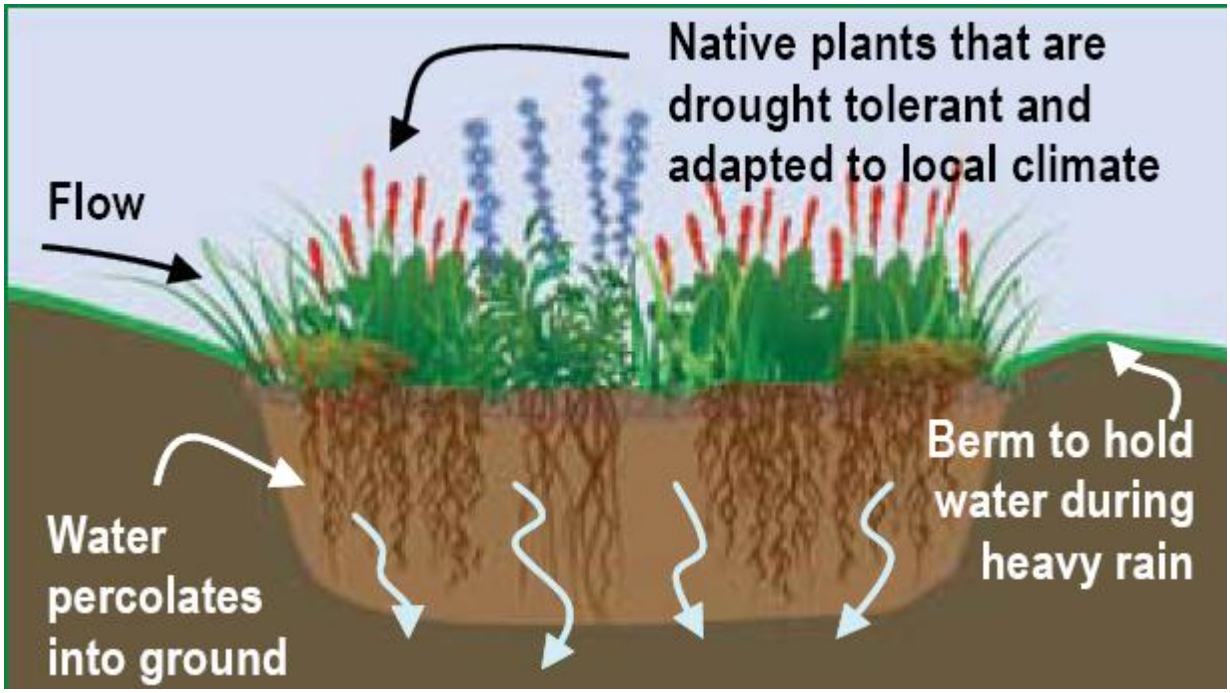
RAIN GARDEN MANUAL FOR SCHOOLS

A HOW-TO MANUAL FOR FAYETTE COUNTY PUBLIC SCHOOLS



It's about kids.
FAYETTE COUNTY PUBLIC SCHOOLS

APPLICATION

School Name: _____

School Address & Phone Number: _____

Rain Garden Primary Contact: _____

Primary Contact Phone Number: _____

Class/group/organization who will take primary ownership of garden: _____

Step 1: Contact Tresine Logsdon at tresine.logsdon@fayette.kyschools.us to get a map of underground utilities and schedule a short rain garden lesson for students.

Step 2: Determine how and where storm water flows on your campus. To do this, schedule a time for your Bluegrass Pride environmental educator to conduct a 55 minute *Storm Water Mapping Activity* (Appendix I) with students who will be the primary custodians of the design, build and maintenance of the rain garden. As a result of this lesson, students will develop a storm water map of their campus. This should be kept on file with other rain garden documents.

Step 3: Based on storm water map, conduct a *Percolation Test* (Appendix II) to determine a suitable location. Keep data on file.

Step 4: Conduct *Sizing a Rain Garden* activity (Appendix III) and use *Rain Garden Species Selection Activity* (Appendix IV) to determine the dimensions of your rain garden. Keep data on file.

Step 5: Draw a scaled diagram of your rain garden to include dimensions and plant number/species. Keep diagram on file.

Step 6: Schedule a site visit with Kelly Breeding to review activity results/map and acquire final approval for your rain garden.

Step 7: Read over this manual carefully to understand the many benefits of your rain garden, required maintenance to ensure longevity and health of your rain garden, design instructions, funding options and core content-based lesson plans to help you convert your campus rain garden into an engaging learning tool.

Step 8: When your rain garden is planted, go to www.bluegrassraingardenalliance.org to register your rain garden with Bluegrass Rain Garden Alliance. Once registered, your school will receive a Bluegrass Rain Garden Alliance sign to post in your garden.

X _____

Teacher Primary Contact

X _____

Principal

TABLE OF CONTENTS

I. Contacts

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I. What Is a Rain Garden?

The Price of Urbanization

In developed areas, roofs, pavement, and other impervious surfaces prevent stormwater from soaking into the ground. Instead, it runs over the land surface and directly into small tributaries and larger streams. Unable to handle the increased water volume and flow, these waterbodies often experience eroded banks, incised channels, loss of habitat and aquatic life, and increased flooding and property damage. In addition, stormwater can carry a broad mix of toxic chemicals, bacteria, sediments, fertilizers, oil and grease to nearby waterbodies.

Retaining as much stormwater as possible on the land - rather than letting it run into storm drains - can help keep harmful flows and pollutants out of our streams and rivers. Rain gardens are one crucial tool to deal with the stormwater runoff problem.

- EPA. "Stormwater Management at EPA Headquarters."

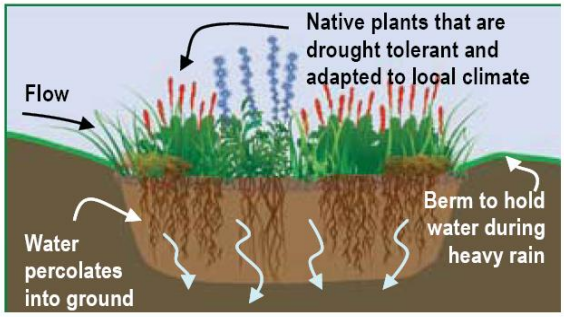
During rainfall events, rooftops, driveways, and yards collect rainwater (shown left). This water gathers polluants and turns into stormwater runoff. Eventually it enters stormwater drains & flows untreated into Lexington's streams and waterways, impacting the stream quality & local wildlife.

Courtesy of Tetra Tech

from the Rooftop . . .

A rain garden is a shallow depression that captures and treats runoff from impervious surfaces, such as rooftops, patios, driveways, and parking lots, before it enters the stormwater system. Rain gardens can be customized for your individual needs, limited only by the resources and time you want to put into them. They use natural processes to improve water quality by filtering pollutants and reducing the amount of stormwater runoff. The water easily infiltrates into the soil because of the deep roots of native plants, where it is filtered of pollutants and recharges the groundwater supply.

In an urban environment, this restored water table and added vegetation helps to reduce the Urban Heat Island Effect, a phenomenon that causes temperatures to be up to 5 °F warmer in urban settings. Additionally, these processes improve water quality before it enters Lexington's streams and waterways, promoting diverse ecosystems and a beautiful community.



Construct your rain garden at least 10 feet from the base of your house to prevent water from seeping into the foundation!

Courtesy of Tetra Tech

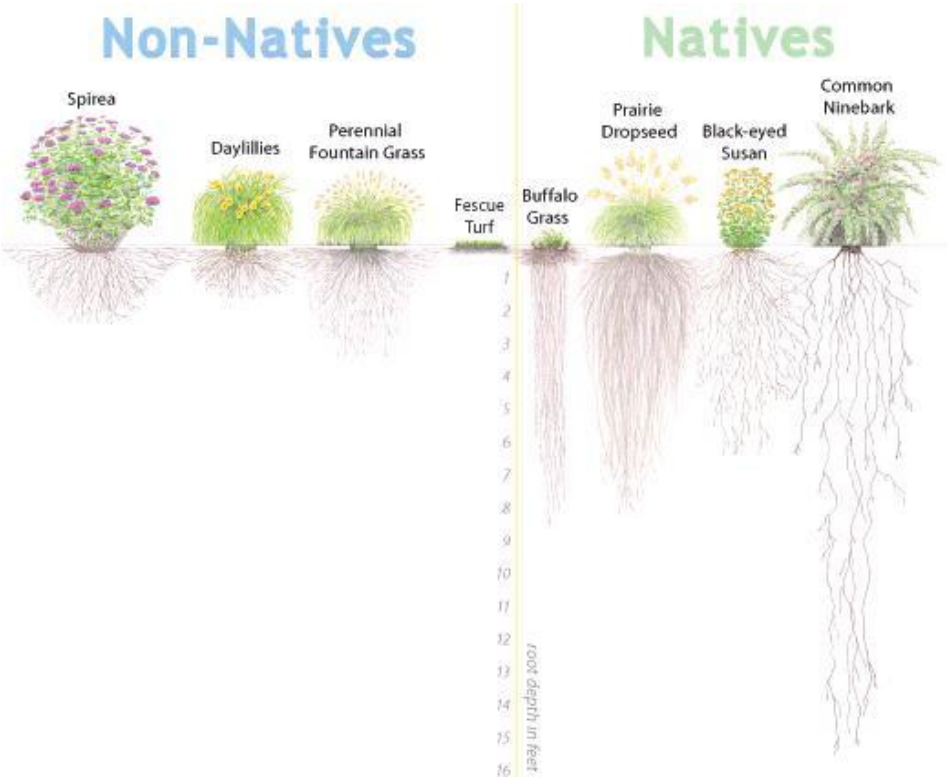
. . . to the Rain Garden!

By capturing clean rainwater from your roof, driveway and sidewalks and diverting it into a great looking rain garden where it can **slowly soak into the ground**, **filter contaminants** and **keep quantities of clean water from going down the sewer system** you'll have a great looking garden that puts water in its place.

A rain garden can mimic the natural absorption and pollutant removal activities of a forest, or a meadow or or a prairie and can absorb runoff more efficiently, sometimes as much as 30% - 40% more then a standard lawn. Capturing rainwater in a rain garden, holding the water for a short time and then slowly releasing it into the soil can reduce the rush of a large storm – quickly, neatly and naturally.

Because rain gardens are dug 4" to 8" deep, and in some cases 1' - 2' deep, they hold larger quantities of rainwater making their overall construction more cost efficient then other green alternatives. Rain gardens also need less technical experience to install and can be installed without permits or heavy equipment.

Rain gardens are one very good option that helps to lower the impact of impervious surfaces and polluted runoff because they are low-tech, inexpensive, sustainable and esthetically beautiful.



Native plants are ideal for rain gardens for many reasons. Because they have adapted Kentucky's climate over millions of years, they don't need chemicals to help them grow, they can tolerate our cold winters and hot summers winter, they have very deep roots which allow them to be more drought resistant, they have developed defenses against harmful native insects, and can serve as habitats for native wildlife (consider planting for butterflies, hummingbirds, or songbirds!). The deep roots of native plants also makes them ideal for rain gardens because they create channels in the soil which allow water to soak in quickly (see diagram on left to compare the root depths of some native vs. non-native species).

II. What Are the Benefits of a Rain Garden?

You know how precious freshwater is to life. You probably also know that freshwater is becoming increasingly scarce due to pollution, misuse, overuse and climate change.

So when someone asks you **"why plant a rain garden?"** you can tell them that you are doing it to help keep clean, fresh rainwater out of the sewer system and you are doing your part to reduce pollution and preserve our water systems.

This sounds like a grand effort that only scientists, ecologists and politicians can do. But you can plant a rain garden and then spread the word and tell others that you plant native plants and rain gardens to improve the world you live in.

Explain to people who question you how rain and melting snow runs off roofs, driveways and even lawns and flows directly to the street, down the storm drain and right to our rivers and lakes. Tell them that this runoff is untreated and carries with it pollutants like oil, salt, fertilizer, pesticides, pet waste, transportation chemicals, sediment and all sorts of other things that shouldn't be in our freshwater.

Tell them that a rain garden can capture that runoff and hold not only thousands of gallons of rainwater that can be used in your own garden and yard but all of these pollutants that contaminate our waterways. Then explain after the capture of the water comes the soaking or infiltrating of the water deep into the ground so that it can be used by the nearby plants and trees. Tell them how the native plants planted in the rain garden also help to soak up the water and how the roots are deep and will break up hard soil and infiltrate water and nutrients deep into the soil.

Then finally, tell them how the plants, mulch and soil break up the pollutants and make them *inert*, not harmful. Explain how the moderate amounts of water and limited amounts of pollutants people shed from their personal property can easily be handled by the rain garden. And that these same pollutants will cause havoc if combined with pollution from your neighbors on your block and the next block and the neighborhood and the community. Imagine all the pollutants from a whole city moving, untreated into your rivers, lakes and streams that you might be drinking!!!!

