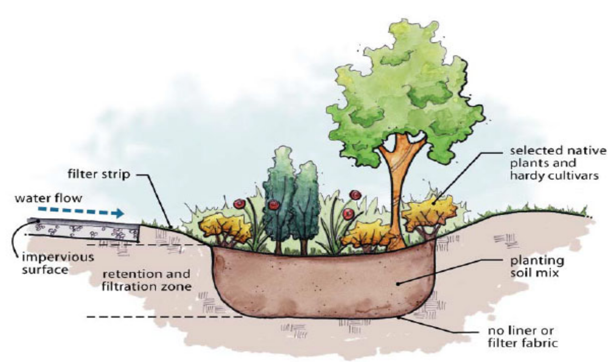
5.2 Bioretention: Rain Garden



Bioretention areas, otherwise known as rain gardens, are bowl shaped depressions designed to collect and filter stormwater. Typical layers from bottom to top include small drainage stone, soil blended to maintain nutrients, a layer of mulch to assist with water filtration, and a vegetative layer. Within the bioretention area, nutrient adsorption media, soils, mulch, and planted vegetation facilitate treatment and remove pollutants from the runoff. Multiple bioretention areas are often distributed throughout a larger catchment, providing numerous treatment and water storage areas. Although any one treatment area may be small, the cumulative effect can be significant. This distributed approach also better mimics predevelopment hydrologic conditions by promoting stormwater infiltration, thereby reducing runoff and recharging groundwater.

Bioretention systems are designed to provide stormwater quality improvements and some measure of attenuation of peak flows. Treating stormwater by bioretention can be very effective due to the variety of chemical, physical, and biological removal mechanisms. This type of LID SWMF is suitable for many types of development because the shape and sizing of the systems are relatively flexible. The systems can be easily incorporated into many landscaped designs. A list of recommended plants is included in **Appendix A**.

important **No fertilizer or pesticides can be applied to the system and its 10-foot perimeter.**

Advantages:

Bioretention systems are well suited to treat roof and pavement runoff. Raingardens are a great management strategy for small drainage areas and can be used at locations where the water table is relatively high. They offer flexible retrofit capabilities and can be planned as an aesthetic feature bridging the gap between hardscapes and the natural hydrology of a site. Additionally, they offer habitat for pollinators and can be planted with vegetation that attracts butterflies.

Limitations:

Limitations to bioretention areas include quick loss of storage volume as sediment is deposited in the shallow depressions. If the initial design depth and vegetation is not maintained, the area may quickly fill in with organic materials, reducing the original storage capacity. Shallow bioretention areas should only be used in areas with high permeable soils, such as HSG A or B. This LID SWMF also requires regularly scheduled landscaping.

Design Considerations:

- When planning a rain garden keep in mind that organic shapes with curves are more aesthetically pleasing.
- A shallow bioretention system typically consists of several components. Some of the components are required elements while others are recommendations.
- You must establish the elevations and dimensions of the rain garden and an overflow should be provided to convey larger flows to a downstream drainage system or another LID SWMF. The overflow should be set slightly below the top of the depression (1-2-inch).
- For raingardens, measure out an additional 10% larger area than calculated to allow room for side slopes and construction errors.
- Pretreatment applications may be necessary in order to ensure that the stormwater entering the rain garden does not erode the channel and is screened for larger debris.
- Energy dissipators such as river stones can be used to reduce the hydraulic energy and to catch sediment.
- The water traveling along the depression should remain relatively tranquil in order to prevent extreme erosion and scour.
- Additionally, to reduce maintenance intervals caused by sedimentation, a small sediment trap should be installed prior to entering the rain garden.
- Ensure that all the water will infiltrate into the soil within 72 hours (refer to **Section 2.4.3** for recovery time calculation).
- A landscape plan for the rain garden should be prepared to indicate how the area will be established with vegetation. You can plan your rain garden with different plant species that will blossom during different times of the year. See **Appendix A** for plant suggestions.

<u>The following are required elements that the shallow bioretention system must contain</u>:

- *Retention area* – An area that provides temporary surface storage (less than 12 inches) for runoff before infiltration through the planting soil filter bed.
- *Organic mulch layer* – A 2-3 inch layer that attenuates heavy metals, reduces weed establishment, regulates soil temperature and moisture, and adds organic matter to the soil.
- *Planting soil filter bed* – A layer that provides at least 6 inches of planting media for vegetation as well as a sorption site for pollutants and a matrix for soil microbes. The assumed hydraulic conductivity for the planting soil must be stated clearly, as this will be used when testing bioretention systems.
- *Overflow pipe or spillway* – A structure to allow rainfall events that exceed cell volume capacity to bypass the system.
- *Woody and herbaceous plants* – Florida-friendly plants that provide a carbon source for the bioretention system, help facilitate microbial activity, and improve infiltration rates.

