Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) For the Kessinger Ditch Watershed, Knox County

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Total Maximum Daily Load (TMDL) for *Escherichia coli* (*E. coli*) in Kessinger Ditch Watershed, Knox County, Indiana

Introduction

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). TMDLs provide states a basis for determining the pollutant reductions necessary from both point and nonpoint sources to restore and maintain the quality of their water resources. The purpose of 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 Kessinger Ditch watershed in Knox County, Indiana.

Background

In 1998 and 2002, Indiana's section 303(d) list cited Kessinger Ditch as being impaired for *E. coli* in Knox County. In 2004, Indiana's section 303(d) list cites, in addition to Kessinger Ditch, Roberson Ditch, Indian Creek, Flat Creek, Opossum Branch, Steen Ditch, Reel Creek, and other tributaries. With the addition of the above streams in 2004, the majority of the Kessinger Ditch is impaired for *E. coli*. This TMDL address approximately 32 miles of the Kessinger Ditch watershed in Knox County, Indiana, where recreational uses are impaired by elevated levels of *E. coli* during the recreational season (Figure 1). All of the five (5) segments of the listed streams for this TMDL are located in the West Fork White River Basin in hydrologic unit code 05120202090. The description of the study area, its topography, and other particulars are as follows:

Waterbody Name	303(d) List ID	Segment ID Number(s)	Length (miles)	Impairment
Kessinger Ditch	124	INW0297_T1043, INW0294_T1041, INW0296_T1042	17.0	*E. coli*
Roberson Ditch, Indian Creek and Flat Creek Tributaries	124	INW0295_00	11.0	*E. coli*
Opossum Branch, Steen Ditch, Reel Creek	124	INW0296_00	4.0	*E. coli*

Historical data collected by IDEM documented elevated levels of *E. coli* in Kessinger Ditch in 1996. This data was the basis for the listing of Kessinger Ditch on the 1998 303(d) list. IDEM completed an intensive survey of the watershed for Kessinger Ditch in 2001. IDEM sampled eighteen sites five times, with the samples evenly spaced over a 30-day period from July 24, 2001 to August 22, 2001. This period falls within Indiana's recreational season (April 1st through October 31st) (Figure 2). Only one site, WWL090-0025, did not violate the single sample maximum standard at least once during this sampling event and also did not violate the geometric mean standard. Based on this intensive survey in 2001, IDEM determined that an *E. coli* TMDL would need to be completed on the Kessinger Ditch 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 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 available 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 (0) percent corresponds to the highest stream discharge (flood condition) and 100 percent corresponds to the lowest discharge (drought condition). The *E. coli* values at one of the sampling sites, WWL090-0003, 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. This sampling site had *E. coli* data that was collected in 1996 and 2001. This sampling site is representative of the hydrodynamics of the Kessinger Ditch watershed (Attachment B).

Numeric Targets

The impaired designated use for the waterbodies in the Kessinger Ditch 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.

[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 1st through October 31st, are also covered under 327 IAC 2-1-6(d).

For the Kessinger Ditch 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

Kessinger Ditch flows southeast to the West Fork of the White River in Knox County. Reel Creek discharges to Kessinger Ditch in the headwaters. Indian Creek combines with Flat Creek to create Roberson Ditch. Steen Ditch discharges into Opossum Branch, right before Opossum Branch and Roberson Ditch discharge into Kessinger Ditch. Frick Ditch enters Kessinger Ditch before it discharges into the West Fork of the White River.

The tributaries of Roberson Ditch, Indian Creek, Flat Creek, Opossum Branch, Steen Ditch, and Reel Creek are listed on the 2004 303(d) list for *E. coli*. Based on *E. coli* sampling completed in 2001, each of these tributaries is also contributing to the *E. coli* impairment in Kessinger Ditch. Frick Ditch is not listed on the 2004 303(d) list for *E. coli* and the sampling completed in 2001 confirms that it is not contributing to the impairment on Kessinger Ditch.

The landuse information, which was gathered from the mid-1970s for Kessinger Ditch watershed, consisted of approximately 94% agriculture, 4% forested, and 2% developed. Landuse information was also assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 88% of the landuse in the Kessinger Ditch watershed was agriculture. The remaining landuse for the Kessinger Ditch watershed consisted of approximately 0.82% developed, 3% palustrine wetlands, 9% terrestrial, and 0.33% water (Figure 3). A comparison of the mid-1970s landuse with the 1992 landuse information shows that no substantial changes to the Kessinger Ditch watershed have occurred. This was also confirmed in field observations conducted by IDEM during the 2001 *E. coli* sampling.

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 all create potential sources of *E. coli*. Wildlife contributes to the potential impact of contaminated runoff from animal habitats, such as urban park areas, forest, and cropland.

Homes within the Kessinger Ditch watershed are almost entirely on septics. Failing septic tanks are known sources of *E. coli* impairment in waterbodies. The Knox County Health Department responds to reports of failing septic systems throughout the county. There have been reports of failing septic systems in the Kessinger Ditch watershed, however none of those reported, would have directly effected Kessinger Ditch (Beamon, M., 2004).

National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers

There are two NPDES permitted facilities in the Kessinger Ditch watershed (Figure 4, Table 1). Permit ING040035 is for Black Beauty Coal Company and discharges into Kessinger Ditch and Reel Creek. Permit IN0058742 is for Solar Sources, Wheatland Rail and discharges into Steen Ditch. Neither of these facilities have a sanitary component to their discharge and are not considered sources of *E. coli* to the Kessinger Ditch watershed.

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 falls under the regulations for confined feeding operations (CFOs) and confined animal feeding operations (CAFOs). There are seven CFOs in the Kessinger Ditch watershed (Figure 5). Of the seven CFOs, one is considered a CAFO and has a general permits (Table 2). The CFOs 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 animal operations in Kessinger Ditch watershed have no open enforcement actions at this time. Therefore, these operations are not considered a significant source of *E. coli* for the Kessinger Ditch TMDL.

There are many smaller livestock operations in the watershed. These operations, due to their small size, are not regulated under the CFO or CAFO regulations. These operations may still 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 Kessinger Ditch 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 Kessinger Ditch watershed indicates that a significant amount of the *E. coli* load enters the Kessinger Ditch 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 Kessinger Ditch 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 non-point).

