# Recommendations of the Expert Panel to Define Removal Rates For Disconnecting Existing Impervious Area Runoff From Stormwater Drainage Systems

Webinar

June 3, 2016

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Jeremy Hanson, Virginia Tech, Panel Coordinator

Reid Christianson, PE, PhD, CWP Staff support
Lisa Fraley-McNeal, CWP Staff support

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# Some notes before we get started

- **Please DO NOT put the conference line on hold at any time, for any reason.** If you need to take another call, please hang up and dial back in.
- Remember that any references to the report (figures, tables, page numbers, etc.) are to the May 16, 2016 version (draft for CBP review). These labels/numbers may change as revisions are made.
- The report is still considered DRAFT until approved by the Water Quality Goal Implementation Team (WQGIT). More info on this process will be provided later in the presentation.
- We will respond to questions after completion of the slides, but please type your questions into the chat box as we go. You're encouraged to use the slide numbers to help us better respond to specific questions about a statement/slide.
- **We are recording this webinar.**

# Today's speakers

- Bill Stack, Center for Watershed Protection
- Reid Christianson, CWP
- Lisa Fraley-McNeal, CWP
- Jeremy Hanson, Virginia Tech, CBPO

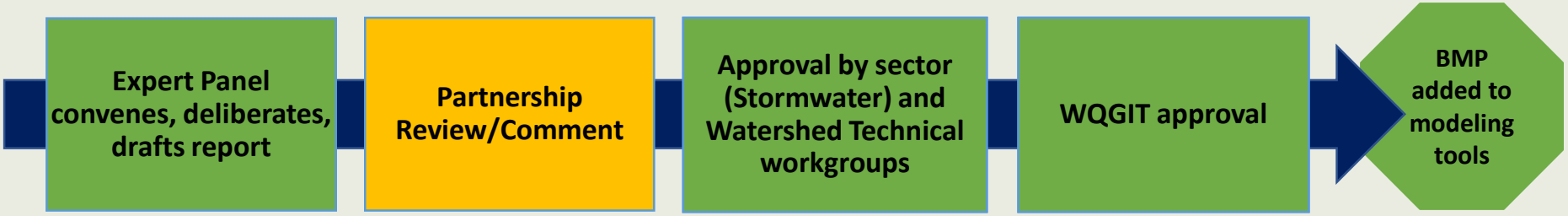
# Overview

- Background
  - The BMP Protocol
  - The panel and its charge
- The panel's recommendations
  - Disconnection to amended soils
  - Treatment in the conveyance system
- Reporting the proposed BMPs in Phase 6
- Timeline for review/approval of the report
- Q&A

# The BMP Protocol

- All expert panels follow the Water Quality Goal Implementation Team's *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*, AKA the "BMP Protocol"
  - http://www.chesapeakebay.net/publications/title/bmp_review_protocol
- BMPs are often revisited as new science becomes available

# The panel process at a glance



# The panel charge

- This panel will evaluate the nutrient and sediment removal and runoff reduction benefits associated with disconnecting existing acres of impervious cover through several engineering and/or field assessment methods as defined within this Charge.
- The Panel can consider and modify these approaches based on available science and their best professional judgment.

# Panel charge cont.

- Impervious disconnection to pervious areas amended with compost and/or vegetative plantings.
- The potential to retrofit existing drainage networks on a site to achieve full or partial impervious disconnection.
- Modeling to determine the degree of disconnection based on a disconnection benchmark established by the Panel.
- The existing retrofit adjustor curves and their suitability to assess the sediment and nutrient reduction potential for this new category of stormwater retrofit or whether some other methodology is preferable.

# Our esteemed panel of experts

Met 9 times from July, 2015 through April 2016.

| Name | Role | Affiliation |
|---|---|---|
| **Bill Stack** | Panel Chair | Center for Watershed Protection |
| **Greg Evanylo** | Panel Member | Virginia Tech |
| **Jason Papacosma** | Panel Member | Arlington County, Dept. of Environmental Services |
| **Ryan Winston** | Panel Member | The Ohio State University (formerly North Carolina State) |
| **David Sample** | Panel Member | Virginia Tech |
| **Franco Montalto** | Panel Member | Drexel University |
| **Justin Shafer** | Panel Member | City of Norfolk (VA) |
| **Panel Support** | | |
| **Jeremy Hanson** | Panel and VT Coordinator | Virginia Tech, CBPO |
| **Brian Benham** | VT Project Lead | Virginia Tech |
| **Greg Sandi** | WTWG Representative | MDE |
| **Jeff Sweeney** | CBP Modeling Team Representative | EPA, CBPO |
| **Liz Ottinger** | Regulatory Support | EPA Region 3 |
| **Reid Christianson** | CWP Staff Support | Center for Watershed Protection |
| **Lisa Fraley-McNeal** | CWP Staff Support | Center for Watershed Protection |
| **Steve Stewart** | Former Panel Member | Baltimore County, Dept. of Environmental Protection and Sustainability |

# Description of Protocols

**Table E - 1. Recommended nutrient and sediment removal for the disconnection of existing impervious area runoff from stormwater drainage systems.**

| Protocol | Units[1] | Pollutant Removal |
|---|---|---|
| **Impervious area disconnection to amended HSG A or B soils that are not compacted.** | Pounds per year | TN, TP, and TSS removal calculated as simple impervious disconnection following recommendations of the Expert Panel to Define Removal Rates for Urban Filter Strips (UFS EP, 2014). |
| **Impervious area disconnection to amended HSG C or D soils or compacted A and B soils** | Pounds per year | TN, TP, and TSS removal calculated based on the runoff reduction from a 1.0 inch rain event, which is used as the water quality volume treated and the RR pollutant removal curves in SRP EP (2013). |
| **Treatment in the conveyance system** | Pounds per year | TN, TP, and TSS removal calculated based on the water quality volume treated and the RR and ST pollutant removal curves in SRP EP (2013). |
| **[1]Note that relative reductions from the SRP EP (2013) curves must be multiplied by location specific TN, TP, and TSS yields (i.e. 50% reduction of 10 pounds per acre per year for one acre gives 5 pounds per year reduction).** | | |

Results expressed in inches of runoff treated per acre of impervious cover to be compatible with runoff adjuster curves

# Impervious Disconnection to Amended Pervious

# Qualifying Conditions

- How IC is directed to amended soil
- Tillage specs.
- Nutrient testing for soils
- Soil testing for parameters used in computational approach
- Compost specs
- Fertilization specs for groundcover

# Draft Panel Report Available

- A draft version of the panel report is available from: http://www.chesapeakebay.net/calendar/event/23993/
- Numbered tables referred to in this presentation can be found in the draft report
- More details and discussion on each topic can also be found in this draft report

# Default Rate

Table 7

| TN | TP | TSS |
|---|---|---|
| 12.3% | 14.6% | 15.6% |
| **Default rates are from the RR curves in the Retrofit Expert Panel recommended protocols, using a value of 0.1 inches per impervious acre treated.** | | |

Assumptions:

- Impervious to pervious ratio (I:P) of 1 or lower
- At least 1 inch of compost (at 50% organic matter) is added
- 3 inches of incorporation into the native soil occurs
- All other qualifying conditions are met.

# Simplified Method for Impervious Area Disconnection Coupled with Soil Amendments

- Grouped soil types
  - Can use Soil Survey Geographic (SSURGO) data
  - Existing organic matter

Table 8

| | Initial Soil Condition | | |
|---|---|---|---|
| **Organic Matter** | **Loose** | **Medium** | **Tight** |
| **1% or less** | Loam | Silt<br>Silt loam<br>Sandy clay loam | Silty clay loam |
| **greater than 1%** | Loam<br>Silt<br>Silt loam | Sandy clay loam<br>Silty clay loam | Clay loam<br>Silty clay |

# Steps for the Simplified Method*

- Step 1. Identify whether the initial soil conditions are loose, medium, or tight.
- Step 2. Determine water treated (inches) per impervious acre.
- Step 3. Compute the annual TN, TP, and TSS load reduction.

*Assumes 1 inch of compost is added and incorporated 3 inches into the existing soil.

