Stormwater Management Program

Effectiveness Literature Review

Traditional BMP White Paper

Prepared for:
Assoc. of Washington Cities &
Washington State Dept. of Ecology

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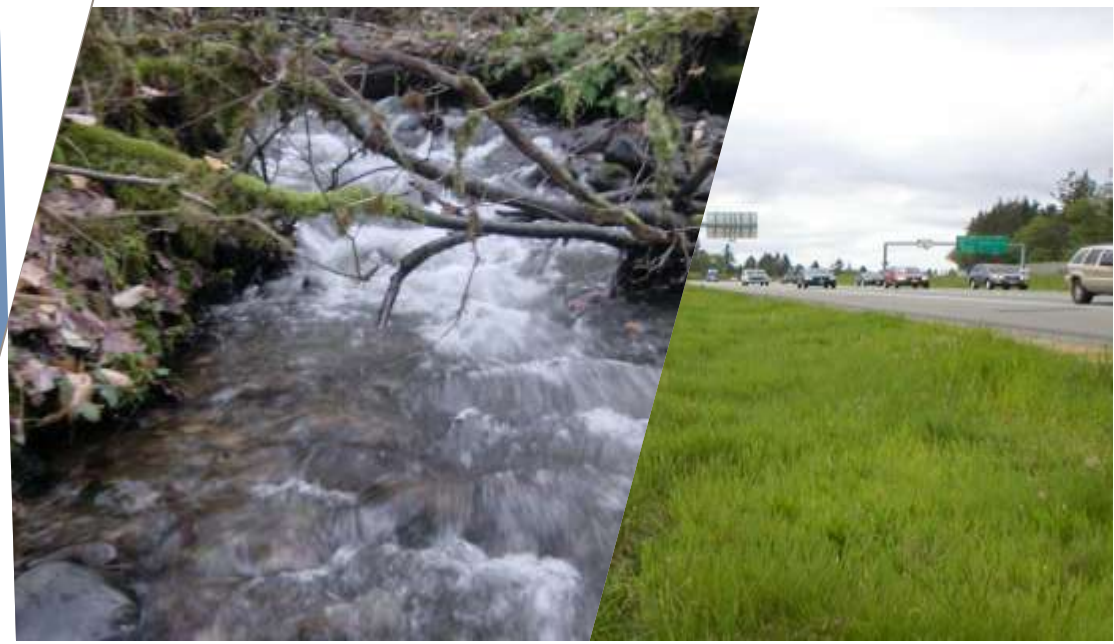

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Ranked Topics and Questions: Topic #10

Null Hypothesis: Reducing the size of a filter strip does not alter its effectiveness at reducing pollutant concentrations.

- Are existing sizing criteria for vegetative filter strips (based on bioswales) overly conservative?
- Which combinations of length, width, slope, soil types and vegetation types result in greatest removal of sediment by vegetative filter strips?

Ranked Topics and Questions: Topic #12

Null Hypothesis: Retrofitting using water quality treatment devices does not reduce pollutant loads.

- Which combinations of retrofit BMPs in a basin are most effective at reducing pollutants to receiving waters?
- To what extent does retrofitting, using water quality treatment devices, reduce urban stormwater pollution to receiving water bodies?
- Once installed, do model predicted quantities of stormwater controls in a basin reduce stormwater impacts enough to support the receiving water's designated beneficial uses?

Background

- Filter strips are widely used in the US to treat highway runoff. They are effective at reducing TSS and particulate pollutants, and are approved in Washington State for Basic Treatment.
- Level of effectiveness varies depending on width, slope, vegetated cover, flow rate, and uniform flow across the filter strip.
- Stormwater from urban areas and existing developments is often unmanaged and is considered a major contributor to stormwater pollution.
- Retrofit BMPs are increasingly being used to address unmanaged stormwater runoff from already developed sites.
- BMP effectiveness models provide a way to predict pollutant removal ability under varying environmental conditions and can assist in looking at the cost versus benefit of various types and sizes of BMPs that may be appropriate for retrofits.

Are existing sizing criteria for vegetative filter strips (based on bioswales) overly conservative?

- Minimum filter strip width of eight feet is recommended by WSDOT.
- Numerous studies have found the size of a filter strip, particularly its width, does have an effect on its pollutant removal ability.
- Filter strips with good removal efficiencies were a minimum of 5 meters (16.4 feet) wide.

