Kentucky Statewide TMDL for Bacteria Impaired Waters

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June 2018

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Why Pathogen TMDLs?

- Protect recreational uses…



- Promote awareness





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Watershed-based TMDL Process…

- 2-3 year data collection effort
- Sample multiple streams in watershed for bacteria levels
- Assess previously unassessed streams
- Determine flow from multiple streams
- Identify all KPDES-permitted sources, obtain design flows

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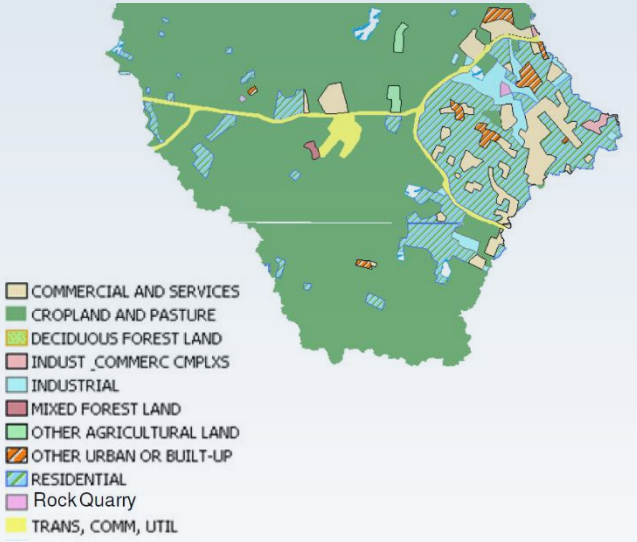
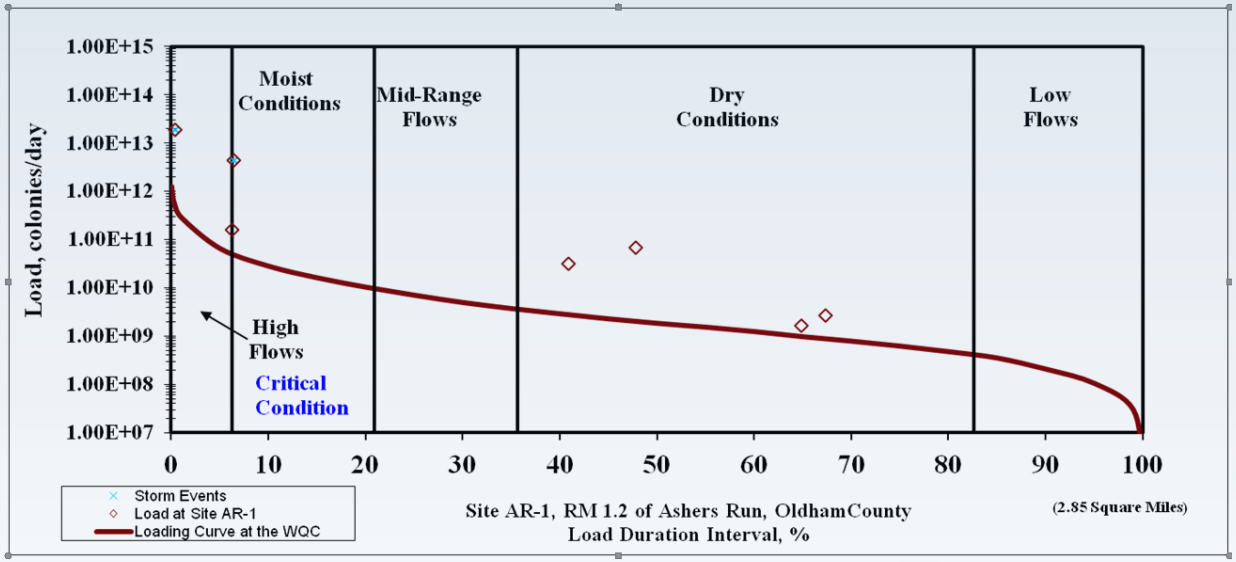
…Watershed TMDL Process