# Simplified Method - Trends

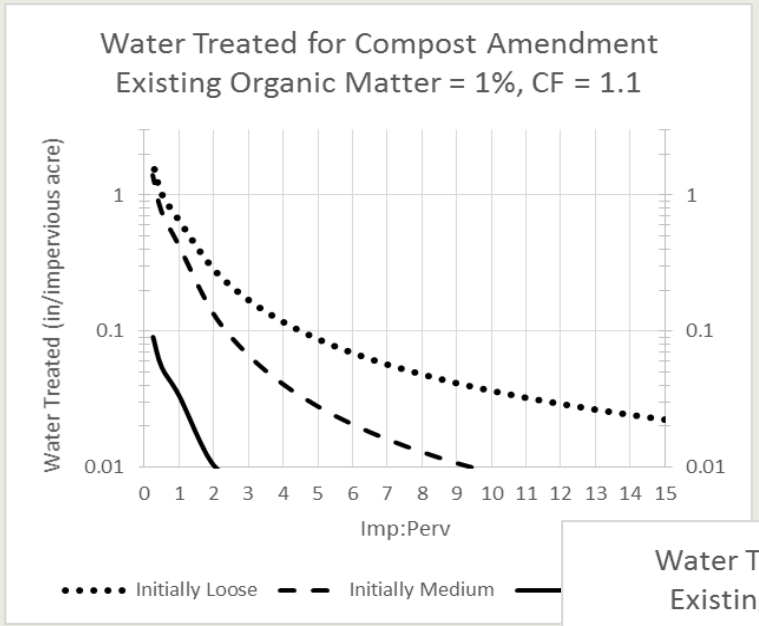



Figure 6

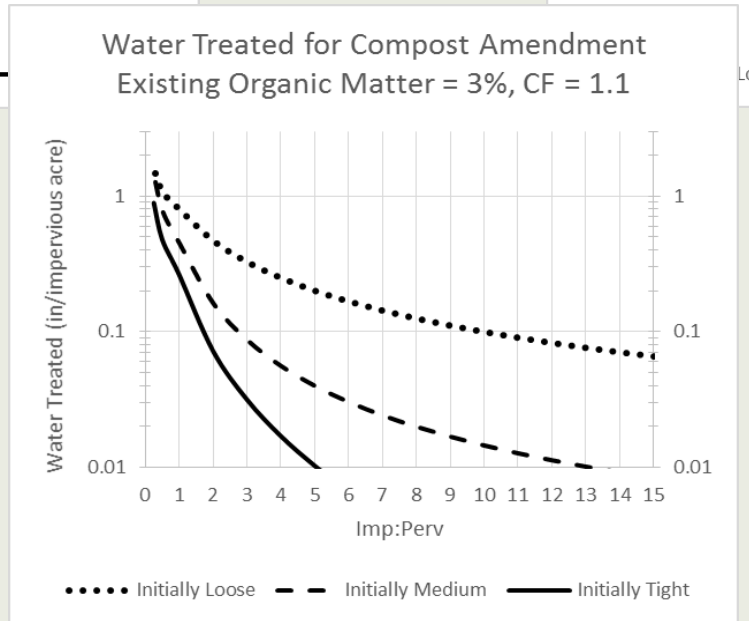



Figure 8

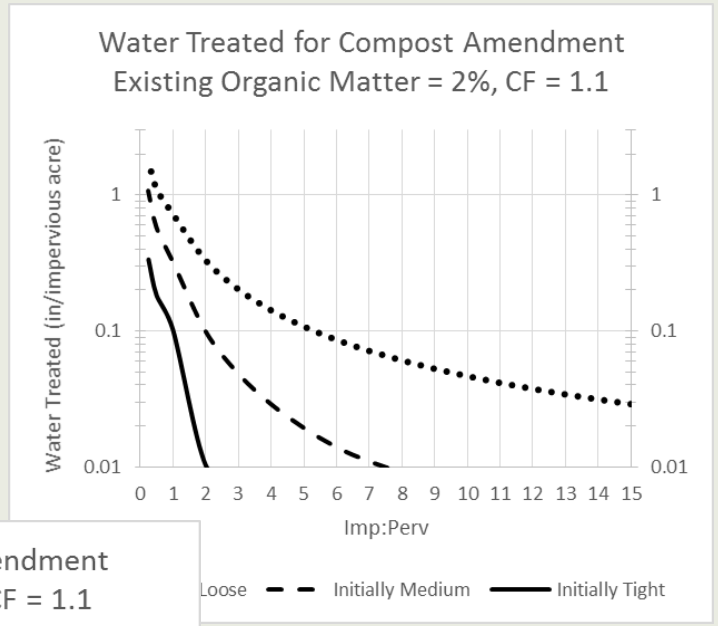



Figure 7

# Tabulated Treatment for Simplified Method

Table 9* Water treated (in) per impervious acre based on initial soil conditions

| | Initial Organic Matter = 1.0% | | | Initial Organic Matter = 2.0% | | | Initial Organic Matter = 3.0% | | |
|---|---|---|---|---|---|---|---|---|---|
| **I:P** | **Loose** | **Medium** | **Tight** | **Loose** | **Medium** | **Tight** | **Loose** | **Medium** | **Tight** |
| **15** | 0.022 | 0.005 | 0.002 | 0.029 | 0.004 | 0.002 | 0.066 | 0.008 | 0.002 |
| **14** | 0.024 | 0.005 | 0.002 | 0.032 | 0.004 | 0.002 | 0.071 | 0.009 | 0.002 |
| **5** | 0.088 | 0.028 | 0.006 | 0.108 | 0.019 | 0.006 | 0.201 | 0.040 | 0.010 |
| **4** | 0.117 | 0.041 | 0.007 | 0.142 | 0.029 | 0.007 | 0.249 | 0.056 | 0.017 |
| **3** | 0.171 | 0.067 | 0.008 | 0.203 | 0.049 | 0.008 | 0.326 | 0.087 | 0.032 |
| **2** | 0.287 | 0.134 | 0.010 | 0.331 | 0.100 | 0.010 | 0.466 | 0.161 | 0.072 |
| **1** | 0.659 | 0.428 | 0.034 | 0.723 | 0.323 | 0.102 | 0.793 | 0.447 | 0.262 |
| **0.5** | 1.039 | 0.765 | 0.054 | 1.106 | 0.580 | 0.182 | 1.067 | 0.775 | 0.477 |
| **0.25** | 1.737 | 1.409 | 0.091 | 1.805 | 1.070 | 0.335 | 1.542 | 1.395 | 0.890 |

*Table has been abbreviated/modified for this presentation

# Computational Method

- Step 1. Estimate Impact of Soil Amendments and Decompaction on Hydraulic Properties of Soils
- **Pre-amendment**
  - Determine pre-amendment sand, clay and organic matter (OM) content, and bulk density by collecting soil samples on-site.
  - Estimate saturated hydraulic conductivity ($K_{Sat}$), of the soil using methods provided in Appendix E Part 1 or the SPAW model (http://hydrolab.arsusda.gov/SPAW/SPAWDownload.html)
- **Post-amendment**
  - Determine amendment details, including OM content of compost, depth to be applied (i.e. 2 inches over the site), and depth to incorporate into existing soil.
  - Re-estimate the $K_{Sat}$ using the same process as above.

# Computational Method (cont.)

- Step 2. Determine *Effective* $K_{Sat}$ of amended soil
  - Determine infiltration depth from Table 12 (how far into the soil water will infiltrate)
  - Depends on the impervious to pervious ratio (I:P)
- Step 3. Convert $K_{Sat}$ to a Curve Number (CN)
  - Existing conditions and amended conditions
- Step 4. Estimate **Site** Curve Number and Water Treated for Disconnected Impervious Area
- Step 5. Compute the annual TN, TP, and TSS Load Reduction (using adjuster curves)

# Computational Method: Infiltration Depth (Step 2)

Table 12

| I:P | Infiltration Depth ($L_f$) (inches) |
|---|---|
| 0.25 | 6 |
| 0.5 | 6 |
| 1 | 6 |
| 2 | 8 |
| 3 | 10 |
| 4 | 12 |
| 5 | 14 |
| 6 | 16 |
| 7 | 18 |
| 8 | 20 |
| 9 | 22 |
| 10 | 24 |
| 11 | 26 |
| 12 | 28 |
| 13 | 30 |
| 14 | 32 |
| 15 | 34 |

$$K_{SatEffective} = \frac{L_f}{\frac{D_{Cond}}{K_{SatCond}} + \frac{L_f - D_{Cond}}{K_{SatNative}}}$$

