Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) in the Highland-Pigeon Creek Watershed and Total Phosphorous for Hurricane Creek, Gibson, Pike, Vanderburgh, Posey, and Warrick Counties

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Indiana Department of Environmental Management
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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 *E. coli* bacteria and total phosphorus that will result in the attainment of the applicable WQS for *E. coli* and targets for total phosphorus in the Highland-Pigeon Creek watershed in Gibson, Vanderburgh, Posey, Warrick, and Pike Counties in Indiana.

Background

In 2006, the portion of the Highland-Pigeon Creek watershed (Figure 3) flowing from Warrick Ditch to an unnamed tributary downstream, near site 2 and 13, was listed on Indiana's 303(d) list as impaired for *E. coli*. A reassessment of the reaches within the Highland-Pigeon Creek watershed, using data collected during the 2007, 2009/2010 sampling seasons, was completed by IDEM during the development of the Highland-Pigeon Creek TMDLs. This reassessment indicated that additional assessment units of the Highland-Pigeon Creek watershed were impaired for both *E. coli* and total phosphorous.

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.

This TMDL will address approximately eleven hundred fifty-six (1156) stream miles, of this three hundred and ninety-nine (399) stream miles are impaired in the Highland-Pigeon Creek watershed in Gibson, Vanderburgh, Posey, Warrick, and Pike Counties. Recreational uses are impaired by elevated levels of *E. coli* during the recreational season and aquatic habitat is impaired for phosphorus. The Highland-Pigeon Creek watershed is an eight digit Hydrologic Unit Code (HUC) unto itself (05140202), and is divided into twenty-four 12-digit HUC subwatersheds (Figure 8). The Highland-Pigeon Creek watershed is in southwest Indiana and sits on the Ohio River bordering Indiana and Kentucky (Figure 1). Figure 2 depicts all the waters in the watershed (unimpaired and not assessed). The red segments are impaired and the blue segments are the remaining unimpaired or non-assessed portion of the watershed. The impaired portions of the Highland-Pigeon Creek will be placed on the 303(d) list in 2012 in category 4e. The fifty-four (54) impaired assessment units (Table 1) for this TMDL are located in the Highland-Pigeon Creek basin hydrologic unit code 05140202 (Figure 3).

Table 1: Impaired Assessment Units in the Highland-Pigeon Creek Watershed

County	Stream Name	TMDL Site Number	AUID*	Segment length**	Impairment
Gibson	Hurricane Creek	2, 8	INE0211_02	10.88	*E. coli* TP***
			INE0211_T1001	5.41	*E. coli* TP***
			INE0211_T1003	3.85	*E. coli* TP***
	Pigeon Creek	4	INE0214_02	14.45	*E. coli*
	Pigeon Creek	6	INE0216_01	9.89	*E. coli*
	Sand Creek	3	INE0212_01	22.7	*E. coli*
			INE0212_01A	0.41	*E. coli*
			INE0212_02	2.99	*E. coli*
			INE0212_02A	0.84	*E. coli*
			INE0212_T1001	20.36	*E. coli*
			INE0212_T1002	3.66	*E. coli*
	Smith Fork	10	INE0217_01	1.62	*E. coli*
			INE0217_02	6.38	*E. coli*
			INE0217_T1001	12.86	*E. coli*
			INE0217_T1002	3.99	*E. coli*
			INE0217_T1005	7.22	*E. coli*
	Unnamed Trib to Big Creek	13	INE0222_T1002	7.23	*E. coli*
	West Fork Pigeon Creek	5, 7	INE0213_01	15.94	*E. coli*
			INE0213_02	6.97	*E. coli*
			INE0213_T1001	7.59	*E. coli*
			INE0213_T1002	13.25	*E. coli*
			INE0213_T1003	3.88	*E. coli*
			INE0213_T1004	9.74	*E. coli*
			INE0213_T1005	5.68	*E. coli*
Posey	Cypress Slough	32	INE0263_01	13.34	*E. coli*
			INE0263_02	16.39	*E. coli*
			INE0263_T1001	2.58	*E. coli*
			INE0263_T1002	2.65	*E. coli*
	McFadden	29	INE0263_T1005	10.07	*E. coli*
			INE0264_01	11.92	*E. coli*
Vanderburgh	Bayou Creek	33	INE0261_01	10.48	*E. coli*
			INE0265_T1008	1.51	*E. coli*
	Carpentier Creek	28	INE0241_T1003	7.02	*E. coli*
			INE0241_T1004	1.21	*E. coli*
	Locust Creek	24, 25	INE0233_01	15.42	*E. coli*
			INE0235_01	5.08	*E. coli*
			INE0234_01	5.23	*E. coli*
			INE0234_T1001	1.38	*E. coli*
			INE0234_T1002	1.33	*E. coli*
			INE0234_T1003	6.61	*E. coli*
			INE0234_T1004	0.67	*E. coli*

			INE0234_T1005	6.48	*E. coli*
			INE0234_T1006	2.95	*E. coli*
			INE0234_T1007	0.94	*E. coli*
	Pigeon Creek-Kleymeyer Park	21	INE0231_02	13.55	*E. coli*
			INE0236_02	3.62	*E. coli*
	Unnamed Tributary-Bayou Creek	35	INE0261_T1003	13.59	*E. coli*
Warrick	Bluegrass Creek	27	INE0233_T1001	1.48	*E. coli*
			INE0231_T1001	2.83	*E. coli*
			INE0232_01	13.33	*E. coli*
	Pigeon Creek	16	INE0223_01	26.21	*E. coli*
			INE0223_02	26.21	*E. coli*
	Pigeon Creek	18, 19	INE0224_01	13.5	*E. coli*
			INE0224_T1002	10.63	*E. coli*

*AUID: Assessment Unit ID
**Segment Length: Length of the Segment
***TP: Total Phosphorous

IDEM conducted a survey of the Highland-Pigeon Creek watershed for *E. coli* in 2007 and for nutrients in September 2009, October 2009, and May 2010. Sites were sampled for *E. coli* September 4, 2007 through October 2, 2007 (Figure 3; Attachment A & G). *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 Highland-Pigeon Creek watershed during the 2007-2010 sampling period were reassessed by IDEM's 303(d)/305(b) Coordinator in March 2011 (Attachment I). Of the thirty-five (35) sites which were sampled for water quality between 2007-2010, thirteen (13) sites, Sites 1, 9, 11, 12, 14, 15, 20, 22, 23, 26, 30, 31, and 34 did not violate the monthly geometric mean for *E. coli* (125 MPN/100 mL). All other sites sampled violated the *E. coli* geometric mean of 125 MPN[1] (Most Probable Number)/100 mL. Sites 1, 9, 14, 15, 30, and 34 did not violate the single sample maximum of 235 MPN/ 100 mL. All other sites violated the single sample maximum of 235 MPN/ 100 mL at least once and overall the single sample maximum was violated 41.7% of the time.

Twenty-nine (29) sites were sampled three times in 2009-2010 for nitrogen and phosphorus. Several sites (1, 14, 30, and 34) were not included from the original 35 due to accessibility limitations. Review of the water quality sampling data from 2009-2010 revealed that the nitrogen benchmark of 10 mg/L was not exceeded. At this time, there are no water quality impairments related to nitrogen in the Highland-Pigeon Creek watershed. Eighteen (18) sites had single exceedances of the phosphorous benchmark 0.30 mg/L but only one site (Site 8, Assessment Units INE0211_02, INE0211_T1001, and INE0211_T1003) had multiple exceedances in a single sample which triggers an impairment according to IDEM's listing criteria and could be then reassessed as impaired for total phosphorus. Nitrogen at this location was at the benchmark of 10 mg/l and therefore triggered an impairment. There are no load reductions for Nitrogen at this site. The sample result is equal to the target value of 10 mg/l therefore, no reductions are necessary. This indicates that the stream is not capable of receiving any additional nitrogen. A nutrient

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

impairment is triggered when there are two or more exceedances in a single sample of total phosphorous, total nitrogen, or dissolved oxygen.

Water quality data collected by IDEM's Assessment Branch in 2005 indicated high levels of *E. coli* in the Highland-Pigeon Creek watershed. Violations ranged from 248 MPN/100 mL to greater than 2420 MPN/100 mL (Figure 2; Attachment B). Eight of the ten samples taken in April and May of 2005 at both sites (TMDL Sites 2 and 13) exceed the single sample maximum.

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, additional water quality sampling within the Highland-Pigeon Creek watershed, and a local request from the Vanderburgh County Soil and Water Conservation District (SWCD) for watersheds they are proposing to implement a watershed management plan (Personal Communication N. Duckworth, Vanderburgh County SWCD, 2007).

A data request to all counties and known watershed groups was made however, the only additional data received was from Vanderburgh County SWCD and the Pigeon Creek Canoeist group which provided Hoosier Riverwatch *E. coli* data. Hoosier Riverwatch data, although useful for education and local decision making purposes, does not meet the rigor to be used for IDEM's listing or de-listing purposes. However, the data can be used to validate the data collected by IDEM against data collected by local groups to determine whether or not the data are in the same range. For example, IDEM data is much more rigorous and can return values to the tenths, where as Hoosier Riverwatch data are limited to groups of 50, i.e. 50 cfu's, 100 cfu's, 150 cfu's, etc.

Water Quality Standards and Numeric Targets

One of the designated uses for the waterbodies in the Highland-Pigeon 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 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.

Aquatic Habitat Use total phosphorus water quality target

High phosphorus concentrations can impact both recreation and the aquatic community. While phosphorus is a nutrient that is needed for plant growth, excessive inputs can lead to algae blooms that affect aesthetics of the water body and impair its support of swimming. High levels of photosynthesis (from algae or plants) can lead to supersaturation of dissolved oxygen during the day, since a by-product of photosynthesis is oxygen. At night, the plants and algae do not produce

oxygen, but they still use oxygen for cellular respiration, and therefore oxygen concentrations can drop. When the plants and algae decompose, the decomposition process can lower oxygen levels in the water, at times so low that aquatic life, such as macroinvertebrates and fish, suffers. The water quality target for total phosphorous should not exceed 0.30 mg/L.

Source Assessment

Watershed Characterization

The description of the study area, its topography, and other particulars are as follows:

Waters in the Highland-Pigeon Creek watershed flow south and southwest from the headwaters to the Ohio River. The waters in Highland-Pigeon Creek watershed flow through five (5) Indiana Counties. The watershed is located in Vanderburgh County (30.8%); Gibson County (27.7%), Warrick County (24.3%), Posey County (17.0%) and Pike County (0.3%) (Figure 1).

Land Use

Land use information was assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 67.3% of the land use in the Highland-Pigeon Creek watershed was agriculture. The remaining land use for the Highland-Pigeon Creek watershed consisted of approximately 15.3% Forest, 6.1% Wetland, 1.9% Water, and 9.4% Urban (Figure 4). Site visits during the sampling events confirm that this watershed is still primarily agricultural with mixtures of forest and wetland uses and some additional suburban growth along the city limits.

Future Growth:
According to the 2010 Census data (U.S. Census, 2010), There has been a slight positive growth rate. Vanderburgh County increased population by 7,781 or 4.33% from 2000 to 2010. Posey County decreased in population by 1,151 or -4.44% from 2000 to 2010. Warrick County increased population by 7,305 or 12.24% from 2000 to 2010. Gibson County increased population by 1,003 or 2.99% from 2000 to 2010. Pike County only accounts for 0.3% of the watershed and was 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 Highland Pigeon Creek watershed, but does include the data as recognition that there is potential for future growth.

