Office of Water Quality
Total Maximum Daily Load Program

Total Maximum Daily Load for *Escherichia coli* (*E. coli*) For the Richland Creek Watershed, Greene, Monroe, and Owen Counties

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Introduction

Section 303(d) of the Federal Clean Water Act and the United States Environmental Protection Agency's (USEPA's) Water Quality Planning and Management Regulations (Title 40 of the Code of Federal Regulations (CFR), Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for waterbodies that are not meeting Water Quality Standards (WQS). TMDLs provide States a basis for determining the pollutant reductions necessary from both point and non-point 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 Richland Creek watershed in Greene, Monroe, and Owen Counties in Indiana.

Background

In 1998, 2002, and 2004, Richland Creek and Little Richland Creek were listed on Indiana's 303(d) list as impaired for *E. coli*. In 2004, Beech Creek, Ore Branch, and the Ore Branch Tributary (Wildcat Branch) were added to Indiana's 303(d) list as impaired for *E. coli* (Attachment A).

A reassessment of Ritter Branch (INW0245_01) indicated that this segment is impaired for *E. coli* and will be listed on the 2008 303(d) list as impaired. Richland Creek segment IN0243_T1021 was not labeled as impaired for *E. coli*, reassessment of this segment indicated that this segment is impaired for *E. coli* and will be listed on the 2008 303(d) list as impaired for *E. coli*.

This TMDL will address approximately fifty-eight (58) miles of the Richland Creek watershed in Greene, Monroe, and Owen Counties where recreational uses are impaired by elevated levels of *E. coli* during the recreational season. The Richland Creek watershed is located in southwestern Indiana (Figure 1). All of the eight (8) segments of the listed streams for this TMDL are located in the Lower White River Basin in hydrologic unit code 05120202. The description of the study area, its topography, and other particulars are as follows:

Waterbody Name	Segment ID Number	Length (miles)	Impairment
RICHLAND CREEK	INW0241_T1019	7.17	*E. coli*, IMPAIRED BIOTIC COMMUNITIES
RICHLAND CREEK	INW0241_T1019	7.17	FCA for PCB's and Hg
LITTLE RICHLAND CREEK	INW0241_T1164	1	IMPAIRED BIOTIC COMMUNITIES, *E. coli*
RICHLAND CREEK	INW0242_T1020	11.88	FCA for PCB's and Hg
RICHLAND CREEK	INW0242_T1020	11.88	IMPAIRED BIOTIC COMMUNITIES, *E. coli*
RICHLAND CREEK	INW0243_T1021	5.98	FCA for PCB's and Hg
RICHLAND CREEK	INW0243_T1021	5.98	IMPAIRED BIOTIC COMMUNITIES, *E. coli*
BEECH CREEK	INW0244_00	12.05	*E. coli*
ORE BRANCH	INW0245_00	7.76	*E. coli*
RITTER BRANCH	INW0245_01	2.77	*E. coli*
RICHLAND CREEK	INW0245_T1022	9.24	FCA for PCB's and Hg
RICHLAND CREEK	INW0245_T1022	9.24	IMPAIRED BIOTIC COMMUNITIES, *E. coli*

Historic data collected by IDEM's Assessment Branch in 1996 indicate high levels of *E. coli* in Richland Creek. Two sites were sampled once a month in February, June, and July. One of the sites was sampled again in October. Both of these sites violated the single sample maximum twice. Violations ranged from 390 MPN/100 mL to 2,800 MPN/100 mL (MPN = Most Probable Number).

IDEM sampled twenty-one (21) sites in the Richland Creek watershed. Samples were collected five (5) times, evenly spaced, within thirty (30) days from September 11, 2001 to October 9, 2001. Of these sites, nineteen (19) violated the geometric mean (Attachment A, Figure 2). All sites violated the single sample maximum at least once. Sites 10 and 11 (WWL040-0021 and WWL040-0023 respectively) were the only two sites that did not violate the geometric mean. The geometric means ranged from 101 MPN/100 mL at site 11 to 1,506 MPN/100 mL at site 2.

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 duration curves were created using data collected by IDEM's Assessment Branch. 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 sites 2, 3, 6, 12, and 20 (sample numbers WWL040-0013, WWL040-0014, WWL040-0017, WWL040-0024, and WWL040-0002 respectively) 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 the recreational season. These sampling sites are located along Richland Creek and were sampled in 2001. These sampling sites are representative of the hydrodynamics of the Richland Creek watershed (Attachment B).

Numeric Targets

The impaired designated use for the waterbodies in the Richland Creek watershed is for total body contact recreation use during the recreational season, April 1 through October 31.

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

For the Richland Creek watershed during the recreational season (April 1 through October 31) 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

<u>Watershed Characterization</u>

The Richland Creek watershed ranges over three counties; 80.20 % of the watershed is in Greene County, 19.20 % is in Monroe County, and 0.60 % is in Owen County. Richland Creek begins in western Monroe County and flows southwest, briefly flowing into Owen County before entering the northeast corner of Greene County. Little Richland Creek flows west from Monroe County into the northern part of Greene County and into Richland Creek. Beech Creek originates in eastern Greene County and flows into Richland Creek in the northeast corner of Greene County. Ore Branch flows to the west to connect with Richland Creek south of Beech Creek. The Ore Branch Tributary flows to the east and connects with Richland Creek just north of Ore Branch. Ritter Branch flows east to connect with Richland Creek opposite of Ore Branch (Figure 1).

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

Landuse information was assembled in 1992 using the Gap Analysis Program (GAP). In 1992, approximately 68.15 % of the landuse in the Richland Creek watershed was forested. The remaining landuse for the Richland Creek watershed consisted of approximately 30.16 % agriculture, 0.95 % urban, 0.62 % wetland, and 0.13 % water (Figure 3). Little landuse change has occurred in the Richland Creek watershed since the 1970's. Forested cover is 4.95 % less in 1992 than it was in the 1970's. Agricultural coverage is 5.06 % greater in 1992 than it was in the 1970's. The urban area covers 0.85 % less of the watershed in 1992 than it did in the 1970's (Figure 4).

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*. Colonies of Great Blue Heron, wild ducks, and geese are reported to feed and nest in wetland areas near Richland Creek (Wiles, Personal Communication). Wildlife contributes to the potential impact of contaminated runoff from animal habitats, such as urban park areas, forest, and cropland.

Failing septic tanks are known sources of *E. coli* impairment in waterbodies. Conversations with the staff from the Greene, Monroe, and Owen County Health Departments indicate that septic system failure does occur. No tangible septic failure rate has been established by the Greene County Health Department at this time (Rotman, 2005 Personal Communication); however, the Monroe County Health Department indicates a failure rate of approximately 2-3% from experimental evidence (Cain, 2005 Personal Communication), and the Owen County Health Department indicates an approximate failure rate of 10 to 15 % (Reeves, 2005 Personal Communication).

<u>National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers</u>

There are two (2) NPDES permitted facilities in the Richland Creek watershed, the Eastern Greene Elementary and High School and the Neals Landfill Springwater Treatment facility (Figure 5, Table 1). Neither of these 2 permitted discharges have *E. coli* limits in their permits.

One (1) of the two (2) NPDES permitted facilities, the Eastern Greene Elementary and High School facility (IN0031470), has total residual chlorine (TRC) limits in the permit. There are possible sanitary components in the discharge. Previously, facilities with design flows less than one (1) MGD (Million Gallons per Day) that typically include 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 can be conclusively drawn. Further, it has been shown that exceedances of *E. coli* bacteria limits may still occur when the chlorine contact tank requirements are met.

Information on the permit compliance history of Eastern Greene Elementary and High School facility (IN0031470) is as follows:

- The Eastern Greene Elementary and High School has violated the TRC permit 9 times in the past 5 years; however, no violations occurred during the sampling event.
- There are no open enforcement cases and there are no past enforcement cases against this facility.

Due to the complications of comparing total residual chlorine to *E. coli*, it is difficult to determine to what extent, if any, this discharger could be a source of *E. coli* in the Richland Creek watershed.

The remaining discharger, Neals Landfill Springwater Treatment facility (IN0045918), does not have *E. coli* or total residual chlorine limits built into the permit. This discharger does not have a sanitary component to the discharge; therefore, *E. coli* limits do not apply to the permit. This permitted discharger is not contributing to the sources of *E. coli* in the Richland Creek watershed.

Storm Water General Permit Rule 13

There are no municipal separate storm sewer systems (MS4) communities in the Richland Creek watershed.

Combined Sewer Overflows (CSO)

There are no CSO communities in the Richland Creek watershed.

Confined Feeding Operations and Concentrated 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 concentrated animal feeding operations (CAFOs). There are two (2) active CFOs in the Richland Creek watershed, James Farms, Inc and the Sparks facility (Figure 6). The Sparks CFO is applying to become a CAFO, which will require a general permit (Table 2). 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 Sparks CFO in the Richland Creek watershed is currently under penalty for manure spills that occurred December 14, 2001 and March 15, 2002. These spills would contribute to high *E. coli* levels in the stream; however, the spills occurred after the sampling event. Additionally, this CFO is meeting the requirements of the agreed order and there is no open enforcement case at this time. Since the Sparks CFO is in compliance with the agreed order requirements and there are no enforcement cases, past or current, against the James Farms, Inc facility, neither of the operations are considered a significant source of *E. coli* in the Richland Creek watershed.

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 for the Richland Creek watershed; 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 Richland 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 Richland Creek watershed indicates that a significant amount of the *E. coli* load enters the Richland Creek watershed through both wet (non-point) 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 Richland 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 non-point).

In order to develop a load duration curve, continuous flow data is required. There are two (2) USGS gages that could be representative of the Richland Creek watershed. One (1) USGS gage (03357000) is located in Spencer, Indiana, which is upstream of Richland Creek, and the other USGS gage (03360500) is located in Newberry, Indiana, which is downstream of Richland Creek. The Spencer gage has not been active since 1971; therefore, the Newberry gage was used for the development of the *E. coli* load duration curve analysis for the Richland Creek watershed TMDL. The Newberry USGS gage (03360500) is located on the White River in Greene County.

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 per 100 mL and 125 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 Richland Creek watershed. However, sampling sites 2, 3, 6, 12, and 20 (sample numbers WWL040-0013, WWL040-0014, WWL040-0017, WWL040-0024, and WWL040-0002 respectively), on Richland Creek provide the best overview of sources of *E. coli* to the Richland Creek watershed (Figure 2, Attachment C). These sampling sites are located at SR 48 (site 2), County Road 960 N (site 3), County Road 1250 E (site 6), County Road 475 E (site 12), and Furnace Road (site 20) and were sampled for *E. coli* in 2001. The data indicate that exceedances of the *E. coli* WQS occur during wet and dry weather events. Both wet and dry weather contributions are sources of *E. coli* to the Richland Creek watershed (Attachment C).

<u>Water Quality Duration Curves</u>

Water quality duration curves were created for five (5) of the twenty-one (21) sampling sites in the Richland Creek watershed (Attachment B). Site 2 (WWL040-0013) is located on State Road 48 in Monroe County. Site 2 had an average geometric mean of 1506 MPN/100 mL (MPN = Most Probable Number) and showed violations in the range of moist conditions to dry conditions.

