Indiana Department of Environmental Management
We Protect Hoosiers and Our Environment.
100 N. Senate Avenue • Indianapolis, IN 46204
(800) 451-6027 • (317) 232-8603 • www.idem.IN.gov

Michael R. Pence
Governor

Carol S. Comer
Commissioner

Notice of 30- day Period for Public Comment

Dear Sir or Madam,

This letter is to invite you to attend the stakeholder Upper Mississinewa River Watershed Draft Total Maximum Daily Load (TMDL) meeting. At this stakeholder meeting, IDEM will provide an overview of the draft TMDL and provide an opportunity for public comments. The stakeholder meeting will be held on **September 8, 2016, starting at 2:00 PM and 6:00 pm** at:

Hartford City Annex Bldg, 121 N High St, Hartford City, IN 47348 (2:00pm)
Davis-Purdue Agricultural Center, 6230 N SR 1, Farmland, IN 47340 (6:00pm)

The Indiana Department of Environmental Management (IDEM) has completed a Total Maximum Daily Load Report for the Upper Mississinewa River Watershed

A copy of the draft document is available on the internet at: http://www.in.gov/idem/nps/2652.htm

The 30-day public comment period for the Draft Upper Mississinewa River TMDL will begin on August 31, 2016, and will end on September 30, 2006. The draft TMDL for the Upper Mississinewa Watershed will be posted on IDEM's website at:

http://www.in.gov/idem/nps/2652.htm

A hard copy of the report can also be requested in writing. **All comments must be in writing and postmarked, emailed, or faxed by close of business (5:00 p.m.) on September 30, 2016.** Written comments and requests for a hard copy of the report can be sent to:

Ross Carlson
MC65-44 SHADELAND
100 North Senate Avenue
Indianapolis, IN 46204-2251

Comments can be emailed to: rcarlson@idem.IN.gov, or faxed to: (317) 308-3219.

If you have questions regarding this stakeholder meeting, please contact Ross Carlson at 317-308-3378. If you know of anyone else who might be interested in this meeting, please pass on this information. IDEM looks forward to your continued input in completing these TMDLs.

Sincerely,

Joe Schmees
Section Chief
Watershed Planning & Restoration Section
Watershed Assessment & Planning Branch
Office of Water Quality
Indiana Department of Environmental Management
jschmees@idem.in.gov

To learn more about watersheds, TMDLs and nonpoint source pollution, visit www.watersheds.in.gov

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Total Maximum Daily Load Report for the Upper Mississinewa River Watershed

DRAFT

[Report Date]

Prepared for

U.S. Environmental Protection Agency Region 5

Prepared by

Indiana Department of Environmental Management

DRAFT

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1.0 EXECUTIVE SUMMARY

The Mississinewa River originates in Ohio before flowing northwest through the central part of Indiana and forms Mississinewa Lake. The Mississinewa River then continues to flow northwest until it empties into the Wabash River near Peru, Indiana. This document will focus on the Upper Mississinewa River watershed, which consists of three watersheds (HUCs 0512010302, 0512010303, and 0512010304). The study area encompasses 315 square miles which make up the Upper Mississinewa River Watershed and drains a total of 446 square miles including the 131 square mile Headwaters of the Mississinewa River upstream of The Upper Mississinewa River Watershed. The Upper Mississinewa River Watershed originates near Randolph County near Ridgeville, and then flows northwest through the town of Eaton towards Grant County. Land use throughout the watershed is predominantly agricultural land. There are no drinking water intakes in the Upper Mississinewa River Watershed.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) impaired waters list. A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for regulated sources and load allocations (LAs) for 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 *E. coli*, phosphorus, and sediment in the Upper Mississinewa River watershed.

After the Indiana Department of Environmental Management (IDEM) identifies a waterbody as having an impairment and places the waterbody on Indiana's Section 303(d) list of impaired waters, IDEM implements a sampling plan to determine the extent and the magnitude of the impairment. The next task is to reassess each waterbody using new sampling data and to examine the watershed as a whole. The reassessment data helps IDEM identify which watersheds are improving, the current condition of the stream, and if any new pollutants or sources are negatively affecting the stream. As a result of the reassessment for the Upper Mississinewa River watershed, the impaired segments may differ from the the way they were listed on the Draft 2014 Section 303(d) list for the following reasons:

- Sampling performed by IDEM in 2014 and 2015 generated new water quality data that were not available at the time the Draft 2014 Section 303(d) list was developed.

Because of the higher quantity of data collected in 2014 and 2015 more impairments were listed in the Upper Mississinewa River Watershed on the 2016 Draft 303 (d) list. More information on the updated listings can be found in Table 4.

Sampling data, used for this report's TMDL analysis, was collected by IDEM in 2014 and 2015 at 35 sites. The recent data collected from April 2014 through March 2015 indicate that all of the sample sites violated one or more of the Indiana Water Quality Standards.

Potential sources of *E. coli*, phosphorus, and sediment in the watershed include regulated point sources such as waste water treatment plants (WWTPs), municipal separate storm sewers (MS4s), combined sewer overflows (CSOs), industrial discharge permitted facilities, and stormwater permitted construction activities. Point sources are regulated through the National Pollutant Discharge Elimination System (NPDES). Nonpoint sources such as unregulated urban storm water, agricultural runoff, combined feeding operations (CFOs) and faulty and failing septic systems are also potential sources.

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 Upper Mississinewa River watershed, subwatersheds with CSO outfalls and multiple CFOs also have the highest average *E. coli* counts. It is therefore possible that WWTP overflow and land application of waste in these subwatersheds is contributing to the elevated *E. coli* counts. However, other factors could also explain this correlation, such as failing septic systems, industrial activity, or the fact these subwatersheds also tend to experience smaller flows and thus have less dilution. Specific sources of *E. coli* to each impaired waterbody should be further evaluated during follow-up implementation activities.

Within the Upper Mississinewa River watershed, subwatersheds with CFOs also have the highest total phosphorus loads. It is therefore possible that field run off in these subwatersheds is contributing to elevated phosphorus loads. However, other factors could also explain this correlation, such as upstream loading, failing septic systems, residential home fertilizer use, or tillage practice.

Subwatersheds with high numbers of permitted outfalls, WWTP or industrial, also have the highest total suspended solid (TSS) loads. It is therefore possible that the influence of wastewater in these subwatersheds is contributing to elevated TSS loads. However, other factors could also explain this correlation, such as gradient and velocity of streams and riparian cover.

Various subwatersheds in the Upper Mississinewa River watershed have impaired biotic communities (IBC). Biological communities include fish and aquatic invertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) list suggests that one or more of the aquatic biological communities is unhealthy as determined by IDEM's monitoring data. IBC is not a source of impairment but a symptom of other sources. To address these impairments in the Upper Mississinewa River watershed, TSS, has been identified as representative pollutant for TMDL development.

An important step in the TMDL process is the allocation of the allowable loads to individual point sources as well as nonpoint sources. The Upper Mississinewa River watershed TMDL includes these allocations, which are presented for each of the 44 Assessment Unit IDs (AUIDs) located in the twelve 12-digit hydrologic unit code (HUC) subwatersheds.

There are 11 WWTPs, and 12 permitted industrial facilities located in the Upper Mississinewa River watershed. Of these facilities, 11 have been found to be in violation of their permit limits for *E. coli,*

phosphorus, or sediment. Although 11 NPDES facilities have been found to be in violation of their permit limits for *E. coli*, phosphorus, and sediment, the majority of the time effluent discharged from these facilities meets water quality standards.

There are several types of nonpoint sources located in the Upper Mississinewa River watershed, including unregulated livestock operations, agricultural row crop land use, straight piped, leaking or failing septic systems, wildlife, and erosion. Of these, agricultural row crop land use and erosion are found most often in the subwatersheds with elevated levels of *E. coli*, phosphorus, and TSS. 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. These areas throughout the Upper Mississinewa River Watershed are referred to as potential priority implementation areas (PPIAs). It also provides recommendations on the types of implementation activities, including best management practices (BMPs) that key implementation partners in the Upper Mississinewa River watershed can consider to achieve the pollutant load reductions calculated for each subwatershed. PPIAs can help watershed stakeholders identify critical areas and select BMPs in the Upper Mississinewa River Watershed through a watershed management planning process. Table 1 presents the PPIAs and associated BMP recommendations identified having a high likely degree of effectiveness to achieve the *E. coli,* nutrient, and sediment load reductions allocated to sources in each subwatershed.

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

Subwatershed	PPIA Rank	Implementation Action
Campbell Creek	1	Outreach and education and training Storm water Planning and Management Conservation tillage/residue management Cover crops Conservation easements Grazing land management Comprehensive Nutrient Management Plan Drainage Water Management Stream fencing (animal exclusion) Manure handling, storage, treatment, and disposal Riparian buffers Filter strips Rain gardens Green roofs Dam modification or removal Constructed Wetlands
Studebaker Ditch	2	
Bear Creek	3	
Rees Ditch	4	
Days Creek	5	
Bush Creek	6	
Townsand Lucas Ditch	7	
Fetid Creek	8	
Holden Ditch	9	
Redkey Run	10	
Platt Nibarger Ditch	11	
Little Lick Creek	12	

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 on March 13, 2014 during which IDEM and a representative from the Delaware County Soil and Water Conservation District described the watershed project in which a TMDL document will be developed and provided a summary of the available data and the proposed modeling approach. The meetings occurred at the Davis-Purdue Agricultural Center in Farmland, Indiana and the Hartford City Annex Building in Hartford City, Indiana.

- A Draft TMDL meeting was held at the Davis-Purdue Agricultural Center in Farmland, Indiana and the Hartford City Annex Building in Hartford City, Indiana on September 8th during which IDEM, Flatland Resources and Delaware County Soil and Water Conservation District described the TMDL program and provided an overview of the draft TMDL results.

2.0 INTRODUCTION

This section of the Total Maximum Daily Load provides an overview of the Upper Mississinewa River Watershed location and the regulatory requirements that have led to the development of this TMDL to address impairments in the Upper Mississinewa River watershed.

The Mississinewa River originates in Ohio before flowing northwest through the central part of Indiana and forms Mississinewa Lake. The Mississinewa River continues to flow northwest until it empties into the Wabash River near Peru, Indiana. This document will focus on the Upper Mississinewa River watershed, which consists of three watersheds (HUCs 0512010302, 0512010303, and 0512010304). The study area encompasses 315 square miles and drains a total of 446 square miles. The Upper Mississinewa River watershed originates in Randolph County near Ridgeville, and then flows northwest through the town of Eaton towards Grant County. Land use throughout the watershed is predominantly agricultural land. There are no drinking water intakes in the Upper Mississinewa River Watershed.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (USEPA) regulations require that states develop TMDLs for waters on the Section 303(d) lists. USEPA defines a TMDL as the sum of the individual wasteload allocations (WLA) for point sources and load allocations (LA) for nonpoint sources, a margin of safety (MOS) that addressed the uncertainty in the analysis, and a future growth allocation to account for development in the watershed. A TMDL is also required to be developed with seasonal variations and must include a margin of safety that addresses the uncertainty in the analysis.

The overall goals and objectives of the TMDL study for the Upper Mississinewa River watershed are:

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

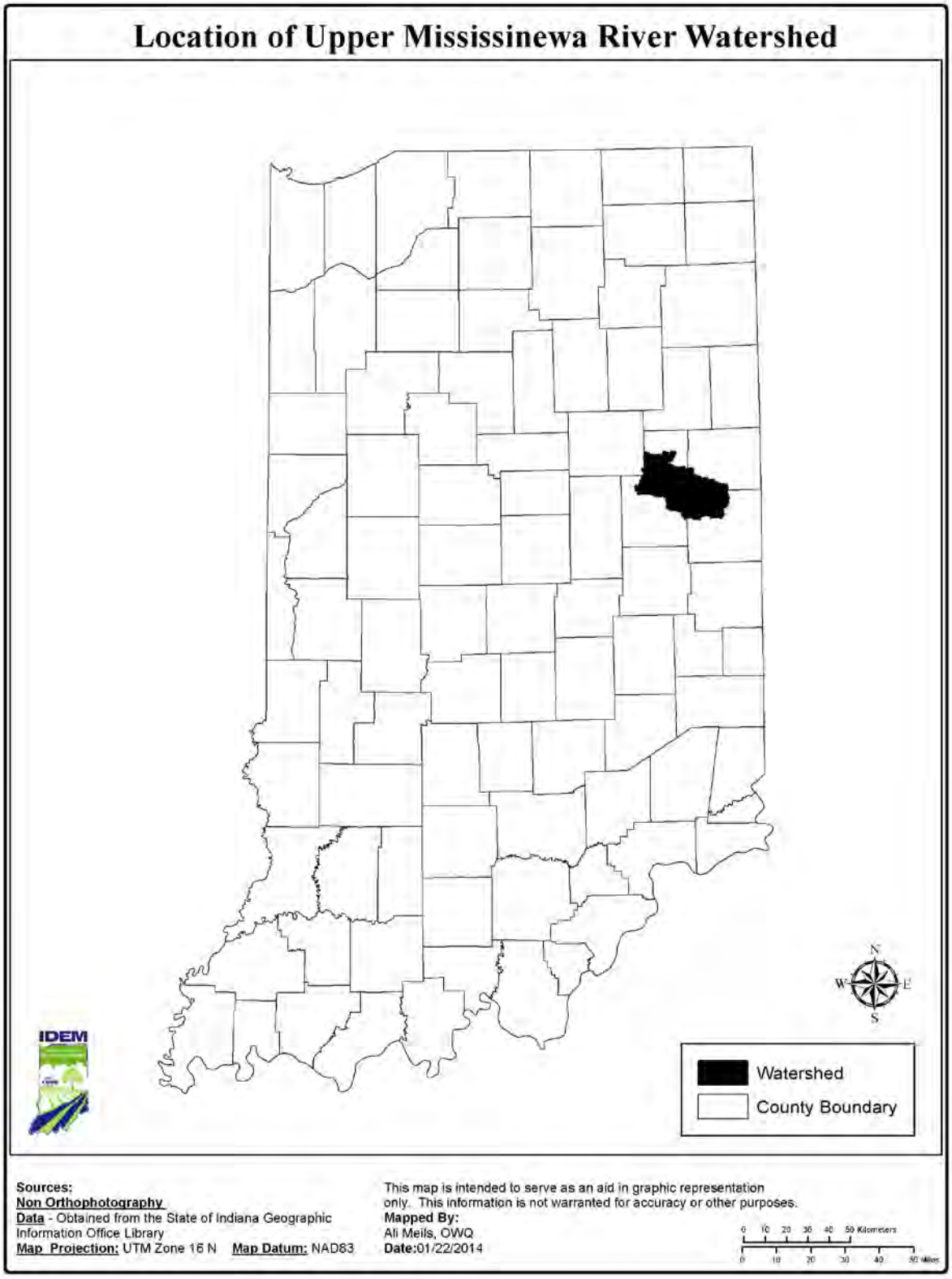

Figure 1. Location of Upper Mississinewa River Watershed

2.1 Water Quality Standards

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

- **Designated uses** reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and full body contact recreation. Every waterbody in Indiana has a designated use or uses; however, not all uses apply to all waters. The Upper Mississinewa River 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 that apply to all surface waters. Numeric criteria for *E. coli*, and narrative criteria for nutrients and sediment, interpreted through numeric benchmarks, were used as the basis of the Upper Mississinewa River watershed TMDLs.

The water quality standards and targets in Indiana pertaining to *E. coli*, phosphorus, and sediment are described below.

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 coliforms, used as an indicator of potential fecal contamination. Concentrations are typically reported as the count of organisms in 100 milliliters of water (count/100 mL) and may vary at a particular site depending on the baseline *E. coli* level already in the river, inputs from other sources, dilution due to precipitation events, and die-off or multiplication of the organism within the river water and sediments.

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

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

Phosphorus is found in various forms in a waterbody. Phosphorus is necessary for aquatic life, and needed at some level in a waterbody to sustain life. The natural amount of phosphorus in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no phosphorus, whereas a lowland, mature stream flowing through wetland areas might have naturally high phosphorus concentrations. Streams draining larger areas are also expected to have higher phosphorus concentrations.

Phosphorus generally does not pose a direct threat to the designated uses of a waterbody. However, excess phosphorus can cause an undesirable abundance of plant and algae growth, a process is called

eutrophication. Eutrophication can have many effects on a stream. One possible effect is low dissolved oxygen concentrations caused by excessive plant respiration and/or decay. Ammonia, which is toxic to fish at high concentrations, can be released from decaying organic matter when eutrophication occurs. For these reasons, excessive phosphorus can result in the non-attainment of biocriteria and impairment of the designated use.

Like most states, Indiana has not yet adopted numeric water quality criteria for phosphorus. The relevant narrative criteria that apply to the TMDLs presented in this report state the following:

> *"All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:" [327 IAC 2-1-6. Sec. 6. (a)(1)]…*
>
> *(a)re in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses." [327 IAC 2-1-6. Sec. 6. (a) (1)(D)]*
>
> *(a)re in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill, aquatic life, other animals, plants, or humans." [327 IAC 2-1-6. Sec. 6. (a) (1)(E)]*

The target value for total suspended solids (TSS) is included because TSS can reduce the amount of sunlight available to aquatic organisms and decrease water clarity. This leads to a number of effects including: reduction of aquatic plants available for consumption by higher level organisms, lower dissolved oxygen, and the impaired ability of fish to see and catch food. TSS particles can also hold heat, resulting in increased stream temperature. Further, TSS can clog fish gills, retard growth rates, decrease resistance to disease, and prevent egg and larval development. When TSS settles on the bottom of a waterbody, eggs of fish and invertebrates are smothered, larvae can suffocate, and habitat quality is degraded (OEPA, 1999). It is due to these effects that TSS will be used as a surrogate TMDL parameter for IBC impairment.

IDEM has not yet adopted numeric water quality criteria for total suspended solids. The relevant narrative criteria that apply to the TMDLs presented in this report state the following:

> *"All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:" [327 IAC 2-1-6. Sec. 6. (a)(1)]…*
>
> *(a)re in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses." [327 IAC 2-1-6. Sec. 6. (a) (1)(D)]*
>
> *(a)re in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill, aquatic life, other animals, plants, or humans." [327 IAC 2-1-6. Sec. 6. (a) (1)(E)]*
>
> *(a)re in amounts sufficient to be unsightly or deleterious. [327 IAC 2-1-6. Sec. 6. (B)*

In addition, the narrative biological criterion [327 IAC 2-1-3 (a) (2)] states the following:

> *(2) All waters, except as described in subdivision (5), will be capable of supporting: (A) a well-balanced, warm water aquatic community; and (B) where natural temperatures will permit, put-and-take trout fishing. All waters capable of supporting the natural reproduction of trout as of February 17, 1977, shall be so maintained.*

The water quality regulatory definition of a "well-balanced aquatic community" is "*an aquatic community which is diverse in species composition, contains several different trophic levels, and is not composed mainly of strictly pollution tolerant species*" [327 IAC 2-1-9(59)]. Table 2 presents the criteria associated with the fish community Warmwater Index of Biotic Integrity (IBI) that indicates whether a watershed is fully supporting, partially supporting, or not supporting the aquatic life use.

Table 2. Aquatic Life Use Support Criteria for Biological Communities

Biotic Index	Aquatic Life Use	Integrity Class	Corresponding Integrity Class	Attributes
Fish community Index of Biotic Integrity (IBI) Scores (Range of possible scores is 0-60)	Fully Supporting IBI ≥ 36	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species
		Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present
		Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure
	Not Supporting IBI < 36	Poor	23-35	Many expected species absent or rare, tolerant species dominant
		Very Poor	12-22	Few species and individuals present, tolerant species dominant
		No Organisms	12	No fish captured during sampling.
Benthic aquatic macroinvertebrate community Index of Biotic Integrity (mIBI) Scores Multihabitat MHAB methods (Range of possible scores is 12-60)	Fully Supporting mIBI ≥ 36	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species
		Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present
		Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure
	Not Supporting mIBI < 36	Poor	23-35	Many expected species absent or rare, tolerant species dominant
		Very Poor	12-22	Few species and individuals present, tolerant species dominant
		No Organisms	12	No macroinvertebrates captured during sampling.

2.2 TMDL Target Values

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 Upper Mississinewa River watershed TMDL are presented below.

2.2.1 *E. coli*

The target value used for the Upper Mississinewa River watershed TMDL was based on the 125 counts/100 mL geometric mean component of the standard (i.e., daily loading capacities were calculated by multiplying flows by 125 counts/100 mL). This approach ensures that both components of the standard will be met since a daily loading capacity based on 125 counts/100 mL will, by definition, meet the 235 counts/100 mL component of the standard. The use of the geometric mean component of the standard results in an added MOS (see Section 6.3 for more details).

2.2.2 Total Phosphorus

Although Indiana has not yet adopted numeric water quality criteria for phosphorus, IDEM has identified the following phosphorus benchmark that is used to assess potential phosphorus impairments:

- Total phosphorus should not exceed 0.30 mg/L

The total phosphorus (0.30 mg/L) value was used as TMDL targets during the development of the Upper Mississinewa River watershed TMDL. IDEM has determined that meeting this target will result in achieving the narrative biological criterion by improving water quality and promoting a well-balanced aquatic community. Phosphorus is interpreted as an average in the NPDES permits. Monitoring data, reviewed by IDEM during the TMDL development process, indicated that when WWTPs were in compliance with their individual permit limit for phosphorus (1.0 mg/L), the in-stream target for phosphorus (0.30 mg/L) was typically met. As such WWTPs were given WLAs based on their 1.0 mg/L permit limitation.

2.2.3 Conventional Inorganics

Conventional inorganics such as Dissolved oxygen, pH, Sulfates, and chlorides were evaluated for the exceedance(s) of Indiana's Water Quality Standards (WQS). For any one pollutant the stream will be listed as not supporting if WQS are exceeded in >10% of measurements. Currently, IDEM is not developing TMDLs for the above parameters, but rather focusing and calculating loads for bacteria (*E. coli*), nutrients (TP), and total suspended solids (TSS). IDEM anticipates revisiting the parameters not addressed in this TMDL in the future.

2.2.4 IBC TMDLs

The following sections describe the TMDL target values used when developing an IBC TMDL. While IBC impairment cannot be remedied by capping the daily load of biota, IDEM has chosen to use both TSS and TP as surrogates for IBC impairment. IDEM has determined that meeting these targets will result in achieving the narrative biological criterion by improving water quality and promoting a well-balanced aquatic community.

2.2.4.1 Total Suspended Solids (TSS)

Although Indiana has not yet adopted numeric water quality criteria for TSS, IDEM has identified a target value based on IDEM's NPDES permitting process. A target of 30.0 mg/L for total suspended solids TSS has been identified as a permit limit for NPDES facilities. A target value of 30.0 mg/L TSS was therefore used as the TSS TMDL target value to ensure consistency with IDEM's NPDES permitting process. IDEM has determined that meeting the TSS target will assist in achieving the narrative biological criterion by improving water quality and promoting a well-balanced aquatic community.

Various subwatersheds in the Upper Mississinewa River watershed have IBC. Biological communities include fish and aquatic invertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) list, means IDEM's monitoring data shows one or both of the aquatic communities are not as healthy as they should be. IBC is not a source of impairment but a symptom of other sources or sometimes a symptom of multiple sources. To address these IBC impairments in the Upper Mississinewa River watershed, TSS and TP have been identified as source pollutants for TMDL development.

2.3 Listing Information

There are a number of existing impairments in the Upper Mississinewa River watershed from the approved Draft 2012 303(d) List of Impaired Waters (Figure 3). These listings are based on results from historical IDEM data collection sites shown in Figure 2. The listings and causes of impairment have been adjusted as a result of reassessment data collected in 2014 and 2015 at 35 sampling locations in the watershed (Figures 4). Details of each sampling site can be found in Table 3. Within the Upper Mississinewa River watershed there is a total of 47 assessment unit IDs (AUIDs). Of these 45 are cited as impaired for *E. coli*, 18 AUIDs are cited as impaired for Nutrients, 18 AUIDs are cited as impaired for Impaired Biotic Communities (IBC), 6 AUIDs are cited as impaired for dissolved oxygen, and 1 AUID is impaired for Chloride on the Indiana's Draft 2016 303(d) list (Figure 5). These impaired segments account for approximately 377 miles. Table 4 presents listing information for the Upper Mississinewa River watershed, including a comparison of the updated listings with the Draft 2012 303(d) listings and associated causes of impairments addressed by the TMDLs. The reassessment data used in updating the listings for the Upper Mississinewa River watershed are available in Appendix A.

In addition PCB contamination has been found along the mainstem of the Mississinewa River. IDEM has chosen to forego TMDL development for PCB impairments but will be seeking alternative methods for addressing this impairment. More on PCB impairment in the Upper Mississinewa River can be found in Section 5.4 and Appendix C.

IDEM identifies the Upper Mississinewa River 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). (For more information on HUCs, go to http://www.in.gov/idem/nps/2422.htm.) Figure 6 shows the 12-digit HUCs located in the Upper Mississinewa River watershed.

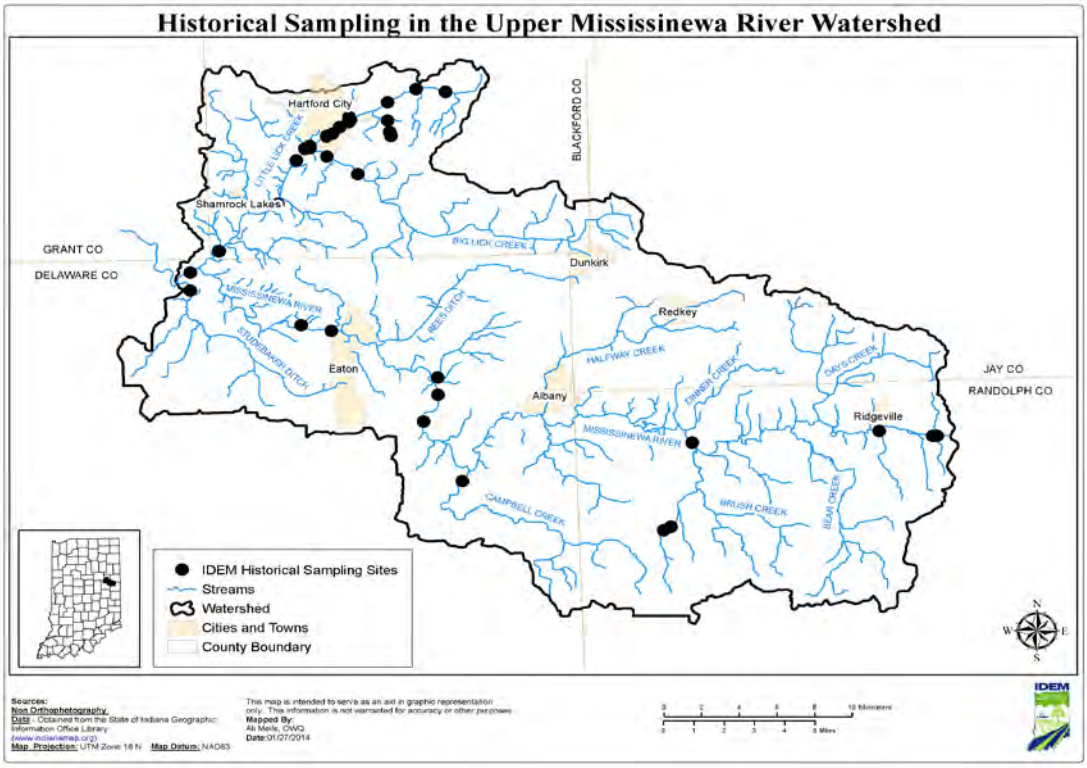

Figure 2. Historical IDEM Sampling Sites in the Upper Mississinewa River Watershed

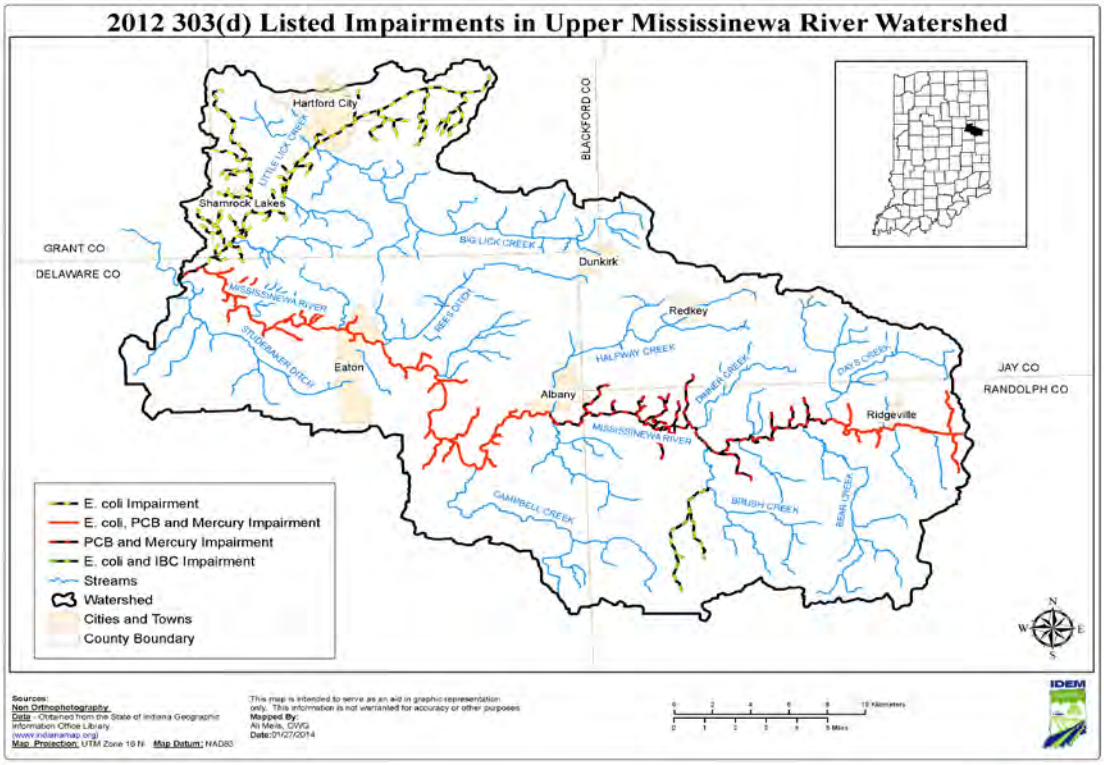

Figure 3. Streams Listed on the Draft 2012 303(d) List in the Upper Mississinewa River Watershed

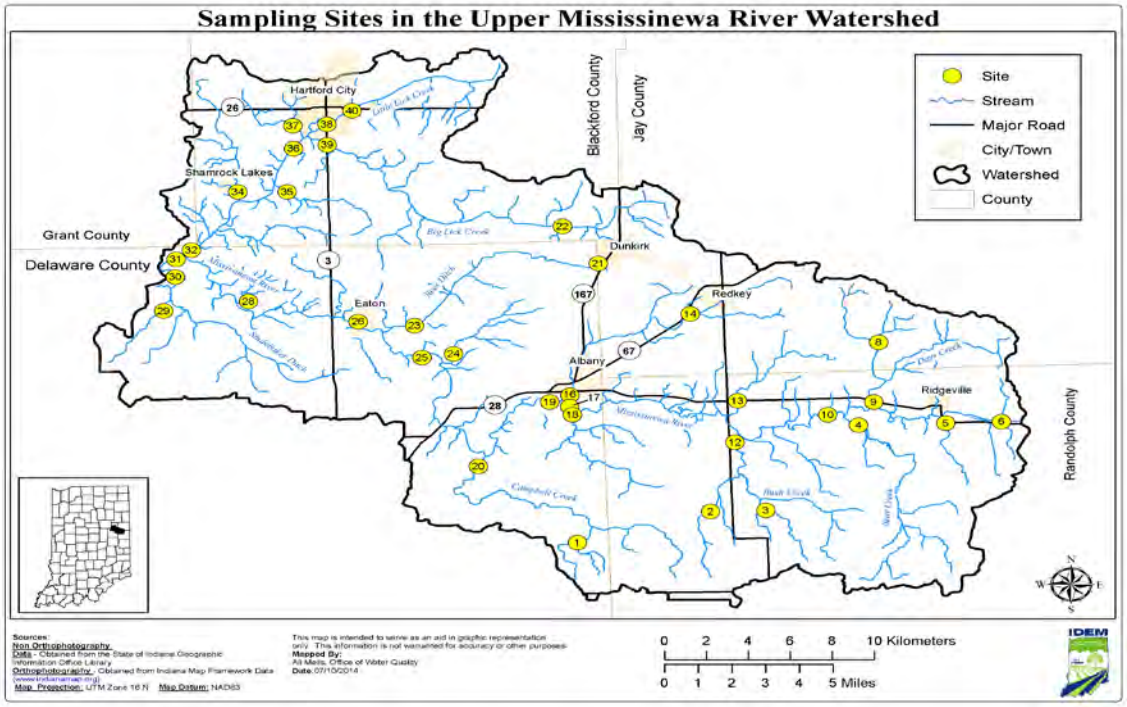

Figure 4. Sampling Locations in 2014 Upper Mississinewa River Watershed TMDL

Table 3. Upper Mississinewa River Sampling Site Information

Site #	AIMS Site #	Stream Name	Location	AUID 2014	AUID 2016
14T-101	WMI-04-0008	Tributary of Campbell Creek	CR 200 N	INB0341_T1001	INB0341_T1001
14T-102	WMI-02-0010	Elkhorn Creek	CR 500 N	INB0324_T1002	INB0324_T1002
14T-103	WMI-02-0011	Tributary of Bush Creek	CR 500 N	INB0324_T1001	INB0324_T1001
14T-104	WMI-02-0012	Bear Creek	CR 800 N	INB0322_01	INB0322_01
14T-105	WMI-02-0013	Fetid Creek	CR 800 N	INB0323_T1002	INB0323_T1002
14T-106	WMI020-0002	Mississinewa River	CR 100 W	INB0323_01	INB0323_01
14T-108	WMI-02-0005	Flesher Creek	CR 800 S	INBO321_T1001	INB0321_T1002
14T-109	WMI-02-0006	Days Creek	SR 28	INBO321_01	INB0321_03
14T-110	WMI-02-0007	Mississinewa River	CR 600 W	INB0323_02	INB0323_02
14T-112	WMI-02-0009	Bush Creek	CR 750 N	INB0324_01	INB0324_01
14T-113	WMI-02-0015	Dinner Creek	SR 28	INB0326_T1001	INB0326_T1001
14T-114	WMI-02-0016	Halfway Creek	CR 1000 W	INB0325_T1002	INB0325_03
14T-116	WMI-02-0017	Halfway Creek	Water Street	INB0325_01	INB0325_03
14T-117	WMI-02-0018	Mississinewa River	Strong Road	INB0326_01	INB0326_01
14T-118	WMI-02-0019	Mud Creek	Edgewater Road	INB0326_T1002	INB0326_T1002
14T-119	WMI-04-0013	Mississinewa River	Dowden Avenue	INB0342_01	INB0342_02
14T-120	WMI-04-0014	Campbell Creek	Schindel Road	INB0341_01	INB0341_01
14T-121	WMI-04-0015	Rees Ditch	Layne Drive	INB0342_T1002	INB0342_T1002
14T-122	WMI-03-0003	Big Lick Creek	CR 700 E	INB0331_01	INB0331_04
14T-123	WMI-04-0018	Rees Ditch	CR 350 E	INB0342_T1002	INB0342_T1002
14T-124	WMI-04-0016	Bosman Ditch	CR 900 N	INB0342_T1001	INB0342_T1001
14T-125	WMI-04-0017	Mississinewa River	CR 371 E	INB0342_01	INB0324_03
14T-126	WMI-04-0019	Mississinewa River	Romy Street	INB344_01	INB344_03
14T-128	WMI-04-0009	Dodge Creek	Eaton-Wheeling Pike	INB0344_T1003	INB0344_T1003

Site #	AIMS Site #	Stream Name	Location	AUID 2014	AUID 2016
14T-129	WMI-04-0010	Hedgeland Ditch	CR 1070 N	INB0343_T1003	INB0343_T1003
14T-130	WMI-04-0011	Pike Creek	Eaton-Wheeling Pike	INB0343_01	INB0343_01
14T-131	WMI-04-0012	Mississinewa River	CR 364 W	INB0344_02	INB0344_05
14T-132	WMI-03-0009	Big Lick Creek	CR 1275 N	INB0332_02	INB0332_02
14T-134	WMI-03-0005	Townsand Lucas Ditch	CR 300 S	INB0332_T1003	INB0332_T1003
14T-135	WMI-03-0010	Little Joe Creek	CR 300 S	INB0332_T1002	INB0332_T1002
14T-136	WMI-03-0006	Big Lick Creek	CR 100 W	INB0332_01	INB0332_01
14T-137	WMI-03-0007	Moore Prong	CR 100 W	INB0332_T1001	INB0331_T1006
14T-138	WMI040-0003	Little Lick Creek	SR 3, S of Hartford City	INB0331_T1001	INB0331_T1008
14T-139	WMI040-0009	Big Lick Creek	SR 3, S of Hartford City	INB0331_02	INB0331_05
14T-140	WMI-03-0008	Little Lick Creek	CR 75 E	INB0331_T1001	INB0331_T1010

Understanding Table 3:

- *Column 1: Site #.* Lists the site number that corresponds to the site location in Figure 4. The last two digits of the Site # correspond to the sites in Figure 4 (Ex. 14T-101 is site 1).
- *Column 2: L-Site #* .Provides the site number from the IDEM AIMS database.
- *Column 3: Stream Name*. Identifies the stream name that the site is located on.
- *Column 3: Road Name.* Identifies the road name that the site is located on.
- *Column 4: AUID 2014.* Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed.
- *Column 5: AUID 2016.* Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed. These AUIDS are used for purposes of the Section 303(d) listing assessment process and TMDL development.

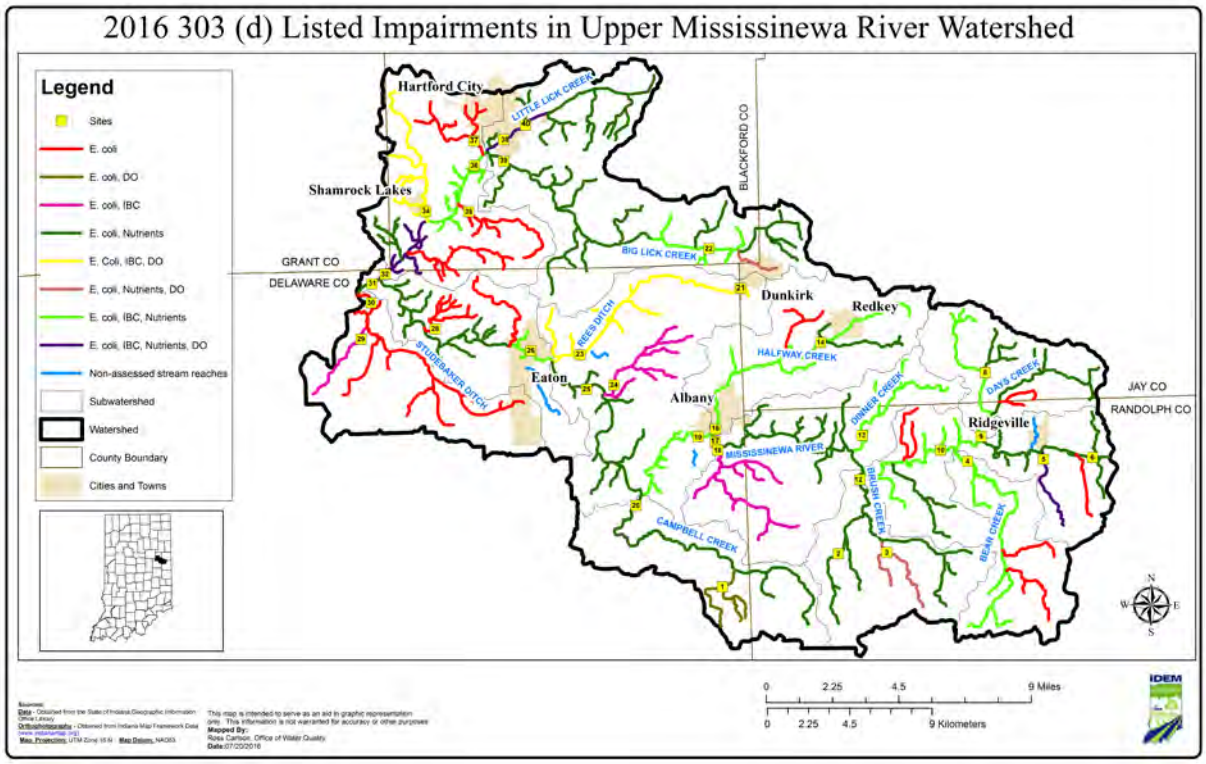

Figure 5. Streams Listed on the Draft 2016 Section 303(d) List in the Upper Mississinewa River Watershed

Table 4. Section 303(d) List Information for the Upper Mississinewa River Watershed for 2014 and 2016.

Watershed (10-digit HUC)	Subwatershed (12-digit HUC)	AUID (2014)	Impairments on Finalized 2014 303(d) List	AUID (2016)	Impairments on 2016 Draft 303(d) List
Halfway Creek (0512010302)	Days Creek (051201030201)	INB0321_01	*	INB0321_02	*E. coli,* Nutrients
				INB0321_03	*E. coli,* IBC, Nutrients
		INB0321_T1001	*	INB0321_T1002	*E. coli,* IBC, Nutrients
				INB0321_T1003	*E. coli,* Nutrients
				INB0321_T1004	*E. coli,* Nutrients
				INB0321_T1005	*E. coli*
	Bear Creek (051201030202)	INB0322_01	*	INB0322_01	*E. coli,* IBC, Nutrients
		INB0322_T1001	*	INB0322_T1001	*E. coli*
		INB0322_T1002	*	INB0322_T1002	*E. coli*
	Fetid Creek (051201030203)	INB0323_01	*E. coli,* PCBs	INB0323_01	*E. coli,* Nutrients, PCBs
		INB0323_02	PCBs	INB0323_02	*E. coli,* IBC, Nutrients, PCBs

Watershed (10-digit HUC)	Subwatershed (12-digit HUC)	AUID (2014)	Impairments on Finalized 2014 303(d) List	AUID (2016)	Impairments on 2016 Draft 303(d) List
		INB0323_T1001	*	INB0323_T1001	*E. coli*
		INB0323_T1002	*	INB0323_T1002	*E. coli,* IBC, Nutrients, DO
		INB0323_T1003	*	INB0323_T1003	*
		INB0323_T1004	*	INB0323_T1004	*E. coli*
		INB0323_T1005	*	INB0323_T1005	*E. coli,* Nutrients
	Bush Creek (051201030204)	INB0324_01	*	INB0324_01	*E. coli,* Nutrients
		INB0324_T1001	*	INB0324_T1001	*E. coli,* Nutrients, DO
		INB0324_T1002	*E. coli,* IBC	INB0324_T1002	*E. coli,* Nutrients
	Redkey Run (051201030205)	INB0325_01	*	INB0325_02	*E. coli,* Nutrients
				INB0325_03	*E. coli,* IBC, Nutrients
		INB0325_T1002	*	INB0325_T1004	*E. coli,* IBC, Nutrients
				INB0325_T1005	*E. coli,* IBC, Nutrients
		INB0325_T1003	*	INB0325_T1006	*E. coli,* Nutrients
				INB0325_T1007	*E. coli*
	Platt Nibarger Ditch (051201030206)	INB0326_01	PCBs	INB0326_01	*E. coli,* Nutrients, PCBs
		INB0326_T1001	*	INB0326_T1001	*E. coli,* IBC, Nutrients
		INB0326_T1002	*	INB0326_T1002	*E. coli,* IBC
Big Lick Creek (0512010303)	**Little Lick Creek (051201030301)**	INB0331_01	*	INB0331_03	*E. coli*, Nutrients
				INB0331_04	*E. coli*, IBC, Nutrients, Chloride*
				INB0331_T1002	*E. coli*, Nutrients, DO
				INB0331_T1003	*E. coli*, Nutrients
		INB0331_02	*	INB0331_05	*E. coli*, Nutrients
				INB0331_06	*E. coli*, Nutrients
				INB0331_T1004	*E. coli*, Nutrients
				INB0331_T1005	*E. coli*, Nutrients
				INB0331_T1006	*E. coli*, Nutrients
				INB0331_T1007	*E. coli*, Nutrients
		INB0331_T1001	*E. coli*	INB0331_T1008	*E. coli*, Nutrients, IBC, DO
				INB0331_T1009	*E. coli*, Nutrients

Watershed (10-digit HUC)	Subwatershed (12-digit HUC)	AUID (2014)	Impairments on Finalized 2014 303(d) List	AUID (2016)	Impairments on 2016 Draft 303(d) List
				INB0331_T1010	*E. coli*, Nutrients
				INB0331_T1011	*E. coli*, Nutrients
				INB0331_T1012	*E. coli*, Nutrients
	Townsand Lucas Ditch (051201030302)	INB0332_01	*E. coli*	INB0332_01	*E. coli*, IBC, Nutrients
		INB0332_02	*E. coli*	INB0332_02	*E. coli*, IBC, Nutrients, DO
				INB0332_T1005	*E. coli*
		INB0332_T1001	*	INB0332_T1006	*E. coli*
				INB0332_T1007	*E. coli*
		INB0332_T1002	*	INB0332_T1002	*E. coli*
		INB0332_T1003	*E. coli*	INB0332_T1003	*E. coli*, IBC, DO
		INB0332_T1004	*	INB0332_T1004	*E. coli*
Pike Creek (0512010304)	**Campbell Creek (051201030401)**	INB0341_01	*	INB0341_01	*E. coli,* Nutrients
		INB0341_T1001	*	INB0341_T1001	*E. coli*, DO
	Rees Ditch (051201030402)	INB0342_01	*E. coli,* PCBs	INB0342_02	*E. coli*, IBC, Nutrients, PCBs
				INB0342_03	*E. coli,* Nutrients, PCBs
		INB0342_01A	*	INB0342_02A	*E. coli*
		INB0342_T1001	*	INB0342_T1001	*E. coli*, IBC
		INB0342_T1002	*	INB0342_T1002	*E. coli*, IBC, DO
	Studebaker Ditch (051201030403)	INB0343_01	*	INB0343_01	*E. coli*
		INB0343_T1001	*	INB0343_T1001	*E. coli*
		INB0343_T1002	*	INB0343_T1002	*E. coli*
		INB0343_T1003	*	INB0343_T1003	*E. coli,* IBC
	Holden Ditch (051201030404)	INB0344_01	*E. coli,* PCBs	INB0344_03	*E. coli*, Nutrients, IBC, PCBs
				INB0344_04	*E. coli*, Nutrients, PCBs
		INB0344_02	PCBs	INB0344_05	*E. coli*, Nutrients, PCBs
		INB0344_T1002	*	INB0344_T1002	*E. coli*
		INB0344_T1003	*	INB0344_T1003	*E. coli*

* Mercury, Chloride, and PCBs are not being developed for the Upper Mississinewa River TMDL. More information on PCB impaired segments is addressed in Section 5.4 and Appendix C.

Understanding Table 4:

- *Column 1: Watershed (10-digit HUC).* Lists the subwatersheds at the 10-digit HUC scale that were part of the initial assessment for the Upper Mississinewa River Watershed.
- *Column 2: Subwatershed (12-digit HUC).* Shows the name of the subwatershed at the 12-digit HUC scale. The subwatershed found in this second column is the appropriate scale for what the IDEM's WMP Checklist defines as a subwatershed for the purposes of watershed management planning.
- *Column 3: AUID 2014.* Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2008 Section 303(d) listing assessment process.
- *Column 4: 2014 Section 303(d) Listed Impairment.* Identifies the cause of impairment associated with the 2012 Section 303(d) listing.
- *Column 5: AUID 2016.* Provides the updated AUIDs associated with each 12-digit HUC subwatershed. Look for these AUIDs used throughout this report to present detailed analysis of sources, load allocations, and recommended implementation activities in PPIAs.
- *Column 6: Updated Impairment to be Listed on 2016 303(d) List.* Provides the updated causes of impairment if new data and information are available.

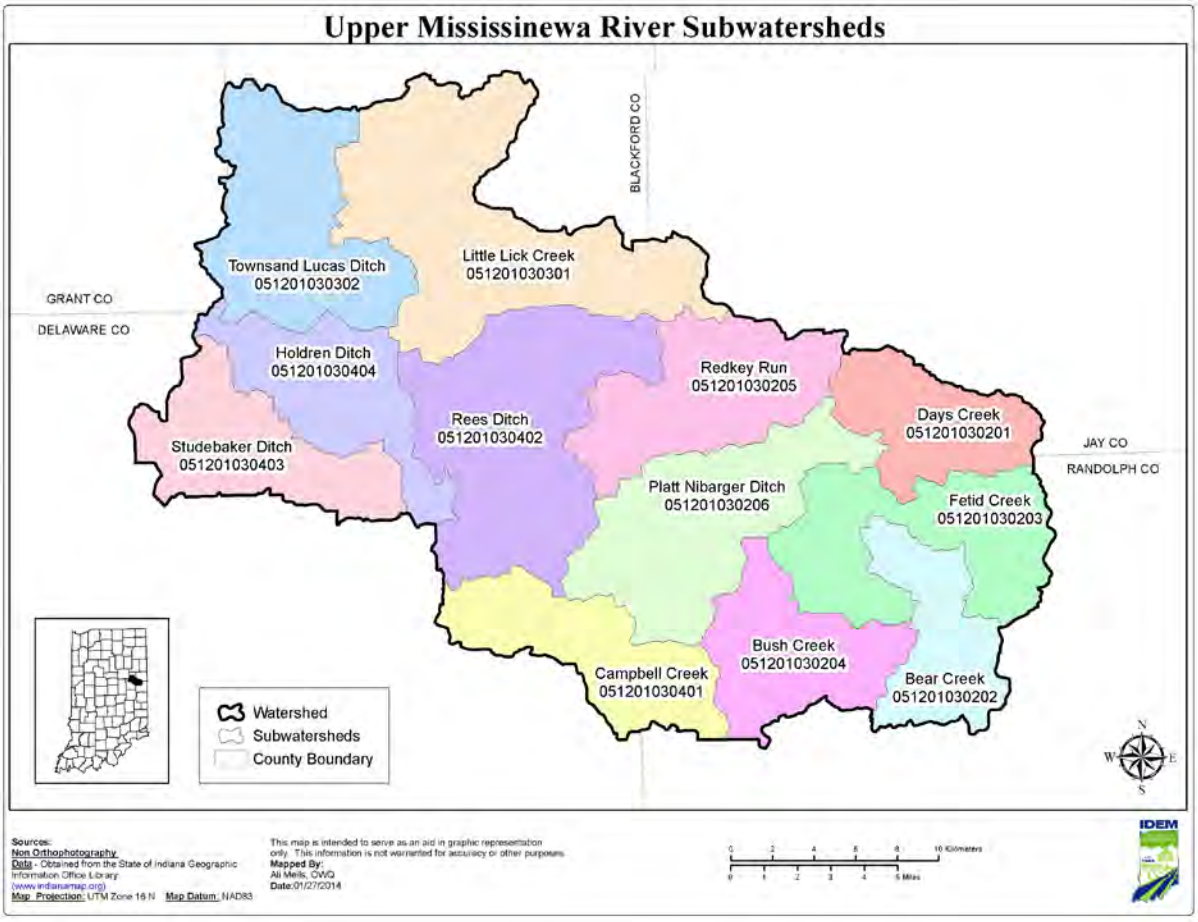

Figure 6. Subwatersheds (12-Digit HUCs) in the Upper Mississinewa River Watershed

2.4 Priority Ranking Discussion

The Upper Mississinewa River Watershed TMDL was prioritized to be completed at this time based on local interest in addressing water quality, IDEM interest in conducting baseline water quality monitoring for local planning, and a competitive Section 319 application from the local partners to develop a watershed management plan in conjunction with the IDEM sampling and TMDL development for streams impaired by *E. coli*, phosphorus and sediment.

3.0 DESCRIPTION OF THE WATERSHED

This section of the TMDL report contains a brief characterization of the Upper Mississinewa River watershed to provide a better understanding of the historic and current conditions of the watershed that affect water quality and contribute to the listed 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.

The Upper Mississinewa River watershed has a diverse network of streams. Tributaries include Halfway Creek, Big Lick Creek, Little Lick Creek, Rees Ditch, Campbell Creek, Days Creek, Bear Creek, Brush Creek and Studebaker Ditch among others. Many of these tributaries are shown in Figure 4 and Figure 5.

3.1 Land Use

Land use patterns provide important clues to the potential sources of *E. coli,* phosphorus, and sediment in a watershed. Land use information for the Upper Mississinewa River watershed is available from the USDA, National Agriculture Statistics Service (NASS), and 2013 Indiana Cropland Data Layer. The Cropland Data Layer (CDL) categorizes the land use for each 30 meters by 30 meters parcel of land in the watershed based on satellite imagery from circa 2013. Figure 7 displays the spatial distribution of the land uses and the data are summarized in Table 5.

Land use in the Upper Mississinewa River watershed is primarily agriculture, comprising 72 percent of the Upper Mississinewa River watershed. Corn and soybean crops are not typically associated with high phosphorus or *E. coli* loads, unless they have been fertilized with manure and/or synthetic fertilizer. Pasture/hay represents 8 percent of the watershed and indicates the presence of animal feedlots that can be significant sources of phosphorus and *E. coli*. Approximately 10 percent of the land is forested and 7 percent is developed. The remaining land categories represent less than 2 percent of the total land area.

The Upper Mississinewa River Watershed is a flow though watershed with a variety of stream sizes ranging from the larger main stem of the Mississinewa to first order agricultural streams in the headwaters. Many of the headwaters in the watershed resemble channelized agricultural ditches with little riparian cover. Hydrology throughout much of the watershed has been altered to facilitate drainage. According to IDEM habitat observations 21of 35 sites displayed signs of recent or recovering channelization. The presence of large amounts of hydric soil in figure 13 with current land use of less and 1% wetlands point to the loss of wetlands as land was drained for more desirable purposes. There are no known aquatic species of special concern in the Mississinewa River watershed. 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 5. Land Use of Upper Mississinewa River Watershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Agricultural Lands	146,056.26	228.21	72.30
Developed Land	14,677.61	22.93	7.26
Forested Land	19,620.79	30.66	9.70
Pasture/Hay	15,472.90	24.18	7.66
Grasslands and Shrubs	4,862.22	7.60	2.41
Wetlands	495.94	0.77	0.25

Open Water	839.10	1.31	0.42
TOTAL	**202,024.82**	**315.66**	**100**

Understanding Table 5: The predominant land use types in the Upper Mississinewa River watershed can indicate potential sources of *E. coli*, phosphorus, and sediment loadings. Different types of land uses are characterized by different types of hydrology. For example, developed lands are characterized by impervious surfaces that increase the potential of storm water events during high flow periods delivering *E. coli,* phosphorus and sediment to downstream streams and rivers. Forested land and wetlands allow water to infiltrate slowly thus reducing the risks of polluted water to running off into waterbodies. In addition to differences in hydrology, land use types are associated with different types of activities that could contribute *E. coli,* phosphorus, and sediment to the watershed. Understanding types of land uses will help identify the type of implementation approaches that watershed stakeholders can use to achieve *E. coli,* phosphorus, and sediment load reductions.

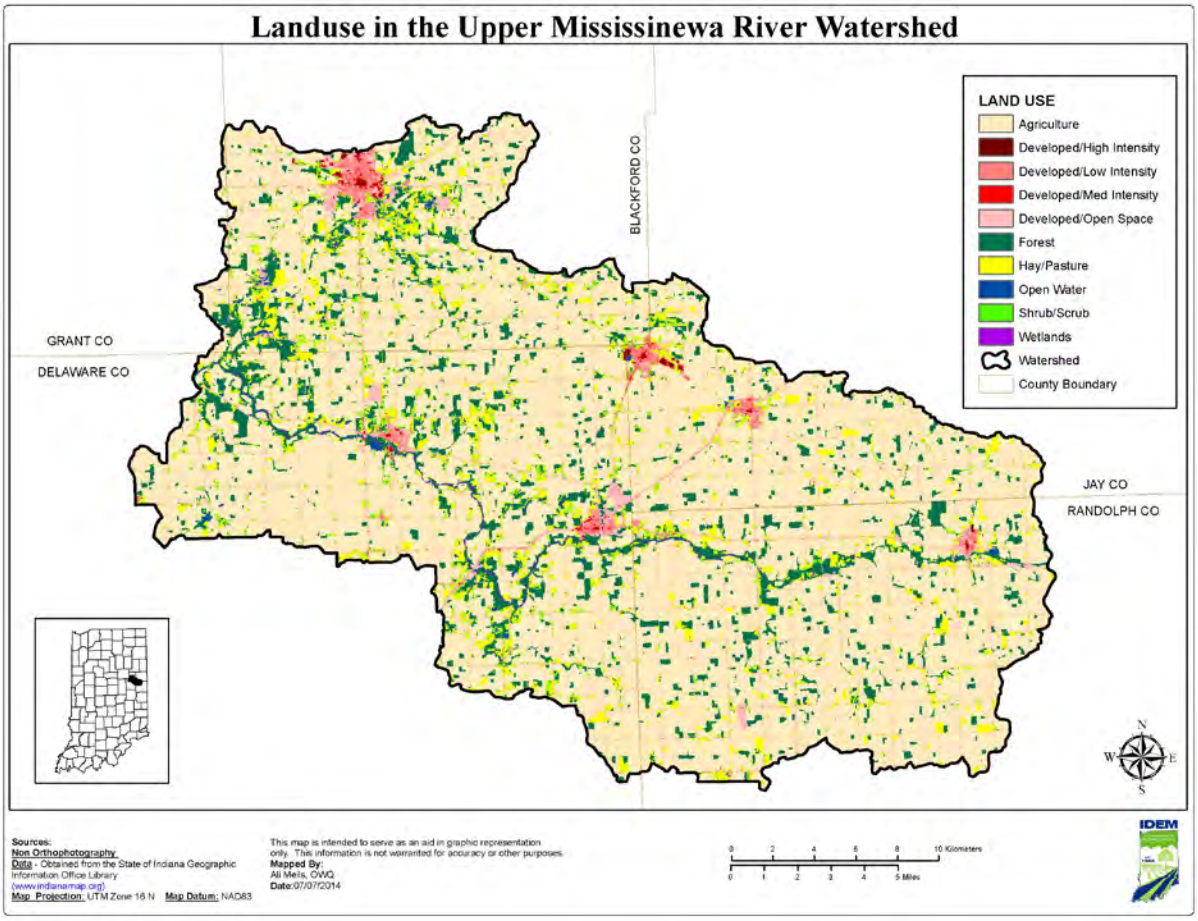

Figure 7. Land Use in the Upper Mississinewa River Watershed

3.2 Human Population

The Upper Mississinewa River Watershed includes land located in Blackford, Delaware, Grant, Jay and Randolph counties. Major government units with jurisdiction at least partially within the Upper Mississinewa River watershed include Albany, Dunkirk, Redkey, Ridgeville, Eaton, Shamrock Lakes and

Hartford City. U.S. Census data for each county during the past three decades are provided in Table 6. Incorporated cities and towns are labeled in Figure 8.

Table 6. Population Data for Counties in the Upper Mississinewa River Watershed

County	1990	2000	2010
Blackford	14,078	14,048	12,766
Delaware	120,337	118,769	117,671
Grant	74,458	73,403	70,061
Jay	21,513	21,806	21,253
Randolph	27,187	27,401	26,171
TOTAL	***257,573***	***255,427***	***247,922***

(U.S. Census Bureau 2012)

Understanding Table 6: Water quality is linked to population growth because a growing population often leads to more development, translating into more houses, roads, and infrastructure to support more people. Table 6 provides information that shows how population has changed in each of the counties located in the Upper Mississinewa River watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future and where action now could help prevent further water quality degradation. As is shown in Table 6 the population for all counties has decreased in the past 20 years. In order to address uncertainty in this analysis, a future growth allocation is given to account for development in the watershed. IDEM uses a moderately conservative 5% Future Growth in TMDL development to account for uncertainty and growth. However, if the trend of declining population continues in the Upper Mississinewa River Watershed, the IDEM calculated Future Growth will provide an even greater degree of protection for instream concentrations. For more information on the Future Growth see Section 6.3.

Estimates of population within Upper Mississinewa River watershed are based on US Census data (2010) and the percentage of the total county and urban area that is within the watershed (Table 7). Based on this analysis, the estimated population of the watershed is nearly 31,000 with approximately 50 percent of the population classified as rural residents and 50 percent classified as urban residents. Figure 9 indicates population density within the Upper Mississinewa River watershed.

Table 7. Estimated Population in the Upper Mississinewa River Watershed

County	2010 Population	Total Estimated Watershed Population	Percent of Total Watershed Population	Non-urban Population	Urban Population
Blackford	12,766	9,508	74.48	3,195	6,313
Delaware	117,671	11,703	9.95	7,341	4,362
Grant	70,061	221	0.32	221	0
Jay	21,253	5,470	25.74	1,651	3,819
Randolph	26,171	3,845	14.69	2,987	858
TOTAL	***247,922***	**30,747**	**12.40**	**15,395**	**15,352**

Understanding Table 7: Understanding where the greatest population is concentrated within the Upper Mississinewa River Watershed will help watershed stakeholders understand where different types of water quality pressures that might currently exist. In general, watersheds with large urban populations are more likely to have problems associated with lots of impervious surfaces, poor riparian habitat, flashy stormwater flows, and large wastewater inputs. Alternatively, watersheds with mostly a non-urban population are more likely to suffer problems from failing septic systems, agricultural runoff, and other

types of poor riparian habitat (e.g., channelized streams). Comparing the information in Table 6 with the information in Table 7 can provide an understanding of how population might change in the Upper Mississinewa River Watershed and which counties are experiencing the most growth and shifts in urban and non-urban population. Population change can serve as an indicator for changes in land uses. For example, growing populations might mean more development, resulting in increased impervious surfaces and more infrastructure (e.g., sanitary sewer and storm sewer). Declining population in areas of the Upper Mississinewa River watershed might signify communities with under-utilized infrastructure and indicate opportunities to "rightsize" existing infrastructure and promote changes to land use that would benefit water quality (e.g., green infrastructure).

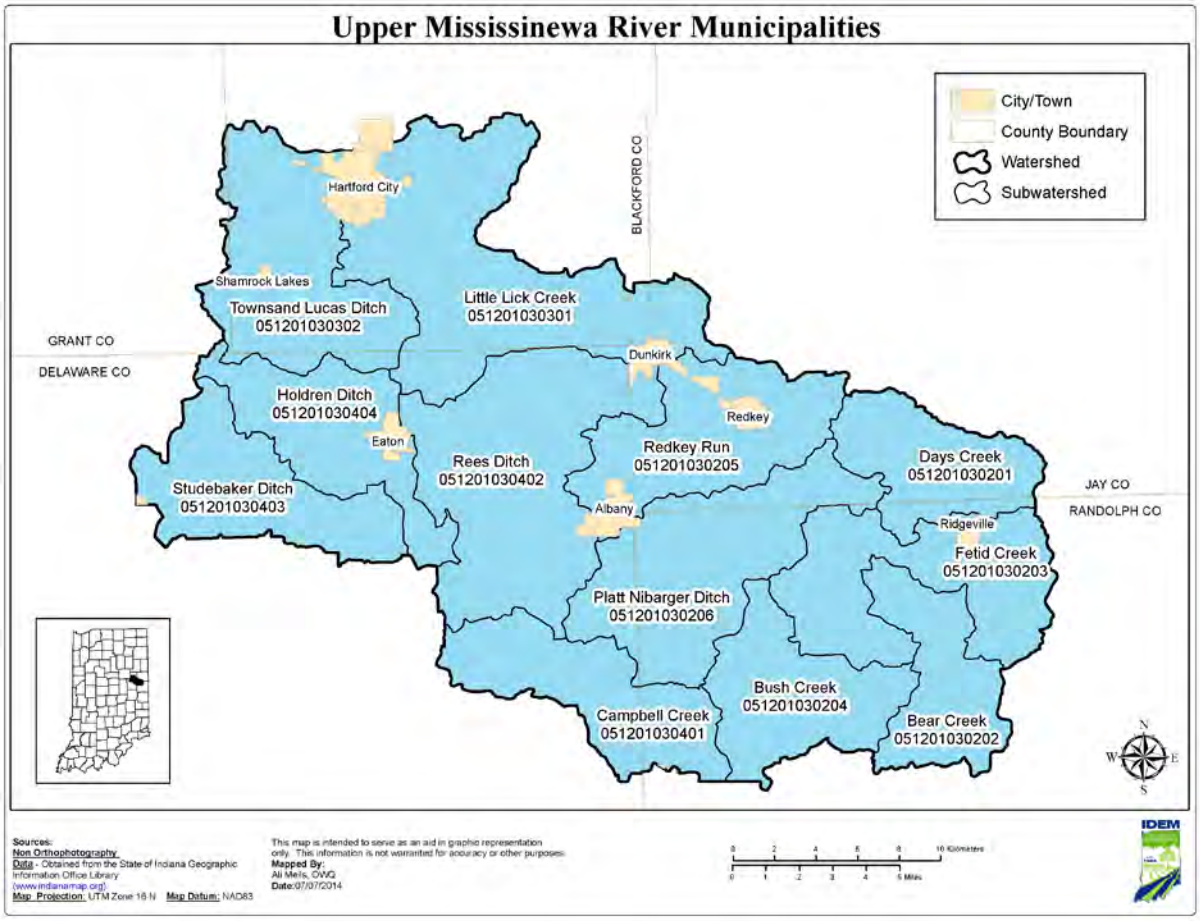

Figure 8. Municipalities in the Upper Mississinewa River Watershed

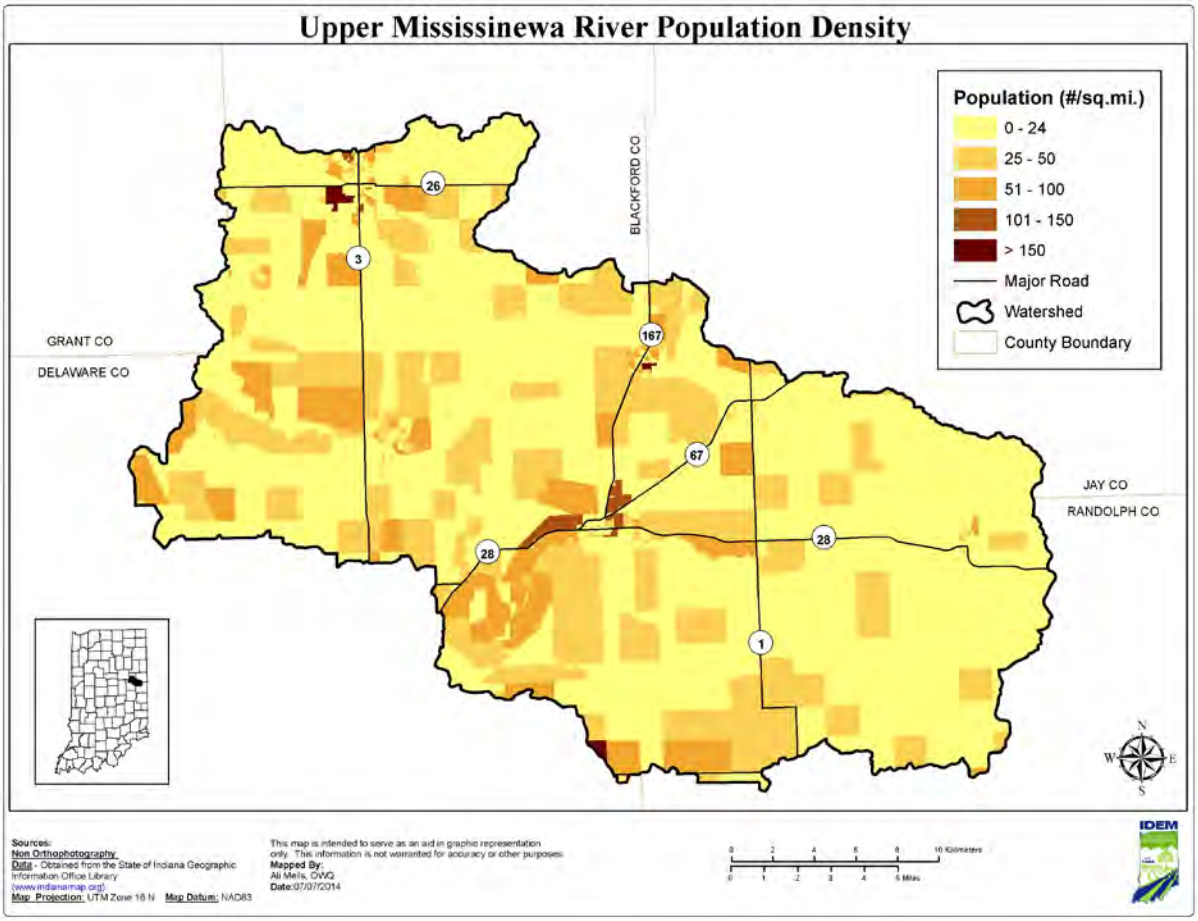

Figure 9. Population Density in the Upper Mississinewa River Watershed

3.3 Topography and Geology

Topographic and geologic features of a watershed play a role in defining a watershed's drainage pattern. Information concerning the topography and geology within the Upper Mississinewa River watershed is available from the Indiana Geologic Survey (IGS). The Mississinewa River originates in Ohio and enters Indiana in Randolph County. The mainstem Mississinewa River continues flowing northwest through Delaware, Blackford, and Grant counties before entering the Wabash River in Miami County. The U.S. Army Corps of Engineers operates a dam along the Mississinewa River which forms Mississinewa Reservoir. The lake was authorized under the Flood Control Act of 1958 to reduce flood damages downstream along the Wabash River. This TMDL document focuses on the Mississinewa River and its drainage as it flows through parts of Randolph, Delaware, Jay and Blackford counties. The Upper Mississinewa River watershed is located in the Eastern Corn Belt Plain (ECBP) physiographic region which is characterized by extensive cropland agriculture with some natural forest cover and gently rolling glacial till plains dissected by moraines, kames and outwash plains. The landscape changes very little throughout the watershed with small agricultural ditches draining into the main stem of the Mississinewa River. The river and the small valley it creates dominate as the natural feature of the region. 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. Geologically this region is characterized by the

predominance of clay-rich soils on relatively level till plain. The clayey till left behind by the Wisconsinan ice sheet is poorly drained. Water table conditions of less than five feet in low-lying floodplains are common. Ground water flow in such shallow water table systems is likely to be dominated by lateral movement through fractures, resulting in an active zone of flow in the upper 20 feet of the till. This perched water table is unlikely, if at all to be connected to deeper flow systems and adjacent aquifers due to the great thickness of till (Fleming 1995).

