Kentucky Statewide Total Maximum Daily Load

for ***Bacteria*** *Impaired Waters*

Final

December 2018

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Kentucky
UNBRIDLED SPIRIT

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Kentucky Department for Environmental Protection
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Frankfort, Kentucky

This report is approved for release

Peter Goodmann, Director
Division of Water

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DOCUMENT REVISION HISTORY

Date of Revision	Section(s) Revised	Revision Explanation

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GLOSSARY OF ACRONYMS AND ABBREVIATIONS

AFO	Animal Feeding Operations
AWQA	Agriculture Water Quality Act
AWQP	Agriculture Water Quality Plan
BMP	Best Management Practice
CAFO	Concentrated Animal Feeding Operation
CFR	Code of Federal Regulations
Co.	County
CPP	Continuing Planning Process

CSO	Combined Sewer Overflow
CWA	Clean Water Act
DCA	Kentucky Division of Compliance Assistance
DMR	Discharge Monitoring Report
DOW	Kentucky Division of Water
EEC	Kentucky Energy and Environment Cabinet
EPA	United States Environmental Protection Agency
FILO	Fee in-lieu of
GIS	Geographic Information System
GM	Geometric Mean
GPP	Groundwater Protection Plan
HUC	Hydrologic Unit Code
KAR	Kentucky Administrative Regulations
KDEP	Kentucky Department for Environmental Protection
KDFWR	Kentucky Department of Fish and Wildlife Resources
KGS	Kentucky Geological Survey
KIA	Kentucky Infrastructure Authority
KNDOP	Kentucky No Discharge Operational Permit
KPDES	Kentucky Pollutant Discharge Elimination System
KRS	Kentucky Revised Statutes
KY EXCEL	Kentucky Excellence in Environmental Leadership
KYTC	Kentucky Transportation Cabinet
KWA	Kentucky Waterways Alliance
LA	Load Allocation
ml	Milliliter
MOS	Margin of Safety
MS4	Municipal Separate Storm Sewer System
NGO	Non-Governmental Organization
NRCS	Natural Resources Conservation Service
OSTDS	On-Site Sewage Treatment and Disposal System
PCR	Primary Contact Recreation
QAPP	Quality Assurance Project Plan
RM	River Mile
SOP	Standard Operating Procedure

SSO	Sanitary Sewer Overflow
STP	Sewage Treatment Plant
SWS	Sanitary Wastewater System
TMDL	Total Maximum Daily Load
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WP	Watershed Plan
WLA	Wasteload Allocation
WMB	Watershed Management Branch
WQC	Water Quality Criteria
WQM	Water Quality Management
WWTP	Wastewater Treatment Plant

A MESSAGE TO STAKEHOLDERS

This document has several aims. One is to provide insight into the scope of surface water quality impairments in Kentucky due to bacteria. Another is to create a framework for initiatives that can be undertaken locally to improve and restore water quality. A third is to fulfill Kentucky's obligation under the Clean Water Act to develop Total Maximum Daily Loads (TMDLs) for impaired waters listed in the biennial Integrated Water Quality Report to Congress. This document provides a method for developing TMDLs for any waterbody impaired by bacteria within Kentucky's jurisdiction.

The Problem: Bacteria-impaired waters occur throughout Kentucky

In its 2014 Integrated Water Quality Report to Congress, the Kentucky Division of Water (Division) identified 331 waterbodies that are impaired due to bacteria. Specifically, these waters have not met the state water quality standards for *E. coli* and/or fecal coliform. These types of bacteria indicate the likelihood that these waters contain pathogens, or disease-causing agents, associated with contamination from human or animal wastes. The *E. coli* and fecal coliform standards are intended to protect the health of those using waterbodies for swimming, wading, boating and other recreation. Waters that are impaired do not fully support these recreational uses. Bacteria-impaired waterbodies occur in every major river basin of Kentucky.

How are bacteria getting into the water?

Bacteria can come from a variety of sources. Some of the sources are regulated under the Kentucky Pollutant Discharge Elimination System (KPDES) and require a permit to discharge. These include sanitary wastewater systems, such as wastewater or sewage treatment plants, and municipal storm sewer systems. Other sources do not fall under KPDES permitting authority and typically are closely tied to land use. These are known as nonpoint sources and often contribute to runoff pollution following rainfall or snowmelt. Nonpoint sources include livestock in or near streams, poorly functioning septic systems, spray irrigation waste handling systems, and pet waste.

How will the bacteria problem be addressed?

For impaired waters to return to full support of recreational uses, actions are needed to curb the amount of bacteria passing into the waterbodies. If necessary and appropriate, KPDES permits can be adjusted to ensure they are consistent with the TMDL. But reducing the bacteria load from nonpoint sources will depend on voluntary actions by citizens, property owners, and other stakeholders who use the land resources within the watershed of an impaired water. Examples of measures for reducing bacteria include reducing livestock access to streams, planting buffers of vegetation to slow runoff and filter out pollutants, providing financial assistance for septic system owners to repair and maintain their systems, eliminating illegal "straight pipes" that discharge untreated sewage directly to streams, and educating citizens on the importance of picking up trash and pet waste.

The measures chosen need to be tailored to the actual sources contributing bacteria to an impaired water. The measures should be feasible to put in place and have a likelihood of success at reducing the amounts of bacteria that reach the water.

Who should address the problem?

Ultimately, everyone in Kentucky has a stake in the quality of the state's waters, so everyone can take part in efforts to improve water quality. The ways we use our land, maintain our property, operate our businesses and manage our waste all have an impact, positive or negative, on the waterways connected to the land. Citizens and other stakeholders concerned with water quality may form a watershed team to develop a watershed plan that identifies specific causes of water pollution and the most effective actions for reducing it. The Division offers technical assistance for watershed planning and manages a grant program that can provide financial help to watershed groups to organize, develop a watershed plan, and carry out activities of approved plans. Through every stage of watershed planning and management, the support and engagement of local citizens and community stakeholders are key to the success of any activity to improve water quality.

TMDL SYNOPSIS

S.1 Impaired Waterbodies

State: Kentucky
Major River Basin: See Appendices
USGS HUC8: See Appendices
Counties: See Appendices
Pollutants of Concern: *E. coli*, Fecal Coliform
Impaired Use: Primary Contact Recreation, Secondary Contact Recreation, or both
Suspected Sources: See Appendices

TMDLs for individual bacteria-impaired segments will be submitted in appendices to this document. The Kentucky Division of Water (Division) will provide public notice of these appendices, which will contain the waterbody-specific information for the impaired segments. The appendices will rely on the TMDL loadings and the general information in this document and thus will not be stand-alone documents.

S.2 TMDL Numeric Water Quality Criteria

Table S.2 Bacteria TMDL Water Quality Criteria for All Surface Waters

Designated Use	Numeric Criterion
PCR	240 *E. coli* colonies/100 ml which must be met in at least 80% of all samples taken within a 30-day period during the Primary Contact Recreational season of May through October
PCR	130 *E. coli* colonies/100 ml as a geometric mean based on not less than 5 samples taken within a 30-day period during the Primary Contact Recreational season of May through October
PCR	400 fecal coliform colonies/100ml which must be met in at least 80% of all samples taken within a 30-day period during the Primary Contact Recreational season of May through October
PCR	200 fecal coliform colonies/100 ml as a geometric mean based on not less than 5 samples taken within a 30-day period during the Primary Contact Recreational season of May through October
SCR	2000 fecal coliform colonies/100ml which must be met in at least 80% of all samples taken within a 30-day period
SCR	1000 fecal coliform colonies/100 ml as a geometric mean based on not less than 5 samples taken within a 30-day period

S.3 TMDL Equation and Allocations

According to EPA (1991), a TMDL calculation is performed as follows:

$$TMDL = \sum WLA + \sum LA + MOS$$
(Equation 1)

Where:
TMDL: The WQC, expressed as a load. The WQC for bacteria are specified in Table S.2.

∑WLA: The sum of all Wasteload Allocations, which is the allowable loading of bacteria into the stream from all contributing KPDES-permitted sources.

∑LA: The sum of all Load Allocations, which is the allowable loading of bacteria into the stream from all sources not permitted by KPDES and from natural background.

MOS: The Margin of Safety, which is implicit since conservative assumptions are applied to account for uncertainties in the relationship between effluent limits and water quality.

Equation 1 can be re-written to group WLAs and LAs:

$$TMDL = (\sum WLA + \sum LA)_{Segment} + (\sum WLA + \sum LA)_{Upstream} + (\sum WLA + \sum LA)_{Tributary} + MOS$$
(Equation 2)

Where:
$(\sum WLA + \sum LA)_{Segment}$: Allowable loads for all WLA and LA sources that contribute bacteria directly to an impaired segment.

$(\sum WLA + \sum LA)_{Upstream}$: A lumped allowable load for all WLA and LA sources that contribute bacteria upstream of an impaired segment.

$(\sum WLA + \sum LA)_{Tributary}$: A lumped allowable load for all WLA and LA sources that contribute bacteria to all tributaries that flow into an impaired segment.

This translates as:
The total maximum daily load is equal to the allowable bacteria loadings discharged directly to an impaired segment plus the allowable upstream load(s) plus the allowable tributary load(s) plus the margin of safety or as:

$$TMDL = (\sum WLA + \sum LA)_{Segment} + \sum \text{Upstream Load(s)} + \sum \text{Tributary Load(s)} + MOS$$
(Equation 3)

An allowable load can be calculated as:

$$\text{Allowable Load} = Q \times WQC \times CF$$
(Equation 4)

Where:

Q: The flow that is contributed by a source or the stream flow itself, in cfs

WQC: The applicable criterion for a bacteria indicator, see Table S.2.

CF: The value that converts the product of concentration and flow to load (in units of colonies per day); it is derived from the calculation of the following components: (28.31685L/ft^3 * 86,400 seconds/day * 1000ml/L)/(100ml) and is equal to 24,465,758.4 seconds*ml/ft^3*day.

The WLA has three potential components:

$$WLA = \sum SWS\text{-}WLA + \sum MS4\text{-}WLA + \sum CSO\text{-}WLA$$
(Equation 5)

Where:

SWS-WLA: The WLA for a KPDES-permitted sanitary wastewater system that has discharge limits for bacteria (including wastewater treatment plants, sewage treatment plants, package plants and home units).

MS4-WLA: The WLA for a KPDES-permitted Municipal Separate Storm Sewer System (MS4), which can include cities, counties, universities and military bases, as well as the roads and right-of-ways owned by the Kentucky Transportation Cabinet (KYTC) within other types of MS4s.

CSO-WLA: The WLA for a KPDES-permitted Combined Sewer Overflow.

Equation 5 can be substituted into the Equation 3 to obtain:

$$TMDL = (\sum SWS\text{-}WLA + \sum MS4\text{-}WLA + \sum CSO\text{-}WLA + \sum LA)_{Segment} + \sum Upstream\ Load(s) + \sum Tributary\ Load(s) + MOS$$
(Equation 6)

There are two methods for incorporating a MOS in the TMDL analysis: implicitly include the MOS using conservative assumptions, or explicitly designate a numerical portion of the TMDL as the MOS. For this TMDL, an implicit MOS is applied (See Footnote 9 for Table S.3).

Equation 4 can be substituted into each load component of Equation 6 to obtain a table of allocations for all potential bacteria sources to an impaired segment (Table S.3). Note that "WQC" incorporates the full definition of each applicable criterion as specified in 401 KAR 10:031 Section 7 (see Section 2.0 of this document). The criteria for geometric means specify a concentration benchmark, an averaging period, a minimum number of samples, and season when applied. The criteria for single sample maxima specify a concentration benchmark, a percent exceedance, a sample collection period, and season when applied. Loads based on the WQC accordingly incorporate all of the elements included in the WQC. Note also if a source does not contribute to an impaired segment, that component drops out of the allocation table (i.e. if there is no MS4, the MS4-WLA component is removed from the table, etc.).

Table S.3 Segment TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment				Allocations for Upstream Loads to the Segment[7]	Allocations for Tributary Loads to the Segment[8]	MOS[9]
	SWS-WLA[3]	MS4-WLA[4]	CSO-WLA[5]	LA[6]			
$Q_S \times WQC \times CF$	$\sum(Q_{SWS} \times WQC \times CF)$	$\sum(Q_{MS4} \times WQC \times CF)$	$\sum(Q_{CSO} \times WQC \times CF)$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{SWS} is the flow (ft^3/s) in the segment due to a SWS entity. New or expanded SWS sources will be allowed to discharge to the segment contingent upon them meeting the PCR bacterial WQCs found in 401 KAR 10:031. SWS-WLAs will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average or as a fecal coliform effluent gross limit of 200 colonies/100 ml as a monthly average and 400 colonies/100 ml as a maximum weekly average.

[4]Q_{MS4} is the flow (ft^3/s) in the segment due to an MS4 entity. The MS4-WLA is not an end-of-pipe limit. The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP). An MS4 permittee is compliant with its MS4-WLA if it is compliant with its permit.

[5]Q_{CSO} is the flow (ft^3/s) in the segment due to a CSO entity. Dry weather CSO flows are prohibited. During wet weather events, a CSO entity is compliant with its CSO-WLA if it is compliant with its Long Term Control Plan and KPDES permit.

[6]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[7]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[8]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[9]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)Although all sources are provided an allocation at the Water Quality Standard, not all sources discharge at this maximum allocation at the same time.

(c)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

(d)For SCR-impaired segments, SWS sources must meet the PCR criterion year-round.

Figure S.3-1 illustrates how the watershed of a hypothetical impaired segment would be divided into areas of direct, upstream, and tributary loading. Allocations in each of these areas would be assigned based on the formulas in Table S.3.

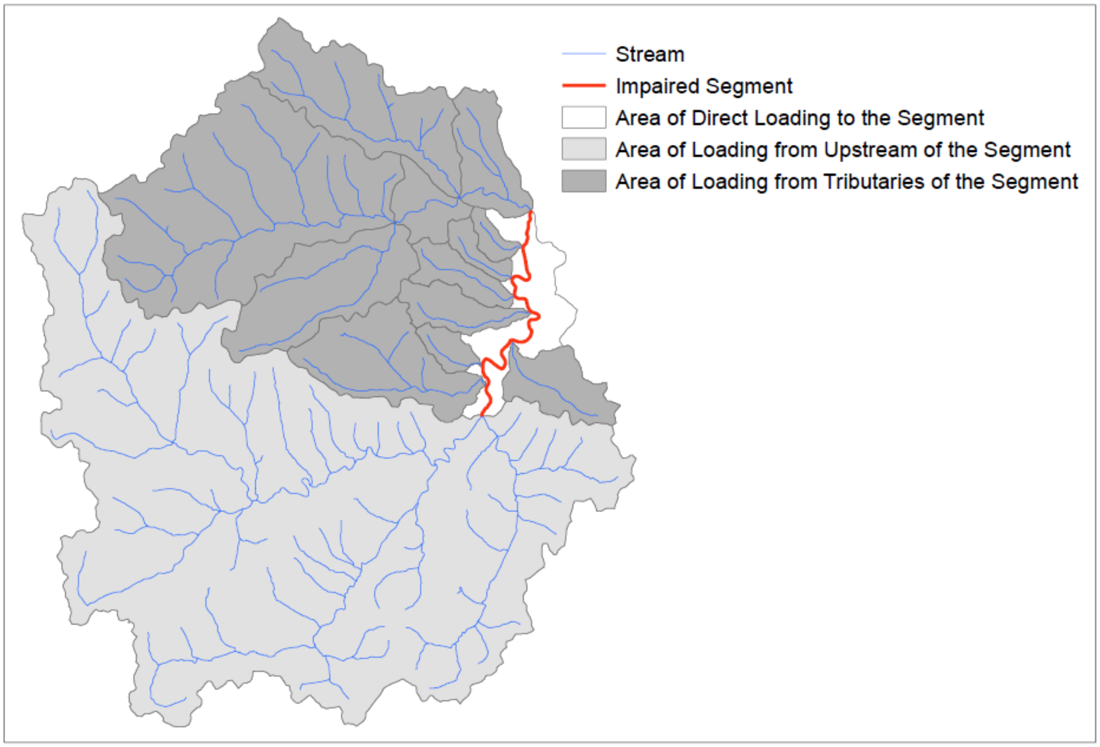

Figure S.3-1 Areas of Direct, Upstream, and Tributary Loading

S.4 Translation of WLAs into Permit Limits

WLAs for Sanitary Wastewater Systems (SWSs) are given in Table S.3. SWS-WLAs will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100ml as a monthly average and 240 colonies/100ml as a maximum weekly average or as a fecal coliform effluent gross limit of 200 colonies/100ml as a monthly average and 400 colonies/100ml as a maximum weekly average.

WLAs for MS4 areas are also given in Table S.3. The following assumptions are provided to facilitate implementation of the MS4-WLA in the permit: The MS4-WLA is not an end-of-pipe limit. The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. MS4-WLAs will be addressed through the storm water permit and implemented through the Storm Water Quality Management Plan. An MS4 permittee is compliant with its MS4-WLA if it is compliant with its KPDES permit.

WLAs for CSOs are also given in Table S.3. The following assumptions are provided to facilitate implementation of the CSO-WLA: Dry weather CSO flows are prohibited. During wet weather events, a CSO entity is compliant with its CSO-WLA if it is compliant with its Long-Term Control Plan and KPDES permit.

All future growth sources must meet the Division's permitting requirements.

1.0 INTRODUCTION

The Clean Water Act requires states to designate uses for surface waters within their jurisdiction. The designated uses assigned to waterbodies in Kentucky can be found in Kentucky Administrative Regulations (KAR) at 401 KAR 10:026 and include primary contact recreation (PCR) and secondary contact recreation (SCR). PCR or SCR waters are defined, respectively, as “waters suitable for full body contact recreation during the recreation season of May 1 through October 31” or “waters suitable for partial body recreation, with minimal threat to public health due to water quality” (401 KAR 10:001). Further, 401 KAR 10:031 establishes water quality standards that are “minimum requirements that apply to all surface waters in the Commonwealth of Kentucky in order to maintain and protect them for designated uses.” The pathogen-related water quality criteria (WQC) in 401 KAR 10:031 are based upon those recommended by the U.S. Environmental Protection Agency (EPA) (U.S. EPA, 1986 and 2012).

The term “pathogen” refers to bacteria, viruses, or other biological agents (such as protozoa) that can cause disease. Because it is currently resource-intensive, difficult, and a potential health hazard to detect most pathogens in water, other organisms are used to indicate whether the presence of pathogens is likely. Consistent with EPA’s recommended criteria, Kentucky uses *Escherichia coli* (*E. coli*) and fecal coliform bacteria as indicator organisms of pathogens. *E. coli* and fecal coliform are found in the fecal waste of humans and warm-blooded animals (birds and mammals). The presence of these bacteria in a waterbody indicates that contamination from human or animal waste has likely occurred and that pathogens may be present.

Section 303(d) of the Clean Water Act (CWA) requires states to identify waterbodies within their boundaries that have been assessed, are not currently meeting their designated uses (401 KAR 10:026 and 10:031), and require the development of a Total Maximum Daily Load (TMDL). States must establish a priority ranking for such waters, taking into account their intended uses and the severity of the pollutant. The resulting list of impaired waters is submitted to the EPA during even-numbered years, and each submittal replaces the previous list. Listings of bacteria-impaired segments can be found in the Division of Water’s most recent *Integrated Report to Congress on the Condition of Water Resources in Kentucky Volume II. 303(d) List of Surface Waters*, which can be obtained at: https://eec.ky.gov/Environmental-Protection/Water/Monitor/Pages/IntegratedReportDownload.aspx.

States are required to develop TMDLs for the pollutants that cause each waterbody to fail to meet its designated uses. The TMDL establishes the allowable amount (i.e., load) of the pollutant the waterbody can naturally assimilate while continuing to meet the water quality standards for each designated use. The pollutant load must be established at a level necessary to achieve the applicable WQCs with seasonal variations and a margin of safety that takes into account any lack of knowledge about the relationship between effluent limitations and water quality. This load is then divided among different sources of the pollutant in a watershed. Information from EPA on TMDLs can be found at: http://www.epa.gov/tmdl.

TMDLs for individual bacteria-impaired segments will be submitted in appendices to this document, with an appendix corresponding to each major river basin. The Division will provide public notice of these appendices, which will contain the waterbody-specific information for the impaired segments. The appendices will rely on the TMDL loadings and the general information in this document and thus will not be stand-alone documents.

2.0 WATER QUALITY CRITERIA

A TMDL provides pollutant allocations for a waterbody to meet its designated uses. As of 2018, the Division used fecal coliform and *E. coli* as indicators of the likelihood of pathogen impairment.

The Primary Contact Recreation WQC are in effect from May 1 through October 31. For this designated use, 401 KAR 10:031 Section 7(1)(a) states that:

Fecal coliform content or Escherichia coli content shall not exceed 200 colonies per 100 ml or 130 colonies per 100 ml respectively as a geometric mean based on not less than five (5) samples taken during a thirty (30) day period. Content also shall not exceed 400 colonies per 100 ml in twenty (20) percent or more of all samples taken during a thirty (30) day period for fecal coliform or 240 colonies per 100 ml for Escherichia coli. These limits shall be applicable during the recreation season of May 1 through October 31.

The Secondary Contact Recreation WQCs are in effect for the entire year. 401 KAR 10:031 Section 7(2)(a) states:

Fecal coliform content shall not exceed 1000 colonies per 100 ml as a monthly geometric mean based on not less than five (5) samples per month; nor exceed 2000 colonies per 100 ml in twenty (20) percent or more of all samples taken during the month.

Because there are multiple WQCs for bacteria, all of which must be met for a waterbody to meet the standards of 401 KAR 10:031, there are also multiple TMDLs that must be developed, which are evaluated based on the type, timing and amount of data collected, as described above.

Bacteria levels in a stream can vary in response to weather, how continuous or intermittent discharges influence stream conditions, and other factors. The recreational criteria reflect this variability by incorporating 30-day evaluation periods. When assessing a waterbody's support of its designated uses, the Division does not make the determination based on a single sample. As stated, for example, a geometric mean requires a minimum of five samples. Likewise, when comparing stream data to the concentration benchmarks for individual samples (i.e., 240 colonies/100 ml of *E. coli*, 400 colonies/100 ml or 2,000 colonies/100 ml of fecal coliform), the Division uses results from multiple samples representing a variety of flow conditions over the recreation season to determine if a stream supports recreational use(s).

3.0 PHYSICAL SETTING

Elements of a waterbody's physical setting, including soil characteristics, underlying geology, and hydrology, can influence topography, land use, and bacteria transport and survival. These aspects of Kentucky's physical setting are described in greater detail in this section.

3.1 Hydrology

The Commonwealth of Kentucky has more than 90,000 miles of streams and springs at a scale of 1:24,000 (KDOW, 2014). The Tug Fork, Big Sandy, Ohio and Mississippi rivers form the state's northern and western border of more than 800 miles. The major river basins that capture the drainage of Kentucky are shown in Figure 3.1-1 (Commonwealth of Kentucky, 2017). With the exception of far western Kentucky, all drainage makes its way to the Ohio River before it discharges to the Mississippi River.

The Division follows the Strahler (1952) method for stream order determination, where small upstream segments with no tributaries are first order. When two first order streams merge, they form a second order stream segment; two second order segments merge to form a third order segment; and so on. In this method, a first order segment merging with a second order segment results in a continuation of the second order segment; order only increases when segments with the same order merge, or if a tributary to a main segment has a larger order. First order streams tend to be small and carry little flow except during wet weather events, while larger stream orders indicate larger systems with greater flow. At the 1:100,000 scale of the National Hydrography Dataset, eight interior rivers discharge to a border river as sixth order or higher: Levisa Fork, Licking, Kentucky, Salt, Green, Tradewater, Cumberland, and Tennessee.

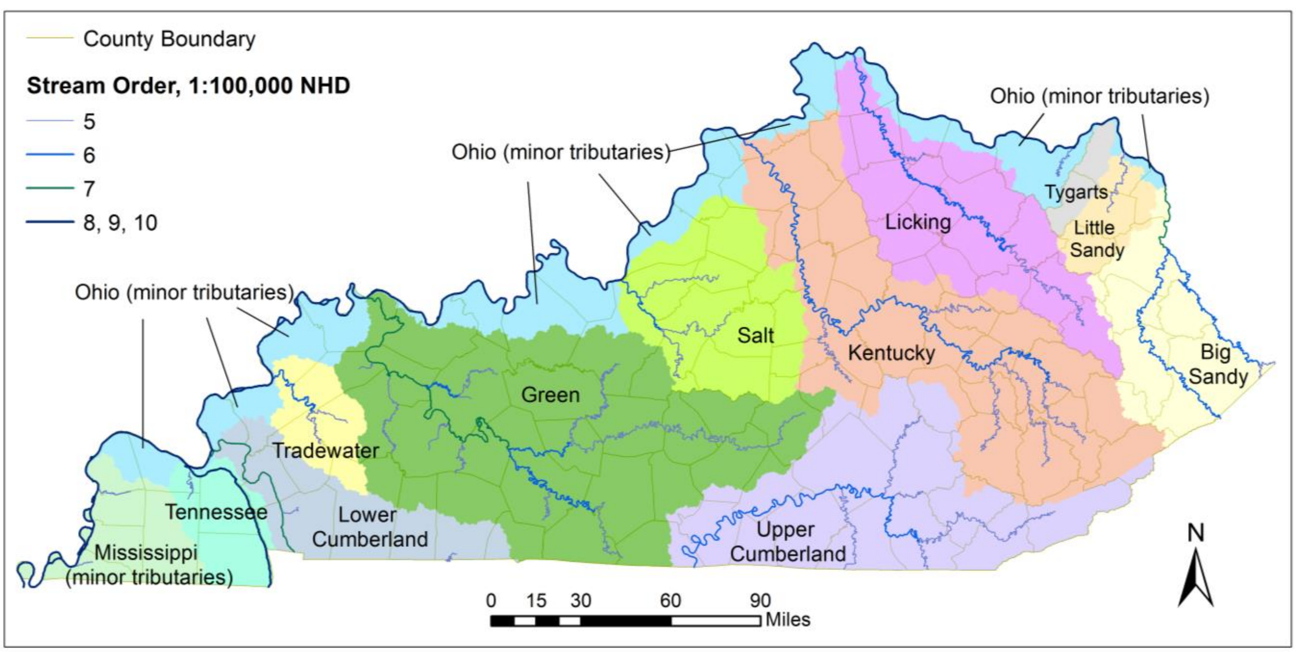

Figure 3.1-1 Major River Basins of Kentucky

A watershed is an area of land draining to a common waterbody. The surrounding ridgelines and high points define the boundary that divides one watershed from another. All of the water that flows off the land or soaks into the ground within that boundary will make its way to the same stream. Each major river basin consists of many tributary rivers and streams that drain sub-watershed areas.

Hydrologic unit codes (HUCs) were developed by the U.S. Geological Survey to assign unique identification numbers to individual watersheds. The longer the identification number, the smaller the watershed. While a 6-digit HUC typically represents a major river basin, a 12-digit HUC represents the watershed of a much smaller stream. For example, the 6-digit HUC for the entire Kentucky River basin is 051002. Within that basin, the watersheds of the North, Middle and South forks of the Kentucky River are assigned 8-digit HUCs of 05100201, 05100202, and 05100203, respectively. Within the Middle Fork of the Kentucky River watershed, tributary Beech Fork is given the 12-digit HUC of 051002020204. The 12-digit HUCs for areas surrounding and immediately upstream of each impaired segment of this TMDL are identified in the appendices to this report.

3.2 Karst

The state's topography includes significant areas of karst development and karst potential, shown in Figure 3.2-1. In Kentucky, karst features such as sinkholes, caves, and sinking springs result from weathering of limestone (and occasionally dolostone) bedrock. The areas where these rocks are located near the surface closely approximate where karst topography will form (KGS, 2016d). This bedrock contains many interconnected bedding planes and vertical joints, and the calcium (or magnesium) carbonate within it is highly soluble in carbonic acid. Rain water and groundwater contain carbonic acid as a result of interaction with carbon dioxide in the atmosphere or soil pore space. As this acidic water infiltrates bedrock and pools temporarily along joints and bedding planes, it can dissolve the carbonates, gradually enlarging the rock fractures into cavities and passages (May, et al., 2005).

About 55 percent of Kentucky overlies rock that could develop karst, given enough time. About 38 percent of the state has at least some karst development discernible on topographic maps; 25 percent of the state has well-developed karst features (KGS, 2016d). Figure 3.2-1 shows areas of Kentucky where the underlying geology is favorable for the development of karst features (Commonwealth of Kentucky, 2017).

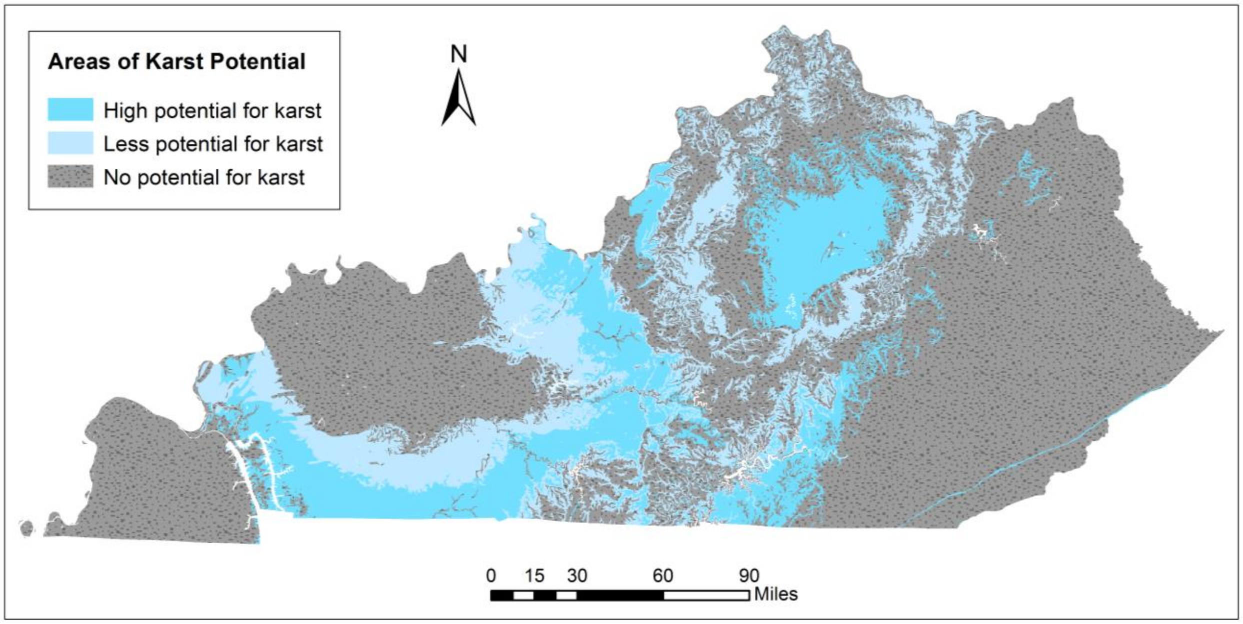

Figure 3.2-1 Simplified Karst Geology of Kentucky

Watershed boundaries based on topography may not be accurate in well-developed karst regions. Although groundwater drainage generally follows topographic basin boundaries, this is not always true. Karst conduits can carry drainage beneath one surface watershed and into another. For example, surface runoff may enter a sinkhole in one watershed and re-emerge with a spring in a different watershed. This transfer increases or decreases the actual boundaries of an affected stream basin (see Figure 3.2-2). The Division and the Kentucky Geological Survey (KGS) maintain a Karst Atlas of groundwater tracing data and delineated basins (both as static PDF maps and ArcGIS shape files) that can be downloaded at http://kygeonet.ky.gov.

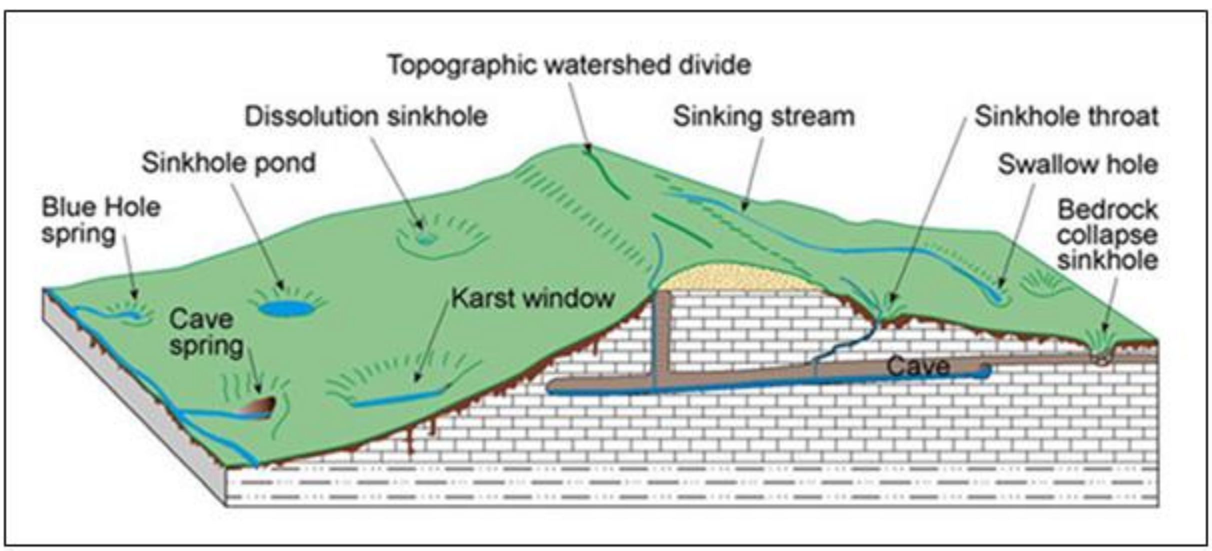

Figure 3.2-2 Conceptual Model of Typical Karst Terrain in Kentucky
Accessed at: https://www.uky.edu/KGS/karst/

Karst pathways can serve as underground tributaries to surface water, and thus a transport pathway for pollutants to streams. Improper waste management activities (e.g., dumping into sinkholes, poorly installed or failing septic systems) or inadequate best management practices (e.g., lack of buffer strips around sinkholes in agricultural fields) can lead to direct contamination of water supplies. Karst also provides a challenge for nonpoint source pollution management, as its pathways have long been regarded as “nature’s sewer system” – sinkhole plains, sinking streams, and springs provide a direct connection between surface water and groundwater systems.

3.3 Geology, Physiography and Soils

Rock outcrops in Kentucky reveal deposits from the Paleozoic Era, with ages ranging from upper Ordovician (oldest) to Pennsylvanian (youngest). Kentucky’s bedrock generally consists of regions of erosion-resistant sandstones, siltstones, conglomerate, and coal, or softer carbonate rocks. The bedrock material, in turn, has influenced the appearance of the surface landforms. In general, Kentucky’s surface setting is a series of dissected plateaus and gently rolling plains separated by escarpments. The plateaus, cut by streams into steep hills, occur over the sandstone, siltstone, conglomerate, and coal. The plains occur on carbonate rocks, mainly limestone and some areas of dolostones. Escarpments– areas of sudden elevation change due to differences in erosion rates of the underlying rock– mark the transition from one type of rock to another (Newell, 2001). More recently deposited alluvium (unconsolidated material carried by streams, glacial melt, or wind) typically occurs along floodplains throughout the state (KGS, 2016h). Figure 3.3-1 shows the locations and geologic ages of the uppermost strata in Kentucky (Commonwealth of Kentucky, 2017).

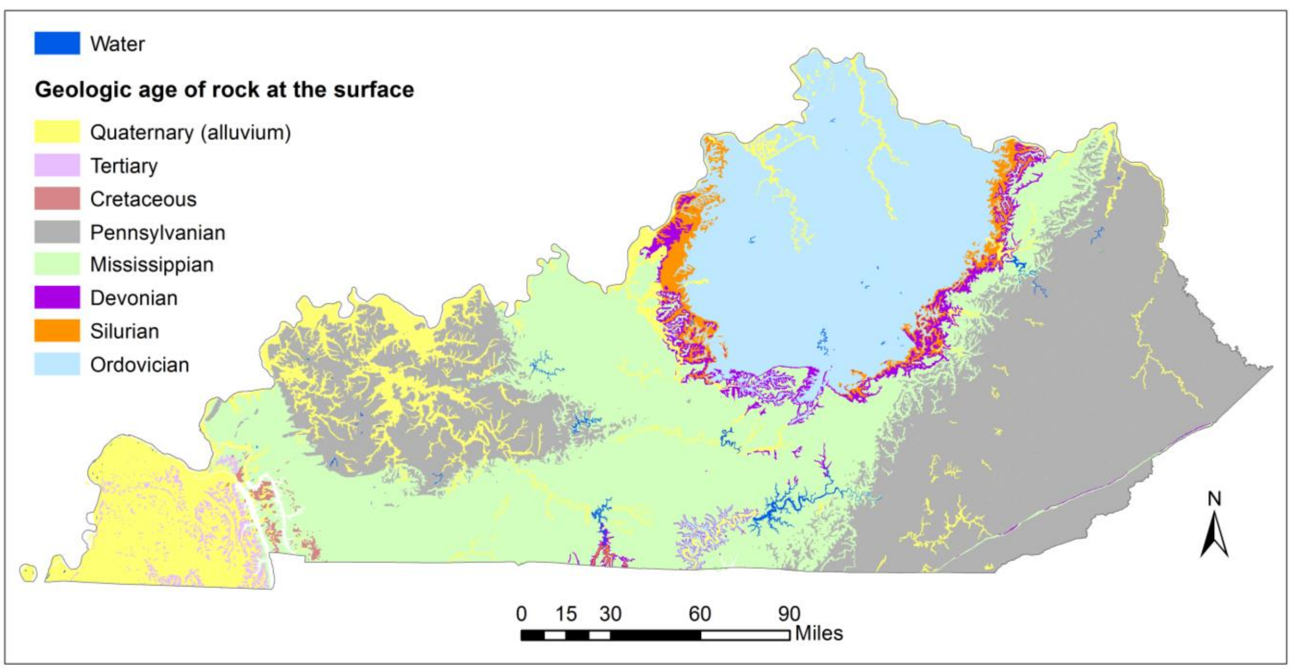

Figure 3.3-1 Simplified Geologic Map of Kentucky

The variations in geology and topography divide the state into several distinct physiographic regions, shown in Figure 3.3-2 (Commonwealth of Kentucky, 2017).

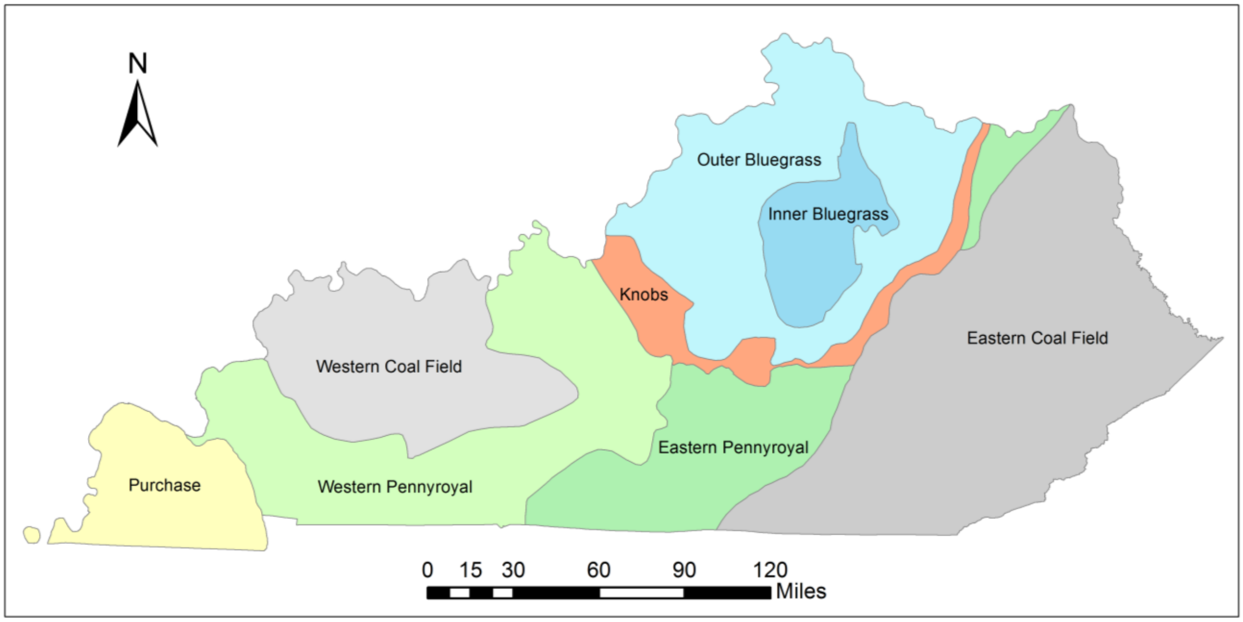

Figure 3.3-2 Physiographic Regions of Kentucky

3.3.1 Eastern Kentucky Coal Field Region

The Eastern Kentucky Coal Field region, part of the Cumberland Plateau extending from Pennsylvania to Alabama, comprises the eastern third of the state. Three of the state's major rivers– the Licking, Kentucky, and Cumberland– originate here. High elevation and high relief characterize this heavily forested region. Pennsylvanian-age sandstone, siltstone, shale, conglomerate, and coal lie beneath the surface. The many streams of the region's interior have carved narrow, winding valleys with steep walls that end in narrow ridges. Because of the scarcity of level land, residential development in the Eastern Coal Field tends to occur on floodplains and low terraces (Woods, 2002). Western areas of quick-eroding shale have wider valleys and less rugged slopes (Carey and Hounshell, 2008).

In the far southeast of the region, Pine Mountain is a 125-mile-long stretch of Devonian, Mississippian, and Pennsylvanian strata pushed upward by a thrust fault (KGS, 2016a). Southeast of Pine Mountain, along the state's border, are the Log Mountains, Black Mountain, and Cumberland Mountain. These mountains' peaks, exceeding 4,000 feet above sea level, represent the highest elevations in the state.

Common upland soil series include Shelocta, Gilpin, and Latham (Woods, 2002). These soils are moderately deep to very deep acidic soils with fine to fine-loamy particle size. All include silt loam or silty clay loam. Loam may also occur in Shelocta and Gilpin soils, and Shelocta may also include clay loam. They are moderately to well drained and have medium to rapid surface runoff. They occur on slopes ranging from 0 to 90 percent. Grigsby is a common series of floodplains and terraces. Grigsby soils are very deep and well drained, with negligible to medium runoff rates. They are coarse-loamy and moderately acid to neutral (USDA-NRCS, 2016).

Along the western margin of the region, the Cumberland Escarpment marks a transition zone between the resistant Pennsylvanian sandstone and conglomerate of the Eastern Coal Field and the older, softer carbonate rock of neighboring regions. The sandstones' response to weathering has resulted in some of the state's most dramatic and scenic formations, including waterfalls, natural arches, "chimney" rocks, and steep gorges and cliffs (Carey and Hounshell, 2008). Some karst features occur in this area (Woods, 2002).

3.3.2 Eastern Pennyroyal Region

The Eastern Pennyroyal region borders the Cumberland Escarpment to the west. It occupies a narrow strip between the escarpment and the Knobs and Bluegrass regions in the north before expanding across south-central Kentucky. The region is underlain by Mississippian limestone, chert, shale, siltstone, and sandstone, with an area of Mississippian through Ordovician soluble limestone, dolomite, and weak shales. The region has rolling plains and hills, and along the Cumberland River, steep bluffs, wide terraces, and bottomlands. Streams commonly have moderate gradients, and a few karst areas occur (Woods, 2002).

Common soil series include Baxter and Garmon. These well-drained upland soils occur on ridges and slopes. Garmon soils are fine-loamy, moderately deep, very strongly acid to neutral, and contain loam, silt loam, or silty clay loam. Their runoff rates range from very low to high. Baxter soils are fine and strongly to very strongly acid unless lime has been added. They contain silt loam or silty clay loam in upper horizons, silty clay or clay in lower horizons, and have low to high runoff rates (USDA-NRCS, 2016).

Nolin and Newark soils are commonly found in Pennyroyal floodplains. These fine, very deep, moderately acid to moderately alkaline soils tend to have very low runoff rates on level surfaces. Both are formed from alluvium from limestones, siltstones, sandstones, shales, and loess. Well drained Nolin soil textures include loam, silt loam, silty clay loam, fine sandy loam, and sandy loam. Newark soils are somewhat poorly drained and include silt loam, silty clay loam, clay loam, and fine sandy loam (USDA-NRCS, 2016).

3.3.3 Bluegrass Region

The Bluegrass region occupies the north-central portion of Kentucky. Ordovician limestones, the oldest rock layers to crop out in the state, underlie the region throughout. The more resistant limestones of the Inner Bluegrass interior have weathered slowly to produce gently rolling hills. Karst features such as sinkholes, springs, and sinking streams are common here (KGS, 2016b). Due to the prevalence of karst, upland surface streams of low to moderate gradient have only weakly dissected the Inner Bluegrass plain. But in contrast with the area's rolling landscape, the Kentucky River has carved a gorge up to 400 feet deep in the limestone

(Woods, 2002). The Palisades, as the gorge is known, stretches 100 miles from Boonesborough to Frankfort.

Silt loam soil predominates in the Inner Bluegrass region (Woods, 2002). Typical soil series in the Inner Bluegrass include Maury and McAfee. These naturally fertile upland soils are fine, well drained, and moderately to very deep, formed from material weathered from phosphatic limestone. Maury soils are neutral to strongly acid and have slow to medium runoff rates. McAfee soils range from moderately acid to mildly alkaline and have medium to very rapid runoff (USDA-NRCS, 2016).

The more erodible interbedded Ordovician limestones and shales of the Outer Bluegrass have given rise to deeper valleys and fewer tracts of flat land (KGS, 2016b). Widespread soil series in the Outer Bluegrass include Lowell and Eden. These fine, well-drained soils on ridge tops and slopes have moderate to rapid runoff rates. Soil textures include silt and clay loams, silty clays, and clay. Lowell soils are very strongly to slightly acid to depths of 30 inches and strongly acid to slightly alkaline at greater depths. Eden soils range from very strongly acid to moderately alkaline in the upper horizons and mildly to strongly alkaline at depths closer to the calcareous bedrock. Nolin and Newark soils are commonly found in Bluegrass floodplains (USDA-NRCS, 2016).

3.3.4 Knobs Region

The Knobs region forms a belt 10 to 15 miles wide around the southern half of the Bluegrass region (McDowell, 2001). The Knobs are separated from the Pennyroyal plateau by two escarpments, the Cumberland to the east and Muldraugh Hill along the south and west. The region includes narrow eastern and western strands of Silurian limestones and dolostones flanked by a narrow belt of Devonian deposits of limestones, dolostones, and a thick layer of shale (KGS, 2016g). The Knobs themselves are a series of many isolated, often conical hills with steep slopes. The typical knob is capped by an erosion-resistant limestone or sandstone of Mississippian age, underlain by layers of Mississippian-age shales that are more prone to erosion. A layer of Devonian black shales typically occurs at the base. (KGS, 2016e). The knobs are remnants of the escarpments' former extent that have thus far outlasted the erosive forces of area streams (McDowell, 2001).

Wide variation in Knobs soils reflects the variable and transitioning geology underneath. Common soil series include Trappist and Beasley. Trappist soils are fine, moderately deep, well-drained upland soils occurring on ridge tops, side slopes, and benches. Silt loam, loam, silty clay loam, and loam tend to occur in upper horizons, and silty clay, clay, and clay loam at depth. Soil reaction is strongly to extremely acid, except where limed. Runoff rates range from high to very high. Beasley series are fine, deep, well-drained soils of ridge tops and hillsides. Silt loam, silty clay loam, and silty clay occur in upper horizons, and silty clay or clay in deeper horizons. Runoff rates range from medium to rapid, and reaction ranges from very strongly acid to moderately alkaline, depending on depth. Both series occur on slopes of 2 to 60 percent (USDA-NRCS, 2016).

3.3.5 Western Pennyroyal Region

The Western Pennyroyal region occurs to the southwest of the Knobs and west of the Eastern Pennyroyal regions. Thick deposits of Mississippian-age limestone help to define this area. The ease with which this very pure limestone bedrock dissolves in contact with groundwater has resulted in tens of thousands of karst features such as sinkholes, caves, springs, sinking streams, and streamless valleys. In the south of the region a vast rolling “sinkhole plain” occurs, weakly dissected by surface streams. Moving into the region’s interior, the Dripping Springs escarpment marks the beginning of the Mammoth Cave uplands. Here, resistant Mississippian (and some Pennsylvanian) sandstone covers the limestone, suppressing the formation of sinkholes at the surface and instead creating the world’s longest known cave system. In this area the Green River has cut a 300-foot-deep gorge through the sandstone cap rock into the St. Louis limestone, setting a regional gradient that draws water from hundreds of square miles of the sinkhole plain through the limestones beneath the Mammoth Cave plateau (May, et al., 2005).

Crider and Baxter are common soil series. The very deep, well-drained upland Crider soils form from a loess mantle and the underlying limestone residuum. They contain silt or silty clay loam in their upper horizons and silty clay, clay, or silty clay loam in lower horizons. Crider soils are neutral to very strongly acid, fine-silty, and occur on slopes of 0 to 30 percent. Surface runoff rates vary from low to high. Baxter soils are described in the Eastern Pennyroyal section. Nolin and Newark soils are widespread soils of floodplains (USDA-NRCS, 2016).

3.3.6 Western Coal Field

The Western Coal Field is part of a larger formation, the Eastern Interior Basin, that extends into Kentucky from Indiana and Illinois (KGS, 2016f). Like the Eastern Coal Field, its Pennsylvanian-age layers consist of interbedded shale, sandstone, conglomerates, and coals (KGS, 2016c). Quaternary deposits (of clay, silts, sand, and gravel) are common in river and stream floodplains (KGS, 2016h). Much of the area consists of lowlands with wide, poorly drained valleys. In the Caseyville Hills area bordering the Western Pennyroyal, where Mississippian rock transitions to Pennsylvanian, valleys are narrower and relief higher. Streams have low to moderate gradients (Woods, 2002).

Common soil series include Zanesville and Wellston. These fine-silty, deep to very deep upland soils occur on ridge tops and slopes of 0 to 35 percent and are moderately to extremely acid, except where lime exists. Zanesville is moderately well drained, has very high surface runoff rates, and has silt loam or silty clay loam textures in upper horizons. Lower horizons also contain loam, silty clay or clay loam, sandy clay loam, or fine sandy loam. Wellston soils are well drained, have medium to high runoff rates, and silt loam or silty clay loam in upper horizons. Loam, clay loam, sandy clay loam or sandy loam can also occur in deeper horizons. Both series may include significant amounts of rock fragments. Newark soils are common in floodplains (USDA-NRCS, 2016).

3.3.7 Jackson Purchase Region

The Jackson Purchase region encompasses far western Kentucky. Bordered by Tennessee to the south, the Tennessee River to the east, the Ohio River to the north, and the Mississippi River to the west, it is the lowest area of the state. During the relatively recent Cretaceous and Tertiary periods, this region lay beneath a northern extension of the Gulf of Mexico. Unconsolidated Cretaceous and Tertiary sediments, rather than bedrock, typically occur just under the soil of this coastal plain (Carey and Hounshell, 2008). Quaternary deposits are common in river and stream floodplains. Rolling plains and broad bottomlands cover large areas of the region. Gullies dissect hills in the eastern portion; western streams are low-gradient and associated with wetland ecosystems along their lower reaches. Sloughs, bayous, oxbow lakes and other wetland ecosystems are common (Woods, 2002).

Grenada and Loring soil series occur throughout the Purchase region. Both are fine-silty, loess-derived, moderately well-drained soils found on nearly level to sloping uplands and stream terraces. Grenada soils are very deep silts, silt loams or silty clay loams that are strongly acid to neutral in lower horizons. Upper horizons are very strongly acid to moderately acid except for the surface layer in areas that have been limed. Runoff rates vary from low on level areas to high on 6- to 12-percent slopes. Loring soils include silt loam and silty clay loam with a fragipan; loam or sandy loam additionally occur in the lowest horizon. They are slightly to very strongly acid depending on depth (USDA-NRCS, 2016).

3.3.8 Runoff Potential of Soils

Soil erosion and water runoff can both move bacteria to a waterbody or to groundwater. The U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) has developed hydrologic soil groups (HSGs) to relay information about the runoff potential of a soil when thoroughly wet. For runoff potential, ratings are low, moderately low, moderately high, and high for HSGs A, B, C, and D, respectively (USDA-NRCS, 2009). For dual HSG assignment (i.e. A/D, B/D, or C/D) soils can be adequately drained, but a water table exists within 24 inches of the soil surface (USDA-NRCS, 2009). In these cases, the first letter denotes the drained condition while the second denotes the undrained condition (USDA-NRCS, 2009). Figure 3.3-3 shows the spatial distribution of HSG types in Kentucky. In general, soils with greater runoff potential occur in the Bluegrass, Western Coal Field and Purchase regions (Commonwealth of Kentucky, 2017).

