Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) in the Cicero Creek Watershed, Hamilton, Tipton, Boone and Clinton Counties

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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 *Escherichia coli* (*E. coli)* bacteria that will result in the attainment of the applicable WQS for *E. coli* in the Cicero Creek watershed in Hamilton, Tipton, Boone, and Clinton Counties in Indiana.

Background

In 1998, portions of the Cicero Creek watershed (Figure 3) were listed on Indiana's 303(d) list as impaired by bacteria (*E. coli*) (Buck Creek, Tobin Ditch, Buscher Ditch, and Taylor Creek). A reassessment of the reaches within the Cicero Creek watershed, using data collected in 2001 and more recently, 2006, was completed by IDEM during the development of the Cicero Creek TMDLs. This reassessment indicated that additional assessment units of the Cicero Creek watershed were impaired by *E. coli*.

Recently IDEM began using the high resolution National Hydrography Dataset (NHD) created by the United States Geological Survey (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.

Previously, each stream network within a 14-digit HUC was identified as one assessment unit. This convention did not accurately represent the stream impairments; therefore, IDEM employed the process of segmenting these assessment units into smaller and more representative reaches. Segmentation is based upon a number of factors that are likely to have similar impacts to water quality. IDEM examines several factors such as hydrology, land use, NPDES facility and outfall locations, confined feeding operation locations (CFOs), concentrated animal feeding operation locations (CAFOs), aerial photography, and topographic maps for the process of segmenting each stream reach or stream network within a watershed. The smaller stream reaches or stream networks resulting from segmentation allow for better characterization of the impairments within the watershed as well as allowing for better overall characterization of the watershed as those reaches or networks with potentially differing impacts are assigned separate assessment unit IDs (AUID).

IDEM switched from using 14-digit HUCs to using the 12-digit HUCs developed by USGS. This switch called for renaming AUIDs as the AUID is based off the numeric hydrologic unit code itself. In 2009, IDEM undertook three simultaneous processes: adding high-resolution streams, segmentation for better representation, and reassigning AUIDs based on the 12-digit HUC. Therefore, in Table 1, there will be an AUID based on the 2008 AUID naming convention and an AUID associated with the new 2012 naming convention, which will be employed from this point forward. For additional details on IDEM's segmentation process please see Attachment G.

This TMDL will address approximately two hundred thirty-one (231) stream miles in the Cicero Creek watershed in Hamilton, Tipton, Boone, and Clinton Counties, of which all stream miles are impaired by elevated levels of *E. coli* during the recreational season. The Cicero Creek watershed is a single ten-digit Hydrologic Unit Code (HUC-10) #0512020106, and is divided into ten (10) 12-digit HUC subwatersheds (051202010601-051202010610) (Figure 8). The Cicero Creek watershed is in central Indiana (Figure 1). Figure 2 depicts all the waters in the watershed. The impaired segments of the Cicero Creek watershed will be placed on the 303(d) list in 2012 in category 4e. The twenty-seven (27) impaired assessment units (Table 1) for this TMDL are located in the Cicero Creek basin hydrologic unit code 0512020106 (Figure 3).

Table 1: Impaired Assessment Units in the Cicero Creek Watershed

County	Stream Name	TMDL Site Number	2012 AUID*	Segment length**	Impairment
Tipton	Prairie Creek	28, 33, 34, 37, 38	INW0161_00	23.55	*E. coli*
	Cicero Creek	27, 31, 32, 19, 36	INW0162_01	20.32	*E. coli*
	Cicero Creek-Unnamed Tributary		INW0162_01A	0.51	*E. coli*
	Cicero Creek	26	INW0163_01	1.17	*E. coli*
	Dixon Creek	59, 30	INW0163_T1001	13.45	*E. coli*
	Cicero Creek	1	INW0164_01	2.49	*E. coli*
	Cicero Creek-Unnamed Tributary		INW0164_T1001	1.54	*E. coli*
	Buck Creek	23, 24, 25	INW0164_T1002	15.34	*E. coli*
	Cicero Creek	17, 18, 21, 22	INW0165_01	9.42	*E. coli*
	Cicero Creek-Unnamed Tributary		INW0165_01A	0.61	*E. coli*
	Tobin Ditch	20	INW0165_T1001	5.29	*E. coli*
	Bacon Prairie Creek	29, 60	INW0165_T1002	15.62	*E. coli*
	Buscher Ditch	35	INW0165_T1003	5.07	*E. coli*
Hamilton	Cicero Creek	15, 54, 57	INW0166_01	11.34	*E. coli*
	Sloan Ditch	56	INW0166_T1001	3.41	*E. coli*
	Weasel Creek	55	INW0166_T1002	6.85	*E. coli*
	Little Cicero Creek	39, 58	INW0167_01	15.82	*E. coli*
	Teter Branch	40	INW0167_T1001	6.00	*E. coli*
	Little Cicero Creek	16, 52, 53	INW0168_01	12.70	*E. coli*
	Bennett Ditch		INW0168_T1001	2.90	*E. coli*
	Taylor Creek	4	INW0168_T1002	4.84	*E. coli*
	Hinkle Creek	3, 41	INW0169_01	14.00	*E. coli*
	Jones Ditch	42, 43	INW0169_T1001	10.37	*E. coli*
	Cicero Creek	5, 6, 13, 14	INW016A_01	8.40	*E. coli*
	Bear Slide Creek	51	INW016A_T1001	4.16	*E. coli*
	Morse Reservoir Inlet	48	INW016A_T1002	2.49	*E. coli*
	Sly Run	7, 8, 9, 10, 11, 12, 46, 47	INW016A_T1003	13.52	*E. coli*

*AUID: Assessment Unit ID
**Segment Length: Length of the Segment

IDEM conducted a sampling survey of the Cicero Creek watershed for *E. coli* in 2001 and again in 2006. The primary data for this TMDL is taken from the 2006 sampling data. Forty-Four sites were sampled for *E. coli* between August 29, 2006 through September 26, 2006 (Figure 3; Attachment A). *E. coli* sample sites were sampled five (5) times, evenly spaced over a thirty (30) day period in accordance with the Water Quality Standard to determine a geometric mean.

Water quality data collected in the Cicero Creek watershed during the 2006 sampling period were reassessed by IDEM's 303(d)/305(b) Coordinator in August 2011 (Attachment B). Of the forty-four (44) sites which were sampled for *E. coli* , six (6) sites, Sites 20, 27, 29, 44, 45, and 49 did not violate the monthly geometric mean for *E. coli* (125 MPN/100 mL). However, sites 45, 44, and 49 are located on the reservoir and are not included in this TMDL. Sites 20, 27, and 29 are in the extreme headwaters of their respective subwatersheds, but sites below increase in *E. coli* values significantly. All other sites sampled violated the *E. coli* geometric mean of 125 MPN[1] (Most Probable Number)/100 mL. All sites violated the single sample maximum of 235 MPN/ 100 mL at least once.

Water quality data collected by IDEM's Assessment Branch in 2006 indicated high levels of *E. coli* in the Cicero Creek watershed. Violations ranged from 235 MPN/100 mL to greater than 2420 MPN/100 mL (Figure 2; Attachment C).

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 IDEM basin-rotation schedule, and on additional water quality sampling within the Cicero Creek watershed.

A data request to all counties and known watershed groups was made; however, no additional data were received.

Water Quality Standards

One of the designated uses for the waterbodies in the Cicero Creek watershed is for total body contact 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

[1] 1 MPN (most probable number) = 1 cfu (colony forming unit)

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 Cicero Creek watershed flow northeast then southeast to south. The waters in Cicero Creek watershed flow through four (4) Indiana Counties. The watershed headwaters begin in Boone County (1.2%) and Clinton County (1.1%) and flows northeast into Tipton County (44.0%) before turning southeast/south into Hamilton County (53.7%) (Figure 1).

Land Use

Land use information was assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 94.1% of the land use in the Cicero Creek watershed was agriculture. The remaining land use for the Cicero Creek watershed consisted of approximately 1.3% Forest, 2.6% Wetland, 1.0% Water, and 1.0% Urban (Figure 4). Site visits during the sampling events confirm that this watershed is still primarily agricultural with mixtures of forest and wetland uses however, there has been significant growth of suburban developments in the Noblesville and Cicero town limits, but until such time as a quantifiable geodatabase of landuse is available, specific percentages of current landuse cannot be calculated.

A landuse survey compiled in the Morse Reservoir/Cicero Creek Watershed Management Plan, 2011 states:

> This watershed has historically been natural areas that were drained and converted for agricultural uses. The area is dominated by agricultural land and based on the 2001 land use information comprises 83.74% (cultivated crops and pasture hay) of its area. Additionally, forests and wetlands comprise 6.38% (open water, forest, shrub/scrub, grassland/herbaceous, woody wetlands and emergent herbaceous), and urban and residential lands comprise 9.87% of the watershed. Only 6.38% of the entire watershed is categorized as green space (e.g. forest and wetland areas).

The Morse Reservoir/Cicero Creek Watershed Management Plan uses different classifications than IDEM for landuse coverage and is only included for information purposes only and not used for any TMDL calculations.

Future Growth

According to the 2010 Census data (U.S. Census, 2010), there has been a significant positive growth rate in Hamilton County, which is 53.7% of the Cicero Creek watershed. Population increased by 96,547 or 34.57% from 2000 to 2009. Tipton County, which is 44.0% of the Cicero Creek watershed, decreased in population by 685 or -4.31% from 2000 to 2009. There are no incorporated areas near the Boone and Clinton County portions of the watershed, which only account for 2.3% (1.2% and 1.1% respectively) of the watershed, therefore, they were not included in the future growth portion of the TMDL.

