RETROFIT PANEL RECOMMENDATIONS

Presented to the

Urban Stormwater Workgroup

April 30, 2012

The Expert Panel

Panelist	Affiliation
Ray Bahr	Maryland Department of the Environment
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Joe Kelly	Pennsylvania Department of Environmental Protection
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Bill Stack	Center for Watershed Protection
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The Process

- Outlined in WQGIT BMP Review Protocol (WQGIT, 2010)
- BMP Expert Panel → reviews existing research → set of recommendations
- 5 calls
- Product: 58 page Technical Memo!

The Charge

The Panel was asked to:

- Define each class of retrofits and qualifying conditions for credits.
- Assess existing CBP-approved removal rates.
- Determine if new methods available to update removal rates.
- Recommend estimation methods to characterize baseline loads.
- Define reporting units.
- Determine whether to recommend interim BMP rates for WIP planning purposes.

Panel also asked to:

- Recommend procedures for reporting, tracking, and verifying removal rates.
- Look at potential for future collaborative monitoring to better define retrofit performance.
- Look closely at issue of double- or over-counting load reductions.

Outline

- Retrofit Categories
- Protocol for determining retrofit removal rates
- Design Examples
- Accountability

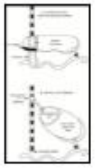
Retrofit Categories

A. New Retrofit Facilities

1. Near Existing Stormwater Outfalls
2. Within the Conveyance System
3. Adjacent to Large Parking Lots
4. Green street retrofits
5. On-site LID retrofits

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

Retrofit Categories

B. Existing BMP Facilities

1. BMP Conversions:
2. BMP Enhancements:
3. BMP Restoration:

EXISTING RETROFITS

BMP CONVERSION

- Retrofits of older stormwater ponds
- Rehabilitating failed infiltration practices
- Adding Bioretention/Filtering to Ponds

EXISTING RETROFITS

BMP ENHANCEMENT

- Utilize the original stormwater treatment mechanism
- Improve removal by increasing storage volume or hydraulic residence time

EXISTING RETROFITS

BMP RESTORATION

- Major maintenance upgrades of existing BMPs constructed prior to Jan 1, 2006
- 4 types allowed:
  1. Major Sediment Cleanouts
  2. Vegetative Harvesting
  3. Filter Media Enhancements
  4. Complete BMP Rehab

Protocol for determining retrofit removal rates

- Extensive review of current BMP performance research (Appendix A)
- 2 main categories
  - Runoff Reduction (RR)
  - Stormwater Treatment (ST)
- Removal rates based on
  - Amount of runoff treated
  - Degree of runoff reduction provided

Protocol for determining retrofit removal rates

- Determined composite "Anchor Rates" of pollutant removal based upon 1.0" of runoff depth captured
- Developed retrofit removal rate 'adjustor curves'

