

# Appendix

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Angela D. Alsobrooks  
County Executive



# Rain Garden Fact Sheet

## What is a rain garden?



A rain garden is a planted shallow depression that uses water-tolerant native plants and landscaping to soak up stormwater flowing from downspouts or hard (impervious) surfaces, such as your driveway, patio, or sidewalk. Rain gardens allow water to slowly seep into the ground, reducing the amount of water that flows directly into the nearest storm drain, creek, or river. Rain gardens typically consist of an absorbent soil mix, a mulch layer, and plants such as shrubs, grasses, and flowering plants. Rain gardens are a beautiful, low-tech, inexpensive way for homeowners, communities, and businesses to help ease stormwater problems and reduce pollution in local streams and rivers.



## What are the benefits to property owners and communities?

- Reduces stormwater problems on your property such as ponding or erosion.
- Protects local streams and the Chesapeake Bay.
- Replenishes the groundwater supply.
- Provides habitat for wildlife and increases the diversity of birds and butterflies.
- Provides an attractive alternative to traditional lawns and requires less maintenance.

## How can you determine if your property is suitable for a rain garden?

Most properties are suitable for a rain garden--all you need is some sun exposure and enough space in the right place. Consider the following points to help you determine whether a rain garden will work on your property.

- Locate your rain garden at least 10 feet away and downhill from the foundations of any nearby homes.
- Place your rain garden at least 25 feet away from a septic field or a well head.
- Choose a gently sloped place that regularly receives runoff from hard surfaces or where downspouts can direct rainwater into your rain garden.
- Locate your rain garden in full or partial sun, avoid large tree roots, and identify areas that naturally pond.
- Evaluate the soil type at the location of the rain garden. Water must be able to seep into the soil quickly enough when the rain garden is full so that it will drain in 24 to 36 hours.
- Ensure that bedrock and groundwater is located at least 2 feet below the rain garden's surface.

## Qualifying for a rebate

Project	Individual Residence or Individual Members of a Housing Cooperative	Commercial, Homeowner Associations, Condominium Associations, Civic Associations, Multi-Family Dwellings, Nonprofit, Not-for-Profit Organizations, Housing Cooperatives
Rain Gardens	\$10 per square foot (minimum of 100 square feet)	\$10 per square foot (minimum of 100 square feet)

## What are the costs?

Costs range from \$4 to \$35 per square foot, depending on the source of the materials, site conditions and who does the work. Use of a professional contractor and landscaper will result in higher costs.

## Can you do this project yourself?

Yes. A professional designer or qualified contractor may be needed if you must treat off-site drainage, have a steep slope, soils that don't drain well where an underdrain system is needed, are considering terracing, or have many trees (roots) on your property.





Angela D. Alsobrooks  
County Executive



# Rain Garden

## What is a rain garden?

A rain garden is a planted shallow depression that uses water-tolerant native plants and landscaping to soak up stormwater flowing from downspouts or hard (impervious) surfaces, such as your driveway, patio, or sidewalk. By absorbing and filtering this runoff, rain gardens allow water to slowly seep into the ground, reducing the amount of water that flows directly into the nearest storm drain, creek, or river. Rain gardens typically consist of an absorbent soil mix, a mulch layer, and shrubs, grasses, and flowering plants. Rain gardens are a beautiful, low-tech, inexpensive way for homeowners, communities, and businesses to help ease stormwater problems and reduce their contribution to the pollution of local streams, rivers, and the Chesapeake Bay.

## What are the benefits to property owners and communities?

Rain gardens, when properly designed and installed, can help reduce stormwater problems on your property such as ponding or erosion. Gutters, downspouts, and paved surfaces collect and move the stormwater to the street, where it's carried into the storm drain system and into local streams. As it flows, stormwater picks up pollutants (such as dirt and toxins, fertilizers, trash and pet waste) and carries them into our waterways.

Once here, these pollutants have many harmful effects.

- Bacteria and other pathogens create health hazards for people and wildlife.
- Debris (e.g., plastic bags, six-pack rings, bottles, and cigarette butts) can choke and kill aquatic life such as ducks, fish, turtles, and birds.
- Excess nutrients cause algae blooms that can destroy aquatic habitats and impact recreational opportunities.



Rain gardens can address these problems by filtering pollutants from stormwater and allowing more clean water to soak into the ground before it gets to local streams or enters the storm drain system. Compared to an equal area of traditional lawn, a rain garden allows at least 30% more water to soak into the ground. In addition to reducing the amount of pollution that reaches our streams through runoff, this helps replenish the groundwater supply.

Rain gardens provide many other benefits to the community and the local environment. They can provide habitat for wildlife and increase the diversity of birds and butterflies. Rain gardens provide an attractive and creative alternative to traditional lawns and require less maintenance because they do not need to be mowed, fertilized, or watered once established. Adopted on a community or neighborhood scale, rain gardens can reduce stormwater surges that cause.



## How can your rain garden qualify for a rebate?

The Rain Check Rebate Program offers rebates to property owners who install rain gardens. The rebate for both residential properties and commercial businesses, homeowner associations, condominium associations, civic

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associations, multi-family dwellings, nonprofits and not-for-profit organizations is \$10 per square foot with a minimum size of 100 square feet.

To alleviate costs, the Rain Check Rebate Program provides a rebate of up to \$4,000 for residential properties, and up to \$20,000 for commercial businesses, homeowner associations, condominium associations, civic associations, multi-family dwellings, nonprofits and not-for-profit organizations.

### How can you determine if your property is suitable for a rain garden?

Most properties are suitable for a rain garden – all you need is some sun exposure and enough space in the right place. Walk around your property while it's raining so you can see how the rain flows across existing landscape features and hard surfaces, like your house, driveway, and sidewalks, and where it ends up. A rain garden should intercept the runoff before it flows off of your property. Consider the following points to help you determine whether a rain garden will work on your property.

- Place your rain garden at least 10 feet away from your home and your neighbors' homes and downhill from the foundations of any nearby homes. When the garden overflows, the excess water must flow away from your home and your neighbors' properties.
- Place your rain garden at least 25 feet away from a septic field or a well head.
- Choose a gently sloping place that regularly receives runoff from patios, sidewalks, or other hard surfaces or where downspouts, rain barrel outlets, or sump pump outlets can direct rainwater into your rain garden.
- Locate your rain garden in full or partial sun.
- Avoid placing your rain garden under a large tree because the roots will make it difficult to dig.
- Identify low-lying areas that naturally pond (as long as they drain well) as they may be good places to locate rain gardens.
- Evaluate the soil type at the location of the rain garden. Water must be able to seep into the soil quickly enough when the rain garden is full so that it will drain in 24 to 36 hours (see the Assessing the soil section).
- Ensure that bedrock and groundwater is located at least 2 feet below the rain garden's surface.

