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Bioswales: A Guide for Your Residents

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Meet Your Bioswale
Do you have a linear or curvilinear path that is low-lying and less frequently mowed than surrounding areas? Does it often stay wet and "spongy" when you walk across it? This path or swale may even have unique plants such as those found in natural wetland areas – sedges, rushes, irises, duck potato and others. If so, you might have a stormwater best management practice known as a bioswale in your community.

After a storm event, rain that falls onto impervious surfaces like roofs, roads and driveways flows as runoff across the land to storm drains. This stormwater runoff, if unmanaged, can lead to flooding around property, buildings and streets. As runoff flows across land, it picks up the contaminants we leave behind (such as fertilizer, auto fluids, trash, and pet waste), carries it to the storm drain and ultimately, to the nearest downstream waterway. Unmanaged and polluted stormwater runoff can negatively impact a receiving waterbody, resulting in potential ecological and human health consequences. The Environmental Protection Agency (EPA) has identified unmanaged stormwater as a major threat to our nation's waterways.

To help reduce the impact of stormwater runoff in our communities, best management practices like bioswales are used to manage stormwater runoff quantity and quality in the following ways:

- Receive and slow runoff generated during small to medium sized storms, allowing it to infiltrate into the ground rather than directly discharge through a pipe or concrete channel,
- Provide minimal flood storage depending on design, and
- Filter, trap and remove contaminants in stormwater runoff that would otherwise be carried without treatment downstream. These pollutants include nutrients, heavy metals, harmful bacteria and pathogens, sediment, oils and grease and other types of organic material (EPA, 1999; Hunt et al., 2008).

Design Principles

A bioswale is typically a vegetated channel with a parabolic or trapezoidal cross-section that can be used in place of a ditch to transport stormwater runoff from streets, parking lots and roofs.

Bioswales are categorized by the type of vegetation used:

- *Grassed swales* are planted with turfgrass that is mowed. These provide a more manicured look, but have been demonstrated as less effective in slowing stormwater runoff than swales with taller plants.
- *Vegetated bioswales* can be planted with ornamental grasses, shrubs, perennials, or a combination of these. Mulch or stone are used to protect soils in areas not covered by turfgrass. Larger stone can also be used to break up concentrated flows of water and reduce velocity.
- *Xeriscape, or low water use, swales* are useful in areas with hot summers or dry conditions. Most bioswales are designed to be dry except just after rain events.
- Wet swales function similarly to stormwater wetlands.

Unlike a rain garden or bioretention cell, bioswales carry water from one place to another and typically include a drain at one end to take away water that does not infiltrate. As the water infiltrates, soil microbes break down pollution, and plants take up some of the water and use availabile nutrients for growth. The rest of the water moves down through the soil to recharge the groundwater table.

Choosing an appropriate site for a bioswale involves several factors including soil infiltration rate, slope, and ground water level.

- The soil infiltration rate should be half an inch per hour or greater. Sites with poorly drained soils will require an underdrain system to remove excess water during peak flows. Soils can also be amended by adding sand to increase infiltration.
- The sides of the bioswale should be constructed with slopes of 5% or less. Recommendations for longitudinal slope ranges from 1-4%, with 4% possibly requiring use of a weir. Check dams within a swale may increase their retention, water quality treatment and manage erosion at steeper grades (EPA, 1999).
- Bioswales are impractical in areas with very flat grades or steep topography.
- Where flow rate may exceed 5 cubic feet per second, swales are not recommended (EPA, 1999).
- Bioswales should not be used in areas with high water tables where groundwater would reach the bottom of the swale (Clark and Acomb, 2008).

The size required for a bioswale is variable, but as a rule of thumb, the size of the swale should be at least one percent the size of the area draining to it (EPA, 1999). The larger the swale, the more storage and infiltration of stormwater is possible, allowing for control of greater rain events. When designing a swale, it is important to consider where water will move to during very large rainfalls. A high flow bypass or overflow control outlet is recommended to safely convey high flows. This could either allow water to spill over into a natural area or tie into a storm sewer system.