IDEM acknowledges that the U.S. Census data is county wide and may not accurately reflect the growth rate/potential within the Cicero Creek watershed, but does include the data as recognition that there is potential for future growth in Hamilton and Tipton Counties within the watershed.

Source Discussion

Point Sources for *E. coli*

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are six (6) NPDES permitted facilities in the Cicero Creek watershed (Figure 5, Table 2). Five (5) dischargers have *E. coli* limits in their permits. The remaining one (1) facility does not have a sanitary component. Facilities that do not discharge *E. coli* are not required to be assigned a wasteload allocation (WLA) for *E. coli*. Following is a list of the NPDES facilities, including their permit numbers and a summary of violations.

- Tipton County Landfill (IN0061441): Does not have a sanitary component to their permit.
- Tipton WWTP (IN0021474): Has a sanitary component with no exceedances of *E. coli* in the last three years.
- Atlanta WWTP (IN0022306): Since April 2008 during the 18 months of recreational season and reporting, this facility has violated the geometric mean seven (7) times, with geometric means as high

as 2420 and single sample maximums reported at 2419.6. A Notice of Violation and Proposed Agreed Order letter was sent out April 21, 2011 and is discussed in more detail below.

- Arcadia WWTP (IN0021334): Since April 2008 during the 18 months of recreational season and reporting, this facility has no exceedances of the geometric mean and only one exceedances of the single sample maximum with a value of 250 (the single sample maximum is 235).
- Sheridan WWTP (IN0031071): Since April 2008 during the 18 months of recreational season reporting, this facility has no exceedances of the geometric mean and no exceedances of the sample maximum.
- Gas America (IN0059943): Since April 2008 during the 18 months of recreational season reporting, this facility has no exceedances of the geometric mean and only two exceedances of the single sample maximum with values of 300 and 2419.6 (the single sample maximum is 235), which does not trigger an enforcement action.

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

There are five (5) municipal separate storm sewer system (MS4) communities in Hamilton County: Hamilton County (INR040066), Town of Cicero (INR040066-Co-Permittee with Hamilton County), City of Noblesville (INR040127), City of Westfield (INR040109), and the Town of Arcadia (INR040004). Sheridan and Atlanta are incorporated into Hamilton County's MS4 permit. There are no municipal separate storm sewer system (MS4) communities within the watershed in Boone, Tipton, or Clinton Counties (R. Korthals, IDEM MS4 Coordinator, Personal Communication, July 2011).

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 is one (1) CSO community and two (2) SSO communities within the Cicero Creek watershed. The City of Tipton has a CSO community. The Town of Atlanta and the Town of Cicero contain the two (2) SSO communities in the watershed.

The City of Tipton, in October 2008, was issued an Agreed Order regarding the eight (8) CSO outfalls and requires the City of Tipton to submit a Long Term Control Plan (LTCP) to be effective not later than October 30, 2030. In March 2010, the City of Tipton submitted their LTCP. The plan was approved on July 9, 2010. The city plans to use a combination of several controls to be constructed over the next ten years at a cost of $6.2M. Some proposed projects include the elimination of CSOs 007 and 009, upgrades to the WWTP to treat wet weather flows. The city has committed to the elimination or capture for treatment of no less than 85% by volume of the combined sewage collected in the CSO system during wet weather events in a typical year.

The Town of Atlanta, in April 2011, was issued a Notice of Violation (NOV) and Proposed Agreed Order (AO) due to a determination that violations exist. The NOV was issued in part to a Sanitary Sewer Overflow from June 15, 2010 through July 3, 2010, which was not reported orally within 24 hours or in writing within five days of the

event. The Town of Atlanta has 60 days to respond to the NOV by June 21, 2011. IDEM officials have met with and are working towards the best solution. In a letter dated June 15, 2011, the Town of Atlanta informed IDEM that the town has voted to proceed with a grant application to improve the situation.

In June 1998, the Town of Arcadia started the separation of its combined sewer system and finished phase I in October 1998. Phase II separation of its combined sewer system began in March of 1999 and completed in September 1999. Arcadia has had in the past a combined CSO with an overflow, with the separation of the system completed; Arcadia now has a separate wastewater collection system and a separate storm sewer system.

The Town of Cicero has a Sewage Treatment plant which discharges directly to Morse Reservoir. There have been no recorded violations at this facility and inspections have had positive results.

Concentrated Animal Feeding Operations (CAFOs)

There are six (6) active CAFOs within the Cicero Creek watershed, five are located in Tipton County and one is located in Hamilton County (Table 13).

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 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.

Nonpoint sources for *E. coli*:

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 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 System

Failing septic tanks are known sources of *E. coli* and 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.

Hamilton County:

On-site sewage disposal is a large portion of the work completed by the Environmental Health Division. Sewage effluent is a concoction of many things such as pathogenic microorganisms, which are capable of causing a variety of diseases such as hepatitis, cholera, E. coli, etc., leading to illness or even death if untreated. These contaminants are illegally discharged from homes often by means of old field tile connections and/or surface failures finally making their way to surface and drinking water supplies of Hamilton County. The goal of the health department is to identify such unlawful conditions and abate the conditions through regulatory enforcement. Water sample results and positive dye tests of homes confirm investigations of possible sewage discharges.

Septic systems installed in Hamilton County are regulated, permitted and inspected by the Health Department. Sizing of septic systems is based on the number of bedrooms and bedroom equivalents multiplied by one hundred fifty gallons per day per bedroom and divided by the soil-loading rate as specified in Indiana State Department of Health Rule 410 IAC 6-8.2. The soil-loading rate is determined during a site inspection performed by a Registered Soil Scientist. An update list of soil scientist and registered septic installers is available by contacting the Hamilton County Health Department.

Tipton County:

Tipton County addresses septic complaints through a specialist. The specialist will visit the site, inspect, and take pictures of a site where a complaint was filed and give a 60-90 day notice to fix the problem should a violation exist. After the 60-90 days, the specialist will return to verify if the issue has been addressed. If the issue is not addressed the health department will send a second notice informing the landowner the issue is being sent to the county board for review and further action that can include up to $500/day for first offense and up to $1000/day for subsequent offenses. Tipton County can fine the installers if the system was installed improperly.

Boone and Clinton Counties were not addressed in the discussion on septic systems due to the small area of representation.

Confined Feeding Operations (CFOs)

There are seven (7) active CFOs within the Cicero Creek watershed, four are located in Tipton County and three are located in Hamilton County (Table 13).

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 feeding operation 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, and are required to have no discharge to waters of the State.

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 Cicero Creek watershed are shown in Figure 7.

It was noted during the watershed tour 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, and 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 Cicero Creek watershed.

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.

Urban Runoff

Runoff from urban areas (urban, residential, commercial or industrial land uses) can contribute *E. coli* to local water bodies. Stormwater from urban areas, which drain impervious surfaces, may introduce bacteria to surface waters. Urban bacteria sources can include wildlife or pet wastes.

Linkage Analysis and *E. coli* Load Duration Curves

The linkage between the *E. coli* concentrations in the Cicero Creek 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 Cicero Creek watershed indicates that a significant amount of the *E. coli* and phosphorus load enters the Cicero Creek watershed through both wet (nonpoint) and dry (point) weather sources.

To investigate further the potential sources mentioned above, an *E. coli* duration curve analysis, as outlined in an unpublished paper by Cleland (2002), was developed for each of the 41 (reservoir sites were not included) sampling sites in the Cicero Creek watershed (Attachments C, D, 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 Cicero Creek near Cicero, Indiana (0335000) was utilized. The Cicero Creek gage station is located on Cicero Creek at Mt. Pleasant Rd approximately 2.5 miles upstream of Morse Reservoir. Due to the uncertainty of extrapolated flows, gage flow values were used to calculate the loadings for all sites.

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 geometric mean standard of 125 *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 area are 90% greater than what is seen most of the time. These flows represent flooding or near flooding stages of a stream. These flows are exceeded 0 – 10 % of the time.

Higher Flows: Flows in this range, to the local observer, might be indicated as near bank full conditions. These flows are exceeded 10 – 40 % of the time.

"Normal" Flows": Normal flows are the "typical" flows an observer would see on an "average" day. These flows are exceeded 40 – 60% of the time.

Lower Flows/Drier Conditions: To the observer, these conditions are seen when the stream begins to "dry up" or have less than "average" type flows. These flows are exceeded 60 -90 % of the time.

Very Low Flows: Flows in this range are the lowest of all flows, typically seen in drought-like conditions or even no water at times. These flows correspond are exceeded 90 -100 % of the time, where all flows recorded are typically higher than these flows.

Load duration curves were created for all the sampling sites in the Cicero Creek watershed (Figure 3, Attachment C, D, E). These sampling sites were sampled for *E. coli* August through September 2006. The data indicate that the largest exceedances of the *E. coli* WQS were prevalent during all flow conditions and weather events (noted by diamonds above the curve on the far left side of the figure in Attachment D).

Subwatershed Summary Tables

Impaired segments are listed in the Tables 2 - 11 and include the following information: impaired segment ID, drainage area, sampling sites, listed segments, land use, NPDES facilities, MS4 community, CSO communities, CFO's, Load Allocations, Wasteload Allocations, and Margin of Safety values for *E. coli*. For simplicity, the last three bolded numbers of the HUC in each table correlate to the three-digit code in Figure 8.