Oh, ya, you can also explain that a rain garden is beautiful, creates habitat for birds and beneficial insects, reduces pest and harmful insects, makes a great statement in your yard and can be used seasonally to teach kids and adults about the nature of nature.

Main purposes and benefits of constructing and maintaining rain gardens:

A. Retain, delay, and reduce storm-water runoff (possibly gain regulatory benefits)
    1. Recharge groundwater and reduce surface-channel erosion downstream
    2. Improve local stream base flow, as replenished from groundwater percolation
B. Buffer and absorb nutrients and contaminants carried in first flush of runoff (bio-retention)
    1. Filter sediment
    2. Degrade waterborne pathogens
C. Expand diversity of native herbaceous species used as vegetative cover in basin
    1. Support pollinators (insects and hummingbirds)
    2. Expand natural beauty and aesthetics
    3. Learn to appreciate natural texture and form of herbaceous plants as supplementing turf
    4. Restore and maintain rare species

5. Advance grass-roots sustainable action of community
6. Develop plant and seed source for new rain gardens and natural areas

Potential benefit in karst area (limestone bedrock):

Amended soil cell intercepts, slows, and distributes water leakage/recharge to natural subsoil. This reduces concentrated runoff, which can trigger soil-collapse sinkholes. Rain gardens may serve as a Best Management Practice (BMP) in karst landscapes such as the Inner Blugrass.

Benefits of a Rain Garden

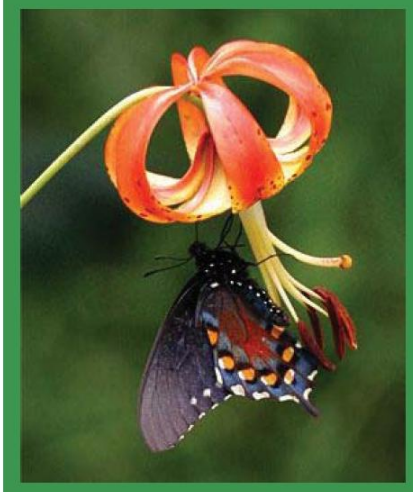
A rain garden has many benefits:

- Significantly filters and reduces runoff before it enters local waterways and groundwater
- Decreases drainage problems and localized flooding
- Conserves water and reduces pollution
- Attracts birds, bees, and butterflies
- Recharges the groundwater supply
- Is a Best Management Practice (BMP) to improve Lexington's water quality

Bring on the Butterflies!

Rain gardens not only look beautiful, but create a habitat for local wildlife, such as butterflies, dragonflies, and birds!

Purple Coneflower (Echinacea purpurea)
Courtesy of Lucinda Reynolds
Mountain Home, Arkansas



Turk's-cap Lily (Lilium superbum)
Courtesy of Thomas G. Barnes
University of Kentucky, © 2006

Purple Stem Aster
(Aster puniceus)

IV. Rain Garden Design & Maintenance

It is extremely important that students be actively engaged and involved in the planning, design, building and maintenance of your campus rain garden and that your school have a long-term plan for which group, team or grade will take ownership of the garden.

Design Steps

- ✓ Complete *Storm Water Mapping* activity with students (Appendix I)
- ✓ Complete *Percolation Test* with students (Appendix II)
- ✓ Complete *Sizing A Rain Garden* activity with students (Appendix III)
- ✓ Complete *Species Selection* activity with students (Appendix IV)
- ✓ **Complete *Designing a Rain Garden* activity with students (Appendix V)**

Rain-garden design and maintenance:

A. Do not locate rain-garden within high-gradient swales and channels
B. When necessary, use off-line design with high-flow bypass and construct under-drain piping
C. Remove accumulated waterborne trash and debris as needed
D. Maintain design records and plant species list; specify inspection personnel and schedule
E. Recognize and remove non-native invasive species, such as Johnson Grass, Poison Hemlock, Queen Ann's Lace, Teasel, Fescue, etc.
    *Need a flip chart of common KY invasive plants and weeds? Contact tresine.logsdon@fayette.kyschools.us for one.
F. Remove woody plants (trees) and vines, which can dominate and shade herbaceous growth

Layout & Construction

1 Preparing the Site

Outline the perimeter of the rain garden with spray paint or a garden hose. Stay at least 10 feet away from the building's foundation and avoid septic systems and utility lines. Think about where the water will flow in and where it will overflow out. The longer side of the garden should face up-slope to allow for the garden to catch as much water as possible. The rain garden should be about twice as long as it is wide.

2 Digging & Leveling

- Make sure your rain garden is level so that any water spreads out evenly over the bottom surface.
- When the rain garden is excavated to the appropriate depth, lay a board in the rain garden with a carpenter's level on it. Correct the spots that aren't level by adding soil to the low places and by removing soil from the high places. Move the board to different positions throughout the rain garden, filling and digging as necessary to level the bottom of the garden.
- Once level, till the bottom of the rain garden up to 1' to break up the soil, adding soil amendments as desired. Take care to avoid disturbing the root systems of trees.
- Use the excavated soil to form a berm on the downslope side of the rain garden. The berm will need to be compacted and either planted with grass or incorporated into the planting plan of the rain garden.
- Shape the berm to that it ties back into the existing landscape and rake the entire rain garden so that it is ready for planting.
- Consider including a spillway, or notch, in the berm to provide an overflow path for water during larger rainfall events.

Make sure your rain garden bed is as flat as possible. If you wish, apply grass seed or additional drought-tolerant flowers to cover and stabilize the berm.

3 Planting & Plant Layout

- When choosing native plants for the garden, be sure to consider plant height, bloom time, color, and texture. Use plants that bloom at different times to create a long flowering season. Mix heights, shapes, and textures to give the garden depth and dimension. This will keep the rain garden looking interesting even when few wildflowers are in bloom.
- Place plants in pots on the bed, according to your design. After determining the plant layout, gently remove plants from the pot, break up the roots, and plant.
- Plants that like wetter conditions should go in the deeper part of your rain garden. Those that can tolerate drier conditions should go along the edge or on top of the berm.
- Add mulch around 2" deep to hold moisture, prevent erosion and add aesthetic interest to your rain garden (Do not mulch around Lobelias and Cardinals flowers, as it will rot their root crown).

When planting, dig holes twice as wide as the root ball and deep enough to keep the crown of the young plant level with the existing grade.

cdpengineers

Courtesy of UIS Prairie Restoration Project

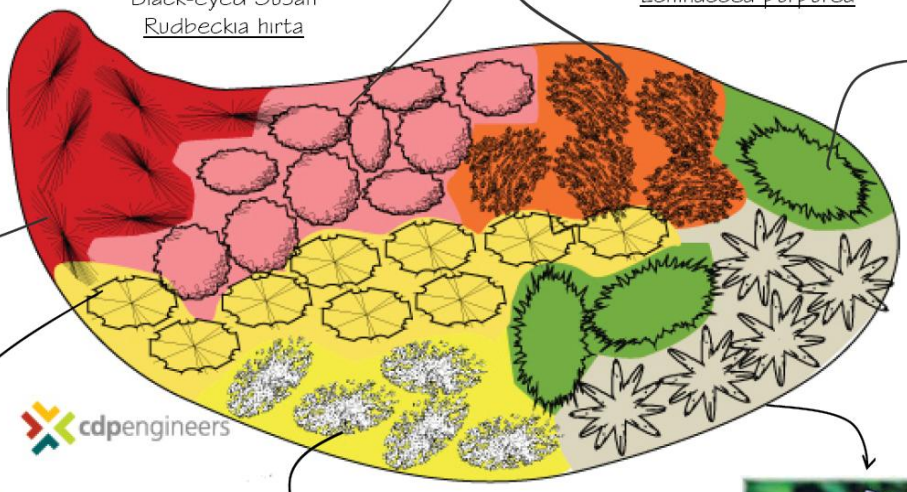
Little Bluestem
Schizachyrium scoparium

Courtesy of Stephanie Cutler

Black-eyed Susan
Rudbeckia hirta

Purple Coneflower
Echinaccea purpurea

Cardinal Flower
Lobelia cardinalis



Courtesy of University of Wisconsin-Madison Arboretum © 2004 - 2007

New England Aster
Aster novae-angliae

Courtesy of Wildflower Farm Inc. www.wildflowerfarm.com © 1999 - 2007 All Rights Reserved

Lanceleaf Coreopsis
Coreopsis lanceolata

Courtesy of Gerald D. Tang © 1990 - 2007 All Rights Reserved

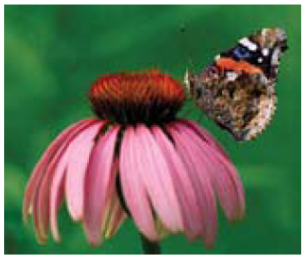
Blue Flag Iris
Iris versicolor

When planting flowers, plant in odd numbers - 3,5,7, etc. - to create a more aesthetically pleasing result!

Choosing Your Plants

Be sure to contact Salato Wildlife Education Center for **25 free native plants**: 1-800-858-1549. Plants above the free 25 can be purchased at a competitive price from Salato's Native Plant Specialist.

Use the table below to start thinking about what KY native plants you would like to use for your rain garden. For a more extensive list of native plants to use in your rain garden, go to www.naturepreserves.ky.gov or see the Rain Garden Species List (Appendix VII).



Courtesy of Thomas G. Barnes University of Kentucky, © 2006

Purple Coneflower
Echinacea purpurea

Courtesy of Thomas G. Barnes University of Kentucky, © 2006

Columbine
Aquilegia canadensis

Courtesy of Thomas G. Barnes University of Kentucky, © 2006

Spiked Blazing Star
Liatris specata

Plant	Sun/Shade*	Moisture	Color	Height	Bloom Period
Flowers					
Aromatic Aster *Aster oblongifolius*	☀ ⛅	dry to average	blue/purple	1 - 3 ft.	Sept - Oct
Blue Flag Iris *Iris versicolor*	☀ ⛅	wet	blue	2 - 3 ft.	June - July
Black Eyed Susan *Rudbeckia hirta*	☀ ⛅	dry to moist	yellow	1 - 3 ft.	June - Sept
Cardinal Flower *Lobelia siphilitica*	☀ ⛅	wet to moist	red	2 - 4 ft.	Aug - Oct
Columbine *Aquilegia canadensis*	☀ ☁	dry to medium	red/yellow	1 - 3 ft.	May - June
Daylilies *Hemerocalis spp.*	☀ ⛅	moist to dry	various	1 - 3 ft.	May - Aug
Dense Blazing Star *Liatris spicata*	☀	medium to moist	purple/pink	3 - 6 ft.	Aug - Sept
Great Blue Lobelia *Lobelia siphilitica*	☀ ⛅	wet to moist	blue/purple	1 - 3 ft.	Sept - Oct
Lanceleaf Coreopsis *Coreopsis lanceolata*	☀	dry to medium	yellow	1 - 2 ft.	June - July
Marsh (Spiked) Blazing Star *Liatris spicata*	☀ ⛅	wet to moist	purple	3 - 6 ft.	Aug - Sept
Mistflower *Eupatorium coelestinum*	☀ ⛅	medium to moist	blue/purple	1 - 3 ft.	July - Oct
Purple Coneflower *Echinacea purpurea*	☀ ⛅	moist to dry	purple	2 - 4 ft.	June - Aug
Wild Bleeding Heart *Dicentra eximia*	⛅ ☁	medium to moist	pink	1 - 2 ft.	June - July
Grasses & Sedges					
Fox Sedge *Carex culpinoidea*	☀ ⛅	saturated to wet	green leaves, brown in fall	2 - 3 ft.	May - July
Little Bluestem *Schizachyrium scoparium*	☀ ⛅	average to dry	green leaves	2 - 4 ft.	Aug
Shrubs					
Red-twigged Dogwood *Cornus sericea*	☀ ⛅	wet to dry	white flower, red bark	6 - 12 ft.	May - June
Blueberries, high bush var. *Vaccinium spp.*	☀ ⛅	moist	fruit, red fall foliage	4 - 6 ft.	June - Aug
Black Chokeberry *Aronia melanocarpa*	☀ ⛅	moist to dry	white flowers, red fall foliage	3 - 6 ft.	May

* ☀ Full Sun ⛅ Partial Shade ☁ Full Shade

Rain Garden Maintenance

- ✓ Review & complete *Rain Garden Maintenance* activity with students (Appendix VI)

It is critical that a group of students at your school have proud ownership of your campus rain garden, i.e. Ms. Thompson's 5th grade class, Ms. Lawson's 7th grade science classes, Mr. Smith's Earth Science class or the Go Green/Environmental Club.

All gardens need some maintenance; Rain Gardens are no exception! However, after the first season the maintenance of a rain garden is typically much less than a vegetable or flower garden. Why? Because the native plants that you plant have been evolving to KY's climate for hundreds of years and know what to expect.