Site 3 (WWL040-0014) is located at County Road 960 North and site 3 had an average geometric mean of 554 MPN/100mL. While both sites 2 and 3 consistently violated the single sample maximum in the moist to dry conditions range, site 2 showed higher violations than site 3. Since violations at both sites occurred within the same flow regimes, similar sources are causing impairment at these two sites. Sources of *E. coli* that are most notable during this flow regime include failing septic systems, cattle, wildlife, and MS4 discharge.

Site 6 (WWL040-0017) is located at County Road 1250 East below the confluence of Little Richland Creek with Richland Creek. This site had an average geometric mean of 128 MPN/100 mL, which is close to the standard. The violation at this site occurred within the moist conditions flow regime. Richland Creek is surrounded by agricultural fields at sites 2 and 3 and passes through forested areas before coming to site 6, which is also surrounded by forest. According to the water quality duration curves, *E. coli* violations occurred more consistently at sites 2 and 3, than at site 6. This indicates a more constant source of *E. coli* at sites 2 and 3, than at site 6.

Site 12 (WWL040-0024) is located on County Road 475 E below the confluence of Dry Branch and Camp Creek with Richland Creek. The geometric mean value for site 12 is 324 MPN/100mL. According to the water quality duration curves, the *E. coli* violations occur in the moist and dry condition flow regimes. This indicates similar sources of *E. coli* among the different sites and that similar best management practices (BMPs) would be beneficial at site 12.

Site 20 is located on Richland Creek below the confluence of Ritter Branch and Ore Branch on Furnace Road. The average geometric mean value at this site is 342 MPN/100mL. The *E. coli* violations occurred in the same flow regimes as the previous sites indicating similar sources throughout the watershed.

<u>Source Linkage</u>

The landuse in this watershed is predominately forest; however, the primary landuse along the streambank appears to be agriculture (Staff Observations). Wildlife is a known source of *E. coli*. The predominant agricultural and forested landuses in this watershed create ideal habitat for wildlife. Wildlife would contribute during all flow conditions with possible spikes in *E. coli* levels during extreme high flow conditions due to runoff or flooding, which carries large quantities of *E. coli* at one time.

Row crops comprise 5.96 % of the landuse. The soils in this watershed necessitate the use of field tiles to drain excess water from the fields. These field tiles then drain to the nearest stream. Field tiles are not themselves sources of *E. coli*, but they can carry *E. coli* from land applied manure, runoff from the fields and pastures, and other sources of *E. coli* not adjacent to the streams. The high *E. coli* value during mid-range to high flow conditions indicates the presence of *E. coli* transportation by field tiles.

Pasture comprises 24.20 % of the landuse. This indicates the presence of non-regulated smaller animal operations in this sub-watershed. Animals located in these smaller animal operations are not as likely to enter a stream during high flow conditions. Since there is a continuous source of *E. coli* present in this watershed during dry conditions, this would indicate that animals have direct access to the stream.

One (1) of the NPDES permitted facilities, the Eastern Greene Elementary and High School facility, in this watershed contains a sanitary component in the discharge; however, this facility is in compliance with the permit and is not considered a source of *E. coli*.

CFOs could be sources of *E. coli* during high flow conditions on the water quality duration curve. These facilities have the potential to cause a violation of the *E. coli* water quality standard through land application or a malfunction at the facility. However, the James Farms, Inc and the Sparks facility are both in compliance with the limits of their permits.

Failing septic systems are a known source of *E. coli* for this watershed based on information provided to IDEM by the Greene, Monroe, and Owen County Health Departments (Rotman, Cain, and Reeves personal communication). The septic systems described by this information would provide a constant source of *E. coli* particularly during low to mid-range flow conditions. According to the water quality duration curves, there are consistent violations of the *E. coli* water quality standard during these flow conditions. Septic systems can also fail during higher flow conditions by leaching to a field tile or other type of pipe that discharges to the stream.

Linkage Conclusions

The *E. coli* data have an average single sample maximum violation 61% of the time and a geometric mean violation 90% of the time. There are no known NPDES permits, CFO, or CAFO violations. Based on the water quality duration curves, it can be concluded that the majority of sources of *E. coli* in this watershed are non-point sources that include small animal operations, wildlife, and leaking and failing septic systems.

While there are point source contributions, compliance with the numeric *E. coli* WQS in the Richland Creek watershed most critically depends on controlling non-point sources using best management practices (BMPs). If the *E. coli* inputs can be controlled, then total body contact recreational use in the Richland Creek watershed will be protected.

TMDL Development

The TMDL represents the maximum loading that can be assimilated by the waterbody while still achieving the Waters Quality Standard (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 the Richland 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 Richland 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). Meeting the Water Quality Standards (WQS) of 125 colony forming unit (cfu) per 100 mL as a geometric mean and 235 cfu/100 mL is the overall goal of the TMDL. The geometric mean *E. coli* WQS allows for the best characterization of the watershed. The geometric mean provides a more reliable measure of *E. coli* concentration because it is less subject to random variation (USEPA, 2004). However, by setting the target to meet the 125 cfu/100 mL geometric mean standard, this TMDL also will meet the 235 cfu/100 mL single day standard. 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).

The Wasteload Allocation and Load Allocations in the TMDL are set at 125 cfu/mL, which, as stated above, also will meet the 235 cfu/100 mL single day standard.

Allocations

TMDLs are comprised of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for non-point 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 non-point 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 previously mentioned, there are two (2) permitted dischargers in the Richland Creek watershed the Eastern Greene Elementary and High School and the Neals Landfill Springwater Treatment facility. One (1) permitted discharger, Eastern Greene Elementary and High School, has a sanitary component to the discharge. This facility has total residual chlorine limits in the permit. IDEM's TMDL Program recommends the addition of *E. coli* limits to this permit during the next permit renewal.

There are no MS4 communities in the Richland 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).

There are no CSO communities in the Richland Creek Watershed.

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 1through October 31. The WLA for straight pipe discharges is set to 0 per 100 mL.

Load Allocations

The LA for non-point sources is equal to the WQS of 125 per one hundred milliliters as a geometric mean based on not less than five samples equally spaced over a thirty-day period from April 1 through October 31. The LA will use the geometric mean of each sampling location to determine the reduction necessary to comply with WQS at each site (Attachment D). The reductions have additionally been broken down into a flow regime that will help identify critical flows and areas for the implementation of this TMDL (Attachment D).

Load allocations may be affected by subsequent work in the watershed. There are currently no watershed projects or plans in the Richland Creek watershed. It is anticipated that watershed projects will be useful in continuing to define and address the non-point sources of the *E. coli* in the Richland 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 through conservative assumptions) or explicit (i.e., expressed in the TMDL as a portion of the loadings). This TMDL uses an implicit MOS by applying a couple of conservative assumptions. First, no rate of decay for *E. coli* was applied. *E. coli* bacteria have a limited capability of surviving outside of their hosts; 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 1 through October 31) 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 Richland 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 Richland 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 whether 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 Richland Creek watershed TMDL allocations and the *E. coli* Water Quality Standard (WQS).

<u>National Pollutant Discharge Elimination System (NPDES) Permitted Dischargers</u>

For the permitted dischargers that have only total residual chlorine limits in their current permits, IDEM's TMDL Program proposes that *E. coli* limits and monitoring be added when the next permit renewals are issued.

<u>Confined Feeding Operations and Concentrated Animal Feeding Operations</u>

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

<u>Watershed Projects</u>

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 Richland Creek watershed. While there are no active planning activities in the Richland Creek watershed, the watershed specialist for this area of the State has been in contact with the Greene County SWCD. Discussions concerning the 319 Grant Program and Watershed Planning have occurred.

Agricultural Programs

Agricultural programs that are in place or will be implemented in Greene County include the Conservation Reserve Program (both Standard and Continuous), the Environmental Quality Incentives Program, and the Wildlife Habitat Incentives Program (Luczynski, 2005 Personal Communication).

Educational Programs and Projects

The Sassafras Audubon Society has recently donated funds for the purchase of a pond in Greene County that will be part of a restoration project. The Sassafras Audubon Society also held an informational meeting in conjunction with Glen Salmon from the Department of Natural Resources (DNR) to explain the importance of this project to the public. For three (3) years the Sassafras Audubon Society has held bird-watching expeditions in Greene County that highlight the importance of riparian buffers and habitat conservation (Lawrence, 2005 Personal Communication).

The Sycamore Land Trust owns property in Greene County and expects to acquire more land for preservation in this area (Freitag, 2005 Personal Communication).

Studies in the Area

Monroe County is currently conducting a project to determine the percentage of failing septic tanks in the area (Cain, 2005 Personal Communication).

The US Fish and Wildlife Service has conducted a biological study (Sparks, 2005 Personal Communication).

TMDL Reports

A TMDL report is being completed in the Plummer Creek watershed. Richland Creek drains into Plummer Creek, which is part of the same 11-digit hydrologic unit code as Richland Creek. Improvements in Richland Creek will lead to improvements in Plummer Creek.

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 a BMP 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 protect stream banks 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 groundwater.

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 runoff.

Drift Fences - Drift fences (short fences or barriers) can be installed to direct livestock movement. A drift fence parallel to a stream keeps 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 Richland Creek watershed include both point and non-point sources. In order for the Richland Creek watershed to achieve Indiana's *E. coli* WQS, the wasteload and load allocations for the Richland 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 1 through October 31. Achieving the wasteload and load allocations for the Richland Creek watershed depends on:

1) *E. coli* limits being added to dischargers who monitor for total residual chlorine.
2) CFOs not violating their permits.
3) Non-point sources of *E. coli* being controlled by implementing best management practices in the watershed.
4) Completion of septic work in Monroe County to help identify sources.
5) Education and outreach for septic system care.

The next phase of this TMDL is to identify and support the implementation of activities that will bring the Richland 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 Richland 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 Richland Creek watershed.

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Table 1: NPDES Permits in the Richland Creek Watershed

Facilities with Total Residual Chlorine Limits

Permit No.	Expiration Date	Facility Name	Receiving Waters
IN0031470	5/31/2010	Eastern Greene Elementary and High School	Beech Creek

Facilities with no Total Residual Chlorine or *E. coli* Limits

Permit No.	Expiration Date	Facility Name	Receiving Waters
IN0045918	6/7/1993	Neals Landfill Spring Water Treatment	Richland Creek

Table 2: Permitted Confined Feeding Operations in the Richland Creek Watershed

			Approved Animals				
Log Number	**Name**	**NPDES Permit Number**	**Nursery Pig**	**Growerfinishers**	**Sowboars**	**Beef**	**Turkeys**
4488	James Farms, Inc						32500
6143	Sparks						44000