Remember to fit the rain garden into your current landscape – let it complement the house and other yard features and be a source of enjoyment for you.

#### Assessing the soil

Soils that are suitable for a rain garden will drain within 24 or 36 hours. Soils high in sand and silt usually provide good drainage. Soils high in clay will not drain well and may not be suitable unless you amend the soil (mix in soil of a more appropriate type) or add an underdrain system. An example of an underdrain system is a slotted pipe that collects water below the surface of the rain garden and discharges it into the storm drain system or to a stable outfall. In cases where infiltration is not possible due to existing soils, you will need to consult with Rain Check Rebate staff or a qualified professional to find out whether a rain garden with an underdrain is an option for you.

It's easy to find out whether your soil is suitable for a rain garden. Dig a hole in the ground about 1 foot wide by 2 feet deep and fill it with water. If the water drains in less than 24 hours, the soil should be suitable. To be sure, refill the hole with water within 12 hours and make sure that it takes no longer than 36 hours to drain. Do this test in the spring, not in the middle of the summer when the soil is dry and cracked and may give an erroneous result. This test should not be performed within 24 hours of a rain event, as that might also give an erroneous result.

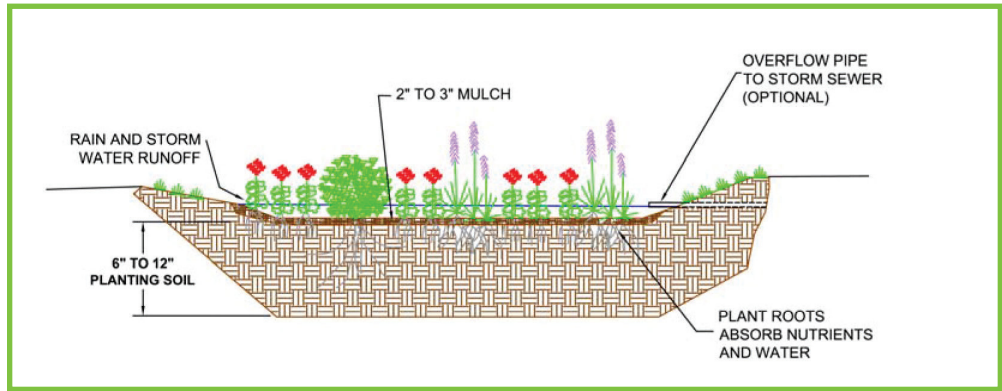
You may have excess soil after completing your garden that you will need to dispose of. If your rain garden is on a slight hill you may want to use some of the soil for a berm on the downhill side. Any excess soil can be used or stored somewhere else on your property, as long as it does not create drainage problems elsewhere.

#### Identify and avoid utilities

Prior to starting your rain garden project, find existing underground utilities, such as water mains, telecommunication lines, and gas lines, so you can avoid them. Call Miss Utility at 811 or 1-800-257-7777, or visit their website at <http://www.missutility.net/maryland/> for assistance.

### How can you determine the proper size and configuration?

Rain gardens are highly versatile and can be constructed in a wide variety of shapes and sizes. The size of your rain garden is determined by a number of variables. Some of these are established by the conditions of your yard (such as soil type), while others are determined by you (such as amount surface area collected). To properly size your rain garden, estimate the area of the hard surface (rooftop, driveway, patio, etc.) that will drain to the rain garden. If you plan to connect a downspout to the rain garden, estimate the footprint (ground area, measured as length x width) of your house or other structure and determine how much of the rooftop area drains to the downspout you will be directing to the rain garden. For gutters with a downspout at each



**Maryland Stormwater Design Manual**

end, assume that half of the water goes to each downspout. Do not take into account the slope of the roof when calculating the roof area, just use the house footprint. If your rain garden will capture runoff from other hard surfaces, such as a patio, just determine the area that will drain to the rain garden.

The surface area of your rain garden should be between 20% and 30% of the roof area (or other hard surface) that will drain into the rain garden. If your soils are very sandy, use 20%. For example, if your rooftop measures 30 feet by 30 feet, the area (footprint) would be 900 square feet. If one-quarter of this area drains to the downspout that will connect to the rain garden, then the roof area draining to the rain garden is 900 square feet divided by 4 = 225 square feet. 20% of 225 square feet = 45 square feet, and 30% of 225 square feet = 67 square feet. In this example, the rain garden area should be between 45 and 67 square feet. If you do not have enough space to install a properly sized rain garden, look at reducing the amount of area draining to your rain garden or splitting your drainage area into two rain gardens.

Be sure to maintain a gentle slope from the surrounding area down to the rain garden. You may have to create a shallow ditch, swale (low area), or underground pipe to carry the stormwater runoff from a disconnected downspout to the rain garden.

If you build a rain garden around your yard drain, the water that overflows from the garden will be conveyed safely to that drain. Otherwise, be sure the overflow is directed away from neighboring properties.

### Planting your rain garden

A rain garden planted with a variety of plants adapted to rain garden conditions will provide years of enjoyment. General garden composition principles apply to rain gardens. For example, choose plants that bloom at different seasons so that you have year-round interest. Select plants and flowers of a variety of shapes, textures, heights, and colors. If you prefer a neater, more landscaped appearance, you may wish to select relatively short plants and plants that do not seed or root aggressively. Remember to keep maintenance requirements in mind as you develop your planting plan.

Plant selection for your rain garden is very important to its success. The best plants for rain gardens are native plants. Native plants are adapted to the local environment, do not need extra water or fertilizer once they are established, provide food and habitat for wildlife, and are attractive to pollinators. Native plants tend to have deep root systems that help hold the soil. In addition, the Rain Check Rebate Program requires the use of native species in rain gardens. Native plant lists and information are provided in the resource links beginning on page 8, including the U.S. Fish and Wildlife Service's *Native Plants for Wildlife Habitat and Conservation Landscaping*.

Most importantly, be sure to match a plant's water tolerance to its position in the rain garden. The center is usually the lowest point, so it will be the wettest. Plants that can withstand wet soil should go here. Plants at the edge will be those that prefer dry conditions. In between, put plants that prefer average soil conditions. All of your plants should be able to tolerate wet soils for up to 24 hours. The U.S. Fish and Wildlife Service resource mentioned above provides moisture tolerance information for each species listed.

Placing the plants close together will reduce the amount of weeding you will need to do. Planting closely (as nature does) also helps ensure that your rain garden won't wash out during heavy storms. In a few years, you will be able to divide some plants for use elsewhere in your yard, or to share with neighbors.

