Rain Gardens

(Source: Albemarle County, VA)

Purpose & Benefits

- Stormwater runoff reduction
- High pollutant removal
- Pollinator habitat
- Attractive landscaping feature

Description

A Rain Garden is a shallow landscaped depression that receives runoff from surrounding rooftops, driveways, or yard areas. Compared with traditional landscaping, which is usually raised a few inches above the surrounding landscape, Rain Gardens are graded as shallow depressions that accumulate runoff from surrounding areas. A Rain Garden simulates the runoff treatment provided by natural areas, such as forests or meadows (but of course, should not replace existing wooded areas). The primary component of a Rain Garden is the filter bed, which can consist of the existing soil (if it percolates well) or an assembled mixture of sand, soil, and organic material, topped with a surface mulch layer and plants.

What to Expect

During storms, runoff temporarily ponds 4 to 12 inches above the mulch layer and then filters through the bed within 1 to 2 days (this is not enough time for mosquitoes to breed). Plants in a Rain Garden must withstand both dry and wet conditions and will need to be thinned and/or replanted over time. Weeds will need to be removed by hand.

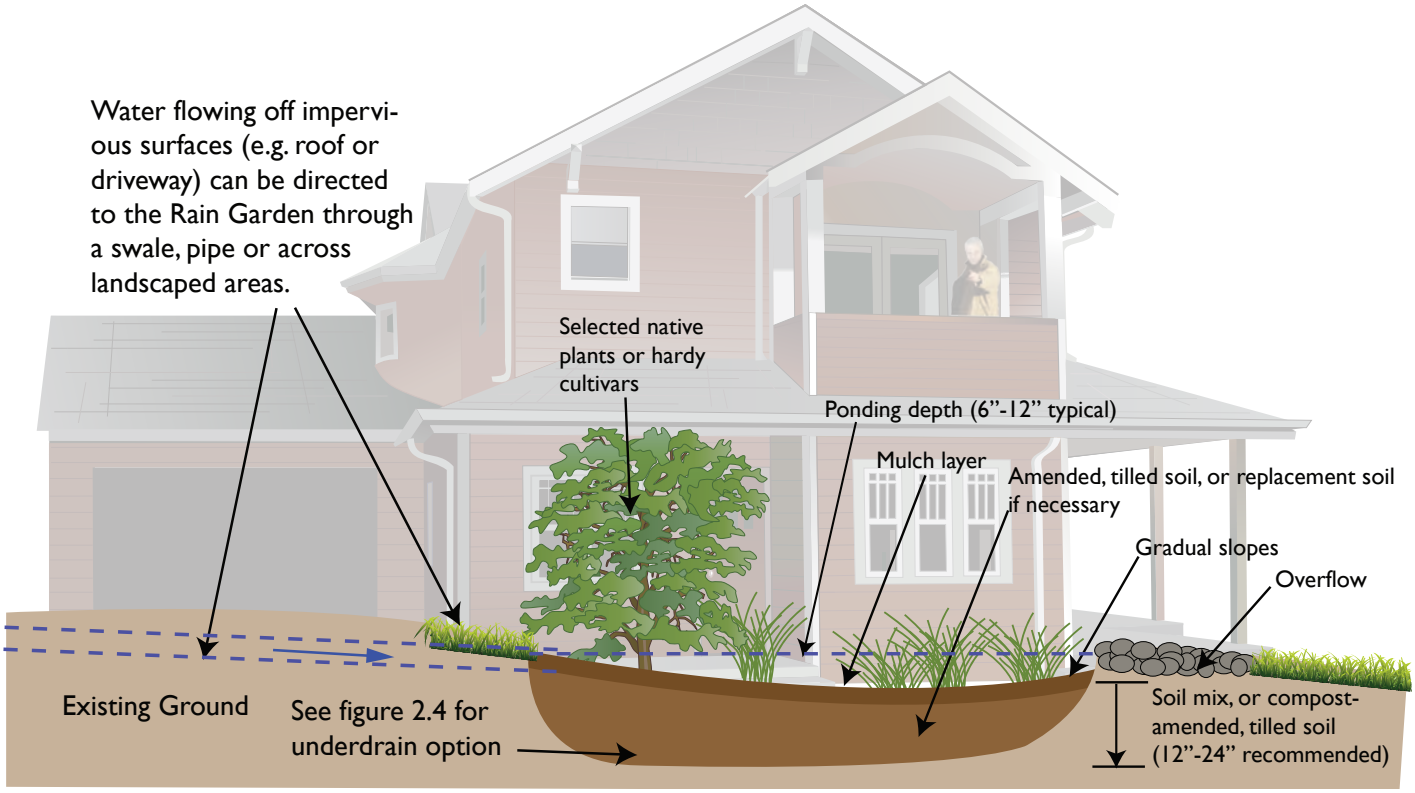


Figure 2.1. *Overview of a Rain Garden*
Adapted from Washington State University Extension, 2013

2.1. Complexity

Rain Gardens are intended to be relatively simple practices, typically ranging in size from 60 to 180 square feet, and often used in residential or small commercial applications.
Typical Rain Garden requirements:

1. Small or medium-sized excavation equipment to dig the hole for the Rain Garden
2. Purchase of materials, such as mulch and native plants adapted to the conditions of the site
3. Special soil mix if the existing soil does not percolate well
4. If needed, an underdrain system to allow the garden to drain properly after storms if the existing soils percolate very poorly.

As Rain Gardens become bigger and more complex, they are often referred to as "Bioretention Cells." As the scale, size, and complexity of the system increases, the contractor should consider whether the practice needs to be designed by an engineer or landscape architect. **Table 2.1** provides some guidance.

Understand the Complexity of the Rain Garden Project
The intent of this guide is for practices in the SIMPLE category. If the practice is moderate or complex, consult with an appropriate design professional.

A Steward or homeowner with experience in landscaping can undertake a simple Rain Garden project. Consult a landscape contractor or design professional for moderate to complex projects, or when the project requirements are uncertain.