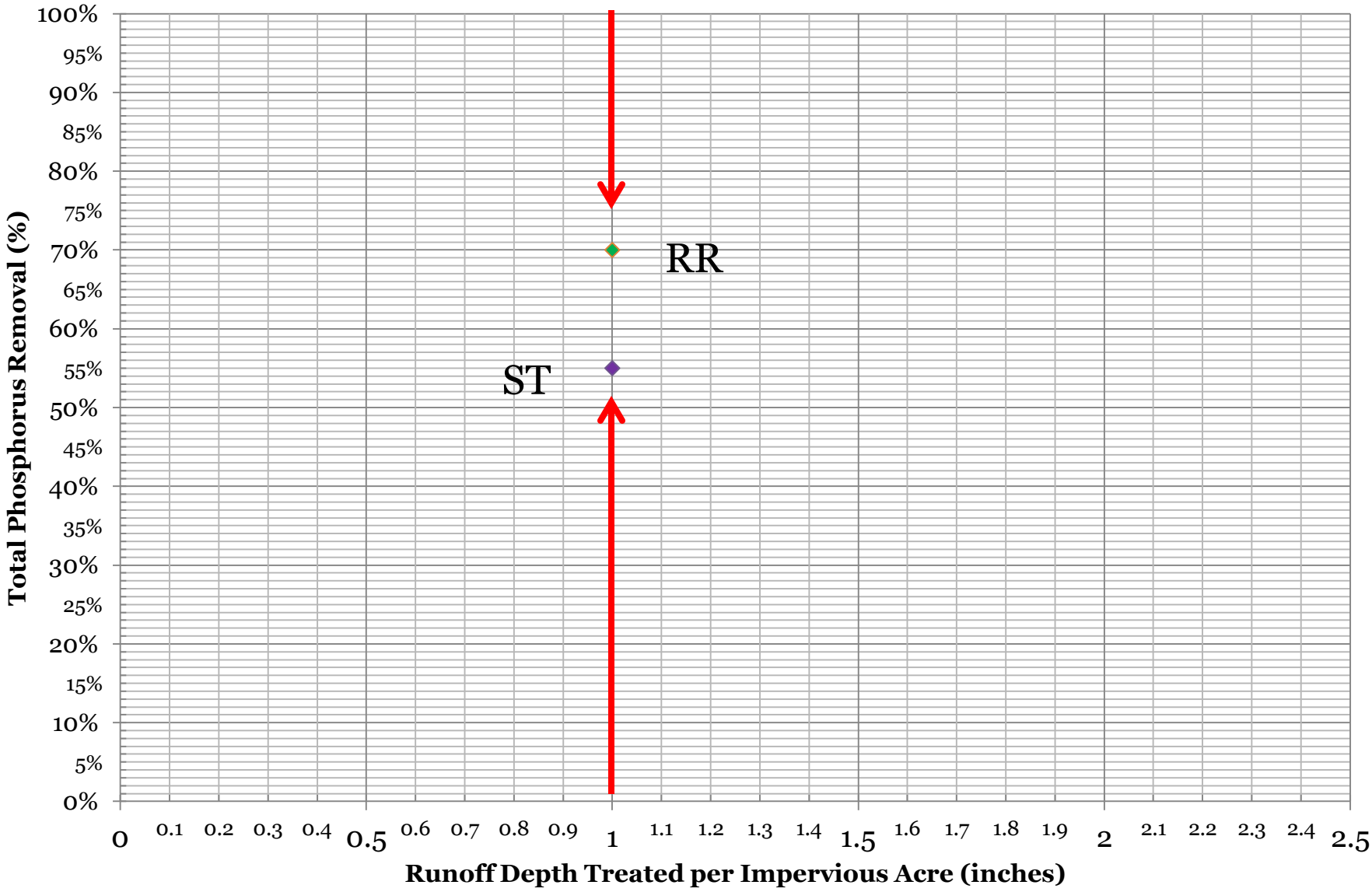
Anchor Rates @ 1"

Table A-3 Composite Approach to Derive Nutrient Mass Load Reductions for RR ad ST Runoff Reduction Practices [1,]

PRACTICE	TP Mass Reduction (%)	TN Mass Reduction (%)
Bioretention	73	77
Dry Swale	66	63
Infiltration	75	78
Permeable Pavers	70	70
Green Roof/Rain Tank	55	55
Average RR	**70**	**70**
Wet Ponds	63	35
Const. Wetlands	63	40
Filtering Practice	63	38
Wet Swale	30	30
Average ST	**55**	**35**

[1] Source: Table A-5, nutrient rates computed using the average mass reduction for both Design Level 1 and Level 2.

Total Phosphorus Removal for RR and ST Stormwater Retrofit Practices



Developing the 'Adjustor Curves'

