Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load (TMDL)
for *Escherichia coli* (*E. coli*)
For the First Creek Watershed, Martin, Daviess, and Greene Counties

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March 18, 2005

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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 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 First Creek watershed in Martin, Daviess, and Greene Counties, Indiana.

Background

In 1998, Indiana's section 303(d) list cites First Creek as being impaired for *E. coli* in Martin, Daviess, and Greene Counties, Indiana. In 2002, Indiana's section 303(d) list only cites First Creek as being impaired in Daviess and Greene Counties, with Rocky Branch and Other Tributaries being impaired for *E. coli* on Indiana's 2004 303(d) list. Upon further review, IDEM has found more segments that are impaired for *E. coli* than are listed in the 2004 303(d) list. Some of the added segments will not be included in Indiana's Reach index update to be completed in 2005 because the National Hydrology Dataset is not yet available in 1:24,000 resolution for this basin; however, these segments are incorporated into this TMDL, as they have been assessed as being impaired for *E. coli*. This TMDL addresses approximately 58 miles of First Creek watershed, in southwest Indiana, in Martin, Daviess, and Greene Counties, along with Rocky Branch and Other Tributaries and Culpepper Branch Tributaries, where recreational uses are impaired by elevated levels of *E. coli* during the recreational season (Figure 1). All of the six (6) segments of the listed streams for this TMDL are located in the West Fork White River Basin in hydrologic unit code 05120202050. The description of the study area, its topography, and other particulars are as follows:

Table 1: Impaired Waterbodies included in TMDL

Waterbody Name	303(d) List ID	Segment ID number(s)	Length (miles)	Impairment
First Creek and Unnamed Tributaries	116	INW0256_T1030, INW0257_T1031, INW0255_00, INW0257_T1030	31.0	*E. coli*
Rocky Branch and Other Tributaries	116	INW0257_00	13.0	*E. coli*
Culpepper Branch Tributaries	116	INW0256_00	14.0	*E. coli*

Historical data collected by IDEM documented elevated levels of *E. coli* in First Creek in 1996. This data was the basis for the listing of First Creek on the 1998 303(d) list. IDEM completed an intensive survey of the watershed for First Creek in 2002. IDEM sampled nineteen sites five times evenly spaced over a 30-day period from April 22, 2002 to May 20, 2002. This period falls within Indiana's recreational season (April 1st through October 31st) (Figure 2). All nineteen sites violated the single sample maximum standard at least once during this sampling event. Of the nineteen sites, only two sites, Site 5 and Site 7, did not violate the geometric mean standard. Based on this intensive study in 2002, IDEM determined that an *E. coli* TMDL would need to be completed on the First Creek watershed (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 waterbodies covered by this TMDL.

Water quality *E. coli* load duration curves were created using IDEM's data. A flow duration interval is described as a percentage. Zero percent corresponds to the highest stream discharge (flood condition) and one-hundred percent corresponds to the lowest discharge (drought condition). The *E. coli* values at two of the sites were plotted with the corresponding flow duration interval to show the *E. coli* violations of the single-sample maximum standard and geometric mean standard during both the recreational and non-recreational seasons. These two sites are representative of the hydrodynamics of the First Creek watershed (Attachment B).

Numeric Targets

The impaired designated use for the waterbodies in the First Creek watershed is for total 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 (WQS[1]) 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.

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

For the First 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

First Creek begins in Greene County, Indiana, then goes into Naval Support Activity Crane in Martin County, and into Greene County before it discharges into the West Fork White River. The major tributaries of First Creek include Culpepper Branch and Rocky Branch. There are also several unnamed tributaries that flow into these major tributaries, as well as into First Creek.

The tributaries of Rocky Branch, along with First Creek are listed on the 2004 303(d) list for *E. coli*. Based on sampling completed by IDEM in 2002, each of these tributaries, along with Culpepper Branch Tributaries, is contributing to the impairment of First Creek.

The landuse information, which was gathered from the mid-1970s for the First Creek watershed, consisted of approximately 39% agriculture and 43% forested. The remaining 18% includes developed, wetlands, strip mines, and water. Landuse information was also assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 36% of the landuse in the First Creek watershed is agriculture. The remaining landuse consists of approximately 1% developed, 3% palustrine, 57% terrestrial, and 3% water (Figure 3). A comparison of the mid-1970s landuse with the 1992 landuse information shows that no substantial changes to the First Creek watershed have occurred.

Wildlife is a known source of *E. coli* impairments in waterbodies. Many animals spend time in or around waterbodies. Wildlife contributes to the potential impact of contaminated runoff from animal habitats, such as urban park areas, forest, and cropland. The portion of the Naval Support Activity (NSA) Crane that is within the First Creek watershed has no septic systems, crops, or livestock; however, it is heavily forested with wildlife. The wildlife includes deer, geese, turkeys, rabbits, coyotes, bob cats, etc. According to NSA Crane, A rough approximation of the deer herd is 2,000 to 3,000 deer and the Canadian geese population ranges from about 200 resident geese in the summer months to over 2,000 during the migratory periods in late fall and winter. NSA

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

Crane is unable to, at this time, identify any new or revised Best Management Practices that would detract wildlife and thus alleviate the contribution of *E. coli* in the First Creek watershed (NSA Crane, 2005).

Most of the homes within the First Creek watershed are on septics. Failing septic tanks are known sources of *E. coli* impairment in waterbodies. The townships in the First Creek watershed in Martin County are located in the Naval Support Activity Crane and there are no known septics in this area (Stone, N., 2004). The Daviess County Health Department, over the past seven years, has found a 40% to 45% failure rate throughout the county (Fitch, J., 2004). Septic systems are also a known problem in Cass and Jackson Townships in Greene County (Personal Communication, 2004).