Figure 1: Richland Creek Watershed

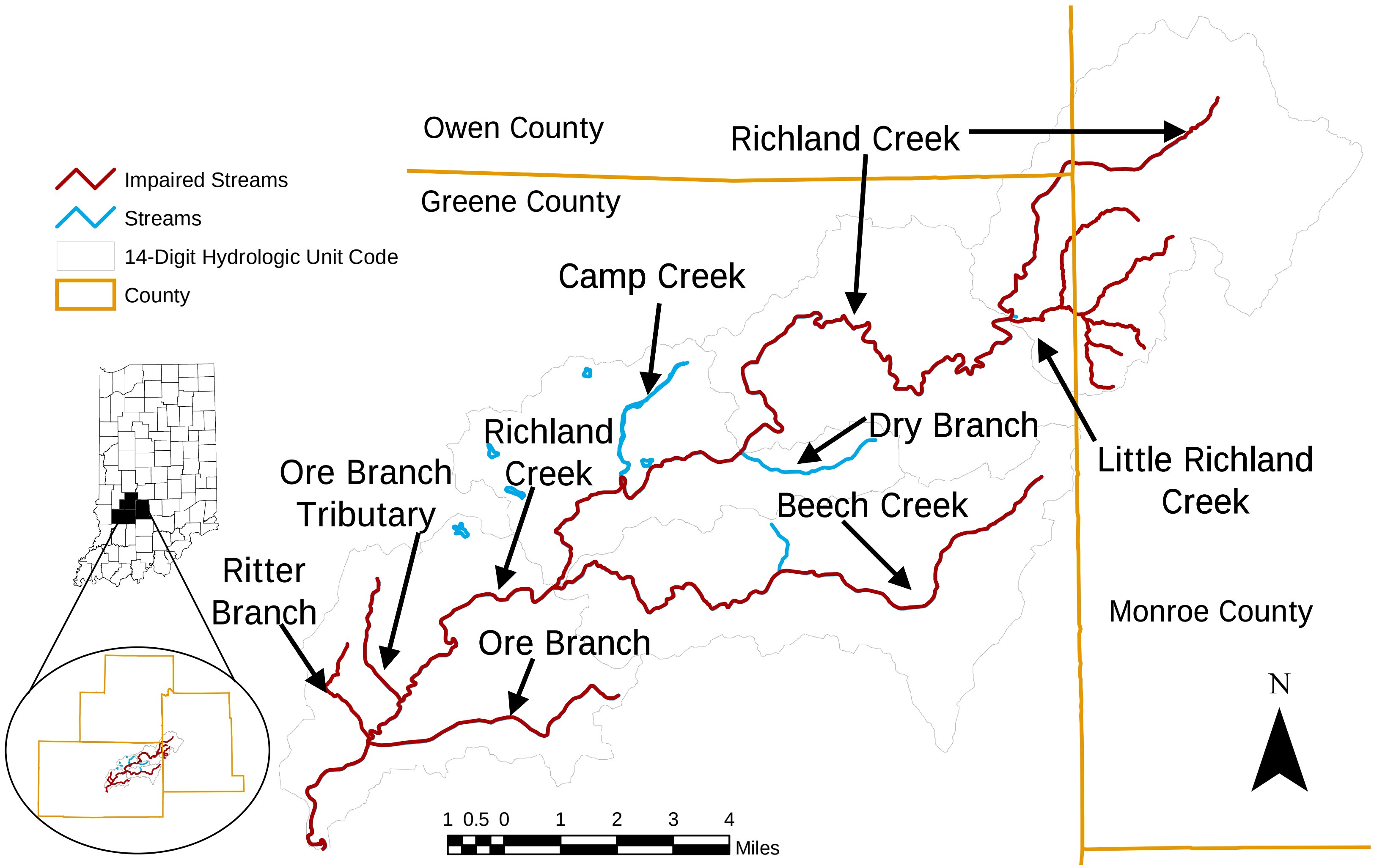


Figure 2: Richland Creek Sampling Sites

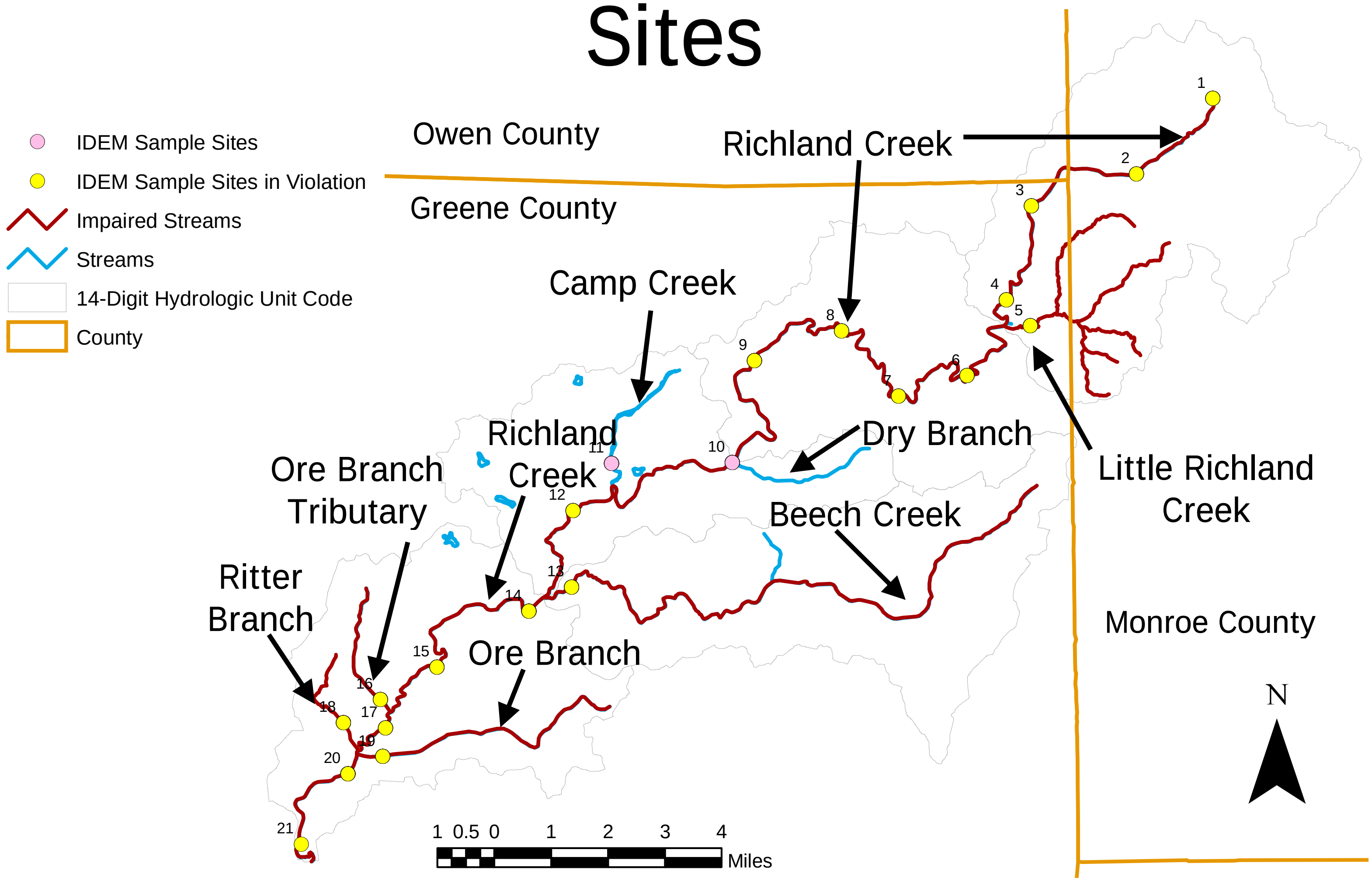


Figure 3: Richland Creek Landuse

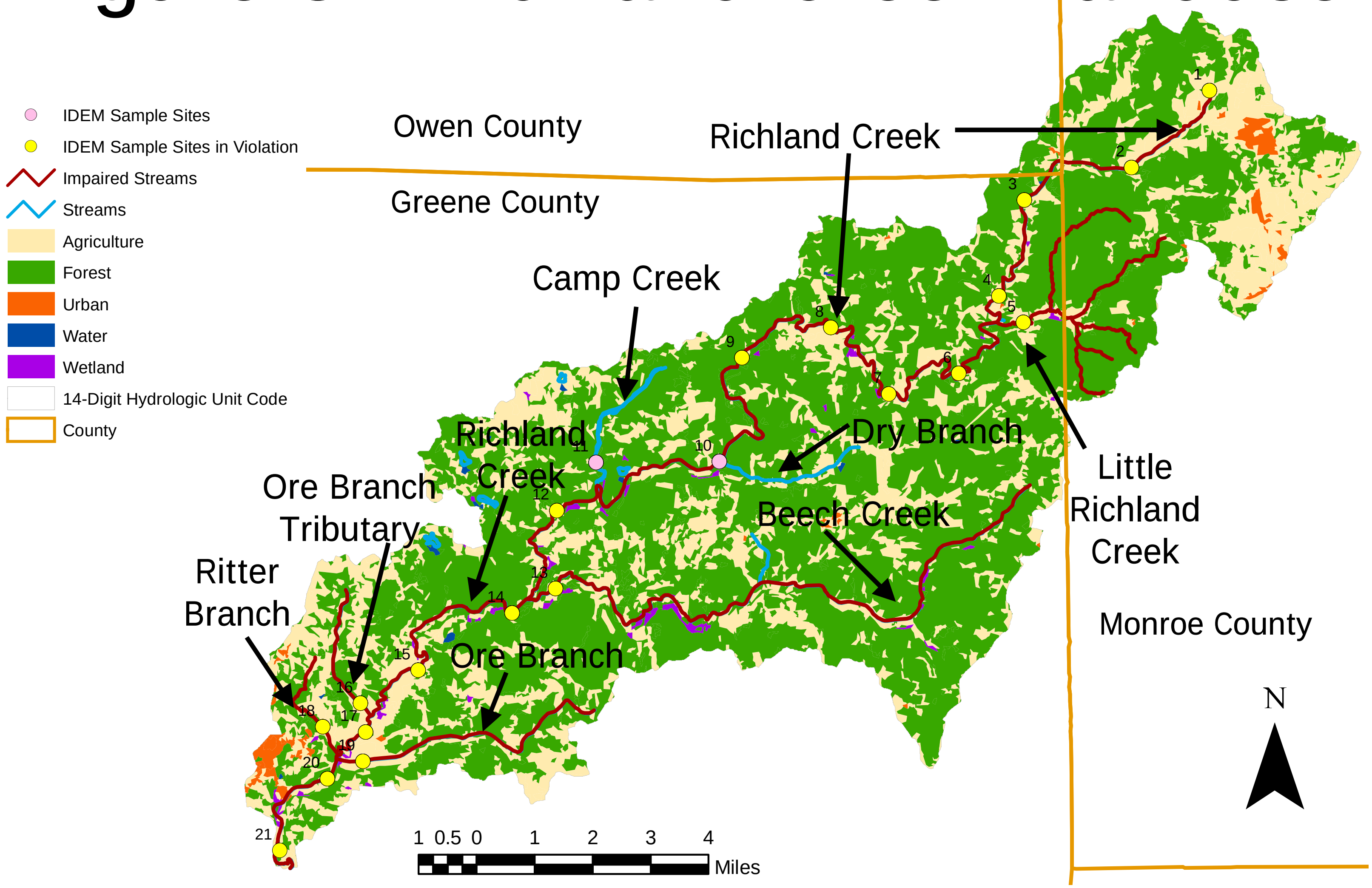
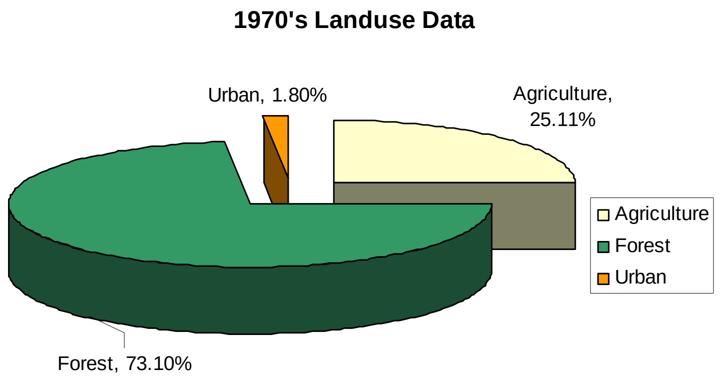


