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Best Management Practice Fact Sheet 8:

Infiltration Practices

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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 an Infiltration Practice?

Infiltration practices provide temporary surface and/or subsurface storage, allowing infiltration of runoff into soils. In practice, an excavated trench is usually filled with gravel or stone media, where runoff is stored in pore spaces or voids between the stones (see figure 1). These systems can reduce significant quantities of *stormwater* by enhancing infiltration, as well as provide filtering and adsorption of pollutants within the stone media and soils. Infiltration practices are part of a group of *stormwater treatment practices*, also known as *best management practices* (BMPs)

Figure 1. Construction of an infiltration basin. *Source: Wetland Studies and Solutions Inc., Gainesville, Va., 2009.*

Where Are Infiltration Practices Used?

Infiltration practices can be used to treat stormwater runoff from parking lots, recreational fields, residential lawns, and other smaller *impervious surfaces*. Implementation consists of an excavated trench filled with gravel or stone backfilled to the surface. Temporary storage volume is provided within pore spaces or voids between the stone. *Sediment* can be easily trapped within the pores and clog them, so pretreatment for sediment removal is advised.

Designs can include or exclude a perforated drainage pipe near the bottom of the stone layer, depending on the quality of the runoff and the infiltration rate. Infiltration practices can reduce significant quantities of runoff and also provide filtration and adsorption of pollutants within the media and soil. These practices work best when implemented over a small drainage area, preferably 2 to 5 acres. A "*perk test*" or percolation test should be performed on the soil to determine minimum infiltration or *percolation rate*.

How Does an Infiltration Practice Work?

Infiltration practices function by impounding runoff, which then allows water to infiltrate into the underlying soil or gravel media (see figure 2). The main differences between infiltration practices are the *residence*

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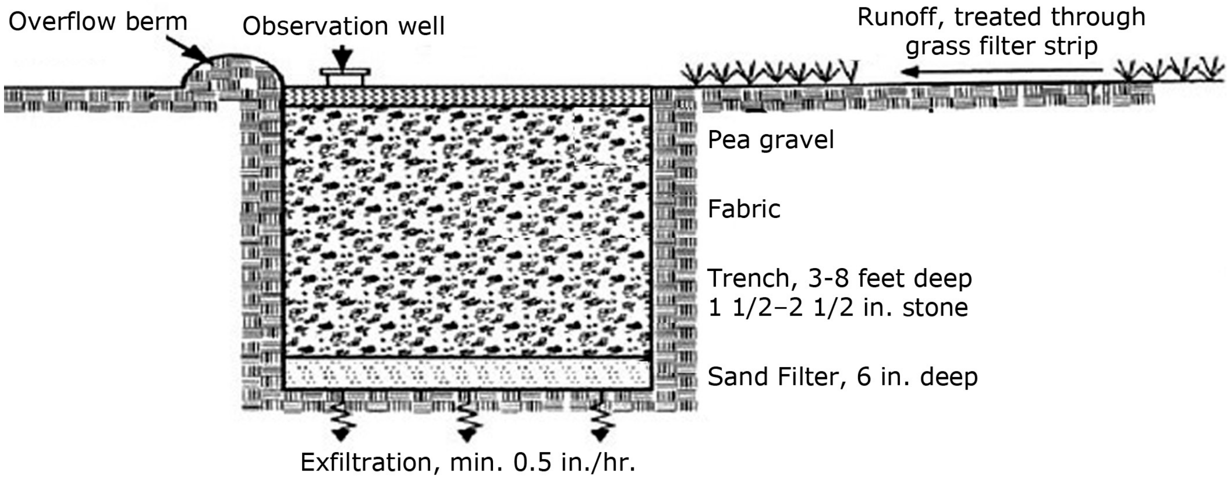

Figure 2. Profile view of typical infiltration practice (VA-DCR 2011).

time, which is the time it takes water to travel through the practice. Trapped in void spaces, runoff water either *exfiltrates* to *groundwater* or evaporates to the atmosphere. In this way, groundwater recharge is improved, which helps to maintain *baseflow* to nearby streams.

Natural processes provide water quality improvement in infiltration practices. Depending on the media, the practice either rapidly infiltrates runoff, thus removing it, or treats it by filtration. Sedimentation also occurs. However, because sediment has the potential to clog the practice, runoff water should be treated using a grass *filter strip* before using this practice (see figure 2).