$D_{Cond}$ = depth of conditioned or amended soil

*Native* = existing soil

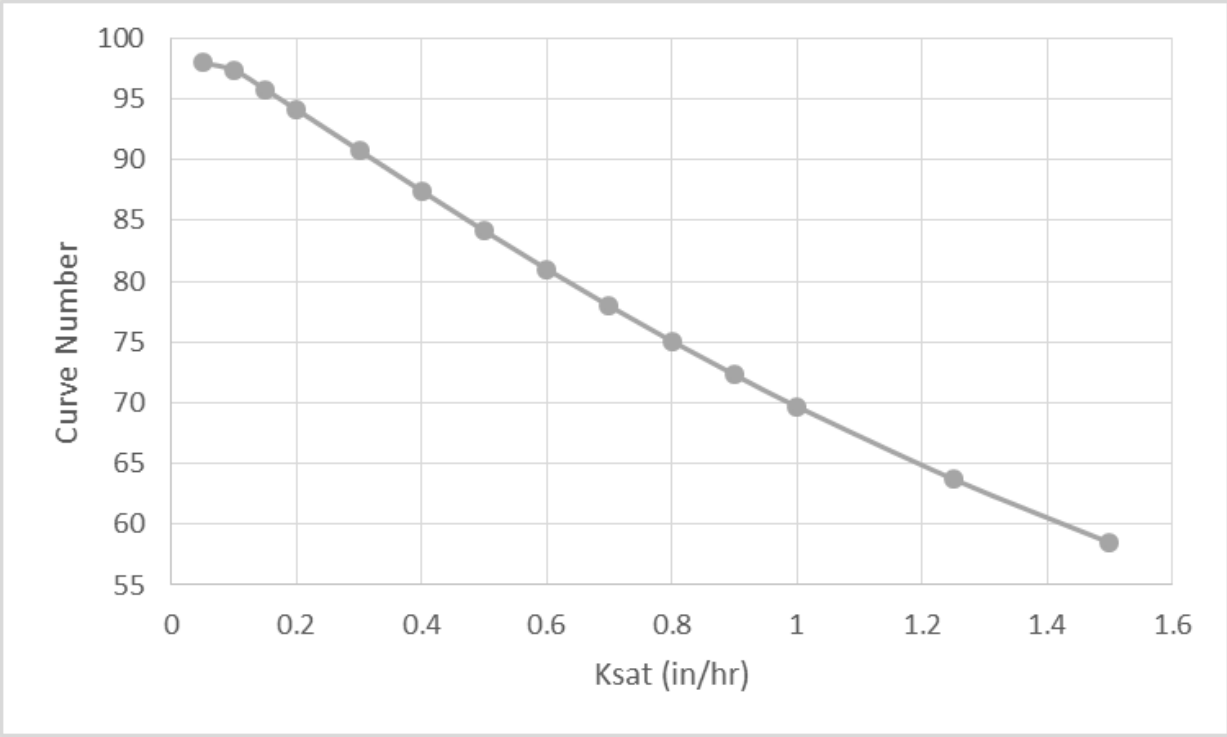
After: Oosterbaan and Nijland, 1994

# Computational Method: $K_{Sat}$ to CN (Step 3)

- $CN = \frac{1000}{4.345 * K_{SatEffective}^{1.208} + 10}$

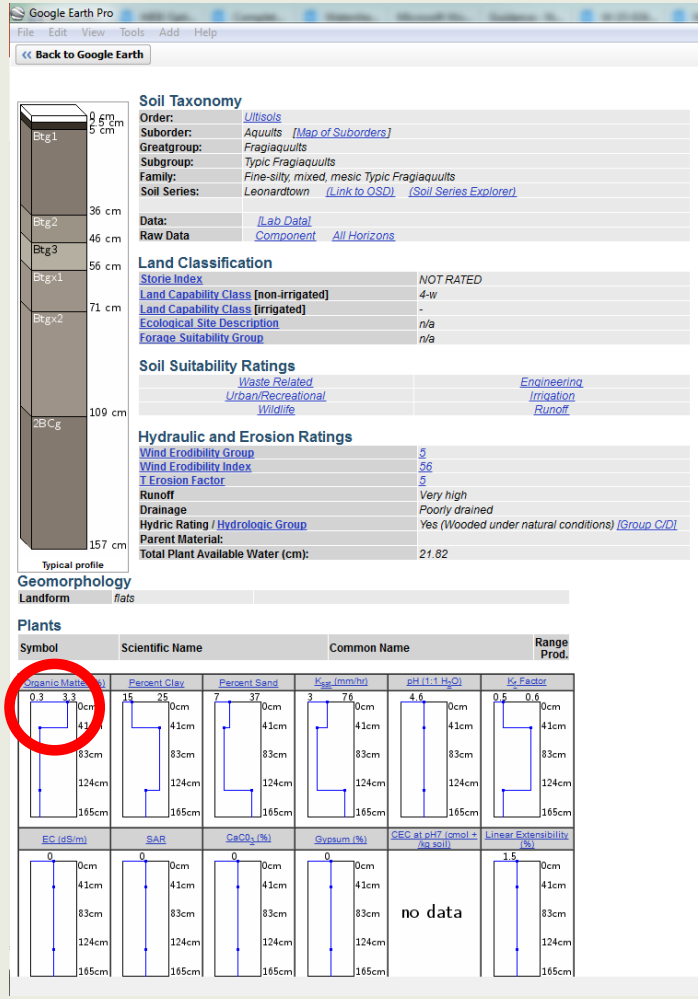
Based on Chong & Teng, 1986

Figure 9



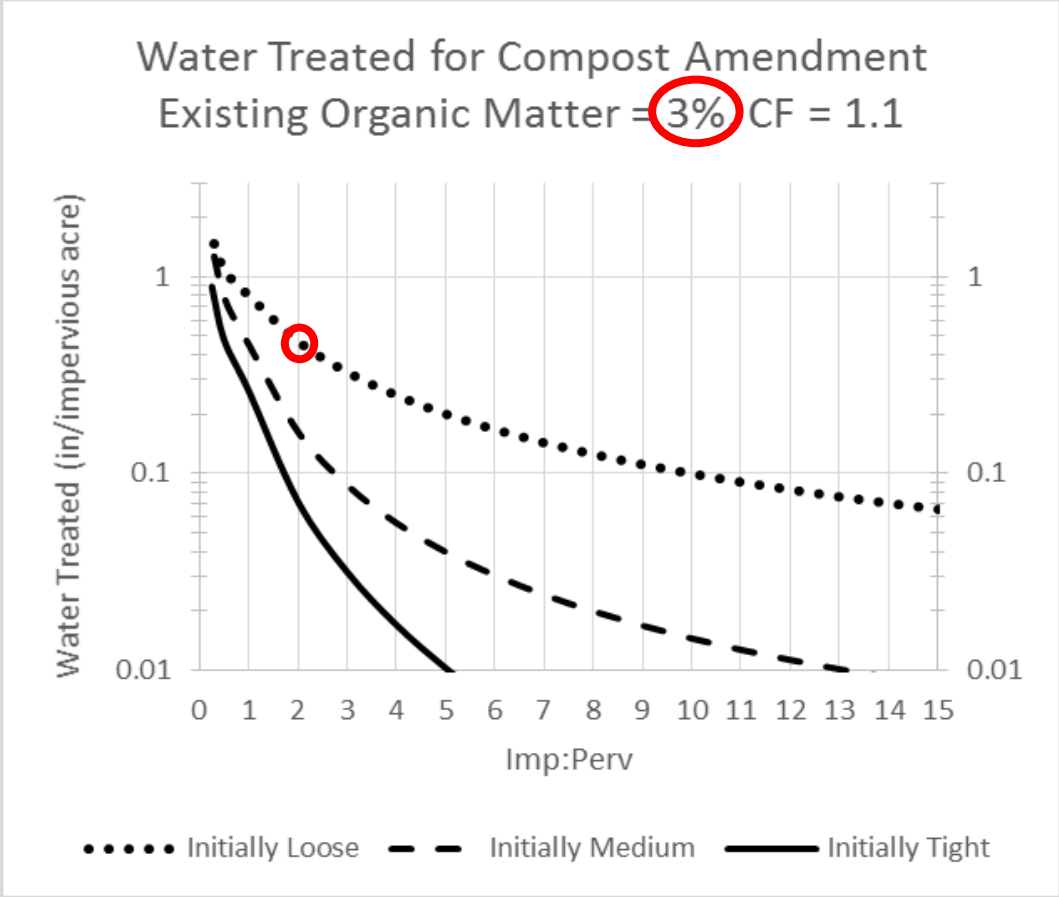
# Example Problem: Simplified Method

- Impervious surface disconnection (public building) to an amended pervious area.
- I:P ratio = 2:1
  - 0.5 acres of roof disconnected to
  - 0.25 acres of pervious
- SSURGO soil data
  - Leonardtown silt loam
  - 3% organic matter.
  - “Loose” initial soil conditions



