Office of Water Quality
Total Maximum Daily Load Program

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Total Maximum Daily Load for *Escherichia coli* (*E. coli*) in the Upper White River Headwaters Watershed in Randolph, Delaware, and Henry Counties

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Total Maximum Daily Load (TMDL) for *Escherichia coli* (*E. coli*) in Upper White River Headwaters watershed, Randolph, Delaware, and Henry Counties, Indiana

Introduction

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of these TMDLs are to identify the sources and determine the allowable levels of *E. coli* bacteria that will result in the attainment of the applicable WQS for *E. coli* in the Upper White River Headwaters watershed in Randolph, Delaware, and Henry Counties in Indiana.

Background

In 2002, the mainstem of the Upper White River Headwaters watershed (Figure 2) flowing through this entire 10-digit watershed was listed on Indiana's 303(d) list as impaired for *E. coli*. A reassessment of the reaches within the Upper White River Headwaters watershed, using data collected during the 2001 and 2006 sampling seasons, was completed by IDEM during the development of the Upper White River Headwaters TMDLs. This reassessment indicated that additional assessment units of the Upper White River Headwaters watershed were impaired for *E. coli*.

Recently IDEM began using the high resolution National Hydrography Dataset (NHD) created by USGS. Previously IDEM could only view streams at medium resolution (1:100,000 scale). The high-resolution streams are at the 1:24,000 scale, which allows for a more detailed view of the watershed. These high-resolution waters have always been present; however, they have not been visible in electronic maps until now. The reassessment of the Upper White River Headwaters watershed was completed with regard to both medium and high resolution streams.

This TMDL will address approximately three-hundred ten (310) stream miles, of which approximately sixty-nine (69) stream miles are impaired in the Upper White River Headwaters watershed in Randolph, Delaware, and Henry Counties where recreational uses are impaired by elevated levels of *E. coli* during the recreational season. The Upper White River Headwaters watershed is part of the larger Upper White River basin with the eight digit Hydrologic Unit Code (HUC) 05120201. The Upper White River Headwaters watershed is in eastern Indiana (Figure 1). Figure 2 depicts all the waters in the watershed. The red segments are impaired and the blue segments are the remaining unimpaired or non-assessed portion of the watershed. The impaired portion of the Upper White River Headwaters listed in Table 1 will be placed into Category 4A on the Indiana's 303(d) List of Impaired Waters in 2012. The nineteen (19) impaired assessment units (Table 1) for this TMDL are located in the Upper White River Headwaters basin hydrologic unit code 0512020101.

Table 1: Impaired Assessment Units in the Upper White River Headwaters Watershed

Assessment Unit Name	2008 AUID*	2012 AUID*	Impairment	Miles	12-Digit HUC	Sample Site
West Fork White River	INW0111_T1001	INW0111_01	*E. coli*	23.45	051202010101	1, 2, 3, 4, 5, 6
	INW0111_T1222					
Owl Creek	INW0111_T1221	INW0111_02	*E. coli*	6.48		7, 8
Unnamed Tributary	INW0112_00	INW0112_T1003	*E. coli*	3.28	051202010102	12
Peach Creek		INW0112_T1004	*E. coli*	7.37		13
West Fork White River	INW0112_T1002	INW0112_01	*E. coli*	11.95		9, 10, 11, 14, 15
Salt Creek	INW0113_00	INW0112_T1005	*E. coli*	13.74		16, 17, 18
Sugar Creek		INW0112_T1006	*E. coli*	7.72		19, 20
West Fork White River	INW0114_T1004	INW0113_01	*E. coli*	12.36	051202010103	21, 22
Eightmile Creek	INW0114_00	INW0113_T1004	*E. coli*	4.92		23
Cabin Creek	INW0116_00	INW0114_01	*E. coli*	33.01	051202010104	29, 30, 31
West Fork White River	INW0115_T1005	INW0115_01	*E. coli*	8.01	051202010105	24, 27, 28
West Fork White River	INW0115_00	INW0115_T1006	*E. coli*	7.16		25, 26
Little White River	INW0118_00	INW0116_01	*E. coli*	36.13	051202010106	33, 35
Poplar Run		INW0116_T1001	*E. coli*	6.54		34
Stoney Creek	INW0117_00	INW0117_01	*E. coli*	32.50	051202010107	36, 39, 40
Little Stoney Creek		INW0117_T1001	*E. coli*	9.77		37, 38, 42, 43
West Fork White River	INW0119_T1006	INW0119_01	*E. coli*	19.15	051202010109	32, 41, 44, 45, 46
Mud Creek	INW011A_00	INW0119_T1008	*E. coli*	5.17		47
West Fork White River	INW011C_T1008	INW011A_01	*E. coli*	12.46	051202010110	51, 52
Medford Drain	INW011C_00	INW011A_T1008	*E. coli*	3.67		50

West Fork White River	INW011D_T1009	INW011B_01	*E. coli*	3.28		53, 54
Muncie Creek	INW011D_00	INW011B_T1001	*E. coli*	7.03	051202010111	55, 56

*AUID: Assessment Unit ID

IDEM conducted a sampling survey of the Upper White River Headwaters watershed for *E. coli* in 2001 and 2006. Sites sampled in 2001 were sampled April 23, 2001 through May 21, 2001 and June 5, 2001 through July 3, 2001. Sites sampled in 2006 were sampled April 10, 2006 through May 8, 2006 and July 17, 2006 through August 18, 2006 (Figure 3; Attachments A & B). All sites were sampled five (5) times, spaced over a thirty (30) day period to determine a geometric mean.

Water quality data collected in the Upper White River Headwaters watershed during the 2001 and 2006 sampling period were reassessed by IDEM's 303(d)/305(b) Coordinator in June 2011 (Attachment C). Of the forty-six (46) sites sampled in 2006, five (5) sites (sites 10, 17, 24, 48, and 49), did not violate the geometric mean for *E. coli*. All other sites sampled violated the *E. coli* geometric mean of 125 MPN (Most Probable Number)/100 mL. Of the forty-six (46) sites sampled in 2006, four (4) sites, (sites 10, 17, 24, and 48) did not violate the single sample maximum. At these forty-two (42) sites, the single sample maximum of 235 MPN/ 100 mL is violated 62.55% of the time. Thirteen (13) sites were sampled in 2001. Sites were sampled April 23, 2001 through May 21, 2001 and June 5, 2001 through July 3, 2001. These sites were sampled as part of the 2001 *E. coli* Upper West Fork White River project. All thirteen (13) sites violate the geometric mean. All sites have violations of the single sample maximum, which is violated 82.43% of the time in 2001.

Two sites are also sampled are part of the IDEM Fixed Station Program. Site 15 was sampled monthly January 8, 1991 through February 3, 1999. The single sample maximum was violated 67.82% of the time during this time period. Site 52 was sampled monthly January 8, 1991 through November 16, 2010. The single sample maximum was violated 36.04% of the time during this time period (Attachment B).

The TMDL development schedule corresponds with IDEM's basin-rotation water quality monitoring schedule. To take advantage of all available resources for TMDL development, impaired waters are scheduled according to the basin-rotation schedule unless there is a significant reason to deviate from this schedule. Waterbodies can be scheduled based on the following:

1) Waterbodies may be given a high or low priority for TMDL development depending on the specific designated uses that are not being met, or in relation to the magnitude of the impairment.

2) TMDL development of waterbodies where other interested parties, such as local watershed groups, are working on alleviating the water quality problem may be delayed to give these other actions time to have a positive impact on the waterbody. If water quality standards still are not met, then the TMDL process will be initiated.

3) TMDLs that are required due to water quality violations relating to pollutant parameters where no EPA guidance is available, may be delayed to give EPA time to develop guidance.

This TMDL was scheduled based on the data available from the basin-rotation schedule, which represents the most accurate and current information available on water quality within waterbodies covered by this TMDL.

Water Quality Standards and Numeric Targets

The impaired designated use for the waterbodies in the Upper White River Headwaters watershed is for total body contact recreational use during the recreational season, April 1 through October 31. The WQS for *E. coli* is 125 per one hundred milliliters as a 30-day geometric mean based on not less than five samples equally spaced over a thirty-day period. High concentrations of *E. coli* may limit the use of the water body for recreation; *E. coli* is an indicator species of fecal contamination, which may contain other microorganisms that are harmful to human health.

327 IAC 2-1-6(d) (3) establishes the full body contact recreational use *E. coli* WQS for all waters in the non-Great Lakes system as follows:

> (3) For full body contact recreational uses, *E. coli* bacteria shall not exceed the following:
>
> > (A) 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.
> >
> > (B) Two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period, except that in cases where there are at least ten (10) samples at a given site, up to ten percent (10%) of the samples may exceed two hundred thirty-five (235) cfu or MPN per one hundred (100) milliliters where the:
> >
> > > (i) *E. coli* exceedances are incidental and attributable solely to *E. coli* resulting from the discharge of treated wastewater from a wastewater treatment plant as defined at IC 13-11-2-258; and
> > >
> > > (ii) criterion in clause (A) is met. However, a single sample shall be used for making beach notification and closure decisions. If a geometric mean cannot be calculated because five (5) equally spaced samples are not available, then the criterion stated in clause (B) must be met.

The sanitary wastewater *E. coli* effluent limits from point sources in the non-Great Lakes system during the recreational season, April 1 through October 31, are also covered under 327 IAC 2-1-6(d)(4) and 327 IAC 2-1-6(d)(5).

