

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) for the Flatrock-Haw Creek Watershed in Henry, Fayette, Rush, Decatur, Shelby, and Bartholomew Counties

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Indiana Department of Environmental Management Total Maximum Daily Load Program August 29, 2005

Total Maximum Daily Load (TMDL) for *Escherichia coli* (*E. coli*) for the Flatrock-Haw Creek Watershed in Henry, Fayette, Rush, Decatur, Shelby, and Bartholomew Counties, Indiana

Introduction

Section 303(d) of the federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are listed on the state's section 303(d) list of impaired waterbodies because they are not meeting state 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 this TMDL is to identify the sources and determine the allowable levels of *E. coli* bacteria that will result in the attainment of the applicable WQS in the Flatrock-Haw Creek Watershed in Henry, Fayette, Rush, Decatur, Shelby, and Bartholomew Counties, Indiana.

Background

In 2002, Indiana's section 303(d) list cited the Flatrock River in Henry, Rush, Decatur, Shelby, and Bartholomew counties as being impaired for *E. coli*. In 2004, Indiana's section 303(d) list cites Flatrock-St. Omer, Flatrock-Germantown, and Gas Wells Ditch, in addition to the Flatrock River as being impaired for *E. coli*. In addition, these segments were cited for fish consumption advisories for PCBs and mercury.

A reassessment of the *E. coli* impairment was completed on the entire Flatrock-Haw Creek Watershed Hydrological Unit Code (HUC 05120205) using the *E. coli* sampling completed in 2002. Based on the reassessment, the entire Flatrock River, Arms Ditch No 1 & 2, Mud Run, Rock Branch, Northeast Tributary (Lewisville), Mills Ditch and other Tributaries, Wickoff Ditch, Shawnee Creek, Turkey Creek, Ben Davis Creek, Tributaries above US 52, Rushville Tributaries, East Tributaries, Bob Creek, Conns Creek, Lewis Creek, Sidney Branch, Ensley Ditch, Northcliff, Big Slough, Columbus Unnamed Tributaries, and Haw Creek will be listed in 2006 on the 303(d) List of Impaired Waters.

This TMDL will address the impaired segments of the Flatrock River, its tributaries and Haw Creek watershed that is a smaller watershed within the larger 8 digit Flatrock-Haw Creek watershed. The Flatrock River portion of the TMDL will address approximately 204 miles of stream. The Haw Creek portion of the TMDL will address approximately 7.47 miles of stream. These streams in Henry, Fayette, Rush, Decatur, Shelby, and Bartholomew Counties are impaired by elevated levels of *E. coli* during the recreational season. The impaired streams are located in south central Indiana (Figure 1). All thirty-nine (39) segments for this TMDL are

located in the East Fork White River Basin. The description of the study area, its topography, and other particulars are as follows:

Segment Name	303d List	Segment ID	Length	Impairment
Elatra als Diver Willburg Wright Creak	Number To be Determined	Number	(Miles)	
Flatrock River-wildur wright Creek	To be Determined	INW0511_00	5.08	E. coll
Flatrock River-Arms No. 1 & 2	To be Determined	INW0512_00	5.35	E. coll
Flatrock River-Mud Run	To be Determined	INW0515_00	5.30	E. coll
Flatrock River-Rock Branch	To be Determined	INW0514_00	2.30	E. coll
Flatrock River-above US 40	To be Determined	1000516 ± 1001	2.16	E. coll
Flatrock River-Applebutter Creek	To be Determined	INW0516_11001	3.10	E. coli
Northeast tributary (Lewisville)	To be Determined	INW0517_00	3.56	E. coli
Mills Ditch and other tributaries	To be Determined	INW0518_00	8.60	E. coli
Flatrock River	To be Determined	INW0518_T1002	4.94	E. coli
Wikoff Ditch	To be Determined	INW0519_00	12.23	E. coli
Shawnee Creek-lower	To be Determined	INW051C_00	8.91	E. coli
Flatrock River-Plum Creek Church	To be Determined	INW051D_T1003	2.72	E. coli
Flatrock River-gravel pits	To be Determined	INW0521_T1004	2.27	E. coli
Turkey Creek (Rush)	To be Determined	INW0522_00	10.30	E. coli
Flatrock River-covered bridges	To be Determined	INW0523_T1005	1.98	E. coli
Ben Davis creek	To be Determined	INW0524_00	14.36	E. coli
Tributaries above US 52	To be Determined	INW0525_00	3.54	E. coli
Flatrock River	To be Determined	INW0525_T1006	3.10	E. coli
Rushville tributaries	To be Determined	INW0526_00	6.56	E. coli
Flatrock River	To be Determined	INW0526_T1007	7.34	E. coli
East tributary Flatrock River	To be Determined	INW0527_00	7.27	E. coli
Flatrock River-Gas Wells	To be Determined	INW0528_T1008	2.99	E. coli
Bob Creek	To be Determined	INW0529_00	4.31	E. coli
Flatrock River	To be Determined	INW052A_T1009	9.93	E. coli
Flatrock River-St. Omer	172	INW0541_T1010	4.22	E. coli
Flatrock River-Germantown (gage)	172	INW0543_T1011	4.65	E. coli
Conns Creek-mouth (valley church)	To be Determined	INW054E_00	1.14	E. coli
Flatrock River-Geneva	To be Determined	INW0551_T1012	6.16	E. coli
Flatrock River-Willow park	To be Determined	INW0552_T1013	8.50	E. coli
Lewis Creek-at mouth	To be Determined	INW055E_00	1.84	E. coli
Flatrock River-Flatrock	172	INW055F T1014	4.04	E. coli
Sidney Branch	To be Determined	INW055G 00	5.89	E. coli
Flatrock River-sec 9	To be Determined	INW055H T1016	1.53	E. coli
Ensley Ditch	To be Determined	INW055J 00	4.99	E. coli
Flatrock River-Northcliff	To be Determined	INW055K T1017	6.38	E. coli
Big Slough	To be Determined	INW055M 00	6.34	E. coli
Flatrock River-Columbus tributaries	To be Determined	INW055N 00	2.87	E. coli
Flatrock River	To be Determined	INW055N T1018	4.98	E. coli
Haw Creek-Columbus	To be Determined	INW0568_00	7.47	E. coli

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IDEM has developed this TMDL to include the entire list of 39 segments found in the previous table. Thirty-six of these segments were not on IDEM's 2004 section 303(d) list. These segments are denoted in the previous table by the "To Be Determined" notation in the 303(d) List Number column. In the process of researching information pertaining to the Flatrock-Haw Creek watershed TMDL, IDEM determined that these additional segments were also impaired by *E. coli* and would have been listed on the most recent 303(d) list if the information had been available at the time of the compilation of the list. The segments are clearly identified in this TMDL and the public has the opportunity to comment on including these additional impaired segments in the TMDL during the IDEM's public comment period for the TMDL. These 36 segments will be included in the 2006 303(d) list.

Historical data collected by IDEM documented elevated levels of *E. coli* in the Flatrock-Haw Creek Watershed in 1997 and 2002. This data was the basis for listing the Flatrock River and Haw Creek Watersheds on the 2002 and 2004 303(d) list.

The IDEM 1997 Synoptic study of the Flatrock River found *E. coli* levels higher than the *E. coli* water quality standard. During the IDEM 1997 Synoptic study, two or three samples were collected at six different sampling sites totaling fourteen *E. coli* water samples. These samples were collected from June 3, 1997, to September 17, 1997. The *E. coli* results ranged from 30 cfu/100ml to 24,000 cfu/100ml (Attachment A)

In a second intensive survey, IDEM sampled fifteen sites, five times each, from May 30, 2002, to June 27, 2002 (Figure 2). All fifteen sites violated the single sample maximum count at least twice during the sampling period. At thirteen sites where a geometric mean could be calculated, all thirteen sites violated the geometric mean standard (Attachment A).