Figure 4: Richland Creek Landuse Comparison



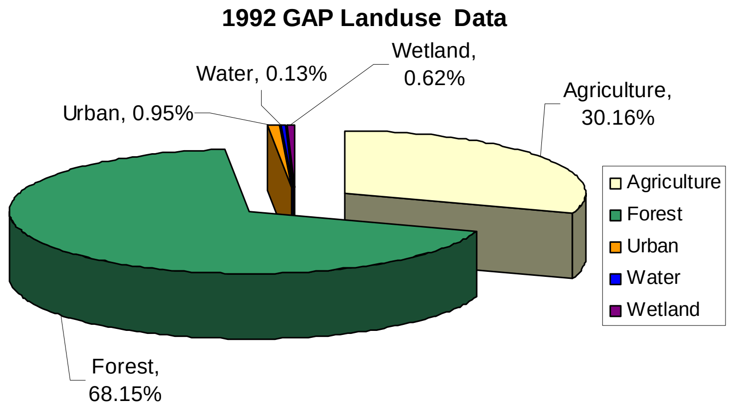


Figure 5: NPDES Permitted Facilities

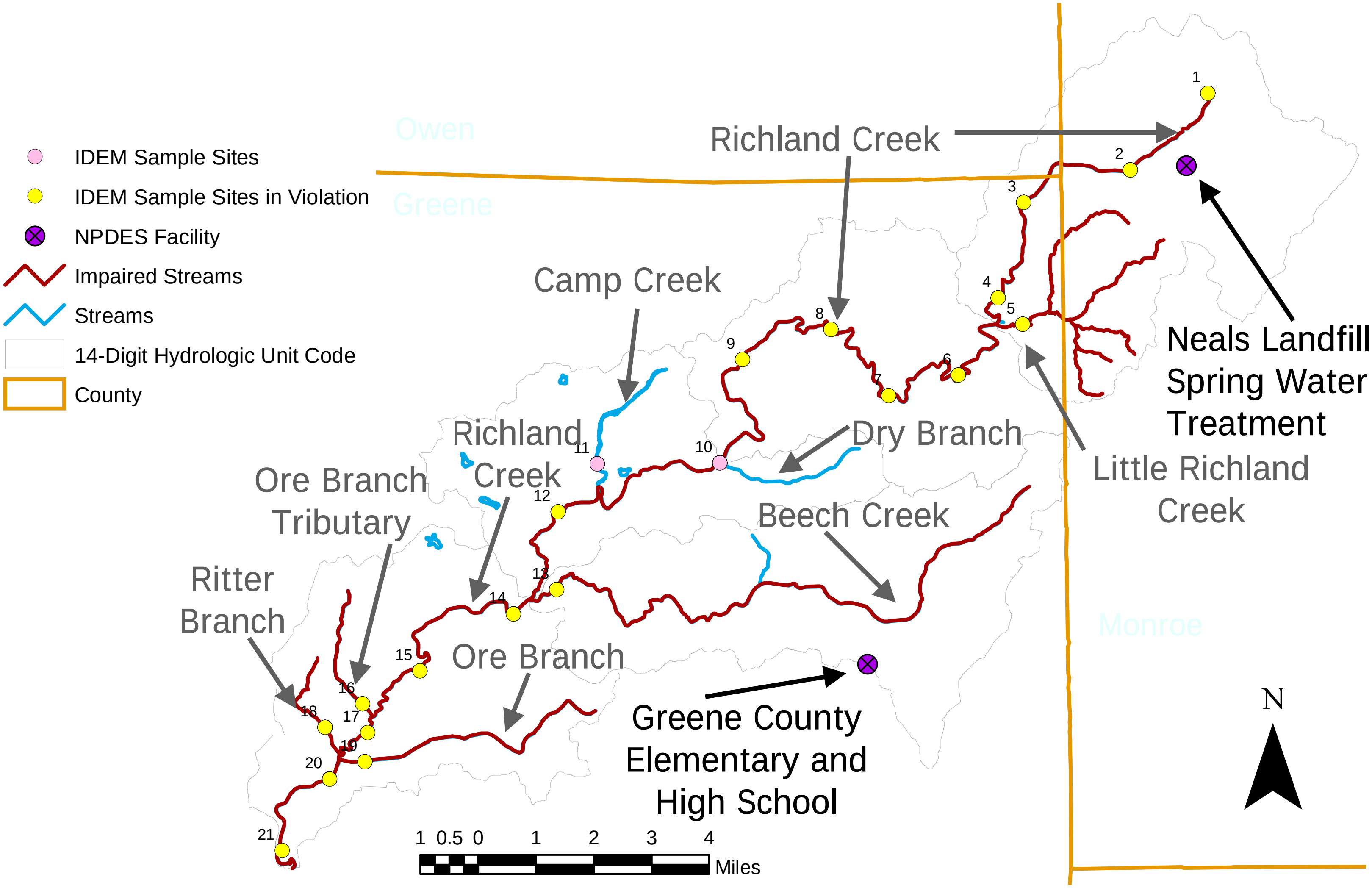
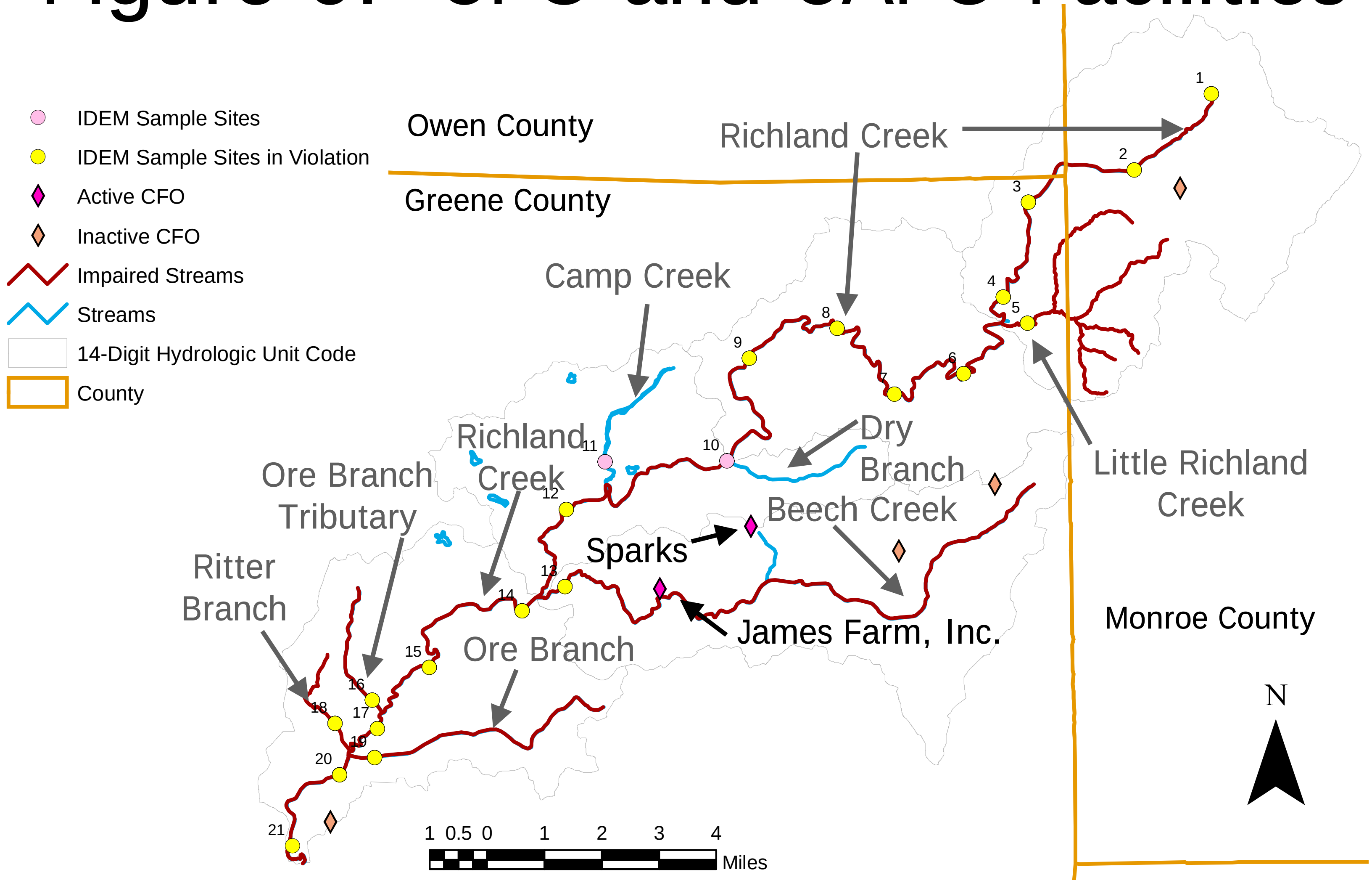


Figure 6: CFO and CAFO Facilities



Attachment A

E. coli Data for the Richland Creek Watershed TMDL

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Site Number	L-Site	Stream Name	Description	Sample Number	Sample Date	*E. coli* (MPN/100 mL)	Geometric Mean
1	WWL040-0012	Richland Cr	West Vernal Pike	AA08368	11-Sep-01	2000	**1196**
				AA08561	18-Sep-01	2400	
				AA08738	25-Sep-01	2000	
				AA08940	02-Oct-01	490	
				AA09117	09-Oct-01	520	
2	WWL040-0013	Richland Cr	SR 48	AA08370	11-Sep-01	2400	**1506**
				AA08563	18-Sep-01	2400	
				AA08740	25-Sep-01	2400	
				AA08942	02-Oct-01	1700	
				AA09119	09-Oct-01	330	
3	WWL040-0014	Richland Cr	CR 960 N	AA08371	11-Sep-01	1700	**554**
				AA08564	18-Sep-01	870	
				AA08741	25-Sep-01	690	
				AA08943	02-Oct-01	340	
				AA09121	09-Oct-01	150	
4	WWL040-0015	Richland Cr	CR 790 N	AA08372	11-Sep-01	1600	**339**
				AA08565	18-Sep-01	440	
				AA08742	25-Sep-01	410	
				AA08944	02-Oct-01	170	
				AA09123	09-Oct-01	91	
5	WWL040-0016	Little Richland Cr	CR 1310 E	AA08373	11-Sep-01	1600	**817**
				AA08566	18-Sep-01	210	
				AA08743	25-Sep-01	490	
				AA08945	02-Oct-01	920	
				AA09125	09-Oct-01	2400	