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are two permitted dischargers in the First Creek TMDL watershed (Figure 5, Table 1). Both dischargers (Triad Mining, Inc ING040177 and Griffin Industries IN0001082) do not have a sanitary component to their discharge and therefore, *E. coli* limits do not apply to their permit. These permitted dischargers are not considered sources of *E. coli*.

Confined Feeding Operations and Confined Animal Feeding Operations

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 confined feeding operations (CFOs) and confined animal feeding operations (CAFOs). There are four (4) CFOs in the First Creek watershed. Of the 4 CFOs, one (1) is considered a CAFO and has a general permit (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". The currently operational CFOs and CAFOs in First Creek watershed have no open enforcement actions at this time. Therefore, these operations are not considered a significant source of *E. coli* for the First Creek TMDL.

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; it is believed that these small livestock operations may be a source of the *E. coli* impairment.

Linkage Analysis and *E. coli* Load Duration Curves

The linkage between the *E. coli* concentrations in the First 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 First Creek watershed indicates that *E. coli* load enters the First Creek watershed through both wet (nonpoint) and dry (point) weather sources.

To investigate further the potential sources mentioned above, an *E. coli* load duration curve analysis, as outlined in an unpublished paper by Cleland (2002), was developed for each sampling site in the First Creek watershed. 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 sources).

In order to develop a load duration curve, continuous flow data is required. The USGS gage (03360500) located in Newberry, Indiana was used for the development of the *E. coli* load duration curve analysis for the First Creek watershed TMDL. USGS gage 03360500 is located upstream from the mouth of First Creek on the West Fork of the White River; however it is the closest gage to the First Creek watershed. To determine if the closer gage was acceptable IDEM compared the USGS gage in Newberry, Indiana with USGS gage (03374000) in Petersburg, Indiana, which is located downstream of First Creek watershed. This comparison uses a coefficient of determination value, r^2, to indicate the "fit" of the data. The comparison found the coefficient of determination, r^2, to be 0.7. Values near 1 for r^2 indicate a good fit of the data, whereas values near 0 indicate a poor fit of the data. Therefore the USGS gage (03360500) in Newberry was used for the load duration curves for the First Creek watershed. The flow from this gage and the *E. coli* data from the First Creek watershed were then used to create the load duration curves for the First Creek watershed.

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 monitoring station to the percent of time that those values are met or exceeded. Flows are ranked from extremely low flows, which are exceeded nearly 100 percent of the time, to extremely high flows, which are rarely exceeded. Flow duration curves are then transformed into load duration curves by multiplying the flow values along the curve by applicable water quality criteria values for *E. coli* and appropriate conversion factors. The load duration curves are conceptually similar to the flow duration curves, in that the x-axis represents the flow recurrence interval and the y-axis represents the allowable load of the water quality parameter. The curve representing the allowable load of *E. coli* was calculated using the 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 provides 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 Standard (WQS); those that fall below the target line meet the WQS (Mississippi DEQ, 2002).

Load duration curves were created for all the sampling sites in the First Creek watershed. However, the sampling site on SR 43 on First Creek provides the best description of the sources of *E. coli* to the First Creek Watershed (Figure 2, Attachment C.) This is because this site has monitoring data from 1996 and 2002. A load duration curve was also created for the sampling site inside the Naval Support Activity (NSA) Crane on First Creek. This site has monitoring data from 2002. The data from both of these sites indicate that the largest exceedances of the *E. coli* WQS are 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 are also a source of *E. coli* to the First Creek watershed (noted by diamonds above the curve on the right side of the second figure in Attachment C).

While there are point source contributions, compliance with the numeric *E. coli* WQS in the First Creek watershed most critically 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 recreational use in First 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 First 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 First 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 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

As mentioned previously, there are two permitted point source dischargers located in the First Creek watershed. These two dischargers (Triad Mining, Inc ING040177 and Griffin Industries IN0001082) do not have a sanitary component to their discharge; and therefore, are not contributing to the *E. coli* impairment in the First Creek watershed.

There is also one CAFO in the First Creek watershed that has a general NPDES permit. Under this NPDES permits, the CAFO must not violate water quality standards. 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 to October 31st.

Load Allocations

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. In order to establish responsibility equally among the entities in the watershed and because land uses throughout the watershed are homogenous, 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 designated total body contact recreational use of the First Creek watershed.

The Martin County government and their corresponding portions of the land area in the First Creek watershed are as follows: Perry Township (37.9%) and Mitcheltree Township (3.5%). The Daviess County government and their corresponding portions of the land area in the watershed are as follows: Madison Township (35.8%) and Elmore Township (0.27%). The Greene County government and their corresponding portions of the land area in the watershed are as follows: Cass Township (13.1%), Jackson Township (8.81%), and Taylor Township (0.62%). (ESRI, 2004) (Table 3 and Figure 6.)

Load allocations may be affected by subsequent work in the watershed. There are currently no watershed projects or plans in the First Creek watershed, however, there are several in the surrounding areas of the watershed. IDEM plans to work with these watershed coordinators along with local government agencies to try and create some watershed projects. It is anticipated that watershed projects will be useful in further defining the nonpoint sources of *E. coli* in the First Creek watershed.

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

Monitoring

Future monitoring of the First 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 First 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.

The Naval Support Activity Crane is monitoring for *E. coli* for 16 sites inside the base and 4 sites outside the base in 2004. This sampling is being conducted in September and October of 2004. The Town of Crane owns feeder lines that connect to sewer trunk lines into the NSA Crane. Four of the sixteen sites are along Culpepper Branch, which parallels the sewer trunk lines in the Town of Crane (Naval Support Activity Crane, 2004). This sampling will show if these sewer lines are a source of *E. coli* in the First Creek watershed. The other 12 sites are located throughout the base, mainly on tributaries to First Creek, with 5 sites located on the northern boundary of the base. The results of the 2004 *E. coli* sampling were forwarded to the Indiana Department of Environmental Management (IDEM) in the Crane Division, Naval Surface Warfare Center letter of January 27, 2005 (Attachment D). The following information are results from this assessment:

1) The *E. coli* sampling results indicated a correlation between precipitation and the presence/absence of *E. coli*.