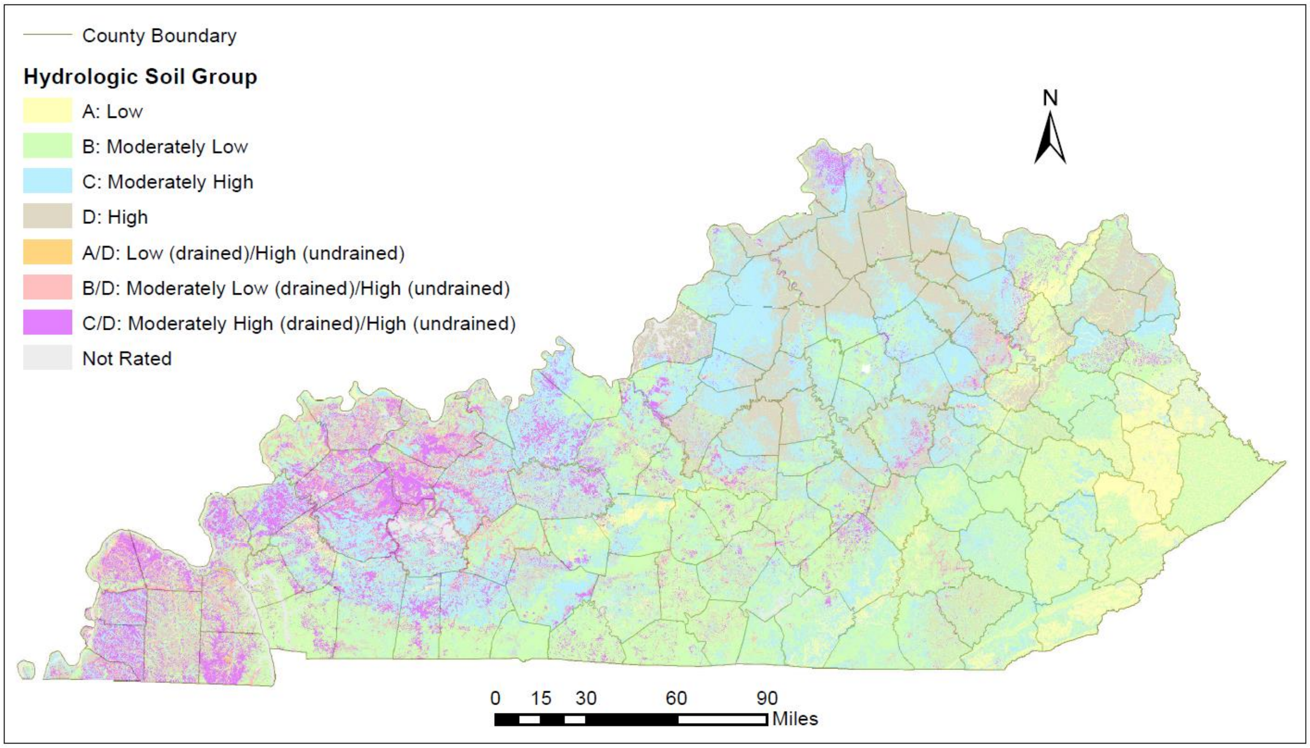

Figure 3.3-3 Runoff Potential of Soils Based on Hydrologic Soil Group

4.0 SOURCE ASSESSMENT

For regulatory purposes, the sources of fecal coliform and *E. coli* in a watershed can be placed into two categories: KPDES-permitted and non-KPDES-permitted sources. A KPDES-permitted source requires a KPDES permit from the Division in order to discharge to a waterbody. KPDES discharge permits include wastewater treatment facilities that discharge directly to a stream, systems that discharge storm water, and some agricultural operations. KPDES is not the only permitting program that may affect water quality or quantity within a watershed; other permitting examples include water withdrawal permits, permits to build structures within a floodplain, permits to construct an onsite sewage treatment disposal system, and permits to land-apply waste from sewage treatment plants. However, within the framework of the TMDL process, a KPDES-permitted source is defined as one regulated under the KPDES program. Non-KPDES-permitted sources include nonpoint sources of pollution. Nonpoint source pollution is often caused by runoff from precipitation over and/or through the ground and is correlated to land use.

4.1 Wasteload Allocation

The Wasteload Allocation (WLA) is the portion of the TMDL allocated to KPDES-permitted sources within the watersheds. KPDES-permitted dischargers are also referred to as point sources. Holders of KPDES permits to discharge bacteria to the waters of the Commonwealth can include Sanitary Wastewater Systems, Municipal Separate Storm Sewer Systems, and Concentrated Animal Feeding Operations. Each type of permittee is discussed in more detail below.

4.1.1 Sanitary Wastewater Systems

Wastewater Treatment Plants (WWTPs), Sewage Treatment Plants (STPs), package plants, and home units collectively are referred to as Sanitary Wastewater Systems (SWSs). In addition to meeting discharge requirements, SWSs are also responsible for the integrity of their collection systems (including trunk mains and pressure mains, for example). Home units either discharge through an outfall or spray-irrigate the treated wastewater. Both types of home units are covered under the same KPDES general permit. However, the home units that spray-irrigate receive a load allocation (see Section 4.2) since they do not discharge to a waterbody through an outfall. Additional information about specific SWSs that discharge directly to an impaired waterbody covered by this TMDL is provided in the appendix for each river basin.

Some SWSs include combined sewers, an outdated form of infrastructure designed to minimize direct human contact with untreated sewage. During periods of wet weather, combined sewers carry wastewater discharges and storm drain flow to a centralized wastewater treatment facility. However, when this combined flow exceeds the capacity of the sewer, some of the flow is diverted to a combined sewer outfall, where it discharges to a surface waterbody. While this discharge relieves pressure within the sewer and helps prevent basement backups in private residences or discharge through manhole structures, it results in loadings of raw sewage into the receiving waterbody (KDOW 2016a).

Combined Sewer Overflows (CSOs) are permitted by KPDES and managed under consent judgments with the state or joint federal/state consent decrees. CSO management plans include enforceable schedules for eliminating or minimizing the impact of the CSOs on water quality. In 2008 more than 28 percent of Kentuckians were customers of sewer systems with CSOs (KDOW, 2008). Table 4.1-1 lists Kentucky communities with CSOs as of September 2016; Figure 4.1-1 shows the locations of communities with CSO sites (Commonwealth of Kentucky, 2017). Additional information about specific CSO outfalls that discharge directly to an impaired waterbody covered by this TMDL is provided in the appendix for each river basin.

Table 4.1-1 CSO Areas in Kentucky (as of September 2016)

Community	Regulated Entity	County	KPDES No.
Ashland	Ashland STP	Boyd	KY0022373
Catlettsburg	Catlettsburg STP	Boyd	KY0035467
Frankfort	Frankfort Municipal STP	Franklin	KY0022861
Harlan	Harlan STP	Harlan	KY0026093
Henderson	Henderson STP	Henderson	KY0020711
Louisville	Metropolitan Sewer District	Jefferson	KY0022411
Loyall	Loyall STP	Harlan	KY0026115
Maysville	Maysville STP	Mason	KY0020257
Morganfield	Morganfield WWTP	Union	KY0021440
Northern Kentucky	Sanitation District No. 1	Campbell, Kenton	KY0021466
Owensboro	RWRA Max Rhoads WWTP	Daviess	KY0020095
Paducah	Paducah/McCracken Joint Sewer Agency	McCracken	KY0022799
Pineville	Pineville STP	Bell	KY0024058
Vanceburg	Vanceburg STP	Lewis	KY0021512
Worthington	Worthington WWTP	Greenup	KY0022926

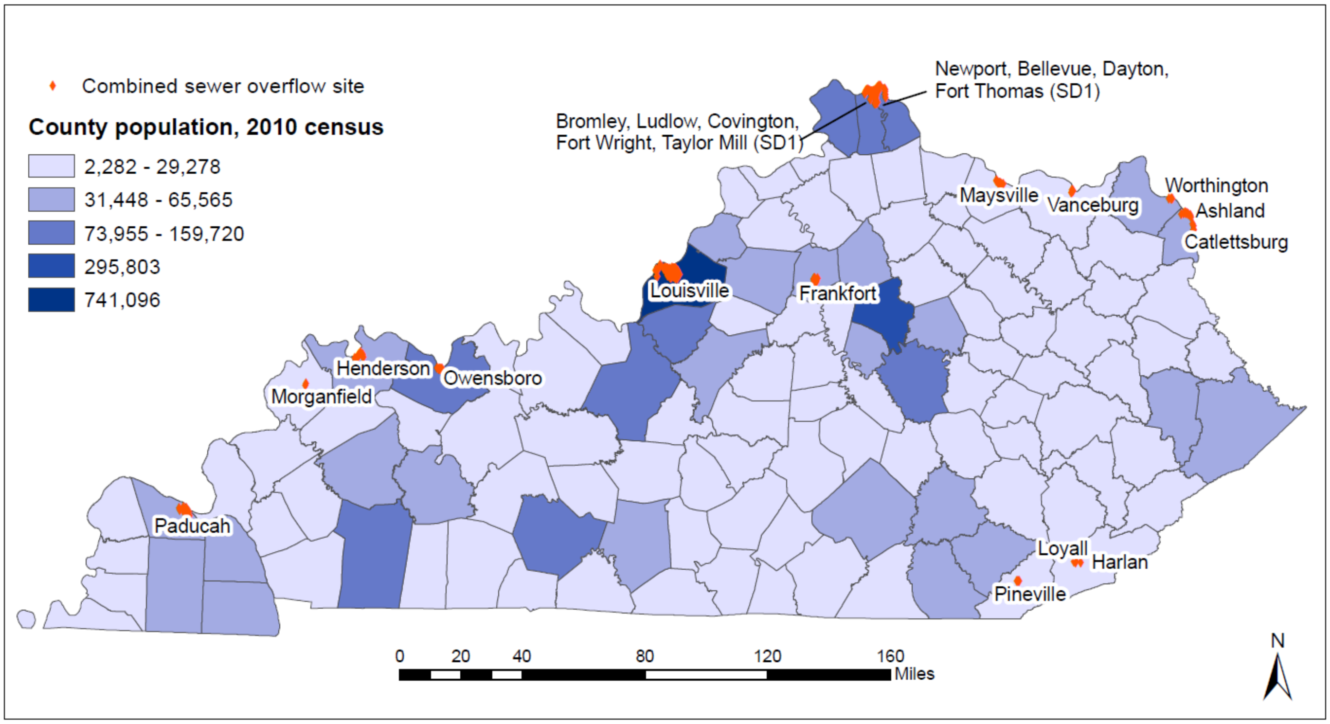

Figure 4.1-1 CSO Communities in Kentucky

Similarly, Sanitary Sewer Overflows (SSOs) are discharges of sanitary wastewater to a waterbody, often as a result of a problem such as power failure, line breaks, blockages or defects in design or construction (https://www.epa.gov/npdes/sanitary-sewer-overflows-ssos, accessed on 4/14/16). They are prohibited and receive no allocation.

4.1.2 Municipal Separate Storm Sewer Systems

Municipal Separate Storm Sewer Systems (MS4s) are defined in 401 KAR 5:002. An MS4 is a publicly owned conveyance or system of conveyances (such as storm drains, curbing and gutters) that is designed or used to collect or convey storm water but is not a combined sewer or part of an STP. Since MS4s may discharge untreated storm water runoff into surface waterbodies, some categories of MS4s must obtain a KPDES permit and develop a storm water management program to prevent harmful pollutants from entering the MS4 (KDOW, 2016b). Permits have five-year permitting cycles and annual reporting requirements.

EPA has categorized MS4s into three categories: small, medium, and large. The medium and large categories are regulated under the Phase I Storm Water program. Large systems, such as the cities of Lexington and Louisville, have populations in excess of 250,000. Medium systems have populations in excess of 100,000 but less than 250,000; however, there are currently no medium-sized systems in Kentucky. The small MS4 category includes all MS4s not covered under Phase I. Since this category covers a large number of systems, only a select group are regulated under the Phase II rule, either being automatically included based on population (i.e., having a total population over 10,000 or a population per square mile in excess of 1,000) or on a case-by-case basis due to the potential to cause adverse impact on surface water. MS4 permit holders can include cities, counties, the Kentucky Transportation Cabinet, universities and military bases. Figure 4.1-2 shows the locations of MS4 communities (Commonwealth of Kentucky, 2017); a table with further information appears in Appendix A.

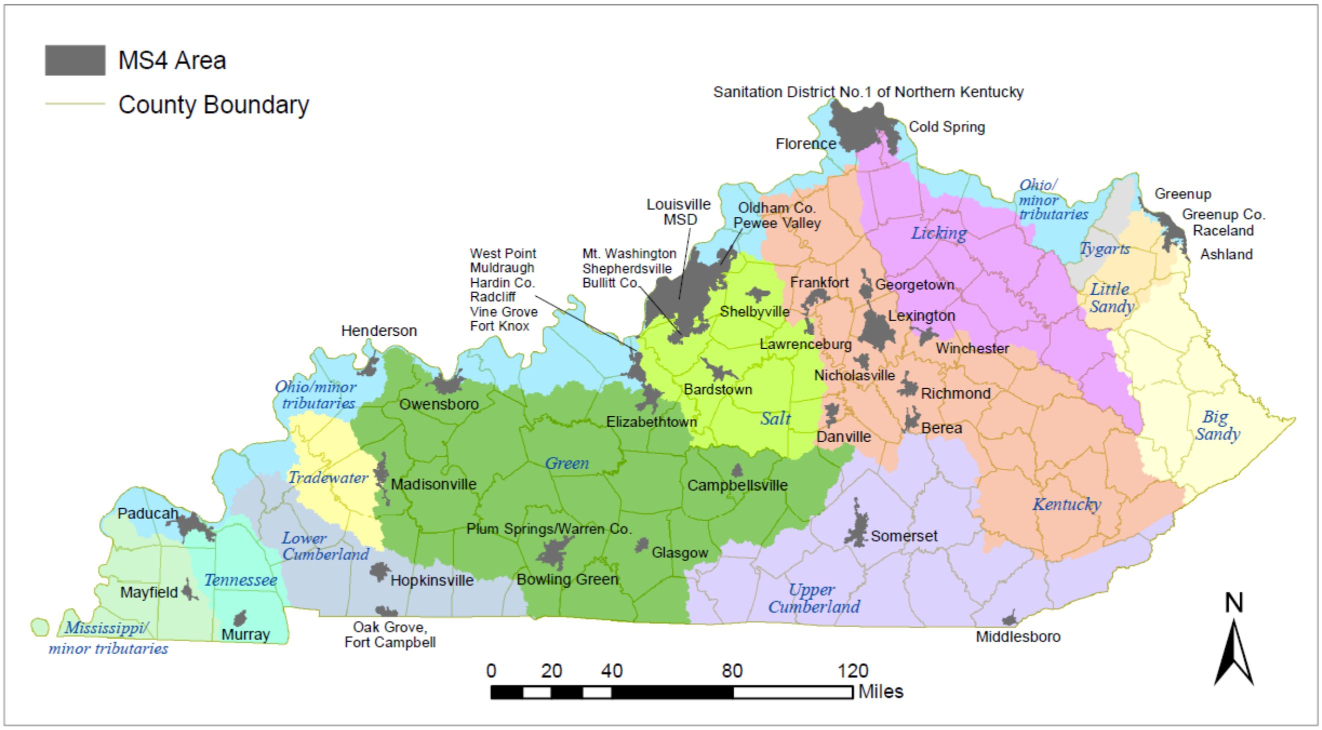

Figure 4.1-2 MS4 Communities in Kentucky by River Basin, February 2017

4.2 Load Allocation

Non-KPDES-permitted sources include all sources not permitted by the KPDES permitting program, including natural background, and are often associated with land use. These sources are also referred to as nonpoint sources. The loads to surface water from non-KPDES permitted sources are regulated by laws such as the Kentucky Agricultural Water Quality Act (AWQA, KRS 224.71-100 through 224.71-145, i.e., implementation of individual agriculture water quality plans and corrective measures), the federal Clean Water Act (i.e., the TMDL process) and 401 KAR 5:037 (Groundwater Protection Plans), among others. Nonpoint sources typically discharge pollutants to surface water in response to rain events. A Load Allocation (LA) is assigned to nonpoint sources.

4.2.1 Wildlife

Wildlife are sources of bacteria in surface water and may live in both urban and rural areas. The Kentucky Department of Fish and Wildlife Resources (KDFWR) estimated the 2014 population of deer in Kentucky at 853,854. Owen County had the highest population of deer, 25,929, as well as the greatest density of deer (74) per square mile of suitable habitat (KDFWR, 2016). Deer density for each county is shown in Figure 4.2-1.

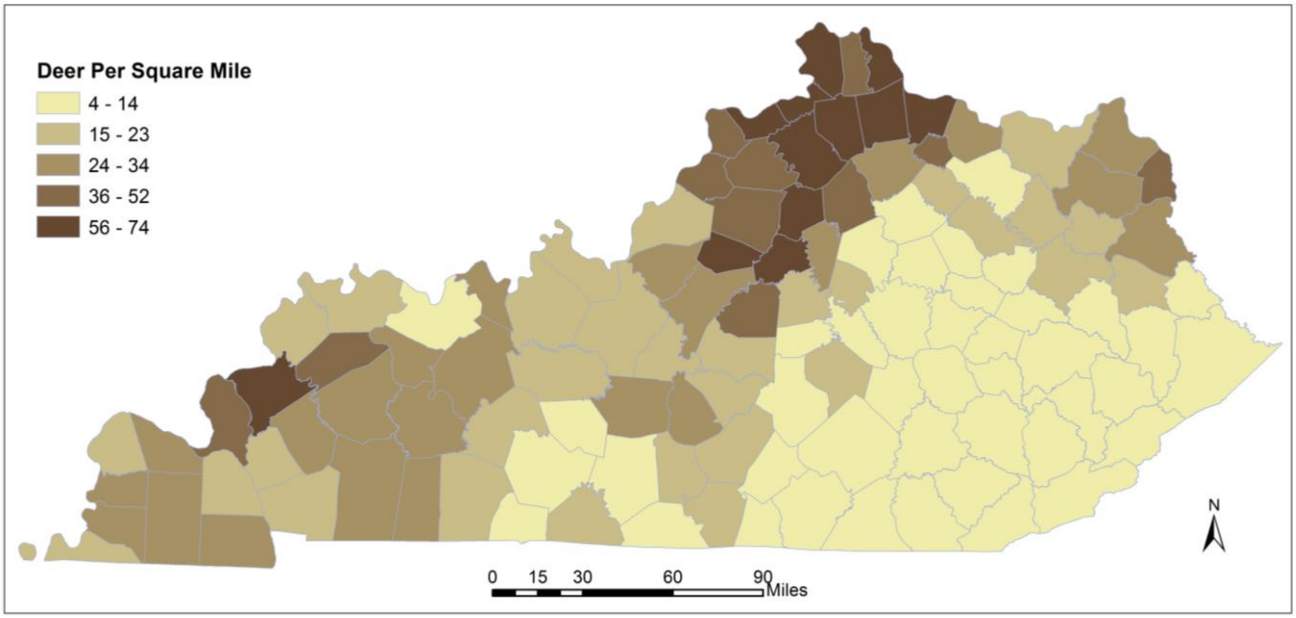

Figure 4.2-1 Estimated Deer Density by County per Square Mile of Suitable Habitat (2014)

Waterfowl such as Canada geese can be a significant source of bacteria to surface water (Alderisio and DeLuca, 1999). Canada geese are attracted to habitats with open water, short grasses, and grain crops or other readily available food sources. For this reason, they may congregate at nuisance levels at parks, golf courses, or farms (Cornell University, 2017). Kentucky's resident population of Canada geese has ranged between approximately 20,000 and 40,000 since 1994. Another 1,000 to 10,000 may pass through the state during the migratory season, depending on winter cold (KDFWR, 2017). A 2016 survey estimated that more than 1.5 million Canada geese used habitat along the Mississippi River migration corridor that includes Kentucky (USFWS, 2016).

Human activities can encourage nuisance-level populations of opportunistic feeders like raccoons, opossums and skunks, in addition to ducks and geese. Such activities include intentionally feeding wildlife, leaving pet food outside, and leaving trash containers open (Barnes, 1999 and Pehling, 2012). Stakeholders can help deter nuisance wildlife by changing these behaviors. Reductions of bacteria load from wildlife under natural background conditions are not expected as a result of this TMDL.

4.2.2 Kentucky No Discharge Operational Permits

Some facilities have wastewater treatment systems that do not discharge to surface water, but instead use a closed loop system or a spray irrigation system to apply treated wastewater to the land. These facilities must have a Kentucky No Discharge Operational Permit (KNDOP) to operate their treatment systems. Examples of operations that might use no-discharge wastewater treatment systems include car washes, laundries, golf courses, swimming pools, municipal water or wastewater treatment facilities, food processing plants, slaughter houses, and manufacturing (KDOW, 2011).

Treatment systems may range from simple to complex and may involve one or more steps. Some examples of common treatment processes include filtration, neutralization, settling of solids, and using biological processes to decompose waste.

Closed loop systems recycle treated wastewater back through the process that generated the wastewater. When the treated wastewater is no longer of suitable quality for recycling, a portion of it is removed from the system and fresh water is added. The removed wastewater must then be treated or disposed in accordance with all applicable environmental regulations.

In Kentucky, spray irrigation systems are more commonly used. These apply the treated wastewater to the land at rates low enough to allow the wastewater to soak into the soil without causing runoff to surface water. Land application that results in wastewater runoff to a stream or ponding in a sinkhole is prohibited (401 KAR 5:005 Section 25(7)(c)).

4.2.3 Agriculture

The Kentucky Agriculture Water Quality Act (AWQA) was passed by the 1994 General Assembly. The law focuses on the protection of surface water and groundwater resources from agricultural and silvicultural activities. The act created the Kentucky Agriculture Water Quality Authority, a 15-member peer group comprising farmers and representatives from various agencies and organizations. The act requires farms 10 acres or more in size to adhere to the Best Management Practices (BMPs) specified in the Kentucky Agriculture Water Quality Plan. Specific BMPs have been designated for all operations.

The USDA National Agricultural Statistics Service compiles Census of Agriculture data by state and county for virtually every facet of U.S. agriculture (USDA, 2012). According to the 2012 census, Kentucky had nearly 13.1 million acres in farm, representing 51.6 percent of the state’s total land area. Some 6 million acres were used for crops (23.8 percent of the state’s total land area). More than 4.2 million acres were used for pasture (16.7 percent of the state’s total land area). Of the land in farm, 99.8 percent were sized 10 acres or greater and thus required to use appropriate BMPs. More detail about agricultural land use is summarized in Table 4.2-1.

Table 4.2-1 Land Use on Kentucky Farms, 2012

Land Use	Acreage
Approximate land area, Kentucky	25,271,542
Land in farms	13,049,347
Farm size 10 acres or greater	13,027,717
Total acres used for crops	6,010,659
Total acreage used for pasture	4,214,208

Animal wastes from agriculture are a potential source of bacteria to waterbodies. Animals grazing in pasture or near streams in search of shade or drinking water often deposit feces on the land or directly into the water; bacteria on the land that do not decay can run off into streams during wet weather events. Livestock with access to streams can also damage and decrease streamside vegetation that would otherwise help filter pathogens out of storm runoff (USDA, 1995). Table 4.2-2 provides an inventory reported to USDA of common livestock types on Kentucky farms on December 31, 2012. These inventories are based on statewide data with no assumptions made on a watershed level.

Table 4.2-2 Livestock Inventory on Kentucky Farms, December 2012

Livestock Category	Inventory (Number) on 12/31/2012
Poultry	57,591,391
Cattle and calves	2,270,871
Hogs and pigs	313,360
Equine	154,483
Goats	64,118
Sheep and lambs	54,612

Broiler chicken and beef cattle production are the leading livestock markets in the state. In 2012 Kentucky ranked seventh nationally for producers' sales of more than 305 million broiler chickens. Broiler producers were concentrated in the southwest, with 12 counties comprising 80 percent of broilers sold (see Figure 4.2-2) (USDA, 2012). Broilers typically are raised in enclosed buildings with floors covered by bedding material. This bedding and the manure that accumulates within it, called poultry litter, is cleaned out between flocks. In a 2006 survey of major broiler states, producers reported applying the litter to their own cropland and/or removing it by selling, exchanging, or giving it away, or paying to have it hauled off site. Nearly 61 percent of broiler litter in the survey was removed from the operation, while 39 percent was applied to fields on the operation. The survey also found that on average, the litter produced by every 4,000 broilers was used to fertilize about an acre on site (MacDonald, 2008).

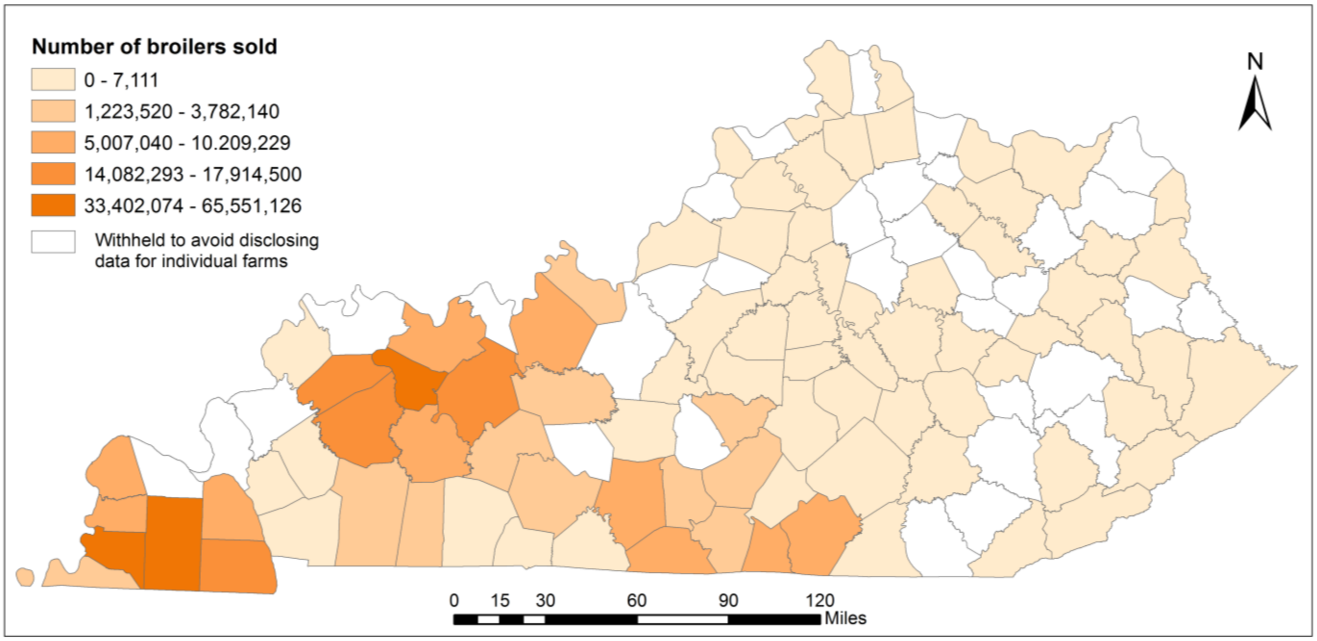

Figure 4.2-2 Broilers Sold in 2012 by County

As reported in the Census of Agriculture, Kentucky's beef cattle inventory on December 31, 2012 was the eighth largest nationally and the largest east of the Mississippi River. The geographic distribution of beef cattle in the state is shown in Figure 4.2-3.

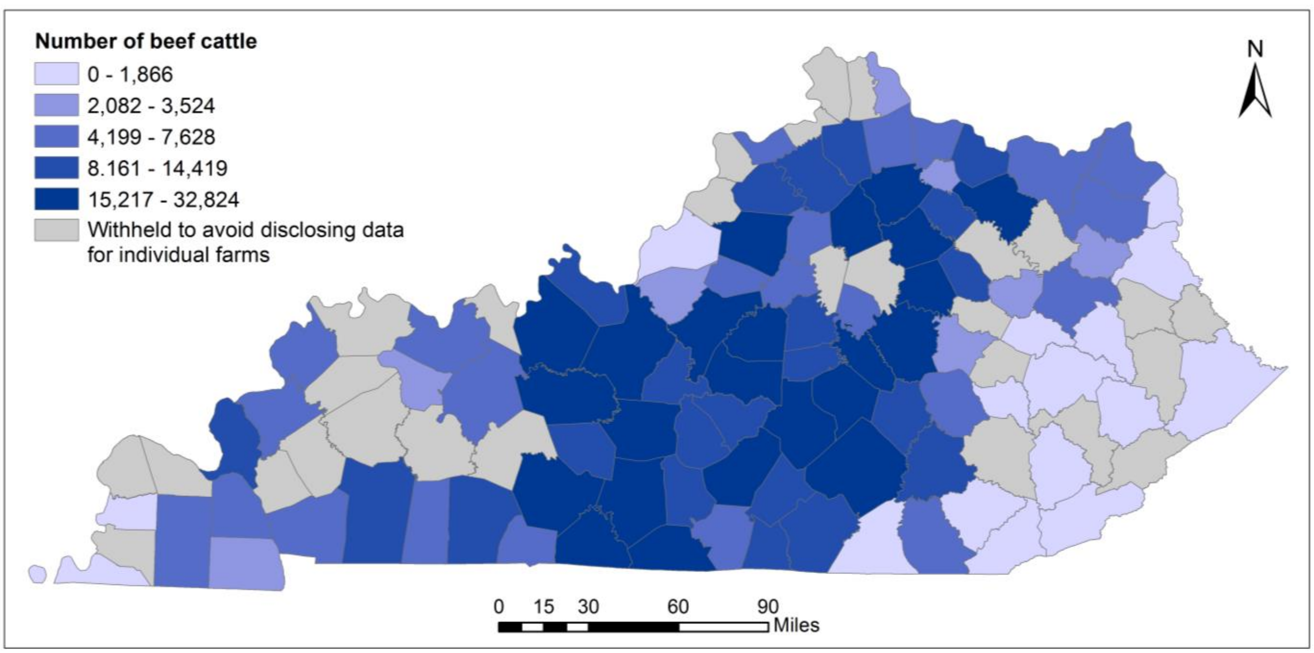

Figure 4.2-3 Inventory of Beef Cattle by County on December 31, 2012

4.2.4 Animal Feeding Operations

As defined in 401 KAR 5:002, an animal feeding operation (AFO) is a lot or facility where animals are stabled or confined and fed or maintained for 45 days or more in any 12-month period, and where crops, forage vegetation, or post-harvest residues are not sustained over any portion of the lot or facility. AFOs with agricultural waste handling systems that discharge to waters of the Commonwealth are required to obtain a KPDES permit. As of August 2016 there were no AFOs in Kentucky with point source discharges.

Some other animal waste handling systems do not discharge to surface water and are required to obtain a construction permit from the Division prior to construction (401 KAR 5:005, Section 1) and a Kentucky No Discharge Operating Permit (KNDOP) prior to operation (401 KAR 5:005 Section 25). These operations handle liquid waste in a storage component of the operation (e.g., lagoon, pit, or tank) and may land-apply the waste via spray irrigation or injection to cropped acreages. Land application that results in runoff of the liquid waste to a stream is prohibited. These AFOs are also required to have a nutrient management plan that includes conservation practices to control pollutant runoff and provisions to ensure adequate storage of manure or poultry litter and proper operation and maintenance of the storage facilities. The size of the operation (as defined in 401 KAR 5:002) determines the type of permit: a general KNDOP covers small and medium AFOs, while large AFOs must apply for an individual KNDOP. Operations using a dry manure system (such as a covered stack pad for beef manure) are not required to obtain KNDOP coverage. As of September 2016, there were about 600 active AFOs with a KNDOP in Kentucky; Figure 4.2-4 shows how these permits are distributed by county (Commonwealth of Kentucky, 2017).

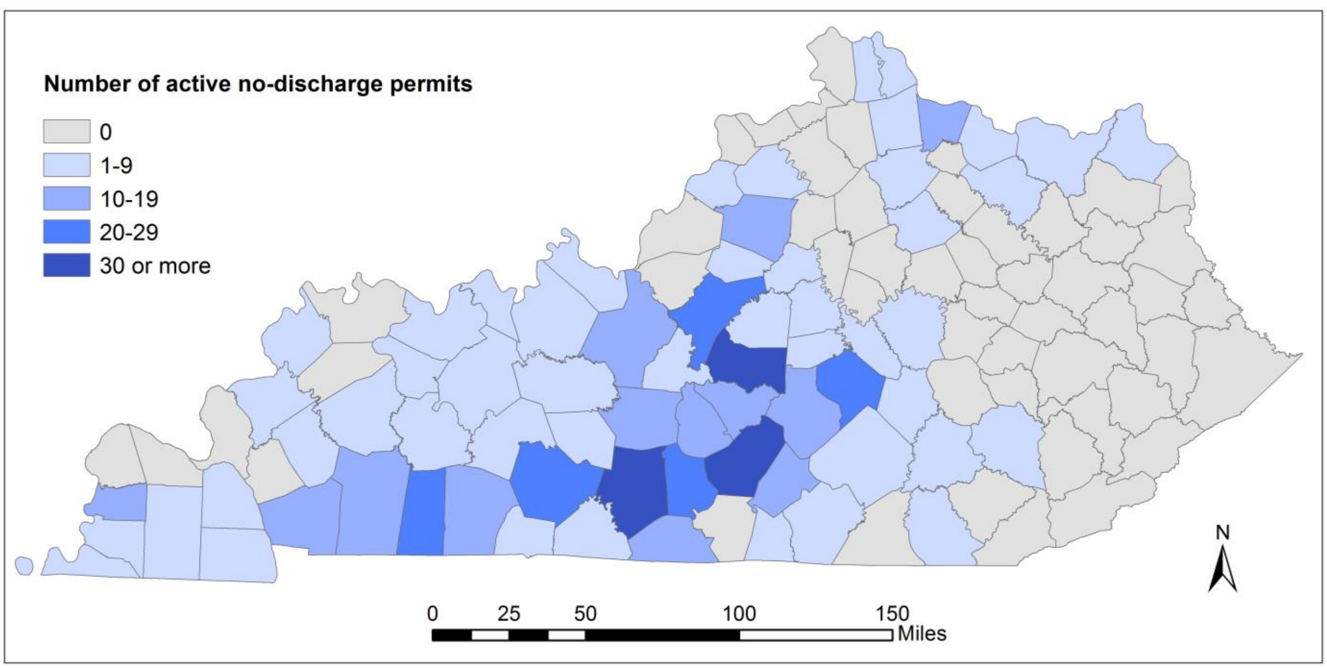

Figure 4.2-4 Number of Active KNDOP-Permitted AFOs by County, September 2016

The Division may also issue KPDES permits to non-discharging AFOs if warranted by the nature of the operation. As of August 2016, three AFOs had individual KPDES permits that prohibit discharges to waters of the Commonwealth (see Table 4.2-3). Because these operations are not point source dischargers, they receive a load allocation (for any residual bacteria that get carried to surface water after a precipitation event).

Table 4.2-3 KPDES-Permitted Animal Feeding Operations

Name of Operation	KPDES Permit No.	County	Community
RR&S Farms	KY0111856	Marshall	Benton, KY
Misty Lake Dairy, LLC	KY0108731	Mason	Mayslick, KY
Woodall Dairy Farm	KY0108481	Logan	Lewisburg, KY

4.2.5 Human Waste

Human waste disposal is of particular concern in rural areas. Areas not served by sewers either use On-Site Sewage Treatment and Disposal Systems (OSTDSs) or do not treat their sewage. OSTDSs, including septic tank systems, are commonly used in areas where providing a centralized sewage collection and treatment system is not cost-effective or practical. These systems may also be common in areas where sewer service is technically feasible, but widespread economic hardship makes monthly sewer fees a burdensome prospect. For example, a study noted that within the multi-state region of Appalachia, many communities eligible for funding support for capital wastewater infrastructure projects were unable to afford the ongoing operating and maintenance costs for such facilities (Hughes, et al., 2005).

When properly sited, designed, constructed, maintained, and operated, septic systems are an effective means of disposing and treating domestic waste. The effluent from a well-functioning OSTDS is comparable to secondarily treated wastewater from a sewage treatment plant.

Based on 2010 census population data and mapped service lines of public wastewater systems, the Kentucky Infrastructure Authority (KIA) estimated that 60 percent of the state's population were served by public sewers (KIA 2015). In 2016 an estimated two percent or fewer of residents were served by a home unit or package plant. Thus, an estimated 38 percent of Kentucky residents either relied on an OSTDS for their household sewage, or did not have a treatment system. Further, in over half of Kentucky counties, two-thirds or more of households were not served by public sewers. Figure 4.2-5 shows KIA sewer service statistics by county; a table of the data is in Appendix B.

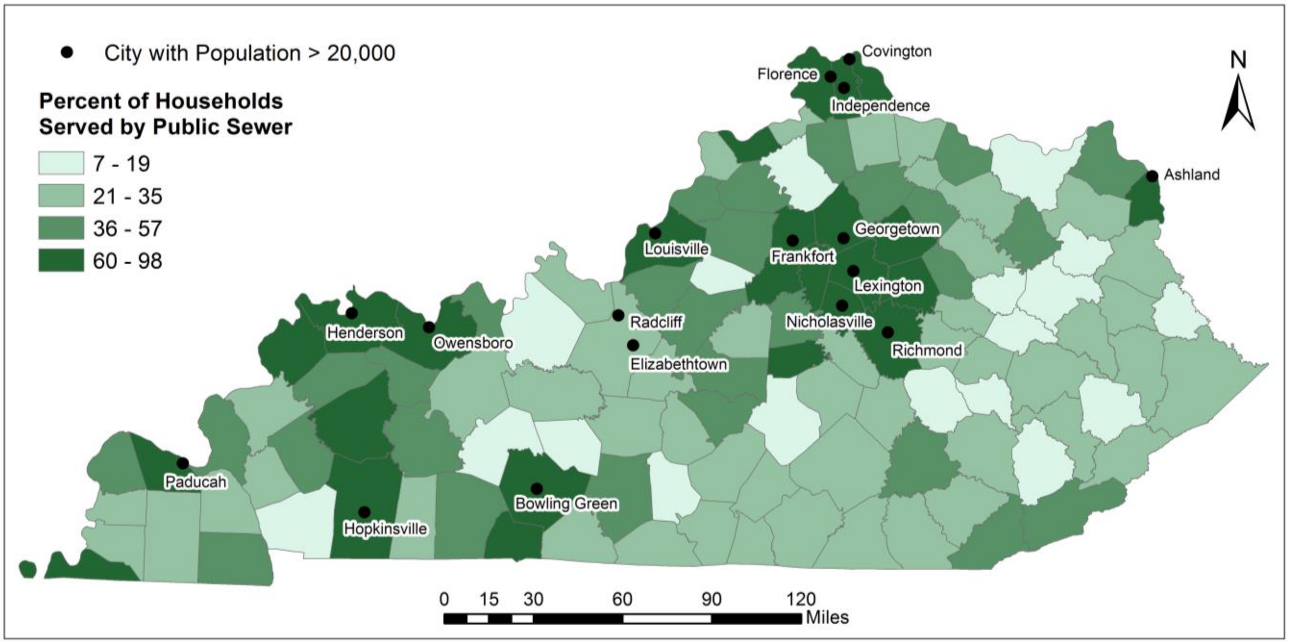

Figure 4.2-5 Percent of Households with Sewer Service by County, 2010

As part of the National Cooperative Soil Survey, the NRCS rates the performance of septic tank absorption fields, defined as the area in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only the soil at a depth range of 24 to 60 inches below the surface is evaluated. Soil ratings are based on soil properties, site features, and the observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of septic tank effluents. Other site characteristics factored into the ratings may interfere with installation or maintenance or may cause lateral seepage and surfacing of tank effluent in downslope areas.

Figure 4.2-6 shows septic soil ratings throughout the state (Commonwealth of Kentucky, 2017). A rating of “Not limited” indicates that the soil has features that are very favorable for the septic system use; good performance and very low maintenance can be expected. “Slightly limited” indicates that the soil has features that are favorable for septic use: limitations are minor and can be easily overcome. Good performance and low maintenance can be expected. “Somewhat limited” indicates that the soil has features that are moderately favorable for septic use. The limitations can be overcome or minimized by special planning, design, or installation. Fair performance and moderate maintenance can be expected. “Very limited” indicates that the soil has one or more features that are unfavorable for septic systems. The limitations generally cannot be overcome without major soil reclamation, special design, or expensive installation procedures. Poor performance and high maintenance can be expected (Jacobs and Eigel, 2008). Soils rated as very limited for installation of septic tank absorption fields often have steep slopes and/or shallow soil profiles.

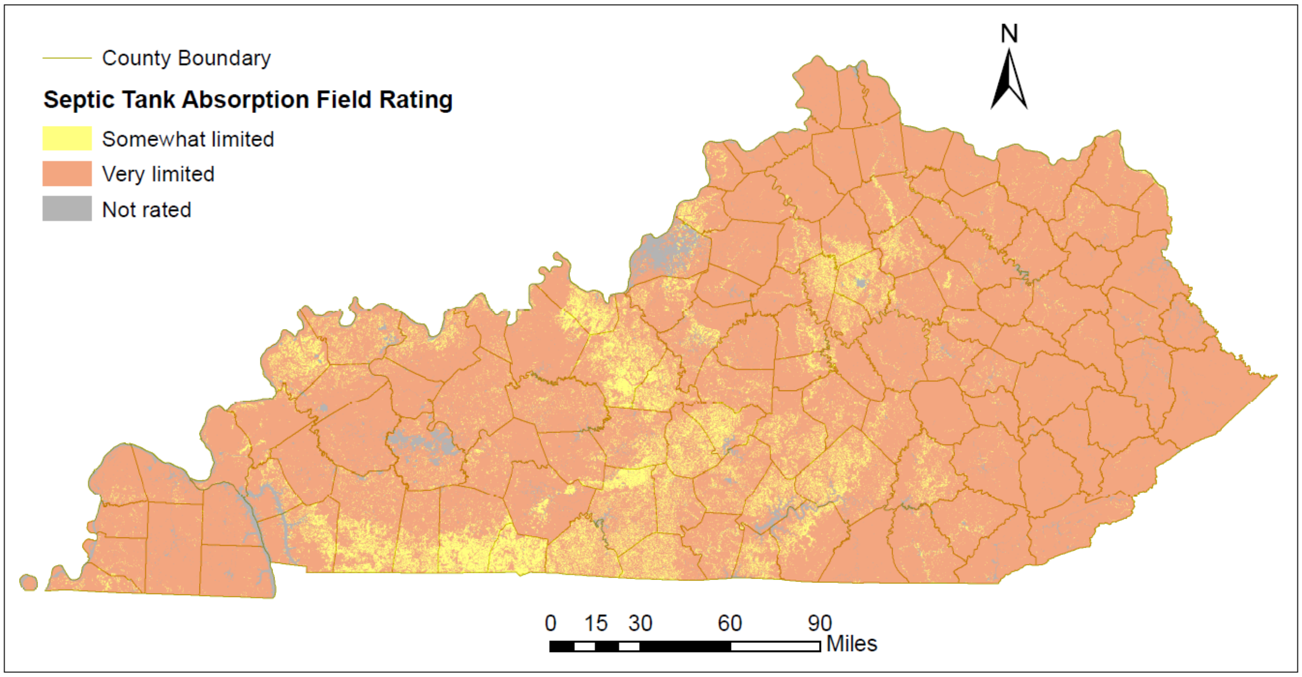

Figure 4.2-6 Generalized Septic Tank Absorption Field Ratings of Kentucky Soils

Throughout Kentucky, many soils have ratings of somewhat or very limited (some areas, such as urban land, large waterbodies, pits and rock outcrops did not receive ratings). Given the widespread limitations, it can be inferred that many septic systems in Kentucky are underperforming or failing, particularly if not regularly or adequately maintained. When not functioning properly, an OTSDS can be a source of bacteria to both groundwater and surface water. A University of Kentucky Cooperative Extension publication has estimated that a failing septic system can discharge about 63,000 gallons of untreated wastewater into the environment in one year (Lee, 2012). See Section 4.3, Prohibited Sources, for further discussion of failing OSTDSs.

Another type of non-KPDES-permitted– and illegal– source of human waste is “straight pipes.” These are discrete conveyances that discharge sewage and gray water (i.e., water from household sinks, laundry, etc.) to the surface waters of the Commonwealth without treatment.

4.2.6 Household Pets

Household pets can be a source of bacteria to surface water. Household pets can be present in both urban and rural areas, although their contribution is expected to be a higher percentage of total loading in urban areas where there is a higher density of households and impermeable surfaces. According to the American Veterinary Medical Association (AVMA, 2012), there were 1.6 dogs per household and 2.1 cats per household, nationally, in 2012.

4.3 Prohibited Sources

Both KPDES-permitted and non-KPDES-permitted sources can discharge bacteria to surface water in an unauthorized manner. This includes sources that are prohibited simply by their existence, such as straight pipes and SSOs, which receive no allocation. There may also be authorized sources that are noncompliant (e.g., operating outside of regulations, permit limits or conditions, etc.), such as WWTP bypasses or failing OSTDSs, which receive no allocation above that of a properly functioning system.

Another potential prohibited source is livestock on farms that have no BMPs (as required under the AWQA) as well as farms where BMPs are present but are insufficient or failing in a manner that causes or contributes to surface water impairment. Livestock with access to streams can have a direct impact on water quality when feces are deposited on stream banks or directly into the stream. Use of manure as crop fertilizer is also a potential source of bacteria to surface water if BMPs are not followed. Such farms receive no allocation above that of a farm with properly installed and functioning BMPs. Also included are KNDOPs, AFOs and CAFOs that cause or contribute to a surface water impairment while out of compliance with the appropriate regulations.

The Division expects implementation of bacteria TMDLs to begin with the elimination of prohibited sources. This is intended to prevent fully compliant sources from having to effect reductions in order to accommodate the pollutant loading of prohibited sources. This section of the TMDL is not intended to summarize the universe of potential prohibited sources that may discharge pollutants into surface waters, nor does it attempt to summarize the universe of authorized sources that may be operating out of compliance. Instead, it gives examples of prohibited sources that may be present in impaired watersheds.

5.0 MONITORING AND DATA VALIDATION

The following types of data may be used for assessment and TMDL development:

- Data collected by the Division, including staff from the TMDL Section and Monitoring Support Section of the Water Quality Branch and from the Watershed Management and Compliance and Technical Assistance Branches. These data are collected under approved Standard Operating Procedures (SOPs) and Quality Assurance Project Plans (QAPPs).
- Discharge Monitoring Report (DMR) data and MS4 storm water data from the KPDES program.
- Data collected by third parties with QAPPs and SOPs either approved by the Division or equivalent to those followed by the Division. This includes 319(h)-grant recipients and government agencies such as the United States Geological Survey (USGS).

Data used in assessments or TMDL development must undergo a validation process to ensure the data are of acceptable quality. Examples of aspects reviewed by the Division as part of data validation include whether:

- Analytical data were collected during the appropriate time frame (such as May through October to evaluate whether a waterbody meets PCR WQC).
- Data collection was consistent with the QAPPs and SOPs.
- The correct methods and analyses were performed by the laboratory.
- Laboratory detection limits were low enough to show exceedances of any WQC.
- Laboratory quality assurance flags show that the data are of acceptable quality.

The Division may not have information on historical data collected by third parties. However, any such data used for past assessments is presumed to have met SOP and QAPP requirements in place at the time.

6.0 TMDL DEVELOPMENT

6.1 TMDL Equation and Definitions

According to EPA (1991), a TMDL is defined as follows:

$$TMDL = \sum WLA + \sum LA + MOS$$
(Equation 1)

Where:
TMDL: The WQC, expressed as a load. The WQC for bacteria are specified in Section 2.0.

∑WLA: The sum of all Wasteload Allocations, which is the allowable loading of bacteria into the stream from all contributing KPDES-permitted sources.

∑LA: The sum of all Load Allocations, which is the allowable loading of bacteria into the stream from all sources not permitted by KPDES and from natural background.

MOS: The Margin of Safety, which is implicit in this TMDL since conservative assumptions are applied to account for uncertainties in the relationship between effluent limits and water quality.

Equation 1 can be re-written to group WLAs and LAs:

$$TMDL = (\sum WLA + \sum LA)_{Segment} + (\sum WLA + \sum LA)_{Upstream} + (\sum WLA + \sum LA)_{Tributary} + MOS$$
(Equation 2)

Where:
$(\sum WLA + \sum LA)_{Segment}$: Allowable loads for all WLA and LA sources that contribute bacteria directly to an impaired segment.

$(\sum WLA + \sum LA)_{Upstream}$: A lumped allowable load for all WLA and LA sources that contribute bacteria upstream of an impaired segment.

$(\sum WLA + \sum LA)_{Tributary}$: A lumped allowable load for all WLA and LA sources that contribute bacteria to all tributaries that flow into an impaired segment.

This translates as:
The total maximum daily load is equal to the allowable bacteria loadings discharged directly to an impaired segment plus the allowable upstream load(s) plus the allowable tributary load(s) plus the margin of safety or as:

$$TMDL = (\sum WLA + \sum LA)_{Segment} + \sum Upstream\ Load(s) + \sum Tributary\ Load(s) + MOS$$
(Equation 3)

An allowable load can be calculated as:

$$\text{Allowable Load} = Q \times WQC \times CF$$
(Equation 4)

Where:
Q: The flow that is contributed by a source or the stream flow itself, in cfs

WQC: The applicable criterion for a bacteria indicator, see Section 2.0

CF: The value that converts the product of concentration and flow to load (in units of colonies per day); it is derived from the calculation of the following components: (28.31685L/ft^3 * 86,400 seconds/day * 1000ml/L)/(100ml) and is equal to 24,465,758.4 seconds*ml/ft^3*day.

The WLA has three potential components:

$$WLA = \sum \text{SWS-WLA} + \sum \text{MS4-WLA} + \sum \text{CSO-WLA}$$
(Equation 5)

Where:
SWS-WLA: The WLA for a KPDES-permitted sanitary wastewater system that has discharge limits for bacteria (including wastewater treatment plants, sewage treatment plants, package plants and home units).

MS4-WLA: The WLA for a KPDES-permitted Municipal Separate Storm Sewer System (MS4), which can include cities, counties, universities and military bases, as well as the roads and right-of-ways owned by the Kentucky Transportation Cabinet (KYTC) within other types of MS4s.

CSO-WLA: The WLA for a KPDES-permitted Combined Sewer Overflow.

Equation 5 can be substituted into the Equation 3 to obtain:

$$TMDL = (\sum \text{SWS-WLA} + \sum \text{MS4-WLA} + \sum \text{CSO-WLA} + \sum LA)_{Segment} + \sum \text{Upstream Load(s)} + \sum \text{Tributary Load(s)} + MOS$$
(Equation 6)

For this TMDL, an implicit MOS is applied based on conservative assumptions (See Section 6.2 and Footnote 9 of Table S.3).

Equation 4 can be substituted into each load component of Equation 6 to obtain a table of allocations for all potential bacteria sources to an impaired segment (Table S.3). Note that "WQC" incorporates the full definition of each applicable criterion as specified in 401 KAR 10:031 Section 7 (see Section 2.0 of this document). The criteria for geometric means specify a concentration benchmark, an averaging period, a minimum number of samples, and season when applied. The criteria for single sample maxima specify a concentration benchmark, a percent exceedance, a sample collection period, and season when applied. Loads based on the WQC accordingly incorporate all of the elements included in the WQC. Note also if a source does not contribute to an impaired segment, that component drops out of the allocation table (i.e. if there is no MS4, the MS4-WLA component is removed from the table, etc.).

Table S.3 Segment TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment				Allocations for Upstream Loads to the Segment[7]	Allocations for Tributary Loads to the Segment[8]	MOS[9]
	SWS-WLA[3]	MS4-WLA[4]	CSO-WLA[5]	LA[6]			
Q_S×WQC×CF	∑(Q_{SWS}×WQC×CF)	∑(Q_{MS4}×WQC×CF)	∑(Q_{CSO}×WQC×CF)	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{SWS} is the flow (ft^3/s) in the segment due to a SWS entity. New or expanded SWS sources will be allowed to discharge to the segment contingent upon them meeting the PCR bacterial WQCs found in 401 KAR 10:031. SWS-WLAs will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average or as a fecal coliform effluent gross limit of 200 colonies/100 ml as a monthly average and 400 colonies/100 ml as a maximum weekly average.

[4]Q_{MS4} is the flow (ft^3/s) in the segment due to an MS4 entity. The MS4-WLA is not an end-of-pipe limit. The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP). An MS4 permittee is compliant with its MS4-WLA if it is compliant with its KPDES permit.

[5]Q_{CSO} is the flow (ft^3/s) in the segment due to a CSO entity. Dry weather CSO flows are prohibited. During wet weather events, a CSO entity is compliant with its CSO-WLA if it is compliant with its Long Term Control Plan and KPDES permit.

[6]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[7]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[8]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[9]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)Although all sources are provided an allocation at the Water Quality Standard, not all sources discharge at this maximum allocation at the same time.

(c)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

(d)For SCR-impaired segments, SWS sources must meet the PCR criterion year-round.

Figure 6.1-1 illustrates how the watershed of a hypothetical impaired segment would be divided into areas of direct, upstream, and tributary loading. Allocations in each of these areas would be assigned based on the formulas in Table S.3.