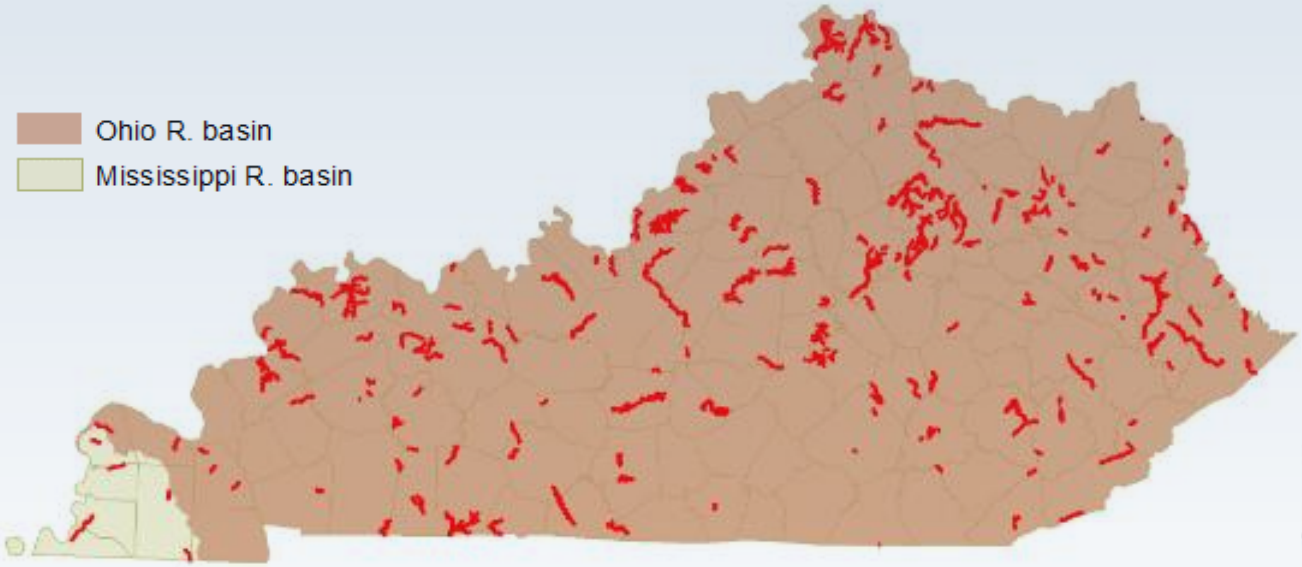
- Use data to develop flow & load duration curves
- Determine critical flow – when conditions at their worst
- Use critical flow to calculate numeric TMDL
- Use GIS to analyze land use within MS4 boundaries
- Identify & evaluate relative impact of nonpoint sources





Current KY Pathogen TMDL Reality

- 2016 draft 303(d) list: 422 bacteria listings
- Decades to complete TMDLs for all current bacteria listings using watershed method – & new waters get added each listing cycle
- KPDES facility permits: require year-round disinfection; bacteria limits based on most protective criteria
- MS4, CSO, and NPS programs have frameworks tailored to addressing bacteria from these sources



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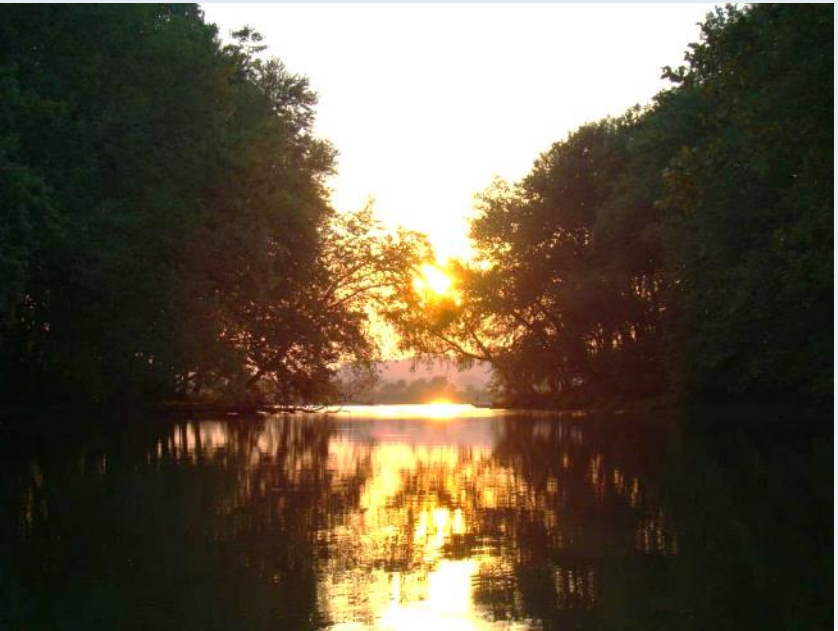
Pathogen TMDL Method Goals

- Efficient/simple method allowing many TMDLs to be produced within a few years
- Applicable to all bacterial indicators and recreational uses, even if indicator changes
- Applicable to all sizes of stream systems
- Does not require additional data collection



- Minimizes or eliminates the need to work with other state TMDL programs
- Meets CWA requirements and EPA TMDL guidance

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Streamlined Method Overview

- **Leave TMDLs & allocations in equation form**

  as opposed to solving equations for one critical condition using one bacteria criterion

- **Produce Segment TMDLs instead of Watershed TMDLs**

  Upstream and tributary loadings are noted separately from the segment loadings

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Method Foundation

- Assumption: applicable Water Quality Criteria (WQCs) represent the assimilative capacity of the impaired segment.

- KY bacteria recreational WQCs are concentration-based:

Recreational Use Protected →	**Primary Contact (swimming)**	**Secondary Contact (wading, boating)**
Instantaneous Criterion →	240 colonies E. coli/100 ml 400 colonies fecal coliform/100 ml	2,000 colonies fecal coliform/100 ml
Geometric Mean Criterion →	130 colonies E. coli/100 ml 200 colonies fecal coliform/100 ml	1,000 colonies fecal coliform/100 ml
Season Applied →	May 1 - Oct. 31	year-round

Instantaneous criteria shall not be exceeded in 20 percent or more of all samples taken during a 30-day period.

