RAIN GARDENS

Rain gardens are landscaped areas designed to capture, store, and treat rainwater. This low-impact development (LID) technique, most commonly found in residential areas and sometimes on commercial and municipal sites, is designed to reduce runoff quantity, improve runoff quality, and recharge groundwater supply.

Why use rain gardens?

Rain gardens reduce the overall quantity of runoff by temporarily storing rainwater in a landscaped area before letting it infiltrate the ground. Plants and soils filter out pollutants from the water before returning it to the ground, where it restores groundwater supplies.

In addition to providing water quality and quantity benefits, rain gardens often result in cost savings from reduced infrastructure. Because rain gardens return water to the landscape, traditional stormwater structures are not needed to carry water away from the site. The use of rain gardens may also reduce irrigation costs. Unlike grass or non-native plants, the native plants used in rain gardens require little to no watering after the plants are established.

Rain gardens may also be attractive landscape features if designed and maintained properly.

How do rain gardens work?

Rain gardens utilize the chemical, biological, and physical properties of plants, microbes, and soils to remove pollutants from stormwater runoff.

During a storm event, stormwater flows over impervious surfaces or yards, down a vegetated slope, and into the rain garden. Allowing the water to flow across a vegetated slope slows the incoming runoff velocity and provides initial filtration of particulates from the runoff. Once in the ponding area, the runoff is filtered by plants, mulch, and amended soil. Many natural and biological processes, such as adsorption, filtration, and decomposition, occur during infiltration. These processes remove pollutants and improve water quality. The filtered runoff then infiltrates the ground, helping to recharge groundwater supply.

Stormwater Benefits

- ✓ Runoff quantity control
- ✓ Runoff quality control
- ✓ Pollutant removal
- ✓ Groundwater recharge

Additional Benefits

- ✓ Attractive landscape
- ✓ Wildlife habitat
- ✓ Cost savings
- ✓ Educational potential

Source: City of Maplewood, Minnesota

Source: City of Maplewood, Minnesota

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DESIGN COMPONENTS

Flow pathway

Most rain gardens are designed so that rain will flow over impervious surfaces or out of downspouts and into the garden. In some cases, however, rain gardens are not built immediately next to the source of runoff. If the owner wishes to avoid having runoff flow long distances across the surface of the landscape, water may be carried directly from the downspout or impervious surface to the rain garden via a pipe. The pipe may be installed above or below the ground.

Filter strip (flow entrance)

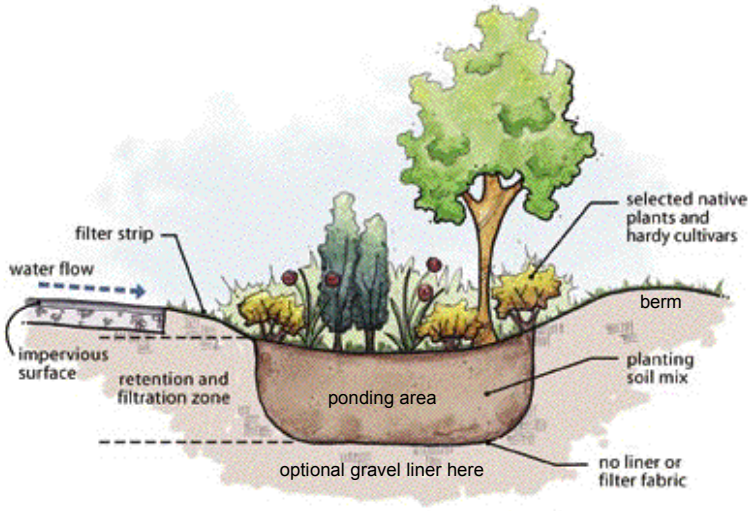
The entrance to a rain garden is designed to slow the velocity of the incoming runoff. The most common method of slowing runoff velocity is to allow water to flow down a grassy slope at the opening of the garden. The grassy slope slows the water and provides initial filtration of particulates before water enters the garden. In areas where there is limited space, a grassy slope may not be feasible. Instead, a rock-lined channel or landscape fabric may be placed at the entrance of the garden to slow runoff velocity.

Plant materials

Both woody and herbaceous plants in the ponding area help to remove water through evapotranspiration and to remove nutrients and pollutants through plant uptake. Plants with deep root systems help to stabilize surrounding soils. Rain garden plants must be both water-tolerant and drought-tolerant. The use of native species is highly recommended. Refer to our Native Plants Fact Sheet for plant list. Unlike wetlands, rain gardens are designed to only *temporarily* store water, so wetland plants should not be used in your rain garden.

