary criteria	FS	NA	422	NA	IBI 30, QHEI 55. mIBI 34, QHEI 48.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Previously impaired for IBC. Current results support previous assessment. Drainage area is small, only about two square miles.
Wolf Creek	51202080806	INW0886_T1005	No Data	SALT CREEK - UNNAMED TRIBUTARY	No Data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	No data collected for this tributary. Although land uses are similar in the tributaries to Salt Creek in this area, the assessment was limited to the main stem of Salt Creek based on the likelihood that US sources, as opposed to any tributary loadings, are driving the impairment.
Wolf Creek	51202080806	INW0886_T1006	No Data	BAILEY BRANCH	No Data	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	No data collected for this tributary. Although land uses are similar in the tributaries to Salt Creek in this area, the assessment was limited to the main stem of Salt Creek based on the likelihood that US sources, as opposed to any tributary loadings, are driving the impairment.

Wolf Creek	51202080806	INW0886_T1008	WEL-08-0026	PLEASANT RUN - UNNAMED TRIBUTARY	28 cfu/100 mL.	FS	NA	421	NA	No Data	No Data	NA	NA	NA	NA	Land uses in this catchment are far more developed than those along Pleasant Run. However, given the very low E. coli result from the site on Pleasant Run just DS of its confluence with this tributary, it is likely that it would have produced a higher result if there were any loadings coming from this catchment. therefore, results were applied to the streams in this catchment, too. Biological and chemistry results were applied only to Pleasant Run.
Wolf Creek	51202080806	INW0886_T1009	WEL-08-0025	GULLETTS CREEK	905 cfu/100 mL.	NS	E. coli	421	85; 143	IBI 34, QHEI 38. mIBI 42, QHEI 59.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Semi-public WWTP located US but likely has small impact. Mostly ag with patchy forest and sparse rural development. Some pastures. Probably flushing during rain events.
Wolf Creek	51202080806	INW0886_T1010	WEL-08-0025	GULLETTS CREEK - UNNAMED TRIBUTARY	905 cfu/100 mL.	NS	E. coli	421	85; 143	No Data	No Data	NA	NA	NA	NA	This catchment is much more forested than the other tributary to Gulletts Creek but its HW drain most ag and residential areas as does most of the larger, Gulletts Creek catchment. Given the magnitude of the impairment on Gulletts Creek, the RECR assessment was applied to all streams in the catchment. Biological and chemistry results were applied only to Gulletts Creek.
Wolf Creek	51202080806	INW0886_T1011	WEL-08-0025	GULLETTS CREEK - UNNAMED TRIBUTARY	905 cfu/100 mL.	NS	E. coli	421	85; 143	No Data	No Data	NA	NA	NA	NA	This catchment is much more forested than the other tributary to Gulletts Creek but its HW drain most ag and residential areas as does most of the larger, Gulletts Creek catchment. Given the magnitude of the impairment on Gulletts Creek, the RECR assessment was applied to all streams in the catchment. Biological and chemistry results were applied only to Gulletts Creek.
Wolf Creek	51202080806	INW0886_T1012	WEL-08-0026	PLEASANT RUN	28 cfu/100 mL.	FS	NA	421	NA	IBI 40, QHEI 68. mIBI 38, QHEI 51.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Previously impaired for IBC. GM cleaned up a large stretch of the stream (an old Superfund site). Algae was bad, though. Almost lake like. Very high DO and DO saturation. Suspect dirunal swings. Delisting for IBC.
Wolf Creek	51202080806	INW0886_T1013	WEL-08-0026	PLEASANT RUN	28 cfu/100 mL.	FS	NA	421	NA	No Data	No Data	NA	NA	NA	NA	E. coli value at the site just DS is extremely low suggesting little or no inputs from US. Entire catchment assessed as FS. Biological and chemistry results were applied only to the reach sampled because while the general land use throughout the catchment appears to be pretty homogenous, there was some work done at the location of the sampling site that makes it not representative of the entire catchment (see notes for INW0886_T1012).
Goose Creek	51202080807	INW0887_02	WEL090-0003	SALT CREEK	210 cfu/100 mL.	NS	E. coli	421	85	IBI 40; QHEI 52. mIBI 34; QHEI 51.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	E. coli results indicate impairment. Small package plant (Needmore Elementary) located US. Four of five samples exceeded suggesting consistent loadings as opposed to flushing events. Although macro score would indicate impairment, stoneflies were found at this site. Site assessed as FS based on presence of stoneflies (BPJ). Site is located at the point where two reaches, INW0887_02 and 03 meet. All assessments applied to both.
Goose Creek	51202080807	INW0887_03	WEL090-0003	SALT CREEK	210 cfu/100 mL.	NS	E. coli	421	85	IBI 40; QHEI 52. mIBI 34; QHEI 51.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Although macro score would indicate impairment, stoneflies were found at this site. Site assessed as FS based on presence of stoneflies (BPJ). Site is located at the point where two reaches, INW0887_02 and 03 meet. All assessments applied to both.

Goose Creek	51202080807	INW0887_04	WEL-08-0033	SALT CREEK	71 cfu/100 mL.	FS	NA	421	NA	IBI 18; QHEI 51. mIBI 32; QHEI 43.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Site located very close to the confluence with EFWR and likely experiencing backwater effects. Backwater effects would impact the macros and the stream very deep there preventing a good fish sample (hard to bring them up with shocker). Probably more representative of EFWR than Salt Creek. This reach assessed as impaired for biology. E. coli results indicate FS, which is probably also influenced by EFWR. Assessment applied to both reaches in the lower WS.
Goose Creek	51202080807	INW0887_05	WEL-08-0033	SALT CREEK	71 cfu/100 mL.	FS	NA	421	NA	IBI 18; QHEI 51. mIBI 32; QHEI 43.	Chem OK. See additional worksheets for individual results.	NS	IBC	140	226; 323; 332; 920	Site located very close to the confluence with EFWR and likely experiencing backwater effects. Backwater effects would impact the macros and the stream very deep there preventing a good fish sample (hard to bring them up with shocker). Probably more representative of EFWR than Salt Creek. This reach assessed as impaired for biology. E. coli results indicate FS, which is probably also influenced by EFWR. Assessment applied to both reaches in the lower WS.
Goose Creek	51202080807	INW0887_T1002A	No Data	GOOSE CREEK - UNNAMED TRIBUTARY	NA	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Stream appears to go underground.
Goose Creek	51202080807	INW0887_T1003B	No Data	SALT CREEK - UNNAMED TRIBUTARY	NA	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Stream appears to flow into quarry.
Goose Creek	51202080807	INW0887_T1004	No Data	ADAMSON BRANCH	NA	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Unlike most of the rest of this WS, the land use in this catchment is almost entirely ag. The difference in land use and the potential influences from EFWR, prevent reliable extrapolation of Salt Creek results to this catchment.
Goose Creek	51202080807	INW0887_T1005C	No Data	ADAMSON BRANCH - UNNAMED TRIBUTARY	NA	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Stream appears to be disconnected from Adamson Branch but a clear connection can be seen in aerial photos. Notes for Adamson Branch apply to this reach.
Goose Creek	51202080807	INW0887_T1006	WEL-08-0031	GOOSE CREEK	329 cfu/100 mL.	NS	E. coli	421	168; 173	No Data	No Data	NA	NA	NA	NA	RECR assessed based on site located DS. Pastures and rural development are the most likely sources for the E.coli impairment. Biological and chemistry results were applied only to the DS reach of Goose Creek.
Goose Creek	51202080807	INW0887_T1007	WEL-08-0031	GOOSE CREEK	329 cfu/100 mL.	NS	E. coli	421	168; 173	IBI 40, QHEI 70. mIBI 36, QHEI 55.	Chem OK. See additional worksheets for individual results.	FS	NA	NA	226; 323; 332	Whitish Color on almost every sampling event; not sure what the source is but there are a lot of quarries in this area. Pastures and rural development are the most likely sources for the E.coli impairment.
Goose Creek	51202080807	INW0887_T1009	No Data	SALT CREEK - UNNAMED TRIBUTARY	NA	NA	NA	NA	NA	No Data	No Data	NA	NA	NA	NA	Site is located immediately DS of the confluence of Salt Creek with this tributary. Given the lack of readily apparent sources and the possibility that this impairment is point-source driven, the results fro Salt Creek cannot be reliably extrapolated to this tributary.

2016
BASELINE MONITORING WORK PLAN FOR LOWER SALT CREEK WATERSHED

PREPARED BY

Anna Settineri
Targeted Monitoring Section

WATERSHED ASSESSMENT and PLANNING BRANCH (WAPB)
Indiana Department of Environmental Management (IDEM)
Office of Water Quality
100 North Senate Avenue
MC65-40-2 Shadeland
Indianapolis, Indiana 46204-2251

November 13, 2015

B-026-OWQ-WAP-TGM-16-W-R0

This page is intended to be blank

SIGNATURE PAGE

2016
Baseline Monitoring Work Plan for Lower Salt Creek Watershed

Indiana Department of Environmental Management
Office of Water Quality
Watershed Assessment & Planning Branch
Indianapolis, Indiana

B-026-OWQ-WAP-TGM-16-W-R0

Reviews and Approvals

Date 3/31/16
Tim Beckman , Project Manager, Targeted Monitoring Section

Date 3/30/16
Staci Goodwin, Total Maximum Daily Load Lead, Watershed Planning and Restoration Section

Date 03/30/16
Kathleen Hagan, Watershed Specialist, Watershed Planning and Restoration Section

Date 3-30-2016
Timothy Bowren, Project Quality Assurance Officer, Technical and Logistical Services Section

Date 3/31/2016
Mike Sutton, Section Chief, WAPB Quality Assurance Manager, Technical and Logistical Services Section

Date 3-31-2016
Stacey Sobat, Chief, Probabilistic Monitoring Section

Date 3/30/16
Cyndi Wagner, Chief, Targeted Monitoring Section

Date 3/30/16
Marylou Renshaw, Branch Chief, Quality Assurance Coordinator, Watershed Assessment and Planning Branch

The IDEM Quality Improvement Section reviewed and approves this Sampling and Analysis Work Plan.

Date 4/6/16
Quality Assurance Staff
IDEM Office of Program Support

WORK PLAN ORGANIZATION

This Sampling and Analysis Work Plan is an extension of the existing Watershed Assessment and Planning Branch's October 2004 "*Quality Assurance Project Plan (QAPP) for Indiana Surface Water Quality Monitoring and Total Maximum Daily Load (TMDL) Program*" and serves as a link to the existing QAPP and as an independent QAPP of the project. Per the United States Environmental Protection Agency (U.S. EPA) 2006 QAPP guidance (U.S. EPA 2006), this Work Plan establishes criteria and specifications pertaining to a specific water quality monitoring project that are usually described in the following four sections as QAPP elements:

Section I. Project Management/Planning

- Project Objective
- Project/Task Organization and Schedule
- Background and Project/Task Description
- Data Quality Objectives (DQOs)
- Training and Staffing Requirements

Section II. Measurement/Data Acquisition

- Sampling Procedures
- Analytical Methods
- Sample and Data Acquisition Requirements
- Quality Control (QC) Measures Specific to the Project

Section III. Assessment/Oversight

- External and Internal Checks
- Audits
- Data Quality Assessments (DQAs)
- Quality Assurance/Quality Control (QA/QC) Review Reports

Section IV. Data Validation and Usability

- Data Handling and Associated QA/QC activities
- QA/QC Review Reports

TABLE OF CONTENTS

This page is intended to be blank

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF ACRONYMS

AAC: Acute Aquatic Criterion
ADC: Acoustic Doppler Current
ADP: Acoustic Doppler Profiler
ADV: Acoustic Doppler Velocimeter
AIMS: Assessment Information Management System
CAC: Chronic Aquatic Criteria
CALM: Consolidated Assessment Listing Methodology
CCC: Criterion Continuous Concentration
CDL: Crop Data Layer
CFR: Code of Federal Regulations
CFU: Colony Forming Units
CLP: Contract Laboratory Program
COD: Chemical Oxygen Demand
CPR: Cardio-Pulmonary Resuscitation
CRQL: Contract Required Quantification Limit
DO: Dissolved Oxygen
DQA: Data Quality Assessment
DQO: Data Quality Objectives
E. coli: Escherichia coli
EPA: Environmental Protection Agency
GPS: Global Positioning System
HUC: Hydrologic Unit Code
IAC: Indiana Administrative Code
IBC: Impaired Biotic Community
IBI: Index of Biotic Integrity
IDEM: Indiana Department of Environmental Management
MDL: Method Detection Limit
µS/cm Micro Siemens per Centimeter
mg/L: Milligram per liter
MHAB: Multi-habitat
mL: Milliliter
MPN: Most Probable Number
MS/MSD: Matrix Spike/Matrix Spike Duplicate
NTU: Nephelometric Turbidity Unit(s)
OWQ: Office of Water Quality
PFD: Personal Floatation Device
PPE: Personal Protective Equipment
QA/QC: Quality Assurance/Quality Control
QAC: Quality Assurance Coordinator

QAM: Quality Assurance Manager
QAO: Quality Assurance Officer
QAPP: Quality Assurance Project Plan
QHEI: Qualitative Habitat Evaluation Index
RFP: Request for Proposals
RL: Reporting Limit
RPD: Relative Percent Difference
S.U.: Standard Units
SM: Standard Method
SOP: Standard Operating Procedures
TDS: Total Dissolved Solids
TKN: Total Kjeldahl Nitrogen
TMDL: Total Maximum Daily Load
TOC: Total Organic Carbon
TP: Total Phosphorus
TS: Total Solids
TSS: Total Suspended Solids
U.S.: United States
USDA: United States Department of Agriculture
WAPB: Watershed Assessment and Planning Branch

DEFINITIONS

Elutriate	To purify, separate, or remove lighter or finer particles by washing, decanting, and settling.
Fifteen (15) Minute Pick	A component of the IDEM multihabitat macroinvertebrate sampling method in which the one minute kick sample and fifty meter sweep sample collected at a site are combined, elutriated, with macroinvertebrates removed from the resulting sample for 15 minutes while in the field.
Fifty (50) Meter Sweep	A component of the IDEM multihabitat macroinvertebrate sampling method in which approximately 50 meters (50m) of shoreline habitat in a stream or river is sampled with a standard 500 micrometer (500 µm) mesh width D-frame dip net by taking 20-25 individual “jab” or “sweep” samples, which are then composited.