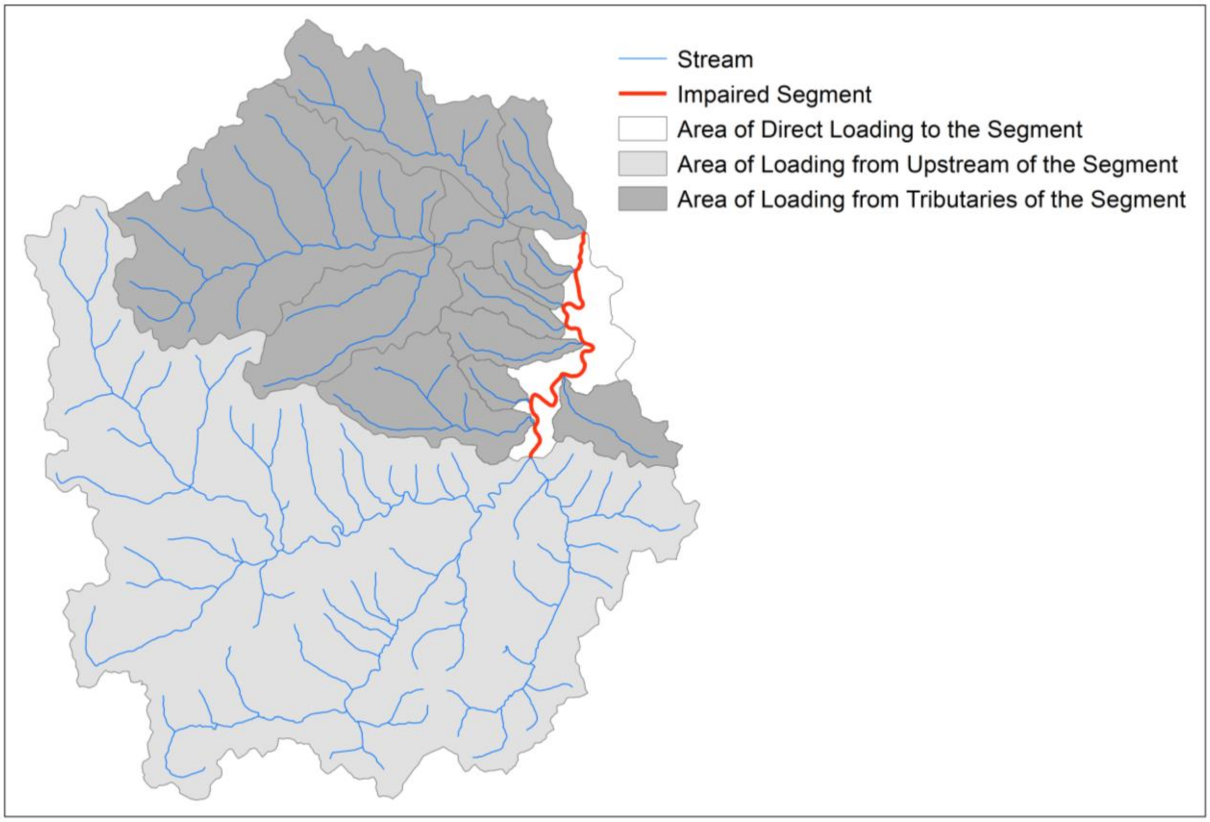

Figure 6.1-1 Areas of Direct, Upstream, and Tributary Loading

6.2 Margin of Safety

There are two methods for incorporating a MOS in the TMDL analysis: implicitly include the MOS using conservative assumptions, or explicitly designate a numerical portion of the TMDL as the MOS. For this TMDL, an implicit MOS is applied, based on the following assumptions:

(a) Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) Although all sources are provided an allocation at the Water Quality Standard, not all sources discharge at this maximum allocation at the same time.

(c) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

(d) For SCR-impaired segments, SWS sources must meet the PCR criterion year-round.

6.3 Seasonality and Critical Conditions

In addition to a WLA, LA, and MOS, federal guidelines of the Clean Water Act require that TMDLs consider seasonality and are written for a critical condition. For bacteria loadings, seasonal factors and critical conditions may differ according to whether a discharge is continuous, as from sanitary wastewater treatment facilities, or intermittent, as those related to precipitation.

6.3.1 Seasonal Variation

Seasonality is defined as yearly factors such as temporal variations in source behavior and stream loading that can affect the relationship between pollutant inputs and the ability of the waterbody to meet its designated uses. A TMDL calculation must take into account seasonality, including a description of the method chosen for including seasonal variations.

6.3.1.1 Nonpoint and KPDES-permitted Storm Water Bacteria Sources

Once deposited on or in soils, fecal bacteria can die off or re-grow. A review of factors important in the survival of fecal bacteria in soils showed, in general, longer bacteria survival time under moist, cool and low sunlight conditions (reviewed in Gerba et. al., 1975); thus, more bacteria may survive and be available for runoff from land surfaces during the late fall through early spring. Soil erosion and water runoff can both move bacteria to a stream or to groundwater. Typically in Kentucky, the highest average monthly precipitation occurs in May and the lowest average monthly precipitation occurs in October. Average precipitation data for specific localities can be found at (http://www.usclimatedata.com/climate/kentucky/united-states/3187).

For storm water and nonpoint sources, the in-stream WQC vary for the PCR and SCR seasons. Seasonality is addressed for these sources by requiring that the WQC be met in-stream during all seasons, applying the appropriate PCR or SCR criteria, and over the range of flow conditions that occur.

6.3.1.2 Sanitary Wastewater Bacteria Sources

KPDES-permitted sanitary wastewater treatment facilities are required to disinfect the wastewater effluent prior to discharge. The concentration of bacteria in the discharge is thus dependent upon the effectiveness of the disinfection process and is not expected to show any specific seasonal trend. Seasonality is addressed in the TMDL calculations by requiring KPDES-permitted sanitary wastewater facilities to meet end-of-pipe limits based on the PCR WQC throughout the year (a permit requirement).

6.3.2 Critical Conditions

For TMDL purposes, the critical condition is defined as the period when the pollutant conditions or effects are expected to be at their worst. TMDLs are required to identify the critical conditions for both point and nonpoint source loadings and to protect designated uses during these conditions.

6.3.2.1 Nonpoint and KPDES-permitted Storm Water Sources

The critical condition for storm water and nonpoint source bacteria loadings is typically an extended dry period followed by a rainfall event that moves bacteria to a stream via soil erosion or storm water runoff. During the dry weather period, bacteria build up on the land surface and are washed off by subsequent rainfall. The critical condition for nonpoint and storm water source loading of bacteria is thus identified as rainfall-related events.

For storm water and nonpoint sources, the in-stream WQC vary for the PCR and SCR seasons. The critical condition is addressed for these sources by requiring that the applicable WQC be met in-stream over the range of precipitation and flow conditions that occur.

6.3.2.2 Sanitary Wastewater Sources

As mentioned in Section 6.3.1.2, KPDES-permitted wastewater facilities are required to disinfect their discharge year-round. However, the relative contribution of fecal bacteria from sanitary wastewater dischargers versus other sources is expected to be greatest during dry periods when storm water sources are not contributing to the load and during periods of low stream flow when dilution is minimized. Therefore, the critical conditions for wastewater facility sources are defined as dry events (i.e. during periods of no rainfall) and low stream flow conditions.

Once in a stream, fecal bacteria are known to sorb to soil particles and settle into the sediments of the stream bed. These soil-sorbed bacteria can become re-suspended in the water column during turbulent water flow conditions. This resuspension of fecal bacteria along with rainfall-related source contributions frequently results in high fecal bacteria concentrations measured following rainfall events.

The critical conditions are addressed in the TMDL calculations by requiring KPDES-permitted sanitary wastewater facilities to meet end-of-pipe limits based on the PCR WQC for bacteria (a permit requirement), regardless of precipitation or flow in the stream.

7.0 IMPLEMENTATION

Implementation of a TMDL may involve a variety of measures to reach the water quality goals for an impaired stream segment. These measures may include limitations in a KPDES permit and a combination of actions or best practices selected by stakeholders to control the discharge of the pollutant(s) of concern into the waterbody. This TMDL determines allowable bacteria loads based on the recreational criteria and flow rates. As discussed in Section 2.0, a waterbody's use support is not assessed based on a single sample result. It follows that it is also not appropriate to evaluate compliance with this TMDL by calculating a load based on a single sample concentration and comparing that calculated load to the allowable load. That is, allocations for discharges should not be interpreted as a "not to exceed" discharge load on any given day.

7.1 KPDES-Permittees with Point Source Discharges

For KPDES-permitted sources of bacteria to impaired waterbodies, an approved TMDL is implemented through the permitting process. Permits must be consistent with the requirements and assumptions of the WLA indicated in the TMDL; typically, any needed updates occur with the next permit reissuance. The TMDL may include alternative expressions of permittees' WLAs to facilitate implementation. When applicable, permits continue to include requirements related to pollution prevention and public education and involvement in water quality issues, which may, in turn, enhance other stakeholders' efforts to address nonpoint sources of pollution.

7.1.1 Permit Translation

SWS-WLAs will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average or as a fecal coliform effluent gross limit of 200 colonies/100 ml as a monthly average and 400 colonies/100 ml as a maximum weekly average. New or expanded SWS sources will be allowed to discharge to an impaired segment covered by this TMDL contingent upon them meeting the PCR bacterial WQCs found in 401 KAR 10:031.

In contrast to the continuously flowing discharges from SWS facilities, permitted discharges from storm water sources are intermittent and vary widely in flow, composition, and duration. Because of the complexity of storm water discharges, EPA recommends that the permitting authority express the WLA for Phase I and II storm water permittees in narrative, rather than numeric, terms when translating the WLA into effluent limitations in the permit (U.S. EPA, 2002 and 2014). Narrative requirements often are expressed in the permit as BMPs or other storm water management measures.

The following assumptions reflect the complex nature of storm water discharges and are provided to facilitate implementation of the WLA for the KPDES-permitted storm water sources in this TMDL.

The MS4-WLA is not an end-of-pipe limit. The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. MS4-WLAs will be addressed through the storm water permit and implemented through the Storm Water Quality Management Plan (SWQMP). An MS4 permittee is compliant with its MS4-WLA if it is compliant with its KPDES permit.

Dry weather CSO flows are prohibited. During wet weather events, a CSO entity is compliant with its CSO-WLA if it is compliant with its Long Term Control Plan and KPDES permit.

7.2 Nonpoint Sources

Nonpoint sources' compliance with the load allocation is voluntary, and many of these sources are not regulated by the Division. Thus, reducing the bacteria load from nonpoint sources – which is highly correlated to how land is used – will depend on voluntary actions by citizens, property owners, and other stakeholders who use the land resources within the watershed of an impaired water. Technical assistance and a watershed-based approach to TMDL implementation can help stakeholders collaborate to achieve water quality goals.

Section 303(e) of the Clean Water Act and 40 CFR Part 130, Section 130.5 require states to have a continuing planning process (CPP) composed of several parts specified in the Act and the regulation. The CPP provides an outline of agency programs and the available authority to address water issues. Under the CPP umbrella, the Division's Watershed Management Branch will be available to provide technical support for developing and implementing watershed plans to address water quality and quantity problems and threats. Developing watershed plans allows limited resources to be targeted more effectively, thus improving environmental benefit, protection and recovery. More information is available at https://eec.ky.gov/Environmental-Protection/Water/Protection/Pages/WatershedPlanning.aspx.

7.2.1 Kentucky Watershed Management Framework

In 1998 the Division adopted a watershed management framework approach to water quality management. The framework divides Kentucky's major drainage basins into five groups of basins which are cycled through a five-year staggered process that involves monitoring, assessment, prioritization, plan development, and plan implementation. As part of the process, the Watershed Management Branch funds and assigns a basin coordinator to each river basin. Basin coordinators work with a variety of government agencies, local officials, nonprofit groups, businesses, citizens and other stakeholders to develop and support a local watershed management team associated with each priority watershed. Coordinators bring together the ongoing efforts in the watershed to evaluate water quality, educate the general public, identify common goals, secure needed funding, and carry out watershed improvement activities. They build community support by promoting awareness of issues, developing relationships and involving partners in projects, which creates a network of stakeholders with a vested interest in the success of the effort. For more information about the river basins and coordinators, see:

https://eec.ky.gov/Environmental-Protection/Water/Outreach/BasinCoordination/Pages/default.aspx.

Local watershed teams may choose to develop a watershed plan to detail conditions in their watershed and guide efforts to protect and restore threatened or impaired waters. Watershed plans provide an integrative approach for identifying and describing who, when, where, what, and how actions should be taken in order to meet water quality standards. A watershed plan should address both point and nonpoint sources of pollution in the watershed, build on existing efforts, and evaluate new approaches. The plan should incorporate all available restoration and protection mechanisms. A comprehensive watershed plan should consider both voluntary and regulatory approaches to meet water quality standards.

The Watershed Management Branch and Kentucky Waterways Alliance have jointly published the Watershed Planning Guidebook for Kentucky Communities. The publication provides guidance on forming a watershed planning team, developing supportive partnerships, understanding watershed hydrology, finding data sources, monitoring for new data, analyzing data, selecting BMPs, securing funding, and measuring progress of plan implementation.

7.2.2 Kentucky Nonpoint Source Pollution Control Program

The Watershed Management Branch administers the Kentucky Nonpoint Source Pollution Control Program, an effort to reduce pollution from storm runoff in the state. The USEPA provides funding for this program through Section 319(h) of the Clean Water Act. The Division uses the 319(h) funding for competitively awarded grants to projects that focus on reducing nonpoint source pollution. Projects eligible to compete include watershed-based plan development and implementation, demonstration of innovative best management practices, education and outreach programs, and protection of Special Use Waters with identified threats. Priority consideration is given to applications for watershed plan development and implementation for waterbodies on the 303(d) list and protection of threatened Special Use Waters. Funds can be used to pay for 60 percent of the total cost for each project. A 40 percent nonfederal match is required. More information, including grant application forms, can be found at https://eec.ky.gov/Environmental-Protection/Water/Protection/Pages/Section-319(h)-Grant-Program-Funding.aspx.

Some projects in an approved watershed plan that improve drinking water sources or provide wastewater management may be eligible for low-interest loans from the State Revolving Fund. More information is available at https://eec.ky.gov/Environmental-Protection/Water/Funding/CWSRF/Pages/default.aspx.

7.3 Other KDEP Programs and Initiatives

7.3.1 Kentucky Division of Compliance Assistance

The Division of Compliance Assistance (DCA) provides a range of services that increase environmental knowledge and encourage behavioral changes, with the goals of improving regulatory compliance, optimizing performance at regulated locations, and enhancing the quality of Kentucky's environment. DCA provides assistance and education to regulated entities so they understand and can comply with their environmental obligations. To assure that operators' actions are appropriate and their operation of regulated facilities is effective, DCA administers the wastewater, drinking water and solid waste operator certification process and provides courses and test preparation materials for applicants. Other programs aim to assist and educate citizens, communities and businesses so they make informed choices that value the environment and promote sustainable practices. More detail is available at https://eec.ky.gov/Environmental-Protection/Compliance-Assistance/Pages/default.aspx.

DCA established and administers KY EXCEL, the Kentucky Excellence in Environmental Leadership program. KY EXCEL is a voluntary membership program that recognizes businesses, organizations, cities, farms and individuals committed to environmental stewardship. The program offers varying levels of membership, but all levels involve completing and reporting on at least one voluntary environmental project each year. Completed projects that relate to water quality include placement of rain barrels and tanks to capture storm water for later use in landscape watering; installation of pervious pavers and bioswales to slow storm water runoff and increase storm water infiltration into the ground; and restoration of native vegetation and natural areas, which also slow storm water runoff.

7.3.2 Kentucky Division of Water

The Division offers additional resources to encourage citizen awareness and involvement in water quality issues and stewardship. The Division publishes TMDL watershed reports at https://eec.ky.gov/Environmental-Protection/Water/Protection/TMDL/Pages/TMDL-HealthReports.aspx. Initial Watershed Reports describe why the watershed is being monitored, where the impaired streams are located within the watershed, and where the TMDL program will monitor the watershed. Watershed Health Reports provide a comprehensive summary of water quality and biological health based on completed monitoring. Health reports assign report card letter grades to the watershed's health as a whole and to component aspects. They also advise citizens on actions they can take to be good stewards of water resources. The reports can be accessed from an interactive map of the major river basins.

The Water Health Portal is a user-friendly, interactive online mapping tool that provides water quality information for any assessed stream in Kentucky. Portal users can find out what uses have been assessed and the use support status of a waterbody of interest. Users can also open existing watershed health reports and TMDL documents and links to data and basin information (such as watershed planning areas and contact information for basin coordinators).

7.4 Other State and Federal Assistance and Programs

Changes in government organization or funding can affect program availability. For the most up-to-date information about available assistance, contact the Watershed Management Branch at (502) 564-3410. The following list of programs is not intended to be exhaustive, but to provide examples of potential options.

7.4.1 Local Conservation Districts

In 2016 the Kentucky Soil Erosion and Water Quality Cost Share Program and the Kentucky Soil Stewardship Program provided financial and technical assistance for agricultural operations to implement their Agriculture Water Quality plans and protect soil and water resources. Funds were administered by local conservation districts and the Kentucky Soil and Water Conservation Commission. Priority was given to animal waste-related problems, agricultural district participants and to producers who have their Agriculture Water Quality plans on file with their local conservation districts.

A wide variety of BMPs were eligible for cost share. Measures related to slowing the movement of bacteria to waterbodies include: agricultural and animal waste control facilities, stream bank stabilization, animal waste utilization, vegetative filter strips, sinkhole protection, pasture and hay land erosion control, heavy use area protection, rotational grazing system establishment, water well protection, closure of agricultural waste impoundments, on-farm fallen animal composting, livestock stream crossings, and riparian area protection. More information about the cost share program is available at https://eec.ky.gov/Natural-Resources/Conservation/Pages/State-Cost-Share.aspx.

Local conservation districts also processed applications and disbursed funds from the County Agricultural Investment Program of the Kentucky Agricultural Development Fund. Projects qualifying for this cost share program have included fencing, on-farm water, and animal waste handling and distribution equipment.

7.4.2 Kentucky Heritage Land Conservation Fund

As of 2016, the Kentucky Heritage Land Conservation Fund provided funding to preserve and conserve unique natural areas that are habitat for rare and endangered species, are important to migratory birds, perform important natural functions that are subject to alteration or loss, or in their preserved natural state serve public use, outdoor recreation, and education. Land has been purchased with Heritage funds to preserve riparian corridors, protect water supply, and provide habitat, among other functions. Half of the funds are allocated to state agency programs (Department of Fish and Wildlife Resources, Department of Parks, Division of Forestry, Kentucky State Nature Preserves Commission, and Kentucky Wild Rivers Program).

The remaining 50 percent of funds are distributed to local governments, state colleges/universities, nonprofit land trusts, and other state agencies. For more information about the fund, visit https://eec.ky.gov/Nature-Preserves/conserving_natural_areas/KHLCF/Pages/heritage-land-conservation-fund.aspx.

7.4.3 Kentucky Department of Fish and Wildlife Resources

In 2016 the Kentucky Department of Fish and Wildlife Resources (KDFWR), under an agreement with the U.S. Army Corps of Engineers, administered the Kentucky Wetland and Stream Mitigation "Fee In-Lieu Of" (FILO) program. When entities acting under Sections 404 and 401 of the Clean Water Act perform activities resulting in the permanent loss of streams or wetlands, they are required to ensure that mitigation projects are completed to compensate for the loss. One option for compensatory mitigation was for permit applicants to pay a fee to the FILO program to conduct a mitigation project rather than conducting it themselves.

The KDFWR has used FILO funds to offer landowners repairs to eroding and unstable streams and wetlands at no cost to the landowner. Projects must meet qualifying criteria and may occur on public or private lands. Projects must be permanently protected; stream projects on private lands must be protected by a permanent conservation easement, typically at least 50 feet wide on each side of the stream. Properties may also be purchased for conservation, in which case deed restrictions are placed on the tracts.

While these stream restoration projects address physical instability (erosion), mitigation measures that stabilize banks with native vegetation, restore meander patterns, and slow the flow of water have the potential to slow and reduce pollutant loadings to a waterbody.

FILO projects in Boone, Kenton, Campbell, Carroll, Gallatin, Grant, Pendleton, Bracken and Mason counties were administered by Northern Kentucky University. More information about the Stream Team Program, as it is known, can be found at http://fw.ky.gov/Fish/Pages/Stream-Team-Program.aspx.

KDFWR also offered technical assistance to owners of private property of at least 25 acres to improve wildlife habitat. Participation in the Habitat Improvement Program can help property owners access related available funds and other assistance offered by state, federal, and private agencies. More information may be found at http://fw.ky.gov/Wildlife/Pages/Improve-Your-Land-for-Wildlife.aspx.

7.4.4 Kentucky Division of Forestry

The Kentucky Division of Forestry's mission is to protect, conserve, and enhance the state's forest resources through a public informed of these resources' importance. The division offers private forestland owners the Kentucky Forest Stewardship Program, in which natural resource professionals provide a customized forest stewardship plan that includes practices that can protect water quality. The division's urban and community forestry program can provide technical assistance to municipalities, nonprofit organizations, educational institutions, and private landowners. The program's primary goal is to assist communities in developing long-term, self-sustaining urban forestry programs in developed areas. More information about Division of Forestry programs can be found at https://eec.ky.gov/Natural-Resources/Forestry/Pages/default.aspx.

7.4.5 Natural Resources Conservation Service

In 2016 the Environmental Quality Incentives Program (EQIP) of the NRCS provided financial and technical assistance to agricultural producers to address natural resource concerns on their property. The program has helped producers plan and implement conservation practices, including BMPs required under AWQA, that improve soil, water, plant, animal and related natural resources on agricultural land and non-industrial private forestland. Eligible measures included BMPs, grazing management, erosion control, and wildlife habitat enhancement, among others. More information about EQIP can be found at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?cid=stelprdb1044009 and http://www.nrcs.usda.gov/wps/portal/nrcs/main/ky/programs/financial/eqip/.

As of 2016, the Farm Service Agency of NRCS administered the Conservation Reserve Program (CRP). Operating under a 10-15 year contract, farmers would receive a yearly rental payment for removing environmentally sensitive land from agricultural production and planting species that will improve the lands' environmental health and quality. The program's long-term goal is to re-establish valuable land cover to help improve water quality, prevent soil erosion, and reduce loss of wildlife habitat.

In 2016 NRCS Wetland Reserve Enhancement Partnership provided funding for wetland easements on agricultural land. In addition to habitat value, conserved or restored wetlands improve stream and lake quality by filtering sediments and contaminants, reducing flooding, and slowing storm runoff. Information about the partnership can be found at https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/.

In 2016 the NRCS Conservation Stewardship Program encouraged landowners to improve and maintain existing conservation practices along with implementing additional activities to address priority natural resource concerns. Participants received financial and technical assistance, with annual land use payments tied to the performance and environmental benefit of the conservation activities (the higher the performance, the higher the payment). For more information, see http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/programs/financial/csp/?cid=nrcs143_008316.

7.4.6 U.S. Geological Survey

The U.S. Geological Survey (USGS) is the principal federal earth science agency dedicated to collecting, interpreting, publishing, and disseminating reliable and impartial information about the nation's energy, land, mineral, and water resources. The USGS Indiana-Kentucky Water Science Center may lead or participate in studies or data collection efforts that help stakeholders identify and address sources of water pollution.

7.5 Local Government and Non-Governmental Organizations

A variety of organizations or institutions in local communities may be able to provide funding, technical, and/or advisory assistance with water quality improvement activities. Such groups include Watershed Watch, local health departments, local government agencies, economic or community development organizations, colleges and universities, and organizations that advocate for environmental stewardship or conservation.

7.5.1 Watershed Watch

The Division is a founding member of Watershed Watch, a citizens' volunteer water monitoring effort. The program promotes awareness of Clean Water Act goals, Kentucky's watershed management framework and local water quality issues. Watershed Watch enlists volunteers to help in the assessment of waterways in the state. The eight Watershed Watch basins in Kentucky operate from individual grant funding, including that received annually from the Virginia Environmental Endowment since the organization's inception.

Other partners providing technical support include:

- Kentucky Geological Survey, which houses all Watershed Watch data in Kentucky and makes it available online in a searchable, interactive mapping portal at http://kgs.uky.edu/wwky/main.htm; and
- Kentucky Center of Excellence for Watershed Management and Kentucky Water Resources Research Institute, which provide technical advice and assistance to volunteers on such topics as collection and interpretation of water quality data.

Watershed Watch supplies all necessary materials and equipment and trains volunteers to learn how to properly collect grab samples and basic water chemistry field data such as pH, dissolved oxygen, temperature and conductivity. Volunteers may also receive training to conduct biological, physical and habitat assessments of stream sites. Collected data may be useful in identifying potential causes and sources of water pollution and developing watershed plans to improve water quality (see also Section 7.2.1).

More information about Watershed Watch and the eight participating basins can be found at http://kywater.org/.

7.5.2 Other Implementation Partners

Local health departments may be able to assist implementation efforts by conducting several activities related to septic system integrity. These include surveys to identify failing systems, providing oversight of system maintenance, increasing the frequency of system inspection, mapping areas where conditions are unfavorable for septic installation, and evaluating the effectiveness of system design criteria.

Local government agencies may be able to provide public education about the importance of proper waste disposal, pollution prevention, or recycling. They may provide sewer or waste pickup services or organize events such as specialty waste drop-off or litter cleanup days. They may introduce and enforce ordinances designed to protect water quality.

College and university personnel may be able to lend expertise in such areas as water quality, hydrology, watershed ecology, stream or ecological restoration, watershed plan development, pollution modeling, pollution prevention, public health, land management, and land use planning.

Local organizations may also be able to assist with a variety of other activities related to improving surface water quality. Examples include:

- Watershed plan development
- Sanitary wastewater management, including straight pipe elimination, extension of sewer lines into communities without service, and septic system education, maintenance, repair, or replacement
- Development or revision of nutrient management or Agriculture Water Quality plans
- Planning and installation of agriculture and forestry BMPs such as fencing, heavy use areas, managed grazing, stream crossings, bank stabilization, etc.
- Stream channel or bank restoration
- Planning and securing of easements or tracts of land for conservation
- Facilitating networking and communication among stakeholders working on water quality issues
- Organizing volunteers
- Planning or advice to businesses, apartment complexes, and places of worship seeking ways to reduce their environmental impact
- Workshops or other educational programming related to water quality, watersheds, storm water, point and nonpoint source pollution, and rain barrels, rain gardens, and other BMPs
- Organizing community involvement activities such as storm drain marking, tree planting, and public tours of installed BMPs

The list of example activities above is not intended to be exhaustive. Many other activities may be undertaken to improve water quality. The best way for stakeholders to identify potential implementation partners is to contact the Watershed Management Branch for an up-to-date list of partners in your watershed.

8.0 PUBLIC PARTICIPATION

The public was invited to provide written comments on the Proposed Draft of the Kentucky Statewide TMDL for Bacteria Impaired Waters during the period March 14, 2018 through June 11, 2018. Legal advertisements were purchased in the following local newspapers throughout the state: The Appalachian News-Express (Pikeville, Pike Co.), The Courier-Journal (Louisville, Jefferson Co.), The Daily Independent (Ashland, Boyd Co.), The Daily News (Bowling Green, Warren Co.), The Gleaner (Henderson, Henderson Co.), The Herald-Leader (Lexington, Fayette Co.), The Middlesboro Daily News (Middlesboro, Bell Co.), and The Paducah Sun (Paducah, McCracken Co.).

In addition, the public notice was distributed electronically through the "Nonpoint Source Pollution Control" mailing list (https://eec.ky.gov/Environmental-Protection/Water/Protection/Pages/Nonpoint-Source-Pollution.aspx) of persons interested in water quality issues, and was emailed to the TMDL Listserv, which is a list of persons interested in TMDL-related issues. Summary information about the TMDL, with emphasis on the methodology used, was presented to stakeholders at the Green River Basin Team meeting on July 25, 2017 and the Kentucky Stormwater Association quarterly meeting on April 30, 2018.

All comments received during the public notice period were incorporated into the administrative record for this TMDL. Comments received and the responses to them have been incorporated into this TMDL in Appendix Q. Based upon comments received, some revisions were made to the final TMDL document.

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APPENDIX A

Appendix A

Table A-1 MS4 Communities in Kentucky as of September 2018

County	Permittee	KPDES No.	Co-Permittee(s) / Included Communities
All	Kentucky Transportation Cabinet	KYS000003	
Anderson	City of Lawrenceburg	KYG200055	
Barren	City of Glasgow	KYG200012	
Bell	City of Middlesboro	KYG200045	
Boone	City of Florence	KYG200013	
Boone, Campbell, Kenton	Sanitation District No.1 of Northern Kentucky	KYG200007	Alexandria, Bellevue, Bromley, Covington, Crescent Springs, Crestview, Crestview Hills, Dayton, Edgewood, Elsmere, Erlanger, Fort Mitchell, Fort Thomas, Fort Wright, Highland Heights, Independence, Kentonvale, Lakeside Park, Ludlow, Melbourne, Newport, Park Hills, Silver Grove, Southgate, Taylor Mill, Union, Villa Hills, Wilder, Woodlawn, unincorporated Boone, Campbell and Kenton counties
Boone, Kenton	City of Walton	pending	
Boyd	City of Ashland	KYG200002	Boyd County Fiscal Court, Cattletsburg
Boyle	City of Danville	KYG200014	
Bullitt	Bullitt County Fiscal Court	KYG200039	Cities of Fox Chase, Hebron Estates, Hillview, Hunters Hollow, Pioneer Village, Shepherdsville
Bullitt	City of Mt. Washington	KYG200010	
Calloway	City of Murray	KYG200011	Murray State University
Campbell	City of Cold Spring	KYG200057	
Christian	City of Hopkinsville	KYG200009	
Christian	City of Oak Grove	KYG200042	
Christian	Fort Campbell	KYG200050	
Clark	City of Winchester	KYG200043	
Daviess	City of Owensboro	KYG200018	Daviess County
Fayette	Lexington-Fayette Urban County Government	KYS000002	
Fayette	University of Kentucky	KYG200052	
Franklin	City of Frankfort	KYG200034	Franklin County
Graves	City of Mayfield	KYG200016	
Greenup	City of Greenup	KYG200026	
Greenup	City of Raceland	KYG200027	
Greenup	Greenup County Fiscal Court	KYG200025	Cities of Bellefonte, Flatwoods, Russell, Worthington, Wurtland

County	Permittee	KPDES No.	Co-Permittee(s) / Included Communities
Hardin	City of Elizabethtown	KYG200035	
Hardin	City of Radcliff	KYG200001	
Hardin	City of Vine Grove	KYG200038	
Hardin	City of West Point	KYG200004	
Hardin, Meade	Fort Knox	federal permit	
Hardin	Hardin County Fiscal Court	KYG200003	
Henderson	City of Henderson	KYG200019	Henderson County
Hopkins	City of Madisonville	KYG200022	
Jefferson	Louisville Metropolitan Sewer District	KYS000001	Cities of Anchorage, Jeffersontown, St. Matthews, Shively, Louisville Metro
Jessamine	City of Nicholasville	KYG200041	
Jessamine	Jessamine County Fiscal Court	KYG200049	
Madison	City of Berea	KYG200054	
Madison	City of Richmond	KYG200006	
Madison	Eastern Kentucky University	KYG200053	
McCracken	City of Paducah	KYG200021	
Meade	City of Muldraugh	KYG200033	
Nelson	City of Bardstown	KYG200037	
Oldham	City of Pewee Valley	KYG200051	
Oldham	Oldham County Fiscal Court	KYG200005	Cities of Crestwood, Goshen, LaGrange, Orchard Grass Hills, River Bluff
Pulaski	City of Somerset	KYG200044	
Scott	City of Georgetown	KYG200040	Georgetown College
Scott	Scott Co. Fiscal Court	Pending	Designated Unincorporated Area(s)
Shelby	City of Shelbyville	KYG200023	
Shelby	Shelby Co. Fiscal Court	pending	Unincorporated Area Adjacent to Louisville Urbanized Area
Taylor	City of Campbellsville	KYG200015	
Warren	City of Bowling Green	KYG200020	
Warren	Plum Springs and Warren Co. Joint Storm Water Sewer Agency	KYG200055	
Warren	Western Kentucky University	KYG200056	

APPENDIX B

Appendix B

Table B-1 Percent of Households Serviceable by Sewer, 2010

County	2010 Population	2010 Households	Serviceable Households	Percent Serviceable
Adair	18,656	8,568	1,970	23
Allen	19,956	9,307	2,043	22
Anderson	21,421	9,127	5,749	63
Ballard	8,249	3,885	1,553	40
Barren	42,173	19,188	8,862	46
Bath	11,591	5,405	1,758	33
Bell	28,691	13,154	6,308	48
Boone	118,811	46,154	39,806	86
Bourbon	19,985	8,927	5,312	60
Boyd	49,542	21,803	17,655	81
Boyle	28,432	12,312	8,643	70
Bracken	8,488	3,840	925	24
Breathitt	13,878	6,231	1,401	23
Breckinridge	20,059	10,630	1,500	14
Bullitt	74,319	29,318	15,818	54
Butler	12,690	5,877	1,129	19
Caldwell	12,984	6,292	3,236	51
Calloway	37,191	18,065	9,208	51
Campbell	90,336	39,523	34,598	88
Carlisle	5,104	2,441	604	25
Carroll	10,811	4,696	3,037	65
Carter	27,720	12,311	2,873	23
Casey	15,955	7,487	1,055	14
Christian	73,955	29,459	19,450	66
Clark	35,613	15,706	11,106	71
Clay	21,730	8,875	1,834	21
Clinton	10,272	5,311	1,297	24
Crittenden	9,315	4,569	1,565	34
Cumberland	6,856	3,690	820	22
Daviess	96,656	41,452	32,213	78
Edmonson	12,161	6,467	633	10
Elliott	7,852	3,371	368	11
Estill	14,672	6,865	2,217	32
Fayette	295,803	135,160	131,252	97
Fleming	14,348	6,623	1,618	24
Floyd	39,451	18,175	4,878	27
Franklin	49,285	23,164	17,084	74
Fulton	6,813	3,372	2,384	71
Gallatin	8,589	3,786	1,204	32
Garrard	16,912	7,463	1,854	25
Grant	24,662	9,942	4,168	42

County	2010 Population	2010 Households	Serviceable Households	Percent Serviceable
Graves	37,121	16,777	5,884	35
Grayson	25,746	13,561	3,323	25
Green	11,258	5,324	1,459	27
Greenup	36,910	16,330	9,286	57
Hancock	8,565	3,734	1,415	38
Hardin	105,543	43,261	12,333	29
Harlan	29,278	13,513	5,544	41
Harrison	18,846	8,208	3,186	39
Hart	18,199	8,559	2,368	28
Henderson	46,250	20,320	13,885	68
Henry	15,416	6,640	2,357	36
Hickman	4,902	2,342	627	27
Hopkins	46,920	21,180	13,785	65
Jackson	13,494	6,523	483	7
Jefferson	741,096	337,616	330,563	98
Jessamine	48,586	19,331	14,439	75
Johnson	23,356	10,624	2,956	28
Kenton	159,720	68,975	64,499	94
Knott	16,346	7,461	885	12
Knox	31,883	14,485	4,632	32
Larue	14,193	6,172	1,535	25
Laurel	58,849	25,446	9,281	37
Lawrence	15,860	7,286	1,934	27
Lee	7,887	3,436	973	28
Leslie	11,310	5,278	664	13
Letcher	24,519	11,601	3,303	29
Lewis	13,870	6,481	1,190	18
Lincoln	24,742	10,819	2,691	25
Livingston	9,519	4,824	2,019	42
Logan	26,835	12,339	4,861	39
Lyon	8,314	4,791	1,602	33
Madison	82,916	35,043	21,955	63
Magoffin	13,333	5,950	1,329	22
Marion	19,820	8,182	3,238	40
Marshall	31,448	15,748	3,881	25
Martin	12,929	5,164	566	11
Mason	17,490	8,105	4,576	57
McCracken	65,565	31,079	21,651	70
McCreary	18,306	7,507	1,730	23
McLean	9,531	4,264	1,812	43
Meade	28,602	11,762	2,562	22
Menifee	6,306	3,744	572	15
Mercer	21,331	9,941	4,349	44
Metcalfe	10,099	4,681	810	17

County	2010 Population	2010 Households	Serviceable Households	Percent Serviceable
Monroe	10,963	5,204	1,510	29
Montgomery	26,499	11,699	6,271	54
Morgan	13,923	5,830	850	15
Muhlenberg	31,499	13,699	5,278	39
Nelson	43,437	18,075	8,263	46
Nicholas	7,135	3,261	1,262	39
Ohio	23,842	10,219	3,290	32
Oldham	60,316	20,688	10,878	53
Owen	10,841	5,634	934	17
Owsley	4,755	2,328	411	18
Pendleton	14,877	6,339	1,575	25
Perry	28,712	12,791	3,780	30
Pike	65,024	30,304	6,489	21
Powell	12,613	5,598	1,923	34
Pulaski	63,063	31,443	7,076	23
Robertson	2,282	1,095	260	24
Rockcastle	17,056	7,703	2,061	27
Rowan	23,333	10,102	5,748	57
Russell	17,565	9,993	2,996	30
Scott	47,173	19,303	13,093	68
Shelby	42,074	16,606	8,598	52
Simpson	17,327	7,435	4,437	60
Spencer	17,061	6,704	667	10
Taylor	24,512	10,864	5,189	48
Todd	12,460	5,286	1,700	32
Trigg	14,339	7,810	1,444	19
Trimble	8,809	3,930	948	24
Union	15,007	6,141	3,706	60
Warren	113,792	47,223	29,328	62
Washington	11,717	5,044	1,305	26
Wayne	20,813	10,942	2,924	27
Webster	13,621	5,936	2,816	47
Whitley	35,637	15,166	4,917	32
Wolfe	7,355	3,660	365	10
Woodford	24,939	10,711	7,309	68

APPENDIX C

Appendix C
Big Sandy River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX D

Appendix D
Green River Basin

HUC 8: 05110001, 05110002, 05110003, 05110004, 05110005, 05110006

Level IV Ecoregions: Green River-Southern Wabash Lowlands, Wabash-Ohio Bottomlands, Caseyville Hills, Crawford-Mammoth Cave Uplands, Western Pennyroyal Karst Plain, Mitchell Plain, Eastern Highland Rim

Drainage Area Within Kentucky: 8,822 square miles

Counties: Adair, Allen, Barren, Breckinridge, Butler, Casey, Christian, Daviess, Edmonson, Grayson, Green, Hancock, Hardin, Hart, Henderson, Hopkins, Larue, Lincoln, Logan, Marion, McLean, Metcalfe, Monroe, Muhlenberg, Ohio, Pulaski, Russell, Simpson, Taylor, Todd, Warren, Webster

Major Cities: Bowling Green, Elizabethtown, Madisonville, Glasgow, Campbellsville, Franklin, Russellville, Leitchfield, Central City, Columbia, Greenville, Scottsville, Beaver Dam, Hodgenville, Hartford, Tompkinsville, Morgantown, Horse Cave

The Green River basin is located in south-central to western Kentucky.

The Green River originates in Lincoln Co., Ky., near Halls Gap. At a 1:100,000 scale, it quickly becomes a fourth order stream at the confluence with the South Fork of the Green. It flows southwest through Casey Co. (where it becomes fifth order below Knob Lick Creek), then west through Adair. The river briefly passes through Taylor Co., where a dam at mile 308.9 forms Green River Lake, before flowing into Green Co. The river meanders westward into Hart and Edmonson counties, where springs draining the area's sinkhole plain replace surface streams as tributaries. After flowing through Mammoth Cave National Park, its meanders broaden and the Green forms the border between Warren and Butler counties. At Rochester, the Green veers northwest along the Muhlenberg-Ohio Co. border. After passing through McLean Co., the river turns north along the borders of Webster, Henderson and Daviess counties. At its confluence with the Barren River, a major tributary, the Green becomes a seventh order stream. It discharges into the Ohio River at river mile 781 near Henderson, Ky., after flowing for nearly 384 miles.

Table D.1. provides a summary of the stream segments in the Green basin that have been included on the 303(d) list for impairment due to fecal coliform and/or *E. coli*. The locations of the stream segments are shown in Figure D.1.

Table D.1 Bacteria-impaired Stream Segments in the Green Basin

Waterbody Name	Waterbody ID	Impaired Use (Support Status)	Pollutant	Suspected Source(s)	Year of TMDL Public Notice
Barren River 0 to 8.4	KY517526_01	PCR (partial support)	*E. coli*	Non-Point Source	2018

Waterbody Name	Waterbody ID	Impaired Use (Support Status)	Pollutant	Suspected Source(s)	Year of TMDL Public Notice
Barren River 104.8 to 119.3	KY517526_06	PCR (nonsupport), SCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Beaver Creek 8.5 to 15.75	KY486609_01	PCR (nonsupport)	Fecal Coliform	Upstream Source	2018
Big Reedy Branch 0 to 2.4[1]	KY487230_01	PCR (nonsupport)	Fecal Coliform	Crop Production (Crop Land or Dry Land), Habitat Modification - other than Hydromodification, Source Unknown	See footnote
Buck Creek 0 to 8.0	KY488213_01	PCR (nonsupport)	Fecal Coliform	Loss of Riparian Habitat, Permitted Runoff from Confined Animal Feeding Operations (CAFOs)	2018
Buck Creek 8.0 to 11.0	KY488213_02	PCR (nonsupport)	*E. coli*	Animal Feeding Operations (NPS), Non-Point Source	2018
Buck Fork Pond River 12.9 to 19.3	KY488223_02	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Caney Creek 0 to 6.8	KY488846_01	PCR (nonsupport)	*E. coli*	Source Unknown	2018
Caney Creek 1.4 to 5.25[1]	KY488828_01	PCR (nonsupport)	Fecal Coliform	Source Unknown	See footnote
Crooked Creek 0 to 3.0	KY490376_00	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Deer Creek 0 to 8.4	KY490771_01	PCR (partial support)	*E. coli*	Non-Point Source	2018
Deserter Creek 0 to 3.1	KY490828_01	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Elk Creek 7.6 to 10.6	KY491656_02	PCR (nonsupport)	Fecal Coliform	Sanitary Sewer Overflows (Collection System Failures)	2018
Elk Pond Creek 0 to 4.9	KY491671_00	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Gasper River 7.8 to 14.6	KY492748_01	PCR (partial support)	*E. coli*	Source Unknown	2018
Goodman Springs (9000-0230)[2]	KY499512-59.65_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
Goren Mill Spring (9000-0793)[2]	KY493284-226.7_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
Graham Spring (9000-0051)[2]	KY517526-34.65_00	PCR (partial support)	*E. coli*	Source Unknown	See footnote
Green River 210.4 to 250.2	KY493284_08	PCR (partial support)	*E. coli*	Source Unknown	2018
Green River 283.1 to 309.0	KY493284_13	PCR (nonsupport)	Fecal Coliform	Package Plant or Other Permitted Small Flows Discharges	2018
Head of Rough River Spring 154.85 to 155.8[2]	KY502390_07	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
Jarrels Creek 0 to 1.8	KY495175_00	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Knoblick Creek 0 to 2.1	KY495848_00	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018

Waterbody Name	Waterbody ID	Impaired Use (Support Status)	Pollutant	Suspected Source(s)	Year of TMDL Public Notice
Long Falls Creek 0 to 7.6	KY497098_01	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Long Falls Creek 7.6 to 11.9	KY497098_02	PCR (nonsupport)	Fecal Coliform	Loss of Riparian Habitat	2018
Lost River Rise (9000-0054)[2]	KY495207-3.2_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
Mahurin Spring (9000-0202)[2]	KY504135-4.35_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
McCoy Bluehole Spring (9000-0792)[2]	KY493284-212.5_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
Mill Creek 0 to 4.2	KY498260_00	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Mill Spring (9000-1193)[2]	KY499512-38.7_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
Nolynn Spring (9000-2673)[2]	KY499559-1.3_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
North Fork of Panther Creek 4.2 to 9.1	KY499562_02	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
Panther Creek 0.1 to 3.0	KY500157_01	PCR (nonsupport)	*E. coli*	Agriculture, Unspecified Urban Stormwater	2018
Panther Creek 0.1 to 3.0	KY500157_01	SCR (nonsupport)	Fecal Coliform	Agriculture, Unspecified Urban Stormwater	2018
Panther Creek 3.0 to 5.9	KY500157_02	PCR (nonsupport)	Fecal Coliform	Agriculture	2018
Pond Run 0 to 6.75	KY501057_01	PCR (partial support)	*E. coli*	Source Unknown	2018
Rough River 0.1 to 10.45	KY502390_01	PCR (partial support)[3]	*E. coli*	Non-Point Source	See footnote
Rough River 0.1 to 10.45	KY502390_01	SCR (partial support)	Fecal Coliform	Non-Point Source	2018
Rough River 125.2 to 149.4	KY502390_06	PCR (partial support)	Fecal Coliform	Source Unknown	2018
Rough River 55.1 to 64.5	KY502390_04	PCR (nonsupport)	*E. coli*	Non-Point Source	2018
Rough River 55.1 to 64.5	KY502390_04	SCR (nonsupport)	Fecal Coliform	Non-Point Source	2018
Skaggs Creek 12.7 to 23.55	KY503595_01	PCR (nonsupport)	*E. coli*	Source Unknown	2018
Skees KW#1 (9000-1398)[2]	KY499512-79.0_00	PCR (nonsupport)	*E. coli*	Source Unknown	See footnote
South Fork of Panther Creek 14.0 to 18.3	KY503939_04	PCR (nonsupport)	Fecal Coliform	Source Unknown	2018
South Fork of Panther Creek 9.55 to 14.0	KY503939_03	PCR (nonsupport)	Fecal Coliform	Managed Pasture Grazing	2018
Trammel Creek 0 to 24.0	KY505463_01	PCR (partial support)[3]	*E. coli*	Source Unknown	See footnote
UT of Buck Creek 0 to 1.7	KY488213-8.0_01	PCR (nonsupport)	*E. coli*	Animal Feeding Operations (NPS)	2018
UT of Elk Creek 0 to 1.0	KY491656-7.1_01	PCR (nonsupport)	Fecal Coliform	Sanitary Sewer Overflows (Collection System Failures)	2018
UT of Flat Creek 3.1 to 4.1	KY492181-2.0_02	PCR (nonsupport)	Fecal Coliform	Sanitary Sewer Overflows (Collection System Failures)	2018

Waterbody Name	Waterbody ID	Impaired Use (Support Status)	Pollutant	Suspected Source(s)	Year of TMDL Public Notice
West Fork of Buck Creek 0 to 3.3	KY506423_01	PCR (nonsupport)	*E. coli*	Non-Point Source	2018
Wolf Lick Creek 0 to 14.6	KY507017_01	PCR (partial support)[3]	*E. coli*	Agriculture, Non-Point Source	See footnote

[1]A TMDL is not included for this segment while the rationale for this listing is researched.
[2]TMDLs for impaired springs will be developed separately from this TMDL document.
[3]A TMDL is not included because this segment will be proposed for delisting in 2018. The most recent monitoring data has indicated that the segment fully supports the designated use.

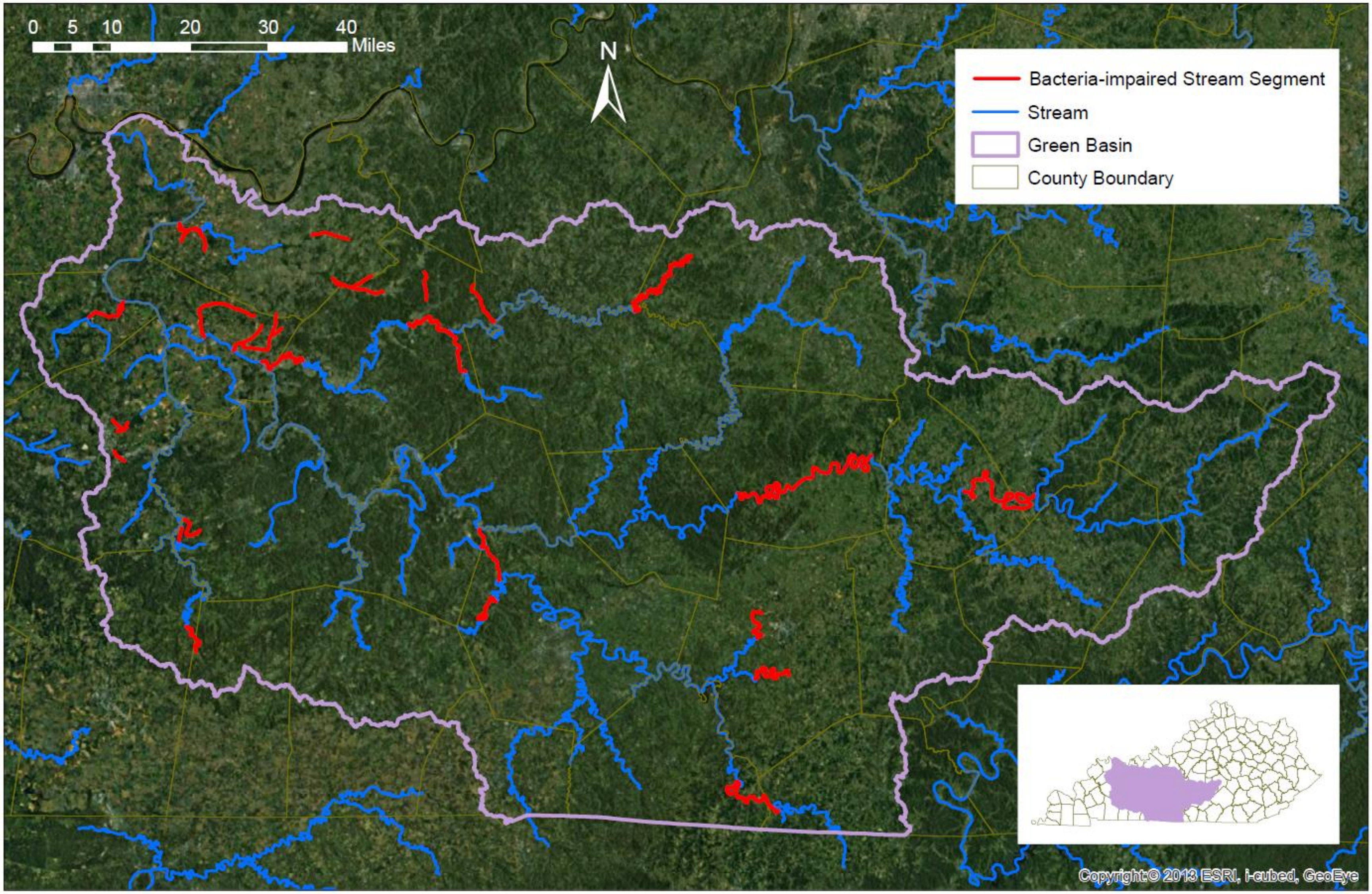

Figure D.1 Location of the Green Basin and Bacteria-impaired Waterbodies (January 2017)

Land cover data is summarized in Table D.2, and its geographic distribution is shown in Figure D.2. Deciduous forest is the predominant class of land cover in the Green basin, accounting for 43 percent. The next three classes by magnitude are pasture/hay, cultivated crops, and open developed. Land cover classes are described in Appendix P.