Watering

- ✓ Right after planting
- ✓ During the first growing season
- ✓ During droughts after the first growing season

Mulching

Mulching is an important part of rain garden maintenance. Mulch keeps the soil moist, allowing for easy infiltration of rain water. Un-mulched surfaces may develop into a hardpan, a condition in which the soil surface becomes cemented together, forming a hard, impervious layer. Mulching also protects plants and reduces weed growth. Each spring, rain gardens should be re-mulched with 2-3 inches of hardwood mulch.

- ✓ **Add mulch annually**
- ✓ **Take care not to bury plants**
- ✓ **Prevents hardpan**
- ✓ **Soaks up pollution**

Weeding

Depending on the selected garden design, there will be varying degrees of weeding and pruning involved. It is important to weed regularly during plant establishment, as newly planted species may have a tough time competing with weeds. Once plants become established, less weeding will be required.

- ✓ **Weed regularly until vegetation becomes established**
- ✓ **Identify weeds carefully in spring – new good plants may come up also!**
- ✓ **Replant as needed**
- ✓ **Monitor plant health, especially right after planting**

Keep your garden healthy and clean.

Rain gardens should be periodically cleared of dead vegetation and any debris that may collect. Replanting may be necessary over time. If a plant is not doing so well in one location of the garden, it may have to be moved to a wetter or dryer area.

Once the rain garden has become established maintenance is minimal and will generally only include periodic mulching, pruning and thinning, and plant replacement. Be sure to inspect your rain garden periodically during and/or immediately after rainfall events to be sure the rain garden is working as designed.

Key Ideas to Remember:

- Rain Gardens need to be maintained
- Weeding is essential. A good hardwood mulch can reduce the number of weeds and make weeding easier.
- Fertilizer is not needed if you use native plants adapted to the region, climate and site.
- Watering during the first growing season is vital. Try to strike a balance between providing too much and too little water. If you choose plants well-adapted to KY's climate, no watering should be needed once the plants are established (after the first growing season).
- Check for exposed soil and erosion and add organic weed-free mulch. If too much sediment is flowing into the garden, find the source and stabilize the area.

V. Rain Garden Funding

The funding that you will need to design, build and maintain a school rain garden will vary depending on the design, size and location, but funding opportunities are often abundant in central KY.

To find an updated list of grants for your school rain garden from state and national organizations, go to Environmental Education in KY's website for grants at **www.eeinkentucky.org** and click on the grants link in the bottom right corner of the page.

For information on a LFUCG Neighborhood Community Sustainability Grant from the Department of Environmental Quality, contact Louise Caldwell-Edmonds at (859) 425-2804 or louisec@lexingtonky.

Remember- FCPS offers assistance and support for grants. All schools who want to apply for a grant must complete the Intent to Apply form that can be found in the Staff Portal under Grants Writing and Accounting Offices Center. The process for grants development and submission is below.

All grants, regardless of funding amount **must** be approved by the superintendent, **prior** to submission. That approval process begins with the grant writing resource specialist. This is a five part process: 1) Finding a funding opportunity/grant; 2) Intent to apply process; 3) Proposal development; 4) Proposal approval; and 5) Proposal submission.

1. **Finding a grant:** There are a lot of funding opportunities out there. However the key is finding an opportunity that 1) is a good fit for your idea, and 2) for which the school/district is eligible to apply. The district grants staff has a limited amount of time to devote to researching opportunities. Because of this, the funding opportunities' database has been developed and is being updated. If you have a project for which need funding, please check the database first. Once you find a possible funding source, get the ok from your principal or supervisor to proceed with the intent to apply process.
2. **Intent to Apply Process:** When you have found a grant, please notify the grants specialist as soon as possible by email (susan.davis@fayette.kyschools.us) and attach the Intent to Apply form. The grants specialist will respond to let you know whether or not to proceed with proposal development. This step in the process is critical for a variety of reasons. Sometimes only one proposal per district can be submitted; sometimes schools or the district are not eligible; if there are matching requirements or positions created, the Board of Education must approve prior to submissions. Once you have the ok to proceed, then it's onto proposal development.
3. **Proposal Development:** The grants specialist cannot write every proposal in the district. However she can provide technical assistance to those developing proposals. Please do not hesitate to contact the grant specialist with questions.
4. **Proposal Approval:** When your proposal is almost complete, please contact the grants specialist, who will facilitate the process that cumulates with the superintendent's approval to submit. This process takes time and involves multiple departments, so please allow plenty of time for this (ideally 5 working days).
5. **Proposal Submission:** Please assume that you are responsible for submitting your proposal to the funding source. The details of this can be discussed with the grants specialist.

VI. Using Your Rain Garden as an Engaging, Core Content Based Learning Tool

It is critical that students be actively engaged and involved in the planning, design, building and maintenance of your campus rain garden and that your school have a long-term plan for which group, team or grade will take proud ownership of your campus garden (Ms. Thompson's 5th grade class, Ms. Lawson's 7th grade science classes, Mr. Smith's Earth Science class or the Go Green/Environmental Club).

To find other school rain garden resources and lesson plans in addition to the ones provided in this manual, go to Bluegrass Rain Garden Alliance's website at **www.bluegrassraingardenalliance.org** and click Rain Garden Resources in the top left corner, then click For Schools.

To further enhance the educational opportunities provided by the rain garden, schools should also provide outreach to nearby neighborhoods. The outreach may take the form of public seminars, self-guided tours, signage, and presentations to neighborhood associations or to other local organizations. Information can include the role rain gardens play in improving water quality and helping Lexington meet its requirements for its Municipal Separate Storm Sewer System permit.

To encourage similar projects by neighborhood associations or individual homeowners and businesses, information should be provided on available resources from the city of Lexington including Neighborhood and Community Sustainability Grants and Class A and Class B Water Quality Management Fee Grants that can be used to fund projects. Residents can also be directed to the city's Web site, www.livegreenlexington.com/stormwater for more information on Lexington's storm water program.

Your Energy & Sustainability Managers are always here to help you navigate the planning, design, build and maintenance of your campus rain garden. If you have any questions or feel like you need more support, please contact Tresine Logsdon at tresine.logsdon@fayette.kyschools.us.

KY Core Content addressed by the planning, designing, building and maintenance of a school rain garden:

Elementary

SC-05-2.3.1
Students will:

- describe the circulation of water (evaporation and condensation) from the surface of the Earth, through the crust, oceans and atmosphere (water cycle);
- explain how matter is conserved in this cycle.

Water, which covers the majority of the Earth's surface, circulates through the crust, oceans and atmosphere in what is known as the water cycle. This cycle maintains the world's supply of fresh water. Students should have experiences that contribute to the understanding of evaporation, condensation and the conservation of matter.

SC-04-4.7.2
Students will:

- describe human interactions in the environment where they live;
- classify the interactions as beneficial or harmful to the environment using data/evidence to support conclusions.

All organisms, including humans, cause changes in the environment where they live. Some of these changes are detrimental to the organism or to other organisms; other changes are beneficial (e.g., dams benefit some aquatic organisms but are detrimental to others). By evaluating the consequences of change using cause and effect relationships, solutions to real life situations/dilemmas can be proposed.

PL-05-3.1.4
Students will describe consumer actions (reusing, reducing, recycling) and identify ways these actions impact the environment (e.g., conserving resources, reducing pollution, reducing solid waste).

PL-05-4.2.1
Students will explain how and why personal responsibility and good work habits (e.g., school attendance, honesty, cooperation) are important at home, school and work.

SC-04-2.3.2
Students will describe and explain consequences of changes to the surface of the Earth, including some common fast changes (e.g., landslides, volcanic eruptions, earthquakes), and some common slow changes (e.g., erosion, weathering).

SC-04-4.6.1
Students will analyze patterns and make generalizations about the basic relationships of plants and animals in an ecosystem (food chain).

Plants make their own food. All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants. Basic relationships and connections between organisms in food chains, including the flow of energy, can be used to discover patterns within ecosystems.

Middle School

PL-08-3.1.4
Students will describe consumer actions (reuse, reduce, recycle) and explain how these actions impact the environment (e.g., conserving resources, reducing pollution, reducing solid waste, conserving energy).

PL-08-4.2.1
Students will describe individual work habits/ethics (e.g., following directions, problem-solving, time management, respect, self-discipline, punctuality) and explain their importance in the workplace.

SC-08-3.4.4
Students will describe and explain patterns found within groups of organisms in order to make biological classifications of those organisms.
Observations and patterns found within groups of organisms allow for biological classifications based on how organisms are related.

SC-08-4.6.5
Students will:

- describe the relationships between organisms and energy flow in ecosystems (food chains and energy pyramids);
- explain the effects of change to any component of the ecosystem.

Energy flows through ecosystems in one direction from photosynthetic organisms to herbivores to carnivores and decomposers.

SC-08-4.7.1
Students will describe the interrelationships and interdependencies within an ecosystem and predict the effects of change on one or more components within an ecosystem.

Organisms both cooperate and compete in ecosystems. Often changes in one component of an ecosystem will have effects on the entire system that are difficult to predict. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
DOK 3

SC-08-4.7.2
Students will:

- explain the interactions of the components of the Earth system (e.g., solid Earth, oceans, atmosphere, living organisms);
- propose solutions to detrimental interactions.

Interactions among the solid Earth, the oceans, the atmosphere and living things have resulted in the ongoing development of a changing Earth system.
DOK 3

High School

SC-HS-4.7.2
Students will:
- evaluate proposed solutions from multiple perspectives to environmental problems caused by human interaction;
- justify positions using evidence/data.

Human beings live within the world's ecosystems. Human activities can deliberately or inadvertently alter the dynamics in ecosystems. These activities can threaten current and future global stability and, if not addressed, ecosystems can be irreversibly affected.

SC-HS-4.7.3
Students will:
- predict the consequences of changes to any component (atmosphere, solid Earth, oceans, living things) of the Earth System;
- propose justifiable solutions to global problems.

Interactions among the solid Earth, the oceans, the atmosphere and living things have resulted in the ongoing development of a changing Earth system.

PL-HS-4.2.1
Students will identify individual work habits/ethics (e.g., individual/team responsibilities, willingness to learn, integrity, respect, confidentiality, self-discipline, problem-solving, punctuality, communication skills) and explain their importance in the workplace.

PL-HS-3.1.4
Students will compare consumer actions (reuse, reduce, recycle, choosing renewable energy sources, using biodegradable packaging materials, composting) and analyze how these actions impact the environment (e.g., conserving resources; reducing water, air, and land pollution; reducing solid waste; conserving energy).

SC-HS-4.6.4
Students will:
- describe the components and reservoirs involved in biogeochemical cycles (water, nitrogen, carbon dioxide and oxygen);
- explain the movement of matter and energy in biogeochemical cycles and related phenomena.

The total energy of the universe is constant. Energy can change forms and/or be transferred in many ways, but it can neither be created nor destroyed. Movement of matter between reservoirs is driven by Earth's internal and external sources of energy. These movements are often accompanied by a change in physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide and in all organisms as complex molecules that control the chemistry of life.

SC-HS-4.6.10
Students will:
- identify the components and mechanisms of energy stored and released from food molecules (photosynthesis and respiration);
- apply information to real-world situations.

Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in the phosphate bonds of adenosine triphosphate (ATP). During the process of cellular respiration, some energy is lost as heat.

Appendix I- Storm Water Mapping

Noting Notable Features for Rain Gardens

Activity Overview
Students survey their schoolyard to begin to identify characteristics and features relevant to building a rain garden.

Objectives
Students will:

- Practice observation and investigative skills
- Survey and collect information about their school site
- Describe interactions and details about their school site

Subjects Covered
Science and Math

Grades
K through 12

Activity Time
1 hour on the school grounds, 3/4 hour discussion in the classroom

Season
Any, Spring and Fall are best

Materials
Clipboards, pencils (or colored pencils), Noting Notable Features field sheets, map of schoolyard showing property lines and building locations, 1 air thermometer, 1 soil thermometer, map transparency, overhead projector, and colored markers

State Standards
Math: A.4.1, A.4.2, A.4.4, A.8.1, A.8.3, A.12.1, B.8.5, C.4.4, C.12.1, D.4.2, D.12.2; Science: F.8.9, F.4.4., F.12.7, F.12.8

Background

Before making any decisions about locating and building a rain garden, students need to understand the characteristics of their school yard. Site analysis activities are a great way to involve students from the very beginning of the project. All of these activities can be represented on a final site analysis map. The map will help you and your students determine where to locate rain gardens and what types of rain gardens are suitable for your site. The exact form a rain garden takes can be determined by design and educational considerations as well.

The site analysis data gathered will include information about physical objects such as buildings and other structures, topography, water movement, land use, existing vegetation, slopes, traffic patterns, patterns of sun and shade, views, and other characteristics such as predominating wind patterns, wildlife, and underground utilities. Students learn about the soil on their school grounds in more depth through experiencing Earth Partnership for Schools activities "Getting to Know Your Soil for Rain Gardens" and "Infiltration Test: Exploring the Flow of Water Through Soils."