Site Number	L-Site	Stream Name	Description	Sample Number	Sample Date	*E. coli* (MPN/100 mL)	Geometric Mean
6	WWL040-0017	Richland Cr	CR 1250 E	AA08374	11-Sep-01	1700	**128**
				AA08567	18-Sep-01	210	
				AA08744	25-Sep-01	86	
				AA08946	02-Oct-01	54	
				AA09127	09-Oct-01	21	
7	WWL040-0018	Richland Cr	SR 43	AA08375	11-Sep-01	2400	**208**
				AA08568	18-Sep-01	340	
				AA08745	25-Sep-01	100	
				AA08947	02-Oct-01	65	
				AA09129	09-Oct-01	73	
8	WWL040-0019	Richland Cr	CR 1000 E	AA08376	11-Sep-01	2400	**374**
				AA08569	18-Sep-01	690	
				AA08746	25-Sep-01	310	
				AA08948	02-Oct-01	110	
				AA09131	09-Oct-01	130	
9	WWL040-0020	Richland Cr	CR 850 E	AA08377	11-Sep-01	2400	**130**
				AA08570	18-Sep-01	130	
				AA08747	25-Sep-01	110	
				AA08949	02-Oct-01	50	
				AA09133	09-Oct-01	22	
10	WWL040-0021	Richland Cr	CR 735 E	AA08378	11-Sep-01	1700	124
				AA08571	18-Sep-01	140	
				AA08748	25-Sep-01	84	
				AA08950	02-Oct-01	34	
				AA09134	09-Oct-01	44	

Site Number	L-Site	Stream Name	Description	Sample Number	Sample Date	*E. coli* (MPN/100 mL)	Geometric Mean
11	WWL040-0023	Camp Cr	CR 515 N	AA08392	11-Sep-01	2400	101
				AA08585	18-Sep-01	99	
				AA08762	25-Sep-01	45	
				AA08963	02-Oct-01	32	
				AA09150	09-Oct-01	31	
12	WWL040-0024	Richland Cr	CR 475 E	AA08391	11-Sep-01	1600	**324**
				AA08584	18-Sep-01	650	
				AA08761	25-Sep-01	110	
				AA08962	02-Oct-01	260	
				AA09149	09-Oct-01	120	
13	WWL040-0025	Beech Cr	CR 230 N	AA08390	11-Sep-01	2000	**209**
				AA08583	18-Sep-01	310	
				AA08760	25-Sep-01	180	
				AA08961	02-Oct-01	100	
				AA09148	09-Oct-01	36	
14	WWL040-0001	Richland Cr	CR 240 N	AA08389	11-Sep-01	2400	**129**
				AA08582	18-Sep-01	170	
				AA08759	25-Sep-01	99	
				AA08960	02-Oct-01	46	
				AA09147	09-Oct-01	19	
15	WWL040-0027	Richland Cr	CR 205 W	AA08388	11-Sep-01	1600	**296**
				AA08581	18-Sep-01	370	
				AA08757	25-Sep-01	190	
				AA08959	02-Oct-01	250	
				AA09146	09-Oct-01	81	

Site Number	L-Site	Stream Name	Description	Sample Number	Sample Date	*E. coli* (MPN/100 mL)	Geometric Mean
16	WWL040-0029	Wildcat Br	CR 175 E	AA08383	11-Sep-01	2400	**400**
				AA08575	18-Sep-01	240	
				AA08752	25-Sep-01	330	
				AA08954	02-Oct-01	70	
				AA09141	09-Oct-01	770	
17	WWL040-0028	Richland Cr	SR 54	AA08381	11-Sep-01	2400	**638**
				AA08573	18-Sep-01	820	
				AA08750	25-Sep-01	650	
				AA08952	02-Oct-01	460	
				AA09139	09-Oct-01	180	
18	WWL040-0030	Ritter Br	SR 54	AA08384	11-Sep-01	1700	**1174**
				AA08576	18-Sep-01	2000	
				AA08753	25-Sep-01	2400	
				AA08955	02-Oct-01	1300	
				AA09142	09-Oct-01	210	
19	WWL040-0031	Ore Br	CR 175 E	AA08387	11-Sep-01	2400	**608**
				AA08580	18-Sep-01	870	
				AA08756	25-Sep-01	490	
				AA08958	02-Oct-01	580	
				AA09145	09-Oct-01	140	
20	WWL040-0002	Richland Cr	Furnace Road	AA08386	11-Sep-01	2400	**342**
				AA08579	18-Sep-01	250	
				AA08755	25-Sep-01	240	
				AA08957	02-Oct-01	120	
				AA09144	09-Oct-01	270	
21	WWL040-0055	Richland Cr	CR 175 S	AA08385	11-Sep-01	2000	**362**
				AA08578	18-Sep-01	490	
				AA08754	25-Sep-01	250	
				AA08956	02-Oct-01	180	
				AA09143	09-Oct-01	140	

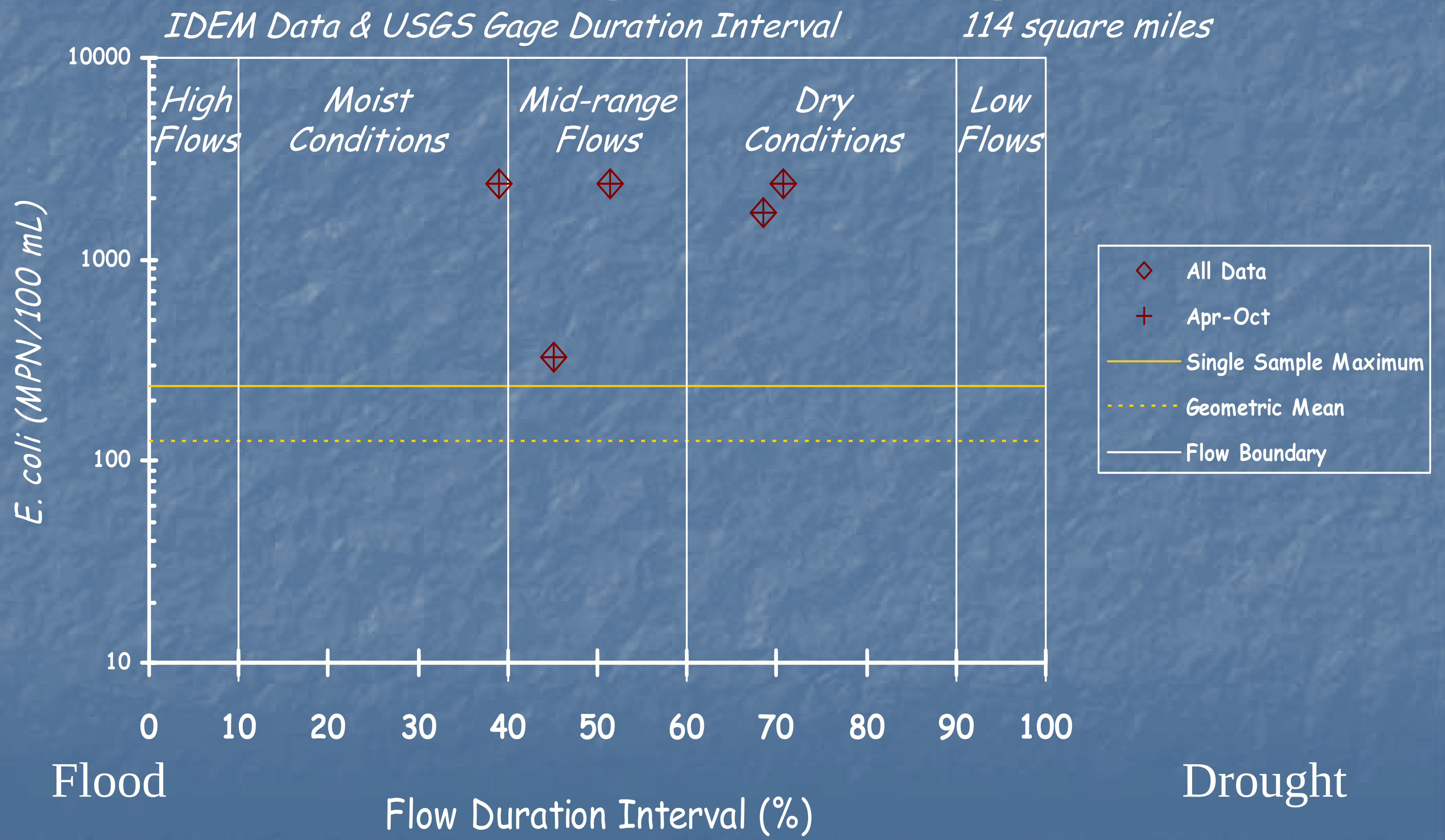
Attachment B

Water Quality Duration Curves for the Richland Creek Watershed TMDL

Richland Creek at SR 48

Water Quality Duration Curve *(2001 Monitoring Data)*

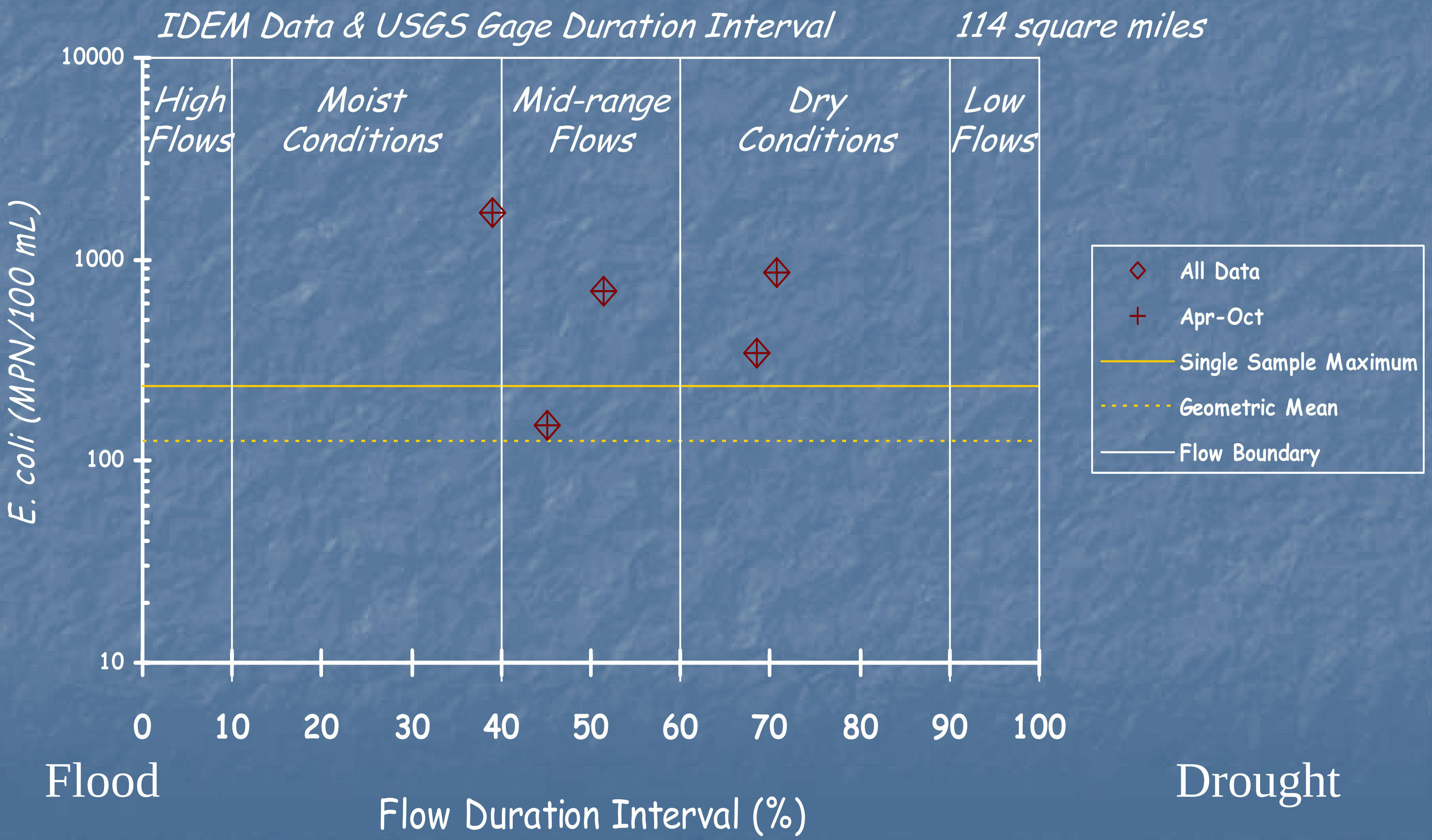
Site: 2 (WWL040-0013)