> (4) For demonstrating compliance with wastewater treatment requirements, sanitary wastewater dischargers shall ensure the following:
>
> > (A) The concentration of *E. coli* in the undiluted discharge does not exceed one hundred twenty-five (125) cfu or MPN per one hundred (100) milliliters as a geometric mean of the effluent samples taken in a calendar month.
> >
> > (B) Not more than ten percent (10%) of all samples when not less than ten (10) samples are taken and analyzed for *E. coli* in a calendar month exceed two hundred thirty-five (235) cfu or MPN per one hundred (100) milliliters as a daily maximum. Under this clause, the calculation of ten percent (10%) of the samples taken shall be limited to the lowest whole number result.
>
> (5) Effluent limits to implement the criteria in subdivision (3) during the recreational season shall be established in NPDES permits by incorporating the following that are to be applied to the undiluted discharge:

(A) The concentration of *E. coli* in the undiluted discharge shall not exceed one hundred twenty-five (125) cfu or MPN per one hundred (100) milliliters as a geometric mean of the effluent samples taken in a calendar month.
(B) Not more than ten percent (10%) of all samples in a calendar month exceed two hundred thirty-five (235) cfu or MPN per one hundred (100) milliliters as a daily maximum. Under this clause, the calculation of ten percent (10%) of the samples taken shall be limited to the lowest whole number result.

Source Assessment

Watershed Characterization

Waters in the Upper White River Headwaters watershed flow through three (3) Indiana Counties. The majority of the watershed is located in Randolph County (65.47%); 30.16% of the watershed is in Delaware County and 4.37% of the watershed is in Henry County (Figure 1). The White River is also a known source of drinking water.

Land Use

Land use information was assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 89.56% of the land use in the Upper White River Headwaters watershed was Agriculture. The remaining land use for the Upper White River Headwaters watershed consisted of approximately 5.74% Forest, 1.95% Wetland, 1.66% Urban, and 1.09% Water (Figure 4). Recent site visits conducted by IDEM staff confirm that this watershed is still primarily agricultural.

Infrared Imagery

Infrared imagery from 2010 is currently available for this area. Inspection of the infrared imagery for this area confirms this watershed is primarily agricultural (Figure 7). This watershed contains a lot of healthy vegetation, primarily in the form of crops. Infrared inspection reveals that many crop fields contain exposed soils and drainage patterns, which suggest that runoff from the fields occurs and enters the streams. Many of the streams in this watershed have very thin to no buffers separating them from crop fields or from manicured lawns. Several portions of the White River and many ponds within the watershed appear to have a high amount of suspended sediments, further indicating runoff to streams as well as erosion.

Future Growth

According to the 2010 Census data (U.S. Census, 2010), the populations of Randolph and Delaware Counties has decreased. The Randolph County population decreased 4.49%from 27,401 in 2000 to 26,171 in 2010. The Delaware County population decreased 0.92% from 118,769 in 2000 to 117,671 in 2010. The Henry County population increased 1.93% from 48,508 in 2000 to 49,462 in 2010.

IDEM acknowledges that the U.S. Census data is county-wide and may not accurately reflect the growth rate/potential within the Upper White River Headwaters watershed, but does include the data as recognition that there is potential for future growth.

Source Discussion

Point Sources

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are five (5) NPDES permitted facilities in the Upper White River Headwaters watershed (Figure 5, Table 13). Of the five (5) NPDES facilities, three (3) dischargers, Union Elementary & High School (Town of Modoc WWTP), and the Winchester WWTP, have *E. coli* limits in their permits. One facility, Farmland Municipal STP, Parker City Municipal WWTP, has *E. coli* monitoring in the permit. The remaining facility, IMI Irving Bros Stone & Gravel, does not have a sanitary component to the discharge; therefore it does not have an *E. coli* limit

- Farmland Municipal Sewage Treatment Plant (STP) has a waste stabilization lagoon with a 90-day detention time; therefore, bacteriological monitoring for *E. coli* has not been required. *E. coli* monitoring has been required in this permit since 2006 to ensure the lagoon is functioning as designed. In 2008, Farmland Municipal had an Agreed Order for exceedences of total suspended solids (TSS), Biochemical Oxygen Demand (BOD) and pH. The cause of the violations has since been resolved (Attachment D).
- Parker City Municipal Wastewater Treatment Plant (WWTP) had *E. coli* violations which occurred April through August of 2006, which encompasses the 2006 sampling event (Attachment D). Parker City Municipal WWTP was under an agreed order due to these violations in 2008. The cause of the violations has since been resolved (Attachment D).
- Union Elementary & High School (Town of Modoc WWTP) had only begun to monitor for *E. coli* in April 2006. There were several *E. coli* exceedences during the sampling event in 2006 (Attachment D).
- Winchester WWTP did not have any *E. coli* violations during the 2006 sampling event (Attachment D).

Municipal Separate Storm Sewer Systems (MS4): Storm Water General Permit Rule 13

There is one (1) municipal separate storm sewer system (MS4) community, Delaware County/City of Muncie (INR040056) in the Upper White River Headwaters watershed. Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11).

> Sec. 10. If a total maximum daily load (TMDL) is approved for any water body into which an MS4 conveyance discharges, the MS4 operator must review and appropriately modify Parts B and C of their Storm Water Quality Management Plan (SWQMP) if the TMDL includes requirements for control of storm water discharges under the jurisdiction of the MS4 operator.

IDEM recognizes that these MS4 communities can be sources of *E. coli* and more information needs to be collected. As part of the permit process these systems will be better defined and will continuously work towards meeting the water quality standard, which is the limit and goal of this TMDL. This process will take several permitting cycles and it is anticipated that in the future, MS4 permits will meet the water quality standards.

Combined Sewer Overflows (CSO) and Sanitary Sewer Overflows (SSO)

There are four (4) CSO outfalls within the Upper White River Headwaters Watershed; all four (4) CSO outfalls are associated with the Muncie Sanitary District (IN0025631).

The Muncie Sanitary District Long Term Control Plan (LTCP) identifies the goal of separating the combined areas of the city through the construction of new sanitary and storm sewers (Personal Communication: T. Trinkle, IDEM-OWQ, 2011). Several projects have already been completed to correct flooding issues. During these projects, the sewers are separated (Personal Communication: Shareen Wagley, 2011).

Concentrated Animal Feeding Operations (CAFOs)

There are ten (10) concentrated animal feeding operations (CAFOs) (Figure 6; Table 14) within the Upper White River Headwaters watershed. All of the CAFOs are located in Randolph County.

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of confined feeding operations falls under the regulations for confined feeding operations CFOs and concentrated animal feeding operations CAFOs. The CFO and CAFO 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). CAFO loads fall under WLA.

Due to size, some confined feeding operations (CFO) are defined as CAFOs. For purposes of discussion, it is important to remember that all CAFOs are confined feeding operations. The CAFO regulation, however, contains more stringent operational requirements and slightly different application requirements. All facilities that are identified as CFO's will be addressed in the nonpoint sources. There are ten (10) CAFO's in the Upper White River Headwaters watershed. One of these CAFOs, Union Go Dairy, had agreed orders in 2007 and 2008. The 2007 agreed order was due to water quality standards violation and has been resolved. The 2008 agreed order was due to a spill, which has also been resolved. All other CAFO facilities have been in compliance with their permits and do not have any enforcement actions.

Nonpoint Sources

Wildlife

Wildlife is a known source of *E. coli* in waterbodies. Many animals spend time in or around waterbodies. Deer, geese, ducks, raccoons, turkeys, and other warm-blooded animals all create potential sources of *E. coli*. Wildlife contributes to the potential impact of contaminated runoff from animal habitats, such as urban park areas, forest, and rural areas.

Septic Systems

Failing septic tanks are known sources of *E. coli* can impair waterbodies. All the counties in the watershed follow the state IAC 16-1-4-9 and IAC 36-1-6-2 rules regarding septic systems. Failures are typically identified through complaints and through the sale of older properties that have not passed inspection. Effluents from failing septic tanks can leach into groundwater or pond at the surface where they can be washed into surface waters via stormwater runoff events.

Delaware County follows the IAC in terms of septic systems.

Randolph County follows the IAC in terms of septic systems. Permits are required and inspections are completed on installed systems (Personal Communication Bradford Koss).

Confined Feeding Operations (CFOs)

There are five (5) CFOs (Figure 6, Table 14) in the Upper White River Headwaters watershed.

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of confined feeding operations falls under the regulations for confined feeding operations CFOs and concentrated animal feeding operations CAFOs. The CFO and CAFO 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 difference between the two types of feeding operations is that concentrated animal feeding operations fall under Federal regulation and confined feeding operations fall under State regulations. Due to this difference CAFO loads fall under WLA and CFO loads fall under LA.

The animals raised in confined feeding operations 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. Confined feeding operations, however, can also pose environmental concerns, including 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 can adversely impact soil productivity.

The locations of confined feeding operations in the Upper White River Headwaters watershed are shown in Figure 6.

It was noted during the watershed tour that there are many smaller livestock operations in the watershed. These operations, due to their small size, are not regulated under the CFO or CAFO regulations. These operations may still add *E. coli* to surface waters via wastewater from the facilities, near-stream pastures, manure spreading onto fields, and livestock with access to stream environments. Runoff from pastures and livestock operations can also be potential agriculture sources of bacteria. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even thought 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 land cover, increasing the possibility of erosion and contaminated runoff during a storm event. Due to the small size of these operations, alternative management

practices need to be in place to reduce their impact on water quality. Some of the management alternatives are outlined in the reasonable assurance activities section to follow.

Stormwater Runoff from Agricultural Land Use Practices

Runoff from agricultural lands (feedlots, pastures and fields) can contain significant amounts of bacteria. Manure spread onto fields is often a source of *E. coli*, which can be exacerbated by field-tile drainage lines, which channelize the stormwater flows and reduce the time available for bacteria to die off. Land applied manure may also reach surface waters via overland runoff and via macropore/preferential flow pathways. Stormwater runoff related to manure stockpiles and manure storage facilities can also contribute *E. coli* to stream environments in the Upper White River Headwaters watershed. Infrared inspection revealed that many crop fields in this watershed contain exposed soils and drainage patterns, which suggest that runoff from the fields occurs. Additionally, many of the streams in this watershed have very thin to no buffers that can slow down or mitigate influences from runoff.