The best plants for bioswales are well-adapted natives including thick growing grasses or other plants with dense, deep root systems (NRCS, 2005). The thicker the vegetation and greater surface area, the more effective it will be at slowing the water and preventing erosion within the swale. Plants chosen should be able to tolerate both very wet and very dry conditions. Ideally, the swale should not need to be irrigated after the plants are established, except during times of severe drought. Plant options for each region of South Caroling for this green infrastructure practice, can be searched for at the Carolina Yards Plant Database (www.clemson.edu/cy/plants).

Bioswale Purpose in Your Landscape

Bioswales are typically less costly to construct than curb and gutter or underground storm sewer systems for residential and commercial applications. Similarly, they are appropriate for linear systems, such as parking lot islands and medians, residential road swales or highway medians. Bioswales can be used alone for stormwater management, but are most effective as part of a series of best management practices, or “treatment train” (EPA, 1999).

Bioswales are considered cost-effective tools for removing sediment and other particulate pollutants from stormwater runoff. The pollutant removal rates of vegetated swales vary depending on soil type and type of vegetation used. (EPA, 1999). Shallow slopes, low flow velocities, and dense vegetation all increase the effectiveness of bioswales. A 2006 study of grassed bioswales along a highway median showed bioswales to be effective at removing total suspended solids (65-71% removal) and zinc (30-60% removal) (Stagge and Davis, 2006). A 2011 study of bioswales with trees and engineered soils in a parking lot found overall pollutant removal rates to be 95%. The swales also reduced the overall volume of stormwater runoff by 88% (Xaio and McPherson, 2011).

Vegetated swales should not be used in stormwater hotspots, such as gas stations, because they are an infiltration practice, and the high concentrations of pollutants in these locations may be transferred to groundwater.

Maintenance of Your Bioswale for Long-Term Function

Maintenance for swales is low and includes periodic cutting of vegetation, reseeding as necessary to maintain a dense cover, watering during times of drought, and removing debris. The use of fertilizer, herbicides and pesticides should be kept to a minimum in and around the bioswale (EPA 1999).

Well-designed and maintained bioswales can be very attractive, and serve as landscaping areas within a site. Compared to other stormwater management practices, they can add aesthetic appeal to a residential or commercial site with texture, color and utility. Bioswales may also reduce the need for or size of a retention pond as part a site's stormwater management plan, allowing for more usable space in a development.

Inspect your bioswale regularly and after large storm events.
Semi-annually and after major storm events, check your bioswale and look for signs of trash and debris, sediment accumulation, clogged inlets or outlets, and erosion. As soon as possible, pick up trash and debris and use a shovel to remove accumulated sediment. If areas are eroding, repair and establish sod or use rock or special erosion-control matting to protect from further failure and slow the flow of water.

Periodically inspect your plants for signs of disease or other concerns.
Visit the Clemson Extension Home and Garden Information Center website for specific tips on maintenance for the grass or plants present. If replanting of shrubs or flowering plants is needed, look for native or well-adapted plants that can tolerate both wet and dry soil conditions. Avoid invasive plant species. Use the Carolina Yard plant database for recommendations (www.clemson.edu/cy/plants).

Avoid using fertilizer and herbicides in and around your swale.
Given the nature of stormwater runoff, bioswales typically receive the nutrients needed to support plant growth and additional fertilizer amendments are unnecessary, other than at the time of planting. If nuisance weeds appear in your cell, hand pull to remove, and select a type of vegetation that will work to out compete the weeds long-term.