Geometric site	Sampling site chosen according to its drainage area within a watershed.
One (1) minute kick sample	A stationary sampling accomplished using a box shaped net comprised of canvas bottom and/or sides and 504μ nylon mesh back. The designated area is sampled for one minute.
Pour point	The outlet of a subwatershed or the common point where all the water flows out of any given subwatershed.
Reach	A segment of a stream used for fish community sampling equal in length to 15 times the average wetted width of the stream, with a minimum length of 50 meters and a maximum length 500 meters.
Targeted site	A sampling site intentionally selected based on specific monitoring objectives or decisions to be made.

This page is intended to be blank

I. PROJECT MANAGEMENT/PLANNING

Project Objective

The objective of the Watershed Characterization Project is to provide a comprehensive assessment of the ability of the streams in the Lower Salt Creek Watershed to support aquatic life and recreational uses. Watershed Characterization uses an intensive targeted watershed design that characterizes the current condition of an individual watershed. This type of monitoring provides valuable data for the purposes of assessment, Total Maximum Daily Load (TMDL) development, watershed planning, and allows for future comparisons to evaluate changes in the water quality within the watershed(s) studied. Selecting a spatial monitoring design with sufficient sampling density to accurately characterize water quality conditions is a critical step in the process of developing an adequate local scale watershed study.

The Indiana Department Environmental Management (IDEM) has selected the Lower Salt Creek Watershed (see Figure 1, Table 1) for a water quality watershed characterization study. Sample sites were chosen using a modified geometric site selection process as well as targeted site selection in order to get the necessary spatial representation of the entire study area. Sites within this watershed were selected based on a geometric progression of drainage areas starting with the area at the mouth of the main stem stream and working upstream through the tributaries to the headwaters. Monitoring sites were then located to the nearest bridge. A more complete description of the geometric site selection process is included as Attachment 1. Sample sites were also chosen at the nearest bridge to the pour point (the lowest point in the basin through which all water flows) of each 12 digit Hydrologic Unit Code (HUC) in the watershed, or chosen to characterize sources for TMDL development.

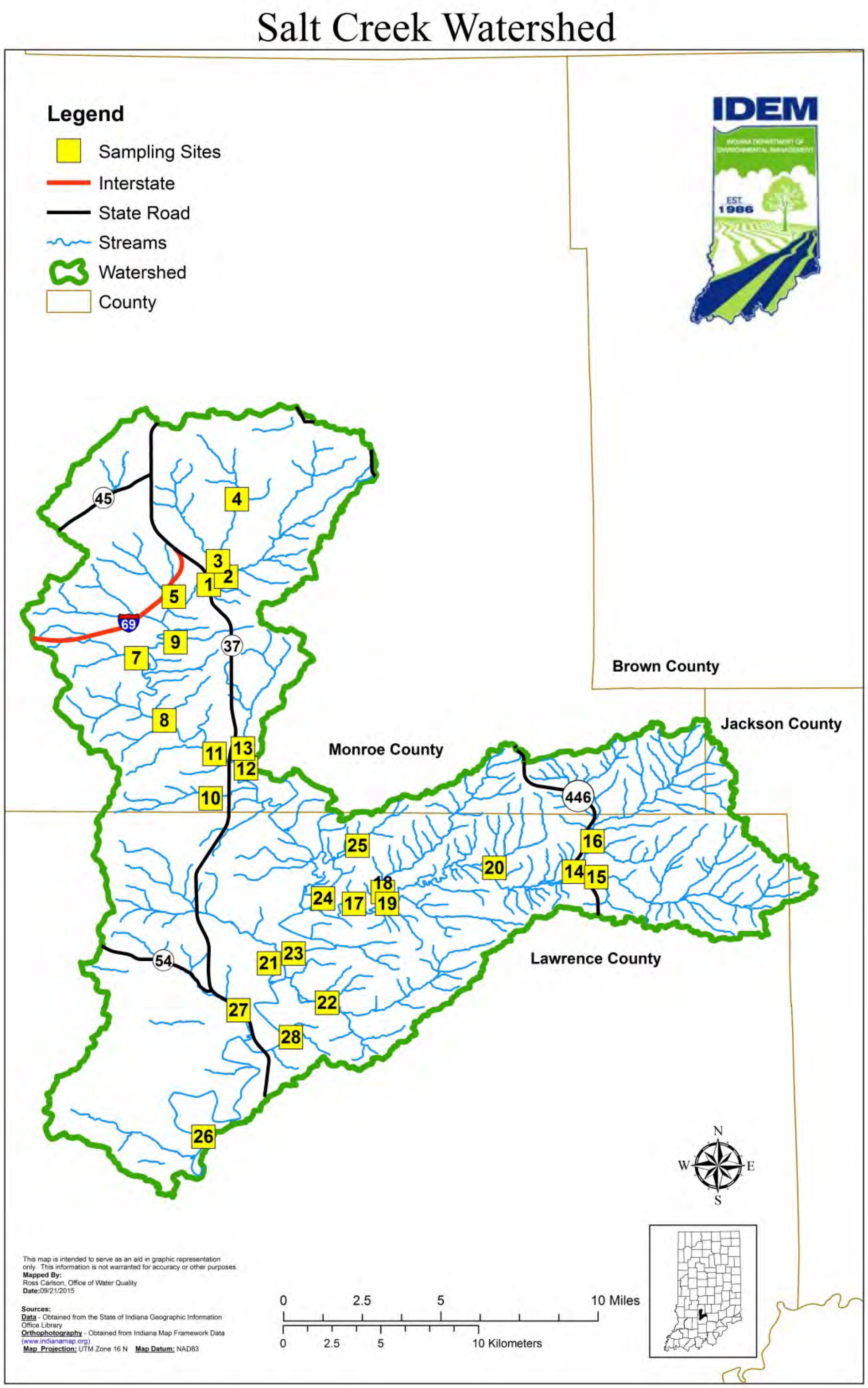
It is anticipated that the water quality data collected through this monitoring effort will provide the information needed to characterize the watershed for the TMDL program and local water quality managers, identify sources of impairment, designate critical areas, and enable users to make valid and informed watershed decisions. This project, by design, will also add new stream reaches for assessment of aquatic life and recreational use support and will allow for future comparisons to evaluate changes in water quality.

The draft 2014 303(d) list submitted to the U.S. EPA (IDEM 2014a) details impairments of approximately 121 miles of the Lower Salt Creek Watershed in the following ways:

- Category 5(a): Impaired Biotic Community (IBC), 61.5 miles
- Category 5(a): *Escherichia coli (E. coli)*, 3.5 miles
- Category 5(b): Fish Tissue Impaired (PCB'S), 55.5 miles
- Category 5(b): Fish Tissue Impaired Mercury (Hg), 33.0 miles

Assessment data in this watershed have been collected by IDEM from multiple programs and projects.

Figure 1. Lower Salt Creek Watershed Characterization Study Sampling Area[1]



[1] Map site numbers refer to last two digits of site number from Table 1; e.g., 16T-010 is site 10 on map

Table 1. Sampling Locations for Watershed Characterization Study of the Lower Salt Creek[2]

Site #	AIMS Site #	Stream Name	Location	County	Latitude	Longitude
16T-001	WEL-08-0005	Clear Creek	State Road 37	Monroe	39.096528	-86.546361
16T-002	WEL-08-0006	Jackson Creek	South Rogers Street	Monroe	39.100189	-86.538442
16T-003	WEL-08-0007	Clear Creek	W Church Lane	Monroe	39.107384	-86.54218
16T-004	WEL-08-0008	Clear Creek	W Country Club Drive	Monroe	39.135947	-86.5335
16T-006	WEL-08-0010	Tributary to Clear Creek	S Victor Pike	Monroe	39.079577	-86.568863
16T-007	WEL-08-0011	Tributary to Clear Creek	S Victor Pike	Monroe	39.062771	-86.579717
16T-008	WEL-08-0012	Clear Creek	S Ketcham Road	Monroe	39.034126	-86.566867
16T-009	WEL-08-0013	Tributary to Clear Creek	Will Flock Mill Road	Monroe	39.070046	-86.561745
16T-010	WEL-08-0014	Judah Branch	S Old State Road 37	Monroe	38.998267	-86.545529
16T-011	WEL-08-0015	Clear Creek	S Gore Road	Monroe	39.018748	-86.543774
16T-012	WEL-08-0016	Clear Creek	Depot Hill Road	Monroe	39.012097	-86.529284
16T-013	WEL-08-0017	Little Clear Creek	E Monroe Dam Road	Monroe	39.021223	-86.530694
16T-014	WEL-08-0018	Little Salt Creek	State Road 446	Lawrence	38.964505	-86.378228
16T-015	WEL-08-0019	Henderson Creek	Humback Ridge Road	Lawrence	38.962027	-86.368041
16T-016	WEL-08-0020	Little Salt Creek	Hunter Creek Road	Lawrence	38.978505	-86.369714
16T-017	WEL-08-0021	Little Salt Creek	Judah Legan Road	Lawrence	38.949759	-86.47954
16T-018	WEL-08-0022	Knob Creek	Bat Hollow Road	Lawrence	38.955139	-86.466257
16T-019	WEL-08-0023	Little Salt Creek	Bat Hollow Road	Lawrence	38.949755	-86.464231
16T-020	WEL-08-0024	Tributary to Little Salt Creek	Heltonville Bartlettsville Road	Lawrence	38.966282	-86.414897
16T-021	WEL-08-0025	Gulletts Creek	Peerless Road	Lawrence	38.922345	-86.518702
16T-022	WEL-08-0026	Pleasant Run	Peerless Road	Lawrence	38.904176	-86.4919
16T-023	WEL-08-0027	Salt Creek	Peerless Road	Lawrence	38.926835	-86.507369
16T-024	WEL-08-0034	Salt Creek	Guthrie Rd	Lawrence	38.976379	-86.477849
16T-025	WEL-08-0029	Wolf Creek	Guthrie Road	Lawrence	38.976474	-86.477949
16T-026	WEL-08-0033	Salt Creek	Old State Road 450	Lawrence	38.838832	-86.548893

Site #	AIMS Site #	Stream Name	Location	County	Latitude	Longitude
16T-027	WEL-08-0031	Goose Creek	Patton Hill Road	Lawrence	38.900756	-86.532697
16T-028	WEL090-0003	Salt Creek	Oolitic Road	Lawrence	38.888333	-86.508611

[2] 16T-### denotes that these are the selected pour points for this project

Project/Task Organization and Schedule

Sampling for this project will begin in November 2015 and end in October 2016. Barring any hazardous weather conditions or unexpected physical barriers to accessing the site, samples will be collected for physical, chemical, bacteriological parameters, and biological communities.

Timeframes for sampling activities include:

Site reconnaissance activities will be completed in August 2015. Reconnaissance activities will be conducted in the office and through physical site visits.

Water chemistry will be sampled monthly at all sites in the watershed during the recreational season, defined as April through October in the Indiana Administrative Code (IAC, updated October 22, 2014) [327 IAC 2-1-6]. During the months of November through March, only sites at the pour point of each 12 digit HUC will be sampled monthly. The first sampling event will be conducted in November 2015 and the study will conclude in October 2016.

Biological sampling activities will begin in the summer of 2016 and end no later than October 16, 2016. The basin will be sampled for fish community, macroinvertebrate community, and habitat quality at all sites in the watershed. Specific dates for fish community and macroinvertebrate collections cannot be given since sampling may be postponed due to scouring of the stream substrate or in-stream cover caused by a high water event, which would result in non-representative samples.