Ponding area

The ponding area provides for temporary storage of stormwater runoff prior to its evaporation, infiltration, or uptake, and provides additional settling capacity of particulates. The ponding area is typically three to four inches deep, with an eight-inch maximum depth.



Source: *LID Technical Guidance Manual for Puget Sound*

Sample Rain Garden Design

Mulch layer

The mulch layer is placed on top of the planting soil mix and provides filtration, adsorption and bonding of heavy metals, as well as an environment conducive to the growth of microorganisms that degrade hydrocarbons and organic material. Two to three inches of mature mulch are recommended.

Planting soil mix

The soil in rain gardens acts as a filtration system, providing adsorption sites for hydrocarbons, heavy metals, nutrients, and other pollutants. Sites with silt, heavy clay, or compacted soils require an amended soil mixture to ensure the proper drainage of the rain garden. The amended soil should be approximately 60% sand, 20-30% topsoil, and 20-30% organic matter (compost); clay content should be less than 10%. Depth of the planting soil varies depending on the vegetation used, but often ranges from four to eight inches.

Gravel liner (optional for clay soils)

In heavy clay soils, three to six inches of gravel may be placed under the amended soil to aid infiltration. Heavy clay soils prevent the timely infiltration of water, so a gravel aggregate allows water to infiltrate more quickly.

Berm

A berm, or small earthen dam, on the downhill side of the rain garden is needed to keep water from flowing out of the garden during regular rainfall events. The soil that was removed during the garden's installation may be used to construct a berm around the downhill side of the garden. The top of the berm should not be higher than the uphill edge of the rain garden (no more than 12 inches).

Overflow path

It is important to provide an overflow path for water if the rain garden happens to overflow. The path should be stabilized with hardy grass or groundcover to slow the flow of water.

Sources: Alabama Master Gardeners, Atlanta Clean Water Campaign, NCSU Designing Rain Gardens

Stormwater FAQ

What's the difference between rain gardens and bioretention areas?

Bioretention areas and rain gardens often look similar on the surface because they both use plants and ponding techniques to filter stormwater runoff. The terms are often used interchangeably; however, there are *key differences* between the two low-impact development techniques.

- ✓ Bioretention areas are typically used on sites where there is extensive impervious surface; common applications include parking lot islands, roadside swales, and some residential areas
- ✓ Rain gardens are used most often in residential or commercial landscapes where there are smaller drainage areas
- ✓ Because bioretention areas generally drain more surface area, an underdrain helps to prevent ponding by directing excess filtered water to a stormwater conveyance system; rain gardens receive less runoff and therefore do not require an underdrain

BENEFITS

Runoff Quantity Control

Rain gardens reduce stormwater runoff volume by temporarily storing runoff water and returning it to the ground. Water that would normally flow into streams and waterways via traditional stormwater structures is, instead, directed to rain gardens where it is temporarily stored before infiltrating the ground. This reduces the immediate volume load on water bodies and the storm drain system by up to 98%, which, in turn, helps to reduce the risk for flash floods (LID Center, Inc.).

This Minnesota rain garden provides an attractive landscape feature to the homeowner and draws birds, butterflies, and other wildlife to the site.

Pollutant Control

Rain gardens use plants and soil to filter stormwater runoff, thereby reducing pollutants in the runoff. The physical, chemical, and biological properties of plants and soil aid in the removal of pollutants from stormwater runoff. Rain gardens have been shown to remove 92-99% of copper, lead, and zinc, over 91% total suspended solids, and over 98% of oil and grease from runoff (LID Center, Inc.).

Groundwater Recharge

Rain gardens allow filtered runoff to infiltrate the ground, thus recharging groundwater supplies. Stormwater runoff that would otherwise be directed to a stormwater conveyance system is instead allowed to soak into the ground. This important feature of rain gardens helps to recharge groundwater, which in turn supplies drinking water and recharges surface water flow during periods of drought.

Cost Savings

Where rain gardens are used, cost savings may occur as a result of reduced stormwater structures on site. Because water is managed on site when rain gardens are used, traditional stormwater structures, such as pipes, drains, and inlets, may not be needed to carry water away from the site. Reducing or eliminating such infrastructure can lead to cost savings for the homeowner or developer. For example, the city of Bellingham, Washington saved $40,000 by installing rain gardens in a city parking lot to manage stormwater on site instead of using underground vaults to carry water away from the site (see EPA "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practice"). It is important to remember that cost savings will vary from place to place and project to project for a variety of reasons (see Cost Estimate section for more information).