Table 2.1. Design Complexity for Rain Gardens

Design Complexity	Description	Guidance
Simple	• Small Rain Garden in residential or small-scale commercial setting • Usually 60 to 180 square feet • Treats rooftops, driveways, very small parking areas, yard areas, with a total drainage area of less than ¼ acre (or 2000 square feet of impervious surface), to each Rain Garden location • Most of the water will enter the Rain Garden as sheetflow (as opposed to water entering in pipes), with the exception of roof downspouts • No underdrain	• Design can be done by anyone with some experience in laying out Rain Gardens, such as a landscape contractor who has done similar projects • The design should consist of a sketch of the site showing setbacks, existing utilities, etc. See **Appendix A** for guidance on site assessments • Sketch of a plan view and cross-section of the Rain Garden, with material types and quantities • Construction can be accomplished by a landscape contractor. Homeowners or volunteers can do the mulching and planting, once the base of the garden is constructed. • Needs maintenance plan
Moderate	• Larger than a residential setting, such as a small business with 10 or more parking spaces, travelways, and rooftops larger than a typical residence • The practice size may range from around 200 square feet to 1,500 square feet. • Water may enter as sheet flow or through small pipes from parking or other impervious areas • May have underdrain	• Design should be provided by a landscape designer, landscape architect, engineer, or other stormwater management specialist. • Check local codes for specific site conditions or design elements that may require an engineer to be involved • Design should include plan and profile views with elevations, materials specifications, and construction details (including erosion and sediment control features during construction) • Needs maintenance plan • Construction will likely require a contractor with a wider variety of equipment
Complex	• Larger commercial or institutional applications, treating parking lots and travelways, larger rooftops, and other areas of impervious cover. • Sized based on state or local stormwater design specifications for Bioretention or similar practices, and may require plan review by the local stormwater program • Any Rain Garden or Bioretention over 1,500 square feet	• Will usually require a licensed landscape architect or engineer and a contractor with capabilities for general site development, with adherence to appropriate state standards (MDE, 2009 or VA DEQ, 2013). • Needs maintenance plan • Construction will likely require a contractor with a wider variety of equipment



Where NOT to Locate a Rain Garden

1. Within 10 feet of a building foundation
2. Over Utilities
3. Near the edge of steep slopes or bluffs
4. Near an existing or reserve septic drainfield or tank
5. In low spots that do not drain well
6. Within 2 feet of high ground water level
7. Under a tree, or in other areas that would require disturbing healthy native vegetation
8. Where there is high groundwatrer during the winter
9. Near Wells- Stay back 50 feet from confined wells, or 100 feet from unconfined wells

Figure 2.2. *Examples of site constraints for locating a Rain Garden*
(Source: Washington State University Extension, 2013)

2.2. Location & Feasibility

When deciding where to build a Rain Garden, consider the siting constraints illustrated in **Figure 2.2,** and also the following considerations:

Shape of the Land A Rain Garden needs to be located in a low spot where stormwater runoff from the surrounding landscape and/or rooftops can drain to it. For the footprint of the Rain Garden itself, look for a relatively flat area, as the basin of the Rain Garden should be as flat as possible. For sites with more slope (up to 12%), Rain Gardens can be split into individual cells that step down a gradual slope. When the uphill cell(s) fill up with water, they can spill over into channels that move the water to the next downhill cell.

Proximity to Buildings To avoid the risk of seepage into basements, do not install Rain Gardens adjacent to building foundations. Recommended setbacks from foundations are:

- 10 feet if Rain Garden is downhill from building (preferred).
- At least 25 feet if the Rain Garden is uphill from the building. This is not a preferred option, but can be used if an overflow channel directs water away from the building and to a downhill channel, driveway, or street.

Do:

- Conduct a full site assessment to choose best spot for Rain Garden
- Place Rain Garden in a low spot
- Consider "treatment train" options, such as catching roof runoff in Rain Barrels and draining those into the Rain Garden

Don't:

- Place Rain Garden in a soggy area (poorly drained soil) that stays wet for many days after rain
- Place Rain Garden within 10 feet of building foundation
- Place Rain Garden under tree canopy, above utilities or septic fields, or next to wells



Other Setbacks For lots with individual wells, locate the Rain Garden at least 50 feet away from the well. Also, keep Rain Gardens outside the drip line of existing trees to avoid damaging tree roots during excavation and do not place them over septic fields.

Proximity to Utilities Interference with underground utilities should be avoided whenever possible, particularly water, sewer, and gas lines. Conflicts with water and sewer lateral pipes (e.g., house connections) might be unavoidable, in which case excavation should be done very carefully to avoid damaging those pipes. Additionally, designers should ensure that future tree canopy growth in the Rain Garden will not interfere with existing overhead utility lines. Call Miss Utility to check the proposed site for existing utilities prior to finalizing the Rain Garden location. Also, be aware that Miss Utility may not always mark private cable, propane, electric, and similar lines, so some additional site work may be necessary to locate these.

Water Table Rain Gardens should not be installed in areas that stay wet more than a few days after a rain event or in any area that appears to be a wetland.

Treatment Train A treatment train is a series of stormwater management features with the uphill practices draining to the subsequent practices in the series. The treatment train provides multiple opportunities for stormwater to be retained, filtered, and/or infiltrated, reducing stormwater impacts from a site. At the residential scale, various practices could be combined into a treatment train. For example, a Rain Barrel or cistern could collect roof runoff and drain it slowly to a Conservation Landscape or Rain Garden. A Green Roof could drain to a Permeable Hardscape or Conservation Landscape. Many combinations are possible! Consider including other practices before or after water flows into the Rain Garden.

Get A Rain Garden and Not a Pond

Based on the existing soils, some Rain Gardens will naturally drain better than others. Water is not supposed to sit in a Rain Garden any more than two days after a storm, and the design should reflect the existing site conditions.