Bacteriological sampling for Escherichia coli (*E. coli*) will take place monthly from April through October of 2016 at all sites in the watershed. In addition, *E. coli* samples will be collected five times from each site at equally spaced intervals over a 30-day period during the recreational season of April to October 2016 to determine a geometric mean.

Stream flow will be quantified over the sampling year at sites designated as “pour points” (Table 1) during the monthly water chemistry sampling in each 12 digit HUC. The first measurement event will be conducted in November 2015 and the study will conclude in October 2016.

Background and Project/Task Description

The Watershed Characterization Study program was instituted to assist in characterizing existing conditions in watersheds throughout the state. The Lower Salt Creek watershed characterization data set will be utilized by the TMDL program and shared with local watershed groups and any other interested parties. This monitoring will provide data for TMDL development and watershed planning uses and will aid in the evaluation of future changes within the basin. For this study, the following media will be used for assessment purposes: Water chemistry, stream flow, bacteriological contamination in the form of *E. coli*, fish community, macroinvertebrate assemblages, and habitat evaluations.

Data Quality Objectives (DQOs)

The DQO process (U.S. EPA 2006) is a planning tool for data collection activities. It provides a basis for balancing decision uncertainty with available resources. The DQO is required for all significant data collection efforts for a project. It is a seven-step systematic planning process used to clarify study objectives, define the appropriate types of data, and establish decision criteria on which to base the final use of the data. The DQO for the watershed characterization of the Lower Salt Creek Watershed is identified in the following seven steps:

1. State the Problem

Indiana is required to assess all waters of the state to determine their designated use attainment status. "Surface waters of the State are designated for full-body contact recreation" and "will be capable of supporting" a "well-balanced, warm water aquatic community" [327 IAC 2-1-3]. Data from the intensive sampling of the Lower Salt Creek Watershed is needed to develop a TMDL and fully characterize the current water quality condition of the watershed. This project will gather stream flow, water chemistry, bacteriological, biological (fish and macroinvertebrates), and habitat data for the purpose of assessing the designated use attainment status of the Lower Salt Creek Watershed.

2. Identify the Decision

The objective of this study is to fully assess whether the surface waters in this watershed are supporting or non-supporting for aquatic life use and recreational use, and the extent of impairment if they are non-supporting. All sites will be sampled for concentrations of physical, chemical, and biological parameters and evaluated as "supporting" or "non-supporting" when compared with water quality criteria shown in Table 2 [327 IAC 2-1-6] following Indiana's 2014 Consolidated Assessment Listing Methodology (CALM, IDEM 2014b pages 24-28).

In addition to the physical, chemical, and bacteriological criteria listed in Table 2, data for several nutrient parameters will be evaluated with the benchmarks described below (IDEM 2014b). Assuming a minimum of three sampling events, if two or more of the conditions below are met on the same date, the waterbody will be classified as non-supporting due to nutrients.

- Total Phosphorus (TP): one or more measurements >0.3 mg/L
- Nitrogen (measured as Nitrate + Nitrite): one or more measurements >10.0 mg/L
- Dissolved Oxygen (DO): any measurement <4.0 mg/L; any measurements consistently at or close to the standard, range 4.0-5.0 mg/L; or, any measurement >12.0 mg/L
- pH: any measurement >9.0 Standard Units (S.U.); or, measurements consistently at or close to the standard, range 8.7-9.0 S.U.

Biological Criteria:

Indiana narrative biological criteria located [327 IAC 2-1-3] states that "all waters, except as described in subdivision (5)," (i.e. limited use waters) "will be capable of supporting" a "well-balanced, warm water aquatic community." The water quality standard definition of a "well-balanced aquatic community" is "an aquatic community that: (A) is diverse in species composition; (B) contains several different trophic levels; and (C) is not composed mainly of pollution tolerant species" [327 IAC 2-1-9]. An interpretation or translation of narrative biological criteria into numeric criteria would be as follows: A stream segment is non-supporting for aquatic life use when the monitored fish or macroinvertebrate community receives an Index of Biotic Integrity (IBI) score of less than 36, which is considered "Poor" or "Very Poor" (IDEM 2014b).

Table 2. Water Quality Criteria 327 IAC 2-1-6

Parameters	Water Quality Criteria	Criterion
E. coli April-October (Recreational season)	≤125 MPN/100 mL	5-Sample Geometric Mean
	≤235 MPN/100 mL	Single Sample Maximum
Total Ammonia (NH_3-N)	Calculated based on pH and Temperature	Calculated CAC
Nitrate+Nitrite-Nitrogen	≤10 mg/L	Human Health point of drinking water intake
Dissolved Oxygen	At least 5.0 mg/L (Warm Waters)	Daily Average
	Not less than 4.0 mg/L at any time	Single Reading
pH	6.0 - 9.0 S.U. except for daily fluctuations that exceed 9.0 due to photosynthetic activity	Single Reading
Temperature	Varies Monthly	1% Annual; Maximum Limits
Chloride	Calculated based on hardness and sulfate	Calculated CAC

MPN = Most Probable Number, CAC = Chronic Aquatic Criterion, S.U. = Standard Units

3. Identify the Inputs to the Decision

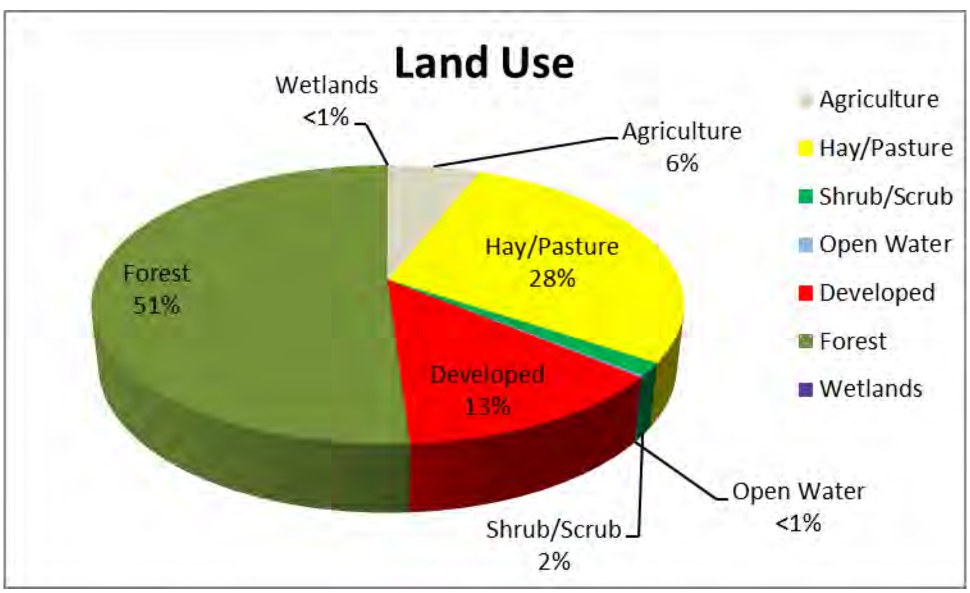
Grab samples will be collected at the surface water sampling locations for *E. coli* and the parameters listed in Table 3. Field measurements (Table 4, page 17) will be conducted at each site during each sampling event. Visual field observations will include weather conditions, stream conditions, and percent stream canopy at each sampling location. All samples collected for bacteriological samples will be analyzed for *E. coli* using the Idexx Colilert Enzyme Substrate Standard Method SM9223B (Clesceri et al., 1998). Surface water chemistry samples will be collected monthly and processed and analyzed by the Indiana State Department of Health (ISDH) Environmental Lab using the analytical methods listed in Table 3. Stream discharge will also be measured monthly at pour points to determine total stream loadings. A fish and macroinvertebrate community sample will be collected once at each site with a corresponding habitat evaluation.

4. Define the Boundaries of the Study

The Lower Salt Creek Watershed covers 203.5 square miles and is located primarily in Monroe, Lawrence, and Jackson counties. The watershed is approximately 51% forested, 28% hay/ pasture, 13% developed, and 6% agriculture. See Figure 2 for the Lower Salt Creek Watershed 2012 land use.

See Figure 1 for the Lower Salt Creek Watershed Watershed Characterization sampling area and Table 1 for the list of sampling locations.

Figure 2. Lower Salt Creek Watershed Land Use[2]



[2]United States Department of Agriculture (USDA) 2012 Crop Data Layer (CDL)

5. Develop a Decision Rule

For assessment purposes in the Indiana Integrated Report (IDEM 2014b), recreational use attainment decisions will be based on bacteriological criteria developed to protect primary contact recreational activities [327 IAC 2-1-6]. Aquatic life use support decisions will include independent evaluations of biological and chemical data as outlined in Indiana's 2014 Consolidated Assessment and Listing Methodology (CALM, IDEM 2014b pages 24-28).

6. Specify Tolerable Limits on Decision Errors

Sampling design error is minimized by utilizing a comprehensive checklist of informational sources, evaluation of historical information, and a thorough watershed pre-survey. This sampling design has been formulated to address data deficiencies and render the optimum amount of data needed to fill gaps in the decision process.

Good quality data are essential for minimizing decision error. By minimizing errors in the sampling design, measurement, and laboratory for physical, chemical, and biological parameters, more confidence can be placed in the conclusions drawn on the stressors and sources affecting the water quality in the study area.

Site specific aquatic life use and recreational use assessments include program specific controls to minimize the introduction of errors. These controls include: water chemistry and bacteriological blanks and duplicates, biological site revisits or duplicates, and laboratory controls through verification of species identifications as described in Field Procedure Manuals (IDEM 2002; Ohio Environmental Protection Agency 2006) and Standard Operating Procedures (SOPs, IDEM 1992b, 1992c, 1992d, 1992e, 2010a).

The QA/QC process detects deficiencies in the data collection as set forth in the IDEM QAPP for the Indiana Surface Water Quality Monitoring Program (IDEM 2004). The QAPP requires all contract laboratories to adhere to rigorous standards during sample analyses and to provide good quality usable data. Chemists within the WAPB review the laboratory analytical results for quality assurance. Any data which is "Rejected" due to analytical problems or errors will not be used for water quality assessment decisions. Any data flagged as "Estimated" may be used on a case-by-case basis. Criteria for acceptance or rejection of results as well as application of data quality flags is presented in the QAPP, Table D3-1: Data Qualifiers and Flags, pages 130-131. Precision and accuracy goals with acceptance limits for applicable analytical methods are provided in the QAPP, Table A7-1: Precision and Accuracy Goals for Data Acceptability by Matrix, pages 45-47 and Table B2-2: Field Parameters page 81.

7. Optimize the Design for Obtaining Data

A Modified Geometric Design (OHEPA 1999, 2012) site selection process (Attachment 1) is used in this study to get the necessary spatial representation of the entire study area. Sites within this watershed have been selected based on a geometric progression of drainage areas and then located to the nearest bridge. Sample sites at road crossings allow for more efficient sampling of the watershed.

Training and Staffing Requirements

The WAPB uses many Standard Operating Procedures (SOPs), so any new staff member must be trained by experienced IDEM professionals on how to operate field and laboratory equipment for the collection of chemical, physical, and biological parameters as well as how to perform required QA/QC procedures (information about SOPs is given in Sections II MEASUREMENT/DATA ACQUISITION and IV DATA VALIDATION and USABILITY). Before sampling starts, IDEM staff spend several days reviewing SOPs with field and laboratory personnel that may be involved with the project.

The fish or macroinvertebrate community field Crew Chief must have a Bachelor of Science degree with a concentration in biology or other closely related area and at least one year of experience with the sampling methodology and taxonomy of the aquatic communities in the region. Prior to conducting electrofishing for fish community sampling, all crew members should review the Principles and Techniques of Electrofishing correspondence course provided by the U.S. Fish & Wildlife Service, National Conservation Training Center. Field Crew Chiefs will test electrofishing equipment and conduct field training with less experienced crew members. The field Crew Chief will be responsible for completion of field data sheets, taxonomic accuracy, sampling efficiency and representation, and voucher specimen tracking.

Staff from the Technical and Logistical Services Section will assist with laboratory work requests and review laboratory data for adherence to QA/QC requirements specified in analytical test methods, contract requirements, and the IDEM QAPP for the Indiana Surface Water Quality Monitoring Program (IDEM 2004) as well as importing electronic data into the Assessment Information Management System (AIMSII) database which is used by the WAPB. The Quality Assurance Officer will create QA/QC review reports for each laboratory analysis set. Quality Assurance staff will conduct audits of field sampling procedures utilized by WAPB staff. Monitoring staff will oversee the entry of the field and laboratory data into AIMSII and perform data QA/QC for accuracy and completeness.

II. MEASUREMENT/DATA ACQUISITION

Sampling Design and Site Locations

The proposed site locations are chosen using a modified geometric and targeted design as described previously in the “Project Objective” section of this Work Plan.

