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Best Management Practice Fact Sheet 10:
Dry Swale

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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 a Dry Swale?

A d*ry swale* (DS) is a shallow, gently sloping channel with broad, vegetated, side slopes. Water flow is slowed by a series of *check dams* (see figure 1). A DS provides temporary storage, *filtration,* and *infiltration* of *stormwater* runoff. Dry swales function similarly to *bioretention,* and are comparable to *wet swales*; however, unlike a wet swale, a DS should remain dry during periods of no rainfall. A DS is an engineered *best management practice* (BMP) that is designed to reduce pollution through runoff reduction and pollutant removal and is part of a site's *stormwater treatment practice* (see figure 2).

Figure 1. Typical dry swale just after construction.
Source: Wetland Studies and Solutions Inc., Gainesville, Va., 2009.

Where Can Dry Swales Be Used?

A dry swale is versatile because the area it requires is relatively small. It can be used in place of curbs, gutters, and sewer systems; and functions very similar to a bioretention cell or rain garden (VCE publication 426-128, "Best Management Practice Fact Sheet 9: Bioretention") arranged in a straight line. A DS is typically installed on a shallow slope so that flow velocities are slowed, thus increasing infiltration and water quality treatment. Vegetation species can include turf, meadow grasses, shrubs, and — in limited quantities — small trees.

How Do Dry Swales Work?

Dry swales are always located above the *water table* to provide drainage. *Underdrains* are not typically used in highly *permeable* soils, while the reverse is true in *impermeable* soils. The purpose of the underdrain is to filter excess runoff that does not infiltrate. This helps the DS regain capacity for the next rainfall event. Underdrains are constructed with a perforated pipe that is fit within a gravel layer at the bottom of the swale. A small amount of runoff storage is provided in small pools upstream from each check dam.

A DS temporarily stores and then filters runoff. It effectively reduces and retards *peak runoff* by acting like a buffer or shock absorber for flows. Depending on the soil permeability, the water either infiltrates the soil and recharges groundwater, or it is collected in the underdrain and directed toward the *stormwater conveyance system*.

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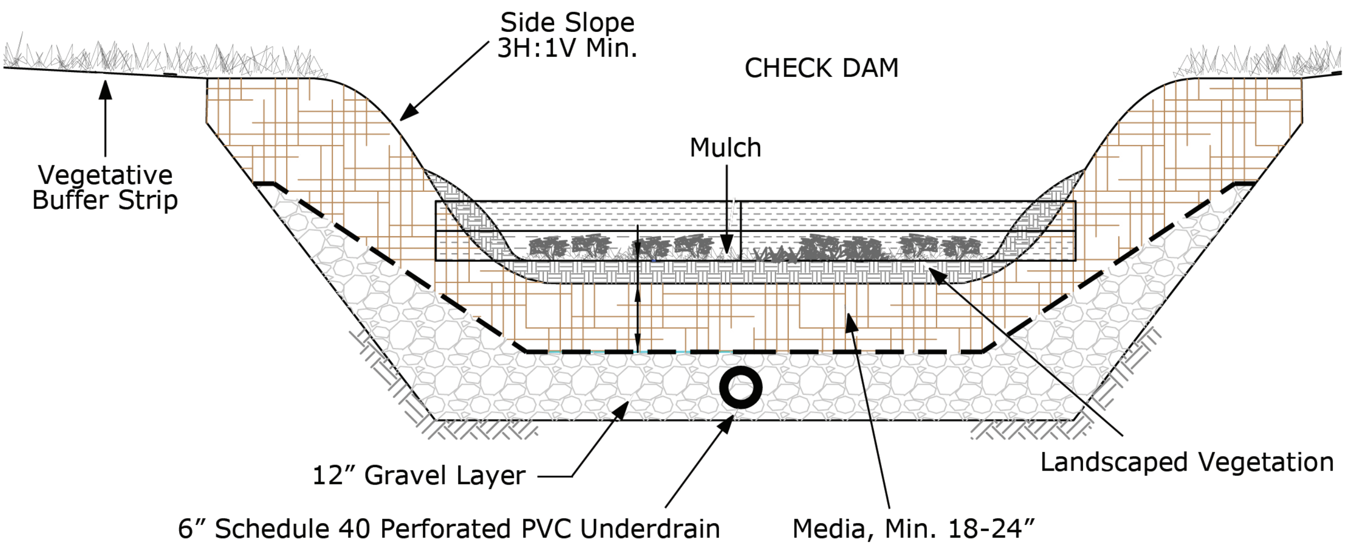

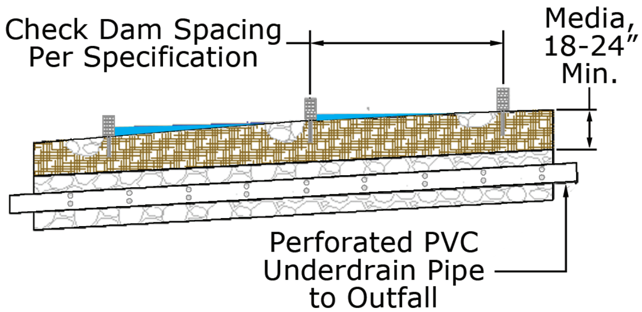

Figure 2. Profiles and sections of a typical dry swale.
(VA-DCR 2011)

Water quality improvement in a DS is provided by natural processes, including *biological uptake*, filtering, infiltration, and *settling*. Dry swales are effective at removing excess *nutrients* and *sediment* and significantly reducing runoff.