In addition to the sunlight and water tolerance considerations mentioned earlier, consider these factors when deciding on a plant list:

- Salt tolerance
- Height and width of full grown plants
- Color and type of seeds, berries, flowers, or other growth
- Species of wildlife you wish to attract
- Coordination with existing landscape

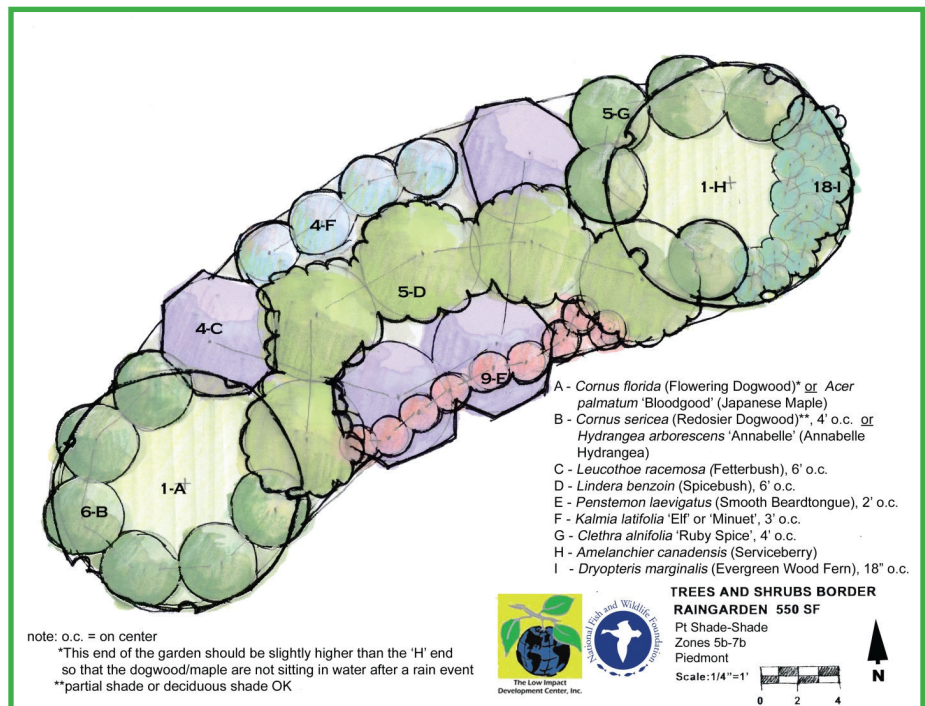
Plant trees 10 feet apart (center to center) and plant large shrubs 7 feet apart (center to center). Plant small shrubs 4 feet apart (center to center) and plant perennials 2 feet apart (center to center). An example rain garden planting plan is presented below.

It's a good idea to plant a variety of plants. Plants with different root types and growth habits will fill in all the available habitat layers both above ground and below ground, helping your garden function more like a natural plant community. A diverse array of plants is also more resilient to stress from pests or disease. However, this only works if whoever maintains the garden is familiar with the plants' appearance throughout their life cycles. If the garden is going to be maintained by a landscaper who is not familiar with native plants, a simple planting design will work better.

Additional resources listing native plants that work well in rain gardens and where to buy them are provided in the For More Information section.

### Getting water into the rain garden

You can direct stormwater to your rain garden from a roof downspout or a rain barrel using a grass- or rock-lined swale or a buried PVC pipe. If you use a pipe, you will need to place rocks or smaller stones at the pipe's entrance to the rain garden to prevent erosion caused by water gushing out of the pipe. If you are collecting runoff from a driveway or other hard surface, you can create a shallow trench drain or install a short (about 1-inch tall) speed bump to divert water to your rain garden. To capture stormwater in a rain garden that is located on a hill, create a low berm around the downhill the edges of your rain garden.



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### *Providing for overflow during periods of heavy rainfall*

Any rain garden will overflow during periods of heavy rainfall. Overflow can be released from a 4- to 8-inch notch cut in the berm that surrounds your rain garden on the downhill side, if located on a slope. Reinforce the notch with grass, stepped stones, or an erosion control blanket to prevent erosion. Locate the notch so that the water goes where it normally went before the rain garden was constructed. If your rain garden is located in a flat landscape, you can create a shallow channel filled with stones that directs flow to a suitable area. This channel should be no more than half as deep as the rain garden so as not to drain the garden during rain storms. A lawn or shrub planting area is usually the best destination for overflow. Be sure that the overflow does not go toward the foundation of your home or onto your neighbors' properties.

### **Which other techniques work well with rain gardens?**

Rain gardens can work well together (two rain gardens in tandem); they can also work with rain barrels or green roofs to absorb some of the overflow.

### **What are the costs?**

The cost of completing a rain garden varies considerably, typically ranging from \$4 per square foot to \$35 per square foot, depending on the source of the materials and who does the work. Use of a professional contractor and landscaper will result in higher costs. Important factors in estimating the cost include (but are not limited to):

- material costs, such as landscaping, seed, stone, and plants;
- the size of the rain garden;
- size of the plants selected for the installation;
- whether heavy equipment and machinery will be required;
- ease of access to the site;
- whether soil will need to be disposed of offsite; and
- duration of construction.

Approval of your rain garden project through the Rain Check Rebate Program can help reduce costs.

### **Can you do this project yourself?**

Yes. You can do this project yourself under most circumstances. You may need to consider hiring a professional designer and/or a qualified contractor if you are trying to treat off-site drainage, have a steep slope, are considering terracing, or have many trees (and roots) on your property. You may also need a qualified professional or contractor when the existing soils do not drain well and an underdrain system is needed.

### **How can you build a rain garden?**

Once you have sized your rain garden, you will need to locate it and mark it out. Use a measuring tape and a rope, string, or hose to lay out the boundaries of the rain garden. Next, dig the rain garden. To be sure that the rain garden will hold several inches of water during a storm, the surface of your rain garden will have to be at least 4 inches below the surface of your yard. Dig out the garden bed 4 to 5 inches deep across the entire surface of the garden, creating a flat-bottomed bowl with gently sloping sides. You can improve the soil if needed by digging 6 to 7 inches deep, and adding 2 to 3 inches of humus or other organic planting material. Make sure the bottom of the garden is level.

Test how the garden will hold water during a storm by letting water flow from a hose onto the hard surface or from the direction of the downspout or outlet. Make any adjustments needed. Finally, add your plants to the rain garden. After all of the plants are in the ground, add a layer (at least 2 inches deep) of double-shredded hardwood mulch to support moisture retention during the dry periods of the year.

### **How should you choose a contractor?**

Use of a professional is recommended for large and complex projects. If you decide to have a contractor design and install your rain garden, choose carefully. Ask potential contractors how much experience they

have installing rain gardens and developing planting plans. Ask them for a description of projects they have completed in the past and for references from past clients. An experienced contractor should be able to make a recommendation regarding the type, dimensions, and location of a rain garden that would best suit your property. Find out if they are insured, bonded, certified, or trained for accurately sizing and properly constructing rain gardens by a local jurisdiction, university, or state cooperative extension service. Ask potential contractors to explain what is included in their services, how long it should take to complete the project, and whether their work would be guaranteed. Ask potential contractors if large and heavy machinery would be used and, if so, whether noise will be kept to a minimum and in compliance with local laws and regulations.

