BMP Enhancement and Conversions (Retrofits)

Enhancements

- Utilizes the original stormwater treatment mechanism but improves removal by:
  - Increasing storage volume
  - Increasing hydraulic residence time
  - Extended flow path
  - Adds internal design features to enhance overall nutrient and/or sediment reduction
- Example of a BMP enhancement is an upgrade older stormwater pond built under less stringent sizing and design standards

BMP Enhancement: by adding a berm you can increase the flow path thereby extending the hydraulic retention time within the practice leading to better treatment.

Conversions

- Involves redesign of an existing BMP such as converting a dry pond into a constructed wetland or wet pond
- BMP conversions can utilize a wide range of stormwater treatment mechanisms

BMP Conversion: from a Dry Pond (left) to a Constructed Wetland (right) to allow for more effective treatment of stormwater.

Restoration

- Applies to major maintenance to existing BMPs that have either failed or lost their original stormwater treatment capacity.
- Under current guidance reduced capacity resulting from routine maintenance not being performed does not qualify for credit

BMP Restoration: increasing performance of a BMP by conducting major repairs or upgrades. In this example, an underperforming pond is dredged for sediment thereby restoring it to its full performance capacity.

Enhancement and Conversion Credit

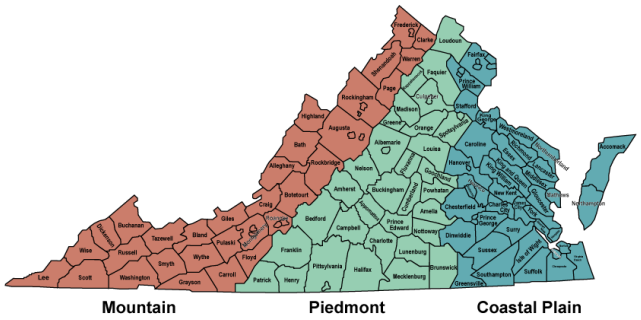
- Removal credit based on enhanced or converted BMP removal subtracted from the existing BMP pollutant removal
- VA BMP Clearinghouse efficiencies, Bay Program efficiencies, or Retrofit Curves can be used
- For more information see Bay Program *Recommendations of Expert Panel to Define Removal Rates for Urban Stormwater Retrofit Projects (10/9/12)*

Enhancement and Conversion Prioritization

- The 2013-2018 Phase II MS4 General Permit requires the BMP Tracking database to include pervious and impervious acres treated (Section II.B.5.e.3)
- The updated database can be used to create weighted ranking system for retrofit planning with following factors considered:
  - Feasibility: ownership, adjacent property, right-of-way, and easement issues
  - Total acres treated
  - Impervious acres treated
  - Enhancement and conversion efficiency
- A weighted ranking system can assist localities with determining the lowest cost per pound of pollutant removal for BMP enhancements and conversions

Wet Pond 1 to Wet Pond 2 Enhancement

- Existing wet pond 1 planned to be upgraded to meet wet pond 2 criteria for Virginia BMP Clearinghouse design specs
- Drainage area
  - 22 acres total
  - 7.5 acres impervious
  - 14.5 acres pervious
  - All land treated is regulated
- Project located in a coastal plain within the James River Basin
- Use loading rates from General Permit Table 2a
- Wet *Pond 1 Removal efficiencies :*
  - *20% TN*
  - *45% TP*
  - *55% TSS*
- Wet Pond 2 Removal efficiencies :
  - 30% TN
  - 65% TP
  - ? TSS