Table 2: Prairie Creek TMDL Summary
(HUC12- 051202010**601**)

Upstream Characteristics					
Drainage Area	23.64 square miles				
TMDL Sample Site	28, 33, 34, 37, 38				
Listed Segments	INW0161_00				
Land Use	Ag: 98.372% Forest: 0.299% Urban: 0.019% Water: 0.0% Wetland: 1.307%				
NPDES Facilities	None located in subwatershed				
MS4 Communities	None located in subwatershed				
CSO Communities	None located in subwatershed				
CAFOs	None located in subwatershed				
CFOs	David Glunt (ID# 1416), Becks Hybrids (ID# 2231)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1989.444	423.872	148.630	30.277	7.432
WLA	NA	NA	NA	NA	NA
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257

Table 3: Cicero Ditch TMDL Summary
(HUC12- 051202010**602**)

Upstream Characteristics					
Drainage Area	20.60 square miles				
TMDL Sample Site	19, 27, 31, 32, 36				
Listed Segments	INW0162_01, INW0162_01A				
Land Use	Ag: 97.983% Forest: 0.136% Urban: 0.0% Water: 0.019% Wetland: 1.861%				
NPDES Facilities	None located in subwatershed				
MS4 Communities	None located in subwatershed				
CSO Communities	None located in subwatershed				
CAFOs	Michael & Nancy Cline (ID# 4384), Autumn Rose LLC (ID# 4848)				
CFOs	Somerset Farm (ID# 4353)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1989.444	423.872	148.630	30.277	7.432
WLA	NA	NA	NA	NA	NA
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257

Table 4: Dixon Creek-Cicero Creek TMDL Summary
(HUC12- 051202010**603**)

Upstream Characteristics					
Drainage Area	17.20 square miles				
TMDL Sample Site	26, 30, 59				
Listed Segments	INW0163_01, INW0163_T1001				
Land Use	Ag: 98.376% Forest: 0.022% Urban: 0.11% Water: 0.026% Wetland: 1.466%				
NPDES Facilities	None located in subwatershed				
MS4 Communities	None located in subwatershed				
CSO Communities	None located in subwatershed				
CAFOs	Stafford Farms (ID# 2032)				
CFOs	None located in subwatershed				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1989.444	423.872	148.630	30.277	7.432
WLA	NA	NA	NA	NA	NA
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257

Table 5: Buck Creek-Cicero Creek TMDL Summary
(HUC12- 051202010**604**)

Upstream Characteristics					
Drainage Area	18.54 square miles				
TMDL Sample Site	23, 24, 25				
Listed Segments	INW0164_01, INW0164_T1001, INW0164_T1002				
Land Use	Ag: 95.277% Forest: 0.182% Urban: 3.284% Water: 0.0% Wetland: 1.231%				
NPDES Facilities	None located in subwatershed				
MS4 Communities	None located in subwatershed				
CSO Communities	Tipton				
CAFOs	Phil Overdorf Farms Inc (ID# 710)				
CFOs	None located in subwatershed				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1989.444	423.872	148.630	30.277	7.432
WLA	NA	NA	NA	NA	NA
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257

Table 6: Tobin Ditch-Cicero Creek TMDL Summary
(HUC12- 051202010**605**)

Upstream Characteristics					
Drainage Area	32.96 square miles				
TMDL Sample Site	20, 21, 22, 29, 35, 60				
Listed Segments	INW0165_01, INW0165_01A, INW0165_T1001, INW0165_T1002, INW0165_T1003				
Land Use	Ag: 95.463% Forest: 0.551% Urban: 1.684% Water: 0.0% Wetland: 2.302%				
NPDES Facilities	Tipton WWTP (IN0021474) Tipton County Landfill (IN0061441)* Atlanta WWTP (IN0022306)				
MS4 Communities	None located in subwatershed				
CSO/SSO Communities	Tipton, Atlanta**				
CAFOs	Schoettmer Prime Pork Farm Inc (ID# 4087)				
CFOs	R&A Swine (ID# 3731), A&J Livestock LLC (ID# 711)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1995.033	429.461	154.219	35.866	13.021
WLA	3.287	3.287	3.287	3.287	3.287
MOS (10%)	222.036	48.083	17.501	4.350	1.812
TMDL = LA+WLA+MOS	2220.355	480.831	175.007	43.503	18.120
* This facility does not receive a portion of the WLA (non-sanitary permit) **Atlanta's SSO outfall is in **605**					

Table 7: Weasel Creek-Cicero Creek TMDL Summary
(HUC12- 051202010**606**)

Upstream Characteristics					
Drainage Area	21.40 square miles				
TMDL Sample Site	54, 55, 56, 57				
Listed Segments	INW0166_01, INW0166_T1001, INW0166_T1002				
Land Use	Ag: 93.563% Forest: 1.238% Urban: 1.088% Water: 0.077% Wetland: 4.033%				
NPDES Facilities	Arcadia WWTP (IN0021334)				
MS4 Communities	Atlanta (1.40%), Arcadia (2.53%)				
CSO Communities	None located in subwatershed				
CAFOs	Bryant Premium Pork LLC (ID# 2683)				
CFOs	Bryant Premium Pork LLC (ID# 841)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1902.225	405.131	141.929	28.752	6.907
WLA*	88.513	20.035	7.996	2.819	1.820
MOS (10%)	221.193	47.241	16.658	3.508	0.970
TMDL = LA+WLA+MOS	2211.932	472.407	166.583	35.079	9.696
WLA includes a 3.94% area of the watershed allocated to the MS4 areas.					

Table 8: Teter Branch-Little Cicero Creek TMDL Summary
(HUC12- 051202010**607**)

Upstream Characteristics					
Drainage Area	20.81 square miles				
TMDL Sample Site	39, 40, 58				
Listed Segments	INW0167_01, INW0167_T1001				
Land Use	Ag: 96.618% Forest: 0.392% Urban: 0.622% Water: 0.059% Wetland: 2.308%				
NPDES Facilities	Sheridan WWTP (IN0031071)				
MS4 Communities	Sheridan (1.93%)				
CSO Communities	None located in subwatershed				
CAFOs	None located in subwatershed				
CFOs	None located in subwatershed				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1946.574	414.516	145.167	29.346	6.990
WLA	44.999	11.485	5.593	3.060	2.571
MOS (10%)	221.286	47.333	16.751	3.601	1.062
TMDL = LA+WLA+MOS	2212.859	473.335	167.511	36.007	10.623
WLA includes a 1.93% area of the watershed allocated to the MS4 areas.					

Table 9: Little Cicero Creek TMDL Summary
(HUC12- 051202010**608**)

Upstream Characteristics					
Drainage Area	22.49 square miles				
TMDL Sample Site	4, 52, 53				
Listed Segments	INW0168_01, INW0168_T1001, INW0168_T1002				
Land Use	Ag: 96.046% Forest: 0.767% Urban: 0.018% Water: 0.019% Wetland: 3.15%				
NPDES Facilities	None located in subwatershed				
MS4 Communities	None located in subwatershed				
CSO Communities	None located in subwatershed				
CAFOs	None located in subwatershed				
CFOs	None located in subwatershed				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1989.444	423.872	148.630	30.277	7.432
WLA	NA	NA	NA	NA	NA
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257

Table 10: Hinkle Creek TMDL Summary
(HUC12- 051202010**609**)

Upstream Characteristics					
Drainage Area	20.10 square miles				
TMDL Sample Site	41, 42, 43				
Listed Segments	INW0169_01, INW0169_T1001				
Land Use	Ag: 92.024% Forest: 5.061% Urban: 0.445% Water: 0.0% Wetland: 2.469%				
NPDES Facilities	Gas America (IN0059943)				
MS4 Communities	Westfield (west) (1.43%)				
CSO Communities	None located in subwatershed				
CAFOs	None located in subwatershed				
CFOs	None located in subwatershed				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows*
LA	1352.550	288.175	101.048	20.584	5.052
WLA	636.894	135.697	47.582	9.693	2.379
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257
WLA includes a 1.43% area of the watershed allocated to the MS4 areas.					

Table 11: Morse Reservoir-Cicero Creek TMDL Summary
(HUC12- 051202010**610**)

Upstream Characteristics					
Drainage Area	27.66 square miles				
TMDL Sample Site	46, 47, 48, 51				
Listed Segments	INW016A_01, INW016A_T1001, INW016A_T1002, INW016A_T1003				
Land Use	Ag: 80.59% Forest: 4.23% Urban: 2.164% Water: 8.131% Wetland: 4.881%				
NPDES Facilities	None located in subwatershed				
MS4 Communities	Noblesville (28.69%), Cicero (5.23%), Westfield (east) (2.08%)				
CSO/SSO Communities	Cicero*				
CAFOs	None located in subwatershed				
CFOs	None located in subwatershed				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1193.299	254.245	89.151	18.160	4.458
WLA*	796.145	169.627	59.480	12.116	2.974
MOS (10%)	221.049	47.097	16.514	3.364	0.826
TMDL = LA+WLA+MOS	2210.493	470.968	165.145	33.641	8.257
WLA includes a 36.02% area of the watershed allocated to the MS4 areas. *Cicero is an SSO community.					

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 and 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 recalculated to account for the new facility.

To further investigate sources of pollution, *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 a weather station in Noblesville, IN and managed by the Indiana State Climate Office at Purdue University.

While there are point source contributions, compliance with the numeric *E. coli* WQS in the Cicero Creek 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 in Cicero Creek 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 Cicero Creek 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 Cicero Creek watershed. For the Cicero Creek 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. The *E. coli* portion of the TMDL is concentration-based consistent with USEPA regulations at 40 CFR, Section 130.2(i).

Wasteload Allocations

As previously mentioned, there are six (6) NPDES permitted facilities in the Cicero Creek watershed (Figure 5, Table 2). Five (5) dischargers have *E. coli* limits in their permits. The remaining one (1) does not have a sanitary component. The WLA assigned to those *E. coli* permitted facilities was set at the WQS of 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.