Source Discussion (Point and Nonpoint sources for *E. coli* and total phosphorus)

Point Sources for *E. coli*

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are nineteen (19) NPDES permitted facilities in the Highland-Pigeon Creek watershed (Figure 5, Table 2). Thirteen (13) dischargers have *E. coli* limits in their permits. The remaining six (6) do not have a sanitary component and are currently not required to monitor or report nitrogen and phosphorous levels. Facilities that do not discharge *E. coli* are not required to have a WLA for *E. coli*. IDEM currently does not require a total phosphorous limit on facilities that do not discharge to a lake watershed. IDEM is currently working on nutrient standards.
Following is a list of the NPDES facilities, including their permit numbers and a summary of violations.

- Air Liquide Industries (IN0001970): *E. coli* permitted facility: has no reported *E. coli* violations in the past 5 years.
- Chandler Municipal WWTP (IN0020435): *E. coli* permitted facility: reported one *E. coli* violation in 2004, 2005, 2006, two *E. coli* violations in 2007 and three *E. coli* violations in 2008.
- Elberfeld Municipal WWTP (IN0020788): *E. coli* permitted facility: reported two *E. coli* violations in 2008.
- Haubstadt Municipal WWTP (IN0021482): *E. coli* permitted facility: has no reported *E. coli* permit violations in the past five years.
- Town of Fort Branch WWTP (IN0022896): *E. coli* permitted facility: has no reported violations in the previous three years for *E. coli*. Fort Branch monitors for Total Nitrogen and has had no values above 0.5 mg/L over the previous five years.
- KOA Kampground (IN0029963): *E. coli* permitted facility: has reported *E. coli* violations during all of the 2008 recreational season and two violations in 2006. The 2008 permit renewal includes monitoring and limits for Ammonia-nitrogen.
- Mount Vernon WWTP (IN0035696): *E. coli* permitted facility: has no reported *E. coli* permit violations in the past 5 years.
- Mount Vernon Transfer Term LLC (IN0049760) Does not have a sanitary component to their discharge. This facility is currently not required to monitor or report nitrogen and phosphorous levels.
- Midstates Rubber Production (IN0004880) Does not have a sanitary component to their discharge. This facility is currently not required to monitor or report nitrogen and phosphorous levels.
- AC Ranch Mobile Home Park (IN0039608): *E. coli* permitted facility: has no reported *E. coli* permit violations in the past 5 years.
- Creekside Court Mobile Home Park WWTP (IN0039616): *E. coli* permitted facility: has no reported *E. coli* or TRC permit violations in the past 5 years.
- Lynnville Municipal WWTP (IN0040282): *E. coli* permitted facility: has no reported *E. coli* permit violations in the past 5 years.
- Harbortown Subdivision Sanitary (IN0109924): *E. coli* permitted facility: has no reported *E. coli* or TRC permit violations in the past 5 years.
- Twin Lakes Mobile Home Park (IN0044491): *E. coli* permitted facility: has *E. coli* violations throughout 2006.
- GAF Building Materials Mfg Crop (IN0051667 Does not have a sanitary component to their discharge. This facility is currently not required to monitor or report nitrogen and phosphorous levels.
- MARRS Elementary School (IN0055255): *E. coli* permitted facility: reported two *E. coli* violations a year in 2006, 2007, and 2008.
- Indiana Hardwoods Inc-Non-Sanitary (IN0058530)-Permit is set to expire April 2011. This facility is currently not required to monitor or report nitrogen and phosphorous levels.
- Tin Lizzie Car Wash-Non-Sanitary (IN0059838)-Permit expired in 2008. This facility is currently not required to monitor or report Nitrogen and Phosphorous levels.
- Industrial Services Mgt Inc-Non-Sanitary (IN0060160)-This facility is currently not required to monitor or report Nitrogen and Phosphorous levels.

<u>Municipal Separate Storm Sewer Systems (MS4):</u> Storm Water General Permit Rule 13

There are five (5) municipal separate storm sewer system (MS4) communities in Vanderburgh County: University of Southern Indiana (INR040028), Vanderburgh County (INR040030), City of Evansville (INR040057), Ivy Tech State College-Southwest (INR040060), and University of Evansville (INR040058).

There are three (3) municipal separate storm sewer system (MS4) communities in Warrick County: Town of Chandler (INR40053), Warrick County (INR040065), and Town of Newburgh (INR040062). The Town of Newburgh MS4 does not fall within the Highland-Pigeon Creek watershed addressed in this TMDL.

There are no municipal separate storm sewer system (MS4) communities in Gibson, Posey, or Pike 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)

> 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 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.

<u>Combined Sewer Overflows (CSO) and Sanitary Sewer Overflows (SSO)</u>

There are three CSO/SSO communities in the Highland-Pigeon Creek watershed, Evansville (CSO), Mount Vernon (CSO), and Fort Branch (CSO).

Fort Branch was previously an SSO community but has closed their SSO and is no longer considered an SSO community. There are no other SSO communities in this watershed.

Evansville is developing an Integrated Overflow Control Plan (IOCP) to control CSOs and eliminate SSOs in accordance with requirements in a federal consent decree (3:09CV128 WTL-WGH). Under the terms of the decree, Evansville will evaluate different CSO control alternatives and submit the IOCP no later than November 30, 2012 (Email communication J Garrad, Evansville Water & Sewer Utility, June 2012).

Mount Vernon has completed Phase I of their Long Term Control Plan (LTCP). The city should be in the process of acquiring construction permits for Phase II. To date, Mount Vernon has three CSO's (002-004), CSO 004 has been permanently closed (Personal Communication: T. Trinkle, IDEM-OWQ, 2011). CSO's 002 and 003 are still in use and will be addressed through further compliance with their Long Term Control Plan.

Fort Branch has a CSO. In 2007, Fort Branch had a revoke/reissue permit, which reflected an upgrade to their facility and elimination of the one SSO. Therefore, Fort Branch is no longer an SSO community, but for purposes of this TMDL, it was important to discuss this community's effort (Personal Communication: J. House, IDEM-OWQ, 2011).

Confined Feeding Operations (CFOs) and Concentrated Animal Feeding Operations (CAFOs)

There are five (5) active CFOs and three (3) active CAFOs within the Highland-Pigeon Creek watershed (Table 20). In addition, it was noted during the sampling runs and a watershed tour that there are many unpermitted small operations present in the watershed. These operations, due to their small size, are not regulated under the CFO or CAFO regulations. These operations may still have an impact on the water quality and the *E. coli* and phosphorus impairment. No specific information on these small livestock operations is currently available for the Highland-Pigeon Creek watershed however; it is believed that these small livestock operations may be a source of the *E. coli* and phosphorous impairments.

Point Sources for Total phosphorus:

Wastewater Treatment Plants (WWTP): Wastewater treatment facilities may contribute phosphorus loads to surface waters through facility discharges of treated wastewater. Permitted treatment facilities must discharge treated wastewater according to their National Pollutant Discharge Elimination System (NPDES) permit.

WWTP KOA Kampground (IN0029963): Phosphorus inputs from the KOA Kampground may contribute phosphorus loading to the Hurricane Creek subwatershed.

Indiana has yet to establish a Water Quality Standard for nutrients, to include phosphorous. Indiana is currently working on a nutrient standard, therefore characterization of the effluent from the WWTP for phosphorus has not been established. It is recommended that nutrient monitoring be added to the facilities within the Highland-Pigeon Creek watershed, that influence the phosphorus impaired segment, for their next permit renewal

Nonpoint sources for *E. coli*:

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.

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

Gibson County issued 60 new septic permits and inspected 44 in 2009 and 74 new septic permits were issued and 48 inspections were completed in 2010 (Personal Communication B. Dye General Sanitarian Gibson County Health Department, 2011).

Vanderburgh County issued 26 new septic permits and 38 repair inspections in 2009 and 36 new septic permit inspections and 44 repair inspections were completed in 2010 (Personal Communication T. Wildeman, 2011).

Posey County issued 38 new permit inspections and nine repairs in 2009 and 47 new septic inspections and 19 repair inspections were completed in 2010 (Personal Communication D. Shafer 2011).

Warrick County issued 46 new permits, 7 repair order permits and 41 inspections with 6 of those being repair inspections in 2009 and 40 new septic permits, 15 repair order permits, and 64 inspections with 12 of those being repair inspections were completed in 2010 (Personal Communication J. Ayscue, 2011).

Pike County has less than two square miles in the Highland-Pigeon Creek TMDL watershed and a visual survey of the 2005 aerial photographs revealed three homes in the watershed but not close enough to a stream to be of any effect. Therefore, Pike County is not considered to have any impact in the Highland-Pigeon Creek watershed TMDL due to failing septic systems.

Small livestock operations: Smaller animal facilities, especially the non-CFO and non-CAFO facilities, may 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 and nutrients. 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. Mid-sized animal facilities are regulated by IDEM as Confined Feeding Operations (CFO), which are required to have no discharge to waters of the State.

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 Highland-Pigeon 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 facilities may add bacteria to surface waters via wastewater from these facilities or 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.

Nonpoint sources for total phosphorus:

Internal loading: The release of phosphorus from stream bottom sediments, the release of phosphorus via physical disturbance from benthic fish (rough fish, ex. carp), and the release of phosphorus from decaying pondweeds, can all contribute internal phosphorus loading to surface waters in the Highland-Pigeon Creek watershed.

Agricultural sources (Pasture and Open Lands): Phosphorus may be added via surface runoff from upland areas which are being used for agricultural purposes (ex. grasslands, croplands etc.). Other potential agricultural sources are related to stormwater runoff which can mobilize nutrients to surface waters from sources such as: livestock manure, fertilizers, decaying vegetation and organic soil particles.

Cropland can be a source of both sediments and nutrients. Accumulation of nutrients, to include nitrogen and phosphorous, on cropland occurs from decomposition of residual crop material, fertilization with chemical (e.g. anhydrous ammonia) and manure fertilizers, atmospheric deposition, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. The majority of nutrient loading from cropland occurs from fertilization with commercial and manure fertilizers (USEPA, 2003). Use of manure for nitrogen supplementation often results in excessive phosphorous loads relative to crop requirements (USEPA, 2003)

Livestock Sources: Phosphorus may be added from livestock sources via the mobilization and transportation of phosphorus laden materials from feeding, holding and manure storage areas.

Non-regulated stormwater runoff: Non-regulated stormwater runoff can add phosphorus to the watershed. The sources of phosphorus in stormwater include: decaying vegetation (leaves, grass clippings, etc.), domestic and wild animal wastes, soil particles, atmospheric deposited particles, phosphorus containing fertilizers, and other anthropogenic derived nutrients.

Inadequate Septic Systems: Phosphorus may be added to the surface waters in the Highland-Pigeon Creek watershed from failing septic systems. Age, construction and use of septic systems can vary throughout a watershed and influence the nutrient contribution from these systems. It is likely that those systems that are sited closer to the surface waters are more likely to contribute nutrients than those systems sited further away from surface waters.

Stream channel erosion: Phosphorus may be added to surface waters by soil erosion from stream bottoms and streambanks. Phosphorus may be attached to eroded streambank materials and may be mobilized through the transport of sediment and suspended solids.

Linkage Analysis and *E. coli* and phosphorus Load Duration Curves

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

To investigate further the potential sources mentioned above, an *E. coli* and phosphorus load duration curve analysis, as outlined in an unpublished paper by Cleland (2002), was developed for each of the 35 (29 for phosphorus due to site accessibility) sampling sites in the Highland-Pigeon Creek watershed (Attachments B, C, D). 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 Big Creek near Wadesville, Indiana (03378550) located in an adjacent watershed was used as a proxy. There are no USGS gage stations within the TMDL watershed. The Wadesville gage offers a watershed similar in size to individual 12-digit HUCs in the larger Highland-Pigeon Creek watershed. In addition to similar size, the topography of the Wadesville gage's watershed is similar to the Highland-Pigeon Creek watershed. The Highland-Pigeon Creek watershed is unique in that there are multiple outfalls to the Ohio River and not a singular point discharging to the Ohio River.