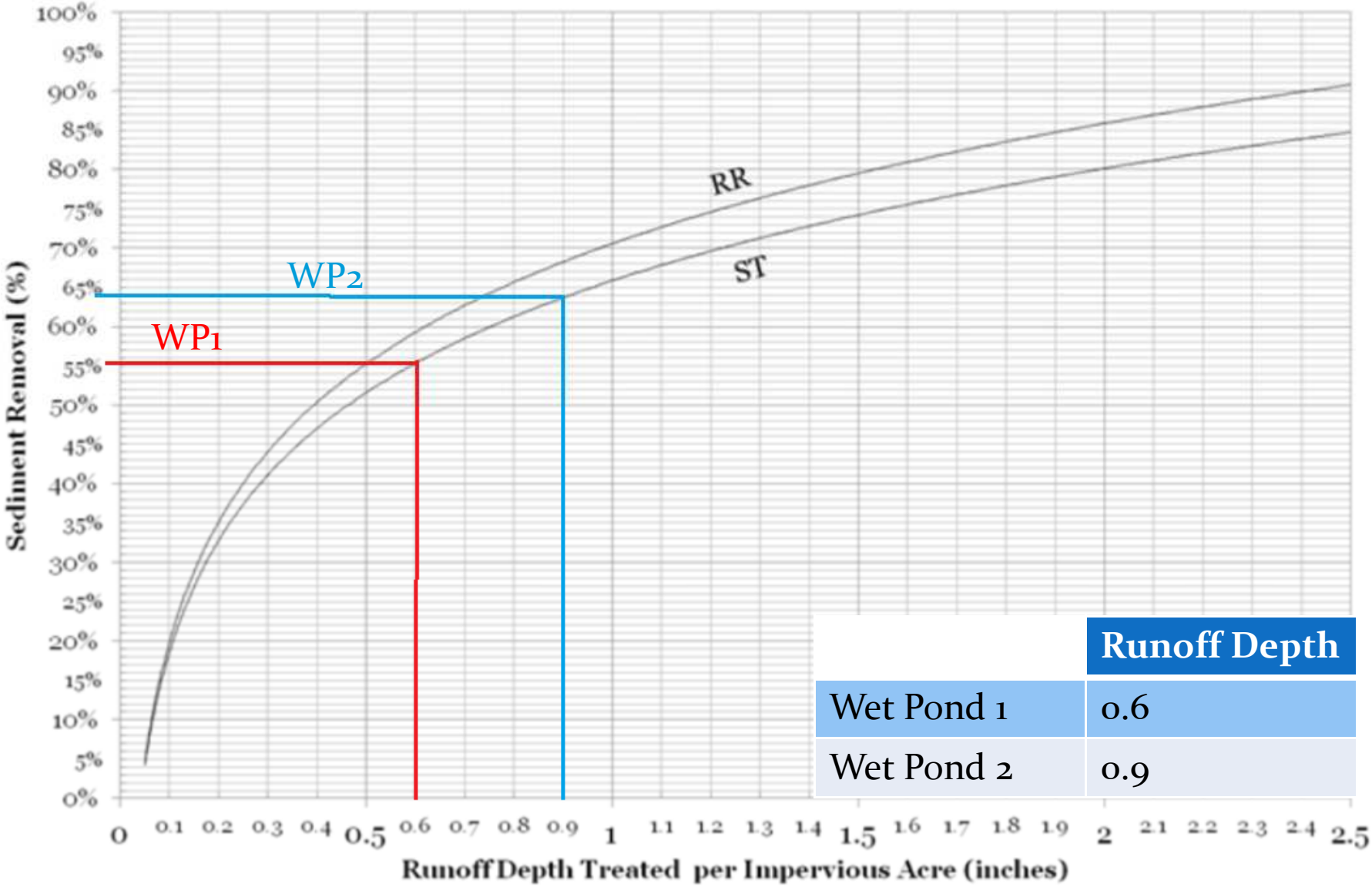


Existing Wet Pond 1 (WP1) to Wet Pond 2 (WP2) Enhancement

- Impervious Load: Multiply impervious acres by impervious loading rate
- Pervious Load: Multiply pervious acres by pervious loading rate
- BMP Load: Add impervious and pervious loads
- WP2 Sediment Efficiency: Use curves to find sediment removal efficiency (Bay TMDL Action Plan Guidance Figure 3)