There are five (5) municipal separate storm sewer system (MS4) communities in Hamilton County: Hamilton County (INR040066), Town of Cicero (INR040066-Co-Permittee with Hamilton County), City of Noblesville (INR040127), City of Westfield (INR040109), and the Town of Arcadia (INR040004). All of the NPDES permitted MS4 communities were assigned a WLA of 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. Sheridan and Atlanta are incorporated into Hamilton County's MS4 permit. There are no municipal separate storm sewer system (MS4) communities within the watershed in Boone, Tipton, or Clinton Counties.

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). All NPDES permitted MS4 communities' WLA were set at the Water Quality Standard for *E. coli* based on the percentage, by land area, of the MS4 community in each subwatershed. The WLA was calculated, based on the load duration curve, and the MS4 WLA allotment was calculated based on the percentage, of land area, which the MS4 community occupies within the subwatershed. IDEM assigned WLAs attributed to MS4 influences at high flow conditions. IDEM assumed that stormwater runoff was more likely to impact urbanized areas during storm events.

IDEM does not require a GIS shapefile for MS4s and MS4s can modify the boundaries via letter to the MS4 coordinator, incorporated areas were used in the absence of a GIS shapefile from the municipalities. However, Hamilton County has confirmed that the MS4 boundaries are consistent with their incorporated areas. Hamilton County also provided a GIS layer showing the extent of their current incorporated areas. Until such time that more accurate spatial GIS shapefiles are provided, the TMDL is limited to estimates like incorporated areas.

CAFOs fall under WLA; however, under permit conditions, CAFOs are prohibited from discharging; therefore, they are not designated a portion of the WLA. CAFOs received a WLA of 0 MPN per 100 mL.

CSO and SSO received a WLA of 0 MPN per 100 mL.

In the event that designated uses and associated water quality criteria applicable to the Cicero Creek are revised in accordance with applicable requirements of state and federal law, this TMDL may be revised to be consistent with such revisions.

Load Allocations

The LA for *E. coli* nonpoint sources is equal to the WQS of 125MPN 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 E). Individual LA were not assigned to potential nonpoint sources (ex. wildlife, septics, livestock in stream environments, etc.). The LA were combined into a singular LA for each AUID.

There are seven (7) active CFOs within the Cicero Creek watershed, four are located in Tipton County and three are located in Hamilton County (Table 13). CFOs fall under state regulation and have no discharge permits; therefore, CFOs fall under LA and have a LA of zero (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 Cicero Creek 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 an implicit MOS by applying a couple of conservative assumptions. First, no rate of decay for *E. coli* was applied. *E. coli* bacteria have a limited capability of surviving outside of their hosts and therefore, a rate of decay normally would be applied. However, applying a rate of decay could result in a discharge limit that would be greater than the *E. coli* WQS, thus no rate of decay was applied. Second, the *E. coli* WQS was applied to all flow conditions. IDEM determined that applying the *E. coli* WQS of 125 per one hundred milliliters to all flow conditions and with no rate of decay for *E. coli* is a more conservative approach that provides for greater protection of the water quality. This adds to the MOS for this TMDL.

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 Cicero Creek 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 Impaired Water List (303(d) list).

Reasonable Assurance Activities

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

Watershed Projects

Hamilton County

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

Local: $205,522
Clean Water Indiana: $19,861
Wildlife Habitat Cost-Share Program: $ 513
Conservation Reserve Program: $179,105
Environmental Quality Incentives Program: $36,277

Three years of significant changes have caused the Hamilton County Soil and Water Conservation District (SWCD) to reinvent the way they do business.

Major changes included three different moves (three new addresses), two different phone numbers, relocation of their federal partners, a 25 percent reduction in staff, and a 16 percent reduction in basic funding. As a result they have had to "think outside the box" in order to maintain the many valuable services they provide to Hamilton County taxpayers. After much brainstorming with staff and SWCD board members, they were able to redesign the SWCD, and not only continue to offer the traditional services of the past, but add new programs as well.

They have developed two fairly new programs: the Agricultural Stewardship Initiative (ASI), and the Backyard Conservation Program (BYC). With both an urban and a rural population in Hamilton County they felt this emphasis was needed. Both programs have seen success, with the BYC showing the greater numbers, in correlation with the local population base.

In addition to these programs, the SWCD has initiated a new sales and services program. Several conservation products are offered under this program, with the most popular being rain barrels and compost bins. Interest in this area is growing as more county residents are becoming aware of these products. In addition, they are now offering a Soil Testing and a Water Testing program. Customers can elect to have the SWCD visit their site and take samples in person, or they can take them and drop them off at the SWCD office.

All of these efforts are starting to show success and broaden their customer base. However, one of the greatest obstacles has been just getting the word out and letting people know what they have to offer. That is where having a good relationship with the local media is important. They strive to keep the doors of communication open with local newspapers, submitting articles on a regular basis, and inviting them to events.

Another area they have prided themselves in over the years is their Annual Meeting and Workshop. Rather than just offering the basics and satisfying the minimum requirements (e.g. public election, report of activities, financial report, etc.) they have broadened the event to offer several breakout sessions, a keynote speaker, a catered meal, exhibits, etc. They strive to offer an event that attendees consider worthwhile to attend, and this has attracted the attention of county officials, department heads and members from other Conservation Partners.

The District also charges admission for certain events and therefore works even harder to make sure they are worthy to attend. This is another way to weather budget cuts and dwindling funds.

Tipton County

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

Local: $31,085
Clean Water Indiana: $16,375
Wildlife Habitat Cost-Share Program: $1,000
Conservation Reserve Program: $228,344
Conservation Stewardship Program: $501,401
Environmental Quality Incentives Program: $185

The Tipton County Soil and Water Conservation District (SWCD) was established in 1974. The District strives to encourage every person to wisely use and protect the county's soil and water through proper land use and watershed management, urban and agricultural.

Educating the public is a key element in encouraging the proper use of our natural resources. The Tipton County SWCD provides workshops in septic system maintenance, backyard conservation, soil quality, filter strips, cover crops and other topics, including natural resource educational programs at local schools.

Through the Clean Water Indiana (CWI) grant program, the Tipton County SWCD offers a cost-share program for closing abandoned wells. The District also was able to purchase a no-till drill to plant filter strips and cover crops. The District is a big promoter of the Conservation Reserve Program (CRP) and Conservation Reserve Enhancement Program (CREP). In 2010, they conducted a soil quality workshop featuring national speakers and a cover crop test plot and soil pit.

The Tipton County SWCD, in partnership with the Howard County SWCD, received a 2011 CWI grant to participate in the On-Farm Network Project. This project addresses nonpoint source pollution caused by a high level of agricultural production. Multiple 14-digit watersheds in the project area are listed on the IDEM 303d for List of Impaired Water Bodies for concerns including: impacted biotic communities, nutrients, phosphorus, *E. coli*, ammonia, dissolved oxygen and algae. IDEM developed total maximum daily loads (TMDLs) for the Upper, Middle and Lower Wildcat Creek Watersheds. The Wildcat Creek Watershed has also been targeted by the Mississippi River Basin Initiative due to its contribution to hypoxia in the Gulf of Mexico.

The District works with their partners and watershed coordinators to ensure that the resources of today are here for tomorrow. They are proud to collaborate with the: USDA Natural Resources Conservation Service (NRCS), Indiana Association of Soil and Water Conservation Districts, County Drainage Board, Planning Commission, Commissioners, Health Department, Indiana Department of Natural Resources, State Soil Conservation Board, Indiana Department of Environmental Management, Farm Service Agency, Purdue Extension Service, National Association of Conservation Districts.

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 Cicero Creek watershed.

Storm Water General Permit Rule 13

There are five (5) municipal separate storm sewer system (MS4) communities in Hamilton County: Hamilton County (INR040066), Town of Cicero (INR040066-Co-Permittee with Hamilton County); City of Noblesville (INR040127), City of Westfield (INR040109), and the Town of Arcadia (INR040004). There are no municipal separate storm sewer system (MS4) communities within the watershed in Boone, Tipton, or Clinton Counties.

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 Cicero Creek 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.

Confined Feeding Operations and Concentrated Animal Feeding Operations

Confined feeding is the raising of animals for food, fur or recreation in lots, pens, ponds, sheds or buildings, where they are confined, fed and maintained for at least 45 days during any year, and where there is no ground

cover or vegetation present over at least half of the animals' confinement area. Livestock markets and sale barns are generally excluded.

Indiana law defines a confined feeding operation as any animal feeding operation engaged in the confined feeding of at least 300 cattle, 500 horses, or 600 swine or sheep, or 30,000 fowl, such as chickens, turkeys or other poultry. The Indiana Department of Environmental Management (IDEM) regulates these confined feeding operations, as well as smaller operations which have violated water pollution rules or laws, under IC 13-18-10, the Confined Feeding Control Law. IDEM's Office of Land Quality administers the regulatory program which includes permitting, compliance monitoring and enforcement activities. IDEM regulation 327 IAC 16 regulating confined feeding was adopted by the Water Pollution Control Board on November 14, 2001 and became effective on March 10, 2002.

Due to size or historical compliance issues some confined feeding operations are defined as concentrated animal feeding operations (CAFOs). The CAFO general permit regulation, 327 IAC 15-15 and the individual permit regulation 327 IAC 5-4-3 were adopted on Jan. 14, 2004 and went into effect on March 24, 2004. The CAFO regulations are based upon a U.S. EPA Clean Water Act regulation that went into effect in December 2003. 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. Details regarding CAFOs will follow the description of requirements for confined feeding operations.

CFO/CAFO Environmental Issues

The animals raised in confined feeding operations produce manure and wastewater which is collected and stored in pits, tanks, lagoons and other storage devices. The manure is then applied to area fields as fertilizer. When stored and applied properly, this beneficial reuse provides a natural source of nutrients for crop production. It also lessens the need for fuel and other resources that are used in the production of commercial fertilizer.