Unrestricted livestock access to streams

Livestock with access to stream environments may add bacteria directly to the surfaces waters or resuspend particles that had settled on the stream bottom. Direct deposit of animal wastes can result in very high localized bacteria counts and can also contribute to downstream impairments. Smaller animal operations may add bacteria to surface waters via stormwater runoff from near-stream pastures. Recent site visit by IDEM staff noted several instances where livestock animals have unrestricted access to the streams in this watershed.

Urban Runoff

Runoff from urban areas (urban, residential, commercial or industrial land uses) can carry *E. coli* to surface waters. Stormwater from urban areas, which drain impervious surfaces, may introduce bacteria to surface waters. Urban bacteria sources can include wildlife or pet wastes. Several portions of the White River and many ponds within the watershed appear to have a high amount of suspended sediments indicating runoff, which carries *E. coli* to surface waters.

Linkage Analysis and *E. coli* Load Duration Curves

The linkage between the *E. coli* concentrations in the Upper White River Headwaters watershed and the potential sources provides the basis for the development of this TMDL. The linkage is defined as the cause and effect relationship between the selected indicators and the sources. Analysis of this relationship allows for estimating the total assimilative capacity of the stream and any needed load reductions. Analysis of the data for the Upper White River Headwaters watershed indicates that a significant amount of the *E. coli* load enters the Upper White River Headwaters watershed through both wet (nonpoint) and dry (point) weather sources.

To investigate further the potential sources mentioned above, an *E. coli* load duration curve analysis, as outlined in an unpublished paper by Cleland (2002), was developed for each of the fifty-six (56) sampling sites in the Upper White River Headwaters watershed (Attachment E). The method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint).

In order to develop a load duration curve, continuous flow data is required. The USGS gage for the White River at Muncie, Indiana (03347000), located downstream on the White River was

used for the development of the *E. coli* load duration curve analysis for the Upper White River Headwaters watershed TMDL.

The flow data is used to create flow duration curves, which display the cumulative frequency of distribution of the daily flow for the period of record. The flow duration curve relates flow values measured at the gage station to the percent of time that those values are met or exceeded. Flows are ranked from extremely low flows, which are exceeded nearly 100 percent of the time, to extremely high flows, which are rarely exceeded. Flow duration curves are then transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for *E. coli* and appropriate conversion factors. The load duration curves are conceptually similar to the flow duration curves in that the x-axis represents the flow recurrence interval and the y-axis represents the allowable load of the water quality parameter. The curve representing the allowable load of *E. coli* was calculated using the single sample standard of 235 *E. coli* MPN per 100 ml. The final step in the development of a load duration curve is to add the water quality pollutant data to the curves. Pollutant loads are estimated from the data as the product of the pollutant concentrations, instantaneous flows measured at the time of sample collection, and appropriate conversion factors. In order to identify the plotting position of each calculated load, the recurrence interval of each instantaneous flow measurement was defined. Water quality pollutant monitoring data are plotted on the same graph as the load duration curve so as to provide a graphical display of the water quality conditions in the waterbody. The pollutant monitoring data points that are above the target line exceed the water quality standards (WQS); those that fall below the target line meet the WQS (Cleland, 2002 and Mississippi DEQ, 2002).

Flow regimes in the load duration curve are broken down into five categories:

Very High Flows: Flows in this represent flooding or near flooding stages of a stream. These flows are exceeded 0 – 10 % of the time.

Moist Zone: Flows in this range are related to wet weather conditions. These flows are exceeded 10 – 40 % of the time.

Mid-Range Zone: Flows in this range represent median stream flow conditions. These flows are exceeded 40 – 60% of the time.

Dry Zone: Flows in this range are related to dry weather flows. These flows are exceeded 60 -90 % of the time.

Very Low Flows: Flows in this range are seen in drought-like conditions. These flows are exceeded 90 -100 % of the time.

Load duration curves were created for all the sampling sites in the Upper White River Headwaters watershed (Figure 3, Attachment A, B, & E). These sampling sites were sampled for *E. coli* April 10, 2006 through May 8, 2006 and July 17, 2006 through August 18, 2006. The data indicate that exceedences of the *E. coli* WQS are prevalent during both wet and dry weather events (Attachment E).

Segment Summary

Impaired segments are listed in the Tables 2 - 12 and include the following information: impaired segment AUID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFOs, CAFOs, Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. Locations of these subwatersheds within the Upper White River Headwaters watershed are depicted in Figure 8.

Table 2: Owl Creek – White River (HUC 051202010101)

Upstream Characteristics					
Drainage Area	21.03 square miles				
TMDL Sample Site	1, 2, 3, 4, 5, 6, 7, 8, 9				
Listed Segments	INW0111_01, INW0111_02				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	94.34%	4.09%	0.00%	0.00%	1.57%
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	Thornburg				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4750.23	1091.83	413.96	150.07	39.33
WLA	NA	NA	NA	NA	NA
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 3: Peach Creek – White River (HUC 051202010102)

Upstream Characteristics					
Drainage Area	29.69 square miles				
TMDL Sample Site	10, 11, 12, 1, 14, 15, 16, 17, 18, 19, 20				
Listed Segments	INW0112_01, INW0112_T1003, INW0112_T1004, INW0112_T1005, INW0112_T1006				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	90.15%	3.70%	3.51%	0.32%	2.32%
NPDES Facilities	Winchester Municipal WWTP				
MS4 Communities	NA				
CSO Communities	Winchester Municipal WWTP				
CAFOs	NA				
CFOs	Peacock				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4739.86	1081.46	403.60	139.70	28.96
WLA	10.37	10.36	10.36	10.36	10.36
MOS (10%)	527.80	121.31	45.99	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 4: Eightmile Creek – White River (HUC 051202010103)

Upstream Characteristics					
Drainage Area	20.49 square miles				
TMDL Sample Site	21, 22, 23				
Listed Segments	INW0113_01, INW0113_T1004				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	92.99%	5.01%	0.02%	0.36%	1.62%
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	Lick Skillet, TK Hog Farm, LLC				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4750.23	1091.83	413.96	150.06	39.33
WLA	NA	NA	NA	NA	NA
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 5: Cabin Creek (HUC 051202010104)

Upstream Characteristics					
Drainage Area	25.89 square miles				
TMDL Sample Site	29, 30, 31, 32				
Listed Segments	INW0114_01				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	90.68%	6.27%	0.00%	0.35%	2.70%
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	Indiana Trail Nurseries, Stoney Creek				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4750.23	1091.83	413.96	150.06	39.33
WLA	NA	NA	NA	NA	NA
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 6: Sparrow Creek – White River (HUC 051202010105)

Upstream Characteristics					
Drainage Area	17.79 square miles				
TMDL Sample Site	24, 25, 26, 27, 28, 32				
Listed Segments	INW0115_01, INW0115_T1006				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	92.99%	3.78%	0.92%	0.07%	2.24%
NPDES Facilities	Farmland Municipal STP				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	Untion-Go Dairy LLC				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4749.45	1091.05	413.18	149.28	38.55
WLA	0.78	0.78	0.78	0.78	0.78
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 7: Little White River (HUC 051202010106)

Upstream Characteristics					
Drainage Area	22.82 square miles				
TMDL Sample Site	33, 34, 35				
Listed Segments	INW0116_01, INW0116_T1001				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	92.73%	5.27%	0.10%	0.00%	1.90%
NPDES Facilities	Union Elementary & High School (Town of Modoc WWTP)				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	Chamberlain Swine, LLC, Harris				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4750.14	1091.83	413.96	150.06	39.33
WLA	0.09	0.09	0.09	0.09	0.09
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 8: Little Stoney Creek – Stoney Creek (HUC 051202010107)

Upstream Characteristics					
Drainage Area	29.32 square miles				
TMDL Sample Site	36, 37, 38, 39, 40, 42, 43				
Listed Segments	INW0117_01, INW0117_T1001				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	93.00%	5.03%	0.12%	0.03%	1.82%
NPDES Facilities	NA				
MS4 Communities	Delaware County/City of Muncie (INR040056)				
CSO Communities	NA				
CAFOs	NA				
CFOs	Stoney Creek, Stoney Creek Farms				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4750.20	1091.83	413.96	150.06	39.33
WLA	0.03	0.00	0.00	0.00	0.00
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 9: Prairie Creek Reservoir – Prairie Creek (HUC 051202010108)

Upstream Characteristics					
Drainage Area	16.95 square miles				
TMDL Sample Site	48, 49				
Listed Segments	INW0118_01				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	79.13%	8.28%	0.04%	11.84%	0.71%
NPDES Facilities	NA				
MS4 Communities	Delaware County/City of Muncie (INR040056)				
CSO Communities	NA				
CAFOs	NA				
CFOs	Farm #1, Reeder Brothers Cattle Farm, Farm #2, Keesling				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4700.20	1091.83	413.96	150.06	39.33
WLA	50.03	0.00	0.00	0.00	0.00
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 10: Mud Creek – White River (HUC 051202010109)

Upstream Characteristics					
Drainage Area	24.60 square miles				
TMDL Sample Site	41, 44, 45, 46, 47				
Listed Segments	INW0119_01, INW0118_T1008				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	88.17%	7.51%	1.19%	0.24%	2.89%
NPDES Facilities	Parker City Municipal WWTP				
MS4 Communities	Delaware County/City of Muncie (INR040056)				
CSO Communities	NA				
CAFOs	NA				
CFOs	Jacobi				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4741.94	1090.93	413.06	149.16	38.43
WLA	8.29	0.90	0.90	0.90	0.90
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 11: Truitt Ditch – White River (HUC 051202010110)

Upstream Characteristics					
Drainage Area	18.40 square miles				
TMDL Sample Site	50, 51, 52				
Listed Segments	INW011A_01, INW011A_T1008				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	82.94%	10.26%	4.43%	0.84%	1.53%
NPDES Facilities	NA				
MS4 Communities	Delaware County/City of Muncie (INR040056)				
CSO Communities	NA				
CAFOs	NA				
CFOs	Keesling & Sons INC, Guthrie, Keesling Leroy				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4693.92	1091.83	413.96	150.06	39.33
WLA	56.31	NA	NA	NA	NA
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

Table 12: Hamilton Ditch – Muncie Creek (HUC 051202010111)

Upstream Characteristics					
Drainage Area	13.44 square miles				
TMDL Sample Site	53, 54, 55, 56				
Listed Segments	INW011B_01, INW011B_T1001				
Land Use	Agriculture:	Forest:	Urban:	Water:	Wetland:
	80.74%	5.16%	12.14%	0.81%	1.15%
NPDES Facilities	NA				
MS4 Communities	Delaware County/City of Muncie (INR040056)				
CSO Communities	Muncie Sanitary District				
CAFOs	NA				
CFOs	Keesling & Sons INC, Guthrie, Keesling Leroy				
TMDL Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	4598.38	1091.83	413.96	150.06	39.33
WLA	151.85	NA	NA	NA	NA
MOS (10%)	527.80	121.31	46.00	16.67	4.37
TMDL = LA+WLA+MOS	5278.03	1213.14	459.96	166.74	43.70

The above tables have listed current NPDES facilities in individual subwatersheds. A "NA under WLA (Wasteload Allocation) indicates that there are currently no NPDES permitted facilities which could have received a portion of the WLA within that particular subwatershed; therefore, a WLA was not calculated for that subwatershed. Should a NPDES permit be granted to a new facility within any of these subwatersheds, the WLA for that subwatershed will be calculated to account for the new facility.