	Impervious			Pervious			
	Area (acres)	Loading Rate (lb/yr)	Load (lb/yr)	Area (acres)	Loading Rate (lb/yr)	Load (lb/yr)	BMP Load (lb/yr)
TN	7.5	9.39	70.4	14.5	6.99	101.4	171.8
TP	7.5	1.76	13.2	14.5	0.5	7.3	20.5
TSS	7.5	676.94	5077.1	14.5	101.08	1465.7	6542.8

Sediment Removal for RR and ST Stormwater Retrofit Practices



	Runoff Depth
Wet Pond 1	0.6
Wet Pond 2	0.9

Existing Wet Pond 1 (WP1) to Wet Pond 2 (WP2) Enhancement

- WP1 Reduction: Multiply total load by WP1 efficiency
- WP2 Reduction: Multiply total load by WP2 efficiency
- Reduction Credit from Enhancement: Subtract WP1 reduction from WP2 reduction

		Wet Pond 1		Wet Pond 2		Reduction Credit from Enhancement (lb/yr)
	Total Load (lb/yr)	Efficiency	Reduction (lb/yr)	Efficiency	Reduction (lb/yr)	
TN	171.8	20%	34.4	30%	51.5	17.1
TP	20.5	45%	9.2	65%	13.3	4.1
TSS	6542.8	55%	3598.5	64%	4187.4	588.9

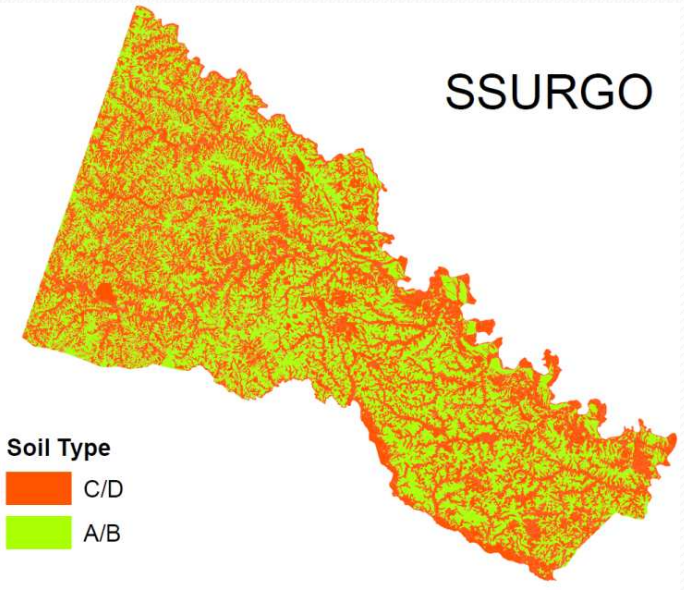
Existing Wet Pond 1 (WP1) to Wet Pond 2 (WP2) Enhancement

- Remaining Reduction Needed: Subtract reduction credit from enhancement from total load

	Total Load (lb/yr)	Reduction Credit from Enhancement (lb/yr)	Remaining Reduction Needed (lb/yr)
TN	178.6	17.1	161.5
TP	31.5	4.1	27.4
TSS	17087.6	588.9	16498.7

Existing Dry Extended Detention Pond (DED) to Bioretention with Underdrain (BR/U) Conversion

- Existing DED planned to be converted to meet Bay Program criteria for BR/U
- Located in A/B soils within the James River Basin
- DED drainage area
  - 2.1 acres total
  - 0.7 acres impervious
  - 1.4 acres pervious
  - All land treated is regulated
- Use the loading rates from General Permit Table 2a
- DED Removal efficiencies :
  - 20% TN
  - 20% TP
  - 60% TSS
- BR/U Removal efficiencies:
  - 70% TN
  - 75% TP
  - 80% TSS



Existing Dry Extended Detention Pond (DED) to Bioretention with Underdrain (BR/U) Conversion

- Impervious Load: Multiply impervious acres by impervious loading rate
- Pervious Load: Multiply pervious acres by pervious loading rate
- BMP Load: Add impervious and pervious loads

