Recommendations of the Expert Panel to Define Removal Rates for Urban Filter Strips and Stream Buffer Upgrade Practices

Photo credit Ryan Winston

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Presentation to the Watershed Technical Workgroup
5/27/2014

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Center for Watershed Protection

Report approved 4/15/2014 by the Urban Stormwater Workgroup

Comments from USWG Review

- MD State Highway Administration
- VA DEQ
- PA DEP
- The comments received did not change the recommendations
- Clarification on the development and application of the recommended credits for urban filter strips

Panel Membership

Name	Affiliation
Joe Battiata	Center for Watershed Protection, Inc.
Sally Claggett	USFS, Chesapeake Bay Program Forestry Work Group Coordinator
Scott Crafton	Virginia Department of Environmental Quality
David Follansbee, PhD	New York Department of Environmental Conservation
David Gasper	New York Department of Environmental Conservation
Randy Greer	Delaware Department of Natural Resources and Environmental Control
Curtis Hardman	West Virginia Department of Environmental Protection
Tom Jordan, PhD	Smithsonian Environmental Research Center
Steve Stewart	Baltimore County , Environmental Protection and Sustainability
Al Todd	Alliance for the Chesapeake Bay
Ryan Winston	North Carolina State University
Jennifer Zielinski	Biohabitats, Inc.

Non-panelists: Neely L. Law (Coordinator, CWP & CBP Sediment Stream Coordinoar), Hannah Martin (CRC), Gary Shenk (CBPO), Matt Johnston (CBPO), Jeff Sweeney (CBPO)

Panel Charge

Review all of the available science on the nutrient and sediment removal and runoff reduction performance associated with qualifying urban filter strips and/or stream buffer upgrade practices.

- Provide a specific definition of what constitutes effective urban filter strips and stream buffer upgrades
- Define the qualifying conditions under which such practices may be eligible to receive the credit.
- Review the current Chesapeake Bay Watershed Model (CBWM) assumptions
- Define the information on implementation of retrofit and new practices implementation that local governments must report to the State to incorporate into the CBWM.

Panel Charge

Beyond this specific charge, the panel is asked to:

- Determine whether to recommend interim treatment credits for UFS or urban stream buffer upgrade for watershed implementation plans (WIP).
- Determine the applicability of including conservation landscaping as part of the definition of this practice
- Recommend procedures for reporting, tracking and verifying any recommended urban filter strips/stream buffer upgrade credits over time.
- Critically analyze any unintended consequence associated with the credit and any potential for double or over-counting of the credit

Summary of Key Recommendations for Urban Filter Strips (UFS)

- Runoff Reduction UFS

Table 9: Recommended pollutant removal rates for urban filter strips as a RR BMP.

	TN	TP	TS
0.5” Runoff depth captured	20%	54%	56%

- Stormwater Treatment UFS

Table 10. Recommended pollutant removal rate for UFS as a ST BMP.

	TN	TP	TS
0.5” Runoff depth captured	n/a	n/a	22%

Summary of Recommendations

- No recommendations to define stream buffer upgrade as a new BMP
- No recommendations to include conservation landscaping as part of the definition in either practice

“The recommendations included in this report do not address or revise the current urban forest buffer BMP nitrogen, phosphorus or sediment removal efficiencies or definition defined by the Chesapeake Bay Program.”

Stream Buffer Upgrade

- Panel began its review of SBU as a **new** BMP by reviewing existing CBP definition of an urban forest buffer:

(a)n area of trees at least 35 feet wide on one side of a stream, usually accompanied by trees, shrubs and other vegetation that is adjacent to a body of water. The riparian area is managed to maintain the integrity of stream channels and shorelines, to reduce the impacts of upland sources of pollution by trapping, filtering, and converting sediments, nutrients, and other chemicals (p. 8-135).

