Tuesday, July 26th, 1:30 PM – 3:00PM ET

Soak up the Rain New England Webinar Series
Stormwater Retrofit Guidance Manual Now Available at SNEPnetwork.org!

The New England Stormwater Retrofit Guidance Manual is a key tool for improving New England's water resources. The guidance is based on how stormwater treatment occurs within structural controls with the understanding of the potential for water quality improvement is beneficial.

In retrofit scenarios, it is often challenging to determine the stormwater control measures (SCM) best suited for a site. The manual is based on the concept that incorporating some stormwater treatment for developed sites is better than none at all together because prescribed design standards cannot be fully met. The manual guides users to develop SCMs based on their core functional and treatment components and encourages the user to piece components together in configurations that best fit project and site-specific needs. The range of sites and scales where this guidance can be applied varies from watershed scale planning to the design of small-scale measures inserted into reconstruction projects.

The manual presents the US EPA (Environmental Protection Agency) SCM Performance Curves as a tool to quantify water quality benefit (i.e. pollutant removal credit) for a range of sizes and types of SCMs to aid in the selection process and justify the retrofit.

Download the New England Stormwater Retrofit Manual
Today’s Speakers

Theresa McGovern
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Southeast New England Program (SNEP) Network Context

2021 - 2025 PRIORITY ACTIONS

SNEP Goals
Resilient Ecosystem of Safe and Healthy Waters; Thriving Watersheds and Natural Lands; Sustainable Communities

Increase Local Capacity to Complete Projects and Adopt New Policies
Increase Available Solutions
Demonstrate Ways to Address Common Challenges
Increase Community Leaders' Understanding of the Benefits of Restoration Projects
Ensure Diverse Representation

Source: Southeast New England Program Fact Sheet, February 2021 (epa.gov)
Outline Slide

• Manual Introduction
• Goals/Why It Matters
• Manual Highlights
• Planning and Crediting
• Retrofit Design Approach
• Breaking through Prescriptive Design Guidance
• Manual Applications
Goals of New England Stormwater Retrofit Manual

• **Retrofit:** the addition of stormwater controls on a currently developed site
Goals of New England Stormwater Retrofit Manual

• Provide research-based guidance on planning, siting, and designing retrofit stormwater control measures (SCMs)

• Present a framework for selecting the optimal SCM for a specific project/site

• Present an approach for crediting pollutant and runoff volume reductions associated with these SCMs

*where regulatory requirements to not dictate prescribed specifications
Why this Manual Matters

This manual...

• Encourages designers to move beyond prescriptive new/redevelopment mindset
• Helps designers piece SCM components together to arrive at the best SCM to meet project and site-specific needs
• Promotes the use of EPA-developed water quality crediting methods to quantify SCM impact
Manual Highlights: Stormwater Control Measure Performance Curves
SCM Performance Curves

Gravel Wetland

% Removal

Total Phosphorus
Total Nitrogen
Bacteria
Total Suspended Solids
Metals

Runoff Depth from Impervious Area (in)

*See our handout for more information on SCM Performance Curves and how to utilize them!
If a designer is working on a site where a pollutant reduction of 60% is desired ...

... the designer would use the curves to determine that a Runoff Depth from Impervious Area of approximately 0.2 inches achieves the desired reduction.

If a designer determines that their SCM provides a DSV equivalent to 1.2 inches from the Impervious Area ...

... the designer would use the curves to determine a 98% pollutant reduction from this SCM.
SCM Performance Curves: Finding the Cost-Optimal Size

% Removal

Runoff Depth from Impervious Area (in)
Infiltration Basin (HSG C) with Cost Optimal Runoff Depths

% Removal

Runoff Depth from Impervious Area (in)

- Bacteria (0.8 in)
- Phosphorus (0.8 in)
- Total Suspended Solids (0.4 in)
- Nitrogen (0.4 in)
- Metals (0.4 in)
- Runoff (1.0 in)
Manual Highlights: Planning Your Retrofit – SCM Selection Approach
SCM Selection and Design: Treatment Unit Operations and Processes (UOPs)