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 pollutants 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 curve representing the total phosphorous load was calculated using 0.03 mg/l. 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 Highland-Pigeon Creek watershed (Figure 3, Attachment B, C, D). These sampling sites were intensively sampled for *E. coli* September through October 2007. In addition to *E. coli* sampling, sites were sampled three times in 2009/2010 for Total Nitrogen and Total Phosphorous. The data indicate that the largest exceedances of the *E. coli* WQS were prevalent during wet weather events (noted by diamonds above the curve on the far left side of the figure in Attachment C). Dry weather contributions were also a source of *E. coli* to the Highland-Pigeon Creek watershed (noted by the diamonds above the curve on right side of the figure in Attachment C). However, the dry weather contributions were less influential in this watershed as indicated by the diamonds on the right side of the graph being near or under the WQS target line.

Impaired segments are listed in the Tables 2 - 18 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*, and Total Phosphorous. For simplicity, the last three bolded numbers of the HUC in each table correlate to the three-digit code in Figure 8.

Table 2: Hurricane Creek TMDL Summary
(HUC12- 051402020**101**)

Upstream Characteristics					
Drainage Area	16.26 square miles				
TMDL Sample Site	2, 8				
Listed Segments	INE0211_02. INE0211_T1001, INE0211_T1003				
Land Use	Agriculture: 88.6% Forest: 5.7% Urban: 4.6% Water: 0.2% Wetland: 1.0%				
NPDES Facilities	KOA Kampground (IN0029963) Haubstadt Municipal WWTP (IN0021482)				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1540.18	192.97	47.62	3.43	.55
WLA	3.86	3.86	3.86	3.86	3.86
MOS (10%)	171.56	21.87	5.72	.81	.49
TMDL = LA+WLA+MOS	1715.60	218.70	57.20	8.10	4.90
TMDL Allocations Phosphorus (pounds/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	742.66	94.49	24.64	3.29	0.27
WLA*	2.04	2.04	2.04	2.04	2.04
MOS (10%)	82.7	10.7	2.9	.59	.25
TMDL = LA+WLA+MOS	827.40	107.23	29.55	5.92	2.56
*TP WLA is estimated on the 0.3 mg/L benchmark. It is recommended that the facilities monitor for total phosphorous in their next permit cycle pending any new nutrient WQS to determine if there is any contribution to the impairment from the facilities.					

Table 3: Sandy Creek TMDL Summary
(HUC12- 051402020**102**)

Upstream Characteristics					
Drainage Area	17.49 square miles				
TMDL Sample Site	3				
Listed Segments	INE0212_01, INE0212_01A, INE0212_02, INE0212_02A, INE0212_T1001, INE0212_T1002				
Land Use	Agriculture: 90.4% Forest: 7.9% Urban: 0.9% Water: 0.01% Wetland: 0.9%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.04	196.74	51.39	7.2	0.9
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.56	21.86	5.71	.80	.10
TMDL = LA+WLA+MOS	1715.60	218.60	57.10	8.00	1.00

Table 4: West Fork Creek TMDL Summary
(HUC12- 051402020**103**)

Upstream Characteristics					
Drainage Area	29.79 square miles				
TMDL Sample Site	5, 7				
Listed Segments	INE0213_01, INE0213_02, INE0213_T1001. INE0213_T1002, INE0213_T1003, INE0213_T1004, INE0213_T1005				
Land Use	Agriculture: 95.0% Forest: 1.3% Urban: 3.1% Water: 0.2% Wetland: 0.4%				
NPDES Facilities	Town of Fort Branch WWTP (IN0022896)				
MS4 Communities	NA				
CSO Communities	Town of Fort Branch-One (1) SSO				
CAFOs	NA				
CFOs	Clay Hill Turkey Farm ID# 4522 (22,000 Turkeys)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.1	196.8	51.5	7.26	0.96
WLA	3.0	3.0	3.0	3.0	3.0
MOS (10%)	171.90	22.20	6.00	1.14	.44
TMDL = LA+WLA+MOS	1719.00	222.00	60.50	11.40	4.40

Table 5: Clear Fork Ditch-Pigeon Creek TMDL Summary
(HUC12- 051402020**104**)

Upstream Characteristics					
Drainage Area	17.74 square miles				
TMDL Sample Site	4				
Listed Segments	INE0214_02				
Land Use	Agriculture: 90.2% Forest: 3.1% Urban: 4.8% Water: 0.1% Wetland: 1.8%				
NPDES Facilities	Midstates Rubber Production Inc (IN0004880)*				
MS4 Communities	NA				
CSO Communities	Mid States Rubber Production-One (1) SSO				
CAFOs	NA				
CFOs	M&D Michel Turkeys ID#4524 (52,000 Turkeys)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.22	196.92	51.66	7.38	1.08
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.58	21.88	5.74	.82	.12
TMDL = LA+WLA+MOS	1715.8	218.8	57.4	8.2	1.2
*Does not have a sanitary component in permit.					

Table 6: Snake Run-Pigeon Creek TMDL Summary
(HUC12- 051402020**106**)

Upstream Characteristics					
Drainage Area	22.58 square miles				
TMDL Sample Site	6, 9				
Listed Segments	INE0216_01				
Land Use	Agriculture: 86.9% Forest: 8.5% Urban: 1.3% Water: 0.04% Wetland: 3.2%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	Obert Legacy Dairy ID# 6654 (900 Dairy Cattle, 80 Dairy Calves)				
CFOs	Stanley Michel ID# 3981 (1800 Nursery Pigs, 480 Finishers, 94 Sows, 11 Beef Cattle)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.04	196.74	51.39	7.2	0.9
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.56	21.86	5.71	.80	.10
TMDL = LA+WLA+MOS	1715.6	218.6	57.1	8.0	1.0

Table 7: Smith Fork-Pigeon Creek TMDL Summary
(HUC12- 051402020**107**)

Upstream Characteristics					
Drainage Area	17.60 square miles				
TMDL Sample Site	10				
Listed Segments	INE0217_01, INE0217_02, INE0217_T1001, INE0217_T1002, INE0217_T1003, INE0217_T1004, INE0217_T1005				
Land Use	Agriculture: 78.1% Forest: 8.2% Urban: 0.9% Water: 0.7% Wetland: 12.0%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	Schoonover Farms ID# 3719 (Finishers 8000)				
CFOs	Jeff Sevier Hog Farm ID# 175 (200 Nursery Pigs, 800 Finishers, 106 Sows) Schurmeier Farms Inc ID# 912 (360 Nursery Pigs, 1600 Finishers, 16 Sows)				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.04	196.74	51.39	7.2	0.9
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.56	21.86	5.71	.80	.10
TMDL = LA+WLA+MOS	1715.6	218.6	57.1	8.0	1.0

Table 8: Big Creek TMDL Summary
(HUC12- 051402020**202**)

Upstream Characteristics					
Drainage Area	27.13 square miles				
TMDL Sample Site	13				
Listed Segments	INE0222_T1002				
Land Use	Agriculture: 64.3% Forest: 17.2% Urban: 5.0% Water: 3.6% Wetland: 9.8%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.04	196.74	51.39	7.2	0.9
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.56	21.86	5.71	.80	.10
TMDL = LA+WLA+MOS	1715.6	218.6	57.1	8.0	1.0

Table 9: Clear Branch-Pigeon Creek TMDL Summary
(HUC12- 051402020**203**)

Upstream Characteristics					
Drainage Area	35.85 square miles				
TMDL Sample Site	16, 17				
Listed Segments	INE0223_01, INE0223_T1009				
Land Use	Agriculture: 51.6% Forest: 19.4% Urban: 6.2% Water: 3.7% Wetland: 19.1%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.04	196.74	51.39	7.2	0.9
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.56	21.86	5.71	.80	.10
TMDL = LA+WLA+MOS	1715.6	218.6	57.1	8.0	1.0

Table 10: Barnes Ditch-Pigeon Creek TMDL Summary
(HUC12- 051402020**204**)

Upstream Characteristics					
Drainage Area	34.85 square miles				
TMDL Sample Site	18, 19				
Listed Segments	INE0224_01, INE0224_T1002				
Land Use	Agriculture: 71.4% Forest: 9.8% Urban: 7.2% Water: 2.2% Wetland: 9.4%				
NPDES Facilities	Chandler Municipal WWTP (IN0020435) Tin Lizzie Car Wash (IN0059838)* Indiana Hardwoods Inc (IN0058530*)				
MS4 Communities	Warrick County				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows*
LA	1544.27	196.97	51.71	7.43	1.13
WLA	8.5	8.5	8.5	8.5	8.5
MOS (10%)	172.53	22.83	6.69	1.77	1.07
TMDL = LA+WLA+MOS	1725.3	228.3	66.9	17.7	10.7
	*Does not have a sanitary component in permit.				

Table 11: Headwaters Bluegrass Creek TMDL Summary
(HUC12- 051402020**301**)

Upstream Characteristics					
Drainage Area	17.83 square miles				
TMDL Sample Site	27				
Listed Segments	INE0231_01, INE0231_T1001				
Land Use	Agriculture: 73.0% Forest: 17.4% Urban: 5.7% Water: 1.1% Wetland: 2.7%				
NPDES Facilities	Elberfeld Municipal WWTP (IN0020788)				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.06	196.76	51.41	7.22	1.0
WLA	0.7	0.7	0.7	0.7	0.7
MOS (10%)	171.64	21.94	5.79	0.88	0.18
TMDL = LA+WLA+MOS	1716.4	219.4	57.9	8.8	1.8

Table 12: Headwaters Locust Creek TMDL Summary
(HUC12- 051402020**304**)

Upstream Characteristics					
Drainage Area	10.25 square miles				
TMDL Sample Site	25				
Listed Segments	INE0234_01, INE0234_T1001, INE0234_T1002, INE0234_T1003, INE0234_T1004, INE0234_T1005, INE0234_T1006, INE0234_T1007				
Land Use	Agriculture: 45.8% Forest: 48.7% Urban: 2.7% Water: 1.3% Wetland: 1.6%				
NPDES Facilities	NA				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.04	196.74	51.39	7.2	0.9
WLA	NA	NA	NA	NA	NA
MOS (10%)	171.56	21.86	5.71	.80	.10
TMDL = LA+WLA+MOS	1715.6	218.6	57.1	8.0	1.0

Table 13: Locust Creek TMDL Summary
(HUC12- 051402020**305**)

Upstream Characteristics					
Drainage Area	7.65 square miles				
TMDL Sample Site	24				
Listed Segments	INE0235_01				
Total Land Use	Ag: 48.2% Forest: 30.1% Urban: 14.4% Water: 0.8% Wetland: 6.5%				
Non-MS4 Land use	Ag: 91.44% Forest: 85.10% Urban: 90.18% Water: 90.33% Wetland: 81.60%				
NPDES Facilities	AC Ranch Mobile Home Park (IN0039608)				
MS4 Communities	City of Evansville MS4(INR040057) (0.655 square miles w/in MS4 8.56%)				
MS4 Land use	Ag: 2.85% Forest: 14.90% Urban: 9.82% Water: 9.67% Wetland: 18.40%				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1411.853	179.882	47.056	6.567	0.806
WLA	132.187	16.858	4.424	0.633	0.094
MOS (10%)	171.56	21.86	5.72	0.8	0.1
TMDL = LA+WLA+MOS	1715.6	218.6	57.2	8	1

Table 14: Kleymeyer Park-Pigeon Creek TMDL Summary
(HUC12-051402020**306**)