	Impervious			Pervious			
	Area (acres)	Loading Rate (lb/yr)	Load (lb/yr)	Area (acres)	Loading Rate (lb/yr)	Load (lb/yr)	BMP Load (lb/yr)
TN	0.7	9.39	6.6	1.4	6.99	9.8	16.4
TP	0.7	1.76	1.2	1.4	0.5	0.7	1.9
TSS	0.7	676.94	473.9	1.4	101.08	141.5	615.4

Existing Dry Extended Detention Pond (DED) to Bioretention with Underdrain (BR/U) Conversion

- DED Reduction: Multiply total load by DED efficiency
- BR/U Reduction: Multiply total load by BR/U efficiency
- Reduction Credit from Conversion: Subtract DED reduction from BR/U reduction

		DED		BR/U		Reduction Credit from Conversion (lb/yr)
	Total Load (lb/yr)	Efficiency	Reduction (lb/yr)	Efficiency	Reduction (lb/yr)	
TN	16.4	20%	3.3	70%	11.5	8.2
TP	1.9	20%	0.4	75%	1.4	1.0
TSS	615.4	60%	369.2	80%	492.3	123.1

Existing Dry Extended Detention Pond (DED) to Bioretention with Underdrain (BR/U) Conversion

- Remaining Reduction Needed: Subtract reduction credit from enhancement from total load

	Total Load (lb/yr)	Reduction Credit from Enhancement (lb/yr)	Remaining Reduction Needed (lb/yr)
TN	178.6	8.2	170.4
TP	31.5	1.0	30.5
TSS	17087.6	123.1	16964.5