Geometric mean based on not less than 5 samples taken during a 30-day period. (401 KAR 10:031)

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…Method Foundation

- Sanitary wastewater systems' KPDES permit compliance evaluated in terms of bacteria concentration, not load
- If all sources contribute at or below the WQC concentration, in-stream water quality standards should be achieved
- Set segment TMDL & source allocations = WQC concentration

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…Method Foundation

Convert maximum allowable concentration to allowable load using the relationship

Load = (Flow) x (concentration) x (units conversion factor)

Allowable Load = Q×WQC×CF

Where:
Q is the flow
WQC is the applicable criterion
CF is the conversion factor to obtain a load (colonies/day)

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Which Flow??

- Instantaneous flow:

  …loads can remain in equation form

- Since flow varies, allowable loads exist on a continuum

- Allowable load for impaired segment based on streamflow:

Segment TMDL = Q_S×WQC×CF

Where Q_S : instantaneous flow in the segment

* MOS is implicit based on conservative assumptions

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Allocating Loads

$$TMDL = \underbrace{\sum WLA}_{\text{Point sources}} + \underbrace{\sum LA}_{\text{Nonpoint sources}} + MOS$$

$$\sum WLA = \sum WLA_{segment} + \sum WLA_{upstream} + \sum WLA_{tributary}$$

$$\sum LA = \sum LA_{segment} + \sum LA_{upstream} + \sum LA_{tributary}$$

Regroup and “lump”:

$$TMDL =$$

$$(\sum WLA + \sum LA)_{Segment} + \underbrace{(\sum WLA + \sum LA)_{Upstream}}_{\text{Lumped allowable upstream load}} + \underbrace{(\sum WLA + \sum LA)_{Tributary}}_{\text{Lumped allowable tributary load}}$$

$$\ldots + MOS$$

In Other Words…

Allowable loads for direct sources
+ Allowable upstream load
+ Allowable tributary load

= TMDL (with implicit MOS)

Segment TMDL Allocations

Source allocation/allowable load:

$= Q_{source} \times WQC \times CF$

Where sources include:

- upstream areas
- tributary areas
- direct discharges from…
  - KPDES sanitary wastewater systems
  - MS4 entities
  - CSO entities
  - nonpoint/runoff

- All flows (Q) are instantaneous
- All allowable loads remain in equation form

Allowable load for each entity depends on the flow contributed by that entity.

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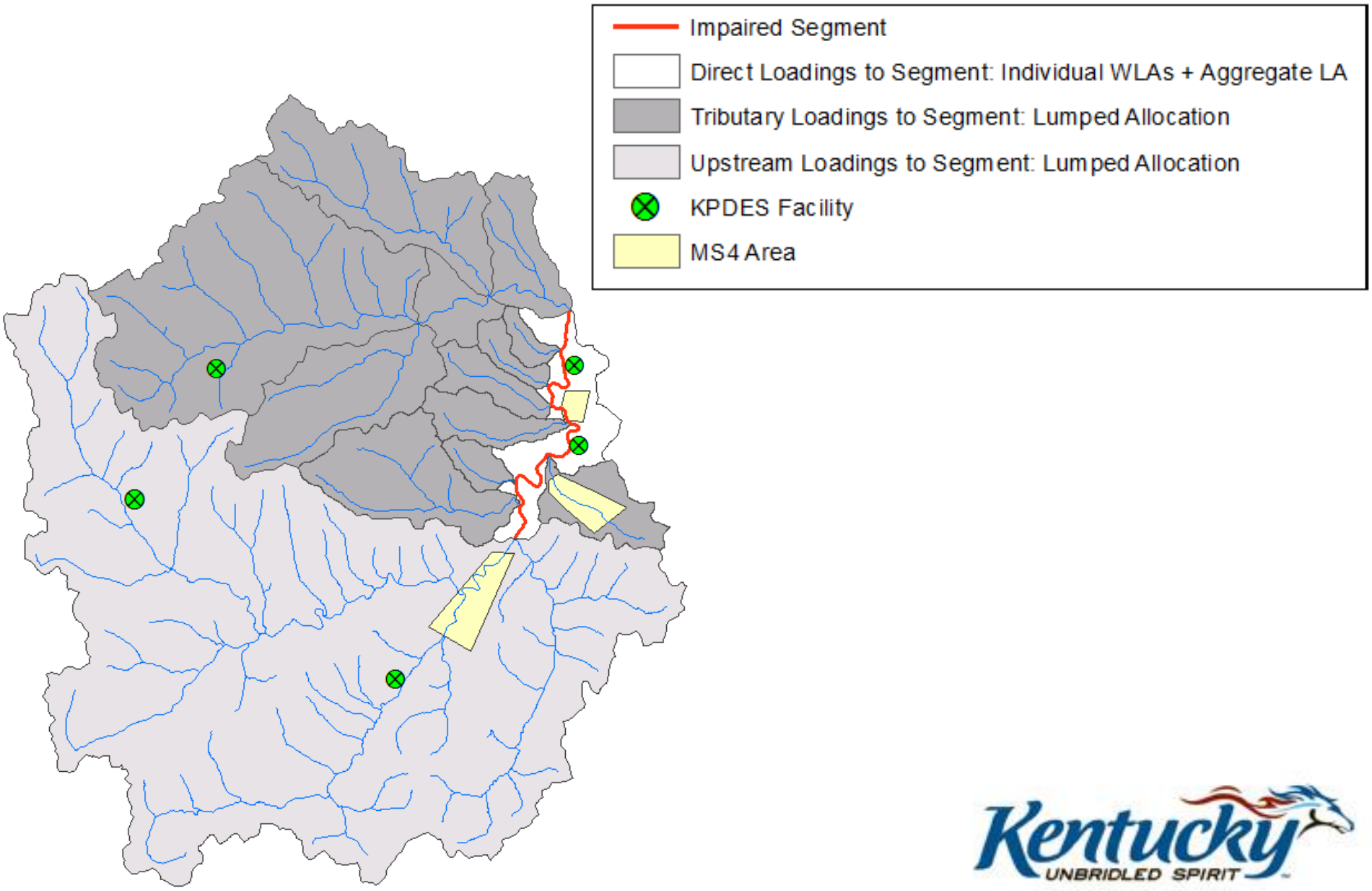
Example Impaired Segment