Table D.2 Land Cover Classes in the Green Basin (NLCD 2011)

Land Cover	Percent of Total Area	Square Miles	Acres
Open Water	1.06	93.12	59,596.34
Developed, Open	4.82	425.18	272,117.43
Developed, Low Intensity	0.76	67.20	43,009.18
Developed, Medium Intensity	0.32	28.29	18,106.54
Developed, High Intensity	0.12	10.87	6,959.78
Barren Land (Rock, Sand, Clay)	0.15	13.46	8,615.49
Deciduous Forest	43.32	3,821.72	2,445,899.36
Evergreen Forest	2.20	193.66	123,943.43
Mixed Forest	0.36	31.32	20,044.03
Shrub/Scrub	0.23	20.17	12,907.89
Grassland/Herbaceous	3.30	291.40	186,498.26
Pasture/Hay	27.03	2,384.18	1,525,875.39
Cultivated Crops	15.38	1,356.89	868,412.64
Woody Wetlands	0.55	48.95	31,329.34
Emergent Herbaceous Wetlands	0.40	35.67	22,827.05

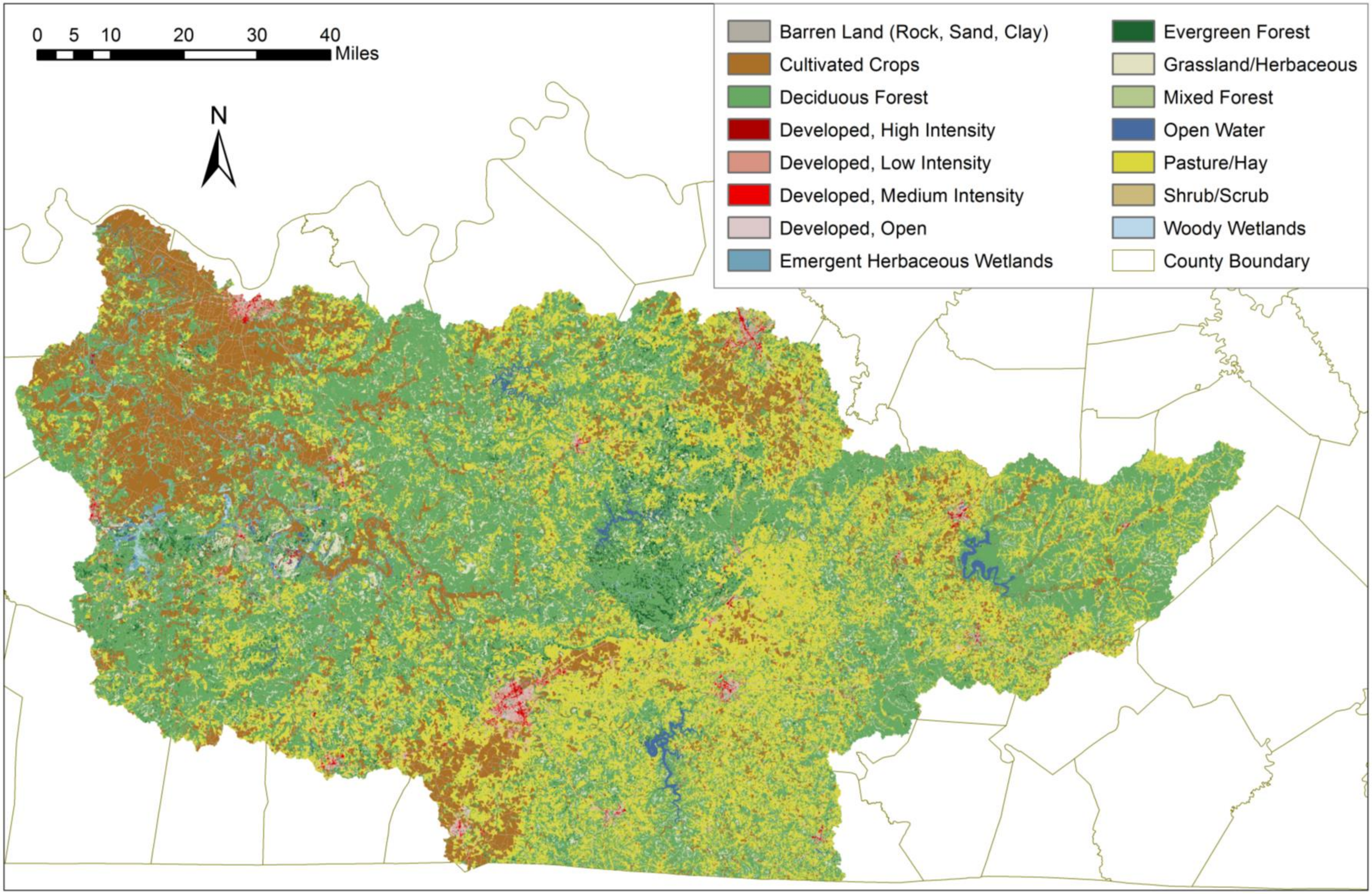

Figure D.2 Land Cover Classes in the Green Basin

Section D.1 Barren River 0.0 to 8.4

Waterbody ID: KY517526_01

Receiving Water: Green River

Impaired Use: PCR

Support Status: partial support

Indicator Bacteria: *E. coli*

HUC 12: 051100020905

Counties: Butler, Warren

The Division of Water has collected samples from station PRI 072, located at river mile 0.55, since 1998. The station typically has been sampled three or more times during the PCR season, although it was not sampled in 2004, 2009 or 2010. Table D.1-1 summarizes information about this sampling station; Table D.1-2 provides a summary of the data collected from this station.

Table D.1-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI 072	37.1732777	-86.6231944	Barren River 0 to 8.4	0.55

Table D.1-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI 072	fecal coliform	30	16.7	2	3,800	412
PRI 072	*E. coli*	35	22.9	10	8,664	468

(1)The full data set for samples collected at PRI 072 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Barren River 0.0 to 8.4 are presented in Table D.1-3. There are no KPDES-permitted discharges of bacteria into this segment of the Barren River. The location of the segment within the Gasper River and Little Muddy Creek-Barren River watersheds is shown in Figure D.1-1.

Table D.1-3 Barren River 0.0 to 8.4 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

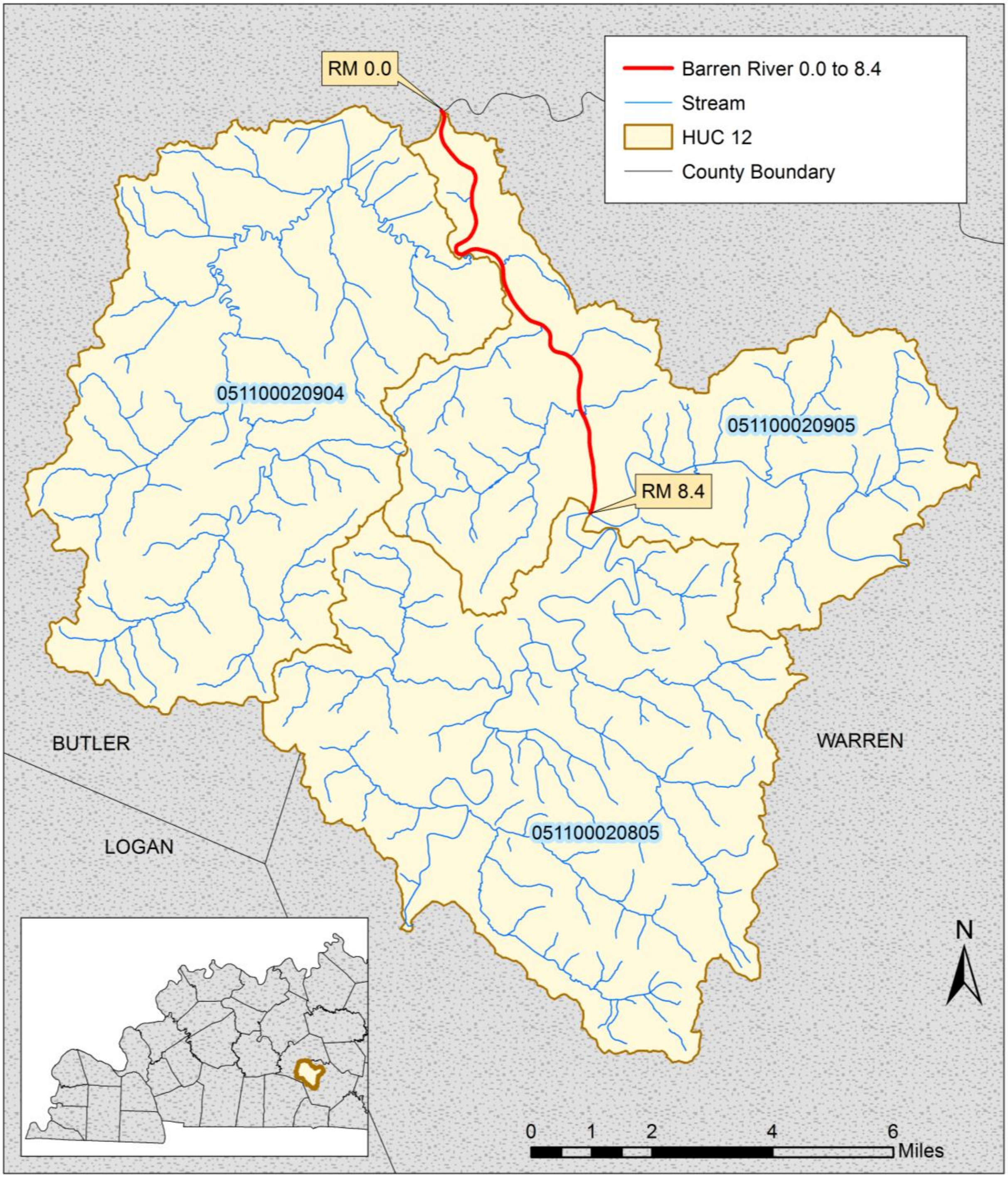

Figure D.1-1 Location of Barren River 0.0 to 8.4

This watershed exists in a karst area with sinkholes and springs. The sink features may capture surface drainage and channel it underground to resurface later at one or more springs. These discharging springs may occur outside the watershed where the drainage originated. However, unless karst dye trace studies indicate otherwise, groundwater catchment is presumed to correspond to the topographic watershed boundaries of surface drainage. Figure D.1-2 shows sinkhole occurrence, trends in traced flow through karst areas, and groundwater basins in the region of Barren River 0.0 to 8.4. Dye tracing in the region has shown that a small area of the Beaverdam Creek-Green River watershed (0511000113) in the north contributes karst flow to Poorhouse Spring, which discharges near milepost 32.6 of the Barren River. In the southwest, a small portion of the Red River watershed contributes karst flow to the Barren River watershed. For more detailed information about karst geology, see Section 3.2, Karst.

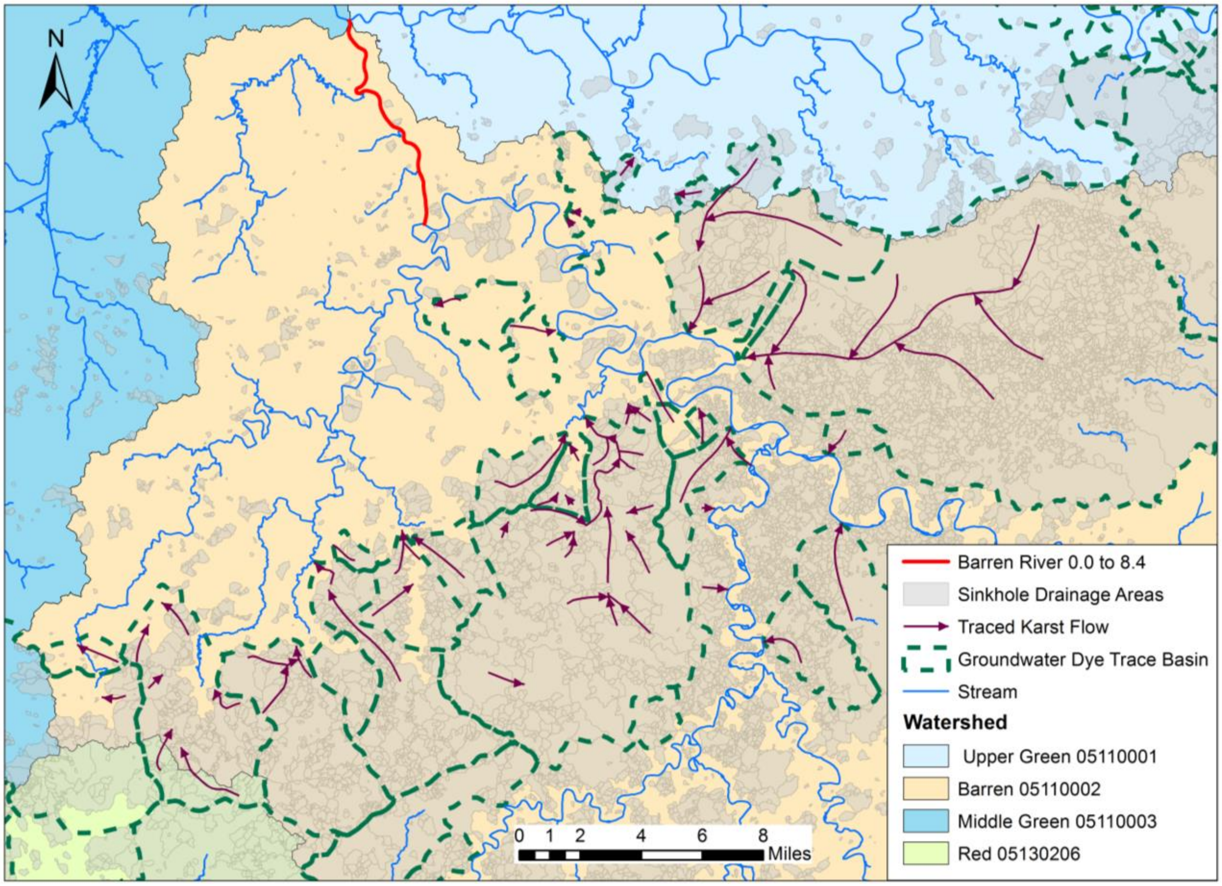

Figure D.1-2 Karst Influence in the Region of Barren River 0.0 to 8.4

Section D.2 Barren River 104.8 to 119.3

Waterbody ID: KY517526_06

Receiving Water: Green River

Impaired Uses: PCR, SCR

Support Status: nonsupport (both uses)

Indicator Bacteria: fecal coliform

HUC 12: 051100020109, 051100020203

Counties: Allen, Barren, Monroe

The Division of Water has collected samples from station PRI 073, located at river mile 108.65, since 1998. The station typically has been sampled three or more times during the PCR season, except in 2007, when it was not sampled. Table D.2-1 summarizes information about this sampling station; Table D.2-2 provides a summary of the data collected from this station.

Table D.2-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI 073	36.6963333	-86.0467222	Barren River 104.8 to 119.3	108.65

Table D.2-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number Of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI 073	fecal coliform	28	57.1	1	30,000	2,711
PRI 073	*E. coli*	37	75.7	52	2,420	698

(1)The full data set for samples collected at PRI 073 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Barren River 104.8 to 119.3 are presented in Table D.2-3. There are no KPDES-permitted discharges of bacteria into this segment of the Barren River. The location of the segment within the Kentucky portions of the Barren River watershed is shown in Figure D.2-1.

Table D.2-3 Barren River 104.8 to 119.3 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

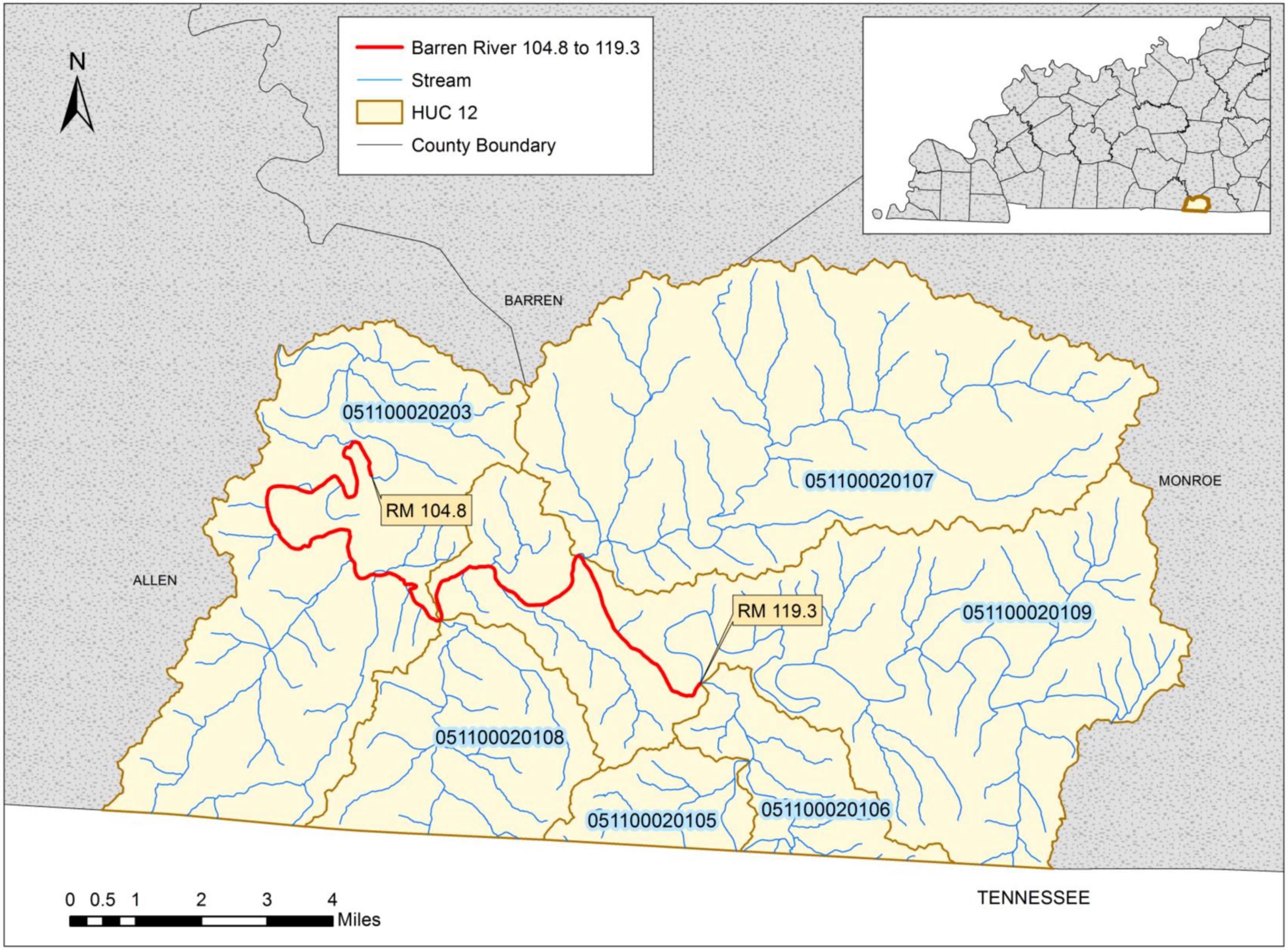

Figure D.2-1 Location of Barren River 104.8 to 119.3

Section D.3 Beaver Creek 8.5 to 15.75

Waterbody ID: KY486609_01

Receiving Water: Skaggs Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100020305, 051100020306

County: Barren

The Division of Water has collected samples from station GRN 023, located at river mile 8.5, since 2001. The station is sampled five to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table D.3-1 summarizes information about this sampling station; Table D.3-2 summarizes the data collected from this station.

Table D.3-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 023	36.98	-85.976	Beaver Creek 8.5 to 15.75	8.5

Table D.3-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 023	fecal coliform	5	40.0	1	564	288
GRN 023	*E. coli*	17	58.8	75	921	352

(1)The full data set for samples collected at GRN 023 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Beaver Creek 8.5 to 15.75 are presented in Table D.3-3. There are no KPDES-permitted discharges of bacteria into this segment of Beaver Creek.

Table D.3-3 Beaver Creek 8.5 to 15.75 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment LA[3]	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a) Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

The location of the segment within the Beaver Creek watershed is shown in Figure D.3-1. The segment occurs in a karst area with sinkholes and springs. The sink features may capture surface drainage and channel it underground to resurface later at one or more springs. These discharging springs may occur outside the watershed where the drainage originated. However, unless karst dye trace studies indicate otherwise, groundwater catchment is presumed to correspond to the topographic watershed boundaries of surface drainage. Dye tracing in the area has shown that groundwater to the north of the Beaver Creek watershed flows generally north toward the Green River. Groundwater west of the Beaver Creek watershed flows west toward the Barren River, while groundwater within the Beaver Creek watershed flows within the watershed (see Figure D.3-2). For more detailed information about karst geology, see Section 3.2, Karst.

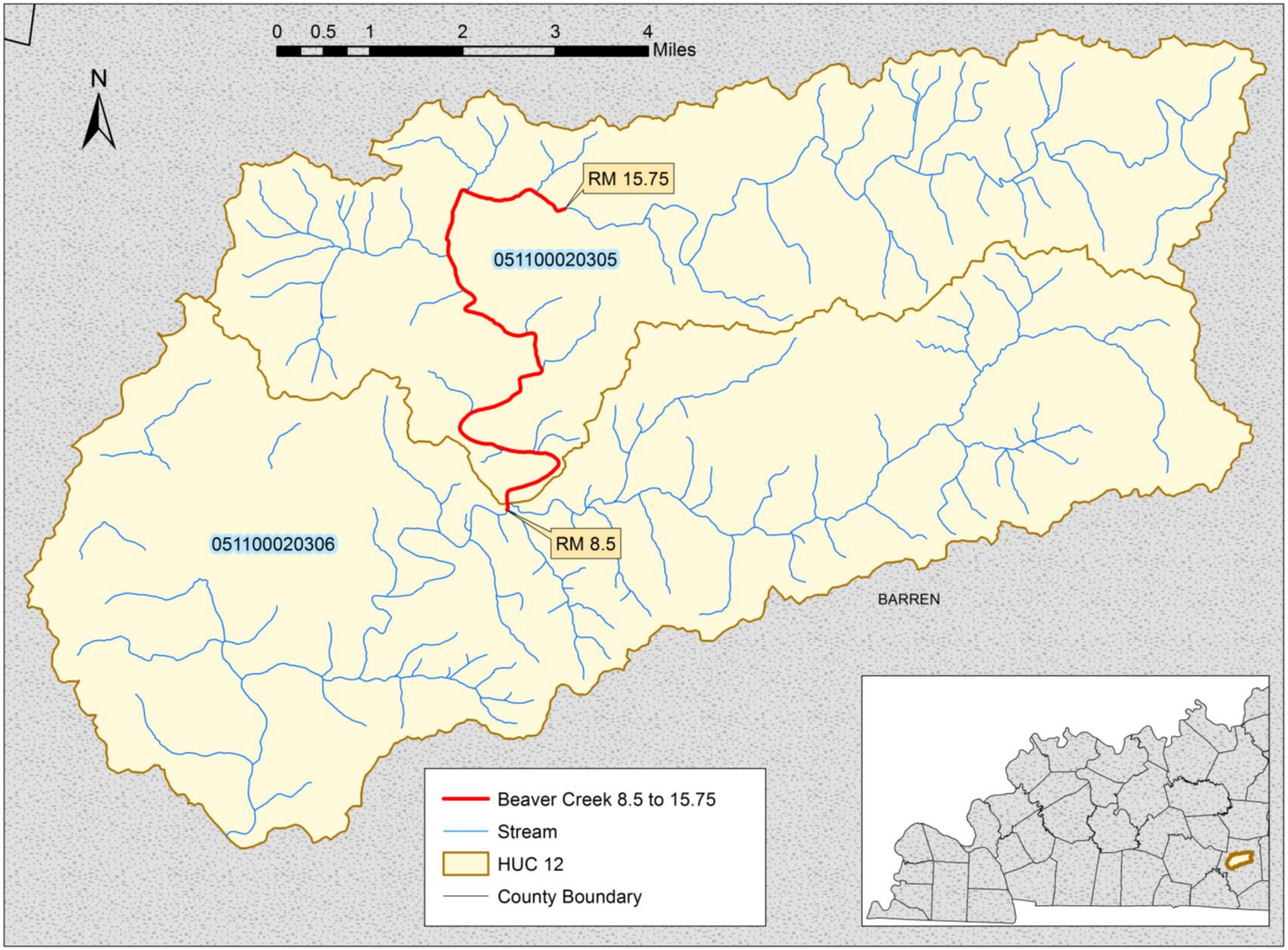

Figure D.3-1 Location of Beaver Creek 8.5 to 15.75

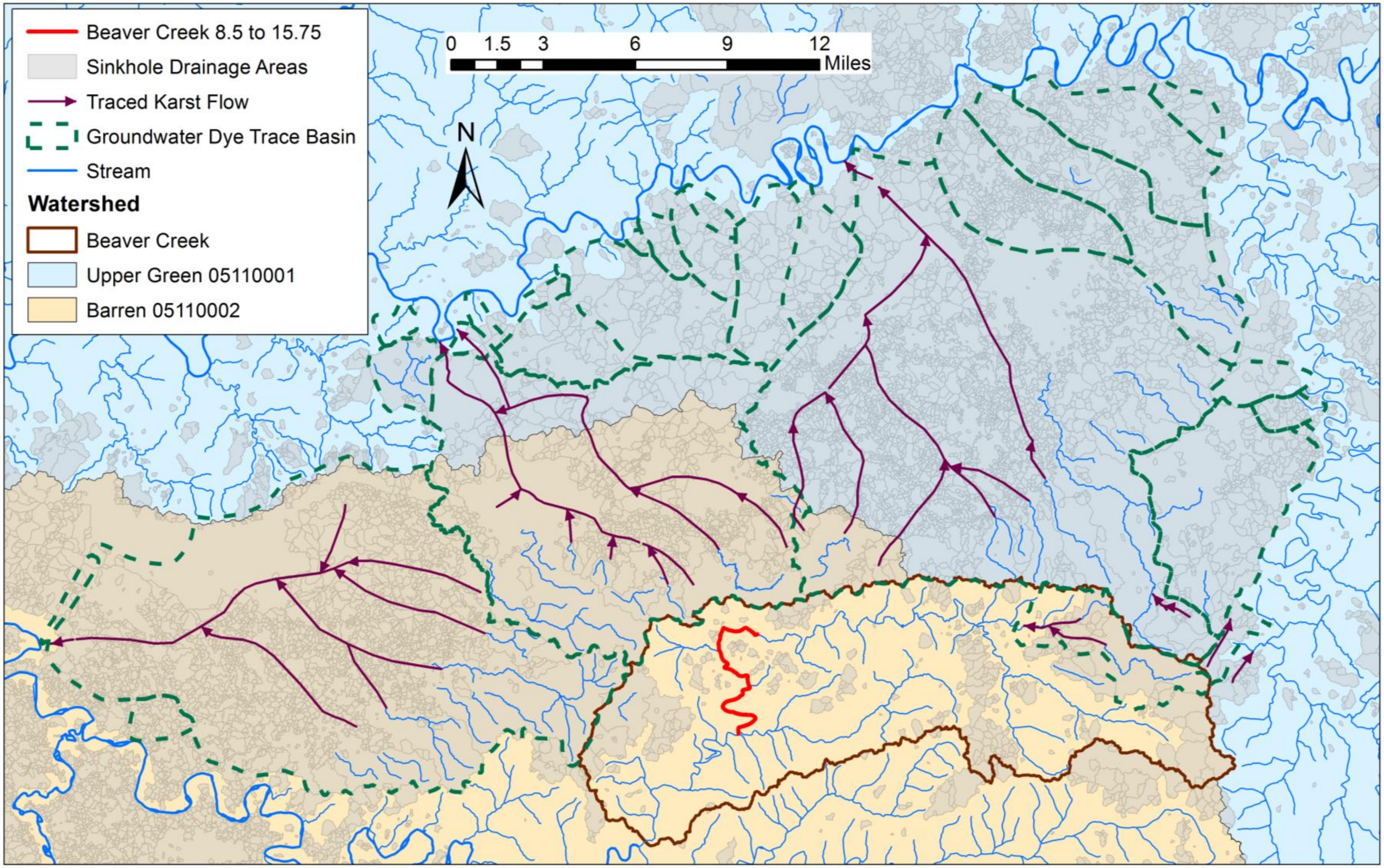

Figure D.3-2 Karst Influence in the Region of Beaver Creek 8.5 to 15.75

Section D.4 Buck Creek 0 to 8.0

Waterbody ID: KY488213_01

Receiving Water: Green River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050201

County: McLean

In 2008 the Division of Water collected samples at three stations along this segment as part of a study of the Buck Creek watershed. Table D.4-1 summarizes information about the stations; Table D.4-2 provides a summary of the data collected from these stations.

Table D.4-1 Division of Water Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
DOW03003005	37.50537	-87.19721	Buck Creek 0.0 to 8.0	0.2
DOW03003006	37.51234	-87.17587	Buck Creek 0.0 to 8.0	2.9
DOW03003009	37.50851	-87.14010	Buck Creek 0.0 to 8.0	4.9

Table D.4-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
DOW03003005	*E. coli*	2	50.0	135	1,500	818
DOW03003006	*E. coli*	7	71.4	105	1,500	643
DOW03003009	*E. coli*	6	33.3	108	1,500	585

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Buck Creek 0.0 to 8.0 are presented in Table D.4-3. There are no KPDES-permitted discharges of bacteria into this segment of Buck Creek. The location of the segment within the Buck Creek watershed is shown in Figure D.4-1.

Table D.4-3 Buck Creek 0.0 to 8.0 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[(4)]	Allocations for Tributary Loads to the Segment[(5)]	MOS[(6)]
	LA[(3)]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

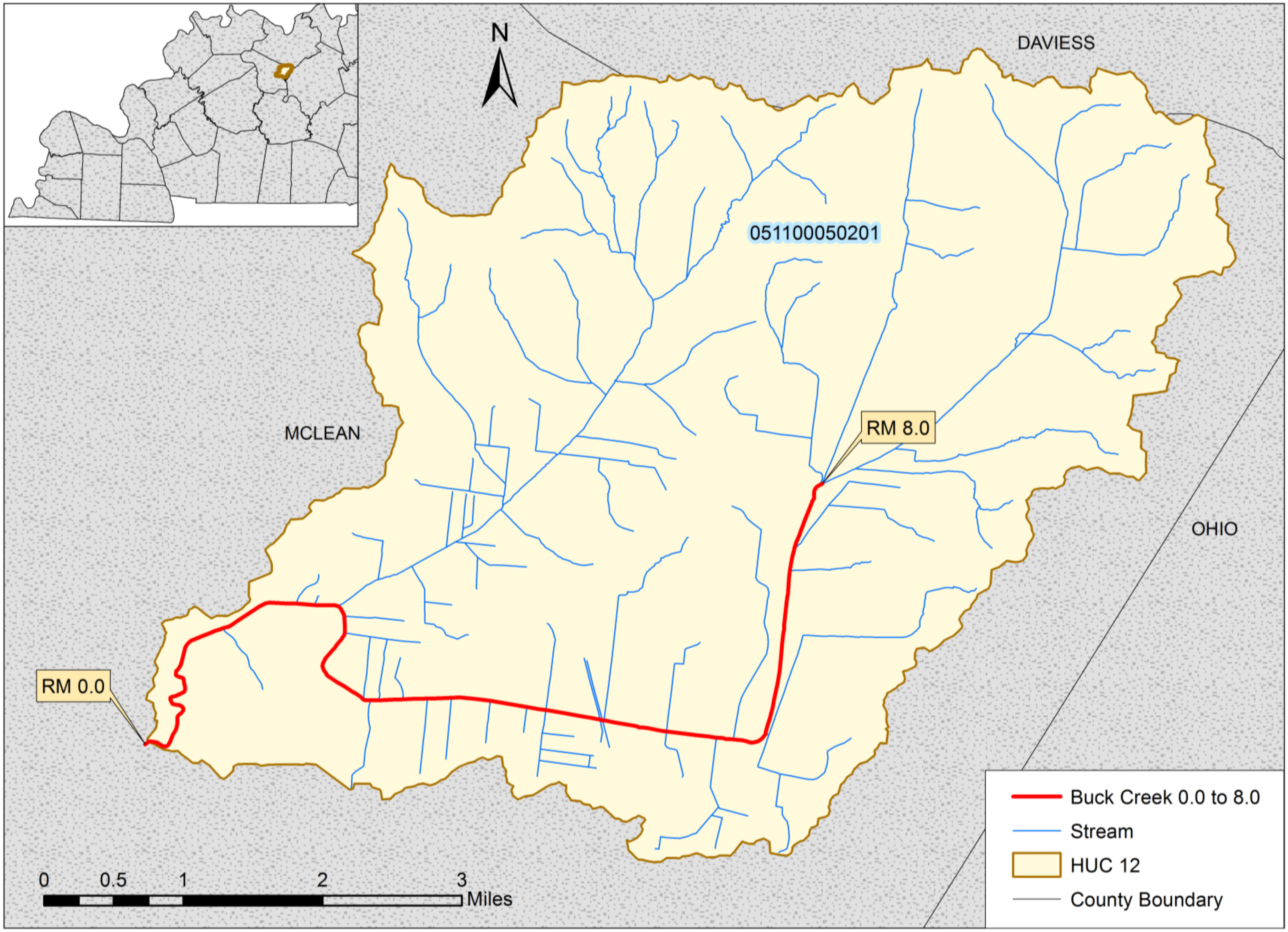

Figure D.4-1 Location of Buck Creek 0.0 to 8.0

Section D.5 Buck Creek 8.0 to 11.0

Waterbody ID: KY488213_02

Receiving Water: Green River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: *E. coli*

HUC 12: 051100050201

Counties: Daviess, McLean

In 2008 the Division of Water collected samples at station DOW03003011 as part of a study of the Buck Creek watershed. Table D.5-1 summarizes information about this sampling station; Table D.5-2 provides a summary of the data collected from this station.

Table D.5-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
DOW03003011	37.54215	-87.10822	Buck Creek 8.0 to 11.0	8.6

Table D.5-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
DOW03003011	*E. coli*	5	60.0	147	1,500	561

(1)The full data set for samples collected from DOW03003011 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)240 colonies/100 ml for *E. coli*.

The TMDL allocations for Buck Creek 8.0 to 11.0 are presented in Table D.5-3. There are no KPDES-permitted discharges of bacteria into this segment of Buck Creek. The location of the segment within the Buck Creek watershed is shown in Figure D.5-1.

Table D.5-3 Buck Creek 8.0 to 11.0 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Tributary Loads to the Segment[4]	MOS[5]
	LA[3]		
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[5]The following assumptions provide an implicit MOS:

(a) Tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

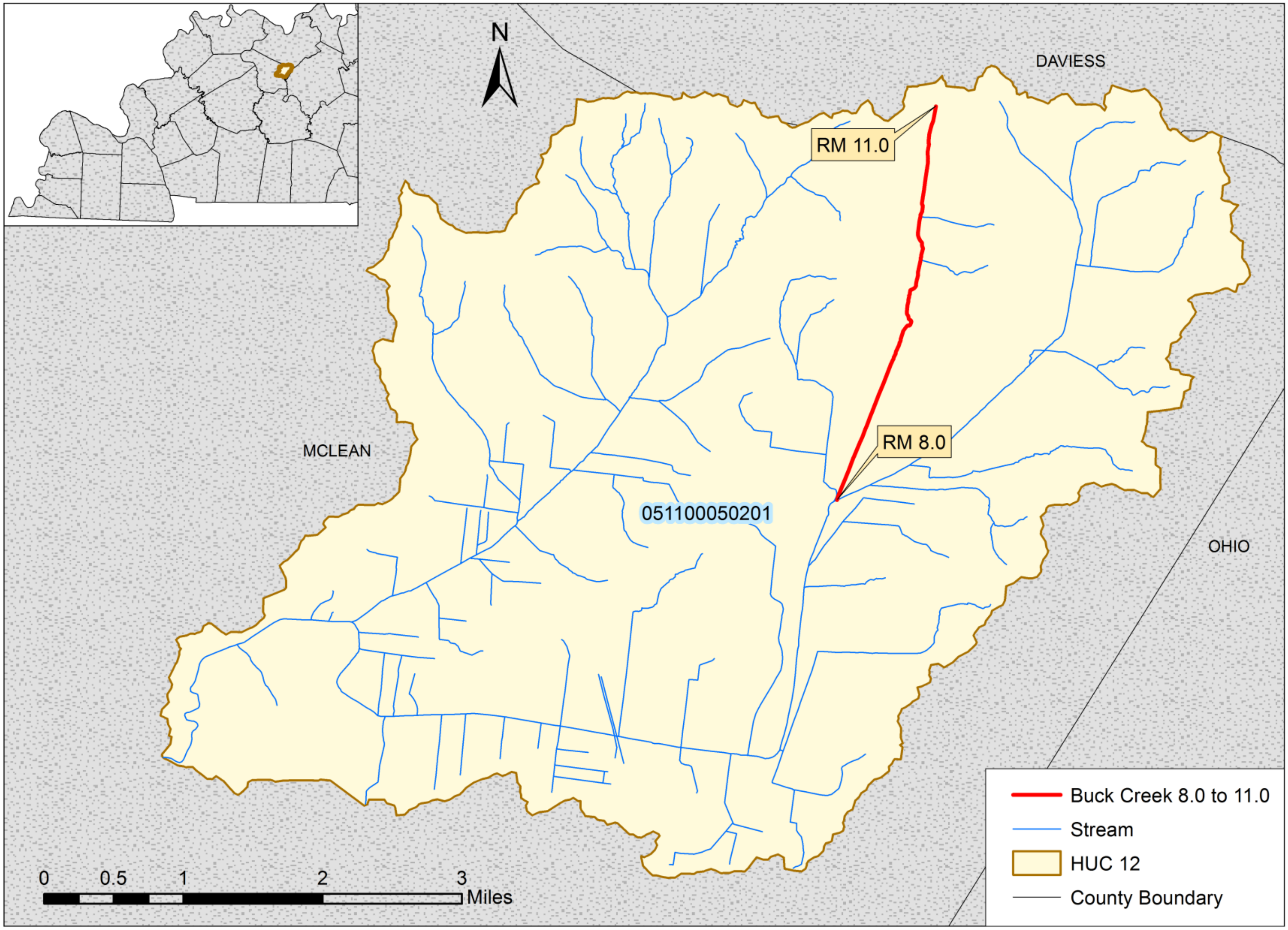

Figure D.5-1 Location of Buck Creek 8.0 to 11.0

Section D.6 Buck Fork Pond River 12.9 to 19.3

Waterbody ID: KY488223_02

Receiving Water: Pond River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060201

Counties: Christian, Todd

In 2001 Western Kentucky University collected five samples at station GRBEX-23. Table D.6-1 summarizes information about this sampling station; Table D.6-2 provides a summary of the data collected from this station.

Table D.6-1 Western Kentucky University Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRBEX-23	36.9925	-87.2986	Buck Fork Pond River 12.9 to 19.3	12.95

Table D.6-2 Western Kentucky University Sample Data Summary(1)

Station Name	Bacterial Indicator	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRBEX-23	fecal coliform	5	40.00	48	1,720	773

(1)The full data set for samples collected from GRBEX-23 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Buck Fork Pond River 12.9 to 19.3 are presented in Table D.6-3. There are no KPDES-permitted discharges of bacteria into this segment of Buck Fork. The location of the segment within the Upper Buck Fork Pond River watershed is shown in Figure D.6-1.

Table D.6-3 Buck Fork Pond River 12.9 to 19.3 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

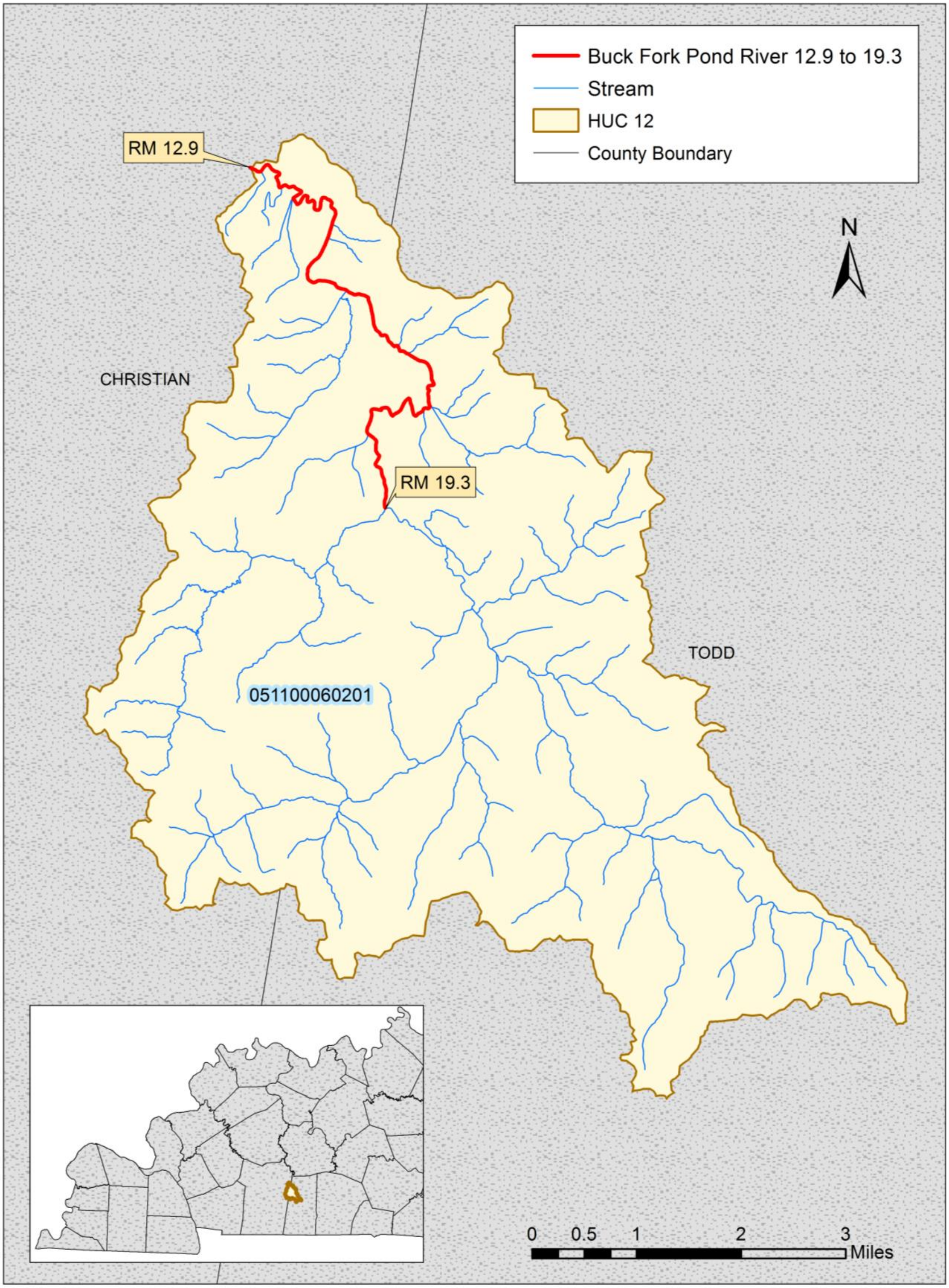

Figure D.6-1 Location of Buck Fork Pond River 12.9 to 19.3

Section D.7 Caney Creek 0.0 to 6.8

Waterbody ID: KY488846_01

Receiving Water: Rough River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: *E. coli*

HUC 12: 051100040403

County: Ohio

The Division of Water has collected samples from station GRN 015, located at river mile 1.85, since 2001. The station has been sampled three to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table D.7-1 summarizes information about this sampling station; Table D.7-2 provides a summary of the data collected from this station.

Table D.7-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 015	37.526211	-86.686632	Caney Creek 0 to 6.8	1.85

Table D.7-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 015	fecal coliform	8	12.5	49	2,600	447
GRN 015	*E. coli*	13	30.8	14	2,420	376

(1)The full data set for samples collected from GRN 015 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Caney Creek 0.0 to 6.8 are presented in Table D.7-3. There are no KPDES-permitted discharges of bacteria into this segment of Caney Creek. The location of the segment within the Lower Caney Creek watershed is shown in Figure D.7-1.

Table D.7-3 Caney Creek 0.0 to 6.8 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.
(2)Q_S is the flow (ft^3/s) in the segment.
(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.
(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.
(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.
(6)The following assumptions provide an implicit MOS:
(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.
(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

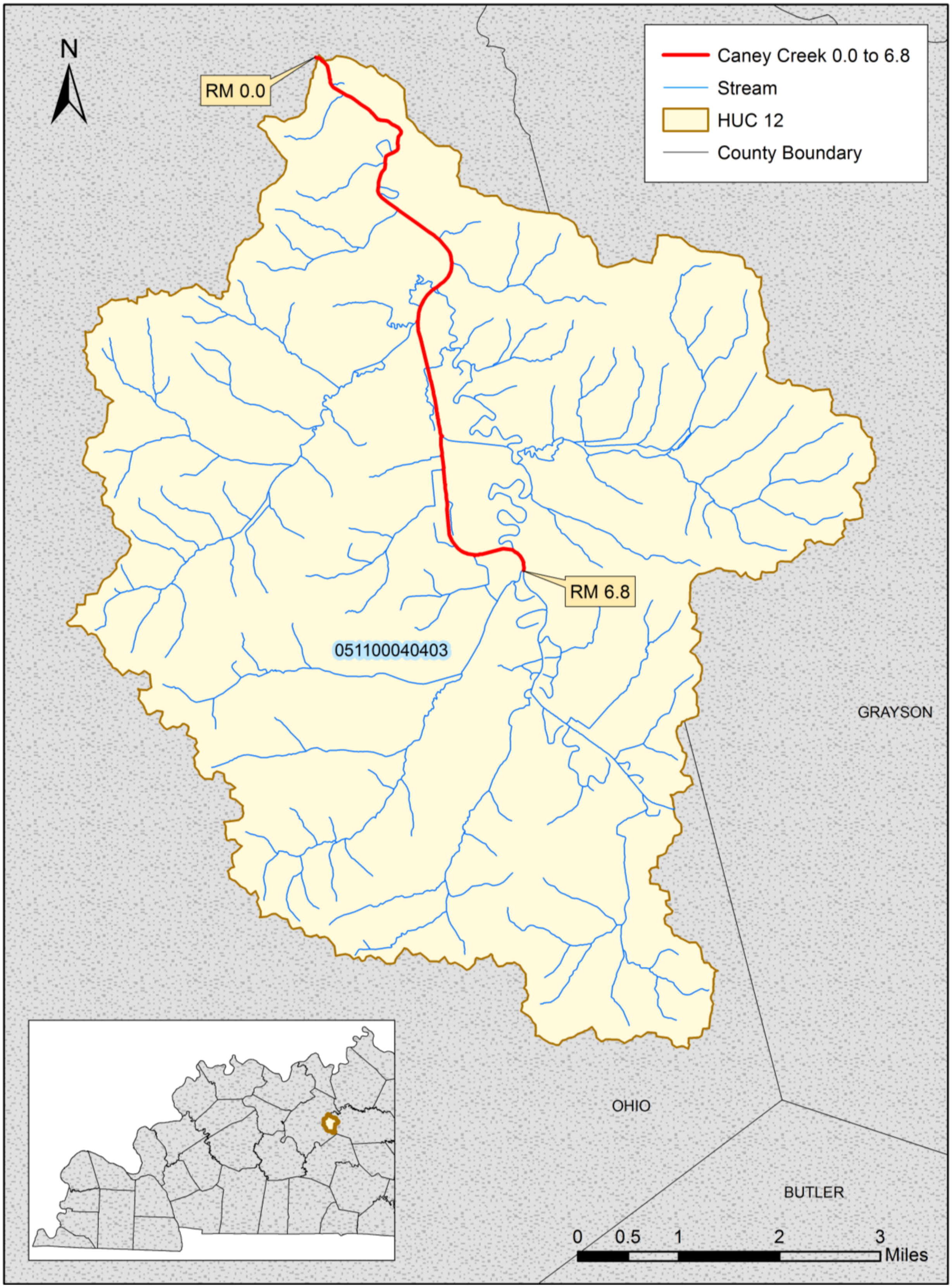

Figure D.7-1 Location of Caney Creek 0.0 to 6.8

Section D.8 Crooked Creek 0.0 to 3.0

Waterbody ID: KY490376_00

Receiving Water: Panther Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050308

County: Daviess

Western Kentucky University has collected samples from three stations on this segment. In 2001, five samples were collected from FC-T48. In 2007 and 2008, samples were collected from two stations as part of a study in the Panther Creek watershed. Table D.8-1 summarizes information about these sampling stations; Table D.8-2 provides a summary of the data collected from the stations.

Table D.8-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
FC-T48	37.7242	-87.2795	Crooked Creek 0.0 to 3.0	0.1
CWRS_ST0001-LP00	37.70867	-87.27047	Crooked Creek 0.0 to 3.0	1.38
CWRS_ST0001-LP01	37.7219	-87.28152	Crooked Creek 0.0 to 3.0	0.27

Table D.8-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
FC-T48	fecal coliform	5	60.0	32	5,800	1,587
ST0001-LP00	*E. coli*	9	88.9	199	2,613	1,094
ST0001-LP01	*E. coli*	10	90.0	152	2,909	884

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Crooked Creek 0.0 to 3.0 are presented in Table D.8-3. There are no KPDES-permitted discharges of bacteria into this segment of Crooked Creek. The location of the segment within the Panther Creek watershed is shown in Figure D.8-1.

Table D.8-3 Crooked Creek 0.0 to 3.0 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Tributary Loads to the Segment[(4)]	MOS[(5)]
	LA[(3)]		
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(5)The following assumptions provide an implicit MOS:

(a)Tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

Figure D.8-1 Location of Crooked Creek 0.0 to 3.0

Section D.9 Deer Creek 0.0 to 8.4

Waterbody ID: KY490771_01

Receiving Water: Green River

Impaired Use: PCR

Support Status: partial support

Indicator Bacteria: *E. coli*

HUC 12: 051100050105

County: Webster

The Division of Water has collected samples from station GRN 012, located at river mile 3.1, since 2001. The station has been sampled six or more times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Western Kentucky University also sampled FC-Station 45 at the same location in 2001. Table D.9-1 summarizes information about this sampling station; Table D.9-2 provides a summary of the data collected from this station.

Table D.9-1 Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 012	37.57300	-87.46500	Deer Creek 0 to 8.4	3.1
FC-Station 45	37.5730	-87.4651	Deer Creek 0 to 8.4	3.1

Table D.9-2 Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
FC-Station 45	fecal coliform	5	20.0	8	8,400	1,813
GRN 012	fecal coliform	13	23.1	40	4,700	808
GRN 012	*E. coli*	12	50.0	11	1,203	359

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Deer Creek 0.0 to 8.4 are presented in Table D.9-3. There are no KPDES-permitted discharges of bacteria into this segment of Deer Creek. The location of the segment within the Deer Creek watershed is shown in Figure D.9-1.

Table D.9-3 Deer Creek 0.0 to 8.4 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[(4)]	Allocations for Tributary Loads to the Segment[(5)]	MOS[(6)]
	LA[(3)]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[(1)]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[(2)]Q_S is the flow (ft^3/s) in the segment.

[(3)]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[(4)]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[(5)]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[(6)]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

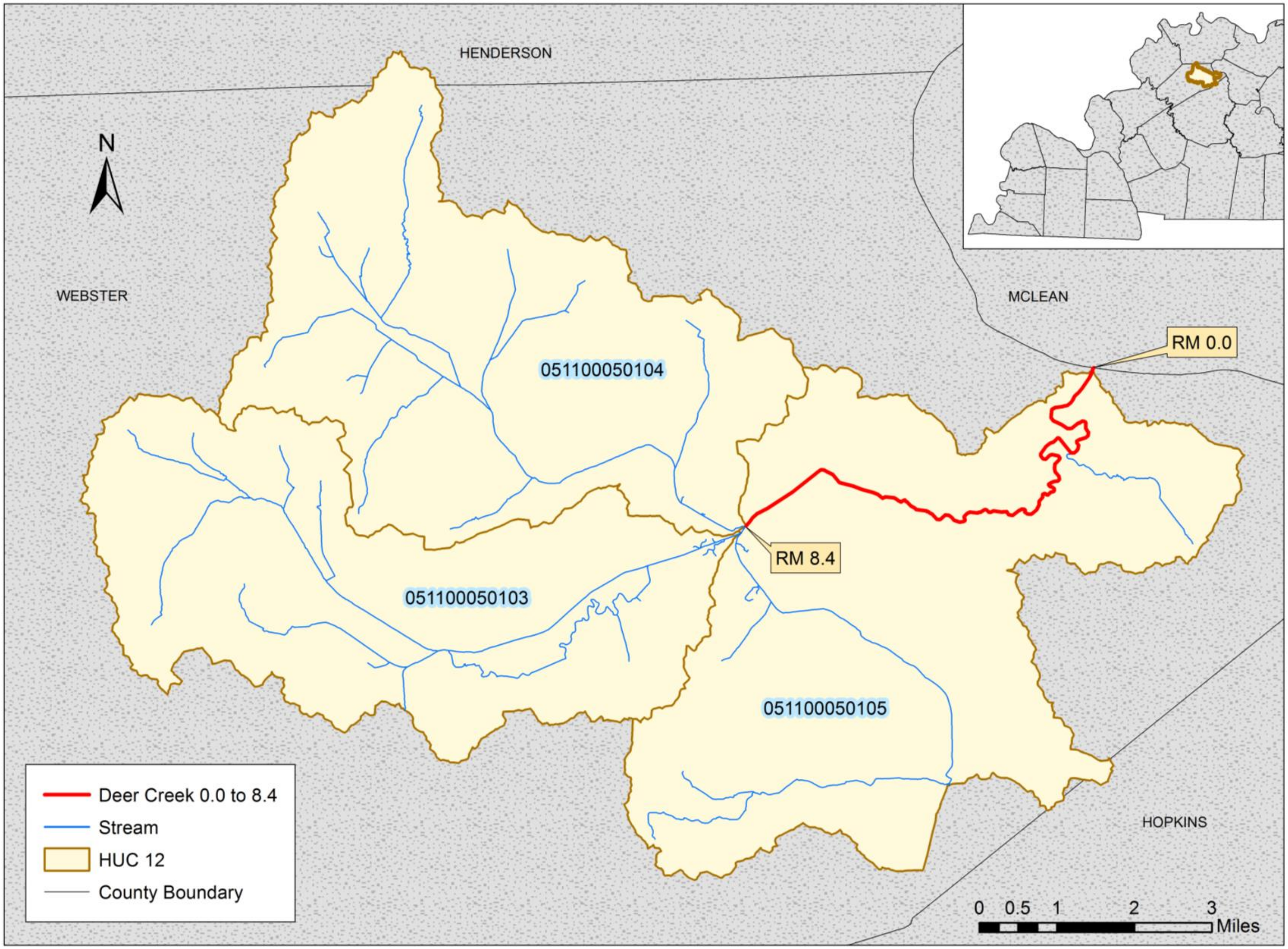

Figure D.9-1 Location of Deer Creek 0.0 to 8.4

Section D.10 Deserter Creek 0.0 to 3.1

Waterbody ID: KY490771_01

Receiving Water: South Fork Panther Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050302

County: Daviess, Ohio

Western Kentucky University has collected samples from two locations on this segment. In 2001, samples were collected from GRBEX-20 and FC-T36. In 2007 and 2008, samples were collected from two stations as part of a study in the Panther Creek watershed. Table D.10-1 summarizes information about these sampling locations; Table D.10-2 provides a summary of the data collected from the stations.