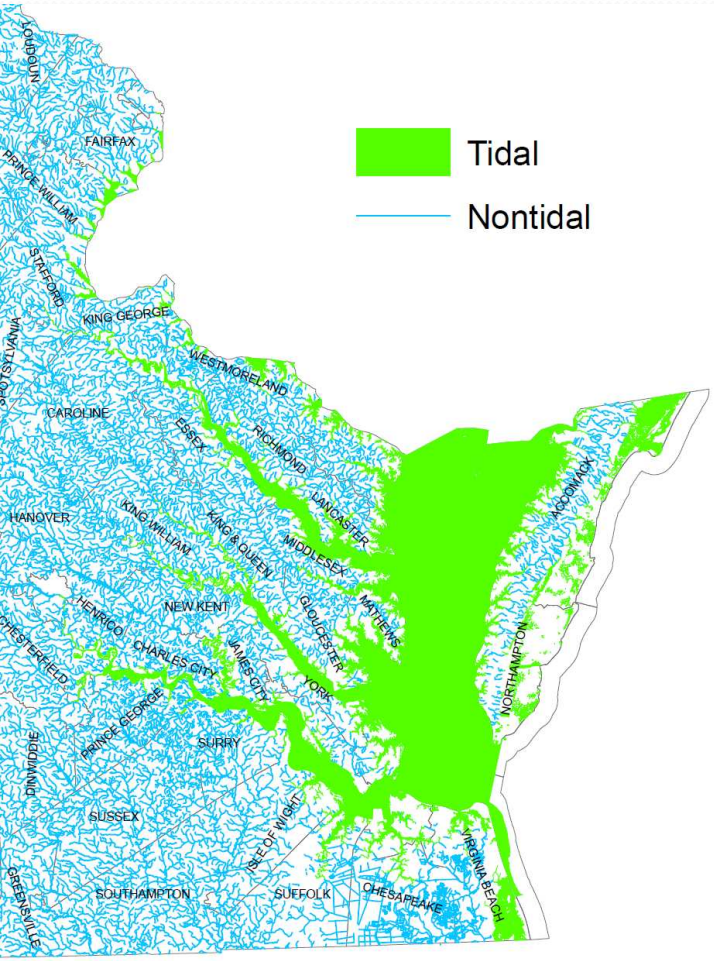
Urban Stream Restoration

Latest Default Removal Rates

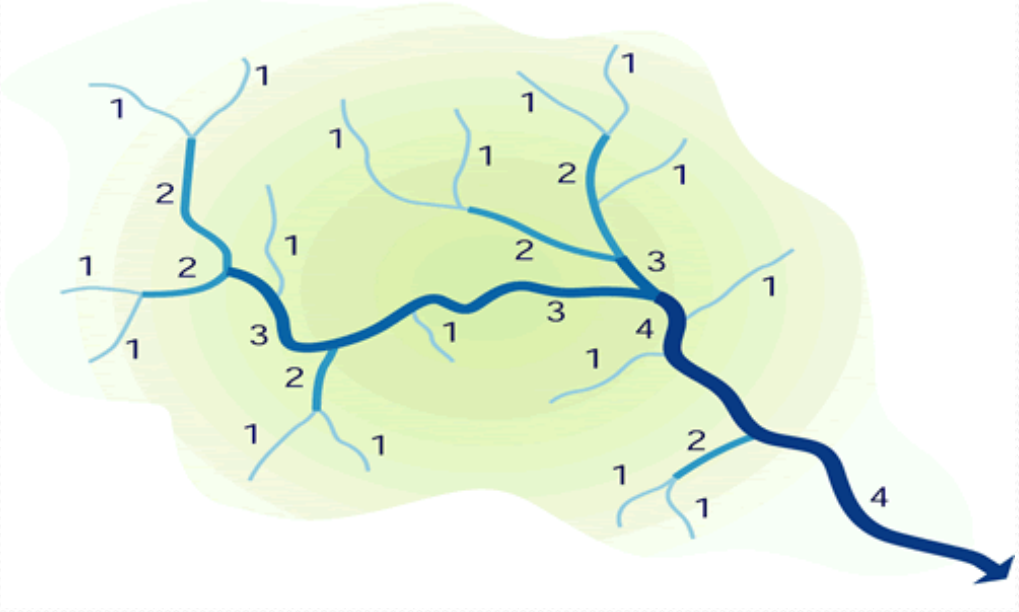
BMP Type	How Credited	TN	TP	TSS
Stream Restoration	Mass Reduction/length (lbs/linear ft)	0.075	0.068	44.88 noncoastal plain
				15.13 coastal plain

- TSS removal rate updated to 15.13 for coastal plain (44.88 for noncoastal plain)
- For Projects Implemented since June 30, 2009
- Rates may only be applied to ephemeral, intermittent, and perennial 0-3rd order streams
- Credit cannot be received for stream sections that are tidally influenced
- See Bay Program *Recommendation of the Expert Panel Report to Define Removal Rates for Individual Stream Restoration Projects (9/8/2014 revision)*

