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G2148

# *Stormwater Management:* Rainwater Harvesting in Residential-Scale Landscapes

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This NebGuide provides an overview of rainwater harvesting systems and the use of collected rainwater for landscape irrigation and other outdoor non-potable uses.

Rainwater harvesting refers to the collection of rainwater to maximize its environmental and landscape value. Harvesting rainwater reduces stormwater runoff volume and velocity and can provide an alternative water source to help conserve potable water supplies. There are typically three components in a rainwater harvesting system: 1) collection; 2) transport; and 3) infiltration or storage and use.

Collection generally occurs from rooftops or paved surfaces. The collected rainwater is then transported, often through downspouts or swales, and temporarily held in a storage device for future use. The rainwater also may be diverted to planted areas, such as a rain garden, for infiltration and use by plants, or directly infiltrated into the soil through permeable paving or an underground structure such as a dry well. Rainwater harvesting systems are classified as green infrastructure which is targeted at collecting stormwater to infiltrate and/or store for later use.

## Rainwater Uses

Harvested rainwater can be used for potable or non-potable purposes. Non-potable uses include landscape or container plant irrigation, car washing, and toilet flushing. The use of rainwater in a domestic plumbing system, even for toilet flushing, requires some form of treatment. Appropriate filtering and disinfection are required for rainwater to be suitable for potable uses like drinking, cooking, or bathing. This NebGuide only deals with residential-scale rainwater harvesting systems and the use of captured rainwater for landscape irrigation and other outdoor, non-potable uses.

## Why Harvest Rainwater?

Rainwater harvesting has been practiced for centuries and was once a primary method of obtaining water for domestic use. Increasing water demands, water use restrictions, new stormwater management regulations, and the growth of low-impact development (LID) and "green building" practices have sparked renewed interest in rainwater harvesting.

In most communities, rainwater is treated as a nuisance and is moved off developed sites as quickly as possible by street gutters, storm drains, and other means. Public water supplies, treated to drinking water standards, are used for virtually every end use including toilet flushing, car washing, and landscape irrigation. Although currently the norm, it is not a sustainable practice to continue using water treated to drinking water standards for non-potable uses. Harvested rainwater can provide an alternative source to help reduce demand on drinking water supplies.

Rainwater harvesting also has an important role in urban stormwater management. Towns and cities with populations greater than 10,000 are required to reduce the amount of stormwater runoff and associated pollution. Using appropriately sited and installed rainwater harvesting systems throughout a community will help municipalities with these requirements.

## Pollution from Runoff

When rain falls on impervious surfaces such as rooftops, parking lots, streets, driveways, and compacted soils, large quantities of runoff are generated. This water is generally directed into storm drains and conveyed directly to a stream, river, or lake without any treatment. In highly urbanized areas, only minimal amounts of precipitation soak into the soil due to the high percentage of impervious surfaces. This results in a high volume and velocity of concentrated stormwater runoff that can lead to flooding and polluted surface waters.

Runoff pollution occurs as stormwater flows over surfaces, collecting contaminants like sediment, fertilizer, pesticides, bacteria, plant debris, metals, fuel, oil, and others. Because most stormwater runoff is not treated before it is discharged to a waterbody, contaminants are carried directly to surface waters. In addition, runoff to storm drains represents a lost opportunity to collect and use rainwater as an alternative water source.

## Water and Energy Use

Water is essential to life and has no substitute. Population growth, climate change, and other factors are placing greater demand on fresh water supplies. This increased demand, combined with water pollution, emphasizes the critical need to efficiently use potable water and to increase the use of alternative sources for non-potable purposes.

In most of the United States, easy access to an abundant, safe, and relatively inexpensive supply of potable water has been the norm since the last half of the 20th century. Public water supplies are required to meet minimum standards defined by the U.S. Environmental Protection Agency's Safe Drinking Water Act. Achieving these standards often involves some form of treatment, and the water must then be delivered to users through a distribution system. These processes can be energy intensive. Even so, this high-quality water is used for virtually every end use even though lesser quality water would suffice for some applications. It is estimated that 40 percent or more of home water use is for landscape irrigation during the growing season. Plants do not require water that has been treated to drinking water standards. Untreated rainwater is suitable for plant and landscape irrigation.

## Benefits of Rainwater Harvesting

Finding and using alternative water sources for landscape irrigation is needed for sustainable water and energy management now and in the future. The benefits of rainwater harvesting include:

- A relatively inexpensive supply of water that needs little or no treatment for most landscape uses.
- Decreased volume and velocity of stormwater runoff leading to reduced stream bank erosion, decreased flooding, and fewer pollutants entering waterbodies.
- Potential reduction of municipal stormwater management and infrastructure costs.
- Reduced demand on public potable water supplies and lowered energy consumption for water treatment and distribution.
- Increased soil moisture and improved plant root growth for increased drought tolerance and less irrigation.
- Potential groundwater recharge.