There are two Fixed Station sampling sites on Flatrock River. Fixed Station FR-64 sampling site #07 (WEF020-0002) is on Gings Road northeast of Rushville and the other sampling site (WEF050-0002) is on SR 252, which is west of Flatrock, Indiana (Attachment A).

On Haw Creek, IDEM sampled one site, five times, from July 3, 2002, to August 28, 2002 (Figure 2). This site violated the single sample maximum count twice during the sampling period. This site also violated the geometric mean standard (Attachment A).

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 for TMDL development according to the basin-rotation schedule unless there is a significant reason to deviate from this schedule. Waterbodies could be scheduled based on the following:

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

- 2. TMDL development of waterbodies where other interested parties, such as local watershed groups, are working on alleviating the water quality problem may be delayed to give these other actions time to have a positive impact on the waterbody. If water quality standards still are not met, then the TMDL process will be initiated.
- 3. TMDLs that are required due to water quality violations relating to pollutant parameters where no EPA guidance is available may be delayed to give EPA time to develop guidance.

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

Water quality *E. coli* load duration curves were created by using IDEM's data. A flow duration interval is described as a percentage. Zero (0) percent corresponds to the highest stream discharge (flood condition) and one-hundred (100) percent corresponds to the lowest discharge (drought condition). The *E. coli* values at five of the sites were plotted with the corresponding flow duration interval to show the *E. coli* violations of the single-sample maximum standard and the geometric mean standard during the recreational seasons. The locations of the sites are:

- a. Flatrock River at US 40 Bridge near Lewisville, IN (Site #05)
- b. Flatrock River at US 52 (SR 3) Bridge in Rushville, IN (Site #08)
- c. Flatrock River at USGS St. Paul Gage SW 0.8 miles of St. Paul, IN (Site #10)
- d. Flatrock River at SR 31 Bridge in Columbus, IN (Site #14)
- e. Haw Creek at SR 7 near Columbus, IN (Site #16)

These five sites are representative of the hydrodynamics of the Flatrock-Haw Creek watershed (Attachment B).

Numeric Targets

The impaired designated use for the waterbodies in the Flatrock-Haw Creek watershed is for full body contact recreational use during the recreational season, April 1st through October 31st.

327 IAC 2-1-6(d) establishes the total body contact recreational use *E. coli* Water Quality Standard (WQS¹) for all waters in the non-Great Lakes system as follows:

E. coli bacteria, using membrane filter (MF) count, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period.

¹ *E.coli* WQS = 125 cfu/100ml or 235 cfu/100ml; 1 cfu (colony forming units)= 1 mpn (most probable number)

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

For the Flatrock-Haw Creek watershed during the recreational season (April 1st through October 31st), the target level is set at the *E. coli* WQS of 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.

Source Assessment

Watershed Characterization

The Flatrock-Haw Creek watershed is an eight digit (05120205) hydrologic unit code (HUC) watershed located in central Indiana. This watershed contains both the Flatrock River and Haw Creek watershed. The watershed encompasses approximately 598 square miles in six different counties. The Flatrock River originates in the northeastern portion of Henry County and flows southwest through Rush, Shelby, and Bartholomew counties. The Flatrock River joins the Driftwood River, near Columbus, Indiana, to form the East Fork of the White River. Haw Creek originates in the Southeast corner of Shelby County as an intermittent stream. It flows southwest into Bartholomew County where it combines with Little Haw Creek near Hope, Indiana. It continues to flow southwest through Columbus, Indiana where it meets East Fork White River approximately two miles after its creation. For the purpose of this TMDL, the Flatrock River and Haw Creek will be treated as the Flatrock-Haw Creek watershed rather than separate entities.

The landuse information, which was gathered from the mid-1970s for the Flatrock-Haw Creek watershed, indicates that approximately 94.7% of the landuse was agriculture and 3.2% was developed. The remaining 2.1% included forested 1.4% and other landuses 0.7% (Table 3.C). IDEM utilized landuse information obtained in 1992 from the Gap Analysis Program (GAP). In 1992, approximately 89.8% of the landuse in the Flatrock-Haw Creek Watershed was agriculture. The remaining landuse consisted of approximately 12.6% developed, 6.5% forested, 0.3% deciduous shrubland, and 0.1% water (Figure 3, Table 3.B). A comparison of the mid-1970s land use with the 1992 land use information shows that there was a reduction of approximately 5% in agricultural and an increase of approximately 10% in developed area to the Flatrock-Haw Creek watershed.

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

Many homes within the Flatrock-Haw Creek watershed are not connected to a sewer system. Failing septic systems are a known source of *E. coli* impairment in waterbodies. A Rush County Health Department official estimated that 10 to 20% of the homes (300 to 400 homes) are not connected to a sewer system with an estimated 1% failing. A Shelby County Health Department official estimated a failure rate of less than 5% (less than 25 homes). A Bartholomew County Health Department official estimated 1,039 homes are not connected to a sewer system with an estimated failure rate of 20%. Henry County Health Department official estimated 100 homes are not on a sewer system with an estimated failure rate of 20% (Personal Communication, 2005).

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are 14 sanitary NPDES permitted dischargers in the Flatrock-Haw Creek watershed (Table 1, Figure 4). Six of the fourteen permitted dischargers have *E. coli* limits. One of these, Rushville Municipal STP (IN0021270), has fecal coliform limits and will be switched to *E. coli* limits on or before March of 2007. The violations of the *E. coli* limits at these facilities have been sporadic and adjustments were made to correct the causes of these violations. Therefore, the six permitted dischargers that have *E. coli* limits are considered to be in compliance and are not considered a significant source of the *E. coli* impairment in the Flatrock-Haw Creek watershed.

Five of the fourteen permitted sanitary dischargers are required to monitor and report *E. coli* values but are not required to provide disinfection. These permitted facilities have a detention time that exceeds the 90% requirement for disinfection of bacteria. Monitoring requirements provide the information necessary to assure compliance with *E. coli* limits. If the monitoring provides information showing the facility is violating WQS, the facility will be required to provide treatment for *E. coli* in the next permit cycle. Due to the lack of information on the discharges of *E. coli* from these facilities, it is difficult to determine to what extent, if any, these five dischargers could be a source of *E. coli* in the Flatrock-Haw Creek watershed.

Three of the fourteen permitted sanitary dischargers are required to chlorinate and de-chlorinate. These dischargers do have a sanitary component in their discharge. Previously, facilities with design flows less than 1 MGD (typically minor municipals and semipublics) were not required to have *E. coli* effluent limits or conduct monitoring for *E. coli* bacteria, provided they maintained specific total residual chlorine levels in the chlorine contact tank. The assumption was that as long as chlorine levels were adequate in the chlorine contact tank, the *E. coli* bacteria would be deactivated and compliance with the *E. coli* WQS would be met by default. The original basis for allowing chlorine contact tank requirements to replace bacteria limits was based on fecal coliform, not *E. coli*. No direct correlation between the total residual chlorine levels and *E. coli* bacteria limits may still occur when the chlorine contact tank requirements are met. Waldron Conservancy District had reported violations of their total residual chlorine limits in 2004 and April 2005. Due to the complications of comparing total residual chlorine to *E. coli*, it is difficult to determine to what extent, if any, these three dischargers could be a source of *E. coli* in the Flatrock-Haw Creek watershed

In addition to the NPDES permitted dischargers in the watershed, there may be unpermitted, illegal discharges to the Flatrock-Haw Creek watershed. Illegal discharges of residential wastewater (septic tank effluent) to streams and ditches from straight pipe discharges and old inadequate systems are a problem throughout the state (Hale, 1999; Fisher, 1999).

Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs)

There are two cities in the Flatrock-Haw Creek watershed, Rushville and Columbus, which have Combined Sewer Overflows (CSOs). Rushville has two CSOs that discharge to Flatrock River. These outfall locations are at Fort Wayne Road and at the treatment plant. Columbus has three CSOs, one of which discharges to the Flatrock River. This outfall is at Noblitt Park. CSOs are a known source of *E. coli*; it is difficult to determine to what extend these discharges have on the *E. coli* impairment in the Flatrock-Haw Creek watershed. The Long Term Control Plans (LTCP) that are under review at IDEM will provide the necessary guidelines to insure that the CSOs do not cause or contribute to the impairment of the Flatrock-Haw Creek watershed.

The Town of St. Paul has two SSOs identified in their NPDES permit. These discharge points are located at Riverbend lift station and Franklin Street lift station. SSOs are prohibited from discharging at any time and any discharge may be addressed through an enforcement action.

Storm Water General Permit Rule 13

There are two municipal separate storm sewer system (MS4) communities, the City of Columbus and Bartholomew County, in the Flatrock-Haw Creek watershed. Guidelines for MS4 permits and timelines are outlined in Indiana's Municipal Separate Storm Sewer System (MS4) Rule 13 (327 IAC 15-13-10 and 327 IAC 15-13-11). It is difficult to determine if these MS4 communities are a significant source of *E. coli* in the Flatrock-Haw Creek watershed.

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

The removal and disposal of the manure, litter, or processed wastewater that is generated as the result of confined feeding operations fall under the regulations for CFO and CAFO. There are fifty-four (54) active CFOs/CAFOs in the Flatrock-Haw Creek watershed. Of the fifty-four (54) CFOs/CAFOs, 13 have general NPDES permits. The 41 remaining facilities have general operational permits. Of the fifty-four (54) active CFOs/CAFOs, ten (10) active CFOs/CAFOs are in the Haw Creek watershed and three (3) have general NPDES permits (Table 2, Figure 5). The CFO and CAFO regulations (327 IAC 16, 327 IAC 15) require operations "not cause or contribute to an impairment of surface waters of the state". Two of the CFOs/CAFOs are under agreed orders, one for a small spill and the other operation for a non-spill violation involving a construction violation. The currently operational CFOs and CAFOs in the Flatrock-Haw Creek watershed do not have any unresolved enforcement actions at this time. Therefore, these operations are not considered a significant source of *E. coli* for the Flatrock-Haw Creek watershed.

There are also many small livestock operations in the watershed. These operations, due to their small size, are not regulated under the CFO or CAFO regulations. These operations may still have an impact on the water quality and the *E. coli* impairment. No specific information on these small livestock operations is currently available however; these small livestock operations may be a source of the *E. coli* impairment.

Flatrock-Haw Creek Watershed TMDL - USEPA APPROVAL TMDL Program – Office of Water Quality

Linkage Analysis and E. coli Load Duration Curves

The linkage between the *E. coli* concentrations in the Flatrock-Haw 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 Flatrock-Haw Creek watershed indicates that *E. coli* load enters the Flatrock-Haw Creek watershed through both wet weather (nonpoint sources and CSO's) and dry weather sources (point sources).

To investigate further the potential sources mentioned above, an *E. coli* load duration curve analysis, as outlined in an unpublished paper by Cleland (2002), was developed for five sampling sites in the Flatrock-Haw Creek watershed (Attachment C). The load duration curve analysis is a relatively new method utilized in TMDL development. The method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). These load duration curves have been included in this TMDL to give a visual representation of the flow conditions at which the *E. coli* violations occur.

In order to develop flow duration curves, water quality duration curves, and load duration curves, continuous flow data is required. Two United States Geological Survey (USGS) gages, Flatrock River gage (03363500) at St. Paul, Indiana and Flatrock River gage (03363900) at Columbus, Indiana, were used for the development of the *E. coli* duration curves analysis for the Flatrock-Haw Creek watershed TMDL. The USGS gage 03363500 on Flatrock River at St. Paul, Indiana has a drainage area of 303 square miles with stream flow data from October 1930 to the present. The USGS gage 03363900 on Flatrock River at Columbus, Indiana has a drainage area of 534 square miles and is located 2.6 miles upstream of the confluence of Flatrock River watershed with the Driftwood River to form the headwaters of East Fork White River.

In order to obtain an estimated flow at the various sample sites on the Flatrock River, the drainage area (in square miles) for each sample site is calculated where duration curve analysis will be conducted. The average flow (flow in cubic feet per second (CFS) per unit area (area in square miles) will be calculated for USGS Flatrock River gage (03363500) at St. Paul, Indiana with a drainage area of 303 square miles and USGS Flatrock River gage (03363900) at Columbus, Indiana with a drainage area of 534 square miles. Any site upstream of the St Paul gage will use the Flatrock River gage (03363500) to calculate the average flow per unit area. Any site downstream of the St. Paul gage will use the Flatrock River gage (03363900) at Columbus to calculate the average flow per unit area. The flow from the Columbus gage will also be utilized for the Haw Creek watershed sampling site. The flow at a sample site will be determined by multiplying the drainage area (square miles) of the sample site by the average flow per unit area (cfs/square mile) calculated from the appropriate gage.

The flow data is used to create flow duration curves that 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 monitoring station to the percent of time those values are met or exceeded. Flows are ranked from extremely low flows, which are exceeded nearly one-hundred percent of the time, to extremely high flows, which are rarely exceeded. Flow duration curves

are then transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for *E. coli* and appropriate conversion factors. The load duration curves are conceptually similar to the flow duration curves in that the x-axis represents the flow recurrence interval and the y-axis represents the allowable load of the water quality parameter. The curve representing the allowable load of *E. coli* was calculated using the daily and geometric mean standards of 235 *E. coli* per 100 ml and 125 *E. coli* per 100 ml, respectively.

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 and 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 WQS (Mississippi DEQ, 2002).

Load duration curves were created for five sampling sites (#05, #08, #10, #14, and #16) in the Flatrock-Haw Creek watershed. Sampling sites 05, 08, 10, and 14 provide an overall characterization of the Flatrock River. Site 16 provides the information available on Haw Creek. (Figure 2, Attachment B)

While there are point source contributors, who must not operate in a manner that impairs water quality, compliance with the numeric *E. coli* WQS in the Flatrock-Haw Creek watershed also depends on the control of nonpoint sources using best management plans (BMPs). If the *E. coli* inputs can be controlled, then the total body contact recreation use in the Flatrock-Haw Creek watershed will be protected.

TMDL Development

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving the Water Quality Standard (WQS). As indicated in the Numeric Targets section of this document, the target for this *E. coli* TMDL is 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 1st through October 31st. 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 critical conditions that, when addressed by appropriate controls, will ensure attainment of the WQS for the pollutant. For example, the critical conditions for the control of point sources in Indiana are given in 327 IAC 5-2-11.1(b). In general, the 7-day average low flow in 10 years (Q7, 10) for a stream is used as the design condition for point source dischargers. However, *E. coli* sources to the Flatrock-Haw Creek watershed arise from a mixture of dry and wet weather-driven conditions and there is no single critical condition that would achieve the *E. coli* WQS. For the Flatrock-Haw Creek watershed and the contributing sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

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

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 term TMDL represents the maximum loading that can be assimilated by the receiving water while still achieving the WQS. The overall loading capacity is subsequently allocated into the TMDL components of WLAs for point sources, LAs for nonpoint sources, and the MOS. This *E. coli* TMDL is concentration-based consistent with USEPA regulations at 40 CFR, Section 130.2(i).