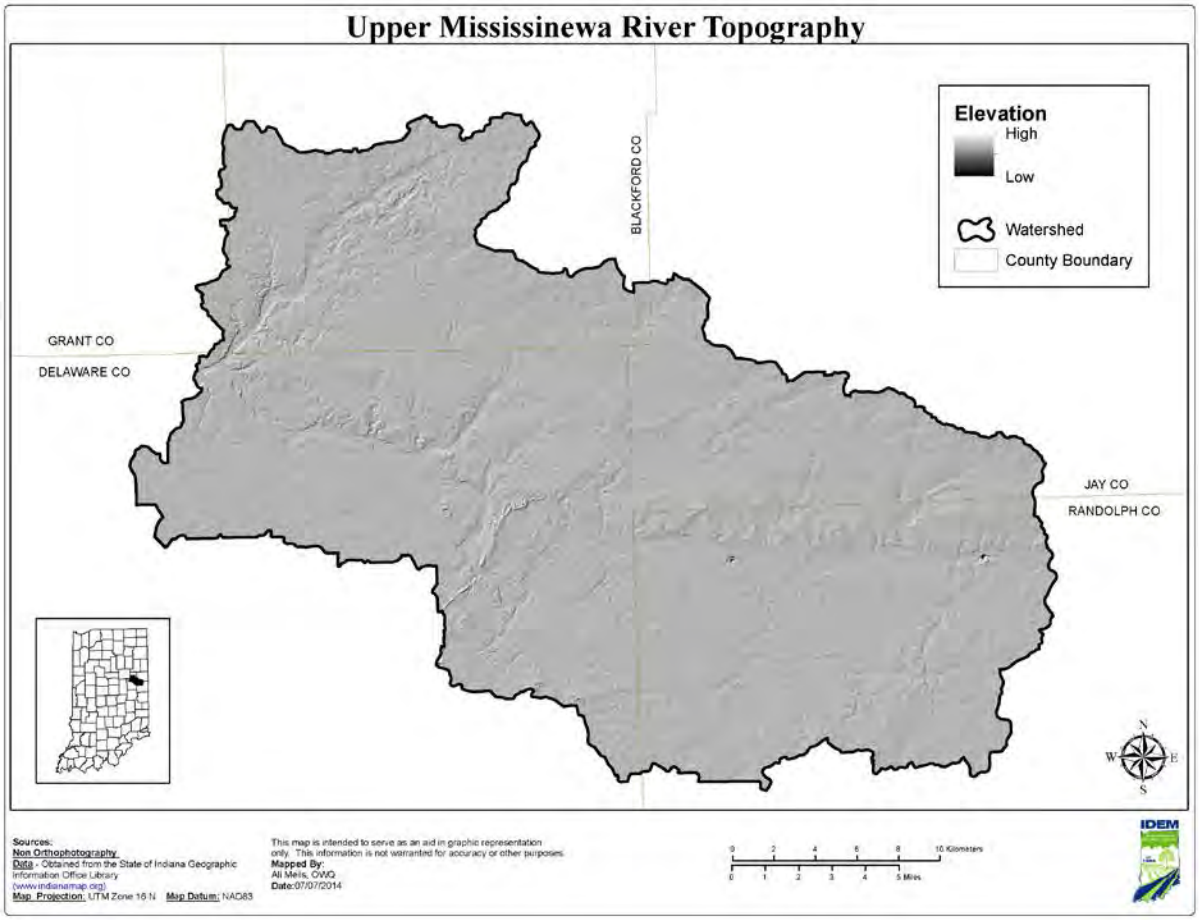

Figure 10. Mississinewa River Topography

Figure10 shows the topography of the Upper Mississinewa River watershed. While the topography of the watershed can have an effect on hydrology, in such a relatively flat area it is more likely that soil characteristics will play a greater role in affecting hydrologic processes.

3.4 Soils

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

3.4.1 Soil Drainage

The hydrologic soil group classification is a means for categorizing soils by similar infiltration and runoff characteristics during periods of prolonged wetting. The NRCS has defined four hydrologic groups for soils, described in Table 8 (NRCS, 2009). Data for the Upper Mississinewa River watershed were

obtained from the 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 in Figure 11.

The majority of the watershed is covered by soil group C (91%) followed by soil group B (7.5%), soil group D (1%) and soil group A (<1%).

Table 8. Hydrologic Soil Groups

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

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

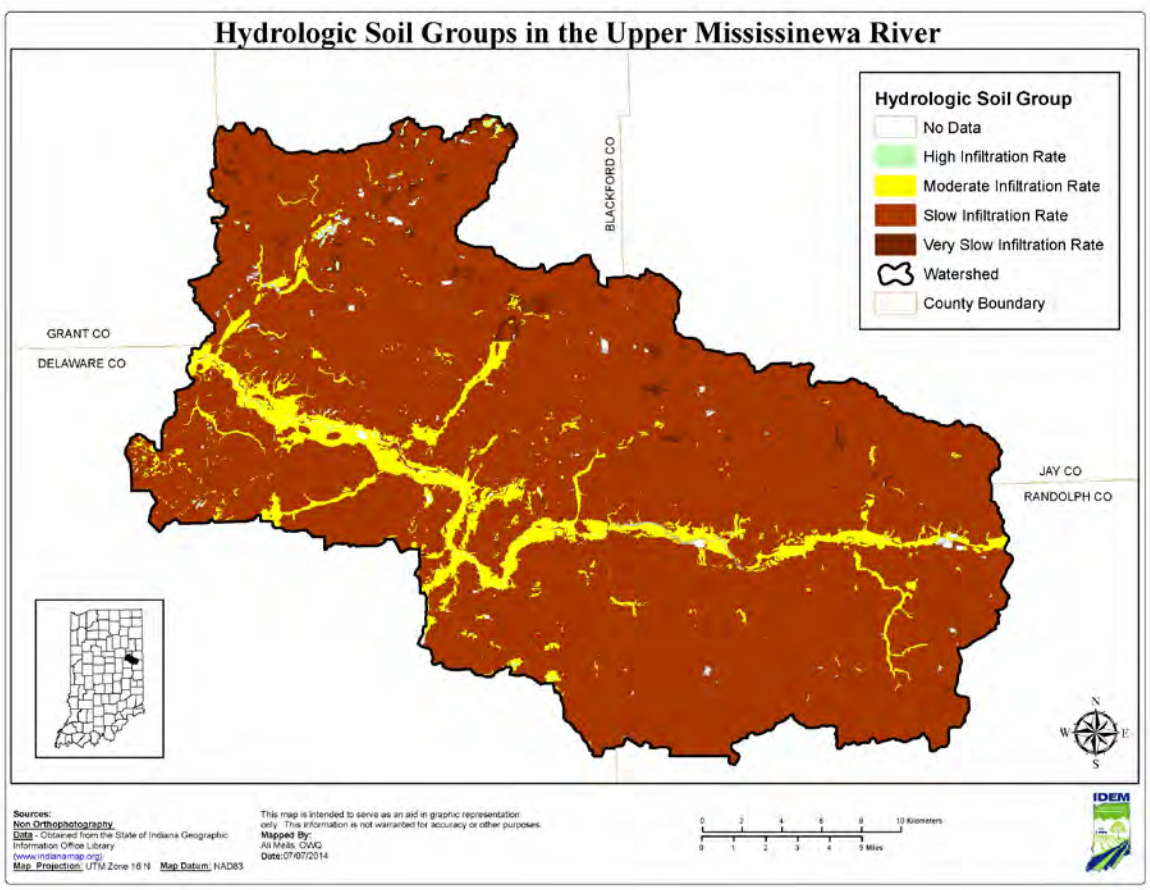

Figure 11. Hydrologic Soil Groups in the Upper Mississinewa River

3.4.2 Septic Tank Suitability

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

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

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

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

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

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

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

Soils labeled “very limited” indicate that the soil has at least one feature that is unfavorable for septic systems. Approximately 99 percent of the Upper Mississinewa River 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. Less than one percent of the soils within the Upper Mississinewa River watershed are either “not rated,” or designated as “not limited.” Soils that are “not rated” mean these soils have not been assigned a rating class because it is not industry standard to install a septic system in these geographic locations. Soils that are designated “not limited,” means that the soil type is suitable for septic systems.

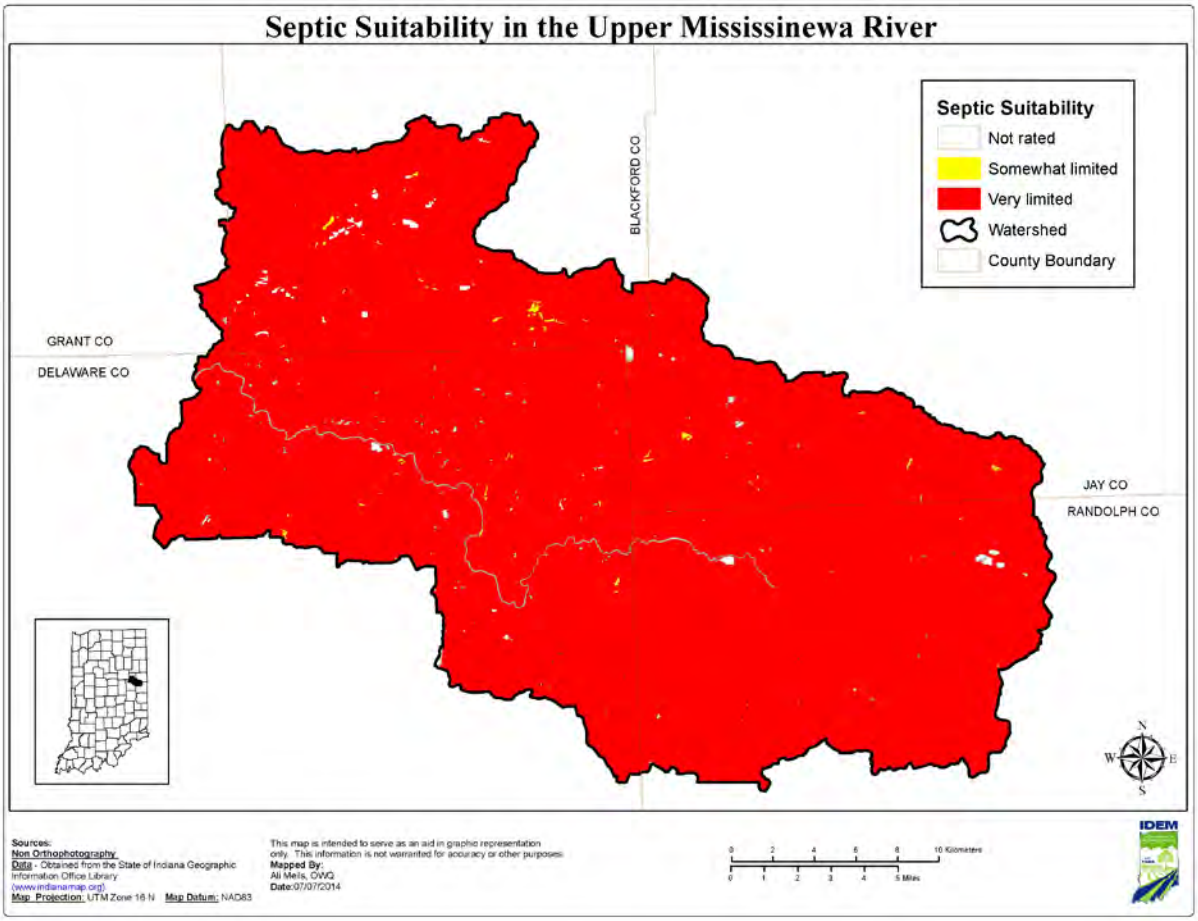

Figure 12. Suitability of Soils for Septic Systems in the Upper Mississinewa River Watershed

3.4.3 Soil Saturation

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 Upper Mississinewa River watershed and are important in consideration of wetland restoration activities. Approximately 101,700 acres or 50 percent of the Upper Mississinewa River watershed area contains soils that are considered hydric, as shown in Table 9. However, a large majority of these soils have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soils, as shown in Figure 13, can be used to consider possible locations of wetland creation or enhancement. There are many components in addition to soil type that must be considered before moving forward with wetland design and creation. Additional information on wetlands can be found on the IDEM website (http://www.in.gov/idem/wetlands/index.htm).

Table 9. Hydric Soils by County in the Upper Mississinewa River Watershed

County	Map Symbol	Hydric Soil Type	Acres	Total Percent of Hydric Soils
Blackford	Bo	Bono silty clay	1,767.58	13.94
	Bs	Bono Variant mucky silty clay	54.31	0.43
	Ho	Houghton muck	243.07	1.92
	Pm	Pewamo silty clay	7,996.84	63.08

County	Map Symbol	Hydric Soil Type	Acres	Total Percent of Hydric Soils
	St	Saranac clay	2,539.64	20.03
	Wa	Wallkill Variant silty clay	75.70	0.60
		Total	**12,677.14**	**100**
Delaware	BdhAH	Bellcreek silty clay loam	441.00	0.78
	BdsAU	Benadum silt loam	31.36	0.06
	BmlA	Blount-Del Rey silt loams	18,306.90	32.30
	BltA	Blount silt loam	5,565.97	9.82
	CdgC3	Casco sandy clay loam	100.66	0.18
	CudA	Crosby silt loam	5.27	0.01
	DdxA	Digby-Haney silt loams	1,158.81	2.04
	EdxC2, EdxD2	Eldean silt loam	70.92	0.13
	GlnAH	Gessie-Eel silt loams	349.34	0.62
	GlyB3	Glynwood-Mississinewa clay loams	383.99	0.68
	HtbAU	Houghton muck	120.13	0.21
	LdfAH	Lash loam	50.93	0.09
	LneAW	Lickcreek silt loam	506.59	0.89
	LteE, LteG	Lybrand-Belmore loams	262.47	0.46
	MorA	Milford mucky silty clay	32.24	0.06
	MphA	Milford silty clay loam	808.50	1.43
	MryA	Millgrove silty clay loam	1,238.73	2.19
	MvbC3, MvbD3	Morley-Mississinewa clay loam	1,757.35	3.10
	MumC2, MumD2	Morley silt loam	789.75	1.39
	MwzAN	Muskego muck	7.95	0.01
	PgaA	Pella silty clay loam	467.53	0.82
	PkkA	Pewamo silty clay loam	19,613.25	34.61
	ReyA	Rensselaer loam	21.48	0.04
	RroAH	Ross-Lash loams	573.66	1.01
	SgmAH	Shoals silt loam	743.11	1.31
	SmsAH	Sloan silt loam	2,056.26	3.63
	SnlA	Southwest silt loam	647.10	1.14
	UdmA	Urban land-Blount-Pewamo complex	565.65	1.00
		Total	**56,676.35**	**100**
Grant	Bn	Bono silty clay	3.55	0.87
	Ht	Houghton muck	3.64	0.89
	Pw	Pewamo silty clay loam	390.81	95.35
	Sn	Sloan clay loam	7.17	1.75
	Wa	Wallkill silt loam	4.70	1.15
		Total	**409.87**	**100**
Jay	Bo	Bono silty clay	549.40	5.54
	Pm	Pewamo silty clay	8,627.76	86.96
	So	Saranac clay loam	432.55	4.36

County	Map Symbol	Hydric Soil Type	Acres	Total Percent of Hydric Soils
	St	Saranac clay	308.95	3.11
	Wa	Wallkill variant silty clay	2.51	0.03
		Total	**9,921.17**	**100**
Randolph	Ca	Houghton muck	42.40	0.19
	Lw	Palms muck	15.68	0.07
	Px	Pewamo silt loam	110.01	0.50
	Pw	Pewamo silty clay loam	19,649.92	89.35
	Sa	Saranac silty clay	1,330.86	6.05
	So	Sloan silt loam	332.92	1.51
	Wa	Wallkill silt loam	156.06	0.71
	Wo	Westland clay loam	354.55	1.61
		Total	**21,992.40**	**100**

Understanding Table 9: In the Upper Mississinewa River Watershed, Delaware County has the most acreage of hydric soils. Areas within these counties might contain opportunities for wetland restoration activities that could help address water quality impairments.

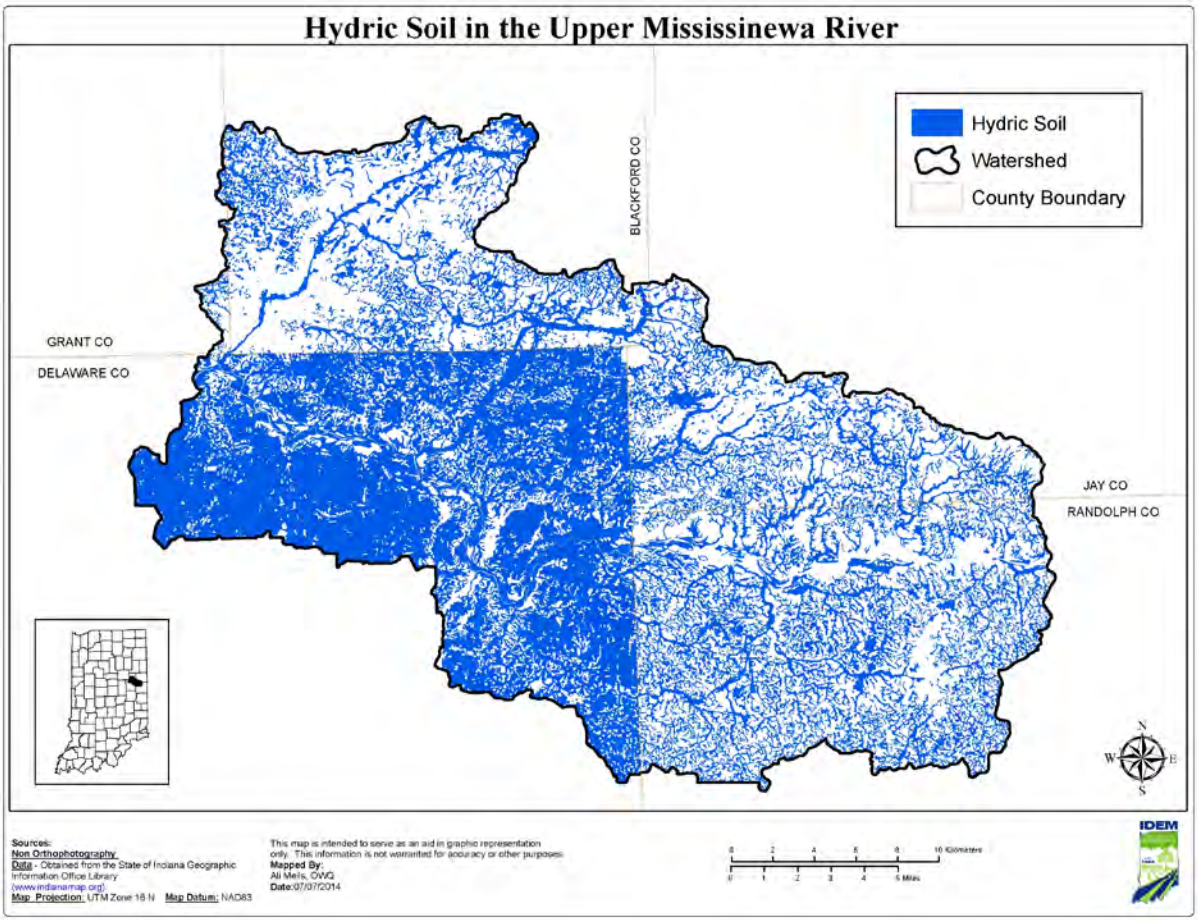

Figure 13. Hydric Soils in the Upper Mississinewa River Watershed

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. (USGS 1999). Currently, the Upper Mississinewa River watershed contains approximately 5,836 acres of wetlands or 3 percent of the total surface area (USFWS, 2003). Figure 14 shows estimated locations of wetlands as defined by the USFWS's National Wetland Inventory (NWI). Wetland data for Indiana is available from the U.S. Fish and Wildlife Service's NWI at (http://www.fws.gov/wetlands/Data/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 wetland information used in Section 3.1 was from the Multi-Resolution Land Characteristics Consortium dataset and is based on soil types, whereas, aerial photography interpretation techniques were used to compile the NWI. Therefore the estimate of the current extent of wetlands in the Upper Mississinewa River watershed from the NWI may not agree with those listed in Section 3.1, which are based upon the Multi-Resolution Land Characteristics Consortium dataset.

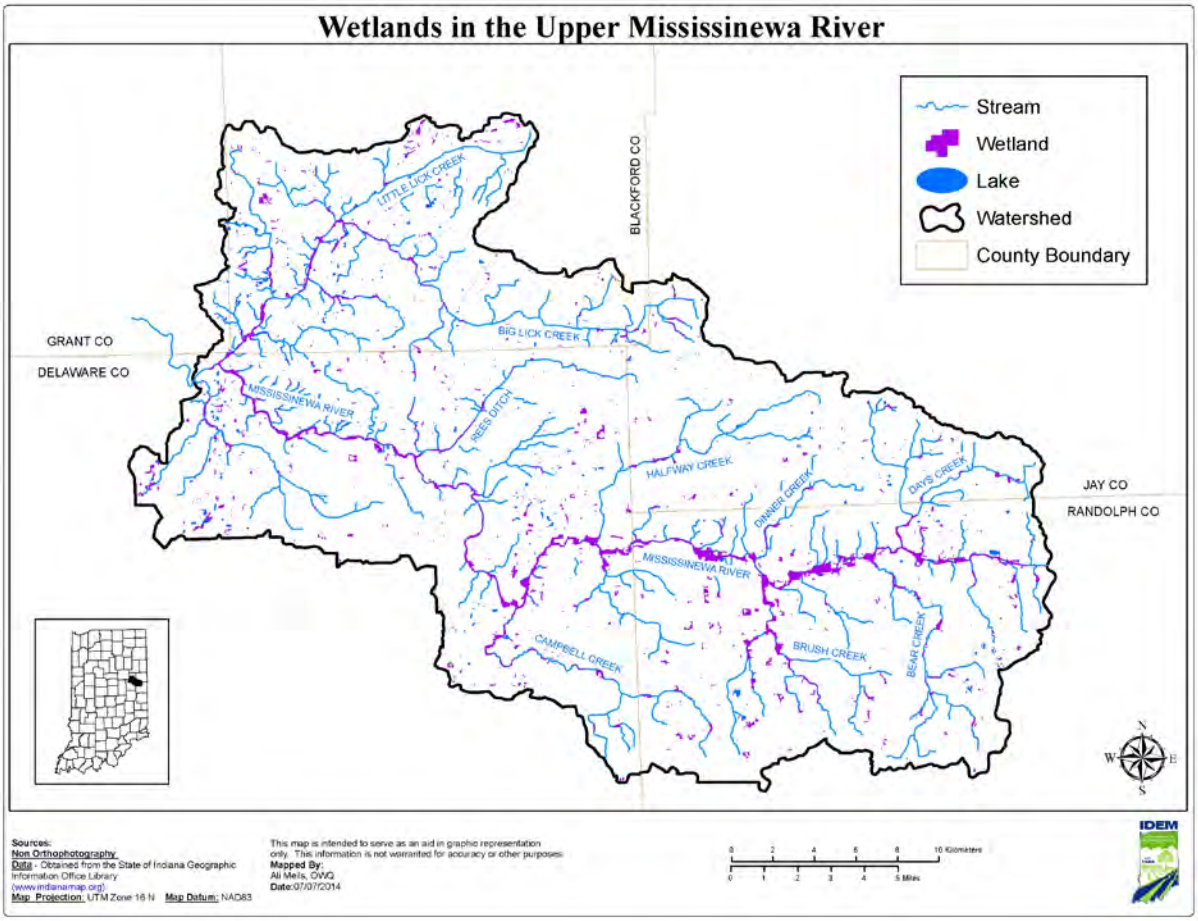

Figure 14. Locations of Wetlands in Upper Mississinewa River Watershed

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. Records were not kept by private landowners as to the location and quantity of these tiles.

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.

3.4.4 Soil Erodibility

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

The NRCS maintains a list of highly erodible 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 Upper Mississinewa River Watershed are listed by county in Table 10. HELs and potential HELs in the Upper Mississinewa River Watershed are mapped in Figure 15. The data used to create Figure 15 was collected from the NRCS offices of Blackford, Delaware, Grant, Jay and Randolph counties. A total of 55,100 acres or 27 percent of the Upper Mississinewa River Watershed is considered highly erodible or potentially highly erodible.

Table 10. HEL/Potential HEL Total Acres in the Counties in the Upper Mississinewa River Watershed

County	Map Symbol	HEL/Potential HEL Soil Types	Acres	Total Percent of HEL Soils
Blackford	EnB3, EnC3	Eldean clay loam	317.55	1.94
	GsB3, GsC3	Glynwood clay loam	15,328.86	93.77
	MoD3	Morley clay loam	504.20	3.08
	Ud	Udorthents, loamy	197.49	1.21
		Total	**16,348.10**	**100**
Delaware	FgrC3, FgrD3	Fox-Muncie clay loams	538.86	14.22
	FgoB2, FgoC2	Fox-Muncie complex	493.48	13.03
	FexB2	Fox loam	53.28	1.41
	MecB	Martinsville loam	45.75	1.21
	MvbC3, MvbD3	Morley-Mississinewa clay loams	1,757.35	46.38
	MumC2, MumD2	Morley silt loam	789.20	20.83
	ObxB2	Ockley silt loam	41.16	1.09
	Pmg, Pml	Gravel pits/quarry	69.62	1.83

County	Map Symbol	HEL/Potential HEL Soil Types	Acres	Total Percent of HEL Soils
		Total	**3,788.70**	**100**
Grant	FtC3	Fox clay loam	3.07	5.02
	HeG	Hennepin clay loam	1.75	2.86
	MxC3	Morley clay	56.32	92.12
		Total	**61.14**	**100**
Jay	EnB3	Eldean clay loam	40.69	0.41
	GsB3, GsC3	Glynwood clay loam	9,688.17	98.75
	Ud	Udorthents, loamy	81.93	0.84
		Total	**9,810.79**	**100**
Randolph	FxC3	Fox clay loam	83.86	0.33
	GnB2	Glynwood silt loam	18,266.10	72.80
	MyC3	Morley clay loam	1,807.17	7.20
	MuB	Morley silt loam	4,790.90	19.09
	Ud	Udorthents, loamy	143.20	0.58
		Total	**25,091.23**	**100**

Understanding Tale 10: In the Upper Mississinewa River Watershed, Randolph County has the most acreage of HEL/potential HEL soils. Areas within these counties might contribute to water quality impairments associated with excessive erosion, including IBC/TSS, and might contain opportunities for restoration to decrease erosion.

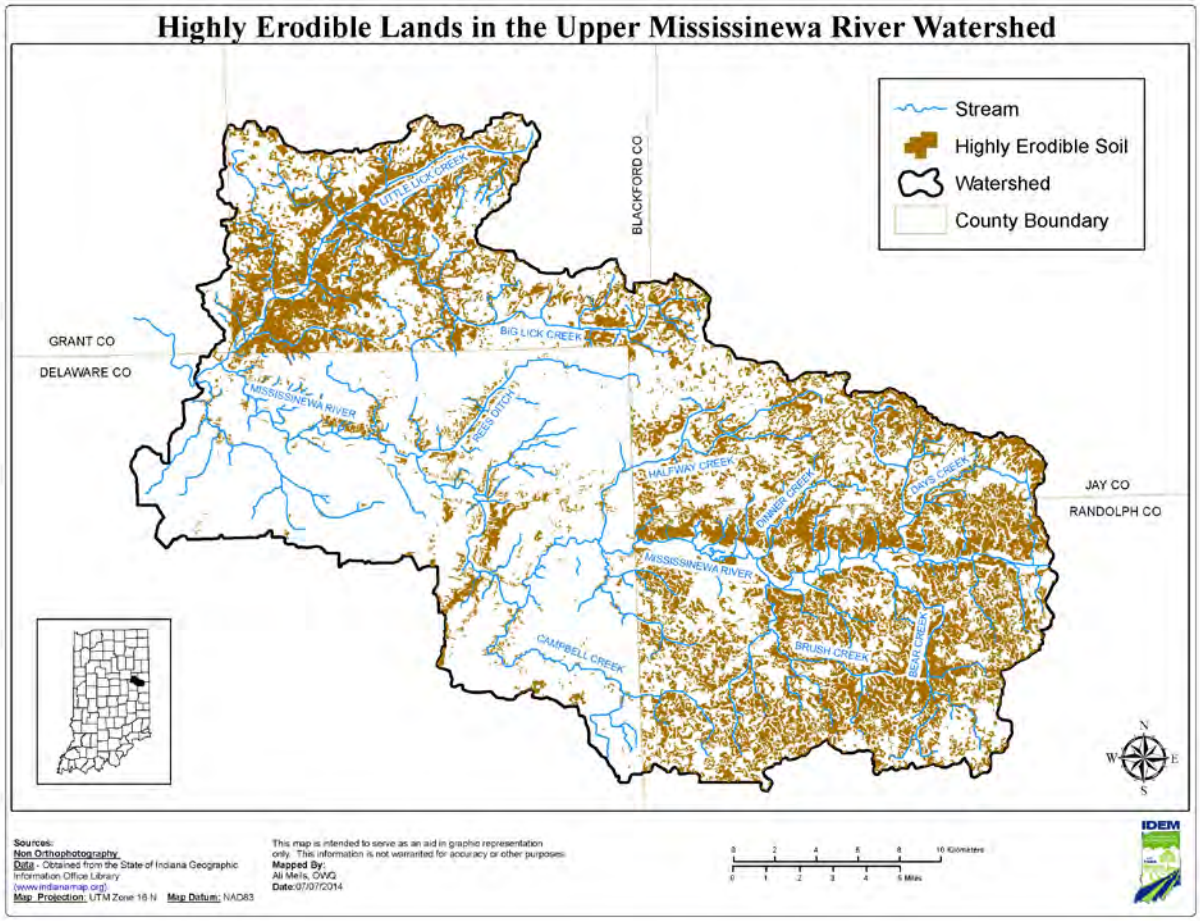

Figure 15. HEL/Potential HEL Soils in the Upper Mississinewa River Watershed

3.4.5 Tillage Data

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropland through annual county tillage transects. Data collected through the tillage transect 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 Upper Mississinewa River watershed are shown in Table 11. Tillage practices captured in ISDA's tillage transect include No-Till, Mulch Till, and conventional tillage practices. ISDA defines No-Till as any direct seeding system including site preparation, with minimal soil disturbance. Mulch Till is any tillage system leaving greater than 30 percent residue cover after planting, excluding no-till. Reduced tillage is a tillage system leaving 16 percent to 30 percent residue cover after planting. Conventional tillage is any tillage system leaving less than 30 percent residue cover after planting.

Table 11. Tillage Transect Data for 2013 by County in the Upper Mississinewa River Watershed

	Tillage Practice 2013 (%)							
	No Till		Mulch Till		Reduced Till		Conventional Till	
County	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn
Blackford	55	6	14	16	11	19	21	59
Delaware	63	20	24	23	7	11	6	46
Grant	36	8	37	2	0	0	27	90
Jay	49	17	34	24	0	0	17	59
Randolph	71	35	10	4	15	31	4	29

Understanding Table 11: Conservation tillage is predominant across all counties for soybean production, however conventional-till remains predominant for corn production across the watershed outside Randolph County. Conservation tillage practices reduce soil loss from wind and water. While soil itself can act as a pollutant it can also carry pollutants, thus practices that help to stabilize the soil will have positive effects on the water quality in nearby streams (Sims 1994).

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 Indiana State Climate Office at Purdue University (http://climate.agry.purdue.edu/climate/narrative.asp).

Climate data from Station Hartford City 4 ESE located in Hartford City, Indiana were used for climate analysis of the Upper Mississinewa River Watershed. Monthly data from 1948 - 2014 were available at the time of analysis. In general, the climate of the region is typical for the Midwest having hot, humid summers and cold winters. From 1948 to 2014, the average winter temperature in Hartford City was 28°F and the average summer temperature was 73°F. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is approximately 165 days.

Examination of precipitation patterns is also a key component of watershed characterization because of the impact of runoff on water quality. From 1948 to 2014, the annual average precipitation in Hartford City at Station 4 ESE was approximately 40 inches, including approximately 29 inches of snowfall. More detailed discussions on precipitation data during sampling periods are presented in Section 7.0.

Rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of storm water on the Upper Mississinewa River watershed. Using data from the Hartford City 4 ESE station from 1948 to 2014, 55 percent of the measureable precipitation events were very low intensity (i.e., less than 0.2 inches), while 7 percent of the measurable precipitation events were greater than one inch. Rainfall within the Upper Mississinewa River Watershed is moderately heavy with an annual average of 39 inches. This rainfall and climate data specific to the watershed is available from the National Climatic Data Center (http://www.ncdc.noaa.gov/oa/ncdc.html). Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

Knowing when precipitation events occur helps in the linkage analysis (Section 7.0), which correlates flow conditions to pollutant concentrations and loads. Data indicates that the wet weather season in the Upper Mississinewa River watershed occurs between the months of May and August.

3.6 Description of Watershed Summary

The information presented in Section 3 helps to provide a better comprehensive understanding of the conditions and characteristics in the Upper Mississinewa River Watershed that, when coupled with the sources presented in Section 4, affect both water quality and water quantity. In summary, the predominant agricultural land use in the watershed serves as an indicator as to the type of sources that are likely to contribute to water quality impairments in the Upper Mississinewa River Watershed. This is also an indicator of what BMP's may be best utilized to address water quality issues in the watershed. Human population, which is greatest in Grant Co and Delaware Co in the Upper Mississinewa River Watershed, indicates where more infrastructure related pressures on water quality might exist. The subsections on topography and geology, as well as soils, provide information on the natural features that affect hydrology in the Upper Mississinewa River Watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the Upper Mississinewa River Watershed. Lastly, the subsection on climate and precipitation provides information on water quantity and the factors that influence flow, which ultimately affects the influence of 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 crafting the linkage analysis that connects the observed water quality impairment to what has caused that impairment.

4.0 SOURCE ASSESSMENT

This section presents information concerning IDEM's segmentation process as it applies to the Upper Mississinewa River Watershed in order to present a source assessment specific to the Upper Mississinewa River Watershed, as well as summaries of significant sources of *E. coli*, phosphorus, and sediment for each subwatershed within the Upper Mississinewa River Watershed.

4.1 Understanding Subwatersheds and Assessment Units

As briefly discussed in Section 2.3, the Upper Mississinewa River watershed contains 12 subwatersheds. Examining subwatersheds enables a closer examination of key factors that affect water quality. The subwatersheds include (Figure 6):

- Days Creek (051201030201)
- Bear Creek (051201030202)
- Fetid Creek (051201030203)
- Bush Creek (051201030204)
- Redkey Run (051201030205)
- Platt Nibarger Ditch (051201030206)
- Little Lick Creek (051201030301)
- Townsand Lucas Ditch (051201030302)
- Campbell Creek (051201030401)
- Rees Ditch (051201030402)
- Studebaker Ditch (051201030403)
- Holden Ditch (051201030404)

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

Table 12 contains the AUIDs in the subwatersheds of the Upper Mississinewa River Watershed and the associated drainage area. Subsequent sections of the TMDL report organize information by subwatershed (if applicable) and AUID.

Table 12. Assessment Units in Upper Mississinewa River Watershed

Name of Watershed	Name of Subwatershed	Surface Area (sq. miles)	Percent Surface Area	Current AUID (2016)	Length (mi)	Drainage area (sq. miles)
Halfway Creek (0512010302)	Days Creek (051201030201)	17.10	5.42	INB0321_01	11.34	17.10
				INB0321_T1001	9.81	
	Bear Creek (051201030202)	16.01	5.07	INB0322_01	14.44	16.01
				INB0322_T1001	3.38	
				INB0322_T1002	2.41	
	Fetid Creek (051201030203)	26.91	8.53	INB0323_01	11.68	190.68
				INB0323_02	10.57	
				INB0323_T1001	2.44	
				INB0323_T1002	3.10	
				INB0323_T1003	1.37	
				INB0323_T1004	3.71	
				INB0323_T1005	5.13	
	Bush Creek (051201030204)	20.10	6.37	INB0324_01	9.92	20.10
				INB0324_T1001	4.81	
				INB0324_T1002	7.01	
	Redkey Run (051201030205)	25.05	7.94	INB0325_01	12.60	25.05
				INB0325_T1002	3.60	
				INB0325_T1003	3.80	
	Platt Nibarger Ditch (051201030206)	30.94	9.80	INB0326_01	18.47	241.74
				INB0326_T1001	8.08	
				INB0326_T1002	12.29	
Big Lick Creek (0512010303)	Little Lick Creek (051201030301)	46.43	14.71	INB0331_01	17.68	46.43
				INB0331_02	22.61	
				INB0331_T1001	19.84	
	Townsand Lucas Ditch (051201030302)	29.82	9.45	INB0332_01	8.37	76.25
				INB0332_02	10.47	
				INB0332_T1001	7.23	
				INB0332_T1002	6.86	
				INB0332_T1003	11.25	

Name of Watershed	Name of Subwatershed	Surface Area (sq. miles)	Percent Surface Area	Current AUID (2016)	Length (mi)	Drainage area (sq. miles)
				INB0332_T1004	7.83	
Pike Creek (0512010304)	Campbell Creek (051201030401)	21.00	6.65	INB0341_01	13.56	21.00
				INB0341_T1001	5.78	
	Rees Ditch (051201030402)	40.27	12.76	INB0342_01	21.61	328.07
				INB0342_01A	0.61	
				INB0342_T1001	10.00	
				INB0342_T1002	15.50	
				INB0342_T1002A	0.75	
	Studebaker Ditch (051201030403)	21.61	6.85	INB0343_01	11.87	21.61
				INB0343_T1001	3.57	
				INB0343_T1002	2.72	
				INB0343_T1003	3.22	
	Holden Ditch (051201030404)	20.35	6.45	INB0344_01	18.41	446.29
				INB0344_01A	2.26	
				INB0344_02	0.94	
				INB0344_T1002	4.35	
				INB0344_T1003	5.99	

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

- *Column 1: Name of watershed.* Lists the name of the watersheds.
- *Column 2: Name of subwatershed.* Lists the name of the subwatersheds.
- *Column 3: surface Area* . Lists the Surface Area of each Subwatershed
- *Column 4: Percent Surface Area:* Provides the Percent Surface are of Subwatershed within the overall watershed
- *Column 5: Current AUID*. Provides the updated AUIDs associated with each subwatershed.
- *Column 6: Length.* Quantifies the length in stream miles of a specific AUID.
- *Column 7: Drainage Area.* Indicates the percent of the total drainage area, providing a relative understanding of the portion of the AUID in the overall Upper Mississinewa River watershed.

IDEM bases percent load reductions on the drainage area for each AUID in the 12-digit HUC subwatersheds. The information contained in this table is the foundation for the technical calculations found in Sections 5, 6, and 7 of this report. This table will help watershed stakeholders look at the smaller

segments within the Upper Mississinewa River Watershed and understand the smaller areas contributing to the impaired waterbody, helping to quantify the geographic scale that influences source characterization and areas for implementation.

4.2 Upper Mississinewa River Subwatershed Summary

This section summarizes the available information on significant point and nonpoint sources of *E. coli*, phosphorus, and sediment in the twelve subwatersheds of the Upper Mississinewa River watershed.

The term "point source" refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a waterbody. By law, the term "point source" also includes: concentrated animal feeding operations (CAFO) which are places where animals are confined and fed; storm water runoff from Municipal Separate Storm Sewer Systems (MS4s), construction site of one acre or more of land disturbance, and specific categories of industrial activities that convey storm water; and illicitly connected "straight pipe" discharges of household waste, and other sources. 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 and other sources.

4.2.1 Landuse

This section of the report presents the available information on the landuse in the Upper Mississinewa River Watershed. Water quality is often a function of what practices are occurring on the surrounding landscape. All land uses have an effect on water quality, whether positive or negative. In forested lands and other areas with good vegetation cover and little disturbance from humans, most rainfall soaks into the soil rather than running off the ground, stream flows are steady, and water quality is good. In developed areas with pavement and buildings, little rainfall soaks into the soil causing high runoff, flashy stream flows, and poorer water quality. The most common land use in Indiana is agriculture, which lies somewhere between these two extremes. Land use and management practices are probably the most important factor in determining water quality in most Indiana landscapes. Table 13 and Figure 16 describe the land use in the Upper Mississinewa River subwatersheds.

Table 13. Land Use in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Area	Land Use							Total
			Agriculture	Developed	Forest	Hay/ Pasture	Shrub	Open Water	Wetlands	
Halfway Creek	Days Creek	Acres	8906.46	490.38	813.30	565.55	153.67	10.01	4.67	10944.04
		Sq. Mi.	13.92	0.77	1.27	0.88	0.24	0.02	0.01	17.11
		Percent	81.38	4.48	7.43	5.17	1.40	0.09	0.04	100
	Bear Creek	Acres	8517.28	414.10	506.84	699.21	105.42	4.45	2.67	10249.97
		Sq. Mi.	13.31	0.65	0.79	1.09	0.16	0.01	<0.01	16.01
		Percent	83.10	4.04	4.94	6.82	1.03	0.04	0.03	100
	Fetid Creek	Acres	12819.28	1163.79	1842.32	1047.26	275.10	38.70	38.47	17224.92
		Sq. Mi.	20.03	1.82	2.88	1.64	0.43	0.06	0.06	26.92
		Percent	74.42	6.76	10.70	6.08	1.60	0.22	0.22	100
	Bush Creek	Acres	9939.72	714.78	1137.33	823.31	207.49	31.80	8.67	12863.1
		Sq. Mi.	15.53	1.12	1.78	1.29	0.32	0.05	0.01	20.1
		Percent	77.27	5.56	8.84	6.40	1.61	0.25	0.07	100
	Redkey Run	Acres	11976.85	1852.99	893.58	965.64	295.79	38.70	12.01	16035.56
		Sq. Mi.	18.71	2.90	1.40	1.51	0.46	0.06	0.02	25.06
		Percent	74.69	11.56	5.57	6.02	1.84	0.24	0.07	100
	Platt Nibarger Ditch	Acres	15274.97	918.49	1966.42	1224.95	320.47	36.70	70.28	19812.28
		Sq. Mi.	23.98	1.44	3.07	1.91	0.50	0.06	0.11	31.07
		Percent	77.10	4.64	9.93	6.18	1.62	0.19	0.35	100
Big Lick Creek	Little Lick Creek	Acres	19700.62	2919.38	3188.03	2741.68	998.55	133.66	40.25	29722.17
		Sq. Mi.	30.78	4.56	4.98	4.28	1.56	0.21	0.06	46.43
		Percent	66.28	9.82	10.73	9.22	3.36	0.45	0.14	100
	Townsand Lucas Ditch	Acres	12056.25	1847.88	2463.67	1892.58	650.06	144.11	39.14	19093.69
		Sq. Mi.	18.84	2.89	3.85	2.96	1.02	0.23	0.06	29.85
		Percent	63.14	9.68	12.90	9.91	3.40	0.75	0.20	100
Pike Creek	Campbell Creek	Acres	10208.37	570.89	1062.38	1228.29	326.92	37.36	7.34	13441.55
		Sq. Mi.	15.95	0.89	1.66	1.92	0.51	0.06	0.01	21
		Percent	75.95	4.25	7.90	9.14	2.43	0.28	0.05	100
	Rees Ditch	Acres	16868.43	1847.88	3297.89	2628.48	809.52	172.36	153.90	25778.46
		Sq. Mi.	26.36	2.89	5.15	4.11	1.26	0.27	0.24	40.28
		Percent	65.44	7.17	12.79	10.20	3.14	0.67	0.60	100
	Studebaker Ditch	Acres	11118.63	771.49	818.19	716.78	342.49	46.70	20.46	13834.74
		Sq. Mi.	17.37	1.21	1.28	1.12	0.54	0.07	0.03	21.62
		Percent	80.37	5.58	5.91	5.18	2.48	0.34	0.15	100
	Holden Ditch	Acres	8667.84	1157.79	1634.60	947.85	378.74	143.67	98.97	13029.46
		Sq. Mi.	13.54	1.81	2.55	1.48	0.59	0.22	0.15	20.34
		Percent	66.52	8.89	12.55	7.27	2.91	1.10	0.76	100

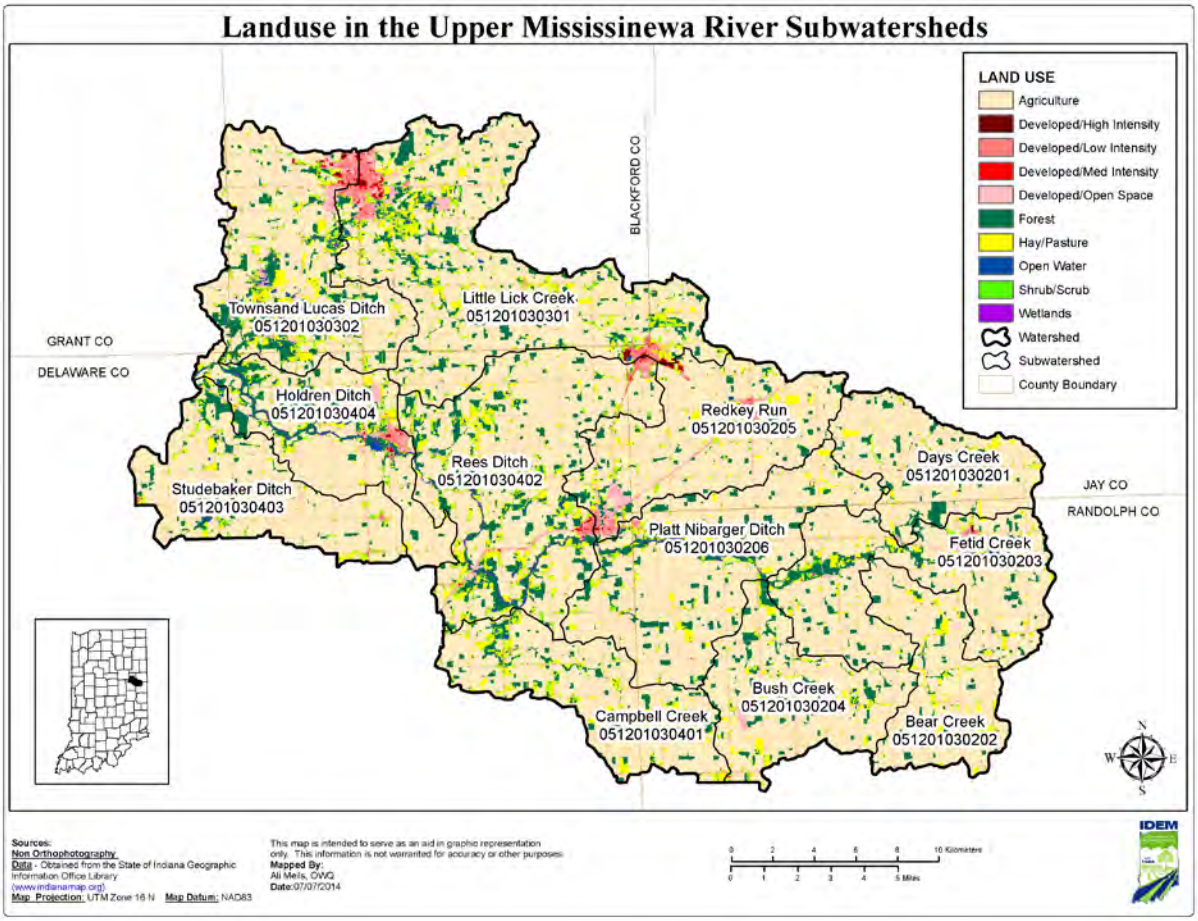

Figure 16. Land Use in the Upper Mississinewa River Subwatersheds

4.2.2 Point Sources

The State of Indiana regulates the direct discharge of pollutants to waters of the State through the National Pollutant Discharge Elimination System (NPDES) Permit Program. The permits issued place limits on the amount of pollutants that may be discharged to surface waters by each facility. These limits are set at levels protective of both aquatic life in the waters which receive the discharge and protective of human health. This section summarizes the potential point sources of *E. coli,* phosphorus, and sediment in the Upper Mississinewa River Watershed, as regulated through the National Pollutant Discharge NPDES Program.

4.2.2.1 Municipal Facilities

A municipal facility, or wastewater treatment plant (WWTP), is designed to remove biological or chemical waste products from water. Some of the functions of a WWTP include sewage treatment and industrial wastewater treatment. WWTPs are critical for maintaining public sanitation and a healthy environment.

Municipal facilities in Indiana are required to disinfect their effluent during the recreational season (April 1 to October 31). Treated municipal sewage is a point source of phosphorus. WWTPs may release water with elevated concentrations of phosphorus into streams. As discussed in Section 2.2, the target value for total phosphorus is 0.30 mg/L. Phosphorus is interpreted as an average in the NPDES permits For

NPDES WWTP permits Peak Design Flow was used in creating WLA's for Very High and Higher Flow allocations, while Average Design Flow was used for Normal, Lower, and Low flow conditions. Monitoring data, reviewed by IDEM during the TMDL development process, indicated that when WWTPs were in compliance with their individual permit limit for phosphorus (1.0 mg/L), the in-stream target for phosphorus (0.30 mg/L) was typically met. As such WWTPs were given WLAs based on their 1.0 mg/L permit limitation.

The TMDL target value for TSS is set at the WWTP's permit effluent limit for TSS. Therefore, a target of 30 mg/L for total suspended solids TSS has been identified as a permit limit for NPDES facilities.

There are Eleven WWTP dischargers that discharge wastewater containing *E. coli*, phosphorus, and sediment within the Upper Mississinewa River watershed (Figure 17 and Table 14). These facilities are as follows: Ridgeville WWTP, Redkey WWTP, Riverside Community MHP, Dunkirk WWTP, Lake Placid Conference Center, Jackson Township RSD, Hartford City WWTP, Shamrock Lakes WWTP, PAWS inc WWTP, Albany WWTP and Eaton WWTP. Summaries of the WWTP permits within the Upper Mississinewa River watershed are described below.

Table 14. NPDES Permitted Wastewater Treatment Plants Discharging within the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Peak Design Flow (MGD)	Average Design Flow (MGD)
Halfway Creek	Days Creek	NA	NA	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA	NA	NA
	Fetid Creek	Ridgeville WWTP	IN0020001	INB0323_01	Mississinewa River	0.3	0.15
	Bush Creek	NA	NA	NA	NA	NA	NA
	Redkey Run	Redkey WWTP	IN0024406	INB0325_T1002	Redkey Run	0.675	0.3
	Platt Nibarger Ditch	Riverside Community MHP	IN0041173	INB0326_01	Mississinewa River	NA	0.008
Big Lick Creek	Little Lick Creek	Dunkirk WWTP	IN0021491	INB0331_01	Big Lick Creek	NA	0.7
		Lake Placid Conference Center	IN0030015	INB0331_T1001	Little Lick Creek	NA	0.028
		Jackson Township RSD	IN0061000	INB0331_02	Big Lick Creek	NA	0.0132
	Townsand Lucas Ditch	Hartford City WWTP	IN0021628	INB0332_T1001	Moore Prong	3.5	2.2
		Shamrock Lakes WWTP	IN0049832	INB0332_T1003	Townsand Lucas Ditch	NA	0.03
Pike Creek	Campbell Creek	PAWS, Inc WWTP	IN0055271	INB0341_01	Unnamed Tributary to Campbell Creek	NA	0.00175
	Rees Ditch	Albany WWTP	IN0022136	INB0342_01	Mississinewa River	NA	0.4
	Studebaker Ditch	NA	NA	NA	NA	NA	NA
	Holden Ditch	Eaton WWTP	IN0021652	INB0344_01	Mississinewa River	0.83	0.36

The Town of Ridgeville operates a Class I. 0.10 MGD wastewater treatment plant consisting of two 0.05 MGD activated sludge wastewater treatment plants each with an aeration tank with fine bubble diffusers, dual hopper bottom clarifiers with sludge-return and scum-removal pumps, a sludge-return measuring box, an aerated sludge holding tank, chlorination/dechlorination facilities, a post aeration tank, a rectangular effluent weir and an effluent flow meter. Sludge is dewatered on drying beds before being landfilled. The collection system is comprised of combined sanitary and storm sewers with two Combined Sewer Overflow (CSO) locations. The mass limits for CBOD, TSS and ammonia-nitrogen have been calculated utilizing the peak design flow of 0.3 MGD to facilitate the maximization of flow through the treatment facility. The long term control plan will ultimately eliminate the CSO 002 outfall. The receiving water has a seven day, ten year low flow ($Q_{7,10}$) of 1.2 cubic feet per second at the outfall location. There has been one *E.coli* violation reported by the facility during the time of sampling between 4/1/2014 and 6/30/2014 from discharge 004, located on the Mississinewa River approximately 4 miles upstream of Site 10. There have been five informal enforcement actions in the last five years, however all enforcement actions were prior to sampling activities for this specific project.

The Town of Redkey operates a minor municipal wastewater treatment plant. The plant consists of a bar screen and grit chamber lift station, oxidation ditch, solution feed chlorine tank, sulfur dioxide injection dechlorination, post aeration by cascade aerator, ultrasonic flow meter, aerobic digester and geotube dewatering. The collection system is comprised of combined sanitary and storm sewers with 8 CSO outfalls. There have been no violations reported by the facility during the time of sampling. There have been six informal enforcement actions in the last five years. There was also one formal enforcement action issued to the facility in 2012 for not turning in the long term control plan by the deadline.

Riverside Community Mobile Home Park operates a Class I, extended aeration treatment facility with an aeration basin, a clarifier, effluent chlorination and dechlorination facilities and an effluent flow meter. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. The final sludge is hauled off site. The facility discharges to the Mississinewa River which has a seven day, ten year low flow ($Q_{7,10}$) of 1.9 cubic feet per second at the outfall location. Their facility serves 12 mobile home units and there are no significant industrial contributions to the wastewater treatment plant. This facility has been in violation seven out of the last twelve quarters. There have been seven informal enforcement actions and one formal enforcement action issued in the last five years, (Table 15) however none of them were during the time of sampling.

The City of Dunkirk currently operates a Class II conventional activated sludge wastewater treatment facility consisting of an influent flow meter, grit removal, three primary clarifiers, two aeration basins with fine air diffusers, chlorination/dechlorination facilities, an effluent flow meter and cascade post-aeration. Sludge is treated in an anaerobic digester and filter belt press. The facility includes three sand drying beds for emergency use. Final sludge is disposed of by landfill. The collection system is comprised of 100% separate sanitary sewers by design with one bypass point. The facility has a 1.0 MGD surge basin followed by two one-day lagoons to temporarily store flows exceeding the treatment plant capacity. In the event that temporary storage capacity is exceeded, the stored wastewater is chlorinated and dechlorinated, and discharged via bypass outfall 001. This facility discharges to the Dunkirk Drain. The facility accepts industrial flow from Ardagh Glass Containers (INP000201). This volume of flow accounts for as much as 50% of the overall flow to the WWTP. Based on the INP000201 effluent, copper, chloride, and oil and grease have been identified as pollutants of concern to the WWTP.

The Lake Placid Conference Center operates a Class I biochemical treatment facility consisting of two plants. The old plant is rated at 0.028 MGD and consists of a bar screen, an oxidation ditch, effluent chlorination/dechlorination facilities, a post aeration tank, and an effluent flow meter. The new plant is rated at 0.012 MGD and consists of a 4,000 gallon aerated equalization tank, one 12,000 gallon aeration

tank, one 2,000 gallon final clarifier, one 1,400 gallon aerated sludge holding tank and chlorination/dechlorination facilities at the effluent point. The new plant functions as the main WWTP during low flow. The old plant is placed in line and both operate during high flow into the plant. The discharge from both plants share a common outfall. Waste sludge is hauled offsite for disposal. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. This facility discharges to Little Lick Creek. There is no significant industrial flow to the Lake Placid Conference Center WWTP.

The Jackson Township Regional Sewer District operates a Class I constructed wetland treatment facility consisting of an influent flow meter, a biological aerated filter, a three-celled constructed wetland, and ultraviolet light disinfection. Bio-solids are hauled off-site. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. This facility discharges to Big Lick Creek. There are no industrial flow contributions to the WWTP. This facility has been in noncompliance 7 out of the last 12 quarters. There were violations for *E. coli* and ammonia nitrogen during the sampling period from 4/1/2014 to 6/30/2014. There have also been five informal enforcement actions and one formal enforcement action, although all were issued outside of sampling for this project.

The Hartford City WWTP is a Class III activated sludge-type treatment facility consisting of primary and secondary clarifiers, tertiary filters, chlorination/dechlorination facilities and an effluent flow meter. Sludge is treated by a lime stabilization system. Final sludge is given away or sold for land application and soil treatment. The collection system is comprised of combined sanitary and storm sewers with sixteen CSO locations. The mass limits for CBOD, TSS and Ammonia have been calculated utilizing the peak design flow of 3.5 MGD. This is to facilitate the maximum of flow through the WWTP in accordance with the IDEM CSO policy. This facility discharges to Moore Prong. The permittee accepts industrial flow from Hartford City Paper (INP000082) and Key Plastics (INP000144). However the flow volume of wastewater makes up less than 5% of the overall flow discharged from the Hartford City WWTP. IDEM has approved a LTCP for the facility which will allow the 1-year/1-hour storm to be fully treated through the WWTP.

The Town of Shamrock Lakes operates a Class I oxidation ditch treatment facility consisting of a macerator with a bar screen bypass, two secondary clarifiers and chlorination/dechlorination equipment. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. This facility discharges to Big Lick Creek. There is no industrial flow to the wastewater treatment plant.

PAWs Incorporated operates a Class I 0.00175 MDG Solar Aquatic Ecosystems wastewater treatment plant with grinder pumps and six aerated solar tanks. The tanks contain water hyacinths, duck weed, algae, snails and zooplankton. The wastewater then flows to an aerated lagoon that contains the aforementioned plants and organisms, as well as water lettuce, water hickory, azalea, koi, goldfish, bluegill, mosquito fish and plecostomus. The water flows by gravity from the aerated lagoon to a two-cell artificial wetland which contains wetland plants, native plants and horticultural crops growing in stone beds. Water from the artificial wetlands flows by gravity into an ultraviolet light disinfection unit and an ultrasonic flow meter before discharge. The collection system is comprised of 100% separate sanitary sewers by design with no overflow or bypass points. This facility discharges to an unnamed ditch to Campbell Creek. There is no significant industrial flow to the wastewater treatment plant.

The Town of Albany operates a Class II 0.4 MGD oxidation ditch treatment facility consisting of two 10,000,000 gallon flow equalization retention ponds with floating aerators, a bar screen, a comminutor, two oxidation ditches, a final clarifier, ultraviolet light disinfection and an effluent flow meter. Solids are handled via two aerobic digesters and three drying beds. Final solids are landfilled. The collection system is comprised of 100% separate sanitary sewers by design with two sanitary sewer overflows

identified and prohibited in Attachment A of the permit. The facility discharges to an unnamed ditch to the Mississinewa River, which has a seven day, ten year low flow ($Q_{7,10}$) of 2.5 cubic feet per second at the outfall location. There is no industrial flow to the wastewater treatment plant. In 2011, the facility completed installation of a new UV system for the treatment of *E. coli* to meet requirements from an enforcement case against the WWTP.

The Town of Eaton operates a Class II wastewater treatment facility consisting of a bar screen, a flow regulation valve, a grit removal chamber, a Parshall Flume influent flow meter, a macerator, raw wastewater pumps, two aeration basins, a flow control structure, two final clarifiers, a cascade aeration structure, a chlorination and dechlorination system and an effluent flow meter. Sludge treatment includes a sludge transfer lift station, aerobic digestion and a sludge storage tank. Final sludge is hauled offsite. The collection system is comprised of combined sanitary and storm sewers with two CSO locations. The CSO locations have been identified and permitted with provisions in Attachment A of the permit. The mass limits for CBOD, TSS and Ammonia have been calculated utilizing the peak design flow of 0.83 MGD. This is to facilitate the maximum of flow through the WWTP in accordance with the IDEM CSO policy. IDEM has approved a LTCP for the facility which will allow the 1-year/1-hour storm to be fully treated through the WWTP. This facility discharges to an unnamed ditch to the Mississinewa River. The permittee accepts industrial flow from Meridian Foods (IN0038016). Meridian Foods only discharges organic material so the facility is not required to do any additional treatment or monitoring.

Table 15 presents a summary of permit compliance for WWTP NPDES facilities in the Upper Mississinewa River watershed for the five year period between 2009 and 2013. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation for facility maintenance). The table also presents the total number of violations in the five year period. According to table 15, there have been 32 NPDES facility inspections resulting in violations in the five year period. Overall, there are a total of 74 permit violations for *E. coli*, nutrient, and sediment in the Upper Mississinewa River watershed.

Table 15. Summary of WWTP Inspections and Permit Compliance in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Inspection and Findings from 8/2009 through 8/2014	Violations from 8/2009 through 8/2015
Halfway Creek	Days Creek	NA	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA	NA

	Fetid Creek	Ridgeville WWTP	IN0020001	INB0323_01	10/20/2009: Marginal 10/27/2009: Marginal 1/20/2010: Unsatisfactory 3/10/2011: Satisfactory 4/23/2012: Unsatisfactory 6/12/20112: Unsatisfactory 10/30/2012:Unsatisfactory 1/16/2014: Unsatisfactory 2/24/2014:Marginal 7/7/2015: Satisfactory	3/31/2013: Nitrogen MO AV/ MX WK AV 10/31/2009: TR Chlorine Daily MX 6/30/2010: TR Chlorine Daily MX 7/31/2010:TR Chlorine Daily MX 9/30/2010: TR Chlorine Daily MX 6/30/2014: TR Chlorine Daily MX 7/31/2014: TR Chlorine Daily MX 8/31/2014: TR Chlorine Daily MX 9/30/2014: TR Chlorine Daily MX 10/31/2014: TR Chlorine Daily MX 5/31/2015: TR Chlorine Daily MX 6/30/2015: TR Chlorine MO AVE/Daily MX 4/30/2014: *E. coli* Daily MX
	Bush Creek	NA	NA	NA	NA	NA
	Redkey Run	Redkey WWTP	IN0024406	INB0325_T1002	4/19/2011: Unsatisfactory 1/5/2012: Unsatisfactory 9/6/2012: Unsatisfactory 1/23/2013: Unsatisfactory 8/22/2013: Unsatisfactory 4/10/2014: Unsatisfactory 9/15/2014: Unsatisfactory 11/12/2014: Unsatisfactory	11/30/2012: DO Daily MIN 12/31/2012: TSS MO AV/MX WK AV 10/31/2013: Nitrogen MO AV/MX WK AV 4/30/2010: TR Chlorine MO AV 10/31/2012 TR Chlorine Daily MX/Daily MX 4/30/2013: TR Chlorine Daily MX 6/30/2015: Daily MX 4/30/2013: *E. coli* Daily MX

	Platt Nibarger Ditch	Riverside Community MHP	IN0041173	INB0326_01	12/8/2009:marginal 8/13/2010: Unsatisfactory 11/4/2010: Unsatisfactory 2/16/2011: Unsatisfactory 3/3/2011: Unsatisfactory 5/12/2011: Unsatisfactory 5/3/2012: Unsatisfactory 7/15/2013: Unsatisfactory 12/19/2013: Unsatisfactory	1/31/2010: BOD MO AV 1/31/2010: TSS MO AV 4/30/2012: TR Chlorine Daily MX 9/30/2012: *E. coli* Daily MX 11/30/2012: TSS MO AV 3/31/2013: TSS MO AV 4/30/2013: TSS MO AV 2/28/2014: TSS MO AV 3/31/2014: TSS MO AV 6/30/2014: *E. coli* Daily MX 8/28/2014: *E. Coli* Daily MX 2/28/15: *E. Coli* Daily MX 7/28/2015: *E. Coli* Daily MX
Big Lick Creek	Little Lick Creek	Dunkirk WWTP	IN0021491	INB0331_01	7/8/2011: Marginal 10/18/2011: Marginal 6/26/2012: Marginal 5/6/2013:Satisfactory 5/19/2013: Satisfactory 3/18/2015: Marginal	6/30/2010: TSS MO Av 6/30/2010: TSS MX WK AV 10/31/2011: TSS MX WK AV 7/31/2015: MX WK AV 7/31/2015: TSS MO AV 7/31/2015: Nitrogen MX WK AV 7/31/2014:TR Chlorine DAILY MX 8/31/2014:TR Chlorine DAILY MX 6/30/2015:TR Chlorine DAILY MX

		Lake Placid Conference Center	IN0030015	INB0331_T1001	7/6/2011: Unsatisfactory 2/28/2012: Satisfactory 4/22/2014: Marginal	6/30/2010: Nitrogen MX WK AV 8/31/2010: Nitrogen MO AV/MX WK AV 6/30/2011: Nitrogen MO AV/MX WK AV 6/30/2012: Nitrogen MO AV/MX WK AV 7/31/2012: Nitrogen MX WK AV 10/31/2012: Nitrogen MX WK AV 6/30/2013: Nitrogen MX WK AV 7/31/2013: Nitrogen MO AV/MX WK AV 10/31/2013: Nitrogen MO AV/MX WK AV 6/30/2014 Nitrogen MO AV/MX WK AV 7/31/2014: Nitrogen MO AV/MX WK AV 10/31/2014: Nitrogen MX WK AV 2/28/2015: Nitrogen MX WK AV

		Jackson County RSD	IN0061000	INB0331_02	2/16/2010: Unsatisfactory 5/17/2010: Unsatisfactory 6/8/2010: Unsatisfactory 5/17/2011: Unsatisfactory 11/9/2012: Unsatisfactory 8/27/2013: Satisfactory 12/4/2014:Unsatisfactory	3/31/2013: TSS MX WK AV 12/31/2013: TSS MX WK AV 8/31/2015: TSS /MO AV/ MX WK AV 6/30/2015: TSS MO AV/ MX WK AV 2/29/2012: Nitrogen MO AV/ MX WK AV 3/31/2012: Nitrogen MO AV/ MX WK AV 4/30/2012: Nitrogen MO AV/ MX WK AV 5/31/2012: Nitrogen MO AV/ MX WK AV 12/31/2013: Nitrogen MO AV/ MX WK AV 5/31/2014 Nitrogen MO AV/ MX WK AV 7/31/2012: *E. coli* Daily MX 6/30/2014: *E. coli* Mo Geo/Daily MX 10/31/2014: *E. coli* Mo Geo/Daily MX 6/30/2015: BOD MO AV/MX WK AV

	Townsand Lucas Ditch	Hartford City WWTP	IN0021628	INB0332_T1001	11/18/2009: Marginal 1/26/2011: Marginal 2/13/2012: Satisfactory 4/3/2013: Unsatisfactory 1/29/2015: Unsatisfactory 5/28/2015: Unsatisfactory	9/30/2013: DO Daily AV MIN 11/30/2014: DO Daily AV MIN 12/31/2014: DO Daily AV MIN 11/30/2014: TSS Mo AV/TSS MX WK AV 12/31/2014:TSS MO AV/TSS MX WK AV 12/31/2014: TSS MO AV/ MX WK AV 1/31/2015: TSS MO AV/MX WK AV 2/25/2015: TSS MO AV/ MX WK AV/ MX WK AV 3/31/2015: TSS MO AV/ MX WK AV 5/31/2015: TSS MO AV 12/31/2013: Nitrogen MO AV/ MX WK AV 1/31/2015: Nitrogen MO AV/ MX WK AV 2/28/2015: Nitrogen MX WK AV 3/31/2015: Nitrogen MO AV/ MX WK AV 4/30/2015: Nitrogen MO AV/ MX WK AV 5/31/2015: Nitrogen MO AV/ MX WK AV 4/30/215: TR Chlorine MO AV 6/30/2015: TR Chlorine MO AV 2/28/2015: Mercury MO AV/Daily MX 11/30/2015: BOD MO AV/ MX WK AV 12/31/2014: BOD MO AV/ MX WK AV 1/31/2015: BOD MO AV/ MX WK AV 2/28/2015: BOD MO AV/ MX WK AV 3/31/2015: BOD MO AV/ MX WK AV

		Shamrock Lakes WWTP	IN0049832	INB0332_T1003	11/18/2009: Marginal 10/24/2011: Satisfactory 9/18/2014: Satisfactory	7/31/2013: *E. Coli* Daily MX
Pike Creek	Campbell Creek	PAWS, Inc WWTP	IN0055271	INB0341_01	1/31/2011: Unsatisfactory 12/20/2011: satisfactory 1/15/2014: Satisfactory	11/30/2010: DO Daily MIN 10/31/2009: Nitrogen MO AV/MX WK AV 1/31/2010: Nitrogen MX WK AV 5/31/2010: Nitrogen MO AV/MX WK AV 8/31/2010: Nitrogen MO AV/MX WK AV 9/30/2010 Nitrogen MX WK AV 10/31/2010: Nitrogen MO AV/MX WK AV 11/30/2010: Nitrogen MO AV/MX WK AV 12/31/2010: Nitrogen MX WK AVE 12/31/2011: Nitrogen MO AV/MX WK AVE 9/30/2012: *E. coli* Daily MX
	Rees Ditch	Albany WWTP	IN0022136	INB0342_01	8/3/2009: Marginal 10/20/2010: Marginal 9/18/2012: Satisfactory 5/30/2014: Marginal 2/4/2015: Satisfactory	2/28/2014 : TSS MX WK AV 4/30/2010: TR Chlorine Daily Min
	Studebaker Ditch	NA	NA	NA	NA	NA

	Holden Ditch	Eaton WWTP	IN0021652	INB0344_01	5/26/2010: Marginal 2/28/2011: Marginal 9/23/2011: Marginal 4/9/2013: Marginal 10/11/2013: Satisfactory 11/18/2014: Marginal	8/31/2014: DO Daily AV MIN 1/31/2011: TSS MX WK AV 12/31/2013: TSS MX WK AV 10/31/2009: Nitrogen MO AV 10/31/2009: Nitrogen MX WK AV 9/30/2009: TR Chlorine Daily MX 10/31/2009 TR Chlorine Daily MX 5/31/2015: TR Chlorine Daily MX 10/31/2009: *E. coli* Daily MX 9/30/2012: *E. coli* Daily MX

Understanding Table 15: WWTP Inspections and Violations may lead to impairments in the waterways into which they discharge. Information in each column is as follows:

- *Column 1: Name of watershed.* Lists the name of the watersheds.
- *Column 2: Name of subwatershed.* Lists the name of the subwatersheds.
- *Column 3: Facility Name.* Lists the Name of each Facility
- *Column 4: Permit Number.* Lists the Permit number for each Facility
- *Column 5: Current AUID*. Provides the updated AUIDs associated with each subwatershed.
- *Column 6: Inspetion and Findings.* Provides dates and results for each inspection.
- *Column 7: Violations.* Provides each violation reported to IDEM by WWTP. MO = Month, MX = Max, AV= Average, TR= Total Reactive, WK = Week,

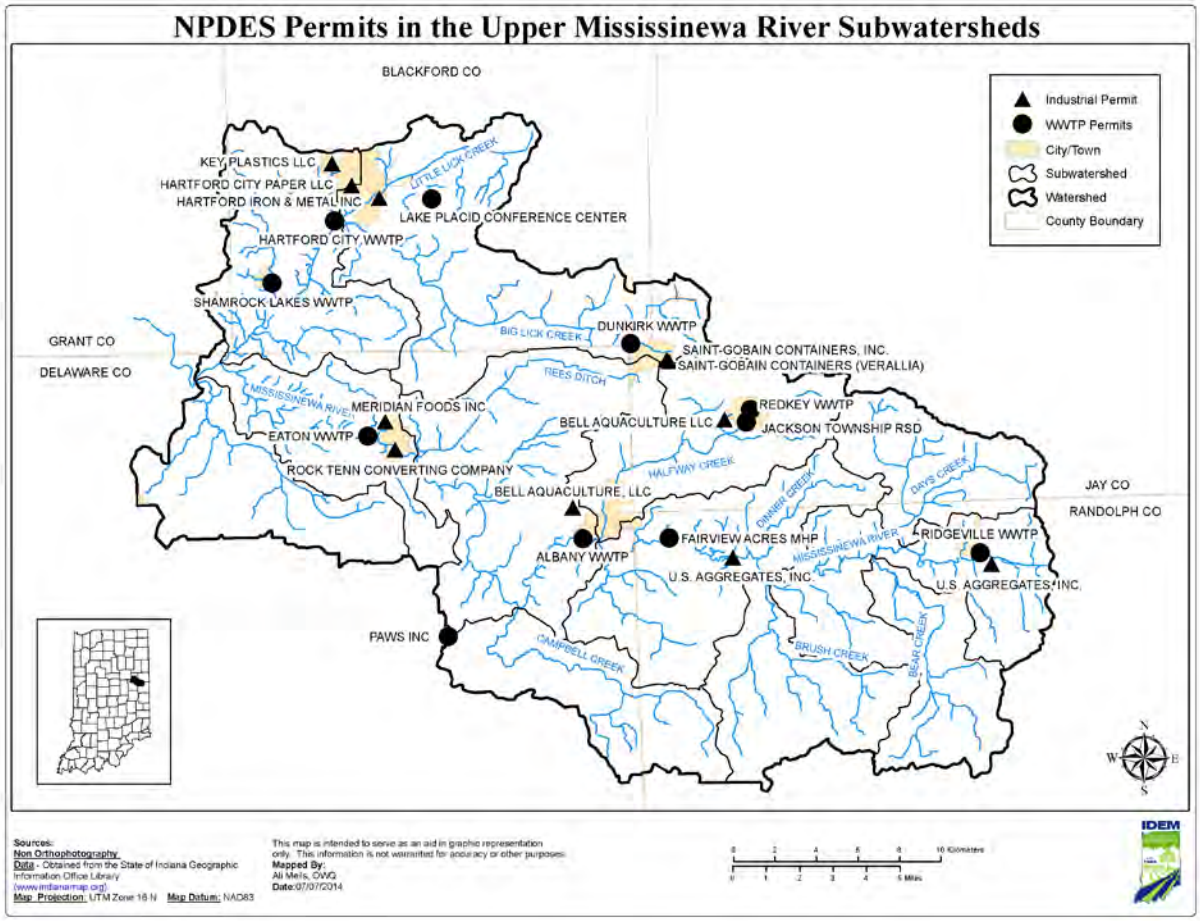

Figure 17. NPDES Permitted Industrial Facilities and Wastewater Treatment Plants Discharging within the Upper Mississinewa River Subwatersheds

4.2.2.2 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. One key component of this program is locating all CSO outfalls for tracking purposes. There are four combined sewer systems in the Upper Mississinewa River Watershed operated by the towns of Ridgeville, Hartford City, Redkey, and Easton. There are 28 CSO outfalls associated with these combined sewer systems as shown in Table 16 and Figure 18.

