CLEMSON
PUBLIC SERVICE

Carolina Clear

RAIN GARDENS

A RAIN GARDEN MANUAL FOR SOUTH CAROLINA

GREEN SOLUTIONS TO STORMWATER POLLUTION

As development increases, so does the area of impervious surface. Impervious surfaces include roadways, rooftops, parking lots and sidewalks. Without planning and appropriate management, water that runs over these surfaces picks up pollutants along the way and carries them directly to our lakes, rivers and estuaries. These pollutants include bacteria, nutrients, litter, sediment, oils and metals. Water that heats up on parking lots and roadways also can lead to warmer than normal water entering nearby waterways. This runoff, called "stormwater," is generated by precipitation, snow melt and irrigation water that runs off the land. **Stormwater is the greatest threat to our nation's surface waters.**

As well as creating hard surfaces where pollutants can be washed into waterways, impervious surfaces also prevent the natural infiltration process that occurs in forests, fields and open areas. Instead of adding to the groundwater supply, stormwater flushes the landscape, often leading to increased flooding, erosion, sedimentation and damage to wetlands, ecosystems and waterways.

Rain gardens have become a popular and attractive method for property owners to decrease the impact of their impervious surfaces. Rain gardens are landscaped depressions that receive stormwater runoff and allow the runoff to slowly infiltrate to the groundwater table. As well as intercepting stormwater runoff that could have added to flooding problems, the rain garden allows nature to play a role, removing some of the pollutants that would have otherwise affected water quality. During infiltration, plants use excess nutrients for growth, sediment is trapped in the garden and biological processes remove pathogens. Dissolved metals and nutrients bind or adsorb to soil particles, and are removed temporarily out of the system. Rain gardens, like any garden, also become habitat for bees, birds and butterflies.

Many other stormwater management techniques address only a portion of the problems caused by stormwater runoff. Rain gardens, however, have the potential to solve all of the problems of stormwater runoff before they occur.

Kevin Beutell,
***Stormwater*, October 2008**

SITING YOUR RAIN GARDEN

MAKING THE BEST OF A DEPRESSED SITUATION

Rain gardens should be located in an area to which rain water typically flows. If a depression already exists in your yard, this could be a good candidate for siting your rain garden. If not, a depression in the ground could be easily dug. Remember, the depression in the landscape should NOT have a seasonally high water table. This would inhibit the amount of infiltration that would take place and restrict the variety and potential success of the plants you use in your rain garden. Often, rain gardens are built down slope of the downspout and ***at least 10 feet away from the home.***

SIMPLE TIPS FOR RAIN GARDENING SUCCESS:

- Be aware of utility lines before you dig. Call P.U.P.S. at 811 or 1-888-721-7877 to request information before digging.
- To help envision the shape and layout of your rain garden, lay a rope or garden hose in the shape and size of your rain garden. Keep this outline as your digging boundary until complete.
- A curved shape makes the rain garden look more interesting and natural. The longest length of the rain garden should be perpendicular to the slope of the property.
- Remember, if you have a septic system, you should be sure that water is not routed to the drainfield area, which could reduce the effectiveness of your drainfield and lead to system failure!
- Trees are primarily for large rain gardens (at least 150 square feet) and should be planted at least 8 feet apart. Consult your Horticulture Agent or nursery for more advice.

SIZING YOUR RAIN GARDEN YOUR INNER ENGINEER

The size of your rain garden is dependent on the area that runs off into the garden, the volume of water it will need to temporarily store, and the soils that will do the infiltrating. The Center for Watershed Protection recommends that the rain garden area be between 20 and 30 percent of the drainage area directed to the depression. For best results and plant growth, it is also recommended that the rain garden depression be approximately 6 inches deep.

Rain gardens are typically designed to store and infiltrate a 1-inch storm. In cases where a storm will produce more than 1 inch of rain in 24 hours, excess water should be able to leave the rain garden without eroding soils and carrying away mulch and soil. Your rain garden design should include an overflow so that excess water from larger storms can be diverted out of the rain garden. To prevent overflow from eroding the soils around the rim of the rain garden, stones or turf reinforcement can be used. A berm will also keep water in the rain garden so that it has the time to infiltrate.

Since rain gardens are supposed to reduce the amount of runoff and encourage infiltration of stormwater, soils play a major role in their effectiveness and success. **Soil mix and drainage piping are two decisions the designer makes in determining drainage capabilities of your rain garden.** The soil mix selected must have a balance of clay soils that will support plant growth and fix pollutants within the soil, as well as sandy soils that will encourage infiltration. ***Sandy loam to loamy sand is the most recommended mix*** for rain gardens, resulting in permeability rates of 1 to 6 inches per hour. If possible, start with the native soils from the depression and amend them to get the results your rain garden requires.

To find out if your soil needs to be amended, you should do two things - conduct a soil perk test and have your native soil tested. For

the perk test, dig a hole in the area where the rain garden will be installed. The hole should be approximately the size of a coffee can. Fill the hole with water. How many inches does it drop in an hour? Ideally, it should be 1 to 6 inches. Given that the site's soils are well-drained, have the soils tested by your local extension office. The results will recommend any necessary amenities to include in the soil mix so that your plants will have the best conditions for success.

To correctly size your rain garden, determine the area of imperviousness that drains to the depression. For gutters with a downspout at each end of the sloped roof, simply divide the size of the roof in half. Then estimate 20 and 30 percent of that roof area; the rain garden should be sized to meet that range in area. The sandier your soils in the depression, the closer to the 20 percent size estimate for your rain garden.

Installing an underdrain is a way to ensure that your rain garden infiltrates if a large volume of water will be draining to the depression, or if the native soils prevent proper infiltration. Drainage pipes are plastic and range from 4 to 8 inches in diameter and may be corrugated. The pipe should be installed 3.5 to 5 feet below the surface, enveloped in *washed* gravel and overlaid with geotextile fabric.