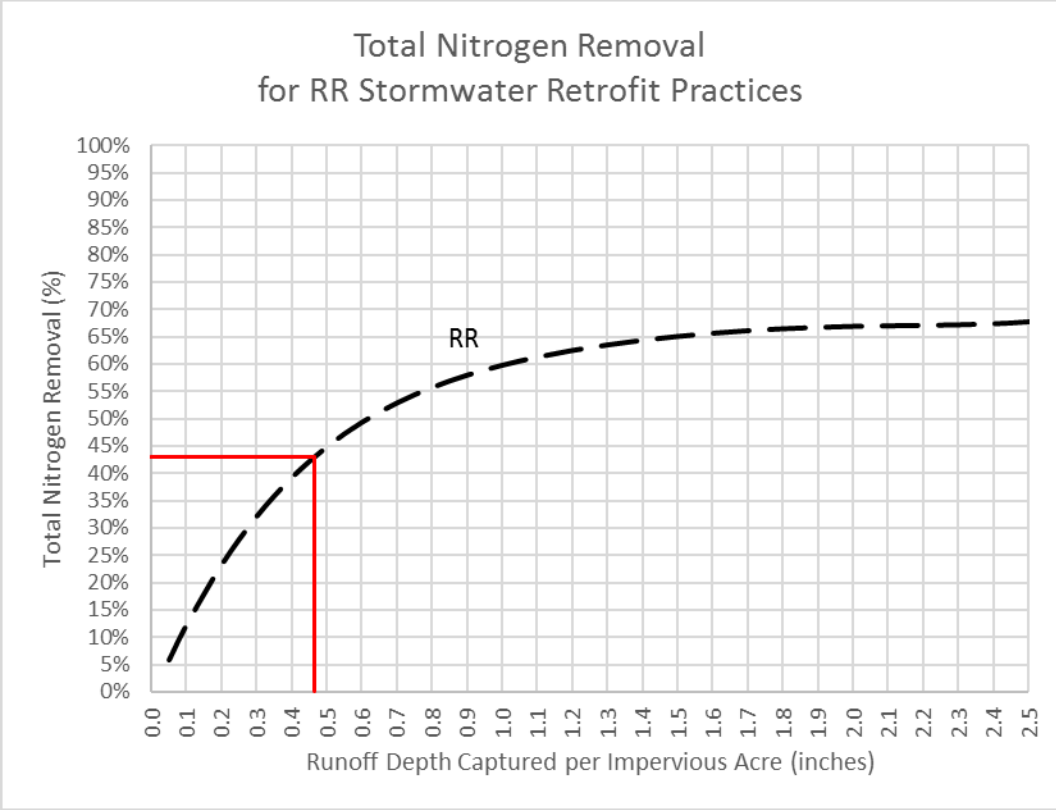
# Simplified Method Example (cont.)

- 0.466 inches per impervious acre



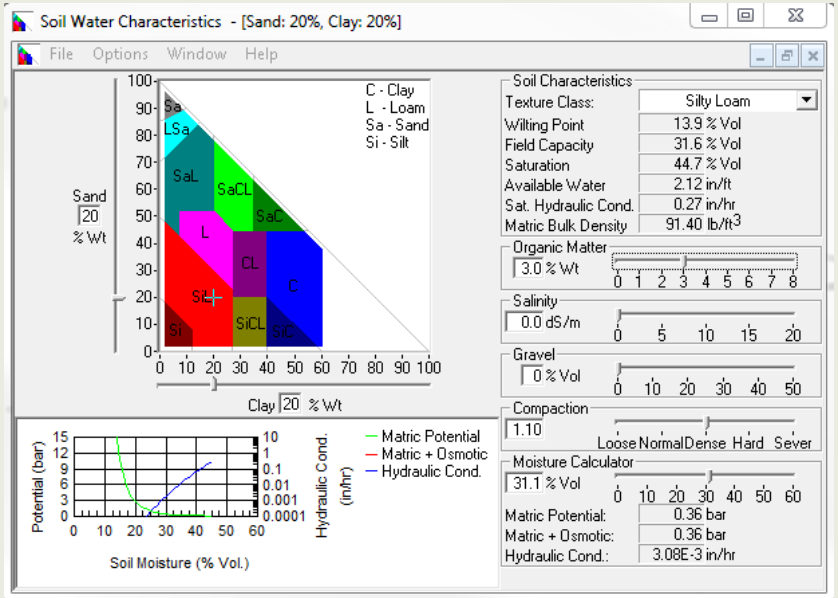
# Simplified Method Example (cont.)

- Using the retrofit curves in Section 5.3
  - 43% TN reduction
  - 50% TP reduction
  - 54% TSS reduction



# Example Problem: Computational Method

- Same Conditions
- I:P ratio = 2:1
- Silt loam
  - 20% sand (by mass)
  - 20% clay (by mass)
  - 3% organic matter
  - Bulk density = 1.46 g/cm$^3$ (CF = 1.1)
  - ➔$K_{Sat\_Initial}$ = 0.27 in/hr (Saxton & Rawls, 2006 or SPAW)
  - ➔$CN_{Initial}$ = 91.7 (Chong & Teng, 1986)
  - Overall site CN = 95.3

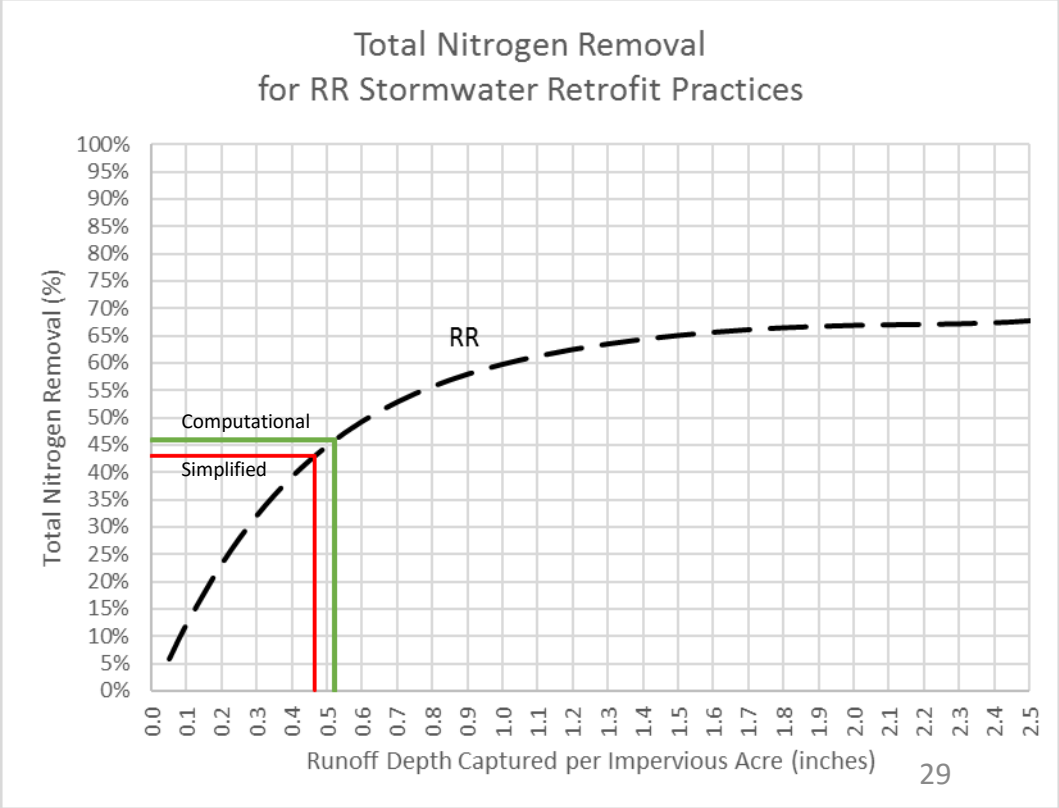


# Computational Method Example (cont.)

- Same amendment as simplified method
  - 1 inch compost (@50% OM)
  - 3 inch incorporation
- I:P = 2 ➔ $L_f$ = 8 inches
- Silt loam
  - Organic matter increases to 6%
  - Bulk density decreases to = 1.08 g/cm$^3$ (CF = 1.0)
  - ➔$K_{Sat\_Conditioned}$ = 1.39 in/hr (Saxton & Rawls, 2006 or SPAW)
    - $K_{Sat\_Effective}$ = 0.64 in/hr
  - ➔$CN_{Conditioned}$ = 79.7 (Chong & Teng, 1986)
  - Overall site CN = 89.7

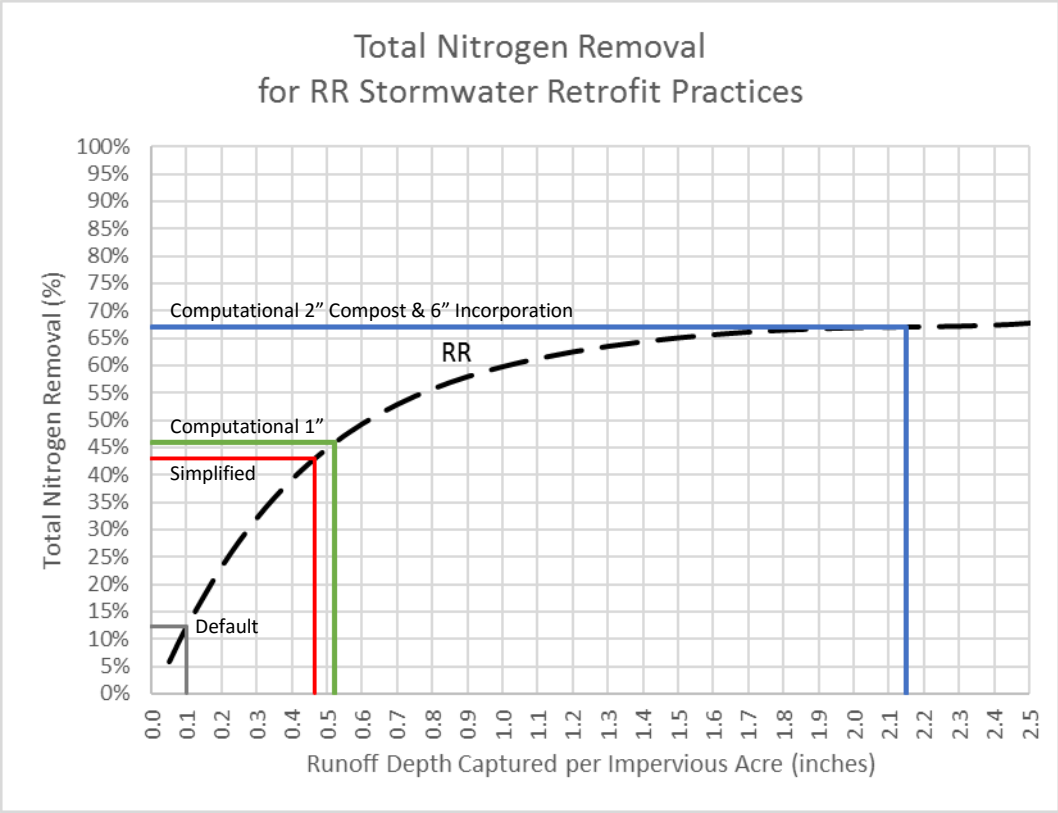
# Computational Method Example (cont.)

