Chesapeake Water Environment Association

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Bacteria TMDL Implementation Plans

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MDE Bacteria TMDLs

Indicator	Impairment	Number of TMDLs
Shellfish	Fecal Coliform	25
Non-tidal WQS	E. Coli	24
Beach WQS	Enterococci	4

TMDL Development vs. TMDL Accounting

- TMDL Development
  - Understand the sources and quantify pollutants causing impairments
    - Model: identifies all potential sources including point sources, stormwater and other non-point sources
    - Data: identifies sources at a coarse level by source sector (e.g., using bacterial source tracking to determine if sources are human wildlife or livestock)
  - Loads identified from:
    - Modeling—loads should be provided in sufficient detail as absolute values and percent reductions, sources should be defined
    - Monitoring—may not have the load source or controllable amount, leaving each source sector/implementation agency to determine its responsibility for load reductions.

- TMDL Accounting
  - Focuses on identifying sources and treatment options
    - Highest load reduction
    - Lowest cost
    - Least maintenance
  - Do not need to model
    - Impacts on receiving waters
    - Required load reductions to meet WQS

Assessing and Tracking Compliance

- Percent Reduction should be a constant goal regardless of how the TMDL was established
- Compare restoration progress against the baseline using percentage instead of absolute loads
- This allows implementers to determine the effectiveness of plans

Implementation Modeling Steps

1. Identify all potential pollutant sources within the implementer's jurisdiction.
2. Use TMDL information to generate runoff loading rates so that the model uses similar data to the TMDL, if model is for a single watershed.
3. Use the best available local land cover data and/or runoff loading to calculate baseline untreated and treated loads.
4. Use approved BMP reductions and other treatment reductions to locate, size, and assess BMPs.
5. Plan enough treatment to meet the TMDL percent reduction.
6. Periodically revise the model with updated information on treatment constructed and change forecast compliance dates and costs.

Citation: William Frost, P.E., D.WRE, F.ASCE; R. Craig Lott; Rosanna LaPlante; and Fred Rose, P.E., M.ASCE. 2019. Modeling for TMDL Implementation. Journal of Hydrologic Engineering. doi:10.1061/(ASCE)HE.1943-5584.0001786

Implementation Model Considerations

- Model capability
  - Bacteria sources
  - Treatment practices
- Input data requirements
- Expertise required
- Model availability and support

Model Capability

- Estimate bacteria loads from a watershed
- Estimate load reductions from many BMPs
- Show the existing (baseline) bacteria loads with current BMPs
- Show the future bacteria loads with planned BMPs for one or more scenarios
- Show a comparison of current and future bacteria loads as a percent reduction
- Estimate costs of BMP implementation (source can be FAPs)

Bacteria Model – Base Data

- Base land use loading rate
  - Pervious and impervious developed
  - Forests, tree canopy, wetlands, and water
  - Methods:
    - source input data on human population, pet ownership, and wildlife population density to estimate a total watershed load
    - NSWQDB
- Potential sources of bacteria that are not included in the land use
  - Sanitary sewer overflows
  - Combined sewer overflows
  - Leaky or failing septic systems

Table 2. Summary of Available Bacteria Concentrations in Stormwater Runoff Included in NSQD, version 1.1 (Pitt and Maestre, 2005)

	Fecal Coliform (mpn/100mL)		Fecal Streptococcus (mpn/100mL)		Total *E. Coli* (mpn/100mL)	
	median	# of observations	median	# of observations	median	# of observations
Mixed Industrial	3,033	79	11,000	59	2,467	14
Freeways	1,700	49	17,000	25	50,000	16
Mixed Freeways	2,600	20	19,000	16		
Open Space	7,200	23	24,900	22		
Mixed Open Space	3,000	86	21,000	75		
Residential	7,000	402	24,300	257	1,750	67
Mixed Residential	11,210	336	27,500	178	700	14
Commercial	4,600	253	12,000	201		
Mixed Commercial	5,400	116	11,900	95		
Industrial	2,400	315	12,000	189		

[2] EPA's recommended recreational water quality criteria standard is 126 cfu/100mL for *E.Coli*. While no longer recommended as an indicator, previous guidance for a fecal coliform standard was 200 MPN/100 ml.

Source: CSN Fecal Indicator Bacteria Management: Reviewing the Latest Science on Bacteria Control for Watershed Managers, 9/28/2018)

Bacteria Model – Base Data, cont.

- BMPs can be categorized into three categories and pollutant removal rates modeled in a step-wise manner
  1. reducing the land area contributing to loads from runoff
  2. applying source control (Sanitary Sewer Repair or Street Sweeping)
  3. reducing the load through an efficiency factor or removal rate (stormwater BMPs)

Bacteria Model – Base Data, cont.