As existing soils range from good infiltration rates to poor, there are three basic options for the design:

1. If existing soils percolate/infiltrate well (greater than 1 inch per hour) and have a sandy or sandy-loam texture, based on the analysis presented in **Appendix B,** the existing soils can be used as the filter bed, although it is recommended that soil amendments be added.
2. If the existing soils do not percolate/infiltrate as well (less than 1 inch per hour but greater than ½ inch per hour, using the procedure in **Appendix B**), it is advised that a pre-made Rain Garden soil mix -- usually purchased from a local vendor -- be used to replace the existing soil for the filter bed.
3. If the existing soils percolate poorly (less than ½ inch per hour based on **Appendix B**) and/or the soil has high clay content, the recommendation is to use the pre-made mix AND an underlying underdrain system to allow the filter bed to drain adequately. If this is the case, perhaps consider a Conservation Landscape or other practice in this manual that may be more affordable and functional for the site.

See the section on *Soil Texture and Infiltration* for more details on these options.

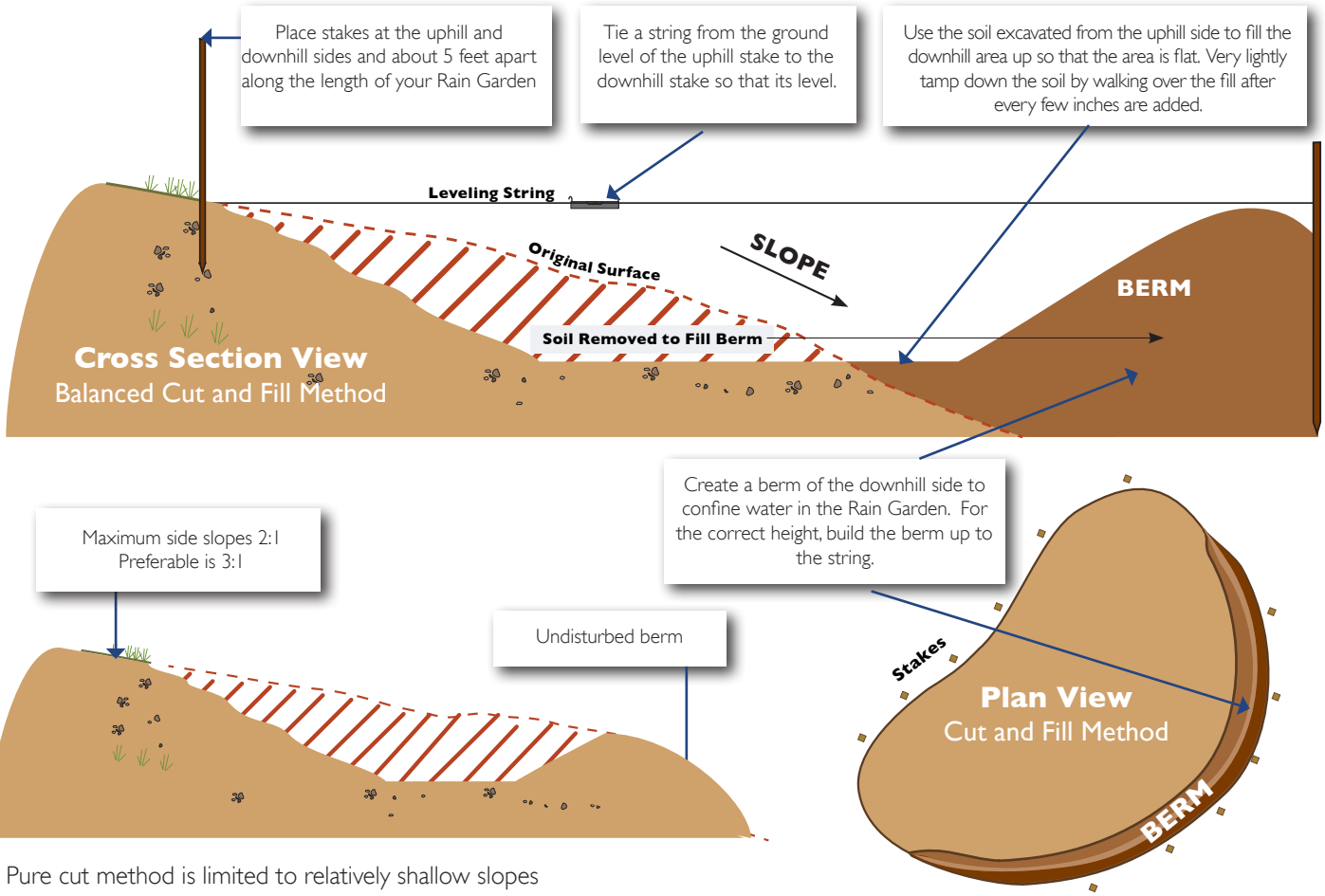


Figure 2.3. *Example of excavation and fill to create a downhill berm to contain the Rain Garden*
(Source: Washington State University Extension, 2013)

2.3. Design

The following section outlines important factors for Rain Garden design. It is important to have an accurate plan showing the various layers and their respective depths and dimensions.

Rain Garden Size A **Rain Garden Worksheet** accompanies this manual to help calculate the optimal size of the Rain Garden for capturing stormwater runoff from its respective drainage area. This worksheet can also help determine material quantities needed for a Rain Garden of a given size, estimate costs for those materials, and estimate the amount of material (i.e., existing soil) that may need to be removed from the site due to excavation and soil replacement. Finally, the worksheet estimates how much nutrient and sediment pollution the Rain Garden can reduce by absorbing and treating stormwater runoff from the drainage area that flows to it. The Rain Garden Worksheet *can be found here.*

As a very general rule, the Rain Garden surface area (not counting side slopes leading down to the flat basin) should be approximately 80 square feet for every 1,000 square feet of impervious area draining to the Rain Garden. This assumes a soil filter bed depth of 2 feet and 6 inches of ponding on the surface. This sizing allows the Rain Garden to capture the runoff generated by the first 1 inch of rainfall from the drainage area. Larger amounts of rain will fill the Rain Garden and some will bypass or overflow to a downhill area that is safe to convey the water.

Ponding Make sure the plan also includes side slopes and a downstream berm if needed so that water will pond (like in a bathtub) to the desired ponding depth without spilling out of the Rain Garden. This will be necessary if the Rain Garden is placed on a moderate slope (see **Figure 2.3**).