- Assumes that sheetflow conditions must exist through the forest buffer

Stream Buffer Upgrade

Definitions explored by the Panel

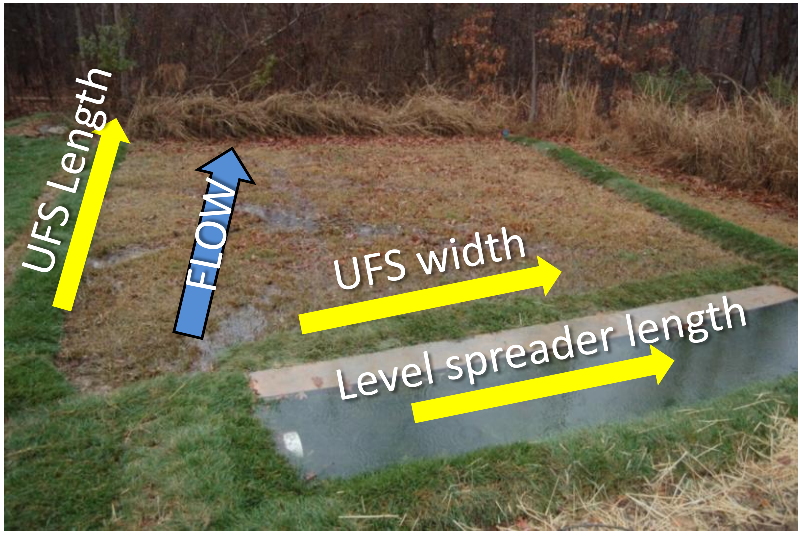
1) More narrow buffers
2) Width vs area
3) Treatment train upslope of buffer
4) Upgrade from grass to forested buffer
5) Hydrologic connectivity

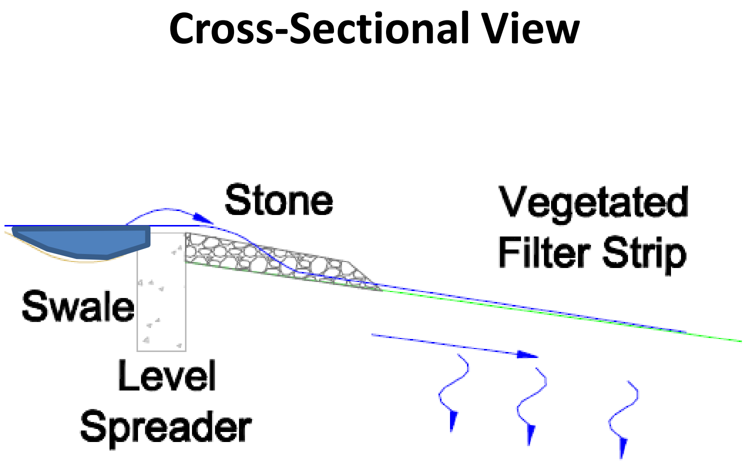
Unable to differentiate with existing CBP approved BMPs

- No recommendations for stream buffer upgrade as a new BMP
  - Insufficient data to differentiate from other urban BMPs (i.e., urban forest buffers, tree planting)
  - Very limited research on urban forest/stream buffers
    - Groffman et al (2003), Gift et al (2010), Bettez and Groffman (2012), Stewart et al (2005)
  - No research to explicitly evaluate more narrow buffers in urban context

UFS Definition

- Runoff reduction (RR) and stormwater treatment (ST) BMP
- *Designed to manage stormwater runoff draining from urban lands. Water quality benefits from urban filter strips are derived from both load reduction through infiltration and recharge as well as removal of pollutants through settling and filtration. UFS are stable areas with vegetated cover on flat to gently sloping land. Runoff entering the UFS must be in the form of sheetflow and at a non-erosive rate for the site-specific soil conditions.*





Images courtesy of R. Winston, Winston et al. 2011a, Winston et al. 2011b www.bae.nscu.edu/stormwater

Section 2.2 Qualifying Conditions

Stand-alone practice to treat relatively small impervious areas for new development, redevelopment or retrofit.

- Sheetflow must enter the UFS and be maintained across the entire flow length
- A 0.4 design ratio of filter strip length: impervious flow length is recommended for runoff reduction urban filter strips (Section 6.1) and 0.2 design ratio for stormwater treatment urban filter strips (Section 6.2). This applies to UFS that meet the maximum impervious flow length design criteria without use of an engineered level spreader or other flow dispersion device to dissipated concentrated flow (see Appendix C).
- Soils must be classified as Hydrologic Soil Group A, B, or C. Soil amendments are required for D soils or compacted (disturbed) soils to make their permeability equivalent to A, B, or C soils.
- Vegetated cover must be in good condition with minimal bare spots
- Minimize use of fertilizer, application rate is based on a site specific soil test.
- Not an applicable practice for hotspots or where there is a high groundwater table

Qualifying Conditions

Additional conditions apply where concentrated flow conditions:

- Must enter a low flow diversion or forebay and into a combination channel and level spreader (or other approved configuration) prior to discharging into the filter strip.
- Level spreader length (or other flow dispersion device) is based on 10ft for every 1 cfs (of the concentrated flow) with a maximum 100 ft length.
- The maximum allowable drainage area to meet the above condition will vary depending on the percentage of imperviousness in the contributing drainage area and the volume of runoff requiring treatment by a particular jurisdiction.