**UOPs: Unit Operations and Processes**

**Operations:** methods of treatment in which application of *Physical* and *Hydrologic* forces dominate.

**Processes:** methods of treatment in which *Chemical* or *Biological* activities are involved.
# Selection and Design: Linking SCMs to UOPs and Performance Curves

<table>
<thead>
<tr>
<th>Primary UOP</th>
<th>SCM Type</th>
<th>Performance Curve Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrologic: Infiltration</td>
<td>Infiltration Swale</td>
<td>Infiltration Basin</td>
</tr>
<tr>
<td>Physical: Filtration</td>
<td>Rain Garden (with underdrain)</td>
<td>Bio-Filtration</td>
</tr>
<tr>
<td>Biological: Nitrification/</td>
<td>Gravel Wet Vegetated Treatment</td>
<td>Gravel Wetland</td>
</tr>
<tr>
<td>Denitrification</td>
<td>System</td>
<td></td>
</tr>
</tbody>
</table>
SCM Guidance: Putting It All Together

Functional Components (Section 5.1)
- Collection & Distribution
- Pretreatment

Treatment Component(s) by Category (Section 5.2)
- IA Disconnection
- Infiltration
- Media Filters
- Traditional

Unit Operations & Processes (Section 4.2)
- Hydrologic
- Physical
- Biological
- Chemical

Performance Curves
- Discharge

Functional Components (Section 5.1)
SCM Guidance: Putting It All Together

Source: Rhode Island Department of Transportation Bio-Filtration Basin at Pawtucket/Central Falls Transit Center
Manual Highlights: Breaking through Prescriptive Guidance
Breaking Through Prescriptive Guidance: Separation to Groundwater/Bedrock

Current Typical Requirement:
Provide 1-3 ft of separation to groundwater/bedrock

Proposed Retrofit Guidance:
Provide 1 ft of separation to groundwater when possible (SCMs with a filtering layer should always provide 1 ft)
Breaking Through Prescriptive Guidance: Flexibility for IA Disconnection Design Criteria

Current Typical Requirement:
Meet slope, length/width, contributing area, soils, vegetation, setback, and ownership criteria

Proposed Retrofit Guidance:
Provide IA Disconnection wherever possible and use the SCM performance curves to determine credit
Breaking Through Prescriptive Guidance: Flexibility for IA Disconnection Design Criteria

% Removal

Impervious Area to Pervious Area Ratio

HSG A
HSG B
HSG C
HSG D
**Breaking Through Prescriptive Guidance:**

**Pretreatment as an O+M Measure**

**Current Typical Requirement:**
Prescribed pretreatment measure types and sizing criteria

**Proposed Retrofit Guidance:**
Provide pretreatment whenever possible
Breaking Through Prescriptive Guidance: HSG D Infiltration

Current Typical Requirement:
Infiltration is not encouraged (and often not permitted) in HSG D Soils

Proposed Retrofit Guidance:
Consider infiltration whenever possible
Other Tools Provided in Manual

- Retrofit Site/Situation Considerations
- Tools utilizing the SCM Performance Curves to experiment with SCM Type/Size
- Considerations for retrofitting “traditional” approaches
- I+M Planning Considerations and a compiled list of I+M Manuals
- Retrofit-specific design guidance/considerations for individual SCMs
Retrofit Approaches

Planning Approach

• Proactively planning retrofits and prioritizing sites

• Steps:
  1. Understand and Quantify Goals
  2. Identify Potential Sites
  3. Identify SCMs
  4. Prioritize Sites and Controls
  5. Implement SCMs

Opportunistic Approach

• Incorporation of SCMs into already planned and needed construction projects

• Key Considerations:
  • Be proactive in identifying opportunities.
  • Develop a suite of typical SCMs.
  • Be willing to be flexible with the project specifications
  • Tailor the scale and type of SCMs to the project
Planning Approach: Rhode Island Department of Transportation Stormwater Control Plans

Source: RIDOT Stormwater Program Public Web Mapping Application
Planning Approach: Rhode Island Department of Transportation Stormwater Control Plans

Impervious Area Disconnection - Pollutant Reduction

EPA Curves End Here

% Removal

0% 50% 100%

Impervious Area to Pervious Area Ratio

8:1 6:1 4:1 2:1 1:1 1:2 1:4 1:10 1:30 1:50 1:70

HSG A
HSG B
HSG C
HSG D
Non-Discharge Area
Planning Approach: Rhode Island Department of Transportation Stormwater Control Plans