Wasteload Allocations

The source assessment section of this document gives a listing of the point sources for the wasteload allocation. As mentioned previously, there are 14 sanitary NPDES permitted dischargers in the Flatrock-Haw Creek watershed (Table 1, Figure 4). Six of the fourteen permitted sanitary dischargers have *E. coli* limits. Five of the fourteen permitted sanitary dischargers are required to monitor and report *E. coli* values but are not required to provide disinfection. These permitted facilities have a detention time that exceeds the 90% requirement for disinfection of bacteria. The monitoring requirements will provide the information necessary to assure compliance with E. coli limits. If the monitoring provides information showing, the facility is violating WQS the facility will be required to provide treatment for E. coli in the next permit cycle. Three of the fourteen permitted sanitary dischargers have *E. coli* limits and are not required to monitor for *E. coli*. IDEM's TMDL program recommends the addition of *E. coli* limits to these three permits during the next permit cycle.

There are two cities in the Flatrock-Haw Creek watershed, Rushville and Columbus that have Combined Sewer Overflows (CSOs). Rushville has two CSOs that discharge to Flatrock River. These outfall locations are at Fort Wayne Road and at the treatment plant. Columbus has three CSOs one of which discharges to the Flatrock River. This outfall is at Noblitt Park. CSOs are a known source of *E. coli*; it is difficult to determine to what extend these discharges have on the *E. coli* impairment in the Flatrock-Haw Creek watershed. The Long Term Control Plans (LTCP)

that are under review at IDEM will provide the necessary guideline to insure that the CSOs do not cause or contribute to the impairment of the Flatrock-Haw Creek watershed

The Town of St. Paul has two SSOs identified in their NPDES permit. These discharge points are located at Riverbend lift station and Franklin Street lift station. SSOs are prohibited from discharging at any time and any discharge may be addressed through an enforcement action.

There are two MS4 communities, the City of Columbus and Bartholomew County, in the Flatrock-Haw Creek watershed. To date, stormwater permits have not been finalized for these MS4 communities. 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). These permits will be issued in accordance with the MS4 permitting cycle.

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 1st through October 31st.

Load Allocations

The watershed characterization portion of the source assessment section of this document gives a listing of the nonpoint source for this load allocation. The LA 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 1st through October 31st. The assumption used in this load allocation strategy is that there are equal bacterial loads per unit area for all lands within the watershed. Therefore, the relative responsibility for achieving the necessary reductions of bacteria and maintaining acceptable conditions is determined by the amount of land under the jurisdiction of the various local units of government within the watershed. This gives a clear indication of the relative amount of effort that will be required by each entity to restore and maintain the full body contact recreational use of the Flatrock-Haw Creek watershed.

The Rush County government and their corresponding portions of the land area in the Flatrock-Haw Creek watershed are as follows: Rushville Township (7.37 %), Orange Township (6.03 %), Union Township (5.98 %), Washington Township (5.60 %), Anderson Township (5.13 %), Noble Township (4.72 %), Walker Township (3.86 %), Jackson Township (2.56 %), Posey Township (1.05 %), Richland Township (0.49 %), and Center Township (0.24 %).

The Shelby County government and their corresponding portions of the land area in the Flatrock-Haw Creek watershed are as follows: Washington Township (5.89 %), Shelby Township (4.68 %), Noble Township (4.68 %), Liberty Township (3.92 %), Jackson Township (2.54 %), Addison Township (1.64 %), Union Township (1.06 %), and Hendricks Township (0.43 %).

The Bartholomew County government and their corresponding portions of the land area in the Flatrock-Haw Creek watershed are as follows: Flat Rock Township (4.81 %), Haw Creek Township (3.47 %), German Township (3.34 %), and Columbus Township (3.17 %).

The Henry County government and their corresponding portions of the land area in the Flatrock-Haw Creek watershed are as follows: Liberty Township (3.33 %), Franklin Township (3.22 %), Dudley Township (1.39 %), Blue River Township (1.37 %), and Henry Township (1.35 %). The Decatur County government and their corresponding portions of the land area in the Flatrock-Haw Creek watershed are as follows: Adams Township (3.28 %) and Clinton Township (0.38 %).

The Fayette County government and their corresponding portions of the land area in the Flatrock-Haw Creek watershed are as follows: Posey Township (1.83 %), Fairview Township (1.08 %), and Orange Township (0.10 %).

The Randolph County government and their corresponding portion of the land area in the Flatrock-Haw Creek watershed are as follows: Union Township (0.000818 %). (ESRI, 2004) (Table 3.A. and Figure 6.)

Margin of Safety

A Margin of Safety (MOS) 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 thorough conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS by applying two 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. This adds to the MOS for this TMDL. 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 conservative approach that provides for greater protection of the water quality.

Seasonality

Seasonality in the TMDL is addressed by expressing the TMDL in terms of the *E. coli* WQS for full body contact during the recreational season (April 1st through October 31st) as defined by 327 IAC 2-1-6(d). There is no applicable full body contact *E. coli* WQS during the remainder of the year in Indiana. Because this is a concentration-based TMDL, *E. coli* WQS will be met regardless of flow conditions in the applicable season.

Monitoring

Future monitoring of the Flatrock-Haw Creek watershed will take place during IDEM's five-year rotating basin schedule and/or once TMDL implementation methods are in place. During the five-year rotating basin schedule, IDEM will monitor the Flatrock-Haw Creek watershed for *E. coli*. Monitoring will be adjusted as needed to assist in continued source identification and elimination. When these results indicate that the waterbody is meeting the *E. coli* WQS, IDEM

will monitor at an appropriate frequency to determine if Indiana's 30-day geometric mean value of 125 *E. coli* per one hundred milliliters is being met.

Reasonable Assurance Activities

Reasonable assurance activities are programs that are in place or will be in place that assist in meeting the Flatrock-Haw Creek watershed TMDL allocations and the *E. coli* Water Quality Standard (WQS).

Confined Feeding Operations and Concentrated Animal Feeding Operations

CFOs and CAFOs are required to manage manure, litter, and processed wastewater pollutants in a manner that does not cause or contribute to the impairment of *E. coli* WQS.

National Pollutant Discharge Elimination Systems

For the permitted dischargers that have total residual chlorine limits in their current permit, IDEM's TMDL program proposes the *E. coli* limits and monitoring be added when the next permit renewals are issued. For the permitted dischargers that have monitoring and reporting requirements, IDEM's TMDL program proposes reviewing the results of the monitoring to assure compliance with WQS during and including *E. coli* limits if needed in the next permit cycle. This review of information and possible inclusion of *E. coli* limits will occur on the 5 year permitting cycle.

Storm Water General Permit Rule 13

MS4 permits are being issued in the State of Indiana. There are two MS4 communities, the City of Columbus and Bartholomew, in the Flatrock-Haw Creek watershed. To date, stormwater permits have not been finalized for these MS4 communities. 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). These permits will be used to address storm water impacts in the Flatrock-Haw Creek watershed.

Combined Sewer Overflows (CSOs) and Sanitary Sewer Overflows (SSOs)

There are two cities in the Flatrock-Haw Creek watershed, Rushville and Columbus that have Combined Sewer Overflows (CSOs). Rushville has two CSOs that discharge to Flatrock River. These outfall locations are at Fort Wayne Road and at the treatment plant. Columbus has three CSOs one of which discharges to the Flatrock River. This outfall is at Noblitt Park. CSO are a known source of *E. coli*; it is difficult to determine to what extend these discharges have on the *E. coli* impairment in the Flatrock-Haw Creek watershed. The Long Term Control Plans (LTCP) that are under review at IDEM will provide the necessary guideline to insure that the CSOs do not cause or contribute to the impairment of the Flatrock-Haw Creek watershed.

The Town of St. Paul has two SSOs identified in their NPDES permit. These discharge points are located at Riverbend lift station and Franklin Street lift station. SSOs are prohibited from discharging at any time and any discharge may be addressed through an enforcement action.