<u>While not required, the following can be incorporated into the system to improve water quality and infiltration rates</u>:

- *Prefilter strip* – Where feasible, a prefilter or grass channel strip should be used between the contributing drainage area and the retention area to capture course sediments and reduce sediment loading to the retention area. The applicant may provide other measures to minimize the sediments entering the system in lieu of a prefilter strip.

- *Nutrient-adsorption media* – A 6-inch minimum layer at the bottom of the bioretention system that facilitates pollutant removal through sorption and denitrification.
- *Energy-dissipation mechanism* – A structure that reduces runoff velocities, distributes flow, and reduces disturbance of the mulch layer.

Locations of bioretention systems should be integrated into the site-planning process, and aesthetic considerations should be taken into account in their siting and design. All control elevations must be specified to ensure that runoff entering the facility does not exceed the design depth. An overflow structure and non-erosive overflow channel must be provided to safely pass flows that exceed the storage capacity of the bioretention system to a stabilized downstream area or additional LID SWMF. The combined system must meet the water quality and quantity requirements listed in this manual.

Retention Area

- The maximum ponding depth must be less than 12 inches below the overflow structure.
- The recovery time must be less than 72 hours under SHGW conditions.

Organic Mulch Layer

- The surface organic mulch layer must be 2-3 inches deep and cover the surface of the basin to above the expected high water line.
- Mulch depth must not exceed 4 inches or soil aeration may be reduced.
- Hardwood mulch must be used due to its higher pH, improved microbial activity, and slower decomposition rate. Examples of acceptable mulches are those made from melaleuca or eucalyptus trees. Pine bark or pine straw is not acceptable.
- Partially composted mulch is acceptable, especially in the lower parts of the depression as this will reduce the tendency of the mulch to float.

Planting Soil Filter Bed

- The planting soil filter bed must be at least 6 inches thick.
- The bed material must be sandy loam, loamy sand, or loam texture.
- Soil organic matter content must be between 3% and 10% by volume. Soil amendments to raise the organic matter content must have a carbon to nitrogen ratio of at least 50%.
- The soil mix must be uniform and free of stones, stumps, roots, or other similar material greater than 2 inches in size.

Prefilter Strip (recommended, not required)

Prefiltration increases the performance of the main structure and reduces the required maintenance.

- The prefilter strip design will depend on topography, flow velocities, volume entering the buffer, and site constraints.
- The prefilter strip is typically a vegetated or grassed channel.

- Flow rates entering the bioretention system should be less than 1 foot per second to minimize erosion. (You may observe a floating item, such as a ping-pong ball, to estimate the speed of the flow.)

Landscaping

Landscaping enhances the performance and function of bioretention systems. Selecting plant material based on hydrologic conditions in the basin and aesthetics will improve plant survival, public acceptance, and overall treatment efficiency. Native or Florida-friendly plants should be selected, they tend to be more resistant to local pests and weather conditions. See **Appendix A** for approved plant list. All landscaping recommendations should be considered before storm flows are conveyed to the bioretention system:

- Unpaved contributing areas should be well vegetated to minimize erosion and sediment inputs to the bioretention system.
- Where feasible a prefilter vegetative strip or vegetative swale should be installed.
- If used, trees should be spaced 12 to 15 feet apart depending on the type.
- Plants should be placed at irregular intervals to simulate a natural ecological succession.
- If woody vegetation is used, it should be placed along the banks and edges of the bioretention system, not in the direct flow path.
- Only species well adapted to the regional climate should be used.
- Species planted in well-drained media should be tolerant of short-term ponding as well as periods of low soil moisture.

Design Steps - Example:

1. First determine the storage volume, soil conditions, depth to the SHGW, and the natural slope of the property at your location using the method described in **Section 2** and **Section 3**, this will assist in choosing the optimal location for the LID SWMF.SWMF

Treatment Volume	***= Total Required Stormwater Volume (ft^3)***
Largest of the three volumes	*= 421 ft^3*

2. For this example, we will use 421 ft^3 for the storage requirement.

3. The rain garden will have vegetation distributed throughout, therefore in order to get a representative volume for the capacity you will need to increase the total volume by 30% (or 0.3).

