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

Photo credit Ryan Winston

Presented to the Urban Stormwater Workgroup

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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 as separate or combined practice(s) in the context of any nutrient, sediment and/or runoff reduction credit, and define the qualifying conditions under which such practices may be eligible to receive the credit.

- Review the current Chesapeake Bay Watershed Model (CBWM) assumptions to simulate the impact of grass buffers, forested and riparian buffers to agricultural and urban land uses and recommend how practice(s) should be represented in the CBWM.

- 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

- 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

Stream Buffer Upgrade

REVIEW OF THE SCIENCE

SBU - Research Summary

- Stream buffer upgrade BMP is not defined by any of the Bay jurisdictions nor the CBP.
- Research focus to provide a definition for this BMP that 1) may reduce the minimum required width for urban forest buffers and/ or 2) as a some type of combined practice with UFS.
- Existing CBP definition, literature synthesis, urban stream buffer

SBU – Research Summary

- 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

- TP, TN and TS reduction credits of 25%, 50% and 50%, respectively.

- Very limited research on urban forest/stream buffers
  - Groffman et al (2003), Stewart et al (2005), Gift et al (2010) and Bettez and Groffman (2012)
- No research to explicitly evaluate narrow buffers in urban context
- Key features affecting nutrient and sediment removal
  - hydrologic flowpaths and denitrification (e.g. “hydrologic drought, see Groffman et al 2003,
  - Disconnect between stream-riparian interface (Kaushal et al 2008, Mayer et al 2013);
- Reconcentration of flowpaths reduces sedimentation within buffer (Helmers et al 2005, Winston et al 2011)

- Baltimore County urban forest buffer study
  - 100-ft buffers
  - Significantly lower N, P, S loads for buffers with higher forest cover (75% vs 40%)
  - Study did not evaluate change in loads (input v output)

Potential SBU Definitions

1) Define as a stream buffer with less stringent width requirements compared to existing urban forest buffer.
2) Define stream buffer upgrade on an area basis whereby the minimum width issue is avoided.
3) Define this practice as a treatment train with a vegetated filter strip located upslope of the buffer.
4) Upgrade a grass buffer to a woody vegetated, forest buffer.
5) Upgrade stream buffer to provide hydrologic connection with the stream channel during baseflow and storm events.

UFS Definition

- Runoff reduction and stormwater treatment 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.

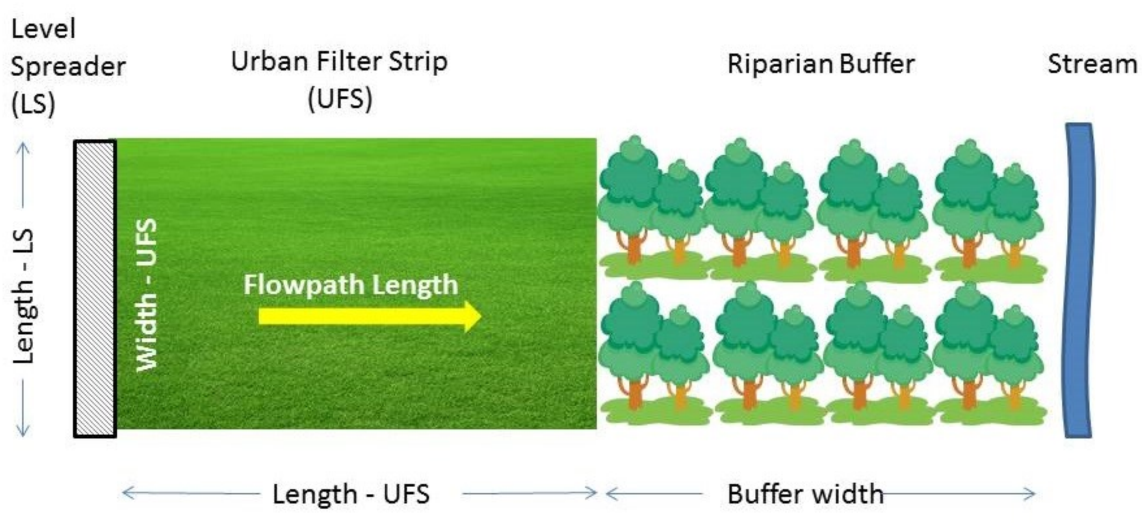


Figure 1. Dimensional elements of an urban filter strip.