Limitations

- Off-road parking and snow removal can destroy a DS.
- The drainage area leading to a DS is generally smaller than 5 acres to keep flows lower and prevent *erosion*. The area depends upon the slope and extent of impervious surfaces upstream of the DS.
- The DS must be placed 2 feet or more above the water table to provide sufficient treatment before reaching groundwater.
- *Groundwater contamination* could result from DS use in commercial and industrial areas. This is due to increased infiltration into the water table and potential contaminants.
- Soils should be highly permeable or may require a soil amendment.
- Underdrains are required for less permeable soils.

Maintenance

Routine Maintenance (annual)

- Inspect the DS and replace vegetation as needed.
- Trim vegetation periodically to keep woody vegetation in check.
- Inspect to make sure the DS is functioning and clear of debris. Repair as needed.
- Remove trash and debris.

Nonroutine Maintenance (as needed)

- Remove excess accumulated sediment above check dams.

Performance

Dry swales are effective at removing multiple pollutants from incoming water flow. A typical DS is expected to reduce total phosphorus (TP) by 52 percent and total nitrogen (TN) by 55 percent. Advanced designs provide for off-line design, multiple treatment cells, and dense and diverse vegetation (i.e., not a single turf species) to enhance treatment. Advanced DS designs can improve the expected reduction of TP to 76 percent and TN to 74 percent (VA-DCR 2011).

Expected Cost

Dry swales vary in price depending on the complexity of the design. A very preliminary estimate of the cost is $7,500 for a drainage area of 5 acres, according to the Federal Highway Administration (U.S. Department of Transportation 2002). This does not include the value of land dedicated to the BMP. A DS is a relatively inexpensive stormwater treatment practice when compared to other alternatives. Maintenance costs are variable and can be reduced if sediment and debris are frequently removed from the DS as a preventive maintenance practice.

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

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

Iowa State University Center for Transportation, Research and Education – www.ctre.iastate.edu/pubs/stormwater/documents/2I-3DryandWetSwales.pdf

Metropolitan Council of Minneapolis (metrocouncil.org) – www.metrocouncil.org/environment/Water/BMP/CH3_STDetDrySwale.pdf

Mississippi State University – www.abe.msstate.edu/csd/NRCS-BMPs/pdf/water/quality/dryswale.pdf

New Jersey Department of Environmental Protection – www.state.nj.us/dep/stormwater/bmp_manual2.htm

Oregon Department of Environmental Quality – www.deq.state.or.us/wq/stormwater/nwrinfo.htm

University of Florida Build Green –http://buildgreen.ufl.edu/Fact_sheet_Bioswales_Vegetated_Swales.pdf

U.S. Environmental Protection Agency – http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=75

Virginia Stormwater BMP Clearinghouse – http://vwrrc.vt.edu/swc/

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.

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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Virginia Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No.10: Dry Swales*, Version 1.9. http://vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec10DRYSWALE.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 have a similar, but different, set of BMPs that are used to mitigate agricultural runoff.

Biological uptake – The process by which plants absorb nutrients for nourishment and growth.

Bioretention, bioretention cell – A BMP that is a shallow, landscaped, depression that receives and treats stormwater with the goal of discharging water of a quality and quantity similar to that of a forested *watershed*. Bioretention cells typically consist of vegetation, soils, an optional underdrain, and an *outlet* structure. Sometimes called "rain gardens."

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

Dry swale – A shallow, gently sloping channel with broad vegetated side slopes and low velocity flows. They are always located above the water table to provide infiltration capacity.

Erosion – A natural process by either physical processes such as water or wind, or chemical means that moves soil or rock deposits. Excessive erosion causes water quality problems and is very difficult to reverse.

Filtration – A process by which solids are separated from fluids by use of *media.*

Groundwater contamination – The presence of unwanted chemical compounds in groundwater.

Impermeable – A hard surface that do not allow water to flow through it

Impervious surface – A hard surface that does not allow infiltration of rainfall into it; not permeable.

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

Media – The topsoil that supports plant growth. Bioretention media is used in DS, and typically has a high sand and low clay content and a low phosphorus content.

Nutrients – The substances required for growth of all biological organisms. When considering water quality, the nutrients of most concern in stormwater are nitrogen and phosphorus, 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.

Outlet – The point of exit of water from a downspout or other BMP.

Peak runoff – The highest water flow off a surface during a storm event.

Permeable – A surface that water can easily flow through (porous); allows infiltration into it.

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

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

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

Stormwater conveyance system – Means by which stormwater is transported in urban areas.

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

Underdrain – A perforated pipe in the bottom of a porous pavement reservoir designed to collect water that does not infiltrate into native soils.

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

Water table – The top level of saturated area under the ground.

Wet swale – A shallow, gently sloping channel with broad, vegetated, side slopes constructed to slow runoff flows. It typically stays wet by intercepting the shallow groundwater table.