Upstream Characteristics					
Drainage Area	27.77 square miles				
TMDL Sample Site	21				
Listed Segments	INE0236_01, INE0236_02				
Total Land Use	Ag: 41.0% Forest: 14.1% Urban 39.0% Water: 0.9% Wetland: 4.9%				
Non-MS4 Land Use	Ag: 64.97% Forest: 15.74% Urban 8.13% Water: 97.23% Wetland: 36.13%				
NPDES Facilities	NA				
MS4 Communities	City of Evansville MS4(INR040057) (18.28 square miles w/in MS4 65.24%)				
MS4 Land Use	Ag: 35.03% Forest: 84.26% Urban 91.87% Water: 2.77% Wetland: 63.879%				
CSO Communities	Evansville-Nine (9) CSOs				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	536.708	68.387	17.863	2.503	0.313
WLA*	1007.332	128.353	33.527	4.697	0.587
MOS (10%)	171.56	21.86	5.71	0.8	0.1
TMDL = LA+WLA+MOS	1715.60	218.60	57.10	8.00	1.00
*65.24% WLA estimated on percent of MS4 in watershed					

Table 15: East Creek-Ohio River TMDL Summary
(HUC12- 051402020**401**)

Upstream Characteristics					
Drainage Area	31.71 square miles				
TMDL Sample Site	28				
Listed Segments	INE0241_02, INE0241_T1003, INE0241_T1004				
Total Land Use	Ag: 32.8% Forest: 19.4% Urban: 43.5% Water: 2.2% Wetland: 2.1%				
Non-MS4 Land Use	Ag: 89.83% Forest: 68.58% Urban 19.80% Water: 90.34% Wetland: 81.06%				
NPDES Facilities	NA				
MS4 Communities	City of Evansville MS4(INR040057) (14.25 square miles w/in MS4 44.94%)				
MS4 Land Use	Ag: 10.17% Forest: 31.42% Urban 80.20% Water: 9.66% Wetland: 18.94%				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	850.148	108.325	28.295	3.964	0.496
WLA	693.892	88.415	23.095	3.236	0.404
MOS (10%)	171.56	21.86	5.71	0.8	0.1
TMDL = LA+WLA+MOS	1715.6	218.6	57.1	8	1

Table 16: Bayou Creek TMDL Summary
(HUC12- 051402020**601**)

Upstream Characteristics					
Drainage Area	21.09 square miles				
TMDL Sample Site	33, 35				
Listed Segments	INE0261_01, INE0261_T1003				
Total Land Use	Ag: 50.4% Forest: 41.0% Urban: 4.3% Water: 0.8% Wetland: 3.6%				
Non-MS4 Land Use	Ag: 99.01% Forest: 96.43% Urban: 81.11% Water: 97.65% Wetland: 100%				
NPDES Facilities	Twin Lakes Mobile Home Park (IN0044491)				
MS4 Communities	City of Evansville MS4(INR040057) (0.5879 square miles w/in MS4, 2.79%)				
MS4 Land Use	Ag: 0.99% Forest: 3.57% Urban: 18.89% Water: 2.35% Wetland: 0.0%				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1501.014	191.216	50.009	7.052	0.927
WLA	43.296	5.704	1.651	0.418	0.243
MOS (10%)	171.59	21.88	5.74	0.83	0.13
TMDL = LA+WLA+MOS	1715.9	218.8	57.4	8.3	1.3

Table 17: Cypress Slough TMDL Summary
(HUC12- 051402020**603**)

Upstream Characteristics					
Drainage Area	25.99 square miles				
TMDL Sample Site	32				
Listed Segments	INE0263_01, INE0263_02, INE0263_T1001, INE0263_T1002				
Land Use	Agriculture: 81.6% Forest: 9.7% Urban: 1.4% Water: 0.2% Wetland: 7.0%				
NPDES Facilities	Marrs Elementary School (IN0055255)				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.088	196.788	51.438	7.29	0.948
WLA	0.042	0.042	0.042	0.042	0.042
MOS (10%)	171.57	21.87	5.72	0.81	0.11
TMDL = LA+WLA+MOS	1715.7	218.7	57.2	8.1	1.1

Table 18: McFadden Creek TMDL Summary
(HUC12- 051402020**604**)

Upstream Characteristics					
Drainage Area	20.42 square miles				
TMDL Sample Site	29				
Listed Segments	INE0264_01				
Land Use	Agriculture: 89.9% Forest: 5.1% Urban: 3.6% Water: 0.1% Wetland: 1.3%				
NPDES Facilities	Harbortown Subdivision Sanitary (IN0109924) Creekside Court Mobile Home Park WWTP (IN0039616) Mount Vernon Transfer Term LLC (IN0049760)*				
MS4 Communities	NA				
CSO Communities	NA				
CAFOs	NA				
CFOs	NA				
TMDL *E. coli* Allocations (billion MPN/day)					
Allocation Category	Very High Flows	Higher Flow Conditions	"Normal" Flows	Lower Flow Conditions	Low Flows
LA	1544.093	196.793	51.443	7.25	0.953
WLA	0.127	0.127	0.127	0.127	0.127
MOS (10%)	171.58	21.88	5.73	0.82	0.12
TMDL = LA+WLA+MOS	1715.8	218.8	57.3	8.2	1.2
*Does not have a sanitary component in permit and is listed for calculations of flow based on the design flow.					

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 can 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 D). 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 Evansville, 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 and phosphorous numeric targets in the Highland-Pigeon Creek watershed most critically depends on controlling nonpoint sources using best management practices (BMPs). If the *E. coli* and phosphorus inputs can be controlled, then total body contact recreational and aquatic habitat use in Highland-Pigeon 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. The TP water quality target is 0.30 mg/L. 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* and phosphorous sources to the Highland-Pigeon 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 or phosphorous benchmark. For this reason, TMDLs were calculated over all of the flow conditions (very high flows to low flows) within the Highland-Pigeon Creek watershed. For the Highland-Pigeon 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). TP in this project is expressed as a mass loading, lbs/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). Phosphorus is based on targets for reduction until such a time when the State of Indiana adopts a nutrient water quality standard.

Wasteload Allocations

As previously mentioned, there are nineteen (19) NPDES permitted facilities in the Highland-Pigeon Creek watershed (Figure 5, Table 2). Thirteen (13) dischargers have *E. coli* limits in their permits. The remaining six (6) do not have a sanitary component and are not currently required to monitor or report nitrogen or phosphorous levels.

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). The City of Evansville's MS4 (INR040057) was given an estimated Wasteload Allocation at the Water Quality Standard for *E. coli* for each of the subwatersheds in which the MS4 is located. Since IDEM does not require a GIS shapefile for MS4s and MS4s can modify the boundaries via letter to the MS4 coordinator, the incorporated area of Evansville was used as an approximation for the MS4 boundary. Ivy Tech State College-Southwest (INR040060), and University of Evansville are within the incorporated limits of the City of Evansville and would be included in the WLA.

The University of Southern Indiana (INR040028) is located west of the City of Evansville outside the incorporated area of Evansville, but is less than 0.5% of the watershed and was not calculated into the WLA at this time. Vanderburgh County (INR040030) MS4 is a countywide MS4, but it would not be in the best interest of the countywide MS4 to calculate the entire county as a Wasteload Allocation. If a WLA were calculated for the entire county then all loadings would be under the WLA and nothing remaining for the LA for the MS4 only.

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 Highland-Pigeon Creek are revised in accordance with applicable requirements of state and federal law, this TMDL may be revised to be consistent with such revisions.

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.

Indiana has yet to establish a Water Quality Standard for nutrients, to include phosphorous. Indiana is currently working on a nutrient standard; therefore characterization of the effluent from the WWTP for phosphorus has not been established. It is recommended that nutrient monitoring be added to the facilities within the Highland-Pigeon Creek watershed, that influence the phosphorus impaired segment, for their next permit renewal

Load Allocations

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. The LA for phosphorus is equal to the target (0.3 mg/L TP) and will be based on the highest value of the sample (Attachment D).

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* and phosphorus in the Highland-Pigeon 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.

Seasonality is not addressed for total phosphorous. Total phosphorous is applicable year round.

Monitoring

Future *E. coli* monitoring of the Highland-Pigeon 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 the 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 Highland-Pigeon Creek watershed TMDL allocations and the *E. coli* Water Quality Standard and phosphorous numeric target.

The Vanderburgh County Soil and Water District is very active in projects geared towards improving the water quality in the Highland-Pigeon Creek watershed so much so that they requested a TMDL for the watershed.

Watershed Projects

The Pigeon Highland Watershed Steering Committee began in 1988 and from their direction; a Watershed Management Plan was developed and recently updated. This plan prioritized subwatersheds according to water quality issues and determined actions needed to improve water quality. Locust Creek is a 19,000-acre watershed prioritized by the plan. A Lake and River Enhancement Grant was received by the Vanderburgh County SWCD. Through cooperation with the Natural Resources Conservation Service and the Indiana State Department of Agriculture over $110,000.00 have been appropriated to local land users for installing practices such as no-till planting, integrated crop management, grade stabilization structures, streambank stabilization and grazing management. Water quality is being monitored through a special project with the University of Southern Indiana Biology Department and Riverwatch.

In addition, continued water quality monitoring is being performed by the Vanderburgh County Soil and Water Conservation District and the Wesselman Nature Society. Both entities have submitted bacteria data for review at various sites along the Pigeon Creek (Attachment F)

Vanderburgh County

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

Local: $125, 607
Clean Water Indiana: $22,572
Lake and River Enhancement: $50,000
Conservation Reserve Program: $268,975
Wetland Reserve program: $136,184

The Vanderburgh County Soil and Water Conservation District (SWCD) partnered their efforts together with the Four Rivers Resource Conservation and Development Council (RC&D), The Nature Conservancy, Wesselman Woods Nature Society, and other local organizations, in the acquisition of 127 acres. This land will be used to educate and promote conservation.

The Indiana Department of Natural Resources was interested in selling two tracts of land consisting of 73.9 acres at the intersection of Highway 41 and Waterworks Road. Traylor Brothers, Inc., a business located in the Evansville area, was the owner of a 52.99 acre tract of land that separated the two tracts, and expressed their desire to donate this tract to the Vanderburgh SWCD.

Almost four years ago, the three newly acquired tracts totaling 127 acres, was named "Eagle Slough Natural Area (ESNA)."

A steering committee was developed to organize and complete this project. Committee members are Dave Elgin, Darrell Rice, Bonnie Bittner, Davie Sue Litov, Maurice Berendes, Susan Haislip, Greg Meyer, Harold Allison, Kemper Lease, Cassie Hauswald, Steve Gifford and Allen Pursell.

The Vanderburgh SWCD had two volunteer cleanup days. Twelve tons of debris was hauled from ESNA. Three eagle scouts have completed projects; a visitor kiosk, road sign frame, six duck boxes, and a new 1.3 miles trail. Thanks to a volunteer and funds from the American Nature Photographers Association, we have a photo blind at ESNA Teal Wetlands. Alcoa and Toyota

have generously supplied grants and employees to help with the cleanup days. We are currently building an observation deck with a grant from Alcoa.

ESNA is used for education and getting children in tune with nature from local schools. The red carpet rolled out at Culver Elementary School for the world premiere of a short documentary entitled "Where Waters Wed: Southwestern Indiana". It chronicles the value and abundance of bottomland forests and wetlands in our area. One of the forests/wetland areas chosen for the documentary was Eagle Slough Natural Area. Several Culver students starred in the portion of the movie filmed at the natural area. Culver Elementary School students also made a special trip to the Eagle Slough Natural Area to produce an artistic rendering of the landscape.

Warrick County
Warrick County has received the following funding to improve water quality in 2010:
Local: $52,742
Clean Water Indiana: $16,610
Wildlife Habitat Cost-Share Program: $2,805
Conservation Reserve Program: $344,512
Environmental Quality Incentives Program: $528,954

The Warrick Soil and Water Conservation District (SWCD) has partnered with neighboring Districts (Vanderburgh, Posey, Gibson, and Pike) on several projects since 2008 to address sediment and nutrient issues and offer reduction solutions.