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
- 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 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

CBWM

- Not currently modeled
- Similar BMPs
  - agriculture grass buffers (land use conversion + efficiency)
- Land use conversion not applicable to UFS

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)

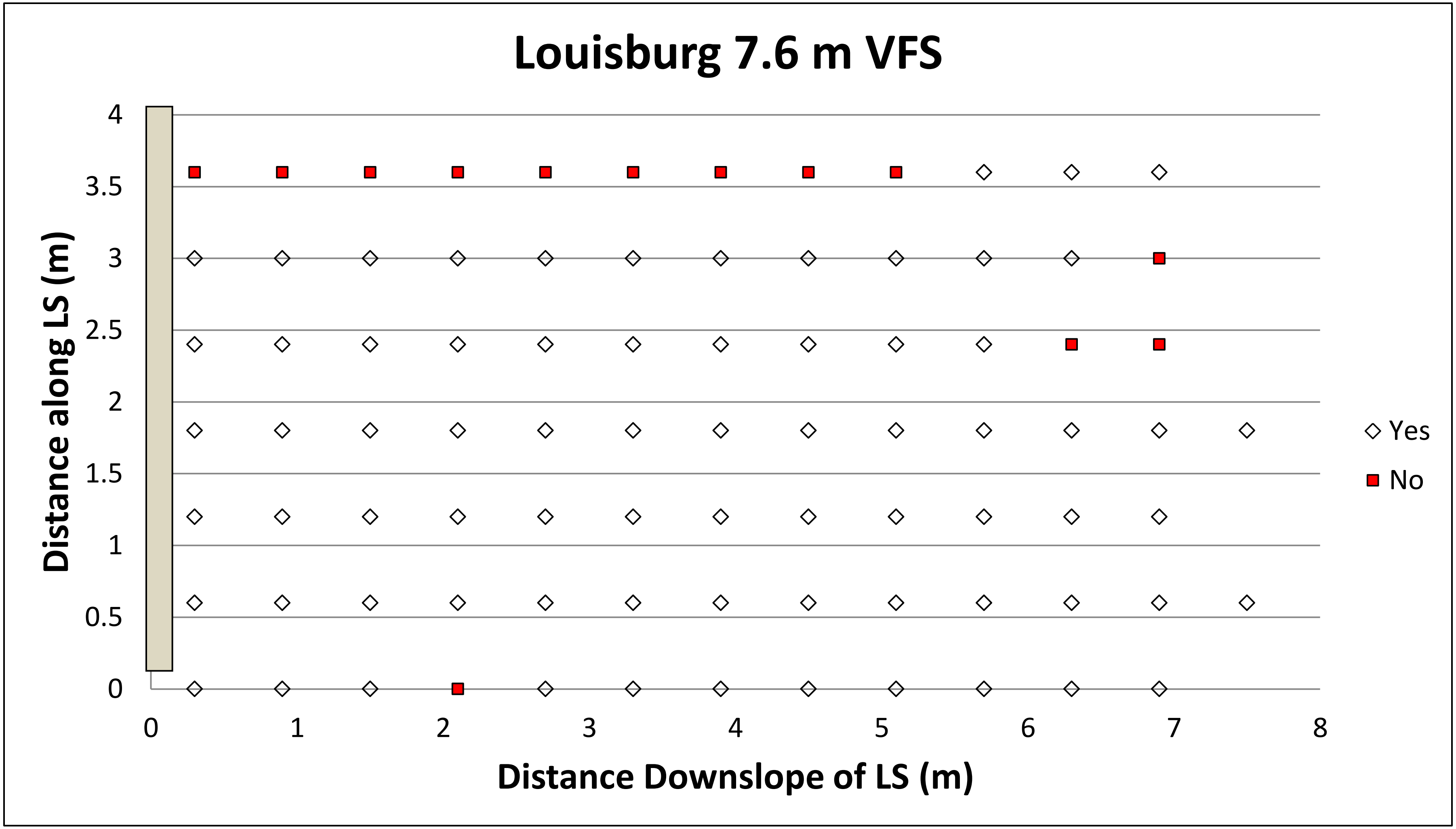
Site	Runoff Reduction (%)	Soil Characteristics
Small FS, Unamended Soils	36	High compaction Low K
Large FS, Unamended Soils	59	
Small FS, Unamended Soils	42	Low compaction High K
Large FS, Unamended Soils	57	