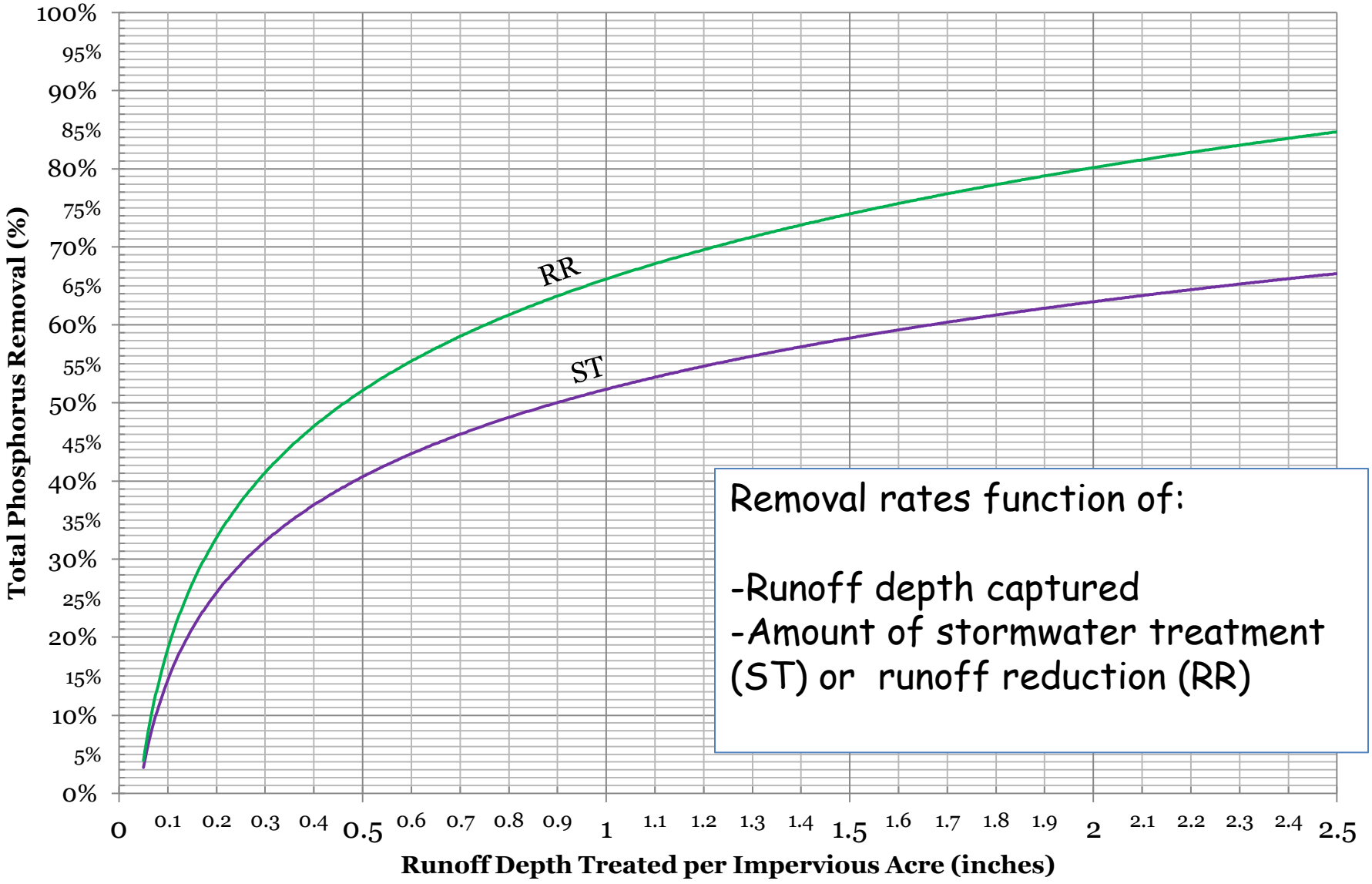
- Rainfall Frequency Analysis
  - Determines bypass and mass pollutant removal for runoff depths above and below 1.0"
  - Converted to 3 curves (TP, TN, TSS)
- Cut-off value at 0.05" = initial abstraction rate
- No real monitoring data above 1.5"

Rainfall Frequency Analysis

Rainfall Depth Controlled	% of annual rainfall	Phosphorus		Nitrogen		Sediment	
		ST	RR	ST	RR	ST	RR
0.05	9%	6	7	4	7	7	8
0.1	18%	11	14	7	14	14	16
0.25	41%	26	33	16	33	33	35
0.5	65%	41	52	26	52	52	56
0.75	80%	50	63	32	63	63	68
1	88%	55	70	35	70	70	75
1.25	92%	58	74	37	74	74	79
1.5	95%	60	76	38	76	76	81
2	98%	61	78	39	78	78	84
2.5	99%	62	79	39	79	79	85

Data plotted and converted to a series of curves

Total Phosphorus Removal for RR and ST Stormwater Retrofit Practices



Adjustor Curves 'mechanics'

- Rainfall frequency analysis assumes runoff delivered generated from a unit impervious cover.
- Runoff storage volumes for each retrofit are function of total contributing drainage area.
- Therefore, need to "unitize" retrofit storage volumes to impervious cover.
- Dividing runoff storage by impervious acreage to get: Runoff Depth Treated per Impervious Acre