Site reconnaissance activities are conducted in-house and through physical site visits. In-house activities include preparation and review of site maps and aerial photographs. Physical site visits include verification of accessibility, safety considerations, equipment needed to properly sample the site, and property owner consultations, if required. All information will be recorded on the IDEM Site Reconnaissance Form (Attachment 2) and entered into the AIMS II database. Final coordinates for each site will be determined during the physical site visits or at the beginning of the sampling phase of this project using a Trimble Juno TM SB handheld Series Global Positioning System

(GPS), with an accuracy of two to five meters (IDEM 2015). These coordinates will be entered into the AIMS II database.

Table 1 provides a list of the selected sampling sites with the stream name, AIMS Site Number, County Name, and the latitude and longitude of each site. The map at Figure 1, paired with that table, provides a good overview of the various sampling site locations.

Sampling Methods

Water Chemistry

One team of two staff will collect grab water chemistry samples and record physical site observations on the IDEM Stream Sampling Field Data Sheet (Attachment 3), during monthly sampling events. All water chemistry sampling will adhere to the Water Quality Surveys Section Field Procedure Manual Section 2.0 (Field Procedure Manual IDEM 2002, pages 8-14).

Bacteriological Sampling

The bacteriological sampling will be conducted by one team consisting of one or two staff. Samples will be processed in an IDEM Fixed and/or Mobile *E. coli* Laboratory equipped with all materials and equipment necessary for the Colilert® Test Method. Per Element A4 Project Organization and Schedule (above), the expected time frame for bacteriological sampling will be April through October of 2016. Staff will collect the samples in a 120 mL pre-sterilized wide-mouth container from the center of flow if stream is wadeable or from the shoreline using a pole sampler if the stream is not wadeable. All samples will be consistently labeled, cooled, and held at a temperature less than 10ºC during transport. All *E. coli* samples will be collected on a schedule such that any sampling crew can deliver them to the appropriate IDEM *E. coli* Laboratory for analyses within the bacteriological holding time of six hours.

The IDEM Mobile *E. coli* Laboratory is used in this project to facilitate *E. coli* testing by eliminating the necessity of transporting samples to distant contract laboratories within a six hour holding time. The IDEM Mobile *E. coli* Laboratory (Van) provides work space containing storage for samples, supplies for Colilert® Quanti-tray testing, and all equipment needed for collecting, preparing, incubating, and analyzing results in the same manner as the IDEM Fixed *E. coli* Laboratory. All supplies will be obtained from IDEXX Laboratories, Inc., Westbrook, Maine.

Fish Community Sampling

The fish community sampling will be completed by teams of three to five staff. Sampling will be performed using various standardized electrofishing methodologies depending on stream size and site accessibility. Fish assemblage assessments will be performed in a sampling reach of 15 times the length of the average wetted width, with a minimum reach of 50 meters and a maximum reach of 500 meters (Simon and Dufour

2005; U.S. EPA 1995). An attempt will be made to sample all habitat types available within the sample reach to ensure adequate representation of the fish community present at the time of the sampling event. The possible list of electrofishers to be utilized include: the Smith-Root LR-24 or LR-20 Series backpack electrofishers; the Smith-Root model 1.5KVA electrofishing system; the Smith-Root model 2.5 Generator Powered Pulsator electrofisher with RCB-6B junction box and rat-tail cathode cable assembled in a canoe (if parts of the stream are not wadeable, the system may require the use of a dropper boom array outfitted in a canoe or possibly a 12 foot Loweline™ boat); or, for non-wadeable sites, the Smith-Root model 6a electrofisher assembled in a 16 foot Loweline™ boat (IDEM 1992a, 1992b, 1992c, 1992d).

Sample collections during high flow or turbid conditions will be avoided due to 1) low collection rates, which result in non-representative samples and 2) safety considerations for the sampling team. Sample collections during late autumn and seasonal cold temperatures will be avoided due to the lack of responsiveness to the electrical field by some species that can also result in samples that are not representative of the streams fish assemblage (Simon 1990; U.S. EPA 1995).

Fish will be collected using dip nets with fiberglass handles and netting of 1/8-inch bag mesh. Fish collected in the sampling reach will be sorted by species into baskets and buckets. Young-of-the year fish, less than 20 millimeters (mm) total length, will not be retained in the community sample (Simon 1990; U.S. EPA 1995).

Prior to processing fish specimens and completion of the fish collection datasheet, one to two individuals per species will be preserved in 3.7% formaldehyde solution for future reference if there are more than 10 individuals for that species collected in the sampling reach, the specimens can be positively identified, and the individuals for preservation are small enough to fit in a 2000 mL jar. If however, there are few individuals captured or the specimens are too large to preserve, a photo of key characteristics will be taken for later examination. Taxonomic characteristics for possible species encountered in the basin of interest will be reviewed prior to field work. Fish specimens should also be preserved if they cannot be positively identified in the field (especially those that co-occur like the Striped and Common Shiner), if they are individuals that appear to be hybrids or have unusual anomalies, or they are dead specimens that are taxonomically valuable for un-described taxa (like the Red shiner or Jade Darter), life history studies, or research projects.

Data will be recorded for non-preserved fish on the IDEM Fish Collection Data Sheet (Attachment 4) consisting of the following: number of individuals, minimum and maximum total length in millimeters (mm), mass weight in grams (g), and number of individuals with deformities, eroded fins, lesions, tumors, and other anomalies. Once the data have been recorded, specimens will be released within the sampling reach if possible. Data will be recorded for preserved fish specimens following taxonomic identification in the laboratory.

Macroinvertebrate Sampling

The macroinvertebrate community sampling may be conducted immediately following the fish community sampling event or on a different date by crews of two to three staff. Samples are collected using a modification of the U.S. EPA Rapid Bioassessment Protocol multi-habitat (MHAB) approach using a D-frame dip net with 500 µm mesh (Barbour et al. 1999; IDEM 2010a; Klemm et al. 1990; Plafkin et al. 1989). The IDEM MHAB approach (IDEM 2010a) is composed of a 1-minute "kick" sample within a riffle or run and a 50 meter "sweep" sample of shoreline habitats (. The 50 meter length of riparian corridor that is sampled at each site will be defined using a rangefinder or GPS unit. If the stream is too deep to wade, a boat will be used to sample the 50 meter zone along the shoreline that has the best available habitat. The 1-minute "kick" and 50 meter "sweep" samples are combined in a bucket of water which will be elutriated through a U.S. standard number 35 (500 µm) sieve a minimum of five times so that all rocks, gravel, sand and large pieces of organic debris are removed from the sample. The remaining sample is then transferred from the sieve to a white plastic tray where the collector (while still on-site) will conduct a 15-minute pick of macroinvertebrates at a single organism rate with an effort to pick for maximum organism diversity through turning and examination of the entire sample in the tray. The resulting picked sample will be preserved in 70% isopropyl alcohol and returned to the laboratory for identification at the lowest practical taxonomic level (usually genus or species level, if possible) and evaluated using the MHAB macroinvertebrate IBI. Before leaving the site, an IDEM OWQ Macroinvertebrate Header Form (Attachment 5) will be completed for the sample. A completed Biological Samples' chain-of- custody form (Attachment 6) accompanies the samples through the identification process.

Habitat Assessments

Habitat assessments will be completed immediately following macroinvertebrate and fish community sample collections at each site using a slightly modified version of the Ohio Environmental Protection Agency (OHEPA) Qualitative Habitat Evaluation Index (QHEI), 2006 edition (OHEPA 2006; Rankin 1995). A separate QHEI (Attachment 7) must be completed for these two media types since the sampling reach length may differ (i.e., 50 meters for macroinvertebrates and between 50 and 500 meters for fish).

Field Parameter Measurements

Dissolved oxygen (DO), pH, water temperature, specific conductance, and DO percent saturation will be measured with a data sonde during each sampling event regardless of the media type being collected (IDEM 2002). Measurement procedures and operation of the data sonde shall be performed according to the manufacturers' manuals (Hydrolab Corporation 2002; YSI 2002) and Sections 2.10 – 2.13 of the Water Quality Surveys Section Field Procedure Manual (IDEM 2002, pages 67-79). Turbidity will be measured with a Hach™ turbidity kit, and the meter number written in the comments under the field parameter measurements. All field parameter measurements and weather codes will be recorded on the IDEM Stream Sampling Field Data Sheet (Attachment 3) with other sampling observations. A digital photo will also be taken upstream and downstream of the site during each sampling event.

Flow Measurements

Flow measurements are to be taken by the water chemistry crew at the pour point sites during each sampling run using the SonTek Acoustic Doppler Profiler (ADP) at non-wadeable sites and the FlowTracker Handheld Acoustic Doppler Velocimeter (ADV)®, Ott Acoustic Digital Current (ADC), or Ott MF pro at the wadeable sites. Procedures shall be according to Section 2.6.5 of the Surveys Section Field Procedure Manual (IDEM 2002) and the manufacturers' operating manuals. (SonTek/YSI Inc 2007; 2001).

Analytical Methods

Laboratory Procedure for *E. coli* Measurements:

At the end of each sampling run and while still in the field, water samples are processed and analyzed for *E. coli* within the six-hour holding time for collection and transportation, and the two-hour holding time for sample processing. All waters sampled are processed and analyzed for *E. coli* in the IDEM *E. coli* Mobile Laboratory or IDEM Shadeland laboratory, which is equipped with required materials and equipment necessary for the Idexx TM Colilert Test. The Colilert Test is a multiple-tube Enzyme Substrate Standard Method SM-9223 B (Clesceri et al., 1998). The *E. coli* test method and quantification limit are identified below in Table 3.

Nutrient and General Chemistry Parameters Measurements:

Nutrient and general chemistry measurement analysis is performed at ISDH Environmental Lab in accordance with pre-approved test methods and allotted time frames. The nutrient and general chemistry parameters and their respective test methods and quantification limits are identified below in Table 3. A chain-of-custody form created by the AIMS II database (Attachment 8) and a sample analysis request form (Attachment 9) accompanies each sample set through the analytical process.

Table 3. *E. coli,* Nutrient and General Chemistry Parameters Test Methods

Parameter	Method	Limits of Quantification	Units	Preservative	Holding Times
E. coli	SM-9223 B Enzyme Substrate Test	1.0	*MPN /100 mL	0.0008% $Na_2S_2O_3$ for CL_2	8 hours
Alkalinity (as $CaCO_3$)	EPA 310.2	10.0	mg/L	None	14 days

Parameter	Method	Limits of Quantification	Units	Preservative	Holding Times
Total Solids	SM 2540B	10.0	mg/L	None	7 days
Total Suspended Solids	SM 2540D	6.0	mg/L	None	7 days
Total Dissolved Solids	SM 2540C	10.0	mg/L	None	7 days
Sulfate	EPA 375.2	5.0	mg/L	None	28 days
Chloride	SM4500Cl-E	5.0	mg/L	None	28 days
Hardness (as $CaCO_3$)	EPA 130.1	30.0	mg/L	HNO_3 < pH 2	6 months
Ammonia Nitrogen	EPA 350.1	0.10	mg/L	H_2SO_4 < pH 2	28 days
TKN	EPA 351.2	0.30	mg/L	H_2SO_4 < pH 2	28 days
Nitrate+Nitrite	EPA 353.1	0.1	mg/L	H_2SO_4 < pH 2	28 days
Total Phosphorus	EPA 365.1	0.03	mg/L	H_2SO_4 < pH 2	28 days
TOC	SM 5310B	1.0	mg/L	H_2SO_4 < pH 2	28 days
COD	SM 5220D	10.0	mg/L	H_2SO_4 < pH 2	28 days

***** Clesceri et al., 1998. 1 MPN = 1 CFU/100 mL

Field Parameters Measurements:

The field measurements of DO, temperature, pH, conductivity, and turbidity are taken each time a sample is collected. The field parameters and their respective test methods and sensitivity limits are identified below in Table 4.

Table 4. Field Parameters Test Methods

Parameter	Method	Sensitivity Limit	Units
Dissolved Oxygen (data sonde optical)	ASTM D888-09(C)	0.01	mg/L
Dissolved Oxygen (Winkler Titration)	SM 4500-OC[1]	0.2	mg/L
Dissolved Oxygen % Saturation (data sonde optical)	ASTM D888-09(C)	0.01	%
Turbidity (data sonde)	SM2130B	0.02	NTU
Turbidity (Hach Turbidimeter)	EPA 180.1[1]	0.01	NTU
Specific Conductance (data sonde)	SM 2510B	1.0	µS/cm
Temperature (data sonde)	SM 2550B(2)	0.1	^{o} C
Temperature (field meter)	SM 2550B(2)[1]	0.1	^{o} C
pH (data sonde)	EPA 150.2	0.01	SU
pH (field meter)	SM 4500H-B[1]	0.01	SU

[1] Method used for Field Calibration Verification

Quality Control and Custody Requirements

Quality assurance protocols will follow part B5 of the WAPB QAPP (IDEM 2004 page 119-121).