2) The September 2004 sampling was taken during dry weather and the October 2004 sampling was taken during wet weather conditions.

3) The results from the sites located on the fence line on the northern boundary of the base dramatically increased from September 2004 to October 2004.

4) The wet weather results generally showed a decrease of *E. coli* from the sites located on the fence line to the sites located mid-way between the northern boundary to First Creek.

5) The wet weather results from the Culpepper Branch tributary showed a marked increase in *E. coli*.

Reasonable Assurance Activities

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

Confined Feeding Operations and Confined 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

327 IAC 5-2-11.1(h) requires effluent limits to be included in NPDES permits for pollutants discharged at levels that have the reasonable potential to cause an exceedance of water quality standards. Since the two permitted dischargers in the First Creek TMDL watershed (Triad Mining, Inc ING040177 and Griffin Industries IN0001082) do not have a sanitary component to their discharge, they are not considered sources of *E. coli*.

Watershed Projects

There are watershed projects in the surrounding areas of the First Creek watershed. IDEM plans to work with these watershed coordinators along with local government agencies to try and create some watershed projects in the First Creek watershed. These watershed projects will help to further identify and reduce the nonpoint sources that are contributing to the *E. coli* impairment in the First Creek watershed.

In addition, 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 First Creek watershed.

Monitoring in Naval Support Activity, Crane

The Naval Support Activity (NSA), Crane is monitoring for *E. coli* inside their base in 2004. This sampling was conducted in September and October of 2004. This additional sampling will assist in locating and identifying the nonpoint sources of *E. coli* in the First Creek watershed inside the NSA, Crane.

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 streambanks and river banks 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 water, protects water quality, and provide wildlife habitat. No-till helps control soil erosion and improve water quality by maintaining maximum residue 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 overapplication 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 First Creek watershed include both point and nonpoint sources. However, no point sources were found to be contributing to the *E. coli* impairment in the First Creek watershed. In order for the First Creek watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the First 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 First Creek watershed depends on:

1) Permitted facilities meeting all their permit limits, as there are no enforcement actions at this time;

2) CFOs and CAFOs not violating their permits; and

3) Nonpoint sources of *E. coli* being controlled by the implementation of best management practices in the watershed, which will take place in the future.

The 2004 sampling that NSA Crane conducted inside the base showed that the *E. coli* collected during wet weather conditions is substantially greater than the *E. coli* collected during dry weather conditions (Attachment D). Since there are no septics, crops, or livestock located within NSA Crane, wildlife and the collection system from the Town of Crane are the potential *E. coli* sources for the First Creek watershed. IDEM and NSA Crane are continuing to work together to address any issues from the Town of Crane's collection system. IDEM recognizes that *E. coli* values are higher on the upstream portions of First Creek before it enters the Naval Surface Warfare Center (NSWC). Once this TMDL is approved and all stakeholders begin work on implementation, identification of critical areas to improve water quality will occur. This may result in greater emphasis placed on water quality improvements in areas of the watershed outside of the boundaries of the NSWC.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the First 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 First Creek watershed are revised in accordance with applicable requirements of state and federal law, the TMDL implementation activities may be adjusted 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 First Creek watershed.

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Table 1: NPDES Permits in First Creek Watershed

Permits with No *E. coli* **or residual chlorine limits**

Permit No.	Facility Name	Receiving Waters
ING040177	Triad Mining, Inc	Unnamed Tributary to First Creek
IN0001082	Griffin Industries, Inc	First Creek

Table 2: Permitted Confined Feeding Operations and Confined Animal Feeding Operations in the First Creek Watershed

			Approved Animals								
Log Number	**Name**	**NPDES Permits**	**Nursery Pig**	**Grower/Finishers**	**Sows/Boars**	**Beef**	**Dairy**	**Dairy Calves**	**Veal**	**Layers**	**Turkeys**
754	Aaron Swartzentruber		150	1,400	88						
793	Nelson B Wittmer			1,000							
5008	Steve Swartzentruber	ING805008		1,000							
4100	First Creek Farms										36,000

Table 3: Land Area Distribution for the First Creek Watershed

Municipality	Square Mile	Percent
Taylor Township	0.32	0.62
Jackson Township	4.6	8.81
Cass Township	6.8	13.1
Mitcheltree Township	1.8	3.5
Perry Township	19.7	37.9
Madison Township	18.5	35.8
Elmore Township	0.14	0.27
Total	**51.9**	**100**