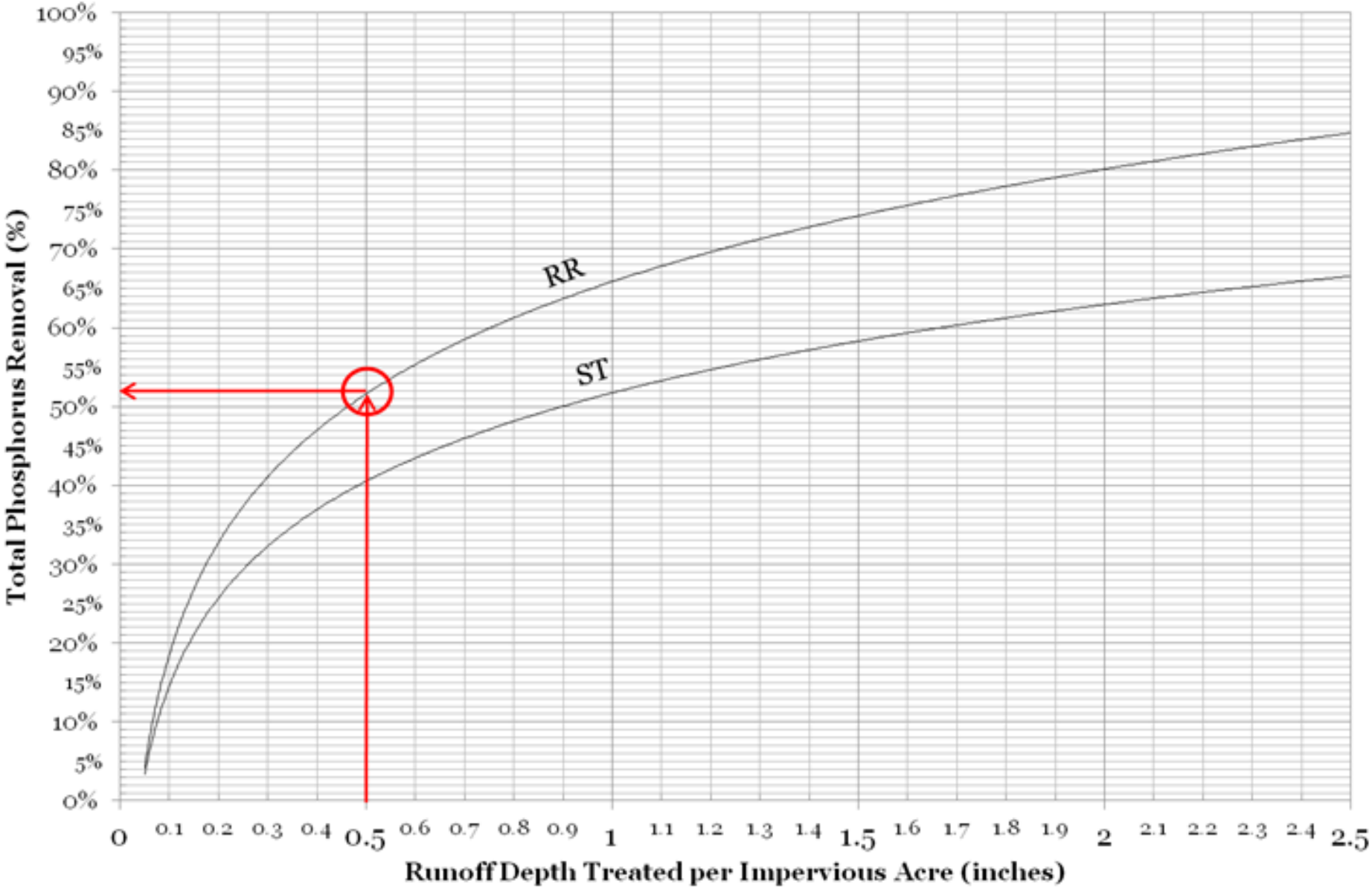
$$= \frac{(RS)(12)}{IA}$$

Where:

