Total Maximum Daily Load (TMDL) Synopsis

State: Kentucky
Major River Basin: Salt
USGS HUC8 #: 05140102
County(s): Nelson, Bullitt and Spencer
Pollutant(s) of Concern: *E. coli*

Table S.1 Impaired Waterbodies Addressed in this Bacteria TMDL Document

Waterbody Name	Pollutant	County	GNIS Number	Suspected Sources	Impaired Use (Support Status)
Cox Creek 0.0 to 4.7	*E. coli*	Bullitt	KY490220_01	Nonpoint Sources	PCR (not supporting)
Cox Creek 4.7 to 11.4	*E. coli*	Nelson	KY490220_02	Nonpoint Sources Animal Feeding Operations (NPS), Agriculture, Unrestricted Cattle Access	PCR (not supporting)
Cox Creek 11.4 to 18.6	*E. coli*	Nelson	KY490220_03	Nonpoint Sources Animal Feeding Operations (NPS), Agriculture, Unrestricted Cattle Access, Other Permitted Small Dischargers	PCR (not supporting)
Cox Creek 18.6 to 23.9	*E. coli*	Nelson	KY490220_04	Nonpoint Sources, Agriculture, Unrestricted Cattle Access, Urban Runoff/ Storm Sewers	PCR (not supporting)
Caney Fork 0.0 to 4.0	*E. coli*	Nelson	KY488864_01	Nonpoint Sources, Agriculture, Unrestricted Cattle Access, Urban Runoff/ Storm Sewers	PCR (not supporting)
East Fork Cox Creek 0.0 to 4.3	*E. coli*	Bullitt	KY491454_01	Nonpoint Sources Animal Feeding Operations (NPS), Agriculture, Unrestricted Cattle Access	PCR (not supporting)
Froman Creek 0.0 to 1.25	*E. coli*	Nelson	KY492574_01	Nonpoint Sources, Agriculture, Unrestricted Cattle Access	PCR (not supporting)

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Waterbody Name	Pollutant	County	GNIS Number	Suspected Sources	Impaired Use (Support Status)
Rocky Run 0.0 to 2.3	*E. coli*	Bullitt	KY502264_01	Nonpoint Sources Animal Feeding Operations (NPS), Agriculture, Unrestricted Cattle Access	PCR (not supporting)
West Fork Cox Creek 0.0 to 6.9	*E. coli*	Bullitt	KY506428_01	Nonpoint Sources Animal Feeding Operations (NPS), Agriculture, Unrestricted Cattle Access	PCR (not supporting)

Kentucky Water Quality Criteria (WQC) and the TMDL Endpoint (i.e. Water Quality Standard/ TMDL Target):

Title 401 KAR 10:031 describe the standards used to "protect the surface waters of the Commonwealth, and thus protect water resources." *Escherichia coli* (*E. coli*) bacteria are pathogen indicator organisms. *E. coli* data are used to indicate the degree of support for primary contact recreation (PCR) use. The stream is assessed as fully supporting the PCR use if the *E. coli* content does not exceed the criterion of 240 colonies per 100 ml in less than 20 percent of samples; it was assessed as partially supporting the PCR use if the criterion was not met in 25-33 percent of samples, and as not supporting the PCR use if the criterion was not met in greater than 33 percent of samples. Streams assessed as either nonsupport or partial support are considered impaired. Stream segments were sampled during twelve sampling events through the PCR season of May 1 through October 31, 2009.

The WQC in 401 KAR 10:031 (Kentucky's Surface Water Standards) for the PCR use are based on both fecal coliform and *E. coli*. Per 401 KAR 10:031:

"The following criteria shall apply to waters designated as primary contact recreation use during the primary contact recreation season of May 1 through October 31: 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."