Challenges/Lessons Learned

• Working with designers who have regulatory requirements ingrained
• Providing enough treatment to meet goals
• Developing new credits for new SCMs
• Approaches to prioritization
Opportunistic/Planning Approach: MassDOT Check Dams

<table>
<thead>
<tr>
<th>CHANNEL SLOPE (%)</th>
<th>LEG LENGTH, L (FT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 2.8</td>
<td>24</td>
</tr>
<tr>
<td>&gt;2.8 - 5.0</td>
<td>36</td>
</tr>
</tbody>
</table>

Infiltration Swale

Slope between channel and leg is 12:1

Flow

Existing Grade

Impermeable Stone Core (Dense Graded Crushed Stone)

6" Loam Borrow

4" Loam Borrow

Ordinary Borrow

1:1 Slope

Dense Graded Crushed Stone

Ponding Depth (2' max) varies based on channel slope and leg length
Yes, climate change gives us pause to think, but IC is the 800-pound gorilla
Distribution of precipitation depth, Boston, MA 1992 – 2014 (excludes events with depths < 0.05 in. and defines an event by minimum 6-hour inter-event dry period)
Sizing for Performance
## Sizing Details

<table>
<thead>
<tr>
<th>System</th>
<th>WQV ft³ (m³)</th>
<th>Actual WQV ft³ aka DSV (m³)</th>
<th>% of normal design</th>
<th>Rain Event in aka PSC (mm)</th>
<th>Sizing Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGWSC</td>
<td>7,577 (214.6)</td>
<td>720 (20.4)</td>
<td>10%</td>
<td>0.10 (2.5)</td>
<td>Static</td>
</tr>
<tr>
<td>IBSCS</td>
<td>1,336 (37.8)</td>
<td>310 (8.8)</td>
<td>23%</td>
<td>0.23 (5.8)</td>
<td>Dynamic</td>
</tr>
</tbody>
</table>

\[ WQV = \left( \frac{P}{12} \right) \times IA \]

**Dynamic Bioretention Sizing**

\[ Af = \frac{df}{(i(hf + df)tf)} \]

**Static SGW System Sizing**

\[ Q = CdA\sqrt{2gh} \]
<table>
<thead>
<tr>
<th>System</th>
<th>TSS</th>
<th>TN</th>
<th>TP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conv. Bioretention Average (4)</td>
<td>91%</td>
<td>36%</td>
<td>34%</td>
</tr>
<tr>
<td>Durham Bioretention (23% IBSC)</td>
<td>81%</td>
<td>27%</td>
<td>45%</td>
</tr>
<tr>
<td>Conv. Subsurface Gravel Wetland</td>
<td>96%</td>
<td>54%</td>
<td>58%</td>
</tr>
<tr>
<td>Subsurface Gravel Wetland (10% SGWSC)</td>
<td>75%</td>
<td>23%</td>
<td>53%</td>
</tr>
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</table>
Design Storage Volume (DSV) - runoff depth from IA (in)

### Subsurface Gravel Wetland Performance

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Depth (in)</th>
<th>Modeled RE</th>
<th>Measured RE</th>
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</thead>
<tbody>
<tr>
<td>TSS</td>
<td>0.1</td>
<td>48</td>
<td>75</td>
</tr>
<tr>
<td>TZn</td>
<td>0.1</td>
<td>57</td>
<td>75</td>
</tr>
<tr>
<td>TN</td>
<td>0.1</td>
<td>55</td>
<td>23</td>
</tr>
<tr>
<td>TP</td>
<td>0.1</td>
<td>19</td>
<td>53</td>
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### Biofiltration Performance