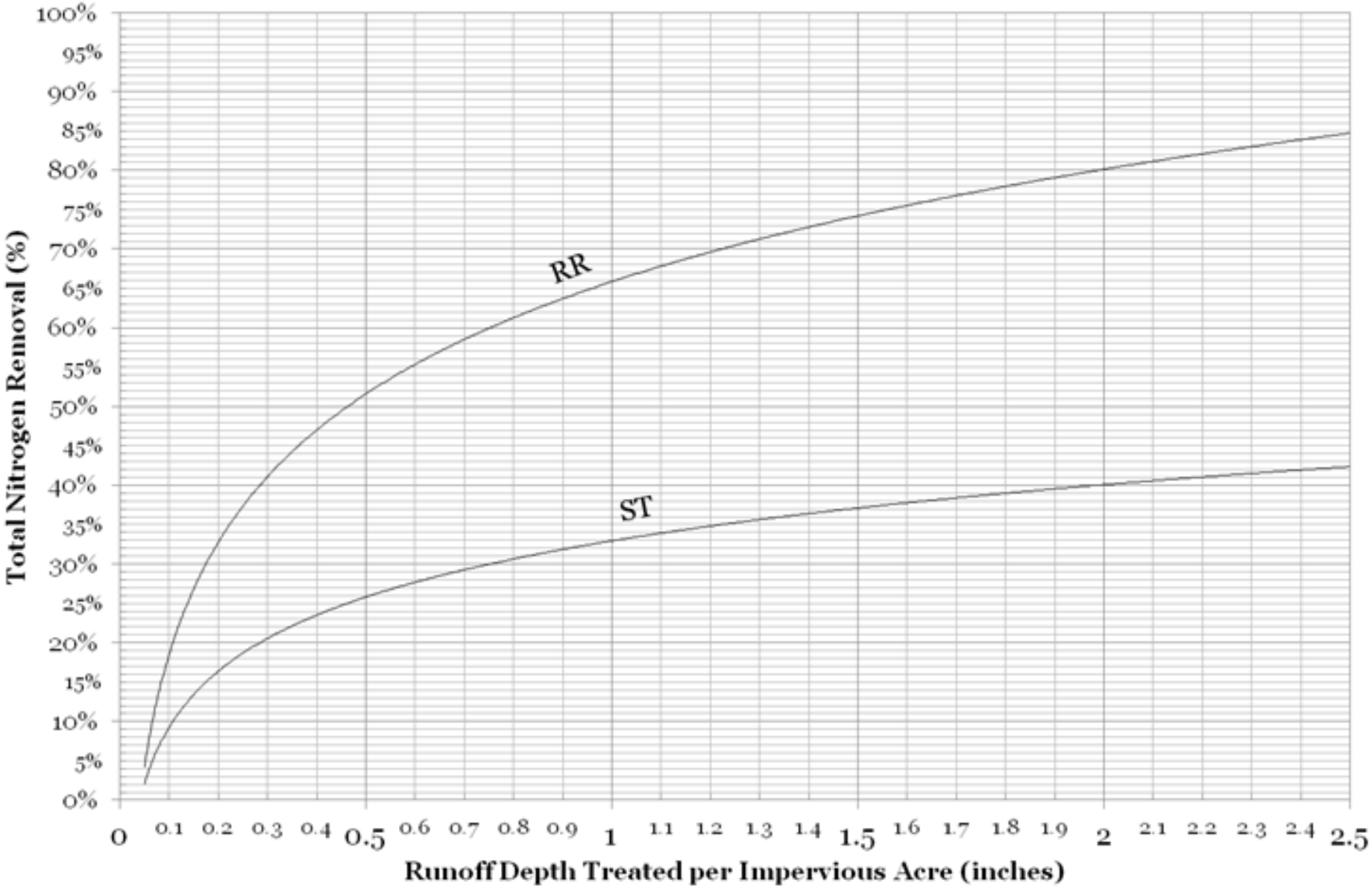
RS = Runoff Storage volume (acre-feet)

IA = Impervious Area (acres)