Pre-activity preparations

- The first step in the process is to outline the physical area of the school grounds. Many schools already have site plans showing measurements of property boundaries and buildings. If you don't have such a plan, you have an excellent opportunity for students to measure and present a site map. See Earth Partnership for Schools activity, "Mapping Your Schoolyard" in the *EPS K-12 Curriculum Guide*.
- Make a copy of an existing map showing the location of buildings, drives, and property lines. Locate north, east, south, and west on the map. Create a transparency of the schoolyard map for focused discussions after the outside portion of the activity. Make enough copies of the map and field sheets for each student or student team.
- If desired, divide the schoolyard into sections. Investigate one section at a time.

Activity Description

Introduction: This activity will help you get acquainted with your schoolyard. It is the first step in understanding the natural and cultural features of your schoolyard. The data you gather will provide information to help make decisions about where to locate rain gardens on your school grounds and what type of rain gardens to build.

Follow these steps –

1. Divide into 8 teams of 2 - 4 students. Each team is responsible for completing instructions on their assigned field sheet. A brief description of what each team will investigate follows:

Noting Notable Features for Rain Gardens (cont.)

Water Flow Team – This team will identify

Water Movement – Diagram the flow of water on the school grounds. Find areas where water is standing for a period of time after a rain and areas that dry out more quickly than others. (See Earth Partnership for Schools activity, "Follow the Drop" for more information or a more in-depth investigation.)

Downspouts and storm Drains – Locate downspouts where water drains from the roof. Locate storm drains where water might exit the school property.

Topography Plus Team – This team will identify

Topography - Find high spots in the schoolyard. Determine the highest spot. Find low spots. Determine the lowest spot. Locate steep slopes, ditches, and flat areas.

Prevailing wind - Determine wind direction. Winter winds are predominantly from the northwest, summer winds from the southwest.

Sun/Shade Team – This team will identify

Sun/Shade patterns - Map shade from trees and buildings. Shade from buildings is different than shade from vegetation because it is solid and nearly shady year-round. Shade from deciduous trees is usually dappled, and the ground under the trees may be sunny from fall to late spring. Map areas of full sun.

Land Surface team – This team will identify

Hard (impervious) and porous surfaces - Locate hard surfaces (impervious) such as parking lots and sidewalks where water runs off. Next locate porous surfaces (pervious) such as planted beds or lawn areas, where water may soak (infiltrate) into the ground.

Soil - Identify areas with bare soil or where you observe erosion. Determine what may be causing the erosion such as foot traffic, steep slopes, or water movement.

Vegetation Team – This team will identify

Existing Vegetation - Locate existing vegetation on site, starting with trees and shrubs. Look for trees, shrubs, and plants that provide food (berries, nuts, or seeds) and cover for wildlife. Locate different ground covers such as lawn grass, flowerbeds, unmowed areas (or old fields), prairies, woodland ground covers, agricultural areas, etc.

Wildlife Team – This team will identify

Wildlife - Identify wildlife or signs of wildlife and where you observed them on your school yard. Do any patterns emerge where you sighted wildlife?

Traffic Patterns Team – This team will identify

Traffic Patterns - Identify traffic patterns for cars and people in and around the school.

Views – Identify good and bad views from drives, walkways, and classrooms.

Land Use Team – This team will identify

Site Use - Locate play areas, sports fields, and play equipment.

Structures - Indicate locations of bike racks, signs, benches, picnic tables, and fences.

Utility features - Locate obvious utility lines above or below ground.

2. Walk the school grounds and follow the instructions on the field sheets.

3. Return to the classroom. Teams orally present their findings and use a map transparency on an overhead to display their observations.

4. Discuss the possible locations for building a rain garden based on the class' observations. Consider the following guidelines:

a. Location
- Near drain spouts
- Where water collects and drains off of a hard surface
- To catch water before it flows over a sidewalk to reduce ice forming in winter
- Along a ditch or swale

b. Sun/Shade
- The amount of sunlight determines plant selection. Generally, gardens in full sun are more effective.

c. Wildlife
- Knowing what wildlife is currently living on the school grounds will inform you about the existing habitat. This way you are able to plan a rain garden that will complement or enhance wildlife habitat on your school grounds.

d. Traffic Patterns
- Well-worn shortcuts or other traffic patterns are more easily accommodated than changed. Habits are hard to break, and people usually take the most direct route to a destination. Therefore, try not to plant a rain garden directly over an existing path.
- Consider locating the rain garden in a visible spot for others in the community to see as an example of sustainable landscaping.
- Locate a rain garden convenient for classes to visit and study.

Extensions

- Survey the school grounds to identify current maintenance practices such as use of fertilizers and herbicides, lawn mowing, composting, mulching, and salt use in winter. Research practices that help to improve water quality and make recommendations based on your research.
- Discuss where you see wildlife on your school ground. How does it interact with its environment? Given your observations, how could you enhance wildlife habitat at your school?

Additional Resources

- Boume, Barbara. (1990). *Taking inquiry outdoors: Reading, writing, and science beyond the classroom walls*. Prtland, ME: Stenhouse Publishers.
- Ripple, Karen, Garbisch, Edgar W. (2000). *POW! The planning of wetlands.* St. Michaels, MD. Environmental Concern Inc.
- Wyzga, Marilyn. (1993). *Homes for wildlife: A planning guide for habitat enhancement on school grounds*. New Hampshire Fish and Game Department.
- Diggers hotline

Assessments

- Describe your schoolyard and how it affects the flow of water during a rainfall.
- Describe a cause and effect relationship on your school grounds.
- Determine the best place to locate a rain garden on your school grounds and explain why.

Appendix II- Percolation Test

Infiltration Test: Exploring the Flow of Water Through Soils

Activity Overview
Students measure water flow into and through soils.

Objectives
Students will:

- Compare water movement through soil at different test sites and over time
- Collect data
- Interpret results to inform decision-making about school ground plantings
- Increase understanding of water soil dynamics
- Understand human impact on the landscape

Subjects Covered
Science, Math and Social Studies

Grades
4 through 12

Activity Time
45 minutes (2 hours wait time)

Season
Spring or Fall

Materials
Option 1: Cut-can Infiltrometer: metal cylinders (approximately 15 cm (six inches) in diameter and 13 to 20 cm (five to eight inches) in length); hammer; scrap wood board (an 18 inch two by four works well); stopwatch, or watch which reads in seconds; and a measuring cup with capacity for one half a liter, or 1 pint.

Option 2: Water Absorption Test: shovel, ruler, stopwatch, 2 - 3 gallons of water

State Standards
Science: B.4.1, C.4.3., C.4.5., C.8.2., C.12.3, C.12.4.

Math: A.8.1., A.12.1, F.8.1., F.12.4.

Background

How water flows into and through a soil has great implications for the diversity of plants that can be supported by that soil. Different species of plants will be favored by a slow versus fast draining soil. Accordingly, the choice of plant species for a native planting or ecological restoration is determined in a large part by the dynamics of soil and water. Water flow through soil also plays a significant role in how large to build a rain garden.

There are a number of factors which can influence how wet or dry a particular soil is and how water infiltrates the soil. The physical structure and texture of the topsoil is a key characteristic affecting water flow. A sandy soil has larger pore spaces than a clay soil. Pore spaces are the air spaces between particles. This allows water to percolate or infiltrate the soil more quickly. Clay soil is made up of smaller particles and pore spaces slowing water's ability to infiltrate.

Subsoil characteristics can also play a major role in water movement. A heavy (clay) subsoil layer can act as a seal underneath the topsoil. If there is enough rain, the topsoil will become saturated and there will be no place for the water to go regardless of the characteristics of the topsoil.

Soil compaction can lead to destruction of soil structure (the arrangement of soil particles and pore spaces), and thus reduce water flow. The pore spaces and natural cracks are squeezed out in a compacted soil creating a cement-like soil. Heavy construction vehicles, poor farming practices and even walking on wet soil destroys soil structure and impedes water flow.

The amount of water being held by a soil at the time of testing can also greatly affect how water soaks into the ground. A saturated soil will usually have a different flow rate than the same soil in an unsaturated state. This is due to the presence of soil-water matrix forces in unsaturated conditions. These matrix forces are complex and result from a combination of adhesion forces (the attraction between soil surfaces and water) and cohesion forces (the attraction of molecules of water to each other). In saturated conditions gravitational forces alone are responsible for water movement in soils.

The first infiltration test described below is used to quantify the ability of water to move into and through a soil. Because of the great number of factors which can affect the flow of water through soils, it is best to use this test on a relative basis. This means that a number of tests could either be run at the same time at different sites or at the same site at different times. The results from that particular set of tests are then only directly compared to each other. This technique is suitable to long-term soil infiltration testing. Usually as native plants mature and their roots spread, infiltration changes. This procedure can be used to track change over time.

The second infiltration test is often used to learn soil type for determining how big to build a rain garden. The rate at which the water soaks into the ground indicates if the soil is sandy, silty, or clayey. Soil is a critical factor for calculating the size of a rain garden. See Earth Partnership for schools activity "Sizing a Rain Garden" for more information and/or to take the next step in planning a rain garden. Learning soil type will also inform in plant selection for any planting. Matching plants to soil type will help in choosing plants that will survive your proposed planting.

Activity Description

Option 1: Cut-Can Infiltrometer (Best for follow-up infiltration tests.)

Carefully choose and prepare a test site. A level location will give the best results by allowing the water to infiltrate evenly into the soil. A site with gravel will most likely be difficult or impossible because of difficulties in sinking the cylinder into the soil. A heavy lawn sod will create similar difficulties because of the dense mat of roots. Work around living plants, and expose bare soil by removing any leaf litter. Disturb the soil surface as little as possible.

Winnequah Middle School students performing water flow testing, Madison, WI. Photo: Cheryl Bauer-Armstrong

Sink the cylinder into the soil approximately five to seven centimeters (two to three inches) to create a tight seal between the bottom of the cylinder and the soil. You will most likely need to use a hammer to do so. It is best to place a wood board on top of the cylinder when hammering to keep from denting its top. Hammer in circles around the top to keep the cylinder perpendicular with the soil surface. During the test, if water leaks out the bottoms and sides of the cylinder, your results will be skewed. You will need to repeat the test with the cylinder either further in the soil or sunk more carefully so the soil is less disturbed along the cutting edge of the cylinder.

Have your watch ready and add the water to the cylinder. Time how long it takes for all of the water to move into the soil with complete elimination of all puddles.

Additional considerations

Some soils have very slow infiltration rates, and this can lead to unnecessarily long run times. If you suspect you might have this problem you can use an alternative procedure which is a bit more complicated, but also more efficient. Graduate your cylinder by making one centimeter (or one half inch) marks up its inside. To calibrate your gradations measure how deep a given amount of water will fill an uncut can and extrapolate to your scale.

As an interesting related math activity, this same measurement can be achieved by calculating the volume corresponding to your gradations. Measure the diameter of your cylinder and calculate its cross-sectional area. (Remember the area of a circle = πr^2.) Multiply this number by the length

of your gradation to determine the corresponding volume. Your calculations will be greatly simplified if you use metric units (one cubic centimeter = one milliliter).

Option 2: Water Absorption Test (Best for rain garden planning.)
Perform the following infiltration test at each location selected for a potential rain garden.

1. Dig a hole 6 inches deep by 6 inches in diameter.
2. Fill hole with water and let stand for one hour.
3. Refill hole with water. Measure depth of water with a ruler.
4. Let stand 1 hour. Then measure the depth again.
5. Use the following chart to determine soil types based on the rate at which water soaks into the soils.

Soil type	Sand	Silt	Clay
Rate	2.5 inches/hour or 4 hours total	1/2 inches/hour or 12 hours total	1/3 inches/hour or 18 hours total

1. Record soil characterization data on field sheets.
2. Use data collected in Earth Partnership for Schools activities, "Designing a Rain Garden" and "Sizing a Rain Garden."

Extensions

- Test the difference in water flow through saturated versus unsaturated soils. Does the rate of infiltration vary with different soils?
- Investigate infiltration through subsoil. Carefully dig off the topsoil and place the infiltrometer into the subsoil layer.
- Compare infiltration rates between compacted soil and uncompacted soil. Observe and identify visual characteristics of compacted soil on the school grounds.
- Research what you can do to improve soil infiltration.

Additional Resources

- If interested, purchase a double ring infiltrometer for infiltration testing. They are available from Turf -Tec International at 1.800.258.7477 or http://www.turf-tec.com/index.html

Websites

- Globe in the City - Infiltration: www.centerx.gseis.ucla.edu/globe/protocols/infilt.htm

Assessments

- Using the results of the infiltration tests, describe how different soil types and/or soil compaction influences water flow through soil.
- Based on the results of the infiltration tests, where would you locate a rain garden for best infiltration?
- Describe the factors that influence soil permeability.