### Is a permit required?

A permit is not required for most rain gardens. However, if installing your rain garden (on its own or in combination with a concurrent project on your property) results in more than 5,000 square feet and/or 100 cubic yards of earth-moving disturbance (such as grading, cutting, and filling), a permit will probably be required. Contact the County’s Department of Permitting, Inspections & Enforcement for more information: call 311 or <https://www.princegeorgescountymd.gov/1024/Permitting-Inspections-and-Enforcement>.

### What maintenance will be required?

Rain gardens require less maintenance compared to traditional gardens. Primary maintenance requirements involve weeding, repair, and replacement of components in the treatment area. The use of native plants reduces fertilizer, pesticide, water, and overall maintenance requirements. During the first growing season, the garden must be watered regularly during dry periods. However, if the soil is moist at a depth of 4 inches, and wilting plants recover at night, watering is not needed. Regularly remove any weeds, litter, sand, and sediment that enter the garden. Weeding should be accomplished routinely, at least monthly during the growing season. Rainwater entering a rain garden normally carries nutrients, so fertilization is normally not needed; however, if a soil test indicates very low soil fertility, an organic fertilizer may be applied. At least once a year, apply a new layer of double-shredded hardwood mulch, maintaining between 2 and 3 inches of cover. You may need to remove old mulch every year or two to maintain the appropriate depth for your rain garden to function properly. As with any garden, divide overcrowded plants in the spring or fall, and prune dead vegetation annually. Perennial plants can be cut back in the spring, when new growth starts, if desired for neatness, but it is not required for plant health. Plants can be pinched, pruned, sheared, or deadheaded during the growing season to encourage flowering, bushier growth, or fresh leaves. Diseased or damaged portions of plants should be pruned, as needed, and trees and shrubs can be pruned in the fall for shape or to increase fruit production.

MAINTENANCE SCHEDULE FOR URBAN RAIN GARDENS													
		Spring			Summer			Fall			Winter		
Plant Care	Trimming, Pruning, and Thinning	Required	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Mowing (turf areas only)	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	
	Weeding	Required as Necessary	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required at Low Frequency	Required as Necessary	Required as Necessary	Required as Necessary	
	Watering (established and drought)	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Fertilizing	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Pest Management	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Plant Replacement	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
Infiltration Maintenance	Ponding and Drainage Problems	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Trash and Debris Removal	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Mulching	Required	Required as Necessary	Required as Necessary	Required as Necessary	Required at Low Frequency	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	
	Pet Waste Removal	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	Required as Necessary	

 Required
  Required at Low Frequency
  Required as Necessary

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Rain gardens are designed to have water standing for up to four hours. If this period is routinely exceeded, the garden may not be functioning properly. The surface blockage problem can often be corrected by removing the mulch layer and raking the surface. For blocked filter fabric, use lengths of small reinforcing bar (2'-3' #4 rebar) to puncture the fabric with holes every 1' on center. If the soils themselves are causing the problem, punch holes in the soil to increase aeration. In a worst case scenario, the entire rain garden may need to be re-installed. Check where the water enters the garden to be sure it is not being clogged by soil, mulch, or debris; and remove obstructions, as needed. Pet waste should not be left to decay in rain gardens.

### **For more information**

While Prince George's County does not endorse any one method of building or installing a rain garden, or any particular rain garden vendor, the following information is supplied for your consideration.

#### **General Information**

**Low Impact Development Center, Urban Design Center, Bioretention**

[http://www.lid-stormwater.net/biotrans\\_home.htm](http://www.lid-stormwater.net/biotrans_home.htm)

**Down the Drain: A Story About Urban Water, this booklet explains how multiple stormwater management techniques (including a rain garden) were used to retrofit the Yorktowne Square Condominium community**

<http://landsandwaters.org/downloads/pdf/down-the-drain-a-story-of-urban-water.pdf>

**EcoScaping: EcoScaping, RainScaping, BayScaping, GreenScaping...It's All About Conservation Landscaping and Habitat Restoration!**

<http://www.chesapeakeecologycenter.org/escaping/principles-of-conservation-landscaping/>

**Chesapeake Bay Trust, Rain Gardens**

[www.cbtrust.org/site/c.mjPKXPCJnH/b.5458177/k.891D/Rain\\_Gardens.htm](http://www.cbtrust.org/site/c.mjPKXPCJnH/b.5458177/k.891D/Rain_Gardens.htm)

**Prince George's County, Maryland, Department of the Environment, Programs and Planning Division, Low-Impact Development Design Strategies: An Integrated Design Approach**

<https://www.princegeorgescountymd.gov/DocumentCenter/View/86/Low-Impact-Development-Design-Strategies-PDF>

#### **Rain Garden Design, Installation, and Maintenance**

**Chapter 5.0 – Environmental Site Design, Maryland Stormwater Design Manual, This chapter of the Design Manual includes guidance on micro-scale practices like rain gardens**

<https://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Documents/www.mde.state.md.us/assets/document/Design%20Manual%20Chapter%205%2003%2024%202009.pdf>

**Rain Gardens Across Maryland – Worcester County Natural Resources Division (guidebook includes easy rain garden instructions as well as more technical information)**

[https://extension.umd.edu/sites/extension.umd.edu/files/\\_docs/articles/Rain\\_Gardens\\_Across\\_MD.pdf](https://extension.umd.edu/sites/extension.umd.edu/files/_docs/articles/Rain_Gardens_Across_MD.pdf)

**Low Impact Development Center, Rain Garden Templates**

<https://lowimpactdevelopment.org/resources/rain-garden-templates-for-maryland/>

**The Native Plant Society of New Jersey, Rain Garden Manual**

[http://www.npsnj.org/pages/nativeplants\\_Rain\\_Gardens.html](http://www.npsnj.org/pages/nativeplants_Rain_Gardens.html)

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**Information on Native Plants**

**Prince George's County Planning Department, Native Plants of Prince George's County, Maryland**

[http://mncppcapps.org/planning/publications/BookDetail.cfm?item\\_id=234&Category\\_id=2](http://mncppcapps.org/planning/publications/BookDetail.cfm?item_id=234&Category_id=2)

**Chesapeake Bay Native Plant Center**

<http://www.nativeplantcenter.net/>

**North America Native Plant Database**

<https://www.wildflower.org/plants/>

**Izel Plants**

<https://www.izelplants.com>

**U.S. Fish & Wildlife Service, Native Plants for Wildlife Habitat and Conservation Landscaping: Chesapeake Bay Watershed**

<https://www.fws.gov/Chesapeakebay/pdf/NativePlantsforWildlifeHabitatandConservationLandscaping.pdf>