Confined feeding operations, however, can also pose environmental concerns, including the following:

- Manure can leak or spill from storage pits, lagoons or tanks
- Improper application of manure to the land can impair surface or ground water quality

The IDEM CFO/CAFO approval/permit program is based on the Confined Feeding Control Law administered through regulations adopted under the Water Pollution Control Board. The focus of the regulations is to protect water quality. The program is intended to provide an oversight process to assure that waste storage structures are designed, constructed and maintained to be structurally sound and that manure is handled and land applied in an environmentally acceptable manner.

CFO and CAFO 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.

Watershed Management Plans

IDEM Watershed Specialists are available to assist stakeholders with facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the Cicero Creek watershed.

The Upper White River Watershed Alliance is spearheading a comprehensive watershed plan which includes all of Cicero Creek, Little Cicero Creek, and other plans within the larger Upper White River Watershed. According to their website:

"A variety of locally-driven watershed studies have been conducted in the larger Upper White River Watershed in recent years. Many of these studies are watershed management plans (WMPs) that have worked to identify critical areas and strategies for water quality improvement. Some of the WMPs have active local steering committees and/or on-going cost-share programs. In addition to these Plans, hundreds of other ecological and hydrologic studies have been completed on the White River and/or its tributaries."

A Lake and River Enhancement Watershed Management Plan was completed in February 2011 and was approved by IDEM as meeting the 2009 Watershed Management Plan Checklist. The executive summary states:

"The Upper White River Watershed Alliance and the Morse Waterways Association has received funding from the Department of Natural Resources, Division of Fish and Wildlife Lake and River Enhancement Program for a Watershed Management Plan (WMP) for the Morse Reservoir and the 10-digit HUC 0512020106 Cicero Creek watershed in Hamilton, Boone, Tipton and Clinton Counties, Indiana. Cicero Creek has its origins in southeast Clinton County and flows northeast through Tipton County before turning south and flowing through central Hamilton County. The watershed also encompasses portions of Boone County. The Morse Reservoir/Cicero Creek Watershed consists of approximately 144,343 acres of mixed land use of which approximately 1,500 acres is Morse Reservoir. Morse Waterways Association (MWA) was founded in May 2005 to serve the Morse Reservoir community by promoting safety and the environment. As a means for achieving the goals of promoting safety and the environment, the Association is operating in partnership with the Upper White River Watershed Alliance (UWRWA), and in alignment with local and state agencies/organizations goals in the development of this Watershed Management Plan. A Steering Committee of stakeholders within the watershed was organized to work with MWA and UWRWA to develop and implement the Watershed Management Plan.

The Morse Reservoir/Cicero Creek Watershed Management Plan (WMP) is intended as a guide for the protection and enhancement of the environment and quality of the watershed while balancing the different uses and demands of the community on this natural resource. This plan will address items such as:

- education and outreach
- increasing preservation, restoration and protection of this vital system
- increasing cooperation, coordination and collaboration among all stakeholders in the watershed
- maintaining a solid organization to look to the welfare of this important natural resource

The WMP follows the Indiana Department of Environmental Management (IDEM) requirements for watershed management plans, including sections on: watershed inventory, identifying problems, identifying causes, sources and load reductions, setting goals and identifying critical areas, choosing measures and BMPs to apply, creating an action register and schedule, and tracking effectiveness."

Additional plans can be found at (www.uwrwa.org/explore/watershedStudies.asp).

TMDLs

Currently, there are no additional TMDL projects within the Cicero Creek Watershed basin.

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 streambanks and riverbanks with a buffer zone of vegetation, either 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 sit'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

There was a public Kickoff Meeting held on May 25, 2011 at the Hamilton East Public Library where the public was invited to submit any additional bacteria data and informed of the TMDL process. A second Kickoff meeting was presented to the Hamilton County Drainage Board on June 27, 2011 at the County Building.

There was a public Draft TMDL Meeting held on August 2, 2011 at the Hamilton East Public Library.

The public comment period lasted from August 2, 2011 to September 2, 2011.

Conclusion

The sources of *E. coli* to the Cicero Creek watershed include both point and nonpoint sources. In order for the Cicero Creek watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the Cicero Creek 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 Cicero Creek 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 through locally led endeavors.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Cicero Creek watershed into compliance with the *E. coli* WQS. 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 Cicero Creek 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 Cicero Creek watershed.

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Cleland, B. 2002 TMDL Development from the "Bottom Up"-Part II. Using Duration Curves to Connect the Pieces. America's Clean Water Foundation.

Indiana State Climate Office. http://www.agry.purdue.edu/climate/. Accessed 2007.

Mississippi Department of Environmental Quality. 2002. Fecal Coliform TMDL for the Big Sunflower River, Yazoo River Basin.

U.S. Census, 2010, County Population data, http://www.census.gov/

USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

Table 12: NPDES Permits in the Cicero Creek Watershed

Permit	Name	Receiving Waters	Notes
IN0021334	Arcadia WWTP	Cicero Creek	*E. coli*
IN0063215	Tipton/Getrag Division E WWTP*	Dixon Creek	*E .coli*
IN0022306	Atlanta WWTP	Cicero Creek	*E. coli*
IN0021474	Tipton WWTP	Cicero Creek	*E. coli*
IN0031071	Sheridan WWTP	Symons Creek	*E. coli*
IN0059943	Gas America	Hinkle Creek	*E. coli*
IN0061441	Tipton County Landfill	Cicero Creek	Non-Sanitary
*Facility was never built			

Table 13: CFOs and CAFOs in the Cicero Creek Watershed

Permit Number	Permit Type	Operation Name	Status	Nursery Pigs	Finishers	Sows	Beef Cattle	Dairy Calves	Dairy Heifers	Layers
4384	CAFO	Michael & Nancy Cline	Active		5870					
4848	CAFO	Autumn Rose LLC	Active	1600	3400	796				
2032	CAFO	Stafford Farms	Active	1900	3600					
710	CAFO	Phil Overdorf INC	Active							480254
4087	CAFO	Schoettmer Prime Pork Farm INC	Active	3500	5868	1136				
2683	CAFO	Bryant Premium Pork LLC	Active	2000	2766	807				
1416	CFO	David Glunt	Active	400	830	42				
4353	CFO	Somerset Farm	Active	500	1190	511				
2231	CFO	Becks Hybrids INC	Active	950	350	42	150			
711	CFO	A & J Livestock LLC	Active				650			
843	CFO	Indiana Academy	Active					300	285	
3731	CFO	R&A Swine	Active		1500					
841	CFO	Bryant Premium Pork LLC	Active		1500					
			Total:	10850	26874	3334	800	300	285	480254