Stream Order and Tidal Streams

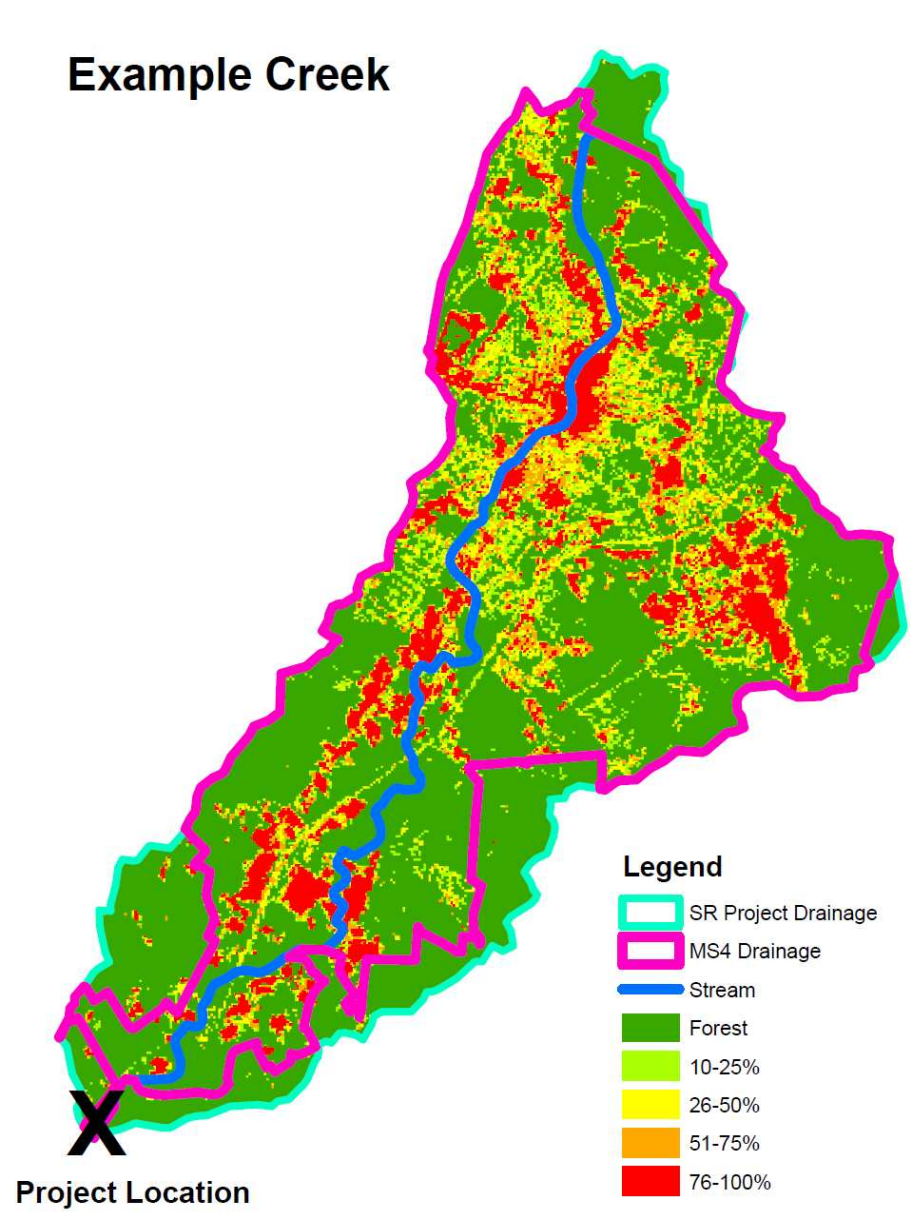


- Assigns each headwater perennial stream an order of 1, and then at the confluence of two 1st-order streams assigns the downstream reach an order of 2
- The confluence of two 2nd-order streams results in a downstream reach of order 3, and so on



Stream Drainage Area, Regulated Area, and Land Cover Characterization

- Delineate the project drainage to restored stream segment
- Delineate regulated and unregulated lands
- Characterize land cover:
  - Impervious acres
  - Pervious acres
  - Forested acres



- Located in coastal plain and Potomac Basin
- Stream restoration project restoring 4000 linear feet
- Project drainage area is 2031.9 acres
- 393.8 impervious acres
- 253.2 pervious acres
- 1384.9 forested acres

STEP 1: Reduction Values

- Estimated Project Reductions: Multiply stream length restored by the default removal rates
- Stream length restored = 4000 linear feet

	Default Removal Rate	Estimated Project Reductions * (lb/yr)
TN	0.075	300
TP	0.068	272
TSS	15.13	60520

* Estimated Project Reductions before forested lands are removed and unregulated baseline load is met

STEP 2: Regulated and Unregulated Land Cover Ratios

- Sum of regulated acres
- Sum of unregulated acres
- Ratio to Total Drainage Area: Divide regulated and unregulated acres by project drainage area
- Project drainage area = 2031.9 acres

	Regulated Acres	Unregulated Acres	Forested Acres	Total Acres
Impervious Acres	378.7	15.1	-	393.8
Pervious Acres	215.6	37.6	1384.9	1638.1
Total Acres	594.3	52.7	1384.9	2031.9
Ratio to Total Drainage Area	0.29	0.03	0.68	1.0