Required Volume of Stormwater to Be Retained (ft^3)	***Capacity Loss (Accounting For Vegetation)***	***Additional Swale Volume to Account for Vegetation***	***Total Required Volume To Account for Vegetation***	
421 ft^3	*0.3*	*421 ft^3 x 0.3 = 126 ft^3*	*421 ft^3 + 126 ft^3*	*= 547 ft^3*

4. Then calculate how much volume the rain garden will store / treat. For example, if you install a rain garden that is 12 inches deep with gently sloping side the calculations would be as follows:

Required Volume of Stormwater to Be Retained (ft^3)
$547\ ft^3$

Convert Design Depth From Inches to Feet
$12\ in * \frac{1\ ft}{12\ in} = 1\ ft$

Required Storage Volume / Design Depth of the Rain Garden	= Required Area of Rain Garden
$\frac{547\ ft^3}{1\ ft}$	$= 547\ ft^2$

5. Next, you will need to establish the length and width associated with the required area. For this example we will use the following dimensions: depth 12 inches, bottom width 6 feet, side slopes 4 horizontal to 1 ft vertical (4H:1V). Using this data, we will determine the required (bottom) length.

Determine the Horizontal Length When the Water Depth is 1 ft Deep	Solve for x To Determine Horizontal Length Associated With 1 ft Depth
Side Slopes	
$\frac{Horizontal}{Vertical} \quad \frac{4}{1} = \frac{x}{1}$	$x = 4*1 \qquad x = 4\ ft$

6. The property has approximately 30 feet of available space to establish the (top) width of the rain garden. We will only use the portion of the rain garden that has a 1 foot depth in our volume calculation. The next step is to subtract the sloped side from the available storage area; this will determine the width that we will use to calculate the required length.

Available Width Minus The Length of the Side Slopes	Available Width For Stormwater Storage
30 ft – 4ft-4ft	= 22 ft

Required Storage Area / Available Width For Stormwater Storage	Required Length
$\frac{547\ ft^2}{22\ ft}$	24.86 ft

Always round up to the next number, so the bottom width would be 25 feet. From this, we can see that we need to install a rain garden that is 25 feet long and 22 feet wide bottom, or you could install two rain gardens that have a 13 feet long and 22 feet wide bottom. Any other arrangement resulting in a bottom area of 547 ft^2 would meet the criteria. Another option would be to use multiple LID SWMF to meet the storage criteria.

7. Now let's double check our calculations:

Provided -> 22 ft x 25 ft x 1 ft = 550 ft^3 > 547 ft^3 <- Required **OK**

8. Next, determine the recovery time (presented in **Section 2.4.3**). For example, if your site has soil identified as Foxworth (HSG A) then according to the information provided in **Section 2 Table 3** the infiltration rate will be 20 in/hr. The LDC requires a safety factor of 2 to be applied to permeability rates; therefore, you will divide the values found in **Table 3** by 2 (Note: ½ = 0.5). The calculations would be as follows:

Recovery Time	***Depth of LID SWMF (in)*** ***0.5*Infiltration Rate (in/hr)***	***= Hours***
Recovery Time For Sandy Soils *(Dry Swale with Well-Drained Soil)*	*12 in* *0.5 * 20 (in/hr)*	*= 1.2 hr*

Refer to Calculation Sheet 5.2 in at the end of this section for assistance in designing rain gardens.

Operation and Maintenance:

The best time to inspect a rain garden is directly after a storm, again a few hours later, and again 3-days later.

Inspection:

The following inspection items should be carried out periodically:

- Inspect inflow/outflow points for any clogging.
- Inspect pre-filter strip/grass channel and bioretention area for erosion or gullying.
- Inspect trees and shrubs to evaluate their health.
- Check for ponding, periodically and 3-days after a large rain event.