Soil Texture and Infiltration See **Appendix B** for detailed guidance on how to test soil texture and infiltration rates. The rate at which the existing soil at the proposed Rain Garden site percolates will have a significant impact on the design, as described in the box above. Soils that already have good infiltration rates can be used in the Rain Garden, with added soil amendments (see below). Whereas, soils that have very slow infiltration rates will need to be replaced with a sandy loam soil mix (see **Section 2.4** for mix recipe) and may also need an underdrain in order to properly drain down between rain storms. The minimum infiltration rate needed for a Rain Garden without an underdrain is ½ inch per hour. Many Rain Gardens do not have underdrains as they add complexity, cost, and labor to the project. However, if adding an underdrain is needed to make a Rain Garden site successful, see the section below about underdrains for guidance.

A Good Soil Mix Will Help Ensure the Success of the Rain Garden

The corollary is also true: if the soil mix has too much clay or gets compacted during installation, the Rain Garden may not drain properly or as anticipated.

Soil Amendments For existing soils that have a sufficient infiltration rate, soil replacement is not needed but soil amendments are recommended. Till in 2 inches of compost or leaf humus into the existing soil in order to improve plant growth and water absorption.

Filter Bed Soil Where the existing soil does need to be replaced due to low infiltration rates, make sure to use a suitable filter bed soil mix at an appropriate depth. The soil should be a uniform mix, free of stones, stumps, roots, or other similar objects larger than two inches. The soil mix should also be free of invasive plants and noxious weeds. If Rain Garden or Bioretention soil mix is purchased, check with the vendor to see that the mix meets specifications outlined in the appropriate state stormwater manual. If trees are included in the Rain Garden planting plan, tree planting holes in the filter bed should be around 4 feet deep to provide enough soil volume for the root structure of mature trees. Use grasses and perennial flowers instead of trees to landscape shallower filter beds. See **Section 2.5** for plant suggestions.

Excess Soil Plan for a place to dispose of or use excess dirt when the Rain Garden is excavated. Some of the soil may be used to make a berm on the lower edge of the Rain Garden, but there will likely still be leftover soil. If some of the excavated soil is used on the lot, make sure to add some topsoil, as that will help grass or other vegetation to establish.

In addition -- depending on the size of the installation, anticipated weather, and number of days needed for installation -- it may be advisable to place silt fence downhill from the Rain Garden excavation and/or stockpiles of excavated material. Stockpiles can also be covered temporarily with a tarp. Take all precautions necessary to not contribute sediment to downhill storm drainage systems and waterways.

Terminology

Commonly, "Rain Garden" is used to describe a practice that has no underdrain. Once the additional layers are added, a Rain Garden becomes a "bioretention" or "biofilter," though terminology for stormwater best management practices has not truly been standardized.

Considering an Underdrain? Underdrains are perforated pipes in a bed of gravel. An underdrain allows more water to flow through a Rain Garden by draining some water from the bottom of the practice. An underdrain also prevents a Rain Garden from staying soggy for too long.

The underdrain pipe is placed in the bottom-most layer of the Rain Garden, surrounded by washed gravel. Two sizes of gravel should be used: a 9 – 12 inch layer that encases the perforated pipe with ⅜ - ¾ inch gravel (commonly available #57 rounded gravel – avoid angular, crushed stone) and a 3 – 4 inch layer on top of this of smaller pea gravel. The pea gravel keeps the soil mix from filtering down into the underdrain (see Materials listed in **Table 2.2**).

The underdrain pipe should be a 3- or 4-inch perforated smooth-walled pipe, either black landscape pipe or PVC. The Maryland Department of the Environment specifies that perforated underdrain pipes be wrapped in two layers of ¼ inch stainless steel wire mesh (often called hardware cloth) to help prevent clogging. Do not wrap the underdrain pipe in geotextile filter fabric, as this will clog. The pipe should be installed with a slight slope of about 1%. Where the perforated underdrain pipe exits the Rain Garden area, it should be connected to a solid pipe that runs to a downhill point where it opens to daylight and can release the water. An apron of stone (at least 3 inches deep) should be placed at the pipe outlet to prevent erosion at that spot.

Best practice would include a cleanout and observation well when using an underdrain. This is a capped, vertical, non-perforated pipe that connects to the underdrain, usually with a 45-degree elbow. It extends up through the Rain Garden layers so that if the underdrain gets clogged, there is easy access to clear it with a plumbing snake or water jet. Finally, adding an underdrain will increase the excavation depth of the Rain Garden by a minimum of 12 inches, at least for a narrow trench area to house the underdrain pipe. See **Figure 2.4** for a cross-section of a typical Rain Garden with an underdrain layer and cleanout.