PLANTING OPTIONS

THE FUN PART

Once the depression has been established with ample drainage, the next step is installing plants. Rain garden ***vegetation should be able to withstand brief periods of standing water, yet thrive between rain events under dry conditions***. Plants by region of South Carolina are listed on the following pages. Native plants are plants that are natural to a region, and therefore may be better suited for the soils and seasons and may also provide the best habitat for birds, bees and butterflies natural to that area.

There are a few rules of caution and advice when choosing vegetation for your rain garden.

1. In situations where an underdrain is installed, plants such as willows will aggressively send roots down to reach water, leading to clogged drainage pipes. ***Therefore, whenever underdrains are in place, shrubs and trees with overly aggressive roots should not be planted***.

2. Cherry trees should also be avoided in rain garden designs. Under flooded conditions, cherry tree roots will release a poison that will kill the tree.

3. Finally, other rain gardeners suggest that you keep the planting design simple by using *fewer varieties of plants that are most suited to the conditions of the site*. This will also allow you to find out what works best in your rain garden, and then plant more when needed.

For more assistance with selecting the appropriate trees, consult the Home and Garden Information Center's Fact Sheet "Tree Selection (HGIC 1004)" available at www.clemson.edu/extension/hgic.

After the plants are installed, the rain garden should be mulched with ***3 to 4 inches of hardwood mulch***. A pine bark mulch is too lightweight and could float out with the next storm.

It is important to remember that a rain garden is still a garden and requires some maintenance. The plants have their own horticultural needs, and not all plants will survive the conditions within the rain garden. ***Plants should be inspected seasonally, and the rain garden itself should be inspected after major rainfalls to ensure that the plants, soil and mulch are stable within the depression. Weeding will be necessary to reduce unwanted competition in your rain garden. Finally, any debris that flows into the rain garden should be removed.***

LOCATION, LOCATION, LOCATION

ADDITIONAL RAIN GARDEN POSSIBILITIES

Typically, rain gardens are installed to treat rooftop, lawn and driveway runoff at residences. From a rooftop's downspout, rain gardens should be sited down-gradient, and water can travel through a 1 percent sloped ditch (1 foot drop in elevation over 100 feet of distance), gutter extender, or from a hose connected to a rain barrel. Partnering rain barrels with rain gardens makes sense, as the barrel will act as a settling basin for any solids running off of the rooftop.

If having a gutter extender over the lawn troubles you, it can be buried underground until it reaches the rain garden.

Rain gardens can be installed at almost any property or facility with an impervious surface and some area that will be used for the treatment from that impervious runoff. The following are some examples of how rain gardens can be used within the landscape:

- Corner of barns to capture and infiltrate runoff.
- Recessed parking lot islands.
- Schools where the rain garden can double as an outdoor classroom.
- Highway medians.

Cornus florida (Flowering Dogwood)
Andy & Sally Wasowski, Lady Bird Johnson Wildflower Center

Photo by Sarah L. Voisin, published in *The Washington Post* on 7/12/2008

Mosquitoes require 7 to 12 days in standing water to lay and hatch eggs. Typically, rain gardens will drain in under 24 hours, therefore removing any mosquito concerns.