Figure 1: First Creek Watershed TMDL

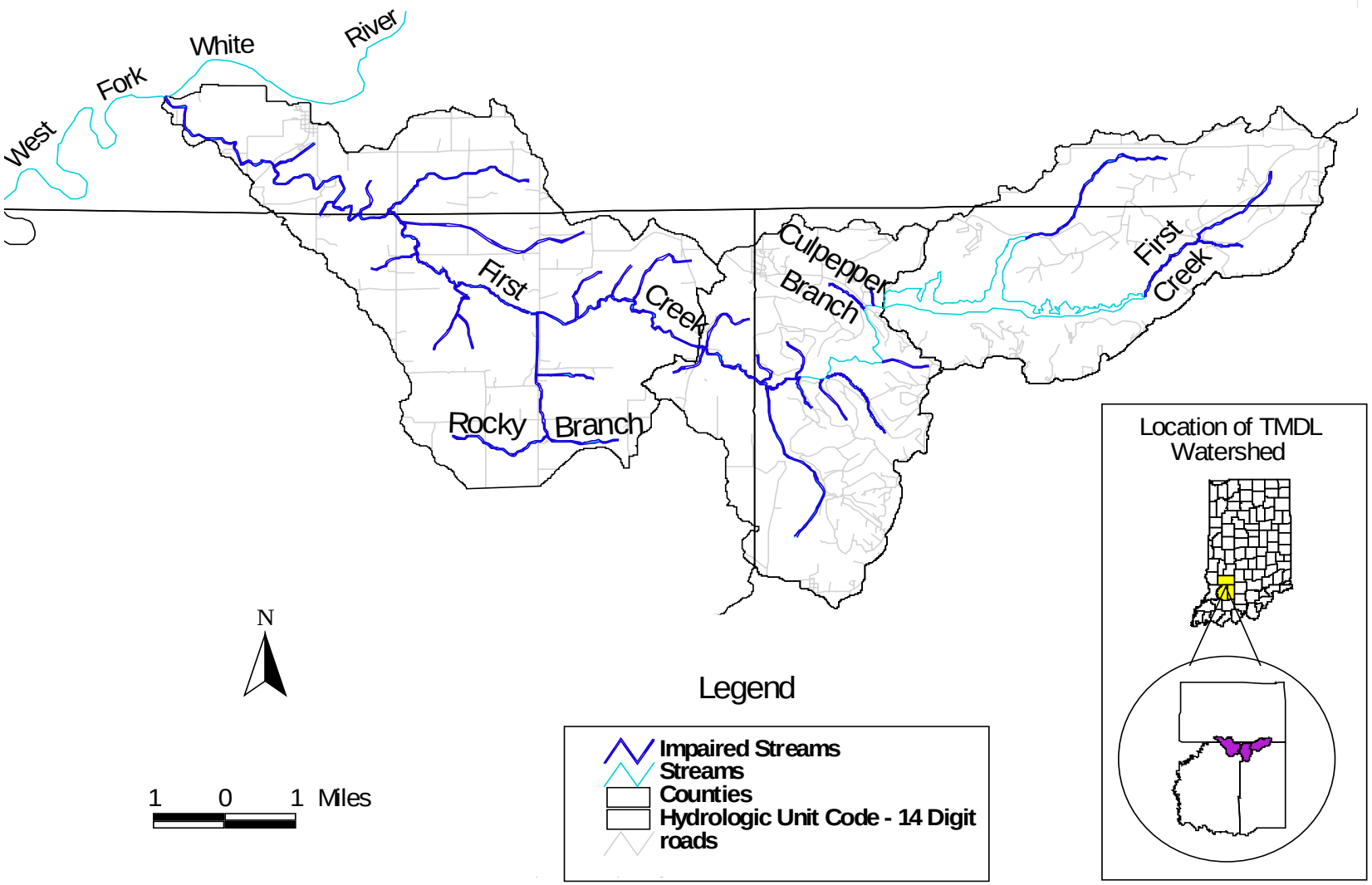


Figure 2: IDEM's E. coli Sampling Sites in First Creek Watershed