**U.S. Fish and Wildlife Service, Native Plants Nurseries in the Chesapeake Bay Watershed**

<https://www.fws.gov/chesapeakebay/BayScapes/bsresources/bs-nurseries.html>

**Maryland Native Plant Society**

<https://mdflora.org>

**Rain Garden Calculator**

**Three Rivers Rain Garden Alliance**

<http://raingardenalliance.org/right/calculator>

*For more information, call 410-974-2941 or visit [The Chesapeake Bay Trust \(cbtrust.org\)](http://TheChesapeakeBayTrust.org).*



### **Protect**

Crystal Lake

### **Infuse**

Natural Beauty

### **Create**

Neighborhood Unity



### **Recognition and Publication**

Minnesota Environmental Initiative Award  
Land & Water Magazine  
St. Paul Pioneer Press  
Minneapolis Star Tribune  
Public Works Magazine

# **Burnsville Rainwater Gardens**

*A nationally significant demonstration project*

## **Purpose**

To protect Crystal Lake from excess phosphorus and large volumes of stormwater runoff through a rainwater garden system. This system is designed to soak vast amounts of water into the ground rather than routing it via storm sewers to Crystal Lake where it is detrimental to water quality.

## **Why nationally significant?**

- It's new technology.
- They work! Stormwater runoff is reduced by more than 90 percent.
- The paired watershed study proves the effectiveness of rainwater gardens in reducing stormwater runoff (see reverse).

## **Rainwater Garden Design**

The gardens were designed to add visual unity to an existing 1980s neighborhood. In all, 17 gardens were constructed—13 along Rushmore Drive and four in a backyard swale that drains to Rushmore Drive. The gardens feature limestone retaining walls, colorful perennials and shrubs, and gradual side slopes. They were designed for easy maintenance.



*The gardens are shown above in green.*

## **Construction and Planting**

In September 2003, the contractor began construction on the rainwater gardens by cutting the sod, excavating below grade, backfilling the depressions with topsoil and compost, and installing edging and retaining walls. Homeowners were involved in planting their own gardens with the help of the project team. Curb cuts were installed in May of 2004.



## **Cost and Funding**

Construction Cost: \$ 8.00 per square foot

Homeowner Education, Design, and Construction Supervision Costs: \$ 4.50 per square foot

Funded by the City of Burnsville and a grant from the Metropolitan Council

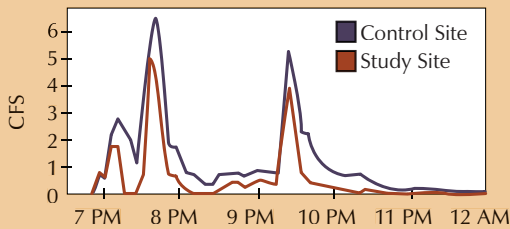


*A dip in the curb allows stormwater runoff from the street to flow into the garden.*

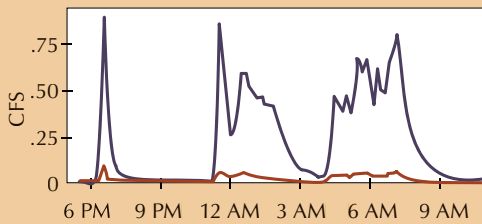


These neat and attractive gardens are easy to maintain, and homeowners love them.

### Before Construction



### After Construction



**Before:** Measured in cubic feet per second (CFS), runoff volumes from a 2.7-inch rainfall in August 2002 demonstrate the control watershed and the study watershed have similar runoff levels.

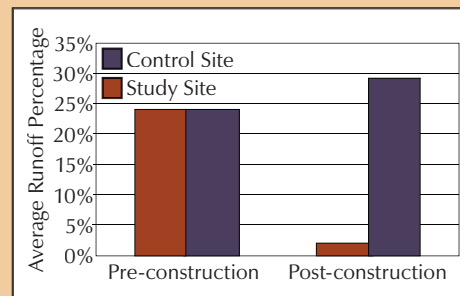
**After:** A 1.4-inch rainfall in June 2004 demonstrates the rainwater gardens have reduced runoff by approximately 90 percent.

## Amazing Results—90% Reduction

Two similar watersheds—a control site and the rainwater garden neighborhood—were monitored prior to and after installation of the new stormwater treatment practices. Runoff rates and volumes were collected in the storm sewer pipe at the outlet of each watershed. After collecting data two seasons before and two seasons after the project's implementation, the results are in, and the project is an overwhelming success.

The paired watershed study determined that the rainwater gardens have reduced runoff volumes by approximately 90 percent confirming that

existing residential neighborhoods can be successfully retrofitted with rainwater gardens and provide high levels of runoff reduction and stormwater quality improvement. In addition, the high participation rate among homeowners indicates that rainwater gardens can be viewed as a valuable amenity to property owners.



There is a 93 percent reduction in the overall runoff volume from the study watershed since the rainwater gardens were installed.



Rain gardens flank the street connecting the neighborhood visually.

## FOR PARTICIPANTS

### STORMWATER TOOL

# Rain Garden

## What is a Rain Garden?

- A rain garden is a shallow, planted depression that absorbs the water that flows from your roof or any hard surface, allowing it to drain directly into the soil.
- Rain gardens are one of the simplest and most effective ways to “green” your landscape and manage stormwater.
- A rain garden will reduce stormwater pollution, replenish the groundwater supply and provide a self-irrigating landscape!

## Benefits of a Rain Garden

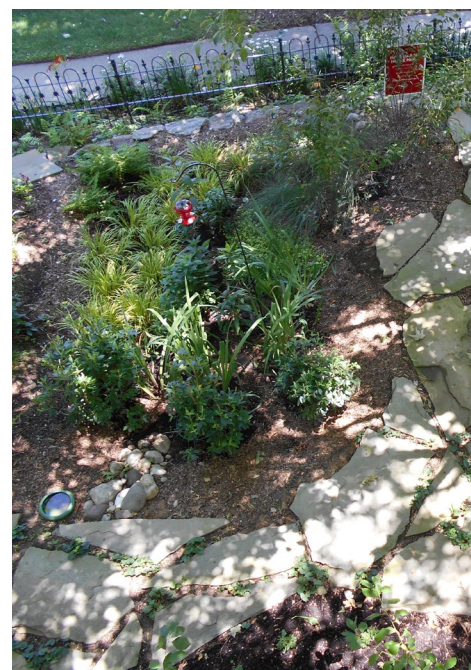
- Create an attractive and unique landscape feature.
- Slow down stormwater runoff and filter pollution.
- Prevent runoff from polluting our local rivers and streams.
- Create habitat for birds and butterflies.