## Rainwater Harvesting Systems With Greenspace

Using greenspace to capture and infiltrate stormwater can be as simple as directing downspouts to planted areas or constructing small berms and drainage channels (swales) to direct rainwater to planted areas such as shrub borders or tree rows. Eliminating direct flows to streets and storm drains lessens runoff volumes during storms. However, rain gardens, bioretention gardens, bioswales, and other planted areas installed specifically to infiltrate stormwater will have greater impact.

Figure 1. Rain garden (Hastings, Neb.)

A **rain garden** is an ornamental garden planted in a shallow depression that is designed to hold water for a short time (12-48 hours) before it drains away. These typically have berms on three sides and are located where rainwater from a roof or pavement can be easily directed to them. Water collected in a properly designed rain garden will infiltrate into the soil for up to 90 percent of all rain events. However, during heavy rain events, water can leave the garden as surface runoff via overflows designed into the berm. The plants and soil in a rain garden facilitate infiltration and evapotranspiration, as well as provide natural pollutant filtering (*Figure 1*).

**Bioretention gardens** are also ornamental and planted in landscape depressions designed to hold and infiltrate stormwater runoff within a short period of time. In contrast to rain gardens, bioretention basins are usually larger, have engineered soils (typically a mixture of sand and compost), and an underdrain system (gravel bed and perforated drain). Collected water infiltrates into the soil or is discharged through the underdrain into the storm drain system after being filtered by plant roots and soil (*Figure 2*).

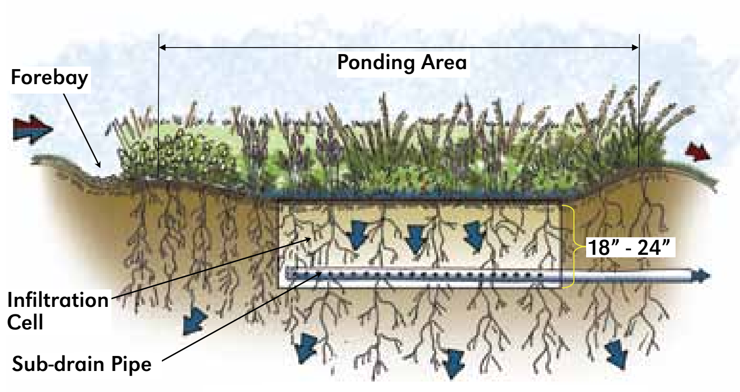


Figure 2. Bioretention garden cross section

A **swale** is a broad, shallow, gently sloped channel used to convey and infiltrate stormwater. Swales may be lined with vegetation, gravel or rocks (dry stream bed), compost, rip-rap, or other material. They are designed to slow runoff water velocity, trap sediment and other contaminants, and promote infiltration. Vegetated swales are also referred to as bioswales, enhanced swales, grassed swales, or water quality swales (*Figure 3*).

Figure 3. Bioswale (Lincoln, Neb.)

**Stormwater planters** are containers typically installed at or beneath street or sidewalk level in which trees and other types of plants are planted. Runoff is directed into the planter box where it is filtered by soil and vegetation and then discharged into a storm drain system through an overflow or underdrain. This helps remove pollutants and slows the flow of stormwater entering a storm drain system (*Figure 4*).

Figure 4. Stormwater planter (Portland, Ore.)

**Green roofs** are vegetated roof systems. They commonly consist of drought-tolerant plants, a layer of growing media, a root barrier, a drainage system, and a waterproof membrane on top of the roof deck. Green roofs directly intercept and absorb rainwater, provide insulation, and moderate rooftop surface temperatures. They may also extend the life of the roof membrane due to decreased exposure to temperature extremes, weather, and ultraviolet light. Green roofs can only be installed on buildings with the structural integrity to support the additional weight (*Figure 5*).

Figure 5. Green roof (Omaha, Neb.)

### Rainwater Harvesting Systems with Permeable Paving

**Permeable paving** includes several methods and materials used for patio construction and paving driveways, parking lots, and streets. Examples include pervious concrete, porous asphalt, and permeable pavers such as paving stones or bricks (*Figure 6*). Pervious hardscape allows water and air to infiltrate through the surface material into soil or supporting material directly below. The design may include an underdrain system or an underlying reservoir, tank, or vault for additional water holding capacity.

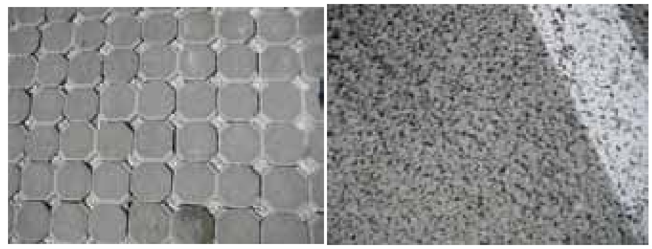

Figure 6. Permeable pavers (left); Pervious concrete (right)

### Rainwater Harvesting Systems with Storage Devices

**Rain barrels** are small tanks that store runoff, usually from a roof. Rain barrels are commercially available or adapted from existing barrels, sit above ground, and typically have a capacity of 55-100 gallons. While rain barrels are a good introduction to rainwater harvesting, they are limited in the amount of rainwater held. Small water storage units will fill quickly. For this reason, an overflow to move excess water away from building foundations is needed. Overflow water can be directed to additional linked storage units, or ideally to a rain garden, bioretention basin, or bioswale (*Figure 7*).