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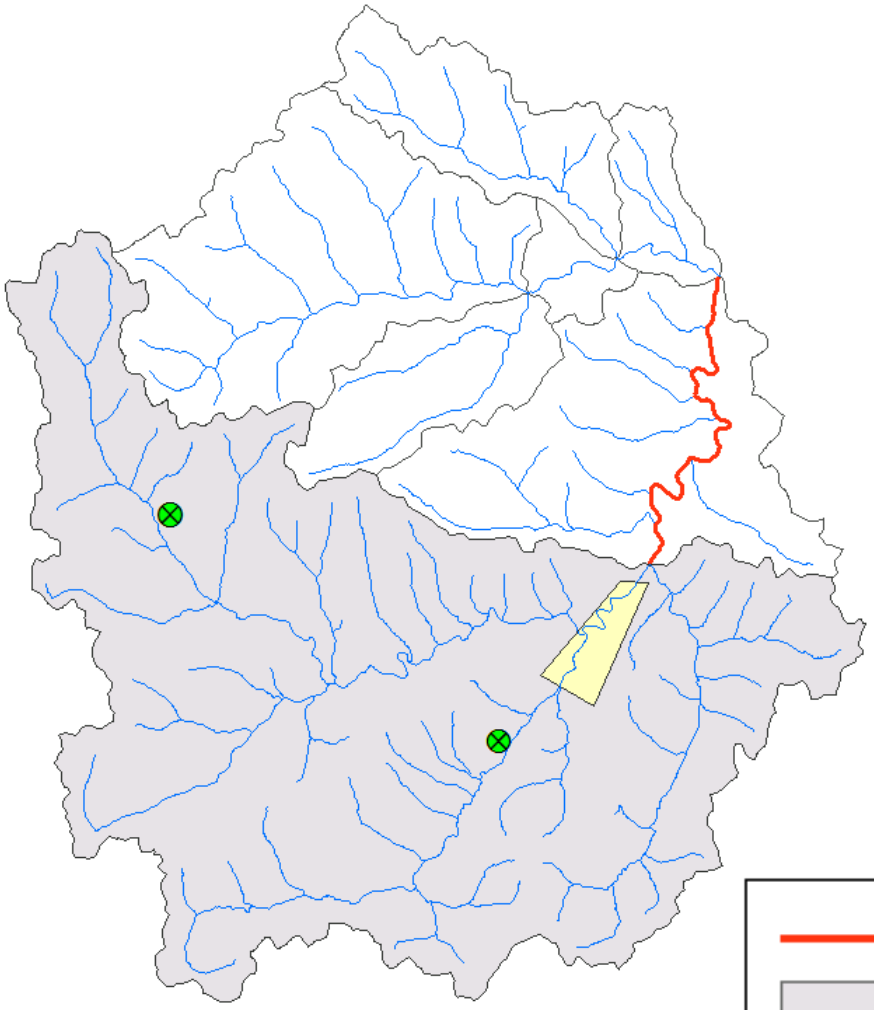
Upstream Loadings



A lumped allocation is given to the area upstream of the segment.

$$\sum(Q_{upstream} \times WQC \times CF)$$

Point sources are not identified with individual WLAs.

Their contribution is accounted for as a portion of total flow & load coming from upstream.