## Caring for Your Rain Garden

- Water the rain garden frequently (once per week for the first month or so). Once established, it should need little to no additional watering.
- Weed and prune as you would any garden.
- Do not be afraid to move plants around if you think they would do better in drier or wetter parts of the garden.
- Do not plant edible food in a rain garden. Stormwater running into the garden may carry dirt and debris not suitable for edible plants. In addition, urban soils should be tested before being used for growing edibles.



*This shallow, planted depression absorbs the water that flows from a roof or patio.*



For more information, frequently asked questions and price points, go to [www.pwdraincheck.org](http://www.pwdraincheck.org)

## FOR PARTICIPANTS

### STORMWATER TOOL

# Rain Garden (CONTINUED)

## Keep in Mind

- Rain gardens should be sloped away from the home and neighboring properties.
- They should also be located approximately 10 ft. from the foundation of the home and cannot be located above underground utilities.
- Soil conditions must be appropriate; the contractor will complete an infiltration test to determine this.
- Plant selection options will vary based on the location of the garden and the availability of plant species.
- A rain garden could be planted following concrete removal if the assessor can verify the soil conditions.

## What Will It Cost?

- If you choose a rain garden, a landscaping contractor will visit your home to provide an estimate based on your property.
- Most gardens cost about \$17–25/sq. ft.
- PWD will pay \$16/sq. ft. up to a maximum of \$1,500.
- The homeowner pays the remainder of the total cost.

## Next Steps:

- Go to [www.pwdraincheck.org](http://www.pwdraincheck.org) and visit the “Pick Your Project” section to see if this tool is right for your property. Then sign up for a free workshop.

## Common Rain Garden Plants

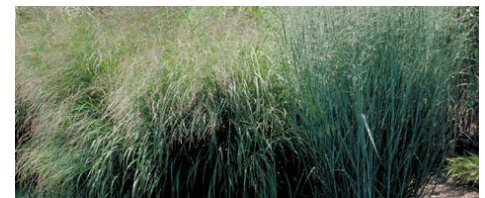
For a more complete list of sample rain garden plants, visit: <http://raingardenalliance.org/planting/plantlist>



**Brown-Eyed Susan**  
(*Rudbeckia triloba*)  
Image: Illinois Wildflowers



**Little Joe Pye Weed**  
(*Eupatorium dubium*)  
Image: The Hiker's Notebook / William Needham



**Switchgrass**  
(*Panicum virgatum*)  
Image: Nature for Cities



**Goldsturm**  
(*Rudbeckia fulgida*)  
Image: Falling Water Designs



**Small-reed or Reedgrass**  
(*Calamagrostis*)  
Image: Environmental Management Landscape, Inc, Chris Matson, 2010

For more information, frequently asked questions and price points, go to [www.pwdraincheck.org](http://www.pwdraincheck.org)

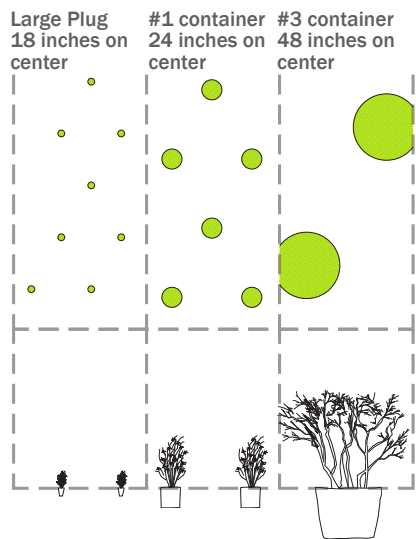
# Getting the most bang for your buck: Fast Growing & Wide Spreading Plants

There are many plants that make for successful rain gardens. The plants listed below have been selected because they can be planted at lower densities and grow quickly, resulting in a rain garden that is lush and full while using fewer plants.

Scientific Name	Common Name	Moisture Preference	Sun/Shade Preference	Height	Width	Recommended Plug Plant Spacing	Planting Area in Rain Garden
<b>Herbaceous Perennials:</b>							
<i>Acorus americanus</i>	Sweetflag	Moist to Wet	Sun	2-3'	12"	12"	Wettest Area
<i>Hibiscus moscheutos</i>	Swamp Mallow	Moist to Wet	Sun	3-6'	24"	24"	Wettest Area
<i>Iris versicolor</i>	Blue Flag Iris	Moist to Wet	Sun to Partial Shade	2-3'	36"	12"	Wettest Area
<i>Lobelia cardinalis</i>	Cardinal Flower	Moist to Wet	Sun to Partial Shade	2-4'	24"	12"	Wettest Area
<i>Mimulus ringens</i>	Monkey Flower	Moist to Wet	Sun to Partial Shade	1-3'	18"	12"	Wettest Area
<i>Vernonia noveboracensis</i>	New York Ironweed	Moist to Wet	Sun	4-6'	36"	18"	Wettest Area
<i>Eupatorium dubium</i> 'Little Joe'	Dwarf Joe Pye Weed	Moist to Wet	Sun	3-4'	24"	24"	Wettest Area
<i>Helenium</i> sp.	Sneezeweed	Moist to Wet	Sun	18-40"	18"	18"	Perimeter
<i>Aster novae-angliae</i>	New England Aster	Moist to Dry	Sun	1-2'	30"	12"	Perimeter
<i>Helianthus</i> sp.	Sunflower	Average to Dry	Sun	4-6'	30"	24"	Outermost Edge
<i>Vernonia glauca</i>	Upland Ironweed	Average to Dry	Sun	3-5'	36"	12"	Outermost Edge
<i>Amsonia hubrichtii</i>	Thread-leaf Blue Star	Average to Dry	Sun to Partial Shade	2-3'	30"	18"	Outermost Edge
<i>Eragrostis spectabilis</i>	Purple Love Grass	Average to Dry	Sun	24"	30"	12"	Outermost Edge
<i>Echinacea purpurea</i>	Purple Coneflower	Average to Dry	Sun to Partial Shade	2-3'	18"-24"	12"	Outermost Edge
<b>Shrubs:</b>							
<i>Aronia melanocarpa</i>	Black Chokeberry	Moist to Wet	Sun to Partial Shade	4'-10'	3'-6'		Wettest Area
<i>Viburnum dentatum</i>	Arrowwood Viburnum	Moist to Wet	Sun to Shade	5'-10'	5'-10'		Wettest Area
<i>Rhododendron viscosum</i>	Swamp Azalea	Moist to Wet	Sun to Partial Shade	4'-8'	4'-8'		Wettest Area
<i>Ilex verticillata</i> 'Red Sprite'	Dwarf Winterberry Holly	Moist to Wet	Sun to Partial Shade	2'-3'	2'		Wettest Area
<i>Ilex glabra</i>	Inkberry Holly	Average	Sun to Shade	5'-8'	5'-8'		Perimeter
<i>Cornus sericea</i>	Redosier Dogwood	Average	Sun	4'-8'	4'-8'		Perimeter
<i>Clethra alnifolia</i>	Summersweet Pepperbush	Average	Sun to Shade	4'-6'	5'-8'		Perimeter
<i>Itea virginica</i>	Virginia Sweetspire	Average	Sun to Shade	4'-8'	4'-8'		Perimeter
<i>Viburnum trilobum</i>	American Cranberry	Average to Dry	Partial Shade to Shade	4'-8'	4'-8'		Outermost Edge
<i>Ceanothus americanus</i>	New Jersey Tea	Average to Dry	Sun to Partial Shade	3'	3'-5'		Outermost Edge
<i>Rhus aromatica</i> 'Gro Low'	Dwarf Aromatic Sumac	Average to Dry	Sun	2'-4'	3'-8'		Outermost Edge
<b>Trees:</b>							
<i>Betula nigra</i>	River Birch	Moist to Wet		30'-60'	15'-40'		Wettest Area
<i>Quercus bicolor</i>	Swamp Oak	Moist to Wet		40'-80'	30'-60'		Wettest Area
<i>Platanus occidentalis</i>	Sycamore	Moist to Wet		40'-80'	30'-80'		Wettest Area
<i>Taxodium distichum</i>	Bald Cypress	Moist to Wet		40'-80'	20'-30'		Wettest Area
<i>Acer rubrum</i>	Red Maple	Average		30'-60'	30'-60'		Perimeter
<i>Amelanchier</i> sp.	Serviceberry	Average		15'-25'	20'-30'		Perimeter
<i>Chionanthus virginicus</i>	Fringtree	Average		15-30'	15-30'		Perimeter
<i>Halesia carolina</i>	Carolina Silverbell	Average to Dry		15-25'	15-25'		Outermost Edge
<i>Rhus typhina</i>	Staghorn Sumac	Average to Dry		15'-30'	15'-30'		Outermost Edge

