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DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Clean Water

BMP Effectiveness Values and Performance Standard Curves

MS4 Workshops – Pollutant Reduction and TMDL Stormwater Plans

Fall 2016

Tom Wolf, Governor

John Quigley, Acting Secretary

Training Goals

Describe BMP pollutant load removal calculations using:

1. Effectiveness Values Table
2. Performance Standards

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Why is this Important?

Calculations for pollutant load reduction occurs in two stages of the process:

1. Reductions from existing BMPs (optional)
2. Reductions from proposed BMPs to meet the target load reduction

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Methods - Effectiveness Values

1. DEP's BMP Effectiveness Values document (3800-PM-BCW0100m)

2. Chesapeake Bay Program Expert Panel Reports

3. For BMPs not listed in either of the above, MS4s may use effectiveness values from other technical resources; such resources must be documented in the PRP.

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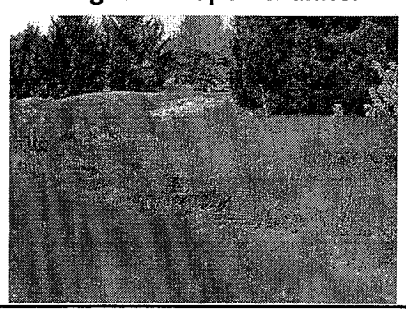
Method 1 - Effectiveness Values

BMP Name	BMP Effectiveness Values			BMP Description
	TN	TP	Sediment	
Infiltration Practices w/ Sand, Veg.	80%	85%	95%	A depression to form an infiltration basin whose sediment is trapped and water infiltrates the soil. Infiltrations are constructed with level bottom, and trenches, because by definition these systems provide complete infiltration. Design specifications require infiltration basins and trenches to be built in good soil, they are not constructed on poor soils, such as C and D soil types. Engineers are required to test the soil before approval to build is issued. To receive credit over the longer term, jurisdictions must conduct yearly inspections to determine if the basin or trenches is still infiltrating as well.
Filtering Practices	40%	60%	80%	Practices that capture and temporarily store runoff and pass it through a filter bed of either sand or an organic media. There are various sand filter designs, such as above ground, below ground perimeter, etc. An organic media filter uses another medium besides sand to enhance pollutant removal for many compounds due to the attraction via charge, chemistry active and by increasing the organic matter. These systems require yearly inspection and maintenance to receive pollutant reduction credit
Filter Strip Runoff Reduction	20%	54%	58%	Urban filter strips are stable areas with vegetated cover on flat or gently sloping land. Runoff entering the filter strip must be in the form of sheet flow and must enter at a maximum rate for the site-specific soil conditions. A 0-4 design rate of filter strip length to impervious flow length is recommended for runoff reduction urban filter strips.
Filter Strip Stormwater Treatment	0%	0%	22%	Urban filter strips are stable areas with vegetated cover on flat or gently sloping land. Runoff entering the filter strip must be in the form of sheet flow and must enter at a maximum rate for the site-specific soil conditions. A 0-2 design rate of filter strip length to impervious flow length is recommended for stormwater treatment urban filter strips.
Bioretention – Raingardens (C/D soils w/ underdrain)	25%	45%	55%	An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has an underdrain and is in C or D soil.
Bioretention / Raingardens (A/B soils w/ underdrain)	70%	75%	80%	An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has an underdrain and is in A or B soil.