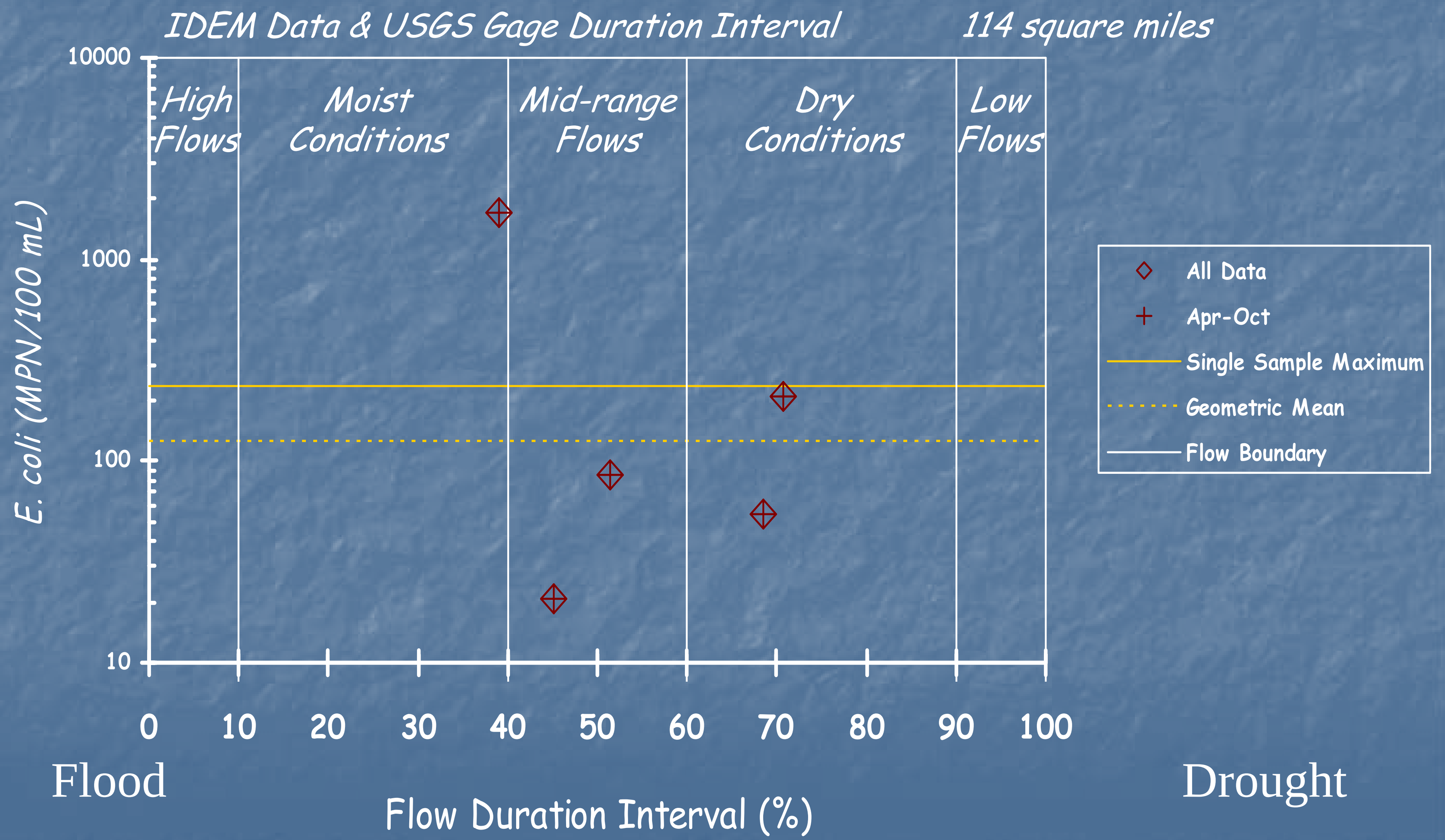
Richland Creek at CR 960 N

Water Quality Duration Curve *(2001 Monitoring Data)*

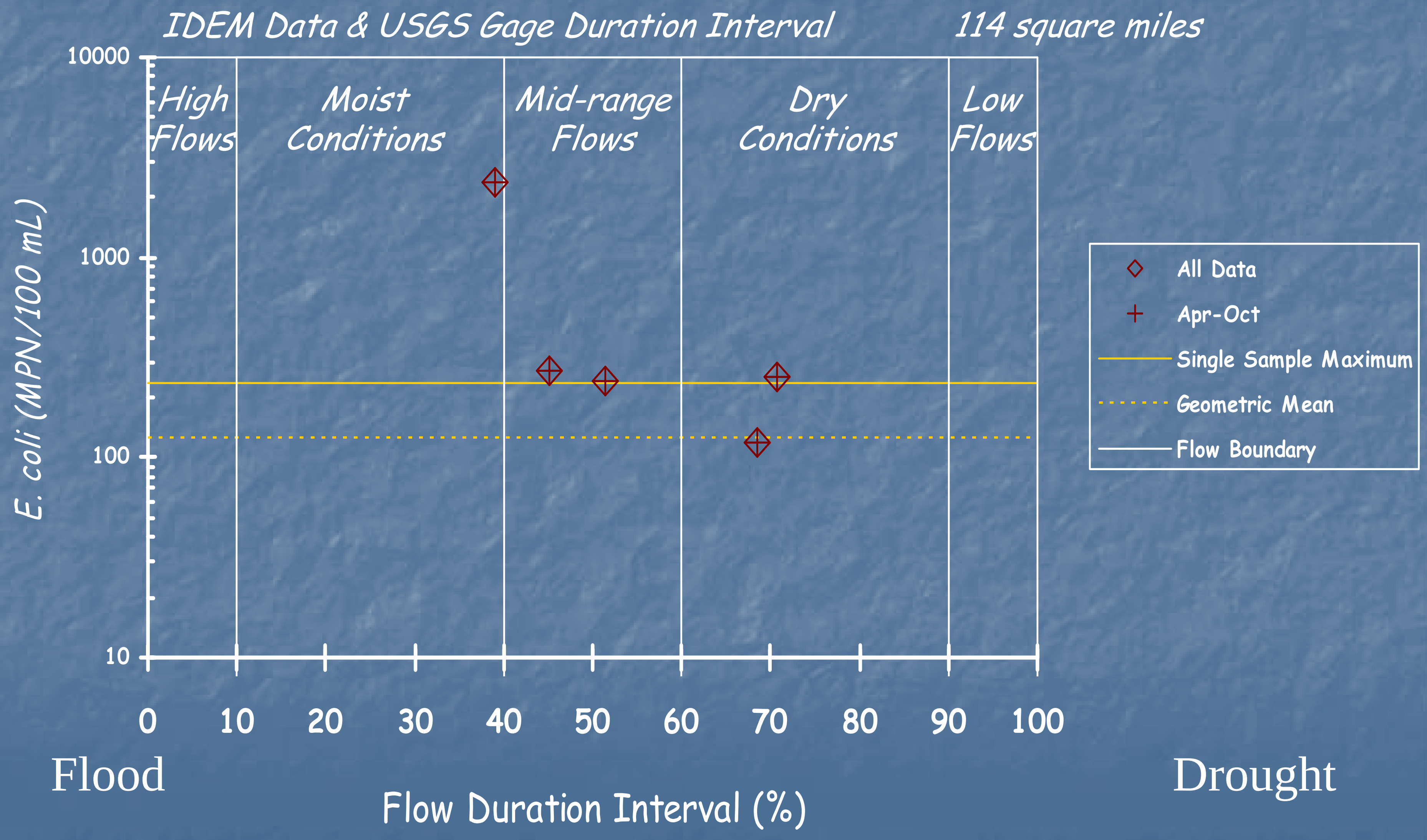
Site: 3 (WWL040-0014)



Richland Creek at CR 1250 E
Water Quality Duration Curve *(2001 Monitoring Data)*
Site: 6 (WWL040-0017)



Richland Creek at Furnace Road
Water Quality Duration Curve *(2001 Monitoring Data)*
Site: 20 (WWL040-0002)