Wastewater Treatment Plant (WWTP), Infrastructure Improvement, and Compliance Activities

The following is a list of activities that have occurred that will or have resulted in an improvement of water quality within the Flatrock-Haw watershed:

- The Town of Mooreland STP has completed a sewer lining project and switched to UV disinfection in 2003. In addition, the IDEM WWTP inspector, along with the Town of Mooreland STP, discovered sampling procedure problems resulting in false permit violations.
- Rushville Municipal STP will be connecting 248 more homes in less than two years to their city sewer system.
- Shelby County Health Department has repaired 12 failing on-site sewage systems including one for a store and one for a church.
- Because of a soon-to-be completed enforcement action, Bartholomew County Cross Cliff Elementary School installed UV disinfection as of December of 2003.
- Western Rush County Regional Water and Sewer District hired a new operator after the previous operator failed to renew their operator certification. An agreed order is being negotiated to resolve two *E. coli* violations in 2003.

Watershed Related Activities

In 1997, a Watershed Management plan was completed for the Flatrock River by a coalition of stakeholders interested in the upper Flatrock River. After this plan was completed, an additional grant was awarded for implementation of the Watershed Management plan. This was awarded to the Rush County SWCD. This watershed plan would need to be expanded upon in order to adequately address *E. coli* impairment within the watershed, but it does represent stakeholder interest in water quality issues.

IDEM has recently hired a Watershed Specialist for this area of the state. The Watershed Specialist will be available to assist stakeholders with starting a watershed group, facilitating planning activities, and serving as a liaison between watershed planning and TMDL activities in the Flatrock-Haw Creek watershed. In addition, Section 319 funding may be available to help implement the TMDL in the watershed.

Potential Future Activities:

Nonpoint source pollution, which is the primary cause of *E. coli* impairment in this watershed, can be reduced by the implementation of "best management practices" (BMPs). BMPs are practices used in agriculture, forestry, urban land development, and industry to reduce the potential for damage to natural resources from human activities. A BMP may be structural, that is, something that is built or involves changes in landforms or equipment, or it may be managerial, that is, a specific way of using or handling infrastructure or resources. BMPs should

be selected based on the goals of a watershed management plan. Livestock owners, farmers, and urban planners, can implement BMPs outside of a watershed management plan, but the success of BMPs would be enhanced if coordinated as part of a watershed management plan. Following are examples of BMPs that may be used to reduce *E. coli* runoff:

Riparian Area Management - Management of riparian areas protects stream banks and 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. A drift fence parallel to a stream keep animals out and prevents 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 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*.

Conclusion

The sources of *E. coli* to the Flatrock-Haw Creek watershed include both point and non-point sources. In order for the Flatrock-Haw Creek watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the Flatrock-Haw 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 period from April 1st through October 31st.

Achieving the wasteload and load allocations for the Flatrock-Haw Creek watershed depends on:

- 1) permitted facilities meeting their permit limits;
- 2) *E. coli* limits being added for sanitary dischargers who currently only monitor for total residual chlorine;
- 3) Review of compliance with *E. coli* standards for sanitary dischargers who currently only monitor for *E. coli*;
- 4) The issuance of MS4 permits and LTCP approvals for the city of Columbus and Bartholomew County;
- 5) Compliance with discharge prohibition for SSOs in St. Paul;
- 6) CFOs and CAFOs not violating their permits;
- 7) Nonpoint sources of *E. coli* being controlled by implementing best management practices in the watershed.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Flatrock-Haw Creek watershed in compliance with the *E. coli* WQS. IDEM will continue to work with its existing programs on implementation. In the event that designated uses and associated water quality criteria applicable to the Flatrock-Haw 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 Flatrock-Haw Creek watershed.

REFERENCES

- Cleland, B. 2002 TMDL Development from the "Bottom Up"-Part II. Using Duration Curves to Connect the Pieces. America's Clean Water Foundation.
- ESRI. July 2004. <http://www.esri.com/data/download/census2000_tigerline/>.
- Indiana Department of Environmental Management (IDEM) May 2001. Flatrock-Haw Creek Watershed Restoration Action Strategy.
- Indiana Department of Environmental Management (IDEM), 2002. Indiana 2002 303(d) List of Impaired Waterbodies for Total Maximum Daily Load (TMDL) Development.
- Indiana Department of Environmental Management (IDEM), 2004. Indiana 2004 303(d) List of Impaired Waterbodies for Total Maximum Daily Load (TMDL) Development.
- Indiana Department of Natural Resources (IDNR). 1999. The Indiana Canoeing Guide. Indiana Department of Natural Resources, Indianapolis, IN. <u>http://www.state.in.us/dnr/outdoor/canoegui/index.htm</u>
- Mississippi Department of Environmental Quality. 2002. Fecal Coliform TMDL for the Big Sunflower River, Yazoo River Basin.
- USEPA. 2001. Protocol for Developing Pathogen TMDLs. United States Environmental Protection Agency, 841-R-00-002.

Table 1: NPDES Permits in Flatrock-Haw Creek Watershed

Permitted Discharger with E. coli limits

Permit No.	Facility Name	Receiving Waters
IN0032573	Columbus Municipal STP	Flatrock River & East Fork White River
IN0031551	Cross Cliff Elementary School	Slash Ditch/Haw Creek
IN0040398	Mooreland Municipal WWTP	Flatrock River
IN0021270	Rushville Municipal STP	Unnamed Oxbow of Flatrock R. (E. coli limits starts on 4/01/2007)
IN0055131	South Henry Regional Sewer District	Flatrock River
IN0061531	Western Rush County RWSD WWTP	Goddard Ditch

Permitted Discharger with Fecal Coliform limits - (switches to *E. coli* limits 4/1/2007)

Permit No.	Facility Name	Receiving Waters
IN0021270	Rushville Municipal STP	Unnamed Oxbow of Flatrock River

Permitted Discharger required to monitor and report E. coli values

Permit No.	Facility Name	Receiving Waters
IN0024783	Waldron Conservancy District	Conns Creek
IN0061778	Glenwood Municipal WWTP	Ben Davis Creek
IN0109746	Anderson Township RSD	Little Flatrock River
IN0021253	Hope Municipal STP	Haw Creek

Permitted Dischargers with Total Residue Chlorine (TRC) limits

Permit No.	Facility Name	Receiving Waters
IN0053546	Southwestern Elementary and High School	East Fork Slash Creek
IN0045748	Wood Products LLP WWTP	Tributary to Haw Creek
IN0039632	Countryside Estates MHP (Shady Creek)	Lewis Creek

Permitted Dischargers not required to chlorinate or monitor for E. coli and no E. coli limits

Permit No.	Facility Name	Receiving Waters
IN0020842	Saint Paul Municipal STP	Flatrock River

Approved Animals NPDES Turkeys # County Log # Name Status Nurserv Grower/ Sows / Beef Beef Dairv Dairv Veal Lavers Permit Pig Finishers Calves Calves Boars Bartholomew -----Shoaf Active Dodd Farms Bartholomew YES Inc. Active Trotter Farms & Feed Bartholomew _____ Active Bartholomew _____ Stafford Farms Active YES Hope Production Site Bartholomew Active Dodds Farms Inc. Bartholomew _____ Active Bartholomew _____ Shoaf Active Farms Shawvue Bartholomew _____ Active Fayette -----Herrmann Active Milco Dairy Farm Henry YES Active Rush -----Megee Active **Buening Family Hog Farm** Rush YES Active Rush **Benson Farms** _____ Active Rush Home Farm _____ Active Rush YES Smith Active E & J Young Farms Rush _____ Active Rush _____ Liggett Active Rush _____ Cain Active K&A Oldham Farms Rush Active -----Rush Cain -----Active Rush P&M Gordon Farms Active _____ Rush _____ Osborne Active White Rush Active _____ **Trebley Farms** Rush -----Active Rush Amos -----Active Rush YES Cain Active Rush YES Amos Active Rush _____ Harmever Active Hoeing Livestock Hog Farm Rush _____ Active