In order to develop a load duration curve, continuous flow data is required. The USGS gage for the West Fork White River (03374000) located in Petersburg, Indiana was used for the development of the *E. coli* load duration curve analysis for the Kessinger Ditch watershed TMDL. USGS gage 03374000 is located downstream from the mouth of Kessinger Ditch on the West Fork of the White River; therefore, the drainage area for the Kessinger Ditch watershed is accounted for in the drainage area for this gauge. In order to obtain an estimated flow for the Kessinger Ditch watershed, the drainage area was calculated at the mouth of the Kessinger Ditch watershed (67.6 square miles) and compared to the drainage area for USGS gage 03374000

(11,125 square miles). The flow for USGS gage 03374000 was then multiplied by the percent of drainage area that is accounted for in the total drainage area at the USGS gage. The calculated flow number and drainage area for the Kessinger Ditch watershed were then used to create the load duration curves for the Kessinger Ditch 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 that 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 standards (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 Kessinger Ditch watershed. However, the sampling site, WWL090-0003 on the Kessinger Ditch provides the best description of the sources of *E. coli* to the Kessinger Ditch watershed (Figure 2, Attachment C). This is because this sampling site has monitoring data from 1996 and 2001. The data 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 Kessinger Ditch watershed (noted by the diamonds above the curve on far right side of the figure in Attachment C).

While there are point source contributions, compliance with the numeric *E. coli* WQS in the Kessinger Ditch watershed most critically depends on controlling of nonpoint sources using best management plans (BMPs). If the *E. coli* inputs can be controlled, then total body contact recreation use in Kessinger Ditch watershed will be protected.

TMDL Development

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving the Waters Quality Standard (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 1 through October 31. Concurrent with the selection of a numeric concentration endpoint, TMDL development also defines the critical conditions that will be used when defining allowable levels. Many TMDLs are designed as the set of environmental conditions that, when addressed by appropriate controls, will ensure attainment of WQS for the pollutant. For example, the critical conditions for the control of point sources in Indiana are given in 327 IAC 5-2-11.1(b). In general, the 7-day average low flow in 10 years (Q7, 10) for a stream is used as the design condition for point source dischargers. However, *E. coli* sources to Kessinger Ditch 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 Kessinger Ditch watershed and the contributing sources, there are a number of different allowable loads that will ensure compliance, as long as they are distributed properly throughout the watershed.

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

Allocations

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

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

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).

<u>Wasteload Allocations</u>

As previously mentioned, there is one CAFO in the Kessinger Ditch watershed that has a general NPDES permit. Under this NPDES permit, 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 1^{st} through October 31^{st}.

<u>Load Allocations</u>

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 1^{st} through October 31^{st}. 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 total body contact designated uses to the Kessinger Ditch watershed.

The Knox County government entities and their corresponding portions of the land area in Kessinger Ditch watershed are as follows: Harrison Township (33%); Steen Township (28%); Palmyra (27%); Washington Township (11%); and Vigo Township (1%). (ESRI, 2004). (Table 3 and Figure 6.)

Load allocations may be affected by subsequent work in the watershed. There is a watershed project that has been proposed for this watershed. It is anticipated that this watershed project will be useful in defining the nonpoint sources of the *E. coli* in the Kessinger Ditch watershed.

<u>Margin of Safety</u>

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 more 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 Kessinger Ditch 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 Kessinger Ditch 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 to assist in meeting the Kessinger Ditch watershed TMDL allocations and the *E. coli* Water Quality Standard (WQS).

Confined Feeding Operations and Confined Animal Feeding Operations

CFO and CAFO are required to manage manure, litter, process wasterwater pollutants in a manner that does not cause or contribute to the impairment of *E. coli* WQS.

Watershed Projects

There is a 205(j) proposal that was submitted for the Kessinger Ditch watershed to address the *E. coli* impairment. The contract for this project has been drafted and should begin in early 2005. It is believed that this project will help to further identify and reduce the nonpoint sources that are contributing to the *E. coli* impairment in the Kessinger Ditch 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 Kessinger Ditch watershed.

Potential Future Activities:

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

1) CAFOs and CFOs not violating their permits; and
2) 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 Kessinger Ditch 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 Kessinger Ditch 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 Kessinger Ditch watershed.

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Table 1: NPDES Permits in the Kessinger Ditch Watershed

Permit No.	Facility Name	Receiving Waters
ING040035	Black Beauty Coal Company	Kessinger Ditch and Reel Creek
IN0058742	Solar Sources, Wheatland Rail	Steen Ditch

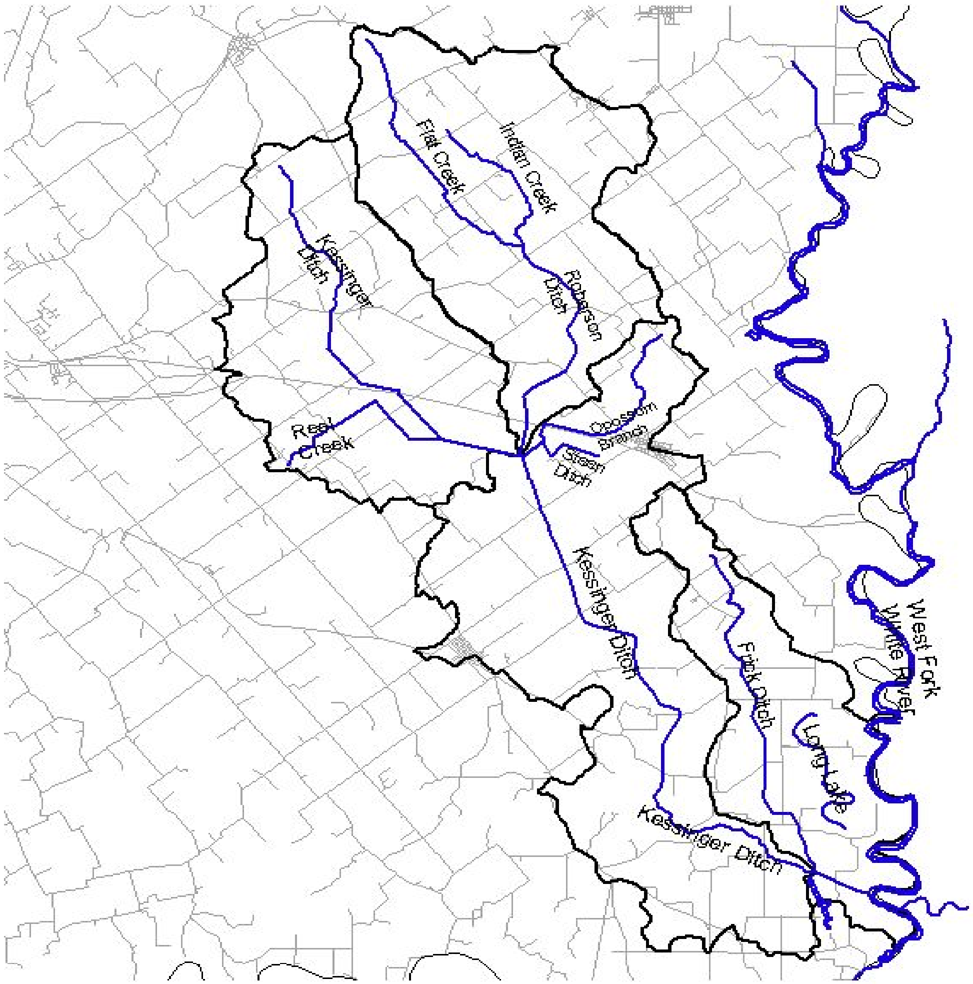
Table 2: Permitted Confined Feeding Operations and Confined Animal Feeding Operations in the Kessinger Ditch Watershed