How to Use the Effectiveness Values

Calculate the reductions from a vegetated open channel



How to Use the Effectiveness Values

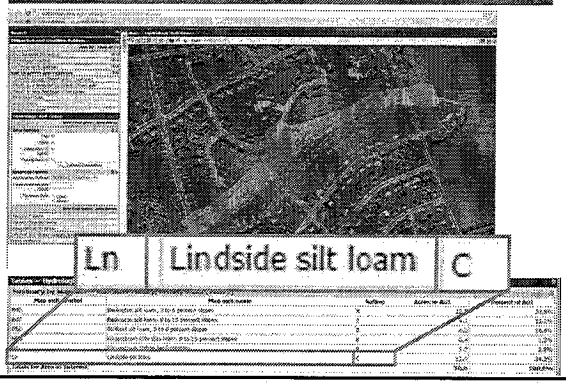
- Two sediment removal values for a vegetated open channel, depending on the soil type
- Hydrologic soil group must be determined

BMP Name	BMP Effectiveness Values			BMP Description
	TN	TP	Sediment	
Bioretention / Raingarden (A/B soils w/o underdrain)	80%	55%	80%	An excavated pit backfilled with engineered media, topsoil, mulch, and vegetation. These are planting areas installed in shallow basins in which the storm water runoff is temporarily ponded and then treated by filtering through the bed components, and through biological and biochemical reactions within the soil matrix and around the root zones of the plants. This BMP has no underdrain and is in A or B soil.
Vegetated Open Channels (C/D Soils)	10%	10%	30%	Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils. This BMP has no underdrain and is in C or D soil.
Vegetated Open Channels (A/B Soils)	45%	45%	70%	Open channels are practices that convey stormwater runoff and provide treatment as the water is conveyed, includes bioswales. Runoff passes through either vegetation in the channel, subsoil matrix, and/or is infiltrated into the underlying soils. This BMP has no underdrain and is in A or B soil.
Bioswale	70%	75%	80%	With a bioswale, the load is reduced because, unlike other open channel designs, there is now treatment through the soil. A bioswale is designed to function as a bioretention area.

Vegetated Open Channels (C/D Soils)

Vegetated Open Channels (A/B Soils)

USDA Web Soil Survey



How to Use the Effectiveness Values

Now we know with C soils the effectiveness value for sediment is 50%

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	TN	TP	Sediment	
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How to Use the Effectiveness Values

We now need to determine what is draining to and being treated by the proposed BMP

1. Analysis yields that 27 acres is being treated by the vegetated open channel
2. The 27 acres is composed of
   - 9 impervious acres
   - 18 pervious acres

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How to Use the Effectiveness Values

- Please recall that the existing loading values are located in Attachment B of the PRP Instructions
- For our example we will use sediment loading rates for Dauphin County

3800-PM-BCW0100A 5/2016
PRP Instructions

ATTACHMENT B

DEVELOPED LAND LOADING RATES FOR PA COUNTIES[1,2,3]

County	Category	Acres	TN lbs/acre/yr	TP lbs/acre/yr	TSS (Sediment) lbs/acre/yr
Dauphin	impervious developed	3,462.4	28.59	1.07	1,999.14
	pervious developed	9,405.8	21.24	0.34	299.62

How to Use the Effectiveness Values

Total estimated pollutant load draining to the BMP

9 impervious acres	✖	1,999.14 lb/ac/yr	=	17,992.26 lb/yr
18 pervious acres	✖	299.62 lb/ac/yr	=	5,393.16 lb/yr
				23,385.16 lb/yr

50% (0.5) sediment removal effectiveness value

23,385 lb/yr X 0.5 = 11,693 lb/yr

How to Use the Effectiveness Values

23,385 lb/yr into the vegetated open channel

11,692 lb/yr discharging from the channel

11,693 lb/yr removed by the channel

Method 2 - Expert Panel Reports

Four key expert panel reports:

1. Performance Standards
2. Urban Stormwater Retrofit Projects
3. Individual Stream Restoration Projects
4. Street and Storm Drain Cleaning Practices

BMP effectiveness values are being phased out and replaced by expert panel methodologies

Performance Standard Curves

Advantages:

1. Provides a simple method to account for the type of BMP and the flow to that BMP
2. Approved by the Chesapeake Bay Program

PA DEP Stormwater Man. Chapter 8

PA	Divide 2-year Volume Increase of Runoff Volume between the proposed conditions and the existing conditions (cubic feet) by 43,560 and insert into Equation X	Cell C-51 in Tab WS4 of 2012 CSN PA Stormwater Spreadsheet