Table D.10-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRBEX-20	37.6362	-86.9016	Deserter Creek 0.0 to 3.1	1.6
CWRS_ST0001-LP39	37.63634	-86.9014	Deserter Creek 0.0 to 3.1	1.6
CWRS_ST0001-LP40	37.64528	-86.8832	Deserter Creek 0.0 to 3.1	2.85
FC-T36	37.6465	-86.8835	Deserter Creek 0.0 to 3.1	2.85

Table D.10-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRBEX-20	fecal coliform	4	50.0	104	12,000	3,196
ST0001-LP39	*E. coli*	6	16.7	10	767	214
ST0001-LP40	*E. coli*	7	71.4	41	6,867	1,625
FC-T36	fecal coliform	4	50.0	104	12,000	5,706

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Deserter Creek 0.0 to 3.1 are presented in Table D.10-3. There are no KPDES-permitted discharges of bacteria into this segment of Deserter Creek. The location of the segment within the Panther Creek watershed is shown in Figure D.10-1.

Table D.10-3 Deserter Creek 0.0 to 3.1 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a) Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

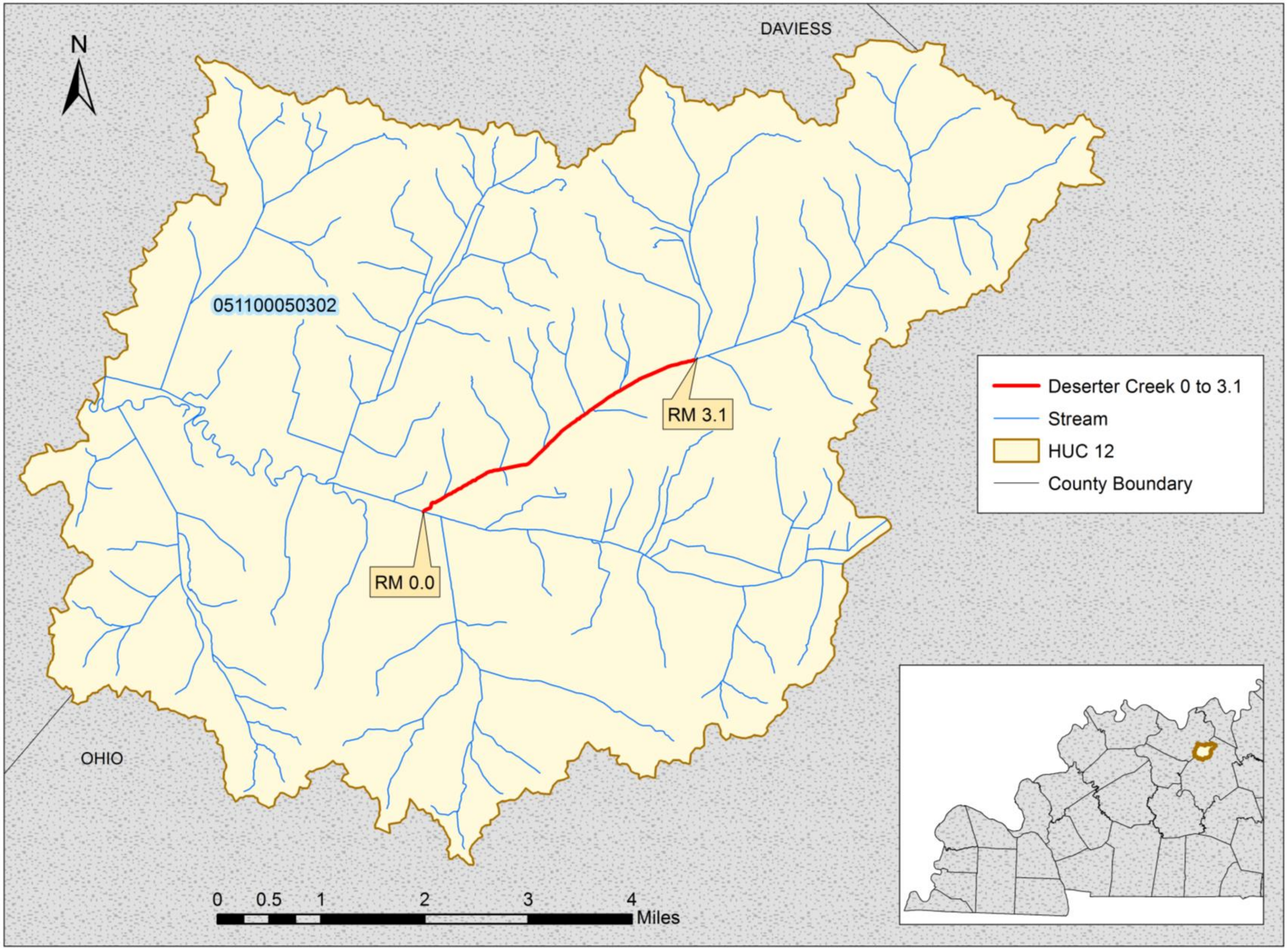

Figure D.10-1 Location of Deserter Creek 0.0 to 3.1

Section D.11 Elk Creek 7.6 to 10.6

Waterbody ID: KY491656_02

Receiving Water: Pond River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060504

County: Hopkins

Sampling data from Elk Creek 7.6 to 10.6 is not available. This segment is located in a sewered area of Madisonville. Beginning in 1994, Division of Water issued Notices of Violation to the City of Madisonville for failure to report the release of untreated wastewater to the waters of the Commonwealth and degradation of the waters of the Commonwealth. These violations were related to a series of sanitary sewer overflows in the Madisonville collection system, and as one of the impacted waters, Elk Creek 7.6 to 10.6 was added to the 303(d) list in 1998. A subsequent Agreed Order outlined the corrective measures required by the city. There are no KPDES-permitted discharges of bacteria into this segment of Elk Creek. The City of Madisonville does have MS4 storm water permit coverage for areas in the watershed, but the discharges occur along tributaries or upstream of the segment.

The TMDL allocations for Elk Creek 7.6 to 10.6 are presented in Table D.11-1. The location of the segment within the Elk Creek watershed is shown in Figure D.11-1.

Table D.11-1 Elk Creek 7.6 to 10.6 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

Figure D.11-1 Location of Elk Creek 7.6 to 10.6

Section D.12 Elk Pond Creek 0.0 to 4.9

Waterbody ID: KY491671_00

Receiving Water: Pond River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060501

County: Muhlenberg

In 2001 Western Kentucky University collected five samples at station GRBEX-27. Table D.12-1 summarizes information about this sampling station; Table D.12-2 provides a summary of the data collected from this station.

Table D.12-1 Western Kentucky University Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRBEX-27	37.1618	-87.2885	Elk Pond Creek 0.0 to 4.9	3.7

Table D.12-2 Western Kentucky University Sample Data Summary[(1)]

Station Name	Indicator Bacteria	Number Of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRBEX-27	fecal coliform	5	60.0	144	12,200	5,005

[(1)]The full data set for samples collected from GRBEX-27 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
[(2)]400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Elk Pond Creek 0.0 to 4.9 are presented in Table D.12-3. There are no KPDES-permitted discharges of bacteria into this segment of Elk Pond Creek. The location of the segment within the Elk Pond Creek-Pond River watershed is shown in Figure D.12-1.

Table D.12-3 Elk Pond Creek 0.0 to 4.9 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Tributary Loads to the Segment(4)	MOS(5)
	LA(3)		
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(5)The following assumptions provide an implicit MOS:

(a)Tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

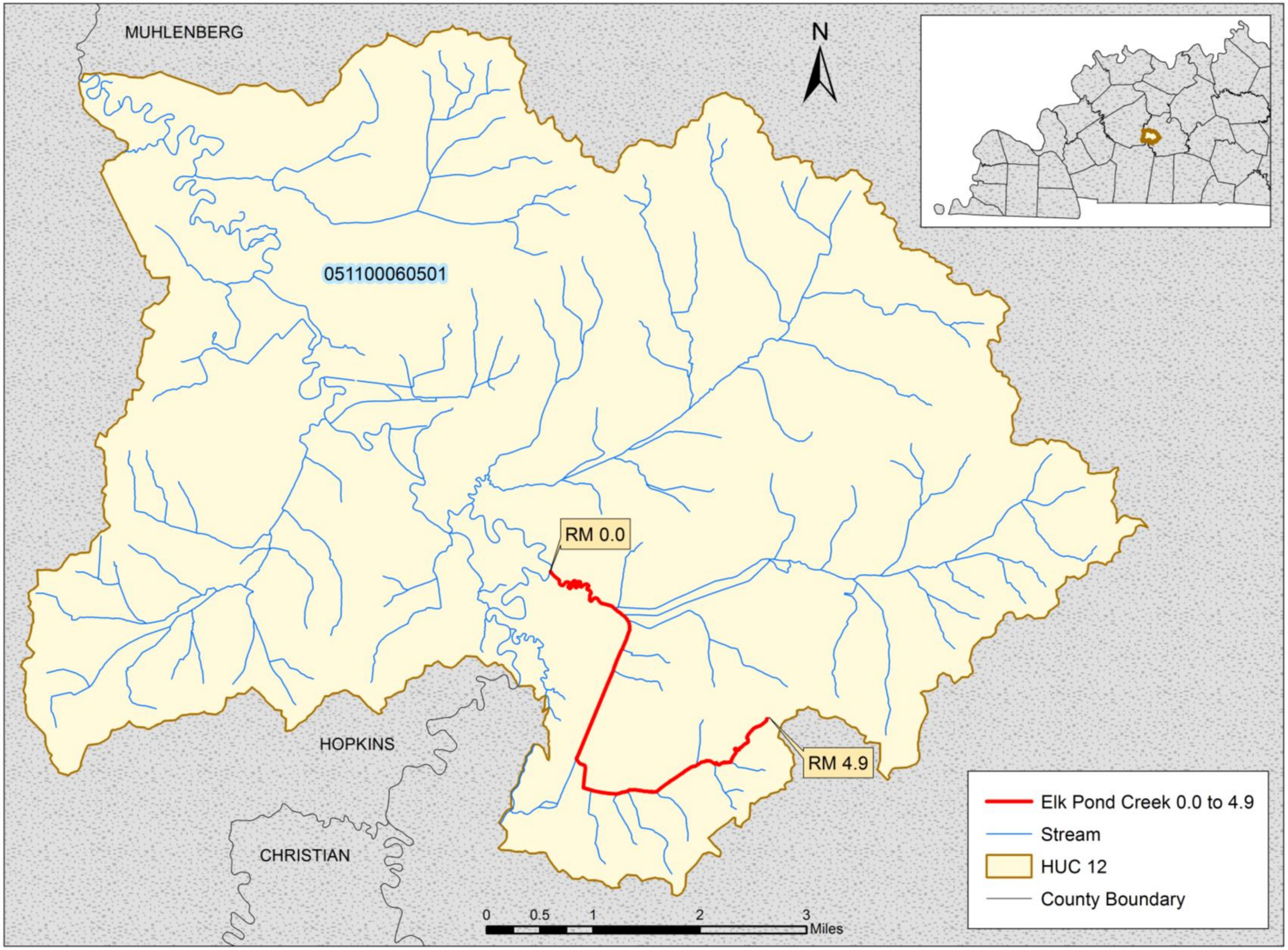

Figure D.12-1 Location of Elk Pond Creek 0.0 to 4.9

Section D.13 Gasper River 7.8 to 14.6

Waterbody ID: KY492748_01

Receiving Water: Barren River

Impaired Use: PCR

Support Status: partial support

Indicator Bacteria: *E. coli*

HUC 12: 051100020805

County: Warren

The Division of Water has collected samples from station GRN 020, located at river mile 12.05, since 2001. The station has been sampled four to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table D.13-1 summarizes information about this sampling station; Table D.13-2 provides a summary of the data collected from this station.

Table D.13-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 020	37.022069	-86.607015	Gasper River 7.8 to 14.6	12.05

Table D.13-2 Division of Water Sample Data Summary[(1)]

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 020	fecal coliform	4	0.0	1	336	149
GRN 020	*E. coli*	15	46.7	56	2,420	854

[(1)]The full data set for samples collected from GRN 020 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
[(2)]400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Gasper River 7.8 to 14.6 are presented in Table D.13-3. There are no KPDES-permitted discharges of bacteria into this segment of the Gasper River.

Table D.13-3 Gasper River 7.8 to 14.6 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment LA[(3)]	Allocations for Upstream Loads to the Segment[(4)]	Allocations for Tributary Loads to the Segment[(5)]	MOS[(6)]
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[(1)]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[(2)]Q_S is the flow (ft^3/s) in the segment.

[(3)]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[(4)]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[(5)]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[(6)]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

The location of the segment within the Gasper River watershed is shown in Figure D.13-1. This watershed exists in a karst area characterized by many sinkholes, sinking streams, and springs. The sink features may capture surface drainage and channel it underground to resurface later at one or more springs. These discharging springs may occur outside the watershed where the drainage originated. However, unless karst dye trace studies indicate otherwise, groundwater catchment is presumed to correspond to the topographic watershed boundaries of surface drainage. Dye trace studies in the area indicate that some dye trace basin boundaries in the south and east extend beyond the HUC 12 topographic boundaries of the Gasper River watershed and should be considered additional contributing areas (see Figure D.13-2). For more detailed information about karst geology, see Section 3.2, Karst.

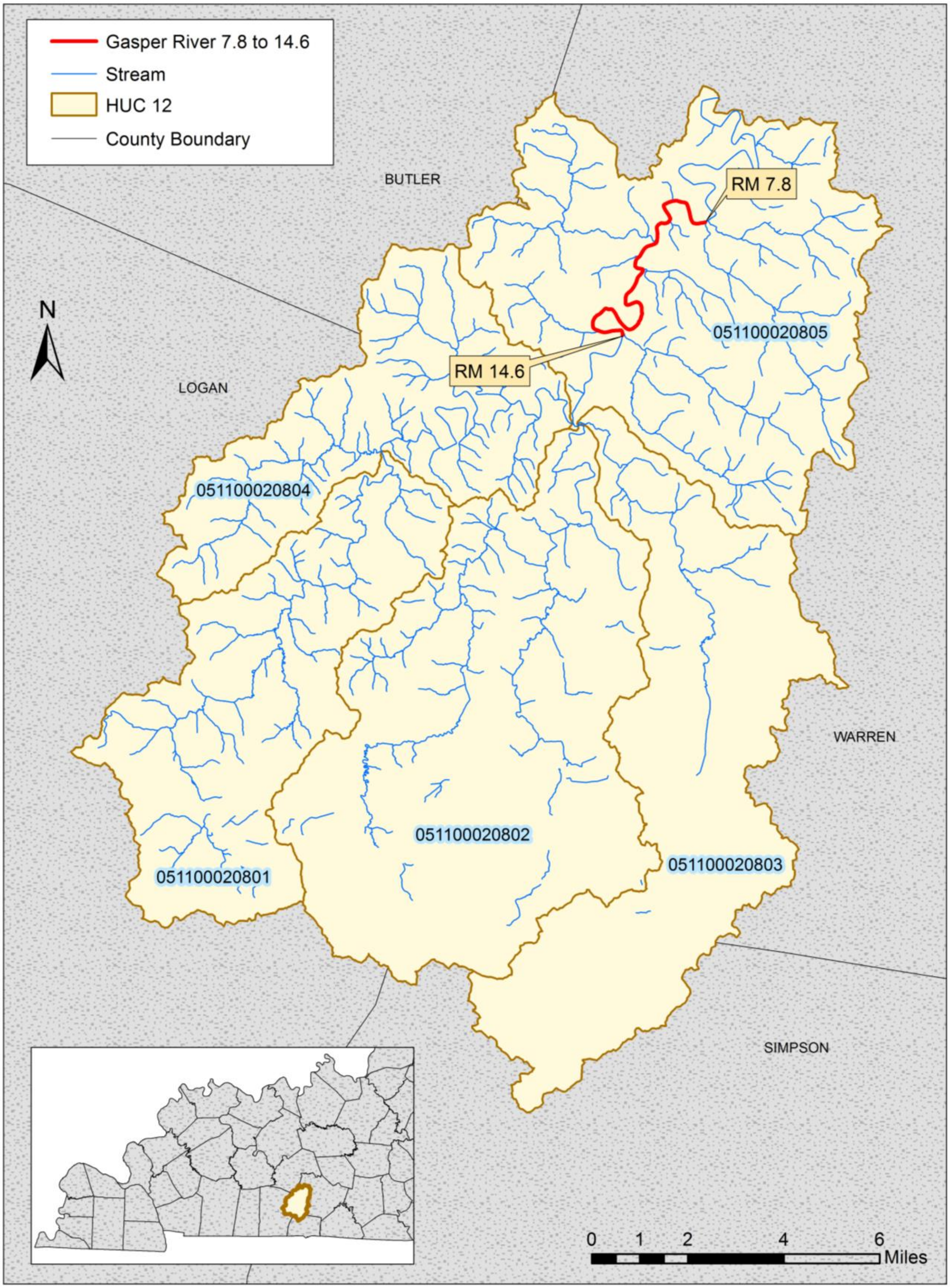

Figure D.13-1 Location of Gasper River 7.8 to 14.6

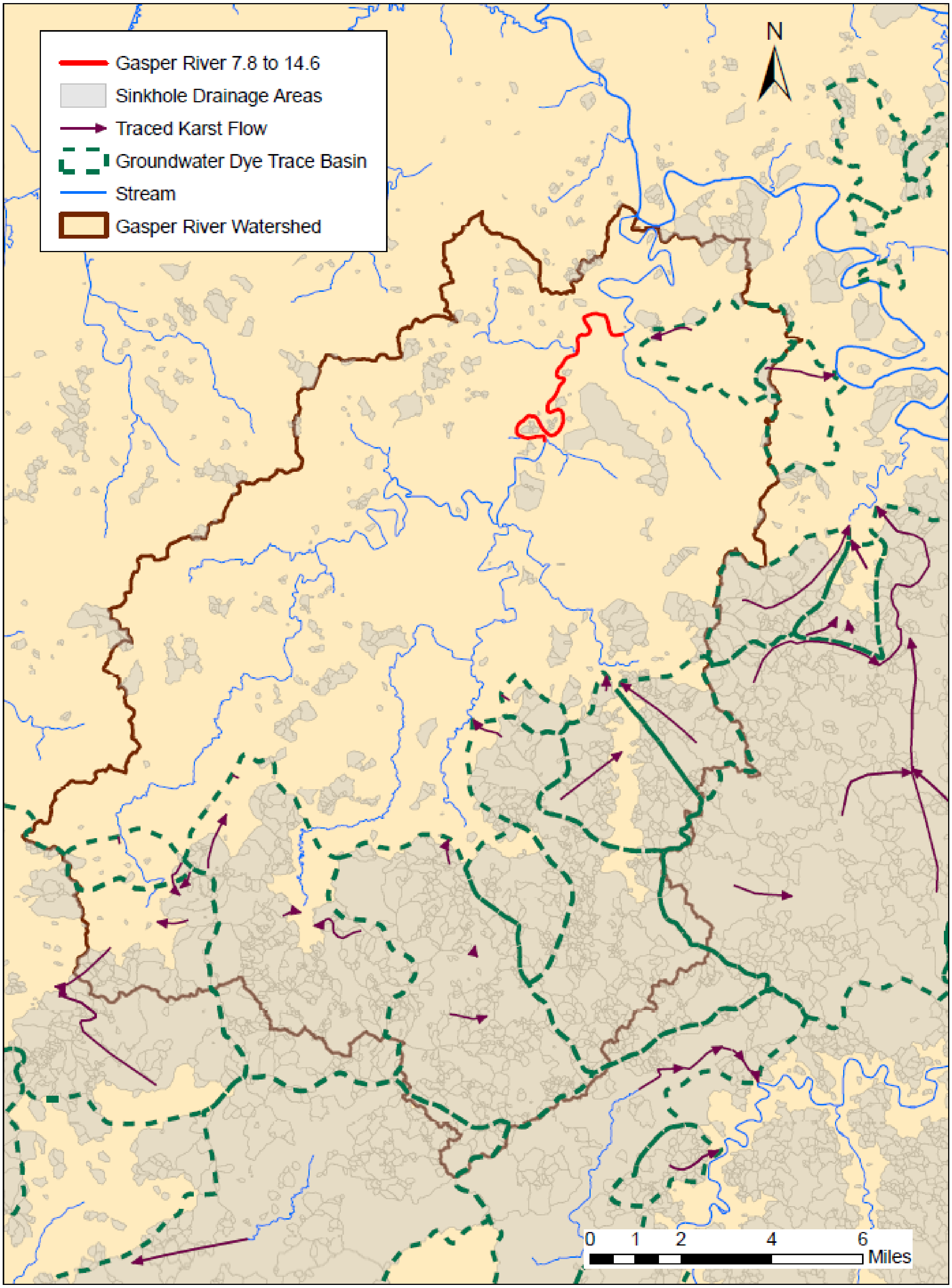

Figure D.13-2 Karst Influence in the Region of Gasper River RM 7.8 to 14.6

Section D.14 Green River 210.4 to 250.2

Waterbody ID: KY493284_08

Receiving Water: Ohio River

Impaired Use: PCR

Support Status: partial support

Indicator Bacteria: *E. coli*

HUC 12s: 051100010805, 051100010806, 051100010807, 051100010808

County: Hart

The Division of Water has collected samples from station PRI 018, located at river mile 229.05, since 1980. The station typically has been sampled three or more times during the PCR season, although it was not sampled in 1982. The USGS collected samples from station USGS-03308500 at Munfordville between 1986 and 1994. The National Park Service collected samples from MACA BIGR, at Bush Island, from 2002-2005 and 2010-2012. Table D.14-1 summarizes information about these stations; Table D.14-2 provides a summary of the data collected from the stations.

Table D.14-1 Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI 018	37.2686666	-85.8852777	Green River 210.4 to 250.2	229.05
MACA_BIGR	37.24779359	-86.02112515	Green River 210.4 to 250.3	210.8
USGS-03308500	37.2694444	-85.8880556	Green River 210.4 to 250.4	227.2

Table D.14-2 Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI 018	fecal coliform	115	30.4	1	16,000	879
PRI 018	*E. coli*	45	17.8	10.9	2,420	385
MACA-BIGR	fecal coliform	14	28.6	36	5,067	647
MACA-BIGR	*E. coli*	14	7.1	9.7	649	101
USGS-03308500	fecal coliform	23	47.8	27	8,200	1,078

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Green River 210.4 to 250.2 are presented in Table D.14-3.

Table D.14-3 Green River 210.4 to 250.2 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment		Allocations for Upstream Loads to the Segment[5]	Allocations for Tributary Loads to the Segment[6]	MOS[7]
	SWS-WLA[3]	LA[4]			
$Q_S \times WQC \times CF$	$\sum(Q_{SWS} \times WQC \times CF)$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{SWS} is the flow (ft^3/s) in the segment due to a SWS entity. New or expanded SWS sources will be allowed to discharge to the segment contingent upon them meeting the PCR bacterial WQCs found in 401 KAR 10:031. SWS-WLAs will be translated into KPDES permit limits as an *E. coli* effluent gross limit of 130 colonies/100 ml as a monthly average and 240 colonies/100 ml as a maximum weekly average or as a fecal coliform effluent gross limit of 200 colonies/100 ml as a monthly average and 400 colonies/100 ml as a maximum weekly average.

[4]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[5]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[6]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[7]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)Although all sources are provided an allocation at the Water Quality Standard, not all sources discharge at this maximum allocation at the same time.

(c)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

Two facilities permitted under the Kentucky Pollutant Discharge Elimination System (KPDES) discharge treated effluent directly into this segment of the Green River. Both of the directly discharging facilities are sanitary wastewater systems (SWSs). There are no MS4 communities or CSOs discharging directly to this segment of the Green River. These facilities are identified in Table D.14-4 and their locations are shown in Figure D.14-1.

Table D.14-4 Summary of Active KPDES-permitted Sources as of May 2017

KPDES Permit Number	Facility Name	Design Flow (MGD)	Indicator Bacteria	Outfall Latitude	Outfall Longitude	Permit Expiration Date	WLA[1] (colonies/day)
KY0091561	Caveland Environmental Authority	0.48	*E. coli*	37.2411	-85.9342	10/31/2021	Q_{SWS}×WQC×CF
KY0031755	Munfordville STP	0.26	*E. coli*	37.268889	-85.888889	1/31/2021	Q_{SWS}×WQC×CF

(1) All loads are colonies/day of either *E. coli* or fecal coliform. Q_{SWS} is the flow in the segment due to a SWS entity. The recreational use bacterial WQC are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day).

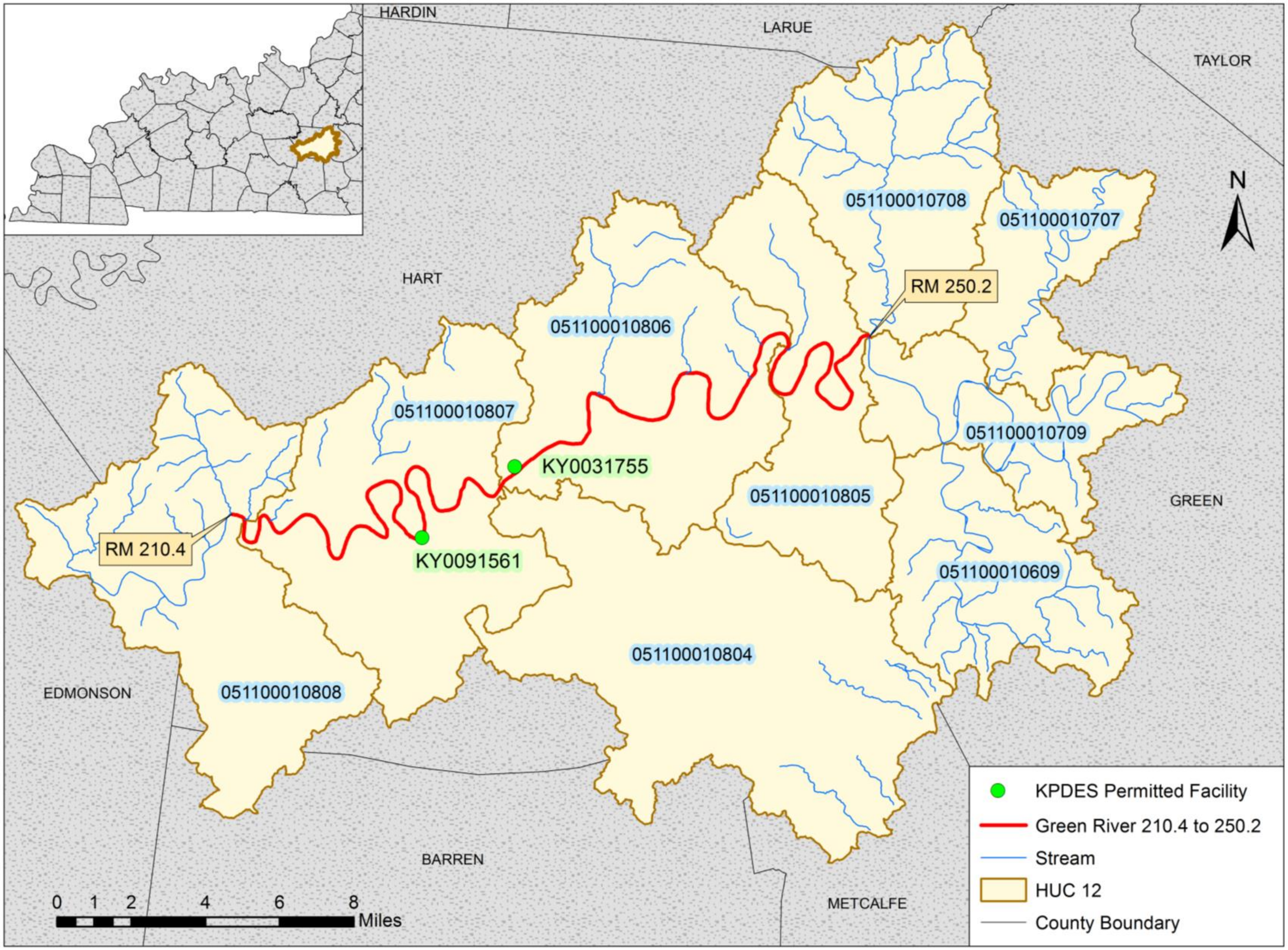

Figure D.14-1 Locations of KPDES-permitted Facilities on Green River 210.4 to 250.2

This watershed exists in a karst area characterized by many sinkholes, sinking streams, and springs. The sink features may capture surface drainage and channel it underground to resurface later at one or more springs. These discharging springs may occur outside the watershed where the drainage originated. However, unless karst dye trace studies indicate otherwise, groundwater catchment is presumed to correspond to the topographic watershed boundaries of surface drainage. Several springs discharge to this reach of Green River, and the associated dye trace basins are shown in Figure D.18-2. Some of these dye trace basin boundaries extend beyond the HUC 12 topographic boundaries and should be considered additional contributing areas. For more detailed information about karst geology, see Section 3.2.

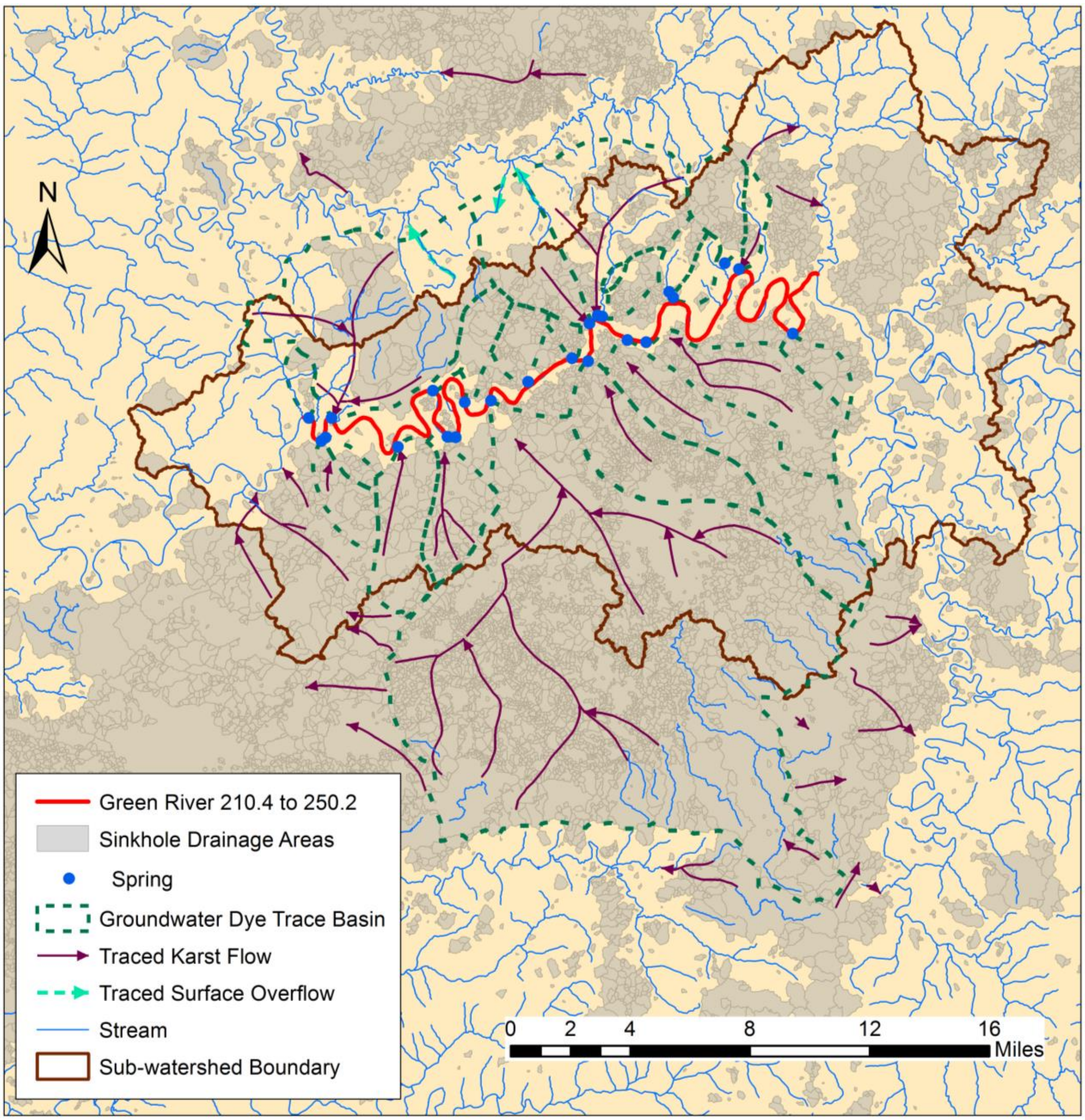

Figure D.14-2 Karst Influence in the Region of Green River 210.4 to 250.2

Section D.15 Green River 283.1 to 309.0

Waterbody ID: KY493284_13

Receiving Water: Ohio River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12s: 051100010308, 051100010701, 051100010703

County: Green, Taylor

The Division of Water collected samples at PRI 019 year-round between 1980 and 1985, except in 1982, when the station was not sampled. Additionally, Western Kentucky University collected bacteria samples from four stations (GR-8.11 through -8.14) along this segment in 2002 and 2003. Table D.15-1 summarizes information about the five sampling stations; Table D.15-2 provides a summary of the data collected from these stations.

Table D.15-1 Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI 019	37.253889	85.503056	Green River 283.1 to 309.0	283.2
GR-8.11	37.2539	-85.5025	Green River 283.1 to 309.0	283.25
GR-8.12	37.2452	-85.4797	Green River 283.1 to 309.0	285.2
GR-8.13	37.235	-85.425	Green River 283.1 to 309.0	294.8
GR-8.14	37.2449	-85.364	Green River 283.1 to 309.0	307.3

Table D.15-2 Sample Data Summary[1]

Station Name	Indicator Bacteria	Number Of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI 019	fecal coliform	27	25.9	39	10,000	888
GR-8.11	fecal coliform	7	28.6	144	560	423
GR-8.12	fecal coliform	7	57.1	176	1,000	550
GR-8.13	fecal coliform	7	0.0	48	304	220
GR-8.14	fecal coliform	7	14.3	7	672	157

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Green River 283.1 to 309.0 are presented in Table D.15-3. As of May 2017, there are no KPDES-permitted bacteria discharges into this segment of the Green River. The former Indian Ridge Campground (KY0077313) discharged sanitary wastewater into this segment until Feb. 1, 2013, but because these discharges have ceased and the permit has been inactivated, the former facility does not receive a wasteload allocation.

Table D.15-3 Green River 283.1 to 309.0 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment LA(3)	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

The location of the segment within the Green River watershed is shown in Figure D.15-1.This watershed exists in a karst area with sinkholes and springs. The sink features may capture surface drainage and channel it underground to resurface later at one or more springs. These discharging springs may occur outside the watershed where the drainage originated. However, unless karst dye trace studies indicate otherwise, groundwater catchment is presumed to correspond to the topographic watershed boundaries of surface drainage. No dye tracing information is available from the area of Green River 283.1 to 309.0. For more detailed information about karst geology, see Section 3.2, Karst.

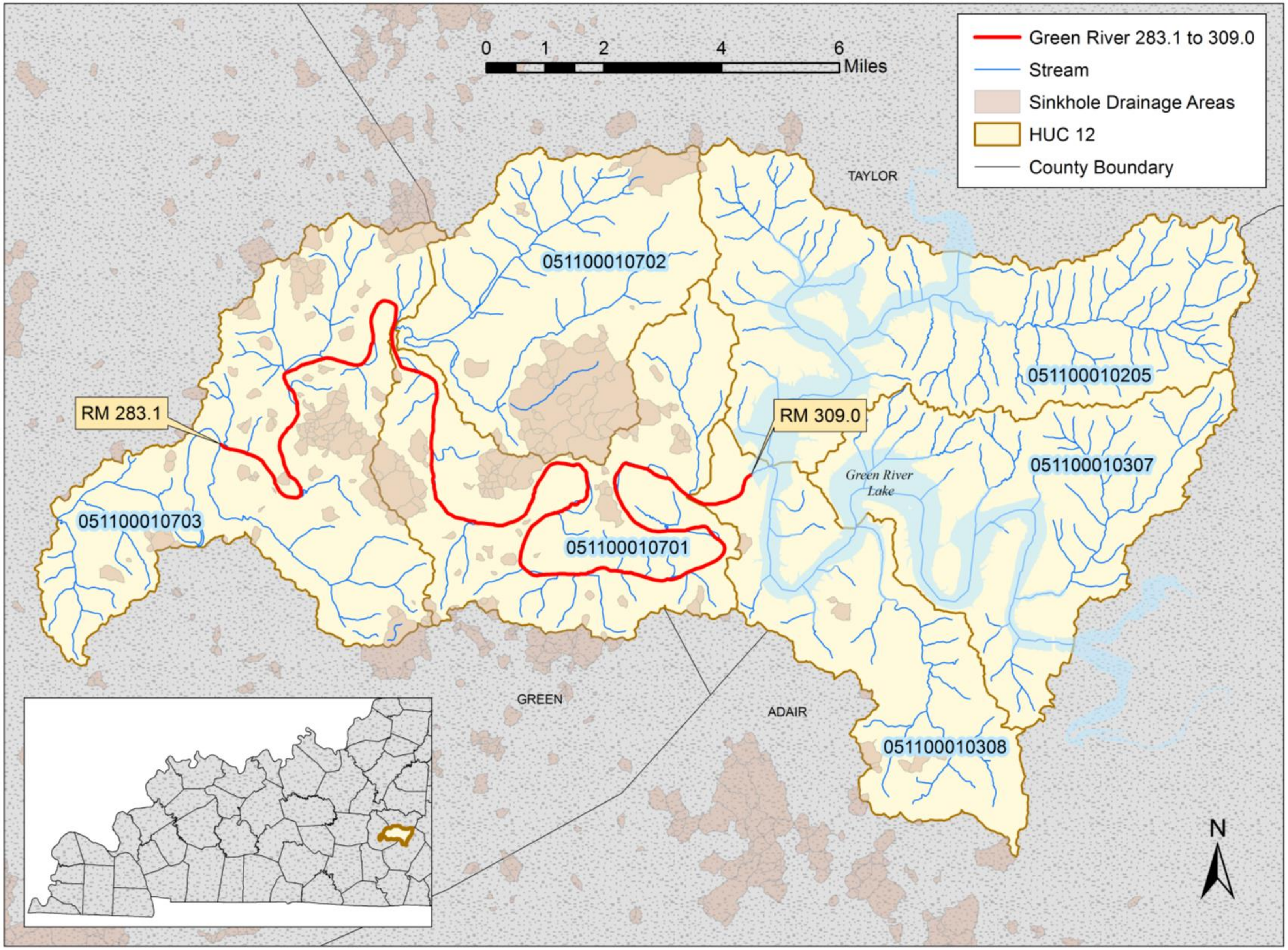

Figure D.15-1 Location of Green River 283.1 to 309.0

Section D.16 Jarrels Creek 0.0 to 1.8

Waterbody ID: KY5495175_00

Receiving Water: Pond River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060206

County: Muhlenberg

In 2001 Western Kentucky University collected five samples at station GRBEX-25. Table D.16-1 summarizes information about this sampling station; Table D.21-2 provides a summary of the data collected from this station.

Table D.16-1 Western Kentucky University Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRBEX-25	37.1573	-87.3171	Jarrels Creek 0.0 to 1.8	1.3

Table D.16-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRBEX-25	fecal coliform	5	40.0	88	10,000	3,128

(1)The full data set for samples collected from GRBEX-25 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Jarrels Creek 0.0 to 1.8 are presented in Table D.16-3. There are no KPDES-permitted discharges of bacteria into this segment of Jarrels Creek. The location of the segment within the Jarrels Creek-Pond River watershed is shown in Figure D.16-1.

Table D.16-3 Jarrels Creek 0.0 to 1.8 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment LA(3)	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

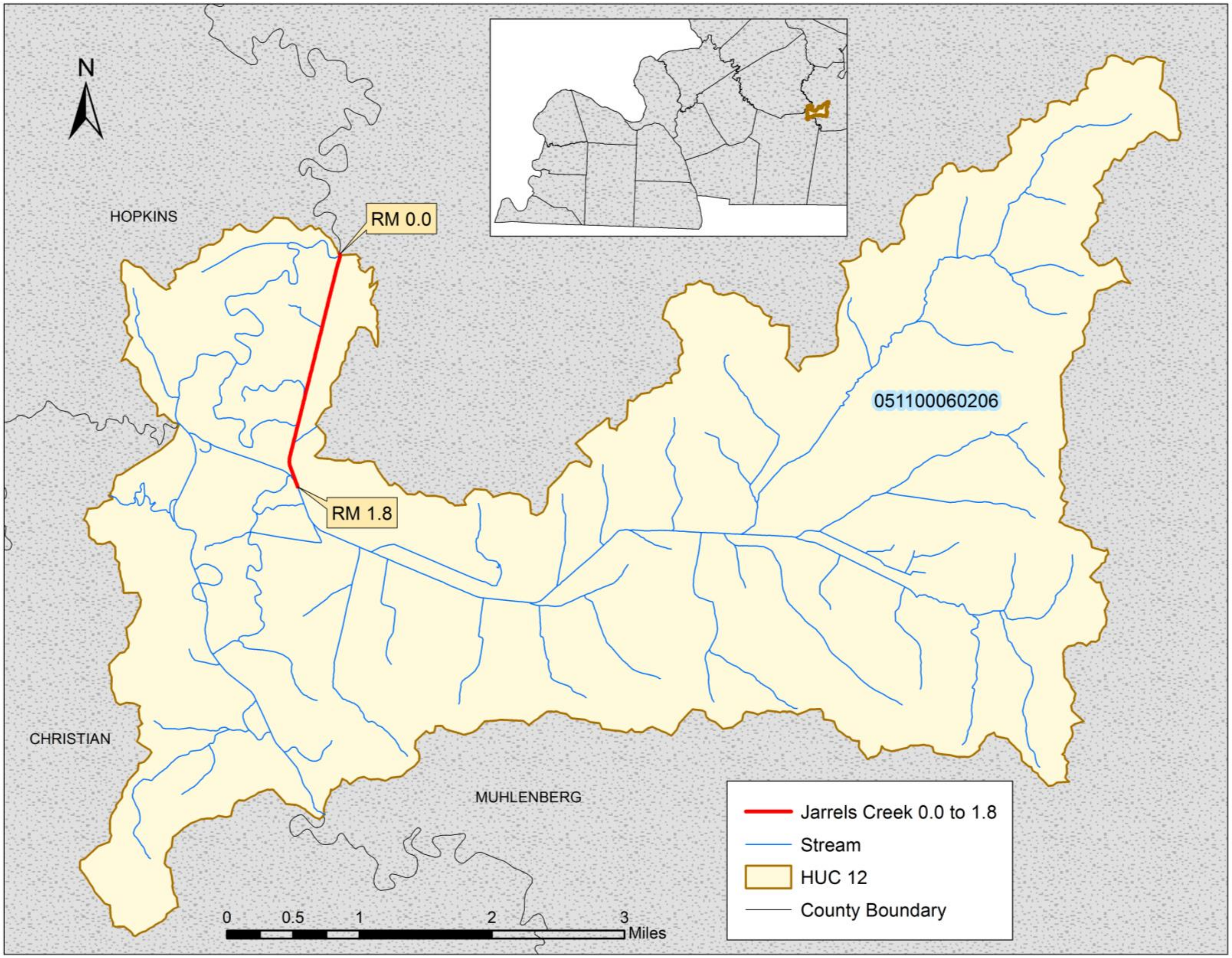

Figure D.16-1 Location of Jarrels Creek 0.0 to 1.8

Section D.17 Knoblick Creek 0 to 2.1

Waterbody ID: KY495848_00

Receiving Water: Panther Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050308

County: Daviess

Western Kentucky University has collected samples from two stations on this segment. In 2001, five samples were collected from FC-T47. In 2007 and 2008, samples were collected from a nearby station as part of a study in the Panther Creek watershed. Table D.17-1 summarizes information about these sampling stations; Table D.17-2 provides a summary of the data collected from the stations.

Table D.17-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
FC-T47	37.7117	-87.3205	Knoblick Creek 0.0 to 2.1	1.45
CWRS_ST0001-LP04	37.71132	-87.32183	Knoblick Creek 0.0 to 2.1	1.53

Table D.17-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
FC-T47	fecal coliform	5	80.0	48	12,000	3,042
ST0001-LP04	*E. coli*	12	58.3	135	1,374	365

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Knoblick Creek 0.0 to 2.1 are presented in Table D.17-3. There are no KPDES-permitted discharges of bacteria into this segment of Knoblick Creek. The location of the segment within the Knoblick-Panther Creek watershed is shown in Figure D.17-1.

Table D.17-3 Knoblick Creek 0.0 to 2.1 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

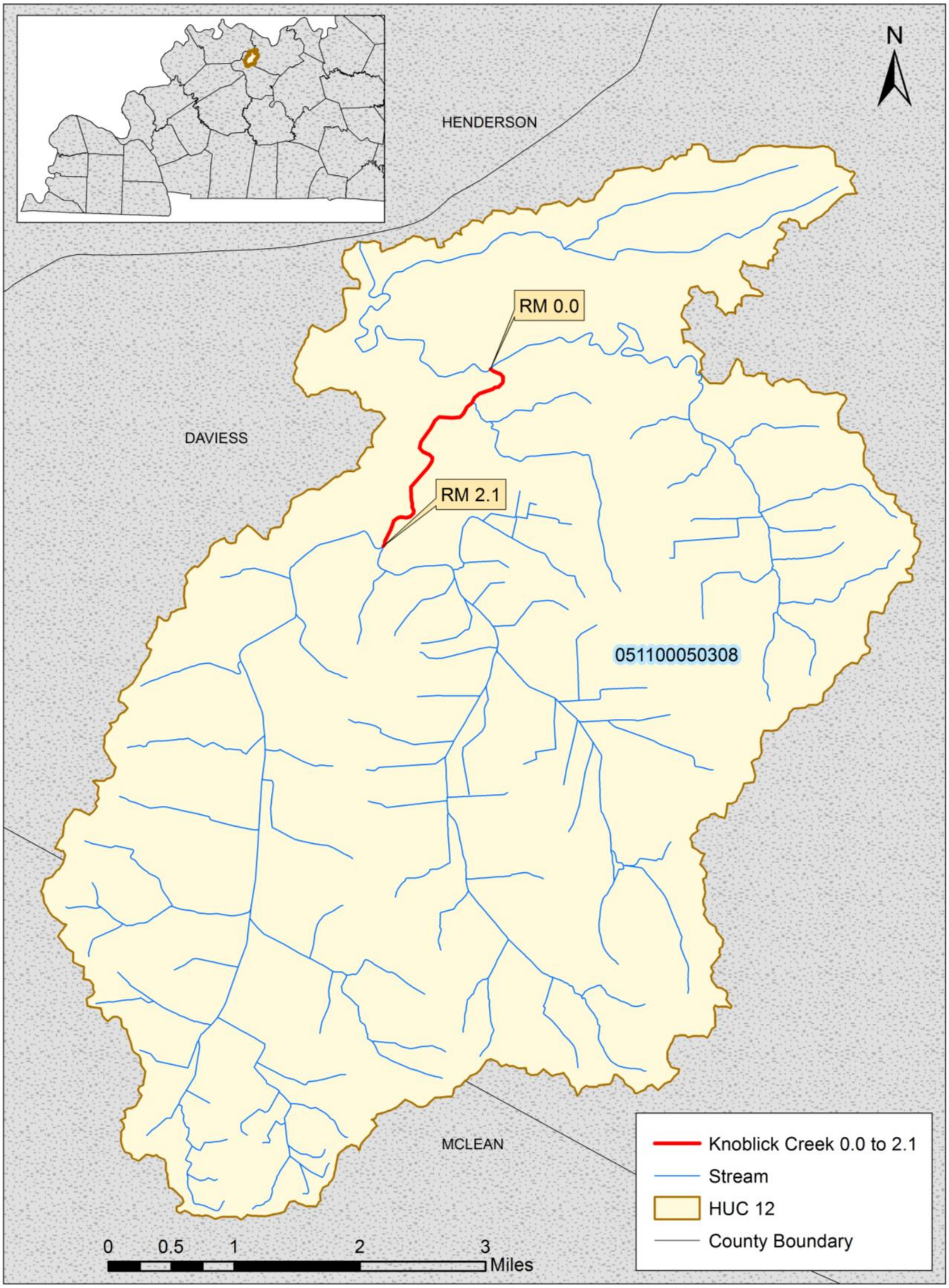

Figure D.17-1 Location of Knoblick Creek 0.0 to 2.1

Section D.18 Long Falls Creek 0.0 to 7.6

Waterbody ID: KY 497098_01

Receiving Water: Green River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050203, 051100050204

County: McLean

In 2007 and 2008, Western Kentucky University collected samples from four stations as part of a study in the Long Falls Creek watershed. Table D.18-1 summarizes information about these sampling locations; Table D.18-2 provides a summary of the data collected from the stations.

Table D.18-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
CWRS_ST0001-LP06	37.56401	-87.2757	Long Falls Creek 0.0 to 7.6	2.95
CWRS_ST0001-LP07	37.53252	-87.2684	Long Falls Creek 0.0 to 7.6	0.23
CWRS_ST0001-LP08	37.58929	-87.2562	Long Falls Creek 0.0 to 7.6	5.7
CWRS_ST0001-LP54	37.58125	-87.2773	Long Falls Creek 0.0 to 7.6	4.35

Table D.18-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
ST0001-LP06	*E. coli*	11	18.2	41	602	188
ST0001-LP07	*E. coli*	9	55.6	121	759	337
ST0001-LP08	*E. coli*	12	58.3	122	495	280
ST0001-LP54	*E. coli*	11	81.8	218	504	315

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Long Falls Creek 0.0 to 7.6 are presented in Table D.18-3. There are no KPDES-permitted discharges of bacteria into this segment of Long Falls Creek. The location of the segment within the Long Falls Creek-Green River watershed is shown in Figure D.18-1.

Table D.18-3 Long Falls Creek 0.0 to 7.6 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[(4)]	Allocations for Tributary Loads to the Segment[(5)]	MOS[(6)]
	LA[(3)]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[(1)]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[(2)]Q_S is the flow (ft^3/s) in the segment.

[(3)]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[(4)]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[(5)]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[(6)]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

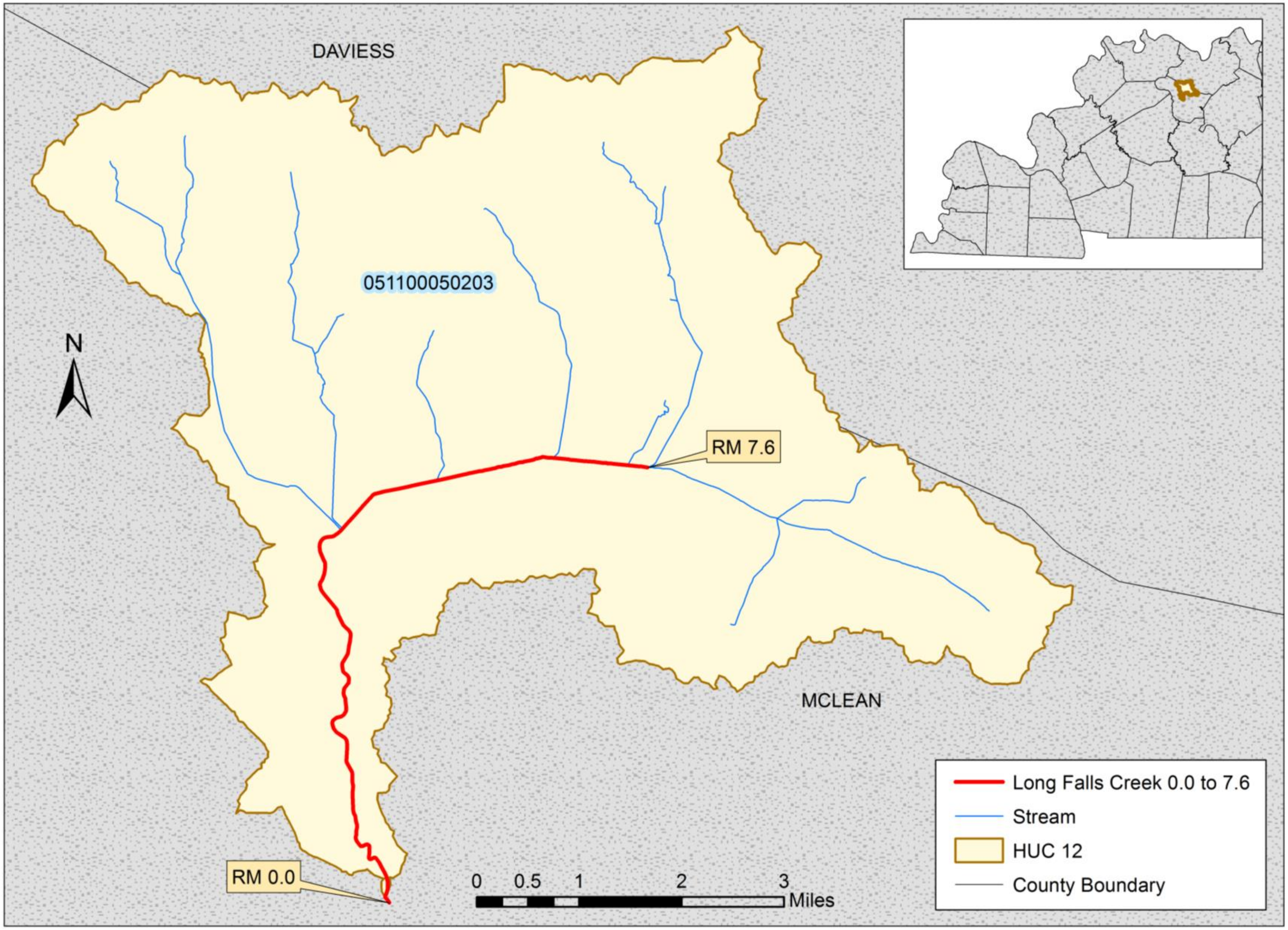

Figure D.18-1 Location of Long Falls Creek 0.0 to 7.6

Section D.19 Long Falls Creek 7.6 to 11.9

Waterbody ID: KY 497098_02

Receiving Water: Green River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050203

County: McLean

In 2007 and 2008, Western Kentucky University collected samples from three stations as part of a study in the Long Falls Creek watershed. Table D.19-1 summarizes information about these sampling locations; Table D.19-2 provides a summary of the data collected from the stations.