- Runoff Reduction = 40%
- 0.521 inches per impervious acre
- Retrofit curves
  - 46% TN reduction
  - 53% TP reduction
  - 57% TSS reduction



# More than 1” of Compost?

- 2 inches of compost
- 6 inch incorporation



# Summary: Impervious Disconnection to Amended Pervious

- Default Rate
  - 0.1 inches of treatment per impervious acre
  - I:P = 1 or lower
  - Excludes very poor infiltrating soils
- Simplified Method
  - Soil Survey information
  - Quick look-up table
- Computational Method
  - More complicated but more options and more credit

# Research Recommendations

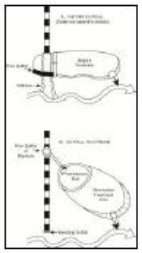
- Benefits of amending soil without impervious disconnect
  - The retrofit curves could easily be decoupled from this method
    - Would need a surrogate
  - Runoff reduction (%) can easily be calculated
  - Good correlation between annual runoff reduction and runoff reduction from a 1.0” storm using CN
- This protocol can consider other amendments
  - Quantify changes in soil hydraulic characteristics
  - Need qualifying conditions for inclusion of others

# Treatment in the Conveyance System

# From the Stormwater Retrofit Expert Panel Report

**Figure 1. Examples of New Retrofit Facilities and their Potential Applications**

New retrofit facilities provide stormwater treatment in places that treatment did not previously occur. There are many opportunities for new retrofit facilities in the urban landscape. Some common examples are listed below.



Near Existing Stormwater Outfalls

Within the Existing Stormwater Conveyance System

Adjacent to Large Parking Lots

Green Street Retrofits

On-Site LID Retrofits

# Treatment in the Conveyance System

- Treatment is the conveyance system is listed as an option in the Stormwater Retrofit Expert Panel Report. Nitrogen, phosphorus, and total suspended sediment reductions are calculated using “retrofit curves”
- The Retrofit Panel Report does not provide the specific options for treatment in the conveyance system or give examples.
- The goal of this Panel is to provide more details on the treatment options and show examples.

# Qualifying Conditions

- Use existing state standards
- In-channel treatment areas should be shown to withstand the erosive velocities associated with the maximum design storm.
- A natural channel should **never** be retrofitted unless it has been previously altered for drainage purposes.
- Since conveyance retrofits rely on vegetation for stability, grass or wetland plant species should be carefully chosen. A vegetation management plan is needed.
- Inflow should either be sheet flow or concentrated flow with pretreatment.

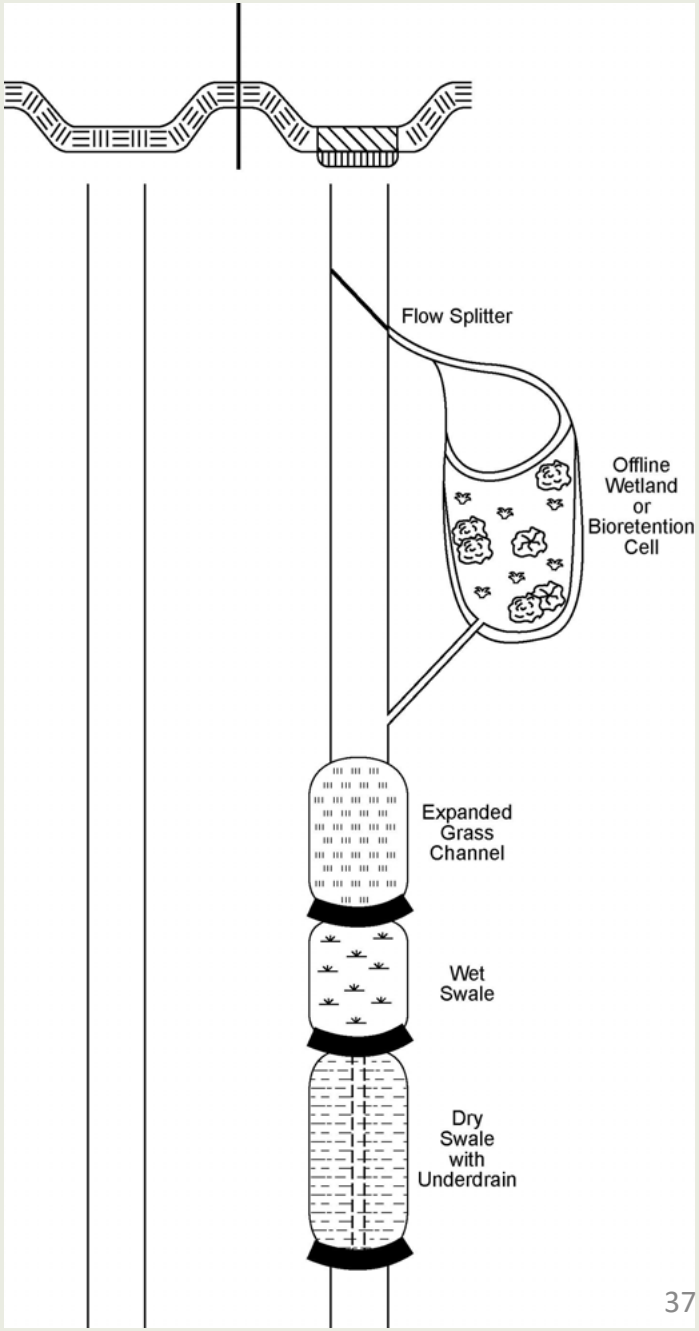
# Treatment in the Conveyance System

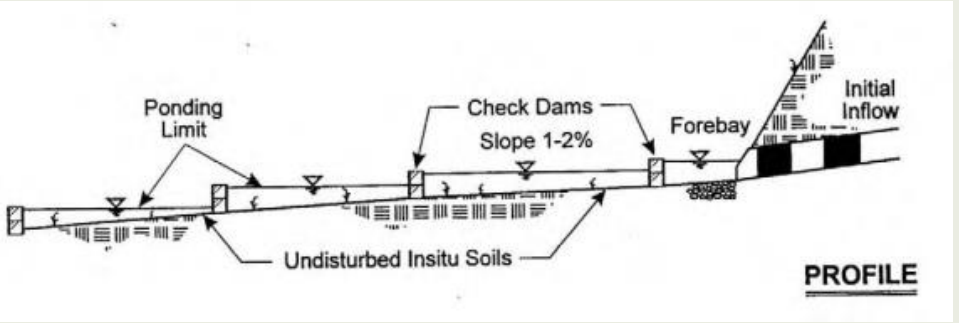
**Runoff Reduction**

- Dry Swale
- Linear series of bioretention cells
- Extending the flowpath
- Offline Bioretention

**Stormwater Treatment**

- Weirs or check dams to provide storage
- Wet swale/wetland
- Offline wetland




Ponding Limit
Check Dams
Slope 1-2%
Forebay
Initial Inflow
Undisturbed Insitu Soils
PROFILE

# Basic Design Process

- Estimate the runoff volume (Rv) for the drainage area, including any additional disconnected impervious cover.
- Estimate the WQv available.
- Verify that the channel has adequate hydraulic capacity to safely pass the design storm.
- Ensure that minimum residence time is achieved for the WQv design storm. Evaluate the channel geometry to ensure that flow spreads evenly over the bottom of the channel.
- Compute the runoff depth treated per impervious acre.
- Use the Retrofit Curves to determine N, P, and TSS load reductions.