Limitations

- Use is generally restricted to small areas (with a drainage area smaller than 5 acres).
- Not effective in compacted soils or soils with poor percolation rates, or when infiltration is less than 0.5 inch per hour.
- Requires initial treatment to remove sediment and prevent clogging.
- Construction in *hot spots*, such as gas stations, is generally prohibited because the potential for *groundwater contamination* may be increased.
- Because of the potential to cause *groundwater mounding*, a 10- to 100-foot buffer from structures must be maintained (VA-DCR 2011). The exact buffer size depends on the size of the practice. The greater range is when the infiltration practice is located at an elevation above the lowest floor elevation of a nearby building.

Maintenance

Routine Maintenance (annual)

- Remove sediment accumulated in initial treatment practices; if using a filter strip, mow strip.
- Remove trash and debris.
- Inspect for any weedy vegetation in gravel substrate that may indicate sediment buildup.

Nonroutine Maintenance (as needed)

- Remove excess, accumulated sediment from either surface of the practice (easier) or stone media (more difficult and expensive).
- Remove trees and shrubs from berms.

Performance

Compared to other best management practices, such as wet ponds, infiltration practices are very effective at removing multiple pollutants from incoming water flow (VCE publication 426-133). Expected removal of total phosphorous and total nitrogen is approximately 80 percent and 75 percent, respectively (VA-DCR 2011). Proper construction and following design specifications is extremely important, because many improperly installed infiltration practices experience failure and other problems. However, when correctly implemented and maintained, these practices have among the highest pollutant removal and runoff reductions that closely follow predevelopment conditions.

Expected Cost

The average estimated cost for an infiltration trench is about $5 per cubic foot of stormwater treated, and they take up about 2 percent of the available land. Because of their geometry, infiltration trenches can be tucked into smaller spaces. Infiltration basins cost about $2 per cubic foot of storage for 0.25 acre of drainage, or $22,000 (EPA 2006) and consume approximately 3 percent of the available land. These costs do not include land costs. Maintenance costs for either type of infiltration practice are estimated to be between 5 percent to 10 percent of the construction costs, or $1,100 to $2,200 annually.

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

California State Water Resources Control Board – www.swrcb.ca.gov/rwqcb6/water_issues/programs/storm_water/docs/Chapter09.pdf

Chesapeake Stormwater Network – www.chesapeakestormwater.net/all-things-stormwater/infiltration-specification.html

Connecticut Stormwater Quality Manual – www.ct.gov/dep/lib/dep/water_regulating_and_discharges/stormwater/manual/CH11_IP_P-3.pdf

University of Minnesota – http://stormwaterbook.safl.umn.edu/content/infiltration-practices

U.S. Environmental Protection Agency – http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=70; http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=69

U.S. Geological Survey – http://pubs.usgs.gov/sir/2010/5102/

Virginia Department of Conservation and Recreation – www.dcr.virginia.gov/stormwater_management/documents/Chapter_3-10.pdf

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 J. 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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U.S. Environmental Protection Agency (EPA). 2006. *Infiltration Trench*. National Pollutant Discharge Elimination System Fact Sheet. http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=browse&Rbutton=detail&bmp=70.

Virginia Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No. 8: Infiltration Practices*, Version 1.8. http://vwrrc.vt.edu/swc/april_22_2010_update/DCR_BMP_Spec_No_8_INFILTRATION_Final_Draft_v1-8_04132010.htm.

Glossary of Terms

Baseflow – The portion of flow in a stream that continues even during extended dry periods.

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.

Exfiltrate – The act of *exfiltration*.

Exfiltration – When water is lost from the surrounding drainage system to the soil as a result of percolation or absorption. (Ant. infiltration)

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

Groundwater – Water located beneath the earth's surface and stored in soil pore spaces, rock fractures, and underground aquifers.

Groundwater contamination – The presence of unwanted chemical compounds in groundwater. In this case, it would normally refer to dissolved nitrogen compounds, such as nitrates. It could possibly include bacteria.

Groundwater mounding – Occurs when the *water table* directly beneath a stormwater infiltration basin is much shallower than the seasonal extreme. Can affect basements and foundations of nearby homes and structures.

Hot spots – Areas that generate exceedingly high concentrations of pollutants due to land use or activities adjacent to the waterway.

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

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

Percolation rate – The speed at which water will infiltrate into unsaturated soil; also known as infiltration rate.

Perk test – A test following uniform procedures to measure the vertical speed at which water infiltrates unsaturated soils.

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. 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.

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.

Water table – The depth at which soils are fully saturated with water.

Watershed – A unit of land that drains to a single "pour point." Boundaries are determined by water flowing from high 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.