Figure 1: Cicero Creek Watershed

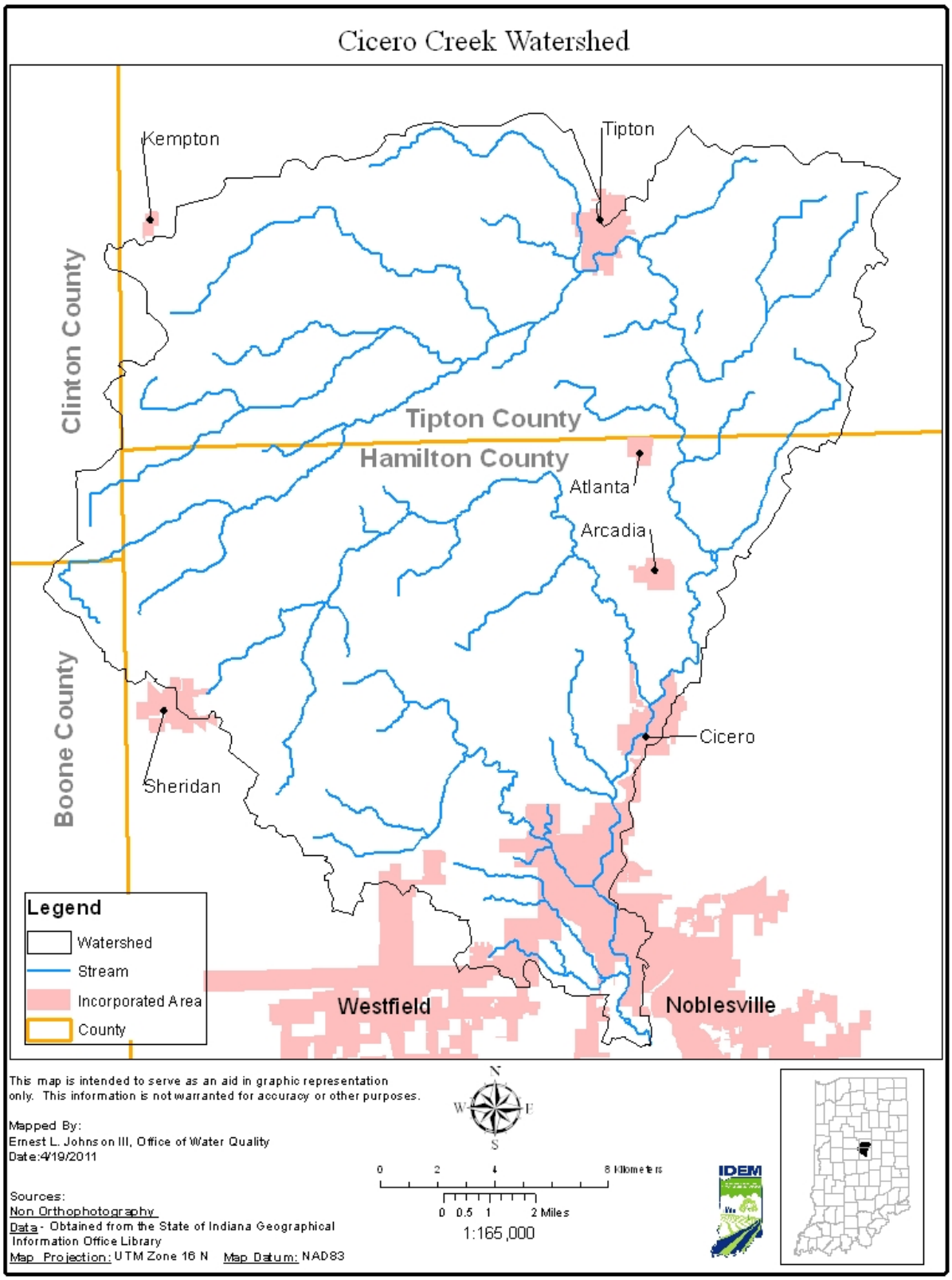


Figure 2: Sample Sites in the Cicero Creek Watershed

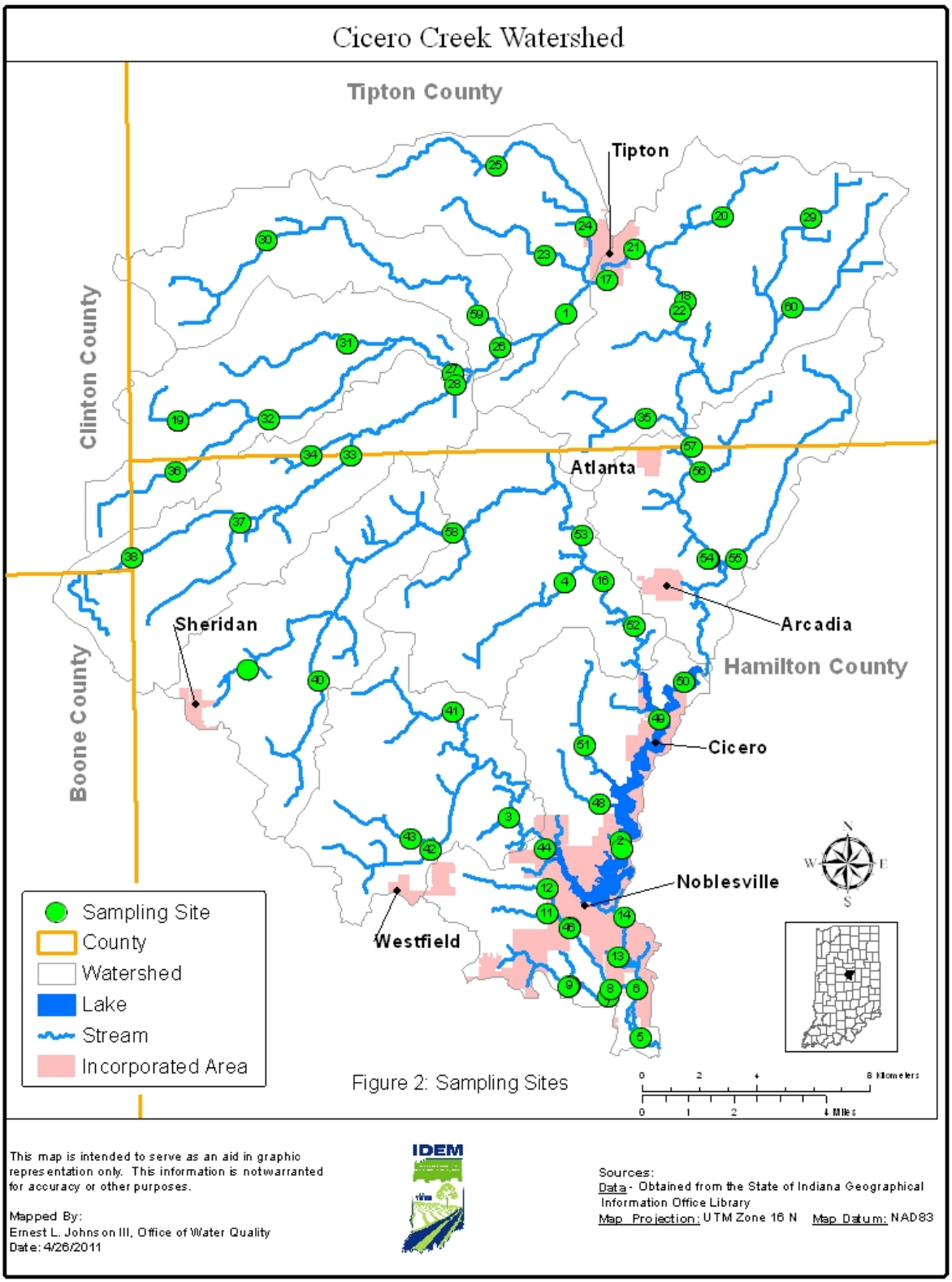


Figure 3: Impaired Streams in the Cicero Creek Watershed

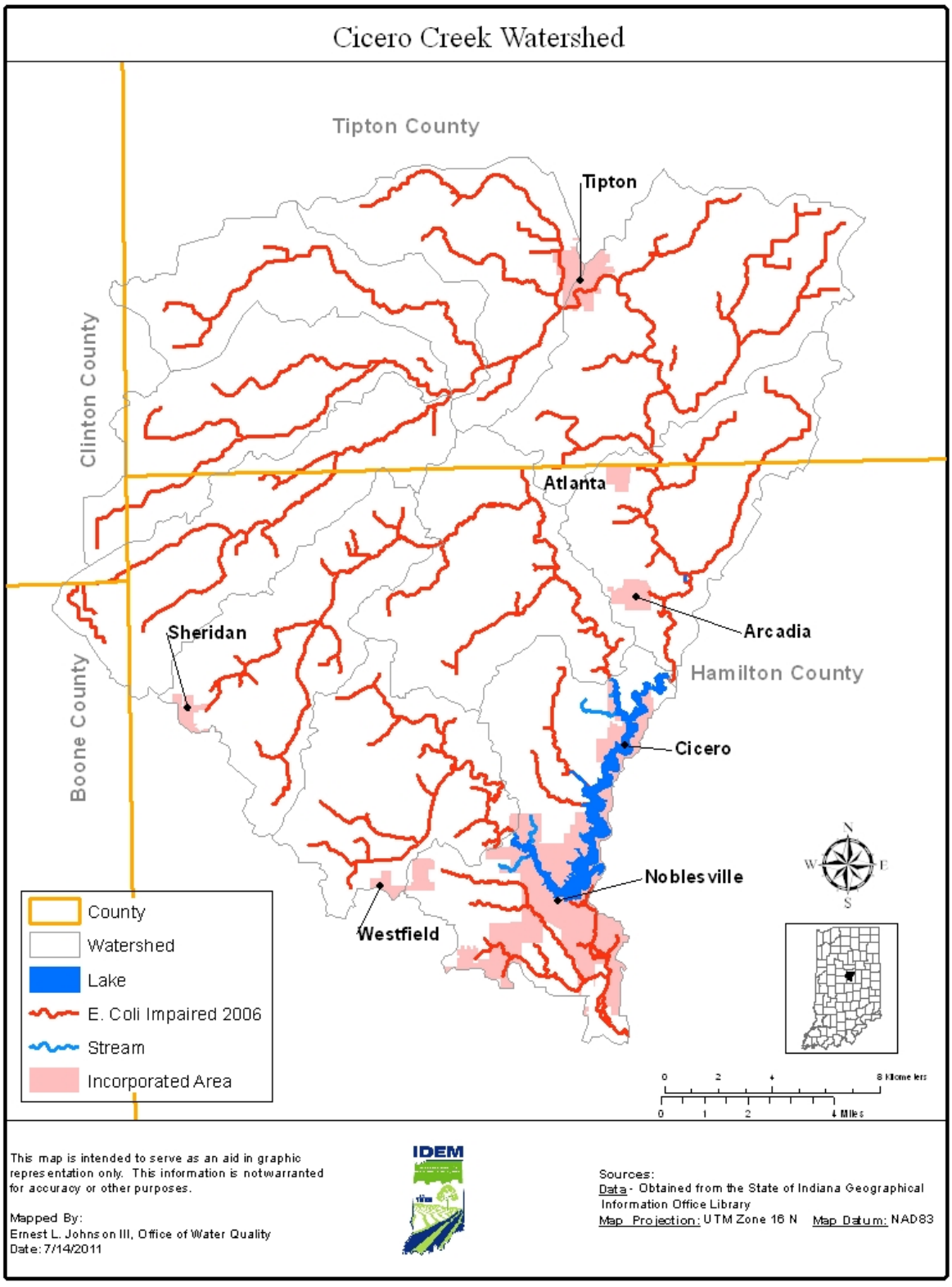


Figure 4: Land use in the Cicero Creek Watershed

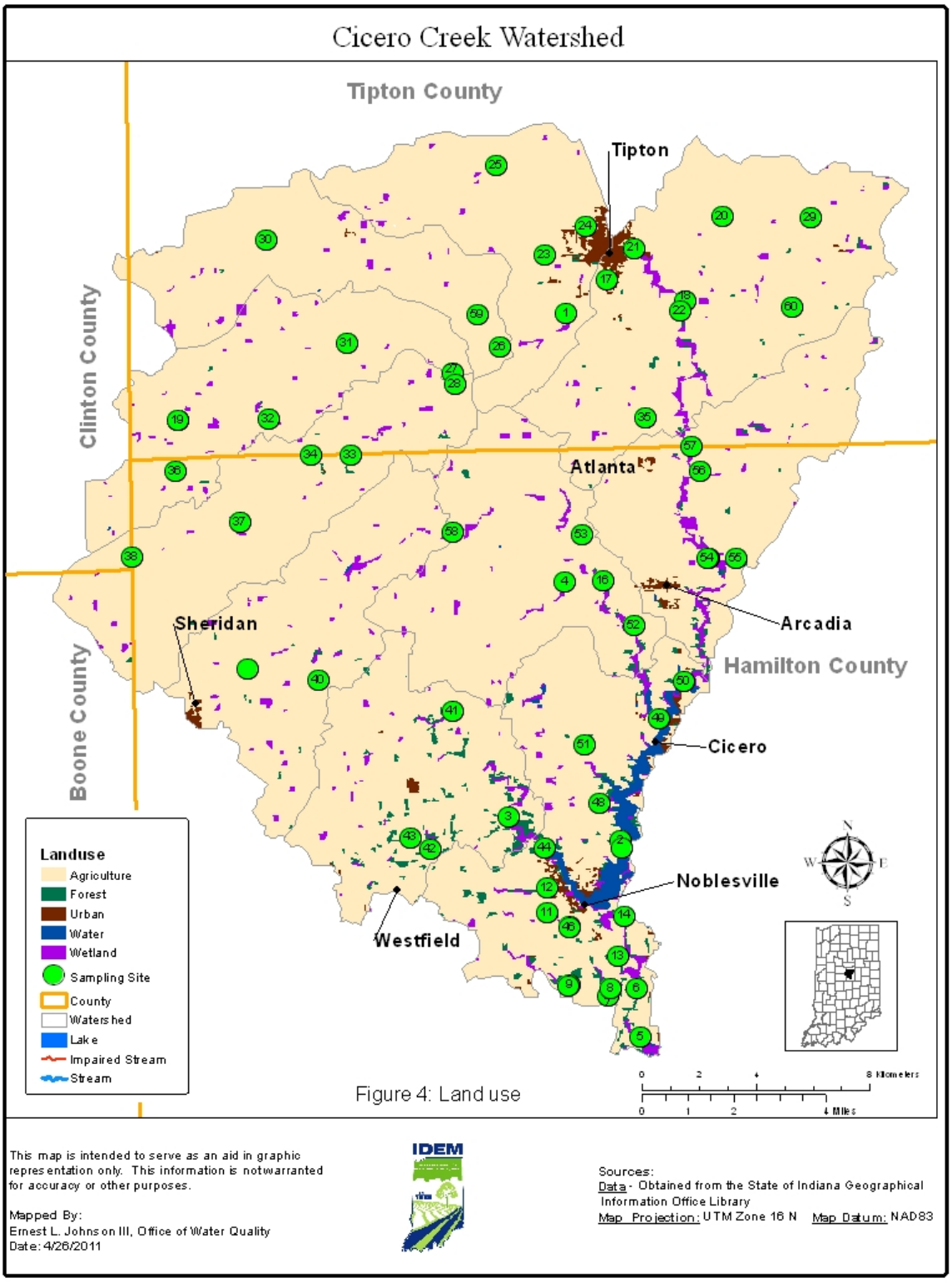