## PLANT SPACING LAYOUT

Spacing for fast growing & wide spreading plants

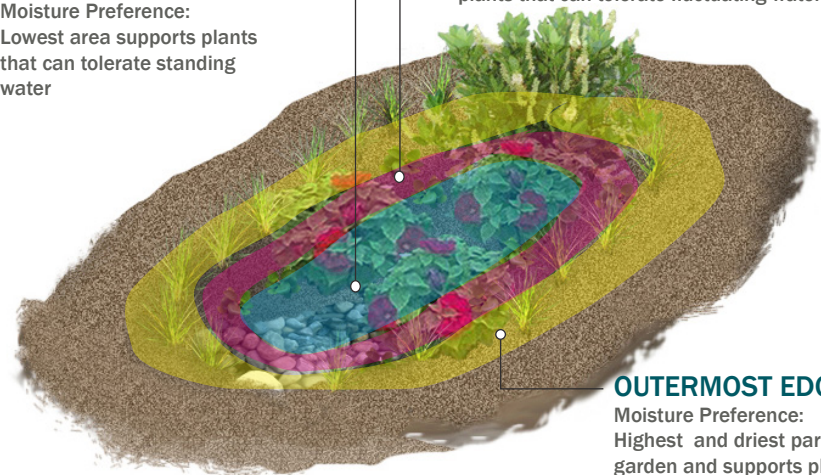


### WETTEST AREA

Moisture Preference: Lowest area supports plants that can tolerate standing water

### PERIMETER

Moisture Preference: Slightly drier than the wettest area. Supports plants that can tolerate fluctuating water levels.



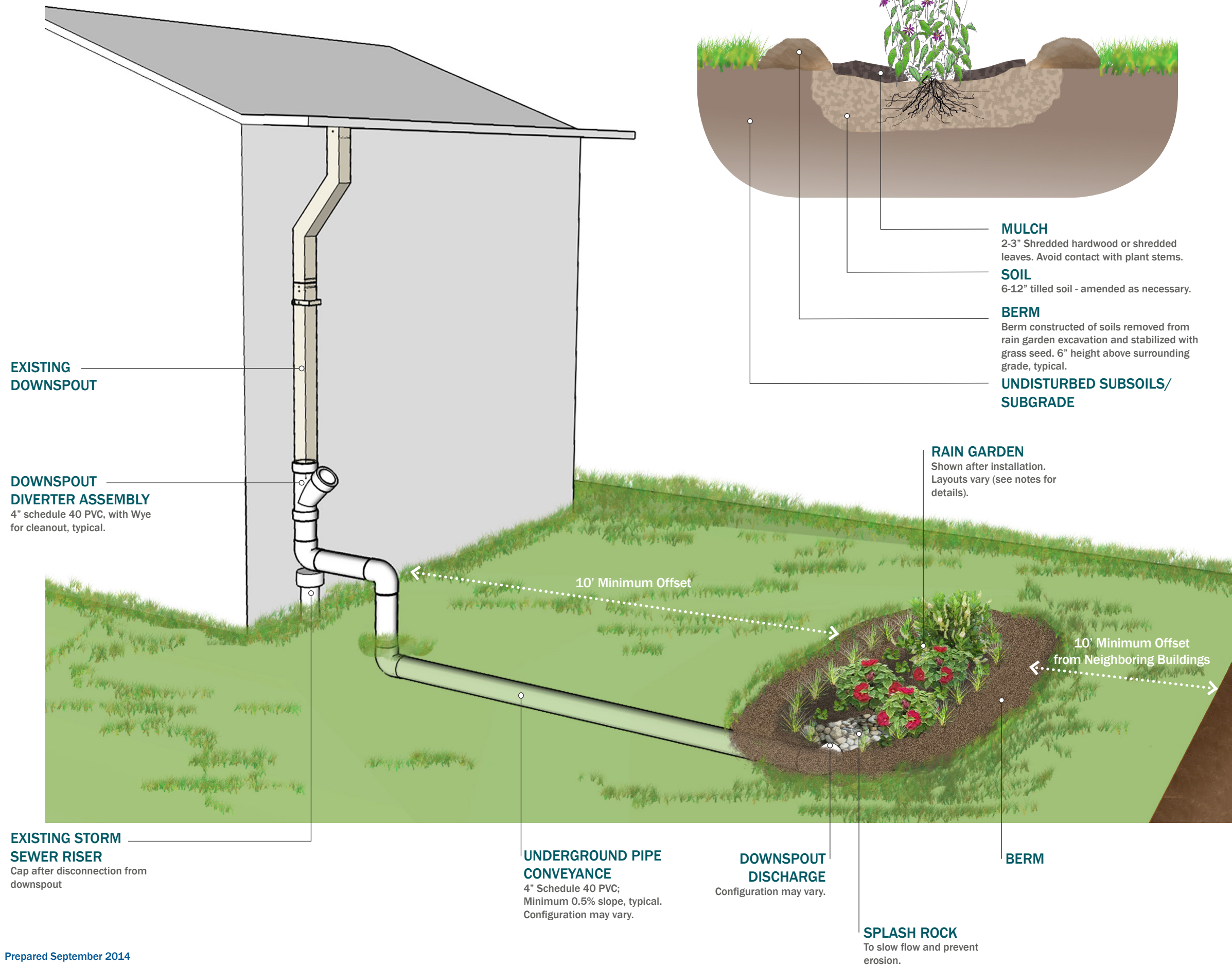
### OUTERMOST EDGE

Moisture Preference: Highest and driest part of the rain garden and supports plants that tolerate drier conditions.