Table D.19-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
CWRS_ST0001-LP12	37.58395	-87.20010	Long Falls Creek 7.6 to 11.9	8.95
CWRS_ST0001-LP13	37.58243	-87.19370	Long Falls Creek 7.6 to 11.9	9.3
CWRS_ST0001-LP14	37.57318	-87.16500	Long Falls Creek 7.6 to 11.9	11.0

Table D.19-2 Western Kentucky University Sample Data Summary[(1)]

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
ST0001-LP12	*E. coli*	8	75.0	20	2,613	583
ST0001-LP13	*E. coli*	10	90.0	40	2,098	625
ST0001-LP14	*E. coli*	4	75.0	86	565	286

[(1)]The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
[(2)]400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Long Falls Creek 7.6 to 11.9 are presented in Table D.19-3. There are no KPDES-permitted discharges of bacteria into this segment of Long Falls Creek. The location of the segment within the Long Falls Creek watershed is shown in Figure D.19-1.

Table D.19-3 Long Falls Creek 7.6 to 11.9 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Tributary Loads to the Segment[(4)]	MOS[(5)]
	LA[(3)]		
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[(1)]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[(2)]Q_S is the flow (ft^3/s) in the segment.

[(3)]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[(4)]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[(5)]The following assumptions provide an implicit MOS:

(a) Tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

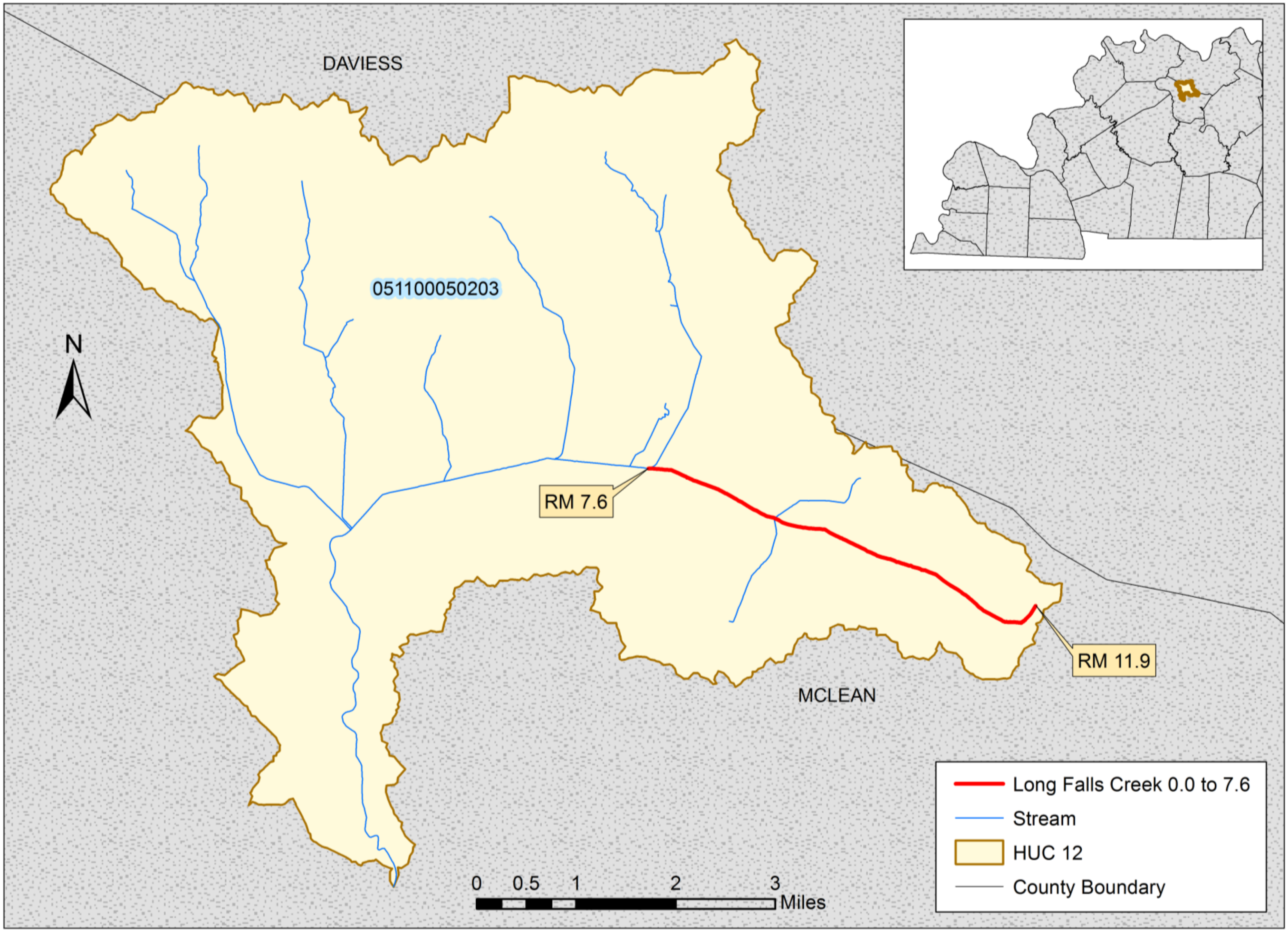

Figure D.19-1 Location of Long Falls Creek 7.6 to 11.9

Section D.20 Mill Creek 0.0 to 4.2

Waterbody ID: KY498260_00

Receiving Water: Smith Creek (incorrectly identified as Spring Creek in the 2014 303(d) list)

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100040404

County: Ohio

In 2001 Western Kentucky University collected five samples at station FC T-35. Table D.20-1 summarizes information about this sampling station; Table D.20-2 provides a summary of the data collected from this station.

Table D.20-1 Western Kentucky University Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
FC-T35	37.63640	-86.75660	Mill Creek 0.0 to 4.2	2.5

Table D.20-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
FC-T35	fecal coliform	5	40.0	8	2,280	648

(1)The full data set for samples collected from FC T-35 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Mill Creek 0.0 to 4.2 are presented in Table D.20-3. There are no KPDES-permitted discharges of bacteria into this segment of Mill Creek. The location of the segment within the Adams Fork watershed is shown in Figure D.20-1.

Table D.20-3 Mill Creek 0.0 to 4.2 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Tributary Loads to the Segment[4]	MOS[5]
	LA[3]		
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[5]The following assumptions provide an implicit MOS:

(a)Tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

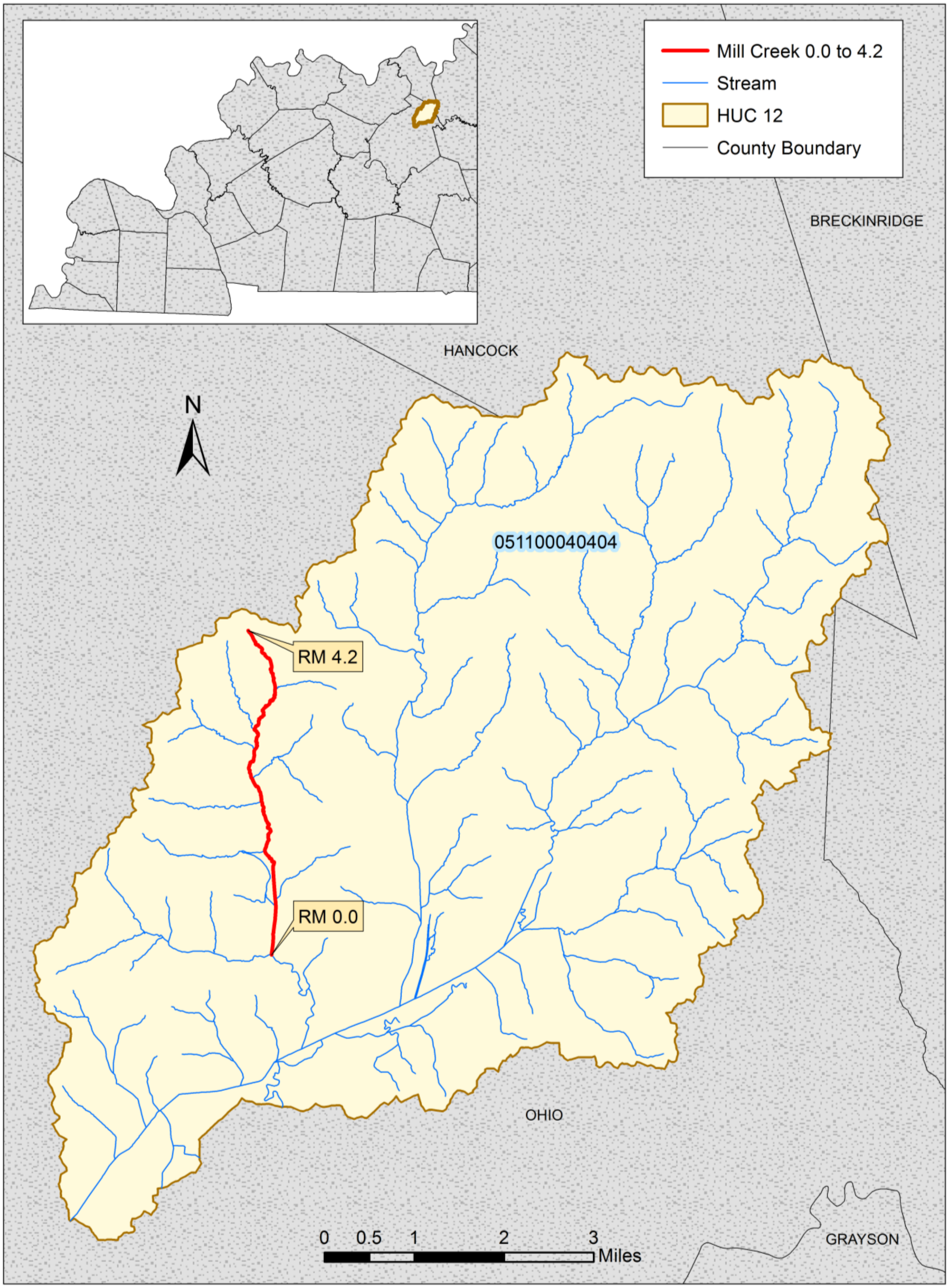

Figure D.20-1 Location of Mill Creek 0.0 to 4.2

Section D.21 North Fork of Panther Creek 4.2 to 9.1

Waterbody ID: KY499562_02

Receiving Water: Panther Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050305

County: Daviess

Western Kentucky University has collected samples from three stations on this segment. In 2001, five samples were collected from FC-T41. In 2007 and 2008, samples were collected from two other stations as part of a study in the Panther Creek watershed. Table D.21-1 summarizes information about these sampling stations; Table D.21-2 provides a summary of the data collected from the stations.

Table D.21-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	RM
FC T-41	37.72490	-86.99150	North Fork of Panther Creek 4.2 to 9.1	5.85
CWRS_ST0001-LP32	37.72529	-86.99220	North Fork of Panther Creek 4.2 to 9.1	5.74
CWRS_ST0001-LP46	37.72200	-86.97200	North Fork of Panther Creek 4.2 to 9.1	6.9

Table D.21-2 Western Kentucky University Sample Data Summary[(1)]

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
FC T-41	fecal coliform	5	60.0	32	12,000	4,928
ST0001-LP32	*E. coli*	11	45.5	41	2,420	644
ST0001-LP46	*E. coli*	12	58.3	41	2,382	622

[(1)]The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
[(2)]400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for the North Fork of Panther Creek 4.2 to 9.1 are presented in Table D.21-3. There are no KPDES-permitted discharges of bacteria into this segment of North Fork of Panther Creek. The location of the segment within the North Fork Panther Creek watershed is shown in Figure D.21-1.

Table D.21-3 North Fork of Panther Creek 4.2 to 9.1 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

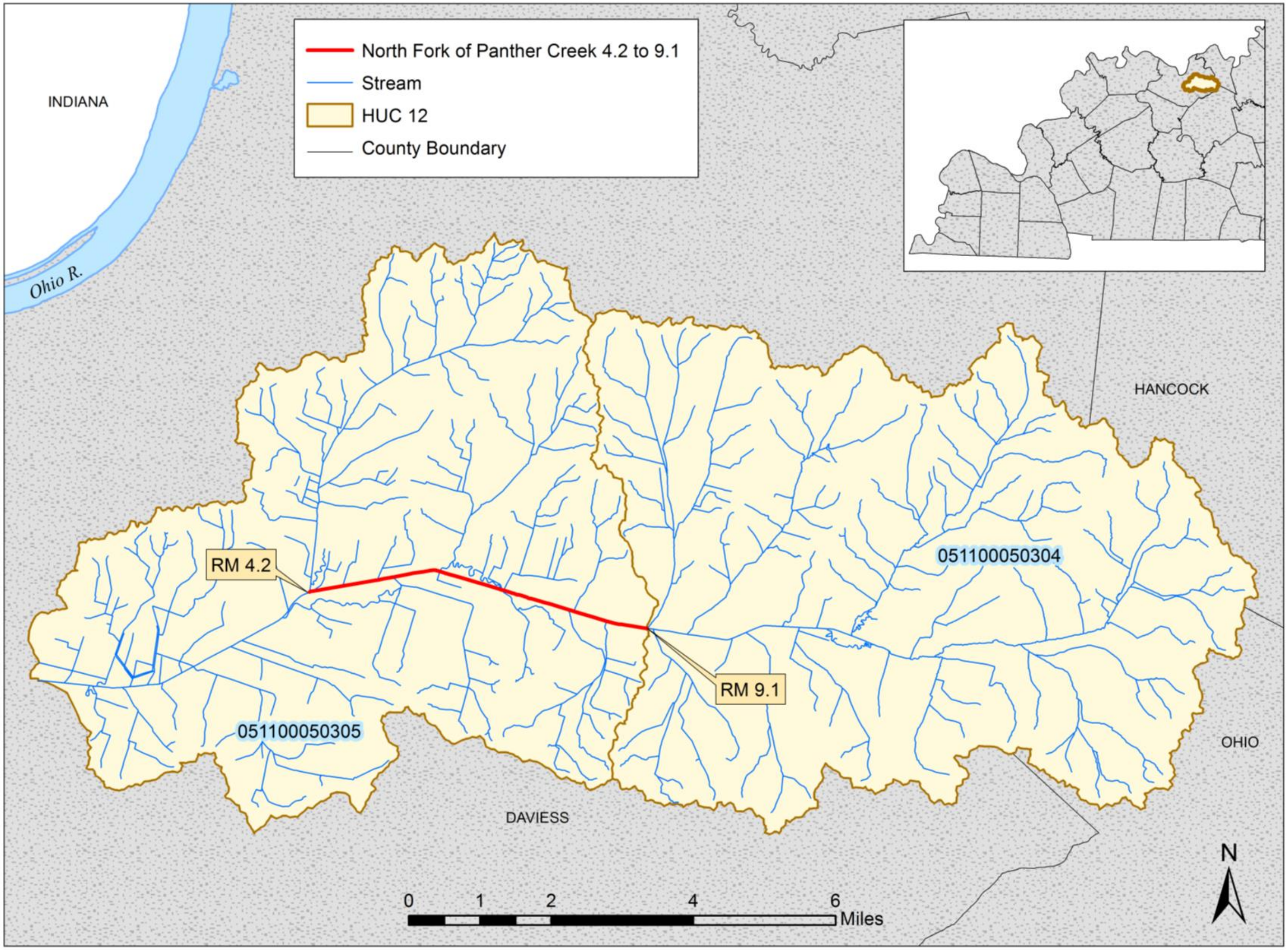

Figure D.21-1 Location of North Fork of Panther Creek 4.2 to 9.1

Section D.22 Panther Creek 0.1 to 3.0

Waterbody ID: KY500157_01

Receiving Water: Green River

Impaired Use: PCR, SCR

Support Status: nonsupport (both uses)

Indicator Bacteria: *E. coli* (PCR), fecal coliform (SCR)

HUC 12: 051100050308

County: Daviess

The Division of Water has collected samples from station PRI 113, located at RM 2.65, since 2005. The station typically has been sampled three or more times during the PCR season. Western Kentucky University also collected samples at a nearby station in 2007 and 2008 as part of a study of the Panther Creek watershed. Table D.22-1 summarizes information about these sampling stations; Table D.22-2 provides a summary of the data collected from the stations.

Table D.22-1 Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI113	37.724965	-87.315125	Panther Creek 0.1 to 3.0	2.65
CWRS_ST0001-LP03	37.72486	-87.31525	Panther Creek 0.1 to 3.0	2.42

Table D.22-2 Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI113	fecal coliform	3	33.3	100	24,000	8,070
PRI113	*E. coli*	40	47.5	3	2,420	478
ST0001-LP03	*E. coli*	11	54.5	63	2,420	744

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)2,000 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Panther Creek 0.1 to 3.0 are presented in Table D.22-3. There are no KPDES-permitted discharges of bacteria into this segment of Panther Creek. The location of the segment within the Knoblick-Panther Creek watershed is shown in Figure D.22-1.

Table D.22-3 Panther Creek 0.1 to 3.0 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment LA(3)	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a) Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

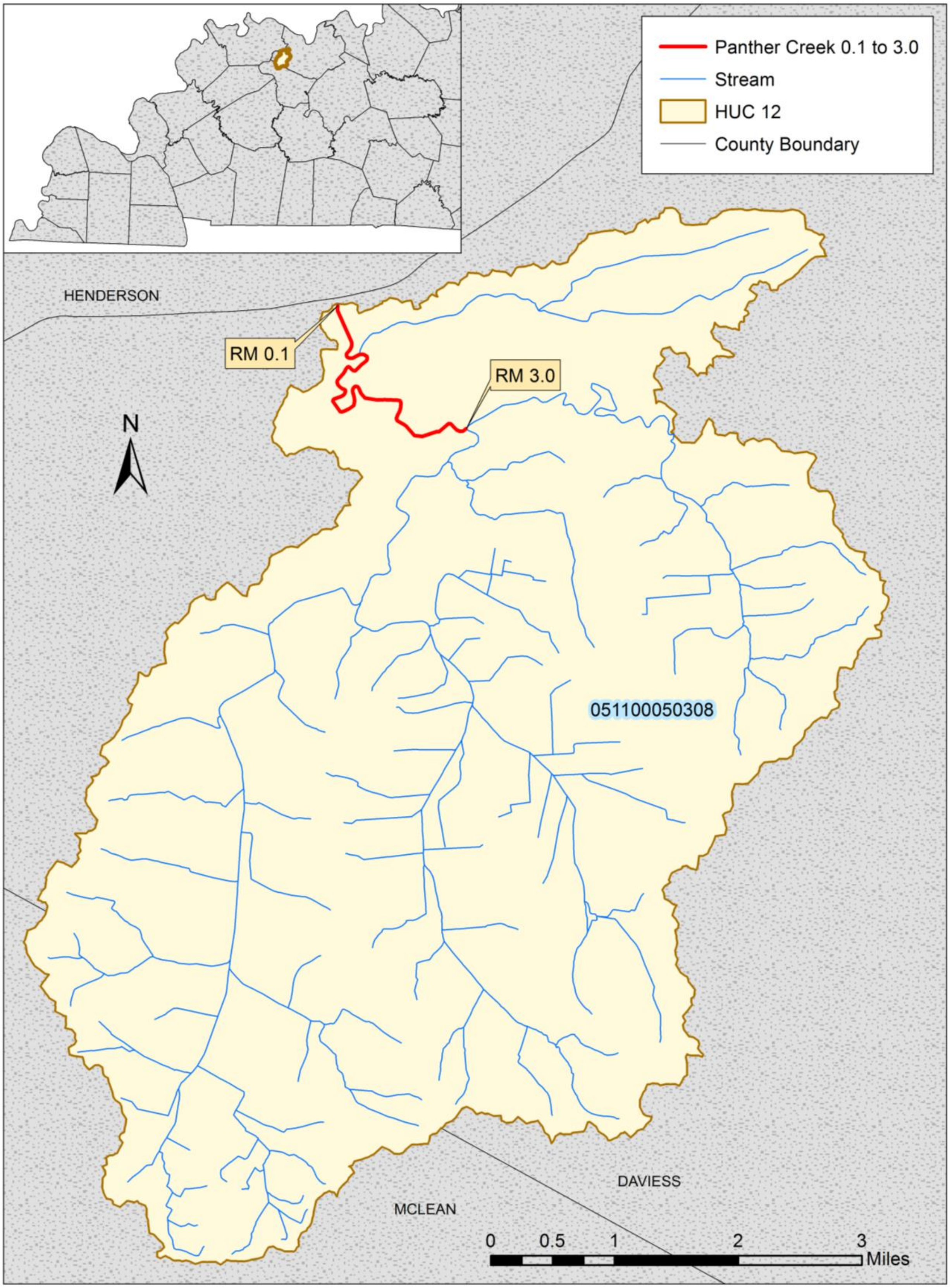

Figure D.22-1 Location of Panther Creek 0.1 to 3.0

Section D.23 Panther Creek 3.0 to 5.9

Waterbody ID: KY500157_02

Receiving Water: Green River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050308

County: Daviess

The Division of Water collected samples from station PRI 070, located at river mile 5.75, between 1998 and 2005. The station typically was sampled three or more times during the PCR season, although no samples were collected in 2004. Western Kentucky University also collected samples at a nearby station in 2007 and 2008 as part of a study of the Panther Creek watershed. Table D.23-1 summarizes information about these sampling stations; Table D.23-2 provides a summary of the data collected from the stations.

Table D.23-1 Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI070	37.7273055	-87.2806944	Panther Creek 3.0 to 5.9	5.75
CWRS_ST0001-LP05	37.72737	-87.28172	Panther Creek 3.0 to 5.9	5.7

Table D.23-2 Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI070	fecal coliform	34	38.2	10	7,400	707
ST0001-LP05	*E. coli*	10	40.0	52	1,785	463

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Panther Creek 3.0 to 5.9 are presented in Table D.23-3. There are no KPDES-permitted discharges of bacteria into this segment of Panther Creek. The location of the segment within the Knoblick-Panther Creek watershed is shown in Figure D.23-1.

Table D.23-3 Panther Creek 3.0 to 5.9 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a)Upstream bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

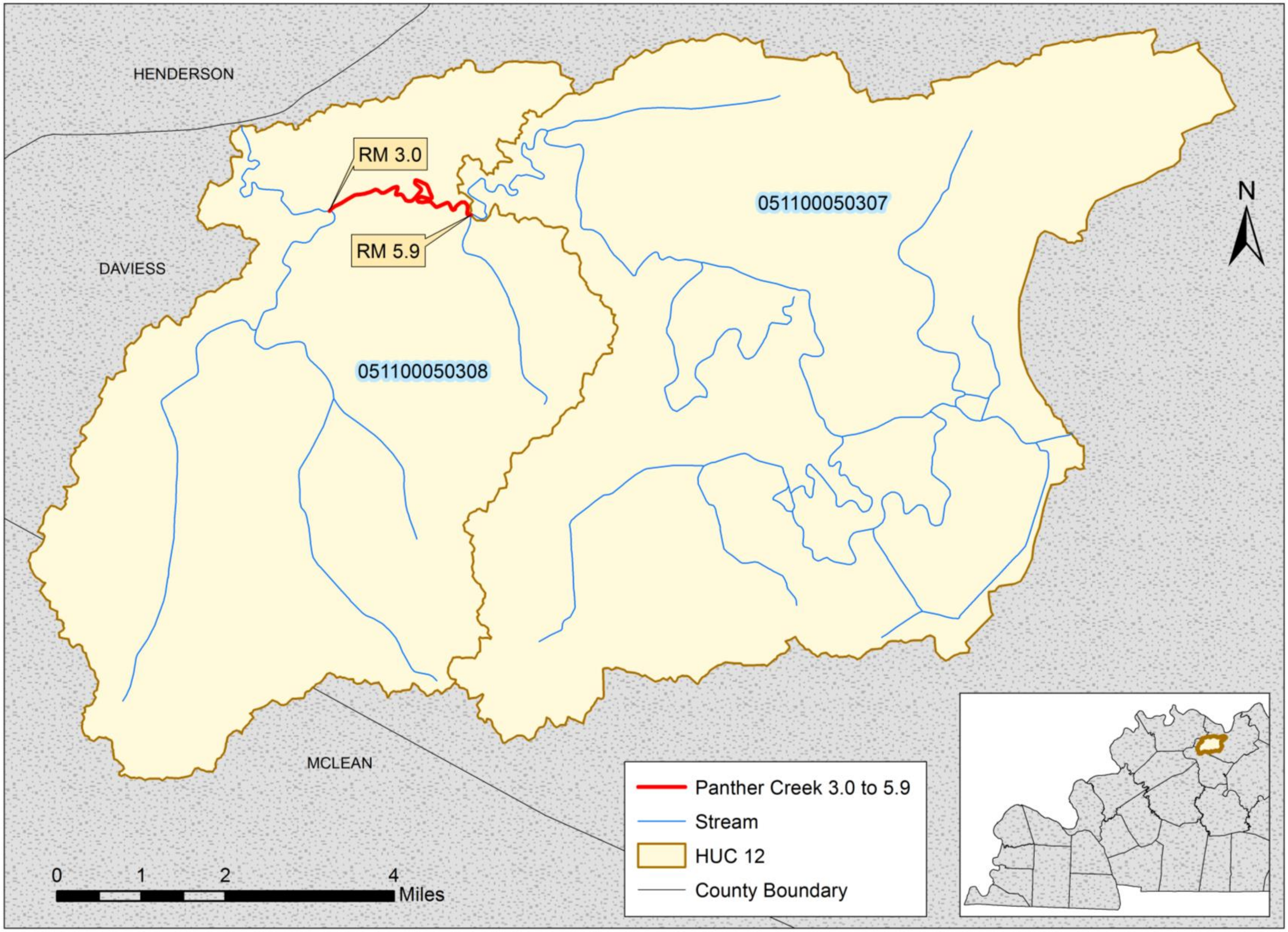

Figure D.23-1 Location of Panther Creek 3.0 to 5.9

Section D.24 Pond Run 0.0 to 6.75

Waterbody ID: KY501057_01

Receiving Water: Rough River

Impaired Use: PCR

Support Status: partial support

Indicator Bacteria: *E. coli*

HUC 12: 051100040306

County: Breckinridge

The Division of Water collected several samples from station DOW03007008 at river mile 2.55 during the 2006 PCR season, and additional samples from station GRN 032 at river mile 2.65 during the 2011 PCR season. Table D.24-1 summarizes information about these sampling stations; Table D.24-2 provides a summary of the data collected from the stations.

Table D.24-1 Division of Water Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
DOW03007008	37.585391	-86.619369	Pond Run 0 to 6.75	2.55
GRN 032	37.58713	-86.6201	Pond Run 0 to 6.75	2.65

Table D.24-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC(2)	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
DOW03007008	fecal coliform	3	33.3	100	1,500	590
DOW03007008	*E. coli*	1	0.0	129	129	129
GRN 032	*E. coli*	5	40.0	22	365	163

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Pond Run 0.0 to 6.75 are presented in Table D.24-3. There are no KPDES-permitted discharges of bacteria into this segment of Pond Run. The location of the segment within the Pipe Run-Rough River watershed is shown in Figure D.24-1.

Table D.24-3 Pond Run 0.0 to 6.75 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Tributary Loads to the Segment[4]	MOS[5]
	LA[3]		
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[5]The following assumptions provide an implicit MOS:

(a) Tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

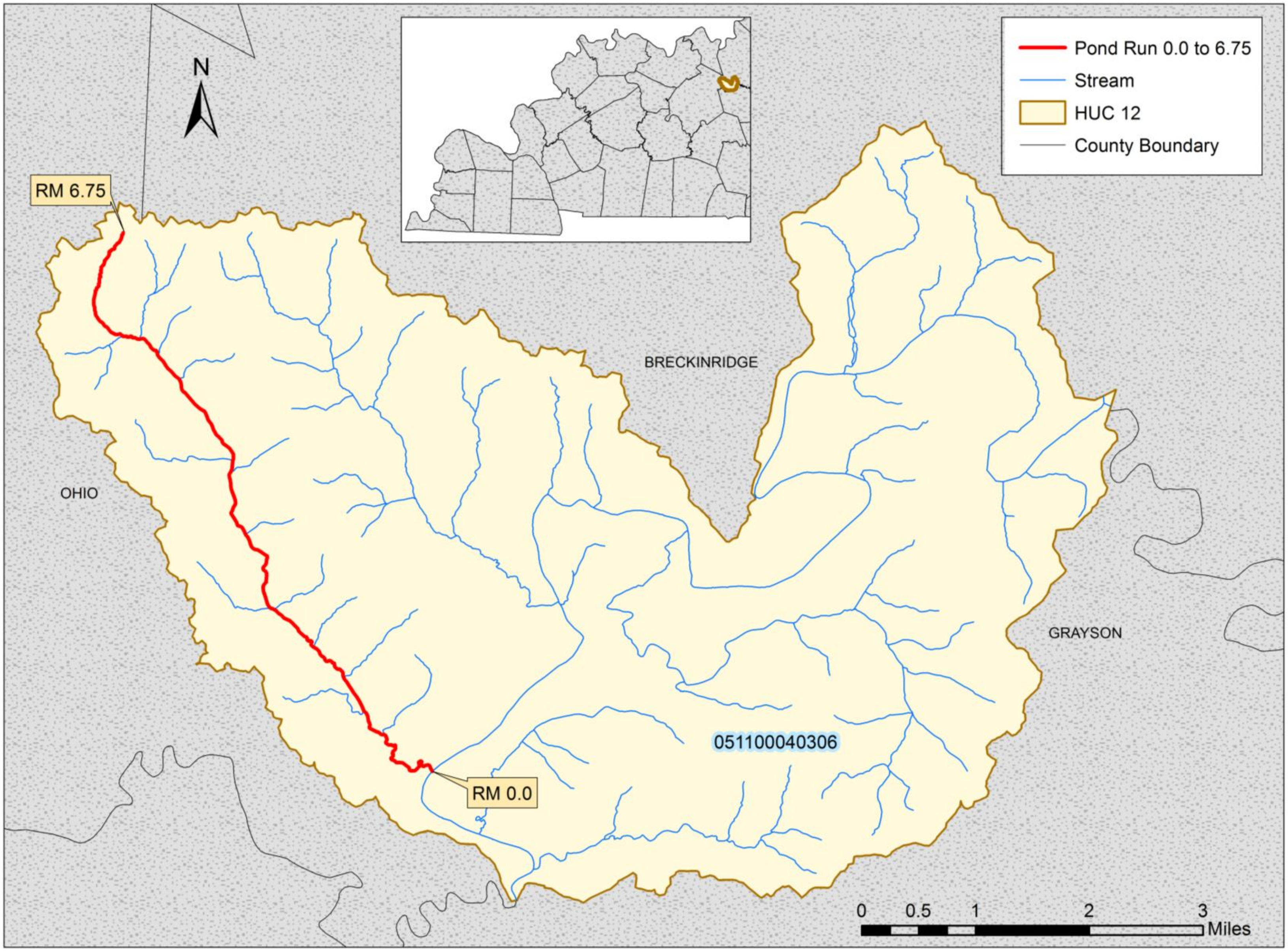

Figure D.24-1 Location of Pond Run 0.0 to 6.75

Section D.25 Rough River 0.1 to 10.45

Waterbody ID: KY502390_01

Receiving Water: Green River

Impaired Use: SCR

Support Status: partial support

Indicator Bacteria: fecal coliform

HUC 12: 051100040507

County: Ohio

The Division of Water has collected samples from station PRI 054 since 1998. The station was located at river mile 1.0 in 1998 and was moved to river mile 7.15 afterward. The station typically has been sampled two or more times each year, although it was not sampled in 2004 and only once in 2002. Table D.34-1 summarizes information about this sampling station; Table D.25-2 provides a summary of the data collected from this station.

Table D.25-1 Division of Water Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI 054	37.484194	-87.118778	Rough River 0.1 to 10.45	1.0
PRI 054	37.499	-87.0656	Rough River 0.1 to 10.45	7.15

Table D.25-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI 054 (RM 1.0)	fecal coliform	4	0.0	46	230	114
PRI 054 (RM 7.15)	fecal coliform	28	10.7	10	33,000	1,518

(1)The full data set for samples collected from PRI 054 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)2,000 colonies/100 ml for fecal coliform.

The TMDL allocations for Rough River 0.1 to 10.45 are presented in Table D.25-3. There are no KPDES-permitted discharges of bacteria into this segment of Rough River. The segment's location within the Muddy Creek-Rough River watershed is shown in Figure D.25-1.

Table D.25-3 Rough River 0.1 to 10.45 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[(4)]	Allocations for Tributary Loads to the Segment[(5)]	MOS[(6)]
	LA[(3)]			
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[(1)]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[(2)]Q_S is the flow (ft^3/s) in the segment.

[(3)]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[(4)]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[(5)]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[(6)]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

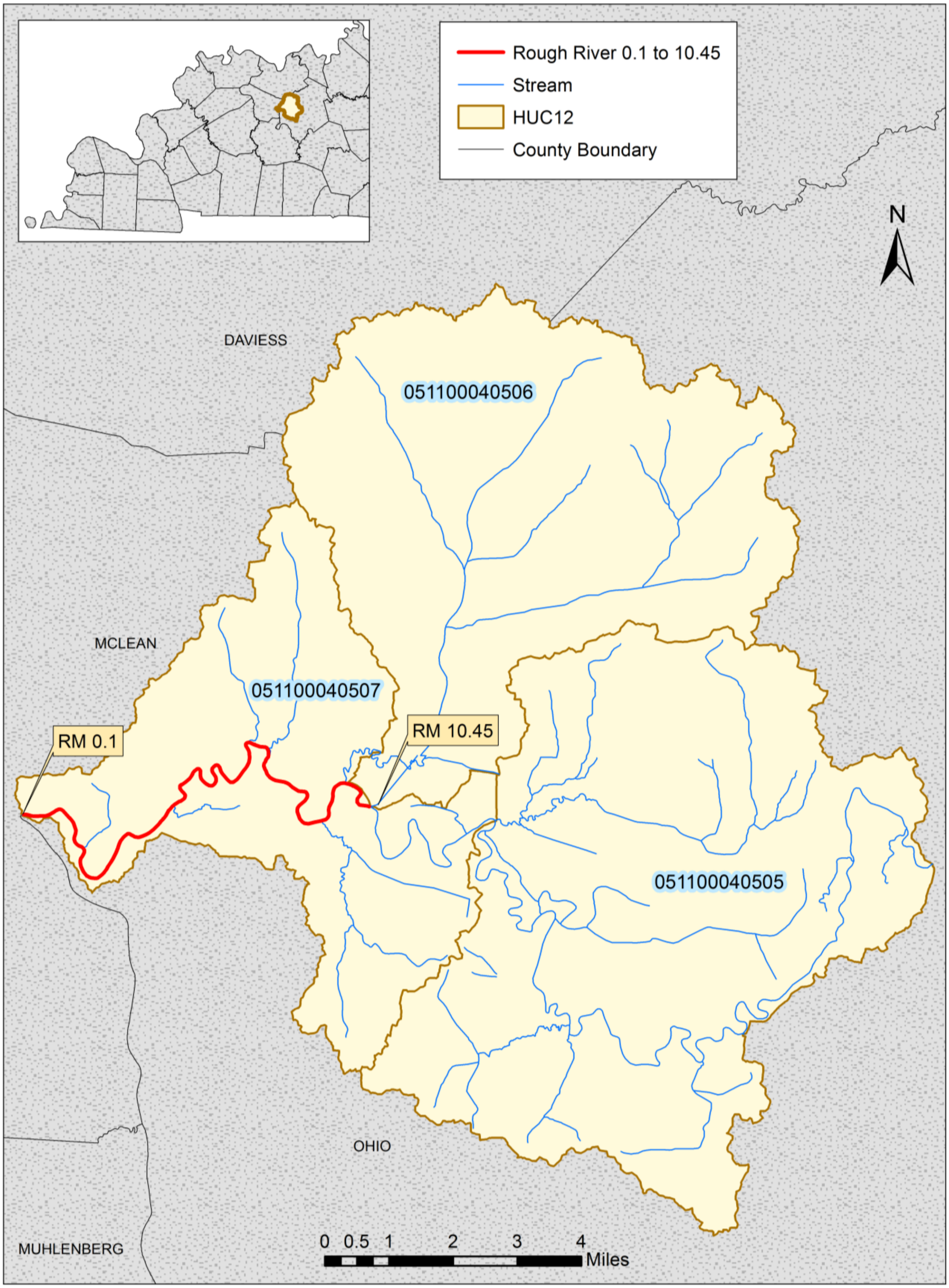

Figure D.25-1 Location of Rough River 0.1 to 10.45

Section D.26 Rough River 125.2 to 149.4

Waterbody ID: KY502390_06

Receiving Water: Green River

Impaired Use: PCR

Support Status: partial support

Indicator Bacteria: fecal coliform

HUC 12: 051100040106

County: Hardin

The Division of Water has collected samples from station GRN 016, located at river mile 129.95, since 2001. The station has been sampled five or more times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table D.26-1 summarizes information about this sampling station; Table D.26-2 provides a summary of the data collected from this station.

Table D.26-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 016	37.6098	-86.2588	Rough River 125.2 to 149.4	129.95

Table D.26-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 016	fecal coliform	5	0.0	1	382	211
GRN 016	*E. coli*	16	43.8	60.2	1,046	320

(1)The full data set for samples collected from GRN 016 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Rough River 125.2 to 149.4 are presented in Table D.26-3. There are no KPDES-permitted discharges of bacteria into this segment of Rough River. The segment's location within the Clifty Creek-Rough River watershed is shown in Figure D.26-1.

Table D.26-3 Rough River 125.2 to 149.4 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

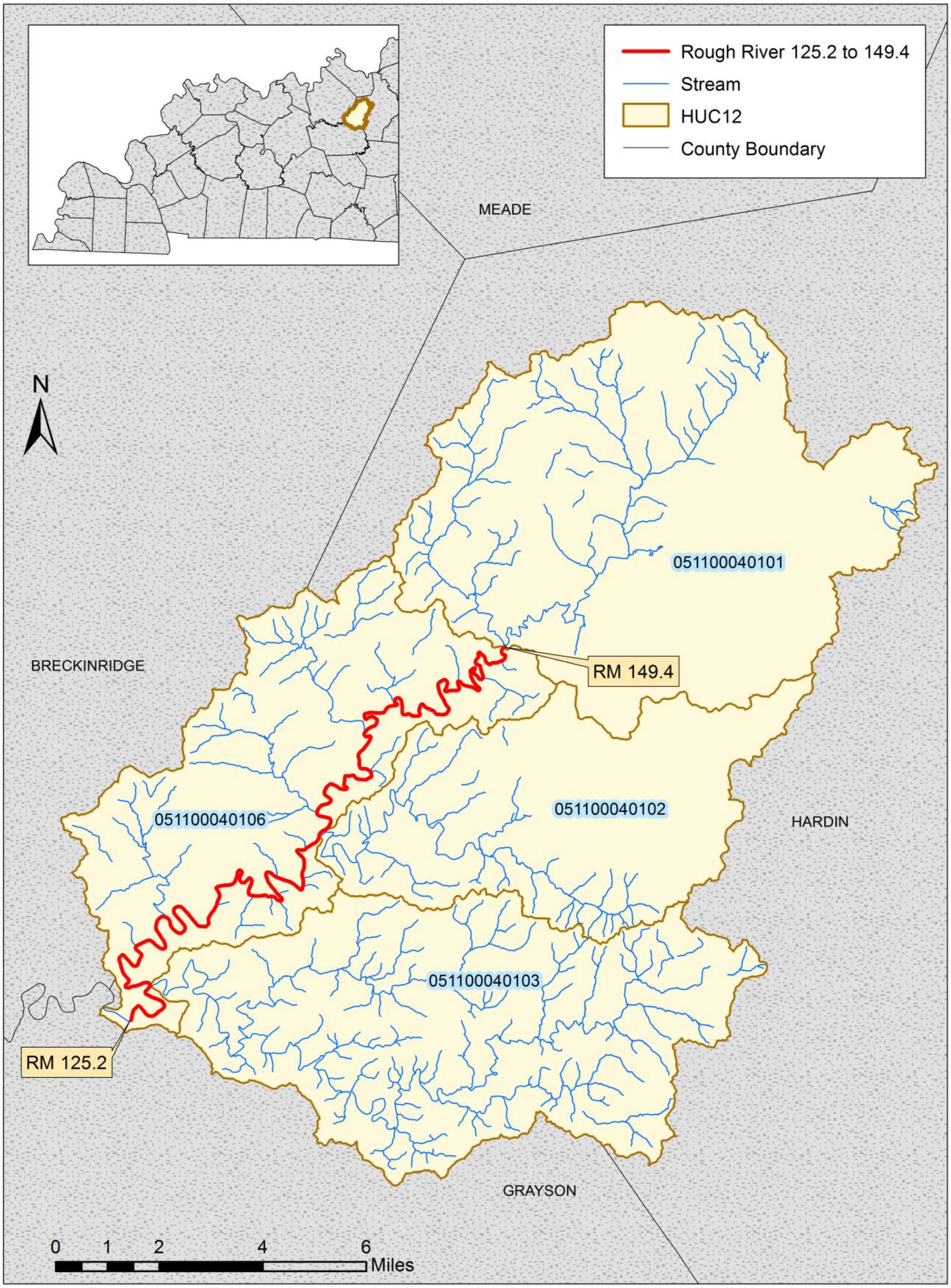

Figure D.26-1 Location of Rough River 125.2 to 149.4

The segment is located in an area where karst features such as sinkholes, sinking streams and springs exist. Groundwater dye traces in the area indicate that groundwater flow paths do not always follow the topographic boundaries of the watershed (see Figure D.26-2). This segment of Rough River may receive surface runoff via karst conduits from areas north and east, respectively, of the 051100040101 and -02 HUC boundaries. For more information about karst, see Section 3.2, Karst.

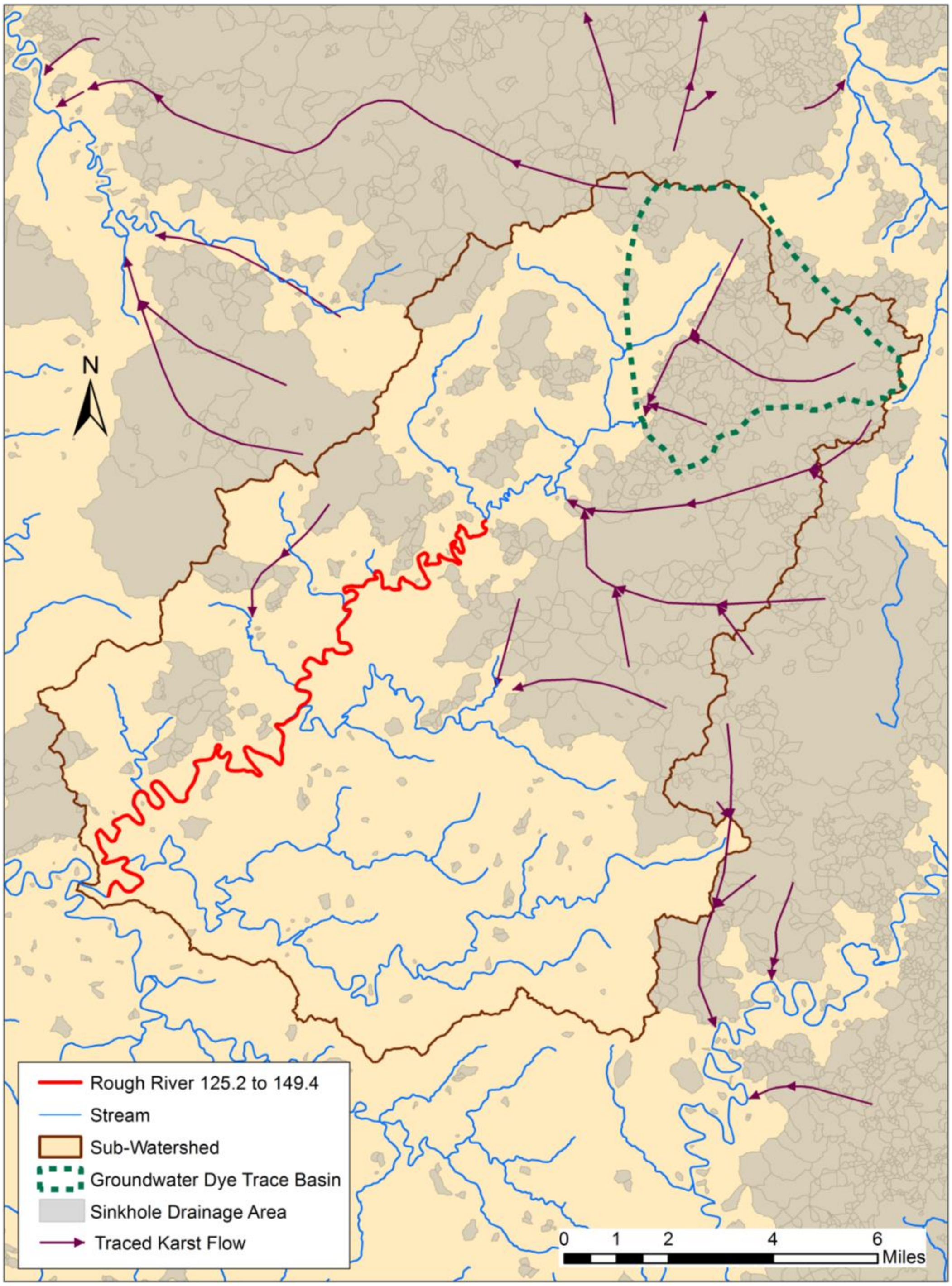

Figure D.26-2 Karst Influence in the Region of Rough River 125.2 to 149.4

Section D.27 Rough River 55.1 to 64.5

Waterbody ID: KY502390_04

Receiving Water: Green River

Impaired Use: PCR, SCR

Support Status: nonsupport (both uses)

Indicator Bacteria: *E. coli* (PCR), fecal coliform (SCR)

HUC 12: 051100040405

County: Ohio

The Division of Water has collected samples from station PRI 014, located at river mile 62.9, since 1980. The station was sampled year-round until 1995. Beginning in 1996, the sampling routine changed to multiple visits each year during the PCR season, although the station was not sampled in 2004. Samples were analyzed for fecal coliform through October, 2006; samples were analyzed for *E. coli* beginning in July, 2006. Table D.27-1 summarizes information about this sampling station; Table D.27-2 provides a summary of the data collected from this station.

Table D.27-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI 014	37.547201	-86.721393	Rough River 55.1 to 64.5	62.9

Table D.27-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI 014	fecal coliform	213	3.8	1	60,000	558
PRI 014	*E. coli*	36	30.6	6	2,420	522

(1)The full data set for samples collected from PRI 014 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)2,000 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*. Among fecal coliform samples collected during the PCR season through 2006, 16.8 percent exceeded the WQC of 400 colonies/100 ml.

The TMDL allocations for Rough River 55.1 to 64.5 are presented in Table D.27-3. There are no KPDES-permitted discharges of bacteria into this segment of Rough River. The location of the segment within the Mistaken Creek-Rough River watershed is shown in Figure D.27-1.

Table D.27-3 Rough River 55.1 to 64.5 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

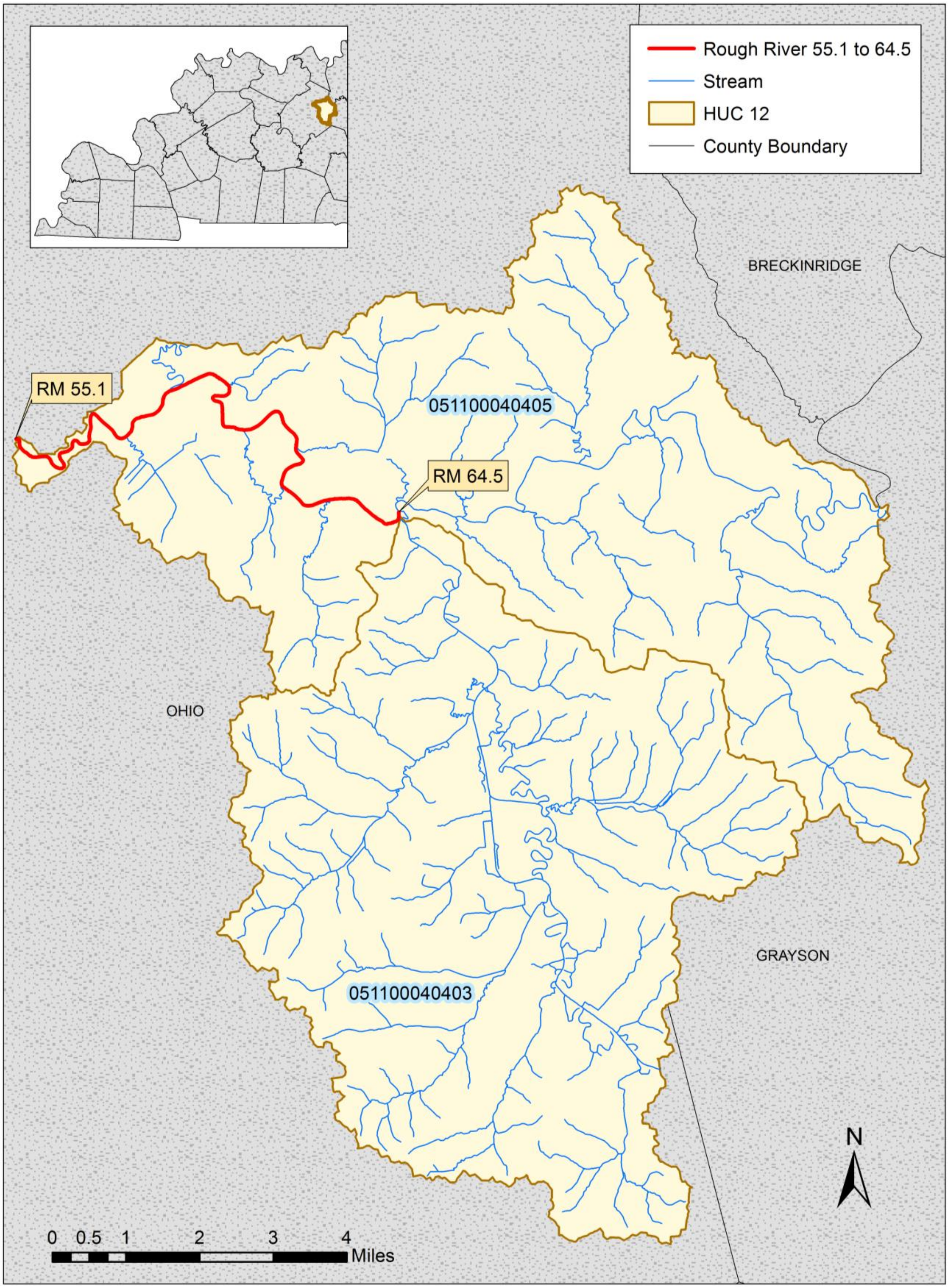

Figure D.27-1 Location of Rough River 55.1 to 64.5

Section D.28 Skaggs Creek 12.7 to 23.55

Waterbody ID: KY503595_01

Receiving Water: Barren River

Impaired Use: PCR

Support Status: nonsupport

Bacteria Indicator: *E. coli*

HUC 12: 051100020307

County: Barren

The Division of Water has collected samples from station GRN 024, located at RM 20.4, since 2001. The station has been sampled five to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table D.28-1 summarizes information about this sampling station; Table D.28-2 provides a summary of the data collected from this station.

Table D.28-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 024	36.9073	-85.939	Skaggs Creek 12.7 to 23.55	20.4

Table D.28-2 Division of Water Sample Data Summary[(1)]

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 024	fecal coliform	5	40.0	1	2,000	684
GRN 024	*E. coli*	17	41.2	41	2,420	688

[(1)]The full data set for samples collected from GRN 024 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
[(2)]400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Skaggs Creek 12.7 to 23.55 are presented in Table D.28-3. There are no KPDES-permitted discharges into this segment of Skaggs Creek.

Table D.28-3 Skaggs Creek 12.7 to 23.55 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

The location of the segment within the Boyds Creek-Skaggs Creek watershed is shown in Figure D.28-1. Some karst features such as sinkholes and sinking springs exist in this watershed. The sink features may capture surface drainage and channel it underground to resurface later at one or more springs. These discharging springs may occur outside the watershed where the drainage originated. However, unless karst dye trace studies indicate otherwise, groundwater catchment is presumed to correspond to the topographic watershed boundaries of surface drainage. No dye tracing information is available from the area of the Boyds Creek-Skaggs Creek watershed. For more detailed information about karst geology, see Section 3.2, Karst.