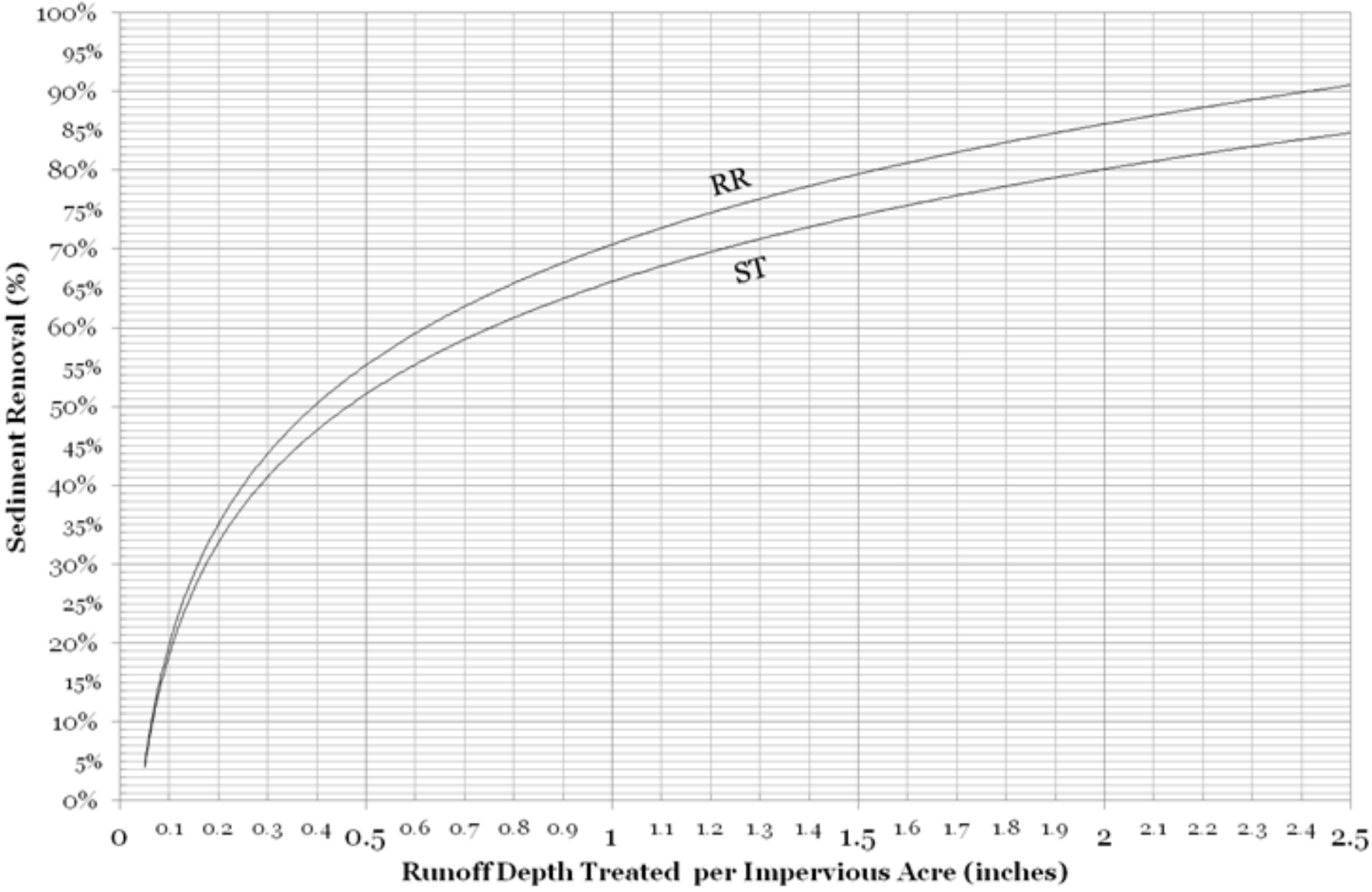
Total Phosphorus Removal for RR and ST Stormwater Retrofit Practices



Total Nitrogen Removal for RR and ST Stormwater Retrofit Practices



Sediment Removal for RR and ST Stormwater Retrofit Practices



Adjustor Curves Notes

- Cut-off value at 0.05" = initial abstraction rate
- No real monitoring data above 1.5"
- For retrofits treating > 2.5", just use 2.5" values (very rare)
- Removal rates applicable to entire drainage area: pervious + impervious

Design Examples

Design Examples – New Retrofit Facility
Constructed Wetland

- Constructed wetland built in parkland, classified as **ST** practice
- Retrofit storage =1.67 acre-feet
- Treats runoff from 50 acre residential neighborhood with 40% impervious cover

