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Best Management Practice Fact Sheet 2:

Sheet Flow to Open Space

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This fact sheet is one of a 15-part series on urban *stormwater management* practices.

Please refer to definitions in the glossary at the end of this fact sheet.
Glossary terms are *italicized* on first mention in the text. For a comprehensive list, see Virginia Cooperative Extension (VCE) publication 426-119, "Urban Stormwater: Terms and Definitions."

What Is Sheet Flow to Open Space?

Sheet flow to open space (SOS) is a group of *best management practices* (BMPs) designed to disperse concentrated runoff to *sheet flow* into *filter strips* or a riparian buffer. An SOS reduces runoff volume and associated *sediment* and *nutrients* that are carried with it (see figure 1). It is used as a *stormwater treatment practice* in both urban and rural areas. This practice is often used after another treatment practice to disperse or eliminate runoff. In a few cases, an SOS can be used as a pretreatment to remove small amounts of sediment via a vegetated filter strip — prior to a bioretention device, for example.

Figure 1. Typical vegetated filter strip (EPA 2009).

Where Can SOS Be Used?

The SOS is located where there is sheet flow runoff from an *impervious surface* to a filter strip — a densely vegetated, uniformly graded area. Filter strips are often vegetated by turfgrass but may consist of meadows or small forest plantings.

An SOS can only intercept flow from small, impervious areas. Larger areas with higher flows are accommodated by the installation of a gravel trench or other *level spreader* (see figure 2).

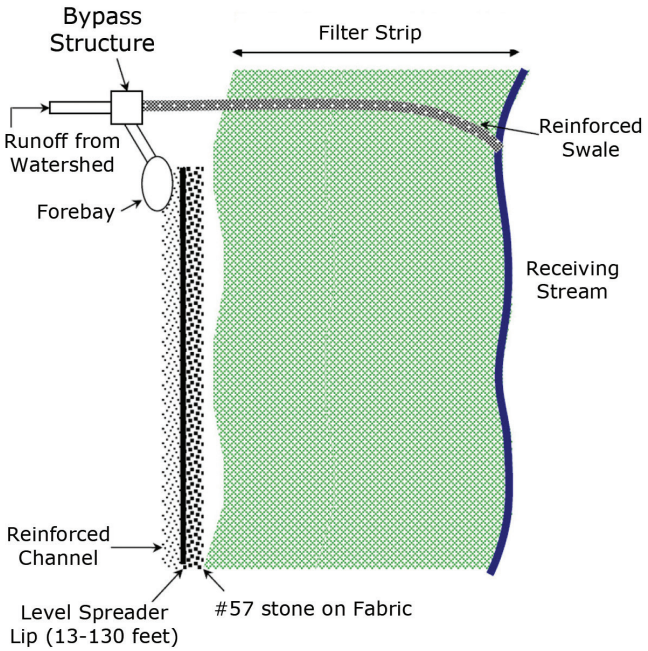

Figure 2. Plan view of sheet flow to open space (VA-DCR 2011).

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How Does SOS Work?

Sheet flow to open space works by maintaining sheet flow from impervious surfaces onto filter strips. An SOS has high runoff-reduction potential due to the vegetative surface roughness that reduces the velocity of runoff and increases the *residence time* of water across the landscape. This results in increased treatment and and promotes *infiltration*.

Filter strips can trap sediment effectively. Water quality improvement from an SOS is provided by natural processes, primarily *filtration* and *sedimentation*.

Limitations

- An SOS can only treat drainage areas smaller than 5 acres.
- The *soil texture* must be able to support vegetation and possess sufficient infiltration capacity.
- It requires a large amount of space, which is infeasible in urban areas.
- Its effectiveness depends on length, slope, type of practice, etc. (See VA-DCR [2011], table 2.2, for design guidance.)
- It may require deed restriction to remain conserved open space.

Maintenance

Routine Maintenance (annual)

- Inspect gravel trench or level spreader (if present) for clogs and built-up sediment.
- Inspect filter strip for *erosion* caused by *concentrated flow*; repair eroded areas.
- Inspect to make sure grass is well-established; seed bare areas to prevent erosion.
- For grassed SOS, tall fescue (cool season) and bermudagrass (warm season) can be obtained from seed or sod and is available throughout Virginia; selection depends on local climate (e.g., cooler climates and higher elevations would tend to support fescue).
- Mow grassy areas seasonally at a tall grass setting, as permissible under conservation restrictions.

Nonroutine Maintenance (as needed)

- Remove sediment that may build up at bottom of filter strip.
- Observe for channel formations, particularly in forested filter strips.
- Manage unwanted and *invasive species*.
- Remove debris.

Performance

Sheet flows to open space are effective at removing sediment and pollutants from incoming water flow. A typical SOS is expected to reduce both total phosphorus (TP) and total nitrogen (TN) by 50 percent, accounting for mass load reduction from runoff removal. Advanced designs, when effective, are larger than simpler designs to provide for additional water filtration. Advanced SOS designs can improve the expected reduction of TP and TN to 75 percent (VA-DCR 2011).

Expected Cost

An SOS is a relatively inexpensive stormwater treatment practice when compared to other alternatives. Most of the cost for filter strips is seed or sod establishment. For the SOS, the price is minimal, amounting only to the level spreader at the top of the filter strip. Additional costs in this case are for the gravel for the spreader. It is estimated that annual maintenance amounts to approximately $350 per treated acre per year.