- Bacteria removal rates for stormwater BMPs were derived from monitoring data.
- Two sources identified:
  - International Stormwater BMP Database (Leisenring, et al., 2014)
  - National Pollutant Removal Performance Database (CWP, 2007)
- Stormwater BMP database consolidated a larger number of studies and appeared to be a better source.
- Removal efficiencies were calculated using median data:

$$Removal\ Rate = \frac{EMC_{in} - EMC_{out}}{EMC_{in}}$$

	Stormwater BMP Database			CWP 2007	
BMP Name	Entero-coccus	E. coli	Fecal Coliform	BMP Name	All bacteria
Grass Strip			2	Open Channel	3
Bioswale / Grass Swale		5	11		
Bioretention	3	4		Bioretention	
Composite			4		
Detention Basin		3	15	Dry Pond	2
Green Roof		1			
Infiltration				Infiltration	
Media Filter				Filtering	6
Retention Pond		4	11	Wet Pond	11
Wetland Basin	4	5	5	Wetland	3
Wetland Basin / Retention Pond	6	9	15		
TOTAL	**13**	**31**	**63**		**25**

Sources of BMP Pollutant Removal Rates with Number of Sampling Studies)

TABLE 1: Potential Sources of FIB in Urbanized Areas and Adjoining Watersheds

General Category	Source/Activity
Municipal Sanitary Infrastructure (piped)	Sanitary sewer overflows (SSOs)
	Leaky sewer pipes (Exfiltration) (see Sercu et al. 2011)
	Illicit Sanitary Connections to MS4
	WWTPs (if inadequate treatment or upsets)
Other Human Sanitary Sources (some also attract urban wildlife)	Leaky or failing septic systems
	Homeless encampments
	Porta-Potties
	Dumpsters (e.g., diapers, pet waste, urban wildlife)
	Swimmers/bathers, boaters, trail users (e.g., hikers, runners)
	RVs (mobile)
	Trash cans
	Garbage trucks
Domestic Pets	Dogs, cats, etc.
Urban Wildlife (naturally-occurring and human attracted)	Rodents/vectors (rats, raccoons, squirrels, opossums)
	Birds (gulls, geese, ducks, pigeons, swallows, etc.)
	Open space (coyotes, foxes, beavers, feral cats, etc.)
Other Urban Sources (including areas that attract vectors)	Landfills
	Food processing facilities
	Outdoor dining
	Restaurant grease bins
	Bars/stairwells (washdown areas)
	Green waste, compost/mulch
	Animal-related facilities (e.g., pet boarding, zoos, off-leash parks)
Urban Non-stormwater Discharges (Potentially mobilizing surface-deposited FIB)	Power washing
	Excessive irrigation/overspray
	Car washing
	Pools/hot tubs
	Reclaimed water/graywater (if not properly managed)
MS4 Infrastructure	Illegal dumping
	Illicit sanitary connections to MS4 (*also listed above*)
	Leaky sewer pipes (exfiltration) (*also listed above*)
	Biofilms/regrowth
	Decaying plant matter, litter and sediment in the storm drain system
Agricultural Sources (potentially including ranchettes within MS4 boundaries or areas in urban growth boundaries)	Livestock, manure storage
	Livestock, pasture
	Livestock, corrals
	Livestock, confined animal feeding operations (CAFO) (NPDES-regulated)
	Manure spreading, pastures/crops
	Municipal biosolids re-use
	Reclaimed water (if not properly managed)
	Irrigation tailwater
	Slaughterhouses (NPDES-regulated)
Natural Open Space/Forested Areas	Wildlife populations
	Grazing
	Natural area parks, off-leash areas
Other Naturalized Sources	Decaying plants/algae, sand, soil (naturalized FIB)

Source: Clary, et al. (2016). "Colorado *E. coli* Toolbox: A Practical Guide for Colorado MS4s", Urban Drainage and Flood Control District, Denver, CO, July 2016.

