



Introducing the New England Stormwater Retrofit Manual

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Manual Team and Manual Funding



Presenting Today:



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<https://snepnetwork.org/stormwater-retrofit-manual/>



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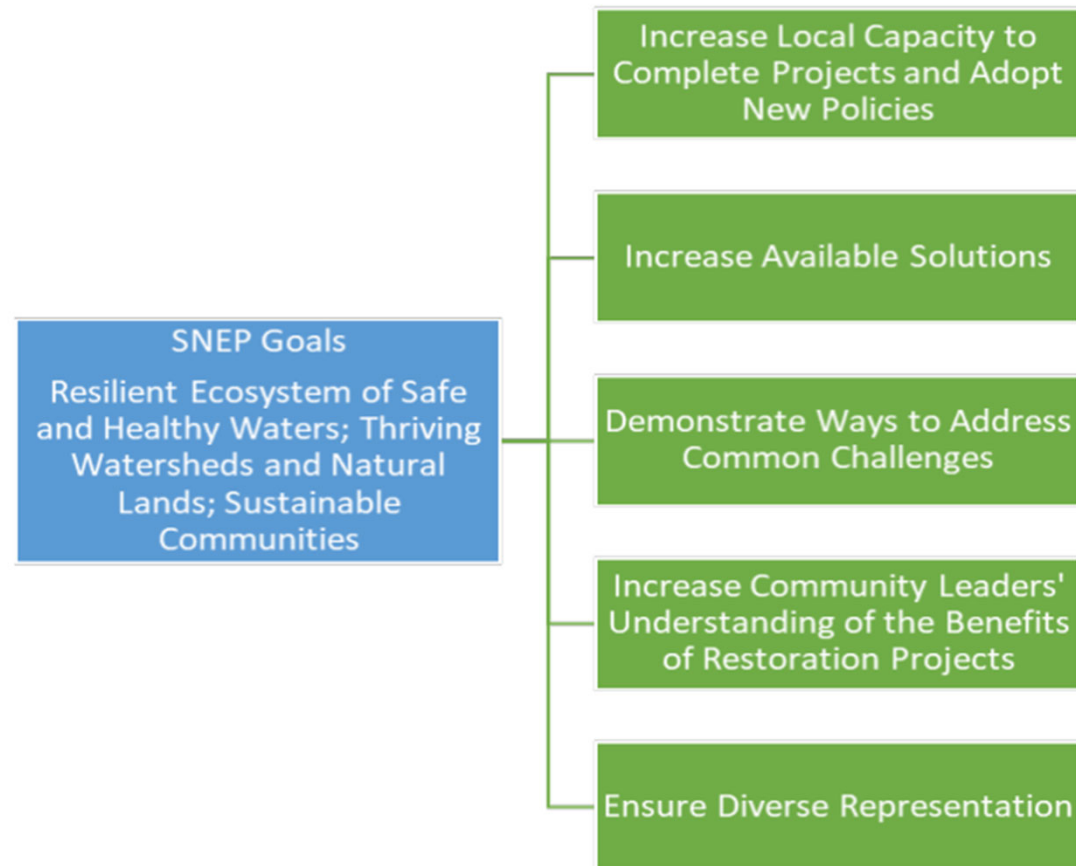
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- VTDEC
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Southeast New England Program (SNEP) Network – Priority Actions



Outline Slide

- Manual Overview
- SCM Performance Curves
- Implementation Example
- Regional Consistency
- Research Results



What are Retrofits?

Retrofit: the addition of stormwater controls on a currently developed site

SCM: Stormwater Control Measure



[Source: Arlington Installs New Rain Gardens to Reduce Stormwater Pollution](#)

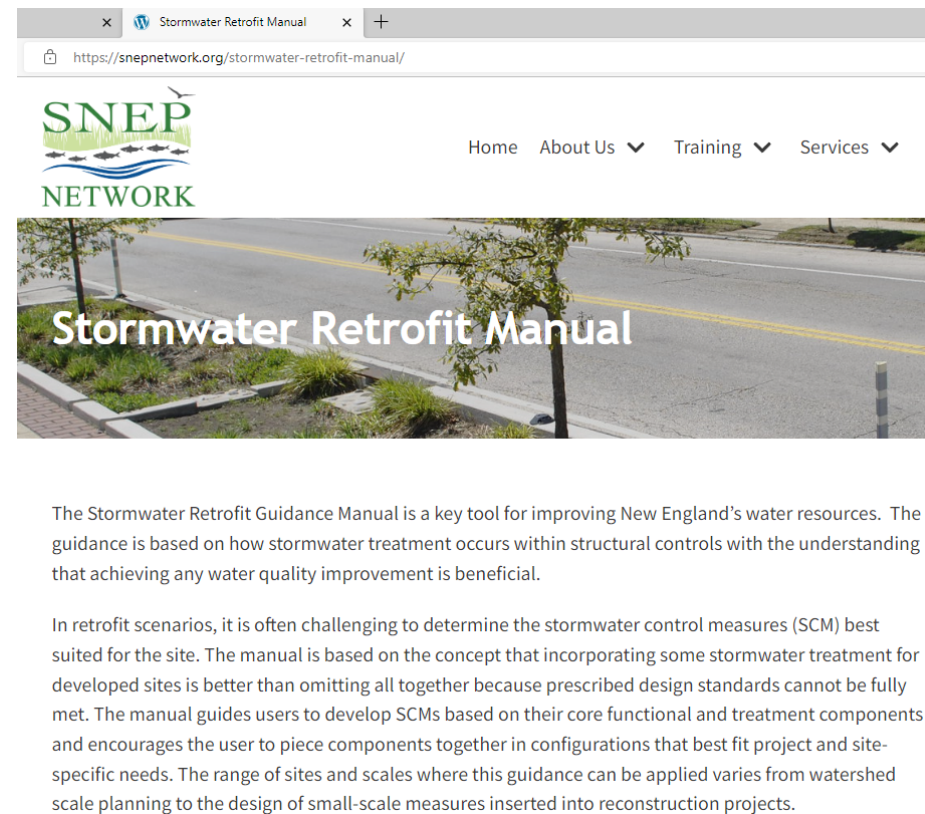
Introducing the New England Stormwater Retrofit Manual



Goals:

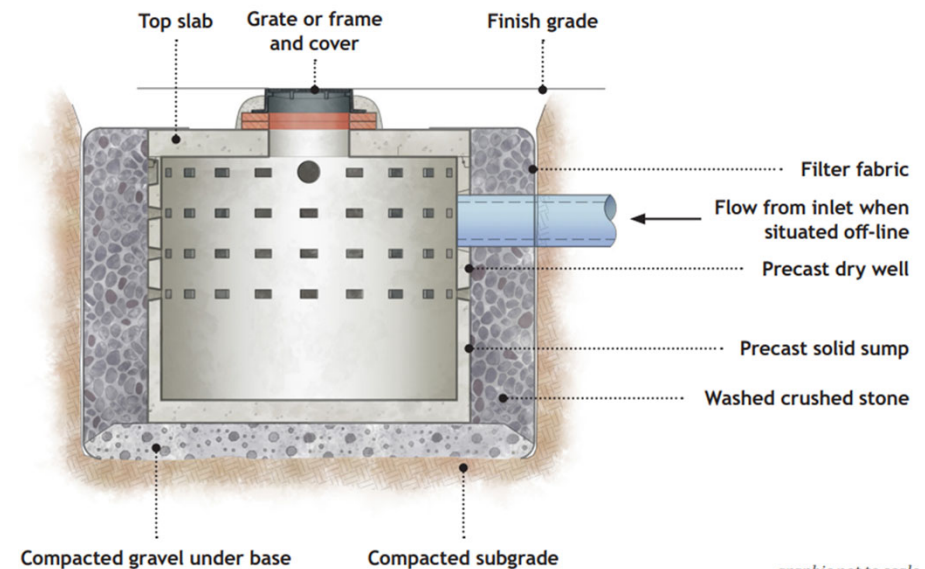
1. Provide **research-based guidance** on planning, siting, and designing retrofit stormwater control measures (SCMs)
2. Present a framework for **selecting the optimal SCM** for a specific project/site
3. Present an approach for **crediting pollutant and runoff volume reductions** associated with these SCMs

**** where regulatory requirements to not dictate prescribed specifications***



Why this Manual Matters

- This manual fills a gap in existing retrofit guidance by...
- Encouraging designers to **move beyond prescriptive new/redevelopment mindset**
- Helping designers **piece SCM components together to arrive at the best SCM** to meet project and site-specific needs
- **Promoting the use of EPA-developed water quality crediting methods** to quantify SCM impact



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



Infiltration

Variation-Specific Design Considerations

Outlet controls should be considered as a means to retain runoff through mechanisms such as impermeable check dams and raised outlet control structures. In addition, maximum depths for design events should be evaluated to ensure no flooding of adjacent infrastructure.

Flow velocity should be zero for the DSV of the SCM; there should be no flow in the system, and therefore all captured runoff will be stored and infiltrated. Flow velocities for larger design events should be evaluated to avoid erosion and resuspension.

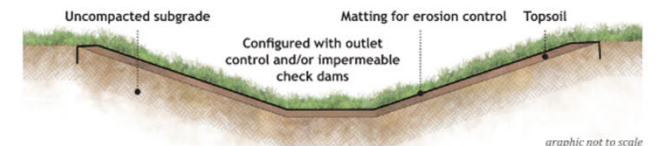
Check dams are often included to isolate cells within the linear basin. Check dams should have an impermeable core to force retention and vertical infiltration. Surface treatments of the check dam can vary to support maintenance needs.