Infiltration Field Test Data Sheet

Date: _____

Cut-Can Infiltrometer Data Sheet - 1

Vegetation Type

Prairie, woodland, savanna, garden, other _____

Soil Characteristics

Texture -- sand, loam, clay, other _____
Tilth -- compacted, intermediate, fluffy, other _____
Moisture -- rate 1-5 where 1 is bone dry, 5 is saturated and 3 is moderate/moist _____

Infiltration Rate

_____minutes/500 ml

(Note: If a different volume was measured, give the rate as minutes per 500mls)

Cut-Can Infiltrometer Data Sheet - 2

Vegetation Type

Prairie, woodland, savanna, garden, other _____

Soil Characteristics

Texture -- sand, loam, clay, other _____
Tilth -- compacted, intermediate, fluffy, other _____
Moisture -- rate 1-5 where 1 is bone dry, 5 is saturated and 3 is moderate/moist _____

Infiltration Rate

_____minutes/500 ml

(Note: If a different volume was measured, give the rate as minutes per 500mls)

Cut-Can Infiltrometer Data Sheet - 3

Vegetation Type

Prairie, woodland, savanna, garden, other _____

Soil Characteristics

Texture -- sand, loam, clay, other _____
Tilth -- compacted, intermediate, fluffy, other _____
Moisture -- rate 1-5 where 1 is bone dry, 5 is saturated and 3 is moderate/moist _____

Infiltration Rate

_____minutes/500 ml

(Note: If a different volume was measured, give the rate as minutes per 500mls)

Infiltration Field Test Data Sheet

Date: _____

Soil type	Sand	Silt	Clay
Rate	2.5 inches/hour or 4 hours total	1/2 inches/hour or 12 hours total	1/3 inches/hour or 18 hours total

Water Absorption Test Data Sheet - 1

Vegetation Type

Lawn, garden, field, other _____

Soil Characteristics

Tilth -- compacted, intermediate, fluffy, other _____
Moisture -- rate 1-5 where 1 is bone dry, 5 is saturated and 3 is moderate/moist _____

Infiltration Rate

_____ inches/hour

Soil Type

_____

Water Absorption Test Data Sheet - 2

Vegetation Type

Lawn, garden, field, other _____

Soil Characteristics

Tilth -- compacted, intermediate, fluffy, other _____
Moisture -- rate 1-5 where 1 is bone dry, 5 is saturated and 3 is moderate/moist _____

Infiltration Rate

_____ inches/hour

Soil Type

_____

Water Absorption Test Data Sheet - 3

Vegetation Type

Lawn, garden, field, other _____

Soil Characteristics

Tilth -- compacted, intermediate, fluffy, other _____
Moisture -- rate 1-5 where 1 is bone dry, 5 is saturated and 3 is moderate/moist _____

Infiltration Rate

_____ inches/hour

Soil Type

_____

Appendix III- Sizing a Rain Garden

Sizing a Rain Garden

Activity Overview
Students calculate the size of a rain garden using measuring tools, tables, and formulas.

Objectives
Students will:

- Determine the drainage area through observation and data collection.
- Measure the area draining into the rain garden using measuring tools.
- Use strategies in real-world situations to solve multiplication problems.

Subjects Covered
Math, Science, and Geography

Grades
4 through 12

Activity Time
Two 50-minute class periods

Season
Any

Materials
Measuring tapes, map of schoolground including location of buildings and paved surfaces; information about soil type (from Earth Partnership for Schools activity, "Getting to Know Your Soil for Rain Gardens" or "Infiltration Test: Exploring the Flow of Water Through Soils"), slope (from Earth Partnership for Schools activity, "Measuring Slope for Rain Gardens"); sizing a rain garden worksheet

State Standards
Math: A.4.1, A.4.3, A.4.5, A.8.1, A.12.1, B.4.5, B.8.1, B.8.7, D.4.1, D.4.2, D.4.3, D.4.4, D.4.5, D.8.1, D.8.2, D.8.3, D.8.4

Science: C.4.3, C.4.5, C.8.1

Background

Determining the size of a rain garden is not an exact science. Experts have different opinions. With that said, how big will you build your rain garden? There are two answers: any size you want, or if you want 100% runoff control, you need to make calculations. The first answer may seem like an odd response. But it means that a rain garden of any size will reduce the amount of precipitation that becomes surface runoff. Each water drop that stays on the school property is one less drop that potentially carries pollutants to lakes, rivers and streams. The second answer involves learning how large the drainage area is, what type of soil is in the garden, and what is the percent slope of the site. Next take this information and plug it into formulas to obtain a square foot area for the garden. The following activity description covers each step of the process for sizing a rain garden.

Activity Description

Calculate Drainage Area

1. Go out to the area designated for the rain garden. Identify the section of roof that will drain into the downspout. Measure the length and width of this area. Take measurements of other hard surfaces such as driveways, parking areas, or sidewalks that may drain into the rain garden. Repeat measurements of lawn that noticeably drain into the proposed rain garden. (It is not necessary to include the lawn area between the building and the garden site. Insert these numbers in the "Sizing a Rain Garden" worksheet.
2. Calculate areas draining into the rain garden. See Figure 1 showing the drainage area for one downspout on a school roof.

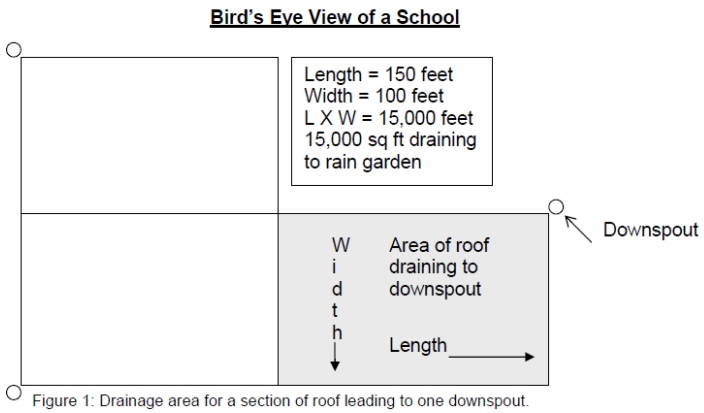


Figure 1: Drainage area for a section of roof leading to one downspout.

3. Add all drainage areas together if more than one area drains into your proposed rain garden, otherwise continue to the next step.

Determine Rain Garden Depth

1. The existing slope of the proposed rain garden site determines how deep to dig your garden. The bottom of the garden needs to be flat so that water spreads out and does not puddle. When digging your garden you will be removing soil from the top of the slope and adding it to the bottom end. See Figure 2. Because of this change in grade you must calculate the depth of the garden based on the slope. Generally the greater the slope the deeper the garden. A 4% slope equals a 3 – 5 inch deep garden, while a 12% slope equals an 8 inch deep garden. Use the results from Earth Partnership for Schools activity, "Measuring Slope for Rain Gardens," to learn what the existing slope is for your proposed rain garden. Add this number to the worksheet.

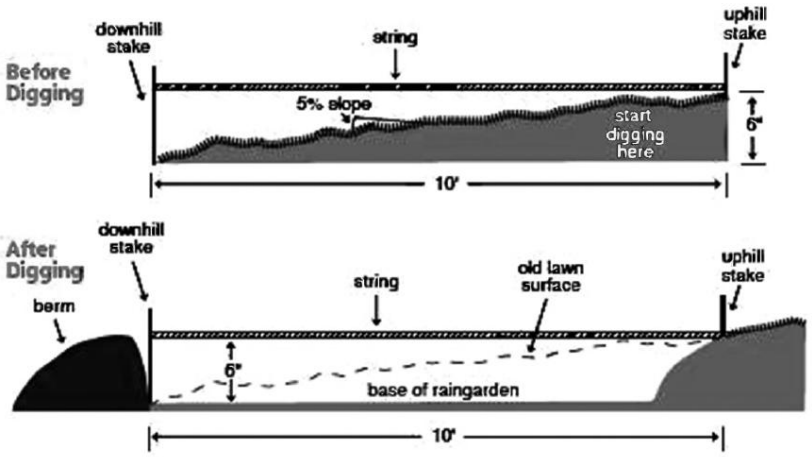


Figure 2: Schematic for digging a rain garden. Illustration from UW-Extension Basin Education Rain Garden Educator's Kit.

Identify Soil Type

1. Soil type influences the time water takes to soak into the ground and the ultimate size of the rain garden. Sandy soil with large particle sizes drain quickly so that a garden can be built deep and small. Slow-draining clay soil requires a large and shallow garden so that the water can spread out over a big surface area. Circle the soil type—sand, silt (loam) or clay—on the worksheet. Learn how to identify your soil type in Earth Partnership for Schools activities, "Identify Your Soil for Rain Gardens" or "Infiltration Test: Exploring the Flow of Water Through Soils."

Determine the Soil Factor

1. The soil factor is a number derived from soil type and rain garden depth. Locate the correct soil factor on the tables to use as the multiplier with drainage area.

2. The worksheet has two sets of factors. Use the table #1 for rain gardens closer than 30 feet from the downspout. Use table #2 for rain gardens 30 feet or more from the downspout and rain gardens collecting water from lawn areas. The two tables are different because some water will infiltrate as it flows over the lawn for 30 feet or more.

Determine Rain Garden Size for 100% Runoff Control

1. Multiply total drainage area by the soil factor. This gives you the size to build the rain garden in square feet.
2. For the next steps in the planning process, go to Earth Partnership for Schools activities, "Designing a Rain Garden" and "Rain Garden Species Selection."

Extensions

- Determine the size of a rain garden for a community building such as your local library or post office.
- Compare rain garden sizes using different soil types, drainage areas and slopes. Discuss how the differences may affect the landscape.

Additional Resources

- … *Build your own rain garden*. Chesapeake Bay Foundation. http://www.cbf.org/site/DocServer/rain_garden_guide-web.pdf?docID=2869
- …*How to install a rain garden* (Instructional Flyer). South River Federation and Center for Watershed Protection. http://www.cwp.org/Community_Watersheds/brochure.pdf
- … *How to build a rain garden*. Dane County Lakes and Watershed Commission. Madison, WI. www.co.dane.wi.us/commissions/lakes/
- ... (2005). Rain garden educator's kit. UW-Extension Basin Education Program and the WI DNR Runoff Management Section.
- …*Rain gardens: A how-to manual for homeowners.* (DNR Publication PUB-WT-776 2003, UWEX Publication GW0037) Available at Dane County's Extension Office: (608) 266-4106 or through Rock River Basin Educator, UW-Extension, Jefferson County, 864 Collins Road, Jefferson, WI 53549-1976; Phone: 920-674-8972; order on the Web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/ Download at http://myfairlakes.com/what_more.asp#yardgarden_raingardens
- …*Rain gardens: A household way to improve water quality in your community* (UWEX Publication GWQ034). Available at Dane County's Extension Office: (608) 266-4106 or through Rock River Basin Educator, UW-Extension, Jefferson County, 864 Collins Road, Jefferson, WI 53549-1976; Phone: 920-674-8972; order on the Web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/ Download at http://myfairlakes.com/what_more.asp#yardgarden_raingardens

Websites:

- How to Build a Rain Garden. Rain Gardens of West Michigan. www.raingardens.org
- Native Plant List for Wisconsin Rain Gardens (Interactive HTML) http://www.dnr.state.

wi.us/org/water/wm/nps/rg/plants/PlantListing.htm

- Dane County Lakes and Watershed Commission: Rain Garden Information. http://www.co.dane.wi.us/commissions/lakes/raingardens.html
- … A Web based homeowner guide for building and maintaining a rain garden. Rain Garden Network: http://www.raingardennetwork.com/index.htm

Assessments

- Describe the process of sizing a rain garden.
- Develop two rain garden scenarios and calculate the final rain garden sizes.

Sizing a Rain Garden Worksheet*

To size a rain garden, you will need to measure your drainage area, determine the percent slope of your lawn, and identify your soil type. This worksheet will walk you through these steps. Use Earth Partnership for Schools activities, "Identifying Your Soil for Rain Gardens" and "Measuring Slope for Rain Gardens" to determine your soil type and percent slope.

1. **Drainage Area:** Measure your drainage area.

   a. Roof area: _____ feet X _____ feet = _____ square feet

   b. Lawn area: _____ feet X _____ feet = _____ square feet

   c. Paved surfaces: _____ feet X _____ feet = _____ square feet

   d. Total drainage area: **_____ square feet**

2. **Rain Garden Depth:** Find the slope of your rain garden site to determine how deep to dig your garden.

   a. Less than a 4% slope = 3 – 5 inch deep rain garden
   b. 5 – 7% slope = 6 – 7 inch deep rain garden
   c. 8 – 12% slope = 8 inch deep rain garden

   _____ inches deep

3. **Soil Type:** Determine your soil type.

   a. Soil Type: (*Please circle)* sand silt (loam) clay

4. **Soil Factor:** Use the appropriate table below to find your soil factor. The soil factor is derived from soil type and rain garden depth.

   a. Soil factor: _____

Table #1: Rain gardens up to 30 feet from a downspout.