- Manicured lawns, athletic fields and other managed turf or pervious areas cannot be used as UFS; other BMPs considered such as Urban Nutrient Management
- Consult state stormwater agency for state-specific design and hydraulic specifications

Urban Filter Strips

REVIEW OF THE SCIENCE

UFS – Research Summary

- Extensive focus on agricultural applications
- Limited urban, but highly relevant
- Supplemental research
  - Turfgrass and agricultural filter strips, specifically related to nitrogen fate

UFS – Runoff Reduction

- Highly effective runoff reduction, from 36% to 85% total annual
- Key factors: vegetative cover, soil characteristics, loading ratio (drainage area: filter strip area)

Site	Runoff Reduction (%)	Soil Characteristics
Small FS, Unamended Soils	36	High compaction Low K
Large FS, Unamended Soils	59	
Small FS, Amended Soils	42	Low compaction High K
Large FS, Amended Soils	57	

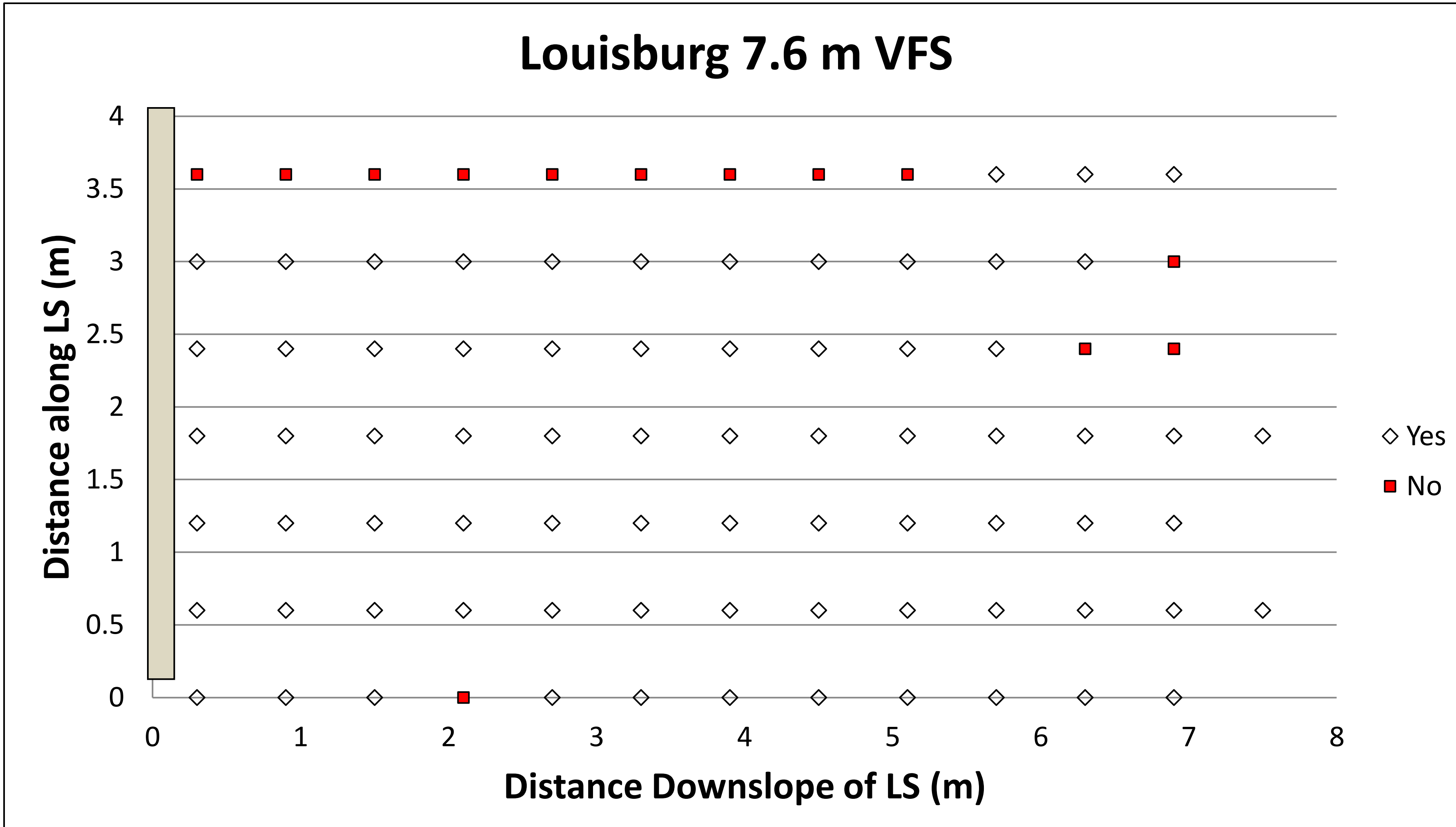
UFS – Water Quality

- Surface monitoring only studies
- Sediment consistent and generally high
- N and P variable

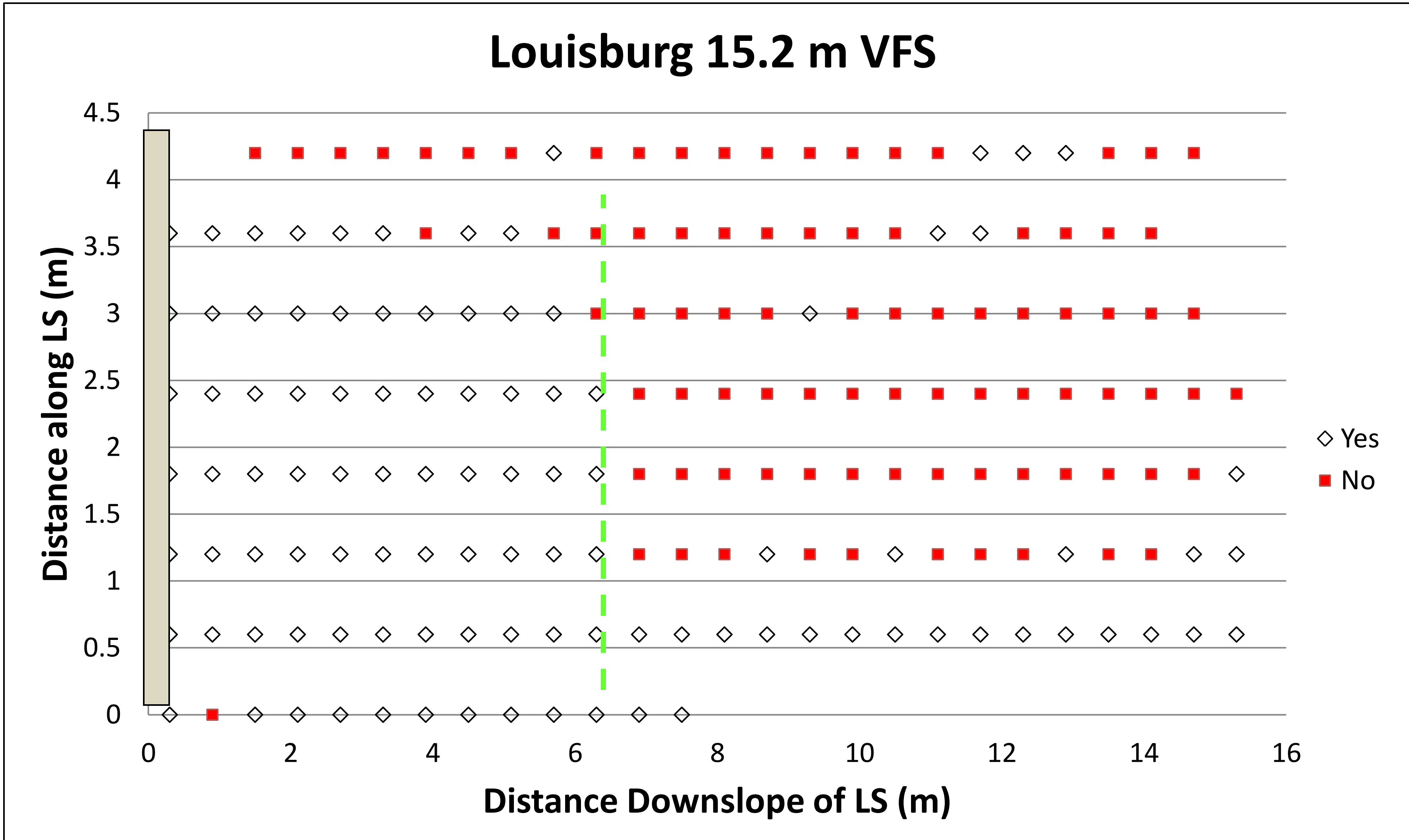
Statistic	TN	TP	TS
Average	51%	33% (45%)	86%
Range	38 to 69%	-42* to 56%	73 to 94%