Initiatives co-sponsored by these Districts include a pond pro workshop, no-till conference, soils quality conference and a corn and soybean day with Purdue Extension. Clean Water Indiana (CWI) grants have enabled these SWCDs to pull in top-notch experts on the subjects at hand, resulting in more conservation practices installed on the ground through information/education/outreach thereby improving water quality. The Warrick SWCD also sent two avid no-till farmers to the National No-Till Conference.

The Vanderburgh SWCD came up with the idea of cost-sharing on an aerial seeding project in the fall of 2010. The goal was to promote cover crops as a sediment and nutrient reduction project. They invited surrounding SWCDs to join them to get more acres seeded. The Warrick County SWCD jumped at the opportunity to partner with the Vanderburgh, Posey and Gibson SWCDs to seed cover crops into standing corn and soybeans on approximately 3,100 acres in southwest Indiana using CWI and matching SWCD funds.

Other partners were drawn in to help with the project. Ed Air, Inc. provided the plane to fly on the seed at $10 per acre and Land-O-Lakes developed and provided the seed mixture at cost to landowners. Superior Ag ordered and transported the seed to the airstrip. They also coordinated the flights and did all the billings to the farmers, who in turn, paid those bills. Receipts were then submitted to their local SWCDs for reimbursement. NRCS and ISDA staff members also were very helpful in the planning and implementation of the project.

Each SWCD developed its own cost-share rate. The Warrick SWCD paid the entire cost of the aerial application to 10 producers on 783 acres. CWI funds used on the project totaled $2,147 while the District matched those funds with $5,604.

Even though this area was experiencing a drought and the seed did not germinate as well as expected in many of those fields until much later, interest among Warrick County's farmers is still high for a program like this in 2011.

The Warrick County SWCD also entered into a Contribution Agreement with NRCS to hire a part-time clerical assistant to help with Farm Bill programs, particularly the Environmental Quality Incentive Program (EQIP) and Conservation Reserve Program (CRP). NRCS matched District and CWI funds to provide salary for 28 hours/week to take full advantage of program cost-share funding rather than leaving unused federal dollars on the table. This in turn drew in a new partner - the Warrick County Storm Water Board. When the District was approached to assist with their education/outreach obligations mandated by IDEM, we were offered limited funding to use to achieve the goals of both the Storm Water Board and the District. This valuable partnership is expected to continue well into the future.

Gibson County

Gibson County has received the following funding to improve water quality in 2010:
Local: $94,691
Clean Water Indiana: $15,786
Conservation Reserve Program: $397,146
Environmental Quality Incentives Program: $13,736
Wildlife Habitat Incentive Program: $18,012
Wetland Reserve Program: $137,280

The Gibson County Soil and Water Conservation District (SWCD) partners annually with adjoining counties to make conservation dollars go farther and reach more land users.

They worked collaboratively on projects last 2010 with Posey, Vanderburgh and Warrick SWCDs on several projects including the: Pond Pro Workshop, Soils Quality Conference and the Cover Crop Program. The Clean Water Indiana Grant assisted in funding these worthwhile initiatives.

The Pond Pro Workshop was a day-long event held in Vanderburgh County. The Saturday event was well attended. Many expert speakers were volunteers from NRCS; IDNR; Aquatic Control; Warrick County Extension; Scott Township Fire Department; and Zeimer, Stayman, Weitzel and Shoulders Attorneys at Law.

The Soil Quality Conference, also held in Vanderburgh County, provided land owners with the latest information on how to build soil tilth, reducing nutrient and chemical inputs to increase productivity and profitability. Nationally recognized speakers for the event were David Brandt, Barry Fisher, Ray Archuleta, Mike Sucik and Hans Kok. Speakers also discussed soil properties and looked at scientific and practical aspects of crop production through proper rotations, cover crops and management.

The Gibson County SWCD partnered to sponsor an Aerial Cover Crop Seeding Program for land users in Southwestern Indiana. The seed mixture was provided to land users at cost by Land-O-Lakes to bring operators an opportunity to improve their farming operation and make them more profitable. Districts also partnered with Superior Ag who ordered and transported the seed to Ed Air Strip. Much appreciation also goes to NRCS and ISDA employees for their assistance in coordinating this project. The District cost shared on the seeding cost with funding received from a 2010 CWI grant. Approximately 430 acres were seeded in Gibson County and over 1,000 in southwest Indiana.

The SWCD newsletter, The Conservation Gram, provides information to land users with articles and information from the SWCD, NRCS, FSA, ISDA, Purdue Extension and other conservation

partners. Information also is distributed to the public using the SWCD website, fair exhibit, news releases, flyers and pamphlets. The SWCD staff also supports NRCS with clerical assistance as needed.

The Gibson County SWCD collaboratively assists with the Southwest Regional Envirothon and the Soils Judging Contest for high school students. The District likewise participates in a variety of environmental education activities for youth including: Hoosier Riverwatch training for the Princeton Community High School Advanced Environmental Science class; and a water quality presentation at YMCA Camp Carson for fifth grade students attending the North Gibson School Corporation Youth Coalition.

The SWCD coordinates the annual fourth grade farm fair held at the Gibson County Fairgrounds. A poster contest is held annually for fifth grade students using the soil stewardship theme. The winning poster is forwarded to the state contest.

The Gibson County SWCD joins the southwestern Indiana counties collaborating again this year on a number of important conservation projects.

Posey County
Posey County has received the following funding to improve water quality in 2010:
Local: $87,830
Clean Waters Indiana: $27,685
Lake and River Enhancement: $54,000
205j: $98,723
Conservation Reserve Program: $220,674
Environmental Quality Incentives Program: $1,744
Floodplain Easement Program: $101,166
Wetlands Reserve program: $1,700,079

The Posey County Soil and Water Conservation District (SWCD) has had great success partnering with surrounding counties on a variety of projects. Most of these initiatives were funded through Clean Water Indiana (CWI) grants. By partnering, they were able to combine resources to bring in well-known speakers and experts. They also were able to broaden their horizons by developing new partnerships with local businesses and offices.

In recent months, the Quad Counties which include Gibson, Vanderburgh, Warrick and Pike, offered a cover crop cost-share program. They also partnered with Purdue Cooperative Extension to offer the Area Corn and Soybean Day. The District hosted a cover crop breakfast and offered a variety of workshops on pond maintenance and soils quality. They also hosted a conservation breakfast.

The cover crop program has been a huge success. The District originally received a 2008 CWI grant for sediment and nutrient reduction. This grant allowed the District to cost-share on cover crops planted either traditionally or by aerial seeding. Of course, people saw the planes and then decided that they too would plant a cover crop.

Posey County ended up with over 1,000 acres of cover crops planted. They spent the original $10,000 and added District funds to the program. The cover crop program has been such a huge success that the Quad Counties have designated a portion of their 2011 CWI grant funds to this project. They have begun a list of interested parties!

They were able to secure Hans Kok, coordinator, Indiana Conservation Cropping Systems Initiative, as their annual meeting speaker. He did such a great job sharing his message on cover crops, that they have had non-farming residents call the office asking for more information!

Because of their work with the local Area Plan office, the Posey County representatives were able to better understand the District's need for a technician who would work on District projects, as well as USDA conservation projects. The SWCD is now given an annual allotment that has enabled them to hire a part-time technician whose main responsibility is Rule 5. This has been a great asset for the county. It also has increased awareness about the SWCD. They have been able to work with the city of Mt. Vernon on several projects as well. This has been their first experience working with the urban community of the county.

A few years back, they were awarded an Emergency Conservation Assistance Program grant due to extensive flooding and damage to the community. They used these funds for cost-share projects on repairs due to flood damage. An original grant of $83,005 was spent and they were able to receive an additional $12,000.

The District is thankful for the grants they receive, the partnerships they are building, and the dedication of their staff and supervisors. They also appreciate the Districts with whom they partner to promote the conservation of their natural resources.

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 Highland-Pigeon Creek watershed.

Storm Water General Permit Rule 13

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* and phosphorous in the Highland-Pigeon Creek watershed. The TMDL recognizes that these MS4 communities can be sources of *E. coli* and phosphorous 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 standards and numeric targets, which are the limits 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. It is the goal of IDEM and the MS4 communities to develop best management practices to improve the stormwater quality within their areas. IDEM will continue to work with these facilities to improve water quality.

Confined Feeding Operations and Concentrated Animal Feeding Operations

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.

319 Projects Conducted in the Highland Pigeon Watershed

319 Grant #00-86 - "Highland-Pigeon Watershed Management Plan" with data collected with Easygel by coliscan method for *E. coli* and Total Phosphate using a Hach method. Conservation

practices installed 1999-2002 in Gibson county: Filter strips, grassy waterways, and pipe structures; in Posey County: grassy waterways, WASCOB's, filter strips. BMPs during the course of this grant prevented 721 tons of soil, 732 lbs of phosphorous, and 1500 lbs of nitrate were prevented from entering the streams.

319 Grant #7-9 -2003 Pigeon Creek Implementation. This watershed plan applied the following BMPs: filter strips, grassed waterways, and water and sediment control structures.

The projects in Posey County (00-86, 4-127, 7-9, and 3-756) have a total reduction of 5,652 tons of sediment, 7,057 pounds of phosphorous, and 17,675 pounds of nitrogen (Personal Communication, 319 Project Manager B. Ratcliff, 2011)

IDEM Watershed Specialists will be available to assist stakeholders with re-forming a watershed group, facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the Highland-Pigeon Creek watershed.

TMDLs

Currently, there are no additional TMDL projects within the Highland-Pigeon Creek Watershed basin. However, an Ohio River TMDL is under development.

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* and nutrient 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 October 13, 2009 at the Vanderburgh County Public Library where the public was invited to submit any additional bacteria or nutrient data and informed of the TMDL process.

There was a public Draft TMDL Meeting held on May 18, 2010 at the Vanderburgh County Public Library.

The public comment period lasted from May 18, 2010 to June 20, 2010.

Conclusion

The sources of *E. coli* to the Highland-Pigeon Creek watershed include both point and nonpoint sources. In order for the Highland-Pigeon Creek watershed to achieve Indiana's *E. coli* WQS, the

wasteload and load allocations for the Highland-Pigeon 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 Highland-Pigeon Creek watershed depends on:

1) Nonpoint sources of *E. coli* being controlled by implementing best management practices in the watershed. Point sources should continue to follow their NPDES permits.
2) Continuing efforts to protect this watershed.

The sources of total phosphorous to the Highland-Pigeon Creek watershed include both point and nonpoint sources. In order for the Highland-Pigeon Creek watershed to achieve the recommended target of 0.3 mg/L:

1) Nonpoint sources of total phosphorous should be controlled by implementing best management practices in the watershed.
2) Continuing efforts to educate the public on ways to protect the watershed.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Highland-Pigeon Creek watershed in compliance with the *E. coli* WQS and achieve the total phosphorous target of 0.3 mg/L. 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 Highland-Pigeon 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 Highland-Pigeon Creek watershed.

References

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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.