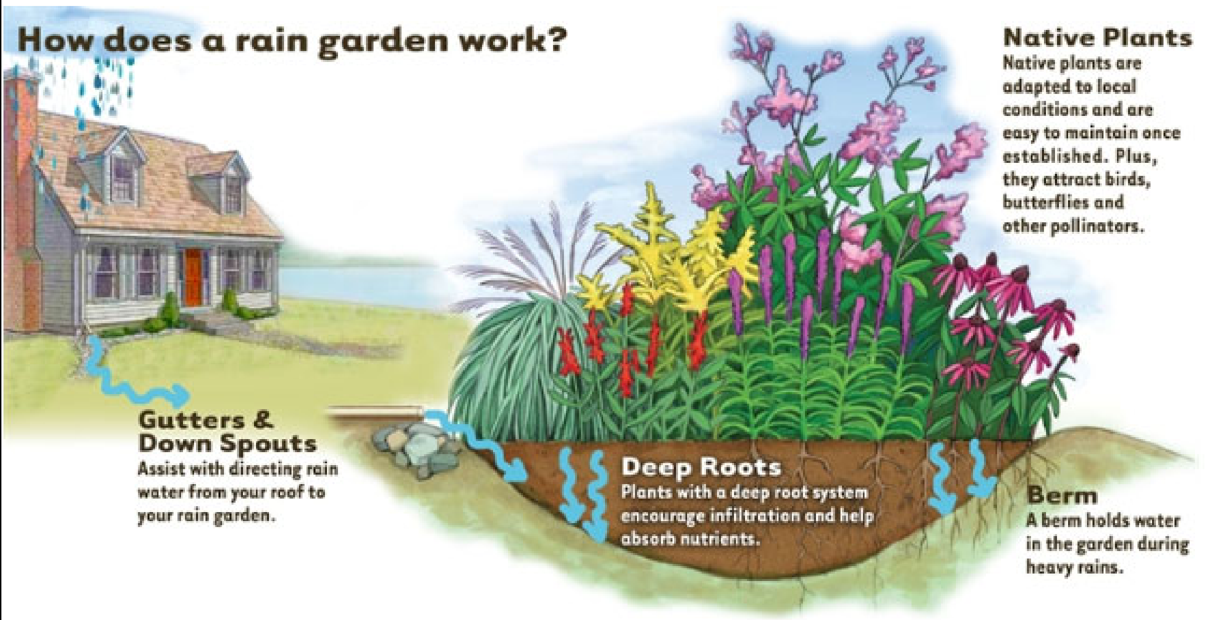
Maintenance:

The following maintenance is recommended after larger storm events, as well as, quarterly:

- Prune and weed to keep any stormwater structures clear (outflow pipes, etc.).
- Maintain/mow the pre-filter or swale at least twice during the growing season and remove clippings from the flow path.
- Replace mulch where needed when erosion is evident.
- Remove trash and debris as needed.

- Replace mulch over the entire area every 2 to 3 years.
- Remove sediment from inflow system and outflow system as needed.
- Stabilize any upstream erosion as needed.
- Remove and replace any dead or severely damaged vegetation.
- In the event the bioretention recovery time becomes significantly longer than the designed 72 hours, the mulch layer and surficial soil layer (min. 6") must be replaced.

Rain Garden Examples:



http://bolincreek.org/blog/policy-alerts/build-a-rain-garden/

Maintenance Form 5.2 – Rain Garden:

Rain Garden LID SWMF

Owner: ______________________________

Address: ______________________________

____

Phone: ______________________________

E-mail: ______________________________

Parcel Number: ______________________________

____

Date of Last Inspection: ______________________________

List any additional LID SWMF on site:

List any previous concerns:

Inspection List	Yes	No
Are sediment basins clean and clear from sediment build up?	☐	☐
Is there any apparent erosion in the area?	☐	☐
Has the soil settled?	☐	☐
Are there any areas with standing water?	☐	☐
Has there been any soil compaction within or near the rain garden?	☐	☐
Is the area directly around the perimeter of the raingarden fully vegetated?	☐	☐
Is the vegetation thriving?	☐	☐
Are there any area with stressed or dying plants?	☐	☐
When was the last date of sediment removal?		

- Please attach pictures

Maintenance Items To be Completed:

By signing this form, I certify that I have inspected this system. ______________________________

Owners Signature **Date**

Site Characteristics

Total Area of Parcel		ft^2	Line 1
Depth To SHGW		ft	Line 2
Infiltration		in/hr	Line 3

Is Your Property In The Following Locations:

	Yes	No
ICPAL	☐	☐
Dune Lake	☐	☐
Near a Mosquito Control Ditch	☐	☐

Treatment Volumes

Treatment Volume (choose the largest)

0.5 in Rainfall Over Disturbed Area		ft^3
1 in Runoff Over Proposed Impervious Surface		ft^3
Attentuation Volume		ft^3

Rain Garden Design

Design Volume		ft^3	Line 4
Additional Volume Requirement		ft^3	Line 5
Total Required Volume of Rain Garden		ft^3	Line 6
Depth of Rain Garden		in	Line 7
		ft	Line 8
Required Area		ft^2	Line 9
Slope — Horizontal		ft	Line 10
Vertical		ft	Line 11
Total Horizontal Extents		ft	Line 12
Available Width For Rain Garden		ft	Line 13
Primary Volume Width		ft	Line 14
Design Length		ft	Line 15
Recovery Time		hr	Line 16

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