MS4 General Permit Tables

Table 3b: Calculation Sheet for Determining Total POC Reductions Required During this Permit Cycle for the Potomac River Basin
***Based on Chesapeake Bay Program Watershed Model Phase 5.3.2**

Subsource	Pollutant	Total Existing Acres Served by MS4 (6/30/09)	First Permit Cycle Required Reduction in Loading Rate (lbs/acre)	Total Reduction Required First Permit Cycle (lbs/yr)
Regulated Urban Impervious	Nitrogen		0.08	
Regulated Urban Pervious			0.03	
Regulated Urban Impervious	Phosphorus		0.01	
Regulated Urban Pervious			0.001	
Regulated Urban Impervious	Total Suspended Solids		11.71	
Regulated Urban Pervious			0.77	

STEP 3: Unregulated Baseline Load

- 5% Baseline Rate: Use Table 3b
- Full Baseline Rate: Multiply values in table 3b by 20
- Impervious Baseline Load: Multiply unregulated impervious acres by impervious full baseline rate
- Pervious Baseline Load: Multiply unregulated pervious acres by pervious full baseline rate
- Unregulated Baseline Load: Add unregulated pervious and impervious baseline loads

	Unreg. Imp. Ac	Unreg. Perv. Ac	Impervious lb/yr			Pervious lb/yr			Unreg. Baseline Load (lb/yr)
			5% Baseline Rate	Full Baseline Rate	Baseline Load	5% Baseline Rate	Full baseline Rate	Baseline Load	
TN	15.1	37.6	0.08	1.6	24.2	0.03	0.6	22.6	46.8
TP	15.1	37.6	0.01	0.2	3.0	0.001	0.02	0.8	3.8
TSS	15.1	37.6	11.71	234.2	3536.4	0.77	15.4	579.0	4115.4

STEP 4: Unregulated Reduction Credits

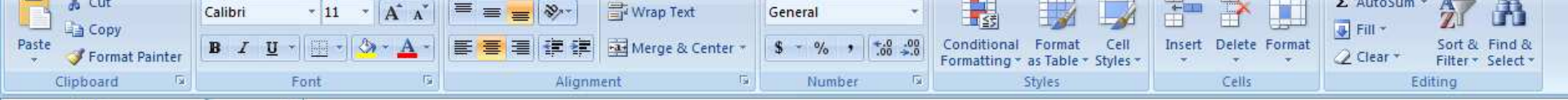
- Unregulated reductions: Multiply unregulated ratio by estimated project reductions
- Unregulated credit: Subtract unregulated baseline load from unregulated reductions

	Estimated Project Reductions (lb/yr)	Unregulated Ratio	Unregulated Baseline Load (lb/yr)	Unregulated Reductions (lb/yr)	Unregulated Credit (lb/yr)
TN	300	0.03	46.8	9	-37.8
TP	272	0.03	3.8	8.2	4.4
TSS	60520	0.03	4115.4	1815.6	-2299.8

STEP 5: Total Reduction Credits

- Regulated Credit: Multiply regulated land cover ratio by estimated project reductions
- Total Credit: Add unregulated credit and regulated credit

	Estimated Project Reductions (lb/yr)	Regulated Ratio	Unregulated Credit (lb/yr)	Regulated Credit (lb/yr)	Total Credit (lb/yr)
TN	300	0.29	0	87	87
TP	272	0.29	4.4	78.9	83.3
TSS	60520	0.29	0	17550.8	17550.8



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STREAM RESTORATION PROJECT CALCULATION SPREADSHEET - YORK RIVER BASIN

For calculating reductions to meet the Chesapeake Bay TMDL*

Special Thanks to Kelsey Brooks for Developing this Spreadsheet!