Figure 5: NPDES Permitted Facilities in the Cicero Creek Watershed

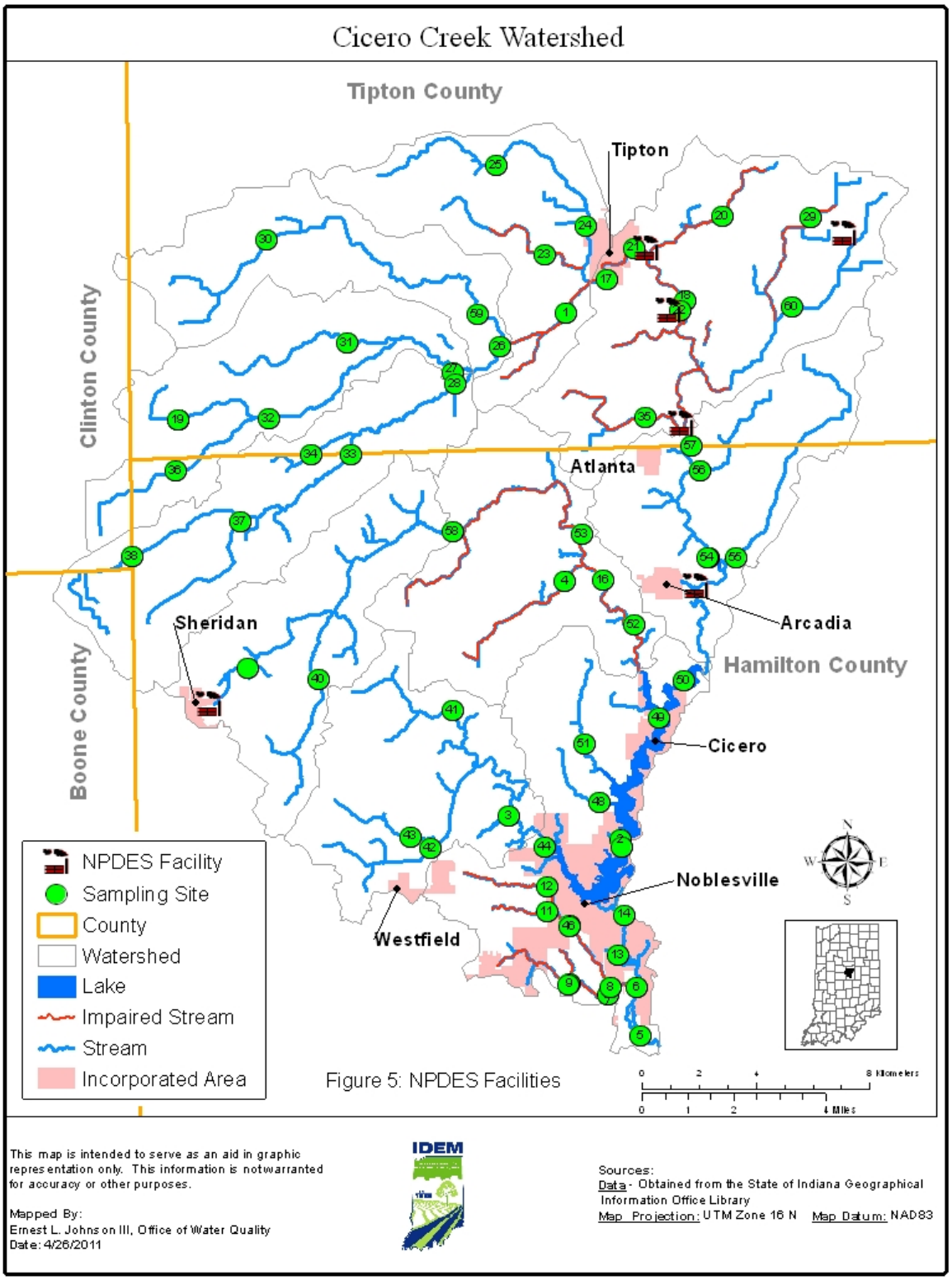


Figure 6: CSO/SSO Outfalls in the Cicero Creek Watershed

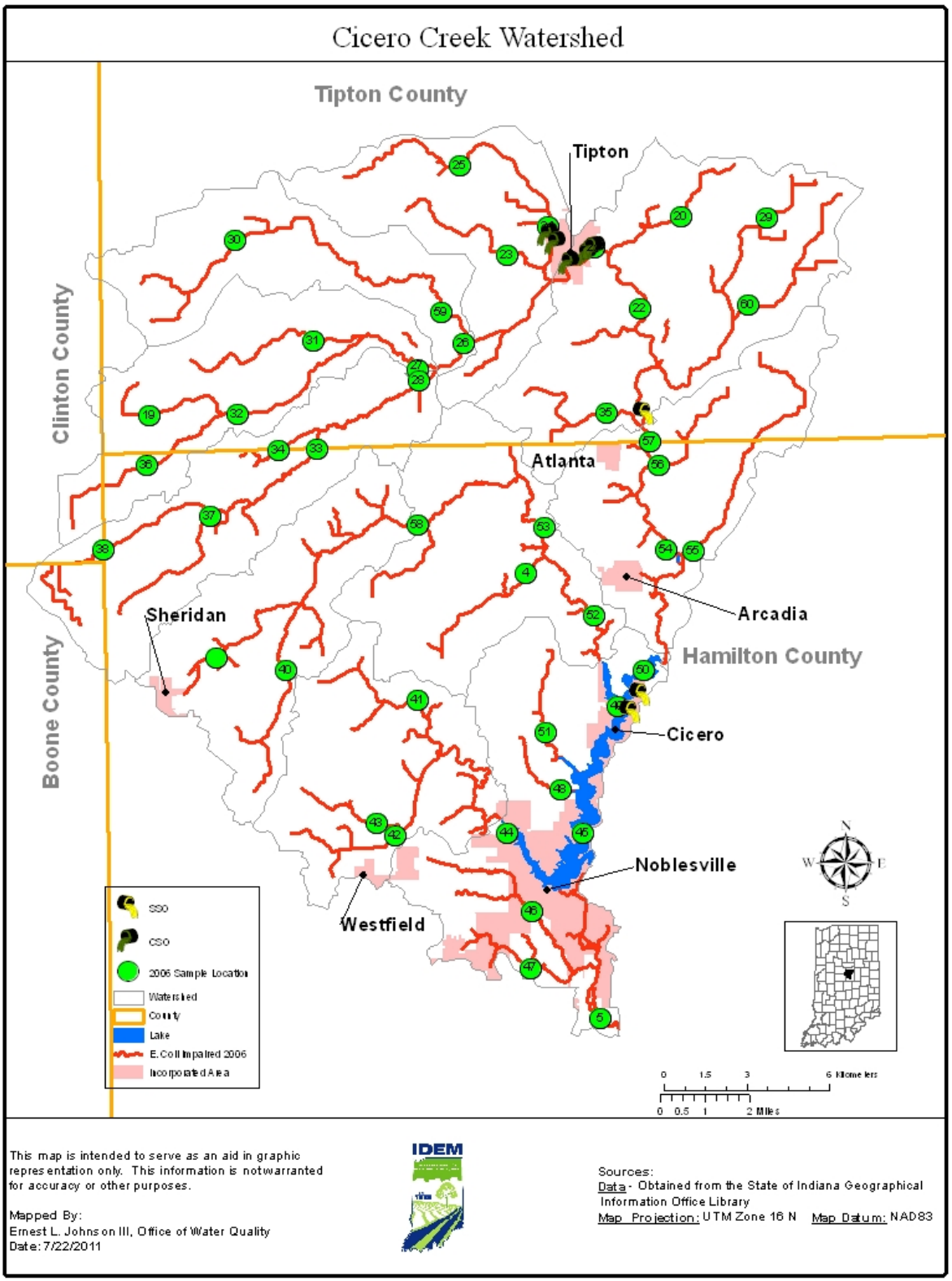


Figure 7: Concentrated Animal Feeding Operations in the Cicero Creek Watershed/Confined Feeding Operations in the Cicero Creek Watershed