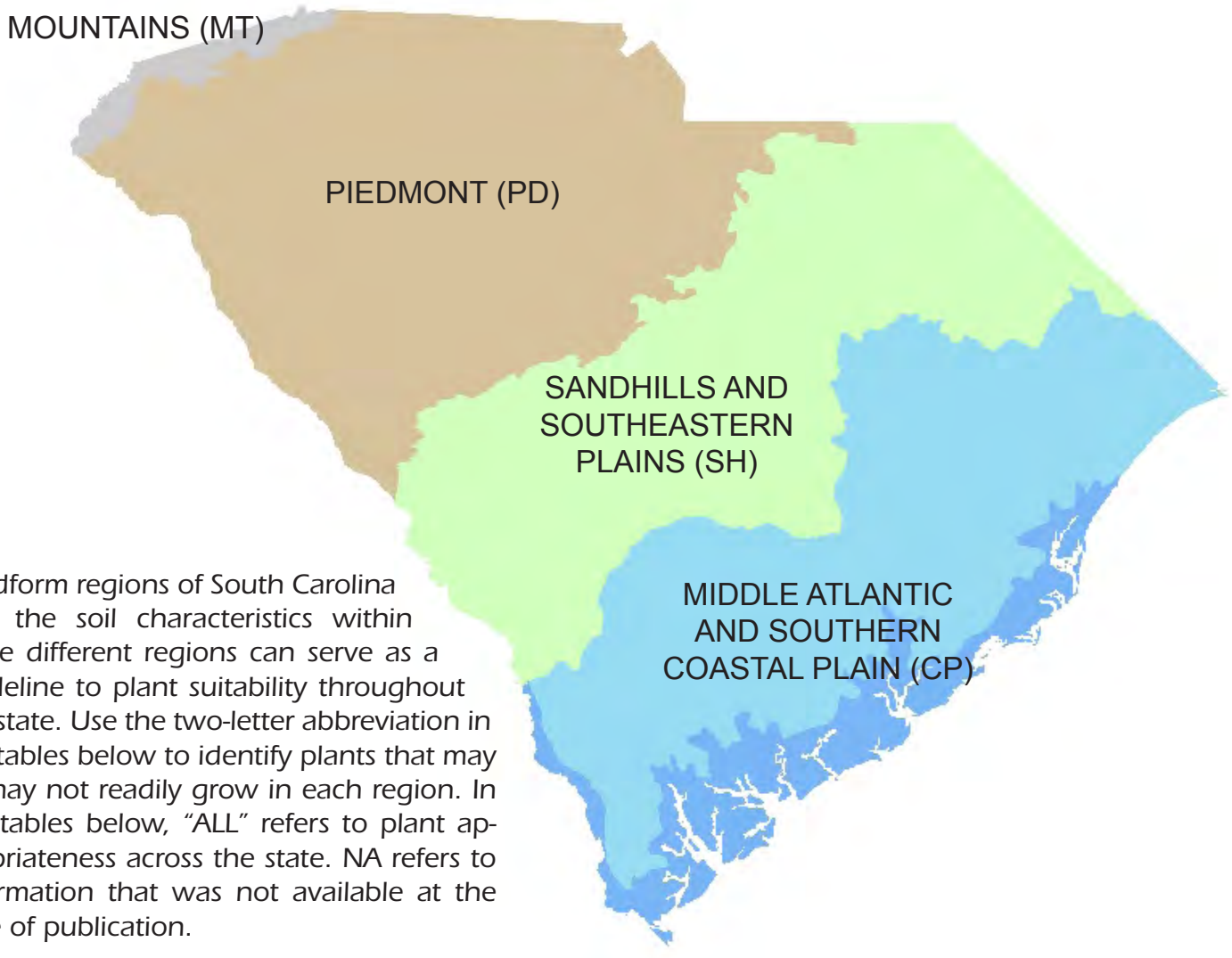
MOSQUITO CONCERNS AND OTHER FREQUENTLY ASKED QUESTIONS

Observe how long it takes for your rain garden to completely drain and monitor how that may change each season. As for keeping mosquitoes at bay, rain gardens also attract dragonflies which feed on mosquitoes.

Many homeowners ask about the cost of rain gardens. Rain gardens can be inexpensive features in your landscape. Ask for help from family and friends in the installation of your rain garden - you can always help them build theirs, too! The main cost will be plants. Remember, rain gardens do not need to be crowded with plants, and many of the plants recommended in the following pages grow in a clumping style, which will fill in more each season.

In times of drought, your rain garden may need to be irrigated.

LANDFORM REGIONS OF SC



Landform regions of South Carolina and the soil characteristics within these different regions can serve as a guideline to plant suitability throughout the state. Use the two-letter abbreviation in the tables below to identify plants that may or may not readily grow in each region. In the tables below, "ALL" refers to plant appropriateness across the state. NA refers to information that was not available at the time of publication.

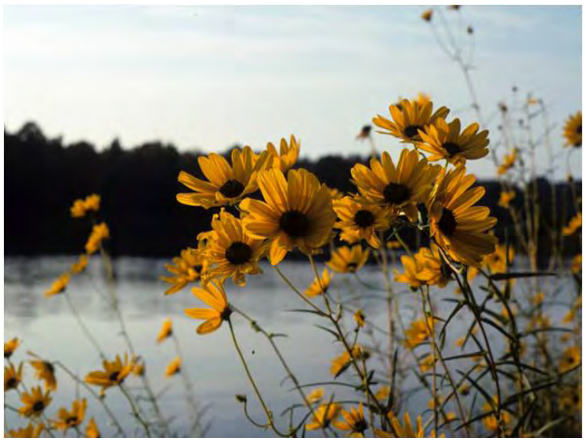
Polygonatum biflurom (Solomon's Seal)
Norman G. Flaigg, Lady Bird Johnson Wildflower Center

PERENNIALS & GRASSES

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
SH to CP	Native	*Aletris farinosa*	Unicorn Root	Yellow-green, grass-like leaves for 2-3.5', sturdy stem at top holds spike-like cluster of small white, urn-shaped flowers.
ALL	Native	*Andropogon gerardii*	Big Bluestem	Blue-green color, deep roots, drought-resistant, tawny color in fall; full sun; tall, reaching 6-8'.
ALL	Native	*Aquilegia canadensis*	Columbine	Erect branching perennial, up to 2' tall; showy flowers with yellow stamens; best in shade and well-drained soils; 3-5 year lifespan, but re-seeds easily.
CP and PD	Native	*Asclepias incarnata*	Swamp Milkweed	Pink bloom in mid-summer, valuable to butterflies; suitable for coast and piedmont; sun; 2-4' tall; small rose-purple flowers.
ALL	Native	*Asclepias tuberosa*	Butterfly Milkweed	Striking and rugged plant with orange flowers; attracts butterflies. Slow to establish; easy to grow from seed. Full sun and 2-3' tall.
NA	Native	*Aster novae-angliae*	New England Aster	Deep violet flowers in fall, fuzzy seedheads; drought-tolerant; can be 2-6' tall; may have 40 flowers at one time.
ALL	Native	*Athyrium filix-femina*	Lady Fern	18-36", yellow-green to medium-green fronds, part to full shade, clump-forming. Great in background and more moist areas of the rain garden. Should be watered under dry conditions.
CP and SH	Native	*Canna glauca*	Canna Lily	Grows approximately 3-4' high. Blooms from April through October in red, orange, and yellows. Very tropical looking.
ALL	Native	*Carex stricta*	Tussock Sedge	Clump-forming, grass-like, emergent plant; used by waterfowl.
ALL	Native	*Chasmanthium latifolium*	River Oats	Tolerates dry soils, shade; dangling oats are ornamental and copper in fall; clump forming.
ALL*	Native	*Chelone glabra*	White Turtlehead	Snapdragon-type white flowers, often lavendar-tinged. Robust perennial, 1-4' tall; attractive to hummingbirds and butterflies; suitable for piedmont; sun.