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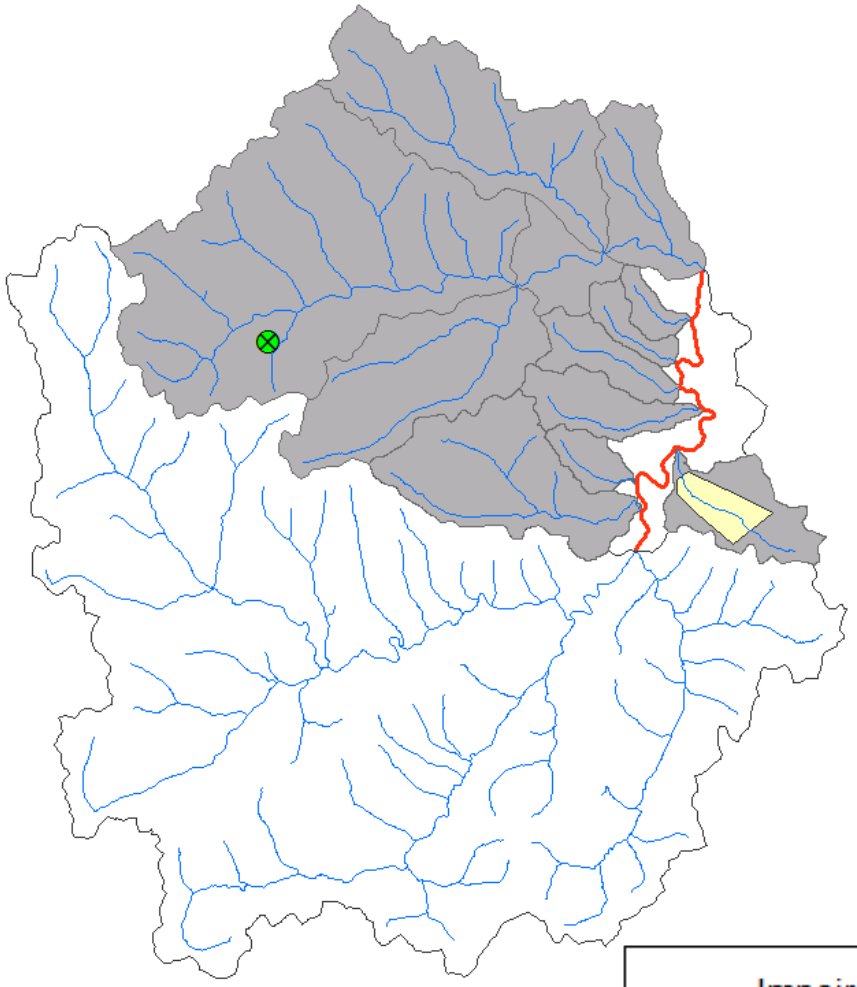
Tributary Loadings



A lumped allocation is given to tributary contributions to the segment.

$$\sum(Q_{tributary} \times WQC \times CF)$$

Point sources are not identified with individual WLAs.

Their contribution is accounted for as a portion of total flow & load coming from tributaries.

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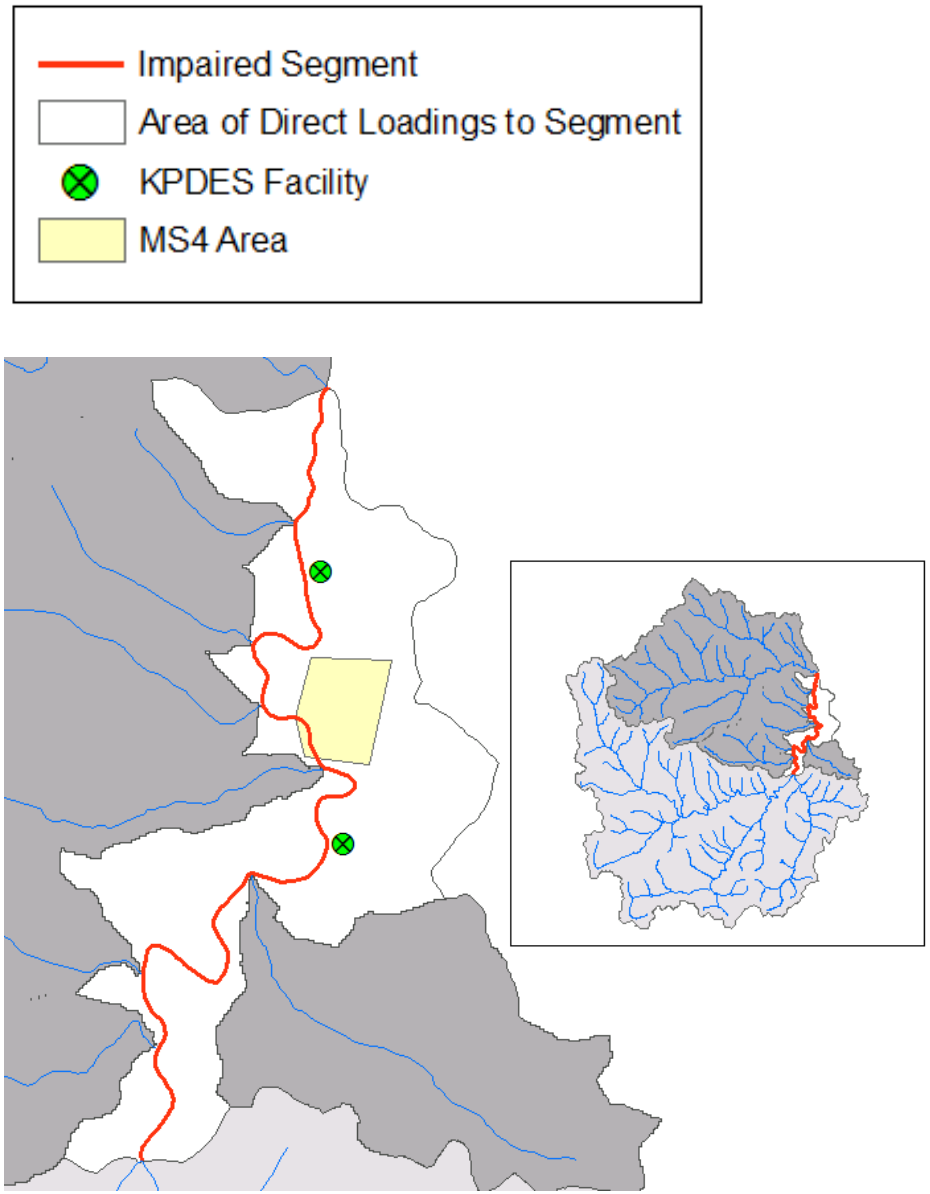
Direct Loadings



KPDES sanitary dischargers and CSOs get individual equation-based WLAs.