Table 16. CSOs in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Facility	Permit #	AUID	Outfall #	Pipe Description	Receiving Stream
Halfway Creek	Days Creek	NA	NA	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA	NA	NA
	Fetid Creek	Ridgeville WWTP	IN0020001	INB0323_T1003	002	CSO	Ridge Run
				INB0323_01	101	CSO	Mississinewa River
	Bush Creek	NA	NA	NA	NA	NA	NA
	Redkey Run	Redkey WWTP	IN0024406	INB0325_T1002	002	Union at Creek	Redkey Run
					004	Bell at Spencer	
					005	Harrison at Bridge	
					006	Hwy 67, E of Hwy 1	
					007	Plant Headworks	
				INB0325_T1003	008	Nixon and Daugherty St	Unnamed Tributary to Halfway Creek
					009	Nixon and Daugherty St	Unnamed Tributary to Halfway Creek
				INB0325_T1002	010	Meridian and Main St	Redkey Run
	Platt Nibarger Ditch	NA	NA	NA	NA	NA	NA
Big Lick Creek	Little Lick Creek	Hartford City WWTP	IN0021628	INB0331_T1001	003	Little Lick Cr and SR 26	Mud Run
					004	Lift Station Overflow at Little Lick Cr and SR 26	
					005	Little Lick Cr and N&W Railroad	Little Lick Creek
					006	CR Railroad Lift Station	
					007	Lift Station at Abandoned Eastside Treatment Plant	
					008	Fulton and Maple	Unnamed Tributary to Little Lick Creek

					009	Little Lick Cr and SR 3	Little Lick Creek
					013	Little Lick Cr and Monroe Street	Little Lick Creek
					014	Little Lick Cr and Jefferson Street	
					015	Big Lick Creek and SR 3	Big Lick Creek
					017	Little Lick Creek and Woodland Dr	Little Lick Creek
					018	Little Lick Creek at 3M	Little Lick Creek
					019	Little Lick Creek and Monroe Street	Little Lick Creek
	Townsand Lucas Ditch	Hartford City WWTP	IN0021628	INB0332_T1001	011	Elm and Wabash	Unnamed Tributary to Moore Prong
					012	Water Street Golf Course	
					016	Westside Treatment Plant	Moore Prong
Pike Creek	Campbell Creek	NA	NA	NA	NA	NA	NA
	Rees Ditch	NA	NA	NA	NA	NA	NA
	Studebaker Ditch	NA	NA	NA	NA	NA	NA
	Holden Ditch	Eaton WWTP	IN0021652	INB0344_01	002	WWTP overflow from plant headworks	Mississinewa River
					003	Romney Street overflow	Mississinewa River

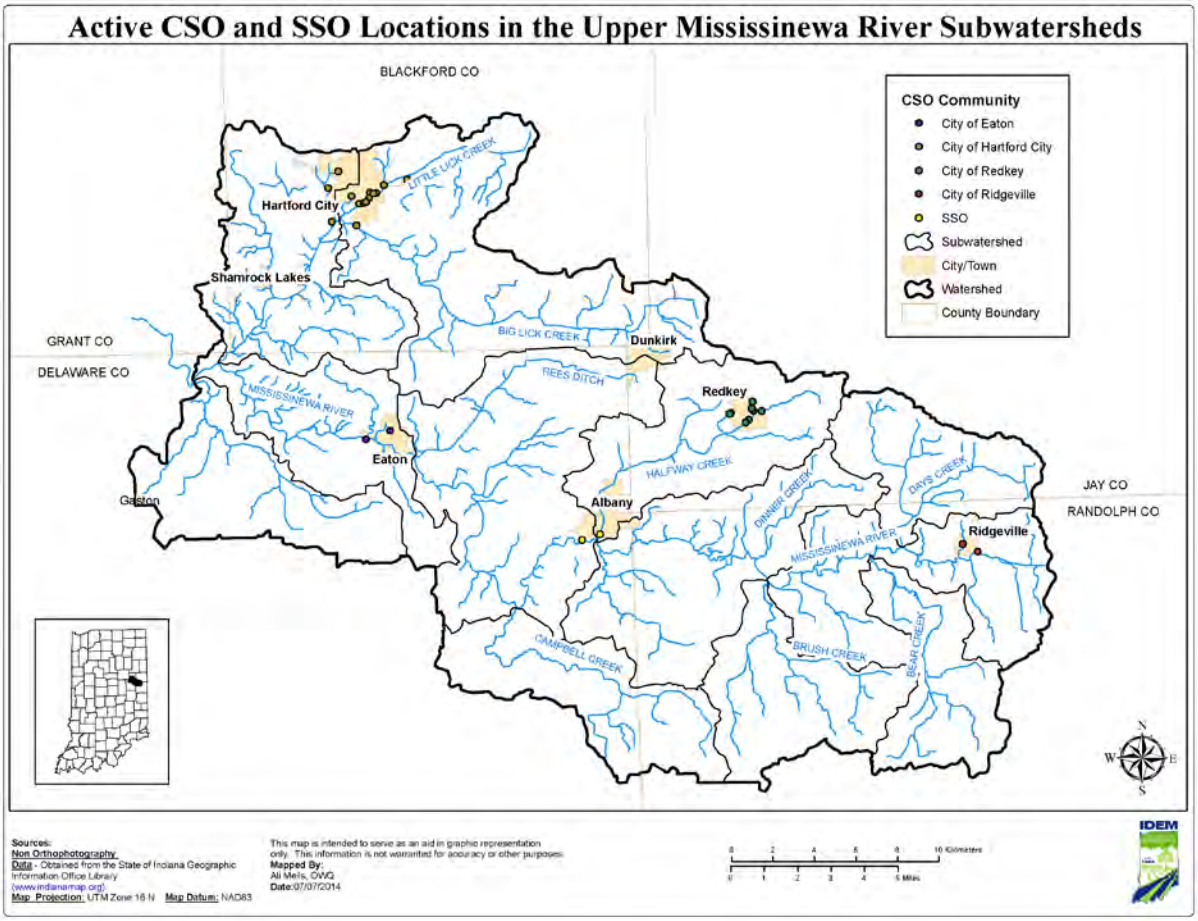

Figure 18. CSOs and SSOs in the Upper Mississinewa River Subwatersheds

Table 17 provides the number of CSO events per year in the Upper Mississinewa River watershed by facility. A CSO event is recorded any time an overflow occurs at any individual outfall. 100 CSO events with ten out falls are more reflective of 10 events with overflow at each outfall rather than 100 days of CSO overflow.

Table 17. Number of CSO Events Per Year in the Upper Mississinewa River Subwatersheds

Subwatershed	Facility Name	Permit #	AUID	Number of Outfalls	Number of CSO Events Per Year				
					2010	2011	2012	2013	2014
Days Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bear Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fetid Creek	Ridgeville WWTP	IN0020001	INB0323_T1003 INB0323_01	2	4 (0.72 million gallons)	17 (7.42 million gallons)	4 (0.26 million gallons)	No Data	No Data
Bush Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA
Redkey Run	Redkey WWTP	IN0024406	INB0325_T1002 INB0325_T1003	8	44 (23.28 million gallons)	59 (21.63 million gallons)	67 (14.10 million gallons)	105 (30.51 million gallons)	118 (44.31 million gallons)

Platt Nibarger Ditch	NA	NA	NA	NA	NA	NA	NA	NA	NA
Little Lick Creek	Hartford City WWTP	IN0021628	INB0331_T1001 INB0331_02	13	417 (46.78 million gallons)	596 (76.19 million gallons)	94 (12.61 million gallons)	207 (26.25 million gallons)	242 (40.71 million gallons)
Townsand Lucas Ditch	Hartford City WWTP	IN0021628	INB0332_T1001	3	96 (10.80 million gallons)	137 (17.58 million gallons)	22 (2.91 million gallons)	48 (6.05 million gallons)	55.92 (9.39 million gallons)
Campbell Creek	NA	NA	NA	NA	NA	NA	NA	NA	NA
Rees Ditch	NA	NA	NA	NA	NA	NA	NA	NA	NA
Studebaker Ditch	NA	NA	NA	NA	NA	NA	NA	NA	NA
Holden Ditch	Eaton WWTP	IN0021652	INB0344_01	2	29 (0.49 million gallons)	132 (26.6 million gallons)	89 (14.74 million gallons)	103 (42.13 million gallons)	177 (51.48 million gallons)

All CSOs in Indiana either have Long Term Control Plans (LTCPs) in place or are in the process of developing them, as required under their NPDES permits. Table 18 summarizes the requirements of the LTCPs and the expected completion date for each facility in the Upper Mississinewa River Watershed.

Table 18. Summary of CSO Long Term Control Plans in the Upper Mississinewa River Subwatershed

Facility Name	Permit #	AUID	LTCP Summary	Expected Completion Date
Ridgeville WWTP	IN0020001	INB0323_T1003 INB0323_01	To eliminate CSO discharges below the ten year/one hour design storm event to be installed in five phases.	December 2018
Redkey WWTP	IN0024406	INB0325_T1002 INB0325_T1003	Update WWTP facility and eliminate six CSOs and turn 4 CSOs into storm drains only.	August 2030
Hartford City WWTP	IN0021628	INB0331_T1001 INB0331_02 INB0332_T1001	Update WWTP to capture and convey flows generated by a 1-year/1-hour storm event.	December 2027
Eaton WWTP	IN0021652	INB0344_01	Update WWTP to capture and convey flows generated by a 1-year/1-hour and a 10-year/1-hour storm event.	December 2030

4.2.2.3 Sanitary Sewer Overflows

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

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

One permitted site with two SSO locations was identified in the Upper Mississinewa River Watershed (Table 19, Figure 18). As SSOs do not constitute a legal discharge they will not receive a Waste Load Allocation (WLA) for TMDL purposes. While it is recognized that SSOs contribute to pollutant loads in the Upper Mississinewa River Watershed these loads should be captured by the Load Allocation (LA) for their perspective Subwatershed.

Table 19. Sanitary Sewer Overflows in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Facility Name	Permit #	Type	AUID
Halfway Creek	Days Creek	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA
	Fetid Creek	NA	NA	NA	NA
	Bush Creek	NA	NA	NA	NA
	Redkey Run	Albany WWTP*	IN0022136	South of Water Street, east of Halfway Creek - Influent Structure	INB0325_01
	Platt Nibarger Ditch	NA	NA	NA	NA
Big Lick Creek	Little Lick Creek	NA	NA	NA	NA
	Townsand Lucas Ditch	NA	NA	NA	NA
Pike Creek	Campbell Creek	NA	NA	NA	NA
	Rees Ditch	Albany WWTP	IN0022136	Plant headworks - Influent Structure	INB0342_01
	Studebaker Ditch	NA	NA	NA	NA
	Holden Ditch	NA	NA	NA	NA

* Albany WWTP received a WLA of 0. Please see Section 7.3.5 for more information.

4.2.2.4 Industrial Facilities

Industrial facilities with NPDES permits produce wastewater generated through producing a product. Wastewater discharges from industrial sources may contain pollutants at levels that could affect the quality of receiving waters. The NPDES permit program establishes specific requirements for dischargers from industrial sources. If the industrial facility discharges wastewater directly to surface water then it requires an individual or general NPDES permit. A general permit, or permit-by-rule, is a "one size fits all" type of activity-specific permit. The general permit rule (327 IAC 15-1 through 15-4) covers the following activities: coal mining, coal processing, and reclamation activities, noncontact cooling water, petroleum products terminals, groundwater petroleum remediation systems, hydrostatic testing of commercial pipelines, and sand, gravel and stone operations. In contrast, individual permits are tailored to the specific activities of the facility and may regulate a number of additional pollutants other than those described under the general permits.

There are a total of 12 industrial facilities with NPDES permits within the Upper Mississinewa River watershed (Table 20). Based on the industrial activities and the regulated parameters within the specific permits there are 12 active industrial facilities that discharge wastewater containing *E. coli*, phosphorus, and/or sediment within the Upper Mississinewa River watershed (Table 20 & Table 21). These facilities are as follows: U.S. Aggregates, Bell Aquaculture, Ardagh Glass Containers, Hartford City Papers, Hartford Iron & Metal, Key Plastics, Meridian Foods, and Rock Tenn Converting Company. Summaries of the industrial permits within the Upper Mississinewa River watershed are described below.

Table 20. NPDES Permitted Industrial Facilities in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Maximum Design Flow (MGD)
Halfway Creek	Days Creek	NA	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA	NA
	Fetid Creek	U.S. Aggregates, Inc – Ridgeville Quarry	ING490050	INB0323_01	Mississinewa River	Outfall 001 – 1.40
	Bush Creek	NA	NA	NA	NA	NA
	Redkey Run	Bell Aquaculture, LLC	INP000288	NA	NA	NA
	Platt Nibarger Ditch	U.S. Aggregates, Inc – Fairview Quarry	ING490051	INB0326_01	Mississinewa River	Outfall 001 – 0.76
Big Lick Creek	Little Lick Creek	Ardagh Glass Containers	INP000201	NA	NA	NA
		Ardagh Glass Containers	IN0061816	IN0331_01	Big Lick Creek	Outfall 001 – 0.025 Outfall 002 – 0.275
		Hartford City Papers LLC	INP000082	NA	NA	NA
		Hartford Iron & Metal Inc	INP000612	NA	NA	NA
	Townsand Lucas Ditch	Key Plastics LLC	INP000144	NA	NA	NA
Pike Creek	Campbell Creek	NA	NA	NA	NA	NA
	Rees Ditch	Bell Aquaculture LLC	IN0062669	INB0342_01	Riley-Stafford Ditch	Outfall 001 – 0.396 Outfall 002 – 0.131 Outfall 003 – 0.056
	Studebaker Ditch	NA	NA	NA	NA	NA
	Holden Ditch	Meridian Foods Inc	INP000633	NA	NA	NA
		Meridian Foods Inc	IN0038016	INB0344_T1002	Holden Ditch	Outfall 001 - 0.13
		Rock Tenn Converting Company	IN0005002	INB0344_01	Mississinewa River	Outfall 001 – 0.036 Outfall 002 – 0.015 (intermittent) Outfall 003 – SW variable

Table 21 presents a summary of permit compliance for industrial NPDES facilities in the Upper Mississinewa River watershed for the five year period between 2009 and 2014. It presents the date of the facility's last inspection and findings from the inspection (i.e., compliance or violation for facility maintenance). The table also presents the total number of violations in the five year. According to table 21, there have been 8 NPDES industrial facility inspections resulting in violations in the five year period. Overall, there are a total of 14 permit violations for sediment (TSS) in the Upper Mississinewa River

watershed. Permits beginning with INP are pretreatment permits and thus have no receiving stream or outfall as the waste water is discharged to a WWTP for processing.

Table 21. Summary of Inspections and Permit Compliance for Industrial Facilities in the Upper Mississinewa River Subwatersheds for the Five Year Period Ending 8/2014.

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Inspection and Findings from 8/2009 through 8/2014	Violations for the Last Five Years				
						Month	Year	Parameter	Type	#Violations
Halfway Creek	Days Creek	NA	NA	NA	NA	NA				
	Bear Creek	NA	NA	NA	NA	NA				
	Fetid Creek	U.S. Aggregates, Inc – Ridgeville Quarry	ING490050	INB0323_01	1/14/2010: Satisfactory 8/28/2012: Satisfactory 1/27/2015:Satisfactory	NA				
	Bush Creek	NA	NA	NA	NA	NA				

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Inspection and Findings from 8/2009 through 8/2014	Violations for the Last Five Years				
						Month	Year	Parameter	Type	#Violations
	Redkey Run	Bell Aquaculture, LLC	INP000288	NA	11/19/2009: Marginal 10/22/2010: Satisfactory 9/18/2012: Satisfactory 12/6/2012: Marginal 10/29/2013: Unsatisfactory 5/15/2015: Unsatisfactory	April	2015	BOD	D. Max	1
						November	2014	BOD	D. Max	1
						March	2015	BOD	D. Max	1
						June	2014	BOD	D. max	1
						November	2013	BOD	D. Max	1
						March	2013	BOD	D. Max	2
						February	2013	BOD	D. Max	2
						January	2012	BOD	D. Max	1
						January	2012	TSS	D. Max	1
						November	2012	BOD	D. Max	2
						November	2012	TSS	D. Max	2
						October	2012	BOD	D. Max	2
						October	2012	TSS	D. Max	1
						September	2012	BOD	D. Max	2
						September	2012	TSS	D. Max	1
						August	2012	BOD	D. Max	4
						August	2012	TSS	D. Max	2
						July	2012	BOD	D. Max	2
						July	2012	TSS	D. max	2
						June	2012	BOD	D. Max	4
						June	2012	TSS	D. Max	4
						April	2012	BOD	D. Max	2
						April	2012	TSS	D. Max	1
						March	2012	BOD	D. Max	4
						March	2012	TSS	D. Max	4
						February	2012	BOD	D. Max	4
						February	2012	TSS	D. Max	4
						January	2012	BOD	D. Max	5
						January	2012	TSS	D. Max	5
	Platt Nibarger Ditch	U.S. Aggregates, Inc – Fairview Quarry	ING490051	INB0326_01	1/14/2010: Satisfactory 8/8/2012: Satisfactory	NA				

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Inspection and Findings from 8/2009 through 8/2014	Violations for the Last Five Years				
						Month	Year	Parameter	Type	#Violations
Big Lick Creek	Little Lick Creek	Ardagh Glass	INP000201	NA	5/8/2014: Marginal 4/29/2015: Satisfactory	January July January January November October September April February October February	2014 2013 2013 2012 2011 2011 2011 2011 2011 2010 2010	pH pH Oil/Grease Oil/Grease Oil/Grease Oil/Grease Oil/Grease Oil/Grease Oil/Grease Oil/Grease Oil/Grease	D. Max D. Max D. Max D. Max D. Max D. Max D. Max D. Max D. Max D. Max D. Max	1 1 1 2 1 2 1 1 1 1 1
		Ardagh Glass	IN0061816	IN0331_01	5/8/2014: Marginal 4/29/2015: Satisfactory	March December September June March December October Janurary	2015 2014 2014 2014 2014 2013 2013 2013	pH pH pH pH pH Temp Oil/Grease Temp	D. Max D. Max D. Max D. Max D. Max D. Max D. Max D. Max	1 1 1 1 1 1 1 2
		Hartford City Papers LLC	INP000082	NA	11/14/2011: Satisfactory 9/25/2014:Unsatisfactory 2/12/2015: Unsatisfactory 5/28/2015: Unsatisfactory	January January	2011 2010	TSS BOD	D. Max D. Max	1 1
		Hartford Iron & Metal Inc	INP000612	NA	5/12/2014: Marginal	NA				

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Inspection and Findings from 8/2009 through 8/2014	Violations for the Last Five Years				
						Month	Year	Parameter	Type	#Violations
	Townsand Lucas Ditch	NA	NA	NA	NA	NA				
Pike Creek	Campbell Creek	NA	NA	NA	NA	NA				
	Rees Ditch	Bell Aquaculture LLC	IN0062669	INB0342_01	11/19/2009: Marginal 10/22/2010: Satisfactory 9/18/2012: Satisfactory 12/6/2012: Marginal 10/29/2013: Unsatisfactory 5/15/2015: Unsatisfactory	February February December October	2015 2015 2014 2014	TSS BOD TSS Nitrogen	D. Max D. Max D. Max D. Max	2 1 1 1
	Studebaker Ditch	NA	NA	NA	NA	NA				
	Holden Ditch	Meridian Foods Inc	INP000633	NA	10/11/2013: Marginal 10/21/2014: Satisfactory					
		Meridian Foods Inc	IN0038016	INB0344_T1002	9/22/2009: Satisfactory 5/26/2010: Satisfactory 9/23/2011: Satisfactory 9/18/2012: Satisfactory 10/11/2013: Satisfactory 10/21/2014: Satisfactory					
		Rock Tenn Converting Company	IN0005002	INB0344_01	8/20/2009: Satisfactory 9/18/2012: Unsatisfactory 6/10/2014: Satisfactory					

U.S. Aggregates Incorporated has two locations within the watershed. Both locations are facilities engaged in sand, gravel, dimension stone or crushed store operations and therefore covered under the general permit rules outlined in 327 IAC 15-1 through 15-4 and 327 IAC 15-12.

Bell Aquaculture also has two locations within the watershed. Permit IN0062669 allows the facility to discharge from a fish hatchery in Albany, Indiana to the receiving waters of Riley Stafford Ditch. The discharge is comprised of processed wastewater. This facility spawns and raises Yellow Perch in aerated flow through tanks. The wastewater from these tanks is discharged to a settling basin, directed to a lift station and pumped to a larger sedimentation basin and directed to a constructed wetland for further treatment before discharging via outfall 001. The wastewater from the pass-through Early Life Stages Hatchery (ELSH) tanks is not considered sufficiently nutrient loaded to discharge to the constructed wetland. Therefore the wastewaters from the two ELSHs are discharged directly to Riley Stafford Ditch via outfalls 002 and 003. This facility discharges to Riley Stafford Ditch.

The Bell Aquaculture facility located in Redkey (INP000288) is a fish cleaning and preparation plant where they process and package fish for resale. In 2012 the facility proposed an installation of a wastewater pretreatment facility to ensure compliance of the sewer use ordinance due to future expansion of plants operations (increasing discharge from 30 gpm to 150 gpm). The wastewater pretreatment facility will include a lift station, a mechanical auger screen and a coalescing oil/water separator. Pretreated effluent will continue to be discharged into Redkey WWTP.

The Ardagh Glass Containers facility (INP000201) manufactures glass bottles and jars for food and beverage customers. The manufacturing processes include quenching, forming, cooling, and packing. The pretreatment discharge consists of wastewater from the glass shearing and molding process, floor washing/mold cleaning, thermal tank overflows and other ancillary wastewater producing operations. The wastewater is sent through a grit chamber and an oil and water separator, then injected with enzymes and nutrients for treatment and pumped to the aeration basins before being sent through a bentonite clay polishing filter. The permittee then discharges to the City of Dunkirk WWTP.

The Ardagh Containers facility (IN0061816) is classified under the Standard Industrial Classification (SIC) code 3221 – Glass Container Manufacturer. The discharge is limited to noncontact cooling water, furnace drain quench water, and stormwater. The permittee discharges to Dunkirk Drain which then drains to Big Lick Creek. This facility discharges to Dunkirk Drain.

Hartford City Paper LLC (INP000082) manufactures brown paper for the corrugating medium material used to manufacture corrugated paper containers and other protective packaging for consumer goods. The waste flows from the paper manufacturing are subject to the Categorical Pretreatment Standards (40 CFR 430, subpart J). The process wastewater consists of pretreatment discharge, sanitary and boiler blowdown. The permittee discharges to the Hartford City WWTP.

Hartford Iron and Metal (INP000612) is a scrap yard for metals recycling. The facility is under site remediation for contamination. The pretreatment facility is in place to treat contaminated storm water for discharge to the Hartford City WWTP. The contaminated storm water contains elevated levels of PCBs, aluminum, copper, iron, lead, zinc, TSS and COD.

Key Plastics LLC (INP000144) produces paints and assembles plastic automotive interior and exterior parts for various automobile manufacturers. Manufacturing processes include chemical etching with phosphoric acid, painting, cleaning and rinsing of plastic parts. The wastewater from these processes are subject to the Categorical Pretreatment Standards for New Source Metal Finishing Category operations (40 CFR 433.17). The wastewater consists of pretreatment discharge, sanitary, cooling water and condensate. The permittee discharges to the Hartford City WWTP.

Meridian Foods Incorporated (IN0038016 and INP000633) processes and cans a variety of beans. Manufacturing processes that generate wastewater include soaking the beans prior to canning and non-contact cooling water from the cooking processes. The permittee is classified under Standard Industrial Classification (SIC) Code 2032 – Canned Specialties and 2033 – Canned Vegetables. The wastewater generated enters a series of three lagoons before being discharged to an unnamed tributary of the Mississinewa River or sent to the Town of Eaton WWTP. The discharge to the unnamed tributary consists of non-contact cooling water combined with the treated process water.

Rock Tenn Converting Company (IN0005002) manufactures paperboard from a mixture of corrugated medium and recycled paper. The facility is classified under the Standard Industrial Classification (SIC) Code 2631 – Paperboard Mills. Outfall 001 discharges non-contact cooling water and stormwater into the Mississinewa River. Outfall 002 discharges process wastewater intermittently (4-5 times a year) to the Mississinewa River and Outfall 003 discharges storm water only. Outfall 002 tends to discharge only in the Fall or during extreme rainfall events. The facility discharges to the Mississinewa River.

Industrial Storm Water

Depending on the type of industrial facility operated more than one NPDES program may apply. Some industrial facilities require an additional permit under the storm water program which will be discussed in this section.

Industrial storm water permits are required for facilities where activities of the industrial operation are exposed to storm water and run-off is discharged though a point source to waters of the state. The general permit 327 IAC 15-6 (Rule 6) applies to specific categories of industrial activities that must obtain permit coverage. Determination of applicable industrial activities is based on a facility's Standard Industrial Classification (SIC) Code(s) or facility activities included in the listed narrative descriptions within the rule. Under certain circumstances, a facility may require an individual storm water permit. This permit is typically required only if a regulated industrial activity category has established effluent limitations or IDEM determines the storm water discharge will significantly lower water quality. Industrial storm water permits in the Upper Mississinewa River watershed are shown in Table 22 and Figure 19.

The facility must develop and implement a Storm Water Pollution Prevention Plan (SWP3), and submit a completed SWP3 Checklist Form certifying to IDEM that such a plan is in place. The SWP3 is used to identify potential and actual storm water pollutant sources, and to determine best management practices and measures that will minimize the pollutants transported in storm water run-off. The SWP3 itself must be retained at the facility, and made available for review during any on-site inspection. Periodically, the plan must be reviewed, and revised if changes at the facility alter conditions that could affect run-off.

Table 22. NPDES Industrial Storm Water Permits in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Estimated Acreage
Halfway Creek	Days Creek	NA	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA	NA
	Fetid Creek	NA	NA	NA	NA	NA
	Bush Creek	NA	NA	NA	NA	NA
	Redkey Run	NA	NA	NA	NA	NA

	Platt Nibarger Ditch	NA	NA	NA	NA	NA
Big Lick Creek	Little Lick Creek	Mosey Manufacturing Company	INRM00733	INB0331_01	Big Lick Creek	6.583
		Saint Gobain Containers LLC	INR210004	INB0331_01	Big Lick Creek	0.18
		Dunkirk Incorporated	INR00I006	INB0331_01	Big Lick Creek	31.036
		Hartford Iron & Metal Inc	INR600266	INB0331_T1001	Little Lick Creek	5.23
		Hartford City Paper LLC	INR00V009	INB0331_T1001	Little Lick Creek	9.77
		Hartford City Paper LLC	INR140013	INB0331_T1001	Little Lick Creek	
		3M Company	INRM00520	INB0331_T1001	Little Lick Creek	17.59
	Townsand Lucas Ditch	Key Plastics LLC	INR110367	INB0332_T1001	Unnamed Tributary to Moore Prong	5.02
		Mayco International	INR230013	INB0332_T1001	Unnamed Tributary to Moore Prong	4.96
		International Paper Company	INR140039	INB0332_T1001	Unnamed Tributary to Moore Prong	13.08
Pike Creek	Campbell Creek	NA	NA	NA	NA	NA
	Rees Ditch	Littler Diecast Corporation	INR200057	INB0342_01	Mississinewa River	4.25
	Studebaker Ditch	NA	NA	NA	NA	NA
	Holden Ditch	Rock Tenn Company Mill Division	INR140026	INB0344_01	Mississinewa River	10.29

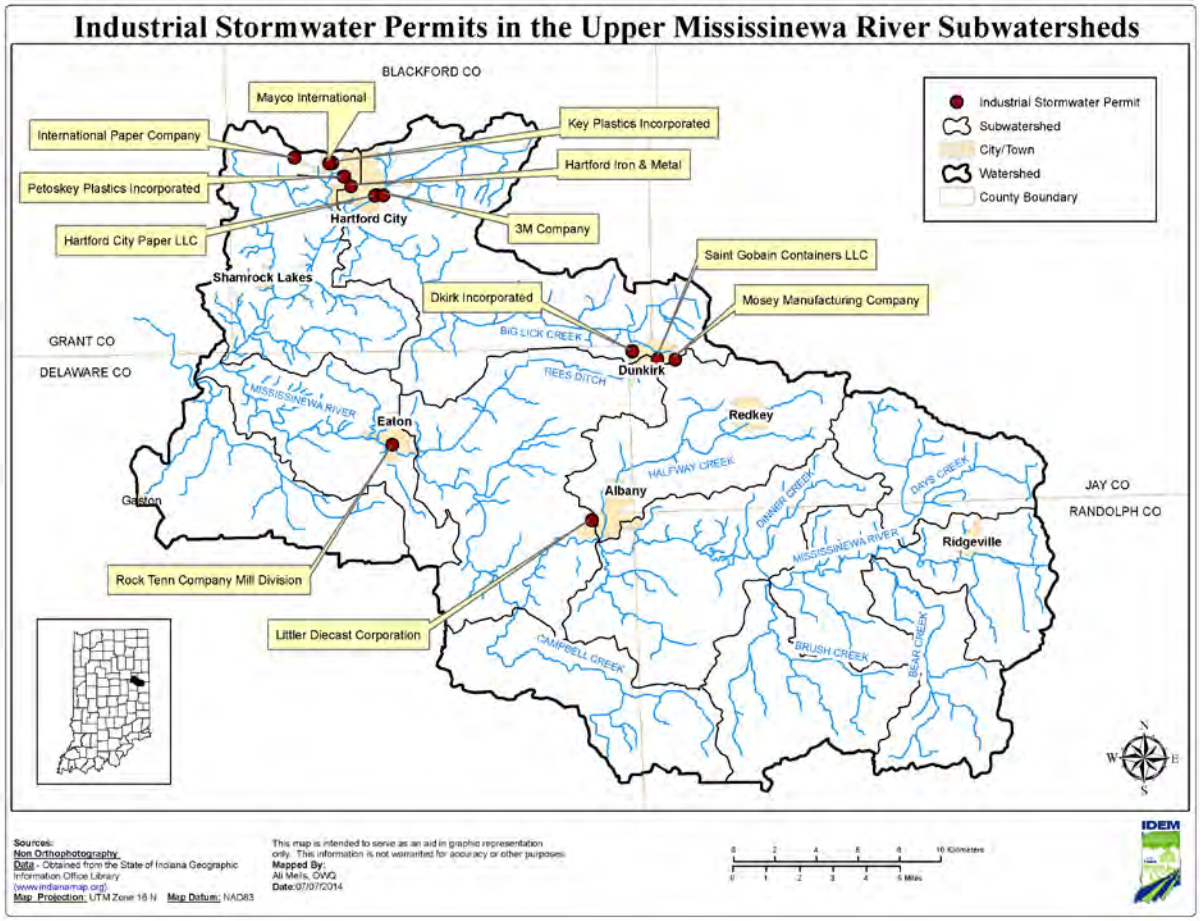

Figure 19. Industrial Stormwater Permits in the Upper Mississinewa River Subwatersheds

Construction Storm Water

Storm water run-off associated with construction activity is regulated under 327 IAC 15-5 which is commonly known as Rule 5. Rule 5 is a performance-based regulation designed to reduce pollutants that are associated with construction and/or land disturbing activities.

The requirements of Rule 5 now apply to all persons who are involved in construction activity (which includes clearing, grading, excavation and other land disturbing activities) that results in the disturbance of one (1) acre or more of total land area. If the land disturbing activity results in the disturbance of less than one (1) acre of total land area, but is part of a larger common plan of development or sale, the project is still subject to storm water permitting.

In Indiana most construction projects subject to Rule 5 are administered through a general permit. A general permit is a permit by rule, and as such it is not "issued" in the same manner as an individual NPDES permit would be issued. Rather, Rule 5 was "conditionally issued" to all future "project site owners" at the time that the rule was adopted by the Indiana Water Pollution Control Board. The permit conditions within Rule 5 apply universally to all "project site owners" who are eligible to operate under the rule.

Rule 5 requires the development of a Construction Plan and an integral part of the Construction Plan is a SWP3. The SWP3 addresses several issues. First, the plan outlines how erosion and sedimentation will be controlled on the project site to minimize the discharge of sediment off-site or to a water of the state. Second, the plan addresses other pollutants that may be associated with construction activity. This can include disposal of building materials, management of fueling operations, etc. Finally, the plan should also address pollutants that will be associated with the post construction land use. It is the responsibility of the project site owner to implement the storm water pollution prevention plan. In addition, it is critical that the site is monitored during the construction process and in field modifications are made to address the discharge of sediment and other pollutants from the project site. This may require modification of the plan and field changes on the project site, as necessary, to prevent pollutants, including sediment, from leaving the project site.

If an adverse environmental impact from a project site is evident, a Rule 5 permit or, in more significant situations, an individual storm water permit may be required. An individual storm water permit is typically required only if IDEM determines the discharge will significantly lower water quality. If an individual storm water permit is required, notice will be given to the project site owner. The acreage numbers in Table 23 were calculated by using an area weighted approach with using the past five years of permitted construction sites in Jay, Randolph, Delaware, Blackford and Grant counties.

Table 23. Permitted Construction Acreage in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Estimated Construction Acreage
Halfway Creek	Days Creek	20.54
	Bear Creek	22.60
	Fetid Creek	40.32
	Bush Creek	30.46
	Redkey Run	57.60
	Platt Nibarger Ditch	50.50
Big Lick Creek	Little Lick Creek	28.54
	Townsand Lucas Ditch	18.04
Pike Creek	Campbell Creek	8.96
	Rees Ditch	101.76
	Studebaker Ditch	55.68
	Holden Ditch	52.86

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

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 combined sewer overflows and publicly owned treatment works.

The federal Clean Water Act requires storm water discharges from certain types of urbanized areas to be permitted under the National Pollutant Discharge Elimination System (NPDES) program. In 1990, Phase

I of these requirements became effective, and municipalities with a population served by a municipal separate storm sewer system (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 is one MS4 entity in the Upper Mississinewa River Watershed. Delaware County is co-permitted with the City of Muncie, the Town of Yorktown and Ivy Tech Community College. The permitted area extends into several subwatersheds as shown in Table 24 and Figure 20. Only the developed area within the Delaware County boundary is used when calculating the MS4 area within each subwatershed.

Table 24. MS4 Communities in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	MS4 Facility Permit ID	MS4 Name	Area (Square Miles)
Halfway Creek	Days Creek	NA	NA	NA
	Bear Creek	NA	NA	NA
	Fetid Creek	NA	NA	NA
	Bush Creek	NA	NA	NA
	Redkey Run	INR040056	Delaware County	1.35
	Platt Nibarger Ditch	INR040056	Delaware County	0.37
Big Lick Creek	Little Lick Creek	INR040056	Delaware County	0.21
	Townsand Lucas Ditch	INR040056	Delaware County	0.13
Pike Creek	Campbell Creek	INR040056	Delaware County	0.67
	Rees Ditch	INR040056	Delaware County	2.84
	Studebaker Ditch	INR040056	Delaware County	1.28
	Holden Ditch	INR040056	Delaware County	1.95

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 20 shows the MS4 boundaries in the Upper Mississinewa River Watershed.

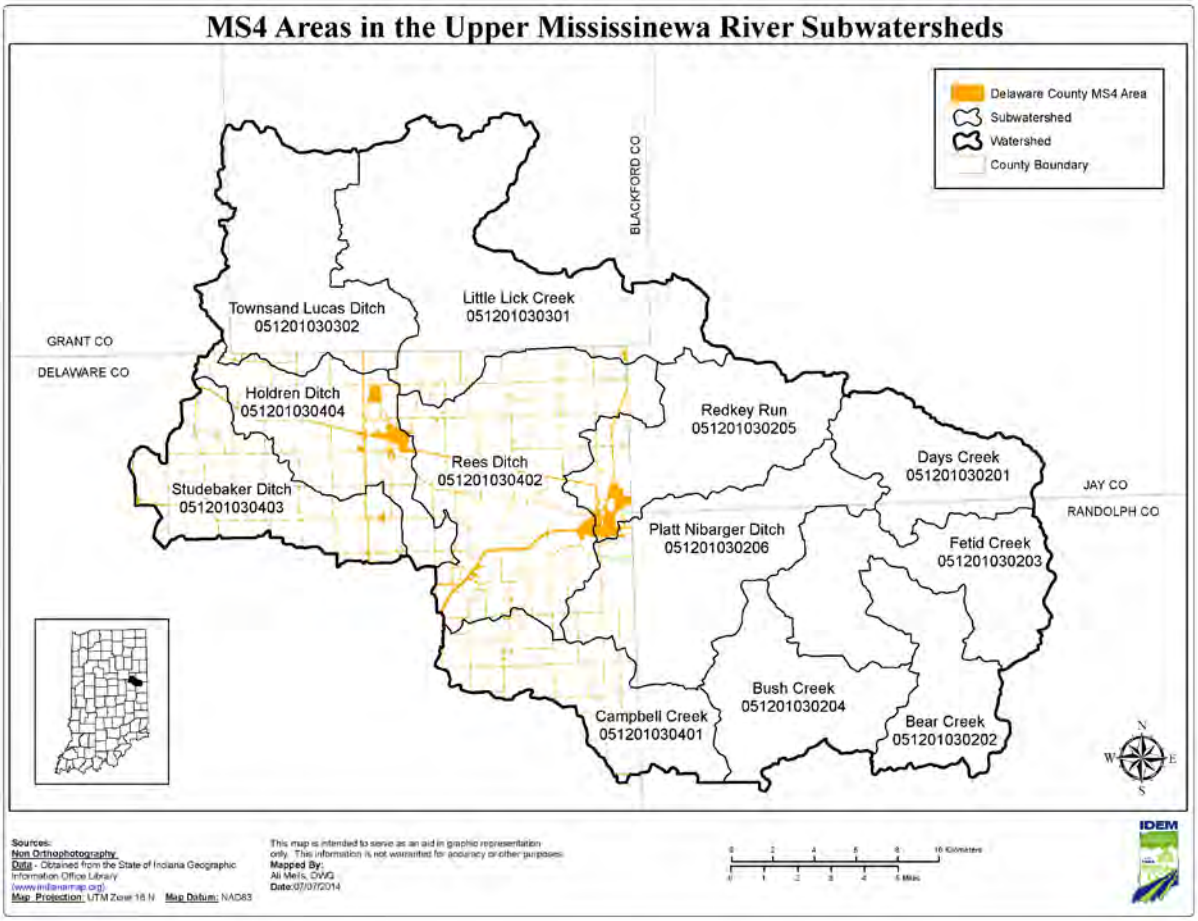

Figure 20. Map of MS4 Boundaries in the Upper Mississinewa River Subwatersheds

4.2.2.5 Illicitly Connected "Straight Pipe" Systems

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

4.2.3 Nonpoint Sources

This section summarizes the potential nonpoint sources of *E. coli,* nutrient, and sediment in the Upper Mississinewa River watershed that are not regulated through the National Pollutant Discharge Elimination System (NPDES) Program.

4.2.3.1 Cropland

Approximately 72 percent of the land in the Upper Mississinewa River Watershed is classified as row crops. Croplands can be a source of *E. coli*, sediments, and nutrients. Accumulation of nutrients and *E. coli* on cropland occurs from decomposition of residual crop material, fertilization with chemical (e.g., anyhdrous ammonia) and manure fertilizers, inorganic fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. The majority of nutrient loading from cropland occurs from fertilization with commercial and manure fertilizers

(Patwardhan, 1997). Use of manure for nitrogen supplementation often results in excessive phosphorus loads relative to crop requirements (Patwardhan, 1997).

Watershed specific data are not available for field specific crops. However, county-wide data available from the National Agricultural Statistic Service (NASS) were downloaded and area weighted to estimate crop acreage in the subwatershed. The area of the county within the subwatershed is divided by the area of the entire county and multiplied by the total acreage of crops in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of cropland with the watershed. The 2013 NASS statistics were used in the analysis as shown in Table 25.

Table 25. Major Cash Crop Acreage in the Upper Mississinewa River Subwatersheds

Crop	Total Acreage in County				
	Blackford	**Delaware**	**Grant**	**Jay**	**Randolph**
Corn	32,500	76,000	80,000	81,500*[2012]	103,000
Soybean	43,900	78,200	95,000	91,300	113,000
Winter Wheat	1,300	2,300	2,900	7,900	7,900*[2011]

Watershed	Subwatershed Area (mi²)	Crop	Total Acreage	Percentage of Subwatershed Crop Acreage
Halfway Creek	Days Creek	Corn	3672.89	45.26
		Soybean	4098.98	50.52
		Winter Wheat	342.91	4.23
		Total	**8114.24**	**100.00**
	Bear Creek	Corn	3638.88	46.00
		Soybean	3992.17	50.47
		Winter Wheat	279.10	3.53
		Total	**7910.14**	**100.00**
	Fetid Creek	Corn	6116.31	46.00
		Soybean	6710.13	50.47
		Winter Wheat	469.12	3.53
		Total	**13295.56**	**100.00**
	Bush Creek	Corn	4568.48	46.00
		Soybean	5012.03	50.47
		Winter Wheat	350.40	3.53
		Total	**9930.91**	**100.00**
	Redkey Run	Corn	5220.93	45.68
		Soybean	5764.33	50.43
		Winter Wheat	444.42	3.89
		Total	**11429.68**	**100.00**
	Platt Nibarger Ditch	Corn	6747.03	46.21
		Soybean	7360.08	50.41

		Winter Wheat	494.63	3.39
		Total	**14601.74**	**100.00**
Big Lick Creek	Little Lick Creek	Corn	9176.32	42.59
		Soybean	11955.53	55.49
		Winter Wheat	413.58	1.92
		Total	**21545.43**	**100.00**
	Townsand Lucas Ditch	Corn	5842.93	42.43
		Soybean	7699.43	55.91
		Winter Wheat	228.30	1.66
		Total	**13770.66**	**100.00**
Pike Creek	Campbell Creek	Corn	4251.04	47.69
		Soybean	4469.66	50.14
		Winter Wheat	193.77	2.17
		Total	**8914.47**	**100.00**
	Rees Ditch	Corn	7772.94	48.37
		Soybean	8034.00	50.00
		Winter Wheat	261.56	1.63
		Total	**16068.49**	**100.00**
	Studebaker Ditch	Corn	4151.04	48.56
		Soybean	4271.20	49.97
		Winter Wheat	125.62	1.47
		Total	**8547.87**	**100.00**
	Holden Ditch	Corn	3909.13	48.54
		Soybean	4026.57	49.99
		Winter Wheat	118.46	1.47
		Total	**8054.16**	**100.00**

*Year the data represents if 2013 numbers were not available.

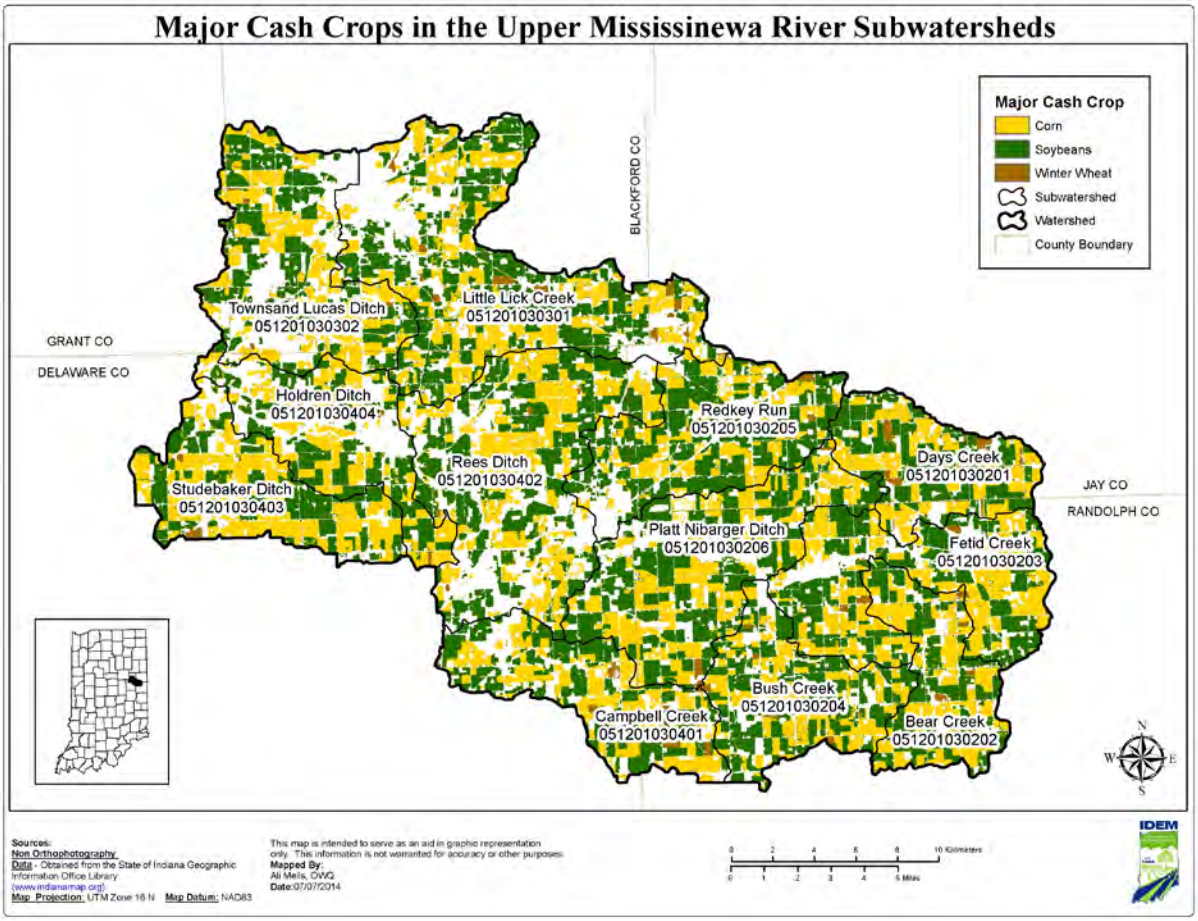

Figure 21. Major Types of Agriculture in the Upper Mississinewa River Subwatersheds

4.2.3.2 Pastures and Livestock Operations

Runoff from pastures and livestock operations can be potential agricultural sources of *E. coli*, nutrients, and TSS. 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* and nutrients to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. However, county-wide data available from the National Agricultural Statistic Service were downloaded and area weighted to estimate animal population in the subwatershed. The area of the county within the subwatershed is divided by the area of the entire county and multiplied by the total number of animals in the county based on the NASS survey. This is done for each county in the subwatershed and summed to get an area weighted estimate of animals with the subwatershed. There are an estimated 46,534 animal units in the Upper Mississinewa River watershed and the animal unit density averages 160 animal units per square mile as shown in table 26. The greatest animal unit densities are found in the Days Creek subwatershed and the Redkey Run subwatershed.

Table 26. Animal Unit Density in the Upper Mississinewa River Subwatersheds

	Hogs and Pigs	Cattle and Calves	Sheep and Goats	Horses and Ponies	Poultry
Number of Animals in One Animal Unit	2.5	1	10	0.5	250
Total Number of Head in County					
Blackford	24,256	1,286	477	195	810
Delaware	15,453	2,891	829	901	959
Grant	17,239	3,190	695	344	64,648[1]
Jay	139,000	10,749	1,016	778	2,646,411
Randolph	55,443	7,487	1,448	588	**

Total Number of Animal Units in Subwatersheds								
Watershed	Subwatershed	Hogs and Pigs	Cattle and Calves	Sheep and Goats	Horses and Ponies	Poultry	**Total**	**Animal Unit Density (animal units/mi²)**
Halfway Creek	Days Creek	2204	445	5	65	750*	3469	203
	Bear Creek	8,360*	265	5	42	**	8672	542
	Fetid Creek	6240*	445	9	70	**	6764	251
	Bush Creek	984	333	6	52	**	1375	68
	Redkey Run	3003	603	6	104	557	4273	171
	Platt Nibarger Ditch	11280*	530	9	100	736	12655	409
Big Lick Creek	Little Lick Creek	2948	448	13	125	122	3656	79
	Townsand Lucas Ditch	1578	230	8	74	336*	2226	75
Pike Creek	Campbell Creek	534	210	5	84	1	834	40
	Rees Ditch	869	333	9	182	52	1445	36
	Studebaker Ditch	338	158	5	98	1	600	28
	Holden Ditch	318	150	4	92	1	565	28

[1]Numbers came from 2002 inventory because 2007 was not available.
*Numbers adjusted based on known CFO farms in the subwatershed.
**No available information.

4.2.3.3 Confined Feeding Operations (CFOs)

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

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

Confined feeding operations that are not classified as CAFOs are known as confined feeding operations (CFOs) in Indiana. Non-CAFO animal feeding operations are considered nonpoint sources by USEPA. CAFOs have federal permits and fall under the jurisdiction of the NPDES program, as described in Section 4.2.2. Indiana's CFOs have state-issued permits but are not under the jurisdiction of the federal NPDES program 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 16, 327 IAC 15) 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 16, which implement the statute regulating confined feeding operations, were effective on March 10, 2002. The rule at 327 IAC 15-15, which regulates concentrated animal feeding operations and complies with most federal CAFO regulations, became effective on March 24, 2004, with two exceptions. 327 IAC 15-15-11 and 327 IAC 15-15-12 became effective on December 28, 2006. Point Source rules can be found at 327 IAC 5-4-3 (effective 12/28/06) and 327 IAC 5-4-3.1 (effective 3/24/04).

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

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

There are 24 CFOs in the Upper Mississinewa River Watershed as shown in Table 27 and Figure 22.

Table 27. CFOs in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Operation Name	Farm ID	AUID	Animal Type and Number
Halfway Creek	Days Creek	Muhlenkamp Swine	3870	INB0321_01	4,000 Nursery Pigs
		Ryan Outcalt	6327	INB0321_T1001	1,600 Nursery Pigs
		DZ Farms Incorporated	6556	INB0321_T1001	4,000 Finishers
		P James & C Ronald Zimmerman	6055	INB0321_T1001	183,120 Layers
	Bear Creek	Andrew Chalfant	6716	INB0322_01	8,000 Finishers
		Aaron Chalfant Farms LLC	6536	INB0322_01	8,000 Finishers
		Roger Gough	4642	INB0322_01	780 Nursery Pigs 500 Finishers 396 Sow
		Mike and Shari Anderson	6420	INB0322_T1002	4,000 Finishers
	Fetid Creek	Dick Lavy	6400	INB0323_T1001	2,000 Finishers 5,600 Sows
		Stone Road Farms LLC	6557	INB0323_T1002	8,000 Finishers
	Bush Creek	NA	NA	NA	NA
	Redkey Run	Eric & Loria Pursifull	6216	INB0325_01	4,000 Finishers
		Retter Swine Finisher	6520	INB0325_T1002	2,180 Finishers
	Platt Nibarger	Stone Lane Farms LLC	6596	INB0326_01	8,000 Finishers

	Ditch	Jackson Farm	6429	INB0326_T1002	5,000 Finishers
		Shaffer Superior Genetics	2454	INB0326_T1002	3,000 Nursery Pigs 4,000 Finishers
		Shaffer T & C	4377	INB0326_T1002	3,200 Finishers
		Tyler Eric & Loria Pursifull	6399	INB0326_01	4,000 Finishers
		2W2M LLC	6496	INB0326_T1001	1,200 Finishers 2,800 Sows
		Retter Farms	4979	INB0326_T1001	184,000 Layers
		Retter Swine Nursery 1	6518	INB0326_T1001	4,400 Nursery Pigs
		Retter Swine Nursery 2	6519	INB0326_T1001	4,400 Nursery Pigs
Big Lick Creek	Little Lick Creek	D & G Farms	3683	INB0331_01	2,450 Finishers
		Price Farms Incorporated	4262	INB0331_02	700 Nursery Pigs 3,200 Finishers 470 Sows
	Townsand Lucas Ditch	Maddox Brothers	4371	INB0332_T1003	84,000 Pullets
Pike Creek	Campbell Creek	NA	NA	NA	NA
	Rees Ditch	NA	NA	NA	NA
	Studebaker Ditch	NA	NA	NA	NA
	Holden Ditch	NA	NA	NA	NA

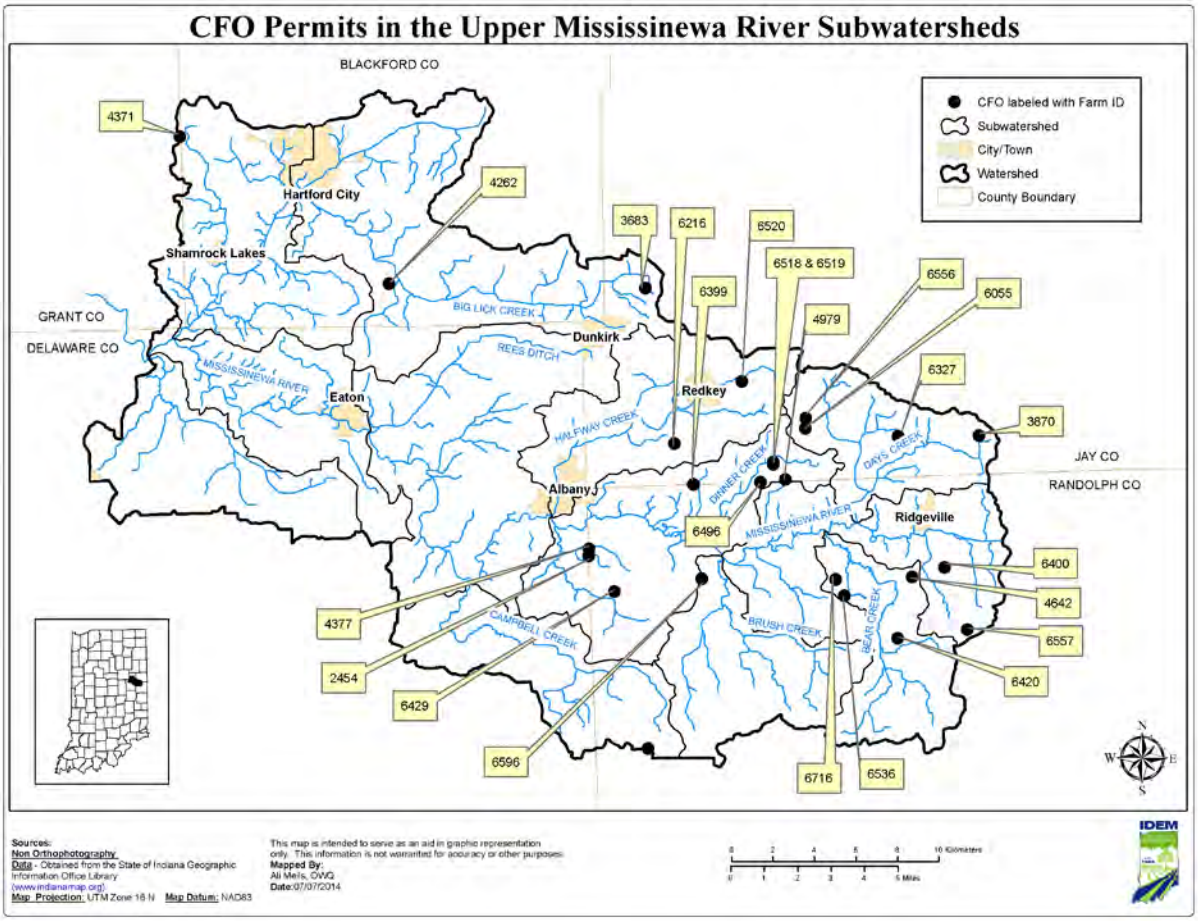

Figure 22. Confined Feeding Operations in the Upper Mississinewa River Subwatersheds

4.2.3.4 Streambank Erosion

Streambank erosion is potentially a significant source of TSS in the Upper Mississinewa River 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.
- Intensive Dredging and ditch maintenance can lead to unstable banks creating further erosion and the need for further dredging.

4.2.3.5 Onsite Wastewater Treatment Systems

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

The Indiana State Department of Health (ISDH) regulates (410 IAC 6-8.3) through the local health departments the residential onsite sewage disposal program. Onsite sewage disposal systems (i.e., septic systems) are those, which do not result in an off-lot discharge of treated effluent, typically consisting 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 Upper Mississinewa River Watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The US Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by dividing the subwatershed area by the total county area and multiplying it by the county census population. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural population density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last Census that inventoried how household wastewater is disposed. The rural households in the Upper Mississinewa River watershed is shown in Table 29, 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 Upper Mississinewa River 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 28 illustrates the hydrologic soil groups for the Upper Mississinewa River Subwatersheds.

Table 28. Hydrologic Soil Groups in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	Hydrologic Soil Group (Acres)			
		A	B	C	D
Halfway Creek	Days Creek	0	159.00	10,407.67	166.00
	Bear Creek	0	1,312.73	23,475.55	9.11
	Fetid Creek	0	1,669.17	30,513.87	16.25
	Bush Creek	0	71.56	25,016.10	32.71
	Redkey Run	0	326.03	15,387.11	310.64
	Platt Nibarger Ditch	0	1,555.72	31,640.10	17.88
Big Lick Creek	Little Lick Creek	179.95	334.07	27,375.60	1,541.41
	Townsand Lucas Ditch	88.36	1,039.08	23,155.94	296.27
Pike Creek	Campbell Creek	21.79	499.47	28,148.95	8.24
	Rees Ditch	20.48	5,638.69	30,574.47	68.25
	Studebaker Ditch	15.67	1,116.21	12,595.66	73.69
	Holden Ditch	24.78	3,923.98	18,758.66	6.10

Table 29. Rural Household Density in the Upper Mississinewa River Subwatersheds

Watershed	Subwatershed	County	Area of County in Subwatershed (mi^2)	County Households	Urban Households	Rural Households	Rural Houshold Density ($Houses/mi^2$)
Halfway Creek	Days Creek	Jay	14.26	178	0	178	11.46
		Randolph	2.84	18	0	18	
	Bear Creek	Randolph	16.01	167	0	167	10.43
	Fetid Creek	Randolph	26.91	663	387	276	10.26
	Bush Creek	Randolph	20.1	289	0	289	14.38
	Redkey Run	Delaware	4.8	727	651	76	13.33
		Jay	20.21	926	668	258	
		Randolph	0.04	0	0	0	
	Platt Nibarger Ditch	Delaware	5.5	195	40	155	14.58
		Jay	6.1	57	0	57	
		Randolph	19.34	319	80	239	
Big Lick Creek	Little Lick Creek	Blackford	38.4	2,816	2,283	533	15.98
		Delaware	3.62	78	0	78	
		Jay	4.41	723	592	131	
	Townsand Lucas Ditch	Blackford	25.8	1,901	1,192	709	28.07
		Delaware	2.19	70	0	70	
		Grant	1.83	59	0	59	
Pike Creek	Campbell Creek	Delaware	14.83	491	0	491	29.67
		Randolph	6.17	160	28	132	
	Rees Ditch	Delaware	38.41	1,459	488	971	27.01
		Jay	1.86	599	482	117	

	Studebaker Ditch	Delaware	21.61	646	86	560	25.90
	Holden Ditch	Delaware	20.21	1193	886	307	15.29
		Grant	0.14	4	0	4	

4.2.3.6 Urban Storm Water

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. The percent and distribution of developed land in the Upper Mississinewa River watershed is discussed in Section 3.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of pet populations and residential areas that might receive fertilizer treatment. These estimates provide insight into the potential of urban nonpoint sources as important sources of nutrients or *E. coli* in the Upper Mississinewa River watershed.

Dog and cat populations were estimated for the Upper Mississinewa River Subwatersheds using statistics reported in the *2007 U.S. Pet Ownership & Demographics Sourcebook* (AVMA 2007). Specifically, the *Sourcebook* reports that on average 37.2 percent of households own dogs and 32.4 percent of households own cats. Typically, the average number of pets per household is 1.7 dogs and 2.2 cats. However, pets are likely only a significant source of *E. coli* and nutrients in population centers (i.e., cities and towns) due to a higher concentration of animals. The estimates of domestic pets in cities and towns in the watershed are presented in Table 30 and are based on the average number of pets per household multiplied by the households in the urban areas of the subwatersheds.

Table 30. Estimated Pet Populations in the Cities and Towns in the Upper Mississinewa River Watershed

Watershed	Subwatershed	City/Town	Households in 2010	Estimated Number of Cats	Estimated Number of Dogs
Halfway Creek	Days Creek	NA	NA	NA	NA
	Bear Creek	NA	NA	NA	NA
	Fetid Creek	Ridgeville	387	851.4	657.9
	Bush Creek	NA	NA	NA	NA
	Redkey Run	Redkey	668	1,469.6	1,135.6
		Dunkirk	4	8.8	6.8
		Albany	651	1,432.2	1,106.7
	Platt Nibarger Ditch	Albany	120	264	448.8
Big Lick Creek	Little Lick Creek	Hartford City	2,283	5,022.6	3,881.1
		Dunkirk	592	1,302.4	1,006.4
	Townsand Lucas Ditch	Hartford City	1,192	2,622.4	2,026.4
		Shamrock	140	308	238
Pike Creek	Campbell Creek	Parker City	28	61.6	47.6
	Rees Ditch	Eaton	20	44	34
		Albany	468	1,029.6	795.6
		Dunkirk	482	1,060.4	819.4
	Studebaker Ditch	Gaston	86	189.2	146.2
	Holden Ditch	Eaton	886	1,949.2	1,506.2
Total			8,007	17,615.4	13,611.9

4.2.3.7 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 exist 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 (Zecoski, 2005). Higher concentrations of wildlife in the habitats described in Table 31 could contribute *E. coli* and nutrients to the watershed, particularly during high flow conditions or flooding events.

Table 31. 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

Managed lands 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. These 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* and nutrients to the 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 32 and Figure 23 show the managed lands within the Upper Mississinewa River watershed. There are approximately 2,668 acres of managed and classified lands in the Upper Mississinewa River watershed.

Table 32. Managed Land and Classified Land in the Upper Mississinewa River Watershed

Managed Lands				
Watershed	**Subwatershed**	**Unit Name**	**Manager**	**Area (acres)**
Halfway Creek	Days Creek	NA	NA	NA
	Bear Creek	NA	NA	NA

	Fetid Creek	McVey Memorial Forest	Red Tail Conservancy	39.19
		Randolph Wildlife Management Area	DNR Fish and Wildlife	324.40
	Bush Creek	Davis Purdue Forest	Purdue University	48.33
		McVey Memorial Forest	Red Tail Conservancy	175.50
	Redkey Run	NA	NA	NA
	Platt Nibarger Ditch	Mississinewa Woods	Red Tail Conservancy	37.73
		McVey Memorial Forest	Red Tail Conservancy	36.62
		Randolph Wildlife Management Area	DNR Fish and Wildlife	181.56
Big Lick Creek	Little Lick Creek	NA	NA	NA
	Townsand Lucas Ditch	NA	NA	NA
Pike Creek	Campbell Creek	NA	NA	NA
	Rees Ditch	NA	NA	NA
	Studebaker Ditch	Ginn Woods	Ball State University	14.48
	Holden Ditch	Ginn Woods	Ball State University	150.93
			Total	**1,008.74**

Classified Lands (Acres)

Watershed	Subwatershed	Grassland	Woodland	Shrubland	Wetland	Other	Total
Halfway Creek	Days Creek	0	114.84	0	0	0	114.84
	Bear Creek	0	18.6	0	0	0	18.6
	Fetid Creek	0	132.03	0	0	0	132.03
	Bush Creek	0	173.15	0	0	0	173.15
	Redkey Run	NA	NA	NA	NA	NA	NA
	Platt Nibarger Ditch	3.8	119.29	0	0	0	123.09
Big Lick Creek	Little Lick Creek	0	140.1	7	0	0	147.1
	Townsand Lucas Ditch	0	143.71	10.3	0	0	154.01
Pike Creek	Campbell Creek	6	70.8	8	3.2	0	88.0
	Rees Ditch	31.04	292.39	80.07	12.3	7	422.8
	Studebaker Ditch	0	92.32	0	0	0	92.32
	Holden Ditch	0	162.25	29	1.9	0	193.14
						Total	**1,659.08**

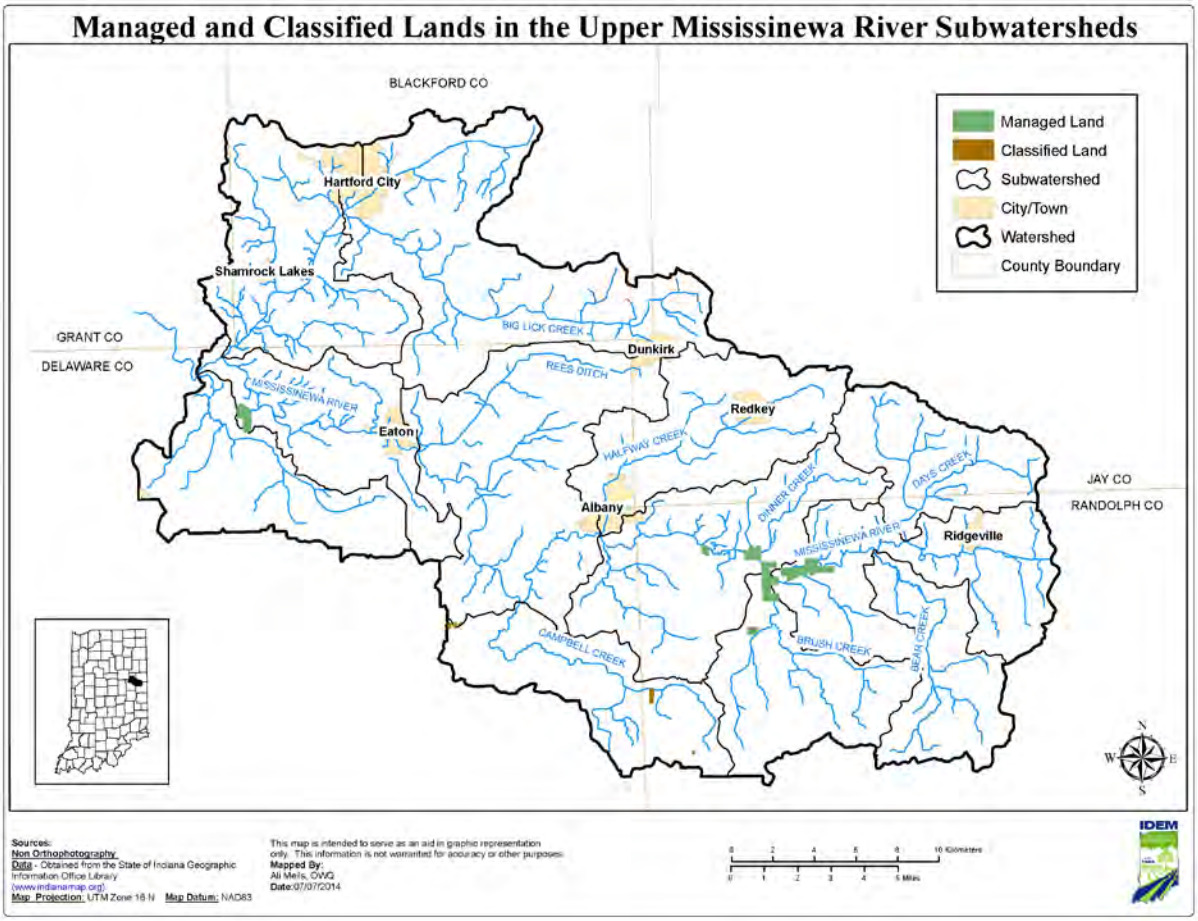

Figure 23. Managed Lands in the Whitewater River Watershed

5.0 INVENTORY AND ASSESSMENT OF WATER QUALITY INFORMATION

Below is an inventory assessment of the available biological and chemistry data for the Upper Mississinewa River Watershed related to *E. coli*, nutrient, TSS, and PCB's . Table 33 reiterates the TMDL target values presented in Section 1.0. The following values were results from IDEM's 2014 Baseline sampling performed by the Targeted Studies Section. A Sampling and Analysis Work plan with and overview of the sampling performed, as well as methodologies and standards for sampling are attached in Appendix D.

These are the water quality standards and target values IDEM used to assess water quality data collected in the Upper Mississinewa River Watershed.

Table 33. Target Values Used for Development of the Upper Mississinewa River Watershed TMDLs

Parameter	Target Value
Total phosphorus	No value should exceed 0.30 mg/L
Total Suspended Solids	No value should exceed 30.0 mg/L
E. coli	No value should exceed 125 counts/100 mL (geometric mean)
E. coli	No value should exceed 235 counts/100 mL (single sample)

5.1 Water Chemistry Data

Table 34 summarize the water chemistry data within the Upper Mississinewa River watershed by displaying the maximum concentrations (and geometric mean for *E. coli*) at all stations along with the reduction needed to meet the Water Quality Standard. Data sampled in 2014 by IDEM were used for the TMDL analysis.

The percent reductions were calculated as follows:

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

Appendix A shows the individual sample results and summaries of all the water quality data for all 35 monitoring stations.

Table 34. Summary of Chemistry Data in Upper Mississinewa River Watershed for Phosphorus, Total Suspended Solids, and Dissolved Oxygen.