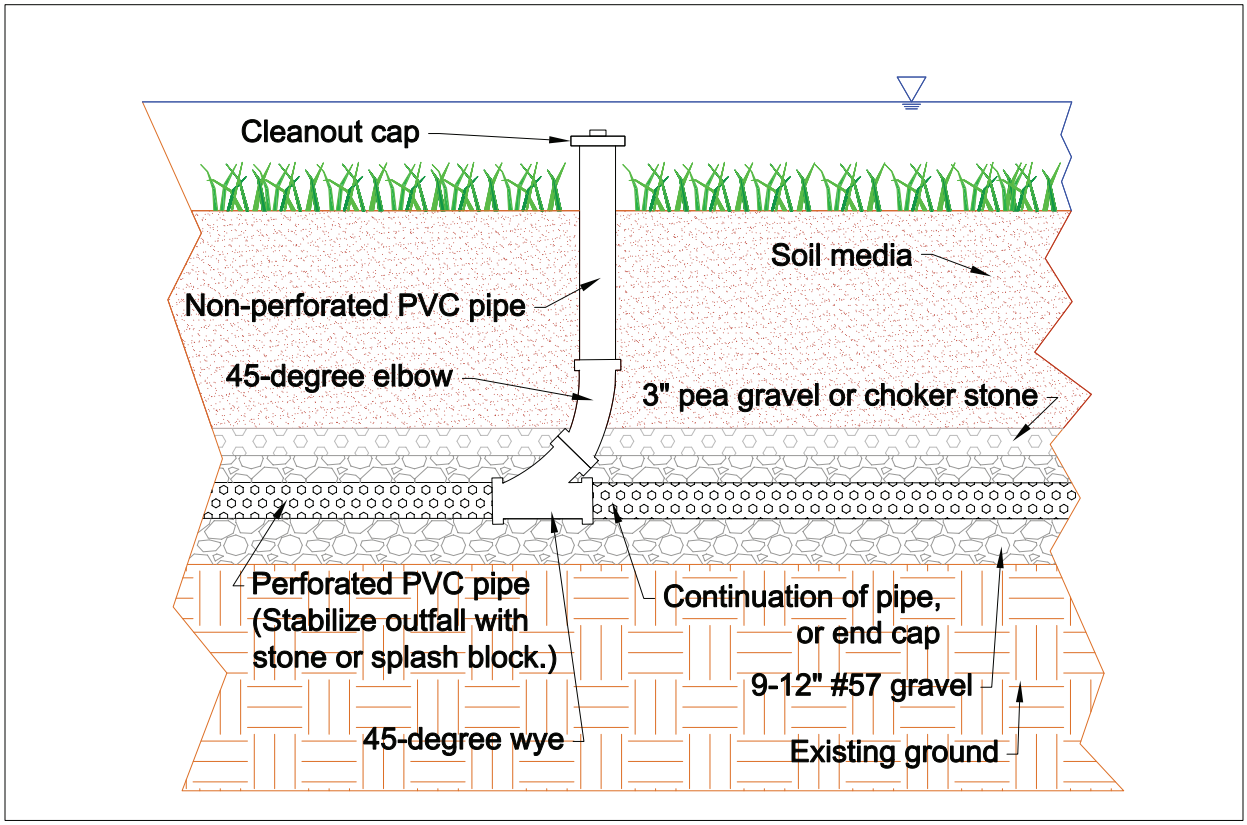


Figure 2.4. *Cross-section of Bioretention With Underdrain*

Pre-Treatment Pre-treatment refers to something that will remove leaves, grit from the roof, and larger particles of dirt from the runoff before it enters the Rain Garden, helping to keep the Rain Garden from clogging. Pre-treatment can consist of gutter leaf screens (for Rain Gardens that treat roof runoff), a strip of grass about 5 feet wide around the Rain Garden, or a stone and/or a shallow grass channel that leads into the Rain Garden. This width should be increased for Rain Gardens that are expected to receive higher levels of sediment than would be generated by a typical yard or roof.



Inlets As much as possible, runoff water should enter the Rain Garden as diffused flow. However, there will likely be at least one inlet or area of concentrated flow (e.g., from a pipe or uphill area where water becomes more concentrated). If the Rain Garden receives stormwater from gutter downspouts, for example, incorporate a pad of river cobble stone or some other means to reduce flow velocity at the mouth of the downspout. Add a strip of stone to other "transition" areas where concentrated water flowing into the Rain Garden may cause erosion. Where a Rain Garden is located next to a sidewalk, patio or driveway, consider including a similar treatment to prevent erosion and undercutting at the edge where the bed meets the hardscape. This stone strip should run the entire length of the Rain Garden edge where it meets the hard surface, be underlain with filter fabric, and be approximately 12 inches wide and 12 inches deep.

Overflow The Rain Garden will need to have a place to safely overflow when it fills up during large rain events without causing erosion, damage to building foundations, or problems with downhill sidewalks or walkways. The height of the overflow spillway will need to be set at the level of the maximum water ponding depth that is desired. The spillway can be made of compacted soil topped with filter fabric and river cobble stone, or similar material. See **Figure 2.5** for several examples. The recommended ponding depth is 6 inches, and calculations in the *Rain Garden Worksheet* assume 6 inches of ponding. The maximum ponding depth should be 12 inches. If children are likely to be playing near the practice, shallower ponding depth is recommended. Also, extra care should be taken to limit the slopes on the sides, and/or limit access to the practice.

Ponding depth set by stone weir (middle of photo below mulch).

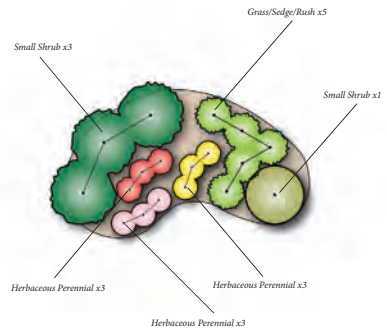
Ponding depth set with timber weir in berm

Ponding depth set with earth and timber weir

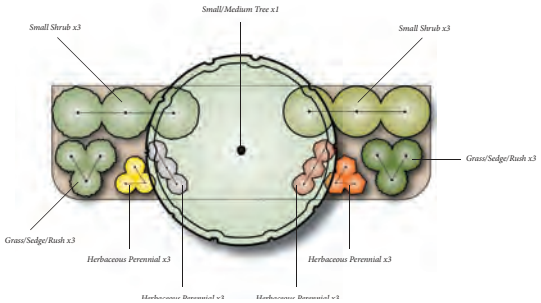
Figure 2.5. *Examples of How to Set the Ponding Depth*

Shape A Rain Garden can be any shape as long as the basin surface is flat, the side slopes are not steep, and the water flowing into the garden spreads out evenly over the surface and does not concentrate at one end or corner of the Rain Garden area, especially close to the overflow. **Figure 2.6** illustrates several typical Rain Garden shapes. **Figure 2.7** portrays a different concept where the Rain Garden (or stormwater planter) is associated with the building design and incorporated in a concrete or other type of planter box. These usually treat rooftop water.

