

Summary Fact Sheet

Category: 1.0 Bioretention Systems
Practice: 1.2 Bioretention Cells

General Description: Bioretention cells, also known as rain gardens, are small-scale, shallow vegetated depressions that provide source control of the water quality volume (WQV) by rapid filtering through bioretention soil media, biological and chemical reactions in the soil matrix and root zone, and infiltration into the underlying subsoil. The WQV is typically defined as the first one-half to one inch of runoff from impervious areas. Properly constructed bioretention cells replicate the ecosystem of an upland forest floor through the use of specific shrubs, trees, groundcover, mulch, and soils. By intercepting, detaining, and infiltrating runoff, bioretention cells reduce the energy of stormwater flows and reduce on-site erosion. They may be designed on-line or off-line from the primary stormwater conveyance system.

Water Quantity Controls

Any volume of stormwater in excess of the WQV can be detained by providing additional ponding and/or subsurface storage in the bioretention cell, thereby reducing the runoff volume and peak discharge rate. The voids in the soil and gravel layers provide stormwater storage capacity. The depth of the gravel layer may be increased to add additional storage. Exfiltration into the subsoil can potentially reduce the volume of stormwater that ultimately enters the conveyance system. The amount of volume reduction depends on the available detention storage in the gravel layer and ponding area, the maximum flow rate into the subsoil, and the flow rate into the cell, which is related to the storm intensity and drainage area size. Additional information is provided in PFM section 6-1300 and in Virginia Stormwater Management Handbook Standard and Specification 3.11.

Water Quality Controls

Phosphorus removal efficiencies for bioretention cells are set by Fairfax County as follows:

- 50% removal for cells that capture 0.5" of runoff from the impervious area
- 65% removal for cells that capture 1.0" of runoff from the impervious area

Because the minimum ponding volume equals the WQV, credit will be given for at least 50% phosphorus removal.

Location: Bioretention cells are appropriate for use in commercial, residential, and industrial areas. Potential applications include median strips, parking lots, residential developments, and swales (see fact sheet 1.4). Bioretention cells should not be located in areas of high sediment loads or where the site is not entirely stabilized.

Design Construction and Materials: Bioretention cells are excavated to a minimum depth of one (1) to three (3) feet, depending on the infiltration rate and depth to the seasonal high groundwater table or bedrock. Deeper excavation can provide for additional storage in the soil or gravel layers.

Underdrains are recommended in areas with low subsoil permeability (e.g. compacted or clay soils) or shallow soil profiles. Underdrains must tie into an adequate conveyance system. Observation/cleanout wells should also be installed if underdrains are used.

A gravel layer provides temporary storage of stormwater, which will exit through an underdrain (if present) and/or through exfiltration into the subsoil. If an underdrain is present, the gravel layer surrounds the underdrain pipe to minimize the chance of clogging. The excavated area is then filled with an engineered media classified as “sandy loam” or “loamy sand” that typically consists of:

- 50% sand
- 30% planting soil with minimal clay content, and
- 20% shredded hardwood mulch.

The area is then mulched and planted with shrubs, perennials, grasses, and small trees. The cell must provide for bypass flow into an inlet or overflow weir. Bioretention cells typically consist of the following cost components.

Item	Unit	Estimated unit cost (2005 Dollars)
Excavation	C.Y.	\$8 - \$10
Bioretention media	C.Y.	\$40 - \$60
Filter fabric	S.Y.	\$1 - \$5
Gravel	C.Y.	\$30 - \$35
4" dia. perforated underdrain pipe	L.F.	\$8 - \$15
Plants	Ea.	\$5 - \$20
Mulch	C.Y.	\$30 - \$35

Depending on space constraints and drainage area characteristics, a pretreatment device, most commonly a vegetated filter strip, can be provided to intercept debris and large particles. A minimum two (2) to four (4) foot clearance must be maintained between the bottom of the cell and the seasonal high groundwater table or bedrock, dependent on the soil structure, water table, and other environmental conditions of the site.

Cost: The cost for a bioretention cell to treat runoff from ½ impervious acre is comprised of both the installation cost and annualized costs. These cost calculations were based upon a bioretention cell with a surface area of 900 ft². A bioretention cell is assumed to have a lifespan of 25 years, at which point it will be removed and replaced.