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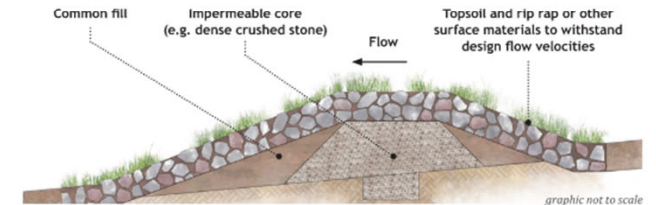
Linear Configuration

Linear Configuration SCMs are basins configured within more linear areas. They contain one or more cells designed to store and infiltrate stormwater into the underlying soils. Overflows are commonly conveyed in the linear system like a swale.

Infiltration Linear Configuration



Check Dam



Well suited for sites with...

≈ A linear stretch of above-ground space (such as a roadway shoulder, a roadway median, or dividing areas within large parking lots)

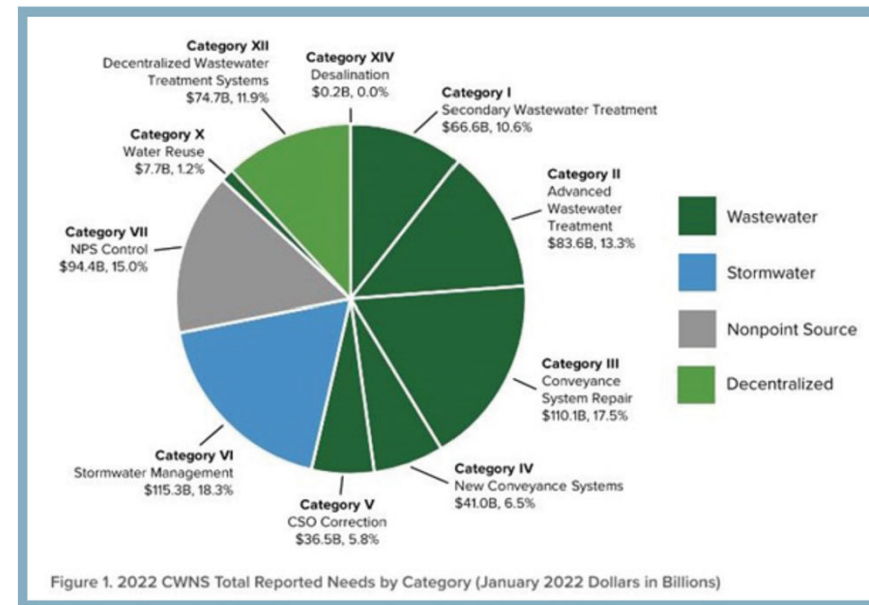
Not well suited for sites with...

≈ Contaminated underlying soils
≈ Steep slopes

Current Stormwater Context

Performance efficiency and effectiveness can deteriorate as systems age.

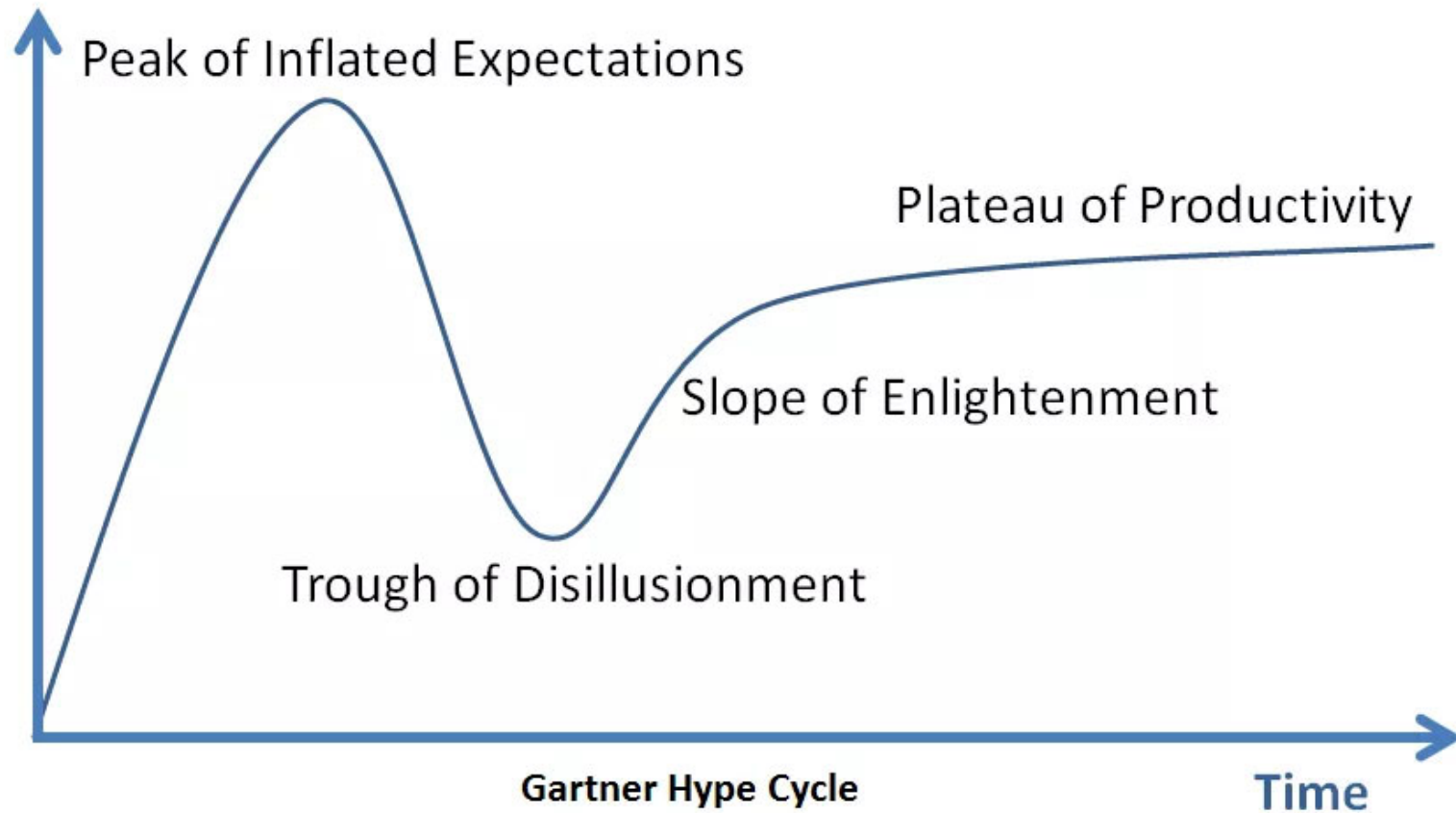
In the Water Environment Federation's (WEF) 2022 National MS4 Needs Assessment, more than 60% of surveyed stormwater utilities (643) cited aging infrastructure and workforce/staffing needs as critical challenges to properly functioning systems.



Stormwater Implementation



Decadal Reflections





Planning to Implementation

TMDLs, while legal and binding have a mixed track record

There is changing and ever improving science

Much of the old pollutant loading has changed.

Technologies innovate

Rainfall hydrology is dynamic and shifting as well.

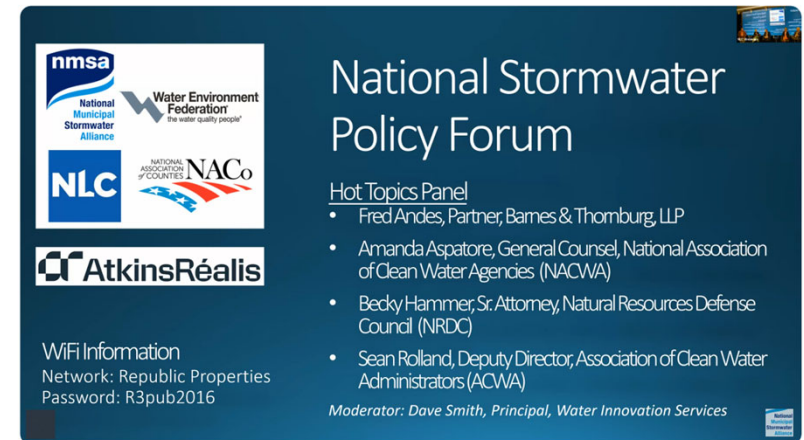
Hot Legal Topics



Loper Bright Enterprises v. Raimondo – demise of “Chevron Deference”

City and County of San Francisco v. Environmental Protection Agency – challenge to narrative standards

Residual Designation and the establishment of new stormwater permit requirements through petition (aka CII)



National Stormwater Policy Forum

Hot Topics Panel

- Fred Andes, Partner, Barnes & Thornburg, LLP
- Amanda Aspatore, General Counsel, National Association of Clean Water Agencies (NACWA)
- Becky Hammer, Sr. Attorney, Natural Resources Defense Council (NRDC)
- Sean Rolland, Deputy Director, Association of Clean Water Administrators (ACWA)

Moderator: Dave Smith, Principal, Water Innovation Services

Logos: nmsa (National Municipal Stormwater Alliance), Water Environment Federation (the water quality people), NLC (National Association of Counties), NACo (National Association of Clean Water Agencies), AtkinsRéalis