Bacteria Model – User Input Data

- Acres of each land use
- Quantifiable non-land use sources
- BMPs in current and multiple future scenarios
- BMP implementation amounts

  - ✓ Stormwater retrofits - ESD and SWM
  - ✓ Illicit connection removal
  - ✓ Structural SWM and ESD practices
  - ✓ Stream restoration
  - ✓ Riparian buffers
  - ✓ Street sweeping
  - ✓ Catch basin cleanouts
  - ✓ Marina pumpouts
  - ✓ CSO repair/ abatement
  - ✓ SSO repair/ abatement
  - ✓ Septic system - surface
  - ✓ Point source reduction
  - ✓ Pet waste education—can apply to either land use or to pets if modeled as a non-land use source

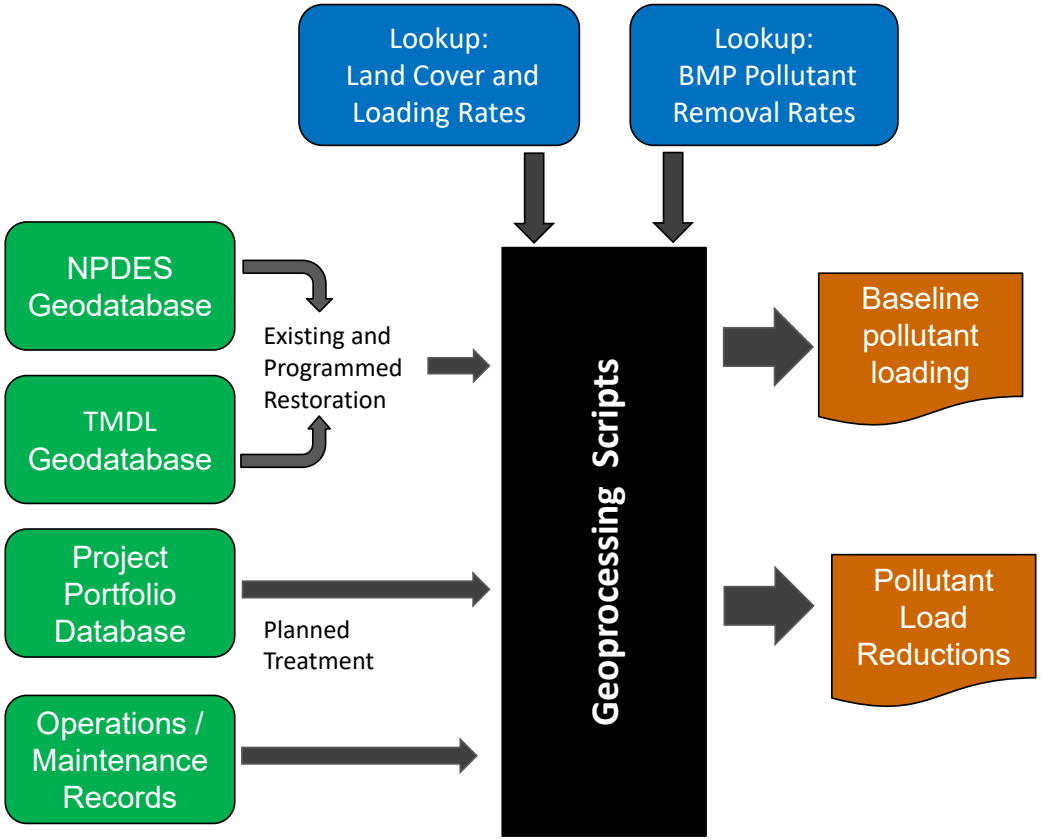
Expertise Required

Type of Tool	Level of Expertise	Consistency of Results
Web based	Low to moderate	High
Spreadsheet	Moderate to advanced	Low to moderate
Look up tables	Low	Low

- ***Web based***—Allows updates to roll out to users automatically. Users typically do not need to load multiple data sets to begin.
- ***Spreadsheet***—Design can make it difficult for some users. Easy to modify, so consistency is lacking. When policy and source data updates are made, these require users to replace the version they were using.
- ***Look up table***—Use of table and interpretation of results varies among users. Requires review by a central entity.

Online Tool

- Can integrate with BMP databases for existing, in design, and planned treatment.
- Allows flexibility to easily develop, test and adjust planning scenarios.
- Tracks pollutant reductions for multiple TMDLs.
- Utilizes current approved loading rates and load reduction data.
- Updates roll out to all users without having different versions on different computers
- Base data is already loaded



Model Availability and Support

- Easy availability—web address for download or online access
- Dedicated contact necessary for support

Too many tools are developed and not used because they are not accessible, not understandable, or have no support

KCI Bacteria Models

- ✓ Maryland State Highway Administration
- ✓ Frederick County, MD
- ✓ Howard County, MD
- ✓ Charles County, MD
- ✓ Johnston Run, PA

Model Selection Recommendations

- Use the same model for consistency among TMDLs and jurisdictions
- Select a model that can identify and quantify all potential sources, potential types of treatment, and for which input data is available
- Keep the analysis simple enough that it can be used within the agency's resources, but not so simple that the results will lead to inefficient or erroneous implementation plans
- Celebrate early progress and incremental success

Questions?

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