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Best Management Practice Fact Sheet 6:

Rainwater Harvesting

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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 Rainwater Harvesting?

Rainwater harvesting (RWH), also known as rainwater harvesting systems or *cisterns*, are devices that intercept, divert, store, and release collected roof runoff from rainfall for later use as an alternative water supply (see figure 1). RWH can also be designed to provide runoff reduction benefits. Therefore, it is classified as a *best management practice* (BMP) for treatment of urban *stormwater*. Because of its dual purpose and benefit, RWH is often classified as a *sustainable* urban BMP.

Where Can Rainwater Harvesting Be Used?

RWH can be used to collect runoff from any impervious area, although roofs are generally the preferred site. Collected runoff can be used for either outdoor or indoor use. Collecting runoff from other *impervious surfaces*, such as driveways and parking lots, is discouraged due to a much higher level of contamination and pollution. RWH can be used in a variety of urban settings; however, periodic maintenance is required. Underground tanks can be installed, but they have to be adequately supported for the anticipated structural loads placed over them.

Figure 1. Typical RWH system.

Source: Wetland Studies and Solutions Inc., Gainesville, Va., 2009. Photo courtesy of D. Sample.

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How Does Rainwater Harvesting Work?

In a typical RWH system, rain falls on the roof (or *roofshed*), runs off, is captured in gutters, and flows to a storage tank, *rain barrel*, or cistern (see figure 2). The storage tank acts as a mini *reservoir*. A filter can be installed on the inlet side to divert contaminants that may wash off the roof, allowing mostly clean water into the tank. Rainwater can be stored above or below ground.

Once the tank's capacity is exceeded, water is diverted through an *overflow* near the top of the tank. Overflow can be channeled into a bioretention area such as a rain garden or swale.

Stored rainwater can be used indoors for *nonpotable water* use (such as toilet flushing) or outdoors for irrigation, car washing, or filling water gardens or birdbaths. This reduces the demand on *potable water* supplies. Runoff reduction benefits occur because the volume of water used is eliminated from site runoff. When water supply needs are reduced, so are water withdrawals, which increases *baseflow* to streamflows.

Limitations

- Tanks may remain full between rain events, so water quality benefits can be reduced due to the potential for overflows.
- Mosquitos need to be screened out or treated to prevent breeding.
- RWH systems do not filter out *nutrients*.
- Current Virginia Department of Conservation and Recreation (VA-DCR 2011) policies only recognize the water quality benefits of indoor nonpotable use.
- Jurisdictions may classify the reused rainwater as graywater, which has additional health requirements, such as backflow prevention. Check with your city/county building code official to confirm.
- Local health department officials may prohibit indoor nonpotable reuse. In some jurisdictions, this can be addressed with appropriate signage.
- The latter two limitations may restrict widespread implementation.

Maintenance

Routine Maintenance

(Cabell Brand Center 2009)

- Inspect and clean prescreening devises and filters (quarterly).
- Clear gutters and downspouts of leaves and debris (semi-annually).
- Inspect and clean storage tank lids, especially vents and screens on inflow/outflow spigots and repair any mosquito screens (annually).
- Inspect overflow pipes, filter path, and secondary BMP, if present (annually).