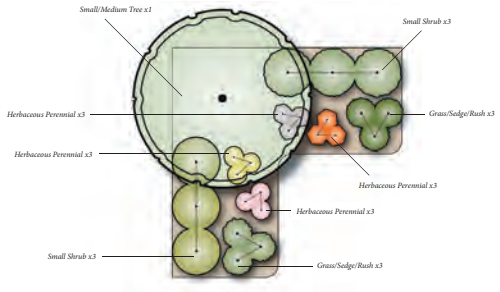




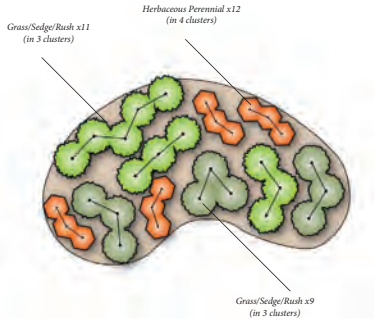
Kidney shape, in yard



Edge shape, often along property line



Corner layout



Alternate Kidney shape

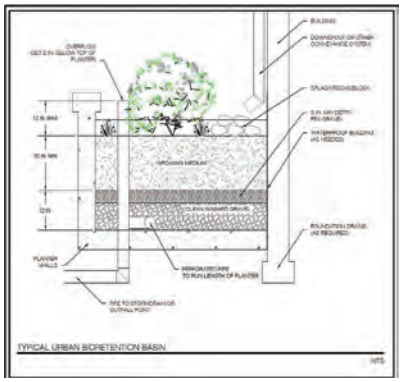
Figure 2.6. *Templates for Various Rain Garden Shapes, from WSA Conservation Landscape Design Tool*

Layouts or templates can be very similar between Conservation Landscapes and Rain Gardens, with the primary differences being Rain Garden ponding storage, and plant selection.

Rain Garden in a Box:

Some Rain Garden applications can be incorporated into planter boxes associated with a building, usually designed to treat runoff from the roof. These are sometimes referred to as stormwater planters or urban Bioretention. These generally qualify as **moderate** complexity practices, as presented in **Table 2.1**, and thus may require design support from a stormwater professional, perhaps working with the project architect**.** These designs make the Rain Garden concept applicable in a densely developed setting. As shown below, most of these will include an underdrain.

Rain Garden in a Box (Stormwater Planter)



Typical Design for Stormwater Planter

Figure 2.7. *Stormwater Planter / Rain Garden in a Box (option)*



2.4. Materials

Table 2.2. Material Specifications for Rain Gardens

(listed in order of location in a Rain Garden cross-section, top to bottom)

Material	Specifications	Size	Depth	Notes
Mulch	Double-shredded hardwood or approved pine straw substitute	N/A	2 – 3 inches	Aged minimum of 6 months; do not let mulch touch base of plants
Cobble/Stone	Washed river rock, large gravel, or small rip-rap	3 - 5 inch diameter stone	1 or 2 layers deep	Use at downspouts, inlets, outlets, and along hardscape edges as needed to dissipate flow and prevent soil erosion Use filter fabric under stone
Compost *(if not replacing the soil)*	The material should be well composted and free of viable weed seeds Fresh manure should not be used because of its high bacteria and nutrient levels	N/A	Add 2 inches of compost across Rain Garden surface area and incorporate into top 6 inches of soil	Follow recommendations from soil test if compost amendments are suggested
Filter bed soil mix *(if replacing the soil)*	Bioretention soil mix from a local vendor OR mixture of about 80% sand, 10% topsoil, and 10% well-composted leaf mulch, mixed well together	N/A	Typically 18 – 24 inches for a residential Rain Garden If planting trees, use more soil volume around the tree	USDA soil type loamy sand or sandy loam, with high sand content. Topsoil no more than 5 to 10% of mix
Underdrain pipe *(if using an underdrain)*	Perforated, corrugated (with smooth-wall interior) HDPE landscape pipe or equivalent	3 - 4 inches		Clean-out, observation well recommended
Underdrain gravel *(if using an underdrain)*	#57 rounded gravel	½ - 1 ½ inch stone	9 - 12 inches	Must be washed clean at quarry; avoid crushed stone, angular type stone
Pea gravel *(if using an underdrain)*	#8 or #78 stone	¼ - ½ inch stone	3 – 4 inches	Must be washed clean at quarry



2.5. Plants

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. Plants should be specified for different areas of the Rain Garden, as the bottom of the Rain Garden will be wetter than the side slopes or upper edges. Plants in the bottom of a Rain Garden must tolerate both periodic inundation and very dry conditions. Thus, these plants must be very adaptable. The slopes and especially the upper edges of a Rain Garden are inundated rarely, so plants that can tolerate drier conditions are specified for this zone.

The plants recommended in the *WSA Conservation Landscape Design Tool* should be suitable for different areas within Rain Gardens. There are many other resources for Rain Garden/Bioretention plant recommendations. To get started, consult those resources listed in **Section 2.8.**