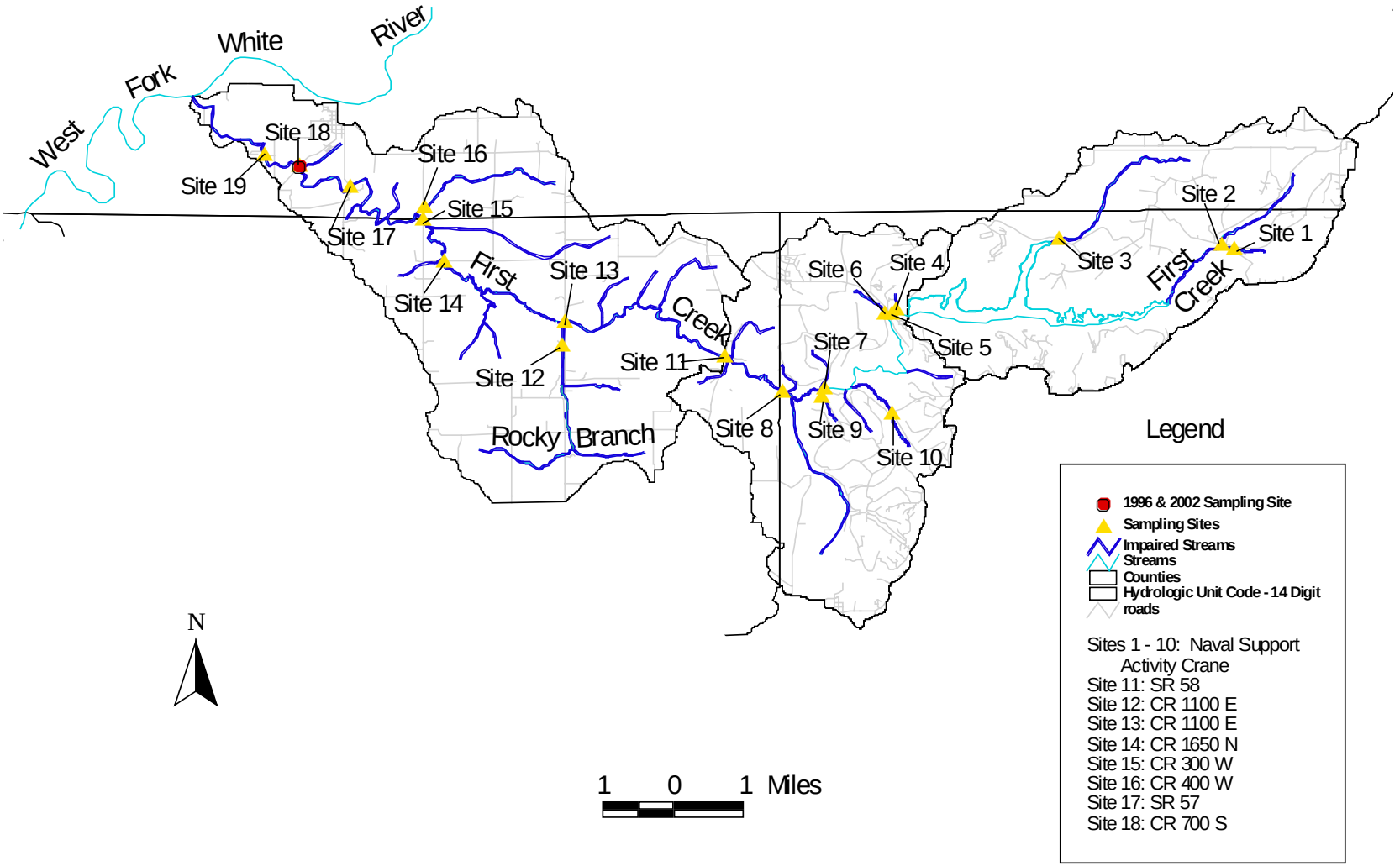


Figure 3: Landuse in First Creek Watershed

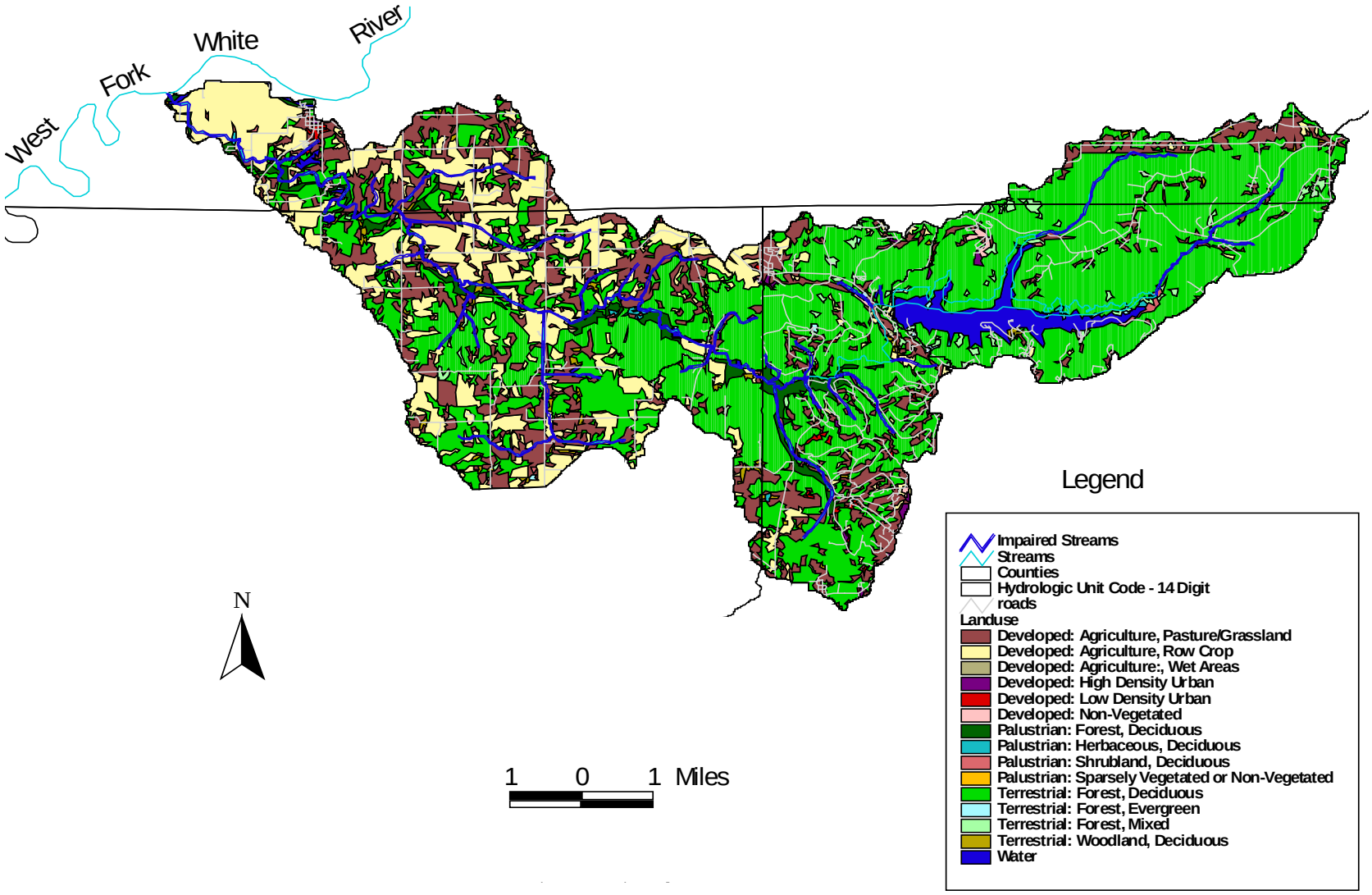