Subwatershed	Station # (TMDL Site)	AUID	Period of Record	Total Phosphorus Single Sample Maximum (mg/L)	% Reduction based on highest concentration	Total Suspended Solids Maximum (mg/L)	% Reduction based on highest concentration	Dissolved Oxygen Minimum (mg/L)	% Below WQS based on minimum concentration
Days Creek	WMI-02-0006 (T9)	INB0321_01	4/14/2014 – 10/27/2014	0.73	58.90%	90	72.22%	5.04	NA
	WMI-02-0005 (T8)	INB0321_T1001	4/14/2014 – 10/27/2014	0.55	45.45%	44	43.18%	5.99	NA
Bear Creek	WMI-02-0012 (T4)	INB0322_01	4/14/2014 – 10/27/2014	0.4	25.0%	44	43.18%	8.05	NA
Fetid Creek	WMI020-0002 (T6)	INB0323_01	4/14/2014 – 10/27/2014	0.67	55.22%	89	71.91%	7.32	NA
	WMI-02-0007 (T10)	INB0323_02	4/14/2014 – 10/27/2014	0.42	28.57%	110	77.27%	4.73	NA
	WMI-02-0013 (T5)	INB0323_T1002	4/14/2014 – 10/27/2014	0.47	36.17%	62	59.67%	0.91	77.25%
Bush Creek	WMI-02-0009 (T12)	INB0324_01	4/14/2014 – 10/27/2014	0.34	11.76%	43	41.86%	5.3	NA
	WMI-02-0011 (T3)	INB0324_T1001	4/14/2014 – 10/27/2014	0.22	NA	27	7.40%	3.88	3.0%
	WMI-02-0010 (T2)	INB0324_T1002	4/14/2014 – 10/27/2014	0.54	44.44%	24	NA	8.33	NA
Redkey Run	WMI-02-0016 (T14)	INB0325_01	4/14/2014 – 10/27/2014	0.57	47.37%	74	66.21%	7.63	NA
	WMI-02-0017 (T16)	INB0325_T1002	4/14/2014 – 11/19/2014	0.35	14.29%	59	57.63%	7.31	NA

Platt Nibarger Ditch	WMI-02-0018 (T17)	INB0326_01	4/14/2014 – 11/19/2014	0.73	58.9%	79	68.35%	4.49	NA
	WMI-02-0015 (T13)	INB0326_T1001	4/14/2014 – 10/27/2014	0.38	21.05%	30	16.67%	5.39	NA
	WMI-02-0019 (T18)	INB0326_T1002	4/15/2014 – 10/28/2014	0.32	6.25%	23	NA	5.26	NA
Little Lick Creek	WMI-03-0003 (T22)	INB0331_01	4/15/2014 – 10/28/2014	0.96	68.75%	41	39.02	6.18	NA
	WMI040-0009 (T39)	INB0331_02	4/16/2014 – 10/29/2014	0.98	69.39%	180	86.11%	7.0	NA
	WMI-03-0008 (T40)	INB0331_T1001	4/16/2014 – 10/29/2014	0.73	58.90%	89	71.91%	2.21	44.75%
	WMI-040-0003 (T38)	INB0331_T1001	4/16/2014 – 10/29/2014	0.88	65.91%	120	79.17%	2.84	29.0%
Townsand Lucas Ditch	WMI-03-0006 (T36)	INB0332_01	4/16/2014 – 11/19/2014	0.98	69.39%	160	84.38%	6.42	NA
	WMI-03-0009 (T32)	INB0332_02	4/16/2014 – 10/29/2014	0.36	16.66%	160	84.38%	4.71	NA
	WMI-03-0007 (T37)	INB0332_T1001	4/16/2014 – 10/29/2014	0.85	64.71%	68	63.24%	7.61	NA
	WMI-03-0010 (T35)	INB0332_T1002	4/16/2014 – 10/29/2014	0.16	NA	73	65.75%	5.51	NA
	WMI-03-0005 (T34)	INB0332_T1003	4/16/2014 – 10/29/2014	0.26	NA	68	63.24%	3.93	1.75%
Campbell Creek	WMI-04-0014 (T20)	INB0341_01	4/14/2014 – 10/27/2014	0.54	44.44%	72	65.28%	6.52	NA
	WMI-04-0008 (T1)	INB0341_T1001	4/14/2014 – 10/27/2014	0.29	NA	98	74.49%	3.08	23.0%

Rees Ditch	WMI-04-0013 (T19)	INB0342_01	4/15/2014 – 10/28/2014	0.68	55.88%	73	65.75%	5.4	NA
	WMI-04-0017 (T25)	INB0342_01	4/15/2014 – 10/28/2014	0.74	59.46%	100	75%	6.19	NA
	WMI-04-0016 (T24)	INB0342_T1001	4/15/2014 – 10/28/2014	0.78	61.54%	2500	99%	5.16	NA
	WMI-04-0015 (T21)	INB0342_T1002	4/15/2014 – 10/28/2014	0.87	65.52%	230	89.13%	3.3	17.5%
	WMI-04-0018 (T23)	INB0342_T1002	4/15/2014 – 10/28/2014	0.98	69.39%	3000	99%	5.35	NA
Studebaker Ditch	WMI-04-0011 (T30)	INB0343_01	4/15/2014 – 11/19/2014	0.28	NA	20	NA	7.52	NA
	WMI-04-0010 (T29)	INB0343_T1003	4/15/2014 – 10/28/2014	0.22	NA	10	NA	5.86	NA
Holden Ditch	WMI-04-0019 (T26)	INB0344_01	4/15/2014 – 11/19/2014	0.48	37.5%	100	75%	7.95	NA
	WMI-04-0012 (T31)	INB0344_02	4/15/2014 – 11/19/2014	0.63	52.38%	95	73.68%	5.68	NA
	WMI-04-0009 (T28)	INB0344_T1003	4/15/2014 – 10/28/2014	0.18	NA	21	NA	6.42	NA

Understanding Table 34***:*** Chemistry data for the Upper Mississinewa River watershed indicates the following:

Days Creek

- Reductions of 52 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 58 percent or greater are needed to meet TMDL target values for TSS

Bear Creek

- Reductions of 25 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 43 percent or greater are needed to meet TMDL target values for TSS

Fetid Creek

- Reductions of 40 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 69 percent or greater are needed to meet TMDL target values for TSS

Bush Creek

- Reductions of 28. percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 25 percent or greater are needed to meet TMDL target values for TSS

Redkey Run

- Reductions of 31 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 62 percent or greater are needed to meet TMDL target values for TSS

Platt Nibarger Ditch

- Reductions of 29 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 43 percent or greater are needed to meet TMDL target values for TSS

Little Lick Creek

- Reductions of 66percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 69 percent or greater are needed to meet TMDL target values for TSS

Towsand Lucas Ditch

- Reductions of 50 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 72 percent or greater are needed to meet TMDL target values for TSS

Campbell Creek

- Reductions of 44 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 70 percent or greater are needed to meet TMDL target values for TSS

Rees Ditch

- Reductions of 62 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 86 percent or greater are needed to meet TMDL target values for TSS

Studebaker Ditch

- No Reductions needed

Holden Ditch

- Reductions of 45 percent or greater are needed to meet the TMDL target values for Phosphorus
- Reductions of 74 percent or greater are needed to meet TMDL target values for TSS

***Sites without needed reduction were not included in the above averages.**

5.2 Pathogen Data

Table 35 provides a summary of pathogen data in the Upper Mississinewa subwatersheds to show which AUIDs are impaired due to pathogens.

Table 35. Summary of Pathogen Data in Upper Mississinewa Subwatersheds

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
Days Creek	WMI-02-0006 (T9)	INB0321_01	4/14/2014 – 10/27/2014	10	7	5	573.53	4352	78.21%
	WMI-02-0005 (T8)	INB0321_T1001	4/14/2014 – 10/27/2014	9	6	4	359.39	4106	65.21%
Bear Creek	WMI-02-0012 (T4)	INB0322_01	4/14/2014 – 10/27/2014	10	9	9	795.86	>1986.3	84.29%
Fetid Creek	WMI020-0002 (T6)	INB0323_01	4/14/2014 – 10/27/2014	10	1	7	530.46	4884	76.44%
	WMI-02-0007 (T10)	INB0323_02	4/14/2014 – 10/27/2014	10	8	4	251.4	4106	50.28%
	WMI-02-0013 (T5)	INB0323_T1002	4/14/2014 – 10/27/2014	10	9	8	757.41	2419.6	83.50%
Bush Creek	WMI-02-0009 (T12)	INB0324_01	4/14/2014 – 10/27/2014	10	8	7	279.08	1553.1	55.20%
	WMI-02-0011 (T3)	INB0324_T1001	4/14/2014 – 10/27/2014	10	9	8	345.66	>1732.9	63.84%
	WMI-02-0010 (T2)	INB0324_T1002	4/14/2014 – 10/27/2014	10	10	7	516.09	>1732.9	75.78%

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
Redkey Run	WMI-02-0016 (T14)	INB0325_01	4/14/2014 – 10/27/2014	10	8	7	427.1	>5794	70.73%
	WMI-02-0017 (T16)	INB0325_T1002	4/14/2014 – 11/19/2014	11	10	8	657.4	2419.6	80.99%
Platt Nibarger Ditch	WMI-02-0018 (T17)	INB0326_01	4/14/2014 – 11/19/2014	11	7	5	292.52	1732.9	57.28%
	WMI-02-0015 (TT13)	INB0326_T1001	4/14/2014 – 10/27/2014	10	9	8	703.75	2419.6	82.24%
	WMI-02-0019 (T18)	INB0326_T1002	4/15/2014 – 10/28/2014	10	7	7	400.97	2909	68.83%
Little Lick Creek	WMI-03-0003 (T22)	INB0331_01	4/15/2014 – 10/28/2014	9	9	9	1473.97	8164	91.52%
	WMI040-0009 (T39)	INB0331_02	4/16/2014 – 10/29/2014	10	8	6	451.8	7701	72.33%
	WMI-03-0008 (T40)	INB0331_T1001	4/16/2014 – 10/29/2014	10	9	6	1109.18	>1203.3	88.72%
	WMI-040-0003 (T38)	INB0331_T1001	4/16/2014 – 10/29/2014	10	10	9	1674.56	>1732.9	92.54%
Towsand Lucas Ditch	WMI-03-0006 (T36)	INB0332_01	4/16/2014 – 11/19/2014	11	10	8	1070.53	>7701	88.32%
	WMI-03-0009 (T32)	INB0332_02	4/16/2014 – 10/29/2014	10	10	7	1057.9	>9208	88.18%

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
	WMI-03-0007 (T37)	INB0332_T1001	4/16/2014 – 10/29/2014	10	10	9	514.48	1553.1	75.12%
	WMI-03-0010 (T35)	INB0332_T1002	4/16/2014 – 10/29/2014	10	9	7	375.32	8664	96.8%
	WMI-03-0005 (T34)	INB0332_T1003	4/16/2014 – 10/29/2014	10	8	5	297.41	3448	57.97%
Campbell Creek	WMI-04-0014 (T20)	INB0341_01	4/14/2014 – 10/27/2014	10	9	5	463.3	1986.3	73.02%
	WMI-04-0008 (T1)	INB0341_T1001	4/14/2014 – 10/27/2014	10	9	10	1539.78	1986.3	91.88%
Rees Ditch	WMI-04-0013 (T19)	INB0342_01	4/15/2014 – 10/28/2014	10	8	7	352.3	3255	64.52%
	WMI-04-0017 (T25)	INB0342_01	4/15/2014 – 10/28/2014	10	6	5	169.38	6131	26.2%
	WMI-04-0016 (T24)	INB0342_T1001	4/15/2014 – 10/28/2014	10	8	6	300.58	10462	58.41%
	WMI-04-0015 (T21)	INB0342_T1002	4/15/2014 – 10/28/2014	10	10	10	1318.34	>2419.6	90.51%
	WMI-04-0018 (T23)	INB0342_T1002	4/15/2014 – 10/28/2014	10	9	7	256.17	>2142	51.20%
Studebaker Ditch	WMI-04-0011 (T30)	INB0343_01	4/15/2014 – 11/19/2014	11	11	10	469.51	866.4	73.38%

Subwatershed	Station #	AUID	Period of Record	Total Number of Samples	Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/ 100 mL)	Single Sample Maximum (#/ 100 mL)	Percent Reduction Based on Geomean (125/ 100mL)
					125	235			
	WMI-04-0010 (T29)	INB0343_T1003	4/15/2014 – 10/28/2014	10	6	4	140.7	>980.4	11.15%
Holden Ditch	WMI-04-0019 (T26)	INB0344_01	4/15/2014 – 11/19/2014	11	6	5	168.78	1553.1	25.94%
	WMI-04-0012 (T31)	INB0344_02	4/15/2014 – 11/19/2014	11	9	5	325.26	1986.3	61.57%
	WMI-04-0009 (T28)	INB0344_T1003	4/15/2014 – 10/28/2014	10	10	10	1113.31	>2419.6	88.77%

Understanding Table 35***:*** *E. coli* data for the Upper Mississinewa River watershed indicates the following:

- Reductions of 72 percent or greater are needed to meet the TMDL target values for *E. coli* in Days Creek.
- Reductions of 85 percent or greater are needed to meet the TMDL target values for *E. coli* in Bear Creek.
- Reductions of 70 percent or greater are needed to meet the TMDL target values for *E. coli* in Fetid Creek.
- Reductions of 65 percent or greater are needed to meet the TMDL target values for *E. coli* in Bush Creek.
- Reductions of 76 percent or greater are needed to meet the TMDL target values for *E. coli* in Redkey Run.
- Reductions of 69 percent or greater are needed to meet the TMDL target values for *E. coli* in Platt Nibarger Ditch.
- Reductions of 86 percent or greater are needed to meet the TMDL target values for *E. coli* in Little Lick Creek.
- Reductions of 81 percent or greater are needed to meet the TMDL target values for *E. coli* in Towsand Lucas Ditch.
- Reductions of 82 percent or greater are needed to meet the TMDL target values for *E. coli* in Campbell Creek
- Reductions of 58 percent or greater are needed to meet the TMDL target values for *E. coli* in Rees Ditch.
- Reductions of 42 percent or greater are needed to meet the TMDL target values for *E. coli* in Studebaker Ditch.
- Reductions of 58 percent or greater are needed to meet the TMDL target values for *E. coli* in Holden Ditch.

5.3 Biological Data

Sampling performed by IDEM between June and October 2014 documented widespread biological impairments in the Upper Mississinewa River watershed as summarized in Table 36. Fish and Macroinvertebrate community sampling took place at 35 sample sites in the Upper Mississinewa River watershed. Sites must receive a score of 36 or greater for fish and macroinvertebrates to be considered a healthy warm water aquatic community. More than 54 percent of the sample sites failed established criteria for aquatic life support during each sampling event.

Through the TMDL efforts, IDEM has identified several potential reasons for the widespread impairments:

- Hydro modification of streams has altered hydraulic regimes and reduced available habitat as well as types of habitat available to aquatic communities.
- TSS can reduce plants available for consumption by inhibiting growth of submerged aquatic plants, lower dissolved oxygen levels by reducing light penetration which impairs algal growth,

impair the ability of fish to see and catch food, decrease interstitial space required by fish and macroinvertebrates, increase stream temperature, clog fish gills which may decrease disease resistance, slow growth rates, and prevent the development of eggs and larvae.

- Total phosphorus can cause excessive plant production resulting in increased turbidity, decrease dissolved oxygen levels, and cause greater fluctuations in diurnal dissolved oxygen and pH levels resulting in lower stream diversity.

Attaining the TSS and total phosphorus target values shown in Table 34 should address the causes of impairment.

Table 36. Impaired Biotic Community Stream Segments in the Upper Mississinewa River Watershed Identified During Biological Sampling

Subwatershed	Site #	Stream Name	Score	Integrity Class	QHEI	Score	Integrity Class	QHEI
			mIBI	mIBI	mIBI	IBI	IBI	IBI
Days Creek	T9	Days Creek	36	Fair	36	28	Poor	34
	T8	Flesher Creek	34	Poor	44	14	Poor	41
Bear Creek	T4	Bear Creek	38	Fair	47	34	Poor	37
Fetid Creek	T6	Mississinewa River	42	Fair	57	46	Good	61
	T10	Mississinewa River	30	Poor	49	42	Fair	44
	T5	Fetid Creek	38	Fair	40	24	Poor	33
Bush Creek	T12	Bush Creek	40	Fair	60	40/38	Fair	51/58
	T3	Trib of Bush Creek	42	Poor	58	38	Fair	69
	T2	Elkhorn Creek	38	Poor	31	36	Poor	29
Redkey Run	T14	Halfway Creek	34	Poor	33	14	Very Poor	32
	T16	Halfway Creek	40	Fair	45	46	Good	50
Platt Nibarger Ditch	T17	Mississinewa River	38	Poor	61	52	Good	67
	T13	Dinner Creek	36	Fair	43	32	Poor	42
	T18	Mud Creek	36	Fair	43	32	Poor	51
Little Lick Creek	T22	Big Lick Creek	38	Fair	25	18	Very Poor	24
	T39	Big Lick Creek	36	Fair	36	38	Fair	40

	T40	Little Lick Creek	38	Fair	46	26	Poor	41
	T38	Little Lick Creek	28	Poor	29	16	Very Poor	28
Townsand Lucas Ditch	T36	Big Lick Creek	32/34	Poor	43/43	42	Fair	56
	T32	Big Lick Creek	27	Poor	47	38	Fair	54
	T37	Morre Prong	38	Fair	34	40	Fair	47
	T35	Little Joe Creek	40	Fair	58	36/44	Fair	59/57
	T34	Townsand Lucas Ditch	28	Poor	58	32	Poor	68
Campbell Creek	T20	Campbell Creek	44/42	Fair	77/72	42	Fair	80
	T1	Trib of Campbell Creek	42	Fair	59	42	Fair	56
Rees Ditch	T19	Mississinewa River	34	Poor	55	50	Good	69
	T25	Mississinewa River	38	Fair	52	54	Excellent	88
	T24	Bosman Ditch	32	Poor	52	38	Fair	56
	T21	Rees Ditch	26	Poor	40	36	Fair	44
	T23	Rees Ditch	26	Poor	43	40/40	Fair	52/55
Studebaker Ditch	T30	Pike Creek	40	Fair	68	36	Fair	80
	T29	Hedgeland Ditch	28	Poor	38	28	Poor	34
Holden Ditch	T26	Mississinewa River	34	Poor	56	56	Excellent	96
	T31	Mississinewa River	44	Fair	58	42	Fair	74
	T28	Dodge Creek	42	Fair	43	38/42	Fair	42/49

Understanding Table 36: IBI = Index of Biotic Integrity. Scores were calculated using IDEM's *Summary of Protocols: Probability Based Site Assessment*. (IDEM, 2005).

The IBI is used to calculate the results of fish assemblage data. The IBI is composed of 12 metrics that assess the community's species and trophic composition (feeding and reproductive guilds) and fish condition and health. The total IBI score, integrity class and attributes help define fish community characteristics. Integrity classes help to classify the stream from those of poor health with no fish, Scores under 12, to streams in excellent condition, Scored 58-60, which are most comparable to "least impacted" conditional with exceptional assemblages of fish species (IDEM, 2006).

5.4 Polychlorinated Biphenyl (PCB) Data

IDEM has determined that the PCB impaired waters of the Upper Mississenewa River Watershed are impaired due to legacy pollution from direct discharge to the watershed from industrial facility and the discharge from of the WWTP in Union City, Indiana due to contamination from these same industrial facilities. A TMDL is not needed because other pollution control requirements are expected to result in the attainment of an applicable water quality standard (WQS). The current information indicates a trend of water quality improvement in PCBs and extensive remediation work has been done to create these improvements. IDEM anticipates full removal from the 303d list in the several sampling cycles. IDEM is proposing a removal of these segments from the 303d list category 5 to category 4b. The following information and the attached documentation support this change in listing. The entire watershed area of concern for the PCB impairment falls outside this TMDL area. IDEM has determined that the appropriate mechanism for public outreach and documentation of improvement on this change in category is the TMDL documentation process. The following is a list of the impaired segments and the proposed listing change.

Table 37. Site events in the Little Mississinewa River (LMR) (U.S. EPA, 2010)

Events	Year
LMR Sediment and Floodplain Investigations	1997
LMR Outfall Area-LMR Sampling and Interim Removal Action	1997-1998
LMR Park and Cemetery Area – Investigation and Engineering Evaluation/Cost Analysis	1998-1999
LMR Park and Cemetery – Removal Action Administrative Order by Consent and Statement of Work	2001
LMR Park and Cemetery – Work Plan for the LMR Time Critical Removal Action	2001
LMR Park and Cemetery –Time Critical Removal Action	2001
LMR Downstream Area – Final Work Plan for the Remedial Investigation and Feasibility Study	2002
LMR Downstream Area –Remedial Investigation Field Work	2002
LMR Downstream Area –Baseline Risk Assessment	2004
LMR Downstream Area –Remedial Investigation Report	2004
LMR Downstream Area –Feasibility Study Report	2004
Record of Decision for LMR Remedial Action	2004
LMR Downstream Area –Remedial Design – Administrative Order on Consent	2004
LMR Remedial Action – Unilateral Administrative Order	2005
LMR Downstream Area – Final Remedial Design Report	2005
LMR Downstream Area –Remedial Action Field Work	2005-2008
Demobilization from Remedial Action	2008
Remedial Action Corrections Period	2009
Remedial Activities Completion	2009
Final Remedial Action Inspection	2009
Preliminary Close Out Report	2010
Remedial Action Report	2010
Operation and Maintenance Plan	2010

Table 38. Activities at the Little Mississinewa River Site (U.S. EPA, 2010)

Action	Responsible Party	Year
Remediated storm water retention basin	Viacom	1989
Excavation	UTAS	1998
Stream channel restoration	UTAS	1998
Addressed residual soils and sediment	Viacom	2001
Sediment removal in channel and in floodplain	Viacom and UTAS	2001-2002
Sediment removal in channel and in floodplain	UTAS	2005-2009

The remediation actions implemented are considered protective of human health and the environment. All exposure pathways that could result in unacceptable risks to humans have been controlled. However, in order for the remedy to be protective in the long term, fish tissue data needs to show that PCB concentrations in fish tissue are decreasing. The second five-year review has been completed, in 2015, but information is not yet available (U.S. EPA 2013).

IDEM data collected from 2008 to present indicates an improvement in fish tissue samples. A portion of the Mississinewa River will be delisted in the 2016 303(d) list based upon current data. The additional sampling results indicate that additional sampling will remove additional segment of the watershed within a short period of time. This information detailed in the provided attachments supports the remove of these segments from category 5 to category 4b.

6.0 TECHNICAL APPROACH

Previous sections of the report have provided a description of the Upper Mississinewa River watershed and summarized the applicable water quality standards, water quality data, and identified the potential sources of *E. coli*, phosphorus , and sediment 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 to estimate the current allowable loads of *E. coli*, phosphorus, and TSS in each subwatershed. This section focuses on describing the methodology for developing the loading for the TMDL report.

6.1 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 and 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 and the appropriate conversion factor, the resulting points are graphed. Conversion factors are used to convert the units of the target (e.g., #/100 mL for *E. coli*) to loads (e.g., G-org/day for *E. coli* [G-org=1E+09 organisms]) the following factors were used for this TMDL:
    - for *E. coli* Flow (cfs) x TMDL Concentration Target (#/100mL) x Conversion Factor (0.024463) = Load (G-org/day)
    - for Phosphorus and TSS Flow (cfs) x TMDL Concentration Target (mg/L) x Conversion Factor (5.39) = Load (lb/day)
- To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected

and the appropriate conversion factor. Then, the existing individual loads are plotted on the TMDL graph with the curve.

- Points plotting above the curve represent violations of the daily load for the applicable water quality standard or target value. 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 or target values.

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

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

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

The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources. Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated storm water discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point source sources (e.g., wastewater treatment facilities, livestock in the stream). Table 40 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 39. Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	Very High	Moist	Mid-Range	Dry	Very Low
Wastewater treatment plants				M	H
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H

On-site wastewater systems/Unsewered Areas	M	M-H	H	H	H
Riparian areas		H	H	M	
Abandoned mines	H	H	H	H	H
Storm water: Impervious		H	H	M	
Combined sewer overflows	H	H	M		
Storm water: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

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

6.2 Stream Flow Estimates

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

The USGS gage for the Mississinewa River near Marion, (03326500) located down steam of the Upper Mississinewa watershed approximately 20 river miles, was used for the development of the *E. coli*, phosphorus, and sediment load duration curve analysis for the Upper Mississinewa River Watershed TMDL. USGS gage 03326500 is located on the Mississinewa River in Grant County.

Since the load duration approach requires a stream flow time series for each site included in the analysis, stream flows were extrapolated from USGS gage 03326500 for each assessment location by using a multiplier based upon the ratio of the upstream drainage area for a given location to the drainage area of the USGS gage 03326500 watershed.

Flows were estimated using the following equation:

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

Where,

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

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

Table 40. USGS Site Assignments for Development of Load Duration Curve

Gage Location	Gage ID	Period of Record
Mississinewa River at Marion, IN	03326500	1985-2015

6.3 Margin of Safety (MOS)

Section 303(d) of the Clean Water Act and USEPA regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between limitations and water quality." USEPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). This TMDL uses both an implicit and explicit MOS. An implicit MOS was used by applying a couple of conservative assumptions. A moderate explicit MOS has been applied by reserving five percent of the allowable load. Five percent was considered an appropriate MOS based on the following considerations:

- The use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the nearest downstream USGS gage.
- The *E. coli* TMDLs include an implicit MOS in that they were based on the geometric mean component of the standard rather than the single sample maximum standard. Using the single sample maximum standard would have resulted in larger loading capacities.
- An additional implicit MOS for *E. coli* is included because the load duration analysis does not address die-off of pathogens.

6.4 Industrial and Construction Storm water

To estimate loads for Industrial and Construction Storm water acreage from Tables 23 and 23 was converted to square miles and then given a load allocation as their percentage of the overall subwatershed.

6.5 Future Growth Calculations

While population trends are indicating that this watershed has been decreasing, uncertainty in future populations in the Upper Mississinewa River 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 approximately 5% of the loading capacity to address increased bacteria, nutrient and sediment loads from those future contributors. In the Rees Ditch and Holden Ditch subwatershed IDEM has received notifications for potential new or upgraded WWTP NPDES permits and thus future growth in this subwatershed has been increased in addition to the 5% to cover these potential permit changes.

7.0 LINKAGE ANALYSIS

A linkage analysis connects the observed water quality impairment to what has caused that impairment. An essential component of developing a TMDL is establishing a relationship between the source loadings and the resulting water quality. Potential point and nonpoint sources are inventoried in Section 4.0 and water quality data within the Upper Mississinewa River Watershed are discussed in Section 5.0. The purpose of this section of the report is to evaluate which of the various potential sources is most likely to be contributing to the observed water quality impairments. To accomplish this load duration curves and precipitation graphs were created for all the sampling sites in the Upper Mississinewa River Watershed.

The load duration curves illustrate water quality standards and target value violations during all flow ranges that occurred during sampling events. A discussion of sampling sites in the subwatershed is included following the figures. Each discussion begins with a table that provides a summary of the subwatershed, including impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, and CAFOs, as well as LAs, WLAs, and MOS values for pollutants of concern. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated pollutants of concern concentrations. For NPDES WWTP permits Peak Design Flow was used in creating WLA's for Very High and Higher Flow allocations, while Average Design Flow was used for Normal, Lower, and Low flow conditions.

Load duration curves were created for the sampling sites in the Upper Mississinewa River Watershed that were sampled by IDEM in 2014. The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Section 6.1 summarizes the load duration curve approach. This section discusses the load duration curves and the linkage between the potential sources in the Upper Mississinewa River Watershed and the observed water quality impairment.

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

Total phosphorus concentrations are naturally low in surface waters, but high in rivers and streams located in agricultural and urban areas, or that receive wastewater discharges. High phosphorus levels in streams increase the growth of plants and algae, reducing the quality of the habitat and causing low oxygen levels at night when the plants and algae are respiring but not photosynthesizing.

Developing a linkage analysis to address the connection between siltation and its effect on aquatic life uses often involves an evaluation of multiple factors. The interaction between erosion processes and hydrology is an important part of the assessment, with land use, riparian areas, and channel conditions being key considerations. Each can play a potential role in both creating and solving sediment problems. The sediment issues can occur when external inputs (e.g., sediment, runoff volume) to the stream become excessive, or when stream characteristics are altered so that it can no longer assimilate the loads, or a combination of both occur.

7.1 Linkage Analysis for *E. coli*

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

Load duration curves were created for the sampling sites in the Upper Mississinewa River watershed that were sampled by IDEM in 2014. The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Section 6.1 summarizes the load duration curve approach. This section discusses the load duration curves and the linkage between the potential sources in the Upper Mississinewa River watershed and the observed water quality impairment.

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

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

7.2 Linkage Analysis for Phosphorus

Nutrients come in many forms, including nitrogen, phosphorus, ammonia, total Kjeldahl nitrogen (TKN), nitrite and nitrate. Information presented in the water quality assessment describes nutrient conditions in the Upper Mississinewa watershed.

Total phosphorus concentrations are naturally low in surface waters, but high in rivers and streams located in agricultural and urban areas, or that receive wastewater discharges. High phosphorus levels in streams increase the growth of plants and algae, reducing the quality of the habitat and causing low oxygen levels at night when the plants and algae are respiring but not photosynthesizing.

The load duration curves indicate that nonpoint sources as well as point sources may be contributing to the impairment. Nonpoint sources might include sediment-bound phosphorus that enters the river during erosional processes, as well as the runoff of storms over fertilized fields and residential areas. Septic systems might also be a potential source of phosphorus if the systems are failing and located adjacent to the streams.

Since monitoring began TSS in the Upper Mississinewa River watershed has sporadically exceeded the target. TSS tends to exceed WQS in the spring and summer months, although data is incomplete or lacking for the winter months. The high loads in the spring may be related to the plowing and planting of agricultural fields occurring during these months, increasing the opportunity for sheet and rill erosion. Further analysis pairing the TSS concentrations with flow conditions reveals elevated TSS concentrations during high flows and slightly lower concentrations during mid-range and lower flow conditions. Elevated TSS concentrations during high flows are consistent with significant loads coming from stream bank and gully erosion.

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

7.3 Linkage Analysis by Subwatershed

7.3.1 Days Creek

The Days Creek subwatershed drains approximately 17 square miles. The subwatershed drains into the main stem of the Mississinewa River just west of Ridgeville. The land use is primarily agriculture (81.3%) followed by forested land (7.4%) and hay and pasture land (5.1%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. The majority of the subwatershed is rural indicating homes utilize on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. The landscape in the area is

relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. While this effects the entire drainage, Flesher creek has been highly channelized with little to no remaining riparian buffer left along its banks. Despite its flat 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 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 or high functioning two stage ditch implementation. With a land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are 4 permitted CFO/CAFOs in the watershed with a total animal density of 203 animals/square mile. This is an average concentration when compared to other subwatersheds in the Upper Mississinewa River.

There are two sample sites located in this subwatershed, one located on Flesher Creek WMI-02-0005 (T8) and one located on Days Creek WMI-02-0006 (T9). In 2014 this watershed was sampled 25 times between the two sites resulting in both failing WQS for *E.coli,* IBC, and target values for Phosphorus. These stream reaches will be placed on the 2016 303(d) list of impaired waters. The *E. coli* geomean for T9 was 573.53 MPN with 5/10 samples in exceedance of the single sample maximum; while T8 had a geomean of 359.39 with 4/9 samples in exceedance of the single sample maximum. The geomeans from site T9 and T8 were taken on the same day approximately one hour apart for five consecutive weeks. High *E. coli* levels are reflective of high animal concentration, leaking or failing septic systems and land application of waste. The fish community IBI score for site T9 was 28 (poor) and the QHEI was 34 (poor). The macro community mIBI score was 36 (fair) and the QHEI was 36 (Poor). The fish community IBI score for site T8 was 14 (very poor) and the QHEI was 41 (fair). The macro community mIBI score was 34 (Poor) and the QHEI was 44 (fair). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources. There are approximately 21 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 21 stream miles impaired for *E. coli,* IBC and Nutrients listed on the 2016 List of Impaired Waters.

Table 41. Summary of Days Creek Subwatershed Characteristics

Days Creek (051201030201)	
Drainage Area (sq. mi.)	17.10
TMDL Sample Sites	WMI-02-0005 (T8), WMI-02-0006 (T9)
AUID's (Listed Impairments covered by this TMDL)	INB0321_02 (*E. coli*, TP), INB0321_03 (*E. coli,* IBC, Nutrients), INB0321_T1002(*E.coli*, IBC, Nutrients), INB0321_T1003(*E. coli,* Nutrients), INB0321_T1004 (*E. coli,* Nutrients), INB0321_T1005 (*E. coli*).
Land Use	Agricultural Land: 81.3% Forested Land: 7.4% Developed Land: 4.4% Open Water: 0.5% Pasture/Hay: 5.1% Grassland/Shrubs: 1.2% Wetland: 0.1%
NPDES Facilities	NA
MS4 Communities	NA
CSO Communities	NA
CAFOs	NA
CFOs	P James & C Ronald Zimmerman, 6055; DZ Farms Incorporated, 6556, Ryan Outcalt, 6327; Muhlenkamp Swine, 3870

Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	417.63	81.72	34.67	14.80	6.22
Future Growth	21.98	4.30	1.82	0.78	0.33
WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	23.14	4.53	1.92	0.82	0.35
TMDL= LA+WLA+MOS	462.75	90.55	38.41	16.40	6.90
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	10,657.92	2,042.66	830.06	354.21	161.01
Future Growth	562.01	107.71	43.69	18.64	8.47
WLA	20.18	3.87	0.00	0.00	0.00
Construction WLA	20.18	3.87	0.00	0.00	0.00
MOS (5%)	591.58	113.38	45.99	19.62	8.92
TMDL = LA+WLA+MOS	11,831.69	2,267.62	919.74	392.47	178.40
Flow Regime TMDL analysis for Total Phosphorus (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	109.04	20.90	8.47	3.62	1.64
Future Growth	5.74	1.10	0.45	0.19	0.09
WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	6.04	1.16	0.47	0.20	0.09
TMDL = LA+WLA+MOS	120.82	23.16	9.39	4.01	1.82

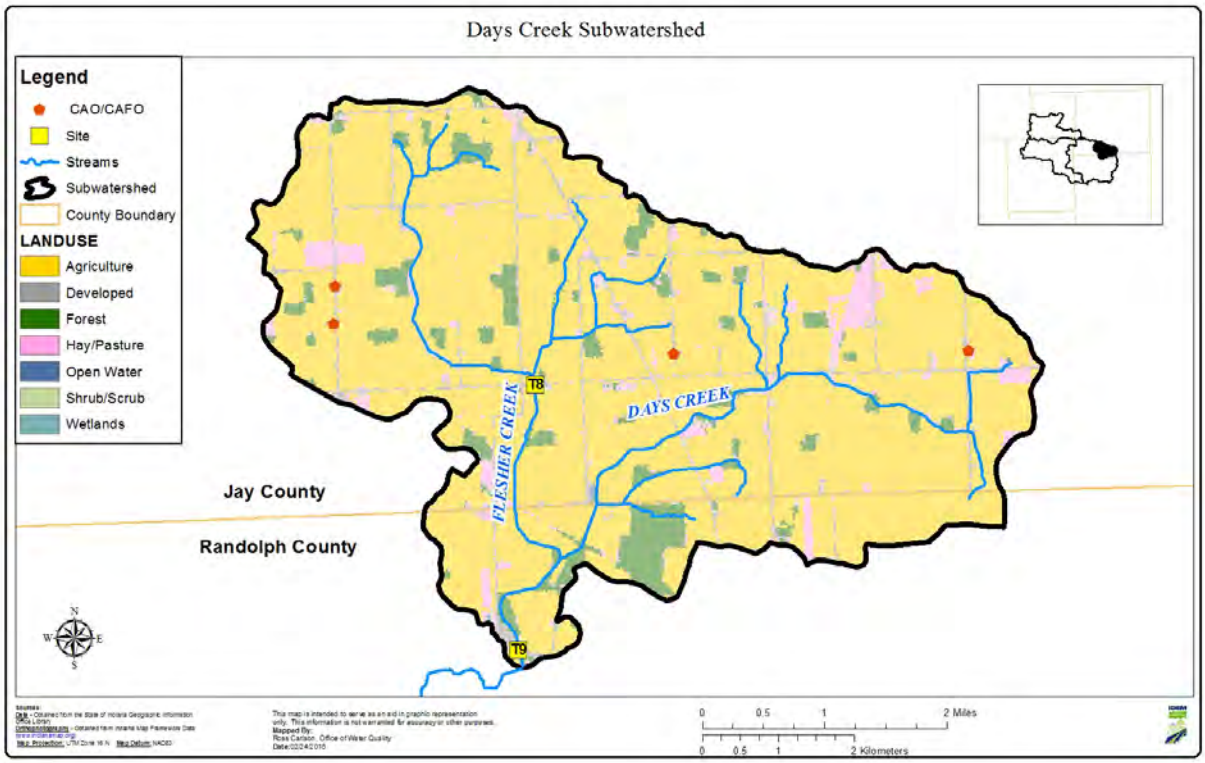

Figure 24. Sampling Stations in the Days Creek Watershed

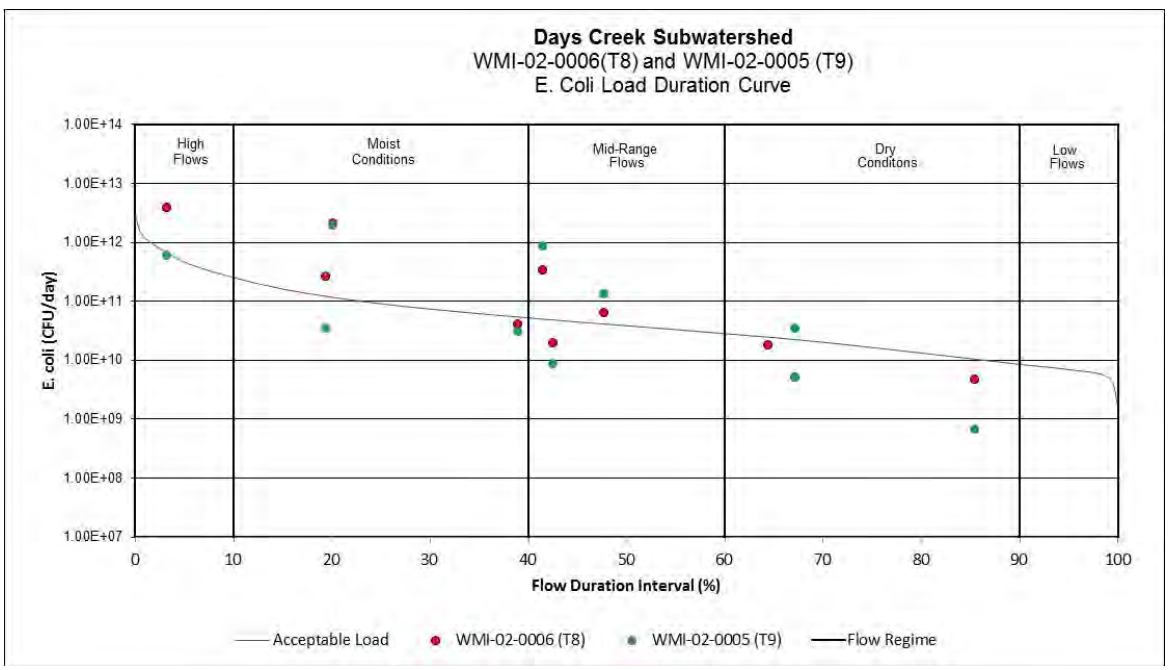

Figure 25. *E. coli* Load Duration Curve for Sites in the Days Creek Subwatershed

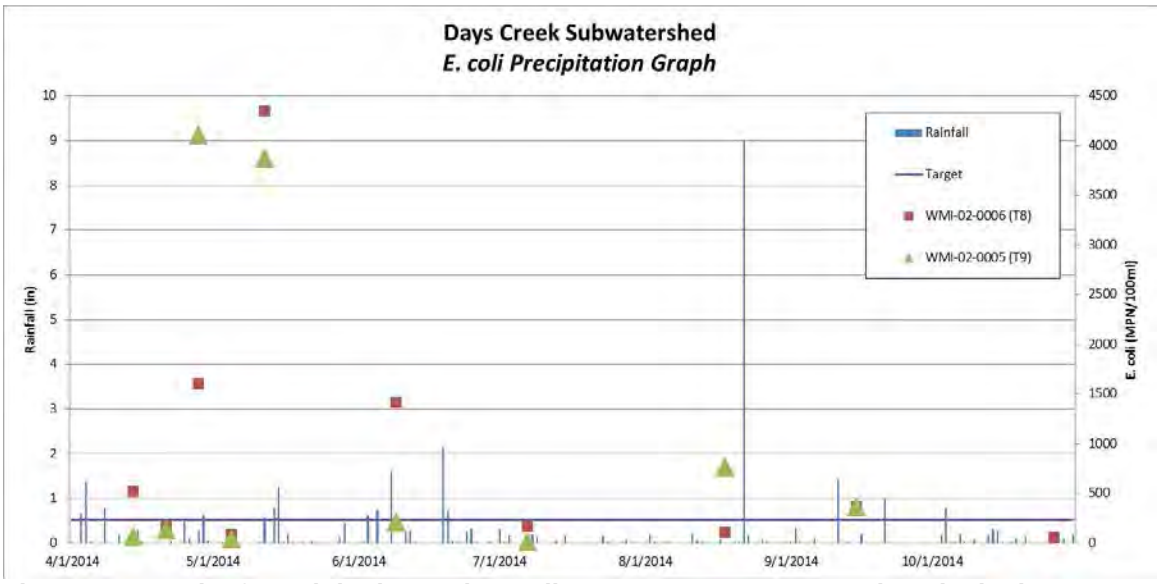

Figure 26. Graph of Precipitation and *E. coli* Data at most representative Site in the Days Creek Subwatershed

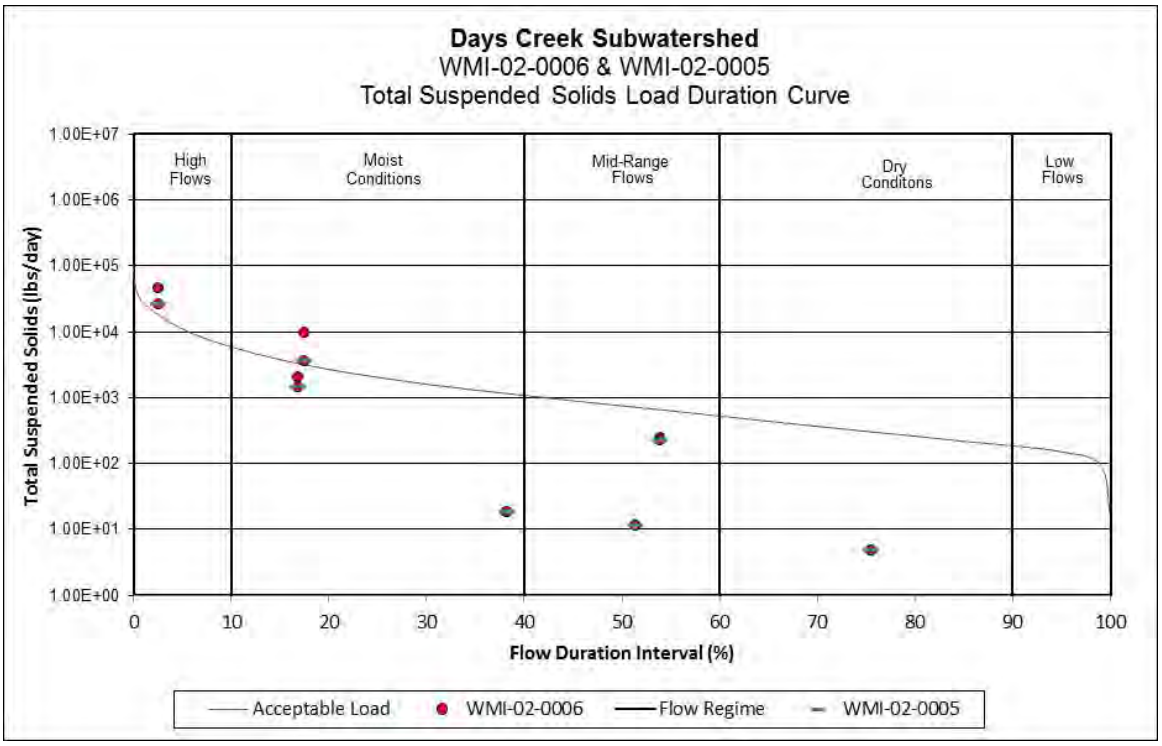

Figure 27. Total Suspended Solids Load Duration Curve for Sites in the Days Creek Subwatershed

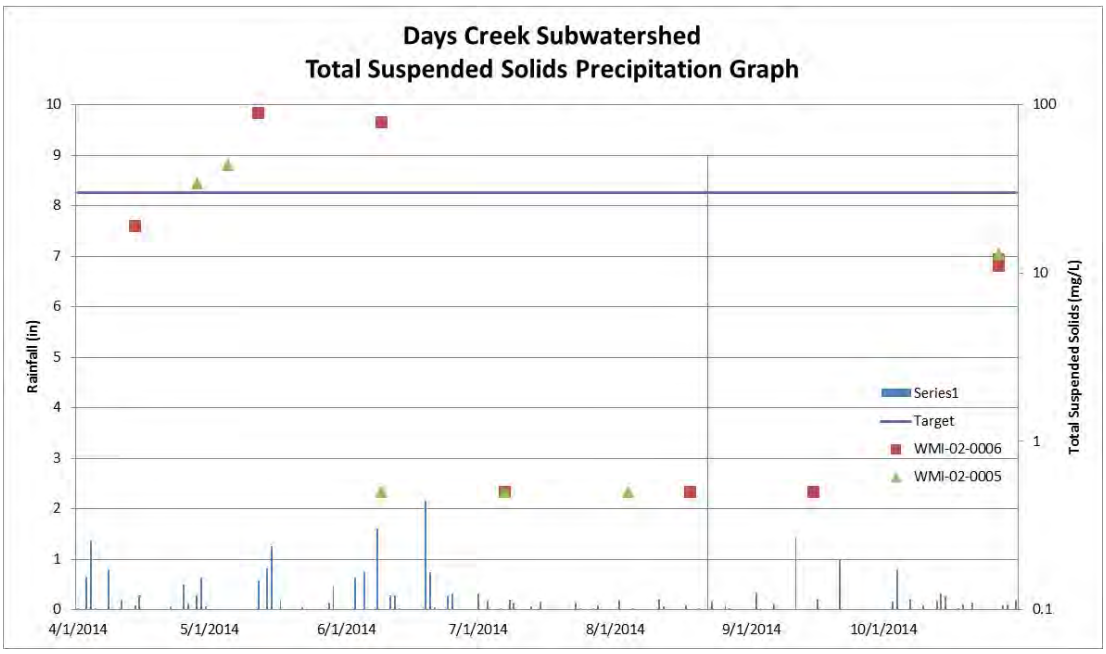

Figure 28. Graph of Precipitation and Total Suspended Solids Data for sites in the Days Creek Subwatershed

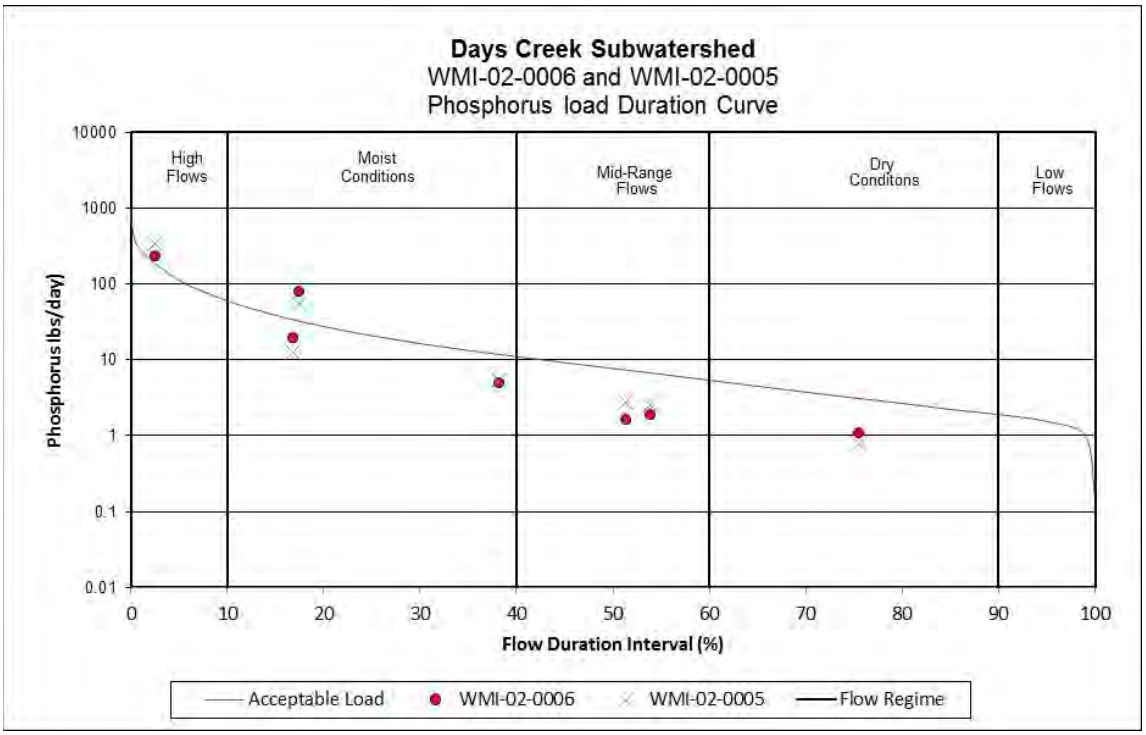

Figure 29. Phosphorus Load Duration Curve for Sites in the Days Creek Subwatershed

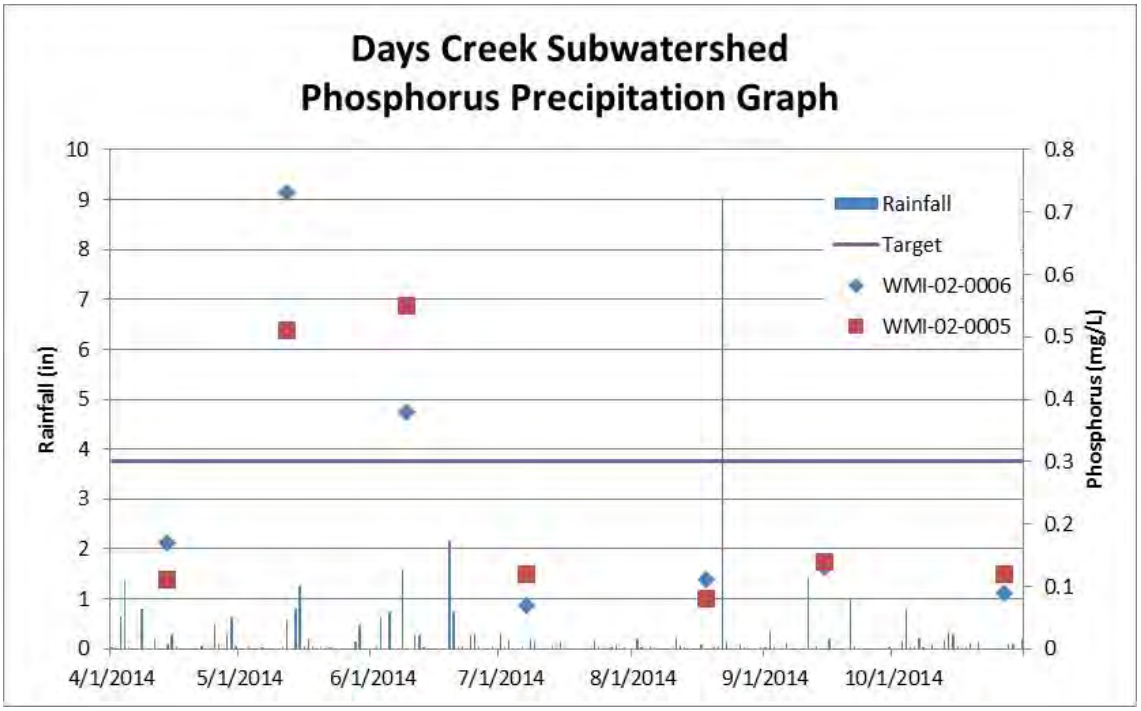

Figure 30. Graph of Precipitation and Phosphorus Data for most sites in the Days Creek Subwatershed

7.3.2 Bear Creek

The Bear Creek subwatershed drains approximately 16 square miles. The subwatershed drains into the main stem of the Mississinewa River east of Ridgeville. The land use is primarily agriculture (83.14%) followed by hay and pasture land (6.81%) and forest (4.68%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. The majority of the subwatershed is rural indicating homes with on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. Despite its flat 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 the high gradient slopes.

This subwatershed does contain fragmented portions of hydric soils, these could be potential areas for wetland restoration. With a land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are 6 permitted CFO/CAFO's in the watershed with a total animal density of 542 animals/square mile. This is the highest concentration when compared to other subwatersheds in the Upper Mississinewa River. It is likely land application of CFO/CAFO waste is a significant contributor to bacteriological waste in the watershed.

There is one site located in this subwatershed on Bear Creek WMI-02-0012 (T4). In 2014 this watershed was sampled 12 times resulting in the site failing WQS for *E.coli,* IBC, and Phosphorus. These stream

reaches will be placed on the 2016 303(d) list of impaired waters. The *E. coli* geomean for T4 was 795.86 MPN with 9/10 samples in exceedance of the single sample max. The geomean from site T4 was taken for five consecutive weeks within in a two hour time frame of one another . High *E. coli* levels are reflective of high animal concentration, land application of waste, and land application of waste. The fish community IBI score for site T4 was 34 (poor) and the QHEI was 37(poor). The macro community mIBI score was 38 (fair) and the QHEI was 40 (Poor).

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources. There are approximately 20 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 20 stream miles impaired for *E. coli,* IBC and Nutrients listed on the 2016 List of Impaired Waters.

Table 42. Summary of Bear Creek Subwatershed Characteristics

Bear Creek (051201030202)					
Drainage Area (sq. mi.)	16.01				
TMDL Sample Sites	WMI-02-0012				
AUID's (Listed Impairments covered by this TMDL)	INB0332_01 (*E. coli,* IBC, Nutrients), INB0332_T1001 (*E.coli),* INB0332_T1002 (*E. coli)*				
Land Use	Agricultural Land: 83.14% Forested Land: 4.68% Developed Land: 4.06% Open Water: 0.4% Pasture/Hay: 6.81% Grassland/Shrubs: 1.0% Wetland: 0.6%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	Aaron Chalfant Farms LLC, 6536; Mike and Shari Anderson, 6420; Andrew Chalfant, 6716.				
CFOs	Roger Gough, 4642; Cuzco Farm, 3794; Reed Farm, 6433.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	376.49	73.67	31.25	13.34	5.62
Future Growth	19.81	3.88	1.64	0.70	0.30
WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	20.86	4.08	1.73	0.74	0.30
TMDL= LA+WLA+MOS	417.16	81.63	34.62	14.78	6.22
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	9,793.72	1,877.03	763.25	325.70	148.04
Future Growth	516.77	99.04	40.17	17.14	7.79
Total WLA	24.89	4.77	0.00	0.00	0.00
Construction WLA	24.89	4.77	0.00	0.00	0.00
MOS (5%)	543.97	104.26	42.29	18.04	8.21

TMDL = LA+WLA+MOS	10,879.35	2,085.10	845.71	360.88	164.04
Flow Regime TMDL analysis for Phosphorus (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	98.29	18.84	7.64	3.26	1.48
Future Growth	5.17	0.99	0.41	0.17	0.08
Total WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	5.45	1.04	0.42	0.18	0.08
TMDL = LA+WLA+MOS	108.91	20.87	8.47	3.61	1.64

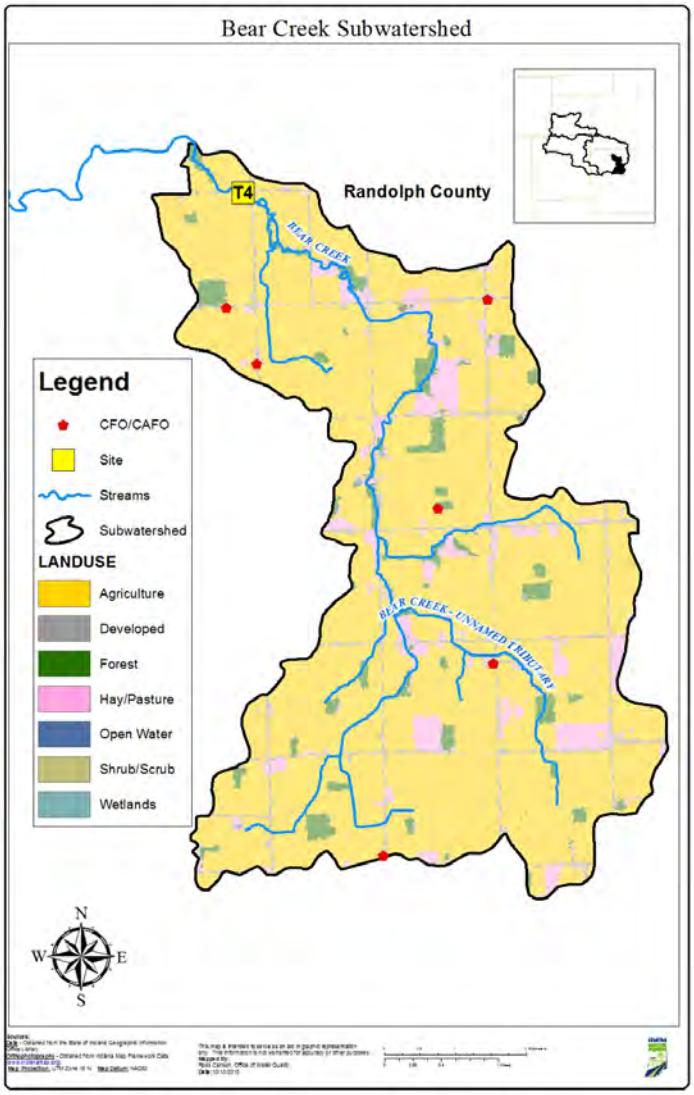

Figure 31. Sampling Stations in the Bear Creek Watershed

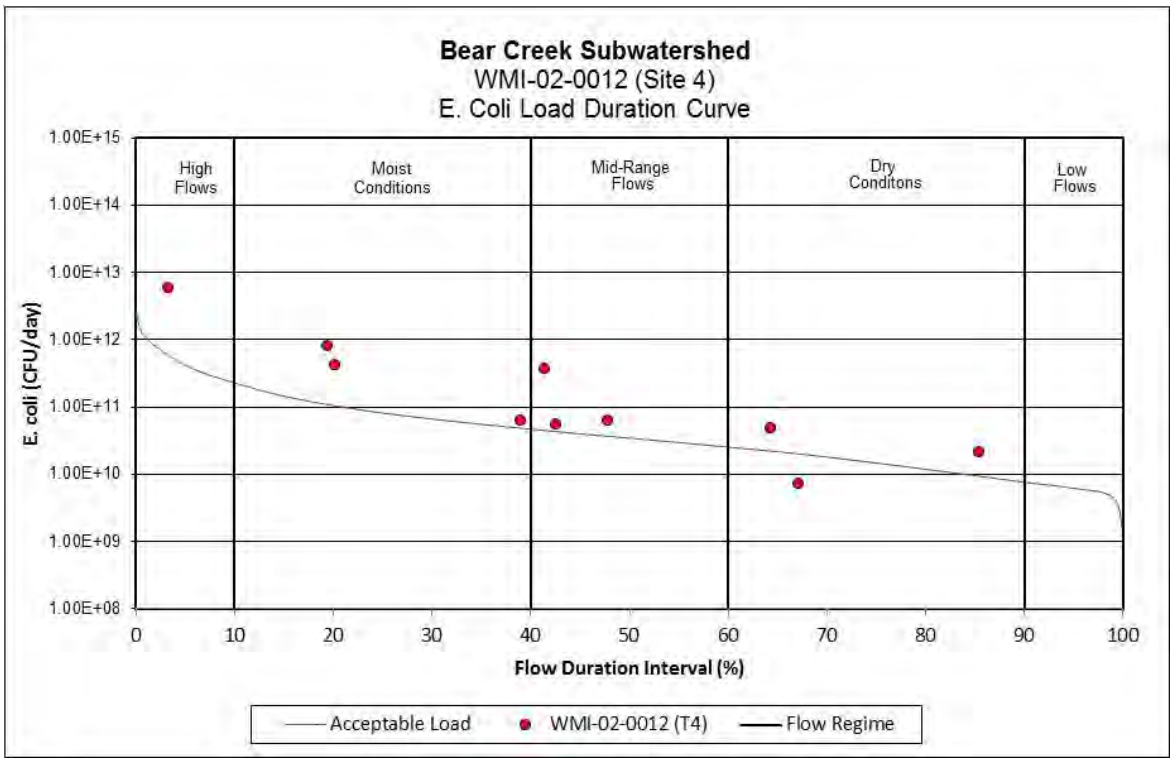

Figure 32. *E. coli* Load Duration Curve for Sites in the Bear Creek Subwatershed

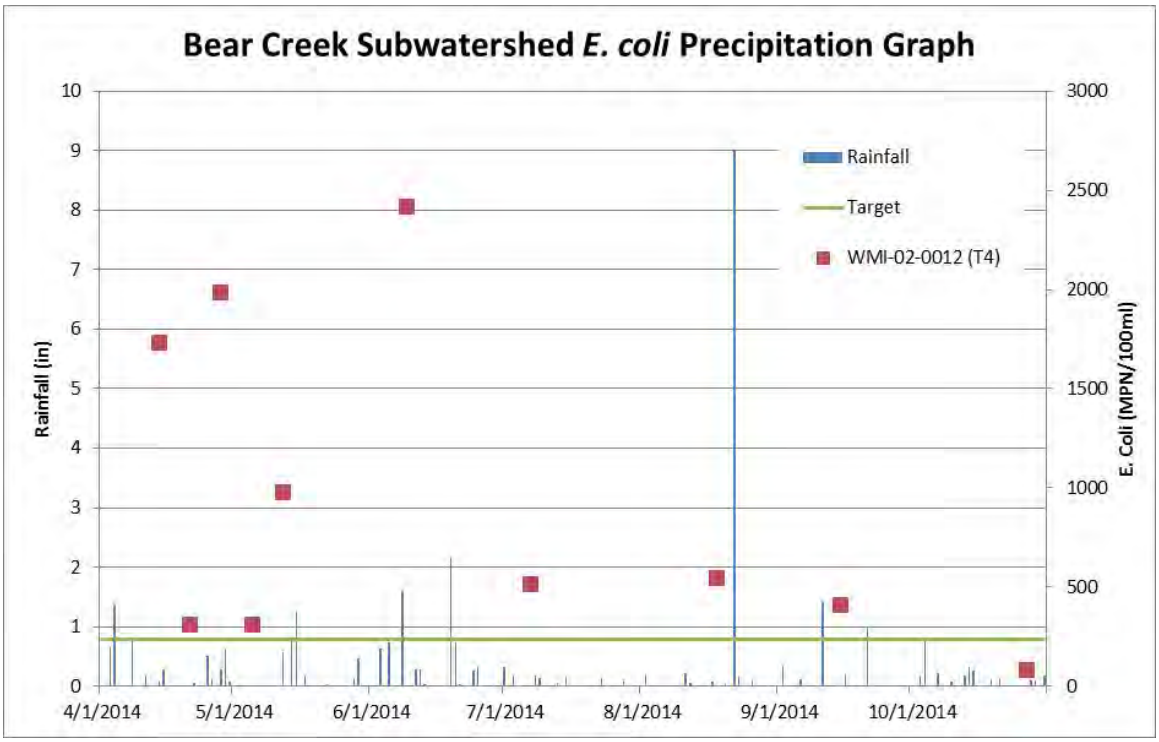

Figure 33. Graph of Precipitation and *E. coli* Data at most representative site in the Bear Creek Subwatershed

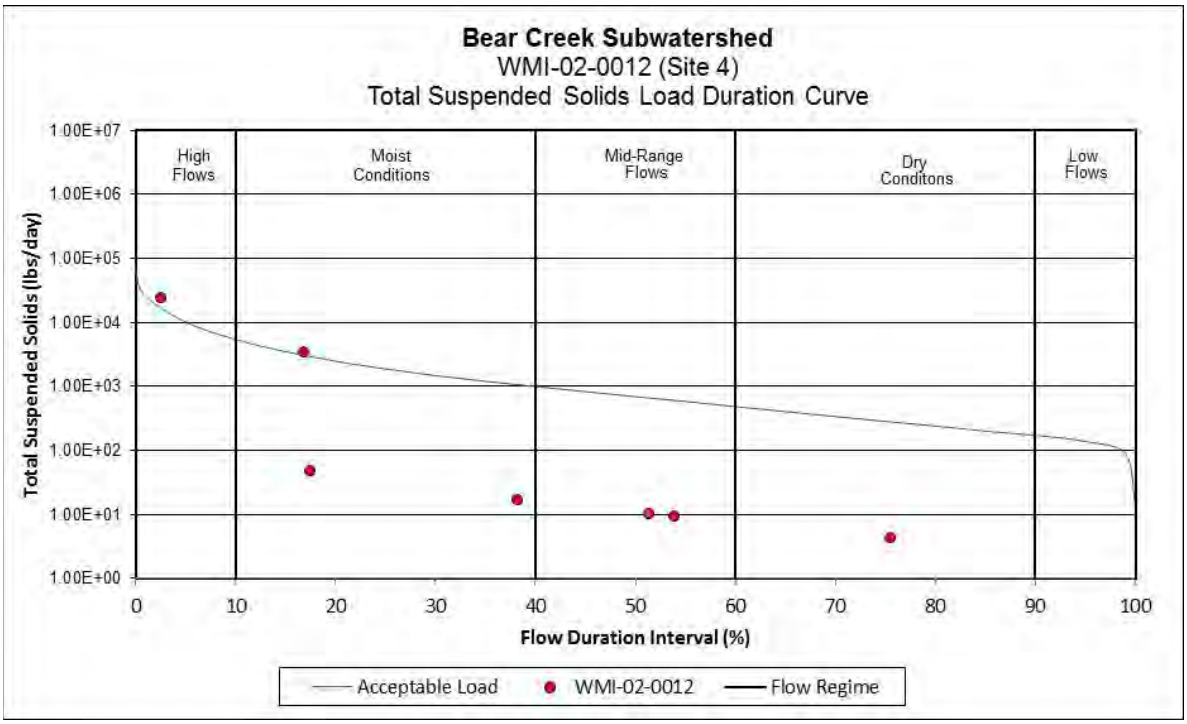

Figure 34. Total Suspended Solids Load Duration Curve for Sites in the Bear Creek Subwatershed

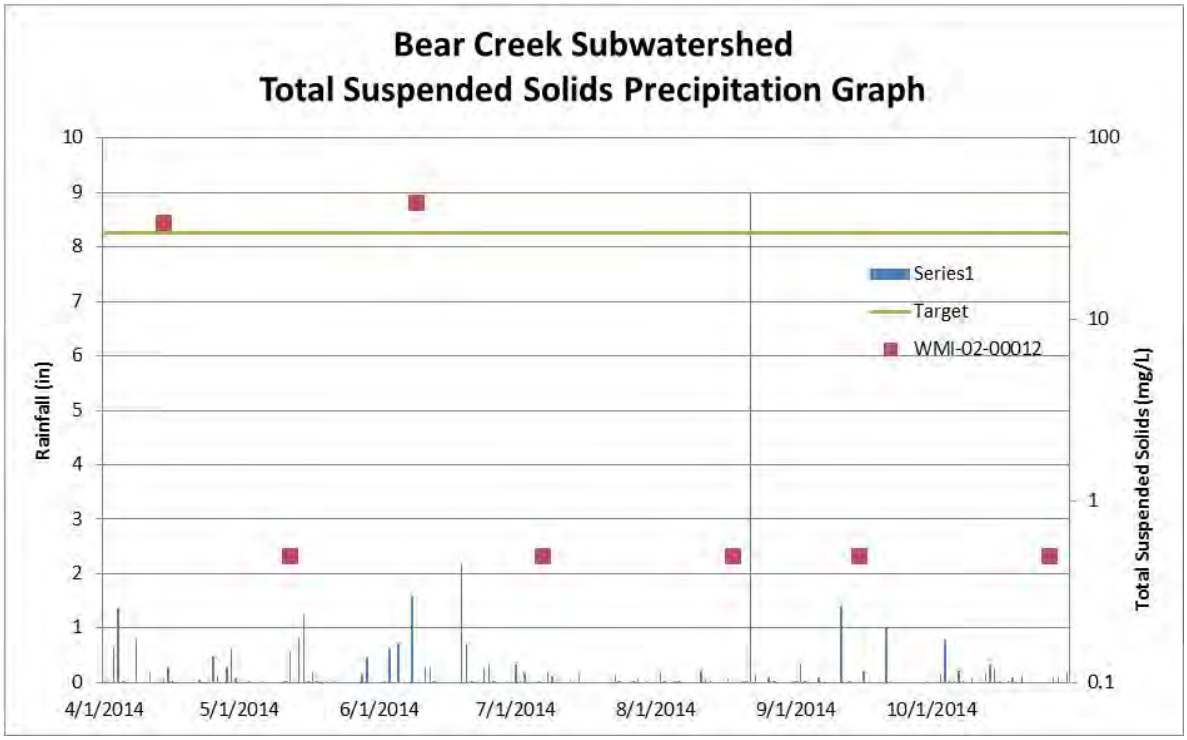

Figure 35. Graph of Precipitation and Total Suspended Solids Data for sites in the Bear Creek Subwatershed

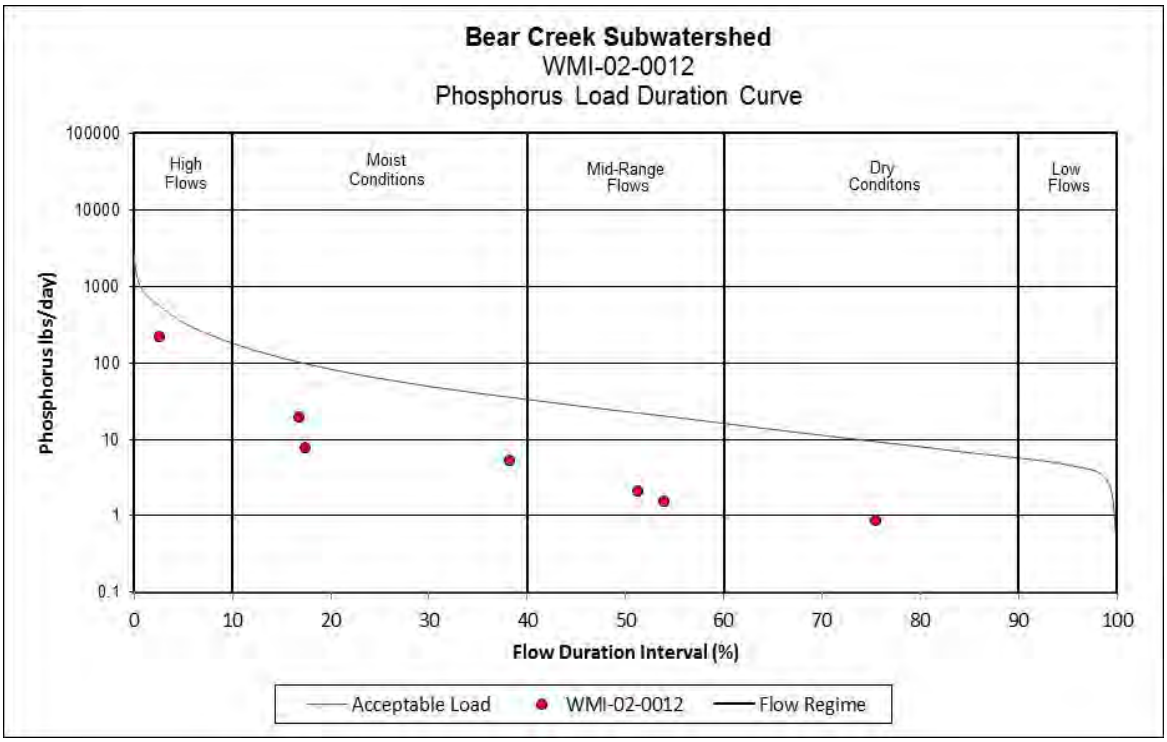

Figure 36. Phosphorus Load Duration Curve for Sites in the Bear Creek Subwatershed

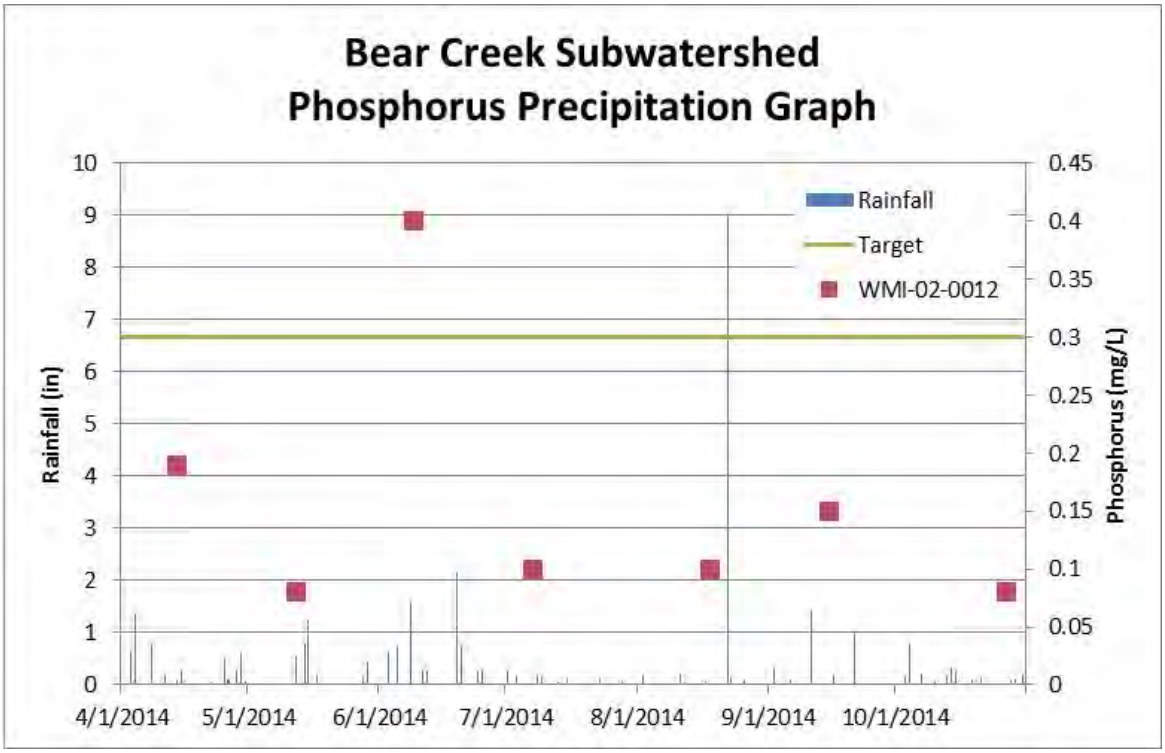

Figure 37. Graph of Precipitation and Phosphorus for sites in the Bear Creek Subwatershed

7.3.3 Fetid Creek

The Fetid Creek subwatershed drains approximately covers an area of 26.91 square miles. When including upstream influences the watershed drains approximately 158 square miles. The subwatershed drains into the main stem of the Mississinewa River as it flows into the subwatershed to its east of CR N 100 W to its pour point near W CR750 N. The land use is primarily agriculture (74.43.3%) followed by forested land (10.7%) and hay and developed land (6.76%). There are two permitted facilities, WWTPs, or industrial storm water permits in the subwatershed, the Ridgeville waste water treatment plant and US Aggregates Ridgeville quarry. Although the town of Ridgeville is within the watershed, the majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. While the main stem of the Mississinewa has maintained its sinuosity and some riparian vegetation to a great deal, many of the creeks draining the surrounding land have been channelized and have little to no riparian vegetation. Despite its flat nature the subwatershed does contain significant amounts of highly erodible soil types, the majority of which are located along the north size of the Mississinewa River. 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. This may be intensified by channelized ditches with little to no riparian cover and contributions from field tiles during heavy rains.