Field Parameter Measurements/Instrument Testing/Calibration

The data sonde will be calibrated prior to each week's sampling (IDEM 2002). The DO component of the calibration procedure will be conducted using the air calibration method (IDEM 2002 page 74). Calibration results and drift values will be recorded and stored in log books located in the calibration laboratories at the Shadeland facility. The drift value is the difference between two successive calibrations. Field parameter calibrations will conform to the procedures as described in the instrument users' manuals (Hydrolab Corporation 2002; YSI 2002). The unit will be field checked for accuracy once during the week by comparison with a Winkler DO test (IDEM 2002 page 64), as well as Hach™ turbidity, pH, and temperature meters. Weekly calibration verification results will be recorded on the Stream Sampling Field Data Sheet (Attachment 3) and entered into the AIMS II database. A Winkler DO test will also be conducted at sites where the DO concentrations detected using a data sonde are 4.0 mg/L or less.

Field Analysis Data

In-situ water chemistry field data will be collected in the field using calibrated or standardized equipment. Calculations may be done in the field or later at the office. Analytical results, which have limited QC checks, are included in this category. Detection limits have been set for each analysis (Table 4). Quality control checks (such as duplicate measurements, measurements of a secondary standard, or measurements using a different test method or instrument) which are performed on field or laboratory data are usable for estimating precision, accuracy, and completeness for the project.

Bacteriological Sampling

Bacteriological samples will be analyzed using the SM 9223 Enzyme Substrate Coliform Test Method, see Table 3 for quantification limits. Samples will be collected using 120 mL pre-sterilized wide-mouth containers and adhere to the six-hour holding time. Analytical results from an IDEM Fixed and/or Mobile *E. coli* Laboratory include QC check sample results from which precision, accuracy, and completeness can be determined for each batch of samples. Raw data are archived by analytical batch for easy retrieval and review. Chain-of-custody procedures must be followed, including: time of collection, time of setup, time of reading the results, and time and method of disposal (IDEM, 2002). Any method deviations will be thoroughly documented in the raw data. All QA/QC samples will be tested according to the following guidelines:

Field Duplicate: Field Duplicates will be collected at a frequency of one per batch or at least one for every 20 samples collected (≥ 5%).

Field Blank: Field Blanks will be collected at a frequency of one per batch or at least one for every 20 samples collected (≥ 5%).

Laboratory Blank: Laboratory Blanks (sterile laboratory water blanks) will be tested at a frequency of one per day.

Positive Control: Each lot of media will be tested for performance using *E. coli* bacterial cultures.

Negative Controls: Each lot of media will be tested for performance using non-*E. coli* and noncoliform bacterial cultures.

Water Chemistry Data

Sample bottles and preservatives used will be certified for purity by the manufacturer. Sample collection for each parameter, preservatives and holding times (Table 3) will adhere to U.S. EPA requirements (U.S. EPA 2007).

- Field duplicates and matrix spike/matrix spike duplicates (MS/MSD) shall be collected at the rate of one per sample analysis set or one per every 20 samples, whichever is greater.
- Field blank samples using ASTM D1193091 Type I water will be taken at a rate of one set per sample analysis set or one per every 20 samples, whichever is greater.

The IDEM OWQ Chain of Custody Form (Attachment 8) and the Sample Analysis Request Form (Attachment 9) accompanies each sample set through the analytical process.

Fish Community Data

Replicate fish community sampling will be performed at a rate of 10 percent of the total fish community sites sampled, three sites chosen using a random numbers table in the basin (IDEM 1992a; U.S. EPA 1995). Replicate sampling will be performed with at least two weeks of recovery between the initial and replicate sampling events. The fish community replicate sampling and habitat assessment will be performed with either a partial or complete change in field team members (U.S. EPA 1994; U.S. EPA 1995). The resulting IBI and QHEI total score between the initial visit and the revisit will be used to evaluate precision. The IDEM Biological Samples Field Chain-of-Custody Form is used to track samples from the field to the laboratory (Attachment 6). Fish in the laboratory may be verified by regionally recognized non-IDEM freshwater fish taxonomists. All data are 1) checked for completeness 2) calculations performed 3) data entered into the AIMS II database and 4) checked again for data entry errors.

Macroinvertebrate Community Data

Replicate macroinvertebrate field samples will be collected at a rate of 10 percent of the total macroinvertebrate community sites sampled, approximately three for the project. The macroinvertebrate community replicate sample and habitat assessment will be performed by the same team member who performed the original sample, immediately after the intial sample is collected. This will result in a precision evaluation based on a 10 percent replicate of samples collected. The IDEM Biological Samples Field Chain of Custody Form is used to track samples from the field to the laboratory (Attachment 6). Laboratory identifications and QA/QC of taxonomic work is maintained by the laboratory supervisor, Macroinvertebrate Community Program Manager.

III. ASSESSMENT/OVERSIGHT

Field and laboratory performance and system audits will be conducted to ensure good quality data. The field and laboratory performance includes precision measurements by relative percent difference (RPD) of field and laboratory duplicate, accuracy measurements by percent of recovery of MS/MSD samples analyzed in the laboratory, and completeness measurements by the percent of planned samples that are actually collected, analyzed, reported, and usable for the project.

Field audits will be conducted to ensure that sampling activities adhere to approved SOPs. Audits are systematically conducted by WAPB Quality Assurance staff to include all WAPB personnel that engage in field sampling activities.

Data Quality Assessment Levels

The samples and various types of data collected by this program are intended to meet the quality assurance criteria and Data Quality Assessment (DQA) Levels as described in the WAPB QAPP (IDEM 2004, pages 128-129).

IV. DATA VALIDATION AND USABILITY

Quality Assurance/Data Qualifiers and Flags

The various data qualifiers and flags that will be used for quality assurance and validation of the data are found on pages 130-131 of the WAPB QAPP (IDEM 2004).

Data Usability

The environmental data collected and their usability are qualified and classified into one or more of the four categories: Enforcement Capable Results, Acceptable Data, Estimated Data, and Rejected Data as described on page 130 of the WAPB QAPP (IDEM 2004).

Data collected for this project will be recorded in the AIMS II database and presented in three compilation summaries:

- A general compilation of the site field and water chemistry data prepared for use in the Indiana Integrated Water Monitoring and Assessment Report.
- A database report format containing biological results and habitat evaluations which will be produced for inclusion in the Integrated Report as well as individual site folders.
- Laboratory bench sheets of the species taxa names and enumerations of all taxon collected.

All data and reports will be made available to public and private entities that find the data useful.

Laboratory and Estimated Cost

Laboratory analysis and data reporting for this project will comply with the WAPB QAPP (IDEM 2004), Request for Proposals (RFP) 12-48 (IDEM 2012), and the OWQ Quality Management Plan(IDEM 2012b). Analytical tests on the general chemistry and nutrient parameters outlined in Table 3 will be performed by the Indiana State Department of Health (ISDH) Environmental Lab in Indianapolis, Indiana at no direct cost. Supplies for the bacteriological sampling will come from IDEXX Laboratories, Inc., Westbrook, Maine with a total estimated cost for this project of $1,700. All fish and macroinvertebrate samples will be collected and analyzed by IDEM staff.

Personnel Safety and Reference Manuals

All staff persons who participate in the field component of this study are required to have completed Basic First Aid and Cardio-Pulmonary Resuscitation (CPR) training. According to the memorandum "Change in status of Water Assessment Branch staff in accordance with the Agency training policy," dated November 29, 2010, OWQ WAPB staff is exempt from initial and annual training requirements set forth in Section 6.0 of the IDEM Health and Safety Training Policy (IDEM 2010b). The memorandum also states "as an alternative to the training requirements of the policy, the WAPB will conduct in-service training at a minimum of four (4) hours per year on topics directly related to duties performed by staff." New hires or those changing job responsibilities without the minimum four-hour training must be accompanied in the field by a staff member who has met the requirements of the branch Health and Safety training.

Field personnel collecting water chemistry and bacteriological samples will follow policies and procedures established in the Surveys Section Field Procedures Manual (IDEM 2002) and the Hazardous Communication Plan Supplement (IDEM 1997). Field personnel collecting fish and macroinvertebrate community samples must read and comply with the Biological Studies Section SOP Manual: Section II. Hazard Communications Manual (IDEM 1992e) which includes four yellow three-ring binders consisting of the:

1) WAPB Safety Manual;
2) IDEM Hazard Communications SOP;
3) Occupational Safety and Health Administration Handbooks;
4) Material Safety Data Sheets;
5) "Field and Laboratory Operating Procedures for use, handling and storage of chemicals in the laboratory" (Newhouse 1998a); and,
6) "Field and Laboratory Operating Procedures for Use, Handling, and Storage of Solutions Containing Formaldehyde" (Newhouse 1998b).

Sampling on surface waters requires safety consciousness of staff members and the use of specialized equipment; thus, staff will comply with the IDEM Personal Protective Equipment (PPE) Policy (IDEM 2008). If an injury or illness arises in the field, staff will follow the IDEM Injury and Illness Resulting from Occupational Exposure Policy (IDEM 2010c).

Operating in and around waterbodies carries inherent risks of drowning; thus, personnel involved in sample collection will wear appropriate clothing and PPE when operating boats or sampling in deep water or swift currents. According to the memorandum "Use of Personal Flotation Devices (PFDs) by Branch Personnel," dated February 29, 2000, WAPB staff must wear U.S. Coast Guard approved Type I, II, or III PFDs whenever:

- the planned work requires them to enter the water and the maximum water depth at any portion of the work site is over their knee (note that this depth depends on the employee but it will usually be between 12 and 20 inches or 300-500 mm);
- the employee is in a watercraft of any kind that is being launched, is in the water, or is being retrieved from the water; or,
- the employee must work from structures that do not possess guard rails and are over or alongside water where the water depth is or could reasonably be expected to be three feet deep or greater.

In addition, when work is being done in boats on co-jurisdictional waters (as defined by Indiana Code (IC) 14-8-2-315) or during hours of darkness on any waters of the state, all personnel in the watercraft must wear a high intensity whistle and Safety of Life at Sea (SOLAS) certified strobe light.

Safety issues are the responsibility of all crew members; however, any questions in the field should be directed to the field crew leader. The field crew leader is responsible for the completion of all work listed in the Work Plan, the health and safety aspects of the sampling event, and successful interactions with landowners and members of the public.

REFERENCES

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA/841/B-99/002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C. Report available at http://water.epa.gov/scitech/monitoring/rsl/bioassessment/

Clesceri, L.S., Greenburg, A.E., Eaton, A.D., 1998. SM-Standards Methods for the Examination of Water and Wastewater 20th Edition. American Public Health Association.

Code of Federal Regulations (CFR). 40 CFR Part 136, Appendix B Revised March 12, 2007. Available at http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol24/pdf/CFR-2012-title40-vol24-part136-appB.pdf

Hydrolab Corporation. 2002, revision c. Quanta Water Quality Monitoring System Operating Manual. Loveland, Colorado. Available at http://www.hachhydromet.com/web/ott_hach.nsf/id/pa_users_manuals_e.html

IAC(Indiana Administrative Code), Title 327 Water Pollution Control Division, Article 2. Water Quality Standards. Last updated November 4, 2015. Available at http://www.in.gov/legislative/iac/iac_title?iact=327

IDEM. 1992a, revision 1. Section 3, Quality Assurance Project Plan, Development of Biological Criteria (Fish) for the Ecoregions of Indiana. Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 1992b, revision 1. Section 4, Standard Operating Procedures for Fish Collections, Use of Seines, Electrofishers, and Sample Processing. Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 1992c, revision 1. Section 5, Standard Operating Procedures for Conducting Rapid Assessment of Ambient Water Quality Using Fish (RBP-V). Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 1992d, revision 1. Section 11, Standard Operating Procedures-Appendices of Operational Equipment Manuals and Procedures. Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 1992e, revision 1. Section 2, Biological Studies Section Hazards Communications Manual (List of Contents). Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana. (This Manual is not available in electronic format but may be inspected at the Watershed and Assessment Branch offices at 2525 North Shadeland, Indianapolis, IN.)

IDEM. 1997. Water Quality Surveys Section Laboratory and Field Hazard Communication Plan Supplement. IDEM 032/02/018/1998, Revised October 1998. Assessment Branch, Indiana Department of Environmental Management, Indianapolis, Indiana

IDEM. 2002. Water Quality Surveys Section Field Procedure Manual, Assessment Branch, Indiana Department of Environmental Management, Indianapolis, Indiana. IDEM, April 2002.

IDEM. 2004. Quality Assurance Project Plan (QAPP) for Indiana Surface Water Quality Monitoring and Total Maximum Daily Load (TMDL) Program, (Rev. 3, Oct. 2004).

IDEM. 2008. IDEM Personal Protective Equipment Policy, revised May 1 2008. A-059-OEA-08-P-R0. Office of External Affairs, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 2010a. Multi-habitat (MHAB) Macroinvertebrate Collection Technical Standard Operating Procedure. S-001-OWQ-W-BS-10-T-R0. Watershed Planning and Assessment Branch, Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 2010b. IDEM Health and Safety Training Policy, revised October 1 2010. A-030-OEA-10-P-R2.Office of External Affairs, Indiana Department of Environmental Management, Indianapolis, Indiana.