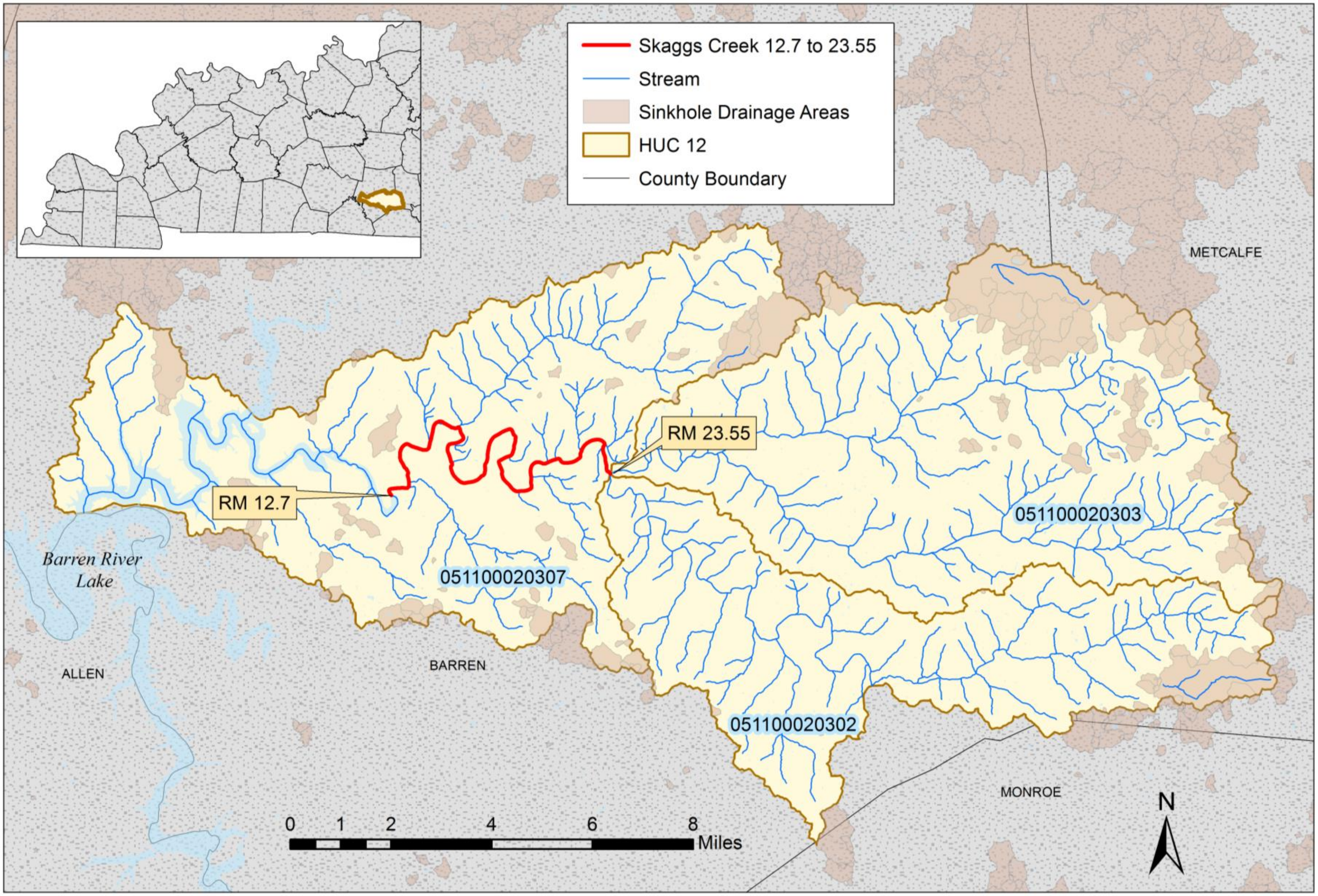

Figure D.28-1 Location of Skaggs Creek 12.7 to 23.55

Section D.29 South Fork of Panther Creek 14.0 to 18.3

Waterbody ID: KY503939_04

Receiving Water: Panther Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050302

County: Ohio

Western Kentucky University collected samples at two stations on this reach in 2007 and 2008 as part of a study of the Panther Creek watershed. Table D.29-1 summarizes information about these sampling stations; Table D.29-2 provides a summary of the data collected from the stations.

Table D.29-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
CWRS_ST0001-LP41	37.61898	-86.8874	South Fork of Panther Creek 14.0 to 18.3	16.15
CWRS_ST0001-LP52	37.624	-86.923	South Fork of Panther Creek 14.0 to 18.3	14.15

Table D.29-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
ST0001-LP41	*E. coli*	9	55.6	41	697	295
ST0001-LP52	*E. coli*	6	50.0	10	4,352	1,266

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for South Fork of Panther Creek 14.0 to 18.3 are presented in Table D.29-3. There are no KPDES-permitted discharges into this segment of the South Fork of Panther Creek. The location of the segment within the South Fork of Panther Creek watershed is shown in Figure D.29-1.

Table D.29-3 South Fork of Panther Creek 14.0 to 18.3 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

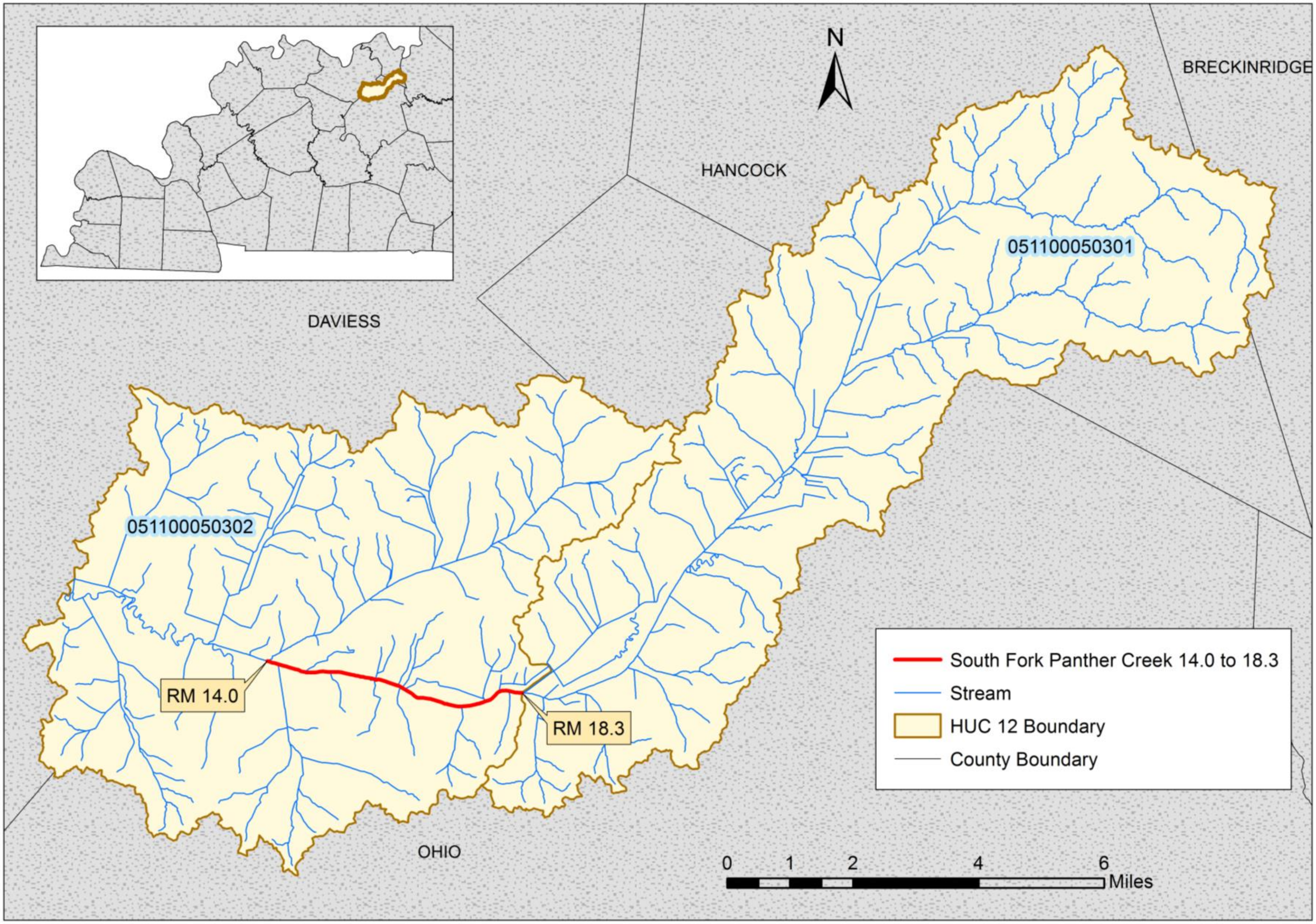

Figure D.29-1 Location of South Fork of Panther Creek 14.0 to 18.3

Section D.30 South Fork of Panther Creek 9.55 to 14.0

Waterbody ID: KY503939_03

Receiving Water: Panther Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100050302

County: Ohio

Western Kentucky University collected samples at two stations on this reach in 2007 and 2008 as part of a study of the Panther Creek watershed. Table D.30-1 summarizes information about these sampling stations; Table D.30-2 provides a summary of the data collected from the stations.

Table D.30-1 Western Kentucky University Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
CWRS_ST0001-LP37	37.63875	-86.9653	South Fork of Panther Creek 9.55 to 14.0	10.0
CWRS_ST0001-LP38	37.62819	-86.9435	South Fork of Panther Creek 9.55 to 14.0	13.0

Table D.30-2 Western Kentucky University Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
ST0001-LP37	*E. coli*	10	20.0	10	1,918	288
ST0001-LP38	*E. coli*	8	25.0	10	6,867	930

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for South Fork of Panther Creek 9.55 to 14.0 are presented in Table D.30-3. There are no KPDES-permitted discharges into this segment of the South Fork of Panther Creek. The location of the segment within the South Fork of Panther Creek watershed is shown in Figure D.30-1.

Table D.30-3 South Fork of Panther Creek 9.55 to 14.0 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

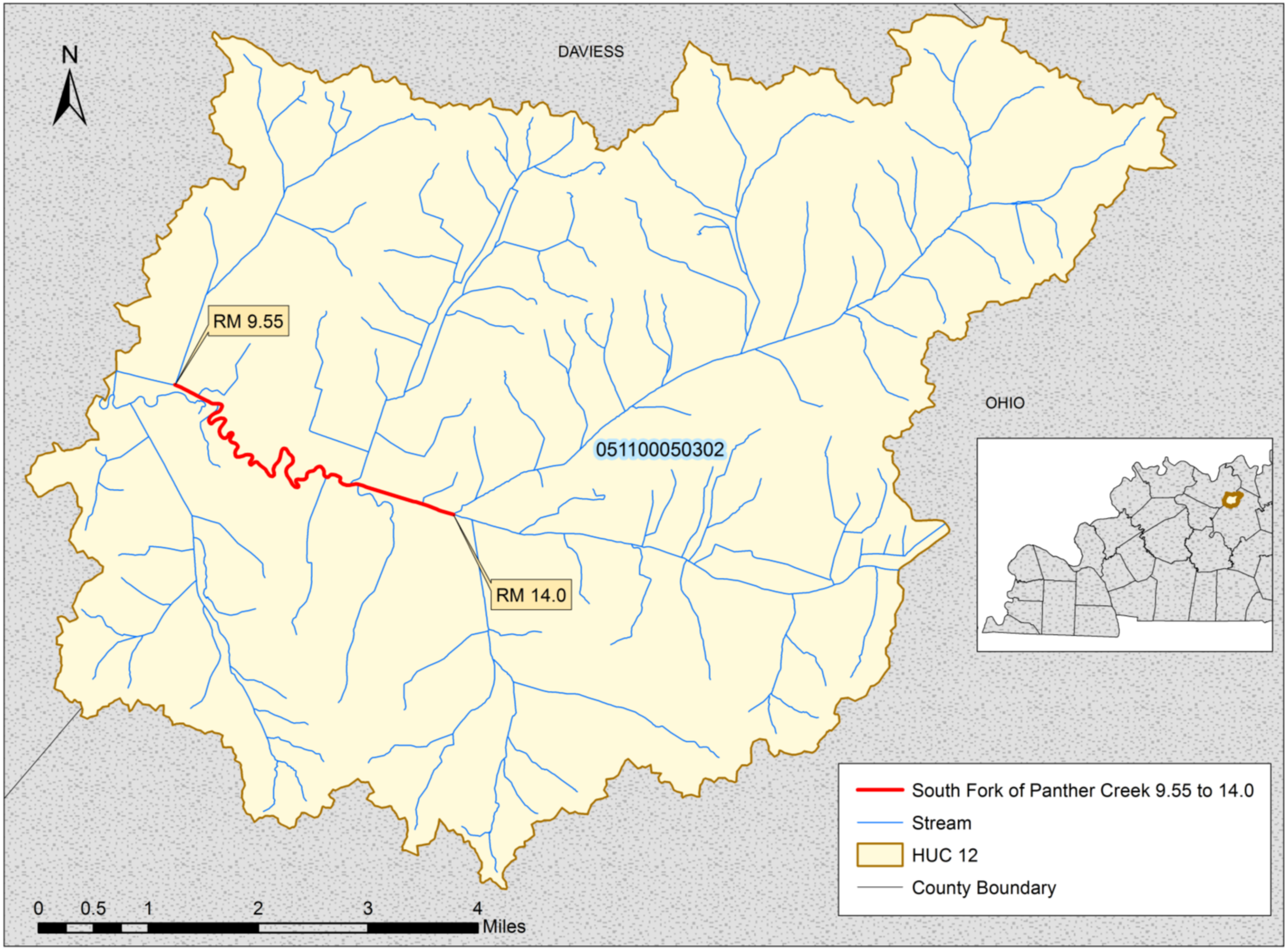

Figure D.30-1 Location of South Fork of Panther Creek 9.55 to 14.0

Section D.31 UT of Buck Creek 0.0 to 1.7

Waterbody ID: KY488213-8.0_01

Receiving Water: Buck Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: *E. coli*

HUC 12: 051100050201

County: McLean

In 2008 the Division of Water collected samples at station DOW03003010 as part of a study of the Buck Creek watershed. Table D.31-1 summarizes information about this sampling station; Table D.31-2 provides a summary of the data collected from this station.

Table D.31-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
DOW03003010	37.53493	-87.10857	UT of Buck Creek 0.0 to 1.7	0.21

Table D.31-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
DOW03003010	*E. coli*	6	100.00	520	1,500	1,085

(1)The full data set for samples collected from DOW03003010 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)240 colonies/100 ml for *E. coli*.

The TMDL allocations for UT of Buck Creek 0.0 to 1.7 are presented in Table D.31-3. There are no KPDES-permitted discharges into this segment of UT of Buck Creek. The location of the segment within the Buck Creek watershed is shown in Figure D.31-1.

Table D.31-3 UT of Buck Creek 0.0 to 1.7 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a) Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b) There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

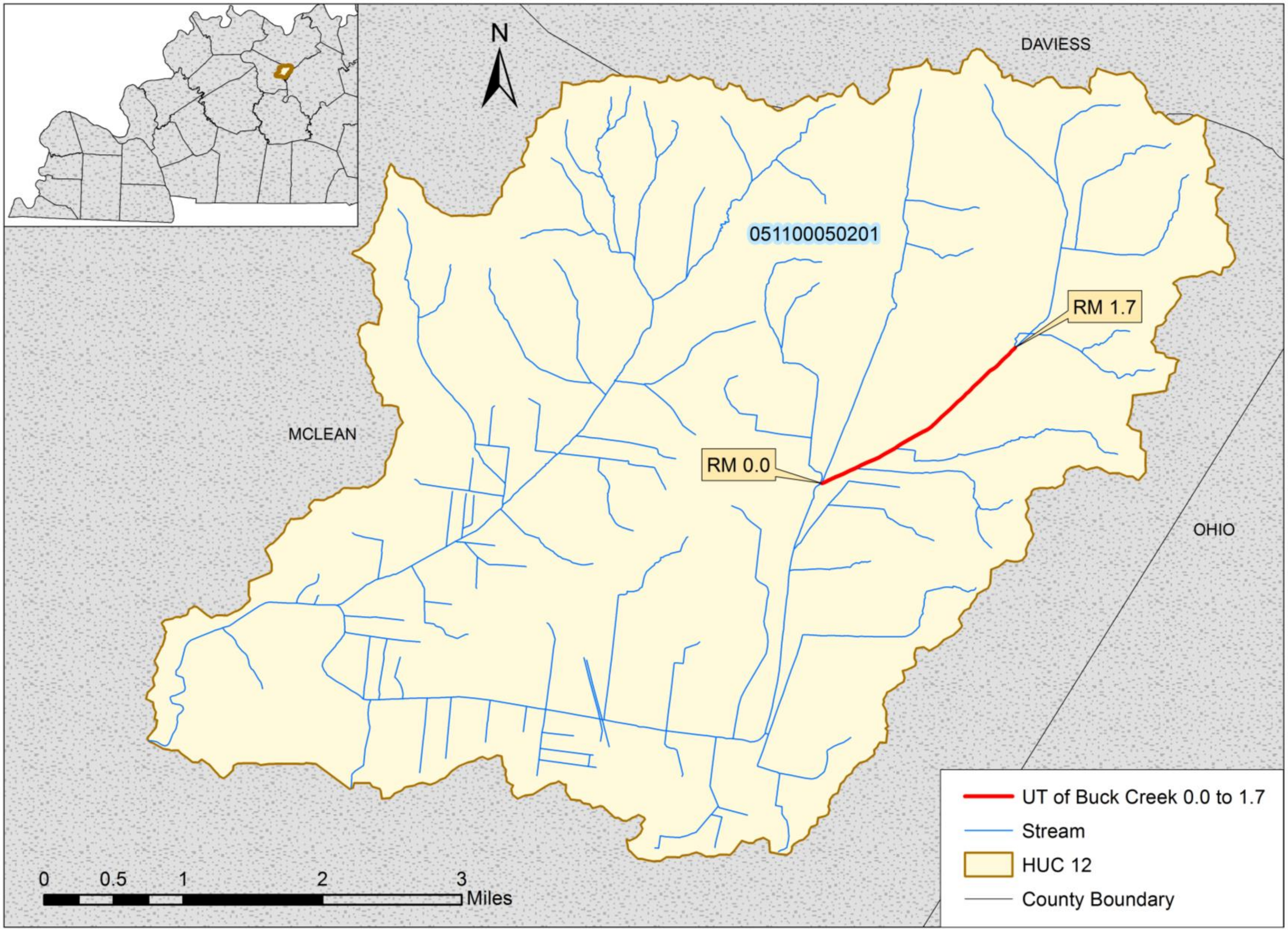

Figure D.31-1 Location of UT of Buck Creek 0.0 to 1.7

Section D.32 UT of Elk Creek 0.0 to 1.0

Waterbody ID: KY491656-7.1_01

Receiving Water: Elk Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060504

County: Hopkins

Sampling data from UT of Elk Creek 0.0 to 1.0 is not available. This segment is located in a sewered area of Madisonville. Beginning in 1994, the Division of Water issued Notices of Violation to the City of Madisonville for failure to report the release of untreated wastewater to the waters of the Commonwealth and degradation of the waters of the Commonwealth. These violations were related to a series of sanitary sewer overflows in the Madisonville collection system, and as one of the impacted waters, UT of Elk Creek 0.0 to 1.0 was added to the 303(d) list in 1998. A subsequent Agreed Order outlined the corrective measures required by the city. There are no KPDES-permitted discharges into this segment of UT of Elk Creek. The City of Madisonville does have MS4 storm water permit coverage for areas in the watershed, but the discharges occur upstream of the segment.

The TMDL allocations for UT of Elk Creek 0.0 to 1.0 are presented in Table D.32-1. The location of the segment within the Elk Creek watershed is shown in Figure D.32-1.

Table D.32-1 UT of Elk Creek 0.0 to 1.0 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

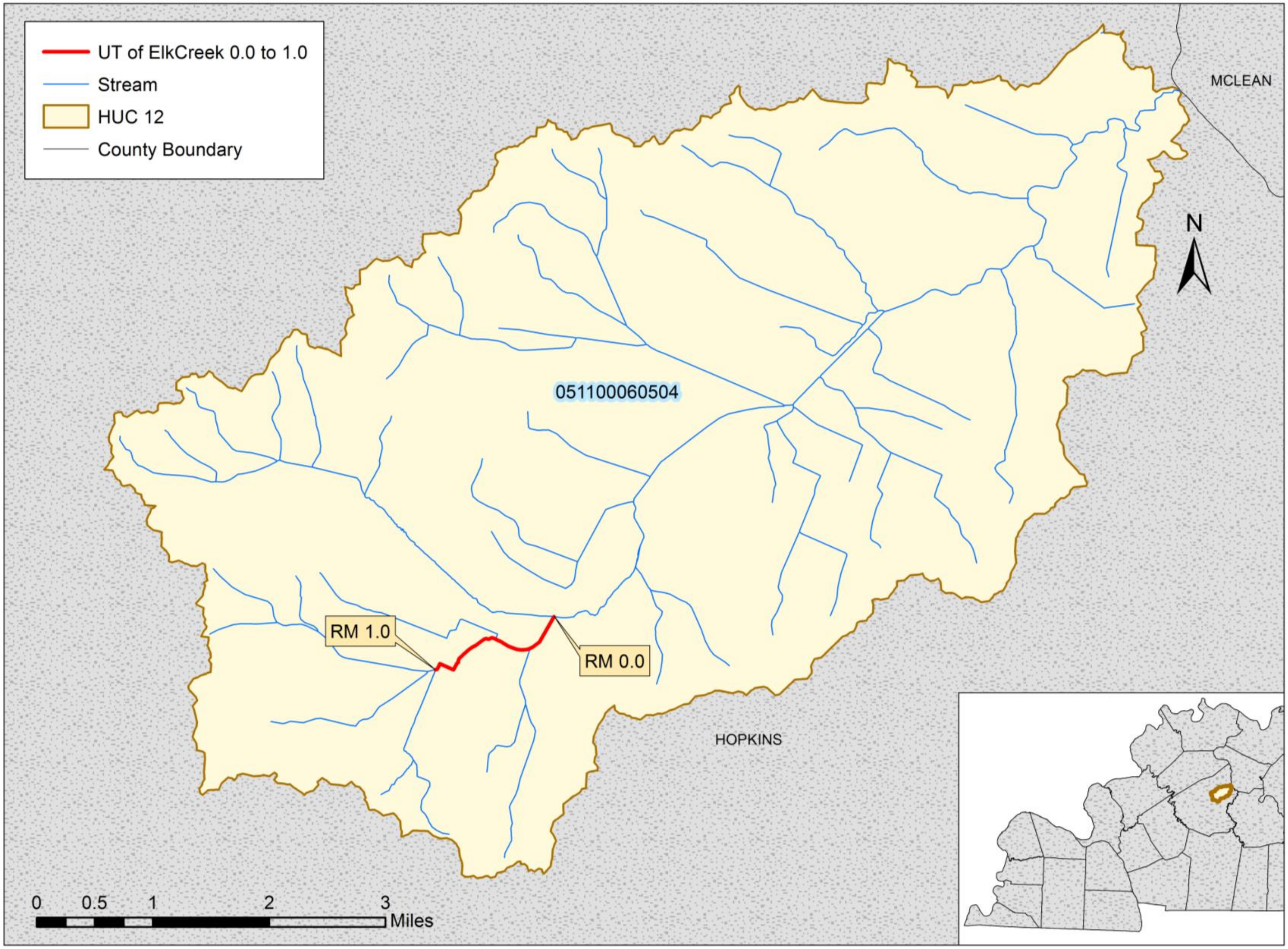

Figure D.32-1 Location of UT of Elk Creek RM 0.0 to 1.0

Section D.33 UT of Flat Creek 3.1 to 4.1

Waterbody ID: KY492181-2.0_02

Receiving Water: Flat Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051100060502

County: Hopkins

Sampling data from UT of Flat Creek 3.1 to 4.1 is not available. This segment is located in a sewered area of Madisonville. Beginning in 1994, the Division of Water issued Notices of Violation to the City of Madisonville for failure to report the release of untreated wastewater to the waters of the Commonwealth and degradation of the waters of the Commonwealth. These violations were related to a series of sanitary sewer overflows in the Madisonville collection system, and as one of the impacted waters, UT of Flat Creek 3.1 to 4.1 was added to the 303(d) list in 1998. A subsequent Agreed Order outlined the corrective measures required by the city.

The TMDL allocations for UT of Flat Creek 3.1 to 4.1 are presented in Table D.33-1.

Table D.33-1 UT of Flat Creek 3.1 to 4.1 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment		Allocations for Upstream Loads to the Segment(5)	Allocations for Tributary Loads to the Segment(6)	MOS(7)
	MS4-WLA(3)	LA(4)			
Q_S×WQC×CF	∑(Q_{MS4}×WQC×CF)	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{MS4} is the flow (ft^3/s) in the segment due to an MS4 entity. The MS4-WLA is not an end-of-pipe limit. The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP). An MS4 permittee is compliant with its MS4-WLA if it is compliant with its KPDES permit.

(4)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(5)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(6)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(7)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

The City of Madisonville and Kentucky Department of Transportation have MS4 storm water permit coverage for areas along UT of Flat Creek 3.1 to 4.1. Information about the MS4 permits is summarized in Table D.33-2. There are no other KPDES-permitted discharges of bacteria into the segment. Although the Madisonville WWTP once discharged to this segment, it ceased discharges before 1999. The location of the segment within the Flat Creek watershed is shown in Figure D.33-1.

Table D.33-2 Summary of Active KPDES-permitted Sources as of September 2018

KPDES Permit Number	Facility Name	Indicator Bacteria	Permit Expiration Date	WLA[1] (colonies/day)
KYG200022	City of Madisonville	Fecal Coliform	4/30/2023	Q_{MS4}×WQC×CF
KYS000003	Kentucky Department of Transportation	Fecal Coliform	9/30/2017	Q_{MS4}×WQC×CF

[1]All loads are colonies/day of either *E. coli* or fecal coliform. Q_{MS4} is the flow in the segment due to a MS4 entity. The recreational use bacterial WQC are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day).

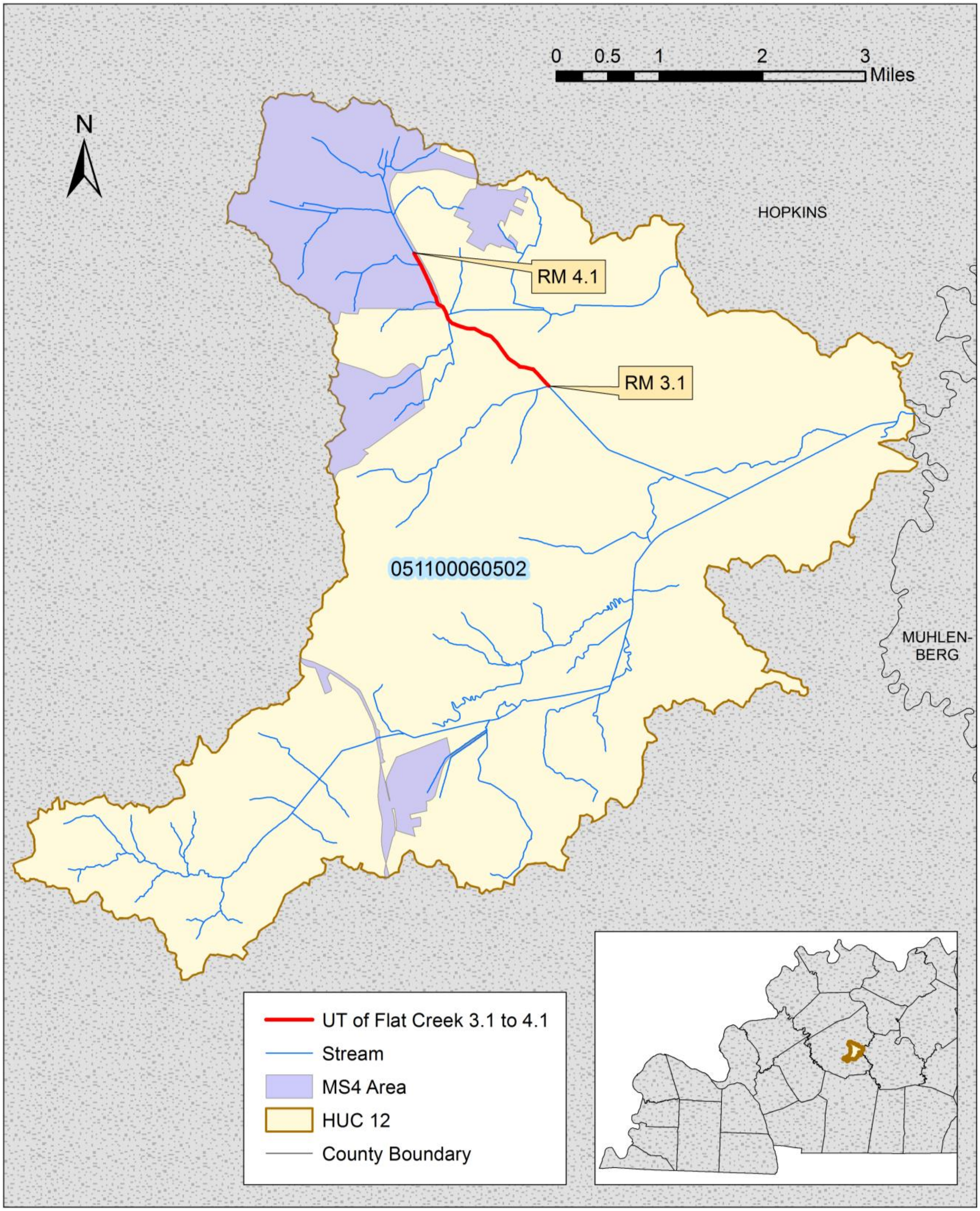

Figure D.33-1 Location of UT of Flat Creek 3.1 to 4.1

Section D.34 West Fork of Buck Creek 0.0 to 3.3

Waterbody ID: KY506423_01

Receiving Water: Buck Creek

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: *E. coli*

HUC 12: 051100050201

County: McLean

In 2008 the Division of Water collected samples at two stations along this segment as part of a study of the Buck Creek watershed. Table D.44-1 summarizes information about the stations; Table D.44-2 provides a summary of the data collected from these stations.

Table D.34-1 Division of Water Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
DOW03003007	37.52391	-87.16674	West Fork of Buck Creek 0.0 to 3.3	0.55
DOW03003008	37.54716	-87.13695	West Fork of Buck Creek 0.0 to 3.3	2.9

Table D.34-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
DOW03003007	*E. coli*	5	40.00	105	580	286
DOW03003008	*E. coli*	5	60.00	168	1,500	607

(1)The full data set for samples collected from these stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)240 colonies/100 ml for *E. coli*.

The TMDL allocations for West Fork of Buck Creek 0.0 to 3.3 are presented in Table D.34-3. There are no KPDES-permitted discharges into this segment of West Fork of Buck Creek. The location of the segment within the Buck Creek watershed is shown in Figure D.34-1.

Table D.34-3 West Fork of Buck Creek 0.0 to 3.3 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

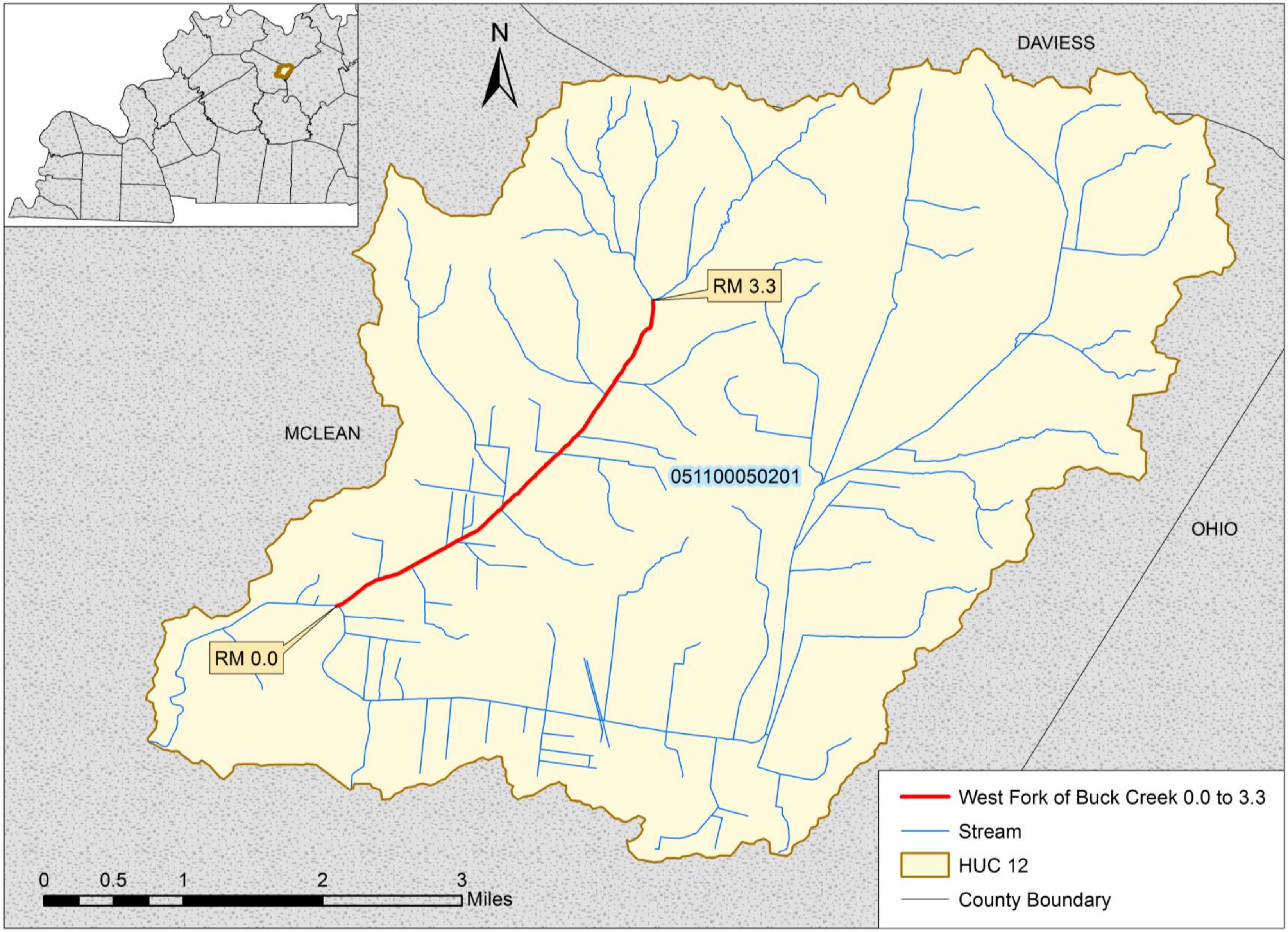

Figure D.34-1 Location of West Fork of Buck Creek 0.0 to 3.3

APPENDIX E

Appendix E
Kentucky River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX F

Appendix F
Licking River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX G

Appendix G
Little Sandy River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX H

Appendix H
Lower Cumberland River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX I

Appendix I
Mississippi River Basin (Minor Tributaries)

Information about this basin will be added under a separate public notice at a future date.

APPENDIX J

Appendix J
Ohio River Basin (Minor Tributaries)

Information about this basin will be added under a separate public notice at a future date.

APPENDIX K

Appendix K
Salt River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX L

Appendix L
Tennessee River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX M

Appendix M
Tradewater River Basin

HUC 8: 05140205

Level IV Ecoregions: Green River-Southern Wabash Lowlands, Caseyville Hills, Crawford-Mammoth Cave Uplands

Drainage Area Within Kentucky: 942.8 square miles

Counties: Caldwell, Christian, Crittenden, Hopkins, Union, Webster

Major Cities: Madisonville, Princeton, Providence, Dawson Springs, Sturgis, Earlington, Clay

The Tradewater River basin is located in far western Kentucky.

The Tradewater River originates in Christian Co., Ky., near Kelly. It flows northwest through Christian Co. and a small portion of Hopkins Co. before forming the border between Caldwell and Hopkins counties. Near Olney, the Tradewater turns north and at its confluence with Donaldson Creek near river mile 63.1 becomes a sixth order stream at a 1:100,000 scale. The river resumes its northwestward course and forms the border between Crittenden Co. on its left bank and Webster and Union counties on its right. After flowing for 135 miles, the Tradewater River discharges into the Ohio River near river mile 873.

Table M.1. provides a summary of the stream segments in the Tradewater basin that have been included on the 303(d) list for impairment due to either fecal coliform or *E. coli*. The locations of the stream segments are shown in Figure M.1.

Table M.1 Bacteria-impaired Stream Segments in the Tradewater Basin

Waterbody Name	Waterbody ID	Impaired Use (Support Status)	Pollutant	Suspected Source(s)	Year of TMDL Public Notice
Clear Creek 26.2 to 26.5	KY489610_03	PCR (nonsupport)	Fecal Coliform	Sanitary Sewer Overflows (Collection System Failures)	2018
Cypress Creek 0.0 to 3.3	KY490527_01	PCR (nonsupport)	*E. coli*	Non-Point Source, Upstream Source	2018
Cypress Creek 0.0 to 3.3	KY490527_01	SCR (partial support)	Fecal Coliform	Non-Point Source, Upstream Source	2018
Donaldson Creek 0.0 to 14.2	KY490999_01	PCR (nonsupport)	*E. coli*	Non-Point Source	2018
Donaldson Creek 0.0 to 14.2	KY490999_01	SCR (partial support)	Fecal Coliform	Non-Point Source	2018
Tradewater River 0.0 to 16.8	KY505460_01	PCR (nonsupport)	Fecal Coliform	Agriculture	2018
Vaughn Ditch 0.0 to 3.25	KY505996_01	PCR (nonsupport)	*E. coli*	Upstream Source	2018

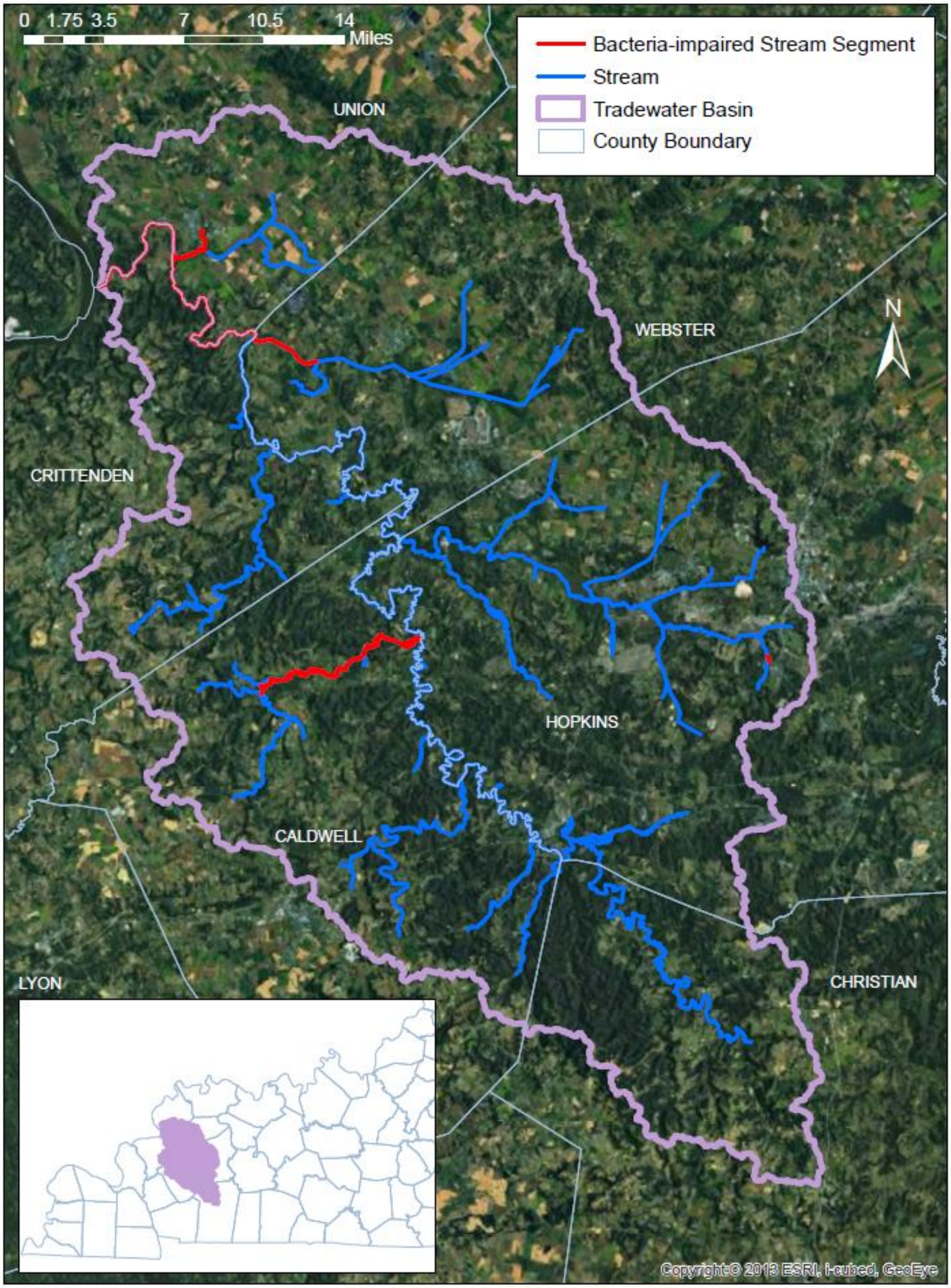

Figure M.1 Location of the Tradewater Basin and Bacteria-impaired Streams (March 2017)

Land cover data is summarized in Table M.2 and its geographic distribution is shown in Figure M.2. Deciduous forest is the predominant class of land cover in the Tradewater basin, accounting for 46 percent. The next three classes by magnitude are cultivated crops, pasture/hay and evergreen forest. Land cover classes are described in Appendix P.

Table M.2 Land Cover Classes in the Tradewater Basin (NLCD 2011)

Land Cover	Percent of Total Area	Square Miles	Acres
Open Water	0.89	8.41	5,382.67
Developed, Open	3.13	29.49	18,874.72
Developed, Low Intensity	0.44	4.14	2,650.86
Developed, Medium Intensity	0.13	1.26	807.27
Developed, High Intensity	0.06	0.55	353.15
Barren Land (Rock, Sand, Clay)	0.12	1.12	715.64
Deciduous Forest	46.22	435.72	278,858.98
Evergreen Forest	5.85	55.18	35,312.96
Mixed Forest	0.03	0.27	173.46
Shrub/Scrub	0.08	0.75	477.24
Grassland/Herbaceous	3.84	36.23	23,187.49
Pasture/Hay	10.30	97.07	62,126.04
Cultivated Crops	24.29	229.03	146,576.48
Woody Wetlands	2.76	26.01	16,643.95
Emergent Herbaceous Wetlands	1.86	17.57	11,247.71

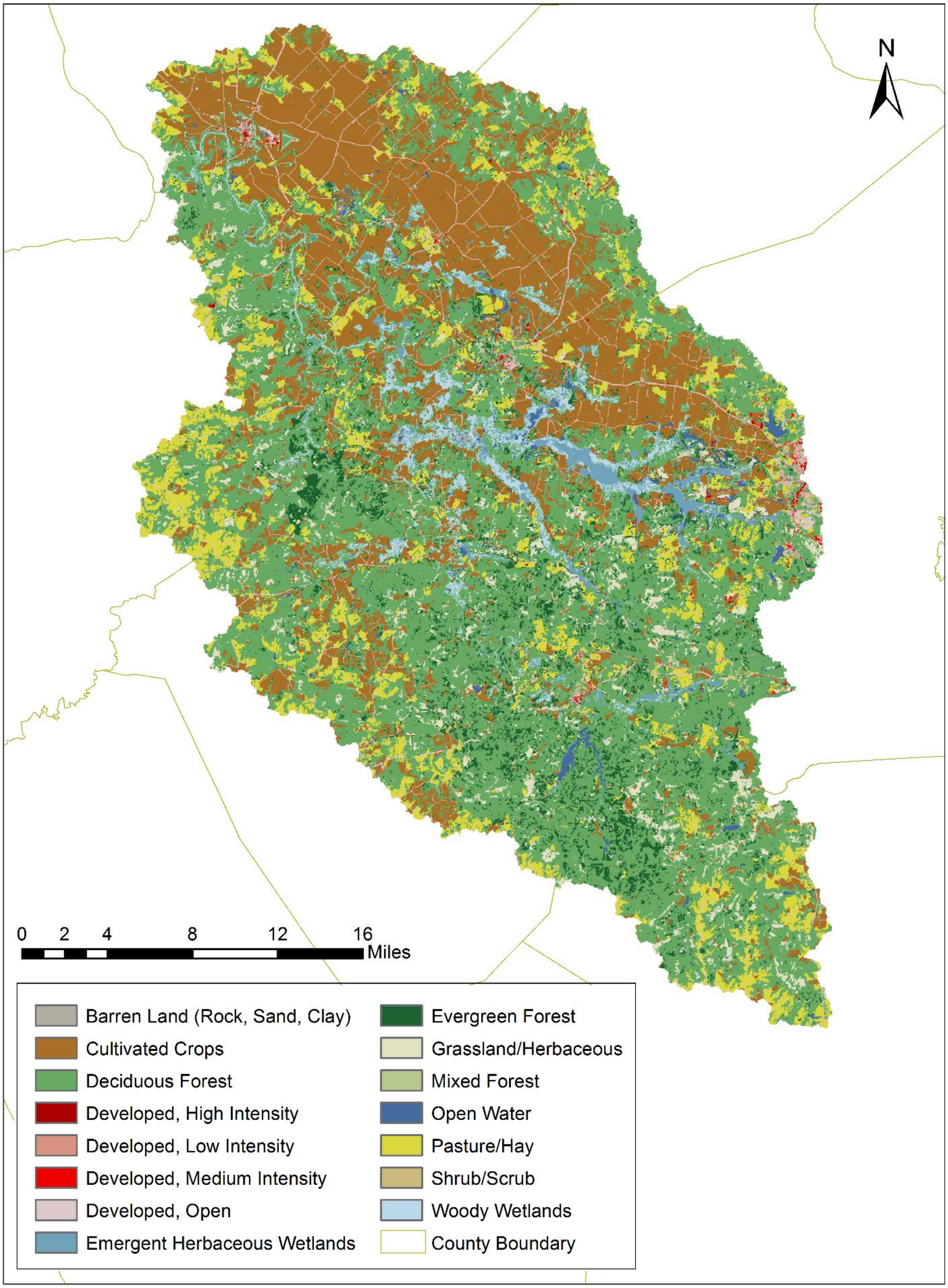

Figure M.2 Land Cover Classes in the Tradewater Basin (NLCD 2011)

Section M.1 Clear Creek 26.2 to 26.5

Waterbody ID: KY489610_03

Receiving Water: Tradewater River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051402050201

County: Hopkins

Sampling data from Clear Creek 26.2 to 26.5 is not available. This segment was first included on the 303(d) list in 1998. The City of Earlington owns and operates a sewage collection system (KYP000043) which transfers sewage to the Madisonville WWTP. The transfer point, a pump station, is located along this segment. On February 25, 1998, the Division of Water issued a Notice of Violation to the City of Earlington for failure to report a spill or discharge from a sewage system and degrading the waters of the Commonwealth. A subsequent Agreed Order outlined the corrective measures required. The City of Earlington's Kentucky Inter-System Operating Permit (KYP000043), which authorizes the collection system and pump station, prohibits discharges to surface water; thus the system does not receive a WLA. There are no KPDES-permitted discharges into this segment of Clear Creek. The City of Madisonville does have MS4 storm water permit coverage for areas in the watershed, but the discharges occur upstream of the segment and are therefore included in the allocations for upstream loads to the segment.

The TMDL allocations for Clear Creek 26.2 to 26.5 are presented in Table M.1-1. The location of the segment within the Richland Creek-Clear Creek watershed is shown in Figure M.1-1.

Table M.1-1 Clear Creek 26.2 to 26.5 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[(4)]	MOS[(5)]
	LA[(3)]		
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)The following assumptions provide an implicit MOS:

(a)Upstream bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

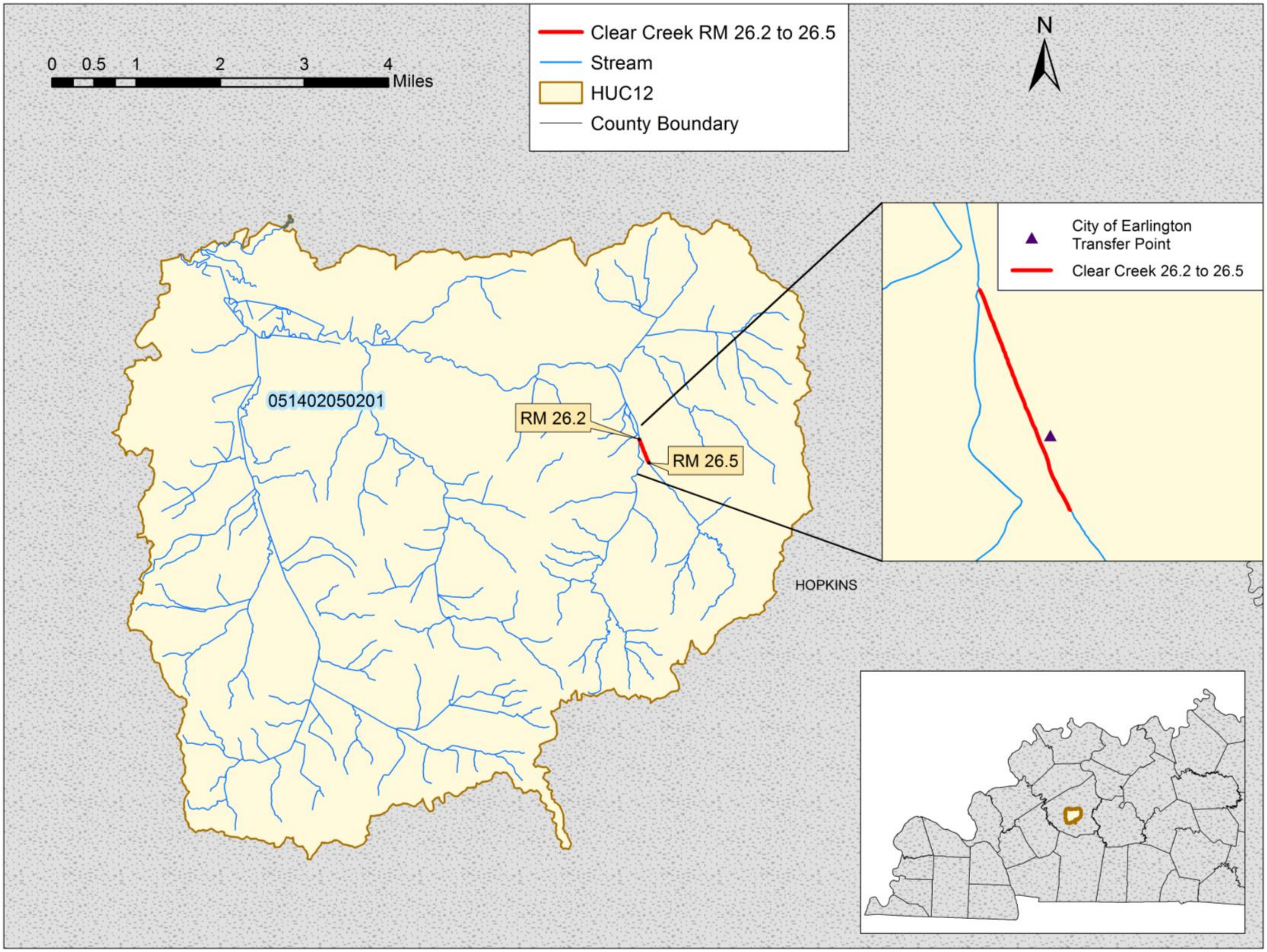

Figure M.1-1 Location of Clear Creek 26.2 to 26.5

Section M.2 Cypress Creek 0.0 to 3.3

Waterbody ID: KY490527_01

Receiving Water: Tradewater River

Impaired Uses: PCR, SCR

Support Status: nonsupport (PCR), partial support (SCR)

Indicator Bacteria: *E. coli*, fecal coliform

HUC 12: 051402050504, 051402050505

County: Union

The Division of Water has collected samples from station GRN 002, located at river mile 2.2, since 2001. The station is sampled five to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table M.2-1 summarizes information about this sampling station; Table M.2-2 provides a summary of the data collected from this station.

Table M.2-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 002	37.5304	-87.9751	Cypress Creek 0.0-3.3	2.2

Table M.2-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC²	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 002	fecal coliform	14	15.4	121	60,000	6,384
GRN 002	*E. coli*	12	75.0	11	2,420	1,010

(1)The full data set for samples collected at GRN 002 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)2,000 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Cypress Creek 0.0 to 3.3 are presented in Table M.2-3. There are no KPDES-permitted discharges into this segment of Cypress Creek. The location of the segment within the Cypress Creek and Caney Creek-Tradewater River watersheds is shown in Figure M.2-1.