Equation X is a site-specific conversion factor equation:

$$= \frac{(12 * EP)}{IA}$$

Where:
EP = State-Specific Engineering Parameter (in acre-feet)
IA = Impervious Area (acres)

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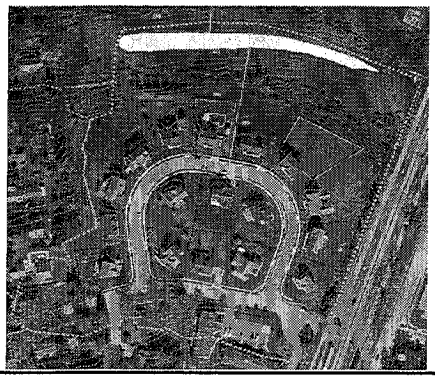
Performance Standard Curves

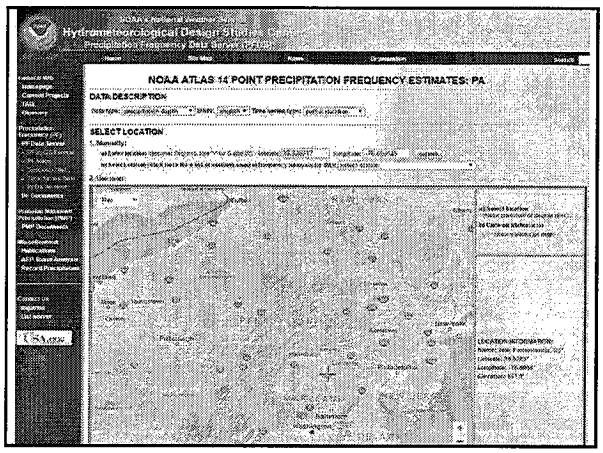
- Curves can be used for any volume of water treated
- If used for new development requiring an NPDES permit, or for existing BMPs constructed for NPDES compliance after November of 2010, the 2-year 24-hour storm will be the runoff volume used

Performance Standard Curves

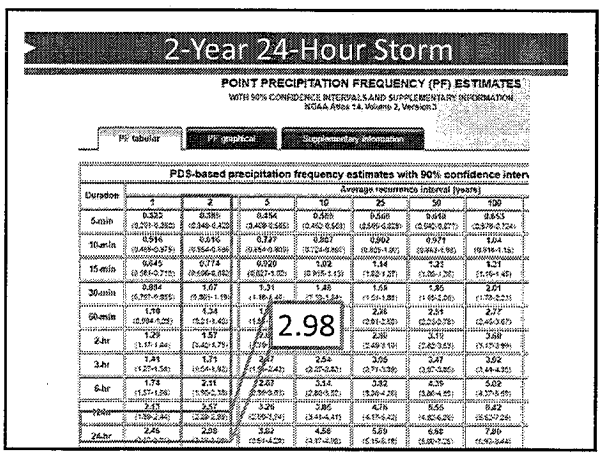
1. Determine volume treated
2. Calculate EP
3. Insert into Equation X
4. Determine if runoff reduction (RR) or stormwater treatment (ST)
5. Determine removal efficiency from the appropriate curve
6. Apply % Removal