Attachment C

Load Duration Curves for the Richland Creek Watershed TMDL

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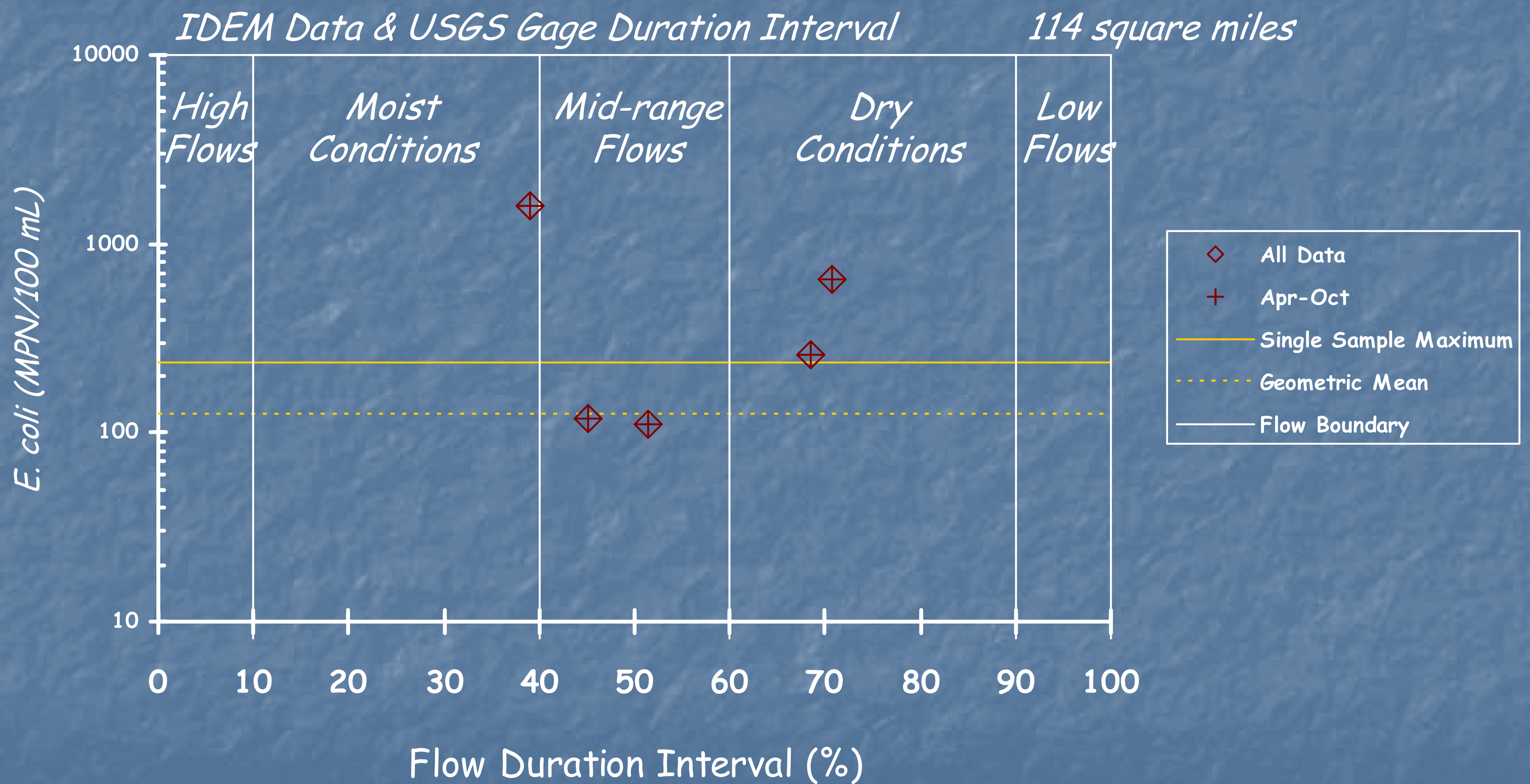
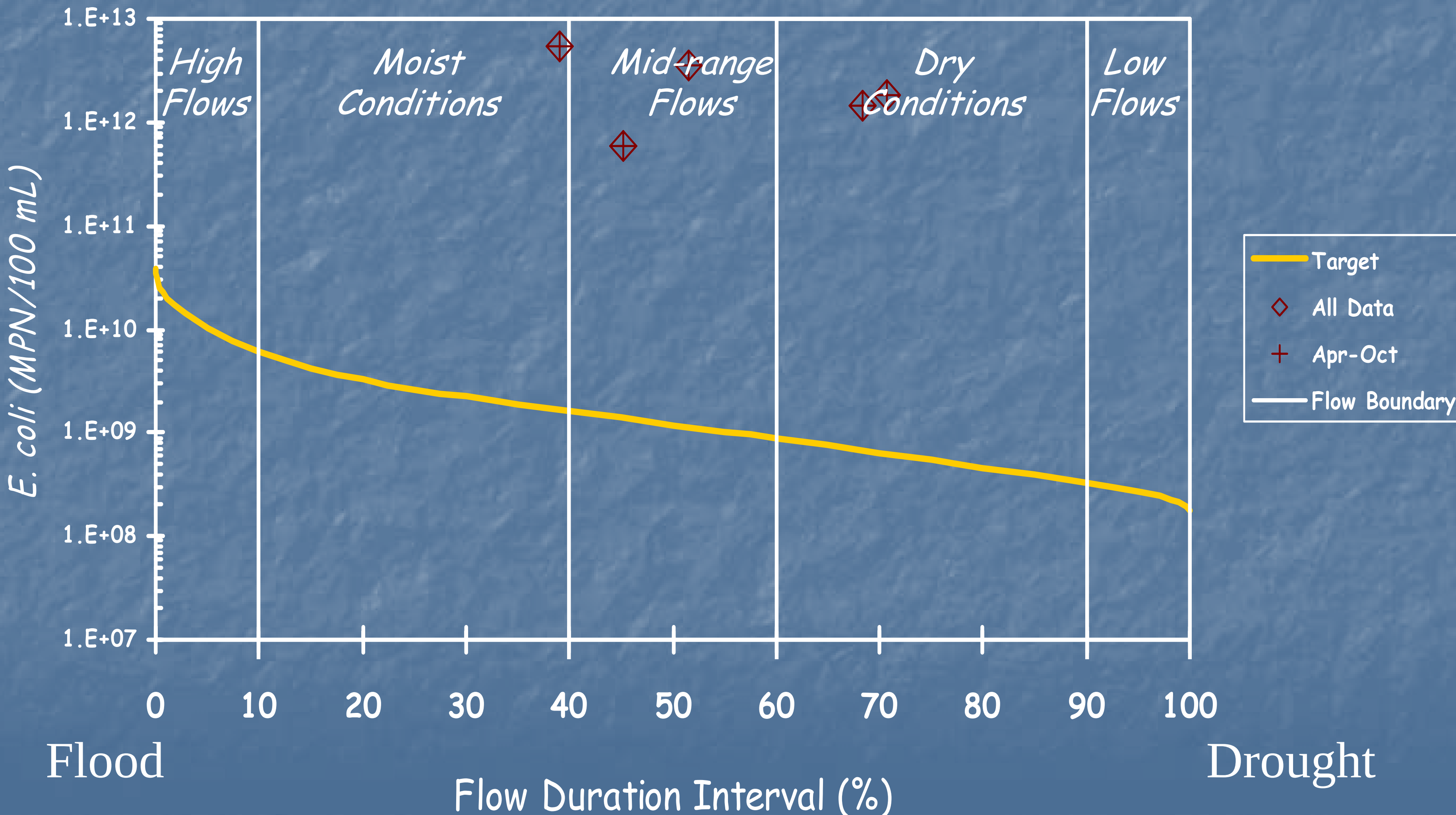
Richland Creek at CR 475 E
Duration Curve *(2001 Monitoring Data)*
Site: 12 (WWL040-0024)



Flood

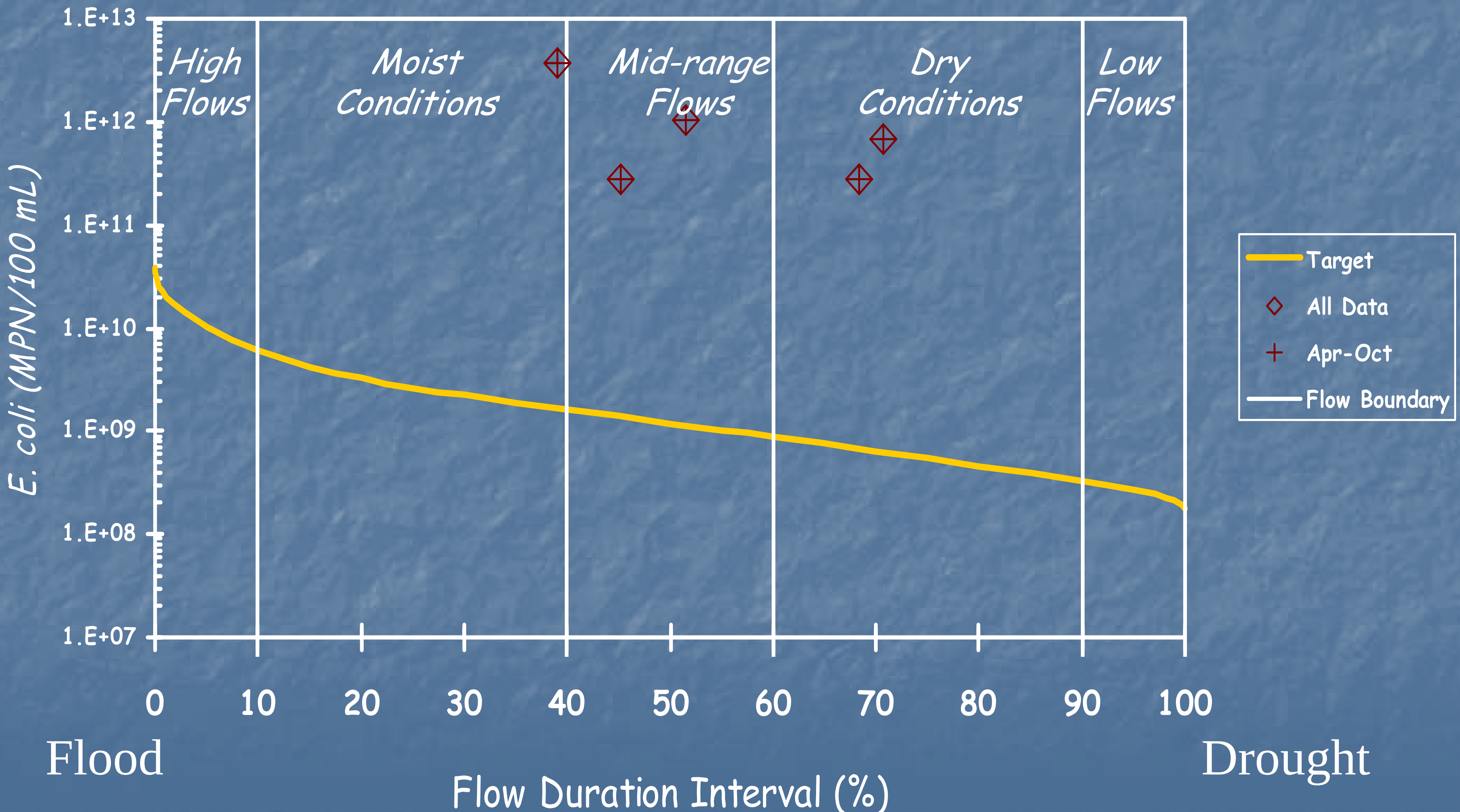
Drought

Richland Creek at SR 48
Load Duration Curve *(2001 Monitoring Data)*
Site: 2 (WWL040-0013)



IDEM Data & USGS Gage Duration Interval *114 square miles*

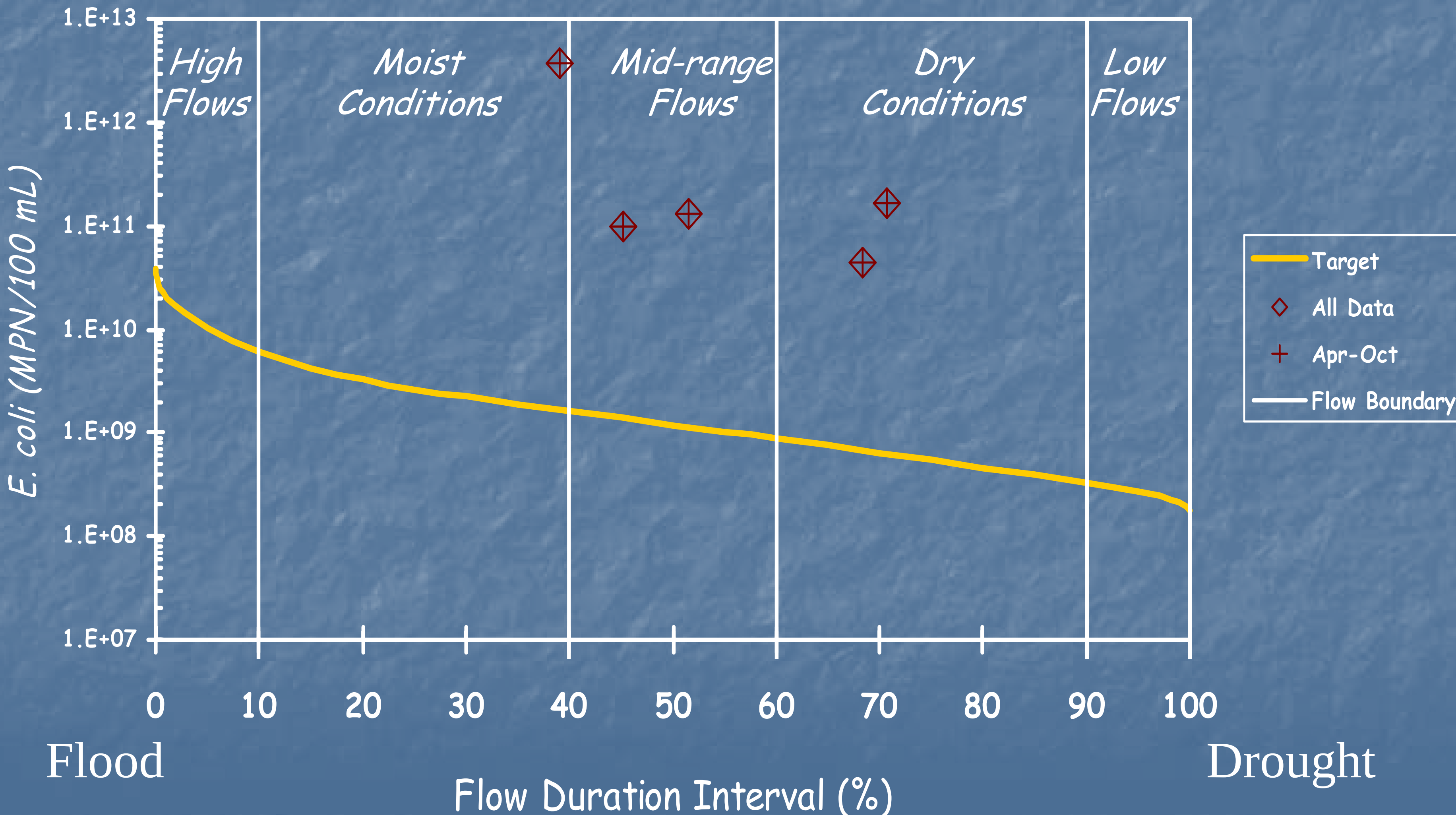
Richland Creek at CR 960 N
Load Duration Curve *(2001 Monitoring Data)*
Site: 3 (WWL040-0014)