UFS – Water Quality

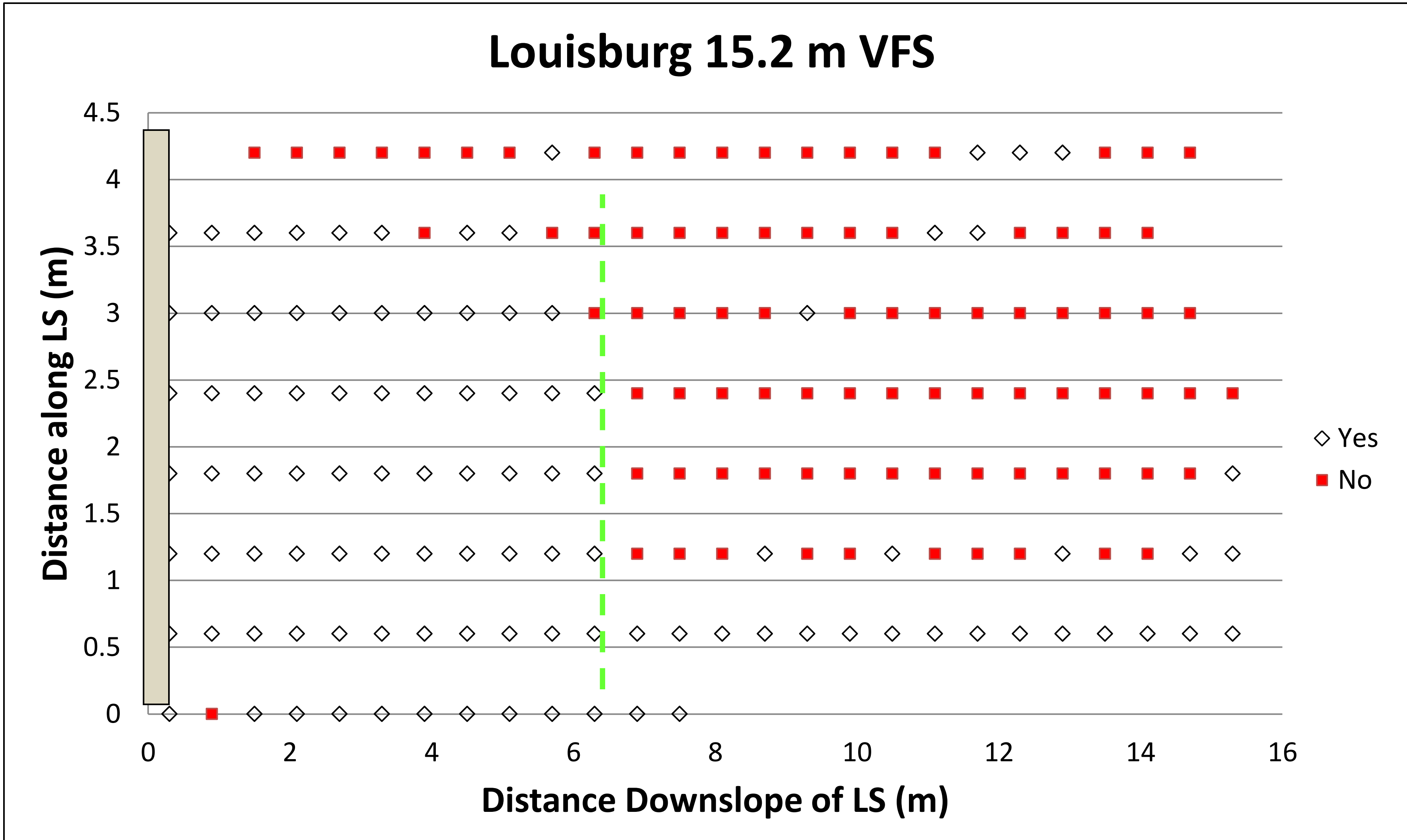
- Sediment consistent and generally high
- N and P variable
- Surface monitoring only studies