IDEM. 2010c. IDEM Injury and Illness Resulting from Occupational Exposure Policy, revised October 1 2010. A-034-OEA-10-P-R2. Office of External Affairs, Indiana Department of Environmental Management, Indianapolis, Indiana

IDEM. 2012. Request for Proposals 12-48, Solicitation for Analyses. IDEM. Indiana Department of Administration. Indianapolis, Indiana.

IDEM. 2012b. IDEM Agency Wide Quality Management Plan. IDEM, Indiana government Center North, 100 N. Senate Ave., Indianapolis, Indiana, 46204. Available at http://www.in.gov/idem/files/idem_qmp_2012.pdf IDEM. 2014a. Draft 2014 303(d) List Submitted to U.S. EPA on April 1, 2014. Edited by Jody Arthur. Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana. Available at http://www.in.gov/idem/nps/2647.htm

IDEM. 2014b. Indiana's 2014 Consolidated Assessment and Listing Methodology (CALM) Revised. Edited by Jody Arthur. Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana. Available at http://www.in.gov/idem/nps/files/ir_2014_report_apndx_h_calm.pdf

IDEM. 2015. Global Positioning System (GPS) Data Creation Technical Standard Operating Procedure. B-001-OWQ-WAP-XXX-15-T-R0. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana. Located at https://extranet.idem.in.gov/standards/docs/sops/owq/B-001-OWQ-WAP-XXX-15-T-R0.pdf

Klemm, D.J., P.A. Lewis, F.Fulk and J.M. Lazorchak. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. EPA/600/4-90/030. Environmental Monitoring Systems Laboratory, Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio.

Newhouse, S.A. 1998a. Field and laboratory operating procedures for use, handling and storage of chemicals in the laboratory. IDEM/32/03/007/1998. Biological Studies Section, Assessment Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.

Newhouse, S.A. 1998b. Field and laboratory operating procedures for use, handling and storage of solutions containing formaldehyde. IDEM/32/03/006/1998. Biological Studies Section, Assessment Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.

Ohio Environmental Protection Agency (OHEPA). 1999. Ohio EPA Five-Year Surface Water Monitoring Strategy: 2000 – 2004. Ohio EPA Technical Bulletin MAS/1999-7-2. Division of Surface Water, Lazarus Government Center, 211 S. Front Street, Columbus, Ohio 43215. Page 70. Report available at: http://www.epa.gov/nheerl/arm/documents/ohiofiveyearmonitstratdraft.pdf

Ohio Environmental Protection Agency (OHEPA). 2006. Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI). OHIO EPA Technical Bulletin EAS/2006-06-1. Revised by the Midwest Biodiversity Institute for State of Ohio Environmental Protection Agency, Division of Surface Water, Ecological Assessment Section, Groveport, Ohio. Report available at http://www.epa.state.oh.us/portals/35/documents/qheimanualjune2006.pdf

Ohio Environmental Protection Agency (OHEPA). 2012. 2011 Biological and Water Quality Study of Mill Creek and Tributaries, Hamilton County, Ohio. Technical Report MBI/2012-6-10. MSD Project Number 10180900. Prepared for: Metropolitan Sewer District of Greater Cincinnati, 1081 Woodrow Street, Cincinnati, OH 45204. Submitted by: Midwest Biodiversity Institute, P.O. Box 21561, Columbus, Ohio 43221-0561. Pages 40-1. Report available at: http://projectgroundwork.org/downloads/reports/2011_mill_creek_biological_water_quality_study.pdf

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/440/4-89/001. Assessment and Watershed Protection Division, U.S. Environmental Protection Agency, Washington, D.C. Report available at http://nepis.epa.gov/Exe/ZyNET.exe/9100LGCA.TXT?ZyActionD=ZyDocument&Clie

nt=EPA&Index=1986+Thru+1990&Docs=&Query=&Time=&EndTime=&SearchMethod=1&TocRestrict=n&Toc=&TocEntry=&QField=&QFieldYear=&QFieldMonth=&QFieldDay=&IntQFieldOp=0&ExtQFieldOp=0&XmlQuery=&File=D%3A%5Czyfiles%5CIndex%20Data%5C86thru90%5CTxt%5C00000022%5C9100LGCA.txt&User=ANONYMOUS&Password=anonymous&SortMethod=h%7C-&MaximumDocuments=1&FuzzyDegree=0&ImageQuality=r75g8/r75g8/x150y150g16/i425&Display=p%7Cf&DefSeekPage=x&SearchBack=ZyActionL&Back=ZyActionS&BackDesc=Results%20page&MaximumPages=1&ZyEntry=1&SeekPage=x&ZyPURL

Rankin, E.T. 1995. Habitat Indices in Water Resource Quality Assessments. pp. 181-208, Chapter 13, Biological Assessment and Criteria: Tools for the Risk-based Planning and Decision Making, edited by Wayne S. Davis and Thomas P. Simon, Lewis Publishers, Boca Raton, Florida.

Simon, T.P. 1990. Quality Assurance Program Plan: Development of Biological Criteria for the Ecoregions of Indiana. Region V, Environmental Sciences Division, Central Regional Laboratory, Organic Chemistry Section: Biology Team, U.S. Environmental Protection Agency, Chicago, Illinois.

Simon, T.P. and R.L. Dufour. 2005. Guide to appropriate metric selection for calculating the Index of Biotic Integrity (IBI) for Indiana Large and Great Rivers, Inland Lakes, and Great Lakes nearshore. U.S. Department of the Interior, Fish and Wildlife Service, Bloomington Field Office, Bloomington, Indiana.

SonTek/YSI Inc 2001, SonTek/YSI ADP® Acoustic Doppler Profiler Technical Documentation. 2001. Available at http://www.sontek.com/adp-adcp.php

SonTek/YSI Inc 2007, FlowTrackers® User's Manual. 2007. Available at http://www.sontek.com/flowtracker.php

United States Environmental Protection Agency (U.S. EPA). March 1994. Environmental Monitoring and Assessment Program, Surface Waters and Region 3 Regional Environmental Monitoring and Assessment Program, 1994 Pilot Field Operations and Methods Manuals for Streams. EPA/620/R-94/004F. Edited by Donald J. Klemm and James M. Lazorchak. Bioassessment and Ecotoxicology Branch, Ecological Monitoring Research Division, Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio. Report available at http://www.epa.gov/emap2/html/pubs/docs/groupdocs/surfwatr/field/ws_abs.html

U.S. EPA 1995, Region 5 R-EMAP Full Proposal: Spatial Evaluation of the Eastern Corn Belt Plain Rivers and Streams for the Development of Reference Condition using EMAP Sampling Design and Indicators, with Comparison of Results to Nonrandom Intensive.

U.S. EPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA/240/B-06/001. U.S. EPA, Office of Environmental Information, Washington D.C.

YSI Incorporated. 2002, revision b. 6-Series Environmental Monitoring Systems Manual, Yellow Springs, Ohio. Available at http://www.ysi.com/mwg-internal/de5fs23hu73ds/progress?id=fdaTJVUSbg

DISTRIBUTION LIST

Electronic Distribution Only:

Name	Organization
Jody Arthur	IDEM/OWQ/WAPB/Technical E7
Tim Beckman	IDEM/OWQ/WAPB/Targeted Monitoring Section
Timothy Bowren	IDEM/OWQ/WAPB/Technical and Logistics Section
Ross Carlson	IDEM/OWQ/WAPB/Watershed Planning and Restoration Section
Kevin Crane	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Todd Davis	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Monika Elion	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Cory Fischer	IDEM/OWQ/WAPB/Targeted Monitoring Section
Kevin Gaston	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Staci Goodwin	IDEM/OWQ/WAPB/Watershed Planning and Restoration Section
Kathleen Hagan	IDEM/OWQ/WAPB/Watershed Planning and Restoration Section
David Jordan	IDEM/OWQ/WAPB/Technical and Logistical Services Section
Paul McMurray	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Myra McShane	IDEM/OWQ/WAPB/Technical and Logistical Services Section
Martha Clark Mettler	IDEM/OWQ/Assistant Commissioner
Reid Morehouse	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Stacy Orlowski	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Dave Parry	IDEM/ Office of Compliance Support/Planning and Assessment/Quality Improvement Section
Marylou Renshaw	IDEM/OWQ/WAPB/Branch Chief
Joe Schmees	IDEM/OWQ/WAPB/Watershed Planning and Restoration Section
Anna Settineri	IDEM/OWQ/WAPB/Targeted Monitoring Section
Stacey Sobat	IDEM/OWQ/WAPB/Probabilistic Monitoring Section
Michael Spinar	IDEM/ Office of Compliance Support/Planning and Assessment/Quality Improvement Section
MikeSutton	IDEM/OWQ/WAPB/Technical and Logistics Section
Cyndi Wagner	IDEM/OWQ/WAPB/Targeted Monitoring Section
Kayla Werbianskyj	IDEM/OWQ/WAPB/Targeted Monitoring Section

Attachment 1: Modified Geometric Design Steps for Watershed Characterization Studies

Introduction

A relatively new design that has recently been implemented in Indiana is termed the Geometric Site Selection process. This design is employed within watersheds that correspond to the 12-14 digit HUC scale in order to fulfill multiple water quality management objectives, not just the conventional focus on status assessment. It is employed at a spatial scale that is representative of the scale at which watershed management is generally being conducted.

Sites within the watershed are allocated based on a geometric progression of drainage areas starting with the area at the mouth of the main stem river or stream (pour point) and working “upwards” through the various tributaries to the primary headwaters. This approach allocates sampling sites in a semi-random fashion and according to the stratification of available stream and river sizes based on drainage area. The Geometric Site Selection process is then modified by adding a targeted selection of additional sampling sites that are used to focus on localized management issues such as point source discharges, habitat modifications, and other potential impacts within a watershed. These sites are then “snapped to bridges” to facilitate safe and easy access to the stream. This design also fosters data analysis that takes into consideration overlying natural and human caused influences within the streams of a watershed. The design has been particularly useful for watersheds that are targeted for TMDL development because missing, incomplete, or outdated assessments can be addressed prior to TMDL development.

Selection Process

In ArcGIS, download from NHD Plus site (http://www.horizon-systems.com/nhdplus/HSC-wthMS.php) the following files for Region 5 (and then again for Region 7) and zip them into the appropriate file structure.

File Description	File Name (.zip***)	Format
Region 05, Version 01_01, Catchment Grid	NHDPlus05V01_01_Catgrid	ESRI Grid
Region 05, Version 01_01, Catchment Shapefile	NHDPlus05V01_01_Catshape	Shapefile
Region 05, Version 01_02, Catchment Flowline Attributes	NHDPlus05V01_02_Cat_Flowline_Attr	DBF
Region 05, Version 01_02, Elevation Unit a	NHDPlus05V01_02_Elev_Unit_a	ESRI Grid
Region 05, Version 01_02, Elevation Unit b	NHDPlus05V01_02_Elev_Unit_b	ESRI Grid
Region 05, Version 01_02, Elevation Unit c	NHDPlus05V01_02_Elev_Unit_c	ESRI Grid
Region 05, Version 01_01, Flow Accumulation and Flow Direction Unit a	NHDPlus05V01_01_FAC_FDR_Unit_a	ESRI Grid
Region 05, Version 01_01, Flow Accumulation and Flow Direction Unit b	NHDPlus05V01_01_FAC_FDR_Unit_b	ESRI Grid
Region 05, Version 01_01, Flow Accumulation and Flow Direction Unit c	NHDPlus05V01_01_FAC_FDR_Unit_c	ESRI Grid
Region 05, Version 01_02, National Hydrography Dataset	NHDPlus05V01_03_NHD	Shapefile and DBF
Region 05, Version 01_01, Stream Gage Events	NHDPlus05V01_01_StreamGageEvent	Shapefile
Region 05, Version 01_01, QAQC Sinks Spreadsheet	NHDPlus05V01_01_QAQC_Sinks	Excel Spreadsheet

Create a new point shapefile (or geodatabase featureclass) named Geometric Design within ArcCatalog with the same projection as the unzipped layers above.

Within an ArcMap project, add the following:

- nhdflowline layer;
- Geometric Design layer;
- catchment shapefile;
- the FlowlineAttributesFlow table.

Add the following fields to the nhdflowline layer:

- LENGTHMi (type: double, precision: 9, scale 4)
- DrainMi (type: double, precision: 9, scale 4)
- MinElev (type: double, precision: 9, scale 4)
- MaxElev (type: double, precision: 9, scale 4)
- Gradient (type: double, precision: 9, scale 4)

Add the following field to the GeometricDesign layer (use the add field-batch tool):

- Geometric (type: double, precision: 5, scale 2)
- Lat (type: double, precision: 8, scale 5)
- Long (type: double, precision: 8, scale 5)
- COMID (type: long, precision: 9)

Join the nhdflowline layer with the FlowlineAttributesFlow table based on the COMID field.