IDEM Data & USGS Gage Duration Interval

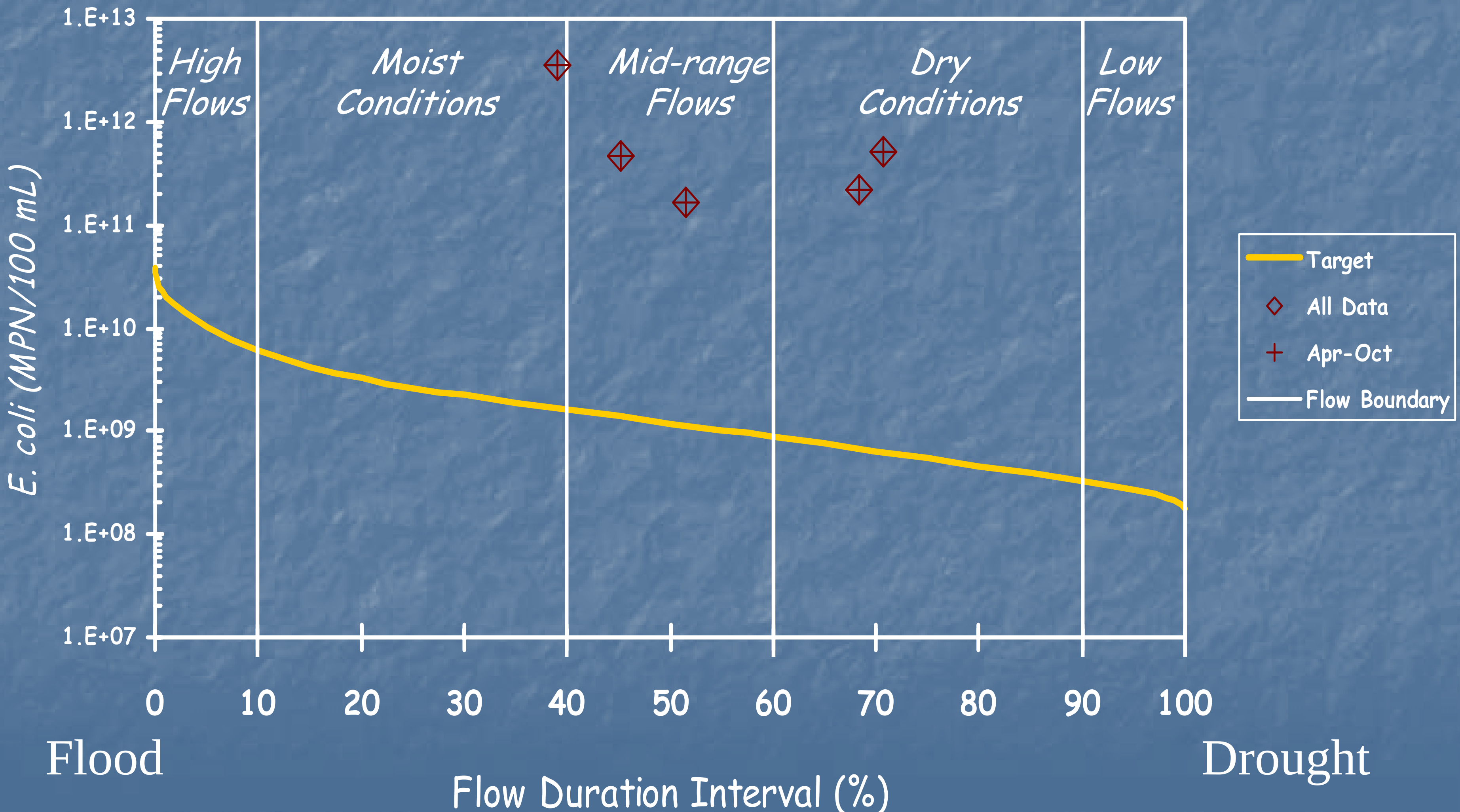
114 square miles

Richland Creek at CR 1250 E
Load Duration Curve *(2001 Monitoring Data)*
Site: 6 (WWL040-0017)



IDEM Data & USGS Gage Duration Interval *114 square miles*

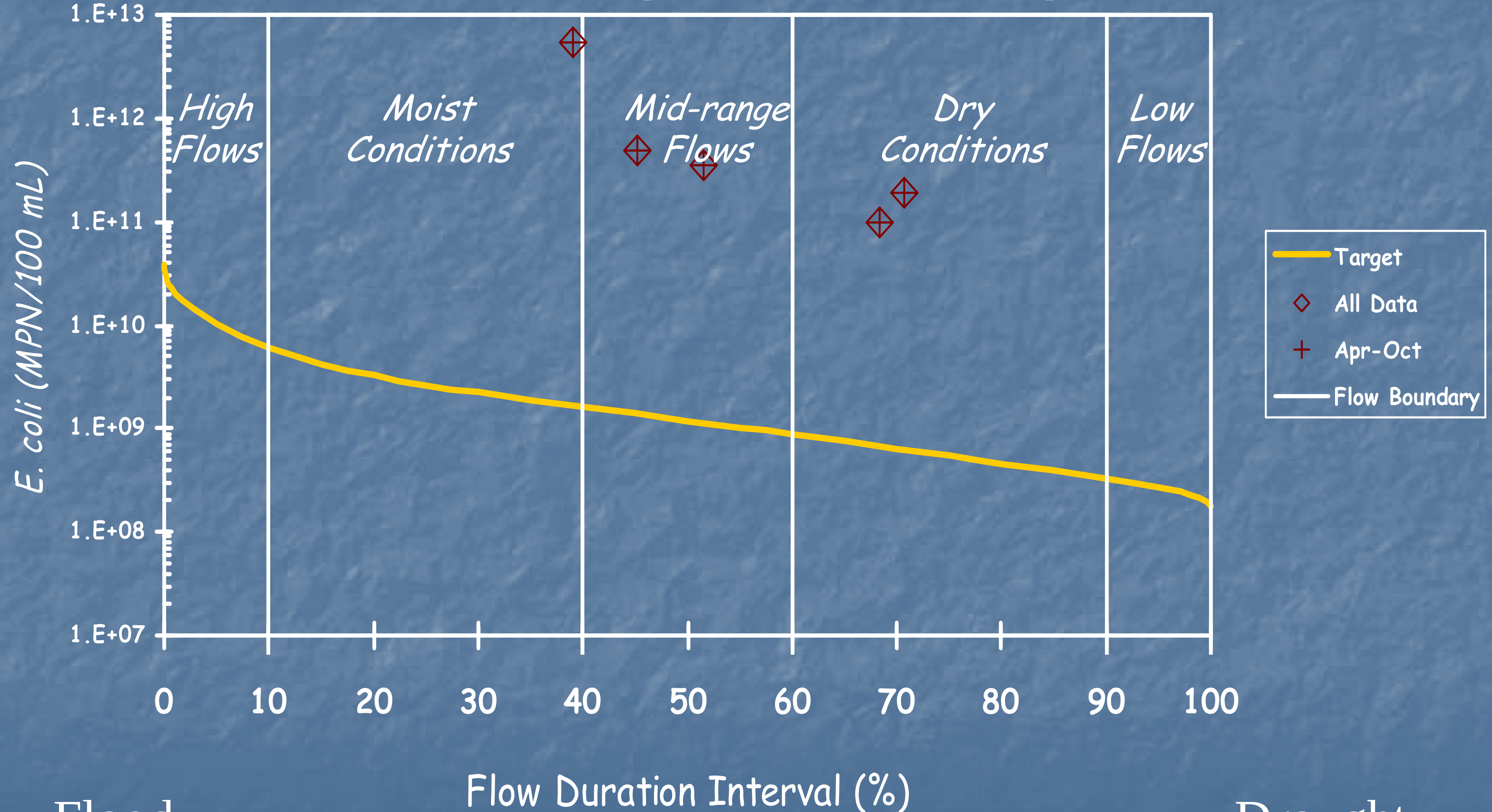
Richland Creek at CR 475 E
Load Duration Curve *(2001 Monitoring Data)*
Site: 12 (WWL040-0024)



IDEM Data & USGS Gage Duration Interval

114 square miles

Richland Creek at Furnace Road
Load Duration Curve *(2001 Monitoring Data)*
Site: 20 (WWL040-0002)



Flood

Drought

IDEM Data & USGS Gage Duration Interval

114 square miles

Attachment D

Load Reductions for the Richland Creek Watershed

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Site Number	L-Site Number	Site Geometric Mean	Overall Site Reductions	Stream Name
1	WWL040-0012	1196	90%	Richland Creek
2	WWL040-0013	1506	92%	Richland Creek
3	WWL040-0014	554	77%	Richland Creek
4	WWL040-0015	339	63%	Richland Creek
5	WWL040-0016	812	85%	Little Richland Creek
6	WWL040-0017	128	2%	Richland Creek
7	WWL040-0018	208	40%	Richland Creek
8	WWL040-0019	374	67%	Richland Creek
9	WWL040-0020	130	4%	Richland Creek
10	WWL040-0021	124	0%	Richland Creek
11	WWL040-0023	101	0%	Camp Creek
12	WWL040-0024	324	61%	Richland Creek
13	WWL040-0025	209	40%	Beech Creek
14	WWL040-0001	129	3%	Richland Creek
15	WWL040-0027	296	58%	Richland Creek
16	WWL040-0029	400	69%	Wildcat Branch
17	WWL040-0028	638	80%	Richland Creek
18	WWL040-0030	1174	89%	Ritter Branch
19	WWL040-0031	608	79%	Ore Branch
20	WWL040-0002	342	63%	Richland Creek
21	WWL040-0055	362	65%	Richland Creek