Method 2 – York Twp Example

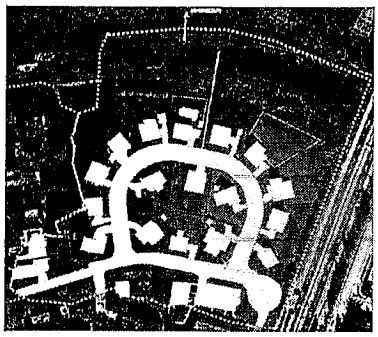




2-Year 24-Hour Storm

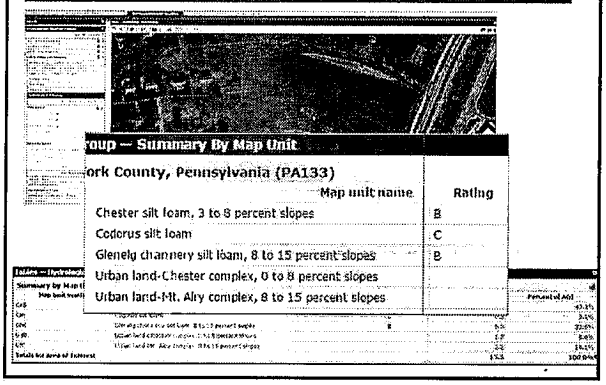


Example



The drainage area to the BMP is composed of 4.3 acres of impervious area and 10.8 acres of pervious area

USDA Web Soil Survey



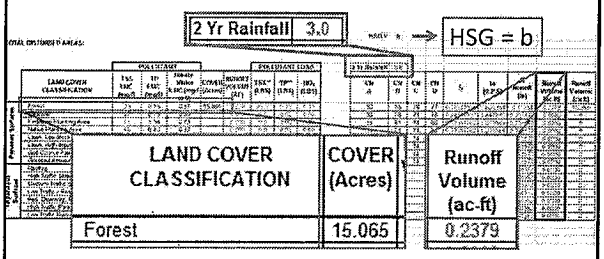
roup — Summary By Map Unit

ork County, Pennsylvania (PA133)

Map unit name	Rating
Chester silt loam, 3 to 8 percent slopes	B
Codorus silt loam	C
Glenelg channery silt loam, 8 to 15 percent slopes	B
Urban land-Chester complex, 0 to 8 percent slopes	
Urban land-Mt. Airy complex, 8 to 15 percent slopes	

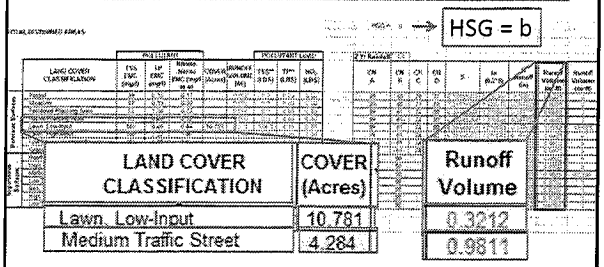
Pre Runoff Volume

Example assumes the site has only B soils



Predevelopment conditions = 0.2379 ac-ft of runoff volume

Post Runoff Volume



LAND COVER CLASSIFICATION	COVER (Acres)	Runoff Volume
Lawn, Low-Input	10.781	0.3212
Medium Traffic Street	4.284	0.9811

Post-development conditions = 1.3023 ac-ft of runoff volume

Impervious area (IA) = 4.284 ac

Using Equation X

EP = Post - Predevelopment volume increase
EP = 1.3023 ac-ft - 0.2379 ac-ft
EP = 1.0644 ac-ft
Post-dev impervious acres (IA) = 4.284 ac

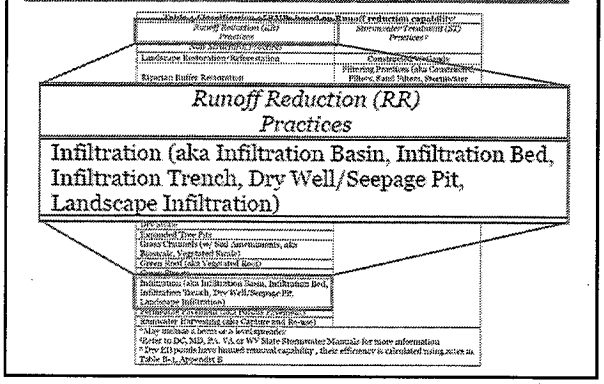
Insert into Equation X

$$\text{X-axis} = \frac{(12 * EP)}{IA}$$

X = [12(in/ft) * 1.0644 ac-ft] / 4.284 ac
X = 2.98 in

Coincidence (^_^) That it corresponds to 2-yr. rainfall

RR or ST?