Figure 4: NPDES Facilities in First Creek Watershed

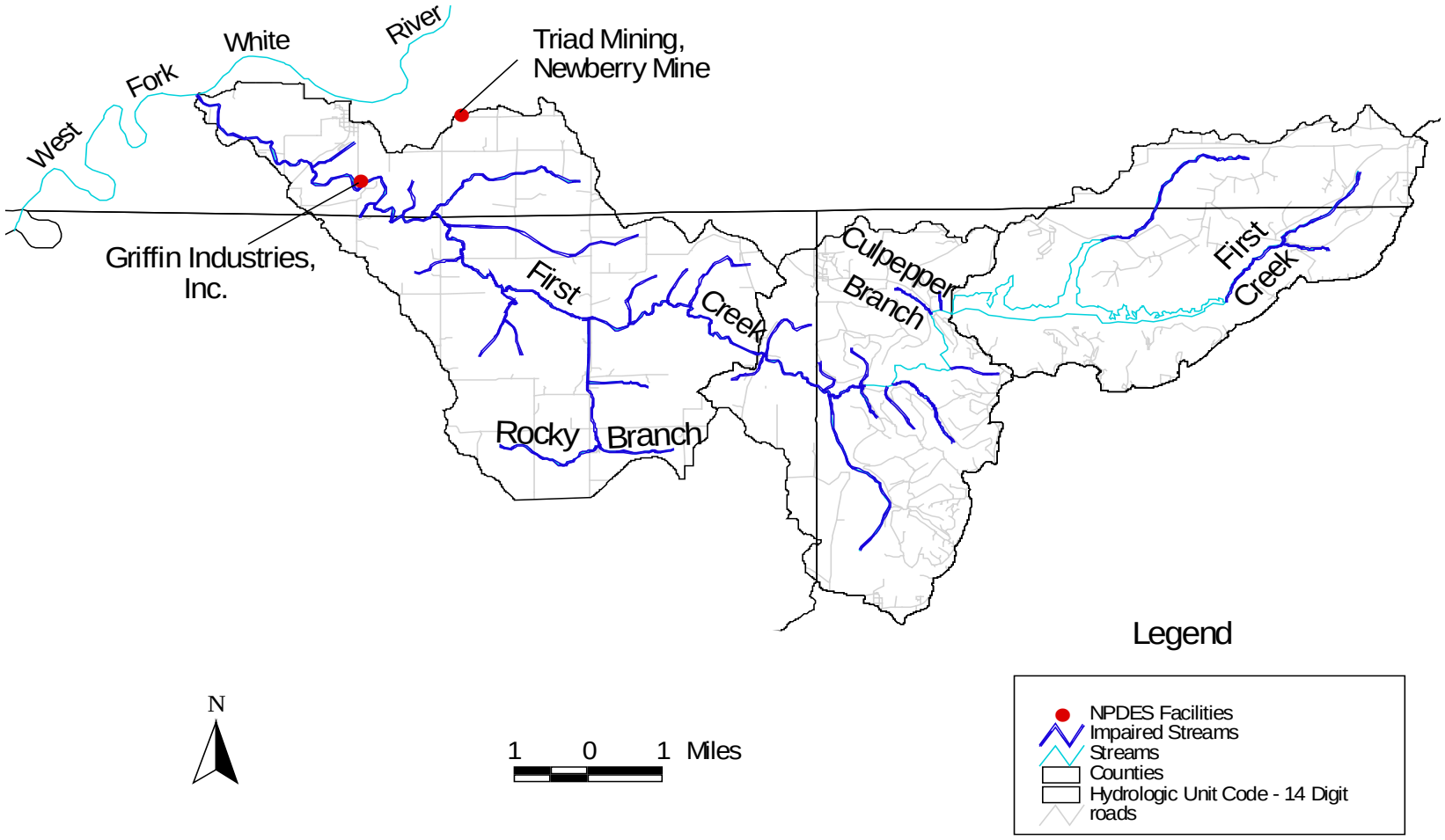