	Input Value
	Calculated Value
	Constants

STEP 1: PROJECT REDUCTIONS

Stream Length Restored (ft)	1000		
	TN (lbs/ln ft)	TP (lbs/ln ft)	TSS (lbs/ln ft)
Default Removal Rate	0.075	0.068	44.88
Project Reductions	75	68	44,880

STEP 1: Permittees should enter the stream length restored (linear feet). That value is multiplied by the default removal rates found in the most recent version of the *Recommendation of the Expert Panel Report to Define Removal Rates for Individual Stream Restoration Projects.*

STEP 2: CHARACTERISE ACRES DRAINING TO THE PROJECT

	Regulated Acres	Unregulated Acres	Forested Acres	
Urban Impervious Acres	9.08	0.21	-	
Urban Pervious Acres	6.37	1.64	-	
Forested Acres	-	-	9.26	Total
Total Acres	15.45	1.85	9.26	26.56

	Regulated	Unregulated	Forested
Ratio of Land Type to Total Acres	0.58	0.07	0.35

STEP 2: Permittees should enter the regulated urban impervious acres and urban pervious acres, unregulated urban impervious acres and urban pervious acres, and forested acres to determine the ratios of regulated acres, unregulated acres, and forested acres to total acres.

STEP 3: UNREGULATED BASELINE

	TN (lbs/ac/yr)	TP (lbs/ac/yr)	TSS (lbs/ac/yr)
Impervious Land Baseline Loading Rate	0.6	0.2	92
Pervious Land Baseline Loading Rate	0.4	0.04	6.4

	TN (lbs/ac/yr)	TP (lbs/ac/yr)	TSS (lbs/ac/yr)
Unregulated Baseline Loads	0.78	0.11	29.82

STEP 3: The unregulated urban impervious acres and unregulated urban pervious acres are multiplied by the baseline loading rates for each POC to determine the unregulated baseline load the permittee may NOT take credit for. The baseline loading rates are based on the loading rates from Table 3a in the permit.

STEP 4: FINAL CREDIT PROJECT REDUCTIONS

	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)
Creditable Reductions	47.97	44.09	29,142.18

STEP 4: Based on the values entered for (1) the stream length being restored and (2) the acres draining to the stream, the spreadsheet will calculate the POC credits the permittee may receive for a stream restoration project using the default removal rates.

Exampleville 1st Permit Cycle Reductions Recap

	Total Reductions Required	Wet Pond 1 Reductions	Wet Pond 2 Enhancement Reductions	Bioretention Conversion Reductions	Stream Restoration Reductions	Remaining Reductions or Credits
TN	178.6	34.4	17.1	8.2	87	31.9
TP	31.5	9.2	4.1	1.0	83.3	+66.1
TSS	17087.6	3598.5	588.9	123.1	17550.8	+4773.7

- 31.9 pounds of TN still needed for 1st permit cycle reductions
- 66.1 pounds of TP credit can be used to meet 2nd permit cycle reductions
- 4773.7 pounds of TSS credit can be used to meet 2nd permit cycle reductions

The Four Protocols

- The Bay Program Expert Panel has outlined Four Protocols to also calculate reductions
- DEQ strongly recommends use of default removal rates because Protocol efficiencies and specs are rapidly changing
- If the assumptions that were used in the protocols have changed substantially within the 5 year verification period because of the implementation of upstream BMPs, then the protocols should be reapplied

The Four Protocols

1. Prevented Sediment During Storm Flow
2. Instream and Riparian Nutrient Processing During Base Flow
3. Floodplain Reconnection Volume
   - The 1st three protocols require direct measurements to estimate pollution reductions

The Four Protocols

4. Dry Channel Regenerative Stormwater Conveyance (RSC) as an Upland Stormwater Retrofit
   - The fourth protocol can be calculated using the Bay Program curves

Initial Verification of Performance

- Post-construction verification is needed to verify stream restoration project was:
  - Installed properly
  - Meets or exceeds functional restoration objectives
  - Hydraulically and vegetatively stable
- Initial verification can be done by either the designer or a local inspector for final credit approval

Removal Credit Renewal

- The maximum duration for the removal credits is 5 years
- Credit can be renewed based on a field performance inspection that verifies the project still exists, is adequately maintained and is operating as designed
- Duration of the credit is shorter than traditional stormwater BMPs
- Typically requires at least 3 to 5 years of post-construction monitoring