MS4 areas get an equation-based in-stream allocation proportional to their flow contribution.

Nonpoint sources receive an equation-based load allocation.

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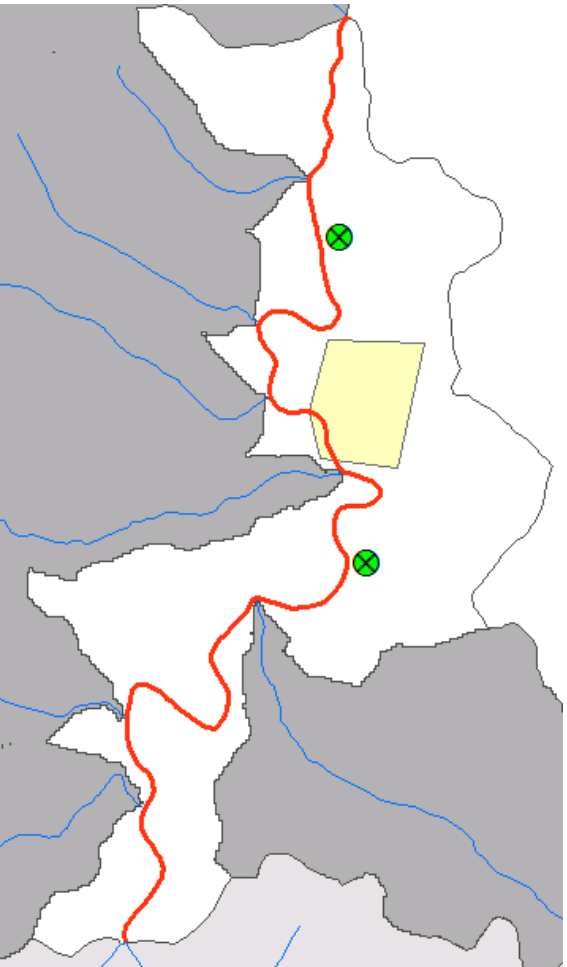
Direct Loading Allocations



Allocations for direct loads to the segment:

$\sum(Q_{SWS} \times WQC \times CF)$ = WLA for KPDES sanitary system discharges

$\sum(Q_{MS4} \times WQC \times CF)$ = WLA for MS4s

$\sum(Q_{CSO} \times WQC \times CF)$ = WLA for CSOs

$\sum(Q_{LA} \times WQC \times CF)$ = Load Allocation for nonpoint sources

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Addressing Storm Water

- “During wet weather events, a CSO entity is considered to be compliant with its CSO-WLA if it is compliant with its KPDES permit.”

- “Dry weather CSO flows are prohibited.”

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MS4s

- Only MS4s with land directly adjacent to the impaired segment would be identified in the segment MS4-WLA.

- Any other MS4s in the watershed would be included in a “lumped allocation” under the tributary or upstream category.

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MS4s

- <u>The MS4-WLA is an in-stream allocation, not an end-of-pipe limit.</u>

  "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)."

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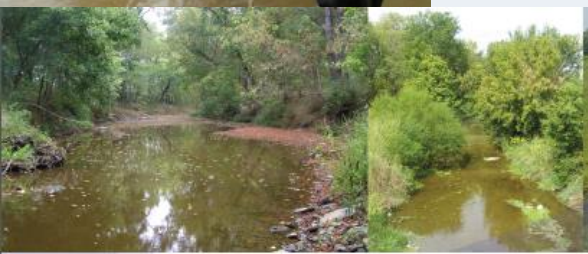
Method Implications

- No numeric WLA or LA calculations
- No existing load calculations
- No percent reduction calculations