## Stormwater Treatment (ST) In the Conveyance System Example

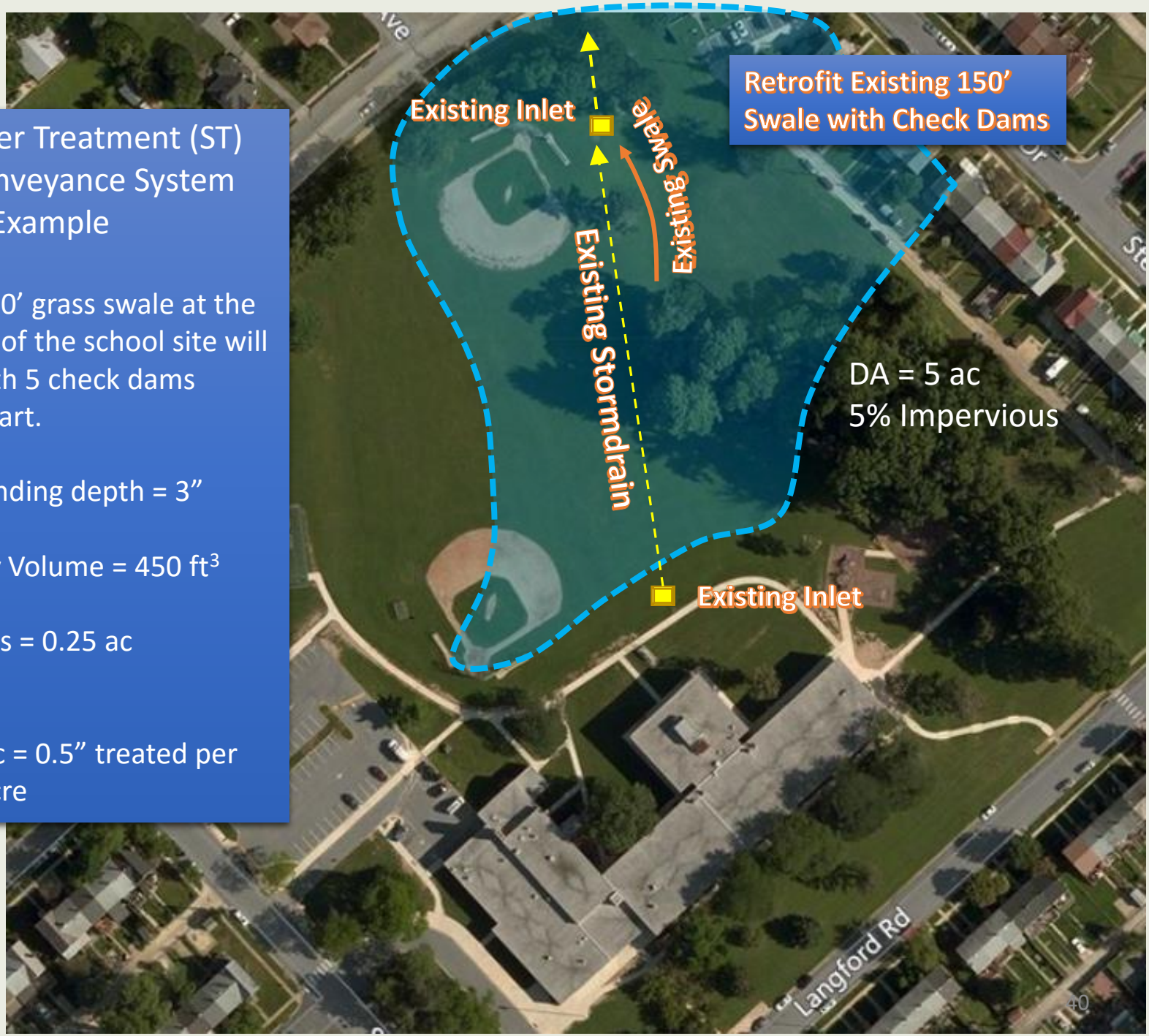
An existing 150’ grass swale at the northern end of the school site will be retrofit with 5 check dams spaced 30’ apart.

Maximum ponding depth = 3”

Water Quality Volume = 450 $ft^3$

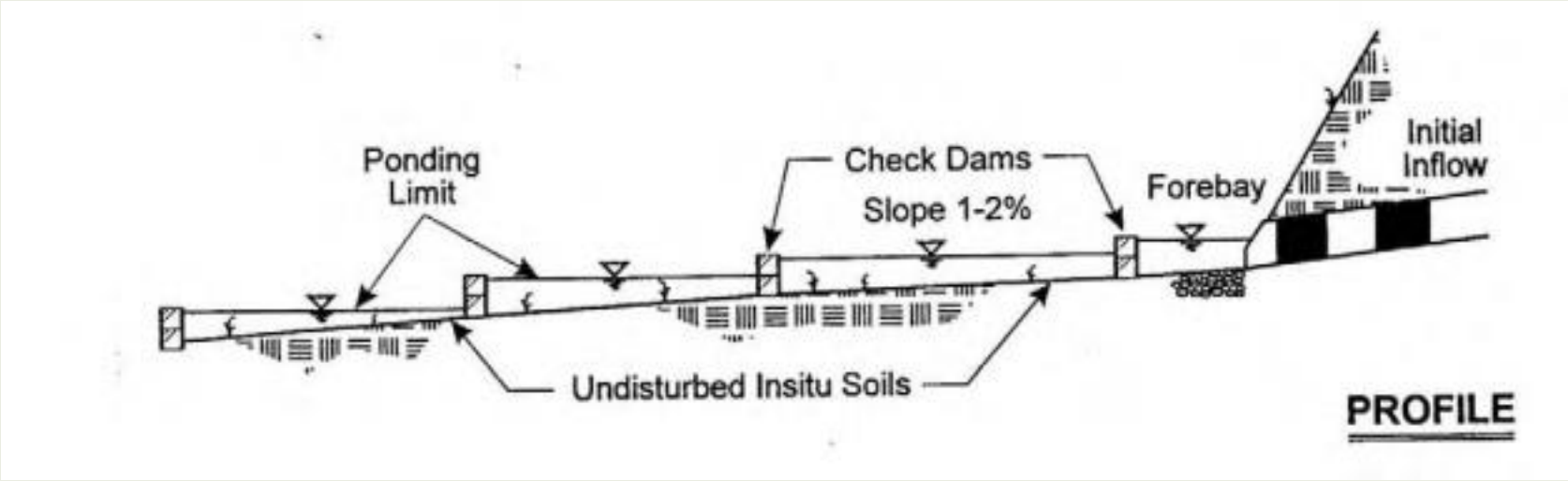
5% Impervious = 0.25 ac impervious

450$ft^3$/0.25 ac = 0.5” treated per impervious acre



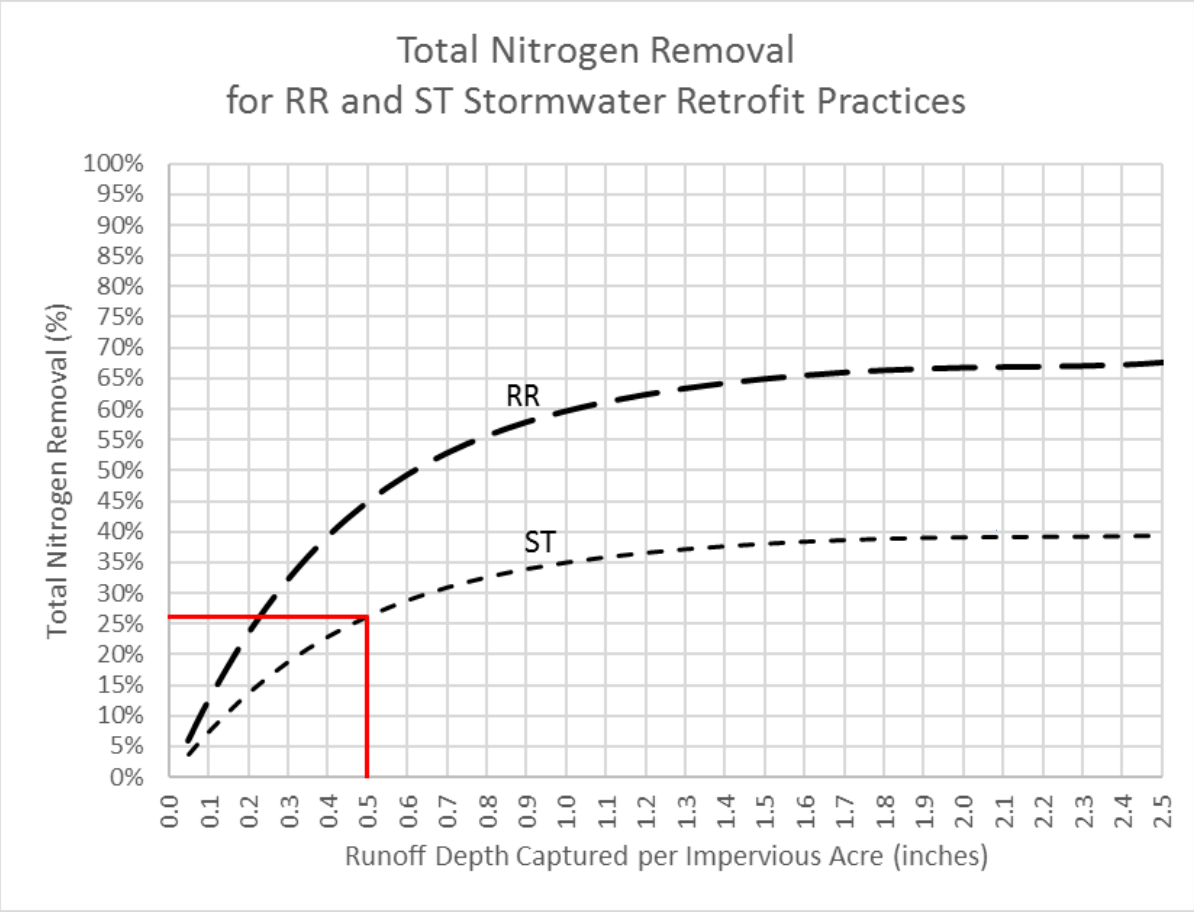
# Stormwater Treatment (ST) in the Conveyance System