Table M.2-3 Cypress Creek 0.0 to 3.3 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
	LA(3)			
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

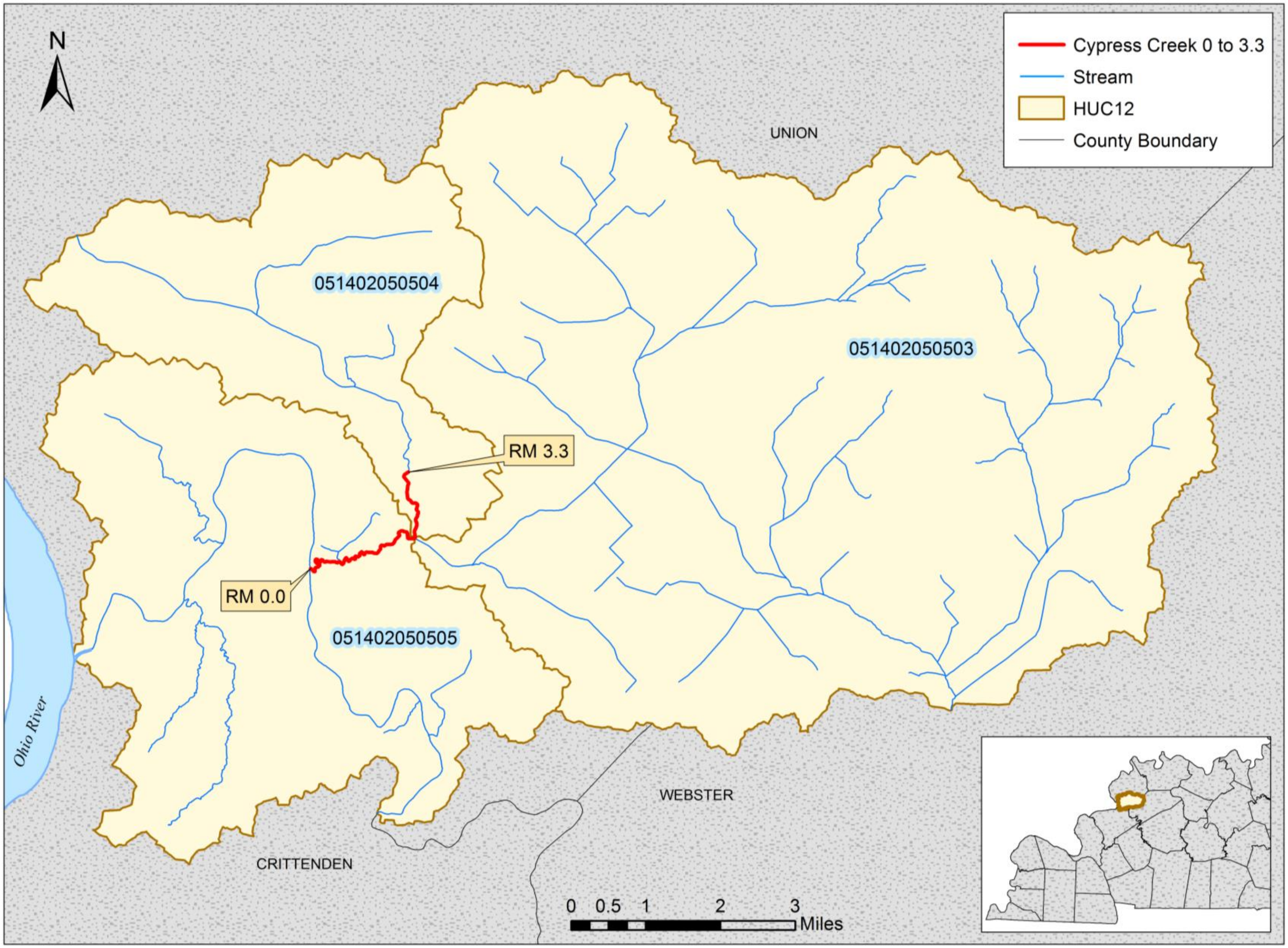

Figure M.2-1 Location of Cypress Creek 0.0 to 3.3

Section M.3 Donaldson Creek 0.0 to 14.2

Waterbody ID: KY490999_01

Receiving Water: Tradewater River

Impaired Uses: PCR, SCR

Support Status: nonsupport (PCR), partial support (SCR)

Indicator Bacteria: *E. coli*, fecal coliform

HUC 12: 051402050304

County: Caldwell

The Division of Water has collected samples from station GRN 005, located at river mile 2.3, since 2001. The station is sampled five to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table M.3-1 summarizes information about this sampling station; Table M.3-2 provides a summary of the data collected from this station.

Table M.3-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 005	37.284	-87.8103	Donaldson Creek 0.0-14.2	2.3

Table M.3-2 Division of Water Sample Data Summary[1]

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC[2]	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 005	fecal coliform	14	7.1	19	45,000	3,478
GRN 005	*E. coli*	12	33.3	11	579	215

[1]The full data set for samples collected at GRN 005 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
[2]2,000 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Donaldson Creek 0.0 to 14.2 are presented in Table M.3-3. There are no KPDES-permitted discharges into this segment of Donaldson Creek. The location of the segment within the Lower Donaldson Creek watershed is shown in Figure M.3-1.

Table M.3-3 Donaldson Creek 0.0 to 14.2 TMDL Allocations[1]

TMDL[2]	Allocations for Direct Loads to the Segment	Allocations for Upstream Loads to the Segment[4]	Allocations for Tributary Loads to the Segment[5]	MOS[6]
	LA[3]			
Q_S×WQC×CF	∑(Q_{LA}×WQC×CF)	∑($Q_{Upstream}$×WQC×CF)	∑($Q_{Tributary}$×WQC×CF)	Implicit

[1]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[2]Q_S is the flow (ft^3/s) in the segment.

[3]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[4]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[5]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[6]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

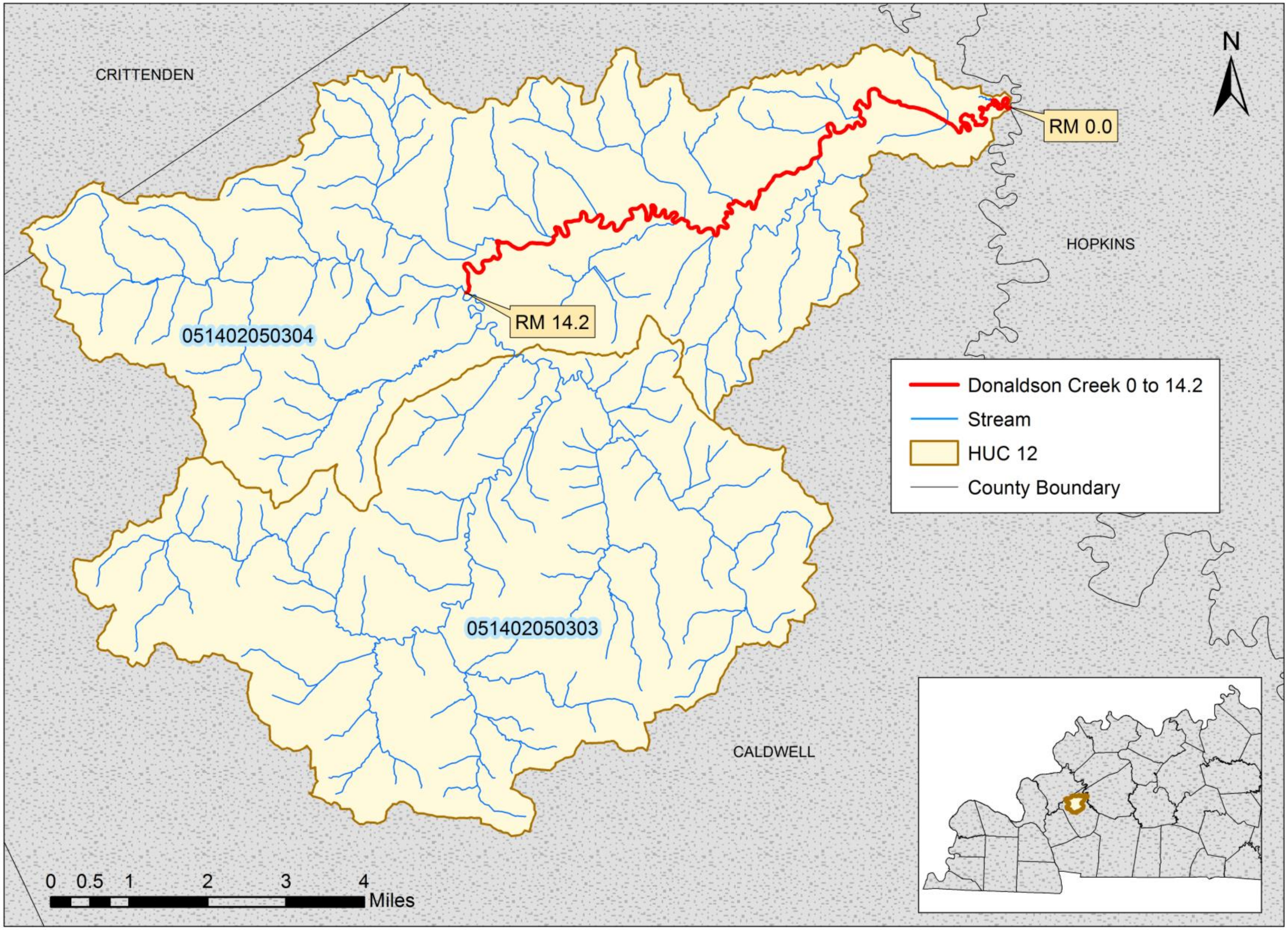

Figure M.3-1 Location of Donaldson Creek 0.0 to 14.2

Section M.4 Tradewater River 0.0 to 16.8

Waterbody ID: KY505460_01

Receiving Water: Ohio River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: fecal coliform

HUC 12: 051402050502, 051402050505

County: Crittenden, Union, Webster

The Division of Water collected samples from station PRI 053, located at river mile 15.25, from 1991 until 2003. The station was sampled five or more times during the PCR season each year from 1991-99, in 2001 and in 2003. The Ohio River Sanitation Commission (ORSANCO) collected samples from two locations along this segment, TR1.2 and TR6.8, as part of a survey of Ohio River tributaries. ORSANCO sampled at TR1.2 between 2004 and 2008 and at TR6.8 between 2007 and 2012. Table M.4-1 summarizes information about these sampling stations; Table M.4-2 provides a summary of the data collected from the stations.

Table M.4-1 Sample Site Locations

Station Name	Latitude	Longitude	Stream Segment	River Mile
PRI053	37.4794444	-87.9536111	Tradewater River 0.0-16.8	15.25
TR1.2	37.518139	-88.045494	Tradewater River 0.0-16.8	1.2
TR6.8	37.52928333	-87.998815	Tradewater River 0.0-16.8	6.8

Table M.4-2 Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
PRI053	fecal coliform	71	7.0	10	800	156
TR1.2	*E. coli*	51	19.6	4	448	117
TR6.8	*E. coli*	13	38.5	20	5,255	729

(1)The full data set for samples collected at the listed stations may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Tradewater River 0.0 to 16.8 are presented in Table M.4-3. There are no

KPDES-permitted discharges into this segment of the Tradewater River. The location of the segment within the Lower Tradewater River watershed is shown in Figure M.4-1.

Table M.4-3 Tradewater River 0.0 to 16.8 TMDL Allocations(1)

TMDL(2)	Allocations for Direct Loads to the Segment LA(3)	Allocations for Upstream Loads to the Segment(4)	Allocations for Tributary Loads to the Segment(5)	MOS(6)
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

(1)All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4 s-ml/ft^3-day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

(2)Q_S is the flow (ft^3/s) in the segment.

(3)Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

(4)$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

(5)$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

(6)The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

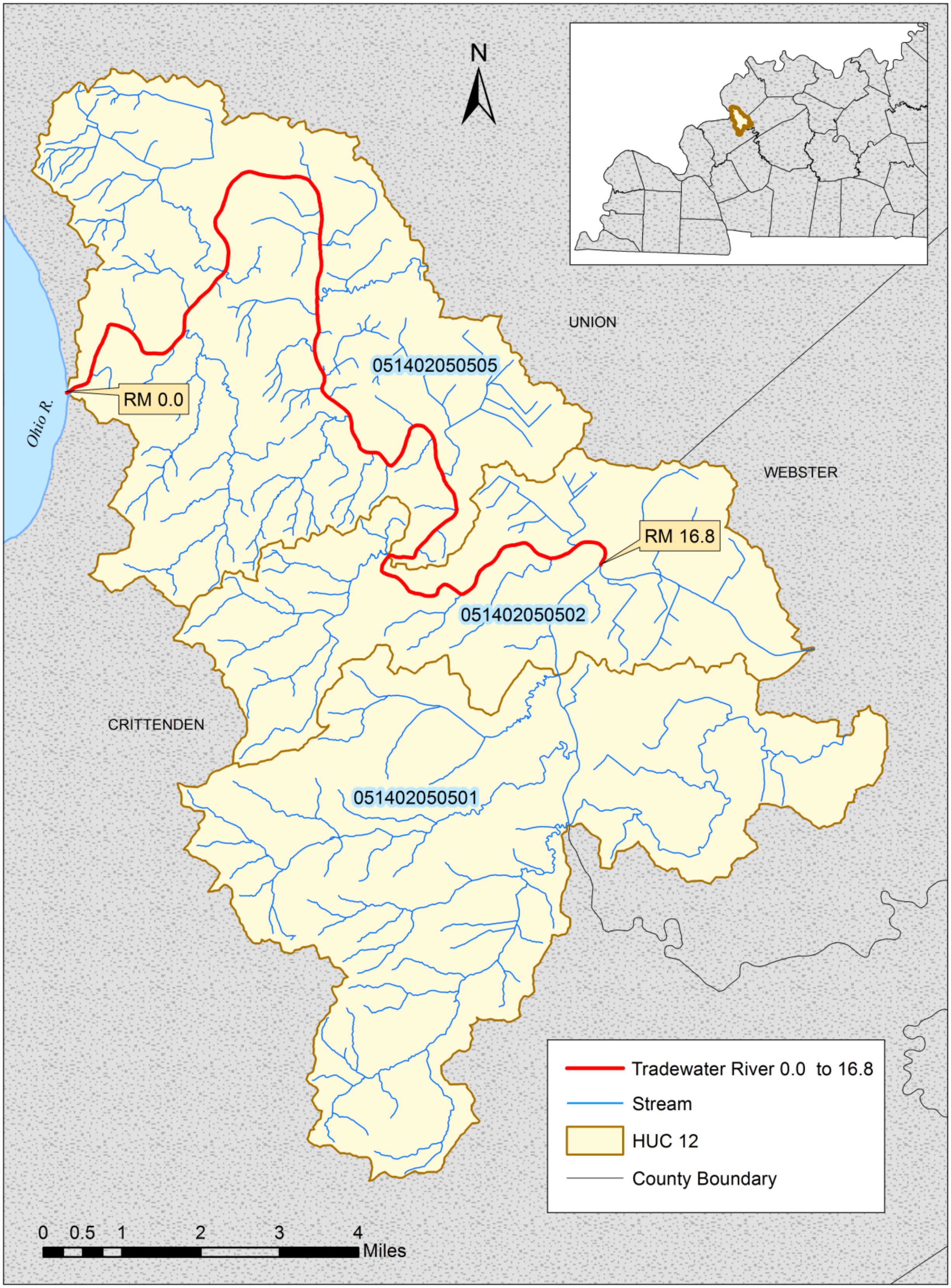

Figure M.4-1 Location of Tradewater River 0.0 to 16.8

Section M.5 Vaughn Ditch 0.0 to 3.25

Waterbody ID: KY505996_01

Receiving Water: Tradewater River

Impaired Use: PCR

Support Status: nonsupport

Indicator Bacteria: *E. coli*

HUC 12: 051402050502

County: Webster

The Division of Water has collected samples from station GRN 003, located at river mile 2.3, since 2001. The station is sampled five to six times during the PCR season as part of the Division's five-year rotating schedule for basin monitoring (see also Section 7.2.1, Kentucky Watershed Management Framework). Table M.5-1 summarizes information about this sampling station; Table M.5-2 provides a summary of the data collected from this station.

Table M.5-1 Division of Water Sample Site Location

Station Name	Latitude	Longitude	Stream Segment	River Mile
GRN 003	37.463433	-87.898336	Vaughn Ditch 0.0-3.25	2.3

Table M.5-2 Division of Water Sample Data Summary(1)

Station Name	Indicator Bacteria	Number of Observations	Percent Exceeding WQC2	Minimum (colonies/ 100 ml)	Maximum (colonies/ 100 ml)	Average (colonies/ 100 ml)
GRN 003	fecal coliform	13	46.2	33	60,000	4,869
GRN 003	*E. coli*	12	33.3	15	2,420	484

(1)The full data set for samples collected at GRN 003 may be obtained by submitting a request of records under the Kentucky Open Records Act (KORA) to DEP.KORA@ky.gov or by fax to 502-564-9232. The DEP KORA point of contact may also be reached at 502-564-3999.
(2)400 colonies/100 ml for fecal coliform; 240 colonies/100 ml for *E. coli*.

The TMDL allocations for Vaughn Ditch 0.0 to 3.25 are presented in Table M.5-3. There are no KPDES-permitted discharges into this segment of Vaughn Ditch. The location of the segment within the Long Branch-Tradewater River and Craborchard Creek-Vaughn Ditch watersheds is shown in Figure M.5-1.

Table M.5-3 Vaughn Ditch 0.0 to 3.25 TMDL Allocations[(1)]

TMDL[(2)]	Allocations for Direct Loads to the Segment LA[(3)]	Allocations for Upstream Loads to the Segment[(4)]	Allocations for Tributary Loads to the Segment[(5)]	MOS[(6)]
$Q_S \times WQC \times CF$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	Implicit

[(1)]All loads are colonies/day of either *E. coli* or fecal coliform. The recreational use bacterial WQCs are found in 401 KAR 10:031. CF is the conversion factor (24,465,758.4/day) to change the product of bacterial concentration (colonies/100 ml) and flow (ft^3/s) into a load (colonies/day). The symbol "∑" indicates that the total allocation is the sum of all the individual allowable loads.

[(2)]Q_S is the flow (ft^3/s) in the segment.

[(3)]Q_{LA} is the flow (ft^3/s) in the segment due to a LA source.

[(4)]$Q_{Upstream}$ is the flow contribution (ft^3/s) from upstream of the segment. This load includes both WLA and LA sources upstream of the impaired segment.

[(5)]$Q_{Tributary}$ is the flow contribution (ft^3/s) from a tributary to the segment. This load includes both WLA and LA sources on tributaries to the impaired segment.

[(6)]The following assumptions provide an implicit MOS:

(a)Upstream and tributary bacterial concentrations are at the maximum allowable limit; there is no dilution capacity from these areas.

(b)There is no bacteria die-off; in reality bacteria concentrations diminish downstream from their source. Thus, bacteria loads to the upper portion of a segment will diminish prior to reaching the lower portion of the segment.

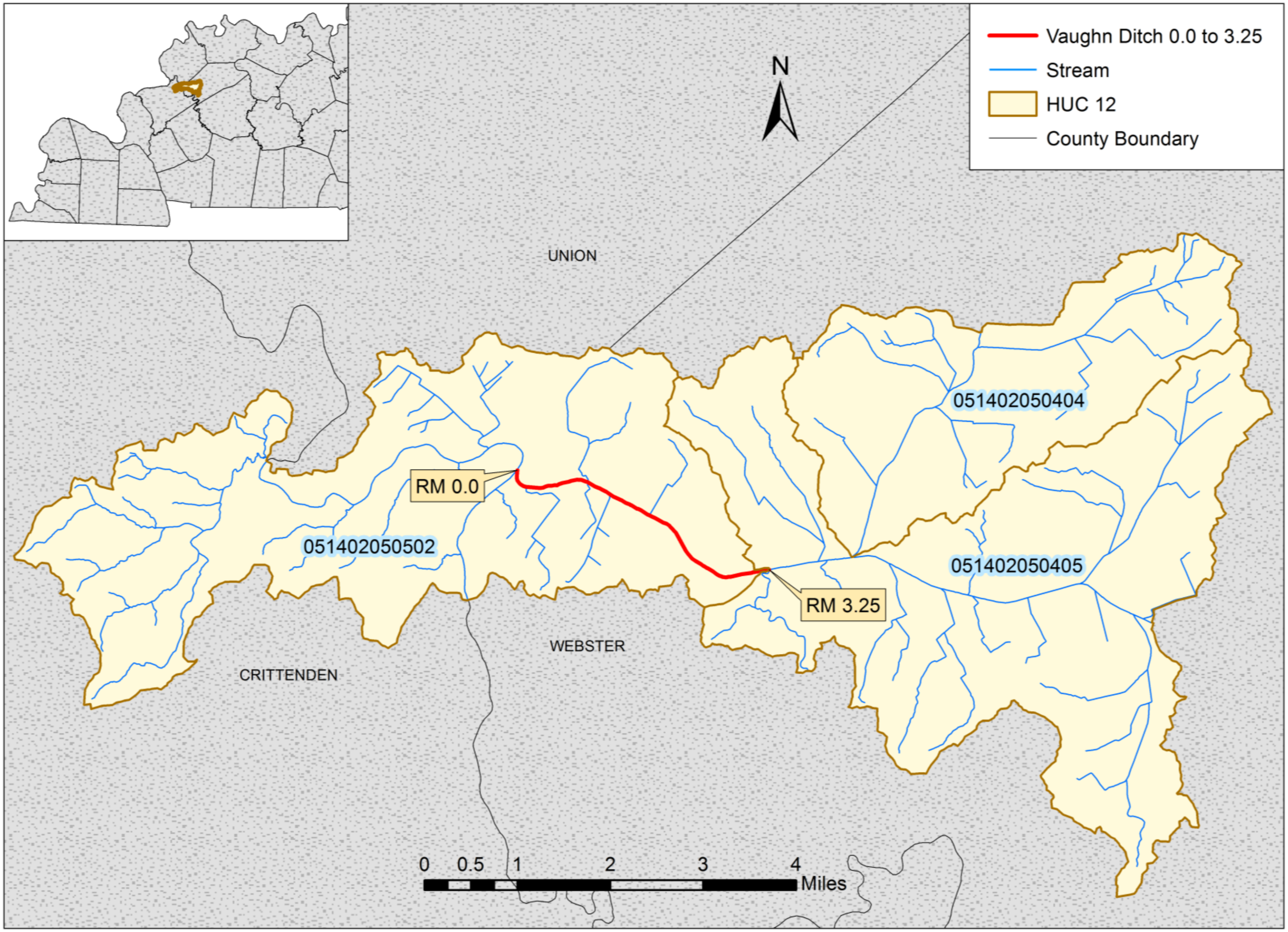

Figure M.5-1 Location of Vaughn Ditch 0.0 to 3.2

APPENDIX N

Appendix N
Tygarts Creek Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX O

Appendix O
Upper Cumberland River Basin

Information about this basin will be added under a separate public notice at a future date.

APPENDIX P

Appendix P
National Land Cover Database Classification Descriptions (NLCD 2011)

11. **Open Water** - areas of open water, generally with less than 25% cover of vegetation or soil.

12. **Perennial Ice/Snow** - areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.

21. **Developed, Open Space** - areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

22. **Developed, Low Intensity** - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.

23. **Developed, Medium Intensity** - areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.

24**. Developed, High Intensity** - highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.

31. **Barren Land (Rock/Sand/Clay)** - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.

41. **Deciduous Forest** - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.

42. **Evergreen Forest** - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. **Mixed Forest** - areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

51. **Dwarf Scrub** - Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.

52. **Shrub/Scrub** - areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.

71. **Grassland/Herbaceous** - areas dominated by gramanoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling, but can be utilized for grazing.

72. **Sedge/Herbaceous** - Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.

73. **Lichens** - Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.

74. **Moss** - Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.

81. **Pasture/Hay** - areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.

82. **Cultivated Crops** - areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.

90. **Woody Wetlands** - areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

95. **Emergent Herbaceous Wetlands** - Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

APPENDIX Q

Appendix Q

Response to Comments on the Kentucky Statewide TMDL for Bacteria Impaired Waters

The Kentucky Division of Water (Division) opened the proposed draft of the statewide bacteria TMDL for public comment between March 14 and June 11, 2018. The Division extended the comment period for individual stakeholders upon request and received several comments by the close of the period. The Division would like to thank all of the stakeholders who took the time to read the document and provide comments. Although all comments were noted, only comments pertaining to the statewide bacteria TMDL document are addressed in this response. Comments are reproduced as received below in black text, and the Division's responses are in blue text.

Commenter #1:
Brian Bingham, Chief of Operations
MSD
700 West Liberty Street
Louisville, KY 40203

Comment 1a:

KDOW has included language in the proposed TMDL that the MS4 wasteload allocations will be addressed through the MS4 permitting program and implemented through Storm Water Quality Management Plans (SWQMPs) to the Maximum Extent Practicable (MEP). The KYS000001 permit states that "*the requirements of this individual permit represent MEP*." …MSD… proposes deleting references to MEP.

DOW Response 1a:

The Division has removed the phrase "to the maximum extent practicable" from all references to implementation of MS4 wasteload allocations. This revision occurs in Section 7.1.1 and all allocations tables that include an MS4 wasteload allocation. The sentence now states, "MS4-WLAs will be addressed through the storm water permit and implemented through the Storm Water Quality Management Plan (SWQMP)."

Comment 1b:

The permit covers TMDLs established prior to permit issuance through implementation of the SWQMP. However, if a new TMDL is approved, the permittee may be asked to modify the SWQMP during the current permit cycle to address the pollutants of concern in the TMDL. Further, the permit requires LTMN stations servicing waters with an approved TMDL. Both of these issues could potentially require substantial resources to modify the SWQMP and potentially expand the Long Term Monitoring Network (LTMN) mid-permit cycle.

Both Michigan and Connecticut allow updates to the permit and SWQMP to define MEP during the permit renewal process, and do not require changes to the SWQMP for the TMDL prior to permit renewal. **MSD recommends clarifying language in the TMDL and explicitly stating that MS4 permits and SWQMPs will be updated during the permit renewal process, and will not be reopened upon implementation of a new TMDL.** Requiring MS4 permittees to update the SWQMP on an annual basis to reflect requirements of a new TMDL is unnecessarily burdensome and not practicable. For example, MSD's current MS4 requirements associated with the LTMN could increase, outside of the existing collaborative science-based process that is currently in place between MSD and KDOW.

MSD… proposes… that the following language be added to Section 7.1 of the TMDL to clarify that this TMDL will not open permits and KDOW will address the TMDL through the permit renewal process: *Consistency of the permit with the TMDL, and any potential deficiencies will be reviewed and addressed as part of the permit reissuance process. Noncompliance with current permits will continue to be addressed through enforcement actions as appropriate.*

DOW Response 1b:

The commenter's interpretation is correct that the referenced permit provides for possible modification of the SWQMP and/or expansion of monitoring locations during a current permit term as a result of an approved TMDL. The commenter's recommended language about deferring TMDL-related modifications until permit reissuance is inconsistent with provisions of existing MS4 permits and would therefore be inappropriate to include in the TMDL; any such changes are more appropriately addressed in the permit language.

Stakeholders can use the biennial 303(d) list of impaired waters as a tool for planning responses to impairments that are expected to result in a TMDL. Concerns about permit provisions, and the resources required to comply with them, are most appropriately addressed to the Division during the public comment period offered with the release of the draft permit.

Comment 1c:

The formulas for the wasteload and load allocations are shown in Tables S.3 and 6.1-1 of the draft TMDL. These formulas are the flow from each pollutant source multiplied by the water quality criteria. The TMDL indicates these formulas should be calculated with instantaneous flows. The current bacteria criteria are not structured as a "never to be exceeded" concentration, and are instead based on evaluating concentrations over a thirty-day period. The two criteria, the geometric mean and the statistical threshold value, reflect the many variabilities (including the variability of in-stream bacteria levels) that were considered when the criteria were first adopted and allows for periodic exceedances of numeric criteria. **MSD requests that KDOW remove references to instantaneous flow and consider development of**

language in the TMDL that better aligns the wasteload allocation with the established compliance period for the contact recreation criteria.

The interpretation of this approach could be more clearly defined by directly referencing implementation of the SWQMP for the MS4 wasteload allocation, the KPDES permit for WQTCs, and implementation of the Long-Term Control Plan for CSOs [as follows].

SWS-WLA: [replace] $\sum(Q_{SWS}\times WQC\times CF)$ [with] “Comply with KPDES permit”

MS4-WLA: [replace] $\sum(Q_{MS4}\times WQC\times CF)$ [with] “Implement SWQMP” [and delete the statement] “Q_{MS4} is the flow (ft^3/s) in the segment due to a MS4 entity” [from footnote 4]

CSO-WLA: [replace] $\sum(Q_{CSO}\times WQC\times CF)$ [with] “Implement LTCP”

These wasteload and load allocation requests are supported by the following excerpt from the USEPA Memorandum titled “Establishing TMDL “Daily” Loads in Light of the Decision by the U.S. Court of Appeals for the D.C. Circuit in Friends of the Earth, Inc. v. EPA, et al., No. 05-5-15, (April 25, 2006) and Implications for NPDES Permits”:

> *In certain circumstances (e.g., impairments caused by storm water), or where the applicable water quality criteria are expressed as a long-term average, it may be appropriate for TMDL documents or their supporting analyses to clearly set forth the implementation-related assumptions underlying any wasteload allocation expressed as a “daily” load. To facilitate implementation of such a load in water bodies where the applicable water quality standard is expressed in non-daily terms, it may be appropriate for the TMDL documentation to include, in addition to wasteload allocations expressed in daily time increments, wasteload allocations expressed as weekly, monthly, seasonal, annual, or other appropriate time increments. When this approach is taken, the TMDL and its supporting documentation should clearly explain that the non-daily loads and allocations are implementation-related assumptions of the daily wasteload allocations and are included to facilitate implementation of the daily allocations as appropriate in NPDES permits and nonpoint source directed management measures. The supporting documentation should discuss the reasons for, and assumptions behind, the non-daily loads to facilitate their understanding and use in the implementation phase.*

DOW Response 1c:

The equations in the allocations tables intentionally use “WQC” and not the numeric values expressed in 401 KAR 10:031 Section 7 in order to incorporate all elements that comprise the water quality criteria, such as sample collection period, minimum number of samples, and percent exceedance, as applicable. Text clarifying this aspect has been added to Section 6.1. The statement, “All flows, denoted by Q with a subscript, are instantaneous flow values at any point in time” has been removed from all allocations tables in the TMDL, consistent with previously approved TMDLs that also involved equation-based loads. The use of flow as a variable in the TMDL equation is intended to represent the full range of loads that correspond to meeting water quality standards in an impaired water. It is not intended to imply that water quality criteria must be met instantaneously at all times, which would be inconsistent with the criteria as they are defined in 401 KAR 10:031.

The EPA memo referenced does not support replacing numeric wasteload allocations with narrative statements and instead recommends that TMDLs include numeric daily wasteload allocations to NPDES permittees. The excerpt quoted indicates that TMDLs may *also* include alternative expressions of the wasteload allocation that facilitate implementation through the permit, "*in addition to* wasteload allocations expressed in daily time increments" (emphasis added). This TMDL accomplishes both by providing: a) equation-based allocations that express a full range of numeric allowable daily loads; and b) footnotes that express the assumptions to be used for implementing the allocations in permits.

Because the equation-based wasteload allocations remain in the allocations table, footnote 4 retains the explanation of Q_{MS4}. For clarity, Table 6.1-1 has been relabeled as Table S.3, since the two tables are identical.

Comment 1d:

[Additional] suggested edits for Tables S.3 and 6.1-1:

[footnote 4] (4)~~Q_{MS4} is the flow (ft^3/s) in the segment due to a MS4 entity.~~ The MS4-WLA is not an end-of-pipe limit~~; the MS4-WLA is an in-stream allocation~~. This means that the MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP) ~~to the Maximum Extent Practicable (MEP)~~. An MS4 permittee is considered to be compliant with its MS4-WLA if it is compliant with its KPDES permit.

DOW Response 1d:

Footnote 4 to Table S.3 has been revised to: "(4)Q_{MS4} is the flow (ft^3/s) in the segment due to an MS4 entity. The MS4-WLA is not an end-of-pipe limit. The MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP). An MS4 permittee is compliant with its MS4-WLA if it is compliant with its KPDES permit."

Comment 1e:

[Additional] suggested edits for Tables S.3 and 6.1-1:

[footnote 5] [5]Q_{CSO} is the flow (ft^3/s) in the segment due to a CSO entity. Dry weather CSO flows are prohibited. The CSO-WLA is not an end-of-pipe limit. During wet weather events, a CSO entity is considered to be compliant with its CSO-WLA if it is compliant with its KPDES permit.

DOW Response 1e:

The requested insertion will not be added to footnote 5 of Table S.3. Due to the case-specific nature of CSO controls, compliance endpoints will be addressed in the CSO permit. Footnote 5 to Table S.3 has been revised to reference the Long Term Control Plan (LTCP) in addition to the permit. This revision addresses facilities that did not have an approved LTCP at the most recent permit reissuance. The footnote now states: "[5]Q_{CSO} is the flow (ft^3/s) in the segment due to a CSO entity. Dry weather CSO flows are prohibited. During wet weather events, a CSO entity is compliant with its CSO-WLA if it is compliant with its Long Term Control Plan and KPDES permit."

Comment 1f:

[Additional] suggested edits for Tables S.3 and 6.1-1:

[Add the following footnote to the "Allocations for Direct Loads to the Segment" portion of the tables:] The Water Quality Criteria for contact recreation is currently based on a 30-day period and is structured to recognize the inherent variability of bacteria concentrations in surface waters. Therefore, it is not appropriate to compare the bacteria loading from an intermittent discharge on any given day to the water quality criteria for bacteria and make a determination of regulatory compliance. The WLA for MS4 and CSO discharges should not be interpreted as a "not to exceed" discharge load on any given day.

DOW Response 1f:

A discussion of the assessment process has been added to Section 2.0 to indicate that due to variability in stream conditions, the Division does not determine a waterbody's support of designated uses based on a single sample. The following discussion has been added to Section 7.0, Implementation: "This TMDL determines allowable bacteria loads based on the recreational criteria and flow rates. As discussed in Section 2.0, a waterbody's use support is not assessed based on a single sample result. It follows that it is also not appropriate to evaluate compliance with this TMDL by calculating a load based on a single sample concentration and comparing that calculated load to the allowable load. That is, the allocations for discharges should not be interpreted as a "not to exceed" discharge load on any given day."

Comment 1g:

For Sanitary Wastewater Sources, the language for discharge "at all times" is not consistent with permit requirements that identify a weekly maximum permit limit. MSD recommends adjusting as follows in section 6.3.2.2: *The critical conditions are addressed in the TMDL* *calculations by requiring KPDES-permitted sanitary wastewater facilities to meet the PCR WQC for bacteria at the outlet of their discharge pipe based on a weekly maximum ~~at all times~~ (a permit requirement).*

DOW Response 1g:

Sanitary wastewater treatment sources must meet both a weekly maximum and a monthly average based on the PCR criteria. The sentence in section 6.3.2.2 referenced above has been revised to: “The critical conditions are addressed in the TMDL calculations by requiring KPDES-permitted sanitary wastewater facilities to meet end-of-pipe limits based on the PCR criteria for bacteria (a permit requirement), regardless of precipitation or flow in the receiving stream.” The following revision has been made in Section 6.3.1.2: “Seasonality is addressed in the TMDL calculations by requiring KPDES-permitted sanitary wastewater facilities to meet end-of-pipe limits based on the PCR criteria throughout the year (a permit requirement).”

Comment 1h:

Global references, i.e. *all* flow conditions and *all* precipitation events, are not applicable to CSOs or MS4s. MSD recommends removing these references throughout the document, including “under all flow conditions,” “at all times,” and “during all precipitation events.” Notable references to this language are in the second paragraphs of sections 6.3.1.1 and 6.3.2.1:

6.3.1.1: For storm water and nonpoint sources, the in-stream WQC vary for the PCR and SCR seasons. Seasonality is addressed for these sources by requiring that the WQC be met in-stream during all seasons, applying the appropriate PCR or SCR criteria~~, and under all flow conditions~~.

6.3.2.1: For storm water and nonpoint sources, the in-stream WQC vary for the PCR and SCR seasons. The critical condition is addressed for these sources by requiring that the WQC be met in-stream during all precipitation events, applying the appropriate PCR or SCR criteria~~, and under all flow conditions~~.

DOW Response 1h:

For a waterbody to support designated uses, applicable water quality criteria must be met. 401 KAR 10:31 does not limit the flow regime under which the standards apply. The referenced sentence in Section 6.3.1.1 has been revised to: “Seasonality is addressed for these sources by requiring that the WQC be met in-stream during all seasons, applying the appropriate PCR or SCR criteria, and over the range of flow conditions that occur.” The referenced sentence in Section 6.3.2.1 has been revised to: “The critical condition is addressed for these sources by requiring that the applicable WQC be met in-stream over the range of precipitation and flow conditions that occur.”

Comment 1i:

In Section 4.2, the draft TMDL load allocation section states that "Unlike most KPDES-permitted sources, nonpoint sources typically discharge pollutants to surface water in response to rain events." Because MS4 and CSO discharges are a result of rain events, MSD suggests deleting the phrase at the beginning of this sentence. *~~Unlike most KPDES-permitted sources, n~~Nonpoint sources typically discharge pollutants to surface water in response to rain events.*

DOW Response 1i:

The suggested revision has been made.

Comment 1j:

The margin of safety is defined as "implicit factor of safety," not defined by percentage. This assumption is a conservative approach that promotes meeting water quality criteria instantaneously and under all flows, and does not consider bacteria die off. MSD recommends that the margin of safety be defined in a more realistic manner and that references to instantaneous flows be removed.

DOW Response 1j:

Recognizing that conservative assumptions used to calculate the TMDL provide an implicit margin of safety allows the Division to allocate 100 percent of a segment's assimilative capacity to bacteria sources, without needing to reserve a portion of loading capacity to account for uncertainty. Not all of the factors that contribute to the TMDL's margin of safety are expected to apply to every impaired segment; thus, the margin of safety is not overly conservative or unrealistic. The TMDL is required to support meeting the recreational water quality criteria in a segment under all flows, because 401 KAR 10:031 does not limit the flow regime under which the standards apply, and the TMDL must be set at the level necessary to meet and maintain water quality standards. The margin of safety explanation does not refer to instantaneous flows, and the reference to instantaneous flows has been removed from footnote 1 of the allocations table.

Comment 1k:

[The margin of safety] may incorrectly assume that upstream segments are meeting water quality criteria, which creates an undue burden on downstream communities and permitted entities. [The following] suggested language to mitigate this issue are proposed for footnote 9(a) of tables S.3 and 6.1-1: Discharges to an impaired segment shall not be responsible for reducing or removing loads from upstream and/or tributary segments.

DOW Response 1k:

Neither the TMDL nor the margin of safety assumes that upstream and/or tributary segments are currently meeting water quality criteria. Footnote 9(a) refers to the fact that allocations for direct discharges are based on meeting water quality criteria in-stream without relying on any dilution capacity from upstream or tributary inputs to reduce the loading from any direct discharges. Any upstream or tributary segments listed for bacteria impairment are also eligible for inclusion in this TMDL, with allocations made to sources contributing to those segments. This was the case for some segment TMDLs in the Green River basin.

The proposed additional text to footnote 9(a) may reflect a concern that upstream and tributary contributions are not required to meet water quality standards. Actually, the allowable load for each source is based on that source's discharge meeting water quality criteria in-stream. In other words, the TMDL requires the in-stream contributions from the source categories identified in Table S.3 to meet water quality criteria after implementation is complete. The TMDL is allocated in this equitable manner so that no source has to effect reductions to offset excess loads from other sources. This concept is discussed in Section 4.3 of the TMDL.

The suggested additional text for footnote 9(a) is not a safety factor, as it does not affect the magnitude of the margin of safety, and will not be added to the footnote. By basing each source's allocation on meeting water quality criteria in-stream, the TMDL holds each source accountable for its own discharges and no other and does not rely on some discharges to reduce loads of other discharges. Section 4.3, Prohibited Sources, states that the Division expects implementation of bacteria TMDLs to begin with the elimination of prohibited discharges, to prevent compliant sources from having to effect reductions in order to accommodate the pollutant loading of prohibited sources.

Comment 1l:

Defining a water quality impairment and improvement plan requires detailed and site-specific investigation, modeling, and analysis. The state has currently pursued a statewide, segmented approach for bacteria that relies on existing KPDES permits for implementation with no analysis of nonpoint sources and how those sources could be effectively controlled. MSD is concerned that this approach continues to place responsibility on KPDES permittees without providing a mechanism for meaningful nonpoint source reduction.

DOW Response 1l:

Site-specific investigation has occurred prior to the assessment of each waterbody that is identified as impaired. Detailed and site-specific investigation, modeling, and analysis can be useful or essential tools for the implementation phase of a TMDL. An implementation plan is beyond the scope of this TMDL; rather, the TMDL is a tool that can be used as a starting point in the development of watershed-specific plans for improving water quality. The specific measures for nonpoint source pollutant reduction can be detailed within such plans. Alternatively, an impaired segment can be addressed outside of the statewide TMDL for bacteria if the Division determines it is more appropriately addressed with a watershed-based TMDL with implementation planning.

The TMDL does not rely exclusively on existing KPDES permits for implementation. The TMDL relies on and requires all sources, point and nonpoint, to meet applicable water quality criteria when implementation is complete. No source is assigned an allowable load based on achieving discharges more stringent than the criteria in order to compensate for other sources being allowed to discharge in excess of the criteria. New KPDES permittees, furthermore, would be subject to the same types of limitations as existing permittees.

Discussion of nonpoint sources of bacteria and the authority under which they are controlled can be found in section 4.2 of the TMDL document. The information includes introductory analysis, such as trends in the locations of sources. Detailed descriptions of a range of potential options for addressing nonpoint source contributions can be found throughout Section 7.0.

Comment 1m:

MSD is concerned that [the statewide, segmented] approach could be expanded to other impairments, such as nutrients, which could create an added burden on point source compliance.

DOW Response 1m:

States are obligated to develop TMDLs for impairments caused by pollutants. The responsibilities of a KPDES permittee following the approval of a TMDL are specified in the permit and do not vary according to the method used to determine the TMDL. Concerns about permit provisions, and the resources required to comply with them, are most appropriately addressed to the Division during the public comment period offered with the release of the draft permit.

Stakeholders can use the biennial 303(d) list of impaired waters as a tool for planning responses to impairments that are expected to result in a TMDL. In selecting and designing best practices in response to an approved TMDL, stakeholders are encouraged to consider whether these measures can also effectively address other pollutants which may cause or contribute to existing water quality impairments.

The level of effort or cost to comply are not factors in establishing appropriate TMDL limitations to meet water quality standards. However, 401 KAR 10:031 Sections 10 and 11 provide alternatives if it is determined that the water quality criteria are not attainable or not economically feasible to attain. It is the applicant’s responsibility to provide the information to demonstrate non-attainability or economic hardship.

Comment 1n:

The TMDL does not offer an exemption for impairments caused by natural background sources such as wildlife within permitted discharges. There is a precedence for allowing this exemption. Connecticut TMDL stakeholders are not responsible for reducing load from natural background sources and the Connecticut Statewide TMDL states that criteria do not apply to conditions brought about by natural causes. This approach captures existing and contributing non-permitted sources that are contributing bacteria loads in local streams. MSD recommends that an exemption for any and all natural background sources, including non-permitted existing and contributing sources to the watershed, be considered in this TMDL. The draft TMDL states that natural background sources are included in the load allocation for non-permitted sources. However, natural background sources do exist and contribute to bacteria loading within the MS4 permit boundary and permitted outfalls as well. MSD requests that natural background sources be exempt in this context, and suggests the following language in sections S.3 and 6.1: Natural background from wildlife – deer, birds, raccoons, rabbits, and any and all other existing and contributing non-permitted source can also contribute to bacteria pollution. According to Kentucky Surface water standards (401 KAR 10:031, Section 10), all Water Quality Criteria do not apply to environmental conditions brought about by natural causes or conditions. Entities affected by this TMDL shall not be responsible for reducing or removing loads from natural background sources of bacteria.

DOW Response 1n:

It is noteworthy that the Connecticut statewide bacteria TMDL provides the referenced exemption if the *only* (emphasis added) source of the pollutant is naturally occurring wildlife unaffected or minimally affected by human influences. (Otherwise, the Connecticut TMDL recommends that municipalities implement or improve their nuisance wildlife programs.) Given the urbanized conditions that exist within MS4 service areas, it is likely that natural and anthropogenic sources of bacteria coexist and comingle in MS4 discharges.

Section 10 of 401 KAR 10:031 describes the procedures by which an applicant may demonstrate, and the cabinet may grant, exceptions to the water quality criteria for a specific surface water. It is the responsibility of the applicant to provide the analysis of the natural conditions or site-specific factors that prevent attainment of water quality standards.

Section 4.2.1 has been revised to differentiate between wildlife contributions that occur under the influence of human activities and those due to natural conditions and to indicate that load reductions from natural conditions are not expected as a result of this TMDL.

Comment 1o:

The TMDL includes references to “illegal” discharges. MSD recommends reviewing the context of this language and adjusting to “non-permitted” discharges that receive no allocation throughout the document. Notable references to this language are in Sections 4.1.1 and 4.3.

DOW Response 1o:

In Sections 4.1.1 and 4.3, “illegal” has been replaced variously with “prohibited,” “unauthorized,” and “noncompliant,” etc., as appropriate.

Comment 1p:

Stream impairments are affected by both point and nonpoint sources. The TMDL document seems weighted on MS4 programs, and does not account for other types of regulated (and non-regulated) stormwater. Both Connecticut and Michigan TMDLs include allocations for other types of regulated stormwater, including industrial, commercial, construction and MS4. MSD recommends consideration for additional regulated and non-regulated sources that contribute to bacteria impairments. Suggested language for section 4.0 is as follows: *KPDES discharge permits include municipal, industrial and construction sites that discharge storm water, and some agricultural operations including concentrated animal feeding operations. Facilities regulated with KPDES permits that are found to be a source of bacteria in excess of the criteria adopted in 401 KAR 10:031, Section 7 shall be incorporated into the TMDL.*

DOW Response 1p:

The TMDL addresses significant sources of bacteria, whether such sources currently discharge below, at, or above the contact recreation water quality criteria. For example, a wasteload allocation is specified in this TMDL for each KPDES-permitted sanitary wastewater treatment system that discharges directly into an impaired segment regardless of the bacteria levels permittees report in their effluent.

More than 1,400 facilities in Kentucky, comprised of individual residences, municipal systems, subdivisions, apartments, mobile home parks, schools, state parks, churches, residential care facilities, and commercial establishments, among others, have a KPDES permit to treat sanitary sewage and discharge the treated wastewater. Any of these that discharge to a bacteria-impaired water have the potential to be subject to this TMDL. By comparison, there are currently 112 MS4 entities and 15 systems with active CSOs in the state. Furthermore, the Message to Stakeholders (formerly General Summary) intentionally emphasizes nonpoint sources of pollution that individuals can control with their own choices and behavior. Section 7.0, Implementation, places the most emphasis on describing the assistance available for a wide range of voluntary responses that citizens can develop and lead to address nonpoint source pollution. Taken as a whole, the TMDL is not weighted toward MS4 programs.

In the development of Kentucky’s general permit for Stormwater Associated with Industrial Activities (KYR00), bacteria were not identified via the Reasonable Potential Analysis as a constituent requiring effluent monitoring. Applicants for the KYR00 general permit are reviewed for their potential to discharge pollutants of concern other than those identified in the general permit. If information submitted by the applicant indicates potential for the presence of additional pollutants of concern, the applicant is required to obtain an individual permit that includes limits for the pollutant(s) of concern. In this way, any industrial storm water permittee subject to bacteria limits and discharging to a bacteria-impaired segment in this TMDL would receive a wasteload allocation.

Permits issued for storm water associated with construction cover temporary activities. The Stormwater Construction general permit (KYR10) requires the permittee to implement site-specific measures to prevent and minimize the discharge of pollutants resulting from precipitation events. The KYR10 permit also specifies short timeframes in which permittees must address and correct ineffective controls during the permit term. As with industrial storm water applicants, the Division retains the authority to require an individual construction storm water permit, which could result in requirements to control specific pollutants. Thus, while wasteload allocations have not been universally assigned for construction sites in this or any previous bacteria TMDL, enforceable protocols exist to address the temporary discharge of potential pollutants of concern.

The TMDL accounts for non-KPDES-regulated storm water, including that associated with commercial sites, by including it in the load allocation (for drainage directly to an impaired segment), upstream allocation, or tributary allocation, as applicable.

Comment 1q:

We are invested in improving in-stream water quality and interested in pursuing alternative approaches to this statewide TMDL that are more focused toward our unique urban and suburban conditions and integrate a variety of regulated and non-regulated stakeholders to address the realistic contribution of bacteria from a wide variety of sources.

DOW Response 1q:

Comment noted. Stakeholders should contact the Division if they are interested in pursuing an alternative approach to the statewide TMDL for a segment that is impaired for bacteria. Plans must be approved by the Division and accepted by EPA as a TMDL alternative. The TMDL alternative plan must demonstrate that the segment addressed is expected to meet water quality. The Division's Clean Water Act obligation for TMDL development is not removed by the development of an alternative plan until the waterbody is assessed and meets water quality standards.

Comment 1r:

[T]he Triennial Review process updating water quality standards is currently underway that will likely effect TMDL implementation.

DOW Response 1r:

TMDLs are required under the Clean Water Act as a means of addressing existing water quality impairments. As water quality standards are reviewed at regular intervals, the possibility of a future change to a standard will continue to exist. However, the Division does not generally consider this as justification for delaying its TMDL obligations.

Commenter #2:
James P. Gibson Jr., Director of Water Resources
SD1
1045 Eaton Dr.
Fort Wright, KY 41017

Comment 2a:

SD1 supports the development of a statewide Bacteria TMDL and KDOW's intent to streamline the process to facilitate better use of limited resources. SD1 also appreciates KDOW's approach to focus on the implementation of existing permits and management plans in place of numeric wasteload allocations for MS4 and CSO communities. However, additional edits are needed in the proposed draft to ensure the correct interpretation of this approach. … [T]he suggested edits for Tables S.3 and 6.1-1 [follow].

SWS-WLA: [replace] $\sum(Q_{SWS} \times WQC \times CF)$ [with] "Comply with KPDES permit"

MS4-WLA: [replace] $\sum(Q_{MS4} \times WQC \times CF)$ [with] "Implement SWQMP" [and delete the statement] "Q_{MS4} is the flow (ft^3/s) in the segment due to a MS4 entity" [from footnote 4]

CSO-WLA: [replace] $\sum(Q_{CSO} \times WQC \times CF)$ [with] "Implement LTCP"

[footnote 4] (4)~~Q_{MS4} is the flow (ft^3/s) in the segment due to a MS4 entity.~~ The MS4-WLA is not an end-of-pipe limit~~; the MS4-WLA is an in-stream allocation~~. This means that the MS4-WLA is an aggregate of the in-stream contribution of all MS4 outfalls within the MS4 jurisdiction, not the storm water contribution from individual MS4 outfalls. The MS4-WLA will be addressed through the MS4 permit and implemented through the Storm Water Quality Management Plan (SWQMP) ~~to the Maximum Extent Practicable (MEP)~~. An MS4 permittee is considered to be compliant with its MS4-WLA if it is compliant with its KPDES permit.

[footnote 5] (5)Q_{CSO} is the flow (ft^3/s) in the segment due to a CSO entity. Dry weather CSO flows are prohibited. The CSO-WLA is not an end-of-pipe limit. During wet weather events, a CSO entity is considered to be compliant with its CSO-WLA if it is compliant with its KPDES permit.

[Add the following footnote to the "Allocations for Direct Loads to the Segment" portion of the tables:] The Water Quality Criteria for contact recreation is currently based on a 30-day period and is structured to recognize the inherent variability of bacteria concentrations in surface waters. Therefore, it is not appropriate to compare the bacteria loading from an intermittent discharge on any given day to the water quality criteria for bacteria and make a determination of regulatory compliance. The WLA for MS4 and CSO discharges should not be interpreted as a "not to exceed" discharge load on any given day.

DOW Response 2a:

Please see responses 1c, 1d, 1e, and 1f regarding these requests for revision of Tables S.3 and 6.1-1.

Comment 2b:

Some of the communities listed as co-permittees with SD1 are incorrect in Appendix A, Table A-1. The following is the correct list of SD-1 co-permittees:

Alexandria, Bellevue, Bromley, Covington, Crescent Springs, Crestview, Crestview Hills, Dayton, Edgewood, Elsmere, Erlanger, Fort Mitchell, Fort Thomas, Fort Wright, Highland Heights, Independence, Kentonvale, Lakeside Park, Ludlow, Melbourne, Newport, Park Hills, Silver Grove, Southgate, Taylor Mill, Union, Villa Hills, Wilder, Woodlawn and unincorporated Boone, Kenton and Campbell counties.

If KDOW has identified the city of Walton as a designated MS4 community, it should be listed separately, similar to Florence and Cold Spring.

DOW Response 2b:

Table A-1 has been corrected.