To further investigate sources of *E. coli,* counts in Most Probable Number (MPN)/100 mL have been plotted on precipitation graphs (Attachment E). Elevated levels of *E. coli* during and soon after rain events indicate *E. coli* contribution due to runoff. The precipitation data was collected by several weather stations managed by the Indiana State Climate Office at Purdue University. Precipitation data for sites 1 through 23 were collected at the Winchester station. Precipitation data for sites 24 through 43 were collected at the Farmland station. Precipitation for site 41 and sites 46 through 56 were collected at the Muncie station.

While there are point source contributions, compliance with the numeric *E. coli* WQS in the Upper White River Headwaters watershed most critically depends on controlling nonpoint sources using best management practices (BMPs). If the *E. coli* inputs can be controlled, then total body contact recreational use in Upper White River Headwaters watershed will be protected.

TMDL Development

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving the Waters Quality Standard. As indicated in the Water Quality Standards and Numeric Targets section of this document, the water quality standard for this *E. coli* TMDL is 125 MPN per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the critical conditions that will be used when defining allowable levels.

Many TMDLs are designed as the set of environmental conditions that, when addressed by appropriate controls, will ensure attainment of WQS for the pollutant. For example, the critical conditions for the control of point sources in Indiana are given in 327 IAC 5-2-11.1(b). In general, the 7-day average low flow in 10 years (Q7, 10) for a stream is used as the design condition for point source dischargers. However, *E. coli* sources to the Upper White River Headwaters watershed arise from a mixture of dry and wet weather-driven conditions, and there is no single critical condition that would achieve the *E. coli* WQS. For this reason, TMDLs were calculated over all of the flow conditions (very high flows to low flows) within the Upper White River Headwaters watershed. For the Upper White River Headwaters watershed and the contributing sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

For most pollutants, TMDLs are expressed on a mass loading basis (e.g. pounds per day). For *E. coli* indicators, however, mass is not an appropriate measure because *E. coli* is expressed in terms of organism counts (or resulting concentration) (USEPA, 2001). The geometric mean *E. coli* WQS allows for the best characterization of the watershed. Therefore, this *E. coli* TMDL is concentration-based consistent with 327 IAC 5-2-11.1(b) and 40 CFR, Section 130.2 (i) and the TMDL is equal to the geometric mean *E. coli* WQS for each month of the recreational season (April 1 through October 31).

Allocations

TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background levels. In addition, the TMDL must include a Margin of Safety (MOS), either implicitly or explicitly, that accounts for uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this definition is denoted by the equation:

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

The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. This *E. coli* TMDL is concentration-based consistent with USEPA regulations at 40 CFR, Section 130.2(i).

<u>Wasteload Allocations</u>

As previously mentioned, there are five (5) NPDES permitted facilities in the Upper White River Headwaters watershed (Figure 5, Table 13). Four (4) dischargers have a sanitary component to their discharge. One (1) discharger has a waste stabilization lagoon with a 90-day detention time; therefore, only bacteriological monitoring for *E. coli* is incorporated into the permit to ensure the

lagoon is functioning properly. Three (3) of the four (4) permitted dischargers with a sanitary component have *E. coli* limits in their permits. The WLA is set at the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31. The WLA is set at the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31.

There are ten (10) CAFOs in the Upper White River Headwaters watershed. CAFOs fall under Federal regulation; therefore, CAFO loads fall under WLA and have a WLA of 0.

Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11). There is one (1) MS4 community, Delaware County/City of Muncie (INR040056) in the Upper White River Headwaters watershed.

The Delaware County/City of Muncie (INR040056) was given an estimated wasteload allocation at the Water Quality Standard for *E. coli* in each of the watersheds the MS4 is located. Since IDEM does not require a GIS shapefile for MS4s and boundaries can be modified via letter to the MS4 coordinator, the percent area of urbanized landuse in each watershed was used as an approximation for the MS4 boundary.

Until such time that more accurate spatial GIS shapefiles are provided, the TMDL is limited to estimates like incorporated areas.

In the event that designated uses and associated water quality criteria applicable to the Upper White River Headwaters are revised in accordance with applicable requirements of state and federal law, this TMDL may be revised to be consistent with such revisions. IDEM recognizes that these MS4 communities can be sources of *E. coli* and more information needs to be collected. As part of the permit process these systems will be better defined and will continuously work towards meeting the water quality standard, which is the limit and goal of this TMDL. This process will take several permitting cycles and it is anticipated that in the future, MS4 permits will meet the water quality standards.

There are 2 CSO communities in the Upper White River Headwaters Watershed, Winchester (IN0021024) and Muncie (IN0025631). Both communities discharge to the White River. The WLA is set at the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31.

<u>Load Allocations</u>

The LA for *E. coli* nonpoint sources is equal to the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31. The LA will use the geometric mean of each sampling location to determine the reduction necessary to comply with WQS at each site (Attachment F).

There are five (5) CFOs in the Upper White River Headwaters watershed. CFOs fall under state regulation and have no discharge permits; therefore, CFOs fall under LA and have a LA of 0.

Load allocations may be affected by subsequent work in the watershed. It is anticipated that future watershed projects will be useful in continuing to define and address the nonpoint sources of the *E. coli* in the Upper White River Headwaters watershed.

Margin of Safety

A Margin of Safety was incorporated into this TMDL analysis. The MOS accounts for any uncertainty or lack of knowledge concerning the relationship between pollutant loading and water quality. The MOS can be either implicit (i.e., incorporated into TMDL analysis through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses both 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 ten percent of the allowable load. Ten percent was considered an appropriate MOS based on the following considerations:

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

Seasonality

Seasonality in the TMDL is addressed by expressing the TMDL in terms of the *E. coli* WQS for total body contact during the recreational season (April 1 through October 31) as defined by 327 IAC 2-1.5-8(e)(2). There is no applicable total body contact *E. coli* WQS during the remainder of the year in Indiana. Because this is a concentration-based TMDL, *E. coli* WQS will be met regardless of flow conditions in the applicable season.

Monitoring

Future *E. coli* monitoring of the Upper White River Headwaters watershed will take place during IDEM's nine-year rotating basin schedule and/or once TMDL implementation methods are in place. Monitoring will be adjusted as needed to assist in continued source identification and elimination. IDEM will monitor at an appropriate frequency to determine whether Indiana's 30-day geometric mean value of 125 *E. coli* per one hundred milliliters is being met. When results indicate that the waterbody is meeting the *E. coli* WQS, the waterbody will then be removed from Indiana's List of Impaired Waters.

Reasonable Assurance Activities

Reasonable assurance activities are programs that are in place or will be in place to assist in meeting the Upper White River Headwaters watershed TMDL allocations and the *E. coli* Water Quality Standard.

Watershed Projects

The White River Project (WRWP) in Delaware County is funded through a 319 grant. The WRWP provides funding for projects that include stream bank restoration, constructed wetlands, best management practice tours, green roof installations, and assisting with providing erosion control solutions to local landowners, as well as hosting educational workshops. Workshop topics include rain garden workshops, pasture walks for owners of grazed livestock, drainage, soil fertility, and an energy efficiency to reduce energy consumption on the farms.

These projects and workshops are designed to reduce runoff, overland flows, and stormwater flows. Reduction in flows can reduce the *E. coli* contribution from sources such as waste from urban pet populations, wildlife and livestock.

In addition, the Delaware County SWCD was awarded the District Showcase Award from the Indiana Association of SWCDs for their work with the John M. Craddock Wetland Nature Preserve. This 27-acre reclaimed natural area is located in Muncie's industrial district and is linked to the White River and the Cardinal Greenway. This project is slated to be completed in 2013.

Delaware County has received the following funding to improve water quality in 2010:

Local: $43,628
Clean Water Indiana: $65,730
Game Bird Habitat Development Program: $1,107
Conservation Reserve Program: $350,668
Wetland Reserve Program: $1,380
Total: $462,513

The Randolph County SWCD received a Clean Water Indiana grant in 2010 to distribute rain barrels to Randolph County Residents. In holding three (3) workshops, the SWCD distributed 56 rain barrels.

Rain barrels typically capture runoff from the roof of a structure. Rain barrels prevent water from running directly off of the roof onto the ground where it contributes to overland flow and carries pollutants to nearby streams. Reduction in flows can reduce the *E. coli* contribution from sources such as waste from urban pet populations, wildlife, and livestock.