Much of the hydric soils in this watershed are fragmented although they constitute a significant portion of the watershed. With a land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are 3 permitted CFO/CAFO's in the watershed with a total animal density of 251animals/square mile. This is a median concentration when compared to other subwatersheds in the Upper Mississinewa River.

There are three sites located in this subwatershed, two located on the Mississinewa River WMI-02-0007 (T10), WMI020-0002 (T6), and one located on Fetid Creek WMI-02-0013 (T5). In 2014 this watershed was sampled 40 times between the Three sites resulting in site T6 failing for *E. coli* and nutrients, site T10 failing for *E. coli,* nutrients and IBC, and site T5 failing for *E. coli*, nutrients, IBC and DO. These stream reaches will be placed on the 2016 303(d) list of impaired waters. The *E. coli* geomean for T10 was 251.4 MPN with 4/10 samples in exceedance of the single sample max; T6 had a geomean of 530.46 with 7/10 samples in exceedance of the single sample max, T5 had a geomean of 757.41 with 8/10 samples in exceedance of the single sample max. The geomean from sites T10 and T6 and T5were taken on the same day within approximately a two hour window for five consecutive weeks. The fish community IBI score for site T10 was 42 (fair) and the QHEI was 44 (fair). The macro community mIBI score was 30 (poor) and the QHEI was 49 (fair). The fish community IBI score for site T6 was 46 (good) and the QHEI was 61 (good). The macro community mIBI score was 42 (fair) and the QHEI was 57 (good). The fish community IBI score for site T5 was 24 (poor) and the QHEI was 33 (poor). The macro community mIBI score was 38 (fair) and the QHEI was 40 (poor). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources with small contributions from permitted sources. There are approximately 54 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 54 stream miles impaired for *E. coli,* IBC D.O., or Nutrients listed on the 2016 List of Impaired Waters. For TMDL Purposes U.S. aggregates will not receive a WLA as they are not discharging into a reach impaired for TSS. TSS is solely used as a surrogate for IBC impairment.

Table 43. Summary of Fetid Creek Subwatershed Characteristics

Fetid Creek (0521201030203)					
Drainage Area	26.91 square miles				
TMDL Sample Site	WMI-02-0013, WMI020-0002, WMI-02-0007				
AUID's (Listed Impairments covered by this TMDL)	INB0323_01 (*E.coli*, Nutrients), INB0323_02 (*E. coli ,* IBC, Nutrients), INB0323_T1001 (*E. coli)*, INB0323_T1002 (*E. coli,* IBC, Nutrients), INB0323_T1003, INB0323_T1004 (*E. coli)*, INB0323_T1005 (*E. coli,* Nutrients).				
Land Use	Agricultural Land: 74.43% Forested Land: 10.70% Developed Land: 6.76% Open Water: 0.22% Pasture/Hay: 6.09% Grassland/Shrubs: 1.6% Wetland: 0.20%				
NPDES Facilities	Ridgeville WWTP, IN0043494; US U.S. Aggregates, Inc – Ridgeville Quarry, ING490050.				
MS4 Communities	NA				
CSO Communities	Ridgeville WWTP, IN0020001				
CAFOs	NA				
CFOs	Stone Road Farms LLC, 6557; Dick Larvy, 6400; Douglas Baldwin, 4289.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	379.6	72.13	30.39	12.22	4.38
Future Growth	20.12	3.94	1.67	0.71	0.30
Total WLA	2.67	2.67	1.33	1.33	1.33
Ridgeville WWTP WLA	2.66	2.66	1.33	1.33	1.33
Ridgeville CSO	0.01	0.01	0.0	0.0	0.0
MOS (5%)	21.18	4.14	1.76	0.75	0.32
TMDL= LA+WLA+MOS	423.57	82.88	35.15	15.01	6.33
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	9885.05	1828.91	769.16	313.88	129.01
Future Growth	537.72	128.09	41.80	17.84	8.11
Total WLA	331.67	104.17	25.03	25.03	25.03
Ridgeville WWTP WLA	50.06	50.06	25.03	25.03	25.03
Ridgeville CSO	0.17	0.17	0.0	0.0	0.0
Construction WLA	281.43	53.94	0.0	0.0	0.0
MOS (5%)	566.02	108.48	44.00	18.77	8.53
TMDL = LA+WLA+MOS	11,320.46	2,169.65	879.99	375.52	170.68
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	97.64	16.97	6.84	2.40	0.59

Future Growth	5.27	1.02	0.43	0.19	0.10
Total WLA	2.5	2.5	1.25	1.25	1.25
Ridgeville WWTP WLA	2.5	2.5	1.25	1.25	1.25
Ridgeville CSO	0.01	0.01	0.01	0.01	0.01
MOS (5%)	5.55	1.08	0.45	0.20	0.11
TMDL = LA+WLA+MOS	110.96	21.57	8.97	4.04	2.05

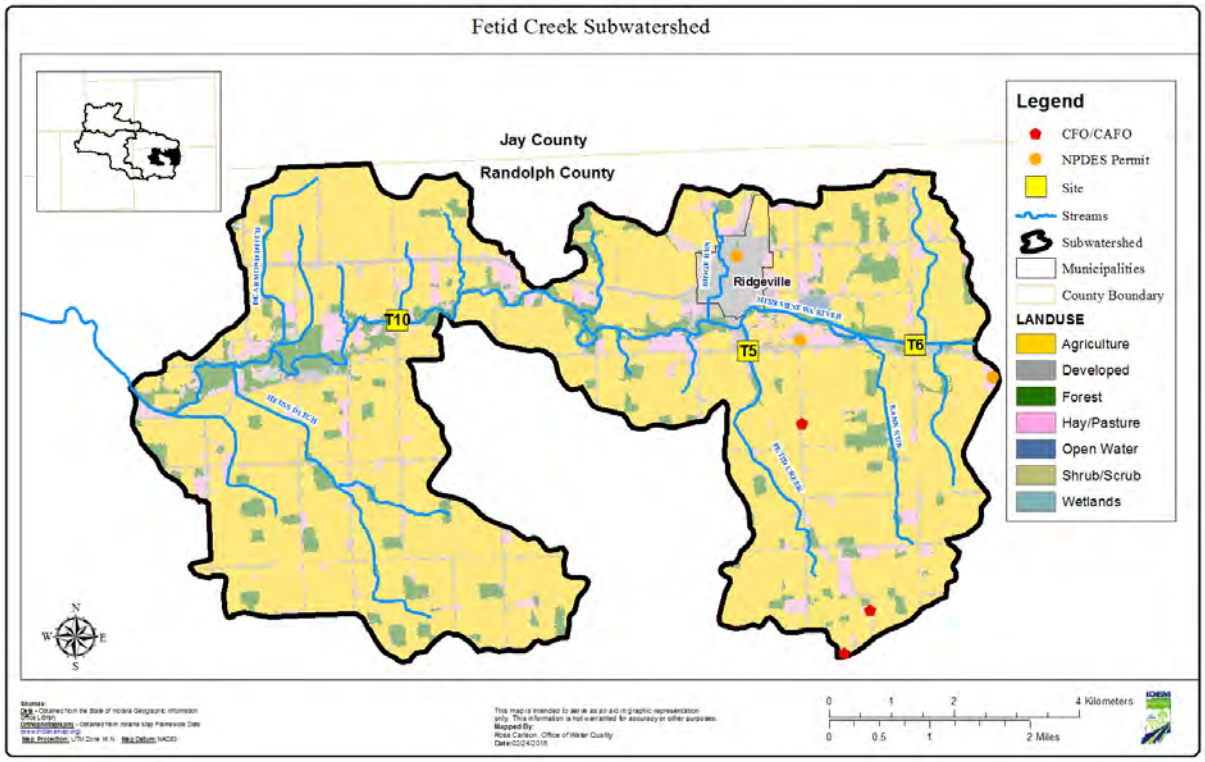

Figure 38. Sampling Stations in the Fetid Creek Watershed

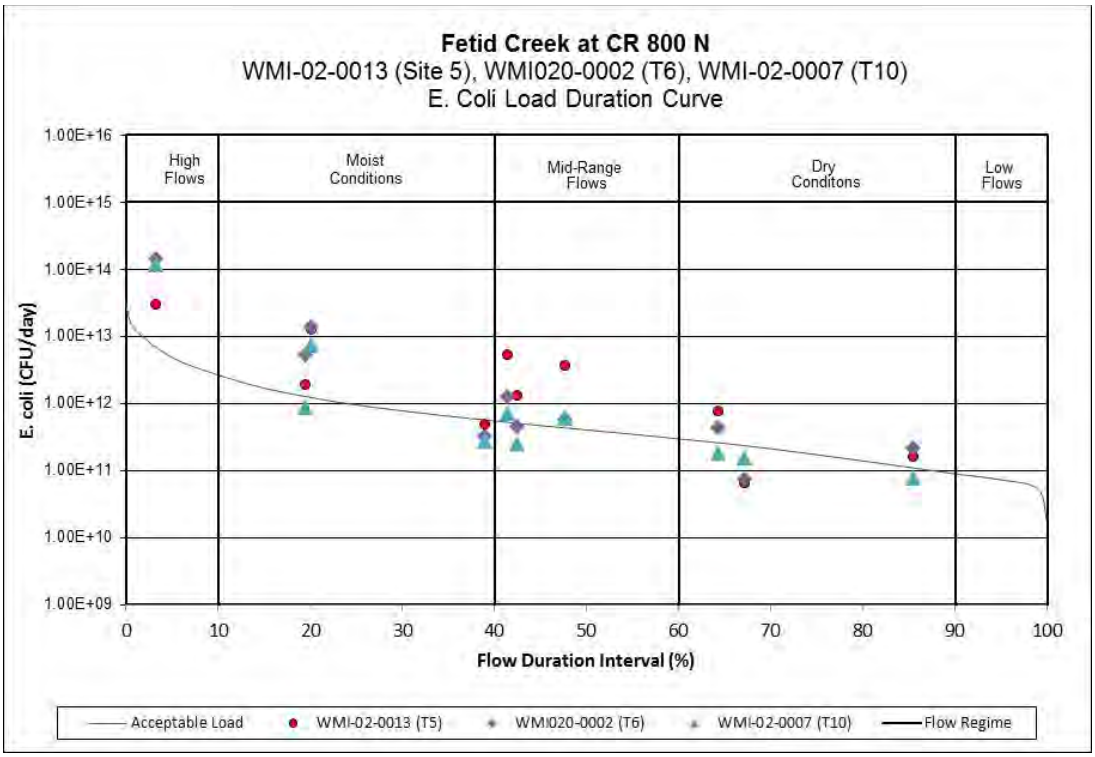

Figure 39. *E. coli* Load Duration Curve for Sites in the Fetid Creek Subwatershed

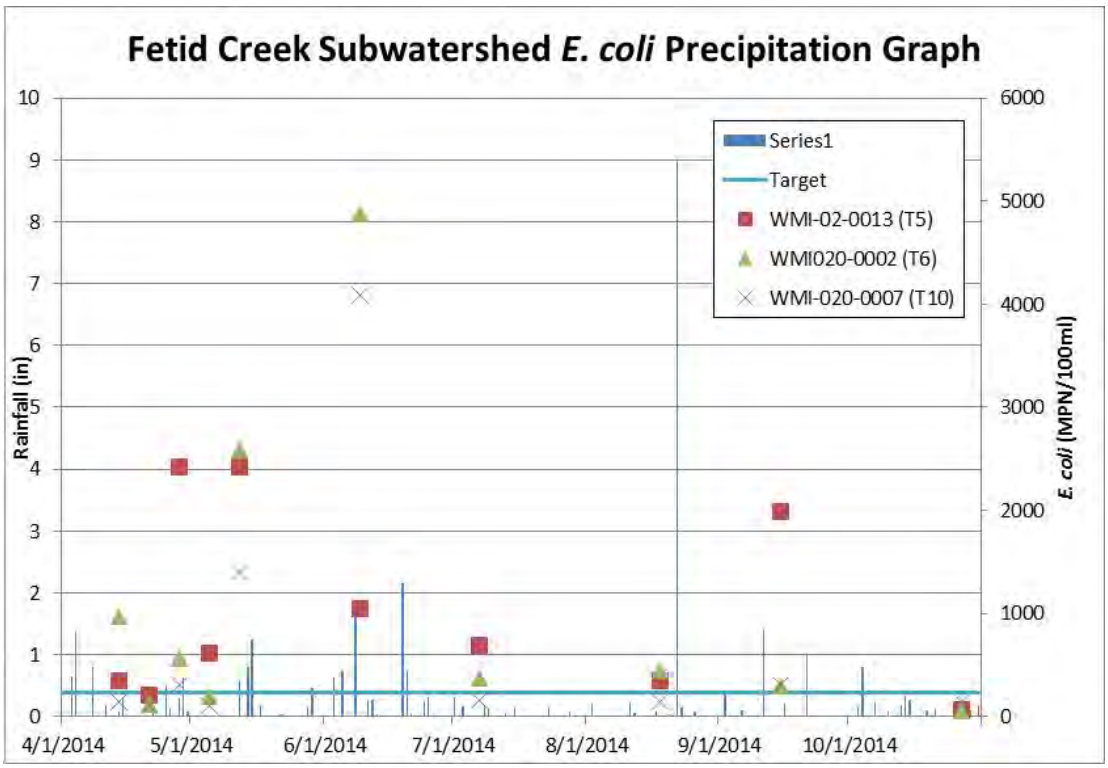

Figure 40. Graph of Precipitation and *E. coli* Data at sites in the Fetid Creek Subwatershed

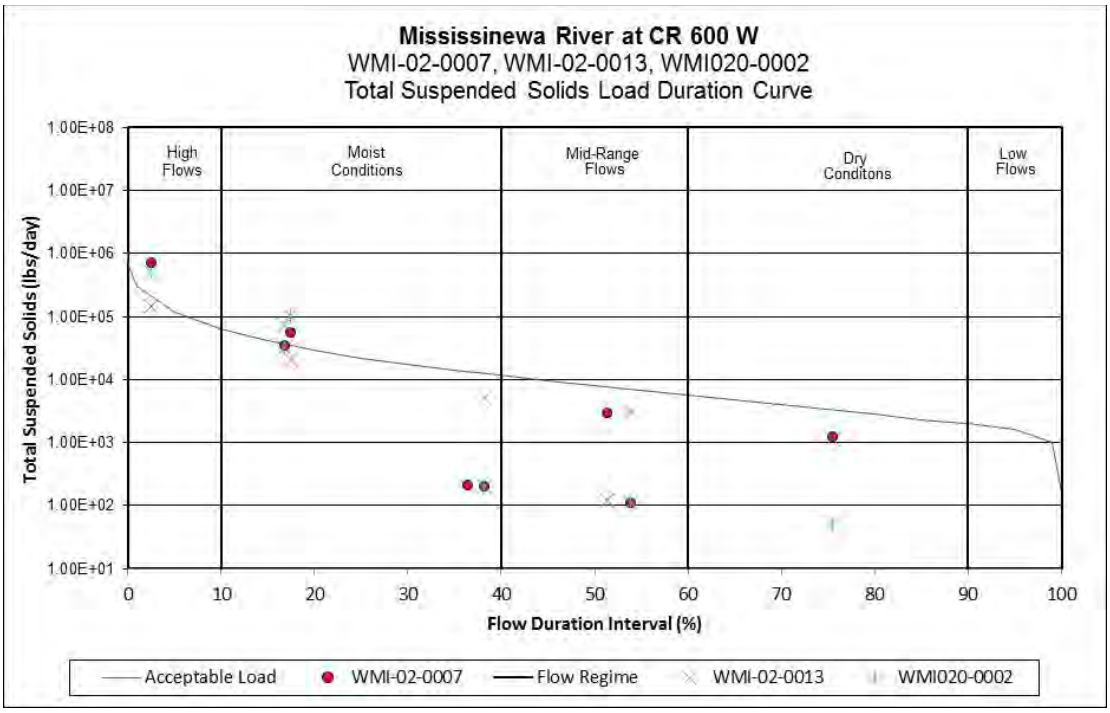

Figure 41. Total Suspended Solids Load Duration Curve for Sites in the Fetid Creek Subwatershed

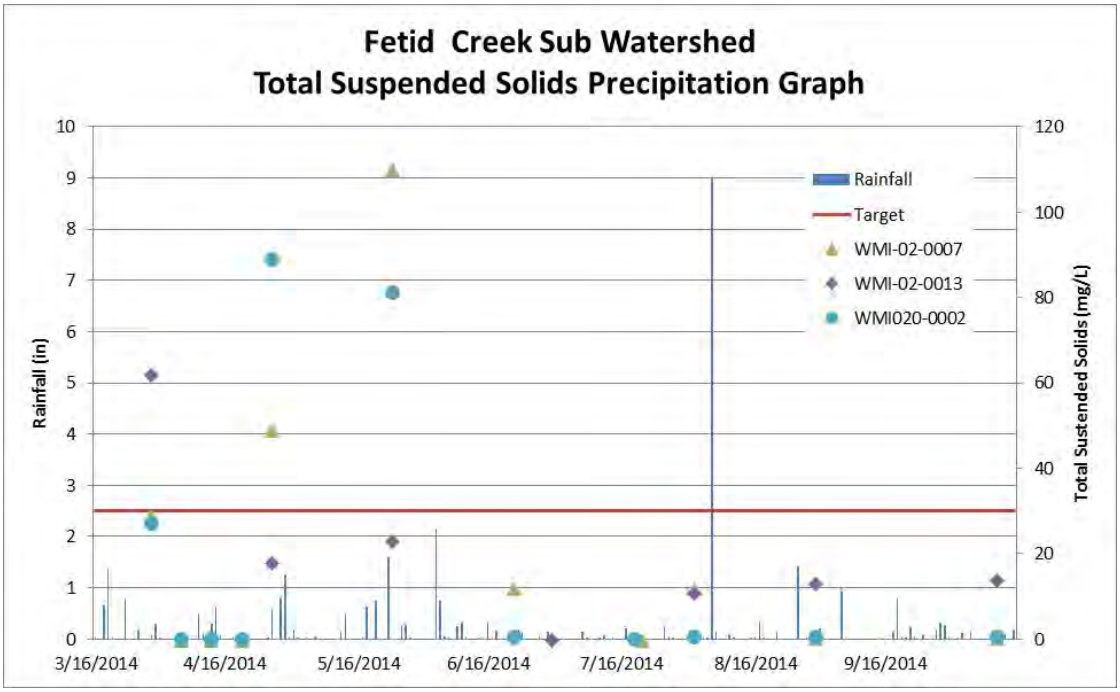

Figure 42. Graph of Precipitation and Total Suspended Solids Data at sites in the Fetid Creek Subwatershed

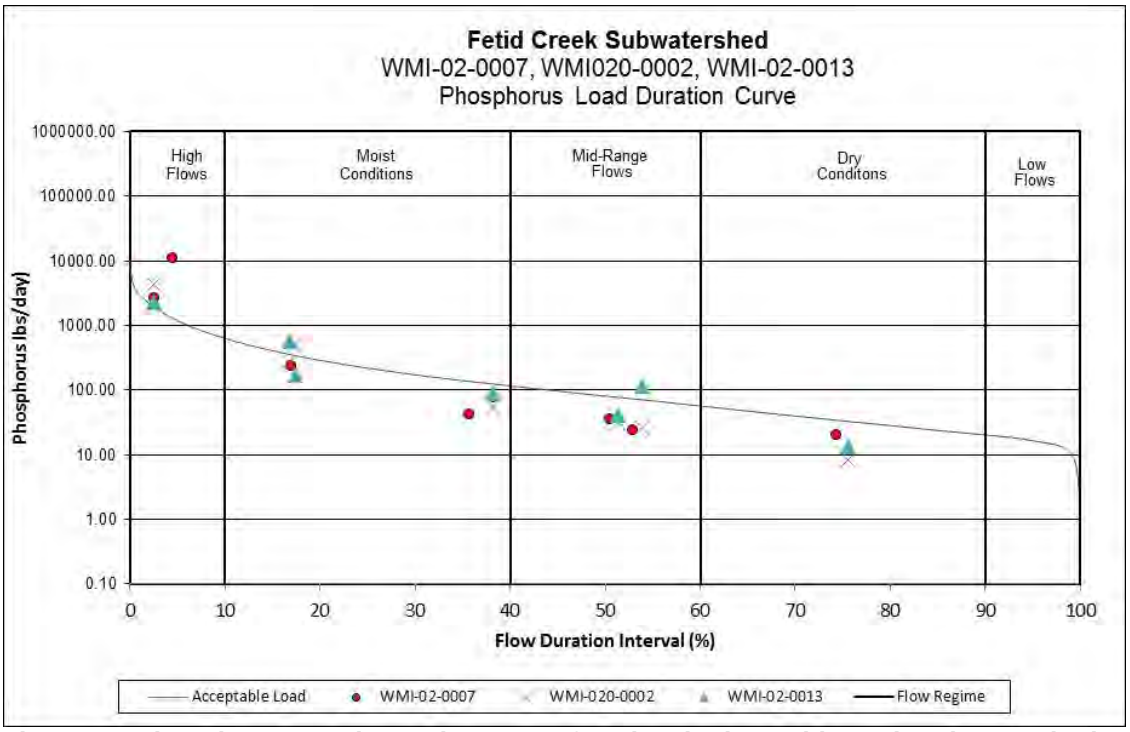

Figure 43. Phosphorus Load Duration Curve for Sites in the Fetid Creek Subwatershed

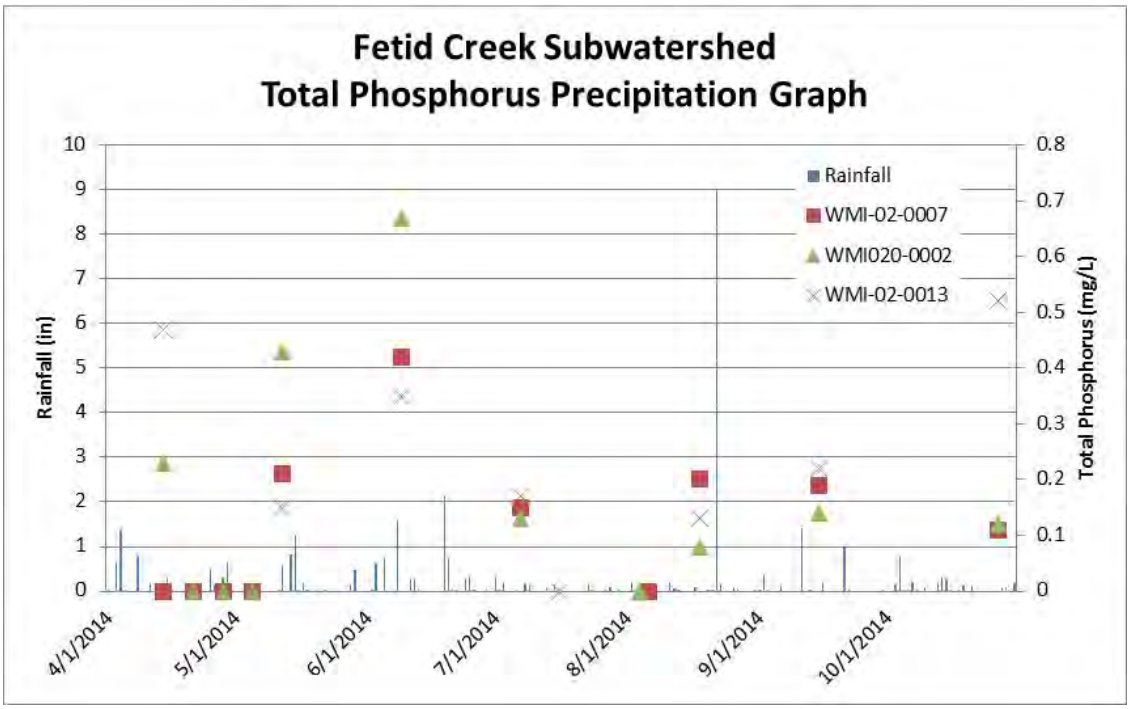

Figure 44. Graph of Precipitation and Total Phosphorous Data at sites in the Fetid Creek Subwatershed

7.3.4 Bush Creek

The Brush Creek subwatershed drains approximately 20 square miles. The subwatershed drains into the main stem of the Mississinewa river midway between Ridgeville and Albany. The land use is primarily agriculture (77.26%) followed by forested land (8.86%) and hay and pasture land (6.42%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. The drainages in this subwatershed have little to no riparian vegetation upstream of the confluence of Brush creek and Elkhorn creek Despite its flat 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 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 or high functioning two stage ditch implementation. With a land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There is 1 permitted CFO/CAFO's in the watershed with a total animal density of 68 animals/square mile. This is below the median concentration when compared to other subwatersheds in the Upper Mississinewa River.

There are three sites located in this subwatershed, one located on Bush Creek WMI-02-0009 (T12), one located on Elkhorn Creek WMI-02-0010 (T2), and one located on a tributary of Bush Creek WMI-02-0011 (T3). In 2014 this watershed was sampled 35 times between the three sites resulting in two (T2, T12) failing WQS for *E.coli* and nutrients, while T3 failed WQS for *E. coli* and D.O. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T12 was 279.08 MPN with 6/10 samples in exceedance of the single sample max; while T3 had a geomean of 345.66 MPN with 8/10 samples in exceedance of the single sample max; and T2 had a geomean of 516.09 MPN with 7/10 samples in exceedance of the single sample max. The geomeans from site T12, T3 and T2 were taken on the same day within an approximately three hour window for five consecutive weeks.

The fish community IBI score for site T12 was 40 (fair) and 38 (fair) on the revisit, the QHEI was 51 (fair) and 58 (good) respectively. The macro community mIBI score was 40 (fair) and the QHEI was 60 (good). The fish community IBI score for site T2 was 36 (fair) and the QHEI was 69 (good). The macro community mIBI score was 38 (fair) and the QHEI was 31 (poor). The fish community IBI score for site T3 was 38 (fair) and the QHEI was 69 (good). The macro community mIBI score was 42 (good) and the QHEI was 58 (good). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and Phosphorus in this watershed are nonpoint sources. There are approximately 22 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 17 stream miles impaired for *E. coli,* Nutrients and 5 stream miles impaired for *E. coli* and D.O. listed on the 2016 List of Impaired Waters.

Table 44. Summary of Bush Creek Subwatershed Characteristics

Bush Creek (051201030204)					
Drainage Area	20.10 square miles				
TMDL Sample Site	WMI-02-0010, WMI-02-0011, WMI-02-0009				
AUID's (Listed Impairments covered by this TMDL)	INB0324_01 (*E. coli,* Nutrients), INB0324_T1001 (*E. coli*, Nutrients, D.O.), INB0324_T1002 (*E. coli*, Nutrients)				
Land Use	Agricultural Land: 77.26% Forested Land: 8.86% Developed Land: 5.52% Open Water: 0.24% Pasture/Hay: 6.42% Grassland/Shrubs: 1.6% Wetland: 0.1%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	Stone Lane Farms LLC, 6596.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	488.03	95.50	40.51	17.29	7.28
Future Growth	25.69	5.03	2.13	0.91	0.38
Total WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	27.03	5.28	2.24	0.96	0.41
TMDL= LA+WLA+MOS	540.75	105.81	44.88	19.16	8.07
Flow Regime TMDL analysis for TSS not needed.					
Flow Regime TMDL analysis for Total Phosphorus (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	127.42	24.42	9.90	4.23	1.92
Future Growth	6.71	1.29	0.52	0.22	0.10
Total WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	7.05	1.35	0.55	0.23	0.11
TMDL = LA+WLA+MOS	141.18	27.06	10.97	4.68	2.13

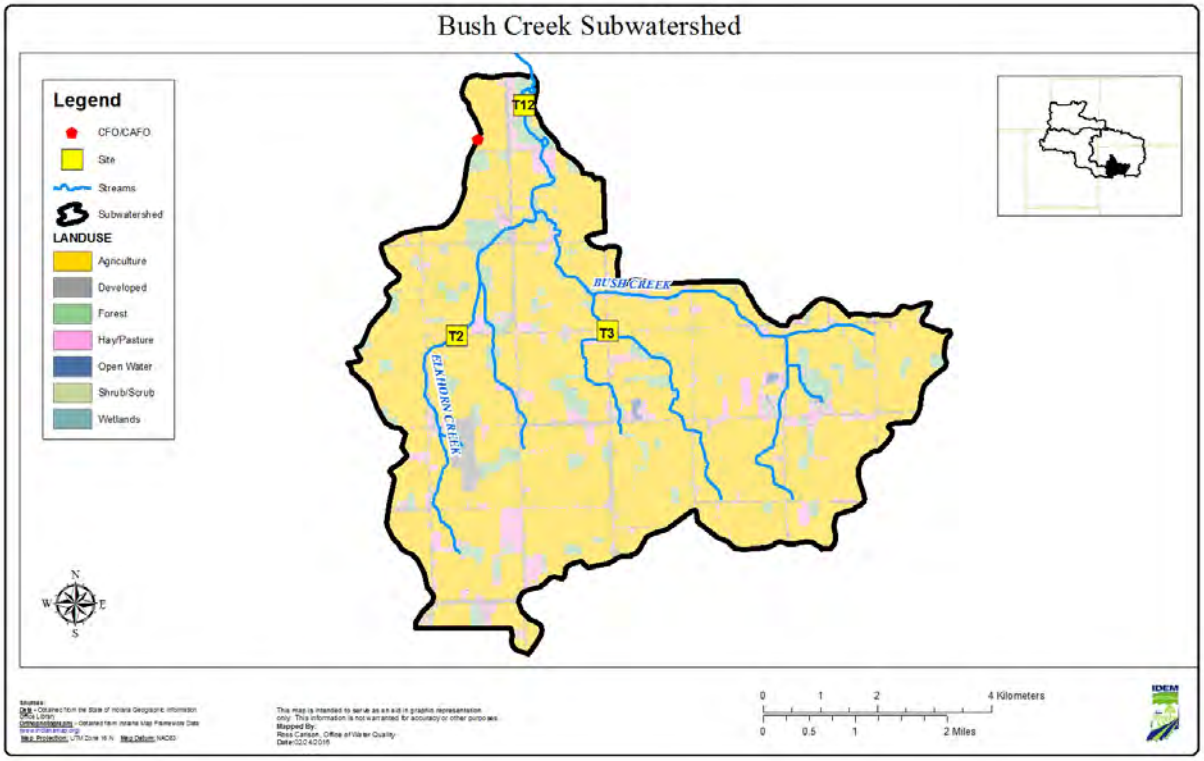

Figure 45. Sampling Stations in the Bush Creek Watershed

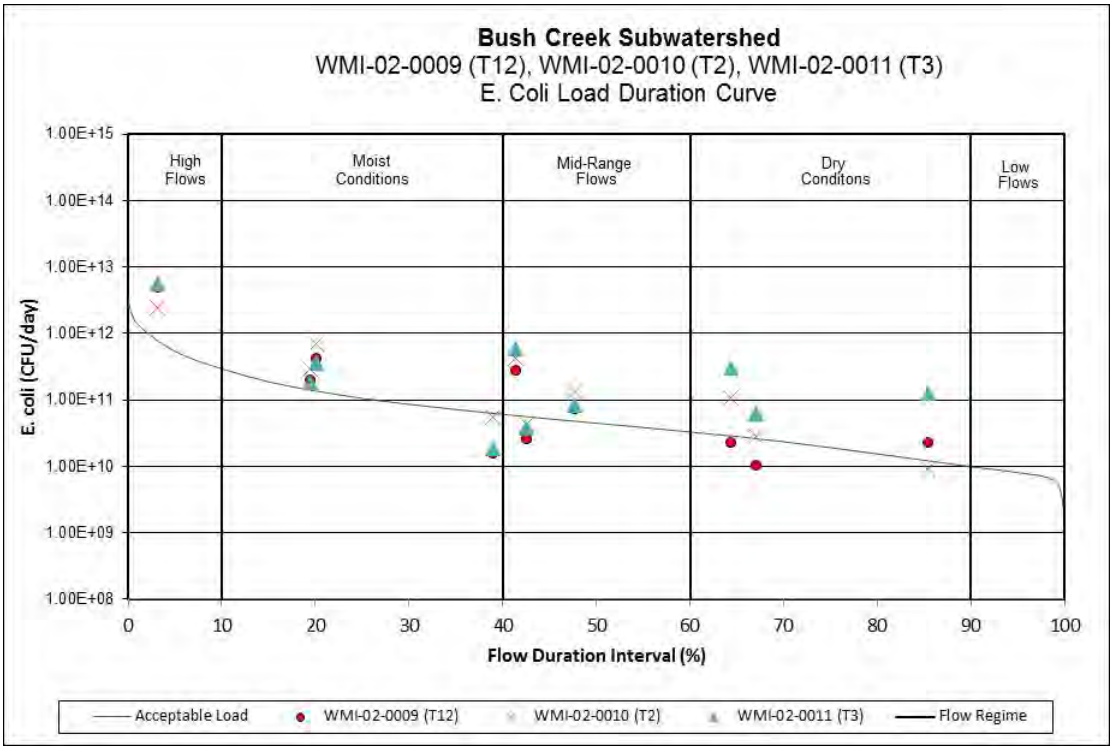

Figure 46. *E. coli* Load Duration Curve for Sites in the Bush Creek Subwatershed

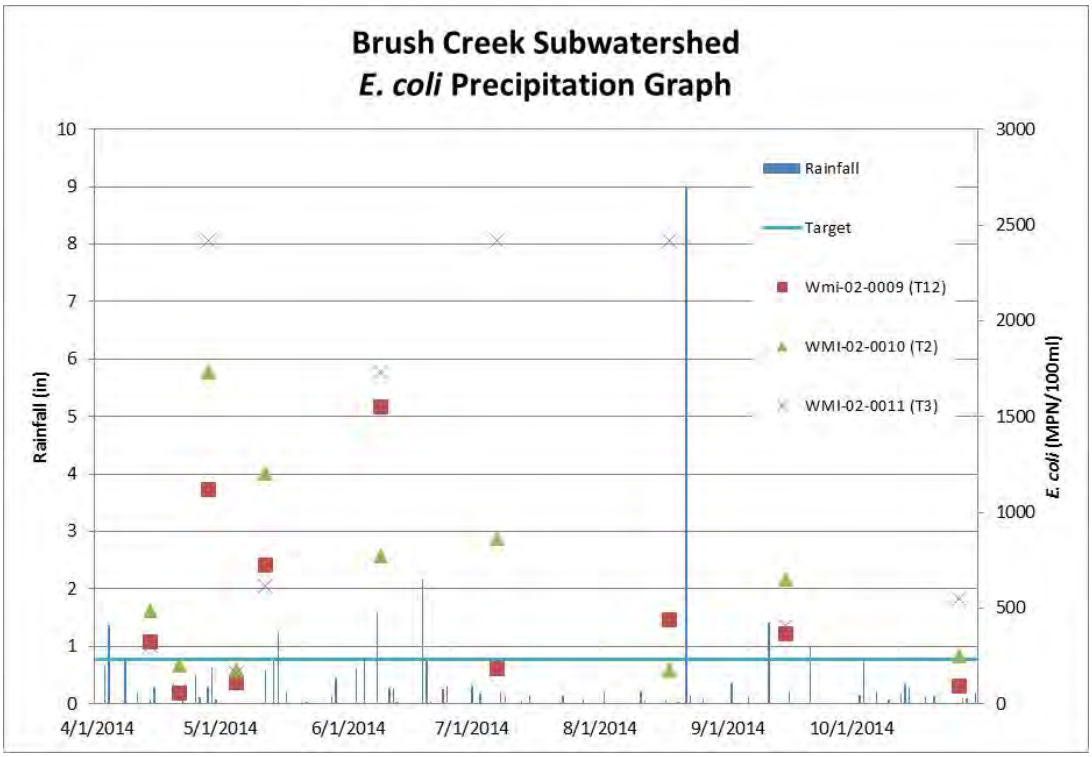

Figure 47. Graph of Precipitation and *E. coli* Data at sites in the Brush Creek Subwatershed

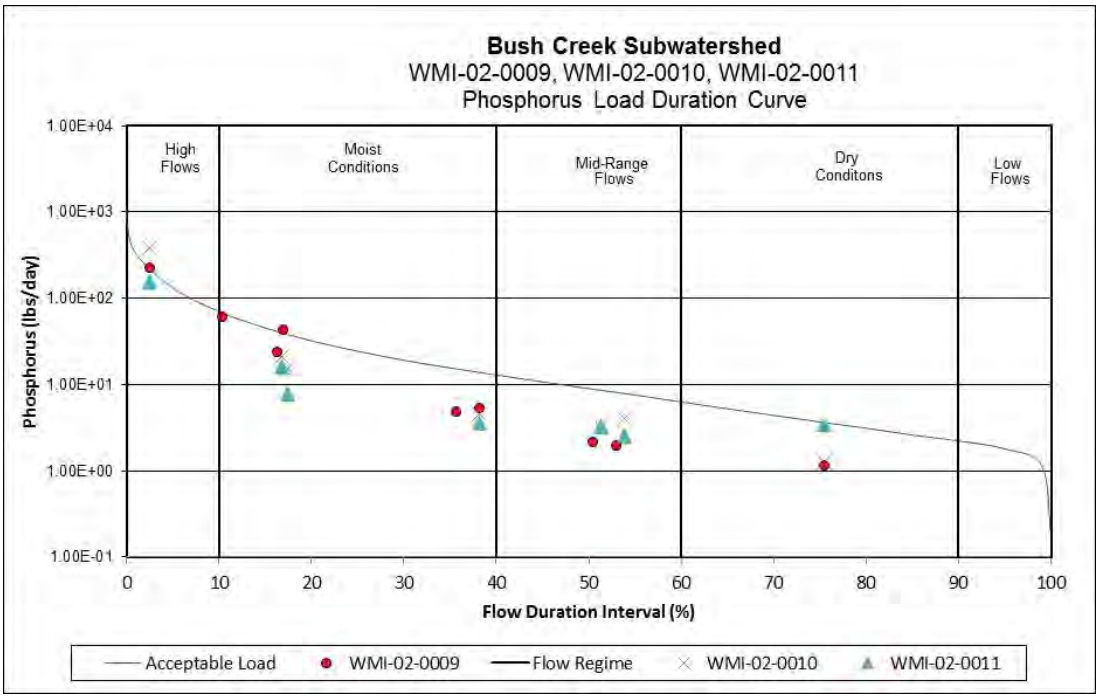

Figure 48. Phosphorous Load Duration Curve for Sites in the Bush Creek Subwatershed

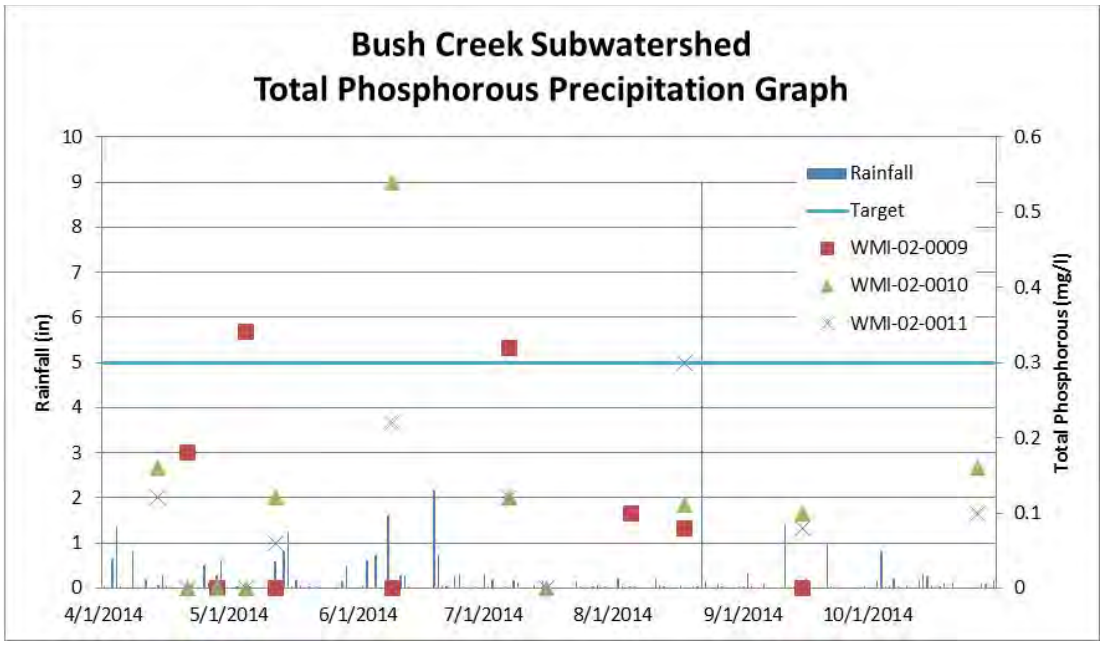

Figure 49. Graph of Precipitation and Total Phosphorous Data at sites in the Bush Creek Subwatershed

7.3.5 Redkey Run

The Redkey Run subwatershed drains approximately 25 square miles. The subwatershed drains into the main stem of the Mississinewa River in Albany. The land use is primarily agriculture (74.66%) followed by developed land (11.57%) and hay and pasture land (5.99%). There are two permitted facilities, WWTPs, or industrial storm water permits in the subwatershed; Bell Aquaculture, and the Redkey Waste Water Treatment Plant. The majority of the population of the subwatershed lives within the towns of Redkey or Albany with homes interspersed along the country roads in the watershed. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. The drainages in this subwatershed have nearly no riparian vegetation. Despite its flat 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 the high gradient slopes.

This watershed contains a significant area of hydric soils in a low lying area west of Redkey along with hydric soils along the riparian zones of Halfway Creek and Redkey Run. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There is 1 permitted CFO/CAFO's in the watershed with a total animal density of 171 animals/square mile. This is close to the median concentration of animals when compared to other subwatersheds in the Upper Mississinewa River.

There are two sites located in this subwatershed both located on Halfway Creek, WMI-02-0016 (T14), and WMI-02-0017 (T16). In 2014 this watershed was sampled 29 times between the two sites resulting in one (T16) failing WQS for *E.coli* and nutrients, while T14 failed WQS for *E. coli* and nutrients. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T14 was 427.1 MPN with 7/10 samples in exceedance of the single sample max; while T16 had a geomean of 657.4 MPN with 8/11 samples in exceedance of the single sample max. The geomeans from site T14 and T16 were taken on the same day within a one hour time frame for five consecutive weeks.

The fish community IBI score for site T14 was 14 (very poor) and the QHEI was 32(very poor). The macro community mIBI score was 34 (poor) and the QHEI was 32 (poor). The fish community IBI score for site T16 was 46 (fair) and the QHEI was 50 (fair). The macro community mIBI score was 40 (fair) and the QHEI was 45 (fair). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and the nature of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources during high flows, while the Redkey WWTP could be contributing to low flow exceedances. There are approximately 20 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 16.5 stream miles impaired for *E. coli,* and 3.5 stream miles impaired for *E. coli,* IBC, and nutrients listed on the 2016 List of Impaired Waters.

Table 45. Summary of Red Key Run Subwatershed Characteristics

Redkey Run (0521201030205)					
Drainage Area	25.06 square miles				
TMDL Sample Site	WMI-02-0016, WMI-02-0017				
AUID's (Listed Impairments covered by this TMDL)	INB0325_02(*E. coli*, Nutrients), INB0325_03 (*E. coli,* IBC, Nutrients), INB0325_T1004 (*E. coli,* IBC, Nutrients), INB0325_T1005 (*E. coli*, IBC, Nutrients), INB0325_T1006 (*E. coli*, Nutrients), INB0325_T1007 (*E. coli).*				
Land Use	Agricultural Land: 74.66% Forested Land: 5.59% Developed Land: 11.57% Open Water: 0.26% Pasture/Hay: 5.99% Grassland/Shrubs: 1.83% Wetland: 0.1%				
NPDES Facilities	Bell Aquaculture LLC Redkey, INP000288; Redkey WWTP, IN0024406;				
MS4 Communities	Delaware County MS4, 1.1 square miles				
CSO Communities	Redkey WWTP, IN0024406				
CAFOs	NA				
CFOs	Eric & Loria Pursifull, 2616.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	563.89	104.66	47.07	18.57	6.27
Future Growth	31.54	6.17	2.62	1.12	0.47
Total WLA	35.41	12.61	2.67	2.67	2.67
Delaware County MS4 WLA	28.34	5.54	0.0	0.0	0.0
Redkey WWTP WLA	6.0	6.0	2.67	2.67	2.67
Redkey CSO	1.07	1.07	0.0	0.0	0.0

MOS (5%)	33.20	6.50	2.75	1.17	0.50
TMDL= LA+WLA+MOS	664.04	129.94	55.11	23.53	9.91
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	14896.27	2694.11	1,160.56	452.19	164.58
Future Growth	836.62	160.34	65.03	27.75	12.61
Total WLA	999.46	352.41	75.09	75.09	75.09
Delaware County MS4 WLA	739.92	141.81	0.0	0.0	0.0
Redkey WWTP WLA	168.96	168.96	75.09	75.09	75.09
Redkey CSO	30.04	30.04	0.0	0.0	0.0
Construction WLA	60.54	11.60	0.0	0.0	0.0
MOS (5%)	880.65	168.79	68.47	29.22	13.29
TMDL = LA+WLA+MOS	17,613.00	3,375.65	1,369.15	584.25	265.57
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	153.7	25.21	10.53	3.45	0.58
Future Growth	8.40	1.64	0.69	0.31	0.16
Total WLA	5.93	5.93	2.50	2.50	2.50
Redkey WWTP WLA	5.63	5.63	2.5	2.5	2.5
Redkey CSO	0.3	0.3	0.0	0.0	0.0
MOS (5%)	8.83	1.73	0.72	0.33	0.17
TMDL = LA+WLA+MOS	176.88	34.51	14.44	6.59	3.41

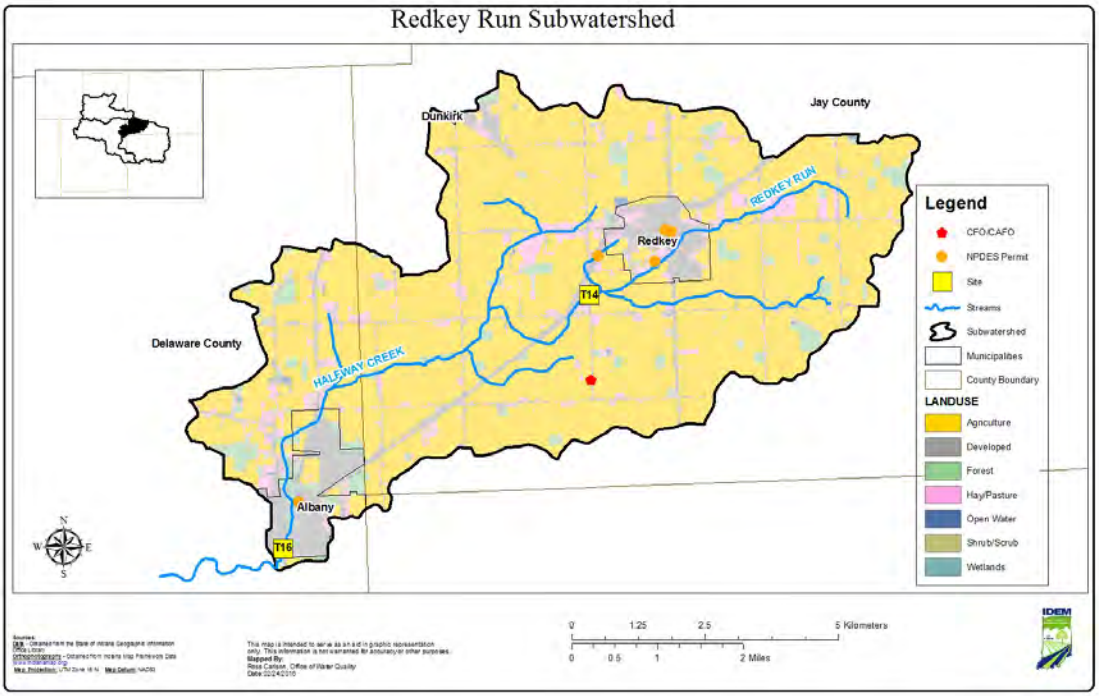

Figure 50. Sampling Stations in the Redkey Run Watershed

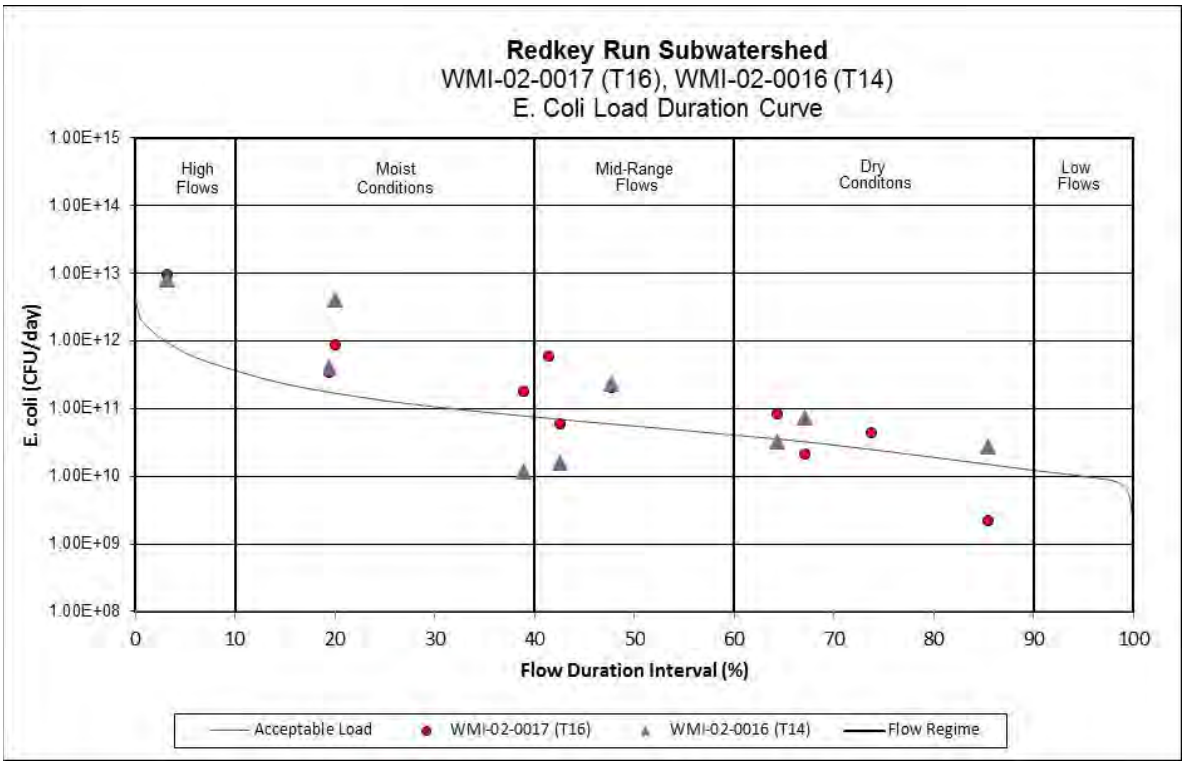

Figure 51. *E. coli* Load Duration Curve for Sites in the Redkey Run Subwatershed

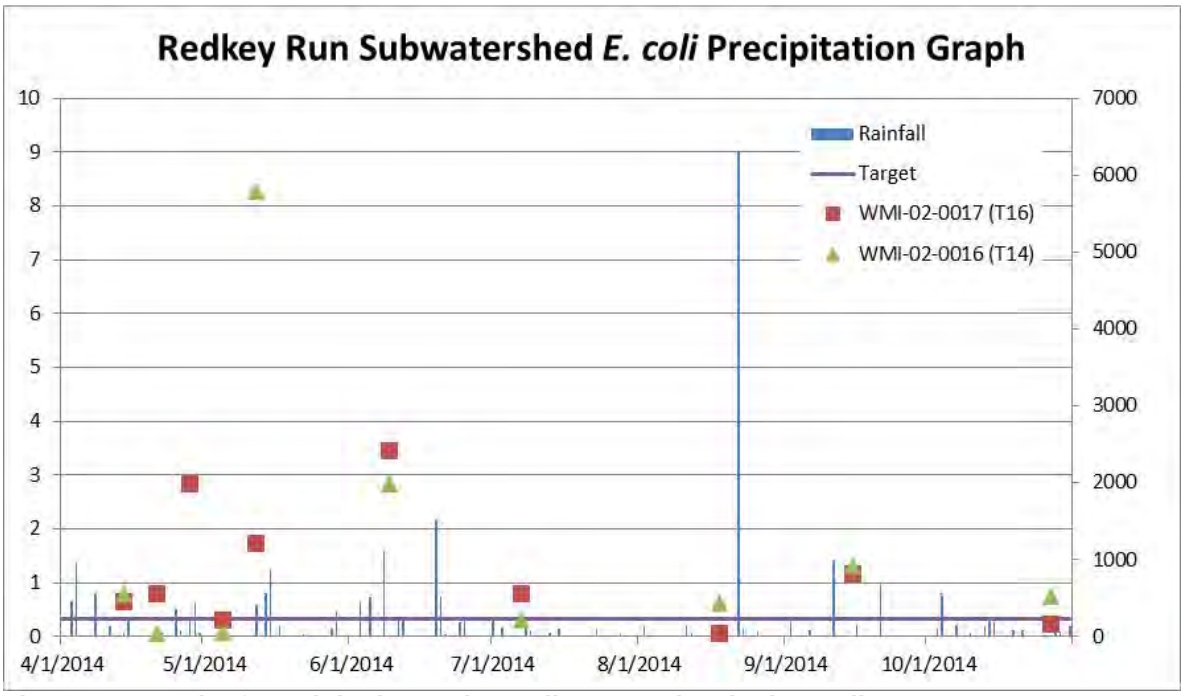

Figure 52. Graph of Precipitation and *E. coli* Data at sites in the Redkey Run Subwatershed

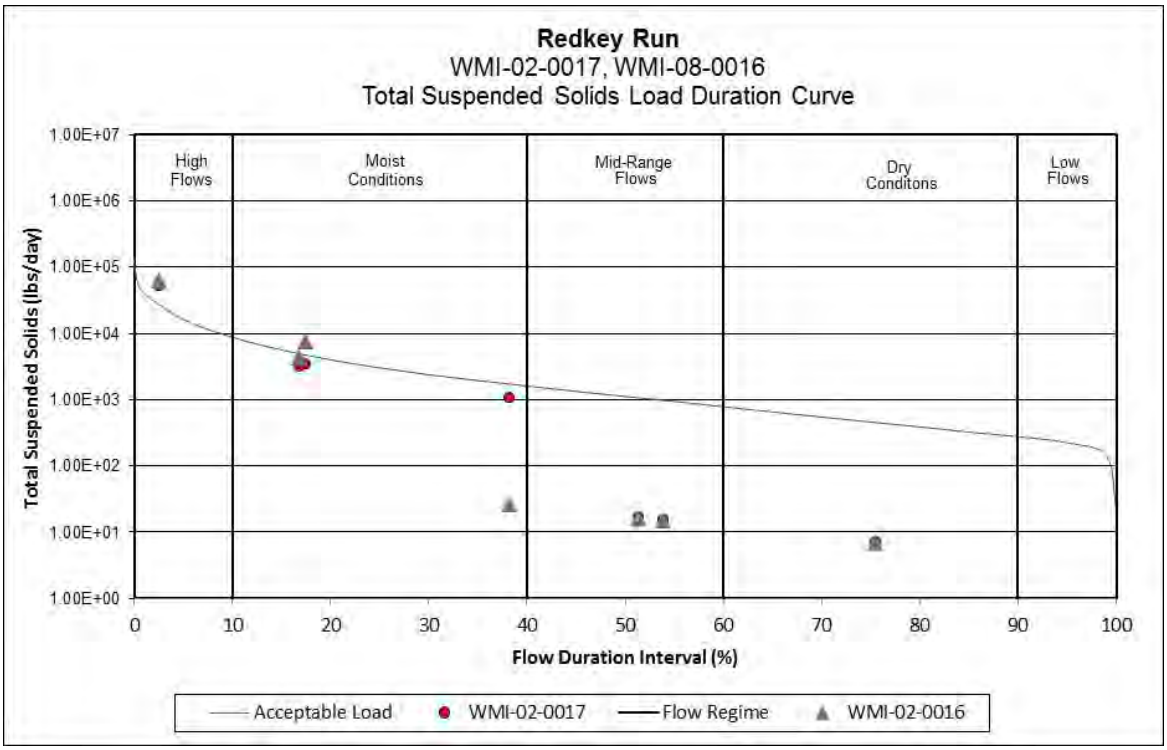

Figure 53. Total Suspended Solids Load Duration Curve for the Red Key Run Subwatershed

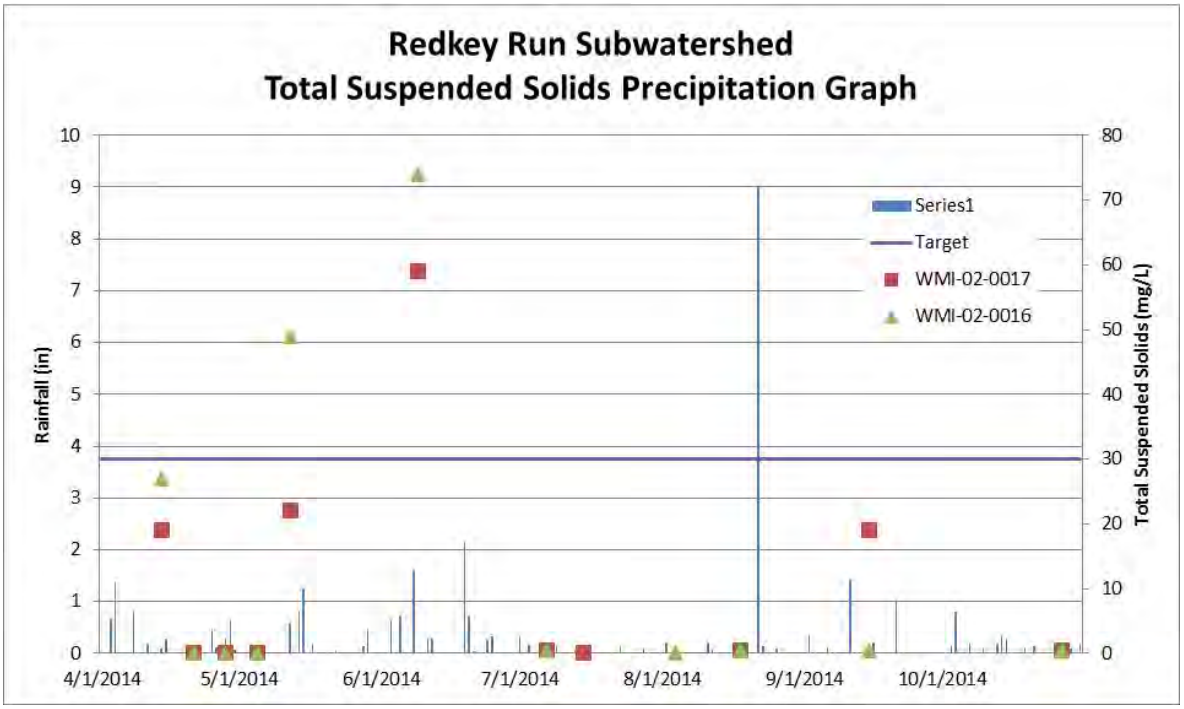

Figure 54. Graph of Precipitation and Total Suspended Solid Data at sites in the Redkey Run Subwatershed

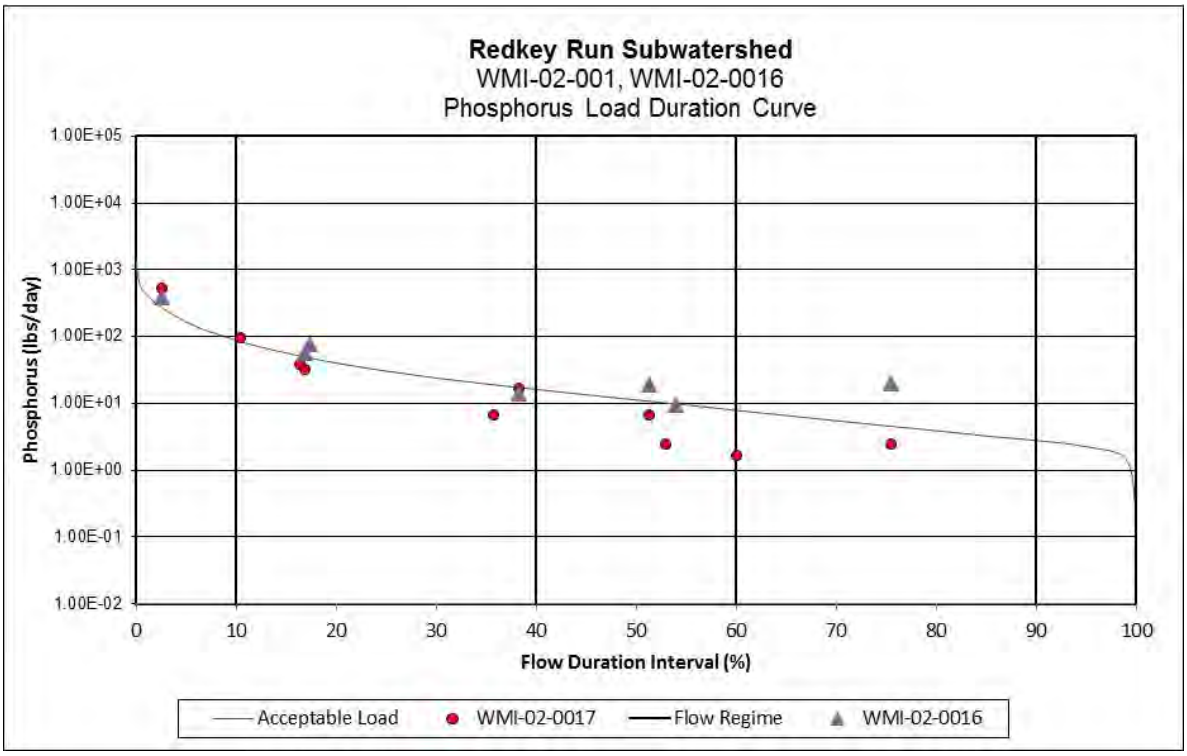

Figure 55. Phosphorous Load Duration Curve for Sites in the Redkey Run Subwatershed

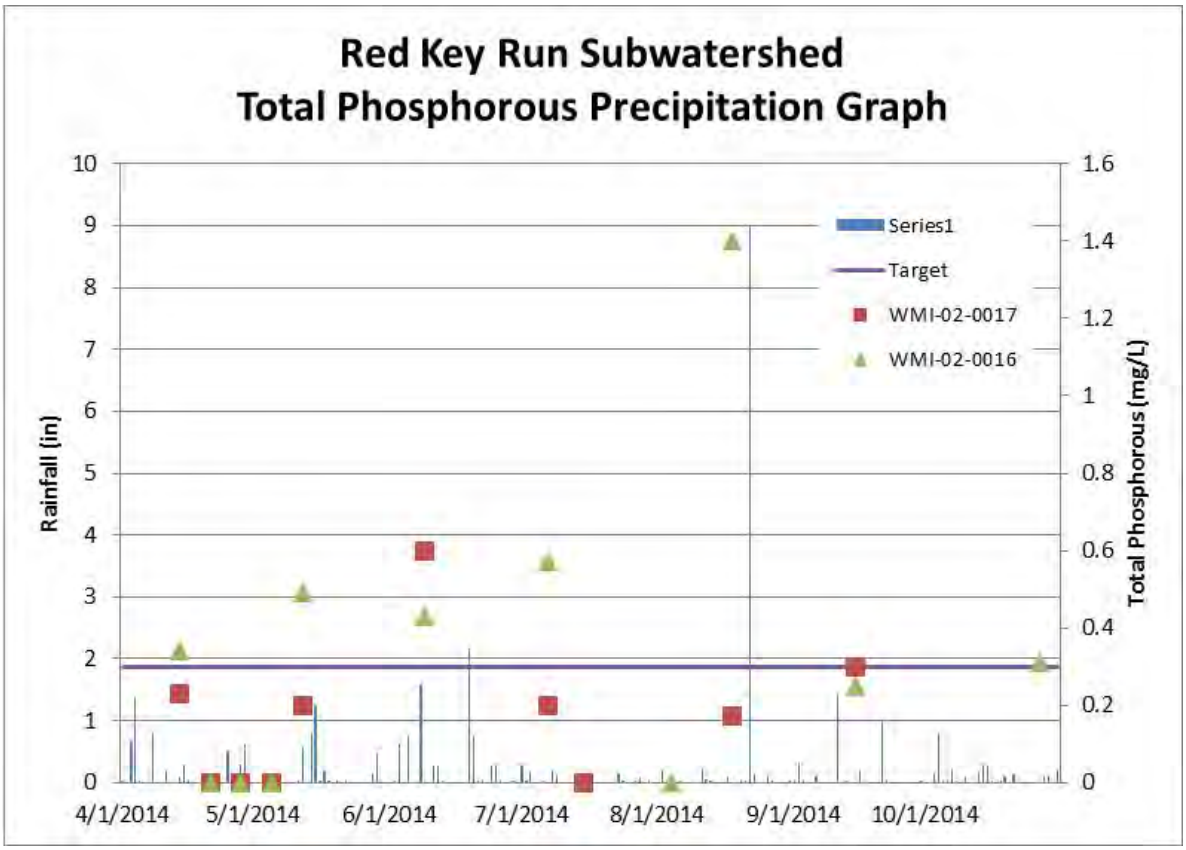

Figure 56. Graph of Precipitation and Phosphorous Data at sites in the Redkey Run Subwatershed

7.3.6 Platt Nibarger Ditch

The Platt Nibarger subwatershed drains approximately 30 square miles. The subwatershed contains the main stem of the Mississinewa River and drains the land surrounding Dinner Creek and Mud Creek with its pour point south of Albany where Halfway Creek meets the Mississinewa. The land use is primarily agriculture (77.07%) followed by forest (9.92%) and hay and pasture land (6.17%). There are two permitted facilities, WWTPs, or industrial storm water permits in the subwatershed; Riverside Community WWTP, and the U.S. Aggregates Fairview quarry. Fairview Quarry was given a smaller TSS WLA during low flows due to lack of need for discharge at max design flow during this flow regime. This subwatershed also has a small portion included in the Delaware county MS4. The subwatershed includes a small portion of the town of Albany with additional homes concentrated on the north side of the Mississinewa along State Route 28. The remainder of the watershed is rural home with onsite septic. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. The drainages in this subwatershed have little riparian vegetation, although many of the streams pass through the patchwork of forest that makes up the watershed. Despite its flat nature the subwatershed does contain significant amounts of highly erodible soil types, the majority of

which are located along the north size of the Mississinewa River. 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.

This watershed contains areas of hydric soils along the stream riparian zones as well as significant continuous zones of hydric soils in the southwest of the watershed in Delaware County. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are 8 permitted CFO/CAFO's in the watershed with a total animal density of 409 animals/square mile. This amount is well above the median concentration of animals when compared to other subwatersheds in the Upper Mississinewa River.