SC REGION	NATIVE TO SC?	LATIN NAME	COMMON NAME	PLANT CHARACTERISTICS
MT	Native	*Chelone lyonii*	Pink Turtlehead	Snapdragon-type pink flowers. Robust perennial, 1-4' tall; attractive to hummingbirds and butterflies; suitable for piedmont; sun.
MT	Native	*Dennstaedtia punctilobula*	Hayscented Fern	Spreads rapidly; fragrant foliage, light green turning yellow in fall.
PD and MT	Native	*Dryopteridaceae marginalis*	Evergreen Wood Fern	Grows to 36", full shade, bluish-green blades.
SH to CP	Native	*Eupatorium coelestinum*	Blue Mist Flower	Misty blue flowers; spreads quickly; tolerates many soils, especially suited to heavy textured and highly organic soils; salt-tolerant; up to 3' tall; full sun to part shade.
ALL	Native	*Eupatorium fistulosum*	Joe Pye Weed	Rapid growers can be 6' tall with wide heads of pink or purple flowers that attract butterflies; no salinity tolerance.
ALL	Native	*Geranium maculatum*	Spotted Geranium	Lavender to pink flowers; semi-evergreen, low fragrant foliage; 1-3' tall.
ALL	Native	*Helianthus angustifolius*	Swamp Sunflower, Narrowleaf Sunflower	Tall yellow daisies with maroon centers; good seed source; salt-tolerant.
ALL	Non-Native	*Hemerocallis spp. any hybrids*	Daylily	Many types of daylilies, and their colors and height vary. Require well-drained soil and 1" of water per week in summer months. Clump-forming and can be divided in spring and fall. Full sun.
SH to PD	Native	*Heuchera americana*	Alumroot, Coral bells	Semi-evergreen groundcover with wine color in winter; airy flowers.
NA	Native	*Hibiscus coccineus*	Scarlet Rosemallow; Texas Star Mallow	4-7' tall. Divided blooms greater than 6" in width, July through September. Full sun.
ALL	Native	*Hibiscus moscheutos*	Rose Mallow; Marsh mallow hibiscus	Shrubby and 3-8' tall, with huge white to pink flowers; can grow near water; salt-tolerant; numerous sturdy stems from a single crown. Strikingly showy.

LEFT: *Lobelia cardinalis* (Cardinal Flower), Joseph A. Marcus, Lady Bird Johnson Wildflower Center
BELOW: *Helianthus angustifolia* (Swamp Sunflower), Andy & Sally Wasowski, Lady Bird Johnson Wildflower Center



SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
CP and MT	Native	*Liatris spicata*	Gayfeather, Blazing Star	Easy to grow; spikes of lavender flowers, nectar and seed valuable; salt-tolerant; straight and slender perennial, reaching 3-4'. Tall spike of rayless, rose-purple flower heads.
ALL	Native	*Lobelia cardinalis*	Cardinal Flower	Brilliant red flower spikes, loved by butterfly and hummingbirds; sun to shade; 1-6'; showy red flowers in 8" terminal spikes.
ALL	Native	*Lobelia siphilitica*	Blue Lobelia	Bright blue flowers attractive to hummingbirds, sun to shade, 2-3' in height.
ALL	Native	*Lysimachia ciliata*	Fringed loosestrife	Yellow, erect to sprawling, sometimes branched perennial, usually 1-2' tall. Yellow flowers droop from stalks.
NA	Native	*Monarda didyma*	Beebalm	Fragrant foliage, red to purple flowers, hummingbirds and butterflies; dense, rounded clusters of flowers. 3' tall; leaves have a minty aroma; vigorously colonizes.
MT	Native	*Monarda fistulosa*	Wild Bergamot; Horsemint	Fragrant foliage, lavender flowers, hummingbirds and butterflies; sun to part shade; ensure good circulation to avoid mildew problems. Vigorously colonizes. 1-3' tall.
CP	Native	*Monarda punctata*	Spotted mint	Fragrant foliage, dusty pink flowers, attractive to hummingbirds and butterflies; salt-tolerant; ranges from 6" to 3' tall.
ALL	Native	*Onoclea cinnamomea*	Cinnamon Fern	3-4' tall. Part sun to shade. Ideal for back drop and more moist areas of the rain garden.
ALL	Native	*Onoclea sensibilis*	Sensitive Fern	Spreads easily; lush green, rusty-gold in fall, spore heads persist.
ALL	Native	*Osmunda regalis*	Royal Fern	Suitable for coast to mountains; 2-3' tall; part shade to shade.



ABOVE LEFT: *Geranium maculatum* (Spotted Geranium), William Justice, courtesy of Smithsonian Institution; ABOVE MIDDLE: *Veronia noveboracensis* (Ironweed), Stefan Bloodworth, Lady Bird Johnson Wildflower Center; ABOVE RIGHT: *Eupatorium coelestinum* (Mist-flower), William Justice, courtesy of Smithsonian Institution

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
ALL	Native	*Panicum virgatum*	Switch Grass	Very tolerant of flooding; fuzzy flower heads; good erosion control; suitable for coast to mountains; sun.
ALL	Native	*Physostegia virginiana*	Obedient Plant	Pink or purple spikes of tubular flowers; spreads rapidly in moist soils.
ALL	Native	*Polygonatum biflorum*	Great Solomon's Seal	Lily family; graceful arching stem, pendulous flowers (often hidden) greenish-white and bell-like; blue berries follow flowers; 1-3' full shade.
ALL	Native	*Rudbeckia laciniata*	Tall Coneflower; Cutleaf Coneflower	Great for stream banks; yellow daisies with green center; seed source.
ALL	Native	*Schizachyrium scoparium*	Little Bluestem	2-3' in height, clumping warm-season grass; full sun; attracts birds and mammals. Suitable for coast; ornamental, slender blue-green stems turn radiant mahogany-red with white shining seed tufts in the fall, color remains all winter.
CP and coastal zone	Native	*Solidago sempervirens*	Seaside Goldenrod	Yellow flowers in August through November; tight clump of narrow, evergreen basal leaves; 2-8' tall; dense flower heads.
ALL	Native	*Sorghastrum elliotti*	Slender Indiangrass	Evergreen grass with a green-white colouring year-round.
ALL	Native	*Tradescantia virginiana*	Virginia Spiderwort	Long-blooming with purple or white flowers, lightly fragrant; grass-like foliage; iris-like leaves can form larger colonies when in full sun.
ALL	Native	*Tridens flavus*	Purpletop	Clump-forming; full sun; 4' tall in flower.
ALL	Native	*Vernonia noveboracensis*	Ironweed	Tall red-purple flowers attract butterflies; tolerates inundation; clump forming, growing 5-8' in height. Deep green leaves and small flower heads occur in larger, loosely-branched clusters.

* Best documented in the Coastal Plain, though should thrive across the state.