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Table 19: NPDES Permits in the Highland-Pigeon Creek Watershed

Permit	Name	Receiving Waters	Notes
IN0001970	Air Liquide Industries US LP	Smith Creek (INE0265_T1006)	*E. coli*
IN0055255	MARRS Elementary School	Unnamed Trib-Dixon/Lewis Ditch (INE0263_T1006)	*E .coli*
IN0020435	Chandler Municipal WWTP	Whittaker Ditch (INE0237_00)	*E. coli*
IN0020788	Elberfeld Municipal WWTP	Bluegrass Creek (INE0231_01)	*E. coli*
IN0021482	Haubstadt Municipal WWTP	Unnamed Trib-Hurricane Creek (INE0211_T1003)	*E. coli*
IN0040282	Lynnville Municipal WWTP	Unnamed Trib-Big Creek (INE0221_T1006)	*E. coli*
IN0044491	Twin Lakes Mobile Home PARK	Unnamed Trib-Bayou Creek (INE0261_T1003)	*E. coli*
IN0035696	Mount Vernon WWTP	Unnamed Trib-Ohio River (INE265_T1003)	*E. coli*
IN0039608	AC Ranch Mobile Home Park	Locust Creek (INE0235_01)	*E. coli*
IN0039616	Creekside Court Mobile Home Park	McFadden Creek (INE0264_01)	*E. coli*
IN0022869	Town of Fort Branch WWTP	West Fork Pigeon Creek (INE0213_01)	*E. coli*
IN0109924	Harbortown Subdivision Sanitary	Unnamed Trib-McFadden Creek (INE 0264_01)	*E.coli*
IN0004880	Midstates Rubber Prod INC	Pigeon Creek (INE 214_01)	Non Sanitary
IN0051667	GAF BLDG Materials MFG CORP	Unnamed Trib-Ohio River (INE0265_T1002)	Non Sanitary
IN0029963	KOA Kampground	Unnamed Trib-Hurricane Creek (INE0211_T1001)	*E. coli*
IN0049760	Mount Vernon Transfer TERM LLC	Unnamed Trib-Ohio River (INE265_T1003)	Non Sanitary
IN0058530	Indiana Hardwoods INC	Unnamed Trib-Pigeon Creek (INE0224_T1005)	Non Sanitary
IN0059838	Tin Lizzie Car Wash	Whittaker Ditch (INE0224_T1002)	Non Sanitary
IN0060160	Industrial Services MGT INC	Smith Creek (INE0265_T1006)	Non Sanitary

Table 20: CFOs and CAFOs in the Highland-Pigeon Creek Watershed

Permit Number	Permit Type	Operation Name	Status	Nursery Pigs	Finishers	Sows	Beef Cattle	Dairy Cattle	Dairy Calves	Turkeys
175	CFO	Jeff Sevier Hog Farm	Active	200	800	106				
912	CFO	Schurmeier Farms Inc	Active	360	1600	16				
3719	CAFO	Schoonover Farms	Active		8000					
3981	CFO	Stanley Michel	Active	1800	480	94	11			
4522	CFO	Clay Hill Turkey Farm	Active							22000
4524	CFO	M & D Michel Turkeys	Active							52000
6167	CAFO	Dave Winkle	Active							57000
6654	CAFO	Obert Legacy Dairy	Active					900	80	
			Total:	2360	10880	216	11	900	80	131000

Figure 1: Highland-Pigeon Creek Watershed

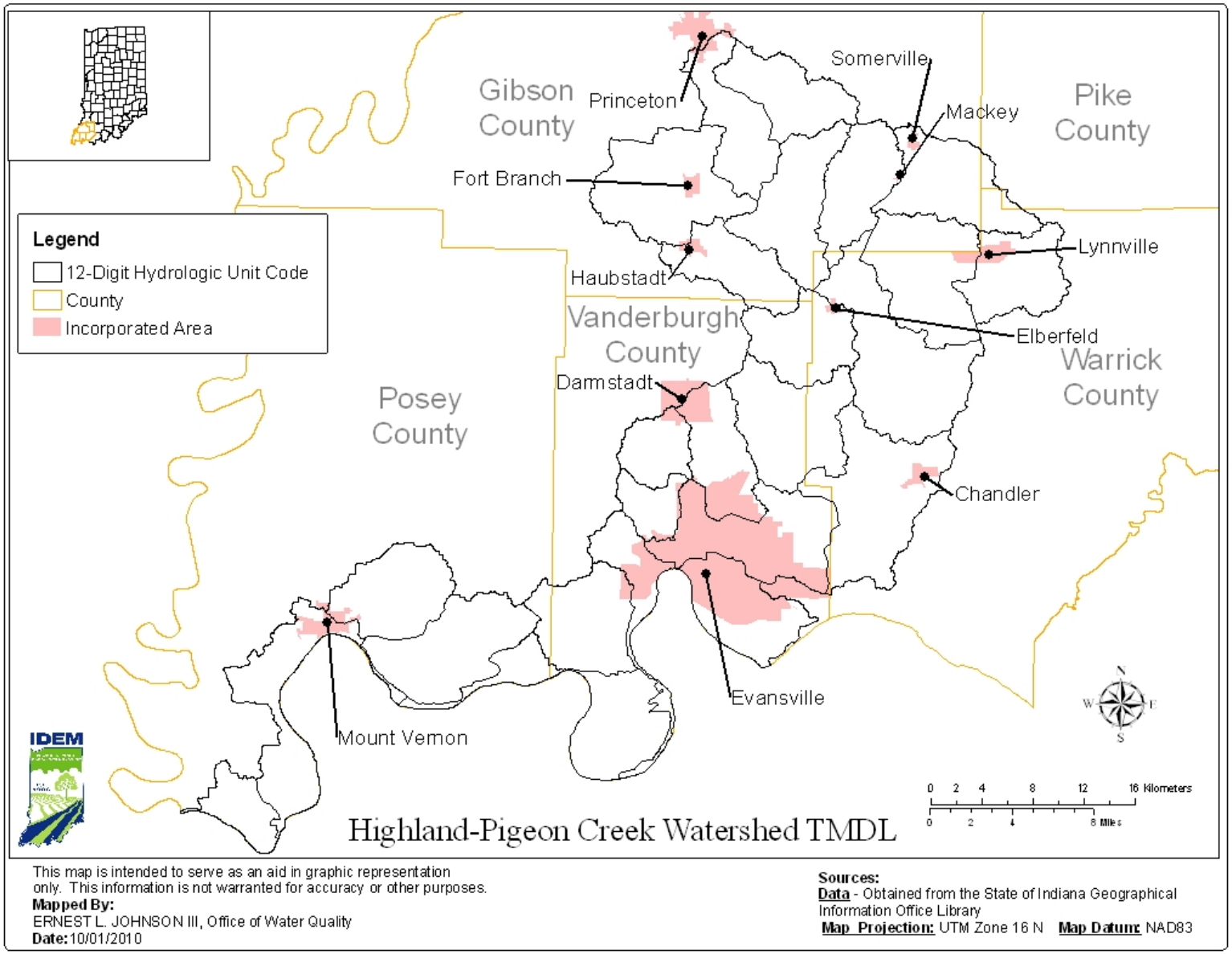
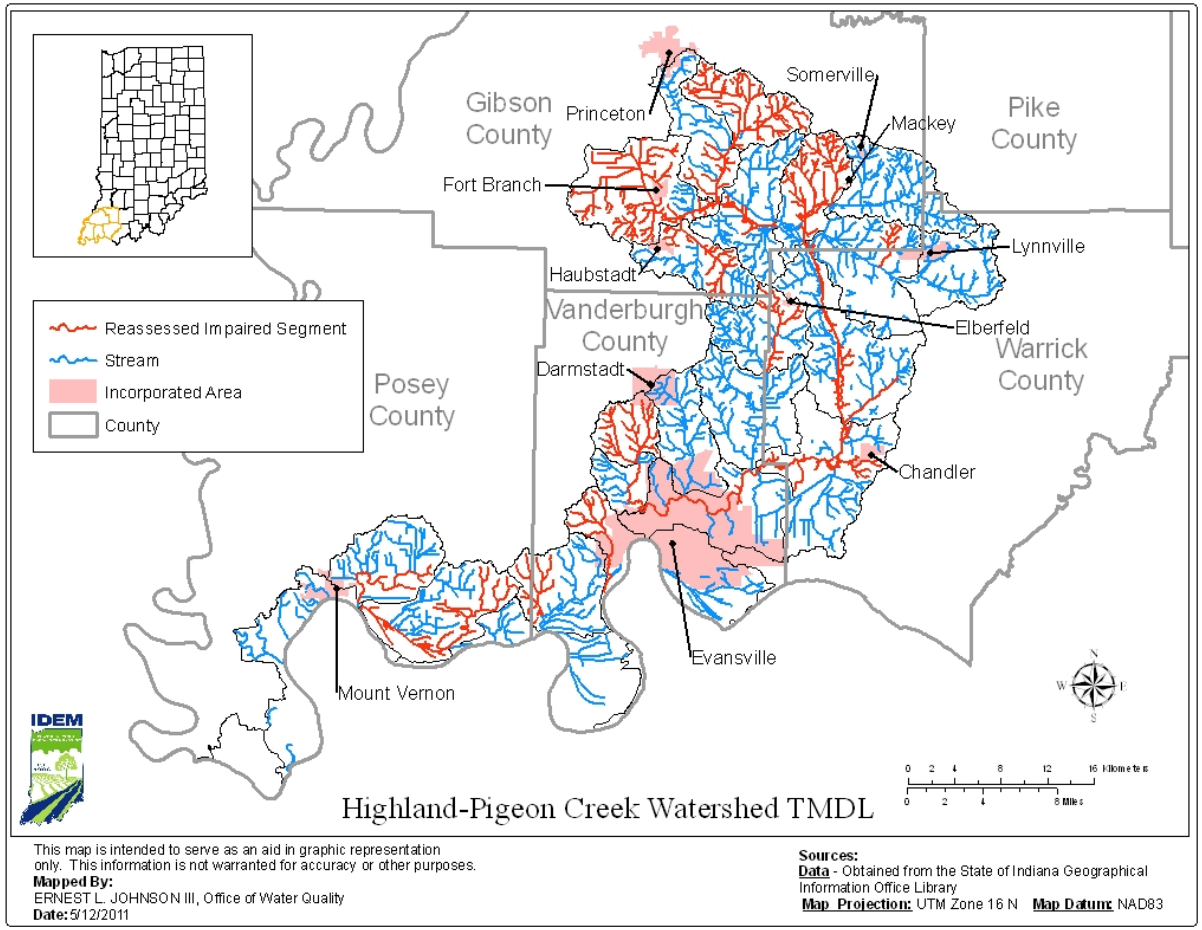