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

Effective Use of Grassed Buffer



Effective Use of Grass-Wooded VFS



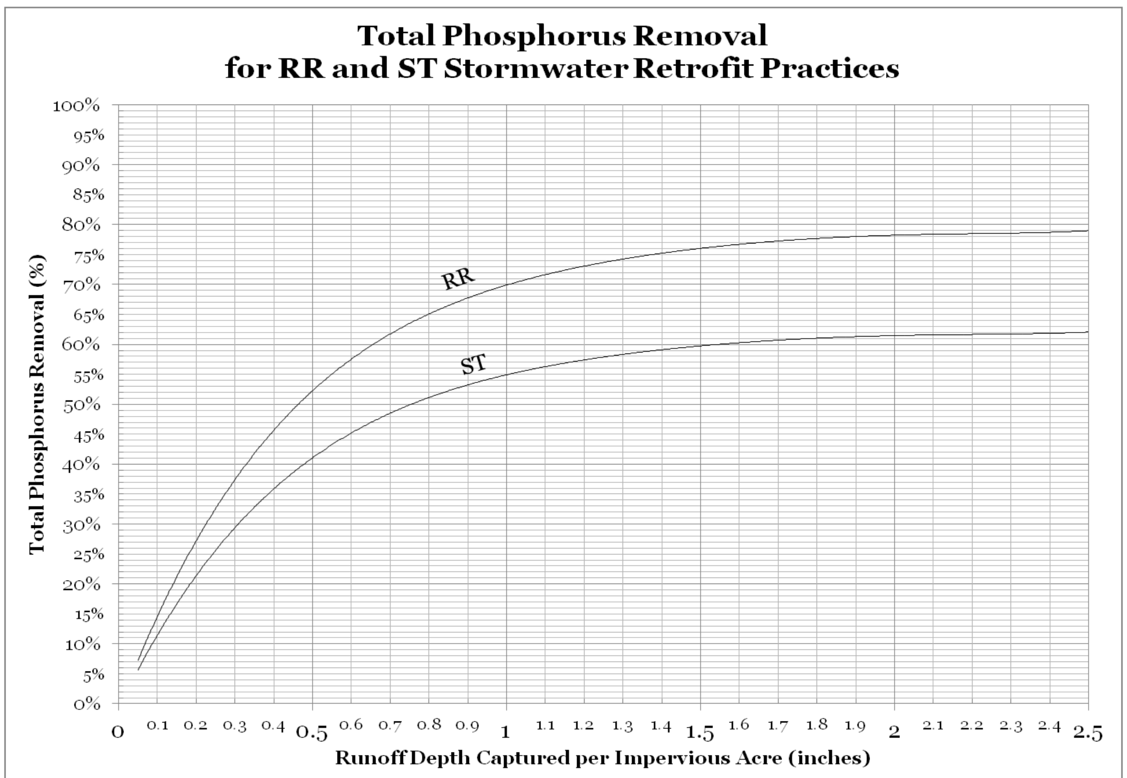
Wooded Filter Strips Cause Reconcentration of Flow

Nitrogen Loss to Groundwater

- Surface runoff monitoring studies
- “Surrogate” turfgrass research to evaluate N leachate & 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 (Morton et al 1988)
  - 13% nitrate leaching, majority N stored in soil (Raciti et al 2011)
  - N transformations within buffer; storage in soil and vegetation
  - “irreducible” or low input concentration affect removal efficiency

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”) and result pollutant removal

TP: 28 – 71% TN: 22-59% TS: 28-75%

Table 8: Runoff depth estimated using hypothetical design example for an urban filter strip.

	DC	DE	MD[1]	PA	NY	VA	WV
Runoff depth captured (in) using New State Stormwater Performance Method	0.32	0.50	0.19 – 0.95	0.33	0.95	0.48	0.42
Runoff reduction (%)	28	20	8-38	33	99	50	44

[1] The values for MD represent the range in P_e available for urban filter strips and range from 0.2 , 0.4, 0.6 to 1.0.

[2] The volume reduction is based on the hypothetical design example provided in Appendix D with an impervious area of 10,800 ft^2

- Modify method to estimate pollutant removal rate
- Average “runoff reduction depth captured” of 0.5”
- Sizing ratio of 0.4 (min length of filter strip: impervious flow length) to constrain size of filter strip available for credit

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

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TN Removal by UFS

- Assumes only particulate N is reduced by UFS; *all* soluble N leaches to groundwater
  - Current performance curves for RR BMPs assumes 60% of soluble N infiltrates 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.