Table 2: Confined Feeding Operations (CFO) and Concentrated Animal Feeding Operations (CAFO) in the Flatrock-Haw Creek Watershed

Entries in BOLD are located in the 11 digit (05120205060) HUC Haw Creek watershed

						Approved Animals									
#	County	Log	NPDES	Name	Status	Nursery	Grower/	Sows /	Beef	Beef	Dairy	Dairy	Veal	Layers	Turkeys
		#	Permit			Pig	Finishers	Boars		Calves		Calves			
30	Rush	2648		Meyer	Active	570	400	30	0	0	0	0	0	0	0
31	Rush	3043		Dora Family, LLC	Active	0	0	745	120	60	0	0	0	0	0
32	Rush	3543		Hoeing Livestock Hog Farm	Active	0	0	0	0	0	600	0	0	0	0
33	Rush	3598		E&D Gordon Farms	Active	750	1300	400	0	0	0	0	0	0	0
34	Rush	3630		Morgan	Active	250	750	73	0	0	0	0	0	0	0
35	Rush	3876		Robert Jackson Farm	Active	0	860	0	0	0	0	0	0	0	0
36	Rush	4077	YES	Spaeth	Active	0	3810	0	0	0	0	0	0	0	0
37	Rush	4172		Ping Farm Trust	Active	250	330	18	0	0	0	0	0	0	0
38	Rush	4193		Garner	Active	252	600	144	0	0	0	0	0	0	0
39	Rush	4521		Layton Acres Inc.	Active	300	400	95	0	0	0	0	0	0	0
40	Rush	4592		Naylor	Active	200	1200	103	0	0	0	0	0	0	0
41	Rush	4675		4 Way Productions Inc.	Active	960	3920	670	0	0	0	0	0	0	0
42	Rush	4757		South Farm	Active	272	580	40	0	0	0	0	0	0	0
43	Rush	4908	YES	Farm #2	Active	0	3800	0	0	0	0	0	0	0	0
44	Rush	4910	YES	Farm #1	Active	0	3800	0	0	0	0	0	0	0	0
45	Rush	4990		Miroy Farm	Active	0	9000	0	0	0	0	0	0	0	0
46	Rush	6236	YES	J&S Pork	Active	0	4000	0	0	0	0	0	0	0	0
47	Shelby	377		Kuhn	Active	600	2100	295	0	0	0	0	0	0	0
48	Shelby	1496		Harker	Active	500	420	133	0	0	0	0	0	0	0
49	Shelby	2205		Kuhn & Sons	Active	260	750	135	0	0	0	0	0	0	0
50	Shelby	3004	YES	Douglas, Jr.	Active	1800	4800	749	0	0	0	0	0	0	0
51	Shelby	4078	YES	Sandefur	Active	0	2760	0	0	0	0	0	0	0	0
52	Shelby	4712		Douglas & Son	Active	288	0	128	0	0	0	0	0	0	0
53	Shelby	4713		P&J Farm LLC	Active	0	840	40	0	0	0	0	0	0	0
54	Shelby	6204		Garner	Active	0	2000	0	0	0	0	0	0	0	0

Cont. Table 2: Confined Feeding Operations (CFO) and Concentrated Animal Feeding Operations (CAFO) in the Flatrock-Haw Creek Watershed

Entries in BOLD are located in the 11 digit (05120205060) HUC Haw Creek watershed

County	Square Meters	Acres	Percent		
Rush	Rushville Township	114,130,429	28,202	7.37 %	
Rush	Orange Township	93,360,452	23,070	6.03 %	
Rush	Union Township	92,505,402	22,858	5.98 %	
Rush	Washington				
	Township	86,672,795	21,417	5.60 %	
Rush	Anderson				
	Township	79,366,004	19,612	5.13 %	
Rush	Noble Township	73,037,068	18,048	4.72 %	
Rush	Walker Township	59,792,263	14,775	3.86 %	
Rush	Jackson Township	39,686,295	9,807	2.56 %	
Rush	Posey Township	16,291,122	4,026	1.05 %	
Rush	Richland Township	7,581,481	1,873	0.49 %	
Rush	Center Township	3,680,434	909	0.24 %	
Rush County	Total	666,103,744	164,597	43.03 %	
Shelby	Washington				
	Township	91,217,080	22,540	5.89 %	
Shelby	Shelby Township	72,512,014	17,918	4.68 %	
Shelby	Noble Township	72,385,075	17,887	4.68 %	
Shelby	Liberty Township	60,757,427	15,013	3.92 %	
Shelby	Jackson Township	39,318,634	9,716	2.54 %	
Shelby	Addison Township	25,460,538	6,291	1.64 %	
Shelby	Union Township	16,434,723	4,061	1.06 %	
Shelby	Hendricks				
	Township	6,722,216	1,661	0.43 %	
Shelby County	Total	384,807,707	95,088	24.86 %	
D (1.1					
Bartholomew	Flat KOCK	74 506 770	10 /10	4.01.0/	
D (1 1	Township	/4,526,778	18,416	4.81 %	
Bartholomew	Haw Creek	52 ((1 272	12.200	2 47 0/	
D	Township Common Torrentin	51,001,572	13,200	3.47%	
Dartholomew	Columbus	51,084,414	12,771	3.34 %	
Darmoiomew	Columbus	40 142 202	12 144	2 17 0/	
Desite all second	Townsnip	49,145,292	12,144	3.1/%	
Bartholomew County	Total	229,015,856	56,591	14.79 %	

Table 3.A: Land Area Distribution by Township for the Flatrock-Haw Creek Watershed

County	Municipality	Square Meters	Acres	Percent
Henry	Liberty Township	51,516,965	12,730	3.33 %
Henry	Franklin Township	49,807,442	12,308	3.22 %
Henry	Dudley Township	21,588,047	5,335	1.39 %
Henry	Blue River			
	Township	21,269,290	5,256	1.37 %
Henry	Henry Township	20,670,680	5,108	1.35 %
Henry County	Total	164,852,424	40,736	10.65 %
Decatur	Decatur Adams Township		12,565	3.28 %
Decatur	Clinton Township	Sownship 5,816,577		0.38 %
Decatur County	Total	56,665,884	14,002	3.66 %
Fayette	Posey Township	28,305,882	6,995	1.83 %
Fayette	Fairview Township	16,789,762	4,149	1.08 %
Fayette	Orange Township	1,617,950	400	0.10 %
Fayette County	Total	46,713,594	11,543	3.02 %
Randolph	Union Township	12,666	3	0.000818 %
Randolph County	Total	12,666	3	0.000818 %
Totals		1,548,171,875	382,560	100 %

Cont. Table 3.A: Land Area Distribution by Township for the Flatrock-Haw Creek Watershed