** Not significant, attributed to high P soil index and loading ratio*

Effective Use of Grassed Buffer

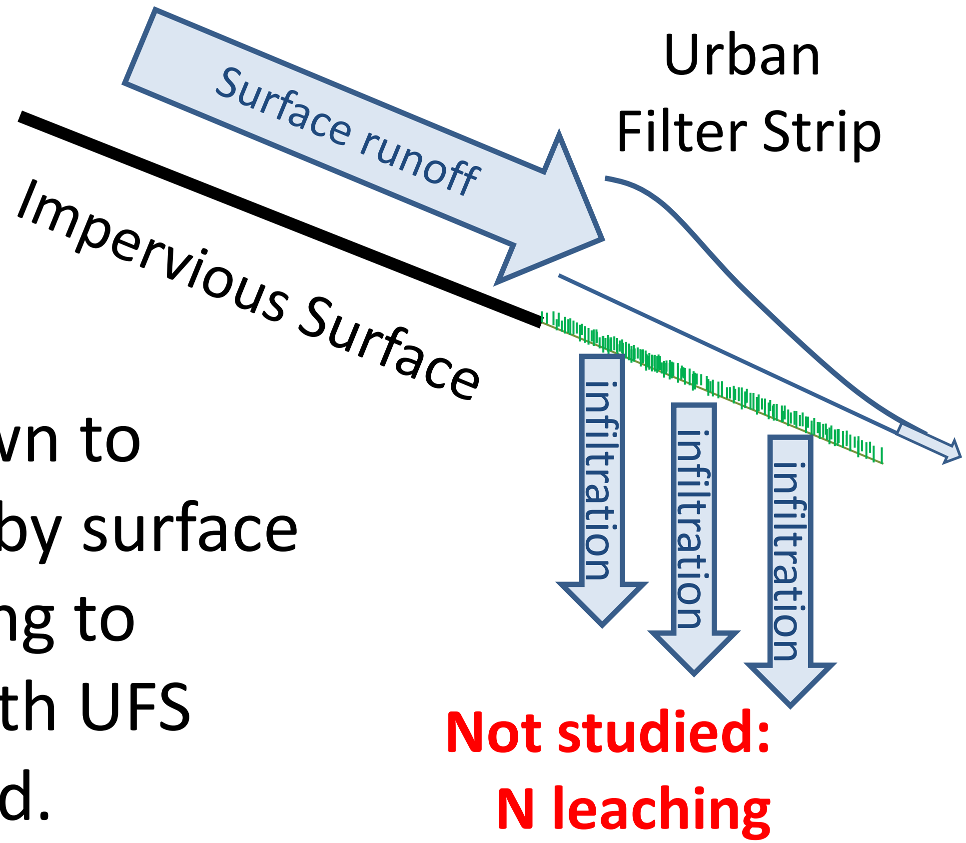


Effective Use of Grass-Wooded VFS



Wooded Filter Strips Cause Reconcentration of Flow

The case for zero nitrogen credit for urban filter strips (UFS)



UFS have been shown to reduce N transport by surface runoff, but N leaching to groundwater beneath UFS has not been studied.

N leaching from UFS could be important

- Leaching of nitrate is a major pathway of loss from cropland
- Organic N and ammonium in soil are converted to nitrate by denitrifying bacteria.
- Nitrate is very soluble and readily leached.
- Nitrate leaching is enhanced by increased water infiltration.
- UFS are designed to receive high water loads and allow high rates of water infiltration in all seasons.