WiFi Information
Network: Republic Properties
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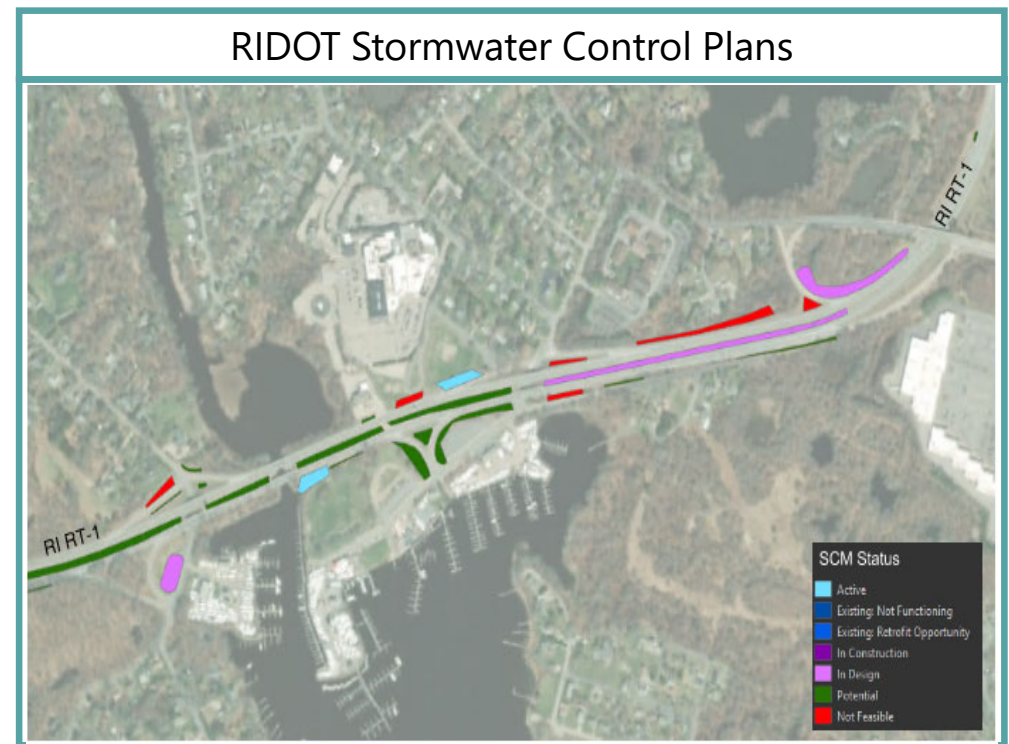


Manual Highlights: Planning and Crediting

Source: <https://www3.epa.gov/region1/npdes/stormwater/tools/arlington-ma-infiltration-trench-conceptual-design.pdf>

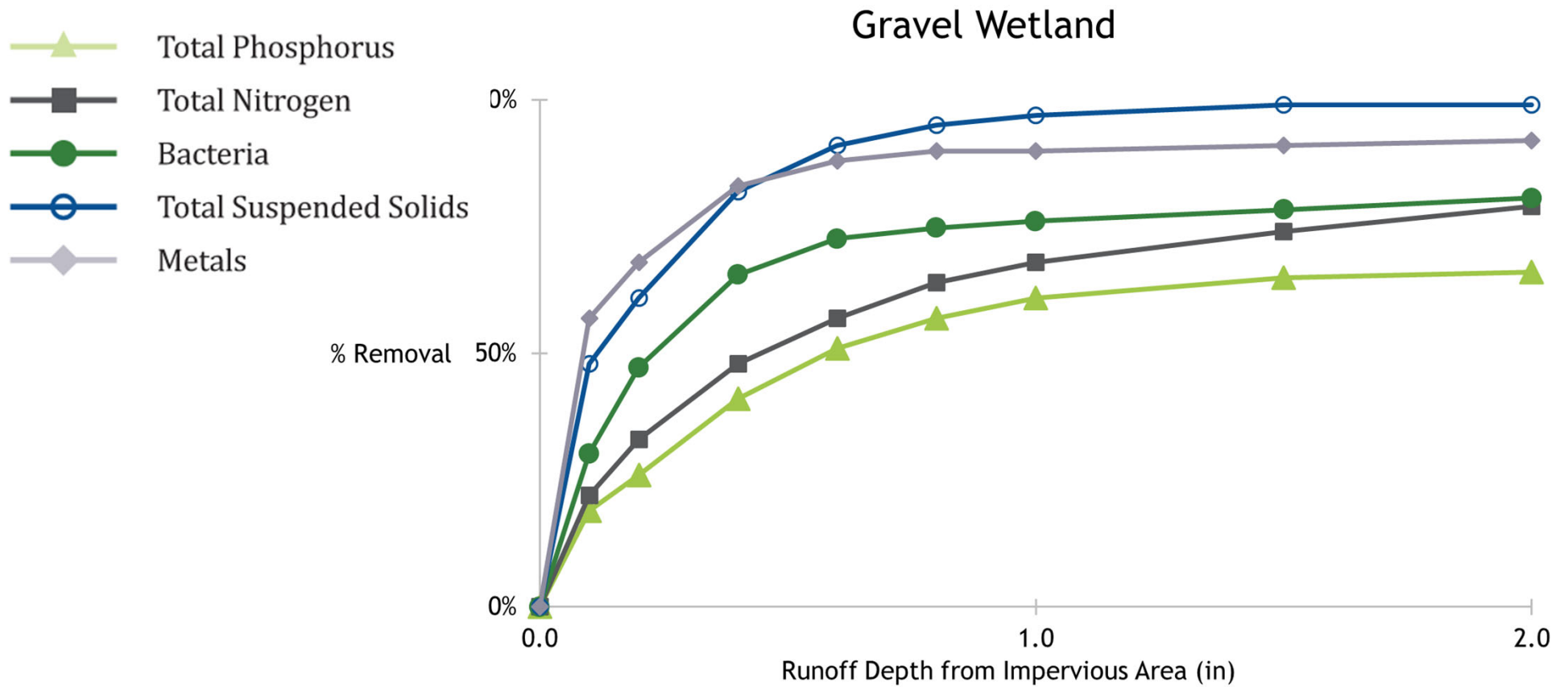
Retrofit Approach: Planning Approach

- 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**

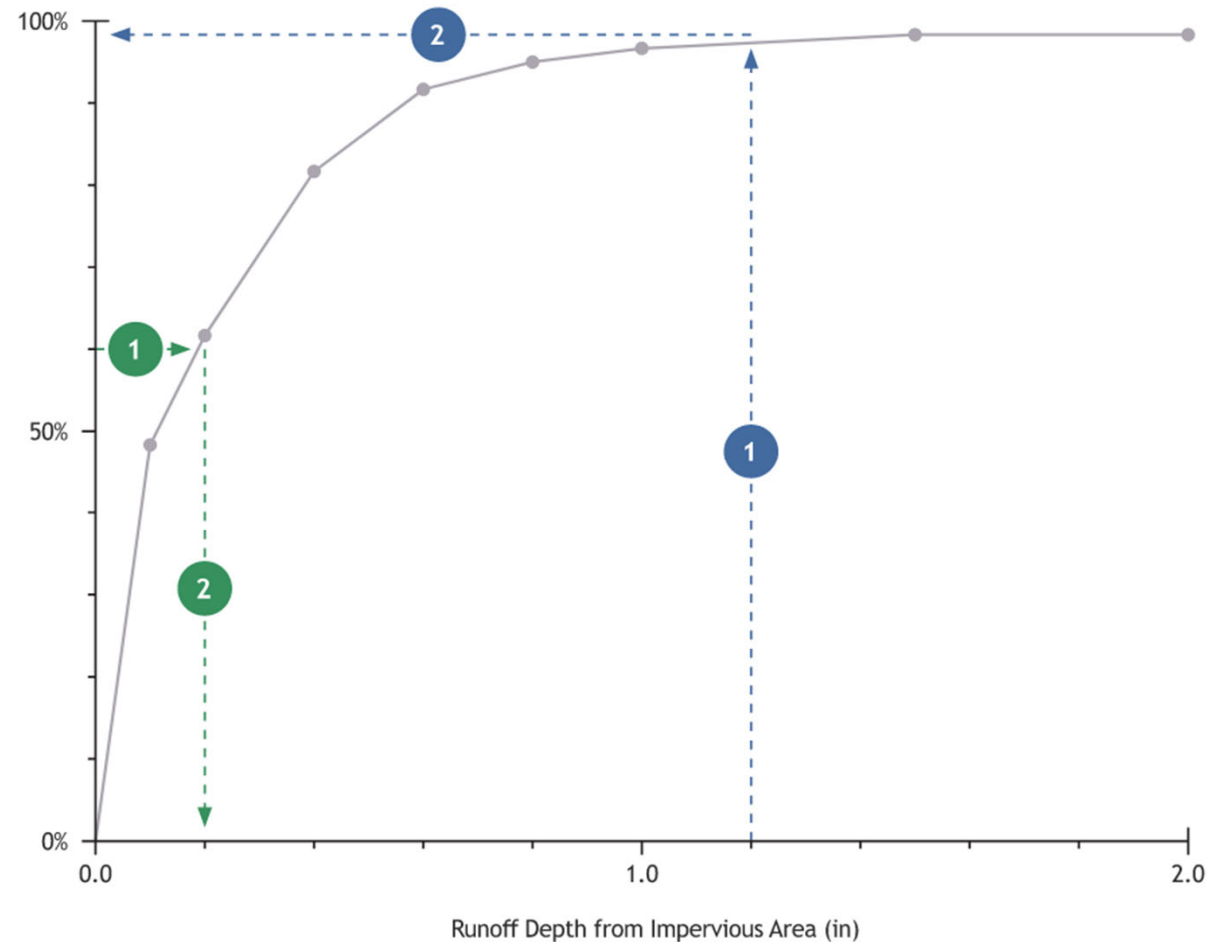


Source: <https://www.arcgis.com/apps/webappviewer/index.html?id=b516ed62a55847e28d0243ac07206856>