SHRUBS

Cephalanthus occidentalis (Buttonbush) Jeff McMillan @ USDA-NRCS PLANTS Database

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
ALL	Native	*Aronia arbutifolia*	Chokeberry	Up to 8', medium shrub. Red berries persist in winter, scarlet fall color, bank stabilizer.
ALL	Native	*Baccharis halimifolia*	Groundsel Tree; Salt Myrtle	Up to 10'. Salt-tolerant, white flowers become fuzzy seed heads in fall; sun to shade.
ALL	Native	*Callicarpa americana*	Beautyberry	Up to 6'. Striking purple berries on new growth, yellow fall color, sun to part shade; well-suited for mountains.
ALL	Native	*Cephalanthus occidentalis*	Buttonbush	Up to 8'. Tolerates flooding, white button flowers persist, attracts hummingbirds; salt-tolerant.
ALL	Native	*Clethra alnifolia*	Summersweet, Sweet Pepperbush	Up to 8'. Extremely fragrant white or pink flowers in summer, yellow in fall; salt-tolerant.
ALL	Native	*Hypericum prolificum*	Shrubby St. John's Wort	Small shrub with yellow flowers; sun to part shade; place on upper edges of rain garden in drier areas.
PD	Native	*Ilex decidua*	Possumhaw	Up to 15', deciduous, red to yellow berries persist through winter; attracts birds; suitable for coast.
MT and PD	Native	*Ilex glabra*	Inkberry Holly	Medium shrub, 6-8'; white flowers, black berries; sun to shade.
ALL	Native	*Ilex verticillata*	Winterberry Holly	Medium shrub, 6-10'; white flowers with red berries; sun to part shade; well-suited for mountains.
ALL	Native	*Ilex vomitoria*	Yaupon Holly	Up to 20'. White flowers, red berries, long lasting translucent scarlet berries, many cultivars, evergreen; full sun to part shade; suitable for coast.
ALL	Non-Native	*Indigofera amblyantha*	Pink Indigo Bush	4-6' tall. Pink flowers with seed pod; full sun to part shade.
ALL	Native	*Itea virginica*	Virginia Sweetspire	Medium shrub. Fragrant white tassel flowers, deep red or purple fall foliage; sun to shade; well-suited for piedmont.
PD	Native	*Lindera benzoin*	Spicebush	Up to 8'. Very early chartreuse flowers, fragrant leaves, pale yellow fall color; part shade to shade; suitable for coast.

SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
PD to CP	Native	*Myrica cerifera*	Waxmyrtle	15-20'. Fragrant evergreen leaves, berries for candles, can prune as hedge; sun to part shade.
SH	Native	*Philadelphus inodorus*	Mock Orange	6-12' globular shrub with upright branching. Older bark is orange-brown and exfoliating. Large, white, sweet scented flowers.
PD to MT	Native	*Rhododendron maximum*	Rosebay Rhododenron; great laurel	Large shrub. Found in northwest corner of SC in piedmont and mountains; evergreen, thicket-forming shrub or tree with short, crooked trunk, large white blossoms; largest leaves of all rhododendrons, also one of the hardiest.
ALL	Native	*Rhododendron viscosum*	Swamp Azalea	Up to 6'. Very sweet fragrant white flowers in summer; part shade.
PD, SH, southern CP	Native	*Rosa carolina*	Carolina Rose	Small shrub; pink to white flowers, red hip; full sun.
SH to CP	Native	*Sabal minor*	Dwarf Palmetto	Up to 5'. Native palm that slowly spreads; black berries; drought-tolerant; suitable for coast.
ALL	Native	*Sambucus canadensis*	Elderberry	Up to 10'. Large white flowers and edible purple berries, fast growing thickets (new growth of American elder can be fatal to livestock).
SH to CP	Native	*Serenoa repens*	Saw Palmetto	5-12' tall. White flowers, purplish-black drupe; sun to part shade.
MT to PD	Native	*Vaccinium corymbosum*	Highbush Blueberry	5-12' tall. White to pink flowers, blue berry; sun to part shade; salt-tolerant.
CP	Native	*Viburnum dentatum*	Arrowwood	Up to 10'. White flowers, bright blue berry clusters, very tolerant of many soils.

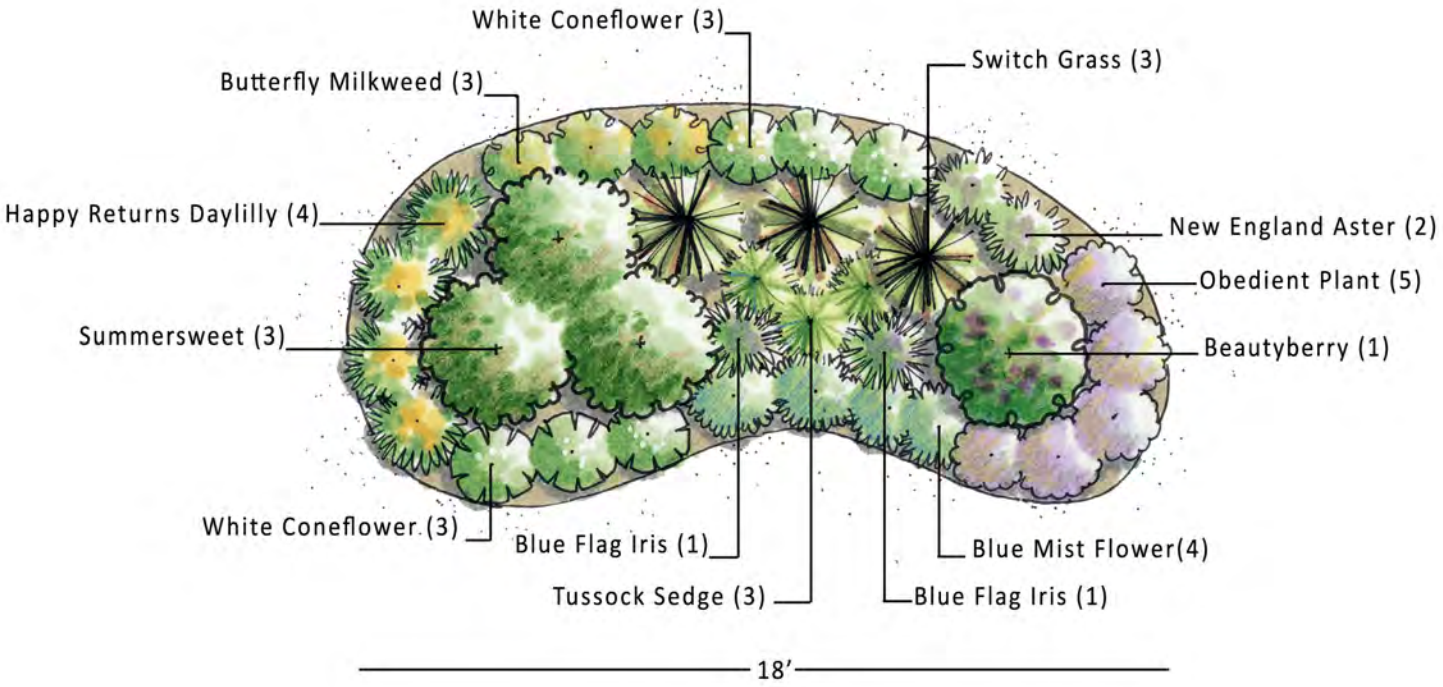
ABOVE:
Ilex vomitoria (Yaupon Holly)
Joseph A. Marcus, Lady Bird Johnson Wildflower Center
LEFT:
Calicarpa americana (Beautyberry)