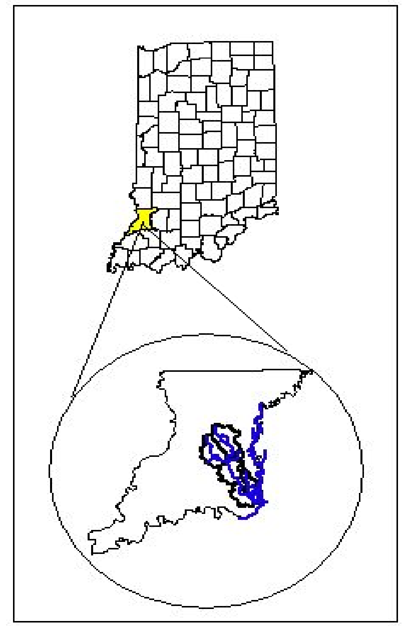
			Approved Animals				
Log Number	**Name**	**NPDES Permit Number**	**Nursery Pig**	**Growerfinishers**	**Sowboars**	**Beef**	**Turkeys**
244	Linneweber Brothers		4700	5450	670		
866	Ice Farms, Inc	ING800868		5310			
1267	Diamond D Farm		304	848	159		
3880	Marchino Brothers Inc		1080	3500			
654	Otten		100	550			
4597	Anson Grain & Livestock Inc		650	1200	257	100	
6121	Casarotto						44000

Table 3: Land Area Distribution for the Kessinger Ditch Watershed

Municipality	**Square Mile**	**Percent**
Harrison Township	22.94	33
Steen Township	19.30	28
Palmyra Township	18.85	27
Washington Township	7.49	11
Virgo Township	0.399	1
Total	**68.99**	**100**