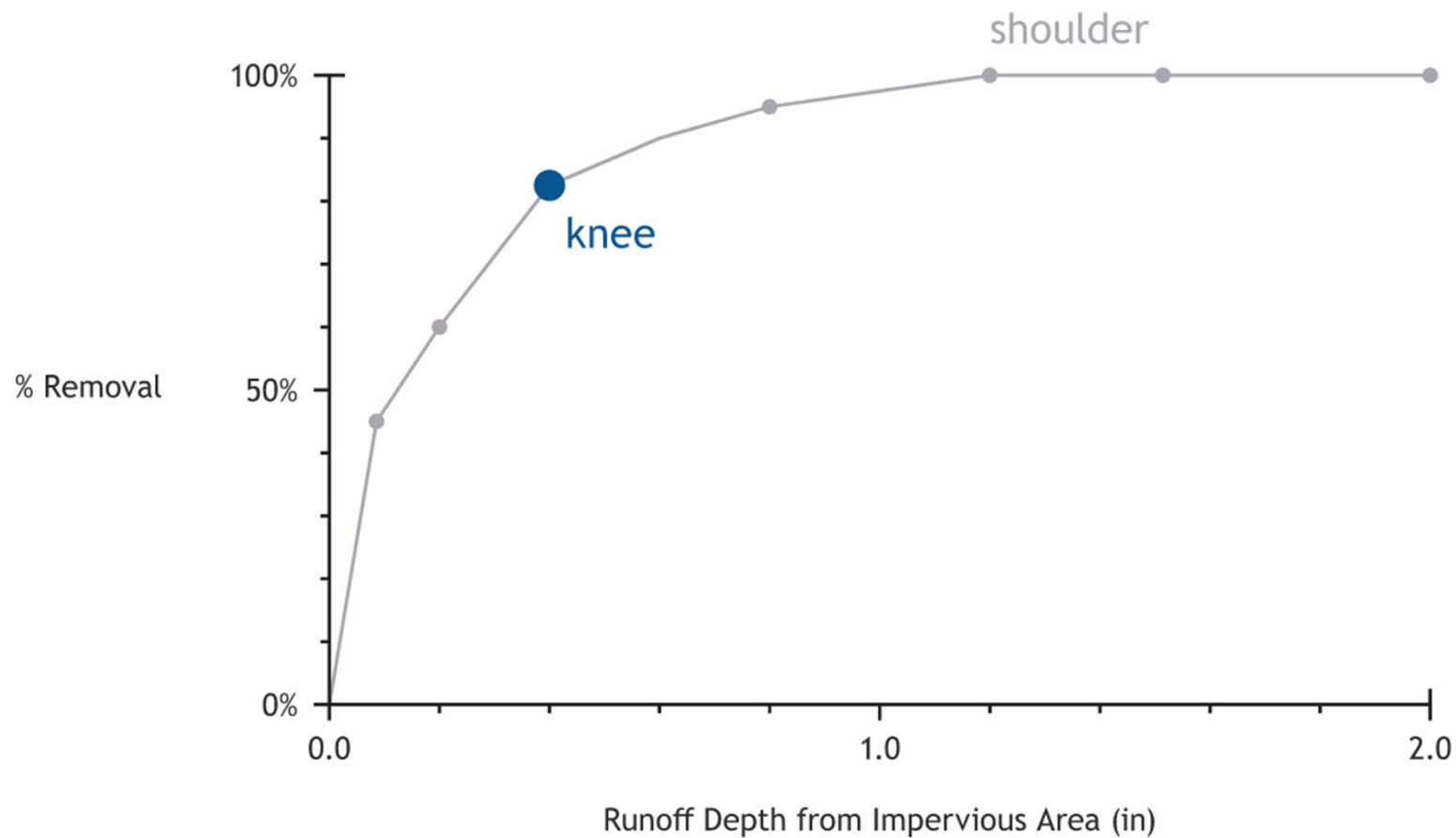
SCM Performance Curves

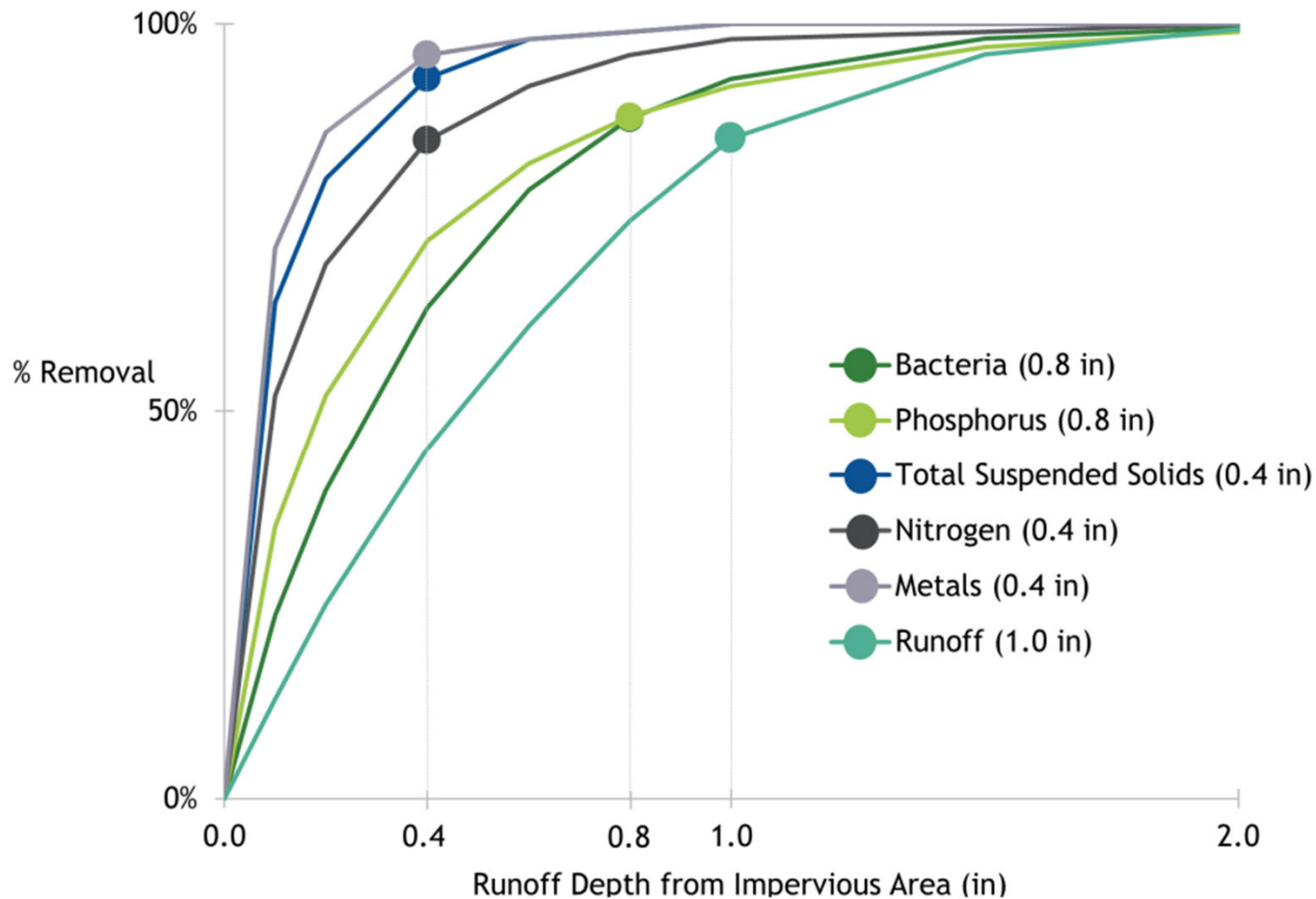


- 1 If a designer is working on a site where a pollutant reduction of 60% is desired ...
- 2 ... the designer would use the curves to determine that a Runoff Depth from Impervious Area of approximately 0.2 inches achieves the desired reduction
- 1 If a designer determines that their SCM provides a DSV equivalent to 1.2 inches from the Impervious Area ...
- 2 ... the designer would use the curves to determine a 98% pollutant reduction from this SCM