TREES

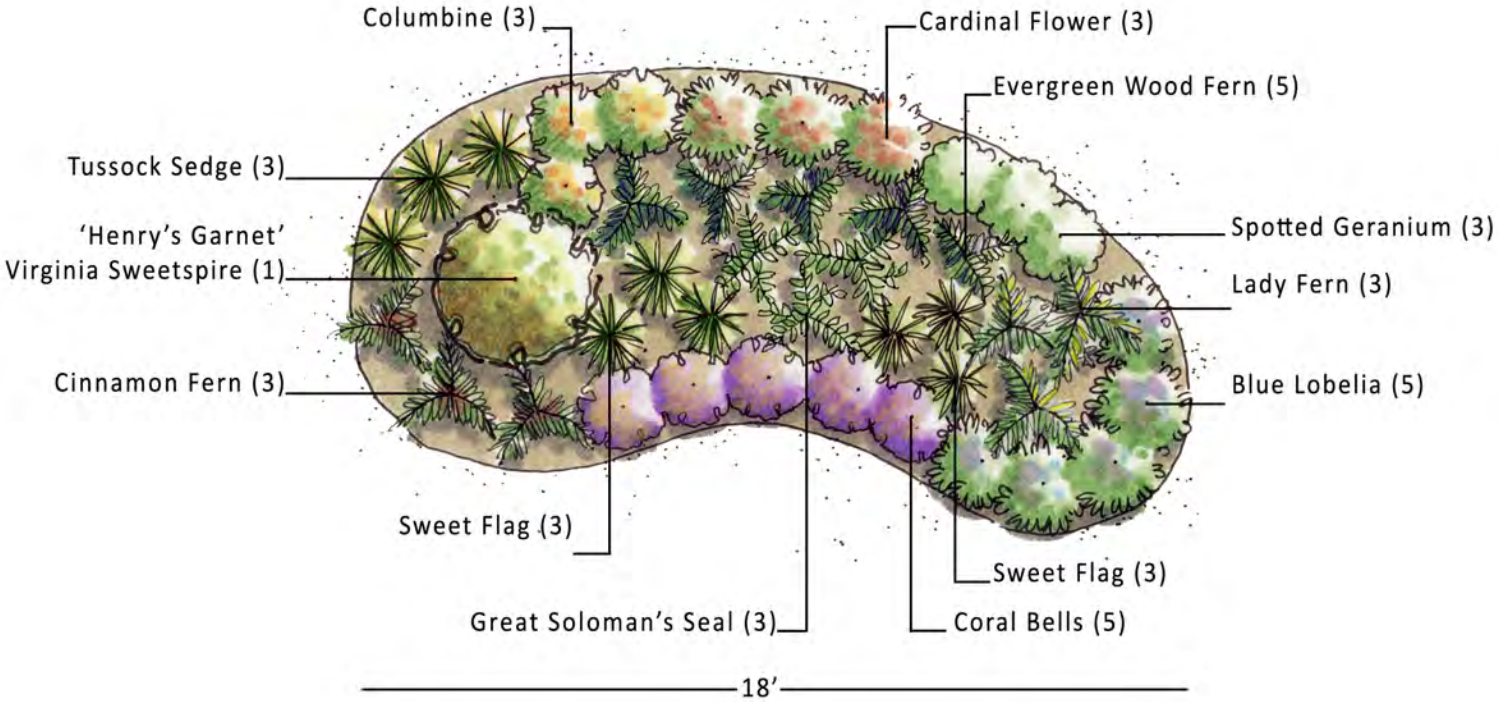
SC REGION	NATIVE TO SC?	SCIENTIFIC NAME	COMMON NAME	PLANT CHARACTERISTICS
ALL	Native	*Amelanchier canadensis*	Serviceberry	Up to 15’. Multi-stem grey bark, white flowers, early purple berries, red in fall; salt-tolerant.
ALL	Native	*Betula nigra*	River Birch	Up to 50’. Good bank stabilizer, beautiful peeling bark, yellow fall color; salt-tolerant.
ALL	Native	*Carpinus caroliniana*	American Hornbeam	Up to 30'. Shade-tolerant, takes inundation, unique silver fluted trunk.
ALL	Native	*Celtis occidentalis*	Hackberry	Up to 40’. Tolerates poor soils and salt, excellent stabilizer, yellow fall color.
ALL	Native	*Chamaecyparis thyoides*	Atlantic White Cedar	Up to 40-50'. Full sun; red or yellow (male) or green (female) flowers; coastal habitat is suitable, though adaptable across the state.
ALL	Native	*Chionanthus virginicus*	Fringetree	Up to 20’. Can be shrubby; fragrant pendulous white flowers and gold fall color.
ALL	Native	*Cornus florida*	Flowering Dogwood	Height is 20-40'. Single or multi-trunked tree with spreading crown and long-lasting white and pink spring blooms. Red fruits and scarlet autumn foliage.
ALL	Native	*Crataegus aestivalis*	Mayhaw, May Hawthorn	Up to 20’. Thorns attractive to nesting birds, red fruit, purple to scarlet in fall.
ALL	Native	*Ilex opaca*	American Holly	Up to 40-50'. Sun to shade; evergreen, slow growing, ornamental red berries on female plants, white flowers.
ALL	Native	*Magnolia virginiana*	Sweetbay Magnolia	Up to 20’. Semi-evergreen, fragrant flowers, bright red berries, often multi-stem; sun to part shade.
ALL	Native	*Nyssa sylvatica*	Black Gum, Black Tupelo	Up to 30-50'. Tolerates flooding or dry rocky uplands, spectacular scarlet in fall; sun to part shade; suitable for coast.
NA	Native	*Sassafras albidum*	Sassafras	Up to 30-60';. Full sun to part shade; yellow flowers, attracts birds.