The instantaneous criteria of 240 *E. coli* colonies/100 ml was applied to calculate allowable loadings to bring the watershed into compliance with the PCR designated use. The TMDL Target is defined as the WQC minus the Margin of Safety (MOS). The MOS can be an implicit or explicit additional reduction applied to the Waste Load allocation (WLA), Load Allocation (LA) or to both types of sources that accounts for uncertainties in the data or TMDL calculations. The TMDL Target is thus 216 colonies per 100ml (240 col/100ml minus a 10% MOS).
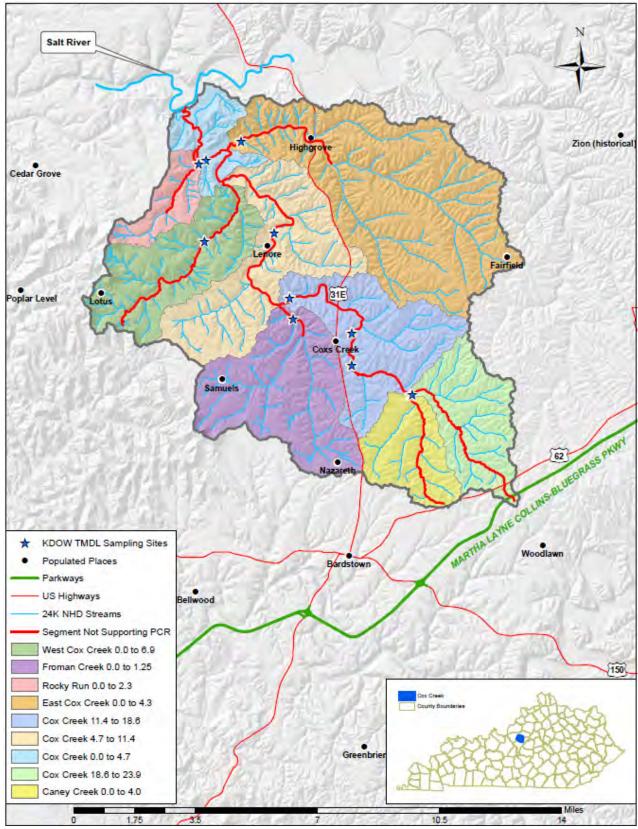
Figure S.1 Location of the Cox Creek Watershed, Sample Sites and Assessed Stream Segments

TMDL Equation and Calculations:

A TMDL calculation is performed as follows:

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

The WLA has three components:

$$WLA = SWS\text{-}WLA + MS4\text{-}WLA + Future\ Growth\text{-}WLA$$
(Equation 2)

Where:
TMDL: the WQC, expressed as a load. The WQC is defined in Section 6.0 as an instantaneous concentration of 240 colonies/100 ml for *E. coli* or 400 colonies/100 ml for fecal coliform.
MOS: the Margin of Safety, which can be an implicit or explicit additional reduction applied to sources of pollutants that accounts for uncertainties in the relationship between effluent limits and water quality.
TMDL Target: the TMDL minus the MOS.
WLA: the Wasteload Allocation, which is the allowable loading of pollutants into the stream from KPDES-permitted sources, such as SWSs and MS4s.
SWS-WLA: the WLA for KPDES-permitted sources, which have discharge limits for pathogen indicators (including wastewater treatment plants, package plants and home units).
Remainder: the TMDL minus the MOS and minus the SWS-WLA (also equal to Future Growth-WLA plus the MS4-WLA and the LA).
Future Growth-WLA: the allowable loading for future KPDES-permitted sources, including new SWSs, expansion of existing SWSs, new storm water sources, and growth of existing storm water sources (such as MS4s). Also includes the allocation for the KPDES-permitted sources that existed but were not known at the time the TMDL was written.
Remainder: the TMDL minus the MOS and minus the SWS-WLA (also equal to Future Growth-WLA plus the MS4-WLA and the LA).
MS4-WLA: the WLA for KPDES-permitted municipal separate storm water sewer systems (including cities, counties, roads and right-of-ways owned by the Kentucky Transportation Cabinet (KYTC), universities and military bases).
LA: the Load Allocation, which is the allowable loading of pollutants into the stream from sources not permitted by KPDES and from natural background.
Seasonality: yearly factors that affect the relationship between pollutant inputs and the ability of the stream to meet its designated uses.
Critical Condition: the time period when the pollutant conditions are expected to be at their worst.
MAF: the Mean Annual Flow as defined by USGS.
Adjusted MAF: the MAF plus SWS-WLA design flows.
Critical Flow: the flow used to calculate the TMDL as a load (is equivalent to the Adjusted MAF for MAF TMDLs)
Existing Conditions: the load that exists in the watershed at the time of TMDL development (i.e., sampling) and is causing the impairment.