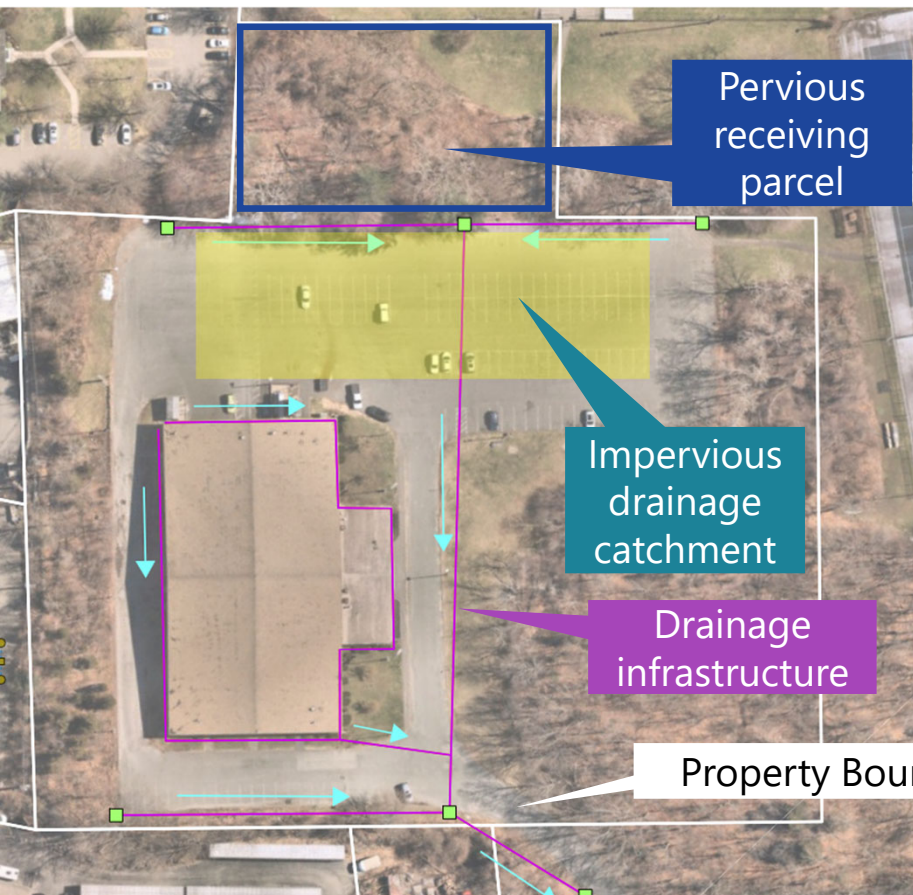


SCM Performance Curves: Finding the Cost-Optimal Size

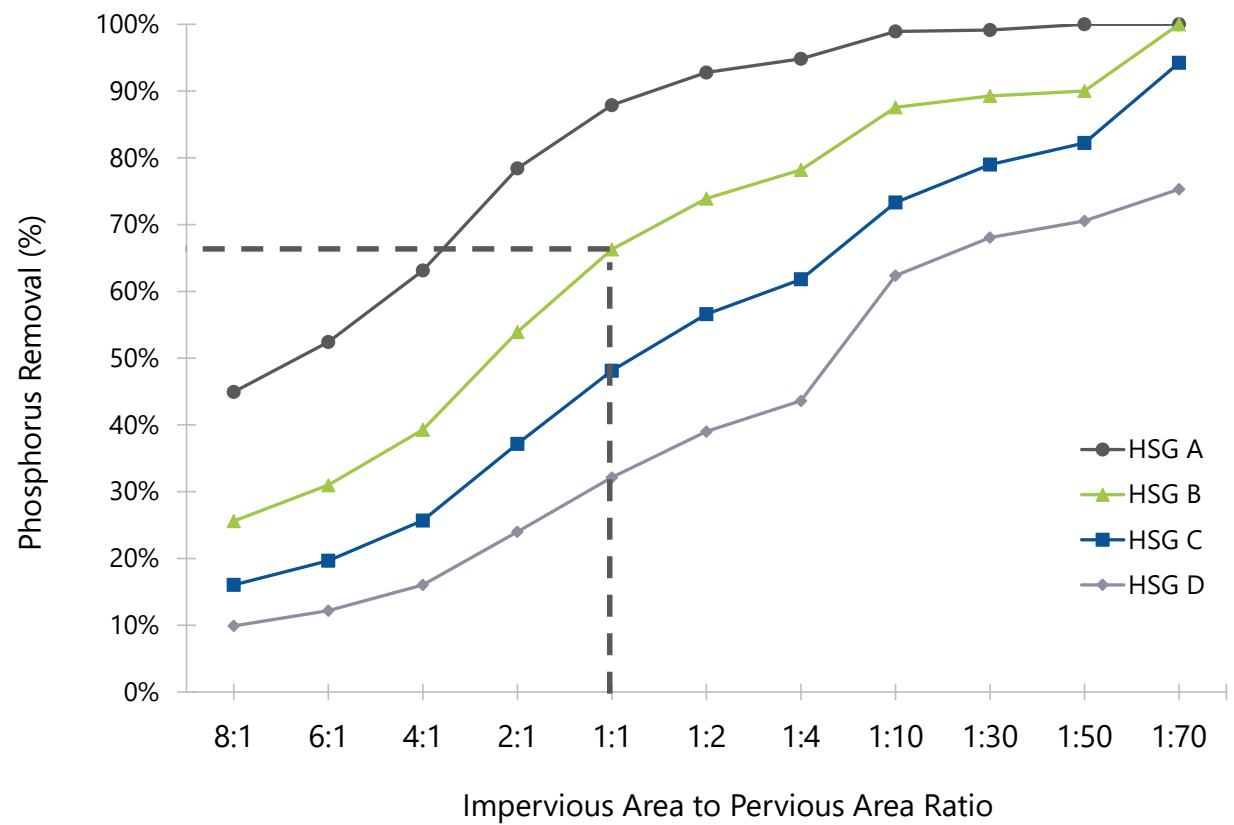




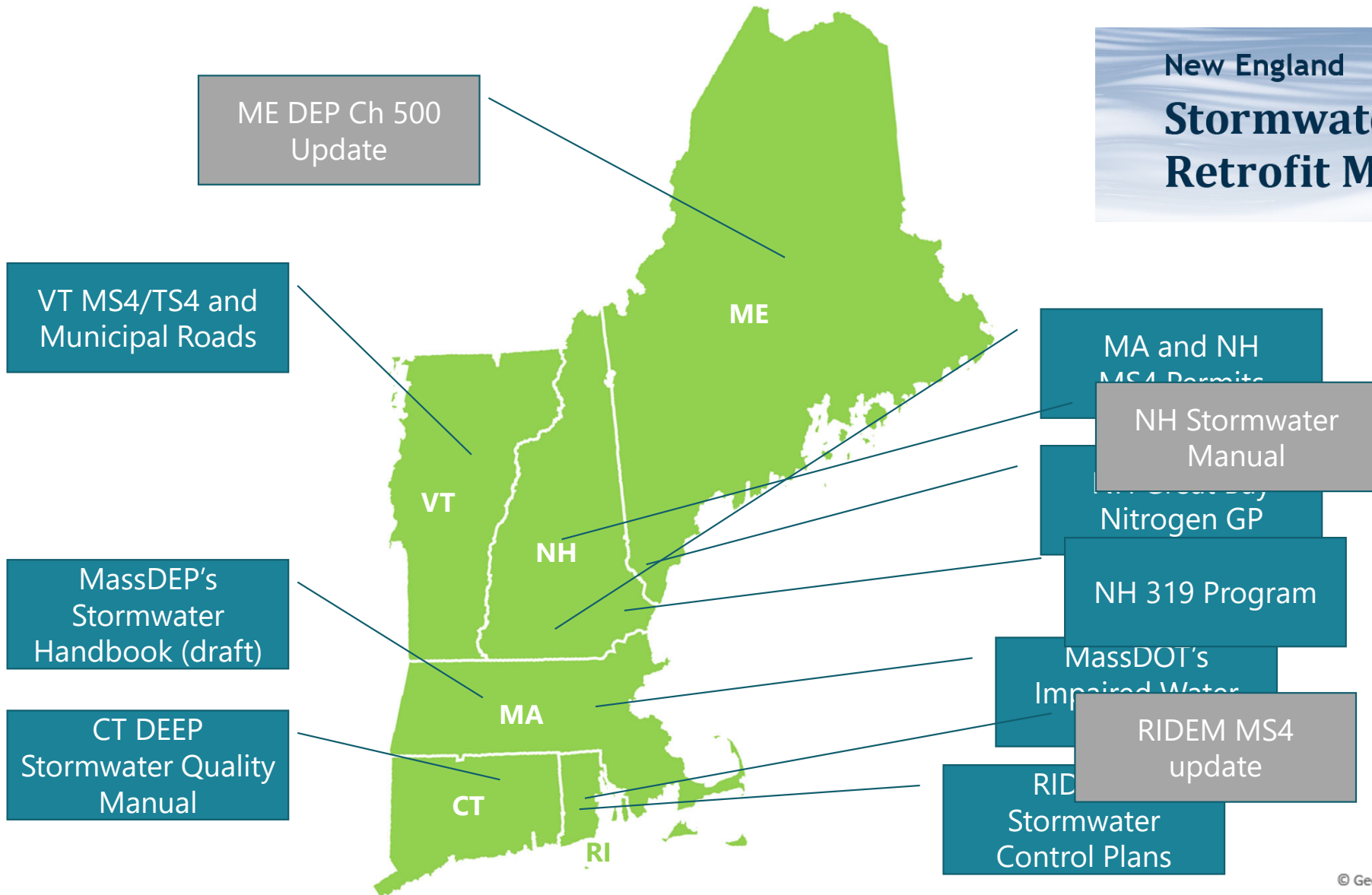
DCR Example: Simple Retrofit – IC Disconnection



IC disconnection provides
significant pollutant removal;
even when IC/Pervious > 1:1



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Sizing for Performance



Sizing Details

System	WQV ft ³ (m ³)	Actual WQV ft ³ (m ³)	% of normal design	Rain Event in (mm)	Sizing Method
SGWSC	7,577 (214.6)	720 (20.4)	10%	0.10 (2.5)	Static
IBSCS	1,336 (37.8)	310 (8.8)	23%	0.23 (5.8)	Dynamic