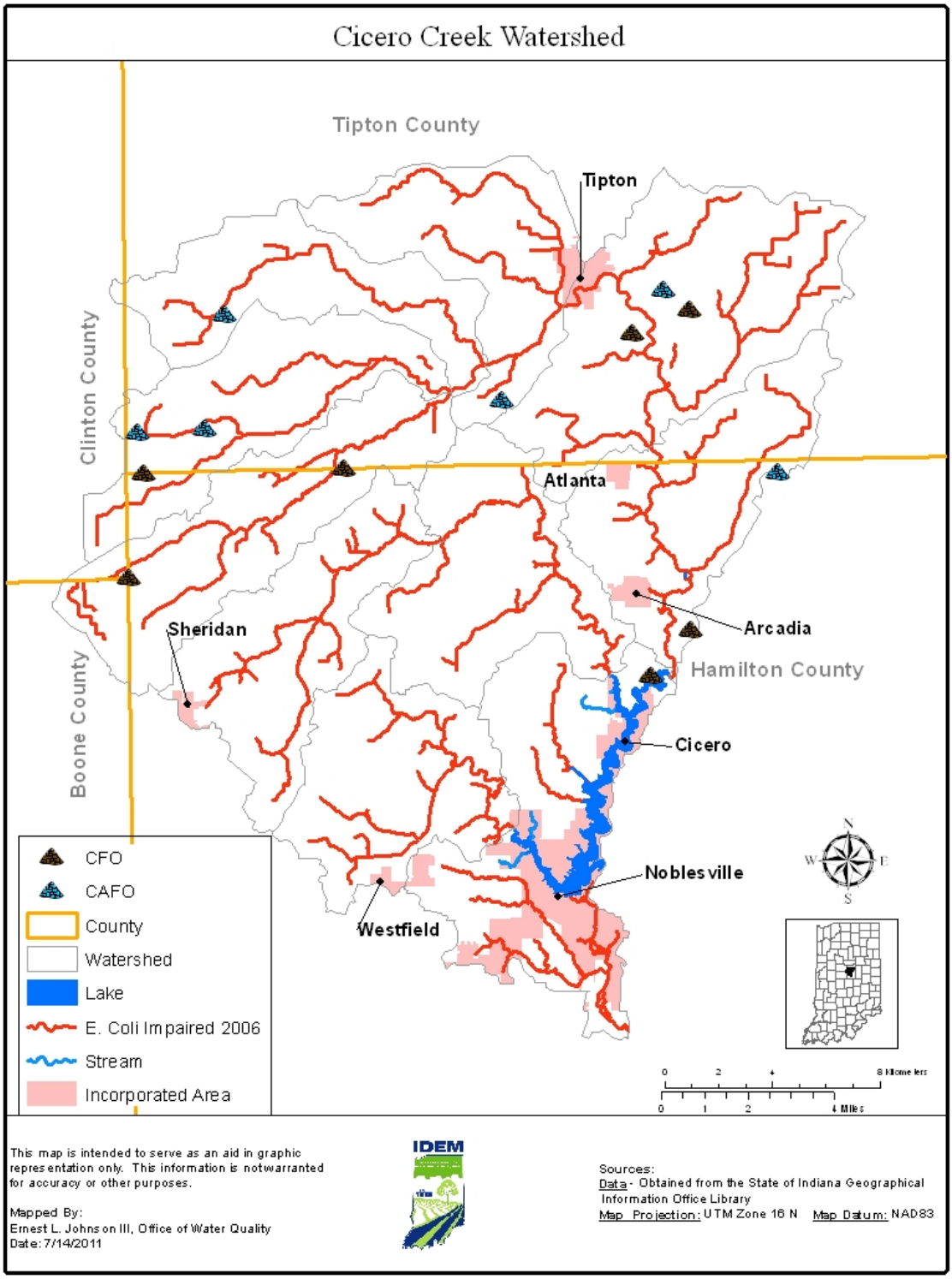
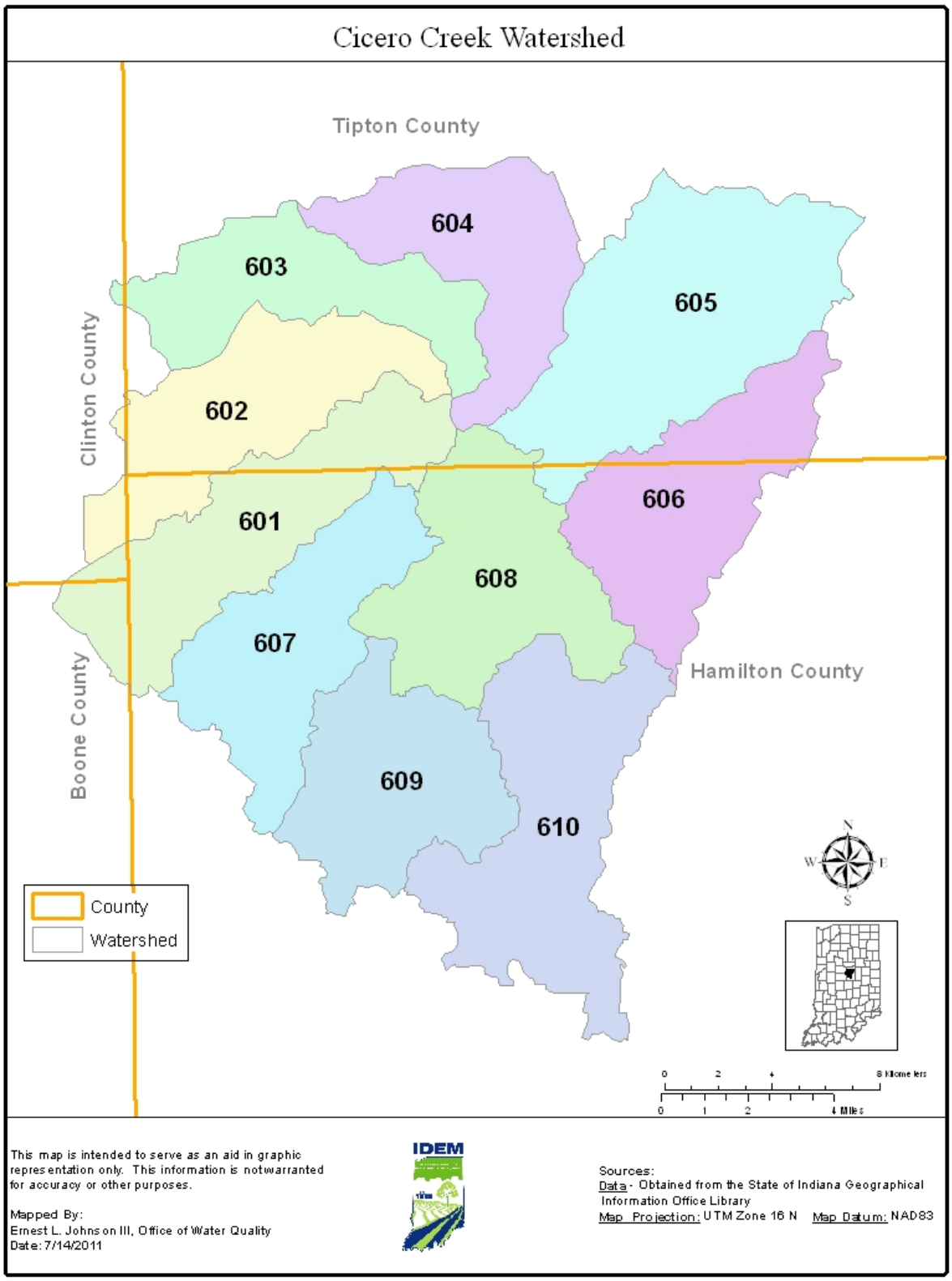


Figure 8: 12-Digit HUCs in the Cicero Creek Watershed



Attachment A

Bacteria Data for Cicero Creek Watershed TMDL

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Attachment B

Reassessment notes for the Cicero Creek Watershed TMDL

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Attachment C

Water Quality Graphs for the Cicero Creek Watershed TMDL

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Attachment D

Load Duration Curves for the Cicero Creek Watershed TMDL

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Attachment E

Precipitation Graphs for Impaired Sites in the Cicero Creek Watershed TMDL

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Attachment F

Load Reductions for the Cicero Creek Watershed TMDL

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Attachment G

IDEM's Segmentation Process

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