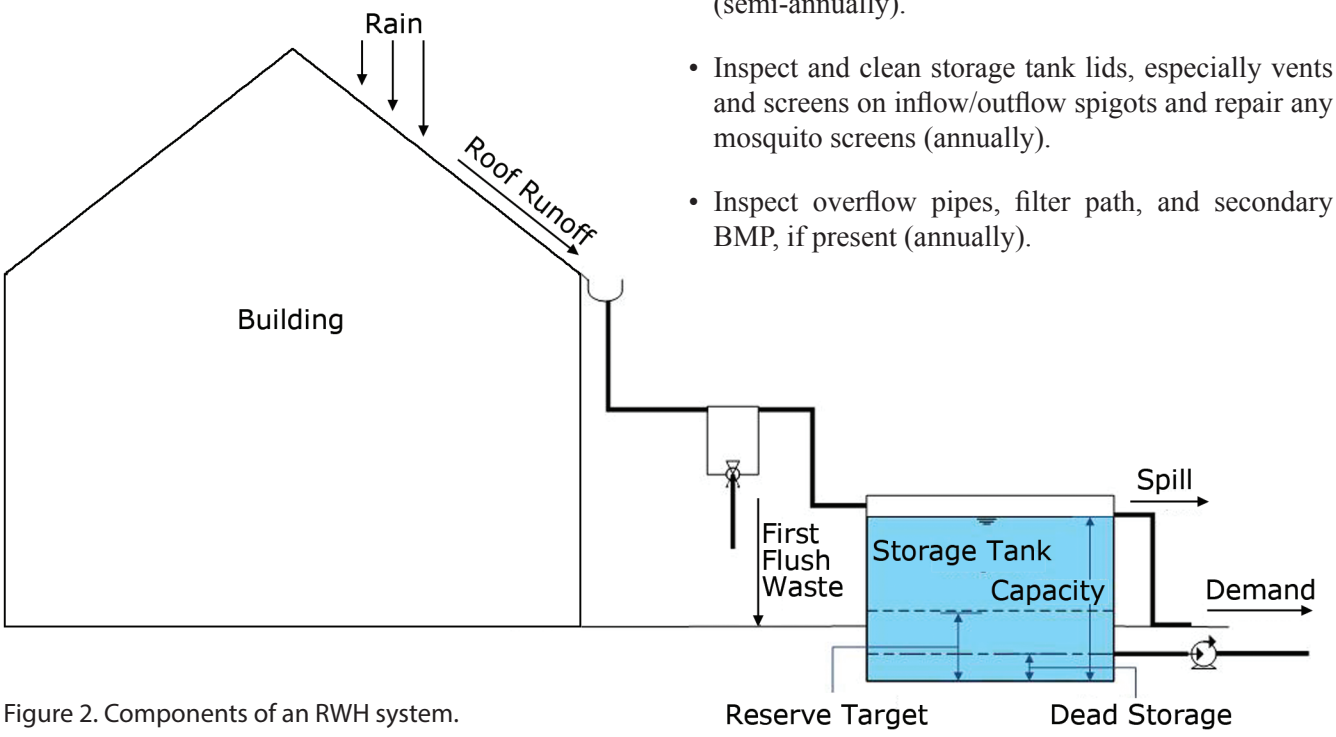

Figure 2. Components of an RWH system.

Nonroutine Maintenance
(as needed)

- Inspect tank for *sediment* buildup.
- Clear overhanging tree branches from above roof.
- Check and inspect backflow preventer, tank, pump, pipe, and electrical system; replace worn or damaged components.

Performance

While an RHS system does not treat for sediments or nutrients by design, it reduces both of the pollutants by reducing runoff volume. Advanced designs can maximize nonpotable reuse of water and can also discharge to a secondary BMP to further filter the water. An advanced RHS design eliminates almost all runoff from the roofshed (VA-DCR 2011).

Expected Cost

RWH is generally an inexpensive *stormwater treatment practice* when compared to other alternatives. A rain barrel can cost as little as $60. On the other hand, a more-sophisticated underground tank and filtering system could cost several thousand dollars. The cost for each system depends on the size of the roofshed, the local rainfall, and the expected demand and management strategy. Higher-cost alternatives can significantly reduce the need for potable water and can also reduce utility costs. These savings should be included in a total cost comparison.

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

Brown University Center for Environmental Studies – http://envstudies.brown.edu/theses/ChristinatangExecutivesummary.pdf

European Rainwater Catchment Systems Association – www.ercsa.eu/uploads/media/Rainwater_Harvesting_-_an_overview_.pdf

GreenSpec – www.greenspec.co.uk/rainwater-harvesting-costs.php

North Carolina State University (Bill Hunt's research website) – www.bae.ncsu.edu/topic/waterharvesting/

Rain Harvest Systems – www.rainharvest.com

Rainwater Management Solutions – www.rainwatermanagement.com

Texas Water Development Board – www.twdb.state.tx.us/publications/reports/rainwaterharvestingmanual_3rdedition.pdf

The Cabell Brand Center – www.cabellbrandcenter.org/Downloads/RWH_Manual2009.pdf

University of Arizona Water Sustainability Program – http://wsp.arizona.edu/education/water_harvesting

U.S. Environmental Protection Agency – www.epa.gov/npdes/pubs/gi_munichandbook_harvesting.pdf

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

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

West Virginia Department of Environmental Protection – www.dep.wv.gov/WWE/Programs/stormwater/MS4/guidance/handbooks/Documents/Rain%20water%20harvesting%20municipal%20handbook.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 J. 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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The Cabell Brand Center, comp. 2009. *Virginia Rainwater Harvesting Manual*, 2nd ed. Salem, Va.: The Cabell Brand Center.

Virginia Department of Conservation and Recreation (VA-DCR). 2011. *Virginia DCR Stormwater Design Specification No. 6: Rainwater Harvesting.* http://vwrrc.vt.edu/swc/NonPBMPSpecsMarch11/VASWMBMPSpec6RAINWATERHARVESTING.html.

Glossary of Terms

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

Best management practice – 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.

Cistern – A storage tank where the roof runoff is diverted and stored after being filtered. Cisterns commonly store water for indoor uses.

Graywater – nonpotable water of sufficient quality for reuse, typically from sinks and laundry. Named because of its gray color.

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

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

Nonpotable water – Water that should not be used for drinking. Does not necessarily mean water is of poor quality for an alternate use. Ant.: potable water.

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.

Overflow – A component of a rainwater harvesting system that diverts any water that exceeds the capacity of the storage tank to another location.

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

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

Potable water – Water that can be used for drinking without immediate or long-term harm.

Rain barrel – A storage tank where roof runoff is diverted and stored. Rain barrels are often smaller than cisterns, and the water is usually used for outdoor purposes.

Rainwater harvesting (RWH) – Also known as rainwater harvesting systems, rain barrels and/or cisterns are systems that intercept, divert, store, and release rainfall for later use as a water supply.

Reservoir – A place where water is stored; in rainwater harvesting, where excess stormwater is stored.

Roofshed – The area of the roof that drains to a single downspout. The boundary is determined by the roof and the roof ridgelines.

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.

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

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

Sustainable – The ability of the system to endure and remain productive over a long period of time.

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.