Nitrogen Loss to Groundwater

- Turfgrass research (Morton et al. 1988, Raciti et al 2011)
- Isotopic tracer studies in ag (Verchot et al 1997, Bedard-Haughan et al 2004)
- Key Findings
  - Higher fertilizer application rates and watering increased nitrate leaching
  - 13% nitrate leaching, majority N stored in soil
  - Majority N storage in soil and vegetation
  - N transformations within buffer
  - “Irreducible” or low input concentration affect removal efficiency

Conclusion

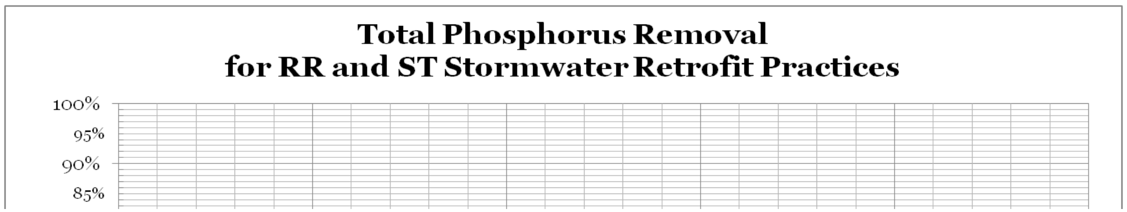
- Because N leaching has not been studied in UFS, estimates of N removal by UFS are best professional judgment given the available data

Urban Filter Strips

PROTOCOL DEVELOPMENT

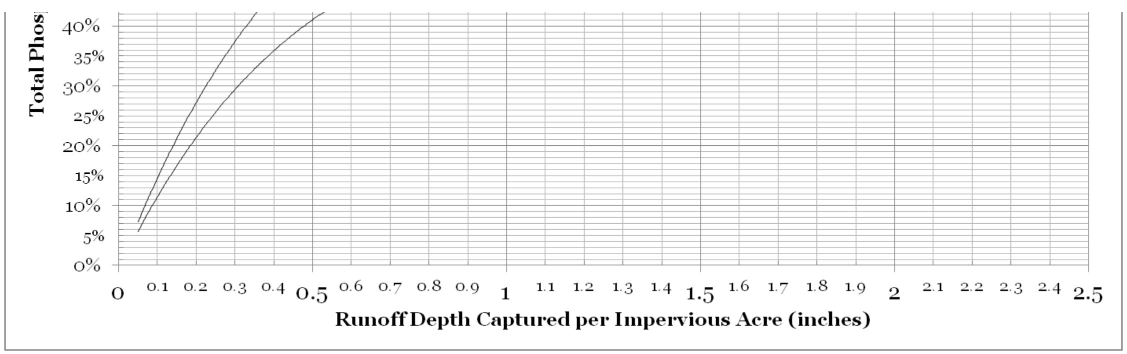
Protocol to Define UFS Nutrient and Sediment Removal Rates

- Newly adopted CBP method to quantify pollutant removal rate based on *pollutant removal adjustor curves* for urban RR and ST BMPs



Application of CBP method resulted variable runoff depths to apply to curves (e.g. 0.2” to 1.8”)

TP: 28 – 72% TN: 22-60% TS: 28-75%



Section 6.1 Protocols to Define Nutrient and Sediment Removal Rates

Table 7. Example methods to estimate runoff volume reduced by urban filter strips in each of the Bay jurisdictions.

DC	DE	MD	NY	PA	VA	WV
For compacted cover, reduce volume conveyed to grass area by 2.0 cu. ft. per 100 sq. ft. of pervious area.	Based on soils and vegetation ranging from 10% to 40%	Up to 1 inch credit provided based upon ratio of Disconnection (filter strip) and contributing (impervious cover) flow lengths varies between 0.2 and 1	100% runoff reduction volume (RRv) credit	100% runoff reduction volume credit	50% runoff volume reduction for treated area	Reduce volume conveyed to conservation area by 0.06 cu. ft per sq. ft. of conservation area. (6 cu.ft per 100 sq ft)

TN Removal by UFS

- Assumes only particulate N is reduced by UFS; *all* solluble N leaches to groundwater
- Derived new TN adjustor curve and applied the 0.5” runoff depth captured and discount factor to account for particulate N

⇨ Resulting 20% pollutant removal

Stormwater Treatment UFS

- Apply only to sediment
- Discount factors (DF) applied to RR UFS
  - Smaller size (~ half length of current design standards). Apply 50% DF
  - coarse sediment trapped. Apply 80% DF

Table 10. Recommended pollutant removal rate for UFS as a ST BMP.