Figure 1: Kessinger Ditch Watershed TMDL





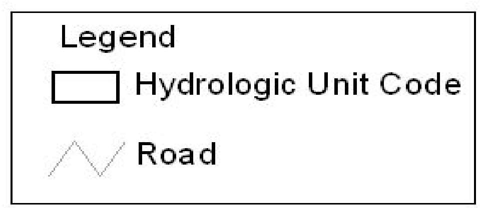


Figure 2: IDEM Sampling Sites in Kessinger Ditch Watershed

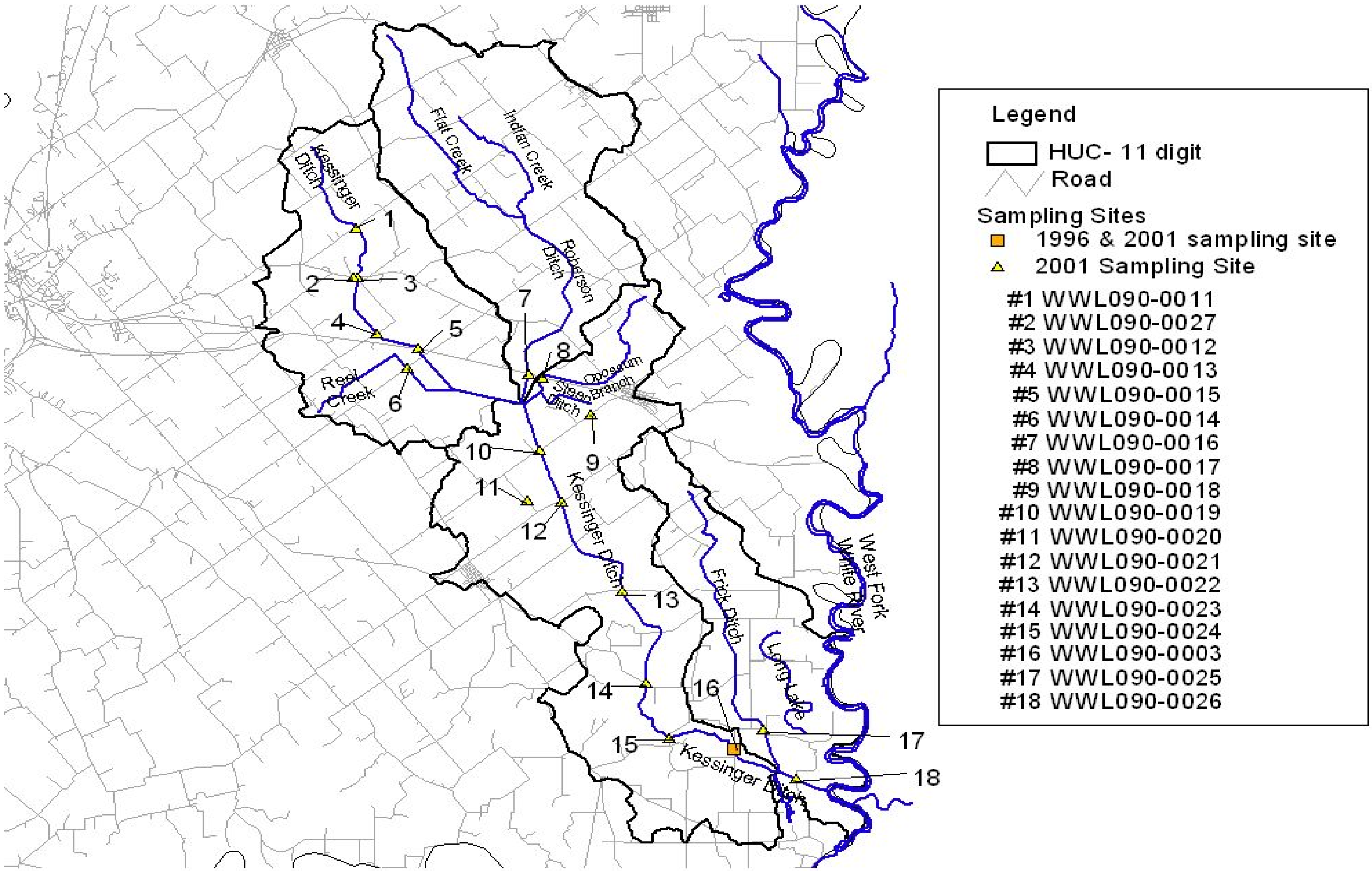


Figure 3: Landuse in Kessinger Ditch Watershed

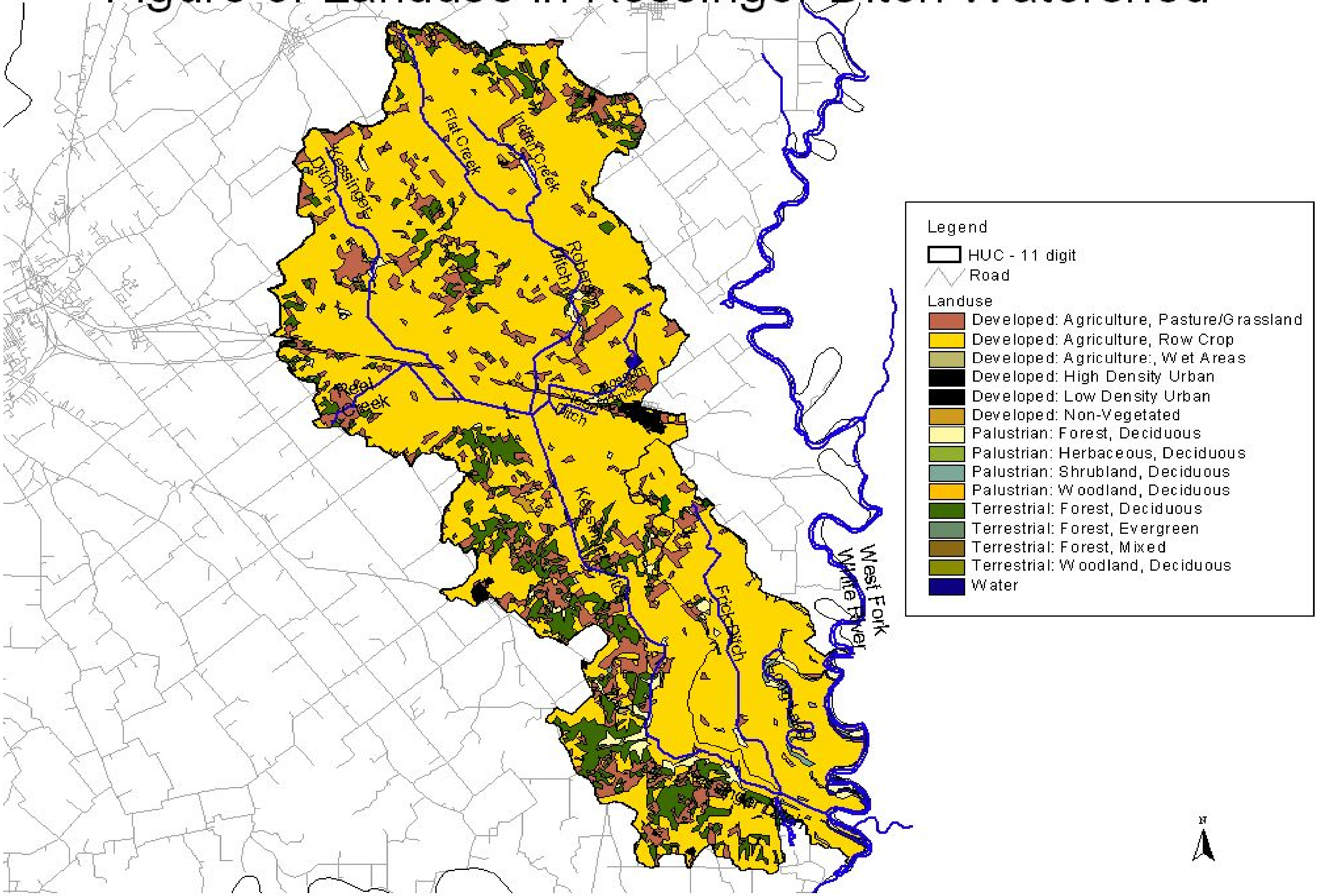


Figure 4: NPDES Permits in Kessinger Ditch Watershed

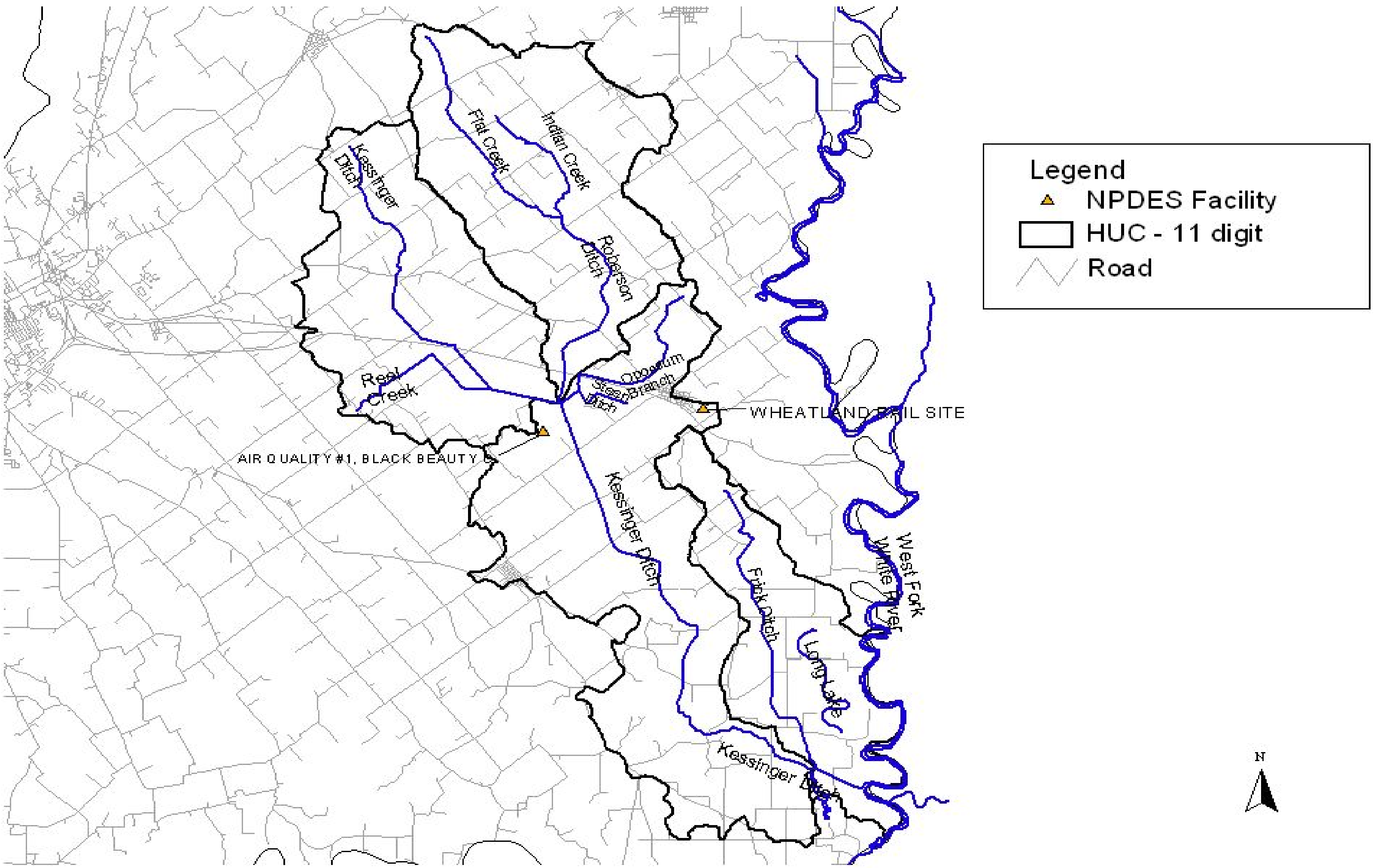


Figure 5: CFO and CAFO in Kessinger Ditch Watershed

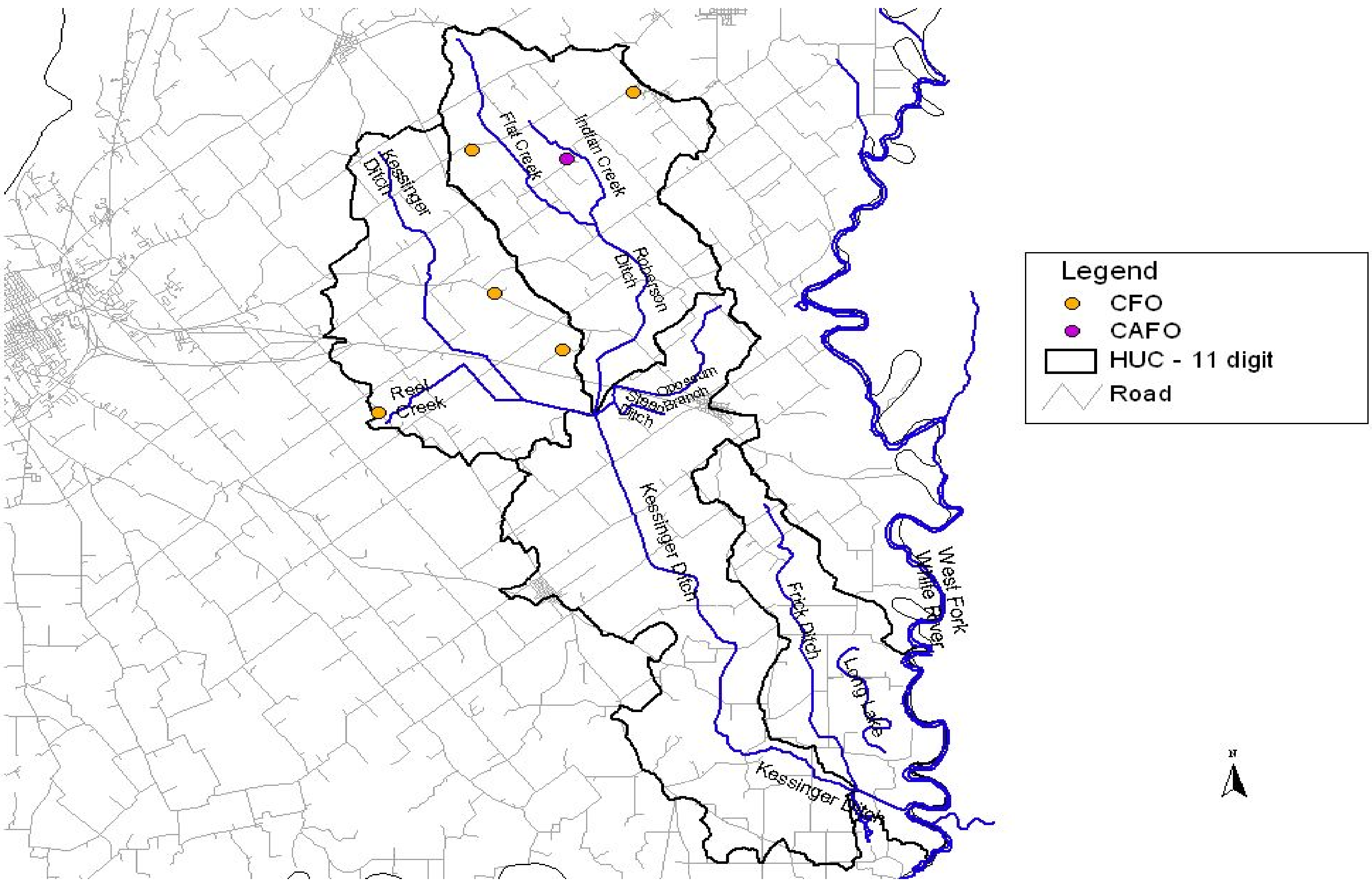
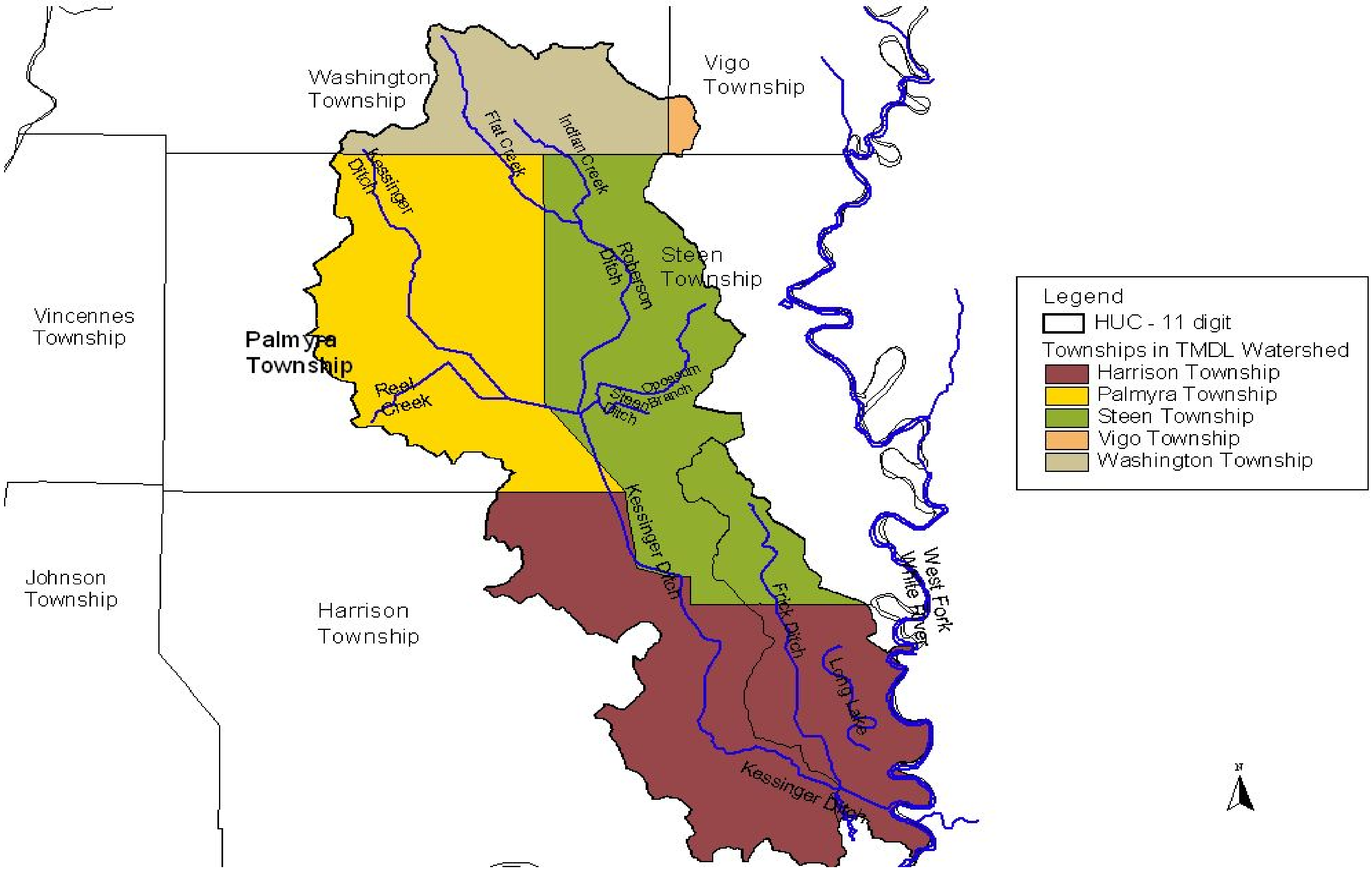


Figure 6: Land Area Distribution in Kessinger Ditch Watershed



Attachment A

Kessinger Ditch Watershed *E. coli* Data