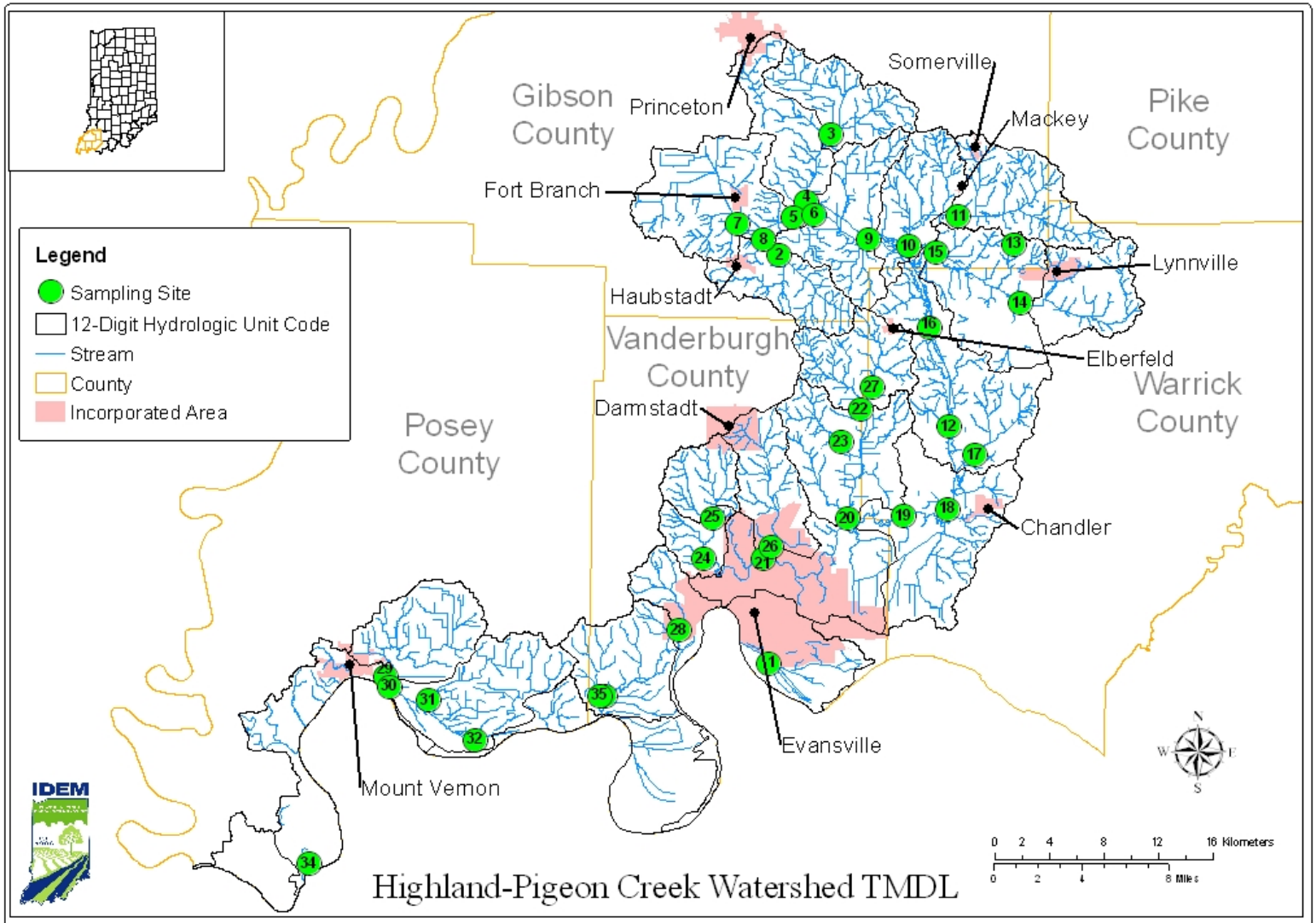
Figure 2: Streams in the Highland-Pigeon Creek Watershed



This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.
Mapped By:
ERNEST L. JOHNSON III, Office of Water Quality
Date: 5/12/2011

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

Figure 3: Sample Sites in the Highland-Pigeon Creek Watershed

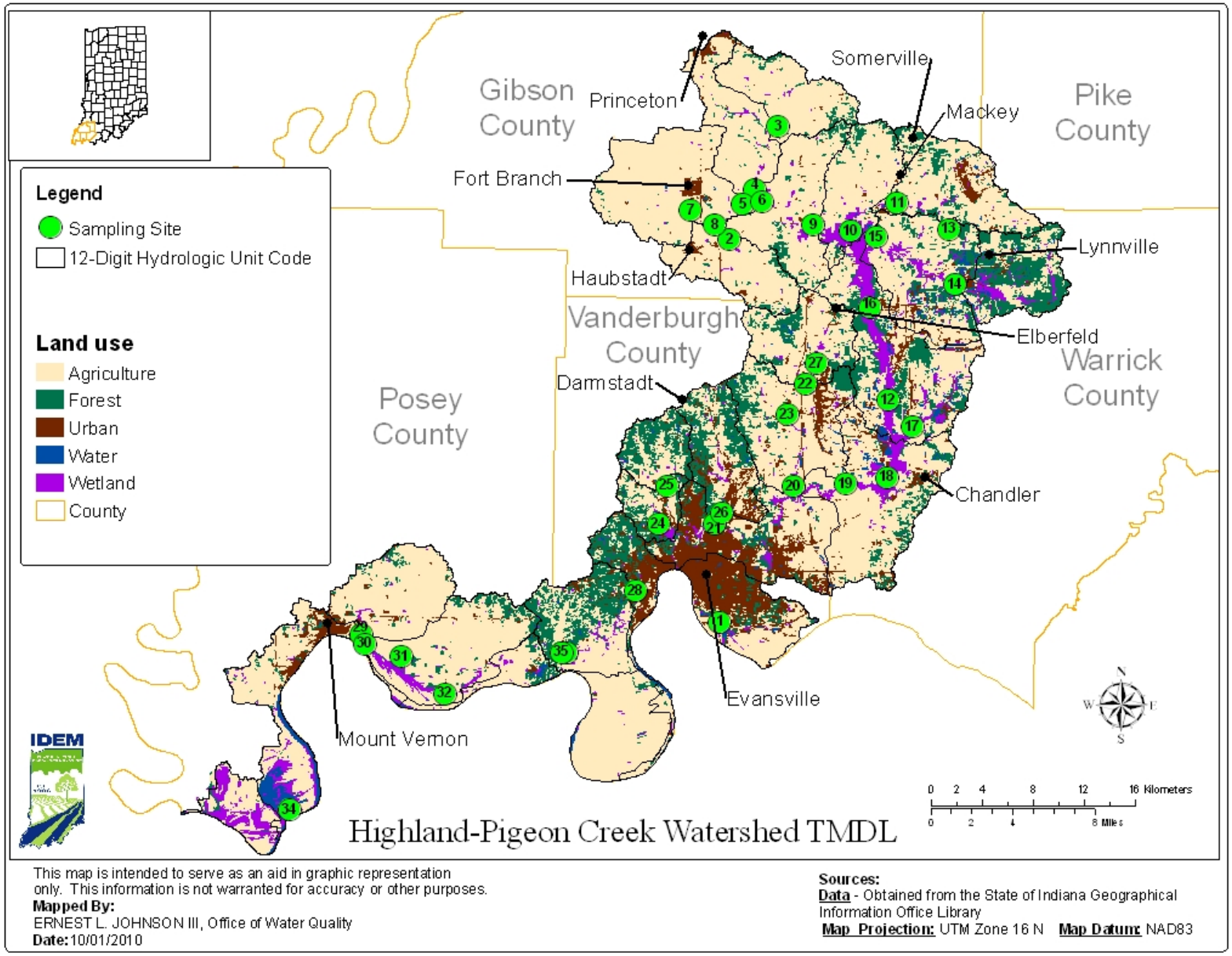


This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Mapped By:
ERNEST L. JOHNSON III, Office of Water Quality
Date: 10/01/2010

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

Figure 4: Land use in the Highland-Pigeon Creek Watershed



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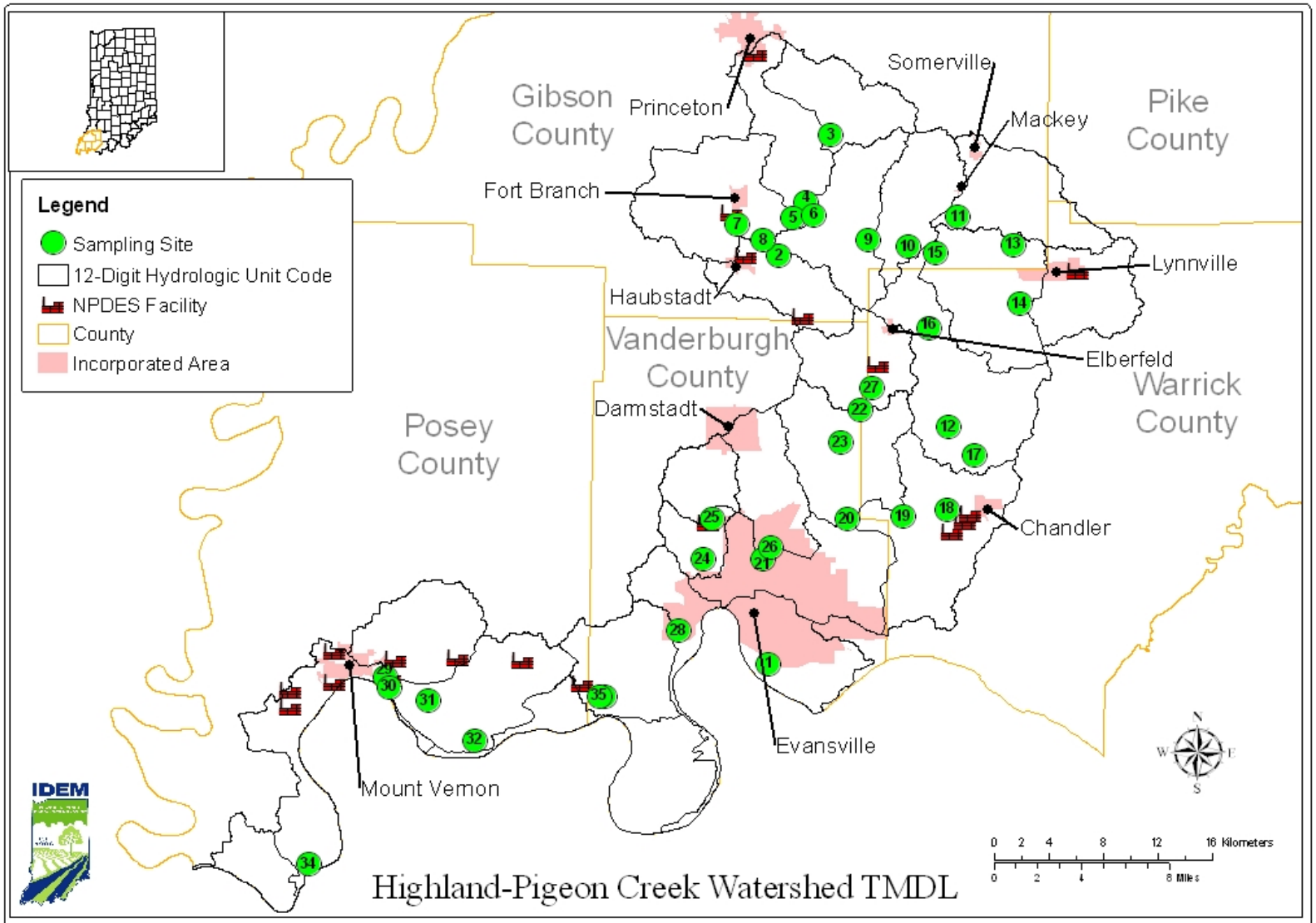
Mapped By:
ERNEST L. JOHNSON III, Office of Water Quality
Date: 10/01/2010

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

Figure 5: NPDES Permitted Facilities in the Highland-Pigeon Creek Watershed



This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.
Mapped By:
ERNEST L. JOHNSON III, Office of Water Quality
Date: 10/01/2010