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Percent Reduction: the loading reduction needed to bring the existing condition in line with the TMDL target.
Load: concentration * flow * conversion factor
Concentration: colonies per 100 milliliters (colonies/100ml)
Flow (i.e. stream discharge): cubic feet per second (cfs)
Conversion Factor: 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: $(28.31685L/f^3 * 86400 seconds/day * 1000ml/L)/ (100ml)$ and is equal to 24,465,758.4.

Calculation Procedure:

1) The MOS, if an explicit value, is calculated and subtracted from the TMDL first, giving the TMDL Target;
2) Percent reductions are calculated to show the difference between Existing Conditions and the TMDL Target;
3) The SWS-WLA is calculated and subtracted from the TMDL Target, leaving the Remainder;
4) The Future Growth-WLA is calculated and subtracted from the Remainder;
5) If there is a MS4 present upstream of the impaired segment, the MS4-WLA is subtracted from the Remainder based on percent land use, leaving the LA.

Translation of WLAs into Permit Limits

All KPDES-permitted sources must meet permit limits based on the Water Quality Criteria (WQC) 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.

The MS4-WLA is not a numerical end-of-pipe limit; it is an in-stream allocation. The MS4-WLA will be addressed through the MS4 permit and implemented through the Stormwater Quality Management Plan (SWQMP) to the Maximum Extent Practicable (MEP).

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Table S.2 TMDLs and Allocations

TMDL[1]	MOS[2]	SWS-WLA[3]	MS4-WLA	Future Growth - WLA	LA	Mean Annual Flow (cfs)
Cox Creek 0.0 to 4.7 into Salt River						
6.68×10^{11} col/day	6.68×10^{10} col/day	9.08×10^{7} col/day	1.94×10^{8} col/day	3.00×10^{9} col/day	5.98×10^{11} col/day	113.7
Cox Creek 4.7 to 11.4 into Salt River						
3.38×10^{11} col/day	3.38×10^{10} col/day	9.08×10^{7} col/day	1.82×10^{8} col/day	1.52×10^{9} col/day	3.02×10^{11} col/day	57.5
Cox Creek 11.4 to 18.6 into Salt River						
1.33×10^{11} col/day	1.33×10^{10} col/day	9.08×10^{7} col/day	5.77×10^{7} col/day	6.00×10^{8} col/day	1.19×10^{11} col/day	22.7
Cox Creek 18.6 to 23.9 into Salt River						
5.99×10^{10} col/day	5.99×10^{9} col/day	n/a	n/a	2.70×10^{8} col/day	5.36×10^{10} col/day	10.2
Caney Fork 0.0 to 4.0 into Cox Creek						
4.46×10^{10} col/day	4.46×10^{9} col/day	n/a	8.21×10^{7} col/day	4.02×10^{8} col/day	3.97×10^{10} col/day	7.6
East Fork Cox Creek 0.0 to 4.3 into Cox Creek						
1.92×10^{11} col/day	1.92×10^{10} col/day	n/a	n/a	8.64×10^{8} col/day	1.73×10^{11} col/day	32.7
Froman Creek 0.0 to 1.25 into Cox Creek						
9.75×10^{10} col/day	9.75×10^{9} col/day	n/a	1.25×10^{8} col/day	4.39×10^{8} col/day	8.72×10^{10} col/day	16.6
Rocky Run 0.0 to 2.3 into Cox Creek						
2.29×10^{10} col/day	2.29×10^{9} col/day	n/a	n/a	1.03×10^{8} col/day	2.05×10^{10} col/day	3.9
West Fork Cox Creek 0.0 to 6.9 into Cox Creek						
5.64×10^{10} col/day	5.64×10^{9} col/day	n/a	n/a	2.54×10^{8} col/day	5.05×10^{10} col/day	9.6

Notes:

[1]. TMDLs are expressed as daily loads of *E. coli* colonies by multiplying the WQC by the mean annual streamflow (MAF) and the appropriate conversion factor. MAF is determined by the USGS. The TMDL is the sum of all components.

[2]. MOS is explicitly set at 10% of the Water Quality Criterion

[3]. Any future KPDES wastewater permitted sources must meet permit limits based on the Water Quality Criterion in 401 KAR 10:031, and must not cause or contribute to an existing impairment. WLA value is based on acute permit limits and design flow and represents the maximum one-day load that can be discharged to the stream segment.