Item	Required Cost per Year (2005 Dollars)													
	0	1	2	3	4	5	6	7	8	9	10	...	25	
Installation ¹	10,000													
Mulching and Debris Removal		350	350	350	350	350	350	350	350	350	350			
Replace Vegetation		200	200	200	200	200	200	200	200	200	200			
Remove & Replace														10,000
Total Cost	10,000	550	550	550	550	550	550	550	550	550	550			10,000
Annualized Cost	\$925 / year (includes replacement in year 25)													

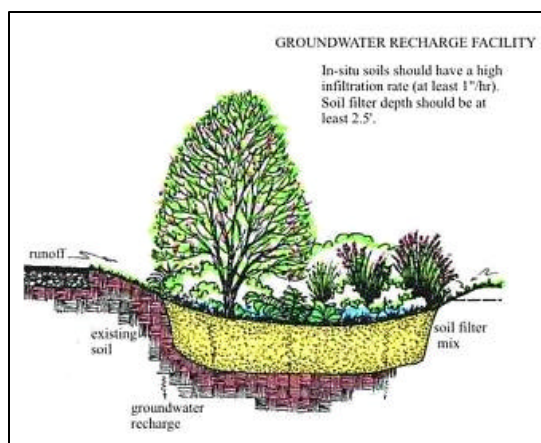
¹Developer Cost. Not included in annualized cost.

Maintenance: The primary maintenance requirement for bioretention cells is to inspect the treatment area's components and repair or replace them if necessary. Generally, maintenance is the same as the routine periodic maintenance that is required of any landscaped area.

Removal of accumulated sediment and debris, replacement of any dead or stressed plants, and replenishment of the mulch layer is recommended on an annual basis. Also, any eroded areas should be repaired as soon as they are detected.

Performance and Inspection: To ensure proper performance, visually inspect that stormwater is infiltrating properly into the bioretention cell. Water ponding in a bioretention cell for more than 48 hours may indicate operational problems. Corrective measures include inspection for and removal of accumulated sediments. Backflushing the underdrain is another option. Samples of the bioretention media should be taken in the case of poor infiltration to determine the condition of the media (e.g. clay content). Full or partial replacement of the bioretention media may be required to restore the flow rate through the cell. Alternately, soil amendments can first be applied in an attempt to restore permeability. Perform this inspection:

- annually in spring, and
- after extreme events (e.g. after hurricanes).



Bioretention Cell Schematic
Source : PG DER



Bioretention Cell
Source: LID Center

Potential LEED Credits

- Primary: Sustainable Sites – Credit 6 “Stormwater Management” (1-2 Points)
Other: Sustainable Sites – Credit 7 “Landscape & Exterior Design to Reduce Heat Islands” (1-2 Points)
Water Efficiency – Credit 1 “Water Efficient Landscaping” (1-2 Points)
Innovation & Design Process (1-4 Points)

Links to Additional Information:

Fairfax County PFM:

<http://www.co.fairfax.va.us/dpwes/publications/pfm/6.htm>

Fairfax County Letters to Industry:

http://www.co.fairfax.va.us/dpwes/publications/LTI_archive.htm

USEPA Office of Water:

<http://www.epa.gov/OW-OWM.html/mtb/biortn.pdf>

Natural Resources Defense Council, 2001: Stormwater Strategies: Community Responses to Runoff Pollution.

<http://www.nrdc.org/water/pollution/storm/stoinx.asp>

United States Environmental Protection Agency, 2000: Bioretention applications: Inglewood Demonstration Project, Largo, Maryland, and Florida Aquarium, Tampa, Florida. Office of Water, Washington, D.C., EPA-841-B-00-005A

U.S. Environmental Protection Agency, 1995: Maryland developer grows 'Rain Gardens' to control residential runoff. Nonpoint Source News-Notes, 42 (August/September)

<http://www.epa.gov/NewsNotes/issue42/urbrnf.html>

Virginia Stormwater Management Handbook

<http://www.dcr.virginia.gov/sw/stormwat.htm>