Randolph County has received the following funding to improve water quality in 2010:

Local: $38,720
Clean Water Indiana: $20,975
Conservation Reserve Program: $424,047
Conservation Stewardship Program: $10,410
Environmental Quality Incentives Program: $87,356
Total: $581,508

<u>Additional 319 Watershed Projects</u>

The Delaware County SWCD has received a grant that will end in December of 2011. This grant is being used to promote the installation of best management practices in areas defined as critical within the watershed. Best management practices include vegetative buffers and grassed waterways for agricultural lands as well as rain barrels and rain gardens in urban areas. BMP demonstration projects include a green roof and a system that captures runoff from gutters into a rain barrel, the rain water then flows into a rain garden. Water quality monitoring is continuing. This group is looking to reduce sediment, nutrients, and *E. coli* from nonpoint sources.

Additional outreach and education includes rain barrel workshops, the benefits of urban BMPs, stream walks, as well as articles and press releases.

Since 1999, students taking biology classes at Anderson University have followed Hoosier Riverwatch protocols to assess macroinvertebrate assemblages and collect chemistry data from the White River, typically once or twice per year (Attachment G). Chemistry data collected include dissolved oxygen, pH, ammonia, nitrates, and phosphates. Other measurements taken include flow, turbidity, and temperature. Fecal coliform and *E. coli* counts were also collected.

IDEM Watershed Specialists will be available to assist stakeholders with starting a watershed group, facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the Upper White River Headwaters watershed.

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

All permitted dischargers with a sanitary component already have *E. coli* limits and monitoring as part of their current permits. By following the guidelines of their permits, the permitted dischargers will attain WQS and reduction of *E. coli* to the surface waters of the Upper White River Headwaters watershed.

Storm Water General Permit Rule 13

There is one (1) municipal separate storm sewer system (MS4) community in the Upper White River Headwaters watershed: Delaware County/City of Muncie (INR040056).

Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11). It is difficult to determine the magnitude of the contributions of these MS4 communities as a source of *E. coli* in the Upper White River Headwaters watershed. The TMDL recognizes that these MS4 communities can be sources of *E. coli* and more information needs to be collected. As part of the permit process these systems will be better defined and will continuously work towards meeting the water quality standard, which is the limit of this TMDL. This process will take several permitting cycles and it is anticipated that in the future, MS4 permits will meet the water quality standards. With each permitting cycle, it is projected that progress will be made towards meeting the water quality standard.

The Delaware County/City of Muncie (INR040056) MS4 is a finalist to receive the Governor's Environmental Award (Wagley, Personal Communication, 2011). This award recognizes entities who have implemented outstanding environmental practices into their operations in an effort to improve Indiana's environmental protection and benefit the health and welfare of Indiana citizens.

Confined Feeding Operations and Concentrated Animal Feeding Operations

CFOs and CAFOs are required to manage manure, litter, and process wastewater pollutants in a manner that does not cause or contribute to the impairment of *E. coli* WQS. IDEM is promulgating a new CFO rule that will further protect water quality by including more stringent guidelines (i.e. phosphorus monitoring, limiting application seasons) that are currently incorporated under CAFO regulations for operations that are currently considered CFOs. This new rule is proposed to go into effect next spring.

TMDLs

Several TMDLs have been approved in the Upper White River watershed. Those TMDLs include the Duck, Pipe, Killbuck, Stony Creek TMDL, the West Fork White River Muncie to Hamilton-Marion County Line, the West Fork White River Marion County to Waverly TMDL, the Fall Creek TMDL, the Pleasant Run TMDL, the Middle West Fork White River TMDL, the Lambs Creek TMDL, and the Indian Creek TMDL.

Potential Future Activities

Nonpoint source pollution can be reduced by the implementation of Best Management Practices. BMPs are practices used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities. A BMP may be structural, that is, something that is built or involves changes in landforms or equipment, or it may be managerial, that is, a specific way of using or handling infrastructure or resources. BMPs should be selected based on the goals of a watershed management plan. Livestock owners, farmers, and urban planners can implement BMPs outside of a watershed management plan, but the success of BMPs would be enhanced if coordinated as part of a watershed management plan. Following are examples of BMPs that may be used to reduce *E. coli* runoff:

Riparian Area Management - Management of riparian areas protects stream banks and river banks with a buffer zone of vegetation consisting of grasses, legumes, or trees.

Manure Collection and Storage - Collecting, storing, and handling manure in such a way that nutrients or bacteria do not run off into surface waters or leach down into ground water.

Contour Row Crops - Farming with row patterns and field operations aligned at or nearly perpendicular to the slope of the land.

No-Till Farming - No-till is a year-round conservation farming system. In its pure form, no-till does not include any tillage operations either before or after planting. The practice reduces wind and water erosion, catches snow, conserves soil and water, protects water quality, and provides wildlife habitat. No-till helps control soil erosion and improve water quality by maintaining maximum residue plant levels on the soil surface. These plant residues: 1) protect soil particles and applied nutrients and pesticides from detachment by wind and water; 2) increase infiltration; and 3) reduce the speed at which wind and water move over the soil surface.

Manure Nutrient-Testing - If manure application is desired, sampling and chemical analysis of manure should be performed to determine nutrient content for establishing the proper manure application rate in order to avoid over-application and run-off.

Drift Fences - Drift fences (short fences or barriers) can be installed to direct livestock movement. Identifying small operations where animals have direct access to streams and installing a drift fence parallel to the stream will keep animals out of the stream and prevent direct input of *E. coli* to the stream.

Pet Clean-up / Education - Education programs for pet owners can improve water quality of runoff from urban areas.

Septic System Management/Public Education - Programs for management of septic systems can provide a systematic approach to reducing septic system pollution. Education on proper

maintenance of septic systems as well as the need to remove illicit discharges could alleviate some anthropogenic sources of *E. coli*.

Cover crop - Grasses, legumes, forbs, or other herbaceous plants established for seasonal cover and other conservation purposes to help reduce erosion from wind and water, increase soil organic matter, capture and recycle nutrients in the soil profile, and minimize and reduce soil compaction.

Alternative Watering Systems - A process to collect water from spring or seeps to provide water for livestock, wildlife or other agriculture uses.

Low Impact Development - An innovative storm water management approach with a basic principle that is modeled after nature: manage rainfall where it falls, using uniformly distributed decentralized micro-scale controls. The goal of LID is to mimic a site's predevelopment hydrology by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to its source.

Bioretention System - The bioretention system is an alternative to conventional BMP structures. It is highly applicable to residential uses in community open space or private lots. The bioretention system is very appropriate for treatment of parking lot runoff, roadways where sufficient space accommodates off-line implementation, and pervious areas such as golf courses.

Public Participation

Public Kickoff Meetings were held on May 26, 2011, at the Farm Bureau Insurance Building in Muncie and at the Randolph County 4-H Fairgrounds in Winchester where the public was invited to submit any additional bacteria data and information was provided on the TMDL process.

Public Draft TMDL Meetings were held on July 27, 2011 at the Kennedy Library in Muncie and at the Randolph County 4-H Fairgrounds in Winchester. The public was invited to submit formal comments on the draft document and informed of the findings of the document.

The public comment period occurred from July 26, 2011 to August 26, 2011.

Conclusion

The sources of *E. coli* to the Upper White River Headwaters watershed include both point and nonpoint sources. In order for the Upper White River Headwaters watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the Upper White River Headwaters watershed in Indiana have been set to the *E. coli* WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty day from April 1 through October 31. Achieving the wasteload and load allocations for the Upper White River Headwaters watershed depends on:

1) Nonpoint sources of *E. coli* being controlled by implementing best management practices in the watershed.
2) Continuing efforts to protect this watershed.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Upper White River Headwaters watershed in compliance with the *E. coli*. IDEM will continue to work with its existing programs on implementation. In the event that designated uses

and associated water quality criteria applicable to the Upper White River Headwaters watershed are revised in accordance with applicable requirements of state and federal law, the TMDL implementation activities may be revised to be consistent with such revisions. Additionally, IDEM will work with local stakeholder groups to pursue best management practices that will result in improvement of the water quality in the Upper White River Headwaters watershed.

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Table 13: NPDES Permits in the Upper White River Headwaters Watershed

Facilities with Sanitary Discharge (*E. coli* Limits)

Permit No.	Facility Name	Receiving Waters
IN0021512	Farmland Municipal STP	West Fork of White River
IN0020729	Parker City Municipal WWTP	West Fork of White River
IN0031135	Union Elementary & High School (Town of Modoc)	Unnamed ditch to Little White River
IN0021024	Winchester WWTP	West Fork of White River

Facilities with Non-Sanitary Discharge

Permit No.	Facility Name	Receiving Waters
ING490028	IMI Irving Bros Stone & Gravel	Muncie Creek

Table 14: CFOs and CAFOs in the Upper White River Headwaters Watershed

CFO #	Operation Name	County	Program	Nursery Pigs	Finishers	Sows	Dairy Cattle
1385	SELDOM REST FARMS INCORPORATED FARM 2	DELAWARE	CFO	0	2,000	100	0
3714	SELDOM REST FARMS INCORPORATED FARM 1	DELAWARE	CFO	2,125	0	708	0
3863	CHRISTOPHER PEACOCK	RANDOLPH	CFO	800	1,110	158	0
4646	STEPHEN HAMILTON	RANDOLPH	CFO	480	1,020	210	0
4894	SCF 1 LLC	RANDOLPH	CAFO	0	4,000	0	0
5011	TK HOG FARM LLC	RANDOLPH	CAFO	0	6,000	0	0
6232	CHARLES JACOBI	DELAWARE	CFO	720	600	250	0
6313	UNION GO DAIRY LLC	RANDOLPH	CAFO	0	0	0	1,972
6333	TED HENDRICKSON	RANDOLPH	CAFO	1,800	3,600	0	0
6438	INDIAN TRAIL NURSERIES	RANDOLPH	CAFO	19,200	0	0	0
6439	UNIONPORT NURSERIES	RANDOLPH	CAFO	19,200	0	0	0
6442	LICK SKILLET NURSERIES	RANDOLPH	CAFO	19,200	0	0	0
6443	BUENA VISTA SOW FARM	RANDOLPH	CAFO	430	1,470	5,842	0
6501	SCF 2 LLC	RANDOLPH	CAFO	0	8,000	0	0
6590	CHAMBERLAIN SWINE LLC	RANDOLPH	CAFO	0	8,000	0	0
			Total:	63,955	35,800	7,268	1,972