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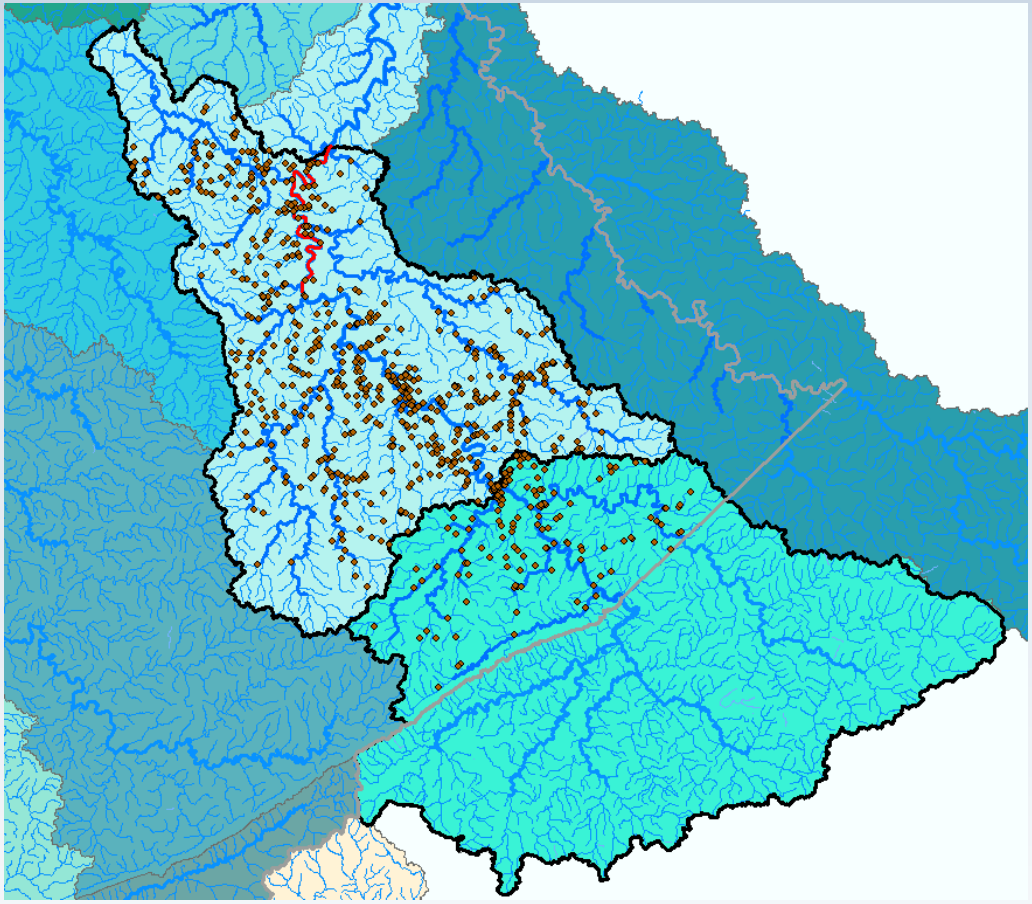
Impact on Example Watershed TMDL

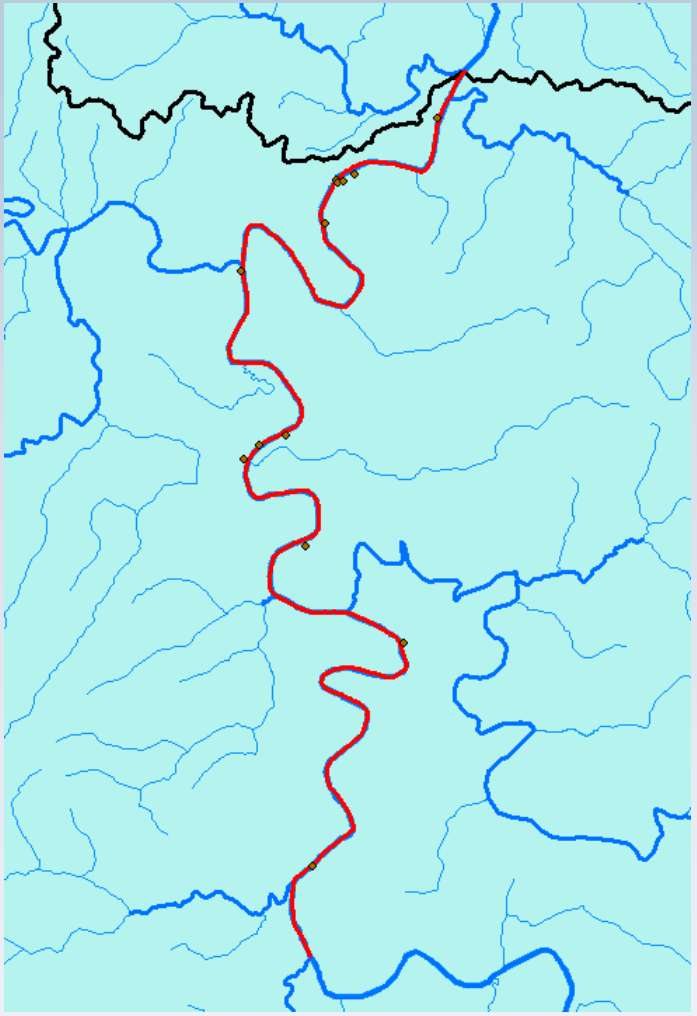
- Levisa Fork 34.1 to 54.7 (3130 mi^2):
  - 791 KPDES sanitary discharges in KY plus unknown number in VA



Segment TMDL Method

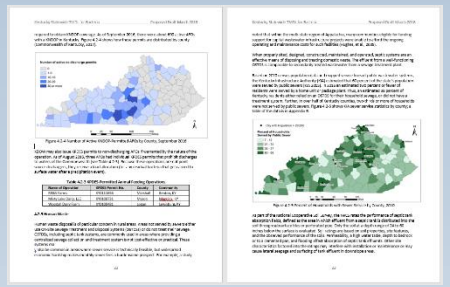
Levisa Fork 34.1 to 54.7:

- 12 KPDES sanitary discharges directly into segment (tributaries at 1:24K)



Report Organization

- **Core document**



Problem statement

WQCs

Physical setting (physiographic regions, karst considerations)

Source types discussion

Explanation of equation-based TMDL method

Implementation options

- **Basin appendices**

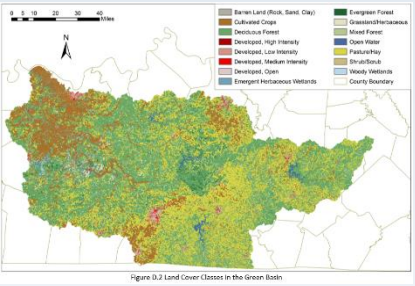


Figure D.2 Land Cover Classes in the Green Basin

1 appendix for each major basin (total of 13)

Overview of basin characteristics (hydrology, land use)

TMDL and allocations for each impaired segment within the basin

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Example Segment from Appendix

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, KDOW 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]			
$Q_S \times WQC \times CF$	$\sum(Q_{MS4} \times WQC \times CF)$	$\sum(Q_{LA} \times WQC \times CF)$	$\sum(Q_{Upstream} \times WQC \times CF)$	$\sum(Q_{Tributary} \times WQC \times CF)$	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. All flows, denoted by Q with a subscript, are instantaneous flow values at any point in time.