- Storage in conveyance systems (i.e. ditches)
  - Calculate volume stored behind check dams and use the Stormwater Treatment (ST) curves
    - Treatment is relative to the impervious in the drainage area



# TN, TP, and TSS Reduction Associated with Stormwater Treatment

26% TN Removal




Recommendations of the Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects

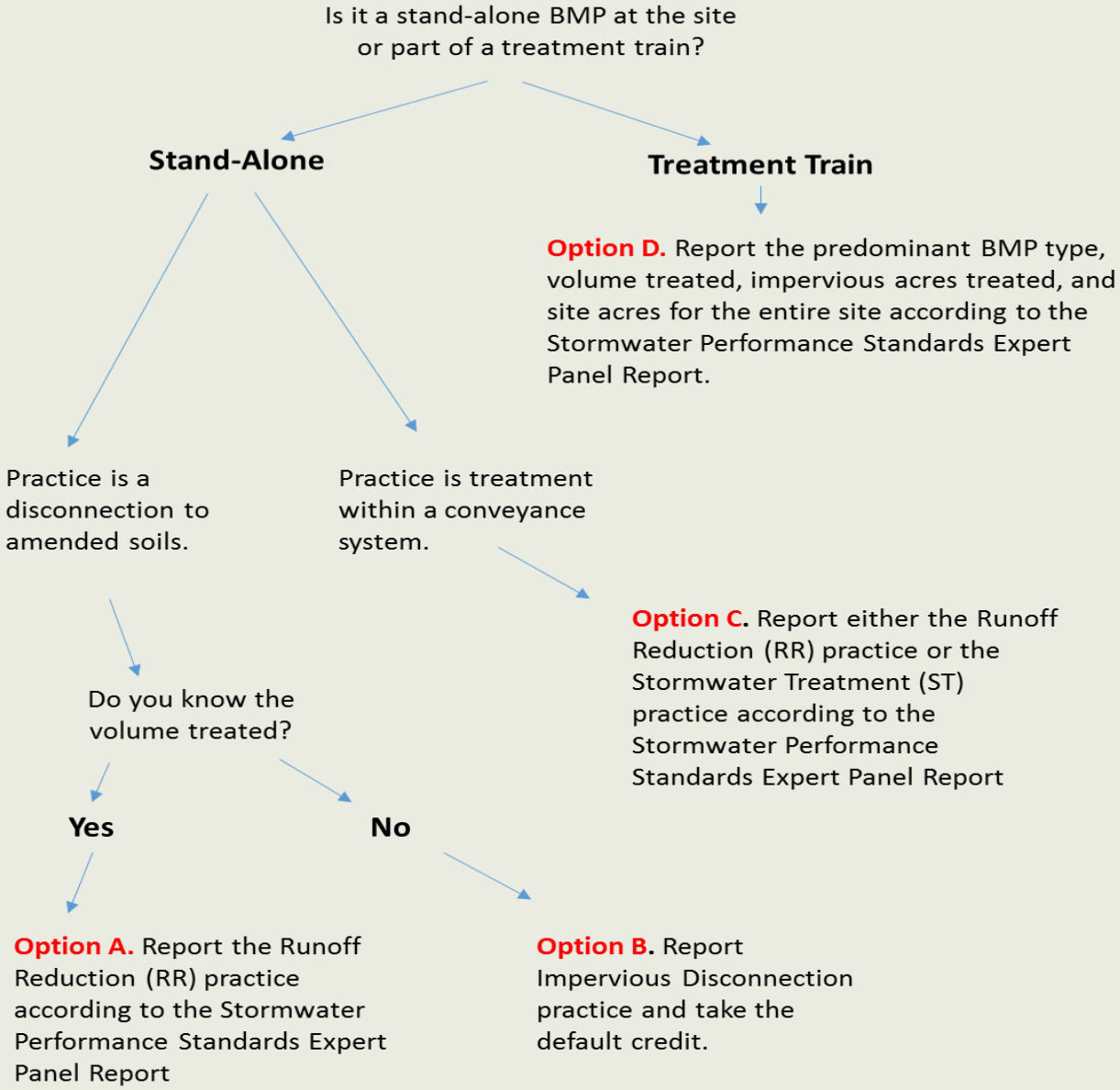
# Research Recommendations

- The restoration of existing ditches that include soil amendments.

An agricultural ditch expert panel is currently underway. Cross-coordination between the urban and agricultural workgroup sectors is recommended.