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Attachment B

Water Quality Duration Curves for Kessinger Ditch Watershed TMDL

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Attachment C

Load Duration Curves for Kessinger Ditch Watershed TMDL

Attachment A: Kessinger Ditch Watershed *E. coli* Data

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100 mL)	Geometeric Mean
1	2001 Kessinger Ditch Assessment	WWL090-0011	Kessinger Ditch	CR SE 100 S	AA06421	07/24/01	365	>182
					AA06760	08/01/01	>2419	
					AA06834	08/08/01	29	
					AA07009	08/14/01	326	
					AA07361	08/22/01	24	
2	2001 Kessinger Ditch Assessment	WWL090-0027	Unnamed Tributary	Old Wheatland Rd	AA06424	07/24/01	<1	<1
					AA06764	08/01/01	<1	
					AA06838	08/08/01	<1	
					AA07013	08/14/01	<1	
					AA07365	08/22/01	<1	
3	2001 Kessinger Ditch Assessment	WWL090-0012	Kessinger Ditch	Old Wheatland Rd	AA06423	07/24/01	201	414
					AA06763	08/01/01	980	
					AA06837	08/08/01	219	
					AA07012	08/14/01	1733	
					AA07364	08/22/01	162	
4	2001 Kessinger Ditch Assessment	WWL090-0013	Kessinger Ditch	CR SE 300 S	AA06425	07/24/01	2419	1693
					AA06765	08/01/01	1553	
					AA06839	08/08/01	2419	
					AA07014	08/14/01	1986	
					AA07366	08/22/01	770	