Perhaps the greatest component of costs is the opportunity cost of the land, i.e., taking it out of development, which is not included in this analysis. This value depends on local land values and should be estimated on a site-specific basis. This will likely be required prior to creation of an open space conservation area.

Additional Information

The Virginia departments of Conservation and Recreation (VA-DCR) and Environmental Quality (VA-DEQ) are the two state agencies that address nonpoint source pollution. The VA-DCR oversees agricultural conservation; VA-DEQ regulates stormwater through the Virginia Stormwater Management Program.

Additional information on best management practices can be found at the Virginia Stormwater BMP Clearinghouse website at http://vwrrc.vt.edu/swc. The BMP Clearinghouse is jointly administered by the VA-DEQ and the Virginia Water Resources Research Center, which has an oversight committee called the Virginia Stormwater BMP Clearinghouse Committee. Committee members represent various stakeholder groups involved with stormwater management.

Online Resources

Center for Watershed Protection and Chesapeake Stormwater Network – www.cwp.org/documents/cat_view/76-stormwater-management-publications/95-runoff-reduction-method-technical-memo.html

Center for Watershed Protection and U.S. Forest Service – www.forestsforwatersheds.org/reduce-stormwater/

Charles River Watershed Association – www.crwa.org/projects/stormwater/stormwaterBMPs.html

Ohio State University Extension – http://ohioline.osu.edu/aex-fact/0467.html

Universities Council on Water Resources – www.ucowr.org/updates/146/3.pdf

U.S. Environmental Protection Agency – www.epa.gov/greeningepa/stormwater/best_practices.htm

Virginia Department of Conservation and Recreation – www.dcr.virginia.gov/documents/LRdavidpresentation.pdf

Companion Virginia Cooperative Extension Publications

Daniels, W., G. Evanylo, L. Fox, K. Haering, S. Hodges, R. Maguire, D. Sample, et al. 2011. *Urban Nutrient Management Handbook*. Edited by M. Goatley. VCE Publication 430-350.

Gilland, T., L. Fox, M. Andruczyk, and L. Swanson. 2009. *Urban Water-Quality Management - What Is a Watershed?* VCE Publication 426-041.

Sample, D., et al. 2011-2012. Best Management Practices Fact Sheet Series 1-15, VCE Publications 426-120 through 426-134.

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References

U.S. Environmental Protection Agency (EPA). 2009. Chesapeake Bay Program. http://www.chesapeakebay.net/photos.

Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No. 2: Sheet Flow to a Vegetated Filter Strip or Conserved Open Space*, Version 1.9. http://vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec2SHEETFLOW.html.

Glossary of Terms

Best management practice (BMP) – Any treatment practice for urban lands that reduces pollution from stormwater. A BMP can be either a physical structure or a management practice. Agricultural lands use a similar, but different, set of BMPs to mitigate agricultural runoff.

Check Dams – either temporary or permanent, a check dam is a small structure usually made of stones or logs constructed across a ditch, swale, or channel to reduce concentrated flow velocity.

Concentrated flow – Occurs when water concentrates into rivulets or channels; the opposite of sheet flow.

Concentrated flow leads to greater water velocity and decreased time for infiltration and *settling*.

Erosion – A natural process by either physical processes, such as water or wind, or chemical means that moves soil or rock deposits from one source and transports them to another. Excessive erosion is considered an environmental problem that is very difficult to reverse.

Filter strip – Densely vegetated, uniformly graded areas that intercept runoff from impervious surfaces.

Filtration – A treatment method that removes pollutants by straining, sedimentation, and similar processes.

Impervious surfaces – Hard surfaces that do not allow infiltration of rainfall into them; not *pervious*.

Infiltration – The process by which water (surface water, rainfall, or runoff) enters the soil.

Invasive species – Nonnative species that can cause adverse economic or ecological impacts to the environment, usually due to the tendency of these introduced species to dominate local habitats and replace native ecological communities.

Level spreader – A gravel trench or other practice, such as a *check dam*, that intercepts concentrated flow and releases it as sheet flow.

Nutrients – Substances required for growth of all biological organisms. When considering water qualities, the nutrients of greatest concern are nitrogen and phosphorus in stormwater, because they are often limiting in downstream waters. Excessive amounts of these substances are pollution and can cause algal blooms and dead zones to occur in downstream waters.

Pervious – A ground surface that is porous and allows infiltration into it.

Residence time – The average time it takes water to travel through a treatment system, such as an SOS. Residence time can also be called detention time.

Sediment – Soil, rock, or biological material particles formed by weathering, decomposition, and erosion. In water environments, sediment is transported across a *watershed* via streams.

Sedimentation – See settling.

Settling – The process by which particles that are heavier than water fall to the bottom under the influence of gravity.

Sheet flow – When runoff travels in a sheet over the surface of the ground.

Sheet flow to open space – When sheet runoff flows from an impervious surface to open space, usually a filter strip.

Soil texture – Describes the composition of soils based on its particle sizes. According to the U.S. Department of Agriculture's classification, soils are classified as sands (larger than 0.05 millimeter, or mm), silts (0.002 to 0.05 mm), and clays (smaller than 0.002 mm).

Stormwater – Water that originates from impervious surfaces during rain events; often associated with urban areas. Also called runoff.

Stormwater treatment practice – A type of best management practice that is structural and reduces pollution in the water that runs through it.

Watershed – A unit of land that drains to a single "pour point." Boundaries are determined by water flowing from higher elevations to the pour point. The pour point is the point of exit from the watershed, or where the water would flow out of the watershed if it were turned on end.