There are three sites located in this subwatershed, WMI-02-0018 (T17) on the main stem Mississinewa, and WMI-02-0015 (T13) on Dinner Creek, and WMI-02-0019 (T18) on mud creek. In 2014 this watershed was sampled 41 times between the three sites resulting in T17 failing for *E. coli* and Nutrients, T13 failing for *E. coli*, IBC and Nutrients, and T18 failing for *E. coli*, and IBC. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The E. coli geomean for T17 was 292.52 MPN with 5/11 samples in exceedance of the single sample max, T13 had a geomean of 703.75 MPN with 8/10 samples in exceedance of the single sample max, and T18 had a geomean of 400.97 MPN with 7/10 sample in exceedance of the single sample max. *E. coli.*

The fish community IBI score for site T17 was 52 (good) and the QHEI was 67 (good). The macro community mIBI score was 38 (fair) and the QHEI was 61 (good). The fish community IBI score for site T13 was 32 (poor) and the QHEI was 42 (poor). The macro community mIBI score was 36 (fair) and the QHEI was 43 (fair). The fish community IBI score for site T18 was 32 (poor) and the QHEI was 51 (fair). The macro community mIBI score was 34 (poor) and the QHEI was 39 (poor). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources. There are approximately 38 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 18 stream miles impaired for *E. coli* and nutrients, 3.5 stream miles impaired for *E. coli* and nutients listed on the 2016 List of Impaired Waters. For TMDL Purposes U.S. aggregates will not receive a WLA as they are not discharging into a reach impaired for TSS. TSS is solely used as a surrogate for IBC impairment.

Table 46. Summary of Platt Nibarger Creek Subwatershed Characteristics

Platt Nibarger (0521201030206)	
Drainage Area	30.96 square miles
TMDL Sample Site	WMI-02-0015, WMI-02-0018, WMI-02-0019
AUID's (Listed Impairments covered by this TMDL)	INB0326_01 (*E. coli*, Nutrients), INB0326_T1001 (*E.coli*, IBC, Nutrients), INB0326_T1002 (*E. coli*, IBC)
Land Use	Agricultural Land: 77.07% Forested Land: 9.92% Developed Land: 4.65% Open Water: 0.22% Pasture/Hay: 6.17% Grassland/Shrubs: 1.61% Wetland: 0.36%
NPDES Facilities	Riverside Community MHP, IN0041173; U.S. Aggregates, Inc – Fairview Quarry, ING490051
MS4 Communities	Delaware County MS4, 0.25 square miles
CSO Communities	NA
CAFOs	NA

CFOs	Shaffer T & C, 4377; Retter Swine Nursery 2, 6519; Jackson Farm, 6429; Retter Farms, 4979; 2W2M LCC,6496; Retter Swine Finisher, 6520; Shaffer Superior Genetics, 2454; Tyler Eric Pursifull, 6399; Retter Swine Nursery 1, 6518.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	995.13	194.69	1675.33	507.43	33.24
Future Growth	52.83	10.34	4.39	1.87	0.79
Total WLA	8.60	1.74	0.07	0.07	0.07
Delaware County MS4 WLA	8.53	1.67	0.0	0.0	0.0
Riverside Community MHP WLA	0.07	0.07	0.07	0.07	0.07
MOS (5%)	55.61	10.88	4.62	1.97	0.83
TMDL= LA+WLA+MOS	1,112.17	217.65	92.32	39.42	16.59
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	25,518.09	4,599.91	1675.33	507.43	33.24
Future Growth	1,370.31	255.33	98.19	36.72	11.76
Total WLA	517.89	251.28	190.23	190.23	190.23
Delaware County MS4 WLA	221.30	41.23	0.0	0.0	0.0
Riverside Community MHP WLA	190.23	190.23	190.23	190.23	190.23
Construction WLA	106.35	19.82	0.0	0.0	0.0
MOS (5%)	1,442.44	268.76	103.36	38.65	12.38
TMDL = LA+WLA+MOS	28,848.73	5,375.28	2,067.11	773.03	247.61
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	261.73	49.88	20.03	8.35	3.60
Future Growth	13.78	2.63	1.05	0.44	0.19
Total WLA	0.01	0.01	0.01	0.01	0.01
Riverside Community MHP WLA	0.01	0.01	0.01	0.01	0.01
MOS (5%)	14.50	2.76	1.11	0.46	0.20
TMDL = LA+WLA+MOS	290.02	55.28	22.20	9.26	4.00

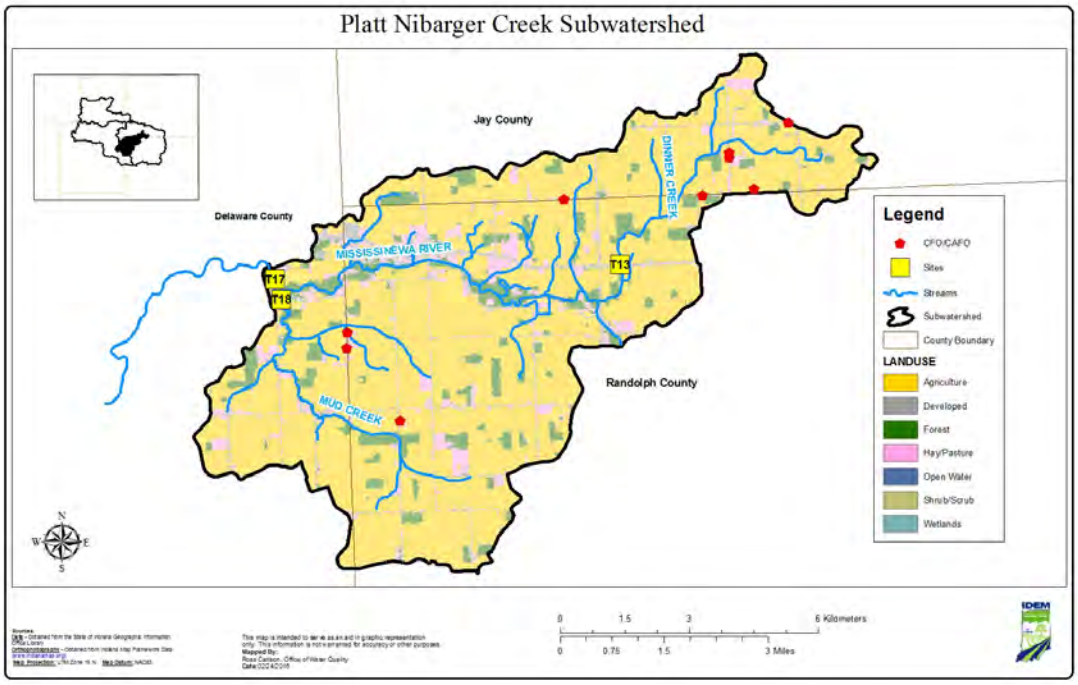

Figure 57. Sampling Stations in the Platt Nibarger Ditch Watershed

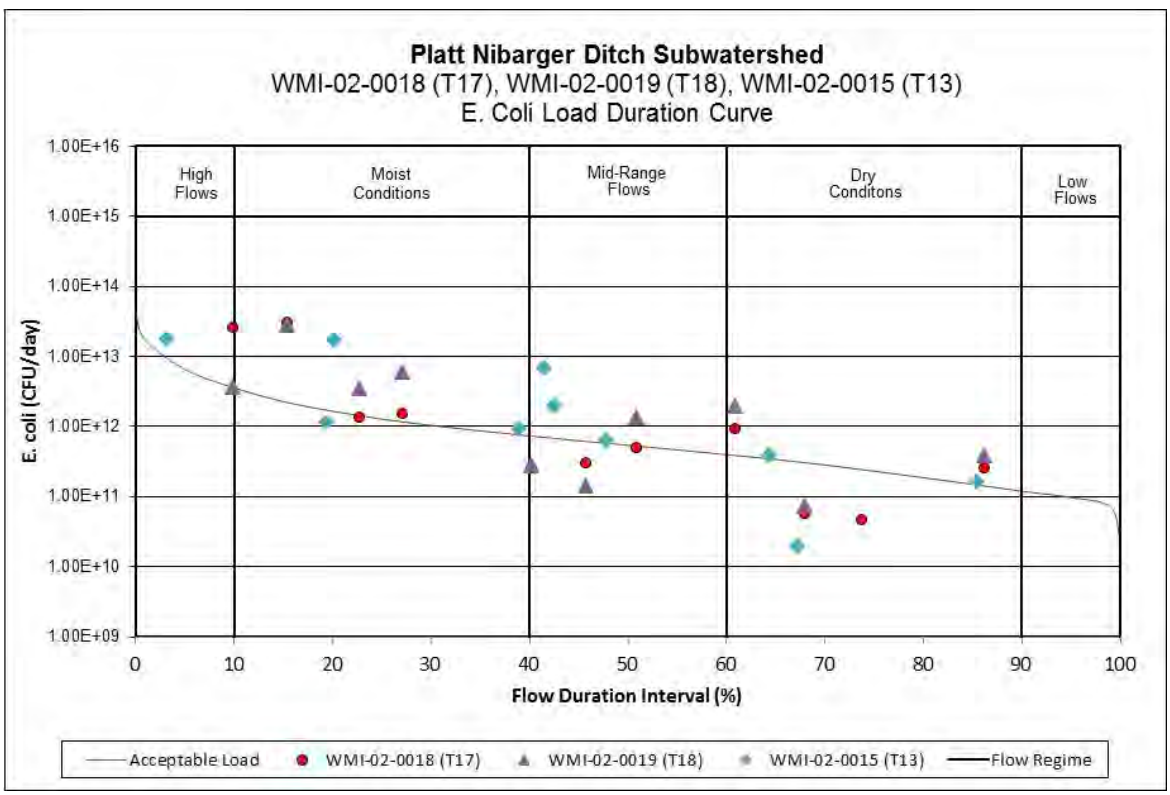

Figure 58. *E. coli* Load Duration Curve for Sites in the Platt Nibarger Ditch Subwatershed

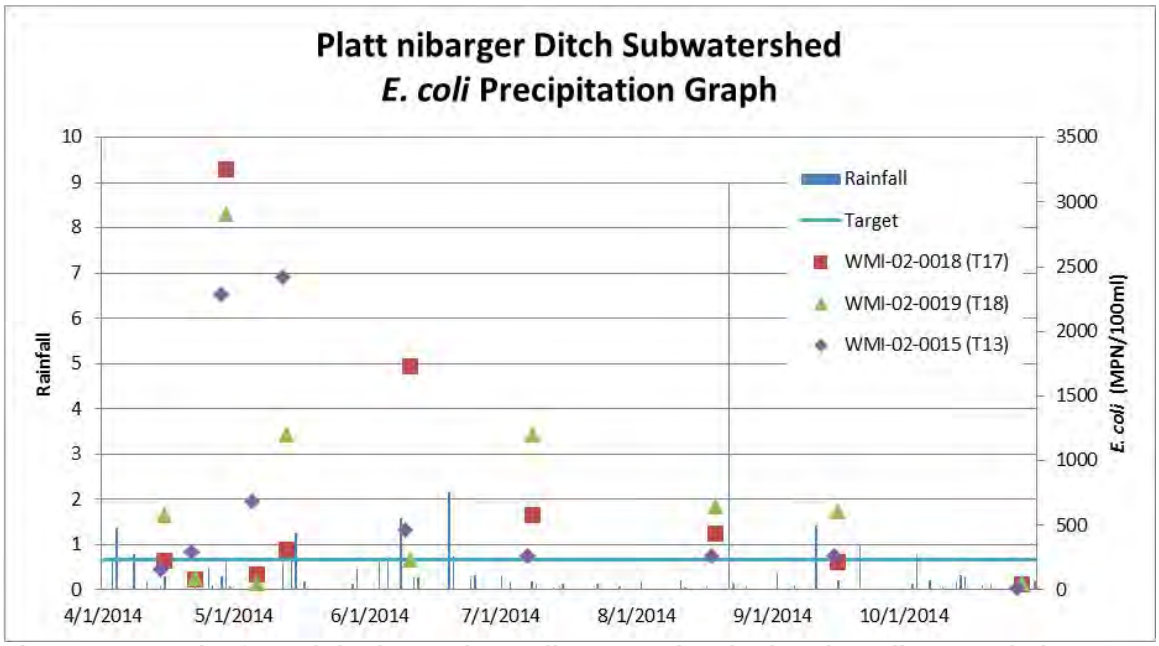

Figure 59. Graph of Precipitation and *E. coli* Data at sites in the Platt Nibarger Ditch Subwatershed

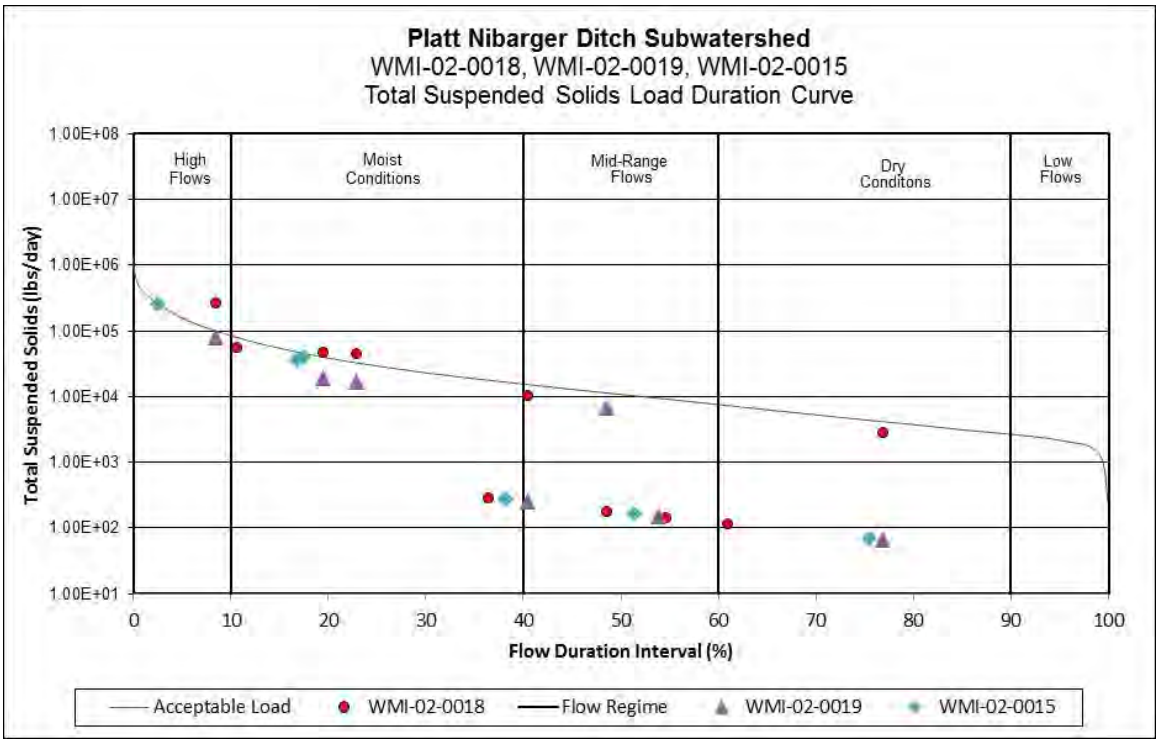

Figure 60. Total Suspended Solid Load Duration Curve for Sites in the Platt Nibarger Ditch Subwatershed

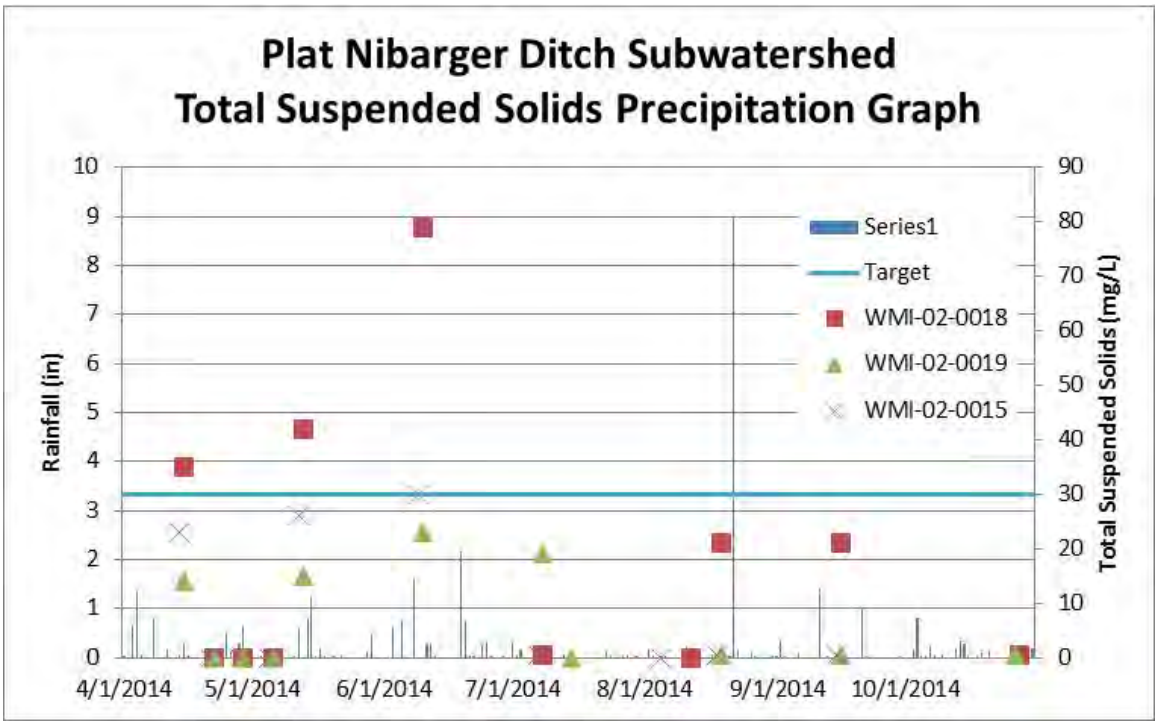

Figure 61. Graph of Precipitation and Total Suspended Solid Data at sites in the Platt Nibarger Ditch Subwatershed

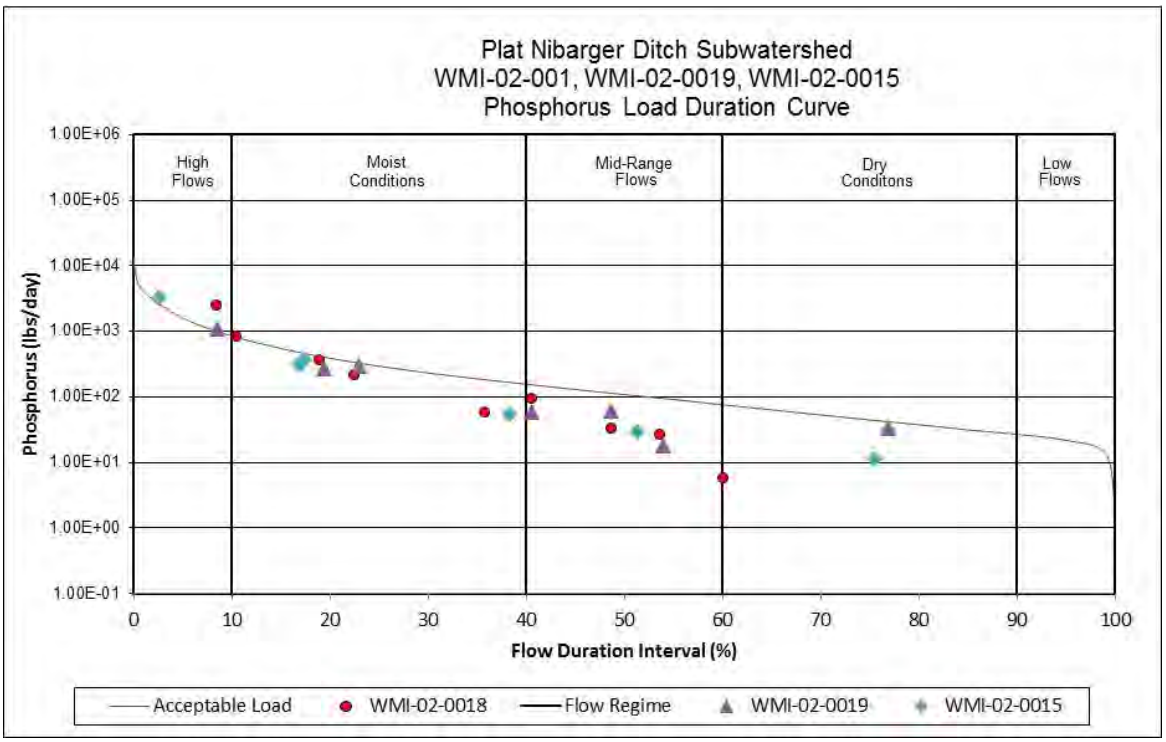

Figure 62. Phosphorous Load Duration Curve for Sites in the Platt Nibarger Ditch Subwatershed

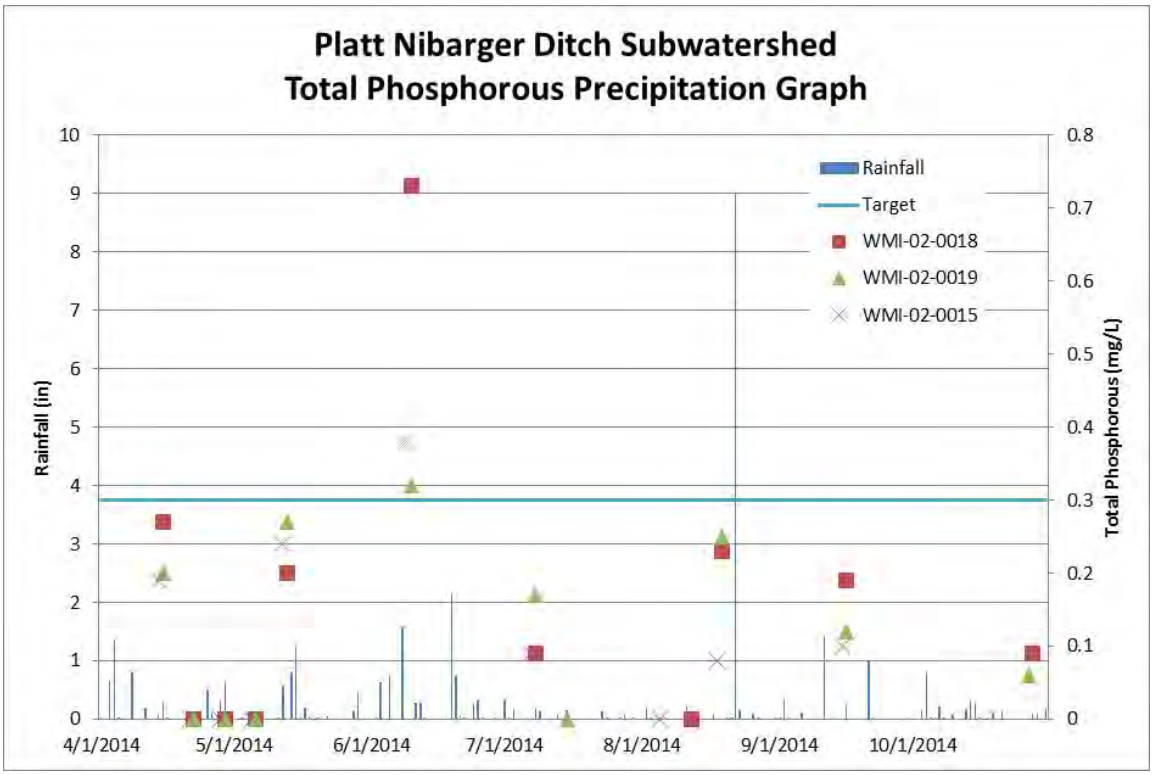

Figure 63. Graph of Precipitation and Phosphorous *Data* at sites in the Platt Nibarger Ditch Subwatershed

7.3.7 Little Lick Creek

The Little Lick Creek subwatershed drains approximately 46 square miles. The subwatershed contains both Big and Little Lick Creeks and drains into the Townsand Lucas Ditch subwatershed south of Hartford City before ultimately joining the Mississinewa River. The land use is primarily agriculture (66.28%) followed by forest (10.72%) and developed land (9.82%). Unlike other subwatersheds in the Upper Mississinewa Little Lick Creek has significant developed land and consequently suffers from the stressors of development. There are Three permitted facilities, WWTPs, or industrial storm water permits in the located subwatershed; Ardagh Glass, Hartford City Paper, and Hartford City WWTP. Additionally three permittees; Dunkirk WWTP, Lake Placid conference Center, and Jackson Township Rural Sewer District have, outfalls in the subwatershed but are located outside the watershed. This subwatershed contains a significant portion of the Hartford city CSO and a small portion included in the Delaware county MS4. The majority of the population of the watershed resides in Hartford City along Little Lick Creek with the city of Dunkirk located at the head waters of Big Lick Creek. The remainder of the watershed is rural home with onsite septic. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. The drainages in this subwatershed have little riparian vegetation, although many of the streams pass through the patchwork of forest that makes up the watershed. Despite its flat nature the subwatershed does highly erodible soil types, the majority of which are located along Little Lick Creek or in the headwaters of Big Lick Creek. 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.

This watershed contains areas of hydric soils along the stream riparian zones as well as significant continuous zones of hydric soils in the southern portion of the watershed in Delaware County. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are 2 permitted CFO/CAFO's in the watershed with a total animal density of 79 animals/square mile. This is below median concentration of animals when compared to other subwatersheds in the Upper Mississinewa River.

There are four sites located in this subwatershed; two on Big Lick Creek WMI-03-0003 (T22) and WMI040-0009 (T39), and two on Little Lick Creek WMI-03-0008 (T40) and WMI040-0003 (T38). In 2014 this watershed was sampled 51 times between the four sites resulting in T40 and T38 failing for *E. coli*, DO, IBC and nutrients, T39 failing for *E. coli,* and T22 failing for *E. coli*, IBC, Nutrients, and Chloride. Chloride hits for T22 were taken during a period with reported violations for Chlorine from the Dunkirk WWTP. With site T22 located approximately 2.5 miles downstream of the outfall of the Dunkirk WWTP it can be reasonably assumed that these violations caused the elevated levels of Chloride that IDEM reported during sampling. Based on this assumption the WWTP will not be required any additional removal of chlorides from the effluent. When the WWTP is in compliance with its Chloride limits the instream WQS are met. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T22 was 1473.97 MPN with 9/9 samples in exceedance of the single sample max, T39 had a geomean of 451.8 MPN with 6/10 samples in exceedance of the single sample max, T40 had a geomean of 1109.18 with 6/10 samples in exceedance of single sample max, and T38 had a geomean of 1674.56 MPN with 9/10 sample in exceedance of the single sample max. The fish community IBI score for site T22 was 18 (poor) and the QHEI was 24 (poor). The macro community mIBI score was 38 (fair) and the QHEI was 25 (poor). The fish community IBI score for site T39 was 38 (fair) and the QHEI was 40 (poor). The macro community mIBI score was 36 (fair) and the QHEI was 36 (poor). The fish community IBI score for site T40 was 26 (poor) and the QHEI was 41 (poor). The macro community mIBI score was 38 (fair) and the QHEI was 41 (poor).The fish community IBI score for site T38 was 16 (poor) and the QHEI was 28 (poor). The macro community mIBI score was 28 (poor) and the QHEI was 29 (poor). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality data, high *E .coli* counts with low animal density and CSO contributions it can be reasonably concluded that humans are the major contributor of sources of *E. coli*. There are approximately 60 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 17.6 stream miles impaired for *E. col,i* IBC, nutrients, and Chloride, 22.6 stream miles impaired for *E. coli*, and 19.8 impaired for *E. coli,* IBC, DO, and nutrients. These impairments will be included on the 2016 List of Impaired Waters.

Table 47. Summary of Little Lick Creek Subwatershed Characteristics

Little Lick Creek (051201030301)	
Drainage Area	46.44 square miles
TMDL Sample Site	WMI-03-0003, WMI040-0003, WMI040-0009, WMI-03-0008
AUID's (Listed Impairments covered by this TMDL)	INB0331_03 (*E. coli,* Nutrients), INB0331_04 (*E. coli,* IBC, Nutrients), INB0331_05 (*E. coli,* Nutrients), INB0331_06 (*E. coli,* Nutrients), INB0331_T1002 (*E. coli,* Nutrients), INB0331_T1003 (*E. coli*, Nutrients), INB0331_T1004 (*E. coli,* Nutrients), INB0331_T1005 (*E. coli,* Nutrients), INB0331_T1006 (*E. coli,* Nutrients) , INB0331_T1007 (*E. coli*, Nutrients), INB0331_T1008 (*E. coli*, IBC, Nutrients, D.O.), INB0331_T1009 (*E. coli,* Nutrients), INB0331_T1010 (*E. coli,* Nutrients), INB0331_T1011 (*E. coli,* Nutrients), INB0331_T1012 (*E. coli,* Nutrients) INB0331_T1013 (*E. coli,* Nutrients), INB0331_T1014 (*E. coli*, Nutrients)
Land Use	Agricultural Land: 66.28% Forested Land: 10.72% Developed Land: 9.82% Open Water:

	0.43% Pasture/Hay: 9.22% Grassland/Shrubs: 3.35% Wetland: 0.18%				
NPDES Facilities	Ardagh Glass Containers, IN0061816; Hartford City Paper LLC, INP000082,				
MS4 Communities	Delaware County MS4, 0.18 square miles				
CSO Communities	Hartford City WWTP, IN0021628				
CAFOs	NA				
CFOs	Price Farms Inc, 4262; D & G Farms, 3683.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	1,267.25	246.65	105.06	44.49	18.36
Future Growth	67.34	13.43	5.88	2.69	1.31
Total WLA	12.23	8.50	6.59	6.59	6.59
Delaware County MS4	4.66	0.93	0.0	0.0	0.0
Dunkirk WWTP	6.23	6.23	6.23	6.23	6.23
Lake Placid Conference Center	0.25	0.25	0.25	0.25	0.25
Jackson Township RSD	0.12	0.12	0.12	0.12	0.12
Hartford City CSO	0.98	0.98	0.0	0.0	0.0
MOS (5%)	70.89	14.14	6.18	2.83	1.39
TMDL= LA+WLA+MOS	1,417.71	282.72	123.71	56.60	27.65
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	20,361.64	3,730.22	1427.11	502.62	127.27
Future Growth	1,091.86	209.26	84.88	36.22	16.46
Total WLA	383.64	245.75	185.53	185.53	185.53
Delaware County MS4 WLA	121.08	23.21	0.0	0.0	0.0
Construction WLA	26.91	5.16	0.0	0.0	0.0
Dunkirk WWTP	175.22	175.22	175.55	175.22	175.22
Lake Placid Conference Center	70.09	70.09	70.09	70.09	70.09
Jackson Township RSD	3.30	3.30	3.30	3.30	3.30
Hartford City CSO	27.53	27.53	0.0	0.0	0.0
Industrial Stormwater WLA	22.59	4.33	0.0	0.0	0.0
MOS (5%)	1,149.33	220.28	89.33	38.12	17.33
TMDL = LA+WLA+MOS	22,986.47	4,405.51	1,786.85	762.49	346.59
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					

Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	352.30	65.08	25.24	8.19	0.84
Future Growth	18.95	3.78	1.65	0.76	0.37
Total WLA	7.77	6.72	6.18	6.18	6.18
Delaware County MS4	1.31	0.26	0.0	0.0	0.0
Dunkirk WWTP	5.84	5.84	5.84	5.84	5.84
Lake Placid Conference Center	0.23	0.23	0.23	0.23	0.23
Jackson Township RSD	0.11	0.11	0.11	0.11	0.11
Hartford City CSO	0.28	0.28	0.0	0.0	0.0
MOS (5%)	19.95	3.98	1.74	0.80	0.39
TMDL = LA+WLA+MOS	398.97	79.56	34.81	15.93	7.78

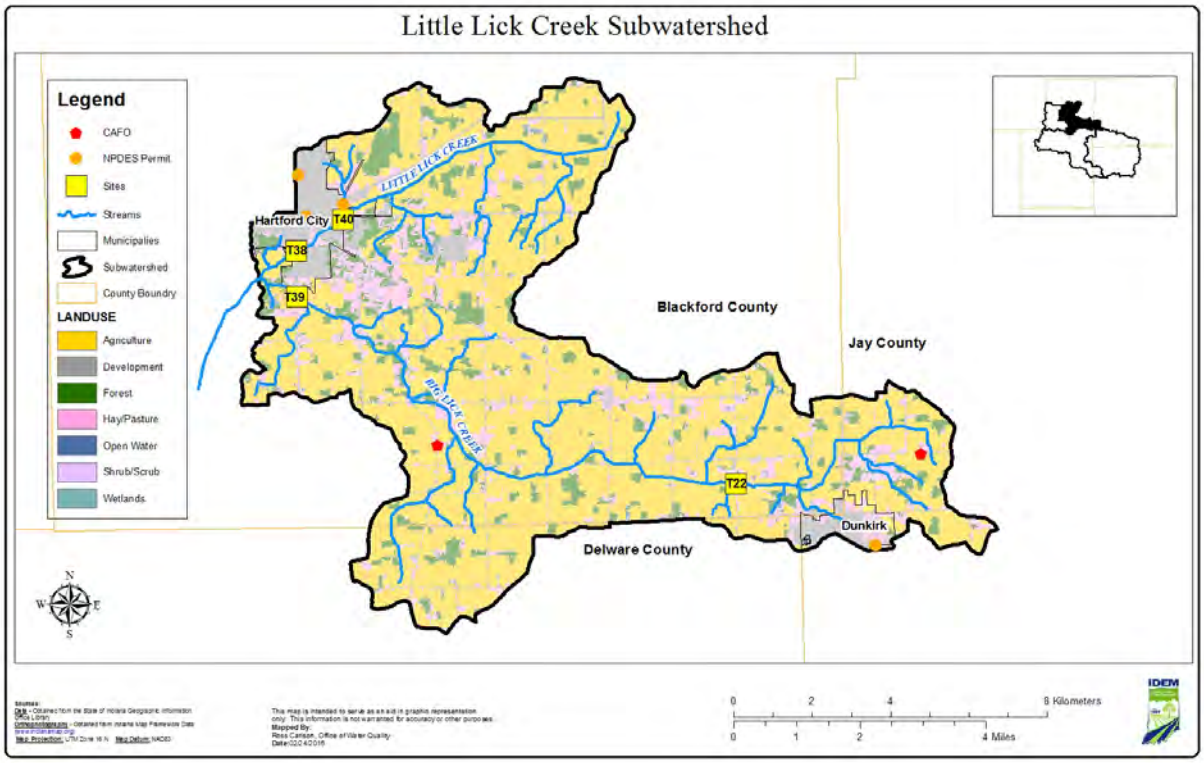

Figure 64. Sampling Stations in the Little Lick Creek Watershed

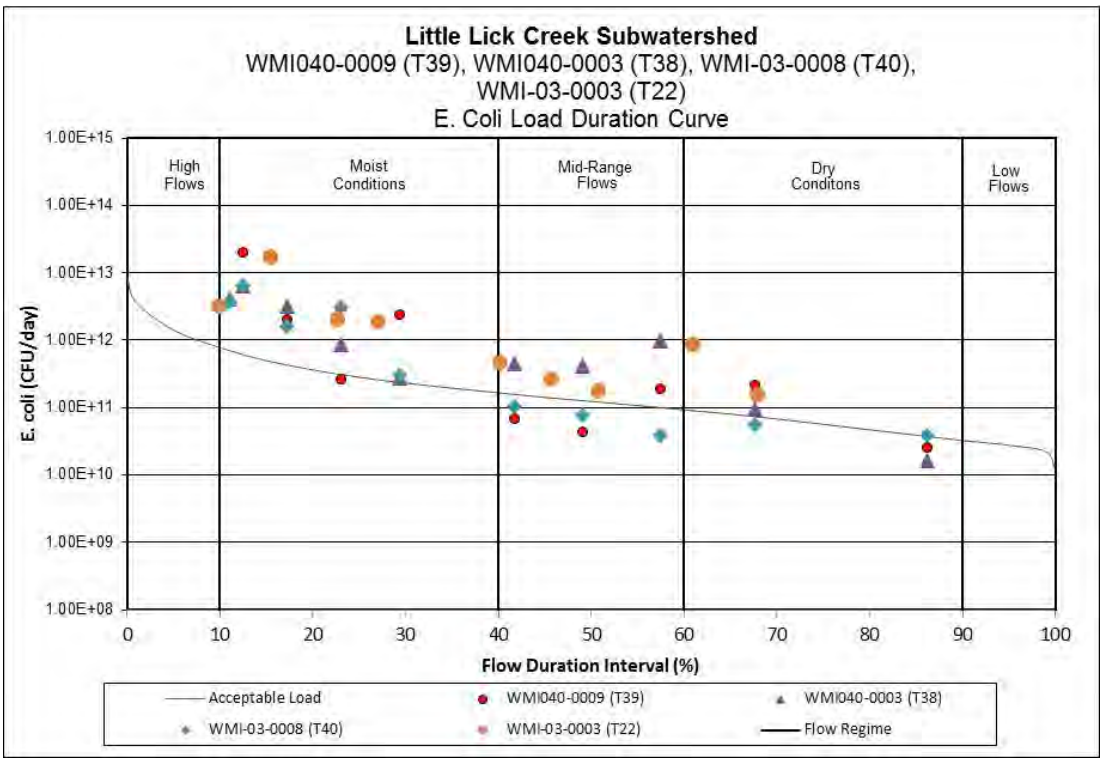

Figure 65. *E. coli* Load Duration Curve for Sites in the Little Lick Creek Subwatershed

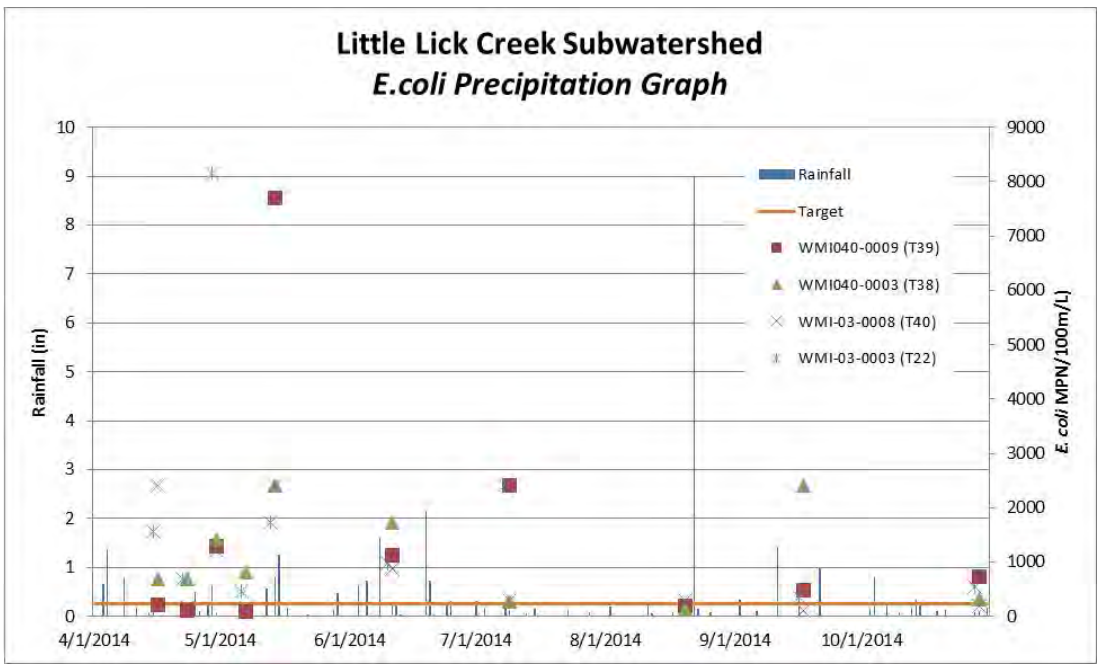

Figure 66. Graph of Precipitation and *E. coli* Data at sites in the Little Lick Creek Subwatershed

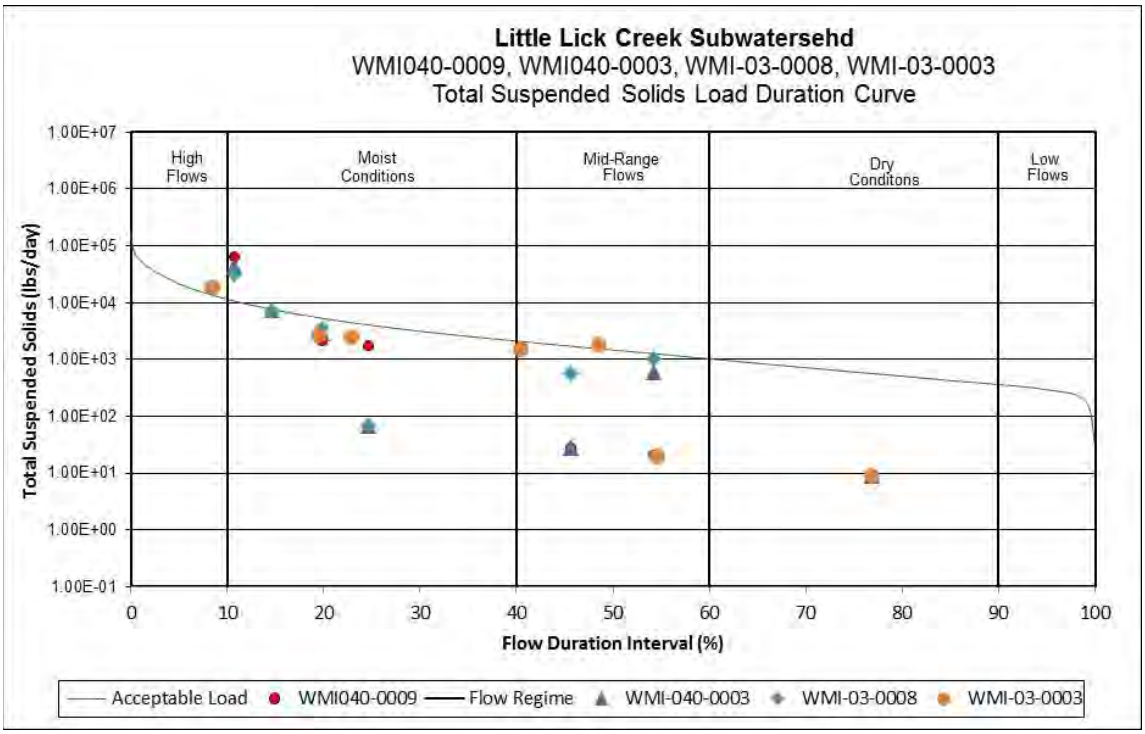

Figure 67. Total Suspended Solid Load Duration Curve for Sites in the Little Lick Creek Subwatershed

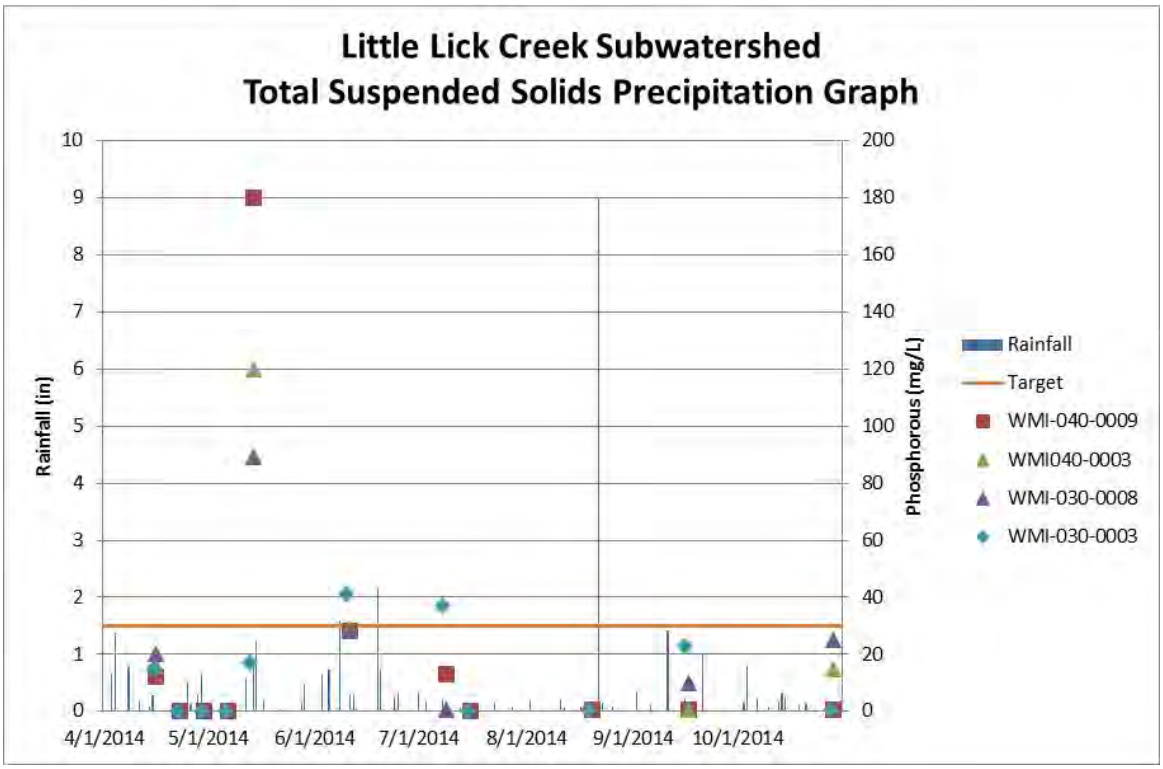

Figure 68. Graph of Precipitation and Total Suspended Solid Data at sites in the Little Lick Creek Subwatershed

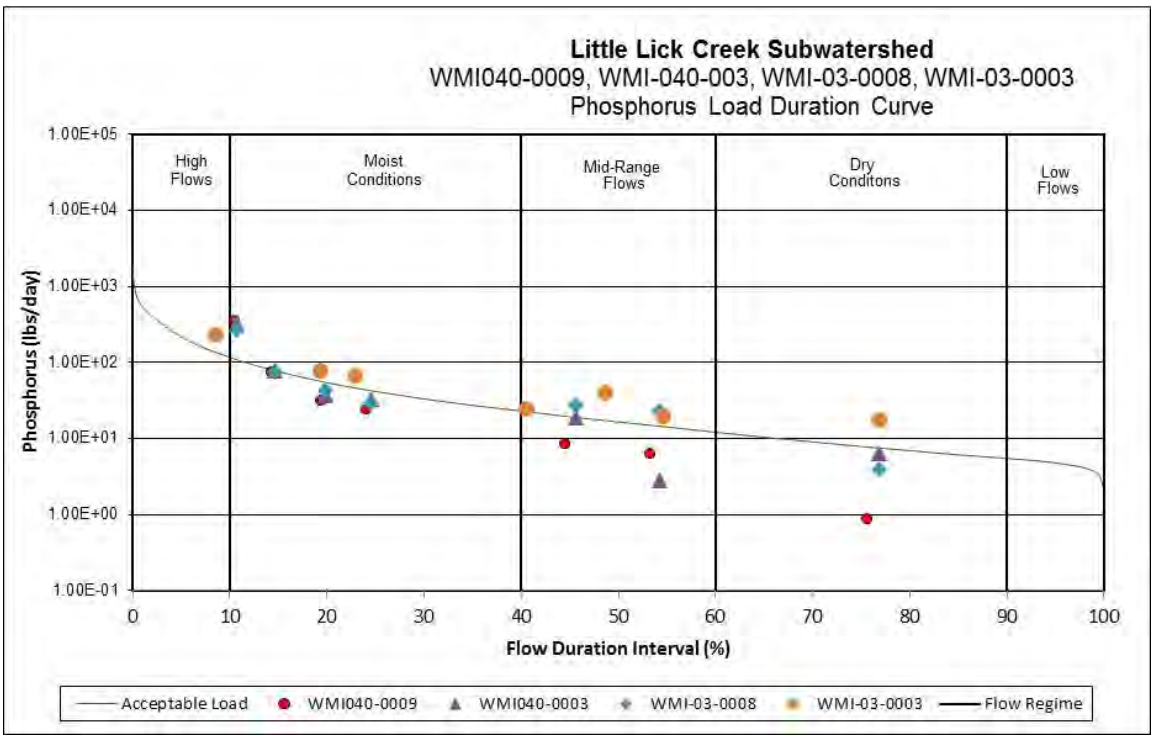

Figure 69. Total Phosphorus Duration Curve for Sites in the Little Lick Creek Subwatershed

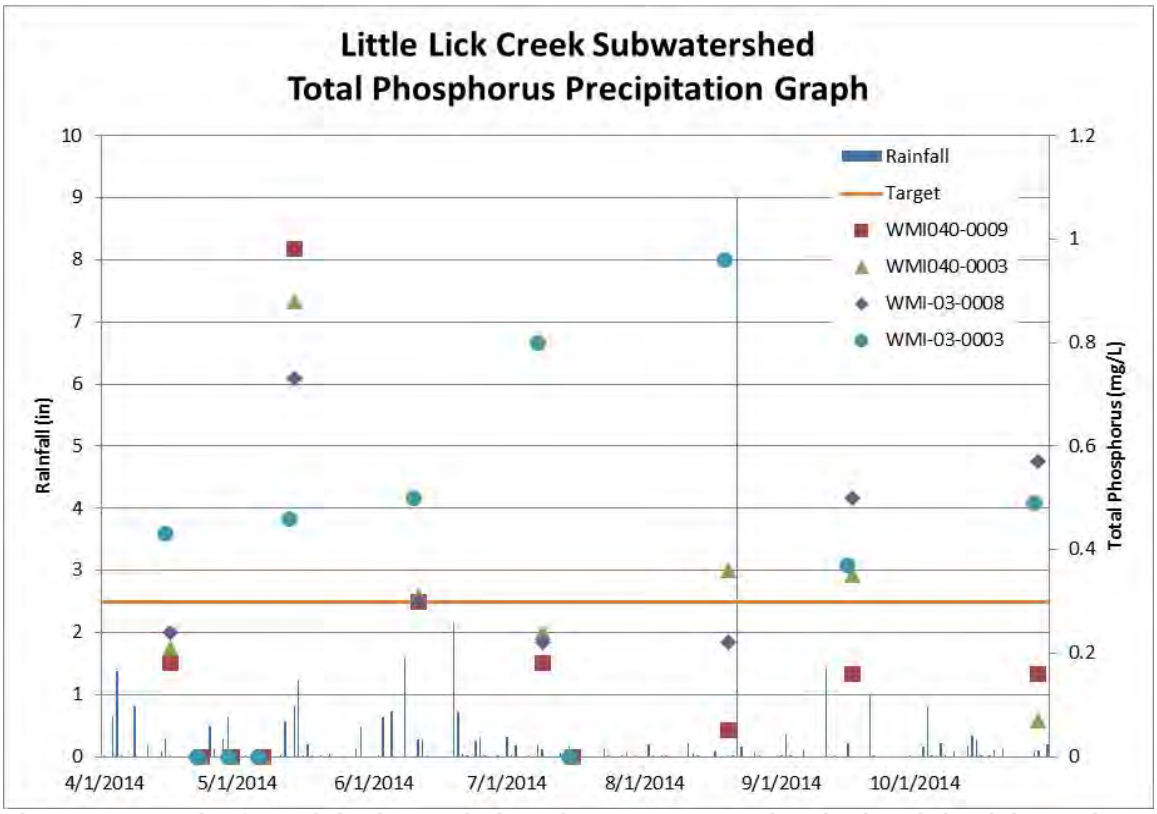

Figure 70. Graph of Precipitation and Phosphorous Data at sites in the Little Lick Creek Subwatershed

7.3.8 Townsand Lucas Ditch

The Townsand Lucas Ditch subwatershed drains approximately 29 square miles. The subwatershed contains Big Lick Creek and its tributaries including; Fiddler ditch, Little Joe Creek, Moore Prong, and Townsand Lucas Ditch. The subwatershed empties into the Mississinewa River. The land use is primarily agriculture (63.16%) followed by forest (13.04%) hay and pasture land (9.88%) and Developed land (9.83%). Unlike other subwatersheds in the Upper Mississinewa Townsand Lucas Ditch has significant developed land in and upstream of its subwatershed, and consequently suffers from the stressors of development. There are two permitted facilities, WWTPs in the subwatershed; Hartford city WWTP and Shamrock Lakes WWTP. This subwatershed contains a portion of the Hartford city CSO and a small portion included in the Delaware county MS4. The majority of the population of the watershed resides in Hartford City along with the town of Shamrock Lakes located in the lower section of Townsand Lucas Ditch. The remainder of the watershed is rural homes with onsite septic. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. The drainages in this subwatershed have little riparian vegetation, although many of the streams pass through the patchwork of forest that makes up the watershed. Despite its flat nature the subwatershed does contain a significant 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.
This watershed contains areas of hydric soils although much of this is small fragmented locations. With land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There is 1 permitted CFO/CAFO's in the watershed with a total animal density of 75 animals/square mile. This is below median concentration of animals when compared to other subwatersheds in the Upper Mississinewa River.

There are five sites located in this subwatershed; two on Big Lick Creek WMI-03-0006 (T36) and WMI-03-0009 (T32), one on Moore Prong WMI-03-0007 (T37), one on Little Joe Creek (T35), and one on Townsand Lucas Ditch WMI-03-0005 (T34).In 2014 this watershed was sampled 71 times between the five sites resulting in T37 and T35 failing for *E. coli,* T36 and T34 failing for *E. coli* and IBC, and T32 failing for *E. coli*, IBC, Nutrients, and DO. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T36 was 1070.53 MPN with 8/11 samples in exceedance of the single sample max, T32 had a geomean of 1057.9 MPN with 7/10 samples in exceedance of the single sample max, T37 had a geomean of 514.48 MPN with 9/10 samples in exceedance of single sample max, T35 had a geomean of 375.32 MPN with 7/10 samples in exceedance of the single sample max. *E. coli,* and T34 has a geomean of 297.41 MPN with 5/10 samples in exceedance of the single sample max.

The fish community IBI score for site T36 was 42 (fair) and the QHEI was 56 (good). The macro community mIBI score was 32 (poor) and 34 (poor) and the QHEI was 43 (fair) and 43 (fair). The fish community IBI score for site T32 was 38 (fair) and the QHEI was 54 (fair). The macro community mIBI score was 24 (poor) and the QHEI was 47 (fair). The fish community IBI score for site T37 was 40 (fair) and the QHEI was 44 (fair). The macro community mIBI score was 38 (fair) and the QHEI was 34 (poor).The fish community IBI score for site T35 was 36 (fair) and 44 (fair) and the QHEI was 59 (good) and 57 (Good). The macro community mIBI score was 40 (fair) and the QHEI was 58 (good). The fish community IBI score for site T34 was 31 (poor) and the QHEI was 68 (good). The macro community mIBI score was 28 (poor) and the QHEI was 58 (good). Load Duration curves for each individual site is located in Appendix B.

There are approximately 50 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 14 stream miles impaired for *E. coli,* 19 stream miles impaired for *E .coli* and IBC, 10 stream miles impaired for *E. coli*, IBC, Nutrients, and DO, and 7 miles of non-assessed streams. These impairments will be included on the 2016 List of Impaired Waters.

Table 48. Summary of Townsand Lucas Ditch Subwatershed Characteristics

Townsand Lucas Ditch (051201030302)					
Drainage Area	29.83 square miles				
TMDL Sample Site	WMI-03-0009, WMI-03-0005, WMI-03-0010, WMI-03-0006, WMI-03-0007				
AUID's (Listed Impairments covered by this TMDL)	INB0332_01 (*E. coli,* IBC, Nutrients) INB0332_02 (*E. coli,* IBC, Nutrients, D.O.) INB0332_T1002 (*E. coli)*, INB0332_T1003 (*E. coli,* IBC, D.O.), INB0332_T1004 (*E. coli*) INB0332_T1005 (*E.coli,* Nutrients), INB0332_T1006 (*E. coli*), INB0332_T1007 (*E. coli).*				
Land Use	Agricultural Land: 63.16% Forested Land: 13.04% Developed Land: 9.53% Open Water: 0.77% Pasture/Hay: 9.88% Grassland/Shrubs: 3.42% Wetland: 0.2%				
NPDES Facilities	Hartford City WWTP, IN0021628, Shamrock Lakes WWTP, IN0049832				
MS4 Communities	Delaware County MS4, 0.09 square miles				
CSO Communities	Hartford City WWTP, IN0021628				
CAFOs	NA				
CFOs	Maddox Brothers, 4371.				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	582.34	107.72	53.05	24.95	12.83
Future Growth	32.35	7.34	3.84	2.36	1.72
Total WLA	32.34	31.75	19.83	19.83	19.83
Delaware County MS4 WLA	0.76	0.17	0.0	0.0	0.0
Hartford City WWTP	31.13	31.13	19.57	19.57	19.57
Shamrock Lakes WWTP	0.27	0.27	0.27	0.27	0.27
Hartford City CSO	0.17	0.17	0.0	0.0	0.0
MOS (5%)	34.05	7.72	4.04	2.47	1.81
TMDL= LA+WLA+MOS	681.08	154.53	80.76	49.63	36.19
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	27662.05	5128.07	2284.14	1039.49	534.14
Future Growth	1505.3	317.1	149.6	84.1	57.5
Total WLA	938.99	896.08	558.18	558.18	558.18
Delaware County MS4 WLA	35.57	7.49	0.0	0.0	0.0
Hartford City WWTP	876.08	876.08	550.68	550.68	550.68
Shamrock Lakes	7.51	7.51	7.51	7.51	7.51

WWTP					
Hartford City CSO	5.01	5.01	0.0	0.0	0.0
Industrial Stormwater WLA	6.91	1.45	0.0	0.0	0.0
Construction WLA	7.90	1.66	0.0	0.0	0.0
MOS (5%)	1584..44	333.71	157.47	88.51	60.51
TMDL = LA+WLA+MOS	31690.9	6674.96	3149.39	1770.28	1210.33
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	141.8	8.07	1.22	3.16	2.04
Future Growth	9.02	1.98	0.99	0.58	.5
Total WLA	29.51	29.51	18.61	7.76	7.76
Hartford City WWTP	29.21	29.21	18.36	7.51	7.51
Shamrock Lakes WWTP	0.25	0.25	0.25	0.25	0.25
Hartford City CSO	0.05	0.05	0.0	0.0	0.0
MOS (5%)	9.49	2.08	1.04	0.61	0.52
TMDL = LA+WLA+MOS	189.82	41.64	21.86	12.11	10.82

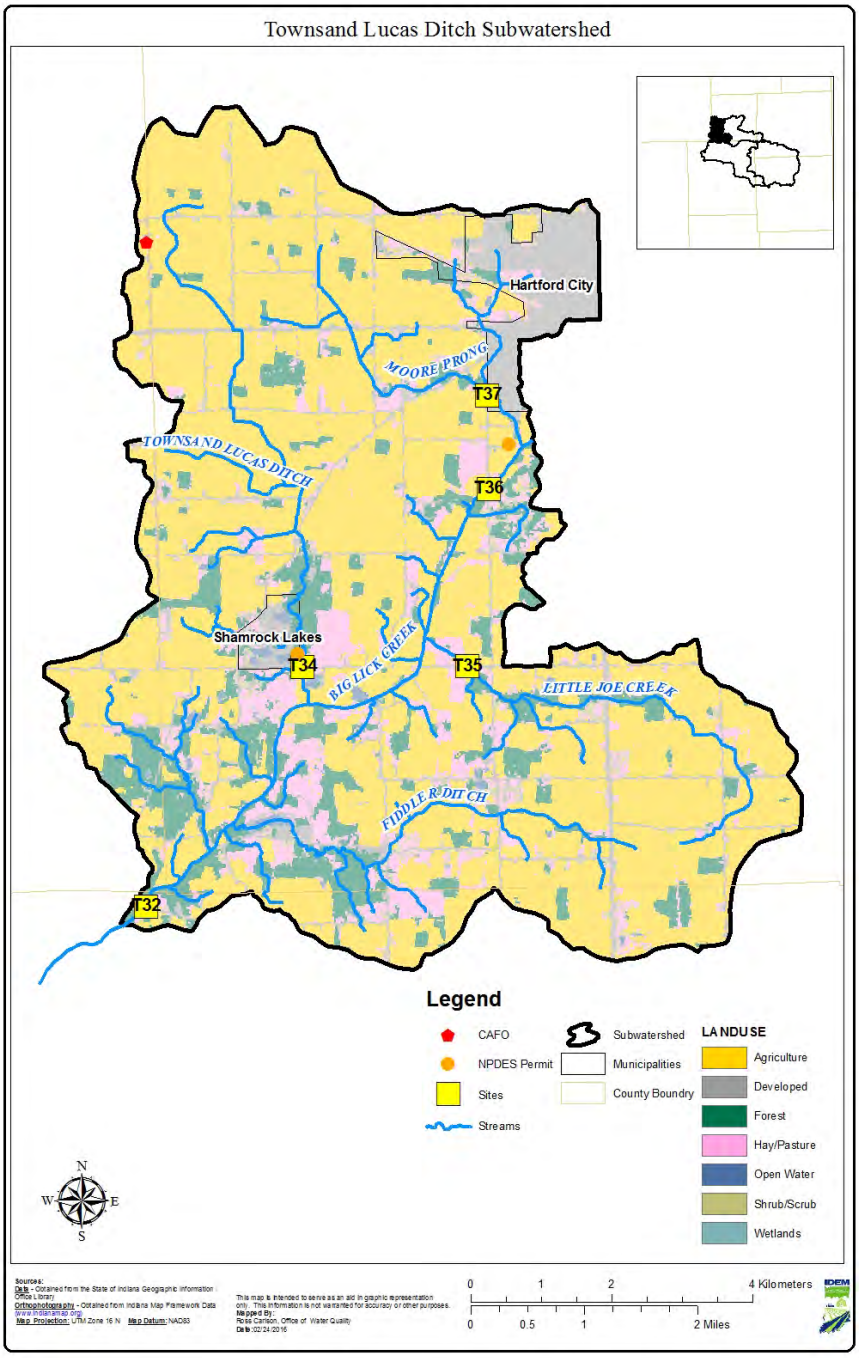

Figure 71. Sampling Stations in the Townsand Lucas Watershed

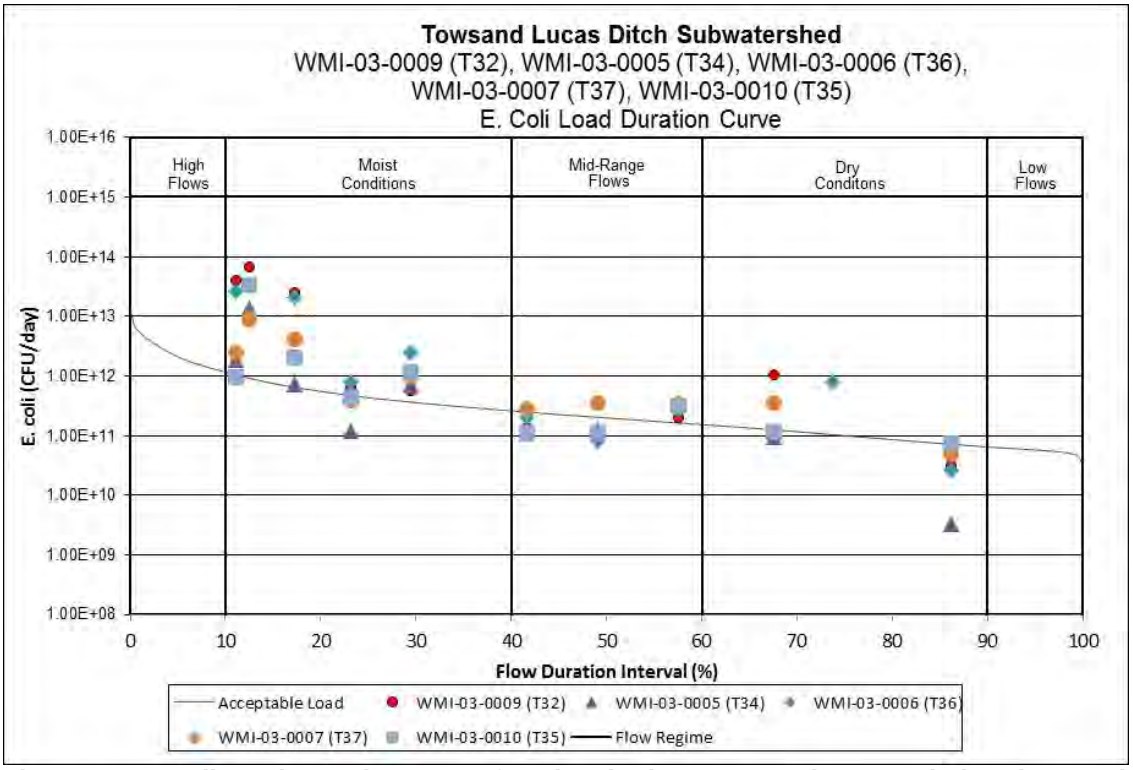

Figure 72. *E. coli* Load Duration Curve for Sites in the Townsand Lucas Ditch Subwatershed

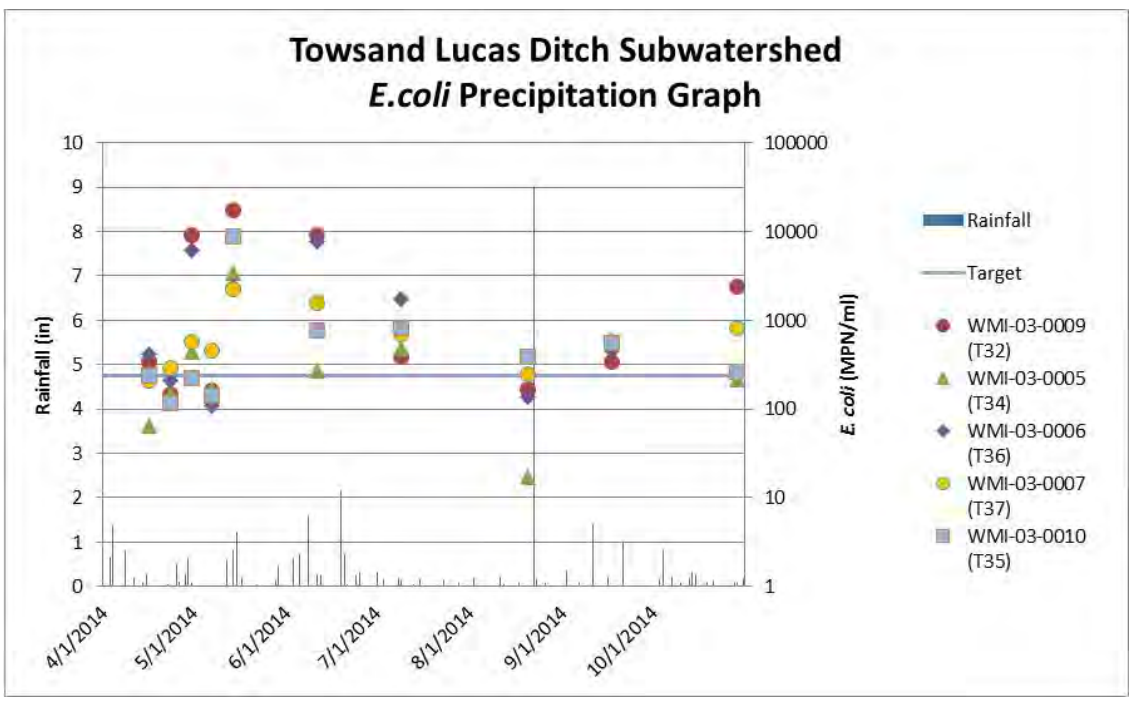

Figure 73. Graph of Precipitation and *E. coli* Data at sites in the Townsand Lucas Ditch Subwatershed

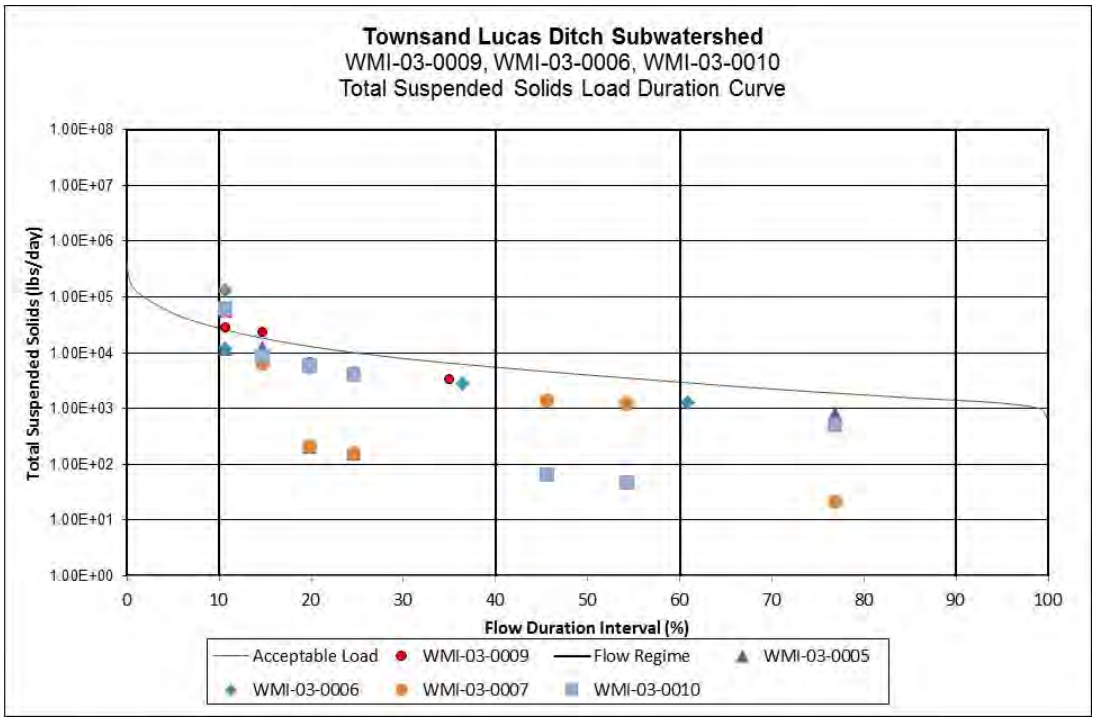

Figure 74. Total Suspended Solid Load Duration Curve for Sites in the Townsand Lucas Ditch Subwatershed

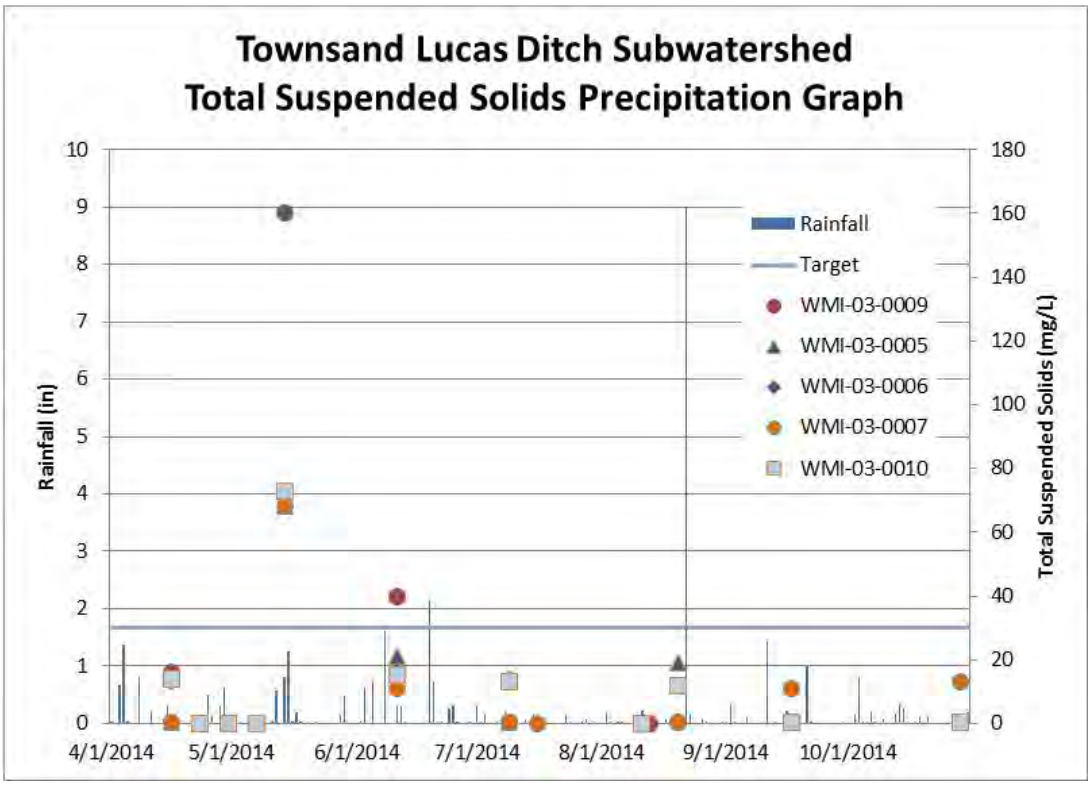

Figure 75. Graph of Precipitation and Total Suspended Solid Data at sites in the Townsand Lucas Ditch Subwatershed

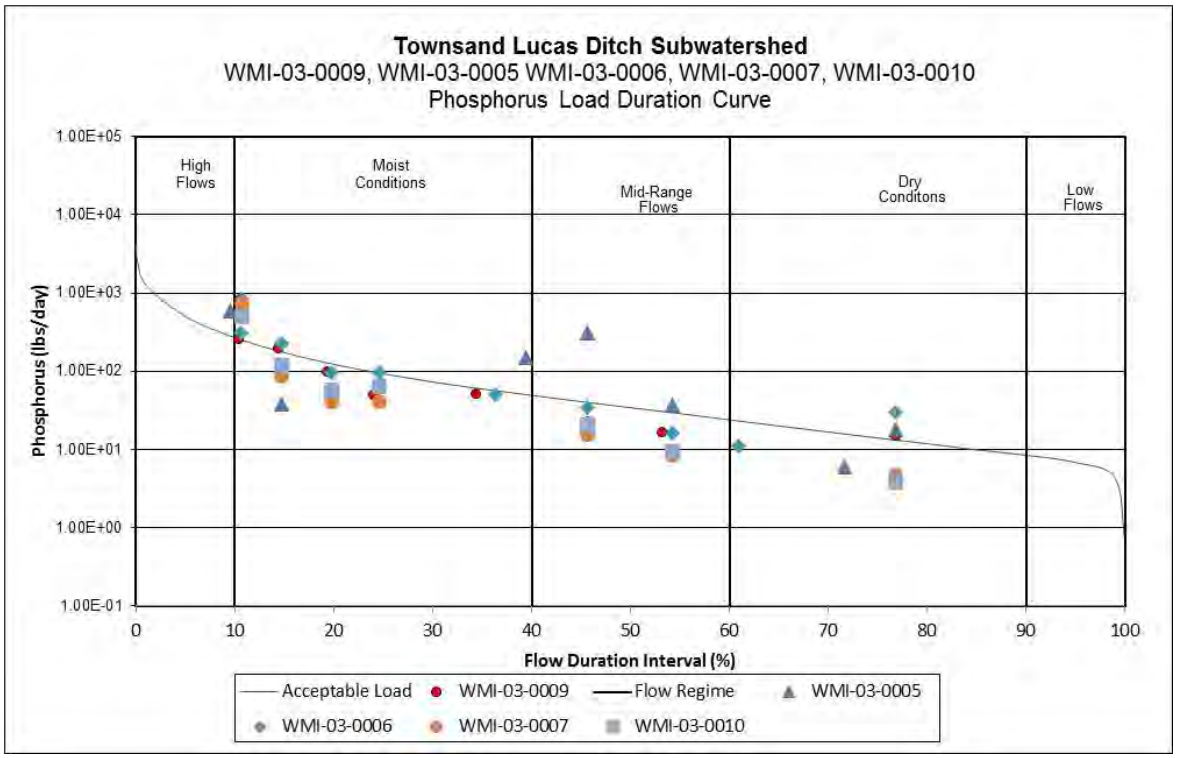

Figure 76. Total Phosphorus Load Duration Curve for Sites in the Townsand Lucas Ditch Subwatershed

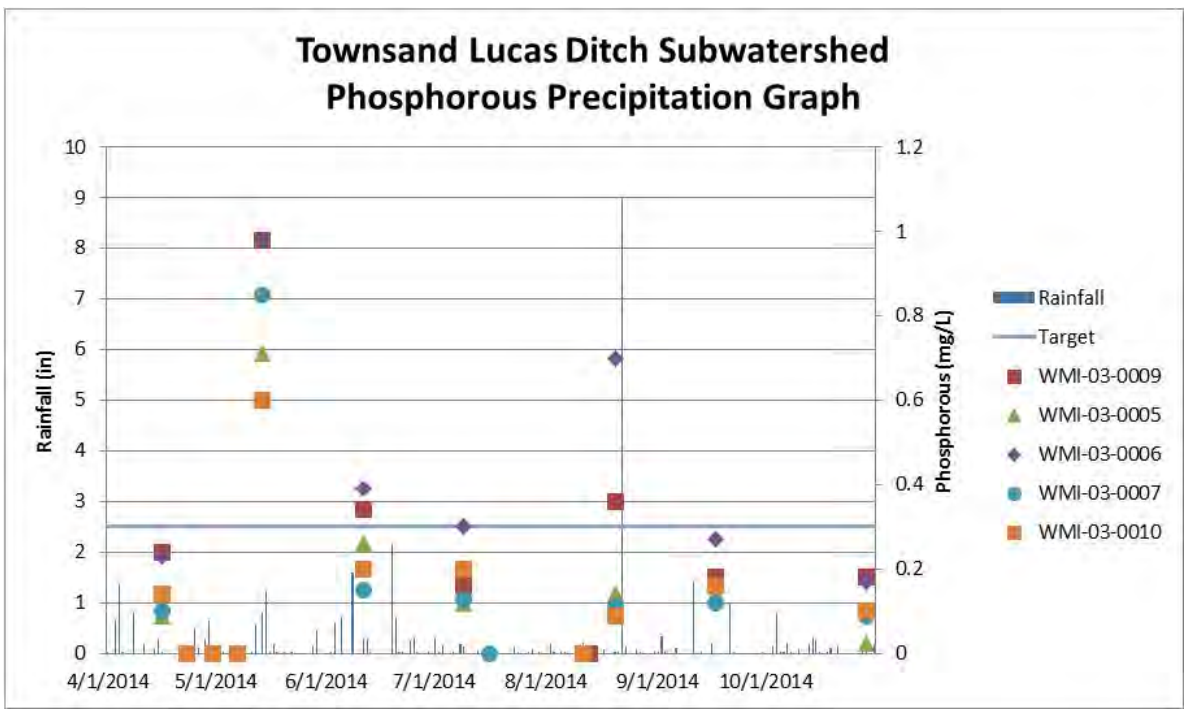

Figure 77. Graph of Precipitation and Total Phosphorus Data at sites in the Townsand Lucas Ditch Subwatershed

7.3.9 Campbell Creek

The Campbell Creek subwatershed drains approximately 21 square miles. The subwatershed drains the southernmost portion of the Upper Mississinewa Watershed and empties into the Mississinewa River south of Albany. The land use is primarily agriculture (75.95%) followed by hay and pasture land (9.42%) and forest (7.85%). There is one permitted WWTP in the subwatershed, PAWS Incorporated. This subwatershed contains a small portion included in the Delaware county MS4. The entirety of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. While Campbell creek had some forested areas along its riparian zone in the lower drainage the head waters have little to no vegetative buffers. While the watershed has very little soil acreage that is classified as highly erodible soil, there is still potential for erosion from disturbed or non-vegetated land. This watershed contains large areas of hydric soils. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are no permitted CFO/CAFO's in the watershed with a total animal density of 40 animals/square mile. This is below median concentration of animals when compared to other subwatersheds in the Upper Mississinewa River.