SAMPLE RAIN GARDEN DESIGNS

FULL SUN RAIN GARDEN

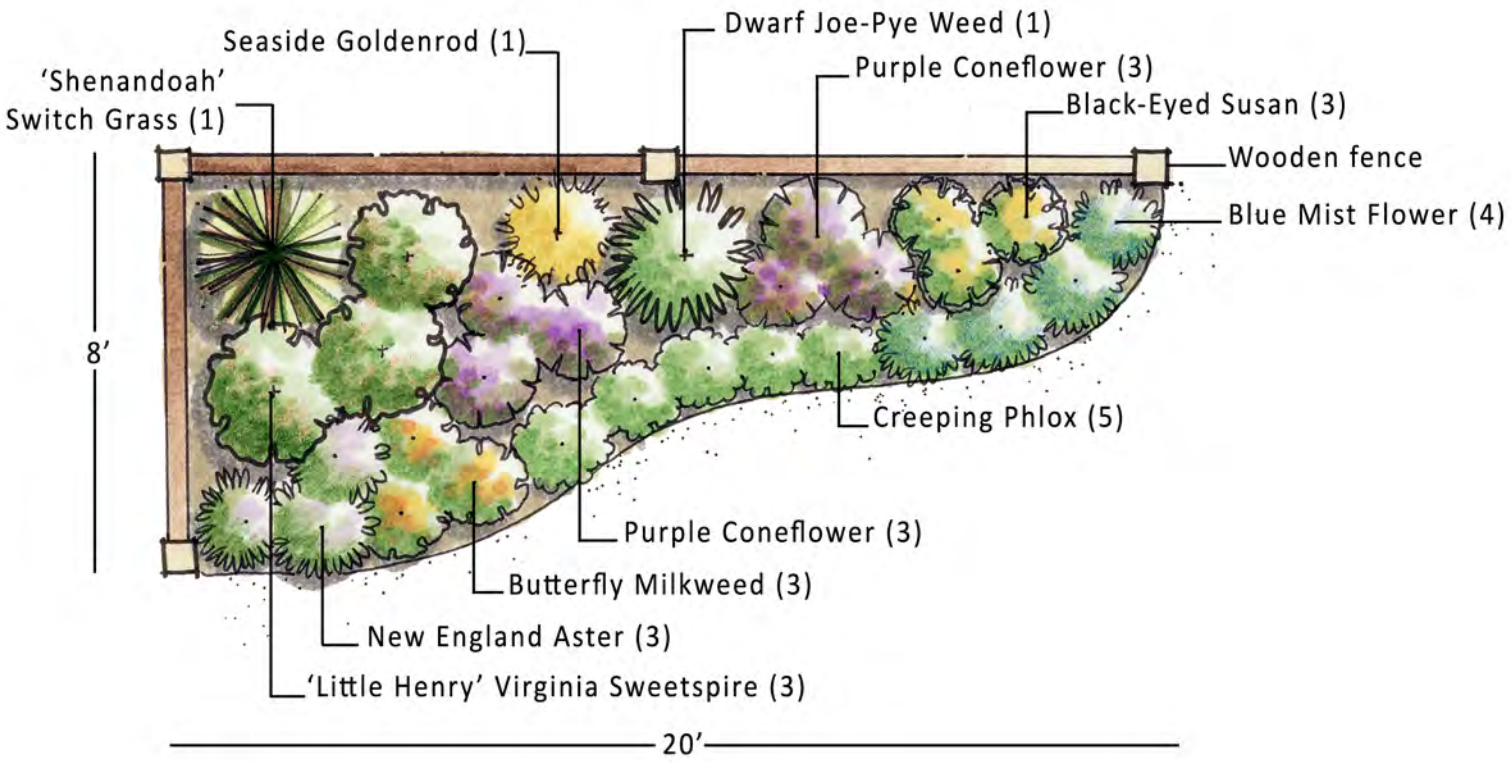


WOODLAND RAIN GARDEN



Rain Garden Illustrations by Renee Byrd

BUTTERFLY BORDER RAIN GARDEN



Rain Garden Illustrations by Renee Byrd

HOW MUCH MULCH DO I NEED?

To calculate the total cubic yards of mulch needed for your rain garden project, follow these steps:

1. Multiply the length of your rain garden by the width to find the square footage.
2. Multiply that square footage by 0.25, which will equate to 3 inches of mulch.
3. Divide that value by 27 to yield cubic yards of mulch needed for your project.

The table to the right can be used to quickly estimate the necessary amount of mulch to purchase based on various depths of mulch.

Remember not to pile mulch alongside the stem of plants. Mulch is moist and can lead to rotting around the stem.

Also, remember to break up any mulch that may be dry or clumped together as you spread it over your rain garden.