Reduced Maintenance Costs

Cost savings may occur as a result of reduced maintenance activities, such as mowing, fertilizing, and irrigating. Rain gardens often replace a portion of the mowable landscape with mulch and native plants. A rain garden, unlike grass, does not require mowing or fertilizing. In addition, rain garden plants are drought-tolerant and, in most cases, require irrigation only for the first one to two years while they are becoming established. For these reasons, costs associated with mowing, fertilizing, and irrigation may be reduced when rain gardens are used. However, rain garden mulch must be replaced periodically, and thus should be considered a maintenance cost.

Other benefits

Rain gardens can be designed as attractive landscape features. Bright flowers or lush grasses may be incorporated to brighten the landscape. Rain gardens also attract birds, butterflies, and other beautiful wildlife to the landscape.

In some cases, **rain gardens may raise nearby property values.** For example, in Kane County, Illinois, research indicated that stormwater management in upstream areas, including the addition of rain gardens, would reduce the risk of flooding and boost property values from $14,538 to $36,345 per acre in downstream areas (Black & Veatch).

Rain gardens may be used in combination with rain harvesting systems. The overflow from rain barrels or cisterns may be directed into a rain garden, where it can then infiltrate the ground.

"Benefits" adapted from the Georgia Stormwater Management Manual Vol. 2 and LID Stormwater Center, Inc.

LID IN THE UPSTATE

Friends of Lake Keowee Society (FOLKS) Headquarters

Seneca, SC

Rain garden in bloom at the FOLKS headquarters

The rain garden at the Friends of Lake Keowee Society (FOLKS) headquarters in Seneca, SC, is designed not only to reduce stormwater runoff from the site to the lake, but to educate local lake landowners, as well as the general public, on "lake-friendly" landscaping.

FOLKS worked with many groups in the community to complete the project. Groups involved in the design and installation process included Clemson University landscape design students, Boy Scouts, Master Gardeners, and other local garden clubs. Funding for the FOLKS rain garden came from several grants, and many of the supplies were donated by businesses that supported the project. To construct the garden, volunteers removed two feet of compacted clay soil and replaced it with a three-inch layer of gravel. The gravel was covered by a permeable landscape fabric and 18 inches of a sandy loam mixture (50% sand, 15% organic matter, and 25% topsoil). A variety of native plants were planted in the new soil mixture.

Thus far, the rain garden at the headquarters site has performed as it was built to, and hasn't posed many challenges to FOLKS staff. Currently, minimum maintenance is required to keep up the garden, but a long-term maintenance plan for the garden will need to be developed. Such a plan may include a group of volunteers or may require a group of paid landscapers.

SITE CONSIDERATIONS

	Rain Garden
Application	• Residential, commercial, municipal
Size	• Depends on garden depth, soil type, and size of drainage area, but 100 to 300 square feet most common • Try to maintain a length to width ratio of at least two to one
Soil depth	• Four to eight inches common
Drainage Area	• Typical ratio of drainage area to rain garden is three to one (for 300 square feet of drainage area, 100 square foot rain garden)
Shape	• Half-moon, kidney bean, teardrop recommended
Soils	• Engineered soil media required to ensure adequate filtration • Recommended: 50-60% sand, 20-30% loamy topsoil, 20-30% organic matter (compost)
Slopes	• Less than twelve percent slope recommended • Should be constructed downgradient from building/home
Distance to water table	• Avoid constructing in areas with shallow water tables (less than 18 inches)
Distance to bedrock	• Minimum distance of three feet
Distance to septic system	• Minimum distance of 25 feet from septic system drainfield
Proximity to build foundations	• Minimum distance of 10 feet downgradient from buildings and foundations
Sunlight	• Full to partial sunlight recommended
Additional considerations	• Do not place rain garden in area where water collects (these areas are poorly drained); rain gardens should be placed up-slope of these areas to reduce the amount of water that flows into them • Special care must be taken when installing rain gardens under large trees (make sure root systems are not damaged in excavation process; make sure the roots are capable of adapting to extra moisture being held by the rain garden)

Adapted from NCSU Designing Rain Gardens, Designing Rain Gardens for Homeowners

Think of all the possibilities for your rain garden!

Image sources: *City of Carter Lake* : *Iowa Urban Water Quality, City of Maplewood, Minnesota*

COST ESTIMATE

Factors influencing rain garden cost	
Soil type	Clay soil sites more expensive because excavation is needed and gravel liner may be used
Rain garden size	Larger rain gardens require more excavation, mulch, plants, and labor
Topography	Steeper sites may require more excavation than flat sites
Plants	Plant prices vary significantly, so plants chosen influence total cost
Labor	Hiring a landscaper is typically more expensive, but design, materials, and installation included in cost When building rain garden yourself, must consider costs for mulch, plants, tools, etc. and time it will take to construct

Adapted from URI Healthy Landscapes Program, Lincoln Watershed Management, NCSU Designing Rain Gardens

Rain Garden Cost Estimate	
Landscaping company	• $10-12 per square foot (design, materials, installation)
Build-it-yourself	• Sandy soil: $1.50-3 per square foot (plants)* • Clay soil: $4-6 per square foot (plants + soil)* * Design and installation costs not included • To find out how much it would cost to build a rain garden in *your* yard, check out the Rain Garden Calculator at BlueThumb.org!