Design Examples – New Retrofit Facility

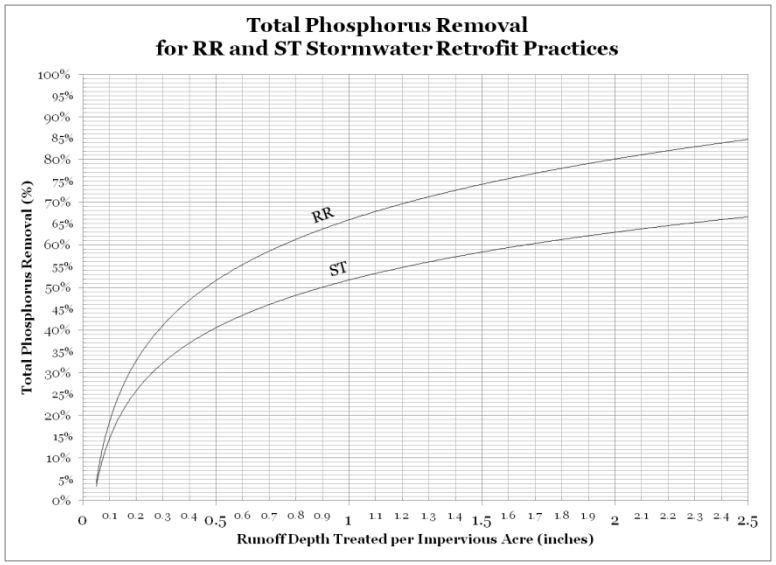
- Using the Standard Retrofit Equation:

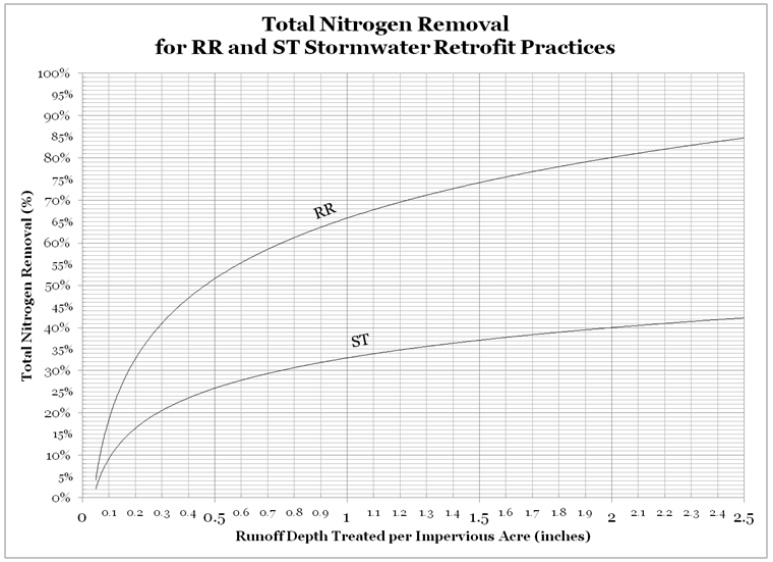
$$= \frac{(RS)(12)}{IA}$$

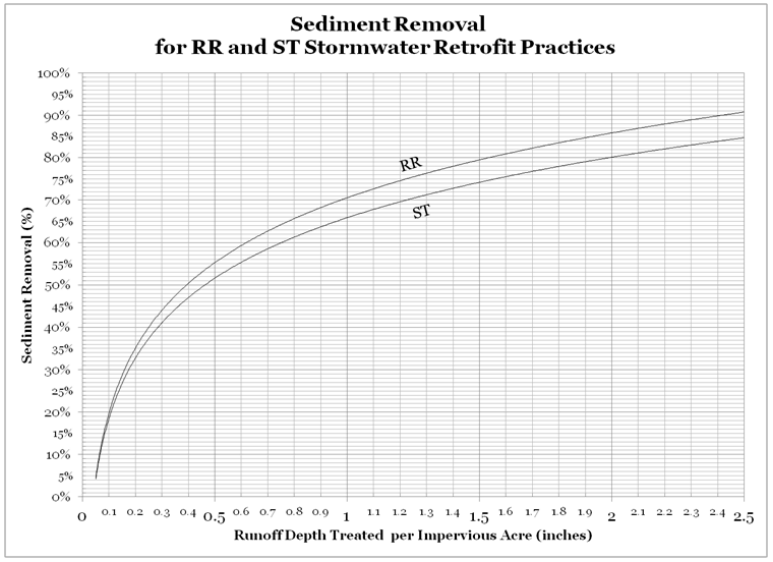
- RS = Retrofit Storage ≈ 1.67 ac-ft
- IA = Impervious Area = 20 acres