Figure 1: Upper White River Headwaters Watershed

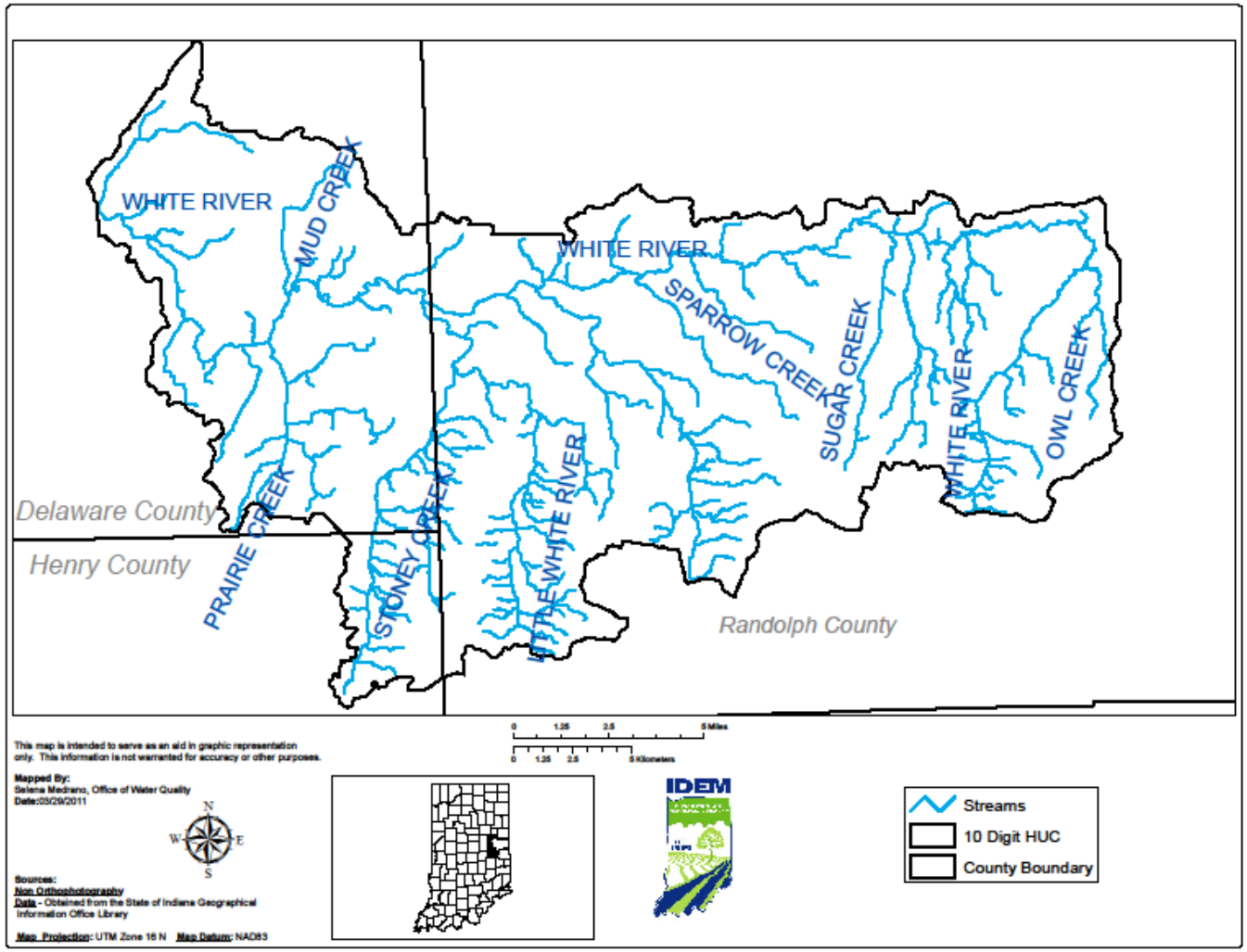

Figure 2: Streams in the Upper White River Headwaters Watershed

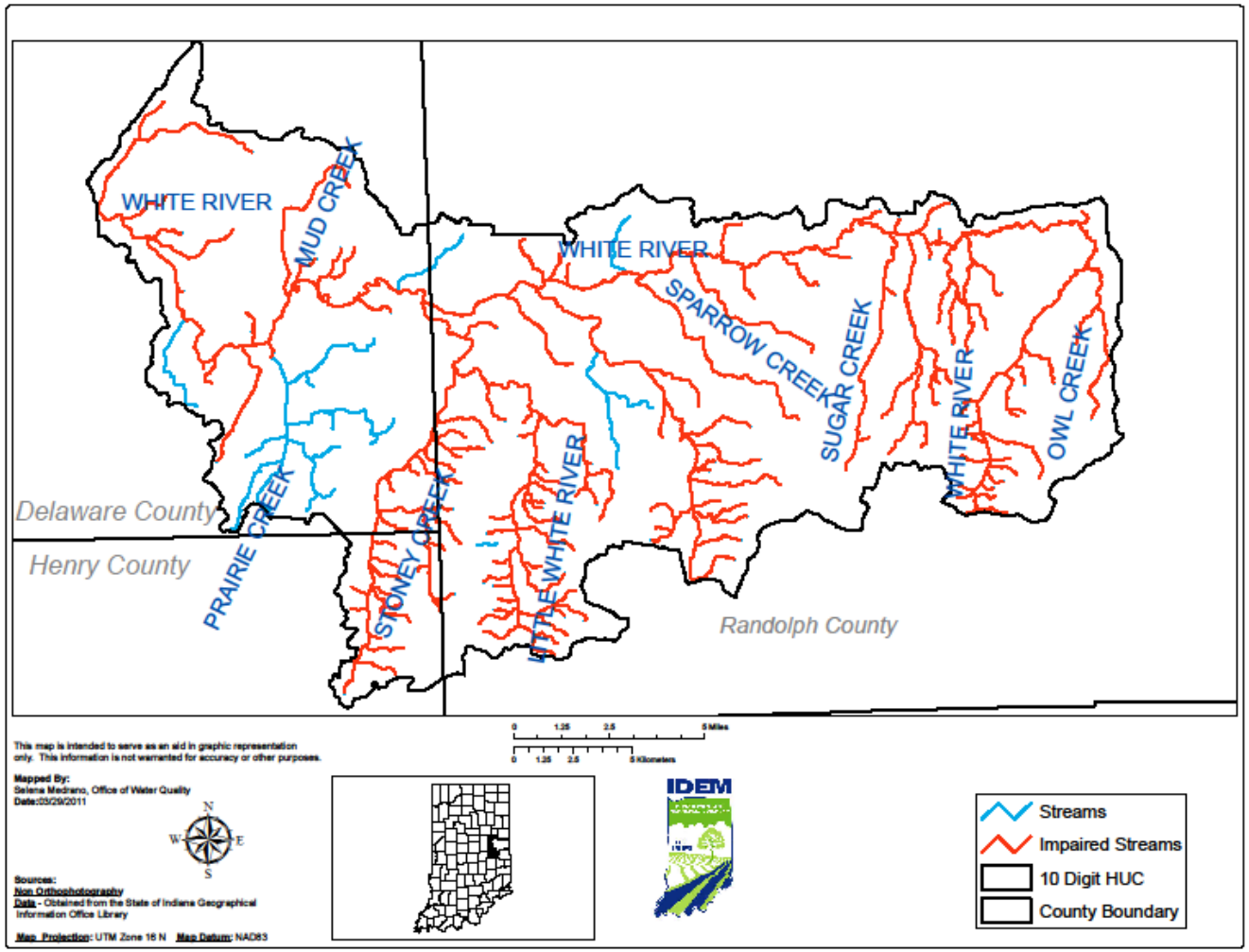

Figure 3: Sample Sites in the Upper White River Headwaters Watershed

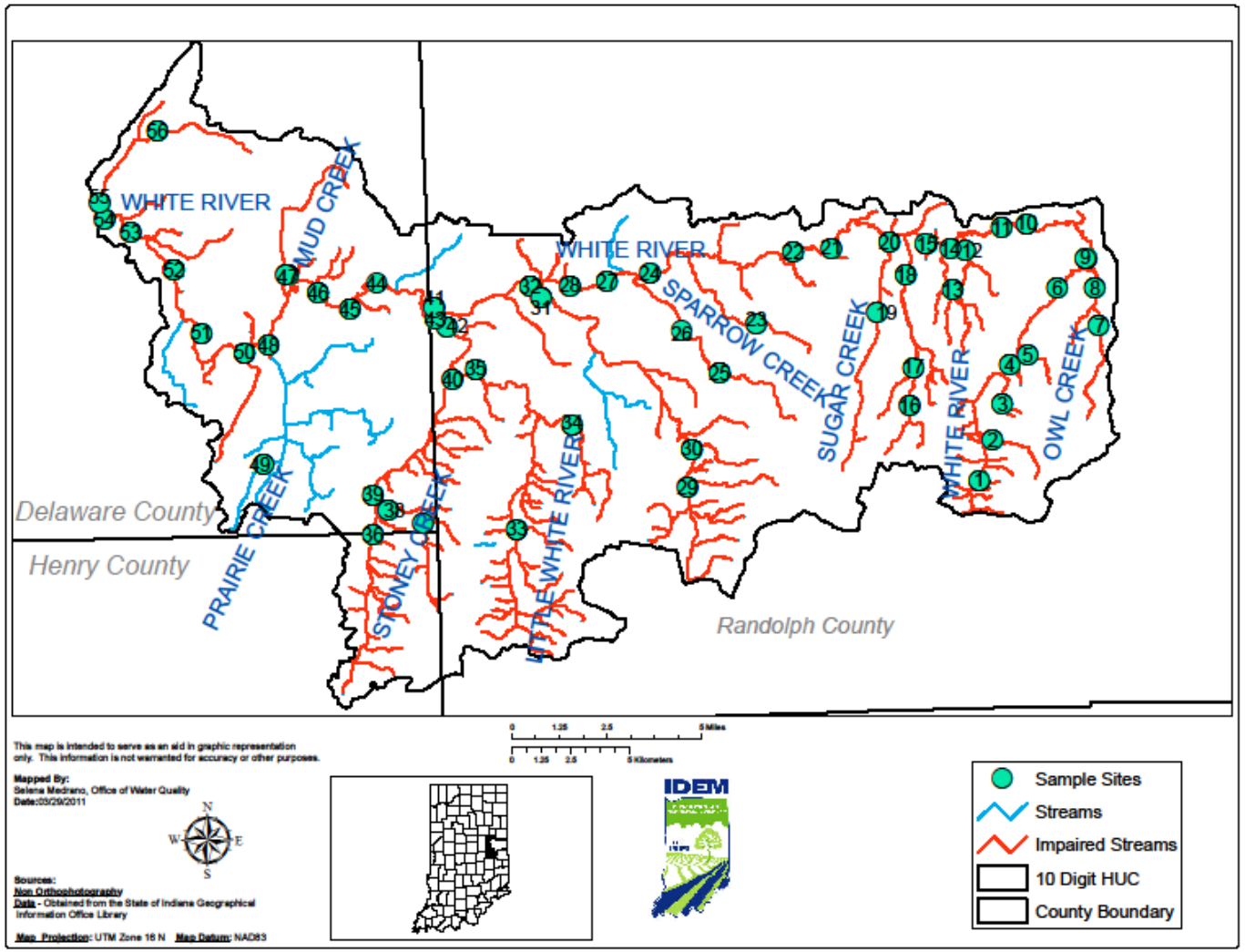