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

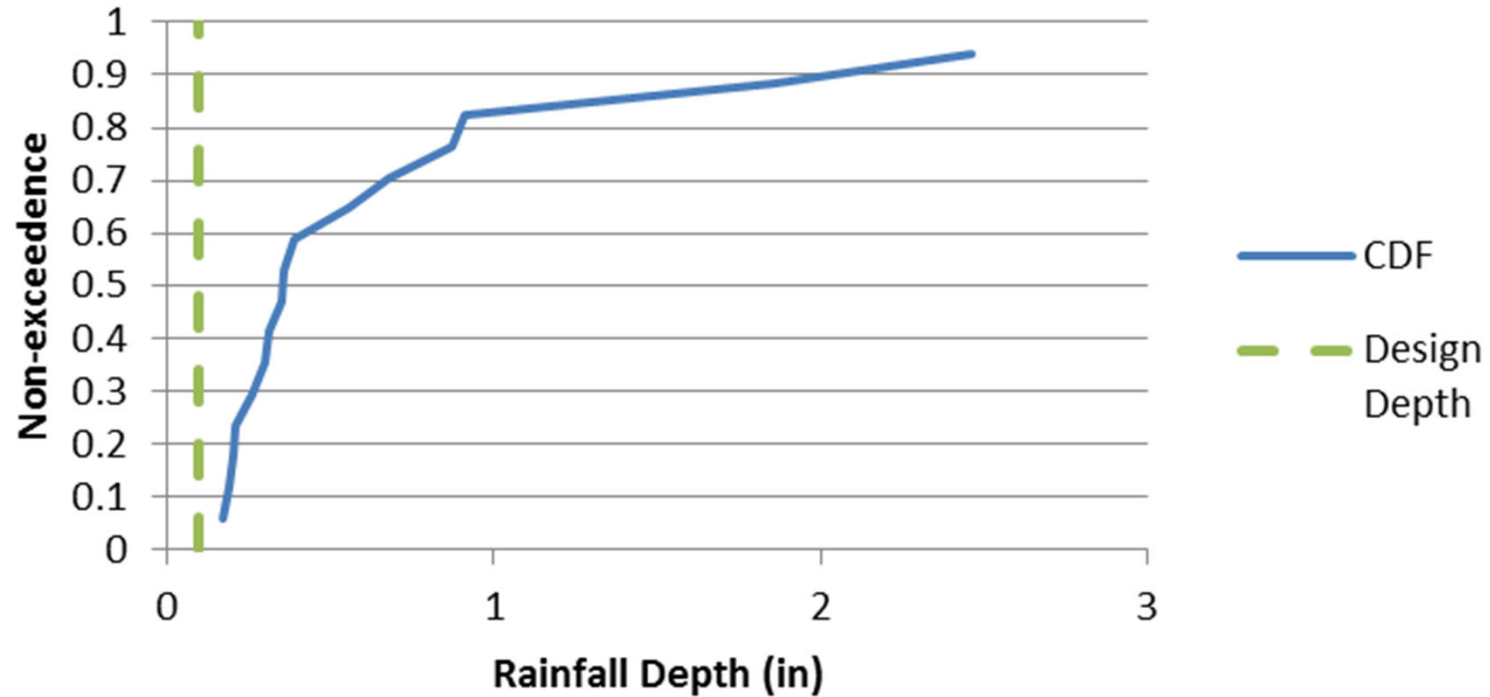
Dynamic Bioretention
Sizing

$$Af = Vwq * \frac{df}{(i(hf + df)tf)}$$

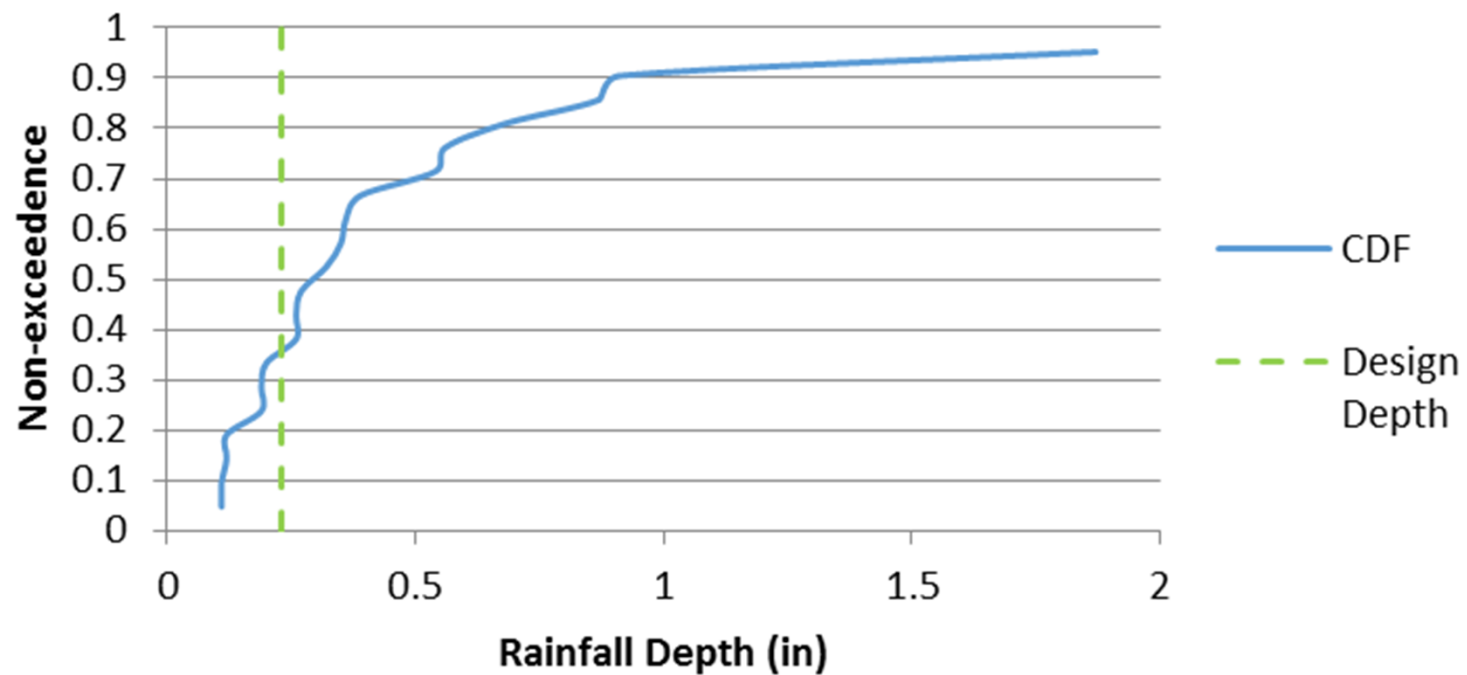
Static SGW System Sizing

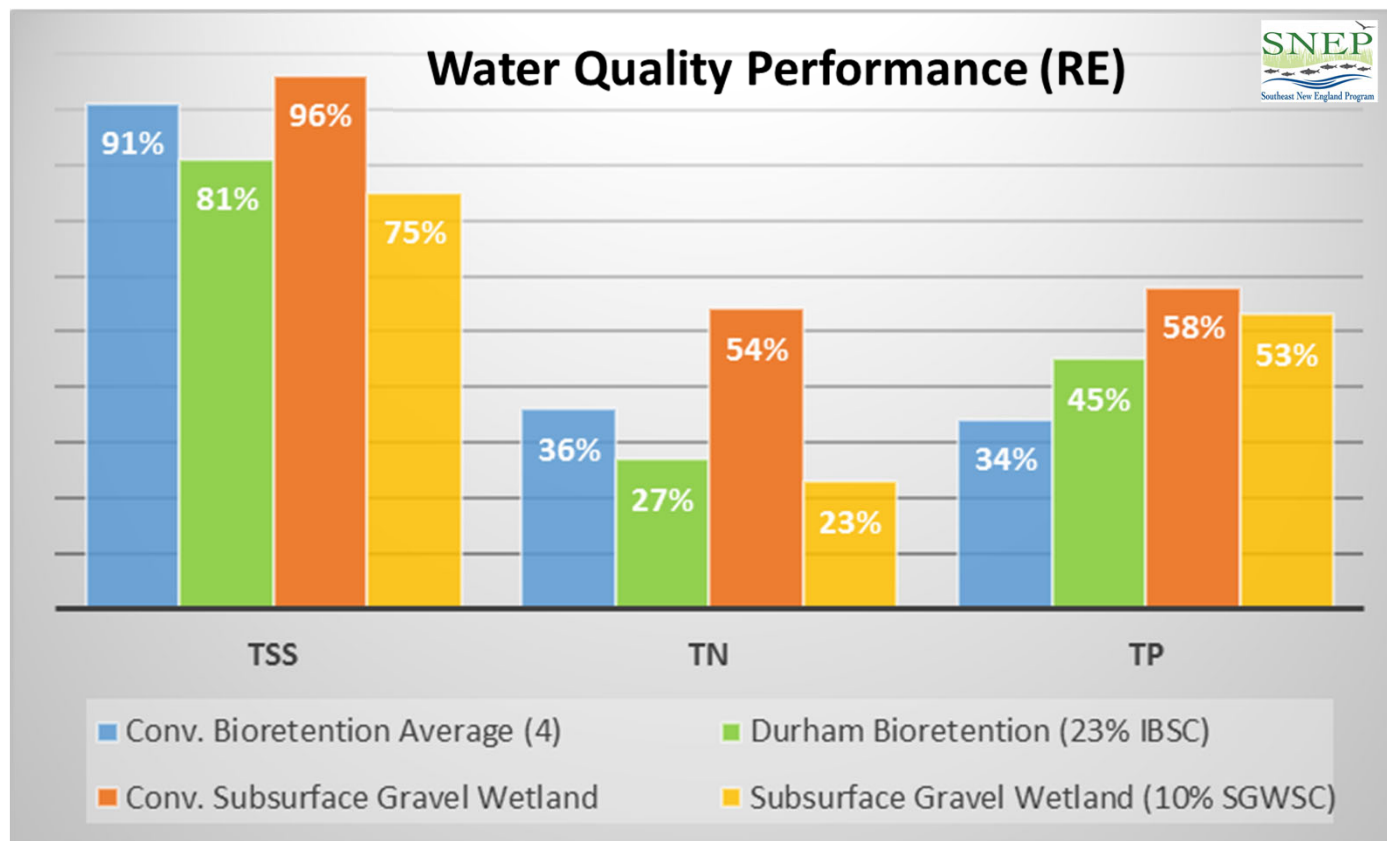
$$Q = CdA\sqrt{2gh}$$

Oyster River Road Cumulative Distribution Frequency



Durham Bio-5 Cumulative Distribution Frequency



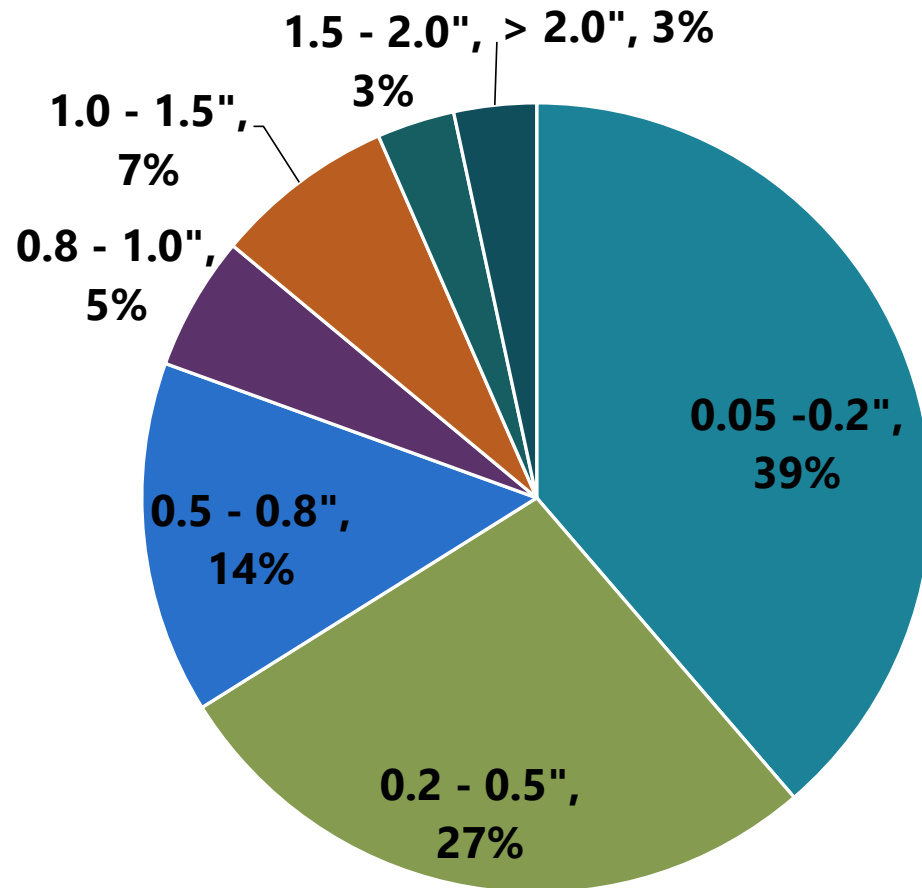


System	TSS	TN	TP
Conv. Bioretention Average (4)	91%	36%	34%
Durham Bioretention (23% IBSC)	81%	27%	45%
Conv. Subsurface Gravel Wetland	96%	54%	58%
Subsurface Gravel Wetland (10% SGWSC)	75%	23%	53%

Uses updated hydrology



Distribution of Precipitation Events by Depth; Boston, MA 1992-2014



Precip Depth (in)	Probability %
0.05-0.2	39
0.2-0.5	66
0.5-0.8	80
0.8-1.0	85
1.0-1.5	92
1.5-2.0	95
>2.0	98

Output	Intermediate Calculations	Design Storage Volume	DSV	cf	1,200
		Impervious to Pervious Ratio <i>(range of 0.014 - 8)</i>	IA/PC	ac/ac	N/A
		Physical Storage Capacity: Depth of Runoff from IA <i>(range of 0 - 2, goal > 0.1, optimal 0.4)</i>	PSC	in	0.11
		PSC Notes			DSV small, increase for optimal range $0.3 \leq PSC \leq 0.6$
	Performance Curve Removal Efficiencies	Removal Efficiency: Volume	Vol _{RE}	-	0%
		Removal Efficiency: P	P _{RE}	-	20%
		Removal Efficiency: N	N _{RE}	-	23%
		Removal Efficiency: TSS	TSS _{RE}	-	49%
		Removal Efficiency: Zn	Zn _{RE}	-	59%
		Removal Efficiency: Bacteria	FIB _{RE}	-	32%