Stabilize upland areas.
Excessive levels of accumulated sediment in your bioswale can result in reduced infiltration capacity and impaired function. Stop problems before they start by working with your community to identify "hot spots" of concern upland of your bioretention cell. Look for areas that have exposed soil or signs of erosion, like gullies near driveways or gutters and active construction. To help address problem spots, try installing turf or seeding with grass, planting flowers or shrubs, or mulching. Use a manufactured erosion controlled mat for protection while waiting for vegetation to establish.

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Fig. 1 Vegetated bioswale in front of a home in The Cove subdivision in Sumter, SC.

Fig. 2 Bioswale in a parking lot in Portland, OR.

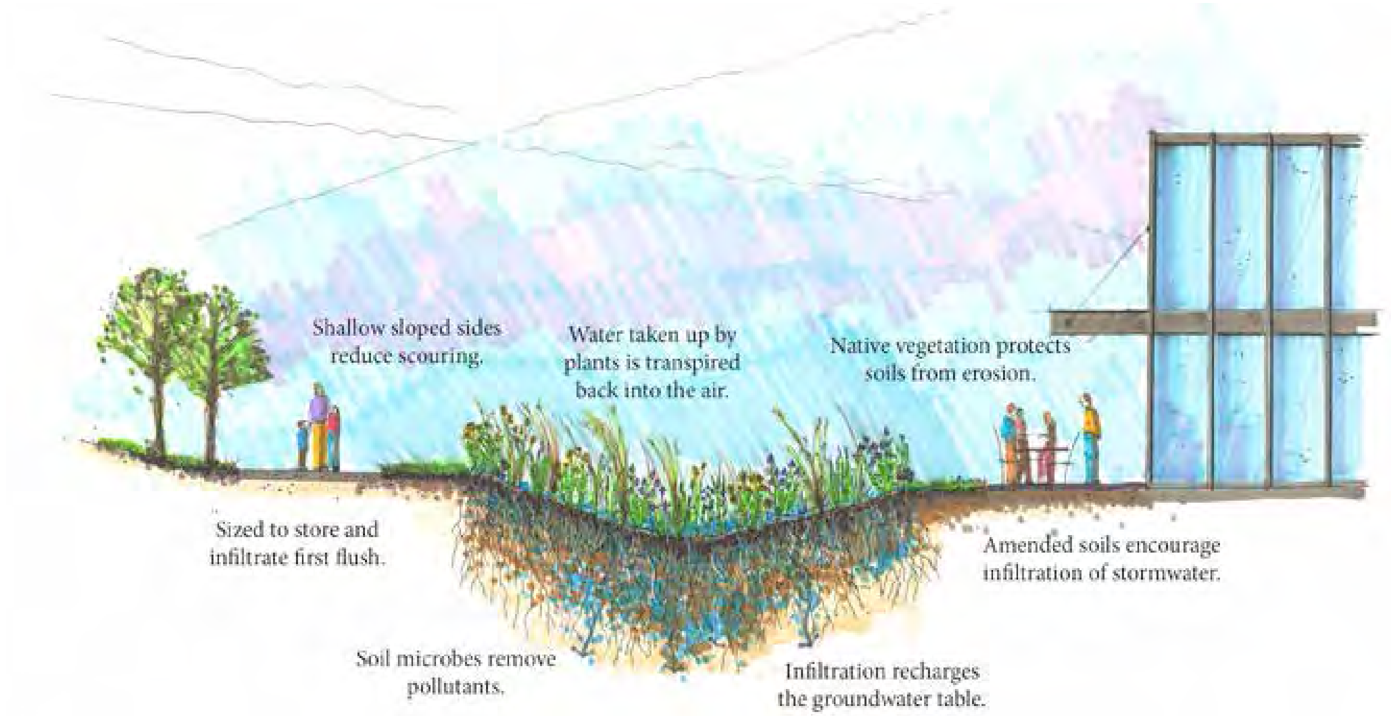

Fig. 3 Illustration by Doug Adamson, RDG Planning & Design, provided by USDA-NRCS in Des Moines, Iowa. Text added by the author.

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