# Reporting the proposed BMPs in Phase 6

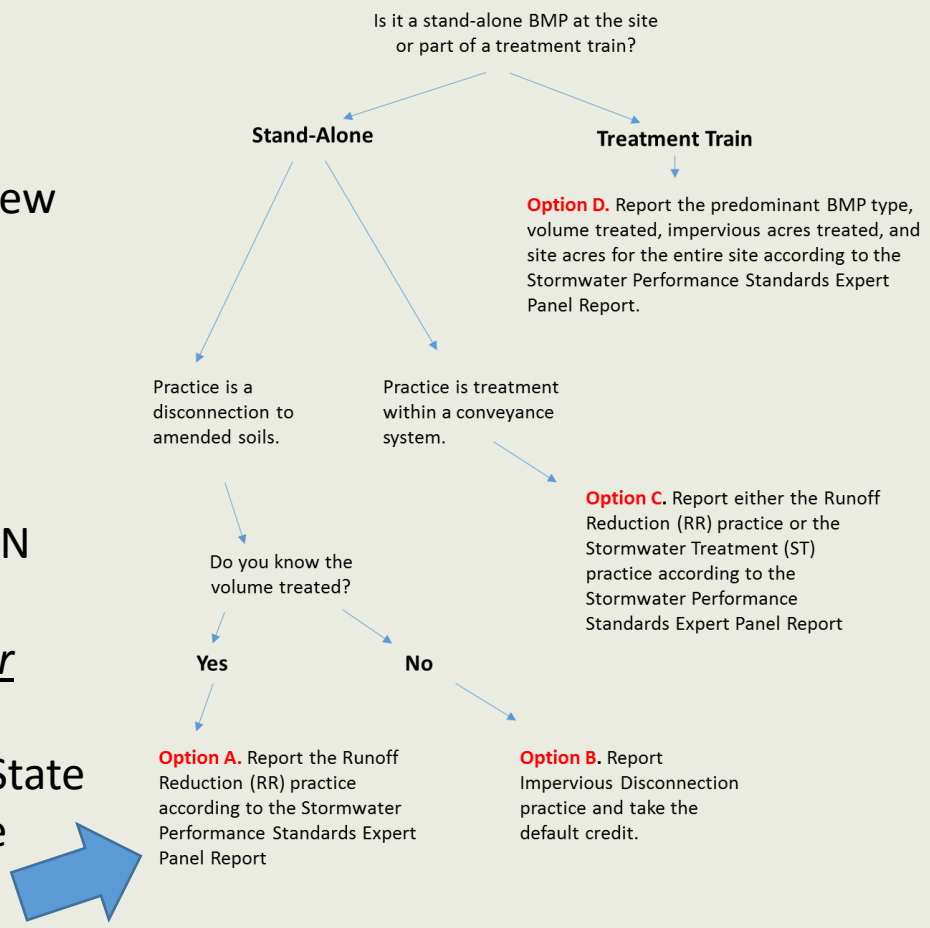
# Appendix D, Figure D1



# Option A

**Uses simplified or computational methods to determine the volume treated. Jurisdiction reports--**

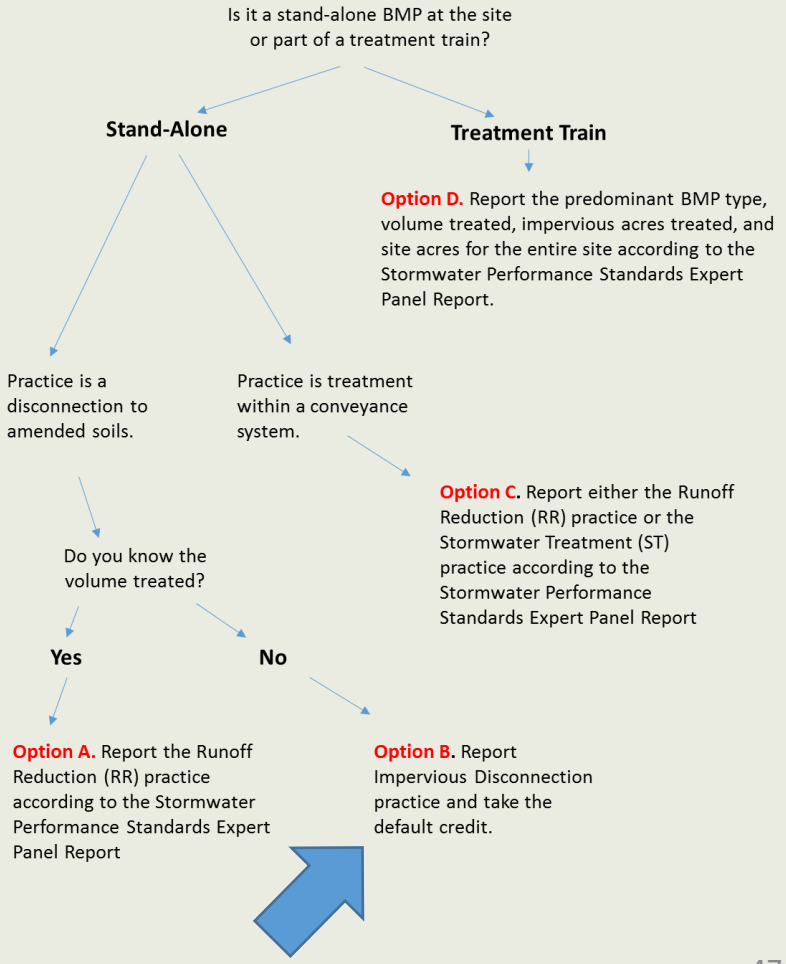
- *BMP Name:* Runoff Reduction (New or Retrofit)
- *Measurement Names:*
  - Site Area (Acres)
  - Impervious Area (Acres)
  - Volume (Acre Feet)
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the practice was installed
- *Land Uses:* Urban



# Option B

**Uses default credit. Jurisdiction reports--**

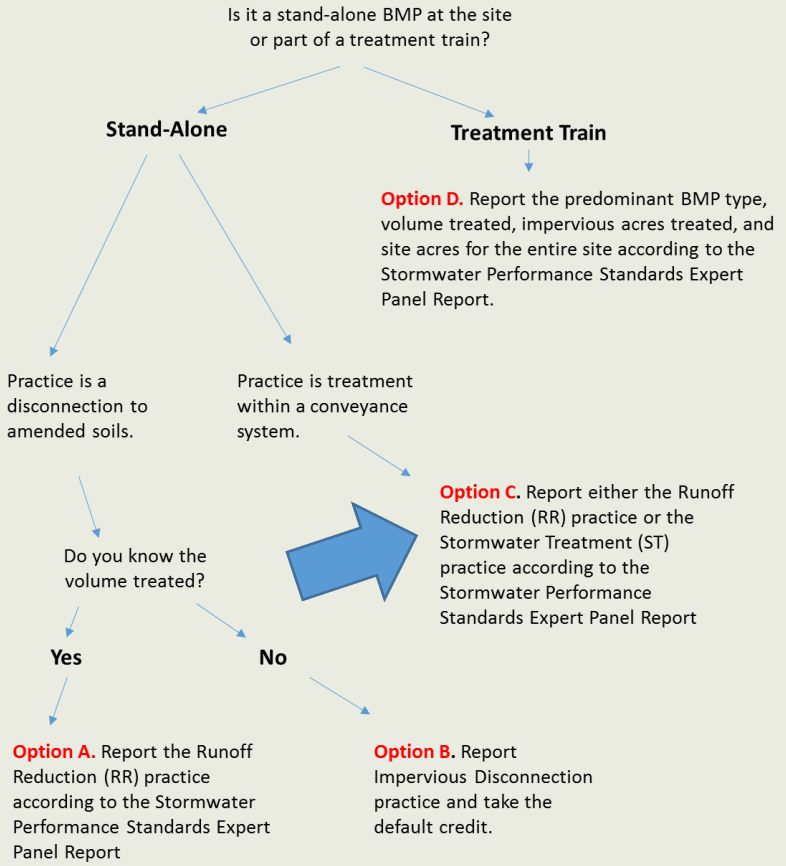
- *BMP Name:* Impervious Disconnection
- *Measurement Names:*
  - Impervious Area (Acres)
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the practice was installed
- *Land Uses:* Urban Impervious



# Option C

**Follow steps from Section 5.2. See Section 5.4.3 for examples. Jurisdictions report--**

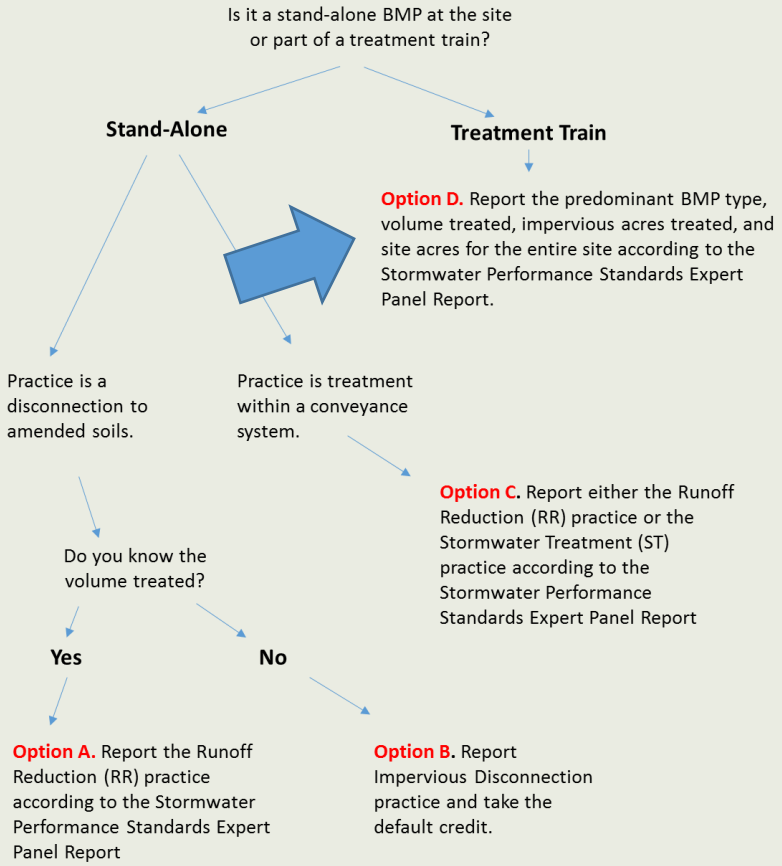
- *BMP Name:* Runoff Reduction (New or Retrofit)
- *Measurement Names:*
  - Site Area (Acres)
  - Impervious Area (Acres)
  - Volume (Acre Feet)
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the practice was installed
- *Land Uses:* Urban



# Option D

**Consider the BMP in conjunction with full treatment train. Jurisdictions report--**

- *BMP Name:* Runoff Reduction or Stormwater Treatment (New or Retrofit)
- *Measurement Names:*
  - Site Area (Acres)
  - Impervious Area (Acres)
  - Volume (Acre Feet)
- *Geographic Unit:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State
- *Date of Implementation:* Year the practice was installed
- *Land Uses:* Urban



# Others

**Disconnection of impervious area to un-treated soils**

- Considered as Urban Filter Strip; can be reported in accordance with that BMP as defined by CBP

**Amended soils, without impervious disconnection**

- Suggested for a future BMP expert panel (see research recommendations)

# Tentative timeline

- **May 16:** Panel's draft report released for CBP review (sent to WQGIT, USWG, WTWG, and advisory committees)
- **June 3:** Today's webinar
- **June 21**: Initial 30-day review period closes. Comments should be submitted to Jeremy Hanson (jchanson@vt.edu) and Bill Stack (bps@cwp.org) by close of business. Members or interested parties of any workgroup or committee are encouraged to submit their input by this date as it allows the best opportunity to effectively resolve substantive issues in a timely manner.
- **July 7:** Brief the WTWG
- **July 19:** Earliest potential date to seek USWG approval
- **August 4**: Earliest potential date to seek WTWG approval
- **August 22**: Earliest potential date to seek WQGIT approval

# Q&A

- First we'll review written questions from the chat box. Then we'll take verbal questions from participants. Please do not un-mute until asked to do so.
  - #6 to un-mute
  - *6 to mute. Please remember to mute when finished with your question. This will limit background noise on our recording. Thank you.

# THANK YOU FOR JOINING US

**Comments on report are request by close of business on Tuesday, June 21. Comments should be submitted to Jeremy Hanson** (jchanson@vt.edu) and Bill Stack (bpw@cwp.org).

Contact Jeremy with questions following today's webinar.

The webinar recording will be placed on the calendar entry soon:

http://www.chesapeakebay.net/calendar/event/23993