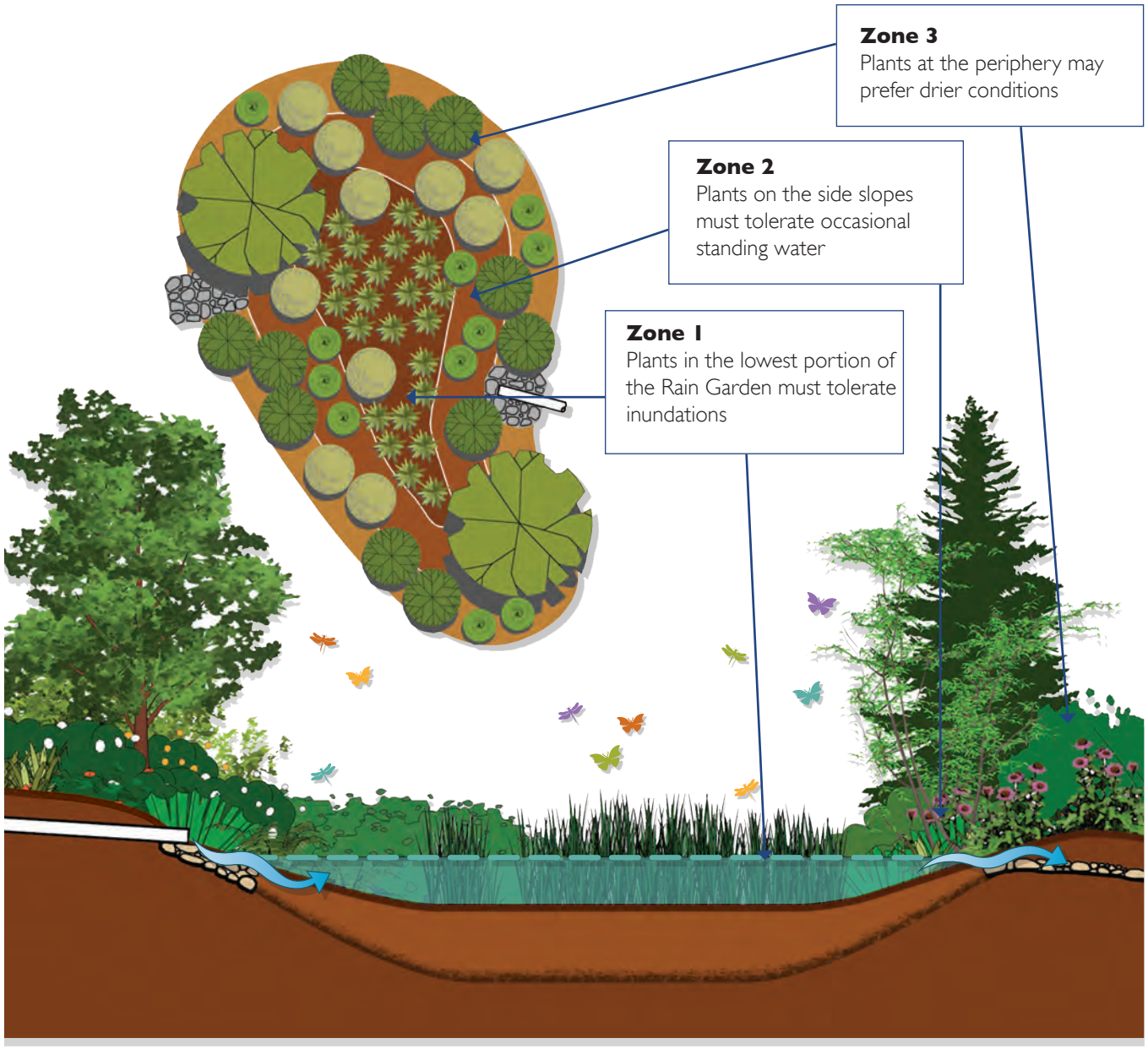


Figure 2.8. *Planting zones within a Rain Garden based on moisture*
(Source: Washington State University Extension, 2013)



Beware: Rain Gardens Can Become Very Dry

Some people make the mistake of selecting plants more adapted to a wetland. If the soil at the site drains moderately well, expect very dry conditions on occasion in the summer. Plants must be selected that are adaptable to the extremes of periodic inundation as well as periodic drought .

Match The Rain Garden to the Owner

Like all other gardens, Rain Gardens are successful if they are maintained. In addition to weeding as in traditional landscapes, Rain Garden inlets and overflows must remain clear to ensure that water enters and exits the Rain Garden. Leaves and excess perennial vegetation should be removed in the spring. Some owners are willing and able to regularly weed, prune, and mulch their Rain Gardens, while others may want a simpler approach that involves periodic cutting and some occasional weeding. Make sure the selection of plant types and layout is a good match for the owner's capabilities.

2.6. Construction

Step 1 - Outline the Garden & Mark Utilities Clearly mark both the boundaries of the Rain Garden and any nearby underground utilities (call Miss Utility at least two business days before digging). Also try to identify private propane, cable, electric, and other small lines. Make sure to have a plan and phone numbers of who to call in case there is any damage to utilities. Confirm the flow of water into the Rain Garden, checking the areas that are to contribute runoff to the practice. This may require using a survey level or hand level and a survey rod to check spot elevations and confirm flow paths.

Figure 2.9. *Have all underground utilities in the vicinity marked by Miss Utility before doing any digging.*

Step 2 - Erosion Control It is best to dig the Rain Garden when the weather is expected to be dry for several days. Install a row of silt fence below the construction site in case of rain. Cover stockpiles of soil temporarily with a tarp to prevent the material washing away.

Figure 2.10. *Install silt fence below the Rain Garden construction site for erosion and sediment control.*

Step 3 - Dig Basin

Elevations are Key:

Excavate the Rain Garden area and side slopes. The Rain Garden surface area should be as flat as possible. Adjacent side slopes should be no steeper than 1 foot of vertical drop for every 3 horizontal feet, referred to as a 3:1 slope. In order to not compact the soil, ensure that heavy equipment works from the sides to excavate the Rain Garden to the depth and dimensions specified in the design.

The outlet or overflow should be set at the maximum ponding elevation and slope downward away from the basin, with the flow path unobstructed. If the Rain Garden is going to be



installed on a slope, see **Figure 2.3** to help guide the balance of excavation and fill for building a berm on the downhill side: the soil removed from the upper portion will build up the containment berm on the lower portion to create the basin. The berm should be thoroughly compacted so it does not fail when it gets saturated. If the site soils are very loose or sandy, this may require some clay to be added.

The bottom of the excavation should be as deep as necessary to account for the component layers included in the design. Working downward from the top, these include ponding depth, mulch, soil filter bed, pea gravel, and underdrain gravel, as necessary. For example:

6 inches ponding +
3 inches mulch +
24 inches soil =
33 inches deep, below the surface elevation.
If using an underdrain, also excavate the trench where the pipe will exit the Rain Garden to daylight. For underdrains, ensure that excavation depth accounts for the underdrain gravel approximately an additional 12 inches.

Figure 2.11. *Excavate from the side in order to prevent compaction within the Rain Garden.*

Step 4 - Rake or Till Bottom of Basin Rake or till the bottom soils as deep as possible to promote greater infiltration. Ensure that the bottom is as level as possible.