Figure 4: Land use in the Upper White River Headwaters Watershed

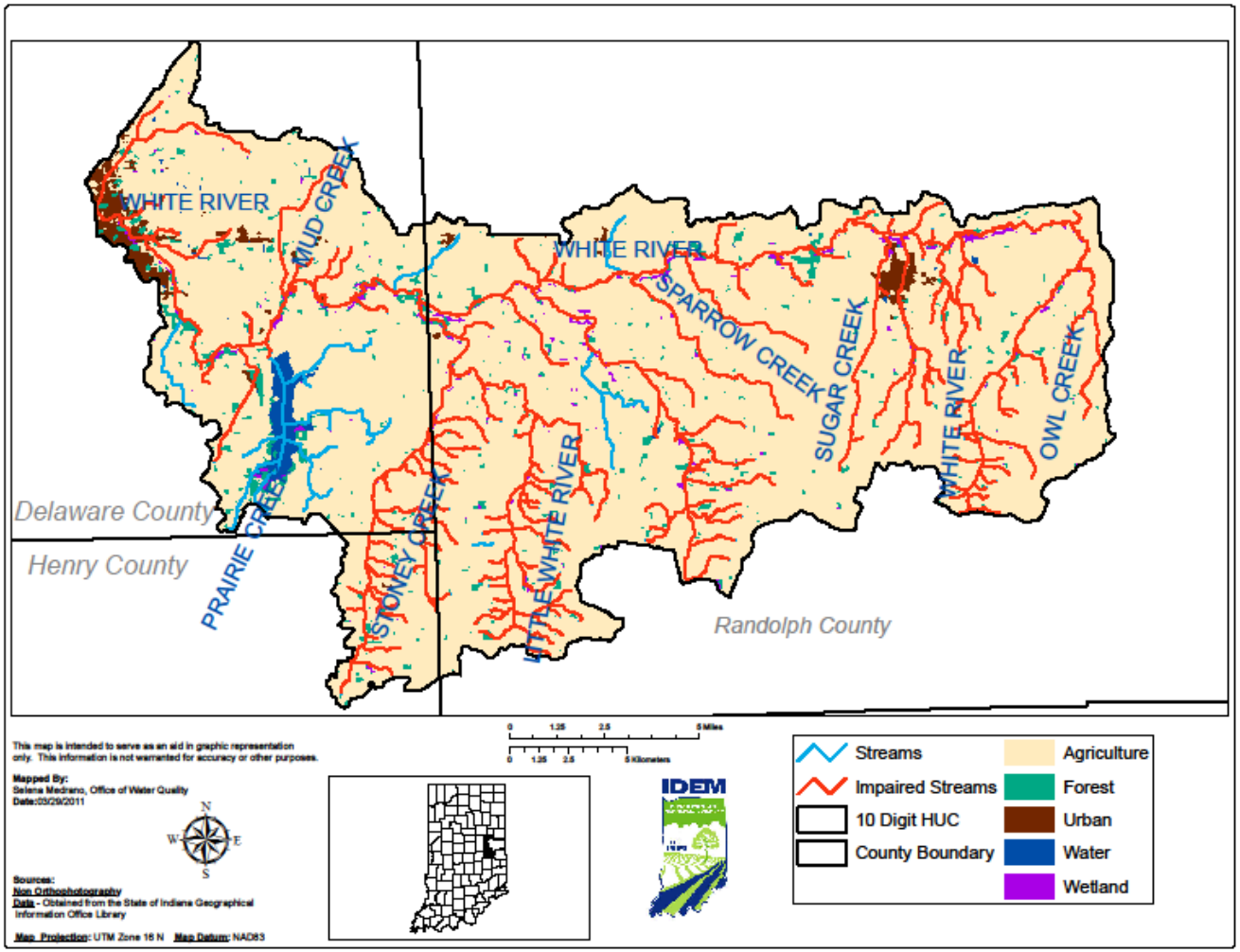

Figure 5: NPDES Permitted Facilities in the Upper White River Headwaters Watershed

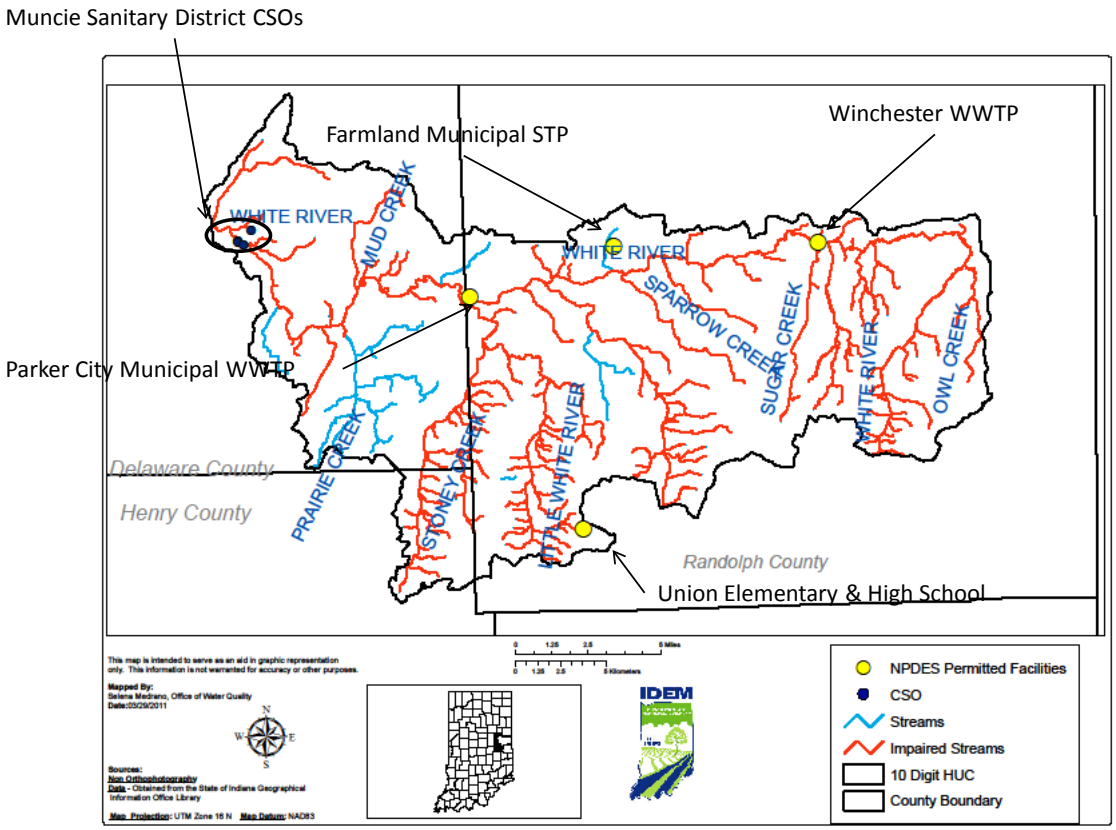

Figure 6: Confined Feeding Operations in the Upper White River Headwaters Watershed