	Loading Rate	Load: Volume	Vol _{LER}	Mgal/yr	3.29
		Load: P	P _{LER}	lb/yr	6.2
		Load: N	N _{LER}	lb/yr	44.3
		Load: TSS	TSS _{LER}	lb/yr	1,378
		Load: Bacteria	FIB _{LER}	Billion MPN/y	20
	Reductions	Reduction: Volume	Vol _{Rrd}	Mgal/yr	0.00
		Reduction: P	P _{Rrd}	lb/yr	1.2
		Reduction: N	N _{Rrd}	lb/yr	10.1
		Reduction: TSS	TSS _{Rrd}	lb/yr	682
		Reduction: Bacteria	FIB _{Rrd}	%/yr	32%
	Costs	Estimated Total Costs		\$	\$22,000
		Removal Costs: Volume		\$/Mgal-yr	N/A
		Removal Costs: P		\$/lb-yr	\$17,940
		Removal Costs: N		\$/lb-yr	\$2,170
		Removal Costs: TSS		\$/lb-yr	\$30
		Removal Costs: Bacteria		\$/%-yr	\$700
	Q&M	Estimated O&M Hours		hr/yr	68



Advances up-to-date SCM Selection and Guidance



Chapter 4 – Stormwater Control Measures Selection:

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.



Hydrologic



Physical



Chemical



Biological

Selection and Design: Linking SCMs to UOPs and Performance Curves



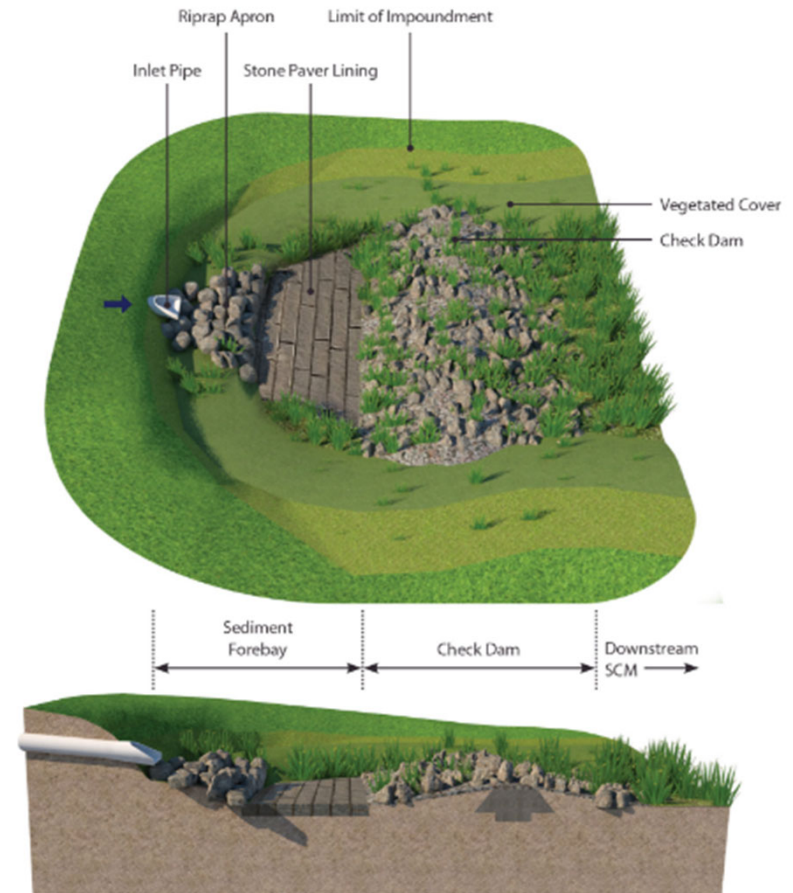
SCM Type	Primary UOP	Performance Curve Category
Infiltration Swale	Hydrologic: Infiltration	Infiltration Basin
Rain Garden (with underdrain)	Physical: Filtration	Bio-Filtration
Gravel Wet Vegetated Treatment System	Biological: Nitrification/ Denitrification	Gravel Wetland

Chapter 5- Stormwater Control Measure Guidance

This chapter steps through the functional components and treatment categories used to construct a SCM. It also steps through SCM variations within each treatment category.

