Overview

- Background and local context
- Bacteria reduction approaches
- Metrics and MS4 reporting
- Monitoring
- Achieving a TMDL and setting better goals
- Conclusion

Background and Local Context
What are Bacteria TMDLs?

The total bacteria load a water can receive while still maintaining its designated use.

<table>
<thead>
<tr>
<th>Designated Uses</th>
<th>Source Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Contact (Recreational)</td>
<td>Human</td>
</tr>
<tr>
<td>Secondary Contact</td>
<td>Pet</td>
</tr>
<tr>
<td>Shellfish harvesting</td>
<td>Wildlife</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
</tr>
</tbody>
</table>

Pollutants of Concern

- Fecal indicator bacteria
- Fecal Coliform for shellfish waters
- E. coli for freshwater
- Enterococci for transitional and salt waters
- Testing methodology
  - Single sample maximums
  - Geometric means

South Carolina TMDLs

- Majority of SC TMDLs for fecal coliform bacteria (~350 of >400 TMDLs)
- Bacteria TMDLs in development for several additional waterbodies
### South Carolina TMDLs

**MS4s Required to:**

- Identify Discharges in TMDL Watershed Draining to Impaired WQ Monitoring Stations
- Include TMDL Monitoring and Assessment Plan in SWMP
- Prepare TMDL Implementation Plan
- Prepare Implementation Schedule
- Document progress in Annual Report

### SC Water Quality Criteria

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Geometric Mean</th>
<th>Single Sample Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trout Waters (TN, TP, TP), Freshwaters (FW) (per 100 mL)</td>
<td>E. coli</td>
<td>106</td>
</tr>
<tr>
<td>Shellfish Harvesting Waters (SFH) (per 100 mL)</td>
<td>Fecal coliform</td>
<td>14</td>
</tr>
<tr>
<td>Enterococci</td>
<td>35</td>
<td>106*</td>
</tr>
<tr>
<td>Saltwater (SA) (per 100 mL)</td>
<td>Enterococci</td>
<td>35</td>
</tr>
<tr>
<td>Saltwater (SB) (per 100 mL)</td>
<td>Enterococci</td>
<td>35</td>
</tr>
</tbody>
</table>

* Beach monitoring and notification threshold, CWA Section 406


### VA Water Quality Criteria

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Geometric Mean</th>
<th>Single Sample Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shellfish Harvesting Waters (per 100 mL)</td>
<td>Fecal Coliform</td>
<td>14</td>
</tr>
<tr>
<td>Recreational/Freshwater (per 100 mL)</td>
<td>E. coli</td>
<td>126</td>
</tr>
<tr>
<td>Recreational Transition and Saltwater (per 100 mL)</td>
<td>Enterococci</td>
<td>35</td>
</tr>
</tbody>
</table>

Virginia TMDL Process

- Impaired Waters
- Total Maximum Daily Loads
- TMDL Implementation Plans
  - Developed by DEQ on a watershed scale
- TMDL Action Plans
  - Developed by individual municipalities

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Bacteria Reduction Approaches

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Approaches to Reduce Bacteria

- Focus on bacteria sources
- Coordination with utilities
- Programmatic measures
- Wet weather reductions
  - Runoff Reduction
  - Environmental site designs
Coordination with WW Utilities

• Primary human sources
• Straight pipes
• Septic tanks
• I & I
• Overflows
• May not be operated by same department or organization as the MS4

Programmatic Measures

• Bacteria removal mechanisms
• UV Radiation
• Predation
• Sedimentation
• Exposure To Air
• Filtration

Runoff Reduction Measures

Example BMP Descriptions and Theoretical Removal Mechanisms

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Treatment Mechanisms Relevant to Pathogen Removal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Detention</td>
<td>Drying, sun exposure, sedimentation</td>
</tr>
<tr>
<td>Wet pond</td>
<td>Sun exposure, sedimentation</td>
</tr>
<tr>
<td>Stormwater Wetland</td>
<td>Sun exposure, sedimentation, some drying</td>
</tr>
<tr>
<td>Sand/Permeable</td>
<td>Drying, sedimentation, filtration</td>
</tr>
<tr>
<td>Bioretention</td>
<td>Drying, sun exposure, sedimentation, Weathering</td>
</tr>
<tr>
<td>Grassed/Grasscrete</td>
<td>Sedimentation, sun exposure, drying</td>
</tr>
<tr>
<td>Proprietary Devices</td>
<td>Varies based on manufacturer: normally sedimentation and sometimes filtration</td>
</tr>
</tbody>
</table>
A Runoff Reduction Case Study

Metrics and MS4 Reporting

Developing Metrics

IT COUNTS
COUNT EVERYTHING
Developing Metrics

- Semi-quantitative approach
- Degree of implementation
- Measurable goals
- Programs may be operated by other municipal departments

Developing Metrics

- Tracking goals for programmatic measures

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Date</th>
<th>End Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity A</td>
<td>1/1/2023</td>
<td>3/31/2023</td>
<td>Ongoing</td>
</tr>
<tr>
<td>Activity B</td>
<td>4/1/2023</td>
<td>6/30/2023</td>
<td>Completed</td>
</tr>
<tr>
<td>Activity C</td>
<td>7/1/2023</td>
<td>9/30/2023</td>
<td>In Progress</td>
</tr>
</tbody>
</table>

Developing Metrics

<table>
<thead>
<tr>
<th>Program</th>
<th>Goals</th>
<th>Objectives</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program A</td>
<td>Goal 1</td>
<td>Objective 1</td>
<td>Measure A</td>
</tr>
<tr>
<td>Program B</td>
<td>Goal 2</td>
<td>Objective 2</td>
<td>Measure B</td>
</tr>
</tbody>
</table>