Figure 7. Rain barrels with overflow to rain garden (Hastings, Neb.)

**Cisterns** are large (100 gallons or more) tanks for storing collected rainwater. They can be built above or belowground and some have integrated pumping devices (*Figure 8*).

**Bladder tanks** are reinforced synthetic bags supported by a metal frame and usually located beneath a deck or porch or in a crawl space.

Figure 8. 6,000 gallon cistern (Papillion, Neb.)

**Dry wells** are permeable underground structures or buried volumes of gravel that store and then slowly release captured rainwater into the surrounding soil.

Proper use and maintenance of storage devices is essential for safety. Some things to consider are covers to prevent children or pets from climbing into the container; a secure, level base to prevent tipping of smaller containers; screening to prevent mosquito entry; and methods to carry overflow away from building foundations.

## General Steps to Selecting a Rainwater Harvesting System

1. Identify areas such as rooftops, paved areas, slopes, or compacted soils from which rainwater could be harvested.
2. Calculate the amount of rainwater that could be harvested from each area.
   a. Determine the square footage of each collection area.
   b. Multiply the square footage of the area by a rainfall amount in inches; then multiply by 0.623 (a conversion factor).
   **Example:** Harvested water (in gallons) = collection area (square feet) x rainfall amount (inches) x 0.623. A 1,200 square foot roof would yield approximately 750 gallons of water from a 1 inch rain.
   c. Estimate the square footage of the roof area that would drain to the downspout from which rainwater would be collected to calculate the potential amount that will flow from that downspout.
3. Calculate the required capacity (size) a rainwater harvesting system needs to be to catch and store enough rainwater from the site.
4. Evaluate the amount of maintenance each rainwater harvesting system requires and your willingness and ability to properly monitor and maintain the system.
5. Based on these evaluations, consider which type of system (or multiple systems) to use for harvesting rainwater from the site.
6. Analyze the suitability of the site specifically for the harvesting system(s) being considered.
   a. Observe drainage patterns during rainfall events. Understand where the water comes from and where it goes. Using natural drainage to direct and move water simplifies installation and may reduce costs.
   b. Consider how rainwater will be moved from the collection area to an infiltration area.
   c. Determine soil type and understand how water moves into and through it. Conduct a soil percolation test (refer to NebGuide G1472, *Residential Onsite Wastewater Treatment: Conducting a Soil Percolation Test*) if an infiltration method is being considered. A soil infiltration method will not work in every location. For example, infiltration methods may not be appropriate for sites with slow infiltration rates or where land slopes steeply or towards a building. Minimum distances are also required between infiltration methods and building foundations, septic systems, and water tables to avoid possible structure damage or water contamination.
   d. Determine if the installation will negatively affect established trees, shrubs, or neighboring properties as a result of root disturbances or drastic changes to soil moisture and grade.
7. If a storage method is to be used, determine:
   a. How water would be moved from the collection site to the storage tank.
   b. How the water will be used and how quickly it can be used. (Can the storage unit be emptied before the next predicted rainfall?)
   c. How and where overflow would be directed when there is heavy rainfall or when rainstorms occur in close succession to one another.
8. Before installing any rainwater harvesting system, become knowledgeable about:
   a. Homeowner association rules.
   b. State and local municipal codes and regulations.
   c. Underground utility locating services.
   d. Potential incentive programs for using rainwater harvesting methods.

## Summary

Renewed interest in rainwater harvesting has come about due to the ever increasing need to maintain and improve fresh water resources. Rainwater harvesting represents an opportunity to conserve water and help protect surface waters from pollution and erosion. By using rainwater harvesting systems, it is possible to take advantage of rainwater as an alternative source of water for non-potable uses; thereby also conserving drinking water and energy.

## Resources

Rainwater Harvesting (B-6153 05-08), AgriLIFE Extension. Texas A & M System. To view, go to *http://repository.tamu.edu/search* and enter B-6153 05-08 into the search box.

Rainwater Harvesting Policies. Managing Wet Weather with Green Infrastructure Municipal Handbook. Environmental Protection Agency. December 2008. To view, go to *http://www.dep.wv.gov/* and enter Rainwater Harvesting Policies into the search box.

Rainwater Harvesting: Soil Storage and Infiltration System (B-6195 08-08), AgriLIFE Extension. Texas A & M System. *http://repository.tamu.edu/search* and enter B-6195 08-08 into the search box.

Harvesting Rainwater for Landscape Use. 2nd Edition, October 2004. Revised 2006. University of Arizona Cooperative Extension/Low 4 Program. To view, go to http://*cals.arizona.edu/pubs/water/az1344.pdf.*

Rainwater Harvesting: Rainscaping Iowa Landscapes for Clean Water, June 2010. *http://www.iowastormwater.org/*.

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