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100 mL)	Geometeric Mean
5	2001 Kessinger Ditch Assessment	WWL090-0015	Kessinger Ditch	Robinson Elevator Rd	AA06427	07/24/01	308	>974
					AA06767	08/01/01	2419	
					AA06841	08/08/01	201	
					AA07016	08/14/01	>2419	
					AA07368	08/22/01	>2419	
6	2001 Kessinger Ditch Assessment	WWL090-0014	Unnamed Tributary	Robinson Elevator Rd	AA06426	07/24/01	517	>993
					AA06766	08/01/01	2419	
					AA06840	08/08/01	980	
					AA07015	08/14/01	326	
					AA07367	08/22/01	>2419	
7	2001 Kessinger Ditch Assessment	WWL090-0016	Roberson Ditch	US 50 & 150	AA06428	07/24/01	45	151
					AA06768	08/01/01	1300	
					AA06842	08/08/01	55	
					AA07017	08/14/01	411	
					AA07369	08/22/01	61	
8	2001 Kessinger Ditch Assessment	WWL090-0017	Opossum Branch	US 50 & 150	AA06429	07/24/01	>2419	>1677
					AA06769	08/01/01	387	
					AA06843	08/08/01	>2419	
					AA07018	08/14/01	>2419	
					AA07370	08/22/01	>2419	
9	2001 Kessinger Ditch Assessment	WWL090-0018	Steen Ditch	Wheatland Road	AA06430	07/24/01	>2419	>1019
					AA06770	08/01/01	921	
					AA06844	08/08/01	1046	
					AA07019	08/14/01	687	
					AA07371	08/22/01	687	

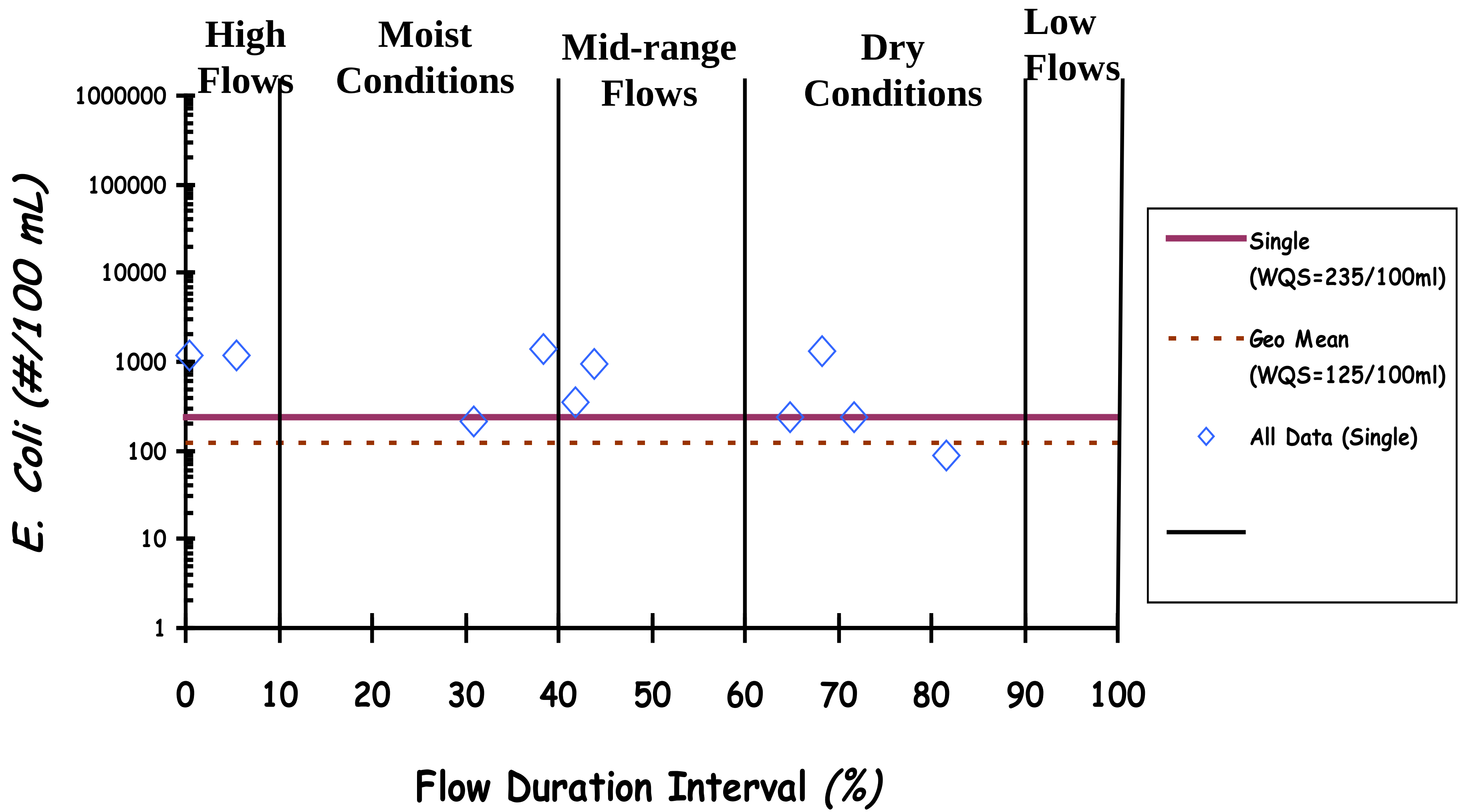
Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100 mL)	Geometeric Mean
10	2001 Kessinger Ditch Assessment	WWL090-0019	Kessinger Ditch	Wheatland Road	AA06431	07/24/01	921	>910
					AA06771	08/01/01	1300	
					AA06845	08/08/01	866	
					AA07020	08/14/01	249	
					AA07372	08/22/01	>2419	
11	2001 Kessinger Ditch Assessment	WWL090-0020	Reel Creek	CR SE 610 E	AA06433	07/24/01	1203	598
					AA06670	08/01/01	579	
					AA06900	08/08/01	687	
					AA07022	08/14/01	328	
					AA07350	08/22/01	488	
12	2001 Kessinger Ditch Assessment	WWL090-0021	Kessinger Ditch	SR 241	AA06435	07/24/01	1120	833
					AA06673	08/01/01	770	
					AA06897	08/08/01	548	
					AA07031	08/14/01	866	
					AA07353	08/22/01	980	
13	2001 Kessinger Ditch Assessment	WWL090-0022	Kessinger Ditch	CR 800 S	AA06436	07/24/01	365	359
					AA06674	08/01/01	579	
					AA06902	08/08/01	291	
					AA07032	08/14/01	199	
					AA07354	08/22/01	488	
14	2001 Kessinger Ditch Assessment	WWL090-0023	Kessinger Ditch	CR 975 S	AA06437	07/24/01	649	1251
					AA06675	08/01/01	1203	
					AA06903	08/08/01	1046	
					AA07033	08/14/01	1553	
					AA07355	08/22/01	2419	