Figure 5: Confined Feeding Operations in First Creek Watershed

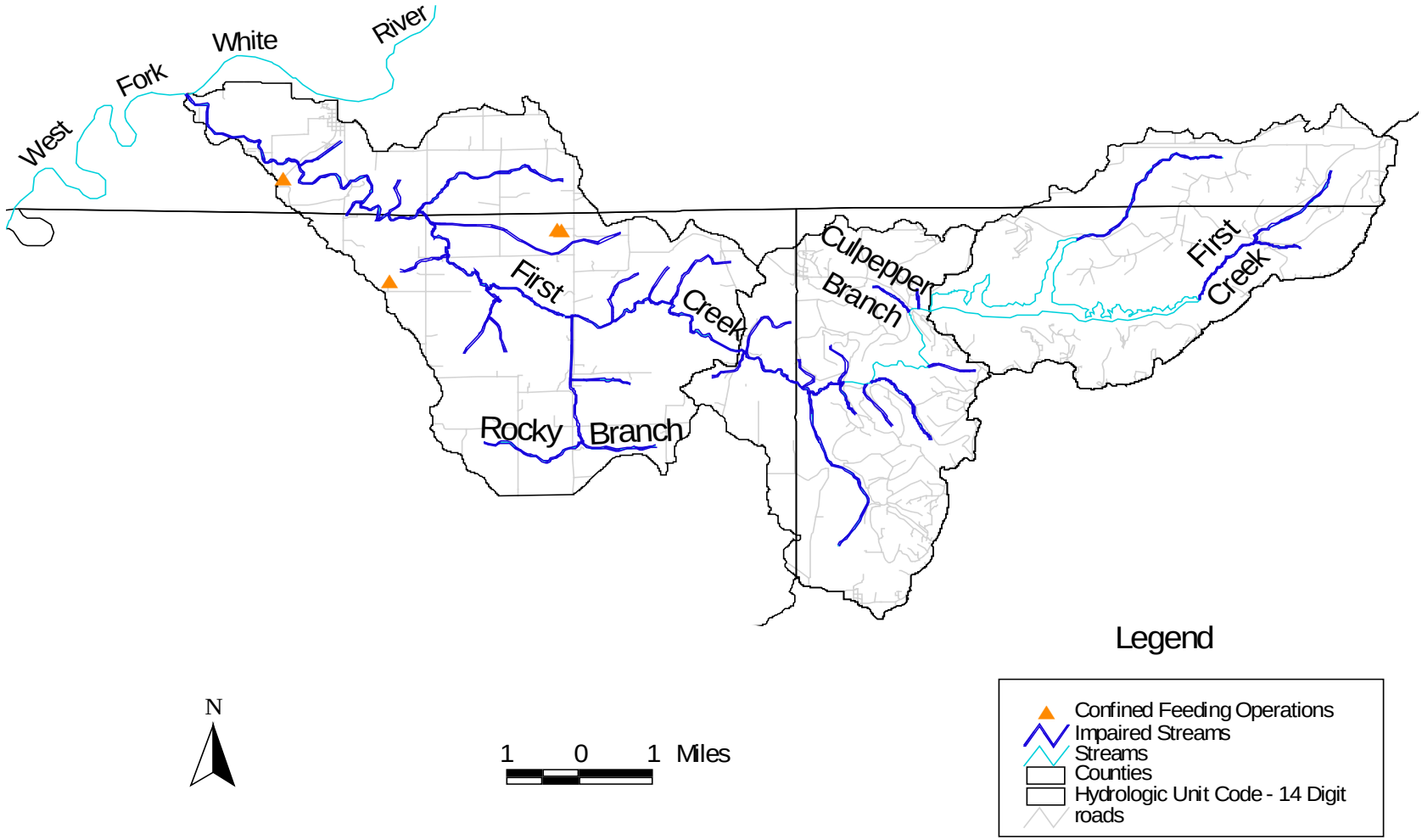
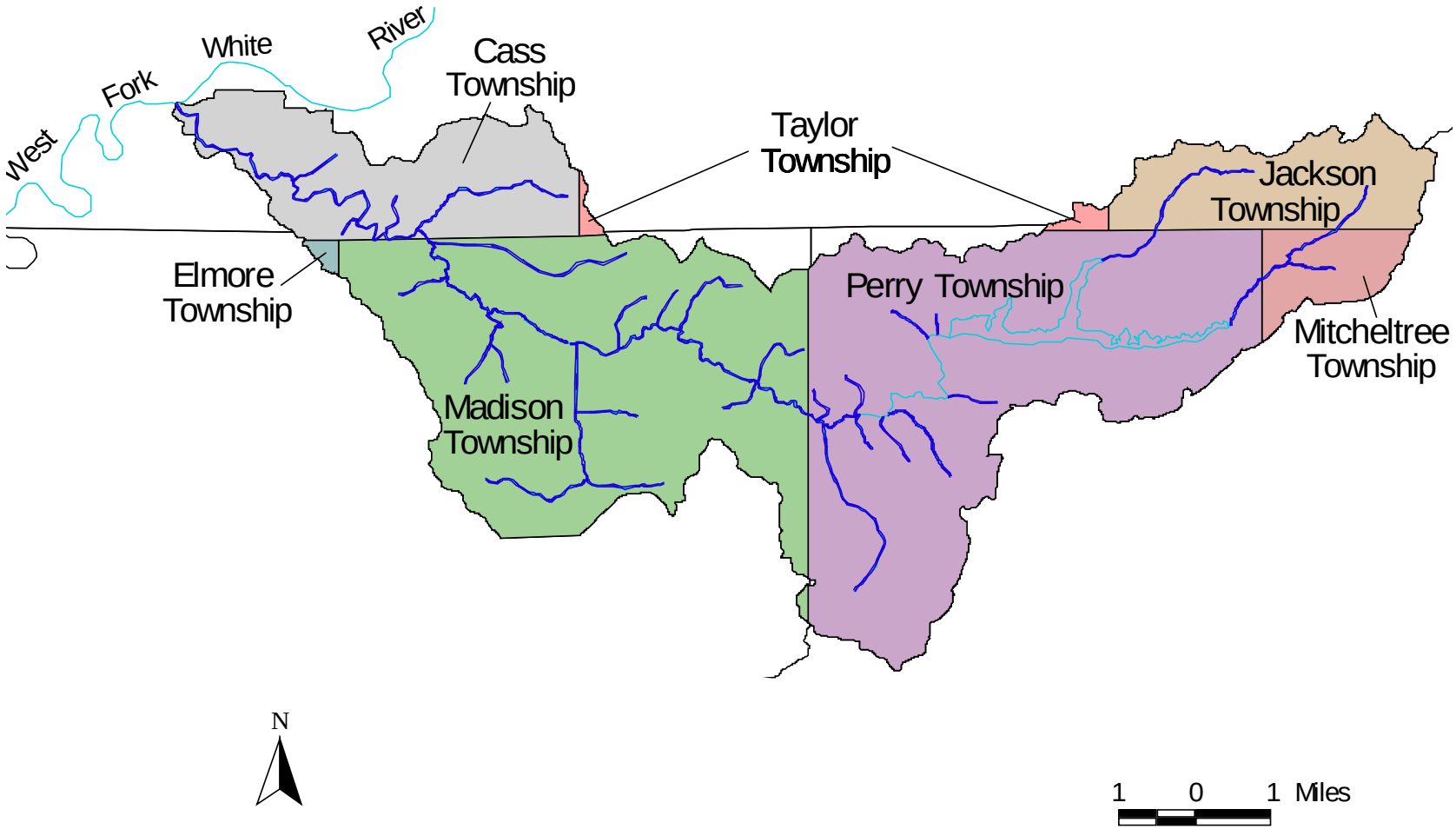