Cubic Yards of Mulch	Rain Garden Square Feet and Mulch Coverage based on Depth		
	1"	2"	3"
1	338 sq. ft.	158 sq. ft.	108 sq. ft.
2	676 sq. ft.	316 sq. ft.	216 sq. ft.
3	1014 sq. ft.	474 sq. ft.	324 sq. ft.
4	1352 sq. ft.	632 sq. ft.	432 sq. ft.
5	1690 sq. ft.	790 sq. ft.	540 sq. ft.
6	2028 sq. ft.	948 sq. ft.	648 sq. ft.
7	2366 sq. ft.	1106 sq. ft.	756 sq. ft.
8	2704 sq. ft.	1264 sq. ft.	864 sq. ft.
9	3042 sq. ft.	1422 sq. ft.	972 sq. ft.
10	3380 sq. ft.	1580 sq. ft.	1080 sq. ft.
11	3718 sq. ft.	1738 sq. ft.	1188 sq. ft.
12	4056 sq. ft.	1896 sq. ft.	1296 sq. ft.

* Using the table above, 1 cubic yard of mulch will cover 108 sq. ft. with 3" of mulch.

ADDITIONAL RESOURCES

More information about stormwater and Clemson University's involvement in stormwater education in South Carolina can be found online at www.clemson.edu/carolinaclear.

Your local cooperative extension office can also provide important soil sample, plant and pest information. To find the contact information for your local extension office, check www.clemson.edu/extension.

For information on suppliers of native plants in South Carolina, please consult the South Carolina Native Plant Society website at www.scnps.org.

Documents and websites consulted in the development of this document include the USDA PLANTS Database (http://plants.usda.gov); Lady Bird Johnson Wildflower Center (www.wildflower.org); *Rain Gardens* tri-fold brochure (Hitchcock, 2008); *Designing Rain Gardens (Bio-Retention Areas)* (Hunt and White, 2001); *Rain Gardens: A How-To Manual for Homeowners* (Bannerman and Considine, 2003).

AUTHOR AND ACKNOWLEDGEMENTS

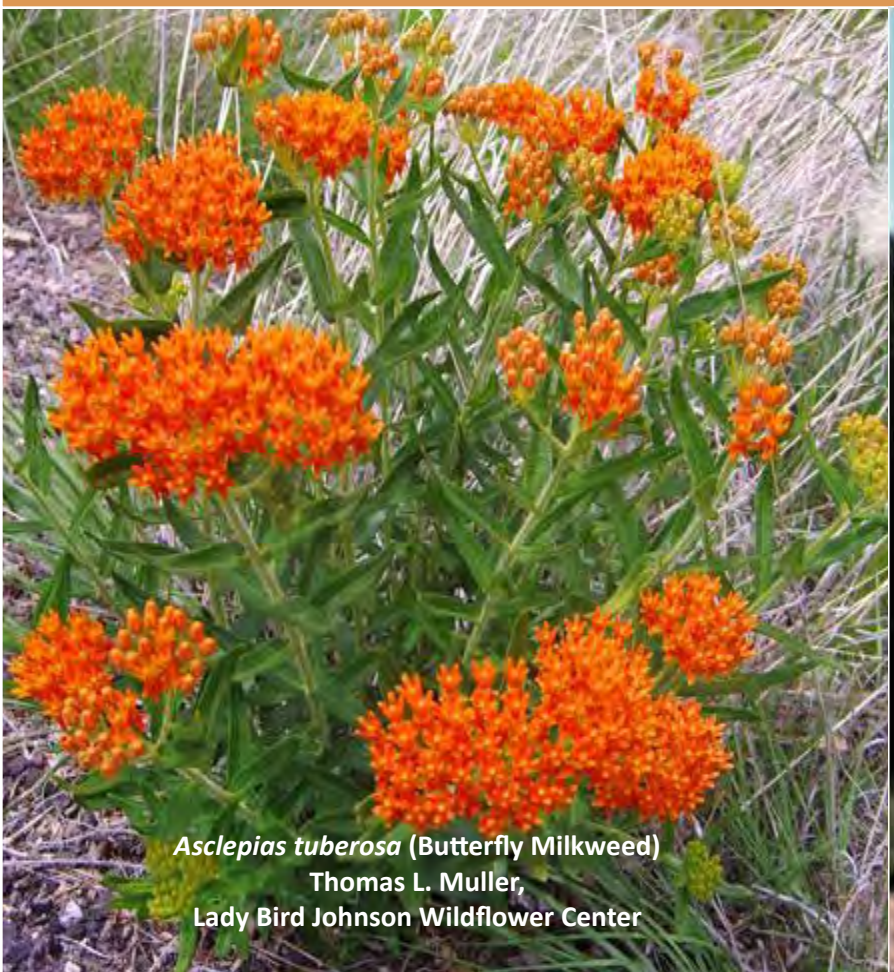
Written and Designed by
Clemson University
Public Service Activities
Carolina Clear
Katie Giacalone

The following people are greatly appreciated for their contribution to this South Carolina rain garden manual:

Contributors
Cal Sawyer, Clemson University Center for Watershed Excellence; Bill Blackston, Clemson Cooperative Extension Service

Plant Lists
Gary Forrester, Clemson Cooperative Extension Service; Betsy Kaemmerlen, Fuss & O'Neill; Bob Polomski, Clemson Cooperative Extension Service; Bill Stringer, Clemson University and President of the South Carolina Native Plant Society; Lisa Wagner, Clemson University, South Carolina Botanical Garden

Rain Garden Drawings
Renee Byrd, Clemson University Department of Horticulture, The Cliffs Communities Botanical Garden



Asclepias tuberosa **(Butterfly Milkweed)**
Thomas L. Muller,
Lady Bird Johnson Wildflower Center

Panicum virgatum **(Switch Grass)**
Andy & Sally Wasowski,
Lady Bird Johnson Wildflower Center

Use this space for your planting design and notes. You may want to include a scale bar and direction of morning and afternoon sun.