Site #	Project ID	L-Site #	Stream Name	Description	Sample #	Sample Date	E.coli (MPN/100 mL)	Geometeric Mean
15	2001 Kessinger Ditch Assessment	WWL090-0024	Kessinger Ditch	CR 1050 E	AA06438	07/24/01	387	528
					AA06676	08/01/01	1203	
					AA06904	08/08/01	291	
					AA07034	08/14/01	214	
					AA07356	08/22/01	1414	
16	2001 Kessinger Ditch Assessment	WWL090-0003	Kessinger Ditch	CR 725 N	AA06439	07/24/01	345	472
					AA06677	08/01/01	921	
					AA06905	08/08/01	238	
					AA07035	08/14/01	238	
					AA07357	08/22/01	1300	
	1996 Synoptic	WWL090-0003	Kessinger Ditch	CR 725 N	D120391	03/06/96	210	
					D120994	05/10/96	1200	
					D121374	06/13/96	1200	
					D121758	07/24/96	1400	
					D122233	10/17/96	90	
17	2001 Kessinger Ditch Assessment	WWL090-0025	Frick Ditch	CR 1050 S	AA06440	07/24/01	36	90
					AA06679	08/01/01	166	
					AA06906	08/08/01	137	
					AA07036	08/14/01	158	
					AA07358	08/22/01	46	
18	2001 Kessinger Ditch Assessment	WWL090-0026	Kessinger Ditch	CR 1100 E	AA06441	07/24/01	435	431
					AA06680	08/01/01	579	
					AA06907	08/08/01	387	
					AA07037	08/14/01	250	
					AA07360	08/22/01	613	

Kessinger Ditch at CR 725 N

WQ Duration Curve *(1996, 2001 Monitoring Data)*

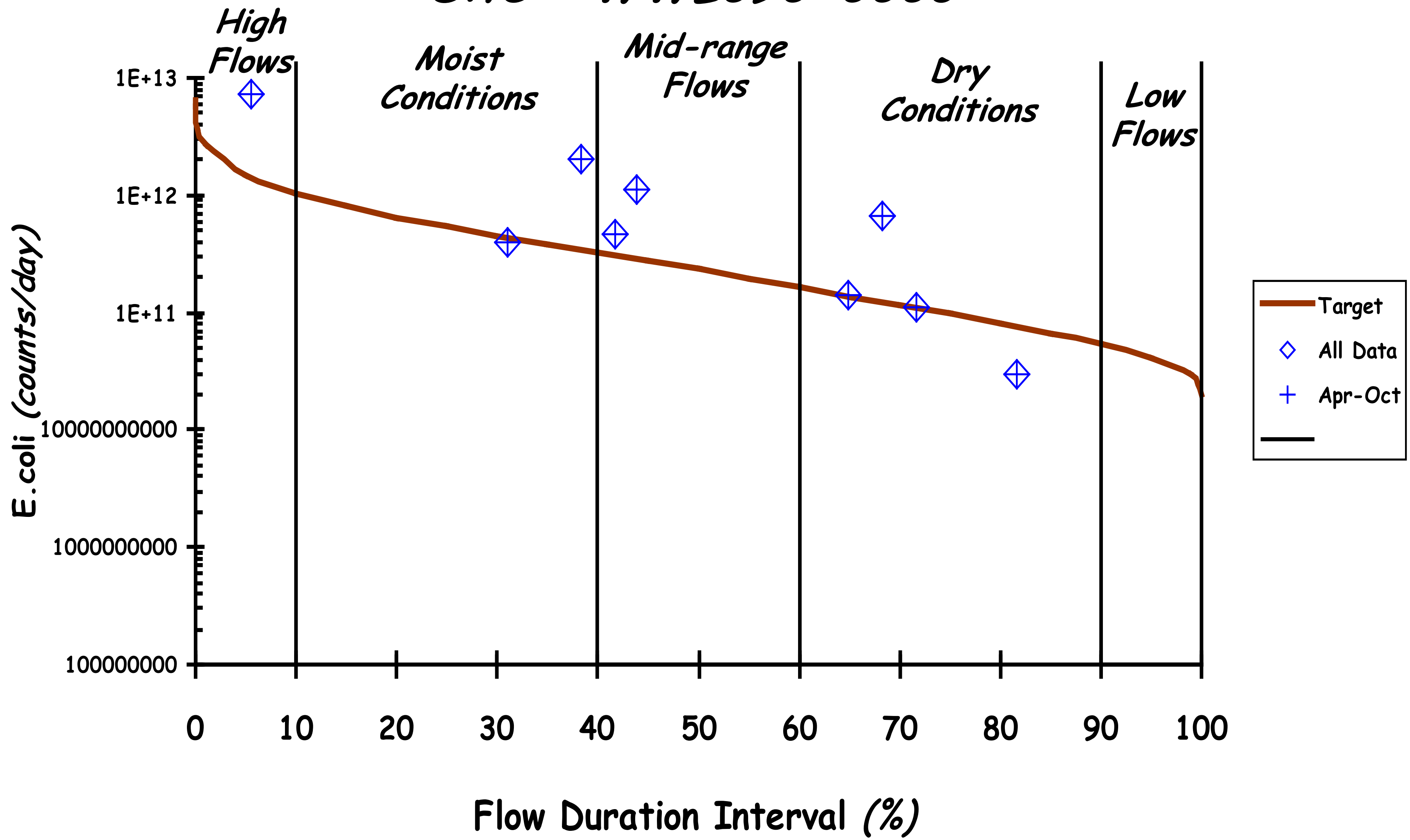
Site: WWL090-0003



IDEM Data & USGS Gage Duration Interval

67.6 square miles

Kessinger Ditch at CR 725 N
Load Duration Curve *(2001 Monitoring Data)*
Site: WWL090-0003



IDEM Data & USGS Gage Duration Interval *67.6 square miles*