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Depth (in)</th>
<th>Modeled RE</th>
<th>Measured RE</th>
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</thead>
<tbody>
<tr>
<td>TSS</td>
<td>0.23</td>
<td>70</td>
<td>81</td>
</tr>
<tr>
<td>TZn</td>
<td>0.23</td>
<td>88</td>
<td>86</td>
</tr>
<tr>
<td>TN</td>
<td>0.23</td>
<td>60</td>
<td>27</td>
</tr>
<tr>
<td>TP</td>
<td>0.23</td>
<td>35</td>
<td>45</td>
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<tr>
<td>Output</td>
<td>Intermediate Calculation</td>
<td>Design Storage Volume (DSV)</td>
<td>Impervious to Pervious Ratio (IAPC)</td>
</tr>
<tr>
<td>--------</td>
<td>--------------------------</td>
<td>-----------------------------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DSV</td>
<td>IAPC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,200</td>
<td>N/A</td>
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<table>
<thead>
<tr>
<th>Performance Curve Removal Efficiencies</th>
<th>Removal Efficiency: Volume</th>
<th>VolRE</th>
<th>0%</th>
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</thead>
<tbody>
<tr>
<td>Removal Efficiency: P</td>
<td>PRE</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Removal Efficiency: N</td>
<td>NRE</td>
<td>23%</td>
<td></td>
</tr>
<tr>
<td>Removal Efficiency: TSS</td>
<td>TSSRE</td>
<td>49%</td>
<td></td>
</tr>
<tr>
<td>Removal Efficiency: Zn</td>
<td>ZnRE</td>
<td>59%</td>
<td></td>
</tr>
<tr>
<td>Removal Efficiency: Bacteria</td>
<td>FIBRE</td>
<td>32%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loading Rate</th>
<th>Load: Volume</th>
<th>VolLER</th>
<th>3.29</th>
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</thead>
<tbody>
<tr>
<td>Load: P</td>
<td>PRE</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Load: N</td>
<td>NLER</td>
<td>44.3</td>
<td></td>
</tr>
<tr>
<td>Load: TSS</td>
<td>TSSLER</td>
<td>1,378</td>
<td></td>
</tr>
<tr>
<td>Load: Bacteria</td>
<td>FIBLER</td>
<td>20</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Reductions</th>
<th>Reduction: Volume</th>
<th>VolRED</th>
<th>0.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction: P</td>
<td>PRED</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Reduction: N</td>
<td>NRED</td>
<td>10.1</td>
<td></td>
</tr>
<tr>
<td>Reduction: TSS</td>
<td>TSSRED</td>
<td>682</td>
<td></td>
</tr>
<tr>
<td>Reduction: Bacteria</td>
<td>FIBRED</td>
<td>32%</td>
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</table>

<table>
<thead>
<tr>
<th>Costs</th>
<th>Estimated Total Costs</th>
<th>$</th>
<th>22,000</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Removal Costs: Volume</td>
<td>$/Mgal-yr</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Removal Costs: P</td>
<td>$/lb-yr</td>
<td>$17,940</td>
</tr>
<tr>
<td></td>
<td>Removal Costs: N</td>
<td>$/lb-yr</td>
<td>$2,170</td>
</tr>
<tr>
<td></td>
<td>Removal Costs: TSS</td>
<td>$/lb-yr</td>
<td>$30</td>
</tr>
<tr>
<td></td>
<td>Removal Costs: Bacteria</td>
<td>$/LC-yr</td>
<td>$700</td>
</tr>
</tbody>
</table>

| O&M | Estimated O&M Hours | h/yr | 68 |

[https://www.unh.edu/unhsc/ms4-resources](https://www.unh.edu/unhsc/ms4-resources)
[https://www.unh.edu/unhsc/sites/default/files/media/unhsc_performance_curve_calculator_v2.3.xlsm](https://www.unh.edu/unhsc/sites/default/files/media/unhsc_performance_curve_calculator_v2.3.xlsm)
Conclusions/Next Steps

• All the guidance and recommendations are based on science and empirical research.
• Retrofit is a unique and often uncharacterized opportunity that requires flexibility.
• Stormwater is a quickly evolving field and this manual forwards new research and new approaches to economically meet WQ standards.
• State departments are updating stormwater manuals and we hope that the retrofit guidance compliments updates and fills gaps in applied approaches.

Acknowledgments

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  - Alisa Richardson – RIDOT
  - Michael Sadler – VTDEC
  - Laura Schifman – MADEP
  - Newt Tedder – EPA
Questions?

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Thank You!