Landuse	Square	Acres	Percent
	Meters		
Developed: Agriculture, Row Crop	1,272,908,855	314,541	82.22 %
Developed: Agriculture, Pasture/Grassland	117,543,393	29,045	7.59 %
Terrestrial: Forest, Deciduous	64,548,433	15,950	4.17 %
Palustrian: Forest, Deciduous	31,585,254	7,805	2.04 %
Developed: Low Density Urban	25,642,242	6,336	1.66 %
Developed: Non-Vegetated	14,236,523	3,518	0.92 %
Developed: High Density Urban	8,352,896	2,064	0.54 %
Terrestrial: Woodland, Deciduous	3,940,805	974	0.25 %
Palustrian: Shrubland, Deciduous	2,975,518	735	0.19 %
Water	2,040,008	504	0.13 %
Palustrian: Herbaceous, Deciduous	1,419,618	351	0.09 %
Terrestrial: Shrubland, Deciduous	1,144,097	283	0.07 %
Terrestrial: Forest, Evergreen	766,078	189	0.05 %
Developed: Agriculture:, Wet Areas	379,108	94	0.02 %
Terrestrial: Forest, Mixed	306,523	76	0.02 %
Palustrian: Sparsely Vegetated or Non-			
Vegetated	296,975	73	0.02 %
Palustrian: Woodland, Deciduous	43,619	11	< 0.01 %
Unclassified Cloud/Shadow	41,931	10	< 0.01 %
Total	1,548,171,875	382,560	99.98%

 Table 3.B: 1992 Gap Analysis Program (GAP) Landuse Distribution for the Flatrock-Haw Creek Watershed

Landuse	Square	Acres	Percent
	Meters		
CROPLAND AND PASTURE	1,460,996,609	361,019	94.37 %
RESIDENTIAL	34,484,909	8,521	2.23 %
DECIDUOUS FOREST LAND	21,182,573	5,234	1.37 %
COMMERCIAL AND SERVICES	12,362,294	3,055	0.80 %
TRANS, COMM, UTIL	9,099,490	2,249	0.59 %
OTHER AGRICULTURAL LAND	5,062,135	1,251	0.33 %
OTHER URBAN OR BUILT-UP	1,876,440	464	0.12 %
STRIP MINES	1,427,462	353	0.09 %
RESERVOIRS	841,090	208	0.05 %
MIXED URBAN OR BUILT-UP	449,006	111	0.03 %
INDUSTRIAL	200,448	50	0.01 %
TRANSITIONAL AREAS	100,506	25	< 0.01 %
LAKES	85,615	21	< 0.01 %
Total	1,548,168,575	382,559	99.99 %

Table 3.C: 1970's Landuse Data for the Flatrock-Haw Creek Watershed

Attachment A:

Flatrock-Haw Creek Watershed E. coli Data

Attachment A: Flatrock-Haw Creek Watershed E. coli Data

Site ID	Stream Name	Site Description	Sample Date	Sample Number	Lab Results
WEF010-	Wilbur	CR 800 E	5/30/02	AA11304	210
0008	Wright	NE	6/6/02	AA11319	270
Site #1	Creek	headwater	6/13/02	A A 11408	410
		fork	6/20/02	ΔΔ11515	410
		Henry	6/27/02	ΔΔ11/198	1300
		County	0/27/02	Geometric	1300
				Mean	451
WEF010-	Mooreland	Outfall on	6/6/02	AA11388	15
0009	Municipal	Flatrock			
Slightly u/s	WWTP	River			
of Site #2		Henry			
		County			
WEF010-	Flatrock	SR 38	5/30/02	AA10962	93
0003	River	Henry	6/6/02	AA11321	270
Site #2		County	6/13/02	AA11394	150
			6/20/02	AA11501	180
			6/27/02	AA11484	280
				Geometric	180
				Mean	
WEF010-	Flatrock	SR 38	5/30/02	AA10962	93
0003	River	Henry	6/6/02	AA11321	270
Site #3		County	6/13/02	AA11394	150
			6/20/02	AA11501	180
			6/27/02	AA11484	280
				Geometric	180
				Mean	
WEF010-	Flatrock	US 103	5/30/02	AA10963	170
0002	River	Henry	6/6/02	AA11322	>2400
Site #4		County	6/13/02	AA11395	260
			6/20/02	AA11502	550
				AA11503	(365) Dup.
			6/27/02	AA11485	2000
				Geometric	651
				Mean	
WEF010	Flatrock	US 40	5/30/02	AA10964	190
0001	River	USGS	6/6/02	AA11323	1200
Site #5		Partial	6/13/02	AA11396	240
		Record	6/20/02	AA11504	230
		Station	6/27/02	AA11486	2000
		Henry		Geometric	479
		County		Mean	

Attachment A: Flatrock-Haw Creek Watershed E. coli Data

Site ID	Stream	Site	Sample	Sample	Lab Results
	Name	Description	Date	Number	(CFU/100ml)
WEF010-	Flatrock	CR 650 N	5/30/02	AA10965	330
0007	River	Rush	6/6/02	AA11324	>2400
Site #6		County	6/13/02	AA11397	480
			6/20/02	AA11505	365
			6/27/02	AA11487	>2400
				Geometric	803
				Mean	
WEF020-	Flatrock	Gings Road	5/30/02	AA10966	220
0002	River	N.E. of	6/6/02	AA11325	< 1
Site #7		Rushville	6/13/02	AA11398	460
		Fixed		AA11409	(490) Dup.
		Station (FR-	6/20/02	AA11506	235
		64)	6/27/02	AA11491	9200
		Rush		AA11492	(2400) Dup.
		County		Geometric	185
				Mean	
WEF020-	Flatrock	US 52 (SR	5/30/02	AA10967	240
0012	River	3)		AA10974	(220) Dup.
Site #8		Rush	6/6/02	AA11326	5800
		County	6/13/02	AA11399	390
			6/20/02	AA11507	390
			6/27/02	AA11489	1400
				Geometric	784
				Mean	
WEF020-	Flatrock	CR 650 S	5/30/02	AA10968	190
0001	River	Forsythe	6/6/02	AA11327	2000
Site #9		Mills	6/13/02	AA11400	490
		Bridge	6/20/02	AA11508	160
		Rush	6/27/02	AA11490	1700
		County		Geometric	551
				Mean	
WEF040-	Flatrock	S. County	5/30/02	AA10969	120
0002	River	Line Road	6/6/02	AA11328	17000
Site #10		0.8 miles		AA11329	(14000)
		SW of St.			Dup.
		Paul	6/13/02	AA11401	520
		USGS Gage	6/20/02	AA11509	68
		03363500	6/27/02	AA11488	210
		Shelby		Geometric	433
		County		Mean	

Site ID	Stream	Site	Sample	Sample	Lab Results
WEE050	Flatrock		5/30/02		
0013	River	SK 9 Shelby	5/50/02	AA10970	> 2400
Site #11	KIVCI	County	6/13/02	AA11330	78
Site #11		County	6/20/02	AA11402	50
			6/27/02	AAIIJIO	50
			0/27/02	Geometric	
				Mean	
WEE050-	Flatrock	SR 252	5/30/02	AA10971	340
0002	River	Fixed Station	6/6/02	AA11331	1700
Site #12		(FR-17)	6/13/02	AA11403	820
		Shelby	6/20/02	AA11511	240
		County	6/27/02	AA11494	440
		5	0/2//02	Geometric	634
				Mean	
WEF050-	Flatrock	CR 800 N	5/30/02	AA10972	550
0009	River	Bartholomew	6/6/02	AA11332	1600
Site #13		County	6/13/02	AA11404	460
		5	6/20/02	AA11512	87
			6/27/02	AA11495	460
				Geometric	438
				Mean	
WEF050-	Flatrock	SR 31	5/30/02	AA10973	580
0001	River	USGS Gage	6/6/02	AA11333	340
Site #14		03363900 d/s	6/13/02	AA11405	210
		Bartholomew		AA11406	(365) Dup.
		County	6/20/02	AA11513	17
			6/27/02		
				Geometric	
				Mean	=
WEF050-	Flatrock	SR 11	5/30/02	AA10959	730
0004	River	Bartholomew	6/6/02	AA11317	550
Site #15		County	6/13/02	AA11407	1300
			6/20/02	AA11514	70
			6/27/02	AA11497	> 2400
				Geometric	615
				Mean	
WEF060-	Haw Creek	SR 7	7/31/2002	AA12542	275
0002		Columbus,	8/7/2002	AA12794	86
Site #16		IN	8/15/2002	AA13007	866
		Bartholomew	8/21/2002	AA13139	228
		County	8/28/2002	AA13251	150
				Geometric	234