	3 – 5 inches deep	6 -7 inches deep	8 inches deep
Sandy soil	0.19	0.15	0.08
Silt/loam soil	0.34	0.25	0.16
Clayey soil	0.43	0.32	0.20

Table #2: Rain gardens more than 30 feet from the downspout.

Sandy soil	.03
Silt/loam soil	.06
Clayey soil	.20

5. **Rain Garden Size:** Multiply total drainage area (#1) by the soil factor (#4).

_____ (sq ft.) total drainage area X _____ soil factor = _____ **(sq ft.) rain garden**

*Based on Rain Gardens: A how-to manual for homeowners

Appendix IV- Rain Garden Species Activity

Rain Garden Species Selection

Activity Overview
Students create a list of native species for their school rain garden site as determined by environmental, ecological, aesthetic, and educational criteria.

Objectives
Students will:

- Identify criteria for selecting native species that will grow in their rain garden
- Choose species based on functional, ecological and aesthetic considerations
- Work cooperatively as a team
- Outline reasons why their species selections are appropriate for their rain garden
- Learn about native plants and identify species that can infiltrate rain water runoff

Subjects Covered
Science

Grades
3 through 12

Activity Time
Two 50 minute blocks (10 minutes introduction, 10 minutes to develop criteria, 30 minutes to select species, 50 minutes to compile species selections and determine quantities desired for each species)

Season
Any

Materials
Rain garden criteria worksheet, rain garden species selection form, wildflower and grass field guides, native plant nursery catalogs/websites and the "Rain Garden Species List"

State Standards
Science: A.4.2, A.4.3, A.8.1, B.4.1, C.4.3, C.4.6, C.4.7, C.8.2, C.8.6, H.8.2, H.12.7

Background

Rain gardens are simply a more natural system of managing storm water, allowing natural functions of infiltration and evaporation that contribute to a natural hydrologic cycle. Rain gardens are constructed shallow depressions designed to collect water primarily from downspouts. Storm water from driveways, streets, and parking areas can also be redirected to rain gardens. The concept is to let plants, bacteria, and soils clean and temporarily hold the water as it infiltrates into the ground close to where the rain falls. Before urban/suburban development, the unique relationship of water, vegetation, and soils resulted in very little runoff on the surface of the land. Today with more built surfaces and less porous ground, most of the precipitation becomes surface runoff. The rain garden keeps water close to where it falls by stopping the water from entering the storm water system as excess surface runoff. The principle for choosing species for a rain garden is to select native plants that infiltrate water into the ground. These species typically have deep root systems with water holding capacity and the ability to direct water through the soil. Instead of runoff, water either transpires through the plant's leaves and stems or seeps into the groundwater to later discharge as clean water into springs, fens, streams, or lakes.

Selecting the right plant species for your rain garden site helps ensure survival of your rain garden plants. A rain garden built on your school grounds collects water after a rain or snow melt, and then dries out. This alternating of wet and dry soils requires that you choose plant species that can tolerate these extreme conditions. Native plants that survive in this environment are usually flood tolerant species, which grow in flood plains, species that grow along rivers (i.e., riparian), and drought/flood tolerant prairie species. Plants suited for a rain garden often have a bimodal characteristic, which means they are able to grow well in opposite site conditions such as in wet or dry soils.

Other important considerations for selecting species for successful plant survival include light availability and soil type. Plant height, attracting wildlife, and aesthetics such as flower color, leaf textures and fruits can also play a role in plant selection. See "Criteria for Selecting Rain Garden Species" below for more details.

To begin the process of species selection, identify your rain garden site features (sun shade, soil type, etc). Then determine what plant characteristics will fit your site and needs. Review the following criteria and identify the criteria that fit your site characteristics and goals for your project. There are several resources available to help you choose appropriate plants. For instance, use the "Rain Garden Species List" from "Rain Garden Curricular Sampler," nursery catalogs, plant field guides or regional web-based, native rain garden plant lists to select species. List those potential species on the rain garden species selection form. You may need to adjust the number of

species in your mix depending upon your budget, availability, and size of your rain garden. As a general rule, try to have a new flower come into bloom every week during the growing season — about 30 wildflowers plus grasses/sedges. Other suitable plant types include ferns, rushes, shrubs and trees. Herbaceous plant species are planted one foot apart; trees and shrubs are spaced according to their ultimate size (see below for more information about spacing).

Criteria for Selecting Rain Garden Species
Necessary criteria for every rain garden:

1. Sunlight availability: The amount of sunlight an area receives determines the types of plants that will survive those light conditions so that they will flower and set seed. Plants that need full sun need at least 6 to 8 hours of direct sun during the growing season; plants that require shade cannot tolerate more that 3 hours of direct sun. The hours and angle of sunlight change with the seasons, too. Some areas shaded most of the day at one time of the year may be in full sun other times of the year or areas sunny in the spring may be shady in summer.

Common guides for choosing plants based on the amount of sun or shade available are:

- **Sun** – Areas receive a minimum of 6 to 8 hours of sun per day during the growing season. Prairie and wetland species including sedge meadow species grow well under these conditions.
- **Partial shade** – Partially shaded areas receive 3 to 6 hours of sun per day. Savanna and some prairie and woodland species grow well in partial shade.
- **Shade** – Areas of shade receive less then 3 hours of direct sun. Woodland groundlayer species grow in this environment.

Trees and shrub species follow the same guidelines. Most species lists will identify a plant's sun/shade requirements.

2. Grass/sedge to forb (wildflower) ratio: The proportion of species for a reasonable mix of grass/sedge and forb species that mimics the natural structure and character of a native prairie rain garden can be anywhere between 30% and 60% grass. Aesthetically, grass species, including sedges and other grass-like species, define the visual character or essence of the prairie. Ecologically, grasses provide structural support for forbs, hold the soil with their fibrous root systems, and provide food and cover for wildlife. Forbs provide visual interest, food for wildlife on a continual basis, and enhance diversity. The ratio of grass/sedge to wildflowers in a woodland tends towards less grass-like species and more wildflowers with some ferns.

3. Phenology: One of the best known and most dramatic sequences in a rain garden involves flowers blooming from mid-April through October. During the growing season approximately one new plant blooms each week. This sequential or phenological change is striking and attractive to pollinating insects such as butterflies. In shady areas, blooming peaks in the spring with a few species blooming during summer and fall. When choosing species, particularly in sunny areas, select plants for a continuous bloom.

4. Height: When selecting species, be aware of each plant's ultimate height and spread at maturity. Plant height should be in proportion with the size of your planting. Typically, small rain

gardens are planted with short species. Large plants in a small area tend to overwhelm the site and appear unkempt. Large areas can be planted with a mix of short and tall prairie species. Short species are less than four feet; tall species are greater than four feet.

Additional Criteria:

1. Color: Flower color is an aesthetic consideration. Look for color combinations and contrasts within each blooming interval. Pairing complimentary colors (yellow/purple, red/green, orange/blue) tends to intensify the colors.

2. Species that attract specific insects, birds, and other wildlife: Planting a diversity of native wildflowers and grasses, along with shrubs and trees nearby (or in the garden), provides maximum habitat and opportunity to attract a variety of butterflies and birds. Wildlife in the schoolyard adds life, beauty, discovery, and educational opportunities. Planning and proper plant selection will increase the number and variety of butterflies and birds attracted to a planting. A diversity of flying and crawling insects are attracted to flowers. Grazing insects such as grasshoppers, leafhoppers, and butterfly larvae feed primarily on the leaves of grasses and forbs. These insects form the base of the food web, especially for birds. Birds also feed on highly nutritious seeds produced by native plants. Tall and short grasses and trees and shrubs provide cover and nesting. Woody plants provide wind protection for butterflies and hummingbirds that seek nectar on prairie flowers.

3. Species desired for lessons, activities and research: A rain garden offers many hands-on learning activities and inquiry-based opportunities. You may select plants Native Americans used for food and medicinal uses or plants that illustrate plant adaptations. Consider species that have a variety of seed types to learn about seed dispersal mechanisms or to test seed germination methods. Also pick plants that awaken your senses and curiosity with fragrances, textures, shapes and sounds. Additionally, a rain garden provides a context to learn about storm water impacts and solutions in the local watershed.

4. Species blooming during the school year: Many species bloom during the summer months when students are on vacation. To make sure students experience plants in bloom during the school year, increase the number of species that bloom in the spring and fall months.

5. Species that are aggressive: Some plants can be overly aggressive either through vegetative reproduction or seed. These species, such as sunflowers, switch grass, common goldenrod, and cupplant often form large masses. Species with this type of growth habit are appropriate for large sites but may become too overpowering in smaller plantings.

6. Plant sources and indigenous species: Choose plants native to your region. Native plants are well adapted to your specific climate and soils and do not require winter protection or fertilizer. They also work more effectively infiltrating water on account of their long root systems.

Activity Description

Select Species

1. As a group, review the rain garden site characteristics and identify criteria that fit your rain garden site and goals for your project. Fill out the rain garden species selection criteria worksheet.
2. Divide into teams. Each team may be responsible for choosing species within a bloom period such as April/May, June, July, August, September/October and a team to select grasses and other grass-like species or trees and shrubs, if desired. You will find that some species choices will overlap.
3. Next have each team select 4 to 5 potential rain garden species using "Rain Garden Species List," nursery catalogs, plant field guides, and Web-based regional native rain garden plant lists.
4. Re-group; go in to the round and share out as teams the species chosen and why.
5. Compile all species selected on a master species selection form.

Develop a Species List

1. Review master species list and make adjustments, if needed.
2. Begin to determine quantities for each species. First divide the grasses/sedges from the wildflowers. Use the criteria for your grass/sedge to wildflower ratio to calculate how many plants you need for each group. The total number of herbaceous plants needed equals the number of square feet of the rain garden. It is possible to space the plants wider to about 1.5 square feet per plant. If you are adding trees and shrubs, use the following spacing guidelines to determine quantities:

a. Trees: 10 to 20 feet apart.

b. Large to medium shrubs: 6 to 8 feet apart.

c. Small shrubs: 3 to 5 feet apart.

3. Assign quantities to each species. For design purposes, order wildflowers in groups of three, five, or more. Order shrubs in quantities of one, three or more. Avoid ordering plants in twos; planting in pairs causes the eyes to jump back and forth between the two plants. Order enough grass-like species to fill the required number needed.
4. The next step is determining the budget for the species selected. See Earth Partnership activity, "Balancing the Budget, 5-2."

Extensions

- Research plants selected using the Earth Partnership activity "Up Close and Personal, 5-12."
- Make posters of plants selected.
- Create your own version of Earth Partnership activity, "A Prairie Year, 5-1" using the species selected.

Additional Resources

- Brown, Lauren. (1979). *Grasses: An identification guide.* New York, NY: Houghton Mifflin Co.
- Brown, Lauren. (1976). *Weeds in winter.* New York, NY: W. W. Norton & Company, Inc.

- Cochrane, T.S., Elliot, K., Lipke, C.S. (2006). *Prairie plants of the University of Wisconsin-Madison Arboretum.* Madison, WI.
- Courtenay, Booth & Zimmerman, James H. (1992). *Wildflowers and weeds: A field guide in full color*. New York, NY: Simon & Schuster. (Out of print, but worth a search)
- Currah, R. & Van Dyk, M. (1983). *Prairie wildflowers: An illustrated manual of species suitable for cultivation and grassland restoration.* Friends of the Devonian Botanic Gardens-University of Alberta, Edmonton.
- Fassett, Norman C. (1951). *Grasses of Wisconsin*. Madison, WI: Regents of the University of Wisconsin, (Recommended for high school level)
- Kindscher, Kelly. (1987). *Edible wild plants of the prairie.* Lawrence, KS: University Press of Kansas.
- Kindscher, Kelly. (1992). *Medicinal wild plants of the prairie.* Lawrence, KS: University Press of Kansas.
- Kirt, Russell R. (1989). *Prairie plants of Northern Illinois: Identification and ecology.* Champaign, IL: Stipes Publishing Company.
- Kirt, Russell R. (1995). *Prairie plants of the Midwest: Identification and ecology*. Champaign, IL: Stipes Publishing Company.
- Mirk, Walter. (1997). *An introduction to the tall grass prairie of the Upper Midwest*. The Prairie Enthusiasts, c/o Gary Eldred, 4192 Sleepy Hollow Trail, Boscobel, WI 53805.
- Newcomb, Lawrence. (1977). *Newcomb's wildflower guide.* Boston, MA: Little, Brown & Co.
- Runkel, Sylvan T. and Roosa, Dean M. (1989). *Wildflowers of the tallgrass prairie: The Upper Midwest*. Ames, IA: Iowa State University Press.

Websites

- Wisconsin Department of Natural Resources. Wisconsin native plants for rain gardens. http://www.dnr.state.wi.us/org/water/wm/nps/rg/plants/PlantListing.htm
- Wisconsin Department of Natural Resources. Wisconsin native plants for shady rain gardens. http://www.dnr.state.wi.us/org/water/wm/nps/rg/plants/shady/shady.htm

Assessments

- Explain why it is important to match species to the site conditions.
- Choose three criteria and explain why you think they are important for selecting plant species for your rain garden.
- Outline reasons why the species selected are appropriate for your rain garden.