Use the field calculator within the nhdflowline attribute table, with the appropriate metric to imperial conversion to populate the following fields:

- LENGTHMi (from LENGTHKM – kilometers to miles)
- DrainMia (from CumDrainage – square kilometers to square miles (sq mi))
- MinElev (from MinElevSmo – meters to feet)
- MaxElev (from MaxElevSmo – meters to feet)
- Gradient ((MaxElev-MinElev)/LENGTHMI).

Unjoin the FlowlineAttributesFlow table.

Label the "nhdflowline" layer based new "LengthMi" field – note: this field shows the cumulative drainage at the *end* of the line segment, which is rarely more than 2-3 miles in between nodes.

Calculate the geometric break points (i.e., for a 500 sq mi watershed: 500, 250, 125, 62.5, 31, 15, 7, 4, 2).

It is recommended to change the symbology (Symbology: Show Quantities: Classification (Manual)) of the actual flowline to reflect the drainage. This will help identify when and where sites need to be allocated.

Start a new editing session, with the GeometricDesign layer as your target layer.

Add a new point within this layer to the pour point for the watershed (500 sq mi in this case).

Travel upstream through the mainstem and "find" the next place on the stream where the river drainage brackets 250 sq mi. Use the catchment shapefile layer to identify more precisely the drainage value if needed.

Populate the "Geometric" field within the GeometricDesign layer accordingly to the identified drainage level, then change the symbology (Symbology: Categories: Unique Values: Geometric field) of this layer to reflect the drainage levels.

Proceed through the watershed (either around the outer portions or start with largest values and work in), adding points accordingly to each geometric level. Change the symbology to find areas or levels that were missed. Note – the drainage level must be exact. Use the catchment shapefile to subtract drainage areas from larger drainage areas until the exact drainage level is reached. It is ok to "skip" a geometric level if it is not exactly reached. Sometimes there are large tributaries whose contribution to the mainstem skips a drainage level.

Populate the COMID (manually), and Lat/Long (right click on field and select calculate geometry – lat = x-coordinates and long = y-coordinates) accordingly for reference within the GeometricDesign Layer

Once sites are selected in this fashion, they will need to be snapped to a bridge or access point.

Additional sites should be placed at pour points of subwatersheds (12-digit HUCs) to meet TMDL document requirements.

Once the initial sites are selected, the following features are taken into account to move or add sites:

- Permitted facilities
- Urban areas
- Historical sampling sites
- Assessment Unit IDs (AUID)
- External stakeholder information
- Resources - maximum of 35 sites per project

After refining site selections, there may be additional sites added to ensure spatial representation of the project area.

Sites may be removed or changed after site reconnaissance if there are problems accessing the site or if sites are dry.

Notes regarding the NHD dataset:

All units are initially set to metric and need to be converted to imperial.

Within the nhdflowline layer, the GNIS_Name/ID refers to the whole river name and ID, while the COMID is a unique identifier for the particular segment.

There is *not* a value GNIS_Name/ID for every river, especially where primary streams and ditches are concerned.

Segments within the nhdflowline layer are based on linear miles between “nodes,” which are broken up (typically) by tributary. Typically these lengths are less than 2-3 miles.

The cumulative drainage values in the NHD dataset have been compared against other and deemed “reasonable” (read – not statistically compared). Also note that the drainage is calculated through the model to be at the pour point of that segment.

The elevation values, however, are **not** reliable and require supervision. These values are calculated from the associated digital elevation model (DEM) and sometimes have null values for either the maximum or minimum elevation values. In addition, the length of the stream is not long enough (i.e. >1 mile) to calculate gradient. In either case, this associated value is helpful to identify contour changes against a USGS contour map. However, to note the calculated gradient from the NHD information has been observed to be within several tenths of mile compared to a manual calculation of gradient.

Important tables from NHD

- FlowlineAttributesFlow (found in: Region 05, Version 01_02, Catchment Flowline Attributes)
    - Key fields: CumDrainag, Max ElevRaw, MinElevSmo,

Important Layers from NHD

- Region 05, Version 01_01, Catchment Shapefile
- Region 05, Version 01_02, National Hydrography Dataset

Attachment 2. IDEM Site Reconnaissance Form.

IDEM

Site Reconnaissance Form

EPA Site Identifier	Rank
Recon #: Trip #:	

Site Number: | Stream: | County:

Location Description:

Reconnaissance Data Collected

Recon Date | Crew Members

Avg. Width (m) | Avg. Depth (m) | Max. Depth (m) | Nearest Town

Water Present? ☐ | Site Wadeable? ☐ | Riffle/Run Present? ☐ | Road/Public Access Possible? ☐

Site Impacted by Livestock? ☐ | Collect Sediment? ☐ | Gauge Present? ☐

Landowner/Contact Information

First Name | Last Name

Street Address

City | State | Zip

Telephone | E-Mail Address

Pamphlet Distributed? ☐ | Please Call In Advance? ☐ | Results Requested? ☐

Rating, Results, Comments, and Planning

Site Rating By Category (1=easy, 10=difficult)
Access Route
Safety Factor
Sampling Effort

Reconnaissance Decision

- Pre-Recon
- Recon in process
- Approved Site
- No, Landowner denied access
- No, Dry
- No, Stream channel missing
- No, Physical barriers
- No, Impounded stream
- No, Marsh/Wetland
- No, Bridge gone or not accessible
- No, Unsafe due to traffic or location
- No, Site impacted by backwater
- No, Other

Equipment Selected

Circle Equipment Needed

- Backpack
- Boat
- Towbarge
- Longline
- Scanoe
- Seine
- Weighted Handline
- Waders
- Gill Net

Comments

Sketch of Stream & Access Route – Indicate Flow, Direction, Obstacles, & Land Use (Use Back of Page, If Necessary)

Attachment 3: Blank Stream Sampling Field Data Sheet

IDEM Stream Sampling Field Data Sheet

Analysis Set #	EPA Site ID	Rank

Sample #	Site #	Sample Medium	Sample Type	Duplicate Sample #

Stream Name:		River Mile:		County:	
Site Description:					

Survey Crew Chief	Sample Collectors 1	2	3	4	Sample Collected Date	Time	Hydrolab #	Water Depth/Gage Ht (ft)	Water Flow (cf/sec)	Flow Estimated?	Algae?	Aquatic Life?
										☐	☐	☐

Sample Taken?	Aliquots	Water Flow Type	Water Appearance	Canopy Closed %
☐ Yes ☐ No; Frozen	☐ 1 ☐ 2 ☐ 3 ☐ 4	☐ Riffle ☐ Dry ☐ Stagnant	☐ Clear ☐ Green ☐ Sheen	☐ 0-20% ☐ 60-80%
☐ No; Stream Dry ☐ No; Other	☐ 6 ☐ 8 ☐ 12 ☐ 24	☐ Pool ☐ Run ☐ Flood	☐ Murky ☐ Black ☐ Other	☐ 20-40% ☐ 80-100%
☐ No; Owner refused Access	☐ 48 ☐ 72 ☐ AS-Flow	☐ Glide ☐ Eddy ☐ Other	☐ Brown ☐ Gray (Septic/Sewage)	☐ 40-60%

Special Notes:

Field Data:

Date (m/d/yy)	24-hr Time (hh:mm)	D.O. (mg/l)	pH	Water Temp (°C)	Spec Cond (µohms/cm)	Turbidity (NTU)	% Sat.	Chlorine (mg/l)	Chloride (mg/l)	Chlorophyll (mg/l)	Weather Codes SC	WD	WS	AT
Comments														
Comments														
Comments														
Comments														
Comments														
Comments														

Measurement Flags		
	<	< Min. Meter Measurement
	>	> Max. Meter Measurement
	E	Estimated (See Comments)
	R	Rejected (See Comments)

Weather Code Definitions

SC Sky Conditions		WD Wind Direction	WS Wind Strength	AT Air Temp
1 Clear	8 Rain	00 North (0 degrees)	0 Calm	1 < 32
2 Scattered	9 Snow	09 East (90 degrees)	1 Light	2 33-45
3 Partly	10 Sleet	18 South (180 degrees)	2 Mod./Light	3 46-60
4 Cloudy		27 West (270 degrees)	3 Moderate	4 61-75
5 Mist			4 Mod./Strong	5 76-85
6 Fog			5 Strong	6 > 86
7 Shower			6 Gale	

Field Calibrations:

Date (m/d/yy)	Time (hh:mm)	Calibrator Initials	Calibrations Type	Meter #	Value	Units

Calibration Type	
	pH
	DO
	Turbidity

Preservatives/Bottle Lots:

Group: Preservative	Preservative Lot #	Bottle Type	Bottle Lot #

Groups: Preservatives		Bottle Types	
GC	General Chemistry: Ice	2000P	2000mL Plastic, Narrow Mouth
Nx	Nutrients: H2SO4	1000P	1000mL Plastic, Narrow Mouth
Metals	Metals: HNO3	500P	500mL Plastic, Narrow Mouth
CN	Cyanide: NaOH	250P	250mL Plastic, Narrow Mouth
O&G	Oil & Grease: H2SO4	1000G	1000mL Glass, Narrow Mouth
Toxics	Toxics: Ice	500G	500mL Glass, Wide Mouth
Ecoli	Bacteriology: Ice	250G	250mL Glass, Wide Mouth
VOA	Volatile Organics: HCl & Thiosulfate	125G	125mL Glass, Wide Mouth
Pest	Pesticides: Ice	40GV	40mL Glass Vial
Phen	Phenols: H2SO4	120PB	120ml Plastic (Bacteria Only)
Sed	Sediment: Ice	1000PF	1000mL Plastic, Corning Filter
Gly	Glyphosate: Thiosulfate	500PF	500mL Plastic, Corning Filter
Hg	Mercury(1631): HCl	60P	60mL Plastic
Cr6	ChromiumVI(1636): NaOH	250T	250mL Teflon
MeHg	Methyl Mercury(1630): HCl	500T	500mL Teflon
		125T	125mL Teflon

Data Entered By: ________________ QC1: ________________
QC2: ________________

Stream Sampling Field Data Sheet

Attachment 4: Fish Collection Data Sheet

IDEM
OWQ-WATERSHED ASSESSMENT AND PLANNING BRANCH

Event ID______________ Voucher jars_______ Unknown jars________ Equipment________________ Page_____ of ______
Voltage_______ Time fished (sec)________ Distance fished (m)_________ Max. depth (m)_________ Avg. depth (m)________
Avg. width (m)______ Bridge in reach_____ Is reach representative_____ If no, why________________________________
Elapsed time at site (hh:mm)____:____ Comments____
____
____

Museum data: Initials__________ ID date__________ Jar count__________ Fish Total__________

Coding for Anomalies: D – deformities E – eroded fins L – lesions T – tumor M – multiple DELT anomalies O – other (A – anchor worm C – leeches W – swirled scales Y – popeye S – emaciated F – fungus P – parasites) H – heavy L – light (these codes may be combined with above codes)

TOTAL # OF FISH				WEIGHT (s) (mass g)				(length mm)	ANOMALIES					
								Min length	D	E	L	T	M	O
								Max length						
V		P												
								Min length	D	E	L	T	M	O
								Max length						
V		P												
								Min length	D	E	L	T	M	O
								Max length						
V		P												
								Min length	D	E	L	T	M	O
								Max length						
V		P												
								Min length	D	E	L	T	M	O
								Max length						
V		P												
								Min length	D	E	L	T	M	O
								Max length						
V		P												

MKM; Rev/February 19, 2014

Attachment 5: Macroinvertebrate Header Form.

IDEM

Office of Water Quality: Macroinvertebrate Header

L-Site #	Event ID	Stream Name	Location	County	Surveyor

Sample Date	Sample #	Macro#	# Containers

Macro Sample Type:
☐ Black Light ☐ Kick
☐ CPOM ☐ MHAB
☐ Hester-Dendy ☐ Qualitative

☐ Normal ____________
☐ Duplicate ____________
☐ Replicate ____________

☐ **Habitat Complete** ☐ **Sample Quality Rejected**

Riparian Zone/Instream Features

Watershed Erosion:
☐ Heavy
☐ Moderate
☐ None

Watershed NPS Pollution:
☐ No Evidence
☐ Obvious Sources
☐ Some Potential Sources

Stream Depth Riffle (m):	Stream Depth Run (m):	Stream Depth Pool (m):	Distances Riffle-Riffle (m):	Distances Bend-Bend (m):

Stream Width (m):	High Water Mark (m):	Velocity (ft/s):

Stream Type:
☐ Cold
☐ Warm

Turbidity (Est):
☐ Clear ☐ Slightly Turbid
☐ Opaque ☐ Turbid

Salinity (mg/L): ________ **ORP (mV):** ________

☐ **Channelization** ☐ **Dam Present**

Predominant Surrounding Land Use: ☐ Forest ☐ Field/Pasture ☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial
Other ____________________

Sediment

Sediment Odors: ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None Other ____________

Sediment Deposits: ☐ Sludge ☐ Sawdust ☐ Paper Fiber ☐ Sand ☐ Relic Shells Other ____________

Sediment Oils: ☐ Absent ☐ Moderate ☐ Profuse ☐ Slight

☐ Are the undersides of stones, which are not deeply embedded, black?