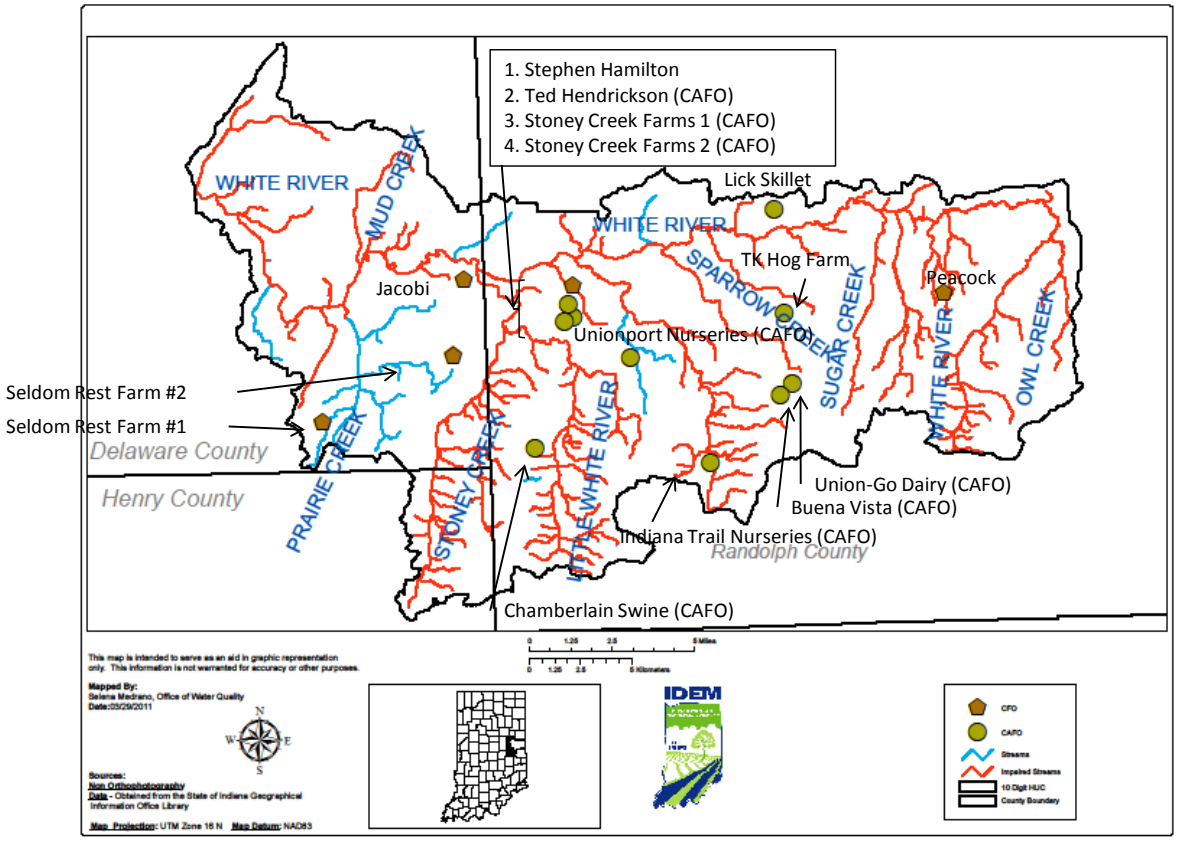

Figure 7: Infrared Imagery of the Upper White River Headwaters Watershed

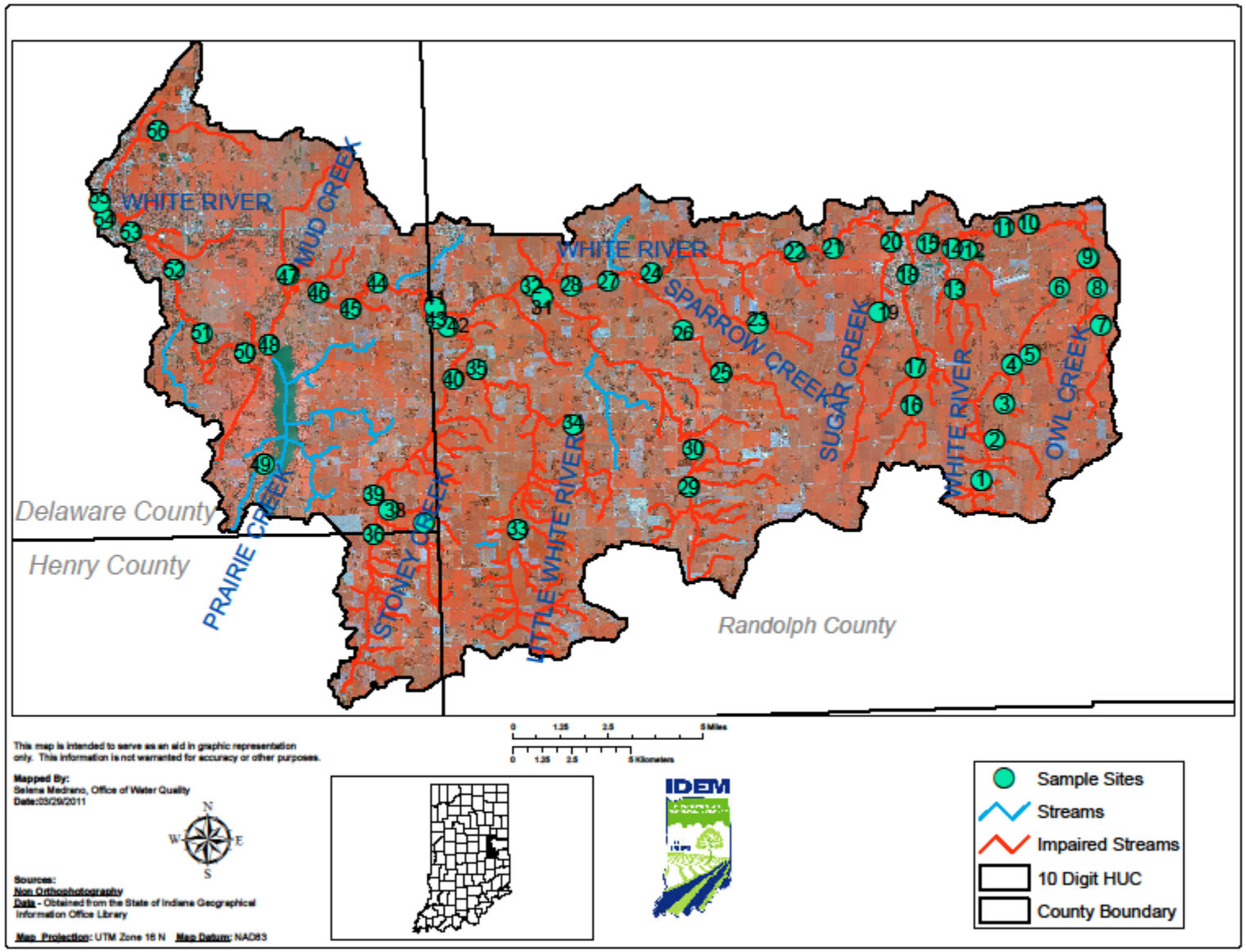
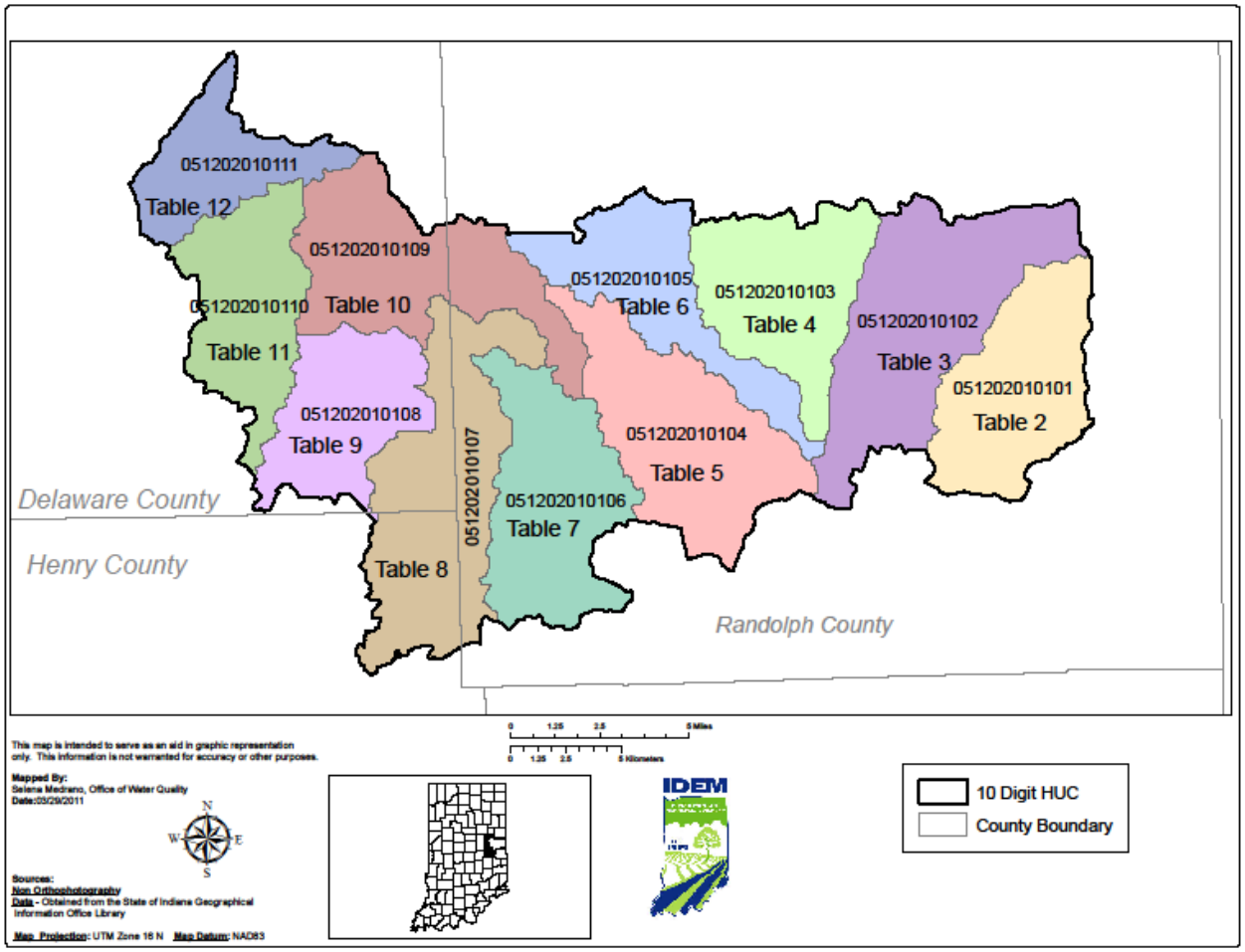
Figure 8: 12-Digit HUCs in the Upper White River Headwaters Watershed