Source: Lincoln Watershed Management, NCSU Designing Rain Gardens

Shrubs are the predominant type of vegetation in this rain garden.

MAINTENANCE

Schedule	Maintenance activity
Establishment period	• Water for 14 consecutive days unless there is sufficient rainfall to help establish new plants • Continue to water plants at least weekly for one to two years until plants are fully established
As needed	• Prune and weed plants to maintain appearance • Replace mulch where erosion is evident • Remove trash and debris • During times of extended drought, look for physical signs of stress (wilting; yellow, brown, or spotted leaves; loss of leaves); water in early morning as needed • Occasionally inspect after rainfall; make sure drainage paths are clear and that ponding water infiltrates over four to six hours
Semi-annually	• Inspect inflow points for clogging and remove any sediment • Inspect flow entrance for erosion or gullying and re-seed or sod as necessary; use small stones to stabilize erosion along drainage paths • Inspect trees or shrubs to evaluate their health and remove any dead or severely diseased vegetation • In spring and fall, add fresh mulch layer
Annually	• Inspect plants, replace as needed • Divide and move plants if they are overcrowded • Prune excess growth • Test planting soils for pH, acidic levels preferred – If pH is below 5.2, limestone should be applied – If pH is above 7.0 to 8.0, then iron sulfate plus sulfur can be added to reduce the pH
2-3 years	• Remove old mulch layer over the entire area before applying new one

Source: Georgia Stormwater Management Manual Vol. 2, Low Impact Development Center

ADDITIONAL LINKS

1. Rain Gardens – A How-to Manual for Homeowners
   (http://www.dnr.state.wi.us/org/water/wm/dsfm/shore/documents/rgmanual.pdf)
   - ❖ Publication from the Wisconsin Department of Natural Resources
   - ❖ Provides thorough guidelines and instructions for sizing, siting, building, and maintaining a rain garden
   - ❖ Includes a variety of sample rain garden designs for different soil types and exposure to sunlight
2. Saluda-Reedy Watershed Consortium
   (http://www.saludareedy.org/outreach/stormwaterdemos.html)
   - ❖ Provides information about Upstate Forever's rain garden
3. City of Maplewood, Minnesota Rain Garden Information
   (http://www.maplewoodmn.govoffice.com)
   - ❖ Provides overview of what rain gardens are and why they are used
   - ❖ Includes rain garden types and details for creating them
   - ❖ Multiple links to other rain garden websites and PDFs
4. Rain Garden Manual for Homeowners
   (http://www.delawareswcd.org/PDFs/raingarden_manual.pdf)
   - ❖ Publication from the Northeast Ohio, Public Involvement Public Education Committee
   - ❖ Provides thorough guidelines and instructions for sizing, siting, building, and maintaining a rain garden; also includes instructions for determining soil type
5. Urban Waterways: Designing Rain Gardens (Bioretention Areas)
   (http://www.bae.ncsu.edu/stormwater/PublicationFiles/DesigningRainGardens2001.pdf)
   - ❖ NC Cooperative Extension publication that provides general info about rain gardens
   - ❖ Provides design information for sites with sandy and clay soils
   - ❖ Includes general cost information
6. Rain Gardens of West Michigan
   (http://www.raingardens.org/Index.php)
   - ❖ Provides information on how to create a rain garden and describes benefits of including rain garden in your yard
7. Prince George's County, Maryland, Bioretention Design Manual
   (http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/Bioretention/bioretention.asp)
   - ❖ Information regarding design, landscaping, construction, maintenance
   - ❖ One of the most-used bioretention sources
8. EPA: "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practice"
   (http://www.epa.gov/owow/nps/lid/costs07/)
   - ❖ Provides an overview of low-impact development (LID) and evaluation of costs and benefits of LID
   - ❖ Includes case studies of LID projects nationwide; cost comparison of LID and conventional approaches for each of the projects
9. Saluda Reedy Watershed Consortium Native Plant List for Rain Gardens
   (http://www.saludareedy.org/outreach/rain_gardens/raingardens_plantlist.pdf)
   - ❖ Lists native trees, shrubs, grasses, perennials, and ferns that are tolerant of Upstate South Carolina rain garden conditions

P.O. Box 2308
Greenville, South Carolina 29602
Office: (864) 250-0500
Fax: (864) 250-0788