Rain Garden Species Selection Criteria Worksheet

Location: _____ **Size:** _____ **(sq ft)**

Environmental Conditions:

Circle the site characteristics that describe your site.

Soil Type: Sand Silt/Loam Clay

Percent Slope: less than 4% 5% - 7% 8% - 12%

Light: Full sun Partial shade Shade

Species Characteristics

Necessary Criteria: Determine your specifications for criteria based on site conditions.

Number of plants needed (1 plant/square foot): _____

Ecosystem type (Habitat): Prairie (sun) Savanna (part sun) Woodland (shade)

Plant types: (circle all that apply.)

Grasses Sedges Wildflowers Ferns Shrubs Tress Other _____

Height: Minimum height: _____ Maximum height: _____

Phenology (time of bloom):

____% Spring (April – May), ____ % Early Summer (June),

____% Summer (July), ____ % Late Summer (August),

____ % Fall (September – October)

Additional Criteria: Identify criteria that fit your project goals such as flower color, texture, fragrance, wildlife value, etc.

_____

_____

_____

_____

_____

RAIN GARDEN SPECIES SELECTION WORKSHEET

Plant Name	Height	Sun	Color	Type	Source	AP	MY	JU	JL	AU	SE	OC	Comments

Earth Partnership for Schools
UW-Madison Arboretum

Appendix V- Rain Garden Design

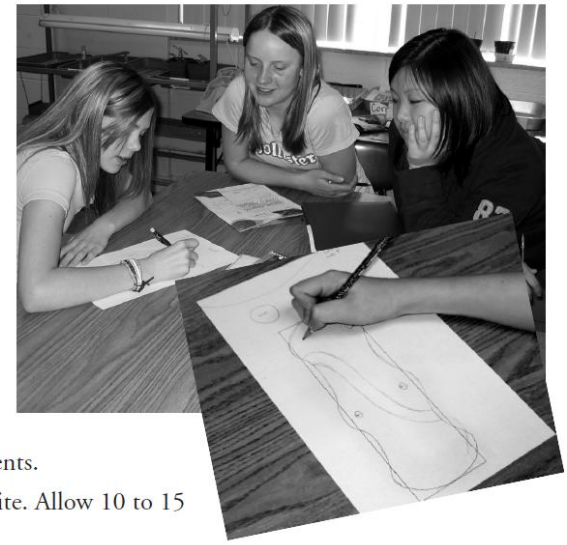
Designing a Rain Garden

With the size and location of the rain garden determined, you may begin designing a native rain garden. The process involves creating a shape for the garden and determining a layout for the plants. Please see following activity directions for implementing these steps with students.

Activity Description

Creating a Rain Garden Design (Integrating the garden into the landscape)

1. Go out to the area designated for the rain garden. Walk the area to get a feel of the space and review the site analysis data such as sun availability, slope, and existing landscape features.
2. Go back to the classroom and discuss what was observed.
3. Brainstorm design criteria such as the goals and objectives for the rain garden. Examples may include creating habitat for wildlife, using native species, educating the community, providing seating nearby, planting trees for shade, signage, etc.



4. Divide into teams of three or four students.
5. Draw rain garden design plans for the site. Allow 10 to 15 minutes.
5. Identify designated team speaker(s) and present plans to the class within two to three minutes.

Student teams drew their designs and presentd their ideas to their classmates at Winequah Middle School, Monona, WI. Photos: Cheryl Bauer-Armstrong

7. Display each design plan. As teams, discuss and choose the best features of each design; write your favorite feature on a "Post-it" and apply it on the plan. Group the "Post-its" with similar desired features on each plan. As a class, summarize the best elements to incorporate into a master design.
8. Choose a committee or have a professional take these ideas and create a composite design plan.

Developing a Planting Plan (Locating plants in the garden)

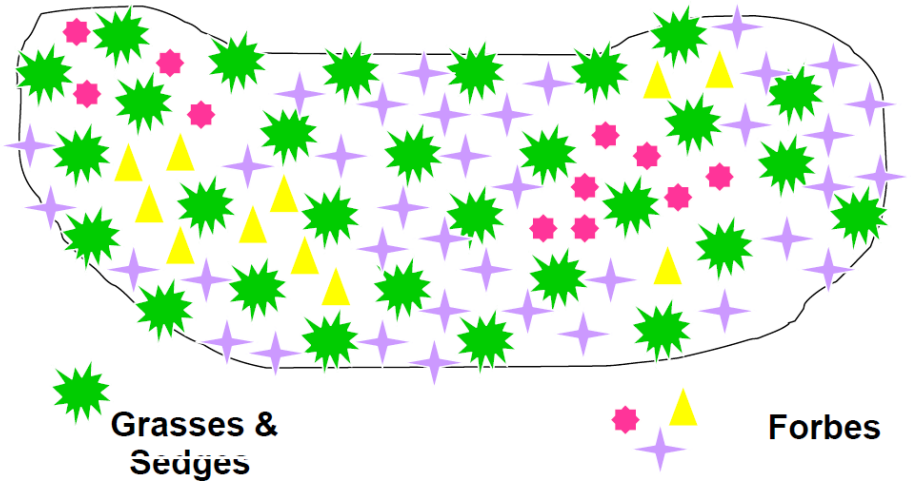
There are many techniques for laying out a planting design on paper. Each method has pros and cons. Choose the method that will work for your class given student ages, time, interest and subject applicability. Techniques include using graph paper where one square represents one

plant, drawing circles/shapes indicating individual plants, or drawing shapes to indicate groups of plants. (Please see an example at the end of the activity description.) Another option is to divide the plants by height and draw zones for tall, medium, or short plants. Within each identified zone, students locate and plant the appropriate species on planting day. The exact location of each plant is not identified on a plan.

The following directions suggest using the graph paper technique. This activity can be accomplished in student teams, individually, or by a student committee.

1. Transfer rain garden design to graph paper. Have one square represent one square foot. Assign one plant per square. Develop a code for each species on the rain garden species selection sheet. Use colored pencils to indicate flower colors. Use green for grass-like species. Combine colors and symbols so there is one color/symbol combination per plant species.
2. Assign every other or every third square to a grass-like species such as a grass, a sedge, or a rush. These plants form the matrix for the planting, physically support the forbs/wildflowers, and help reduce weed competition.
3. Locate the wildflowers on the design plan. Color coding the wildflowers by season—spring, early summer, late summer and fall—will help you to visualize what is blooming at similar times and what the garden will look like at a given time of year.
4. Landscape designers/architects often use design guidelines to determine plant placement so that the rain garden will look attractive and well-designed. Consider the following guidelines for your rain garden:

- Locate shorter plants in the foreground and larger species in the rear or middle.
- Place plants in groups of three, five, or more. Avoid planting in pairs—the eye jumps back and forth between the two.



Sample rain garden planting plan. Plan drawn by Susan Kilmer.

- Species such as the sunflowers and blazing stars tend to self-spread by rhizomes, stolens, corms, or bulbs. These types of species can form large masses. When planting transplants, plant these species in groups to mimic the spatial patterns of these species. Some designers cluster a few plants together and a few plants outside the cluster to form "drifts" of color.
- Avoid planting in straight lines or perfect circles.
- Use repetition of groups of plants and colors to allow the eye to flow through the planting.
- Be aware of each plant's ultimate height and spread at maturity. This is most important when planting shrubs or trees. Space shrubs 3 to 6 feet apart depending upon their mature size. Spacing varies for trees; in a woodland planting space trees about 5 – 10 feet apart; for open-grown trees space plants 20 or more feet apart.

5. Present planting plans to the class.
6. Display plans on school bulletin boards.

Extensions

- Design a rain garden planting for a local park or other public land or for your home.
- Build models of the design plans.
- Write descriptions of the rain garden plants with a photo and compile into a rain garden book.

Additional Resources

- … Build your own rain garden. Chesapeake Bay Foundation. http://www.cbf.org/site/DocServer/rain_garden_guide-web.pdf?docID=2869
- …Landscaping with native plants. 4th Edition Wild Ones Handbook. Wild Ones Natural Landscapers, Ltd.
- ... (2005). Rain garden educator's kit. UW-Extension Basin Education Program and the WI DNR Runoff Management Section.
- ...Rain gardens: A how-to manual for homeowners. (DNR Publication PUB-WT-776 2003, UWEX Publication GW0037) Order on the Web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/ Download at http://myfairlakes.com/what_more.asp#yardgarden_raingardens

Web Sites

- How to Build a Rain Garden. Rain Gardens of West Michigan. www.raingardens.org
- Dane County Lakes and Watershed Commission: Rain Garden Information. http://www.co.dane.wi.us/commissions/lakes/raingarden.shtml
- Rain Garden Network: http://www.raingardennetwork.com/index.htm

Assessment

- Describe three basic guidelines for locating and designing a rain garden.
- Develop a rubric for a rain garden design.
- Describe your experience as a team member in your design group; identify what went well and what you would change.

Appendix VI- Rain Garden Maintenance

Rain Garden Maintenance

Activity Overview
Students learn about plant and garden care while managing a newly planted rain garden.

Objectives
Students will:

- Understand plant needs for growth and survival
- Learn basic land care principles
- Participate in a service-learning project

Subjects Covered
Science and Health

Grades
3 through 12

Activity Time
50 minutes

Season
Spring, Summer, and Fall

Materials
Gardening gloves (optional; buckets, wheelbarrow or plastic garbage bags; water source, recycled milk jugs or equivalent.

State Standards
Science: Science: B.8.4, C.4.5, C.4.6, C.4.7, C.4.8, C.8.4, C.8.5, C.8.6, C.8.7, C.8.8, C.8.9, C.8.10, C.8.11, C.12.6, C.12.7, F.8.9

Health: A.4.5, A.12.3, A.12.8, C.4.4, F.4.3.

Background

A native rain garden planting is not maintenance free and will regularly need some maintenance to remove weeds and dead plant material. Fortunately, time spent caring for the garden decreases over time. Native rain garden plants do not need fertilizers, winter protection or irrigation. Native plants are adapted to the climate and soils and can tolerate excessive heat, bitter cold, drought, and flooding.

The first two years require the most care while the plants are establishing themselves in the garden. As they are maturing during the first year, they need regular watering to encourage good root development. Irrigate the plants so that the water soaks deeply into the ground, which is equivalent to a one-inch of rainfall. Short sprinkles of water encourage the roots to grow along the surface. When roots grow along the surface plants are less hardy during droughts and freezing temperatures.

Pull weeds to reduce competition for space, light, and water. Most weeds are pioneer species, which means they can grow very quickly. They fill in the open spaces and often can crowd out new rain garden plants. Additionally, they give the garden a messy, unkempt appearance. Spreading a three inch layer of wood chip or leaf mulch around the new planting helps control some of these uninvited species.

Much of the maintenance during the establishment years occurs during the summer months. Therefore, before summer vacation, enlist volunteers to monitor, water, and weed the garden during summer vacation. Local garden clubs, summer school students, scout troops, families, Wild Ones members and Master Gardeners may be willing to volunteer during the summer. Most potential volunteers will say, "yes," when asked.

Activity Description

Specific instructions for rain garden care follows:

Year 1

Watering

1. For the first three weeks after planting, water the rain garden once per week. It is not necessary to water during a given week if one–inch of rain accumulates.
2. Water the garden during droughty periods in mid-summer, if needed.

Weeding

1. First identify what is a weed and what is a rain garden plant. Rain garden plants may be marked with planting stakes. Once the weeds are identified, assign a specific weed for each student or group of students to hand

pull. This way ensures only the weeds are removed. Have students look closely at the weed to become familiar with its leaf shape and arrangement, current height and other noteworthy features.

2. Remove plants carefully so not to disrupt the rain garden species. Pull from the base of the plant. It is easier to pull weeds when the weeds are young and small.
3. Keep track of how many different weeds are pulled and how many of each kind.
4. Take the pulled weeds to a compost pile.
5. Return to the classroom and make a chart of the weeds pulled. Save the chart to compare with future weeding sessions. Take note how numbers and types of weeds change over time.

Check status of weeds and pull them, if necessary, once every three weeks during the summer. A layer of mulch helps to reduce weed growth, therefore, weeding time.

Year 2

General maintenance

- In spring when new growth begins, cut off dead plant material. (Keep stems and seedheads on during winter for visual interest, winter lessons, wildlife cover, and food for birds.)

Watering

- Water only if in a drought.

Weeding

- Continue weeding as needed. Rain garden plants will fill in the spaces and form a dense root mass, which will significantly reduce weeding over time. It is still worthwhile to monitor the garden for weeds once every three to four weeks during the summer.

And Beyond

General maintenance

- Each spring when the rain garden plants begin to grow, go out to the rain garden and clip last year's growth.