Substrate Components

(Note: Select from 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% for each inorganic/ organic substrate component)

Inorganic Substrate Components (% Diameter)							Organic Substrate Components (% Type)			
Bedrock	Boulder (>10 in)	Cobble (2.5-10 in)	Gravel (0.1-2.5 in)	Sand (gritty)	Silt	Clay (slick)	Detritus (sticks, wood)	Detritus (CPOM)	Muck/Mud (black, fine FPOM)	Marl(gray w/ shell fragments)

Water Quality

Water Odors: ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ None Other ____________

Water Surface Oils: ☐ Slick ☐ Sheen ☐ Glob ☐ Flocks ☐ None

IDEM 03/14/13

Attachment 6: Biological Samples Field Chain-of-custody Form

INDIANA DEPARTMENT OF
ENVIRONMENTAL MANAGEMENT
OFFICE OF WATER QUALITY
BIOLOGICAL STUDIES SECTION

BIOLOGICAL SAMPLES FIELD CHAIN OF CUSTODY

I certify that the sample(s) listed below was/were collected by me or in my presence.

Signature:

Date: ____/____/____

Sample Type:
(ie. fish, macro, algae) ____________

EVENT ID (YY _ _ _)/ MACRO # (9 DIGIT)	IDEM SAMPLE # (AB _ _ _ _ _)	2000mL Nalgene	250mL Nalgene	125mL Glass	Type (AD or AS)	Volume (mL)	COLLECTED Date (mm/dd/yyyy)	COLLECTED Time (24 hr)	PLACED IN STORAGE Date (mm/dd/yyyy)	PLACED IN STORAGE Time (24 hr)	Storage Room #	Check line for sample present and accounted for! One check per bottle.
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		
								:		:		

SIGNATURE	DATE AND TIME	Comments:
RELINQUISHED BY:	/ /	
RECEIVED BY:	:	
RELINQUISHED BY:	/ /	
RECEIVED BY:	:	

Lab Custodian

I certify that I received the above sample(s) and is/are recorded in the official record book. The same samples will be in custody of competent laboratory personnel at all times or locked in a secure area.

Signature: ______________________ Date: / / Time: :

Lab: Indiana Department of Environmental Management | Address: 2525 N. Shadeland Ave., Indianapolis, IN 46219

Attachment 7: Blank OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index) form (front)

OWQ Biological QHEI (Qualitative Habitat Evaluation Index)

IDEM

Sample # | bioSample # | Stream Name | Location

Surveyor | Sample Date | County | Macro Sample Type | ☐ Habitat Complete

QHEI Score:

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

BEST TYPES

PREDOMINANT P/G R/R		PRESENT P/G R/R	TOTAL %
☐☐	BLDR/SLABS [10]	☐☐	___
☐☐	BOULDER [9]	☐☐	___
☐☐	COBBLE [8]	☐☐	___
☐☐	GRAVEL [7]	☐☐	___
☐☐	SAND [6]	☐☐	___
☐☐	BEDROCK [5]	☐☐	___

OTHER TYPES

PREDOMINANT P/G R/R		PRESENT P/G R/R	TOTAL %
☐☐	HARDPAN [4]	☐☐	___
☐☐	DETRITUS [3]	☐☐	___
☐☐	MUCK [2]	☐☐	___
☐☐	SILT [2]	☐☐	___
☐☐	ARTIFICIAL [0]	☐☐	___

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

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

Check ONE (Or 2 & average)

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

QUALITY

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

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

Substrate ☐ Maximum 20

Comments

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

% Amount		% Amount		% Amount	
___ ___	UNDERCUT BANKS [1]	___ ___	POOLS > 70cm [2]	___ ___	OXBOWS, BACKWATERS [1]
___ ___	OVERHANGING VEGETATION [1]	___ ___	ROOTWADS [1]	___ ___	AQUATIC MACROPHYTES [1]
___ ___	SHALLOWS (IN SLOW WATER) [1]	___ ___	BOULDERS [1]	___ ___	LOGS OR WOODY DEBRIS [1]
___ ___	ROOTMATS [1]				

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

Cover ☐ Maximum 20

Comments

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

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
☐ HIGH [4]	☐ EXCELLENT [7]	☐ NONE [6]	☐ HIGH [3]
☐ MODERATE [3]	☐ GOOD [5]	☐ RECOVERED [4]	☐ MODERATE [2]
☐ LOW [2]	☐ FAIR [3]	☐ RECOVERING [3]	☐ LOW [1]
☐ NONE [1]	☐ POOR [1]	☐ RECENT OR NO RECOVERY [1]	

Channel ☐ Maximum 20

Comments

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

River right looking downstream

L R	EROSION	L R	RIPARIAN WIDTH	L R	FLOOD PLAIN QUALITY	L R	
☐☐	NONE/LITTLE [3]	☐☐	WIDE > 50m [4]	☐☐	FOREST, SWAMP [3]	☐☐	CONSERVATION TILLAGE [1]
☐☐	MODERATE [2]	☐☐	MODERATE 10-50m [3]	☐☐	SHRUB OR OLD FIELD [2]	☐☐	URBAN OR INDUSTRIAL [0]
☐☐	HEAVY/SEVERE [1]	☐☐	NARROW 5-10m [2]	☐☐	RESIDENTIAL, PARK, NEW FIELD [1]	☐☐	MINING / CONSTRUCTION [0]
		☐☐	VERY NARROW [1]	☐☐	FENCED PASTURE [1]		
		☐☐	NONE [0]	☐☐	OPEN PASTURE, ROWCROP [0]		

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

Riparian ☐ Maximum 10

Comments

5] POOL/GLIDE AND RIFFLE/RUN QUALITY

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

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

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

Indicate for reach – pools and riffles.

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

Pool/ Current ☐ Maximum 12

Comments

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

Check ONE (Or 2 & average)

☐ NO RIFFLE [metric = 0]

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

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

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

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

Riffle/ Run ☐ Maximum 8

Comments

6] GRADIENT (ft/mi)

DRAINAGE AREA (mi²)

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

%POOL: ☐ %GLIDE: ☐

%RUN: ☐ %RIFFLE: ☐

Gradient ☐ Maximum 10

IDEM 11/15/12

Attachment 7 (continued). IDEM OWQ Biological QHEI (back).

OWQ Biological QHEI (Qualitative Habitat Evaluation Index)

COMMENT ______________________________

A-CANOPY

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

B-AESTHETICS

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

C-RECREATION

	Area	Depth
Pool:	☐ > 100 ft²	☐ > 3 ft

D-MAINTENANCE

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

E-ISSUES

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

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

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

Stream Drawing:

IDEM 11/15/12

Attachment 8: Chain-of-custody Form

IDEM

Indiana Department of Environmental Management
OWQ Chain of Custody Form

Project: ____________________
Team: ____________________
OWQ Analysis Set: ____________________

I Certify that the sample(s) listed below was/were collected by me, or in my presence.

Date: ____________________

Signature: ____________________

Section: ____________________

Lab Assigned Number	IDEM Control Number	Sample Type	ID	1000 ml P, N. M.	1000 ml G, N. M.	40 ml VIAL	120 ml G (Bact)	500 ml P, N. M.	250 ml P, N. M.			Date And Time Collected: Date	Date And Time Collected: Time

P = Plastic G = Glass N. M. = Narrow Mouth Bact = Bacteriological Only Should samples be iced? Y N

Carriers

I certify that I have received the above sample(s).

Signature	Date	Time	Seals Intact		Comments
Relinquished By:					
Received By:			Y	N	
Relinquished By:					
Received By:			Y	N	
Relinquished By:					
Received By:			Y	N	

Lab Custodian

I certify that I have received the above sample(s), which has/have been recorded in the official record book. The same sample(s) will be in the custody of competent laboratory personnel at all times, or locked in a secured area.

Signature: ____________________ Date: ____________ Time: ____________

Lab: ____________________ Address: ____________________

04/17/2003 12:31:20 PM 04/17/2003 12:31:20 PM Fixed Station Chain of Custody Datasheet, Page 1 of 1

Attachment 9: Sample Analysis Request form.

Indiana Department of Environmental Management
Office of Water Quality
Watershed Planning and Assessment Branch
www.idem.IN.gov

Water Sample Analysis Request

Project Name: ____________ **Composite** ☐ **Grab** ⊠

OWQ Sample Set	1	IDEM Sample Nos.	
Crew Chief		Lab Sample Nos.	
Collection Date		Lab Delivery Date	

Anions and Physical Parameters

Parameter	Test Method	Total	Dissolved
Alkalinity (as $CaCO_3$)	EPA 310.2	⊠ **	☐
Total Solids	SM 2540B	⊠ **	
Suspended Solids	SM 2540D	⊠ **	
Dissolved Solids	SM 2540C		⊠ **
Sulfate	EPA 375.2	⊠ **	☐ **
Chloride	SM 4500Cl-E	⊠ **	☐
Hardness (as $CaCO_3$)	EPA 130.1	⊠ **	☐
Fluoride	380-75WE	☐ **	☐
Silica (Reactive)	SM 4500-SiD	☐ **	☐

Priority Pollutant Metals Water Parameters

Parameter	Test Method	Total	Dissolved
Antimony	200.8	☐	☐
Arsenic	200.8	☐	☐
Beryllium	200.8	☐	☐
Cadmium	200.8	☐	☐
Chromium (Hex)	SM 3500Cr-D	☐	☐
Chromium (Total)	200.8	☐	☐
Copper	200.8	☐	☐
Lead	200.8	☐	☐
Mercury,	EPA 245.1	☐	☐
Nickel	200.8	☐	☐
Selenium	200.8	☐	☐
Silver	200.8	☐	☐
Thallium	200.8	☐	☐
Zinc	200.7	☐	☐

Cations and Secondary Metals Parameters

Parameter	Test Method	Total	Dissolved
Aluminum	200.7, 200.8	☐	☐
Barium	200.8	☐	☐
Boron	200.8	☐	☐
Calcium	200.7, 200.8	⊠ ***	☐
Calcium (as $CaCO_3$)	SM 3500Ca-D	☐	☐
Cobalt	200.8	☐	☐
Iron	200.7	☐	☐
Magnesium	200.7, 200.8	⊠ ***	☐
Manganese	200.8	☐	☐
Potassium	SM 3500-K D	☐	☐
Sodium	200.7	☐	☐
Strontium	200.7	☐	☐

Organic Water Parameters

Parameter	Test Method	Total
Priority Pollutants: Oranochlorine Pesticides and PCBs	EPA 608	☐
Polynuclear Aromatic Hydrocarbons	EPA 610	☐
Priority Pollutants: VOCs - Purgeable Organics	EPA 624	☐
Priority Pollutants: Base/Neutral Extractables	EPA 625	☐
Priority Pollutants: Acid Extractables	EPA 625	☐
Phenolics, 4AAP	EPA 420.4	☐
Oil and Grease, Total	EPA 1664A	☐
Semi-volatile Organics & Pesticides	EPA 525.2	☐

Nutrient & Organic Water Chemistry Parameters

Parameter	Test Method	Total	Dissolved
Ammonia Nitrogen	EPA 350.1	⊠	☐
$CBOD_5$	SM 5210B	☐	
$CBOD_u$	SM 5210B	☐	
Total Kjeldahl Nitrogen (TKN)	EPA 351.2	⊠	☐
Nitrate + Nitrite	EPA 353.1	⊠	☐
Dissolved Reactive Phosphorus	SM4500-P	☐	☐
Total Phosphorus	EPA 365.1	⊠	☐
TOC	SM 5310B	⊠	☐
COD (Low Level)	SM 5220D	☐	☐
Cyanide (Total)	EPA 335.4	☐	☐
Cyanide (Free)	SM 4500CN-I	☐ *	☐
Cyanide (Amenable)	SM 4500CN-G	☐ *	☐

Bacteriological Water Parameters

Parameter	Test Method	Total	Dissolved
E. coli (Colilert Method)	SM9223B	☐	

30 day reporting time required.

Notes:

** = DO NOT RUN PARAMETER IF SAMPLE IDENTIFIED AS A BLANK ON THE CHAIN OF CUSTODY

* = RUN ONLY IF TOTAL CYANIDE IS DETECTED

*** = *Report Calcium, Magnesium as Total Hardness components if Hardness is calculated*

Send reports (Fed. Ex. or UPS) to:
David Jordan - IDEM
Mail Code 65-40-2 (Shadeland)
100 N. Senate Ave.
Indianapolis, IN 46204-2251

Deliver reports to:
David Jordan - IDEM
STE 100
2525 North Shadeland Ave.
Indianapolis, IN 46219
DJordan@idem.in.gov

Testing Laboratory:
Indiana State Department of Health (ISDH)
Environmental Laboratory Division
550 W. 16th Street
Indianapolis, IN 46202
Phone: 317-921-5815 (Ray Beebe) (Rev. 6/2013)