Step 5 - Install the Underdrain If an underdrain will be used, place about 3 inches of clean #57 rounded gravel evenly across the bottom of the pit. Place the perforated underdrain pipe at a slight slope (e.g., 1%) on top of the initial layer of gravel (see F**igure 2.12**). Add a non-perforated vertical clean-out pipe that extends above the top elevation of the Rain Garden; connect to the underdrain pipe with a 45-degree elbow and add a screw cap to the top of the clean-out pipe. Pack the remaining #57 stone around the underdrain pipe so that the pipe is covered by about 3 inches of gravel. Add about 3 inches of pea gravel so that it completely covers the #57 gravel layer.

Figure 2.12. *Install underdrain on top of initial layer of gravel.*

Do:

- Call Miss Utility before digging
- Use appropriate soil mix
- Direct runoff to Rain Garden
- Water plants during 1st month
- Inspect finished Rain Garden after several storms

Don't:

- Compact the soil
- Place Rain Garden within 10 feet of building foundation
- Install Rain Gardens under trees

Step 6 - Install Inlet, Overflow and Berm Install any pre-treatment features associated with the plan, such as a stone pad at the mouth of downspouts. Seed and straw all side slopes, berms, and disturbed areas, unless these areas will be landscaped with other vegetation and mulch. Refer to Step 5 in **Section 1.6** – Construction of the Conservation Landscape chapter for detailed instructions for the stone inlet channel..

Step 7 - Spread Soil Replacement Mix or Compost Amendment If there is no underdrain, place the soil mix directly into the bottom of the excavation. If an underdrain is used, place the soil mix on top of the pea gravel layer. Place the soil mix until the desired top elevation of the Rain Garden is achieved. Water the soil mix well with a hose to allow it to settle. Wait a few days to check for more settling, and add additional soil as needed.

Figure 2.13. *Double-check elevations throughout the construction process to ensure each layer is at the correct height according to the Rain Garden design.*

Figure 2.14. *Add soil mix into excavated area until it reaches desired elevation for Rain Garden surface.*

Step 8 - Install Plants Prepare holes for trees and shrubs on Rain Garden basin surface (if used), install vegetation, and water accordingly. Plant trees and shrubs after they go dormant in the late fall, if possible. Avoid trees and shrubs on the berm, if it is present. Install any temporary irrigation. Place the surface cover (mulch, river stone, and/or grasses) around the plants, as per the design. Do not let mulch touch the base of plants. Water plants during weeks of no rain for at least the first two to three months.

Step 9 - Inspect Inspect the Rain Garden after several rain events to look for any needed adjustments: ensure that runoff is entering the Rain Garden properly, the garden is draining properly, there is no erosion at inlets and outlets, and plants are surviving. Remove silt fence once the site is sufficiently vegetated and stable.



2.7. Maintenance

Table 2.3. Recommended Maintenance for Rain Gardens

Maintenance Tasks	Frequency
• Water often during the first 2 months, and then as needed during first growing season (April-October), depending on rainfall • Expect up to 10% of the plant stock to fail in the first year, and plan accordingly for replacement plants	Upon establishment. Small herbaceous plants will require more watering
• Check and repair eroded areas • Check inlets and overflow areas for debris or leaves that are blocking flow	After heavy rains in first 6 months; periodically in subsequent years
• Remove weeds by hand	Monthly for first growing season; every 3 months in subsequent years
• For meadow type Rain Gardens consisting of grasses, mow the Rain Garden in early spring • For other types of plantings, check for winter damage and add mulch to bare spots as desired (2–3 inches). Do not let much touch base of plants. • Cut back perennials and remove dead growth • High winter wildlife value perennials/grasses can be left until they start sprouting in the spring	February or March
• Add reinforcement planting to maintain the desired vegetation density • Prune trees and shrubs • Thin herbaceous plants as desired • Remove excess leaf matter after all leaves have fallen in the fall	Fall
• Remove invasive plants using recommended control methods • Remove any dead or diseased plants • Stabilize bare areas draining to the Rain Garden, especially is there is erosion • Remove trash	As needed
• Remove accumulated sediment at inflow points	Annually



2.8. Resources & References

Albemarle County, VA, *Piedmont Native Plant Data Base*
http://www.albemarle.org/nativeplants/

Anne Arundel County Rain Garden webpage
http://www.aacounty.org/DPW/Highways/RainGarden.cfm

Ladybird Johnson Plant Database
http://www.wildflower.org/plants/

Maryland Department of the Environment (revised 2009). Maryland Stormwater Design Manual, Vols. 1 & 2
Chesapeake Conservation Network, Homeowner Guide for a More Bay-Friendly Property, Appendix C, List of Plant Resources (2013)
http://chesapeakestormwater.net/download/3859/

North American Native Plant Society
http://www.nanps.org/

StormwaterPA website, *Rain Gardens: Saving Streams One Yard at a Time* video
http://www.stormwaterpa.org/raingarden.html

USDA, *Plants Database*,
http://plants.usda.gov/java/

Virginia Department of Environmental Quality. 2013. *Virginia Stormwater BMP Specifications – Rev. 2013 (DRAFT).* Richmond, VA. Available at:
http://www.deq.virginia.gov/Programs/Water/StormwaterManagement/Publications.aspx

Washington State University Extension, *Rain Garden Handbook for Western Washington: A Guide for Design, Installation, and Maintenance,* 2013
https://fortress.wa.gov/ecy/publications/documents/1310027.pdf

Another possible native plant resource:
http://www.iconservepa.org/plantsmart/nativeplants/index.htm

Low Impact Development Center – Bioretention – Rain Gardens Design – Infiltration Model
http://www.lid-stormwater.net/index.html

Schott Nurseries – Native Trees/Shrubs
http://www.schottnurseries.com/

Native Plants – Super Plugs
http://www.northcreeknurseries.com/

Pine Straw Store – pine straw mulch
http://pinestraw.com/pine-mulch-facts/

Rain Gardens Across Maryland
https://extension.umd.edu/sites/default/files/_docs/articles/Rain_Gardens_Across_MD.pdf