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

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Example Segment, Cont.

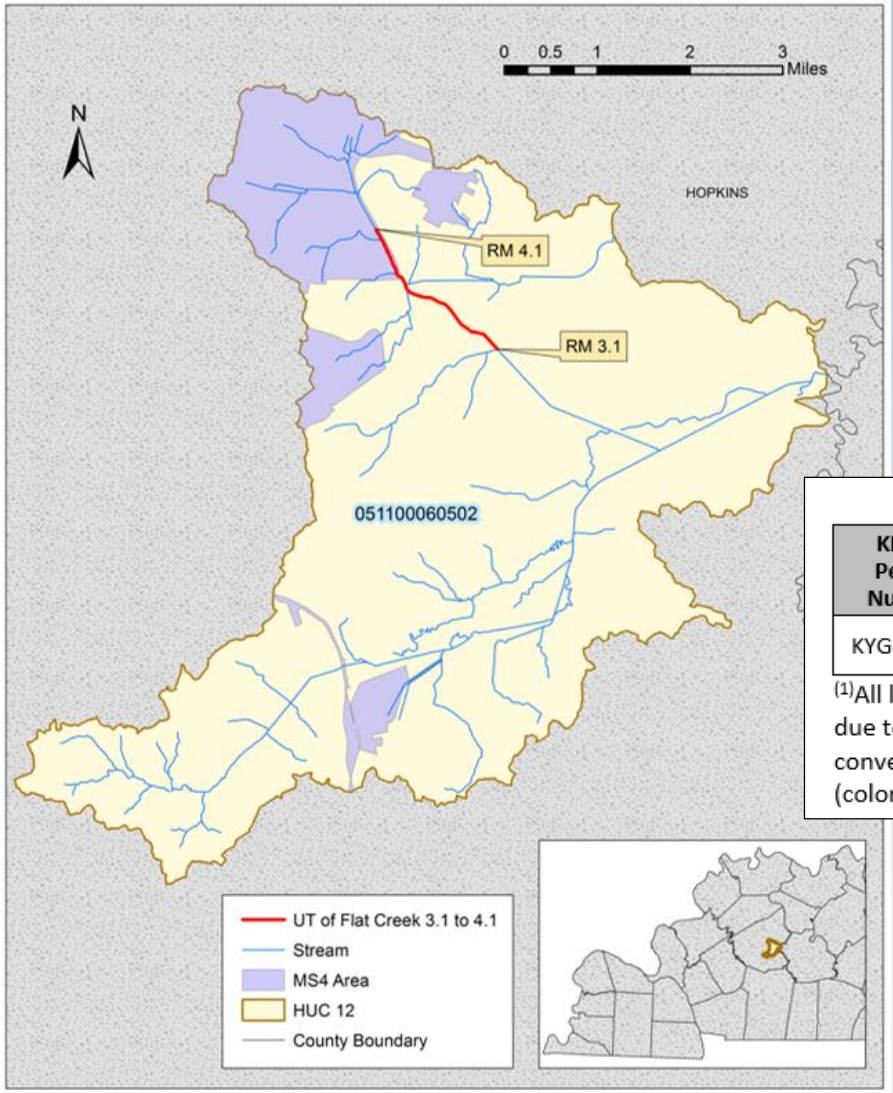

Figure D.33-1 Location of UT of Flat Creek 3.1 to 4.1

Table D.33-2 Summary of Active KPDES-permitted Sources as of May 2017

KPDES Permit Number	Facility Name	Indicator Bacteria	Permit Expiration Date	WLA[(1)] (colonies *E. coli*/day)
KYG200022	City of Madisonville	*E. coli*	renewal pending as of August 2017	$Q_{MS4} \times WQC \times CF$

[(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 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).

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Benefits of Segment Method

- ✓ Flexible
  - Applicable to PCR/SCR uses, *E. coli*/fecal coliform, large river/small stream
  - Accommodates changes to standards
- ✓ Efficient
  - Does not require collection of new data
  - 5-6 years to complete TMDLs for currently listed segments
- ✓ Contributes reasonable assurance to Ohio River bacteria TMDL
- ✓ TMDL applies to all flow conditions
- ✓ Aligns with permitting programs

Drawback: loss of watershed information at beginning of restoration process

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Final Thoughts

- The streamlined approach allows KDOW to allocate resources for water quality projects more strategically

  - Focus data collection efforts on data to be used in near-term

- Segments/watersheds recommended for TMDL alternative or watershed-based TMDL can be withheld from statewide document

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Comment Period Ends June 11, 2018

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Questions?

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