WSDOT sizing criteria uses a series of calculations to determine the width of a filter strip, therefore it is difficult to say if this criterion is overly conservative. WSDOT minimum filter strip width of 8 feet does not seem conservative.

Which combination of length, width, slope, soil types and vegetation types result in the greatest removal of sediment by vegetative filter strips?

- Size, slope, soil type, and vegetation type can all influence the effectiveness of filter strips, however studies did not examine what combination were most effective at removing sediments.
  - Length: Equal length of contributing area, max of 150 feet.
  - Width: First 5 meters play critical role in effectiveness.
  - Slope: HRM calls for 2-15%, other studies suggest <5%.
  - Soil type: recommended 60% sandy loam, 40% compost. Top 18” amended with an infiltration rate between ½-12 inches per hour.
  - Vegetation type: Denser vegetation more efficient. HRM states filter strips in WA should include grass that can withstand high velocities and extended dry periods.

Width, slope, soil type, and vegetation type can all influence the effectiveness of filter strips. However, no studies were obtained that looked at which design combination resulted in the greatest removal of sediment.

Which combinations of retrofit BMPs in a basin are most effective at reducing pollutants to receiving waters?

- CALTRANS retrofitted developed areas with sand filters and found consistently low effluent levels of TSS and particle associated pollutants. Significant removal of dissolved constituents was observed at higher influent concentrations.
- Models show effective phosphorus removals from developed sites retrofitted with wet detention ponds and biofiltration cells.

Few studies were found that evaluated the effectiveness of retrofit BMPs. However these studies did not assess compare the various combinations of retrofit BMPs.

To what extent does retrofitting using water quality treatment devices reduce urban stormwater pollution to receiving water bodies?

- CALTRANS study of retrofit sand filters showed a 90% removal of TSS, with an average effluent concentration of 7.5 mg/L. Removal of total copper, total lead and total zinc were 50%, 87% and 80% respectively.
- Sand filter showed a significant reduction in dissolved copper and other metals when the influent concentrations were high.
- Model predicted a 65% removal of total phosphorus from a retrofit detention pond if the pond covered 5% of the site's area and received 100% of the runoff.
- Retrofitting an extended detention basin to provide batch treatment rather than flow through treatment improved TSS removal from 60 or 70% to 91%. Also showed significant reductions in total copper, lead and zinc, COD, total phosphorus, nitrate and nitrite, and TKN.

Studies indicate retrofitting using water quality treatment devices can reduce pollutant levels as effectively, and sometimes more effectively, that standard BMPs installed in newly constructed areas.

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Once installed, do model predicted quantities of stormwater controls in a basin reduce stormwater impacts enough to support the receiving water's designated beneficial uses?

- Single study was found that aimed to verify a model of sediment behavior in grass.
- Study conducted on grass swales and filter strips at two sites, and found the difference between the predicted and measured sediment loading rates was +/- 17% and +/- 11% for grass swales, and +/- 25% and +/- 50% for the filter strips.
- Overall study determined the model was a reliable tool at predicting sediment removals.

BMP effectiveness models are a valuable tool to predict effectiveness under varying environmental conditions and to evaluate the cost-benefit of various types of BMPs. Assessing or increasing the accuracy of these models would be very beneficial.

Recommended Effectiveness Studies

1. Assess effectiveness of filter strips in W. Washington where lower rainfall intensities may allow for narrower filter strips.
2. Conduct literature search of studies to assess current widths and effectiveness of filter strips in W. Washington.
3. Perform local field studies on filter strips of varying widths, slopes and vegetation to determine if there is an optimal combination.
4. Perform field studies on filter strips narrower than 8 feet in width, comparing results to Ecology's Basic Treatment requirements.

Recommended Effectiveness Studies (cont'd)

5. Perform field studies on existing urban retrofitted BMPs within W. Washington to assess their effectiveness.
6. Assess feasibility of adding BMPs to existing developed areas.
7. Conduct a more extensive literature search on which retrofitted BMPs are most effective at removing specific pollutants of interest.
8. Conduct field studies to compare model predicted BMP effectiveness to field verified BMP effectiveness.
9. Improve BMP models by incorporating urban stormwater runoff data.