Performance Standard Curve

90%

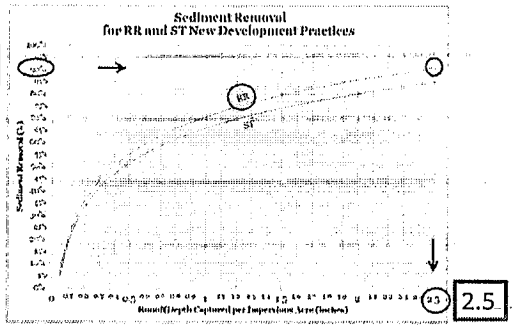


Figure 3. New BMP Removal Rate Adjustor Curve for Sediment

Calculate Load to BMP

- Impervious area = **4.284 ac**
- Pervious area = **10.781 ac**
- Impervious sediment load:

  4.284 ac X 1,614.15 lb/ac/yr = 6914.929 lb/yr
- Pervious sediment load:

  10.781 ac X 220.4 lb/ac/yr = 2376.112 lb/yr
- Total sediment load:

  6914.929 lb/yr + 2376.112 lb/yr = **9291 lb/yr**

Apply Percent Removal

- Curve yields 90% sediment removal
- Apply 90% removal to post-development load

  9,291 lb/yr * 0.90 = **8,361.9 lb/yr** removed
- Remaining discharge

  9,291 lb/yr – 8,361 lb/yr = 929.1 lb/yr

9,291 lb/yr sediment IN →  → **929.1 lb/yr** sediment OUT

Model Methodology

Appendix 1 Preliminary Existing Loading without Accounting for Existing BMPs

Sewershed	Impaired	Sediment Loading w/o BMP (lb/yr)
1	Y	9,283.04
2	Y	5,013.10
3	Y	84,690.22
4		449.44
5		26,437.13
6		2,916.97
7		44,700.92
8	Y	2,525.87
9		9,673.63
11		22,265.65
12	Y	5,240.06
13	Y	9,617.15
14	Y	1,783.50
15	Y	3,660.05
16	Y	1,969.65
17	Y	945.76

Existing Loading Summary

- Total Sediment Load without accounting for existing BMPs:
  362,118 lb/yr
- Sediment removed from the existing load calculations by BMPs:
  115,419 lb/yr
- Overall existing load for "Model Municipality":
  362,118 lb/yr – 115,419 lb/yr = **246,699 lb/yr**

Local Impaired vs Bay

- Appendix D & E requirements
- Meet local impairment requirements first
- Local impairment reduction also count for Bay
- Divide list of storm sewersheds into Local Impairment and Bay
- Calculate reduction requirements for each

Total → **Local Impaired**, **Bay**

Required Reductions

1. Existing load to locally impaired sewershed areas is 126,698 lb/yr
   - Required reduction from locally impaired waters
     126,698 lb/yr * 0.10 = 12,670 lb/yr
2. Existing load to Bay sewershed areas is 120,001 lb/yr
   - Required reduction from Bay sewersheds are
     120,001 lb/yr * 0.10 = 12,000 lb/yr

Summary

1. Describe BMP pollutant load removal calculations using the Effectiveness Values Table
2. The Performance Standard Approach

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Crediting Reductions to Current Load and 2023 Goal

BMP Reductions to Current Load		BMP Credit to 2023 Goal	
Allow crediting of BMPs currently operating as designed?[1] (all, including 102s)	Yes	N/A	N/A
Allow crediting of BMPs currently providing less than design level of WQ treatment?[2] (all, including 102s)	Yes[3] (requires the permittee to calculate the current reduction)	Credit retrofits (net improvement[4]) of 102s?	No. BMP should have been maintained
		Credit retrofits (net improvement [5] of non-102s?	Yes

[1] Using the CB Performance Curve methodology
[2] Same as 1
[3] Allow this here rather than as part of the credit against the 10% goal
[4] To whatever degree it was functional it could have been used to reduce the current load
[5] Same as 4