Figure 6: Land Area Distribution in First Creek Watershed



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Attachment A

First Creek Watershed *E. coli* Data

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Attachment B

Water Quality Duration Curves for the First Creek Watershed TMDL

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Attachment C

Load Duration Curves for the First Creek Watershed TMDL

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Attachment D

2004 NSA Crane *E. coli* Sampling

Attachment A: First Creek Watershed *E. coli* Data

Site #	Project ID	L-Site #	Stream Name	Description	Sample Date	IDEM's E. coli (MPN/100mL)	Crane's E. coli (Colonies/100ml)	Geometric Mean (IDEM / Crane)
1	2002 First Creek Assessment	WWL050-0016	First Creek	Naval Support Activity Crane	04/22/02	56	67	>177 / 321
					04/29/02	30	24.8	
					05/06/02	>2419*	63200	
					05/13/02	920	1300	
					05/20/02	46	25	
2	2002 First Creek Assessment	WWL050-0017	Unnamed Tributary	Naval Support Activity Crane	04/22/02	126	156	>292 / 470
					04/29/02	31	26.4	
					05/06/02	>2419*	63200	
					05/13/02	>2419*	3873	
					05/20/02	58	14	
3	2002 First Creek Assessment	WWL050-0018	Unnamed Tributary	Naval Support Activity Crane	04/22/02	155	128	>157 / 274
					04/29/02	20	24.8	
					05/06/02	>2419*	63200	
					05/13/02	980	1280	
					05/20/02	13	6	
4	2002 First Creek Assessment	WWL050-0033	Unnamed Tributary	Naval Support Activity Crane	04/22/02	1733	1400	240 / 284
					04/29/02	44	103	
					05/06/02	770	680	
					05/13/02	1120	1340	
					05/20/02	12	14	
5	2002 First Creek Assessment	WWL050-0019	First Creek	Naval Support Activity Crane	04/22/02	135	176	67 / 67
					04/29/02	10	10	
					05/06/02	248	316	
					05/13/02	410	340	
					05/20/02	10	7	

Site #	Project ID	L-Site #	Stream Name	Description	Sample Date	IDEM's E. coli (MPN/100mL)	Crane's E. coli (Colonies/100ml)	Geometric Mean (IDEM / Crane)
6	2002 First Creek Assessment	WWL050-0020	Culpepper Branch	Naval Support Activity Crane	04/22/02	299	212	>521 / 893
					04/29/02	58	100	
					05/06/02	>2419*	63200	
					05/13/02	>2419*	6320	
					05/20/02	222	67	
7	2002 First Creek Assessment	WWL050-0021	First Creek	Naval Support Activity Crane	04/22/02	19	15	27 / N/A
					04/29/02	3	0	
					05/06/02	185	215	
					05/13/02	488	480	
					05/20/02	3	12	
8	2002 First Creek Assessment	WWL050-0022	First Creek	Naval Support Activity Crane	04/22/02	345	200	227 / 439
					04/29/02	34	64	
					05/06/02	2419	63200	
					05/13/02	687	490	
					05/20/02	31	41	
9	2002 First Creek Assessment	WWL050-0023	Unnamed Tributary	Naval Support Activity Crane	04/22/02	58	67	>180 / N/A
					04/29/02	33	36	
					05/06/02	>2419*	63200	
					05/13/02	1046	Colonies overwhelmed plate	
					05/20/02	39	41	
10	2002 First Creek Assessment	WWL050-0024	Unnamed Tributary	Naval Support Activity Crane	04/22/02	248	308	206 / 629
					04/29/02	39	61	
					05/06/02	2419	63200	
					05/13/02	436	1800	
					05/20/02	36	46	
11	2002 First Creek Assessment	WWL050-0025	First Creek	SR 58	04/22/02	866		>356
					04/29/02	27		
					05/06/02	>2419*		
					05/13/02	>2419*		
					05/20/02	42		

Site #	Project ID	L-Site #	Stream Name	Description	Sample Date	IDEM's E. coli (MPN/100mL)	Geometric Mean
12	2002 First Creek Assessment	WWL050-0027	Unnamed Tributary	CR 1100 E	04/22/02	4884	2400
					04/29/02	249	
					05/06/02	15530	
					05/13/02	6131	
					05/20/02	687	
13	2002 First Creek Assessment	WWL050-0026	First Creek	CR 1100 E	04/22/02	>2419*	>666
					04/29/02	76	
					05/06/02	6867	
					05/13/02	2419	
					05/20/02	43	
14	2002 First Creek Assessment	WWL050-0028	First Creek	CR 1650 N	04/22/02	3448	1272
					04/29/02	157	
					05/06/02	15531	
					05/13/02	4884	
					05/20/02	81	
15	2002 First Creek Assessment	WWL050-0029	First Creek	CR 300 W	04/22/02	3609	1870
					04/29/02	344	
					05/06/02	24192	
					05/13/02	11199	
					05/20/02	68	
16	2002 First Creek Assessment	WWL050-0030	Unnamed Tributary	CR 300 W	04/22/02	6131	1782
					04/29/02	285	
					05/06/02	24192	
					05/13/02	8664	
					05/20/02	49	
17	2002 First Creek Assessment	WWL050-0031	First Creek	CR 400 W	04/22/02	6488	2246
					04/29/02	517	
					05/06/02	19863	
					05/13/02	8164	
					05/20/02	105	

Site #	Project ID	L-Site #	Stream Name	Description	Sample Date	IDEM's E. coli (MPN/100mL)	Geometric Mean
18	2002 First Creek Assessment	WWL050-0004	First Creek	SR 57	04/22/02	3654	>2319
					04/29/02	461	
					05/06/02	>24192**	
					05/13/02	8664	
					05/20/02	190	
	1996 Synoptic				05/02/96	170	N/A
					06/11/96	1400	
					07/19/96	210	
					10/11/96	90	
19	2002 First Creek Assessment	WWL050-0032	First Creek	CR 700 S	04/22/02	2142	>1924
					04/29/02	649	
					05/06/02	>24192**	
					05/13/02	11199	
					05/20/02	70	

*These results show the maximum value, which is 2419 MPN/100mL. The samples collected on the date 5/6/02, were during a storm event.
**These samples were analyzed using a 1mL dilution.