Burning

- If desired, and permitted in your community, burn the rain garden in spring. Burning is not necessary for a healthy rain garden community.

Litter Removal

- Periodically remove litter that may blow into the rain garden.

Extensions

- Create a field guide of the rain garden plants and weeds.
- Identify and research the rain garden and weed species. Find out if the weeds are native or non-native. Learn about their history and life cycles.

Additional Resources

Websites

- National Gardening Association: http://www.garden.org/home
- Kids Gardening: http://www.kidsgardening.com/
- Weed Library: http://www.garden.org/weedlibrary/

Assessments

- Develop a poster describing the importance of weeding.
- Write a management plan for how to care for a new rain garden.

2006 Institute participants are removing Sweet White Clover (Melilotus alba) at Prairie View Elementary School, Oregon, WI. Photo: Libby McCann

Appendix VII

Rain Garden Species List

FORBS & WILDFLOWERS						SUN			Moisture Gradient				
GENUS	SPECIES	COMMON NAME	Bloom Time	Flower Color	Height	S	PS	Sh	Dry	DM	Mesic	WM	Wet
Actaea	*rubra*	Red Baneberry	Apr-May	White	2'		x	x			x	x	x
Agastache	*foeniculum*	Lavender Hyssop	July-Sept	Purple	1' - 3'	x	x					x	x
Agastache	*scrophulariaefolia*	Purple Hyssop	July-August	Purple	1'	x	x				x	x	
Allium	*canadense*	Meadow Garlic, Wild Garlic	May-July	Pale Pink/White	1' - 2'	x	x	x	x	x	x	x	
Allium	*cernuum*	Nodding Wild Onion	July-Aug.	Pink-White	1' - 2'	x					x	x	
Anemone	*canadensis*	Canada Anemone	May-July	White	1' - 2'	x	x			x	x		
Angelica	*atropupurea*	Great Angelica	May-July	White	2' - 8'	x	x				x	x	
Aquilegia	*canadensis*	Columbine	May-June	Orange	1' - 2'		x	x	x	x	x		
Arisaema	*triphyllum*	Jack-in-the-pulpit	Apr-June	Green	1' - 2'		x	x			x	x	
Arnoglossum	*atriplicifolium*	Pale Indian Plantain	July-Sept.	White	3' - 9'	x	x		x	x	x	x	
Arnoglossum	*plantagineum*	Prairie Indian Plantain	July-Aug.	White	3' - 5'	x					x	x	
Arnoglossum	*reniforme*	Great Indian Plantain	July-Sept.	White	4' - 6'	x	x				x	x	
Asarum	*canadense*	Wild Ginger	May-June	Red	1'		x	x			x		
Asclepias	*incarnata*	Marsh Milkweed	July-Aug.	Magenta	1' - 4'	x						x	x
Aster	*ericoides*	Heath Aster	July-Oct.	White	1' - 3'	x	x		x	x	x		
Aster	*furcatus*	Forked Aster	Aug-Oct.	White	1' - 3'		x	x		x	x	x	x
Aster	*laevis*	Smooth Blue Aster	Aug-Oct.	Purple	1' - 3'	x	x			x	x	x	
Aster	*lanceolatus*	Panicled Aster	Sept.-Nov.	White	2' - 5'		x	x			x	x	x
Aster	*lateriflorus*	Calico Aster	Aug.-Sept.	White	1' - 2'	x			x				
Aster	*macrophyllus*	Large Leaved Aster	July-Sept.	Purple-White	1' - 5'		x	x	x	x	x	x	
Aster	*novae-angliae*	New England Aster	Aug-Oct.	Purple	3' - 7'	x	x			x	x	x	x
Aster	*puniceus*	Bristly Aster	Aug-Nov.	Purple	2' - 8'	x	x			x	x	x	x
Aster	*shortii*	Short's Aster	Aug.-Oct.	Blue	1' - 4'	x	x		x	x	x		
Aster	*umbellatus*	Flat-top Aster	Aug.-Sept.	White	2' - 7'	x	x				x	x	
Baptisia	*alba*	White Wild Indigo	June-July	White	3' - 4'	x	x			x	x	x	
Baptisia	*brateata*	Cream False Indigo	May-June	Cream	1' - 2'	x	x		x	x	x	x	
Blephilia	*ciliata*	Downy Wood Mint	May-Aug.	Purple	18" - 24"	x	x	x			x	x	x
Blephilia	*hirsuta*	Hairy Wood Mint	June-Aug.	White	1' - 2'	x	x	x		x	x	x	
Caltha	*palustris*	Marsh-marigold	April-June	Yellow	1' - 2'	x	x	x				x	x
Campanula	*americana*	Tall Bellflower	July-Aug.	Purple	1' - 2'	x	x	x		x	x	x	
Campanula	*rotundifolia*	Bluebell, Harebell	June-Sept.	Blue	6" - 2'	x	x			x	x	x	
Cardamine	*concatenata*	Cut-Leaved toothwort	Apr.June	White	8" - 16"			x		x	x	x	
Caulophyllum	*thalictroides*	Blue Cohosh	May	Yellow/Green-Brown	1' - 3'		x	x			x	x	
Ceanothus	*americanus*	New Jersey Tea	June-Aug.	White	1' - 3'	x			x	x	x		
Chelona	*glabra*	White turtlehead	Aug.-Sept.	White	2' - 4'	x	x				x	x	x

Legend
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FORBS & WILDFLOWERS (Con't)						SUN			Moisture Gradient				
GENUS	SPECIES	COMMON NAME	Bloom Time	Flower Color	Height	S	PS	Sh	Dry	DM	Mesic	WM	Wet
Veronicastrum	*fasiculata*	Ironweed	Aug.-Oct.	Purple	2' - 6'	x	x				x	x	
Veronicastrum	*virginicum*	Culver's Root	June-Aug.	White	3' - 6'	x					x	x	x
Viola	*canadensis*	Canadian White Violet	May-June	White	1' - 2'			x				x	x
Zizia	*aptera*	Heartleaf Golden Alexander	May-June	Yellow	1' - 3'	x	x		x	x	x		
Zizia	*aurea*	Golden Alexander	May-July	Yellow	2' - 4'	x	x	x		x	x	x	
FERNS													
Adiantum	*pedatum*	Maidenhair Fern			2' - 4'	x	x	x			x	x	x
Athyrium	*fili-femina*	Lady Fern			2' - 3'		x	x	x	x	x	x	x
Matteuccia	*struthiopteris*	Ostrich Fern			3' - 5'	x	x	x			x	x	x
Onoclea	*sensibilis*	Sensitive Fern			18" - 24"	x	x	x				x	x
GRASSES													
Andropogon	*gerardii*	Big Bluestem	Apr.-May	Greenish-Grey	3' - 8'	x			x	x	x	x	
Bromus	*ciliatus*	Fringed Brome	Apr.-May	Yellow	1' - 5'	x	x					x	
Bromus	*kalmii*	Prairie Brome	June-July	Yellow	1' - 3'	x	x				x	x	x
Calamagrostis	*canadensis*	Blue-joint Grass	Apr.-May	Green	4' - 5'	x	x				x	x	x
Cinna	*arundinacea*	Wood Reed Grass	June-July	Green	3' - 5'	x	x				x	x	x
Diarrhena	*obovata*	Beak Grass	June-July	Green	2' - 3'		x	x			x	x	x
Elymus	*canadensis*	Canada Wild Rye	Apr.-May	Yellow	3' - 5'	x	x			x	x	x	
Elymus	*riparius*	Wild Rye	July-Aug.	Yellow	3' - 5'	x	x				x	x	
Elymus	*villosus*	Silky Wild Rye	July-Aug.	Yellow	3' - 5'	x	x			x	x	x	
Elymus	*virginicus*	Virginia Wild Rye	July-Aug.	Straw	3' - 5'	x	x			x	x	x	
Glyceria	*canadensis*	Rattlesnake grass	June-July	Green	2' - 4'	x	x					x	x
Glyceria	*grandis*	Reed Manna Grass	June-July	Straw	3' - 5'	x						x	x
Glyceria	*striata*	Fowl Manna Grass	June-July	Green	4' - 5'	x	x				x	x	x
Hierochloe	*hirta*	Northern Sweet Grass	June-July	Green	2' - 3'	x	x				x	x	x
Hystrix	*patula*	Bottlebrush Grass	June-Aug.	Straw	3' - 5'	x	x	x		x	x	x	
Panicum	*virgatum*	Switch Grass	Aug.-Sept.	Gold	3' - 6'	x	x			x	x	x	x
Schizachyrium	*scoparium*	Little Bluestem	Aug.-Oct.	Crimson-red	2' - 3'	x					x	x	x
Spartina	*pectinata*	Prairie Cord Grass	Aug.-Sept.	Gold	6' - 9'	x					x	x	x
Sporobolis	*heterolepis*	Prairie Dropseed	Aug.-Sept.	Gold	2' - 3'	x			x	x	x		
RUSHES													
Juncus	*effusus*	Soft Rush	June-July	Green	6" - 24"	x					x	x	x
Juncus	*torreyi*	Torrey's rush	June-July	Green	6" - 24"	x					x	x	

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SEDGES													
Carex	*bebbii*	Bebb's Sedge	June - July	Green-Brown	1' - 3'	x	x				x	x	
Carex	*bicknellii*	Prairie Sedge	May-July	Green	1' - 3'	x	x				x	x	x
Carex	*comosa*	Bristly Sedge	June - July	Green	1' - 3'	x					x	x	
Carex	*crinita*	Fringed Sedge	May-June	Green	3' - 5'	x	x	x				x	x
Carex	*grayi*	Bur Sedge	May-June	Green	2' - 3'	x	x	x			x	x	x
Carex	*hystericina*	Bottlebrush Sedge	May-July	Green	1' - 3'	x						x	x
Carex	*scoparia*	Pointed Broom Sedge	May-June	Green	1' - 3'	x					x	x	x
Carex	*sprengelii*	Woodland Sedge	May-June	Green-Brown	6"- 1'	x	x	x		x	x	x	
Carex	*stipata*	Fox Sedge	May-July	Green	1' - 3'	x	x	x				x	x
Carex	*stricta*	Tussock Sedge	May-July	Green	1' - 4'	x	x					x	x
Carex	*vulpinoidea*	Brown Fox Sedge	May-June	Green	1' - 3'	x	x				x	x	x
Scirpus	*atrovirens*	Dark Green Bulrush	May-July	Green	3' - 5'	x						x	x
Scirpus	*cyperinus*	Wool Grass	May-July	Green/Rust	3' - 5'	x						x	x
SHRUBS													
Amelanchier	*laevis*	Allegheny Serviceberry	March-May	White	15' - 25'	x	x		x	x	x	x	x
Amorpha	*fruticosa*	False Indigo	May-July	Purple	3' - 7'	x	x			x	x	x	
Aronia	*melanocarpa*	Black Chokeberry	May-July	White	1' - 3'	x	x			x	x	x	x
Cornus	*alternifolia*	Pagoda Dogwood	April-May	White	20' - 25'		x	x			x	x	x
Cornus	*stolonifera*	Red-osier Dogwood	May-June	White	4' - 6'	x	x	x			x	x	x
Corylus	*americana*	American Hazelnut	March-Sept.	Yellow-Orange	8' - 18'	x	x			x	x	x	
Hamamelis	*virginiana*	Witch Hazel	Aug. - Oct.	Yellow	15' - 30'		x	x		x	x	x	
Hypericum	*kalmianum*	Kalm St. Johnswort	July-Aug.	Yellow	2' - 4'	x	x			x	x	x	
Hypericum	*pyramidatum*	Great St. Johnswort	July-Aug.	Yellow	2' - 4'	x	x			x	x	x	
Ilex	*verticillata*	Common Winterberry	June-July	Greenish-White	3' - 12'	x	x					x	x
Physocarpus	*opulifolius*	Common Ninebark	May-June	White-Pink	5' - 8'	x	x		x	x	x		
Ribes	*americanum*	American Black Currant	May-June	White-Yellow	12' - 18'		x	x				x	x
Salix	*discolor*	Pussy Willow	March	White	15' - 20'	x	x	x			x	x	x
Sambucus	*canadensis*	Elderberry	June-Aug.	Yellow-Green	6' - 12'	x	x	x		x	x	x	
Spiraea	*alba*	Meadow Sweet	Spring-Fall	Yellow-Brown	8' - 12'	x	x					x	x
Viburnum	*acerifolium*	Maple-Leaf Arrowwood	June	White	3' - 6'		x	x	x	x	x	x	
Viburnum	*lentago*	Nannyberry	May-Sept	Purple	15' - 25'	x	x	x			x	x	x
Viburnum	*rafinesquianum*	Downy Arrowwood	May-June	White	6' - 10'		x	x		x	x	x	
Viburnum	*trilobum*	American Cranberry	May-June	White	5' - 12'	x	x	x			x	x	x

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This rain garden manual was compiled through the efforts of the FCPS Rain Garden Steering Committee:

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