Site ID	Stream Name	Site Description	Sample Date	Sample Number	Lab Results (CFU/100ml)
WEF010-	Flatrock	US 40	07/09/1997	DA10351	24000 (JH)
0001 Site #5	River	USGS Partial			
SILC #J		Station	09/16/1997	DA10454	140 (JH)
		Henry			
		County	07/00/1007	D.4.10252	
WEF020-	Flatrock	CR 650 S Forsythe	07/09/1997	DA10353	130 (JH)
Site #9	River	Mills			
		Bridge	09/16/1997	DA10456	470 (JH)
		Rush County			
WEF020- 0002	Flatrock River	Gings Road N.E. of	9/23/2002	AA18746	2000
Site #/		Fixed Station	5/13/2004	AA22586	250
		(FR-64) Rush County	7/13/2004	AA23298	440
WEF020-	Flatrock	CR 300 N,	7/9/1997	DA10352	600 (JH)
0003	River	NE Of Rushville -	9/16/1997	DA10455	300 (IH)
		Rush County	<i>)</i> /10/1///	Diffo 155	500 (311)
WEF030-	Little	CR 650 N	07/09/1997	DA10354	150 (JH)
0001	Flatrock River	Decatur - County	09/16/1997	DA10457	130 (JH)
WEF030-	Little	SR 3 South	9/11/2002	AA13574	122.3
0005	Flatrock	of Milroy -	9/18/2002	AA13639	161.6
	River	Rush County	9/25/2002	AA13715	214.2
			10/2/2002	AA13984	248.1
			10/9/2002	AA14079	231
WEF040- 0002 Site #10	Flatrock River	S. County Line Road	6/3/1997	DA10246	1600 (JH)
Site #10		of St. Paul USGS Gage 03363500 Shelby County	7/9/1997	DA10356	30 (JH)
			9/16/1997	DA10458	130 (JH)
WEF040-	Conns Cr	CR 700 S –	06/03/1997	DA10247	1000 (JH)
0003		Shelby	07/09/1997	DA10357	60 (JH)
		County	09/16/1997	DA10459	1200 (JH)

Attachment A: Flatrock-Haw Creek Watershed E. coli Data

Site ID	Stream	Site	Sample	Sample	Lab Results
	Name	Description	Date	Number	(CFU/100ml)
WEF050-	Flatrock	SR 252 near	6/16/2000	DI29697	830
0002	River	Flatrock	7/27/2000	DI29894	120
Site #12		Fixed Station	5/31/2001	DI31835	200
		(FR-17)	9/16/2002	AA13599	153
		Shelby	9/23/2002	AA13674	48.8
		County	9/30/2002	AA13943	54.6
			10/7/2002	AA14038	52
			6/23/2004	AA23112	290
			9/30/2004	AA24235	93
WEF050-	Lewis Cr	SR 252 -	6/3/1997	DA10248	600 (JH)
0003		Shelby	7/9/1997	DA10358	310 (JH)
		County	9/16/1997	DA10461	130 (JH)
WEF050-	Flatrock	SR 11	6/4/1997	DA10249	1800
0004	River	Bartholomew	7/10/1997	DA10359	120
Site #15		County	9/17/1997	DA10462	90
WEF050-	Lewis Cr	SR 252 –	9/9/2002	AA13575	270
0006		County	9/16/2002	AA13598	> 2419
		5	9/23/2002	AA13673	308
			9/30/2002	AA13942	260
			10/7/2002	AA14037	308
WEF060-	Haw Creek	SR 7	5/30/1997	DA10259	180
0002 Site #16		Columbus, IN	7/16/1997	D 4 102 60	100
		Bartholomew		DA10368	100
		County	9/19/1997	DA10471	30

Attachment B.

Water Quality Duration Curves for the Flatrock-Haw Creek Watershed

Flatrock River at US 40 Bridge near Lewisville, IN E. coli Water Quality Duration Curve

Site: #05 (WEF010-0001)

USGS Stream Flow Data (10/01/1930 to 9/30/2003) and IDEM *E. coli* Sampling Data (1997 & 2002)





Geometric Mean = 479 cfu/100ml

Total Maximum Daily Load Program-Office of Water Quality

IDEM Water Quality Data & USGS Gage 03363500 Stream Flow Data

Upstream Drainage Area is 47.8 square miles

Flatrock River at US 52 (SR 3) Bridge in Rushville, IN *E. coli* Water Quality Duration Curve Site: #8 (WEF020-0012) USGS Streasm Flow Data (10/01/1930 to 9/30/2003) and IDEM *E. coli* Sampling Data (2002)



Total Maximum Daily Load Program-Office of Water Quality

IDEM Water Quality Data & USGS Gage 03363500 Stream Flow Data

Upstream Drainage Area is 168 square miles

Geometric Mean = 784 cfu/100ml

Flatrock River at USGS St. Paul Gage Site *E. coli* Water Quality Duration Curve Site: #10 (WEF040-0002) USGS Stream Flow Data (10/01/1930 to 9/30/2003)

and IDEM *E. coli* Sampling Data (1997 & 2003)



Total Maximum Daily Load Program-Office of Water Quality

IDEM Water Quality Data & USGS Gage 03363500 Stream Flow Data

Upstream Drainage Area is 303 square miles

Geometric Mean = 433 cfu/100ml



Total Maximum Daily Load Program-Office of Water Quality

IDEM Water Quality Data & USGS Gage 03363900 Stream Flow Data Upstream Drainage Area is 534 square miles



Total Maximum Daily Load Program-Office of Water Quality

IDEM Water Quality Data & USGS Gage 03363900 Stream Flow Data Upstream Drainage Area is 55.5 square miles

Attachment C

Load Duration Curves for the Flatrock-Haw Creek Watershed

Flatrock River at US 40 Bridge near Lewisville, IN E. coli Load Duration Curve Site: #05 (WEF010-0001)



IDEM Water Quality Data & USGS Gage 03363500 Stream Flow Data

Upstream Drainage Area of 47.8 square mile

Flatrock River at US 52 (SR 3) Bridge in Rushville, IN *E. coli* Load Duration Curve - Site: #8 (WEF020-0012)



IDEM Water Quality Data & USGS Gage 03363500 Stream Flow Data

Upstream Drainage Area of 168 square mile

Flatrock River at USGS St. Paul Gage Site E. coli Load Duration Curve - Site: #10 (WEF040-0002)



IDEM Water Quality Data & USGS Gage 03363500 Stream Flow Data

Upstream Drainage Area of 303 square mile

Flatrock River at SR 31 Bridge in Columbus, IN E. coli Load Duration Curve - Site: #14 (WEF050-0001)



IDEM Water Quality Data & USGS Gage 03363900 Stream Flow Data

Upstream Drainage Area of 534 square mile

Haw Creek at SR 7 in Columbus, IN *E. coli* Load Duration Curve - Site: #16 (WEF060-0002)



IDEM Water Quality Data & USGS Gage 03363900 Stream Flow Data

Upstream Drainage Area of 55.5 square mile

Figure 6: Townships in the Flatrock-Haw Creek Watershed



Figure 1: Flatrock-Haw Creek Watershed TMDL



Figure 2: IDEM 2002 E. coli Sampling Sites in Flatrock-Haw Creek Watershed



Figure 4: National Pollution Discharge Elimination System Permitted Sanitary Wastewater Dischargers to Flatrock-Haw Creek Watershed



Figure 3: Landuse for the Flatrock-Haw Creek Watershed



Figure 5: Confined Feeding Operations in the Flatrock-Haw Creek Watershed