	TN	TP	TS
0.5" Runoff Reduction depth	n/a	n/a	22%

Reporting, Tracking & Verification

- Guidance provided in New State Stormwater Performance Standards and Retrofit Projects expert panel report recommendations
- USWG BMP Verification Guidance (1/23/2014)

Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards

Stewart Comstock, Scott Crafton, Randy Greer, Peter Hill, Dave Hirschman, Shoreh Karimpour, Ken Murin, Jennifer Orr, Fred Rose, Sherry Wilkins

Accepted by Urban Stormwater Work Group: **April 30, 2012**
Revised based on Watershed Technical Work Group feedback: **May 29, 2012**
Resubmitted to Watershed Technical Work Group: **July 15, 2012**
Conditionally Approved by Watershed Technical Work Group: **August 1, 2012**
Conditionally Approved by Water Quality Goal Implementation Team: **August 13, 2012**
Errata Correction Approved by USWG: **September 14, 2012**
Resubmitted to WQGIT **September 28, 2012**
Final Approval by WQGIT: **October 9, 2012**

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Chesapeake Stormwater Network

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

Ray Bahr, Ted Brown, LJ Hansen, Joe Kelly, Jason Papacosma, Virginia Snead, Bill Stack, Rebecca Stack and Steve Stewart

Accepted by Urban Stormwater Work Group: **April 30, 2012**
Revised based on Watershed Technical Work Group feedback: **May 29, 2012**
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Appendix K. Workgroups' BMP Verification Guidance

III. Urban Stormwater BMP Verification Guidance

Version: USWG Approved Guidance, January 21, 2014

This section describes guidance on how to verify the performance of urban BMPs in the Bay watershed, and is organized into 8 parts.

1. The Need for BMP Verification and the CBP Process to Define it.
2. Key Verification Definitions
3. Background on Urban BMP Verification
4. Verification Guidance for BMPs Located in MS4 areas
5. Verification Guidance for BMPs Located in non-MS4 areas
6. Verification Guidance for Non-Regulatory BMPs
7. Verification Guidance for Legacy BMPs
8. Process for Developing Urban BMP Verification Protocols

Section 7. Accountability Mechanisms

- *Basic Reporting Unit*
- *Reporting to the State*
- *Initial Verification of BMP Installation*
- *New BMP Record-Keeping*. *Non-Conforming Projects*
- *Verification for Older UFS*
- *Periodic BMP Inspections*
- *Suggested Process for BMP Downgrades*
- *Special Procedures for BMPs Installed in Non-Regulated Areas*

Un-Intended Consequences and Double-Counting

- Given the qualifying conditions for fertilizer management for UFS, pollutant load reductions for Urban Nutrient Management (UNM) may not be applied to the area of an UFS, however, any pervious areas draining to the UFS may be eligible for UNM. A UFS may be credited as pretreatment to an urban forest buffer where the purpose of the UFS is to create the sheetflow conditions that are required for urban forest buffers. In this circumstance, the area of the UFS may not be included as buffer area but must meet the qualifying conditions outlined in Section 2.2 to be eligible for credit.

Future Research & Management Needs

- The Urban Stormwater Work Group review and update the New State stormwater performance standards and retrofits expert panel reports to reference the recommendations in this report as the method to credit TN, TP and TS load reductions for UFS.

- Monitoring studies to evaluate the fate of nitrogen and phosphorus treated by urban filter strips.
  - leaching of N and P into the groundwater beneath the UFS at different distances along the flow path from the level spreader.
  - accumulation of N and P over time in the surface soils of the UFS at different distances along the flow path

Future Research & Management Needs

- Monitoring studies to further evaluate the impact of concentrated flow through forested buffers. As part of this review, it is important to evaluate the function throughout the buffer. The areas with no flow might significantly reduce the load while concentrated flow areas may have slightly higher concentrated loading. Studies that review event mean concentration through various types of vegetated buffer may be helpful.

- Research to evaluate the function and pollutant removal capabilities of urban forested buffers less than 35ft along the flow path.

- In forested stream buffers, investigate the effect of hydric soils or groundwater flow close to the soil surface on the nitrate removal capacity. Hydric soils of near-surface groundwater may decrease the flow path distance required for nitrate removal.

Thank you.

Comments & Questions?