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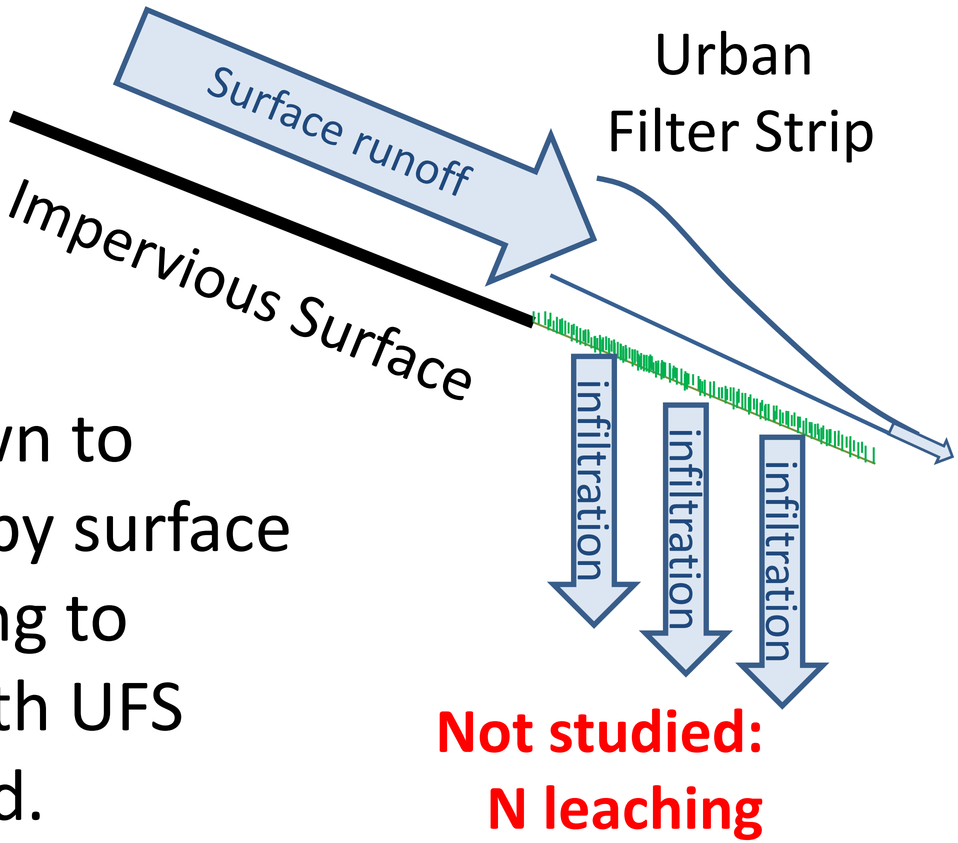
No Credit for TN

DISSENTING OPINION

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.

Conclusion:

Because N leaching has not been studied in UFS, estimates of N removal by UFS are best professional judgement.

Consequences of assigning a non-zero N removal credit to UFS

- Assigning a non-zero credit will be a disincentive for doing the research needed to measure N removal by UFS.

- UFS will be selected as practices for meeting TMDLs in place of practices with demonstrated abilities for N removal.

- Failure of N removal by UFS will not be detected because leaching losses will not be measured.

Managed turf can retain extra N loads applied in fertilizer but this is very different from N loads to UFS

- Adding fertilizer increases the concentration of N in the soil, which increases rates of N uptake by plant roots and microbes.

- Fertilizer is added during the growing season when plant N demand is highest.

- Managed turf is watered during dry periods to support plant growth.

In contrast to managed turf, UFS receive extra N loads in runoff from impervious surfaces

- Runoff occurs in any season including the non-growing season.
- Runoff occurs during wet conditions when plant water demand is already met.
- Adding N in runoff does not increase N concentration in the soil and therefore does not increase the rates of biological N uptake.

Reporting, Tracking & Verification

- USWG BMP Verification Guidance
- Guidance provided in New State Stormwater Performance Standards and Retrofit Projects expert panel report recommendations

Reporting, Tracking & Verification

- Specific guidance for UFS includes:
  - *Non-Conforming Projects.* Jurisdictions should also keep track of any future development projects that are designed under the old standard, or cannot fully comply with the new standards. No credit is available for urban filter strips that do not conform to the expert panel recommendations. The pollutant load reduction is available for both RR UFS and ST UFS.

- *Periodic BMP Inspections*. Simple visual indicators are used during routine maintenance inspections to verify that the system of practices still exists, is adequately maintained and is operating as designed. Inspections for UFS should specifically ensure: 1) the absence of any erosional channels, 2) the vegetative cover is in condition according to the qualifying conditions for this BMP and 3) structural integrity of the level spreader is intact. A record of a soil test to determine the amount of nitrogen and phosphorus applied from fertilizer application should be noted on the inspection form, or as a separate follow-up action according to State or District guidance. It is recommended that these rapid investigations be conducted as part of every other routine stormwater BMP inspection required under their MS4 NPDES permits. Inspectors should evaluate BMPs once every other inspection permit cycle, as mandated in their MS4 permit, to assure that individual LID and site design practices are still capable of removing nutrients/sediments.

Un-intended Consequences & Double Counting

- Not unforeseen unintended consequences
- Qualifying conditions for ST UFS and RR UFS provide the States and DC clear guidance for their application and pollutant removal.

- Given the sequential implementation of BMPs in the CBWM, the Expert Panel does not foresee any double counting related to UFS.
  - UFS may be used as part of a treatment train approach to urban stormwater management and as such is discounted accordingly in the CBWM. G
- Given the qualifying conditions for fertilizer management for UFS, pollutant load reductions for UNM may not applied to the area of an UFS, nor can UFS be credited as part of urban forest buffer where the purpose of the UFS is to create sheetflow conditions to the buffer.

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
- 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?