There are two sites located in this subwatershed one on Campbell Creek WMI-04-0008 (T1) and on a Tributary of Campbell Creek WMI-04-0014 (T20). In 2014 this watershed was sampled 29 times between the two sites resulting in T20 failing for *E. coli,* and T1 failing for *E. coli* and DO. These stream reaches will be placed on the 2016 303(d) list of impaired waters. The *E. coli* geomean for T1 was 1539.78 MPN with 9/10 samples in exceedance of the single sample max; while T20 had a geomean of 463.3 MPN with 5/10 samples in exceedance of the single sample max.

The fish community IBI score for site T1 was 42 (fair) and the QHEI was 56 (good). The macro community mIBI score was 42 (good) and the QHEI was 59 (good). The fish community IBI score for site T20 was 42 (fair) and the QHEI was 80 (excellent). The macro community mIBI score was 44 (fair) and 42 (fair) and the QHEI was 77 (excellent) and 72 (excellent).

There are approximately 19 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 13.5 stream miles impaired for *E. coli,* and 5.5 stream miles impaired for *E .coli* and DO. These impairments will be included on the 2016 List of Impaired Waters.

Table 49. Summary of Campbell Creek Subwatershed Characteristics

Campbell Creek (051201030401)	
Drainage Area	21.00 square miles
TMDL Sample Site	WMI-04-0008, WMI-04-0014
AUID's (Listed Impairments covered by this TMDL)	INB0341_01 (*E. coli,* Nutrients), INB0341_T1001 (*E. coli,* D.O.)
Land Use	Agricultural Land: 75.95% Forested Land: 7.85% Developed Land: 4.23% Open Water: 0.28% Pasture/Hay: 9.42% Grassland/Shrubs: 2.22% Wetland: 0.05%
NPDES Facilities	PAWS Inc, IN0055271.
MS4 Communities	Delaware County MS4, 0.64 square miles
CSO Communities	NA
CAFOs	NA

CFOs	NA				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	480.87	94.08	41.27	17.61	7.41
Future Growth	26.18	5.12	2.17	0.93	0.39
Total WLA	16.50	3.24	0.02	0.02	0.02
Delaware County MS4 WLA	16.5	3.24	0.0	0.0	0.0
PAWS WWTP WLA	0.02	0.02	0.02	0.02	0.02
MOS (5%)	27.56	5.38	2.30	0.99	0.40
TMDL= LA+WLA+MOS	551.11	107.84	45.74	19.53	8.22
Flow Regime TMDL analysis for TSS not needed					
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	141.64	29.05	13.28	6.62	3.75
Future Growth	7.46	1.53	0.70	0.35	0.20
Total WLA	0.01	0.01	0.01	0.01	0.01
PAWS WWTP WLA	0.01	0.01	0.01	0.01	0.01
MOS (5%)	7.86	1.62	0.74	0.38	0.21
TMDL= LA+WLA+MOS	156.95	32.21	14.73	7.36	4.17

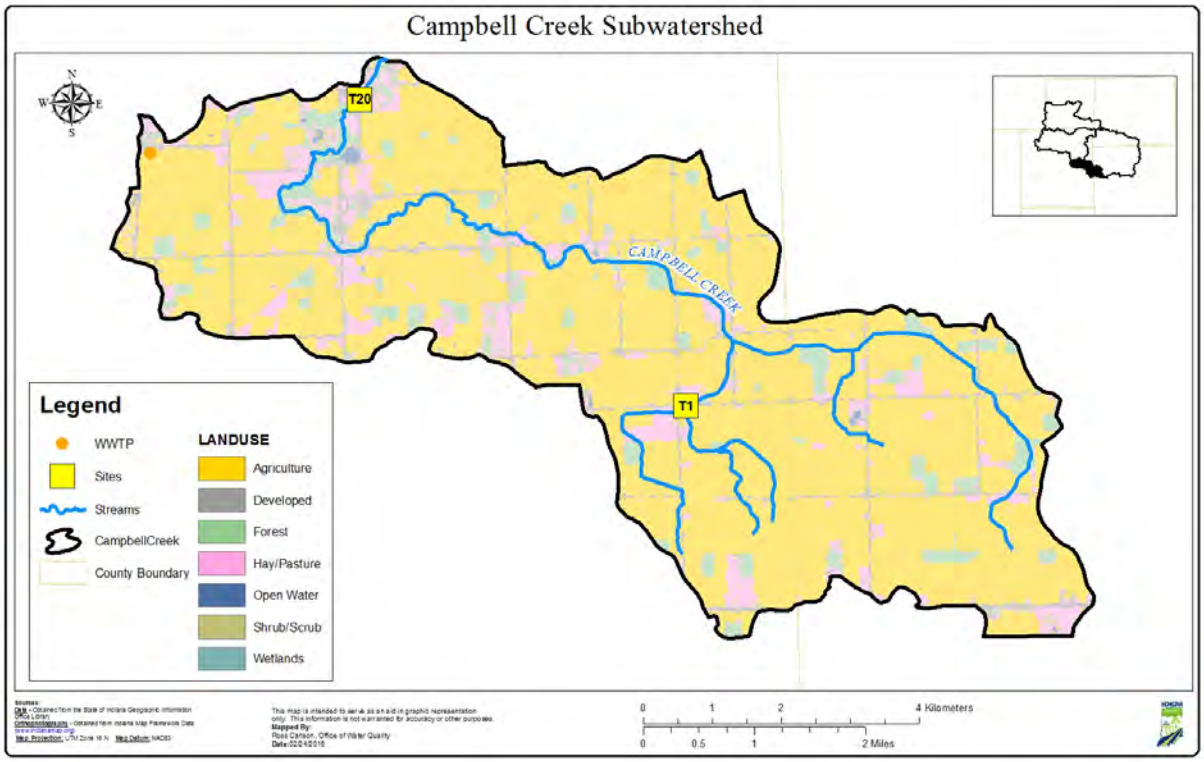

Figure 78. Sampling Stations in the Campbell Creek subwatershed

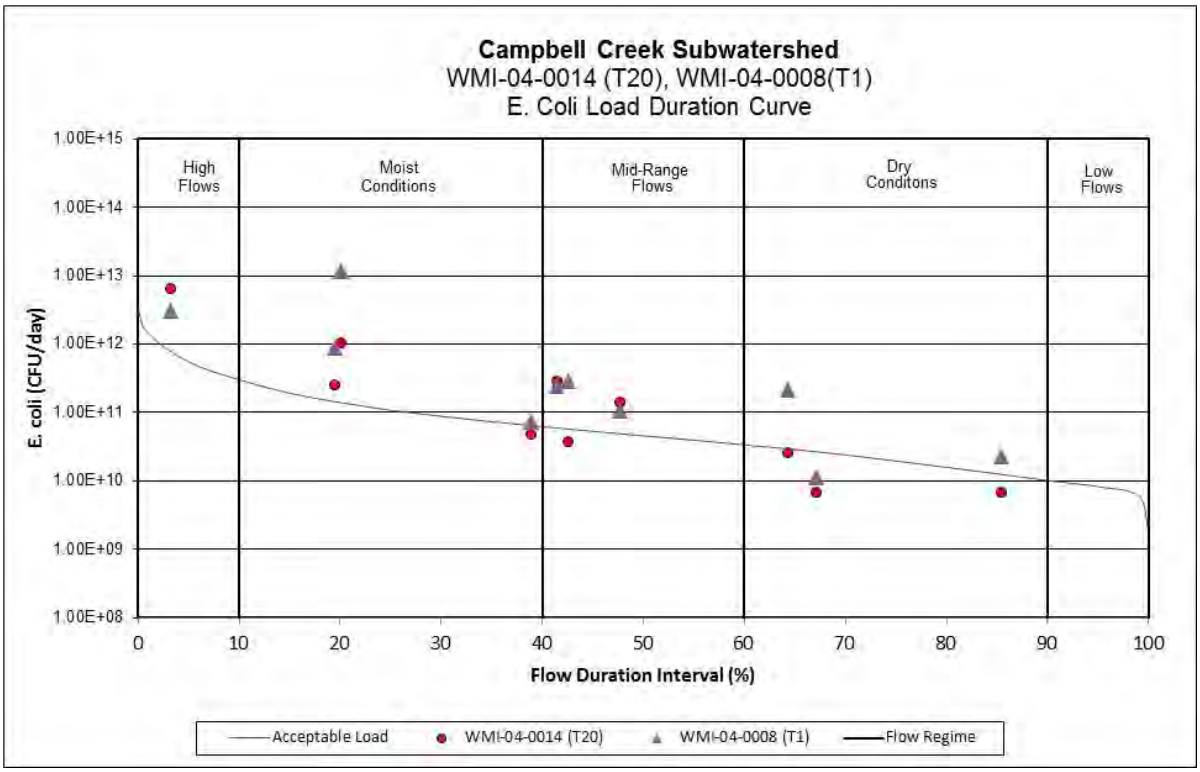

Figure 79. *E. coli* Load Duration Curve for Sites in the Campbell Creek Subwatershed

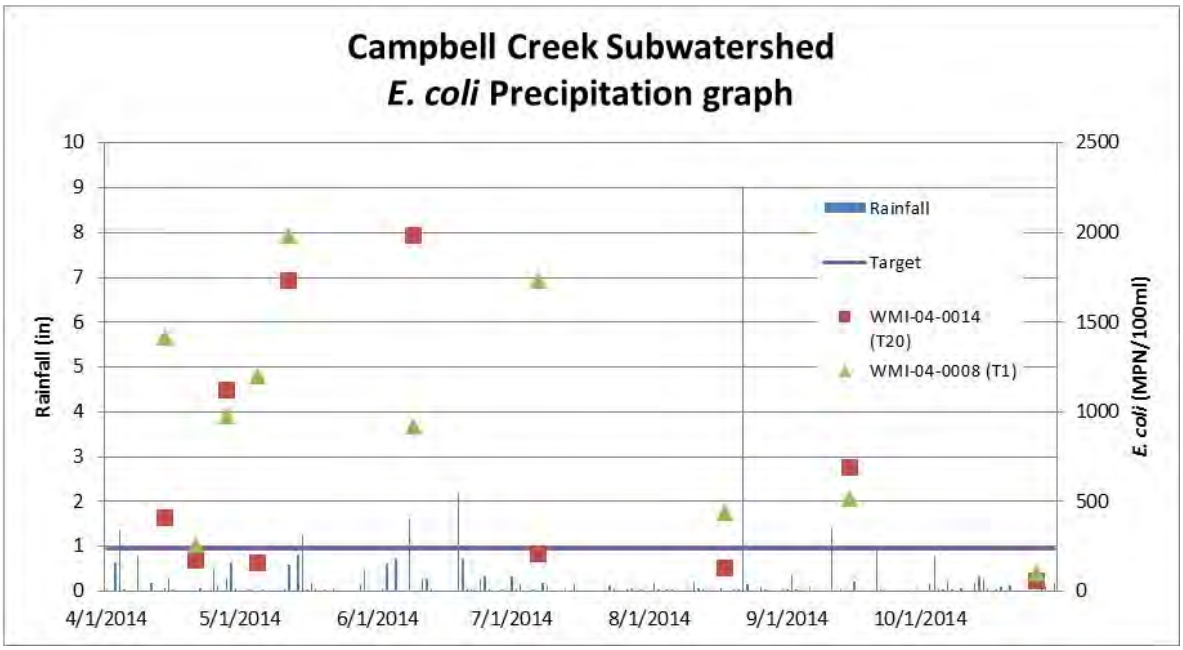

Figure 80. Graph of Precipitation and *E. coli* Data at sites in the Campbell Creek Subwatershed

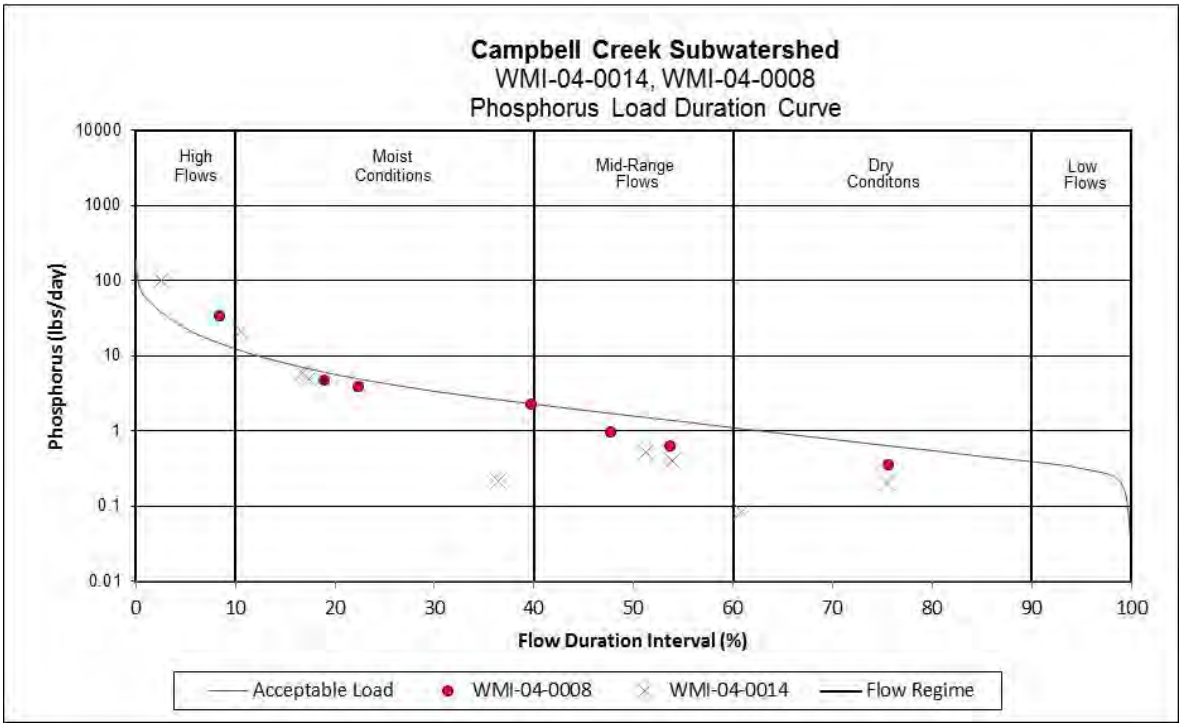

Figure 81. Phosphorus Load Duration Curve for Sites in the Campbell Creek Subwatershed

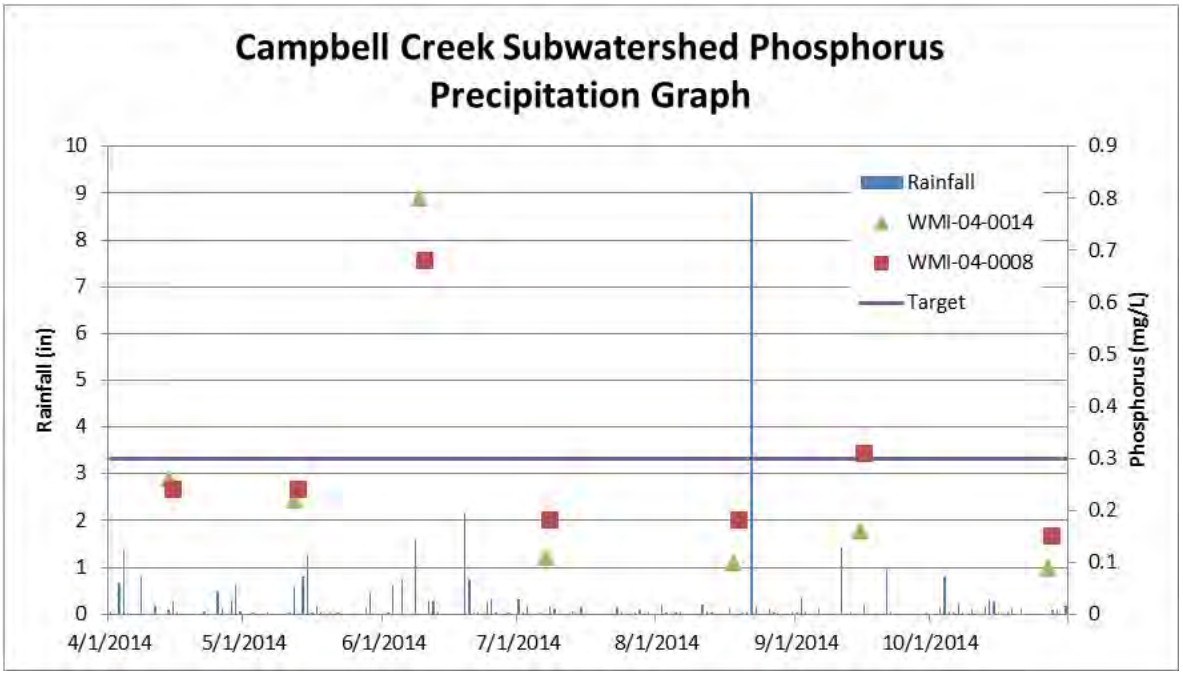

Figure 82. Graph of Precipitation and Phosphorus Data at sites in the Campbell Creek Subwatershed

7.3.10 Rees ditch

The Rees Ditch subwatershed drains approximately 40 square miles. The subwatershed contains the main stem of the Mississinewa River from Albany to Eaton as well as Rees ditch and its tributaries. The Campbell creek subwatershed joins the Mississinewa river in the Rees Ditch subwatershed. The land use is primarily agriculture (65.46%) followed by forested land (12.79%) and hay and pasture land (10.21%). There are three permitted facilities, WWTPs, or industrial storm water permits in the subwatershed. Additional The Albany WWTP and the Delaware County RSD have submitted preliminary effluent limits letter to IDEM requesting to upgrade the facility to 0.8mgd with a peak design flow of 2.0mgd and creation of a WWTP near Eaton Indiana respectively. These additional capacities were incorporated into the future growth allocations for Rees ditch and thus explain the lerger Future Growth allocations in the Rees Ditch subwatershed. While the watershed includes portions of the towns of Albany, Eaton, and Dunkirk, the majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. The hydrology has likewise undergone significant change to facilitate drainage. This has led to the loss of natural character for Rees ditch and Bosman Ditch, both with little to no riparian vegetation. While the watershed has very little soil acreage that is classified as highly erodible soil, there is still potential for erosion from disturbed or non-vegetated land. This watershed contains large areas of hydric soils. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use close to 10 percent pasture land a heavy presence of pasture animals in not expected. There are no permitted CFO/CAFO's in the watershed with a total animal density of 36 animals/square mile. This is a low concentration when compared to other subwatersheds in the Upper Mississinewa River.

There are five sites located in this subwatershed, two located on the Mississinewa River WMI-04-0013 (T19) and WMI-04-0017 (T25), one located on Bosman Ditch WMI-04-0016 (T24), and two located on Rees Ditch WMI-04-0015 (T21) and WMI-01-0018 (T23). In 2014 this watershed was sampled 66 times between the five sites resulting in one site (T25) failing for *E. coli*, three sites (T24, T21, and T19) failing for *E. coli* and IBC, and one site (T23) failing for *E. coli* IBC and D.O. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T19 was 352.3 MPN with 7/10 samples in exceedance of the single sample max, T25 had a geomean of 169.38 with 5/10 samples in exceedance of the single sample max, T24 had a geomean of 300.58 with 6/10 samples in exceedance of the single sample max, T21 has a geomean of 1318.34 with 10/10 samples in exceedance of the single sample max, and T23 had a geomean of 265.17 with 7/10 samples in exceedance of the single sample max. The geomean for all sites in the subwatershed were taken on the same day for five consecutive weeks.

The fish community IBI score for site T19 was 50 (good) and the QHEI was 69 (good). The macro community mIBI score was 34 (poor) and the QHEI was 55 (fair). The fish community IBI score for site T25 was 54 (excellent) and the QHEI was 88 (excellent). The macro community mIBI score was 38 (fair) and the QHEI was 52 (fair). The fish community IBI score for site T24 was 38 (fair) and the QHEI was 56 (good). The macro community mIBI score was 32 (poor) and the QHEI was 52 (fair). The fish community IBI score for site T21 was 36 (fair) and the QHEI was 44 (fair). The macro community mIBI score was 26 (poor) and the QHEI was 40 (poor). The fish community IBI score for site T23 was 40 (fair) and 40 (fair) and the QHEI was 52 (good) and 55 (good). The macro community mIBI score was 26 (poor) and the QHEI was 43 (fair). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS Rees Ditch, and Bosman Ditch are nonpoint sources. There are approximately 48 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 31.5 stream miles impaired for *E. coli,* and IBC, 15.5 miles impaired *E. coli*, IBC, and D.O. and 1 mile of stream unassessed for listed on the 2016 List of Impaired Waters.

Table 50. Summary of Rees Ditch Subwatershed Characteristics

Rees Ditch (051201030402)					
Drainage Area	40.27 square miles				
TMDL Sample Site	WMI-04-0013, WMI-04-0015, WMI-04-0018, WMI-04-0016, WMI-04-0017				
AUID's (Listed Impairments covered by this TMDL)	INB0342_02 (*E. coli*, IBC, Nutrients), INB0342_03 (*E. coli*, Nutrients), INB0342_T1001 (*E. coli,* IBC), INB0342_T1002 (*E. coli,* IBC, D.O.)				
Land Use	Agricultural Land: 65.46% Forested Land: 12.79% Developed Land: 7.18% Open Water: 0.6% Pasture/Hay: 10.21% Grassland/Shrubs: 3.16% Wetland: 0.6%				
NPDES Facilities	Bell Aquaculture LLC, IN0062669; Albany WWTP, IN0022136, Albany Water Works, IN0042803.				
MS4 Communities	Delaware County MS4, 2.43 square miles				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**

Duration level	0-10%	10-40%	40-60%	60-90%	90-100%
LA	1677.23	309.02	138.03	51.63	14.37
Future Growth	122.64	45.75	24.30	19.76	17.8
Total WLA	119.37	26.57	3.56	3.56	3.56
Delaware County MS4 WLA	115.76	22.69	0.0	0.0	0.0
Albany WWTP	3.56	3.56	3.56	3.56	3
MOS (5%)	101.01	20.07	8.73	3.95	1.88
TMDL= LA+WLA+MOS	2,020.25	401.41	174.62	78.90	37.61
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
Duration level	0-10%	10-40%	40-60%	60-90%	90-100%
LA	14427.69	2205.68	895.32	169.75	125.53
Future Growth	1623.71	931.02	533.03	494.89	229.03
Total WLA	1,404.42	465.23	221.05	221.05	221.05
Delaware County MS4 WLA	1034.19	198.21	0.0	0.0	0.0
Albany WWTP	100.12	100.12	100.12	100.12	100.12
Bell Aquaculture WLA	120.92	120.92	120.92	120.92	120.92
Industrial Stormwater WLA	63.84	12.24	0.0	0.0	0.0
Construction WLA	63.84	12.24	0.0	0.0	0.0
MOS (5%)	918.73	189.57	86.81	46.62	30.29
TMDL = LA+WLA+MOS	18,374.55	3,791.50	1,736.27	932.31	605.90
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
Duration level	0-10%	10-40%	40-60%	60-90%	90-100%
LA	446.85	77.11	36.9	9.37	3.96
Future Growth	50.23	30.62	17.92	16.48	7.4
Total WLA	7.00	4.15	3.34	3.34	3.34
Delaware County MS4 WLA	3.61	0.76	0.0	0.0	0.0
Albany WWTP	3.34	3.34	3.34	3.34	3.34
MOS (5%)	26.53	5.89	3.06	1.54	0.77
TMDL = LA+WLA+MOS	530.61	117.77	61.22	30.73	15.47

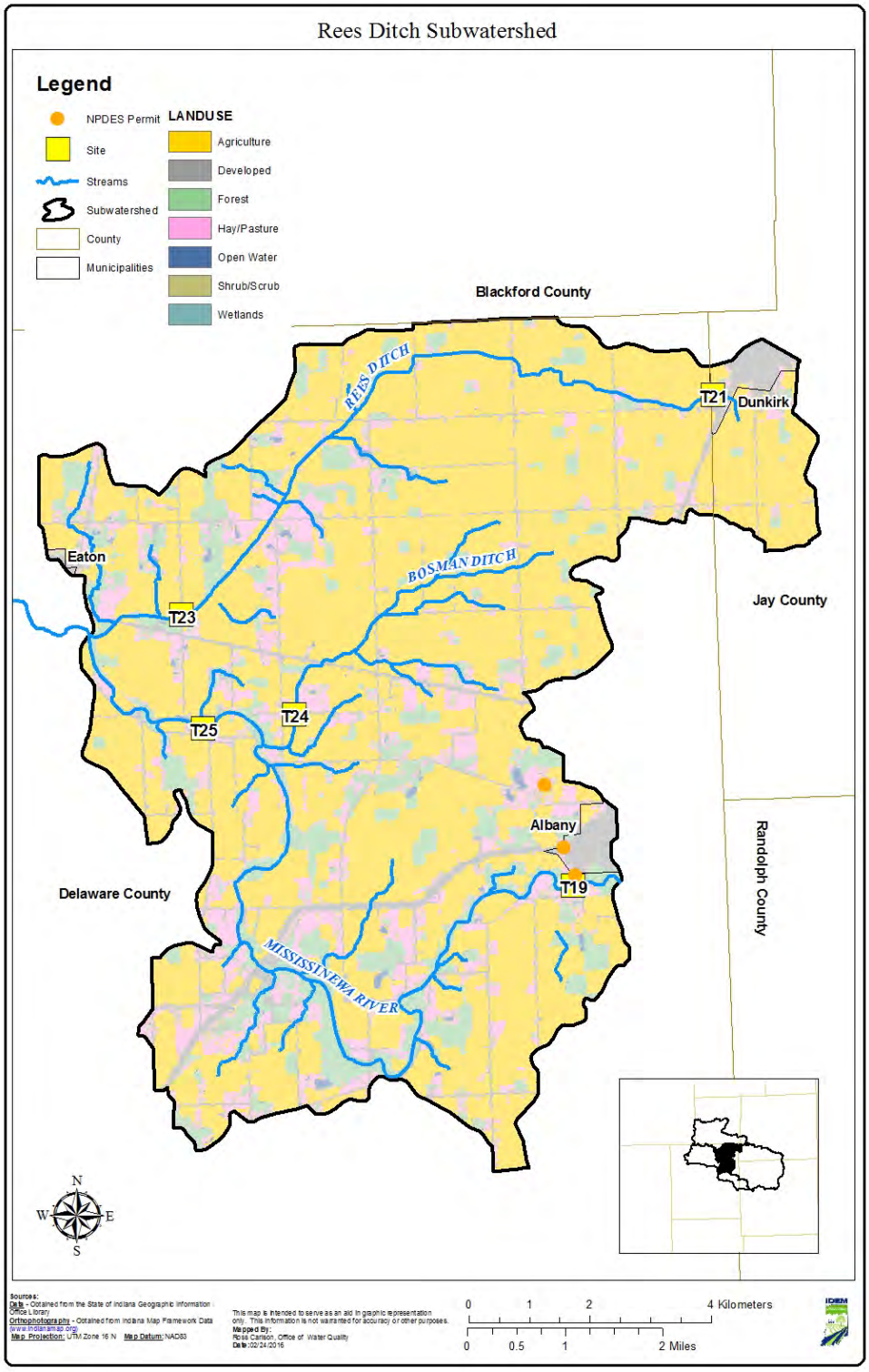

Figure 83. Sampling Stations in the Rees Ditch Watershed

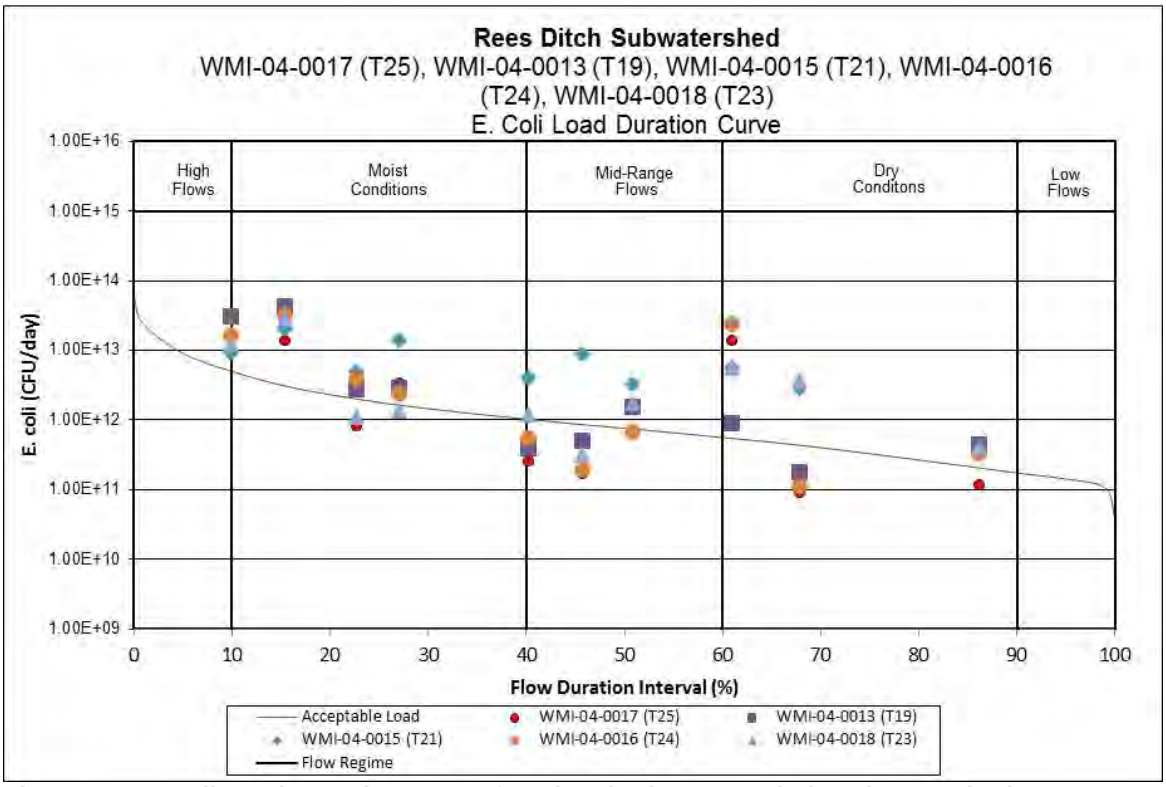

Figure 84. *E. coli* Load Duration Curve for Sites in the Rees Ditch Subwatershed

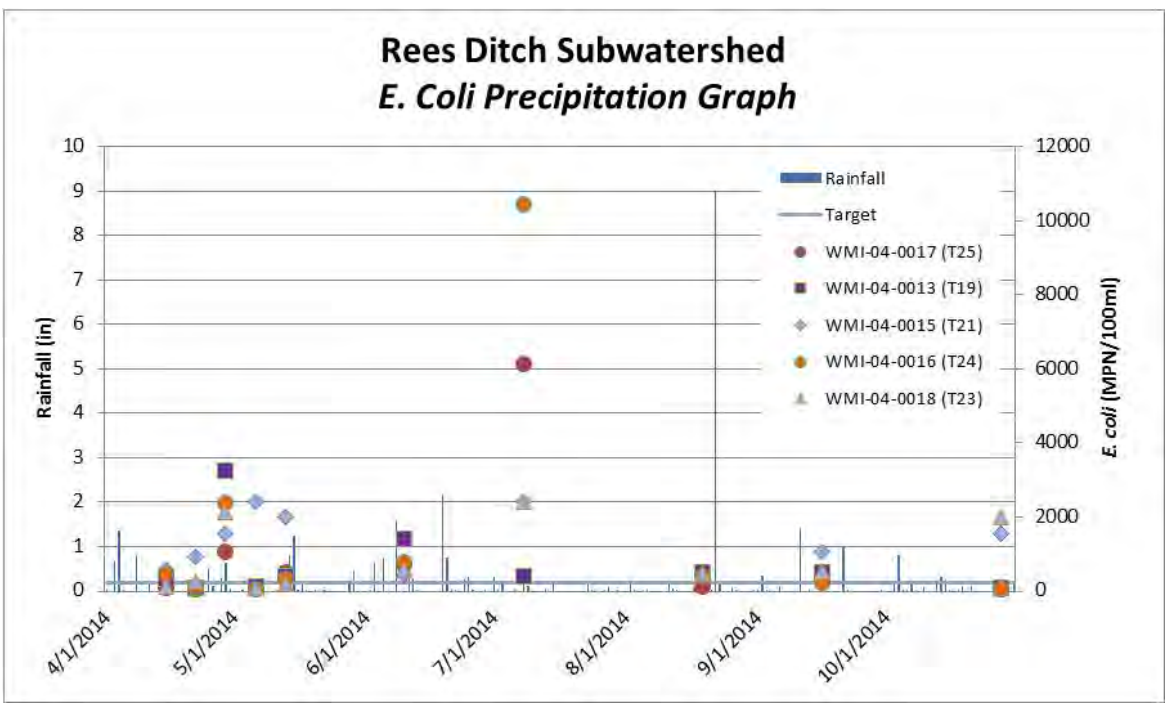

Figure 85. Graph of Precipitation and *E. coli* Data at sites in the Rees Ditch Subwatershed

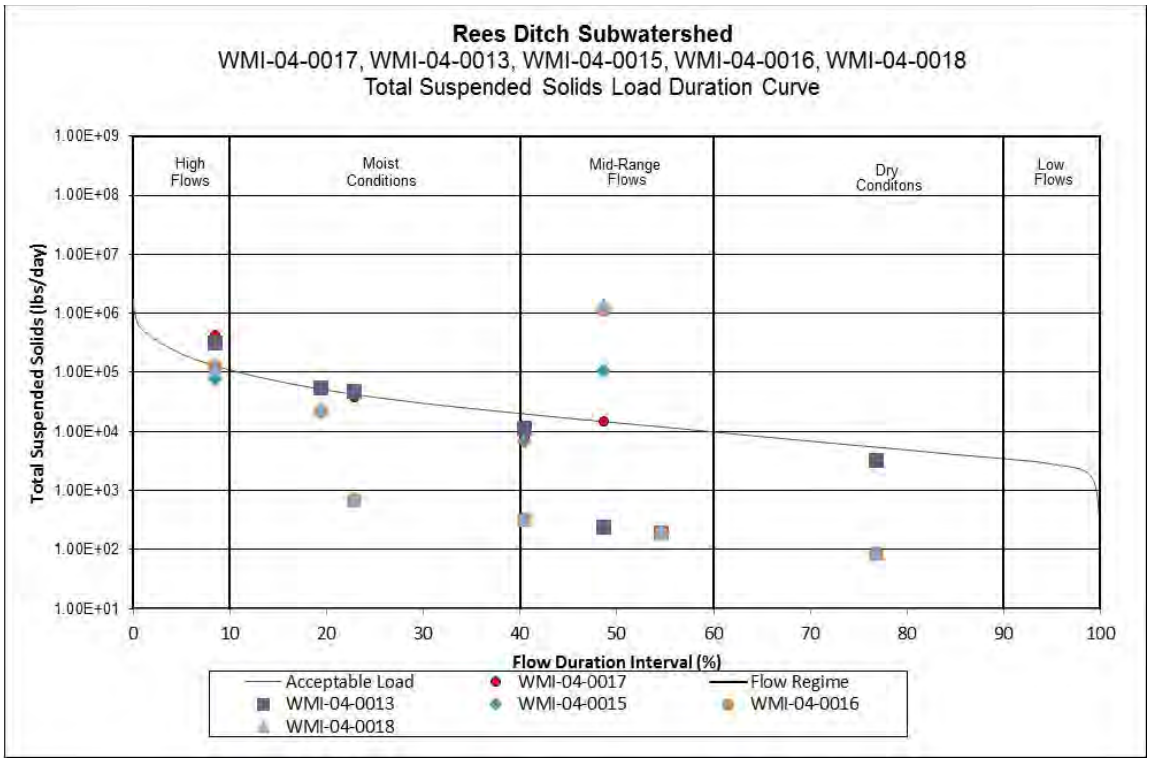

Figure 86. Total Suspended Solid Load Duration Curve for Sites in the Rees Ditch Subwatershed

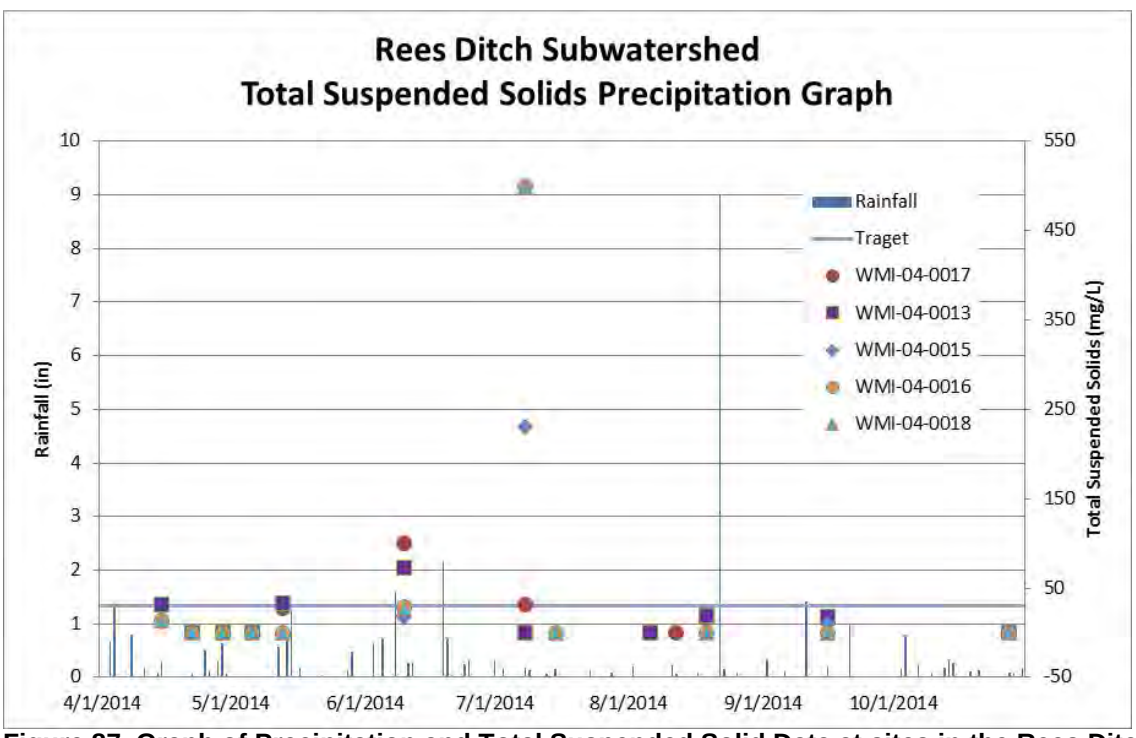

Figure 87. Graph of Precipitation and Total Suspended Solid Data at sites in the Rees Ditch Subwatershed

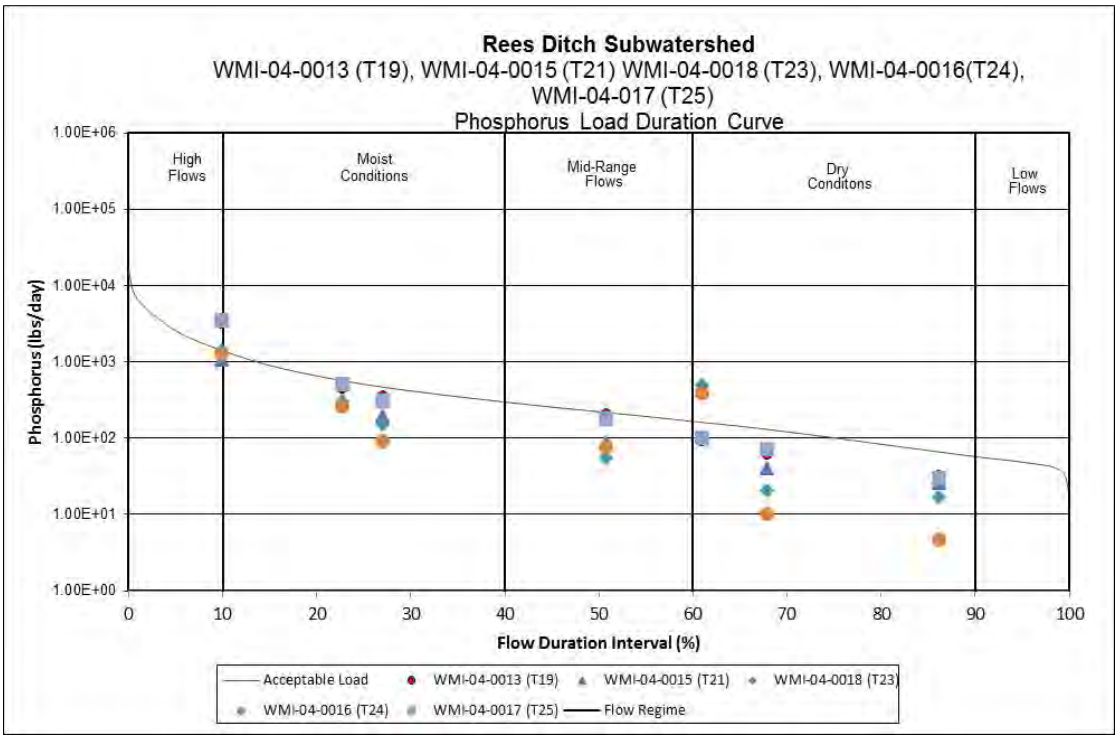

Figure 88. Total Phosphorus Load Duration Curve for Sites in the Rees Ditch Subwatershed

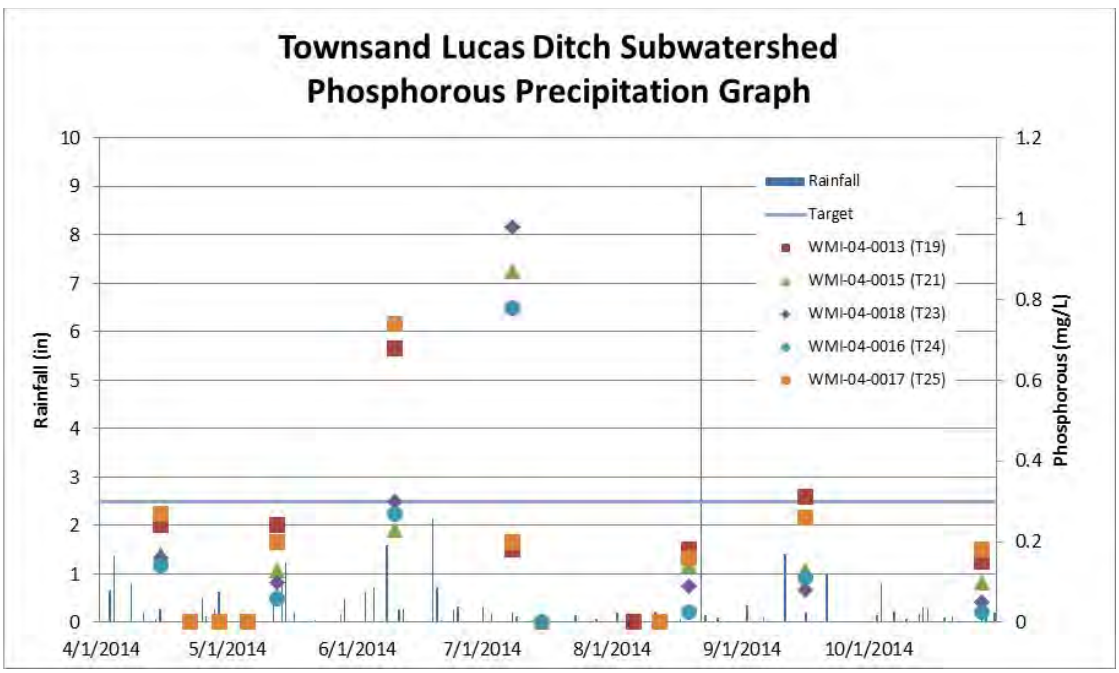

Figure 89. Graph of Precipitation and Phosphorus Data at sites in the Rees Ditch Subwatershed

7.3.11 Studebaker Ditch

The Studebaker Ditch subwatershed drains approximately 21 square miles. The subwatershed drains the southwest portion of the Upper Mississinewa Watershed including Hedgeland Ditch, Studebaker Ditch

and its tributaries. The subwatershed joins the Mississinewa River as it exits the Upper Mississinewa Watershed just upstream of Matthews, Indiana. The land use is primarily agriculture (80.34%) followed by forested land (8.28%) and developed land (5.59%). There are no permitted facilities, WWTPs, or industrial storm water permits in the subwatershed although a small portion of the watershed is covered by the Delaware County MS4. While the watershed includes portions of town of Eaton, the majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. This has led to the loss of natural character of stream corridors with little to no riparian vegetation. While the watershed has very little soil acreage that is classified as highly erodible soil, there is still potential for erosion from disturbed or non-vegetated land. This watershed contains large areas of hydric soils. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land less and 10 percent pasture land a heavy presence of pasture animals in not expected. There are no permitted CFO/CAFO's in the watershed with a total animal density of 28 animals/square mile. This is a low concentration when compared to other subwatersheds in the Upper Mississinewa River.

There are two sites located in this subwatershed, one located on Studebaker Ditch WMI-04-0011 (T30) and one located on Hedgeland Ditch WMI-04-0010 (T29). In 2014 this watershed was sampled 30 times between the two sites resulting in T30 failing for *E. coli,* and T29 failing for *E. coli* and IBC. These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T30 was 469.51 MPN with 10/11 samples in exceedance of the single sample max, while T29 had a geomean of 140.7 with 4/10 samples in exceedance of the single sample max The geomean for all sites in the subwatershed were taken on the same day within an hour from one another for five consecutive weeks.

The fish community IBI score for site T30 was 36 (fair) and the QHEI was 80 (excellent). The macro community mIBI score was 40 (fair) and the QHEI was 68 (good). The fish community IBI score for site T29 was 28 (poor) and the QHEI was 34 (poor). The macro community mIBI score was 28 (poor) and the QHEI was 38 (poor). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources. There are approximately 21.5 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 18.5 stream miles impaired for *E. coli,* and 3 miles impaired *E. coli* and IBC listed on the 2016 List of Impaired Waters.

Table 51. Summary of Studebaker Ditch Subwatershed Characteristics

Studebaker Ditch (051201030403)	
Drainage Area	21.60 square miles
TMDL Sample Site	WMI-04-0010, WMI-04-0011
AUID's (Listed Impairments covered by this TMDL)	INB0343_01 (*E. coli)*, INB0343_T1001 (*E. coli*), INB0343_T1002 (*E. coli)*, INB0343_T1003 (*E. coli*, IBC)
Land Use	Agricultural Land: 80.34% Forested Land: 8.28% Developed Land: 5.59% Open Water: 0.32% Pasture/Hay: 0.15% Grassland/Shrubs: 0.15% Wetland: 0.14%
NPDES Facilities	NA
MS4 Communities	Delaware County MS4, 1.28 square miles

CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	488.63	95.62	43.29	18.49	7.78
Future Growth	27.45	5.37	2.28	0.97	0.41
Total WLA	32.98	6.45	0.00	0.00	0.00
Delaware County MS4 WLA	32.98	6.45	0.00	0.00	0.00
MOS (5%)	28.90	5.65	2.40	1.02	0.43
TMDL= LA+WLA+MOS	577.96	113.09	47.97	20.48	8.62
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	12,703.44	2,434.70	1058.61	451.73	205.33
Future Growth	716.75	137.37	55.72	23.78	10.81
Total WLA	914.81	175.33	0.00	0.00	0.00
Delaware County MS4 WLA	861.00	165.02	0.0	0.0	0.0
Construction WLA	53.81	10.31			
MOS (5%)	754.47	144.60	58.65	25.03	11.38
TMDL = LA+WLA+MOS	15,089.47	2,892.00	1,172.98	500.54	227.52
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	136.18	26.10	10.58	4.52	2.06
Future Growth	7.17	1.37	0.56	0.24	0.11
Total WLA	0.00	0.00	0.00	0.00	0.00
MOS (5%)	7.54	1.45	0.59	0.25	0.11
TMDL = LA+WLA+MOS	150.89	28.92	11.73	5.01	2.28

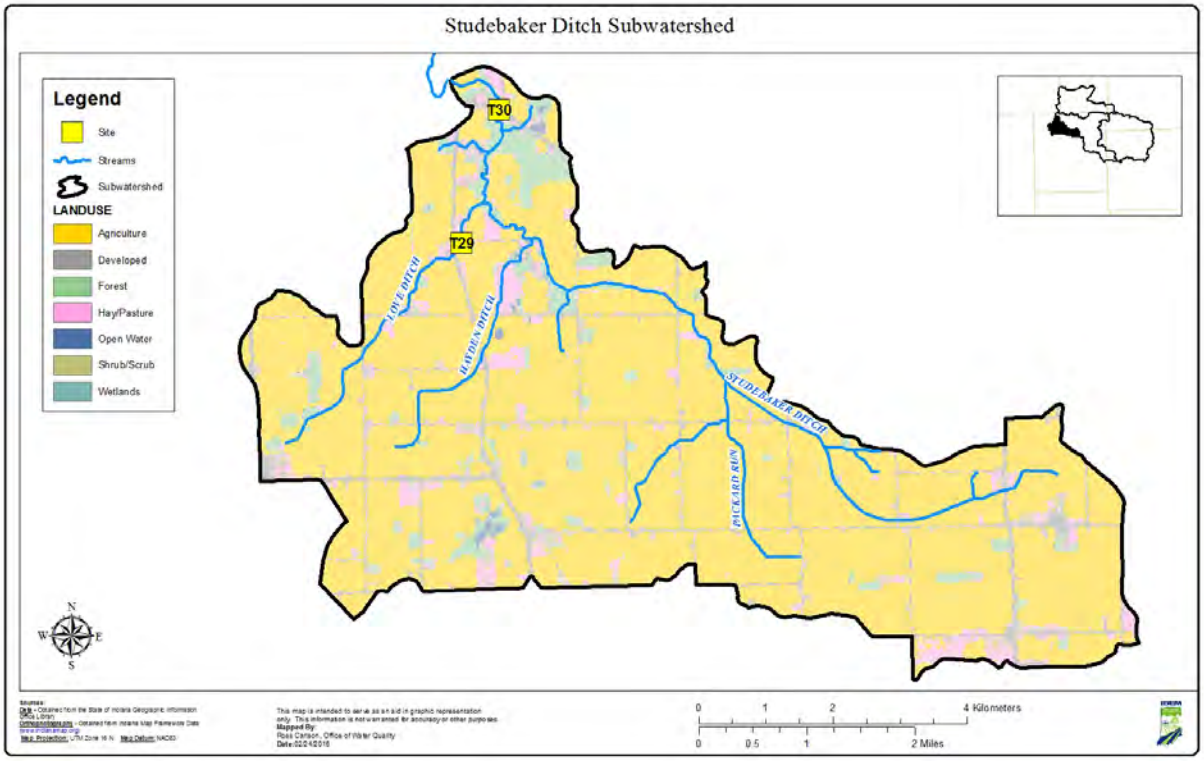

Figure 90. Sampling Stations in the Studebaker Ditch Watershed

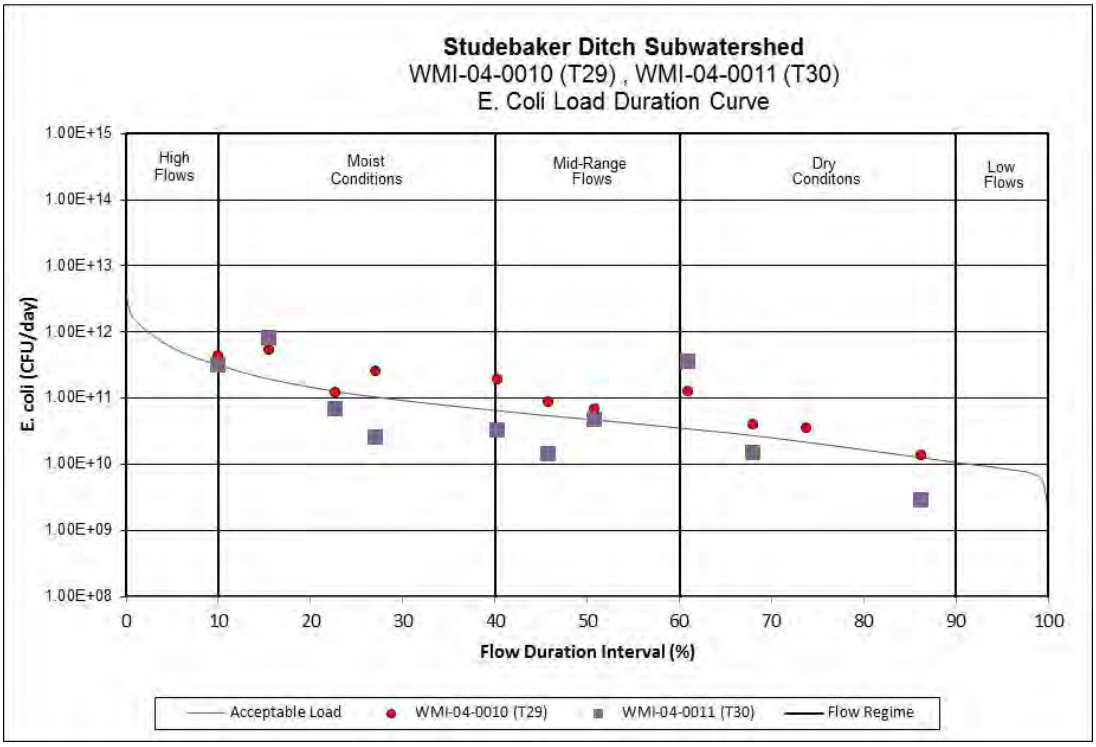

Figure 91. *E. coli* Load Duration Curve for Sites in the Studebaker Ditch Subwatershed

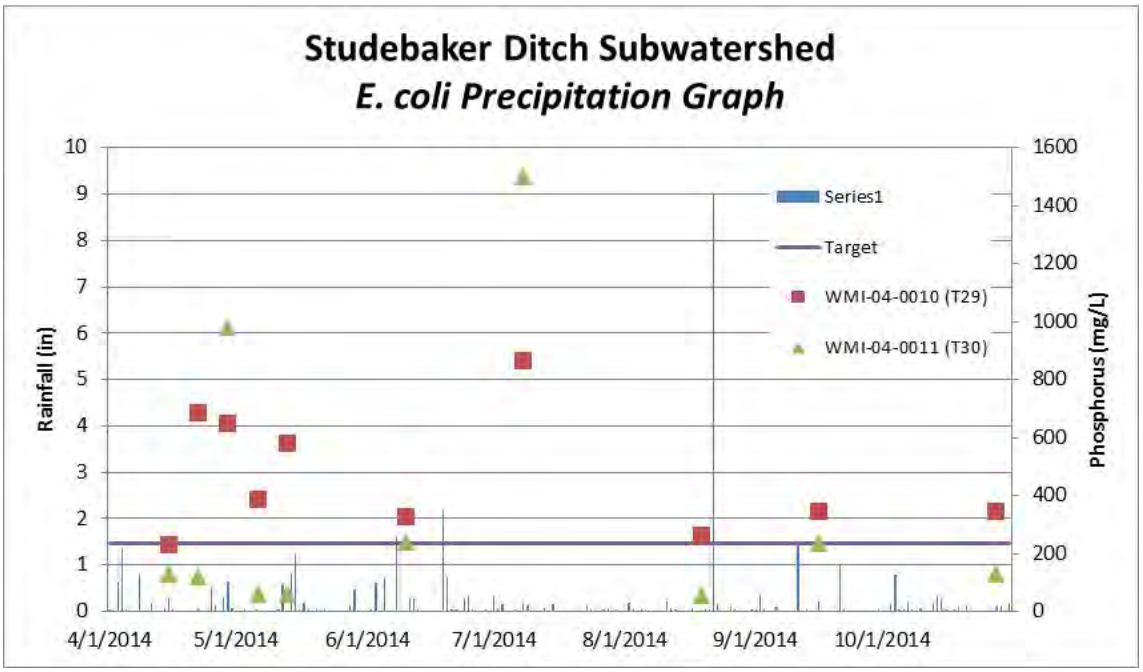

Figure 92. Graph of Precipitation and *E. coli* Data at sites in the Studebaker Ditch Subwatershed

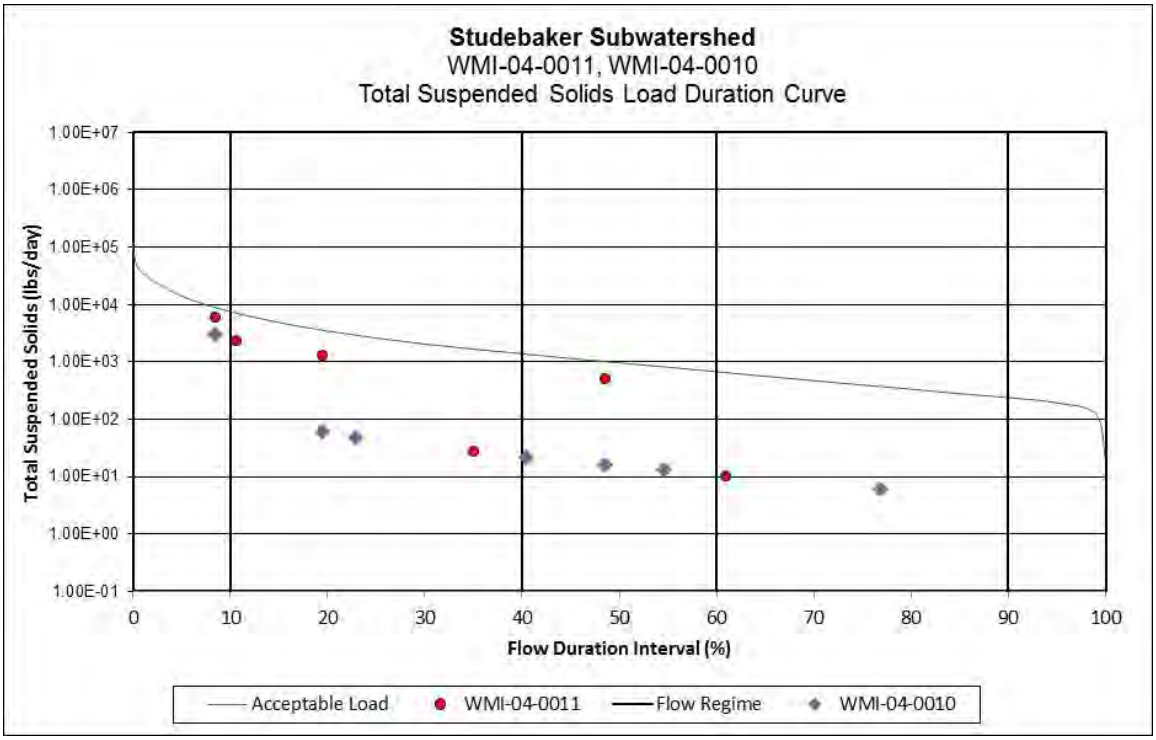

Figure 93. Total Suspended Solid Load Duration Curve for Sites in the Studebaker Ditch Subwatershed

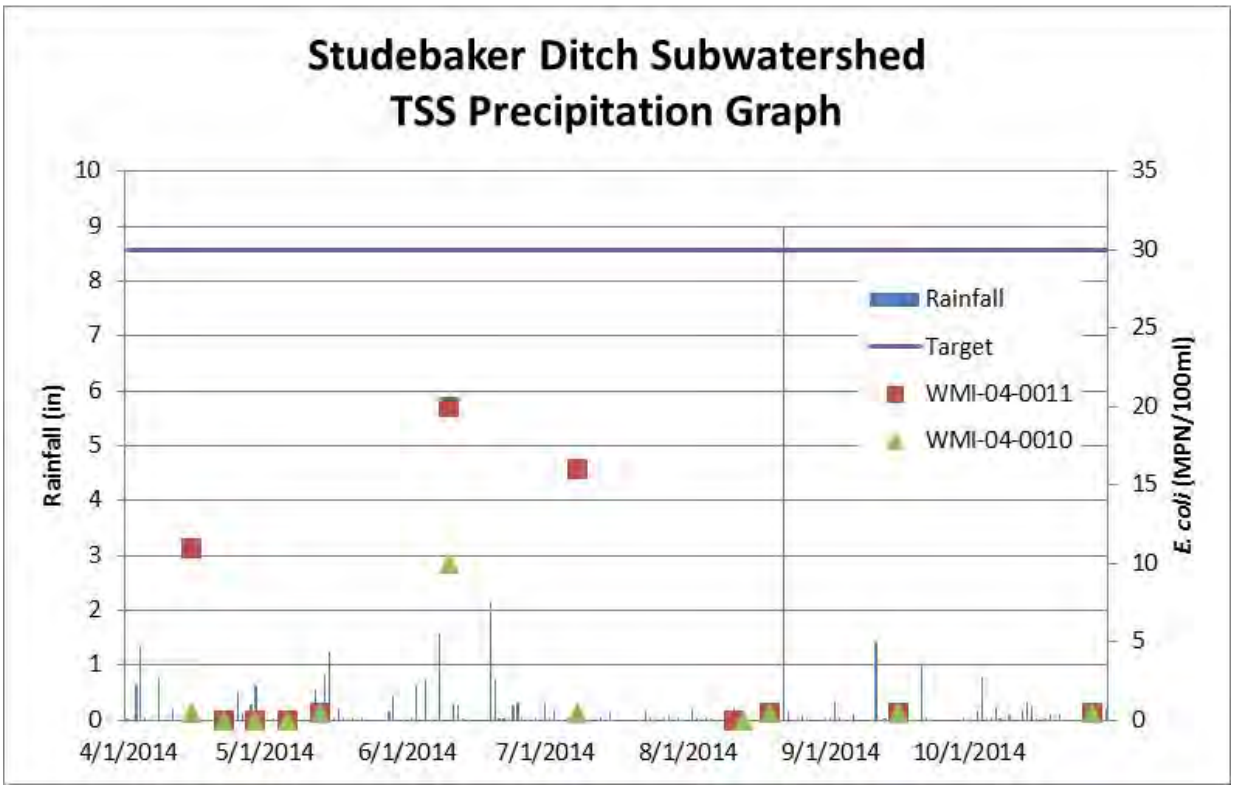

Figure 94. Graph of Precipitation and Total Suspended Solid Data at sites in the Studebaker Ditch Subwatershed

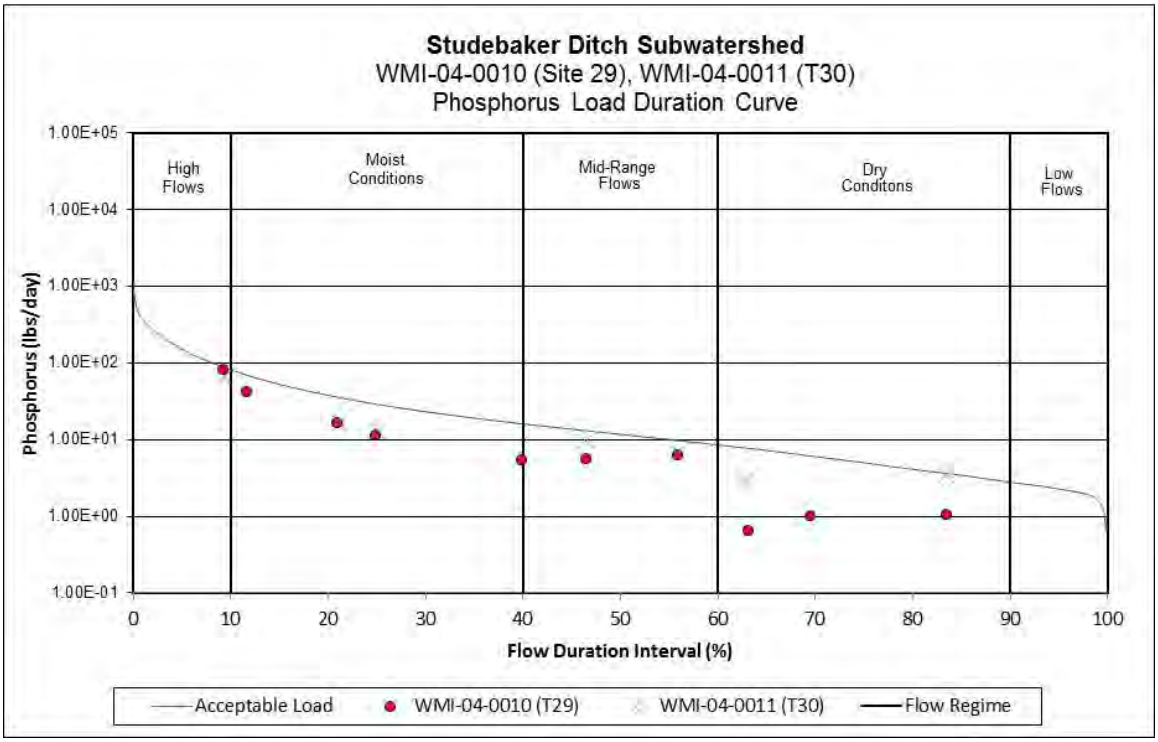

Figure 95. Phosphorus Load Duration Curve for Sites in the Studebaker Ditch Subwatershed

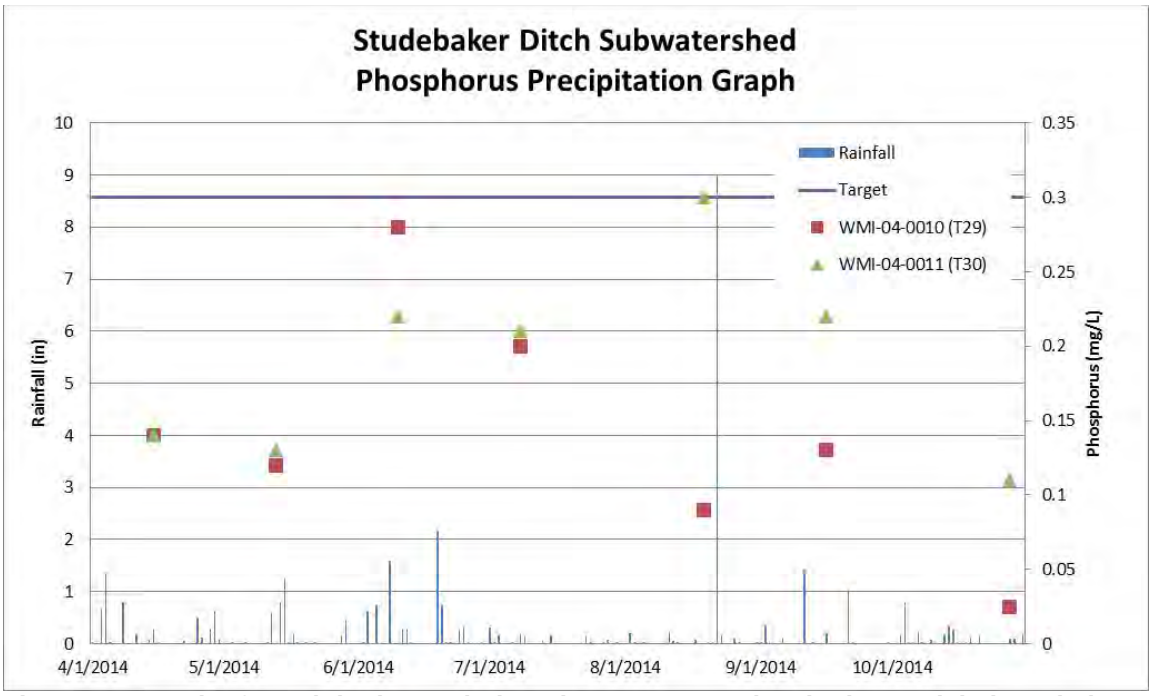

Figure 96. Graph of Precipitation and Phosphorus Data at sites in the Studebaker Ditch Subwatershed

7.3.12 Holden Ditch

The Holden Ditch subwatershed drains approximately 20 square miles. The subwatershed drains into the main stem of the Mississinewa River from Eaton to the pour point of the watershed just upstream of Matthews Indiana. The land use is primarily agriculture (68.5%) followed by forested land (12.5%) and hay and developed land (8.88%). There are three permitted facilities, WWTPs, or industrial storm water permits in the subwatershed, Eaton WWTP, Meridian Foods, and Rock Tenn Converting Company. IDEM has received a request from the Delaware County RSD to create a new WWTP to replace the Eaton plant with a 1.0mgd increase. This additional flow was added into the Future Growth of this subwatershed in normal to high flows as it may be a possible candidate for outfall sites. The majority of the Town of Eaton is in the watershed while the remainder of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this entire subwatershed is very limited (see Section 3.4.2). Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. The hydrology has likewise undergone significant change to facilitate drainage through the use of field tiling. Despite its flat nature the subwatershed does contain small amounts of highly erodible soil types, located along the lower reaches of Holden ditch and the downstream tributaries north for the main stem Mississinewa. 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.