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
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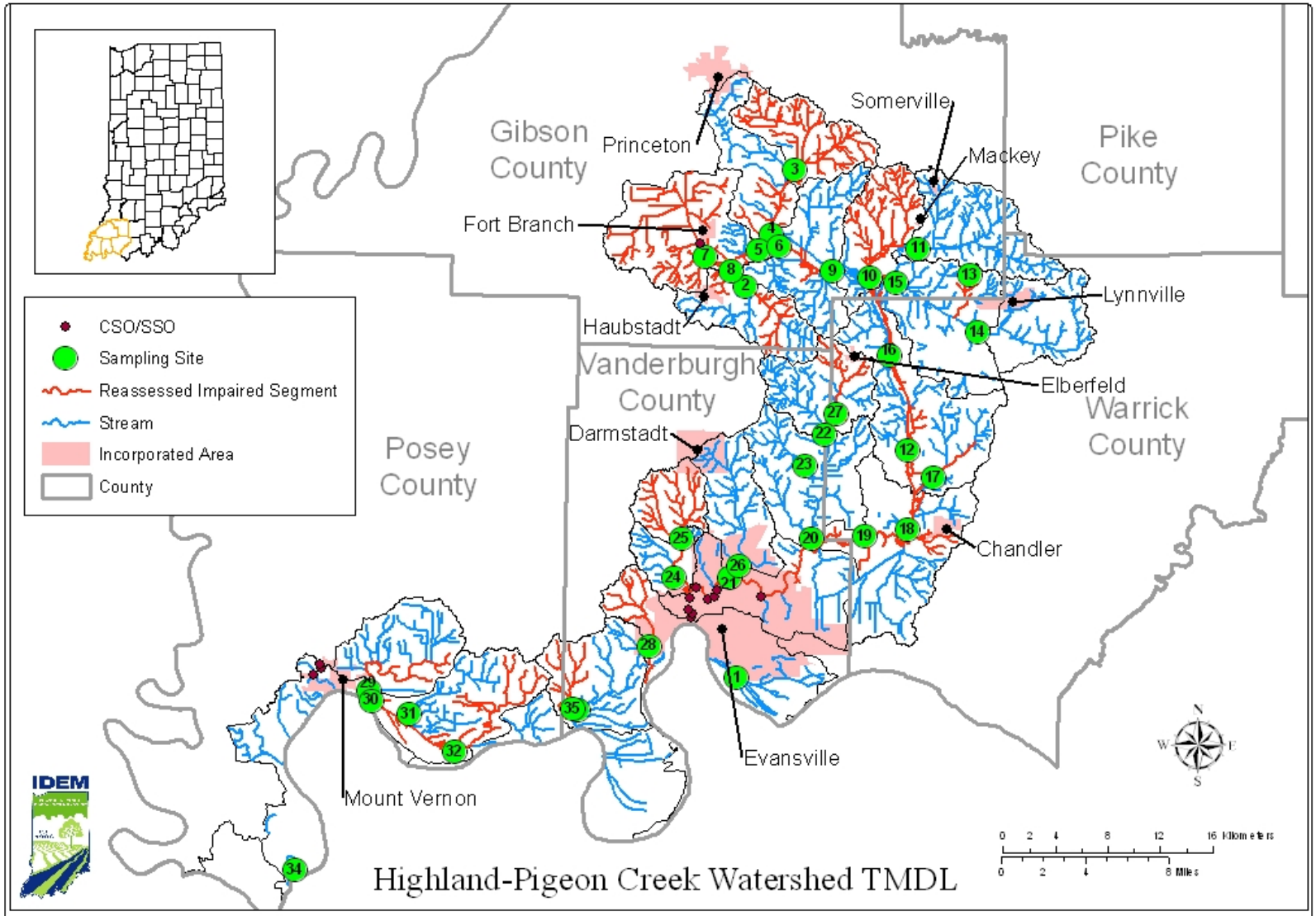
Figure 6: CSO/SSO Outfalls in the Highland-Pigeon Creek Watershed



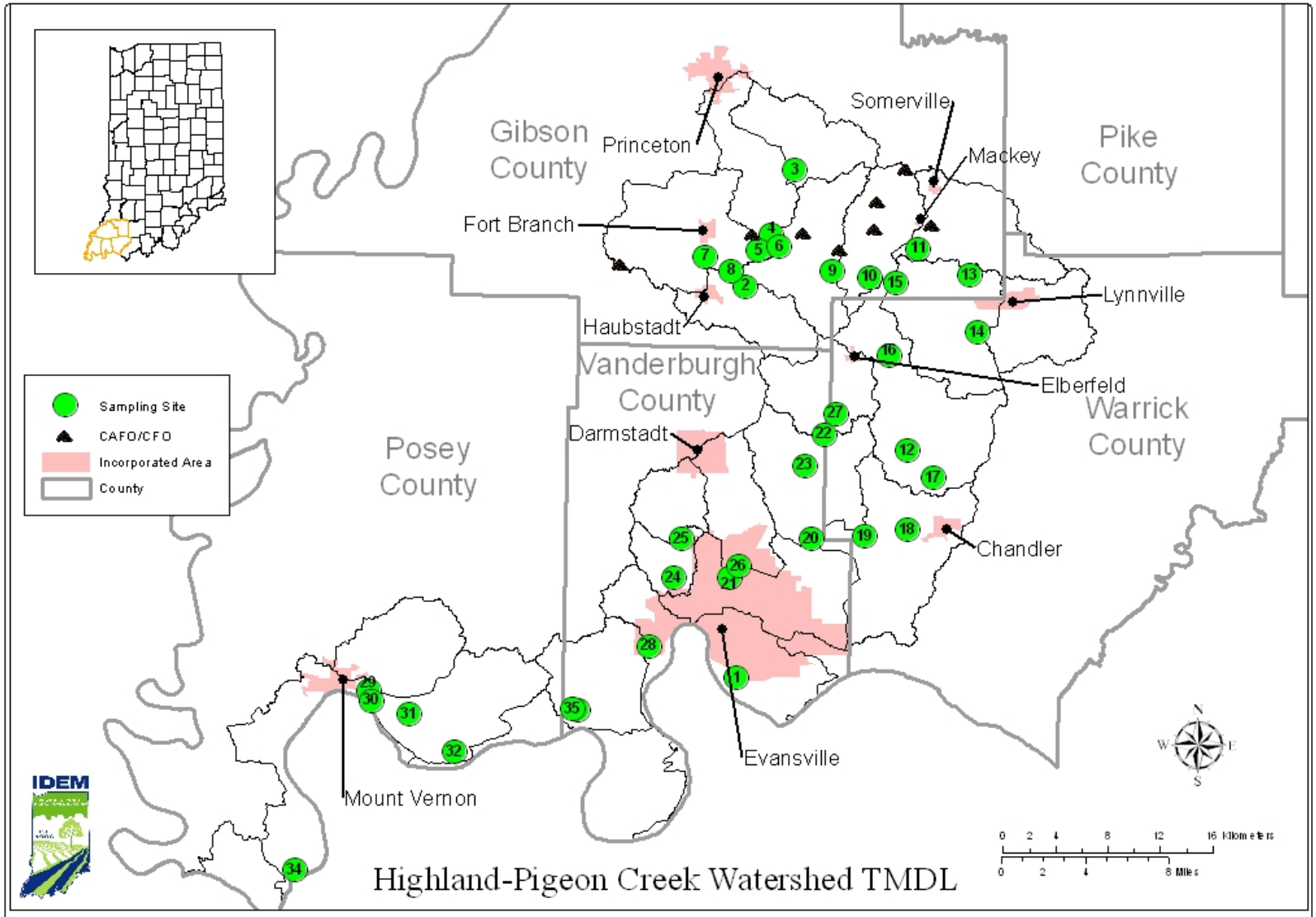
This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Mapped By:
ERNEST L. JOHNSON III, Office of Water Quality
Date: 6/14/2011

Figure 6: Combined Sewer Overflows and Storm Sewer Overflows

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

Figure 7: Confined Feeding Operations in the Highland-Pigeon Creek Watershed



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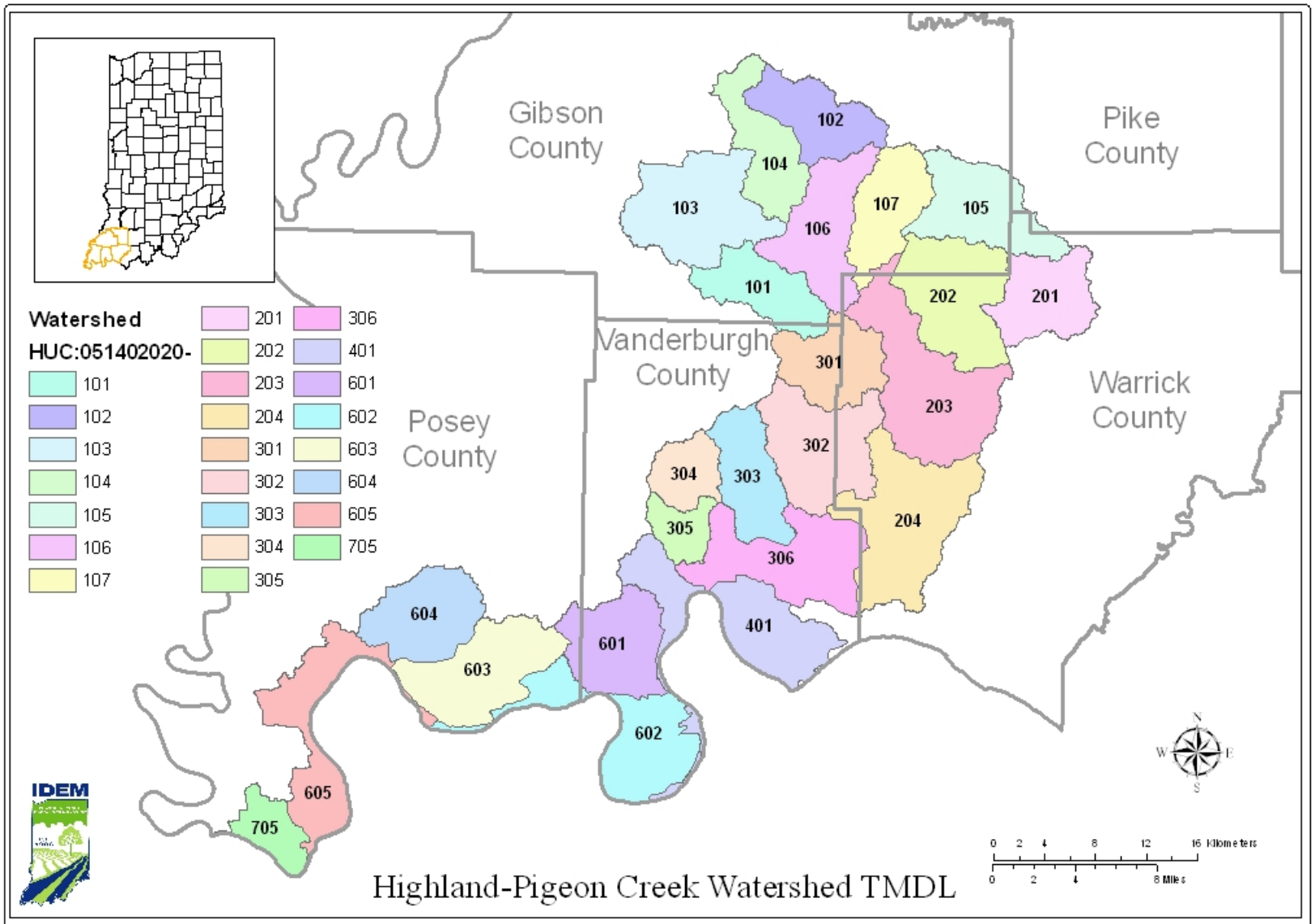
ERNEST L. JOHNSON III, Office of Water Quality
Date: 6/14/2011

Figure 7: CAFO/CFO

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

Figure 8: 12-Digit HUCs in the Highland-Pigeon Creek Watershed



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ERNEST L. JOHNSON III, Office of Water Quality
Date: 5/11/2011

Figure 8: Individual 12-Digit HUC

Sources:
Data - Obtained from the State of Indiana Geographical Information Office Library
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

Attachment A

Bacteria Data for Highland-Pigeon Creek Watershed TMDL

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Attachment B

Water Quality Graphs for the Highland-Pigeon Creek Watershed TMDL

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Attachment C

Load Duration Curves for the Highland-Pigeon Creek Watershed TMDL

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Attachment D

Precipitation Graphs for Impaired Sites in the Highland-Pigeon Creek Watershed TMDL

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Attachment E

Load Reductions for the Highland-Pigeon Creek Watershed TMDL

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Attachment F

Third-Party Data for the Highland-Pigeon Creek Watershed

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Attachment G

Nutrient Data for Highland-Pigeon Creek Watershed TMDL

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Attachment H

Reassessment notes for the Highland-Pigeon Creek Watershed TMDL

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Attachment I

Response to Public Comments