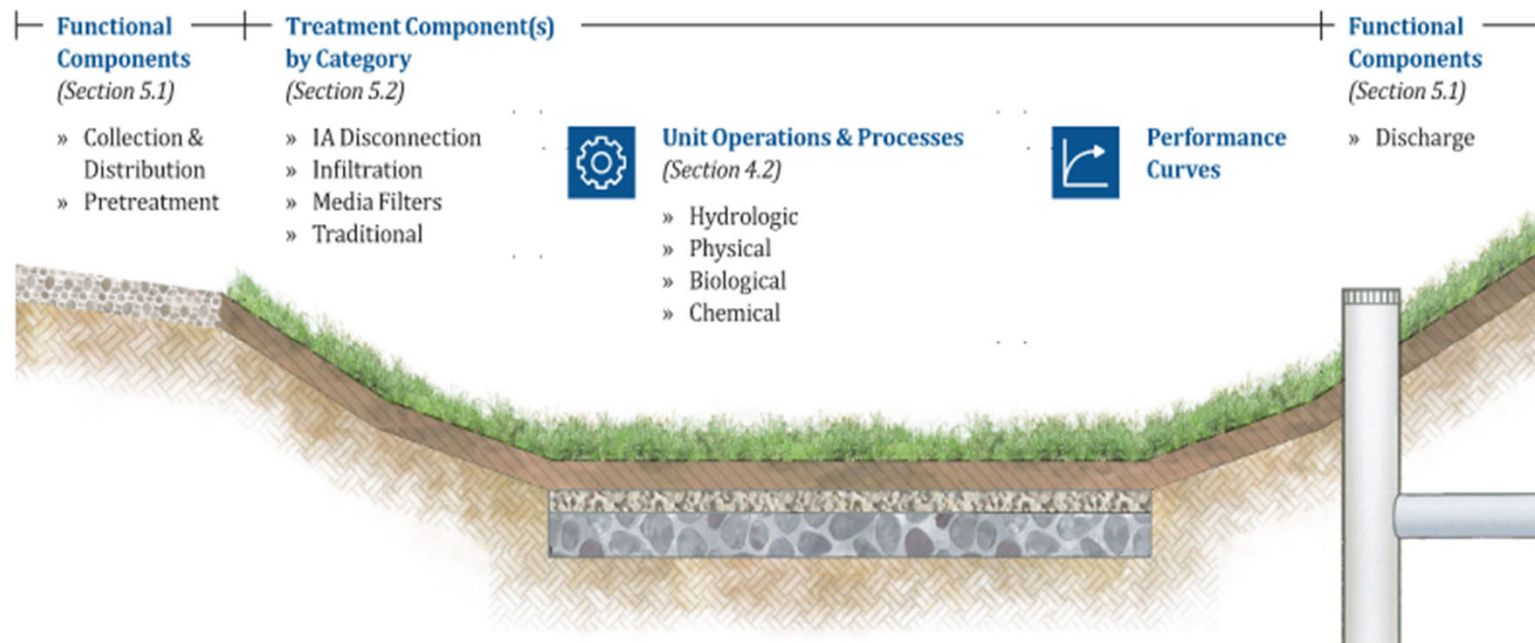
SCM Guidance: Functional Components

- Determine form and function of SCM
- Can be broken down as follows:
 - Collection and Distribution
 - Pretreatment
 - Discharge



Source: MassDOT Stormwater Design Guide, 2022

SCM Guidance: Putting It All Together



Manual Highlights: Breaking through Prescriptive Guidance

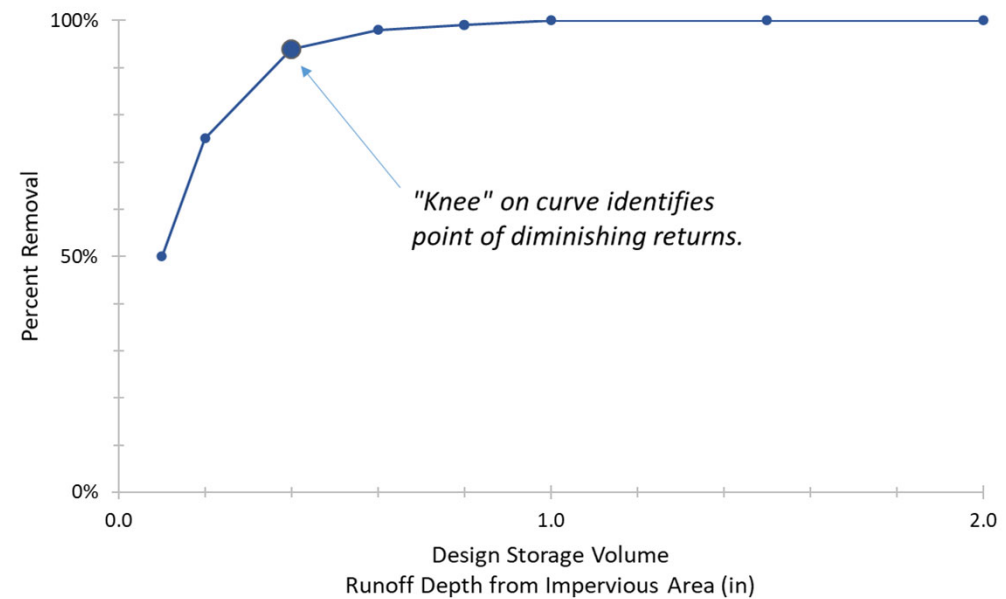
Breaking Through Prescriptive Guidance: Sizing Requirements

Current Typical Requirement:

Size SCMs to meet the required
WQV (typically 1 inch)

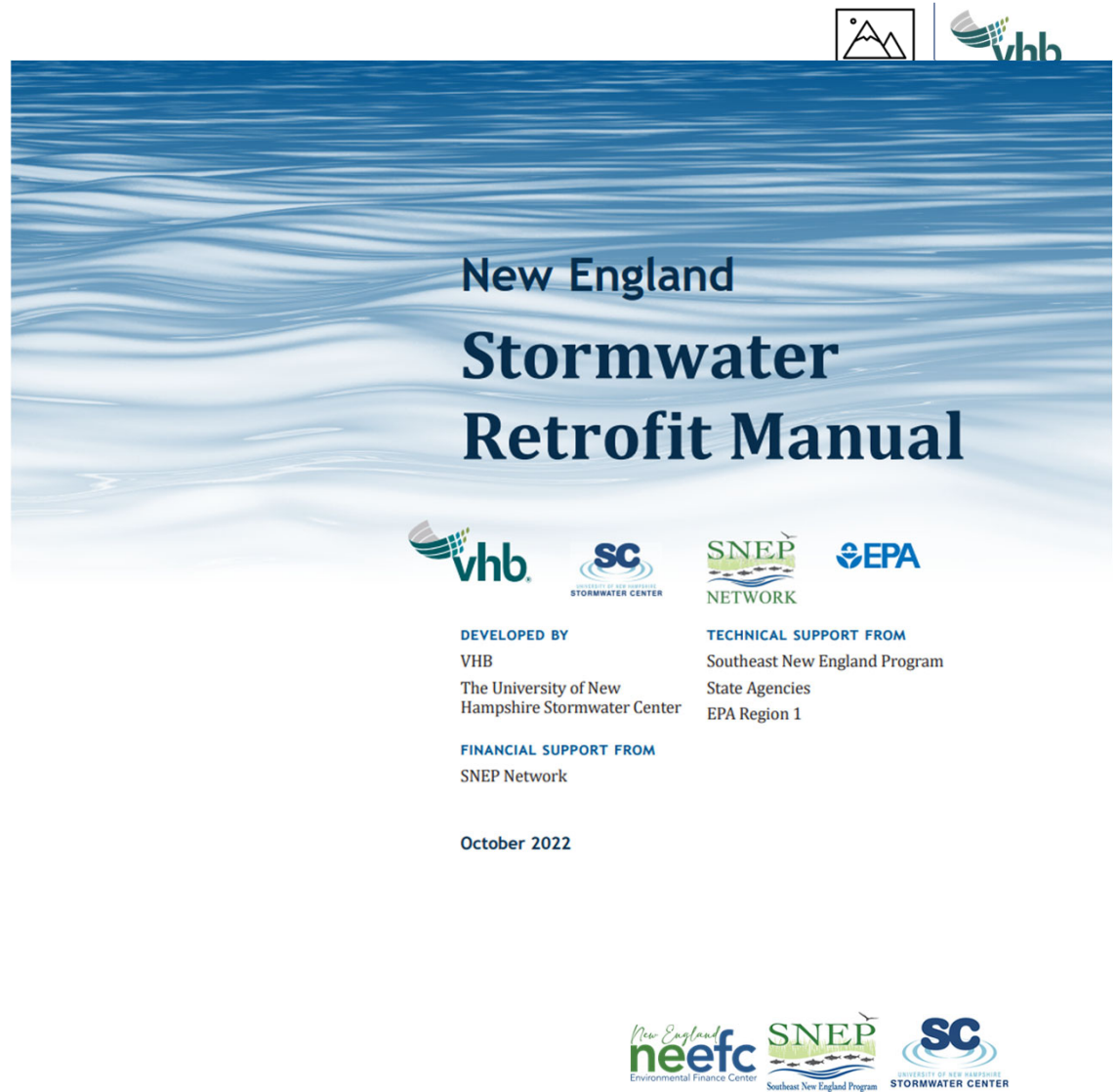
Proposed Retrofit Guidance:

Use SCM Performance Curves
to size optimal cost-effective
SCMs within a site



Conclusions

- The curves...
 - Are based on the latest science
 - Help us practice adaptive management
 - Ensure regional consistency in water quality tracking and accounting
- Are already being used by municipalities, regulatory agencies, and transportation departments in Region 1
- Allow for flexible and scalable sizing in SCM selection and design
- Can be readily remodeled and adopted in other EPA Regions



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.

Access the manual here:
<https://snepnetwork.org/stormwater-retrofit-manual/>

Acknowledgments



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 - Kathleen Knight – CTDEEP
 - Daniel Macadam – UNHSWC
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 - Cody Ray – EPA
 - Matthew Reardon – MADEP
 - Alisa Richardson – RIDOT
 - Michael Sadler – VT
 - Laura Schiffman – MADEP
 - Newt Tedder – EPA

Resources



The Retrofit Manual:

<https://snepnetwork.org/stormwater-retrofit-manual/>

Calculator

<https://scholars.unh.edu/stormwater/120>

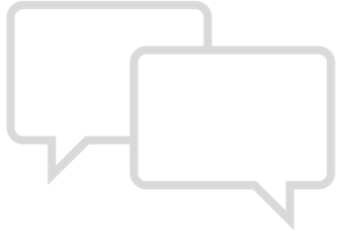
MS4

<https://extension.unh.edu/stormwater-center/ms4-resources>

Tracking and accounting

<https://www.nhms4.des.nh.gov/nh-resources/pollutant-tracking-and-accounting-project-ptap>





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