$$\frac{(1.67)(12)}{20} = 1.0\ inch$$

Design Examples – New Retrofit Facility







Pollutant Removal Efficiencies of the practice

TP	TN	TSS
52%	33%	66%

BMP Conversion Example

- Dry pond conversion
- Create new water quality storage: add forebay with permanent pool, submerged gravel wetland cell, and final bioretention polishing cell
- New facility provides runoff storage volume of 1.3 acre-feet
- Treats 65 acres @ 40% impervious
- **Classified as a RR practice**

Design Examples – *BMP Conversion*

- Using the Standard Retrofit Equation:

$$= \frac{(RS)(12)}{IA}$$

- RS = Retrofit Storage ≈ 1.3 ac-ft
- IA = Impervious Area = 26 acres

$$\frac{(1.3)(12)}{26} = 0.6\ inches$$

Pollutant Removal Efficiencies of the practice

TP	TN	TSS
55%	55%	59%

Design Examples – *BMP Enhancement*

- Dry Extended Detention pond sized to capture 0.3" of runoff
- 10 acre commercial drainage area @ 100% impervious
- Short-circuiting of pond led to half of original storage volume ≈ 0.15"

Design Examples – *BMP Enhancement*

- Pond enhanced to:
  - Increase hydraulic retention time (prevent short-circuiting)
  - Provide pretreatment
  - Include wetland cells for better treatment
- Enhancements recovered 0.15" of lost storage and created additional 0.3" of storage for combined new storage of: 0.45" per impervious acre

Design Examples – *BMP Enhancement*

- Slightly different
- New removal rates = difference between original rates and enhanced rates
- Original and enhanced rates from curves
- Increase in both runoff volume captured AND runoff reduction capabilities

	TP	TN	TSS
Enhanced Rate	39%	25%	50%
Original Rate	21%	14%	28%
Incremental Removal Rate	18%	11%	22%

Design Example – BMP Restoration

- Captures 0.5" of runoff from impervious cover of contributing watershed: 40 acres @ 50% impervious
- Sedimentation and invasive plant growth → decreased storage volume by 60%
- Only provides 0.2" runoff capture
- City conducts major sediment dredging, invasive plant removal, replants pond with natives
- Recovers 0.2" of storage for total storage of **0.4"**

Design Examples – *BMP Restoration*

If the BMP has previously reported to the state (and already included in CBWM input deck), then the removal rates is determined from the curves as an incremental rate

incremental removal rate = restored rates – original rates.

	TP	TN	TSS
Restored Rate	37%	24%	47%
Original Rate	26%	16%	33%
Incremental Removal Rate	11%	8%	14%

Computing Load Reductions

- Needed for retrofit planning/analysis
- Panel recommends several options:
  - CBWM urban unit loading rates
  - Simple Method
  - CWP Watershed Treatment model
- Pros/cons of each
- Work with State MS4 permitting agency

Accountability

1. Duration:
   - 10 yrs MAX
     - Can be renewed based on field performance inspection
   - 5 yrs for on-site LID
     - Can be renewed upon visual inspection
2. No Double Counting!
   - Rate cannot be used if retrofit is an offset for new development
3. Initial Verification of Performance
   - Installed to design standards, functioning properly

Accountability

4. Local Reporting
   - Check with State stormwater agency!!
   - Panel recommendations on typical items
   - Aggregate data okay for private retrofits
5. Local Recordkeeping
   - More extensive record keeping
   - Lifetime of the retrofit
6. Ongoing Field Verification
   - Inspection every 10 years
   - If facility not performing to original design, up to 1 year to take corrective maintenance
   - Renewal of removal rates if corrective maintenance occurs

Key panel outcomes

- More retrofit options = more opportunities to get credit!
- Simple to use method for determining pollutant removal!
- Reporting and verification procedures are flexible and can be adapted to align with existing state reporting requirements.
- Not a "one size fits all" approach

Next Steps??

- Get the info out to the people who need it….
- Add to CSN **website**
- CSN to share report with Network of over **1300** Bay-wide stormwater professionals
- Bay-wide **webcast** on retrofitting planned for Summer 2012
- Retrofit **workshop** planned for Fall 2012