Reporting

<table>
<thead>
<tr>
<th>Date Range</th>
<th>Completed Tasks</th>
<th>In Progress Tasks</th>
<th>Planned Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1/2023</td>
<td>20/25</td>
<td>15/20</td>
<td>10/15</td>
</tr>
<tr>
<td>2/1/2023</td>
<td>18/25</td>
<td>12/20</td>
<td>12/15</td>
</tr>
<tr>
<td>3/1/2023</td>
<td>20/25</td>
<td>14/20</td>
<td>12/15</td>
</tr>
<tr>
<td>4/1/2023</td>
<td>18/25</td>
<td>12/20</td>
<td>12/15</td>
</tr>
<tr>
<td>5/1/2023</td>
<td>20/25</td>
<td>14/20</td>
<td>12/15</td>
</tr>
</tbody>
</table>
Monitoring

• Monitoring locations and explanation of why selected
• Sampling seasons
• Sampling parameters (pollutants of concern, or surrogates)
• Description of sampling equipment
• Rationale supporting the proposed monitored location(s) as reflective of water quality concerns to the MEP.

SC MS4 Monitoring Plans

Long Term Trend Monitoring

 Sampling occurs at a standard set of stations at regular intervals, capturing ambient water conditions downstream of MS4 outfalls.

Strengths
• Documents reductions in response to implementation
• Demonstrate that waterbodies are no longer impaired

Limitations
• Cannot quantify benefits of individual projects/programs
Sampling Analysis

- Single sample maximums
- Geometric mean (if available)
- Trend analysis

<table>
<thead>
<tr>
<th>Date Range</th>
<th>No. of Samples</th>
<th>Min Cts/100mL</th>
<th>Max Cts/100mL</th>
<th>Avg Cts/100mL</th>
<th>Inst. Max Exceedances</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002-2012</td>
<td>61</td>
<td>N/A</td>
<td>N/A</td>
<td>478</td>
<td>76%</td>
</tr>
<tr>
<td>2012-2013</td>
<td>11</td>
<td>25</td>
<td>2,000</td>
<td>639</td>
<td>73%</td>
</tr>
</tbody>
</table>

Monitoring Input/output Loads

Within a single SCM, sampling occurs at each stormwater inlet and outfall and ambient water sampling, capturing the change in POC loads.

Strengths
- Direct approach to quantify SCM pathogen removal

Limitations
- High cost to conduct monitoring
- Removal rates identified may not be applicable to other SCMs

Monitoring Outlet before/after SCM

Within a single SCM, sampling occurs at outfall before and after SCM construction, capturing the change in POC loads.

Strengths
- Direct approach to quantify SCM pathogen removal

Limitations
- High number of samples required for analysis
- Timeframe may require extensive monitoring prior to project construction
- Removal rates identified may not be applicable to other SCMs
Achieving a TMDL and Setting Better Goals

• Current methodology
• Removal of bacteria without consideration of the source
• Chickahominy River and Tributaries Bacterial Implementation Plan (developed by DEQ)
• Percent required bacterial load reductions
  • Wildlife direct and land based – 77%
  • Livestock direct – 100%
  • Agricultural land based – 99%
  • Human direct – 100%
  • Human and pet land based – 99%

Reference: Chickahominy River and Tributaries Implementation Plan, MapTech, Inc. (2016)

Achieving a TMDL

Best Management Practice | Stage 1 Years 1-10 | Stage 2 Years 11-20
--- | --- | ---
Septic System Pump Outs (systems) | 5,234 | 5,234
Septic Repairs, Replacements, Instalations (systems) | 377 | 0
Sewer Connections (systems) | 245 | 245
Pet waste pickup and composting program (% program) | 75% | 25%
Stormwater Treatment (acres) | 300 | 5,400
Vegetated Buffers (linear feet) | 10,000 | 10,000
Residential Education Program (% program) | 100% | 0%
Technical Assistance (FTE) | 1.5 | 1.5

Reference: Chickahominy River and Tributaries Implementation Plan, MapTech, Inc. (2016)
Achieving a TMDL

• Current methodology
  • removal of bacteria without consideration of the source

*Cost (in millions)*

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Chickahominy River and Tributaries Implementation Plan

Brown and Caldwell

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Is there a better way?

2012 EPA Recreational WQ Criteria

• WQ Criteria developed based upon health risks
• Bacteria is easier to identify than other pathogens
• States have the option to adopt other scientifically defensible criteria
What makes people sick?

Figure 2-2. QMRA-Based Probability of Gastrointestinal Illness from Ingestion of Water Containing Fresh Fecal Contamination from Various Sources

(Safai et al. 2010b)

- Using MST to understand human and animal contributions and reductions
- Presence or absence testing
- Select one or more sources to test
- Prioritize removing sources that impact people
- Reducing the probability of illness

Microbial Source Tracking Technology

Focused Approach to Implementation

- Removing the stormwater BMPs

Chickahominy River and Tributaries Implementation Plan

[Diagram of cost in millions by phase]
Implementing a Targeted Approach

• Identify and quantify bacteria sources
• Eliminate "controllable" anthropogenic sources
• Determine the remaining exceedances
• Remaining exceedances become allowable exceedances

Conclusion

• Implementing a bacteria reduction program may require coordination with multiple departments or organizations
• Metrics may need to be developed to track progress for MS4 permitting
• Monitoring of bacteria loads key to document reductions
• MST analysis may increase the precision of early implementation
• The future of implementation may change focus to MST
Questions?

Stephanie Hanses
shanses@brwncald.com

Jane McDonough
jmcdonough@brwncald.com