More than any other subwatershed the Holden Ditch Subwatershed is nearly completely comprised of hydric soils. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use of less than 10 percent pasture land a heavy presence of pasture animals in not expected. There are no permitted CFO/CAFO's in the watershed with a total animal density of 28 animals/square mile. This is a lower than the median concentration when compared to other subwatersheds in the Upper Mississinewa River.

There are three sites located in this subwatershed, two located on the Mississinewa River WMI-04-0019 (T26) and WMI-04-0012 (T31) and one located on Dodge Creek WMI-04-0009 (T28). In 2014 this watershed was sampled 29 times between the three sites resulting in T26 failing for *E. Coli* and IBC, T31 failing for *E. coli* and nutrients and T28 failing for *E.coli.* These stream reaches will be placed on the 2016 303(d) list of impaired waters.

The *E. coli* geomean for T26 was 168.78 MPN with 5/11 samples in exceedance of the single sample max, T31 had a geomean of 325.26 with 5/11 samples in exceedance of the single sample max, and T28 had a geomean of 1113.31 MPN with 10/10 samples in exceedance of the single sample max. The geomeans from all sites in the watershed were taken on the same day within approximately a two hour window for five consecutive weeks. The fish community IBI score for site T26 was 56 (excellent) and the QHEI was 96 (excellent). The macro community mIBI score was 34 (poor) and the QHEI was 56 (good). These disparities could be contributed to preference for different habitat, or in the fact that fish sampling distance is 15 times the wetted width of the stream, while macro sampling distance is 50 meters regardless of stream size. This allows for fish sampling to possible cover more habitat types and result in different scores between the two sampling types on a single stream segment. The fish community IBI score for site T31 was 42 (fair) and the QHEI was 74 (excellent). The macro community mIBI score was 44 (fair) and the QHEI was 58 (Fair). The fish community IBI score for site T28 was 38 (fair) and 42 (fair) and the QHEI was 42 (poor) and 49 (fair). The macro community mIBI score was 42 (fair) and the QHEI was 43 (fair). Load Duration curves for each individual site is located in Appendix B.

Based on the water quality duration curves and lack of permitted sources, it can be concluded that the majority of sources of *E. coli* and TSS in this watershed are nonpoint sources. There are approximately 30 miles of stream in the subwatershed. Based on IDEM data collected in 2014 there will be 1 stream mile impaired for *E. coli* and nutrients, 10 stream miles impaired for *E.coli*, and 19 stream miles impaired for *E.coli* and IBC listed on the 2016 List of Impaired Waters.

Table 52. Summary of Holden Creek Subwatershed Characteristics

Holden Ditch (051201030404)					
Drainage Area	20.35				
TMDL Sample Site	WMI-04-0019, WMI-04-0009, WMI-04-0012				
AUID's (Listed Impairments covered by this TMDL)	INB0344_03 (*E. coli*, IBC, Nutrients), INB0344_03 (*E. coli*, Nutrients), INB0344_05 (*E. coli*, Nutrients), INB0344_T1002 (*E. coli)*, INB0344_T1003 (*E. coli).*				
Land Use	Agricultural Land: 68.5% Forested Land: 12.5% Developed Land: 8.8% Open Water: 0.01% Pasture/Hay: 7.38% Grassland/Shrubs: 2.8% Wetland: 0.01%				
NPDES Facilities	Eaton WWTP IN0021652, Meridian Foods IN0038016, Rock Tenn Converting Company IN0005002				
MS4 Communities	Delaware Co MS4 1.95				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
Flow Regime TMDL analysis for *E. coli* (billions of bacteria/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	722.49	126.92	56.68	27.49	9.73

Future Growth	52.21	17.73	12.49	1.53	0.65
Total WLA	91.64	24.87	3.20	3.20	3.20
Delaware County MS4 WLA	83.02	16.26	0.0	0.0	0.0
Eaton WWTP	7.38	7.38	3.20	3.20	3.20
Eaton CSO	1.25	1.25	0.0	0.0	0.0
MOS (5%)	45.60	8.92	3.78	1.62	0.68
TMDL= LA+WLA+MOS	911.94	178.44	75.69	32.31	13.61
Flow Regime TMDL analysis for Total Suspended Solids (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	8794.30	1252.98	433.36	211.43	33.75
Future Growth	796.24	354.94	292.75	18.11	8.23
Total WLA	1328.02	484.7	122.65	122.65	122.65
Delaware County MS4 WLA	1046.25	200.52	0.0	0.0	0.0
Eaton WWTP WLA	207.75	207.75	90.11	90.11	90.11
Eaton CSO	35.04	35.04	0.0	0.0	0.0
Meridian Foods WLA	32.54	32.54	32.54	32.54	32.54
Construction WLA	42.92	8.23	0.0	0.0	0.0
Industrial WLA	3.22	0.62	0.0	0.0	0.0
MOS (5%)	574.66	110.14	44.67	19.06	8.66
TMDL = LA+WLA+MOS	11,493.22	2,202.76	893.43	381.25	173.29
Flow Regime TMDL analysis for Total Phosphorous (lbs/day)					
Allocation Category	**Very High Flows**	**Higher Flow Conditions**	**"Normal" Flows**	**Lower Flow Conditions**	**Low Flows**
Duration level	**0-10%**	**10-40%**	**40-60%**	**60-90%**	**90-100%**
LA	339.46	50.06	13.12	7.64	2.84
Future Growth	27.03	11.8	9.63	0.56	0.31
Total WLA	7.27	7.27	3.00	3.00	3.00
Eaton WWTP	7.27	7.27	3.0	3.0	3.0
Eaton CSO	0.35	0.35	0.0	0.0	0.0
MOS (5%)	19.67	3.64	1.36	0.59	0.32
TMDL = LA+WLA+MOS	393.43	72.77	27.11	11.79	6.47

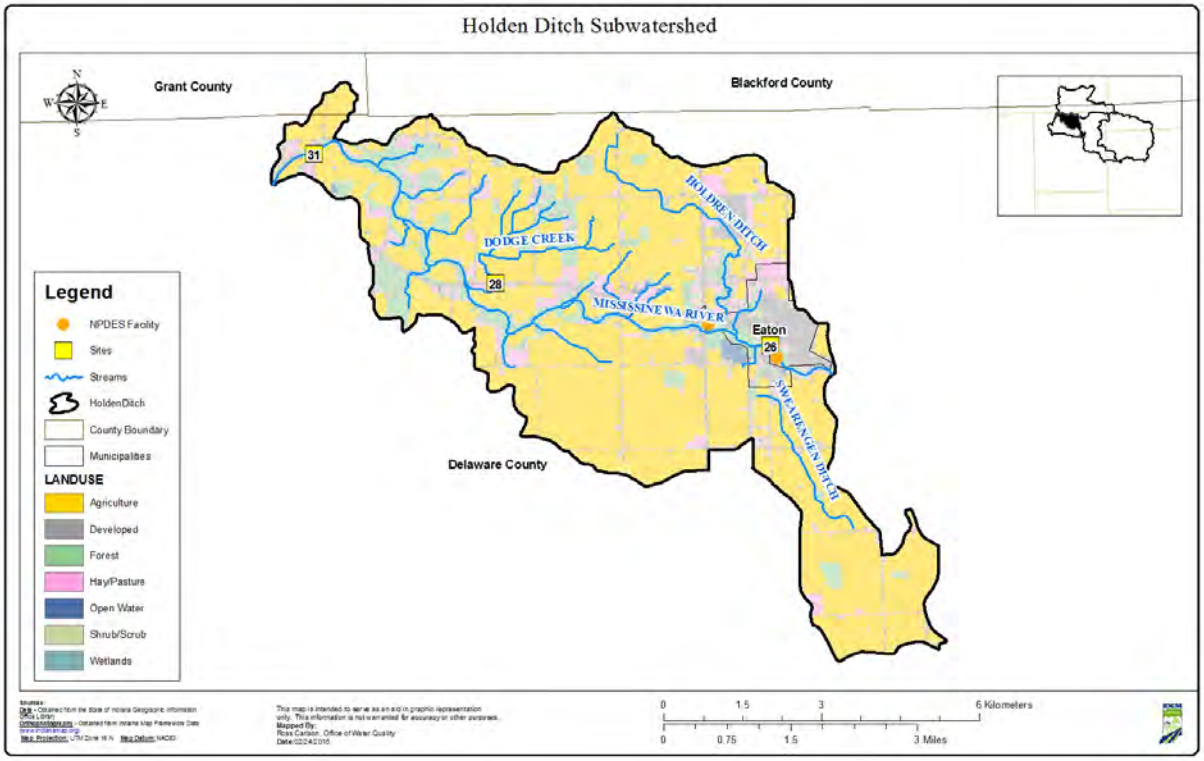

Figure 97. Sampling Stations in the Holden Ditch Watershed

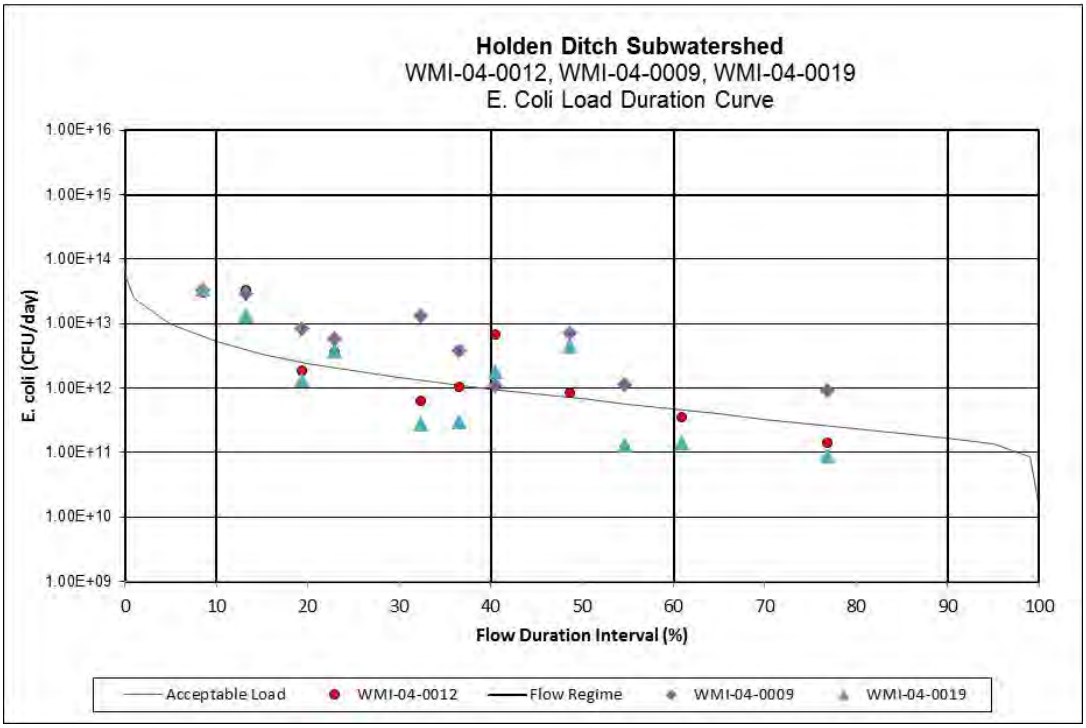

Figure 98. *E. coli* Load Duration Curve for Sites in the Holden Ditch Subwatershed

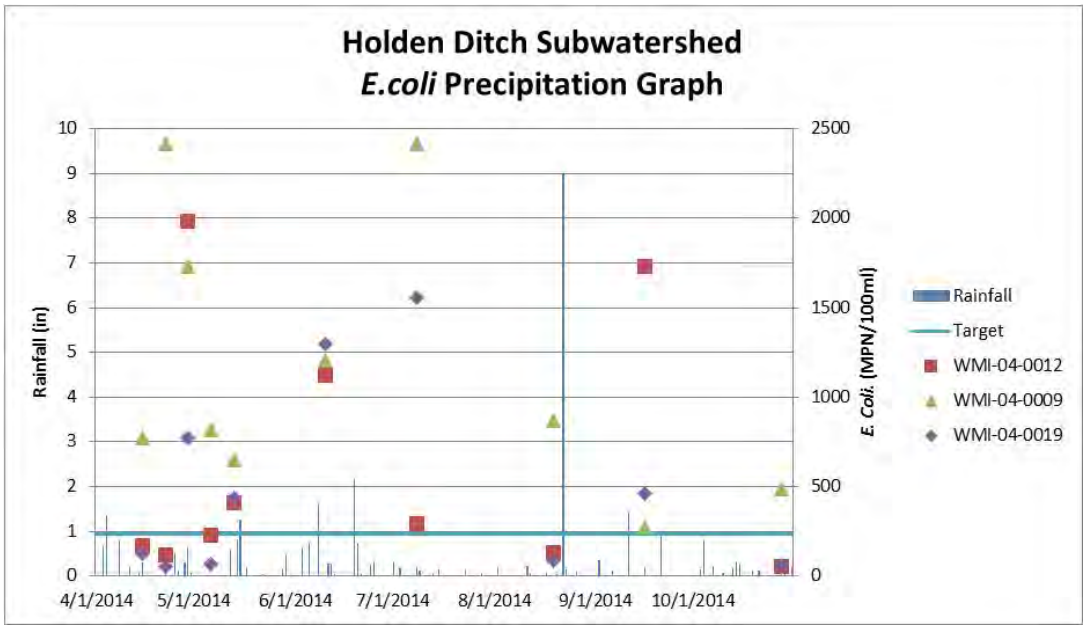

Figure 99. Graph of Precipitation and *E. coli* Data at sites in the Holden Ditch Subwatershed

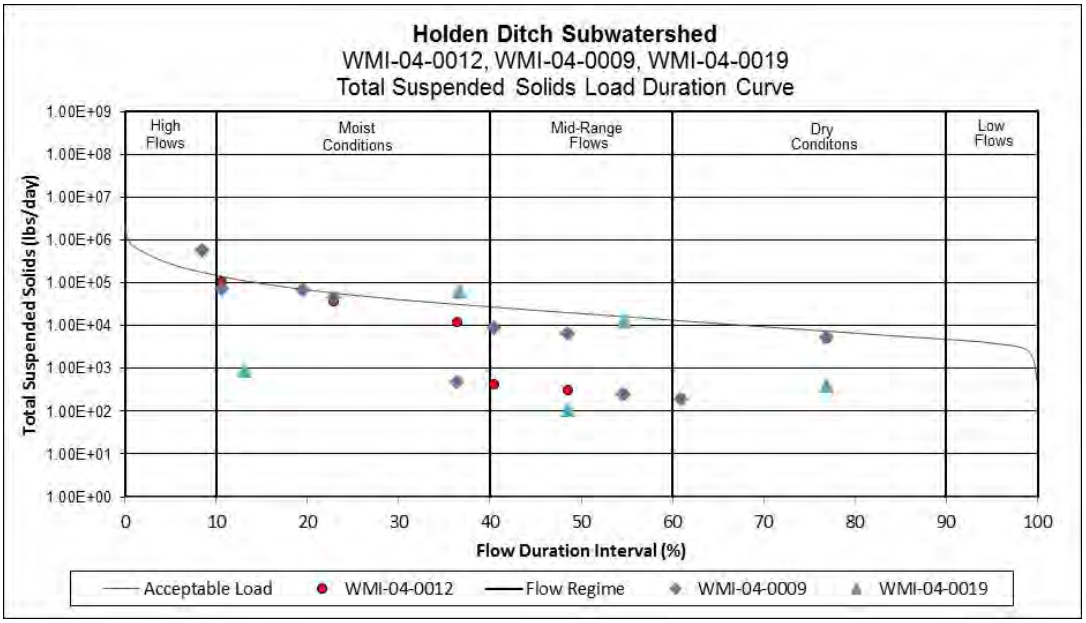

Figure 100. Total Suspended Solid Load Duration Curve for Sites in the Rees Ditch Subwatershed

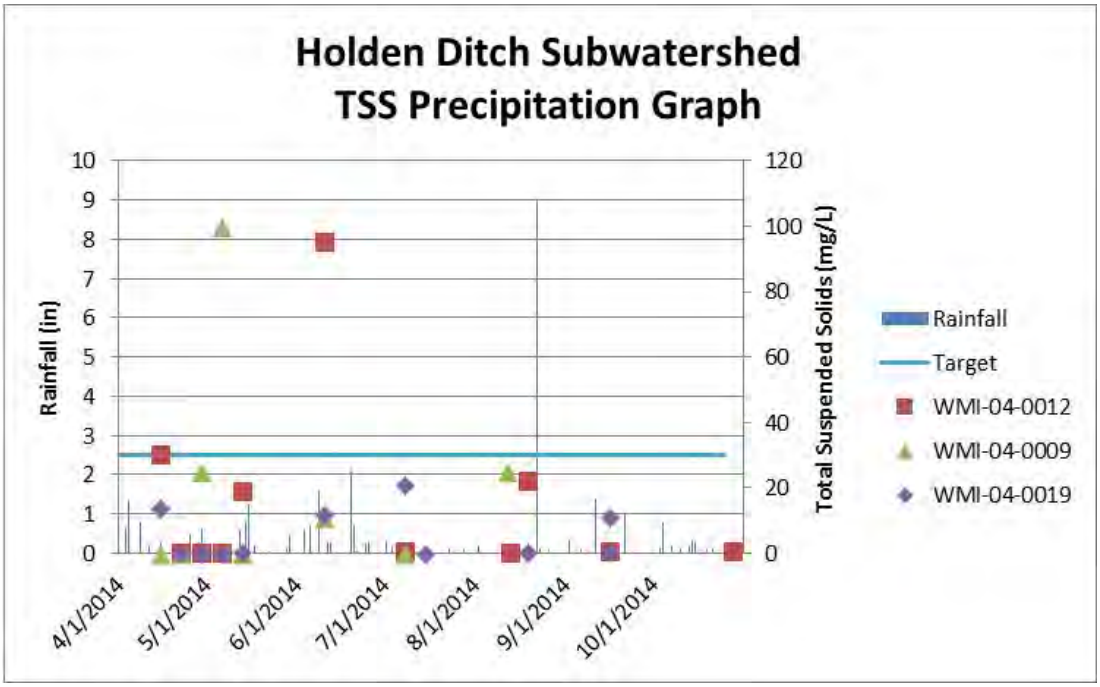

Figure 101. Graph of Precipitation and Total Suspended Solid Data at sites in the Holden Ditch Subwatershed

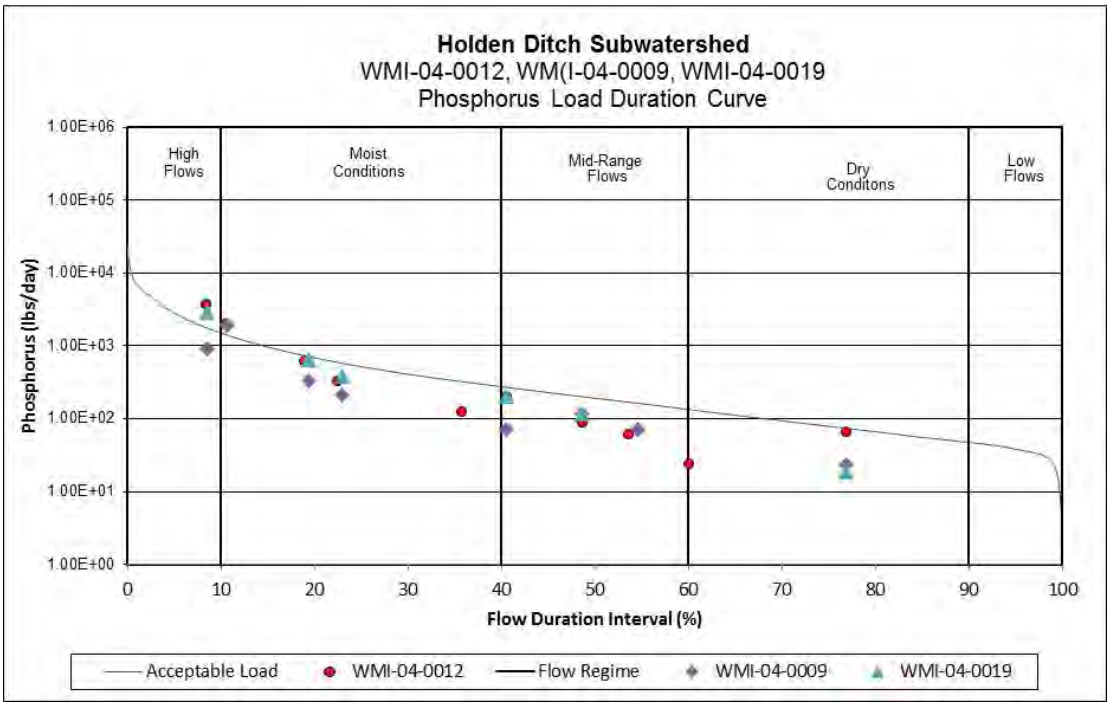

Figure 102. Total Phosphorus Load Duration Curve for Sites in the Holden Ditch Subwatershed

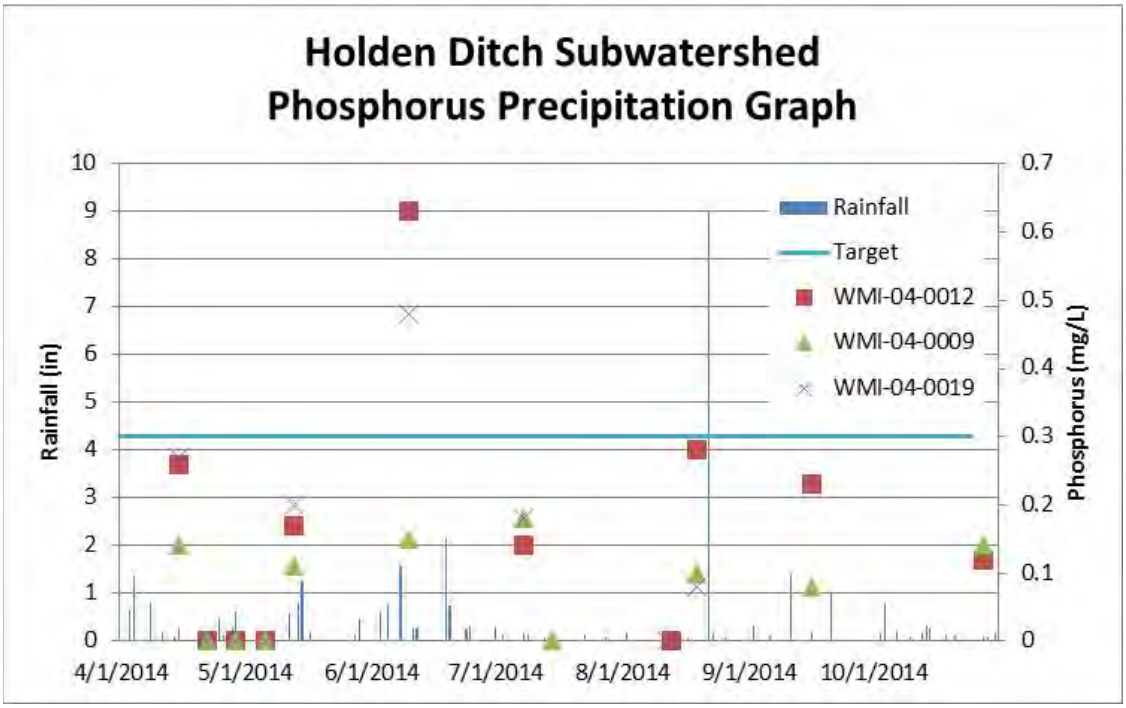

Figure 103. Graph of Precipitation and Total Phosphorus Data at sites in the Holden Ditch Subwatershed

8.0 ALLOCATIONS

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality 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:

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

8.1 Results by Assessment Location

The following sections present the allowable *E. coli*, phosphorus, and sediment loads and associated allocations for each of the study sites and NPDES permitted dischargers in the Upper Mississinewa River Watershed. WLAs were calculated based on the Peak Design Flow for Very High and Higher Flow allocations, while Average Design Flow was used for Normal, Lower, and Low flow conditions. For site allocations flow regime breakdowns are as follows; High Flows are those in the top 90th percentile of flow, Moist Flows are those from the 60th to 90th percentile, Mid-Range Flows are those in the 40th to 60th percentile, Dry conditions are those in the10th to 40th percentile, and Low Flows are those in the bottom 10th percentile of flow.

Table 54 presents the individual WLAs for NPDES facilities in the Upper Mississinewa River watershed by subwatershed. The NPDES WLAs were established based on the design flow multiplied by the TMDL target value for bacteria: 125#/100 mL for *E. coli*, for TP: 1.0 mg/L for WWTP and 0.3 mg/L for instream permits, and for TSS: 30 mg/L.

The WWTPs are estimated to contribute to the phosphorus load in the Upper Mississinewa River Watershed. The WWTP TP loadings were established based on the design flow multiplied by the TMDL target value for TP of 1.0 mg/L. TP is interpreted as an average in the NPDES permits.

Table 53. Individual WLAs for NPDES Facilities in the Upper Mississinewa River Watershed.

Subwatershed	AUID	Facility Name	Permit ID	Design Flow (MGD)	Peak Flow (MGD)	*E. coli* WLA (Billion/day)	TP WLA (lb/day)	TSS WLA (lb/day)
Days Creek	NA	NA	NA	NA	NA	NA	NA	NA
Bear Creek	NA	NA	NA	NA	NA	NA	NA	NA
Fetid Creek	INB0323_01	Ridgeville WWTP	IN0020001	0.15	0.3	1.33/2.66	1.25/2.5	25.03/50.06
	INB0323_01	U.S. Aggregates, Inc – Ridgeville Quarry	ING490050	1.40	NA	NA	NA	350.43
Bush Creek	NA	NA	NA	NA	NA	NA	NA	NA
Redkey Run	INB0325_T1002	Redkey WWTP	IN0024406	0.3	0.675	2.67/6.0	2.5/5.63	75.09/168.96
Platt Nibarger Ditch	INB0326_01	Riverside Community MHP	IN0041173	0.008	NA	0.07	0.01	0.2
	INB0326_01	U.S. Aggregates, Inc – Fairview Quarry	ING490051	0.76	NA	NA	NA	190.23
Little Lick Creek	INB0331_01	Dunkirk WWTP	IN0021491	0.7	NA	6.23	5.84	175.22
	INB0331_T1001	Lake Placid Conference Center	IN0030015	0.028	NA	0.25	0.23	7.01
	INB0331_02	Jackson Township RSD	IN0061000	0.0132	NA	0.12	0.11	3.30
Townsand Lucas Ditch	INB0332_T1001	Hartford City WWTP	IN0021628	2.2	3.5	19.57/31.13	18.36/29.21	550.68/876.08
	INB0332_T1003	Shamrock Lakes WWTP	IN0049832	0.03	NA	0.27	0.25	7.51
Campbell Creek	INB0341_01	PAWS, Inc WWTP	IN0055271	0.00175	NA	0.02	0.1	NA*
Rees Ditch	INB0342_01	Albany WWTP	IN0022136	0.3	NA	2.67	3.34	75.09
	INB0342_01	Bell Aquaculture LLC	IN0062669	0.583	NA	NA	NA	145.95
Studebaker Ditch	NA	NA	NA	NA	NA	NA	NA	NA
Holden Ditch	INB0344_01	Eaton WWTP	IN0021652	0.36	0.83	3.2/7.38	3.0/7.27	90.11/207.75
	INB0344_T1002	Meridian Foods Inc	IN0038016	0.13	NA	NA	NA	32.54

Table 54 presents the individual WLAs for NPDES Permit holders in the Upper Mississinewa River watershed by subwatershed, NA* represents conditions where WLA's are not needed.

The WLAs for all the CSOs were calculated to be equal to the maximum observed daily flow (as reported on the 2014 discharge monitoring reports) multiplied by the TMDL target value of for bacteria: 125#/100 mL for *E. coli,* for TP: 1.0 mg/L, and for TSS: 30 mg/L. The reported overflow events were assumed to occur during one day and the WLAs were only assigned to the high flow zones. During the development of Long-Term Control Plans for the CSO communities, IDEM might decide to modify the WLA if deemed appropriate. CSO WLA's are reflective of pollutant loads contributed per day into the watershed at target concentration. CSO WLA's should not be construed as either actual loads contributed by CSOs or an effluent limitation on CSOs.

Table 54. Individual WLAs for CSO Communities in the Upper Mississinewa River Watershed TMDL

Subwatershed	Facility Name	Permit ID	Pipe ID	*E. Coli* WLA (Billion/ day)	TSS WLA (lbs/ day)	TP WLA (lbs/ day)
Days Creek	NA	NA	NA	NA	NA	NA
Bear Creek	NA	NA	NA	NA	NA	NA
Fetid Creek	Ridgeville WWTP	IN0020001	101, 002	0.01	0.1	0.01
Bush Creek	NA	NA	NA	NA	NA	NA
Redkey Run	Redkey WWTP	IN0024406	002, 003, 003, 004, 005, 006, 007, 008, 009, 010	1.07	30.04	0.3
Platt Nibarger Ditch	NA	NA	NA	NA	NA	NA
Little Lick Creek	Hartford City WWTP	IN0021628	003, 004, 005, 006, 007, 008, 009, 011, 012, 013, 014, 015, 016, 017, 018, 019	0.98	27.53	0.33
Townsand Lucas Ditch	Hartford City WWTP	IN0021628	011, 012, 016	0.17	5.01	0.05
Campbell Creek	NA	NA	NA	NA	NA	NA
Rees Ditch	NA	NA	NA	NA	NA	NA
Studebaker Ditch	NA	NA	NA	NA	NA	NA
Holden Ditch	Eaton WWTP	IN0021652	002, 003	1.25	35.04	0.35

Table 55 presents the individual WLAs for MS4 communities in the Upper Mississinewa River watershed by subwatershed.

Different WLAs were established for each MS4 depending on the area of the MS4 upstream of each assessment location. The jurisdictional areas of townships, municipalities, and urbanized areas were used as surrogates for the regulated area of each MS4. These areas were then used to calculate WLAs based on the proportion of the upstream drainage area located within the MS4 boundaries by multiplying that proportional area by the loading capacity of the assessment location. The MS4 WLAs therefore are equal to the estimated flows from the MS4 multiplied by the TMDL target value of for bacteria: 125#/100 mL for *E. coli,* for TP: 1.0 mg/L, and for TSS: 30 mg/L.

MS4 WLA's are only calculated using the two highest flow regimes in this TMDL. By using the higher flow regimes values, it accounts for higher reliability in the calculations, since the high flow captures the highest concentrations of pollutants.

Table 55. Individual WLAs for MS4 Communities in the Upper Mississinewa River watershed TMDLs

Subwatershed	MS4 Community	Permit ID	Area in Drainage (sq miles)	*E. coli* WLA (Billion/day)		TSS WLA (lbs/day)	
				High	Moist	High	Moist
Days Creek	NA	NA	NA	NA		NA	
Bear Creek	NA	NA	NA	NA		NA	
Fetid Creek	NA	NA	NA	NA		NA	
Bush Creek	NA	NA	NA	NA		NA	
Redkey Run	Delaware County	INR040056	1.35	24.49	4.54	692.38	130.83
Platt Nibarger Ditch	Delaware County	INR040056	0.37	7.38	1.37	205.98	36.92
Little Lick Creek	Delaware County	INR040056	0.21	4.01	0.74	112.78	20.89
Townsand Lucas Ditch	Delaware County	INR040056	0.13	1.15	0.21	32.98	6.61
Campbell Creek	Delaware County	INR040056	0.67	14.25	2.64	0	0
Rees Ditch	Delaware County	INR040056	2.84	34.23	6.34	1465.66	278.33
Studebaker Ditch	Delaware County	INR040056	1.28	28.50	5.28	802.00	148.57
Holden Ditch	Delaware County	INR040056	1.95	98.46	18.24	829.96	994.14

8.2 Critical Conditions

The Clean Water Act requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. Through the load duration curve approach it has been determined that load reductions for the parameters of concern are needed for specific flow conditions; the critical conditions (the periods when the greatest reductions are required) vary by parameter and location and are summarized in Table 57. The table indicates that critical conditions for most pollutants for most locations occur during normal to very high flow regimes and therefore implementation of controls should be targeted for these conditions.

Table 56. Critical Conditions for TMDL Parameters

Station ID	Parameter	Critical Condition				
		Very High	Higher	Normal	Dry	Low
WMI-04-0008 T1	*E. coli*	X	X	X		
	TSS	X	X			
	Phosphorus	X				
WMI-02-0010 T2	*E. coli*	X	X	X		
	TSS					
	Phosphorus	X				

Station ID	Parameter	Critical Condition				
		Very High	Higher	Normal	Dry	Low
WMI-02-0011 T3	*E. coli*	X	X	X	X	
	TSS					
	Phosphorus					
WMI-02-0012 T4	*E. coli*	X	X	X	X	
	TSS	X	X			
	Phosphorus	X				
WMI-02-0013 T5	*E. coli*	X	X	X	X	
	TSS		X			
	Phosphorus	X	X	X		
WMI020-0002 T6	*E. coli*	X	X	X	X	
	TSS	X	X			
	Phosphorus	X	X			
WMI-02-0005 T8	*E. coli*		X	X		
	TSS	X	X			
	Phosphorus	X	X			
WMI-02-0006 T9	*E. coli*	X	X			
	TSS	X	X			
	Phosphorus	X	X			
WMI-02-0007 T10	*E. coli*	X	X			
	TSS	X	X			
	Phosphorus	X				
WMI-02-0009 T12	*E. coli*	X	X		X	
	TSS	X				
	Phosphorus	X				
WMI-02-0015 T13	*E. coli*	X	X			
	TSS					
	Phosphorus	X				
WMI-02-0016 T14	*E. coli*	X	X	X	x	
	TSS	X	X			
	Phosphorus	X	X	X	X	
WMI-02-0017 T16	*E. coli*	X	X	X	X	
	TSS	X				
	Phosphorus	X	X			
WMI-02-0018 T17	*E. coli*	X	X	X	X	
	TSS	X	X			
	Phosphorus	X				
WMI-02-0019 T18	*E. coli*		X	X	X	
	TSS					
	Phosphorus	X				
WMI-04-0013 T19	*E. coli*	X	X	X	X	
	TSS	X	X			
	Phosphorus	X				
WMI-04-0014	*E. coli*	X	X			

Station ID	Parameter	Critical Condition				
		Very High	Higher	Normal	Dry	Low
T20	TSS	X	X			
	Phosphorus	X	X			
WMI-04-0015 T21	*E. coli*	X	X	X		
	TSS			X		
	Phosphorus			X		
WMI-03-0003 T22	*E. coli*	X	X	X		
	TSS	X		X		
	Phosphorus	X	X	X	X	
WMI-04-0018 T23	*E. coli*	X	X	X	X	
	TSS		X			
	Phosphorus	X		X		
WMI-04-0016 T24	*E. coli*	X	X	X	X	
	TSS		X			
	Phosphorus			X		
WMI-04-0017 T25	*E. coli*	X	X	X		
	TSS	X				
	Phosphorus	X				
WMI-04-0019 T26	*E. coli*	X	X	X		
	TSS	X				
	Phosphorus	X				
WMI-04-0009 T28	*E. coli*	X	X	X	X	
	TSS					
	Phosphorus					
WMI-04-0010 T29	*E. coli*		X	X		
	TSS					
	Phosphorus					
WMI-04-0011 T30	*E. coli*	X	X	X	X	
	TSS					
	Phosphorus					
WMI-04-0012 T31	*E. coli*	X	X	X		
	TSS	X				
	Phosphorus	X	X			
WMI-03-0009 T32	*E. coli*	X	X	X		
	TSS		X			
	Phosphorus		X			
WMI-03-0005 T34	*E. coli*	X	X	X		
	TSS		X			
	Phosphorus		X			
WMI-03-0010 T35	*E. Coli*		X	X		
	TSS		X			
	Phosphorus		X			
WMI-03-0006	*E. coli*	X	X	X	X	

Station ID	Parameter	Critical Condition				
		Very High	Higher	Normal	Dry	Low
T36	TSS		X			
	Phosphorus		X		X	
WMI-03-0007 T37	*E. coli*	X	X	X		
	TSS		X			
	Phosphorus		X			
WMI040-0003 T38	*E. coli*	X	X	X		
	TSS		X			
	Phosphorus		X			
WMI040-0009 T39	*E. coli*	X	X	X		
	TSS		X			
	Phosphorus		X			
WMI-03-0008 T40	*E. coli*	X	X			
	TSS		X			
	Phosphorus		X			

8.3 Potential Priority Implementation Areas (PPIAs)

The information in Section 6 and the allocations presented in this section provide the foundation necessary to identify subwatersheds that are in need of the most significant *E. coli,* nutrient, and sediment reductions to achieve water quality standards in the Upper Mississinewa River watershed. The areas in need of the most significant *E. coli*, nutrient, and sediment reductions under high flow and low flow conditions (as shown in Table 58 and Tables 42-53) are considered PPIAs. Using the PPIA rankings, watershed organizations will gain a better understanding of which subwatersheds require the most pollutant load reductions. This can assist in future efforts to identify critical areas in the Upper Mississinewa River watershed for implementation. PPIAs differ from critical areas in that PPIAs focus on the information and data collected and analyzed through the TMDL development process for ranking purposes, whereas critical areas take into account other factors into 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.

In order to rank each subwatershed IDEM used EPA's Recovery Potential Screening Tool which is a technical method for comparing the relative restorability of large numbers of water bodies. This is a method that measures, for each water or watershed, several ecological, stressor, and social context indicators that are associated with the likelihood that a restoration effort may succeed. The user selects the indicators based on what is most appropriate to the waters being assessed and their surrounding communities, the availability of quality data, and the goals of the restoration effort. Measuring the same indicators on all waters allows for systematic, even-handed and information-based comparison. Calculating separate ecological, stressor, and social indices enables the user to consider each of these three classes of factors, individually or in combination. The ecological index score reflects overall condition and the capacity of the watershed to regain functionality, based on metrics related to natural watershed processes and structure. The stressor score reflects the pressures on watershed condition from several primary sources of pollutants and water quality impairments. The social context score includes many factors, such as community involvement, incentives, economics, governance, regulation and planning status that do not constitute watershed condition but often strongly influence the level of effort and complexity of making improvements. A Recovery Potential Integrated (RPI) score is calculated by

combining these three indices. For more information on the Recovery Potential Screening process visit EPA's website: (http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/recovery/index.cfm)

8.3.1 PPIAs for *E. coli*, phosphorus, and sediment

Table 58 ranks subwatersheds in the Upper Mississinewa River Watershed according to *E. coli*, phosphorus, and sediment load reduction needed to achieve water quality standards, from highest pollutant load reduction to least pollutant load reduction, with the associated flow regime (e.g., very high, higher, normal, lower, low).

Table 57. PPIA Ranking for Subwatersheds in the Upper Mississinewa River Watershed

PPIA Ranking	Subwatershed	RPI Score	Ecological Rank	Stressor Rank	Social Rank
1	Campbell Creek	6.74	8	2	1
2	Studebaker Ditch	5.85	10	1	8
3	Bear Creek	3.42	11	3	11
4	Rees Ditch	2.96	1	6	2
5	Days Creek	2.81	12	4	12
6	Bush Creek	2.72	6	5	7
7	Townsand Lucas Ditch	2.36	4	7	9
8	Fetid Creek	2.28	5	8	6
9	Holden Ditch	2.10	2	11	5
10	Redkey Run	2.03	9	9	4
11	Platt Nibarger Ditch	1.93	3	12	3
12	Little Lick Creek	1.85	7	10	10

Understanding Table 58: According to this table, Campbell Creek has the highest PPIA ranking under Normal flow conditions with a 82 percent, 44 percent, and 70 percent load reduction needed for *E. coli*, nutrient, and sediment respectively. Implementation activities for the highest ranked PPIAs in Table 58 should focus on wet weather sources as the critical conditions in this subwatershed tend to center on wet weather flows.

Table 58. Indicators Used in the Recovery Potential Calculator

Ecological Indicator	Stressor Indicator	Social Indicator
Percent Forested Land Watershed Surface Area QHEI Substrate Score Fish IBI Score Total QHEI Score Stream Order (%2-4) QHEI Score QHEI Channel Morphology Drainage area	Percent Agricultural Land Number of Impairment Parameters Number of CFOs # of MS4s Percent Stream Miles Impaired Percent Urban Land Number of CSOs	Percent Managed Lands Population Density Percent of Crop in Reduced Tillage Percent Drinking Water Source Protection Area Jurisdictional Complexity Number of Ecological Attributes Watershed Income Level

This information is important for watershed organizations in the process of identifying and selecting critical areas and implementation activities for the purposes of watershed management plan development.

While PPIAs are not intended to dictate those critical areas for watershed organizations, IDEM recommends that watershed organizations take the PPIA rankings into consideration when selecting critical areas for purposes of watershed management planning.

Section 9 identifies recommended implementation activities for each subwatershed and shows the associated PPIA rankings. This information can be key to watershed organizations in the process of identifying and selecting critical areas and implementation activities for the purposes of watershed management plan development.

9.0 REASONABLE ASSURANCES/IMPLEMENTATION

This section of the Upper Mississinewa River Watershed TMDL focuses on implementation activities that have the potential to achieve the WLAs and LAs presented in Section 8.4.1. The focus of this section is to identify and select the most appropriate structural and non-structural best management practices (BMPs) and control technologies to reduce *E. coli,* nutrient, and sediment loads from sources throughout the Upper Mississinewa River Watershed, particularly in the PPIAs identified in Section 7.3. 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 Upper Mississinewa River 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 Upper Mississinewa River watershed.

Point Sources

- WWTPs
- Industrial facilities
- CSOs
- Regulated storm water sources
- Illicitly connected straight pipe systems

Nonpoint Sources

- Cropland
- Pastures and livestock operations
- CFOs and AFOs
- Streambank erosion
- Onsite wastewater treatment systems
- Wildlife/domestic pets
- Urban nonpoint source runoff

9.1 Implementation Activity Options for Sources in the Upper Mississinewa River Watershed

Keeping the list of significant sources in the Upper Mississinewa River Watershed in mind, it is possible to review the types of BMPs that are most appropriate for the *E. coli*, nutrient, and sediment and the source type. Table 60 provides a list of implementation activities that are potentially suitable for the Upper Mississinewa River watershed based on the *E. coli*, nutrient, and sediment and the types of sources. 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 60 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 other locations where sources contribute indirectly to the water quality impairment.

Table 59. List of Potentially Suitable BMPs for the Upper Mississinewa River Watershed

Implementation Activities	Pollutant			Point Sources					Nonpoint Sources						
	Bacteria	Nutrients	Sediment	WWTPs and Industrial Facilities	CSOs	Regulated Stormwater Sources	CAFOs	Illicitly Connected "Straight Pipe" Systems	Cropland	Pastures and Livestock Operations	CFOs	Streambank Erosion	Onsite Wastewater Treatment Systems	Wildlife/Domestic Pets	Urban NPS Runoff
Inspection and maintenance	X	X	X	X	X	X	X						X		
Outreach and education and training	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
System replacement	X	X			X			X					X		
Conservation tillage/residue management	X	X	X						X						
Cover crops	X	X	X						X			X			
Filter strips	X	X	X			X	X		X	X	X	X			X
Grassed waterways	X		X				X		X		X	X			
Riparian forested/herbaceous buffers	X	X	X				X		X	X	X	X		X	X
Manure handling, storage, treatment, and disposal	X	X					X			X	X				
Composting	X	X				X									X
Alternative watering systems	X		X							X		X			
Stream fencing (animal exclusion)	X	X	X							X		X			
Prescribed grazing	X	X	X							X		X			
Conservation easements	X	X	X			X			X	X					X
Two-stage ditches		X	X			X			X			X			X
Rain barrel		X	X			X						X			X
Rain garden		X	X		X	X						X			X
Street rain garden		X	X		X	X						X			X
Block bioretention		X	X		X	X						X			X
Regional bioretention		X	X		X	X						X			X
Porous pavement		X	X		X	X						X			X
Green alley		X	X		X	X						X			X
Green roof		X	X		X	X						X			X
Dam modification or removal		X	X									X			
Levee or dike modification or removal		X	X												
Stormwater planning and management	X	X	X	X	X	X						X	X	X	X
Comprehensive Nutrient Management Plan	X	X							X		X				
Constructed Wetland	X	X	X	X	X	X		X	X			X		X	X
Critical Area Planting			X							X		X			
Drainage Water Management		X							X			X			
Heavy Use Area Pad	X		X							X					
Nutrient Management Plan		X							X	X		X			
Terrace			X						X						

Implementation Activities	Pollutant			Point Sources					Nonpoint Sources						
	Bacteria	Nutrients	Sediment	WWTPs and Industrial Facilities	CSOs	Regulated Stormwater Sources	CAFOs	Illicitly Connected "Straight Pipe" Systems	Cropland	Pastures and Livestock Operations	CFOs	Streambank Erosion	Onsite Wastewater Treatment Systems	Wildlife/Domestic Pets	Urban NPS Runoff
Land Reconstruction of Mined Land			X									X			
Sediment Basin		X	X			X									X
Pasture and Hay Planting	X	X	X						X	X	X	X		X	
Streambank and Shoreline Protection			X						X	X	X	X		X	X
Conservation Crop Rotation		X	X						X						
Field Border	X	X							X	X	X			X	
Waste Treatment Lagoon	X	X					X			X	X				

The information provided in Table 60 assisted in the development of Table 61, which provides a more refined suite of recommended implementation activities targeted to the PPIAs identified in Section 8.3.

Watershed stakeholders can use the implementation activities identified in Table 61 for each PPIA and select activities that are most feasible in the Upper Mississinewa River watershed. This table can also help watershed stakeholders to identify implementation activities for critical areas that they select through the watershed management planning process.

Table 60. Recommended Implementation Activities by Subwatershed

Subwatershed	PPIA Rank	Implementation Action
Campbell Creek	1	Outreach and education and training Stormwater Planning and Management Conservation tillage/residue management Cover crops Two Stage Ditch Conservation easements Grazing land management Comprehensive Nutrient Management Plan Drainage Water Management Stream fencing (animal exclusion) Manure handling, storage, treatment, and disposal Riparian buffers Filter strips Rain gardens Green roof Constructed Wetlands
Studebaker Ditch	2	
Bear Creek	3	
Rees Ditch	4	
Days Creek	5	
Bush Creek	6	
Townsand Lucas Ditch	7	
Fetid Creek	8	
Holden Ditch	9	
Redkey Run	10	
Platt Nibarger Ditch	11	
Little Lick Creek	12	

9.2 Implementation Goals and Indicators

For each *E. coli*, phosphorus, and sediment in the Upper Mississinewa River watershed, IDEM has identified broad goal statements and indicators. This information is to help watershed stakeholders determine how to track implementation progress over time and also provides the information necessary to complete a watershed management plan.

***E. coli* Goal Statement:** The waterbodies (or streams) in the Upper Mississinewa River 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.

Total Phosphorus Goal Statement: The waterbodies (or streams) in the Upper Mississinewa River watershed should meet the 0.30 mg/L TMDL total phosphorus target value.

Total Phosphorus Indicator: Water quality monitoring by IDEM will serve as the environmental indicator to determine progress toward the total phosphorus target value.

Total Suspended Solids Goal Statement: The waterbodies (or streams) in the Upper Mississinewa River watershed should meet the 30 mg/L TMDL total suspended solids target value.

Total Suspended Solids Indicator: Water quality monitoring by IDEM will serve as the environmental indicator to determine progress toward the total suspended solids target value.

9.3 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 Upper Mississinewa River watershed in Table 60 and Table 61. 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 Upper Mississinewa River watershed.

9.3.1 Federal Programs

9.3.1.1 Clean Water Act Section 319(h) Grants

Section 319 of the federal Clean Water Act contains provisions for the control of nonpoint source pollution. The Section 319 program provides 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 NPS pollution. The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the Office of Water Quality administers the Section 319 program for the NPS-related projects.

USEPA offers Clean Water Act Section 319(h) grant monies to the state on an annual basis. These grants must be used to fund projects that address nonpoint source pollution issues. Some projects which the Office of Water Quality has funded with this money in the past include developing and implementing Watershed Management Plans (WMPs), BMP demonstrations, data management, educational programs, modeling, stream restoration, and riparian buffer establishment. Projects are usually two to three years in length. Section 319(h) grants are intended to be used for project start-up, not as a continuous funding source. Units of government, nonprofit groups, and universities in the state that have expertise in

nonpoint source pollution problems are invited to submit Section 319(h) proposals to the Office of Water Quality.

9.3.1.2 Clean Water Action Section 205(j) Grants

Section 205(j) provides for planning activities relating to the improvement of water quality from nonpoint and point sources by making funding available to municipal and county governments, regional planning commissions, and other public organizations. For-profit entities, non-profit organizations, private associations, universities and individuals are not eligible for funding through Section 205(j). The CWA states that the grants are to be used for water quality management and planning, including, but not limited to:

- Identifying most cost effective and locally acceptable facility and non-point source measures to meet and maintain water quality 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.

9.3.1.3 USDA's Conservation Technical Assistance (CTA)

The purpose of the CTA program is to assist landusers, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. The purpose of the conservation systems is to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands.

One objective of the program is to assist individual landusers, communities, conservation districts, and other units of State and local government and Federal agencies to meet their goals for resource stewardship and assist individuals in complying with State and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the Memorandum of Understanding signed by the Secretary of Agriculture, the Governor of the State, and the conservation district. Assistance is provided to landusers voluntarily applying conservation practices and to those who must comply with local or State laws and regulations.

Another objective is to provide assistance to agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.), the Federal Agriculture Improvement and Reform Act of 1996, and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps landusers develop and implement conservation plans to comply with the law. The program also provides technical assistance to participants in USDA cost-share and conservation incentive programs.

NRCS collects, analyzes, interprets, displays, and disseminates information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. They also develop effective science-based technologies for natural resource assessment, management, and conservation.

There are many programs within the USDA NRCS that assist with water conservation. The 2014 Farm Bill has streamlined many of these programs to further enable farmers, ranchers, and forest landowners to get assistance. These programs include:

- Environmental Quality Incentives Program
- Conservations Stewardship Program
- Agricultural Management Assistance
- Agricultural Water Enhancement Program
- Cooperative Conservation Partnership Program
- Conservation Innovation Grants
- Emergency Watershed Protection Program
- Wildlife Habitat Incentive Program
- Conservation Technical Assistance
- Conservation of Private Grazing Land
- Farm and Ranch Lands protection program
- Agricultural Conservations Easement Program
- Grassland Reserve Program
- Healthy Forest Reserve program
- Wetlands Reserve Program
- Regional Conservation Partnership Program

9.3.2 State Programs

9.3.2.1 State Point Source Control

The State's Point Source Control, administered by the IDEM office of Water Quality's Permitting section is charges with fulfillment of the Clean Water Act through the NPDES permit 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, MS4s, and CSOs consistent with WLAs is implemented through the NPDES program. The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

9.3.2.2 State Nonpoint Source Control Program

The State's Nonpoint Source Program, administered by the IDEM Office of Water Quality's Watershed Planning and Restoration Section, focuses on the assessment and prevention of nonpoint source water pollution. The program also provides for education and outreach to improve the way land is managed. Through the use of federal funding for the installation of BMPs, the development of watershed management plans, and the implementation of watershed restoration pollution prevention activities, the program reaches out to citizens so that land is managed in such a way that less pollution is generated.

Nonpoint source projects funded through the Office of Water Quality are a combination of local, regional, and statewide efforts sponsored by various public and not-for-profit organizations. The emphasis of these projects has been on the local, voluntary implementation of nonpoint source water pollution controls. The

Watershed Planning and Restoration Section administers the Section 319 funding for nonpoint source-related projects, as well as Section 205(j) grants.

To award 319 grants, Watershed Planning and Restoration Section staff review proposals for minimum 319(h) eligibility criteria and rank each proposal. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; strength of local partnerships; and competence/reliability of contracting agency. They then convene to discuss individual project merits and pool all rankings to arrive at final rankings for the projects. All proposals that rank above the funding target are included in the annual grant application to USEPA, with USEPA reserving the right to make final changes to the list. Actual funding depends on approval from USEPA and yearly congressional appropriations.

Section 205(j) projects are administered through grant agreements that define the tasks, schedule, and budget for the project. IDEM project managers work closely with the project sponsors to help ensure that the project runs smoothly and the tasks of the grant agreement are fulfilled. Site visits are conducted at least quarterly to touch base on the project, provide guidance and technical assistance as needed, and to work with the grantee on any issues that arise to ensure a successful project closeout.

9.3.2.3 Indiana State Department of Agriculture (ISDA) 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 by increasing agricultural economic benefits by assisting Indiana's farmers in the application of advanced agronomic technologies while improving upon Indiana's soil health and water quality.

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, assisting in the selection, design, and installation of practices to reduce soil erosion on agricultural land. District Support Specialists work cooperatively with soil and water conservation districts and other conservations partners in the design of programs that reach land users, the general public, governmental officials, and primary and secondary educational institutions on the husbandry and management of soil and water resources. The Storm water and Sediment Control Program works primarily with developers, contractors, realtors, property holders and others to address erosion and sediment concerns on non-agricultural lands, especially those undergoing development.

9.3.2.4 Indiana Conservation Partnership

The Partnership is comprised of eight Indiana agencies and organizations who share a common goal of promoting conservation. To that end, the mission of the Indiana Conservation Partnership is to provide technical, financial and educational assistance needed to implement economically and environmentally compatible land and water stewardship decisions, practices and technologies. 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.

9.3.2.5 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.

9.3.2.6 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. These projects include septic education and mainline hookups. The Program's mission is to provide eligible entities with the lowest interest rates possible on the financing of such projects while protecting public health and the environment. SRF also funds non-point source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

9.3.2.7 Hoosier Riverwatch

Hoosier Riverwatch, administered by the IDEM OWQ Watershed Assessment and Planning Branch,is a water quality monitoring initiative which aims to increase public awareness of water quality issues and concerns through hands-on training of volunteers in-stream monitoring and cleanup activities. Hoosier Riverwatch collaborates with agencies and volunteers to educate local communities about the relationship between land use and water quality and to provide water quality information to citizens and governmental agencies working to protect Indiana's rivers and streams.

9.3.3 Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Local Partners such as Muncie Bureau of Water Quality, Taylor University, Ball State University, and participating county soil and water conservation districts are instrumental to bringing grant funding into the Upper Mississinewa River watershed to support local protection and restoration projects. This section provides a brief summary of the local programs taking place in the Upper Mississinewa River watershed that will help to reduce *E. coli*, nutrient, and sediment loads, as well as provides ancillary benefits to the Upper Mississinewa River watershed.

Blackford County
Blackford County received the following funding to improve water quality in 2014:
Local: $25,149
CWI: $10,000
CRP/CREP: $110,997
EQUIP: $7,145
Total: $153,291
Delaware County
Delaware County received the following funding to improve water quality in 2014:
Local: $5,352
CWI: $10,000
CRP/CREP: $259,196
EQUIP: $16,660
Total: $291,208

Grant County
Grant County received the following funding to improve water quality in 2014:
Local: $20,000
CWI: $10,0000
CRP/CREP: $376,853
EQUIP: $14,066
Total: $420,919

Jay County
Jay County received the following funding to improve water quality in 2014:
Local: $20,000
CWI: $85,000
CRP/CREP: $652,486
EQUIP: $373,578
Total: $1,155,552

Randolph County
Randolph County received the following funding to improve water quality in 2014:
Local: $39,861
CWI: $10,000
CRP/CREP: $578,234
EQUIP: $164,908
GRP: $1,668
Total: $824,707

9.3.4 Local Watershed Group

The Delaware County SWCD received $187,750.00 from IDEM through a Section 205(J) grant to produce a WMP for the Upper Mississinewa River watershed, HUCs 0512010302, 0512010303, and 0512010304. The WMP will meet both IDEM checklist and EPA guidelines. The group will also develop a Quality Assurance Project Plan for monitoring in the adjacent upstream and downstream HUC's (0512010301, 0512010305). Baseline characteristics for core parameters were sampled at 10 pour point sites in the aforementioned HUC's for the creation of the WMP. This data was not used in the calculation of LDC's or for assessment purposes. An education and outreach program will also be created to increase awareness in watershed problems. This will include stakeholder meetings and a newsletter informing on project progress, conduct educational events and workshops to educate stakeholders on BMPs that reduce pollutant loading form urban and/or agricultural areas, and a social indicator survey to gauge community understand and interest in water quality.

Steering Committee

Delaware County SWCD
Grant County SWCD
Randolph County SWCD
Blackford County SWCD
Jay County SWCD
Darke County SWCD (Ohio)
Delaware County Department of GIS
Delaware Muncie Metropolitan Planning Commission
Purdue Extension
Indiana Trust
Muncie Bureau of Water Quality
Taylor University
Ball State Department of Natural Resources and Environmental Science/ Department of Geology

9.4 Implementation Programs by Source

Section 9.3 identified a number of federal, state, and local programs that can support implementation of the recommended management or restoration activities for the Upper Mississinewa River watershed. **Error! Reference source not found.** 61 and the following sections identify which programs are relevant to the various sources in the Upper Mississinewa River watershed.

Table 61. Summary of Programs Relevant to Sources in the Upper Mississinewa River Watershed

Source	State NPDES program	Local agencies/programs	Section 319 program	Section 205(j) program	ISDA Division of Soil Conservation	IDNR Division of Fish and Wildlife	USDA's Conservation of Private Grazing Land Initiative	USDA's Conservation Reserve Program	USDA's Conservation Technical Assistance	USDA's Environmental Quality Incentives Program	USDA's Small Watershed Program and Flood Prevention Program	USDA's Watershed Surveys and Planning	USDA's Wetlands Reserve Program	USDA's Wildlife Habitat Incentives Program
WWTPs and Industrial Facilities	X			X										
CSOs	X			X										
Regulated Stormwater Sources	X			X										
CAFOs	X			X										
Illicitly Connected "Straight Pipe" Systems	X	X		X										
Cropland		X	X	X	X	X		X	X	X	X	X	X	X
Pastures and Livestock Operations		X	X	X	X	X	X	X	X	X	X	X		
CFOs	X			X										
Streambank Erosion		X	X	X	X	X	X		X	X	X	X		
Onsite Wastewater Treatment Systems		X		X										
Wildlife/Domestic Pets	X	X	X											
In-stream Habitat	X	X	X											X

9.4.1 Point Source Programs

9.4.1.1 WWTPs

Discharges from WWTPs are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

9.4.1.2 Industrial facilities

As with discharges from WWTPs, industrial discharges are regulated under the NPDES program, with permits that authorize the discharge of substances at levels that meet the more stringent of technology- or water quality-based effluent limits. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

9.4.1.3 CSOs

IDEM regulates CSOs in Indiana through the state's NPDES program. As discussed in Section 3.0, all CSOs in the state have in place LTCPs. Enforcement mechanisms for LTCPs and their implementation schedules include associated NPDES permits and state consent decrees.

Ridgeville WWTP LTCP runs through 2018. The LTCP states treatment capacity would be upgraded to include 100,000 gallons of additional waste water and CSO treatment. By 2016 two CSO outfalls are scheduled to be removed from operation and by 2018 broken sewer pipes, risers and manholes are to be replaced. Redkey WWTP LTCP runs through 2030 and includes removal of illicit connections, upgrading WWTP capacity, and a two phase CSO improvement project. The Hartford City LCTP runs through 2027 and plans to update the facility to handle flows generated by a 1-year/1-hour storm event. Separation of sanitary and storm sewers is stated as a goal in the plan. Eaton WWTP LTCP runs through 2030 and plans to update the facility to handle flows generated by a 1-year/1-hour storm event. The plan includes construction of a wet weather treatment facility. Completion of these projects should result in a significant elimination to CSO events in the watershed.

9.4.1.4 Regulated storm water sources

Regulated MS4s are required to obtain permit covered under IDEM's MS4 general permit that requires a storm water management program (SWMP) to address six minimum control measures. There is one MS4 in the Upper Mississinewa River watershed that has coverage under IDEM's MS4 general permit. The SWMPs for this MS4 describes best management practices implemented to fulfill the six minimum control measure requirements.

9.4.1.5 CAFOs

CAFOs are point sources regulated through the NPDES Program. Indiana regulations for CAFOs can be found in 327 IAC 15-15 and federal regulations for all CAFOs can be found in 40 CFR Parts 9, 122, and 412. The Effluent Limitations Guidelines and New Source Performance Standards for CAFOs require, in general, zero discharge from these areas and require proper design, construction, operation, and maintenance of the structures to contain all manure, litter, and process wastewater including the runoff and direct precipitation from a 25-year, 24-hour rainfall event. The NPDES general permit also requires that water quality standards shall not be exceeded in the event of an overflow from production areas.

Examples of requirements for CAFO operators include

- weekly inspections of their waste storage facilities
- develop a Soil Conservation Practice Plan for all manure application sites controlled by the CAFO
- develop a Storm Water Pollution Prevention Plan for the area immediately around the production barns
- submit an annual report to IDEM
- adjust land application rates based on nitrogen and phosphorus

9.4.1.6 Illegal straight pipes

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

9.4.2 Nonpoint Sources Programs

9.4.2.1 Cropland

Nonpoint source pollution from cropland areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of cropland BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- Clean Water Indiana
- USDA's Conservation Reserve Program (CRP)
- USDA Conservation Reserve Enhancement Program (CREP)
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Watershed and Flood Prevention Program (WFPO)
- USDA's Watershed Surveys and Planning
- USDA's Agricultural Conservation Easement Program (ACEP)

9.4.2.2 Pastures and livestock operations

Nonpoint source pollution from pasture and livestock areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of pasture and grazing BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs
- USDA's Conservation of Private Grazing Land Initiative (CPGL)
- USDA's Conservation Reserve Program (CRP)
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA's Watershed Surveys and Planning
- USDA's Wildlife Habitat Incentives Program (WHIP)

9.4.2.3 CFOs

While CAFOs are regulated by federal law, CFOs are not. However, Indiana has CFO regulations 327 IAC 16, 327 IAC 15 that require that operations manage manure, litter, and process wastewater in a manner that "does not cause or contribute to an impairment of surface waters of the state." IDEM regulates CFOs under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 16, which

implement the statute regulating CFOs, were effective on March 10, 2002. IDEM's Office of Land Quality administers the regulatory program, which includes permitting, compliance monitoring and enforcement activities.

9.4.2.4 Streambank erosion

Streambank erosion can be the result of changes in the physical structure of the immediate bank from activities such as removal of riparian vegetation or frequent use by livestock, or it can be the result of increased flow volumes and velocities resulting from increased surface runoff throughout the upstream watershed. Therefore, streambank erosion might be addressed through BMPs and restoration targeted to the specific stream reach, and further degradation could be addressed through the use of BMPs implemented to address storm water issues throughout the watershed. Programs available to support implementation of BMPs to address streambank erosion, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319 program
- Indiana Department of Natural Resources Lake and River Enhancement Program (LARE)
- USDA's Conservation Technical Assistance (CTA)
- USDA's Environmental Quality Incentives Program (EQIP)
- USDA's Small Watershed Program and Flood Prevention Program (WF 08 or FP 03)
- USDA's Watershed Surveys and Planning
- USDA's Wildlife Habitat Incentives Program (WHIP)
- Mitigation Funds

9.4.2.5 Onsite wastewater treatment systems

Indiana State Department of Health (ISDH) Rule 410 IAC 6-8.1 outlines regulations for septic systems, including a series of regulatory constraints on the location and design of current septic systems in an effort to prevent system failures. The rule prohibits failing systems, requiring that:

- No system will contaminate ground water.
- No system will discharge untreated effluent to the surface.

9.4.2.6 Wildlife/domestic pets

Addressing pollutant contributions from wildlife and domestic pets is typically done at the local level through education and outreach efforts. For wildlife, educational programs focus on proper maintenance of riparian areas and discouraging the public from feeding wildlife. For domestic pets, education programs focus on responsible pet waste maintenance (e.g., scoop the poop campaigns) coupled with local ordinances.

9.5 Potential 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 63 identifies key potential implementation partners and the type of technical assistance they can provide to watershed stakeholders.

Table 62. Potential Implementation Partners in the Upper Mississinewa River 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	Agricultural Conservation Easement Program
USDA	Wildlife Habitat Incentives Program
State	
ISDA	Division of Soil Conservation soil and water conservation districts
IDNR	Division of Fish and Wildlife Lake and River Enhancement program
IDEM	Section 319 program grants
IDEM	Section 205(j) program grants

IDEM has compiled a matrix of public and private grants and other funding resources available to fund watershed implementation activities. The matrix is available on IDEM's website at http://www.in.gov/idem/nps/3439.htm .

10.0 PUBLIC PARTICIPATION

Public participation is an important and required component of the TMDL development process. The following public meetings were held in the watershed to discuss this project:

- Two kickoff meetings were held on March, 13 2014 during which IDEM and a representative from the Delaware County Soil and Water Conservation District described the watershed project in which a TMDL document will be developed and provided a summary of the available data and the proposed modeling approach. The meetings occurred at the Davis-Purdue Agricultural Center in Farmland, Indiana and the Hartford City Annex Building in Hartford City, Indiana.
- Draft TMDL public meetings will be held in the watershed at the Davis-Purdue Agricultural Center in Farmland, Indiana and the Hartford City Annex Building in Hartford City, Indiana on September 8th, 2016. The draft findings of the TMDL were presented at these meetings and the public will have the opportunity ask questions and provide information to be included in the final TMDL report. A public comment period was from [date-date].

APPENDIX A. WATER QUALITY DATA FOR THE UPPER MISSISSINEWA RIVER WATERSHED TMDL

APPENDIX B. LOAD DURATION CURVES AND PRECIPITATION GRAPHS FOR THE UPPER MISSISSINEWA RIVER WATERSHED TMDL

APPENDIX C. TRENDS IN PCB CONCENTRATIONS IN THE MISSISSINEWA RIVER WATERSHED FROM 1984 TO 2013

APPENDIX D. 2014 SAMPLING AND ANALYSIS WORKPLAN FOR BASELINE MONITORING OF THE UPPER MISSISSINEWA RIVER WATERSHED.

APPENDIX E. SOURCES