# Residential Rain Garden Design Guidelines



# Typical Residential Rain Garden



## Siting Requirements

- 1. The rain garden should be 10 feet from all basements or sub-surface structures.
- 2. The rain garden should not be near a septic field.
- 3. There should be a suitable spot for overflow from the rain garden that will not impact any nearby structures or properties (e.g. downslope pervious surface, area drain).
- 4. The infiltration rate should be adequate to safely infiltrate runoff (typically between 0.5 in/hr and 6 in/hr).
- 5. The rain garden cannot be within a drip line of a tree.
- 6. Rain garden must manage stormwater from existing downspout that would otherwise run into sewer.

## Installation Requirements

- 1. Garden meets sizing requirements as specified in design.  
The rain garden must be between 20% and 30% the size of the total roof area draining to garden and 6-12 inches deep.
- 2. Water conveyance to rain garden cannot create trip or ice hazard.
- 3. Plants meet coverage requirements specified in the Plant Spacing Diagram.
- 4. Splash rock greater than 4 inches in diameter must be installed in the rain garden at the downspout discharge to dissipate flow and avoid erosion. Splash rock must be placed so as to slow the flow of water conveyed to the rain garden while not impeding it.
- 5. Berms should be created on the perimeter of the rain garden at 1.5:1 horizontal to vertical. Berms may be constructed of soils removed from the rain garden excavation.

For additional guidance please refer to Philadelphia Water Department's Rain Check Website

[http://www.phillywatersheds.org/whats\\_in\\_it\\_for\\_you/residents/how-build-rain-garden](http://www.phillywatersheds.org/whats_in_it_for_you/residents/how-build-rain-garden)

## FOR PARTICIPANTS

### STORMWATER TOOL

# Rain Barrel

## What is a Rain Barrel?

- A rain barrel is a storage container connected to a downspout to capture stormwater runoff from the roof.
- Rain barrels usually consist of a plastic storage container, a system that diverts water into the barrel, and a water spigot to which a garden hose can attach or a watering-can can be filled.
- PWD rain barrels are 55 gallon, blue, recycled, food-grade barrels that measure approximately 22.5" diameter and 36.5" height.
- Our rain barrels are completely sealed so there is no need to worry about mosquitoes.

## Benefits of a Rain Barrel

- Rain water can be reused for watering gardens, lawns and more.
- Philadelphia homeowners can save money that would otherwise be spent on tap water.
- By storing rain water during rain events, there is a decreased impact of stormwater runoff on our streams and rivers, making them healthier waterways.
- The rain barrel and installation are FREE!

## Caring for your Rain Barrel

- Be sure to empty your rain barrel after each rainstorm (full rain barrels can't capture stormwater!)
- In the winter, you should completely drain your barrel and detach it from the downspout. A winter plug is provided to seal the hole in your downspout.



## What will it cost?

- Rain barrels and the installation are free!

## Sign Up!

- Sign up for a free Rain Check workshop: [pwdraincheck.org](http://pwdraincheck.org)

For more information, frequently asked questions and price points, go to [www.pwdraincheck.org](http://www.pwdraincheck.org)

1. Confirm location of installation with participant.
2. Take “Before” photo of the location.
3. Place concrete blocks at ground level at the installation location. Level using shims if necessary.
4. Using a 1-1/4” hole saw, drill two holes in barrel for the spigots. One should be at the bottom of the barrel (for complete drainage); the other should be at ~1/3 of the height of the barrel (for filling up a bucket or watering can).



5. Place the planter onto the base, with the spigots facing an area that is accessible for the participant.
6. Using a 2” hole saw, drill a hole into the downspout slightly above the top rim of the rain barrel.
7. Using a 1-1/2” hole saw, drill a hole into the side of the rain barrel, near the top.
8. Insert collection end of flexi-spout into downspout, fasten using stainless steel screws. Insert the other end into the hole on the rain barrel (as shown below).



9. Double check to make sure all connections are secure.
10. Take “After” photo.



**Note:** To view an instructional video, visit <https://www.youtube.com/watch?v=eFM-J5OGR7c> or search for “DIY Rain Barrel Kit” by aquabarrel on YouTube.

## FOR PARTICIPANTS

### STORMWATER TOOL

# Metal Downspout Planter

## What is a Downspout Planter?

- A downspout planter is a decorative garden planter filled with gravel, soil and vegetation that uses rainfall from the roof to irrigate the plants.
- Downspout planters are connected to the roof downspout to let water flow in and hold it temporarily before entering the sewer system.
- Downspout planters contain a special soil mix that is optimal for absorbing and filtering stormwater runoff. It is a mix of sand, topsoil, compost, and biochar.

## Benefits of a Downspout Planter

- A downspout planter is an attractive green addition to a yard or patio and comes with its own rain-driven irrigation system. Downspout planters filter sediment and pollutants, reducing the impact of stormwater pollution on our waterways.

## Caring for Your Downspout Planter

- Water the plants (once per week for the first month or so, but water more if the soil in the planter seems dry).
- Water vegetation during extended droughts too; otherwise the downspout planter should not require any watering. A good rule of thumb is if plants appear to be wilting then water as you would any planter.
- Keep the overflow pipe (view image) free and clear of debris, checking it periodically after rainstorms.
- Keep the downspout connection (or diverter) connected and directed to the planter.
- Leave underdrain valve with opening of 1/8" to allow water to be released slowly over time.
- Do not plant edible food in a downspout planter. Stormwater running into the planter may carry dirt and debris not suitable for edible plants.

## What Will It Cost?

- Homeowner pays: \$100
- PWD pays: \$900
- Total cost: \$1,000

## Next Steps:

- Go to [www.pwdraincheck.org](http://www.pwdraincheck.org) and visit the "Pick Your Project" section to see if this tool is right for your property. Then sign up for a free workshop.



Connected to the roof downspout, these planters slow water down before entering the sewer while irrigating plants and removing pollutants.



Overflow Pipe

Downspout Connector

Underdrain Valve

For more information, frequently asked questions and price points, go to [www.pwdraincheck.org](http://www.pwdraincheck.org)

## FOR PARTICIPANTS

### STORMWATER TOOL

# Metal Downspout Planter (CONTINUED)

## Keep an Eye on Your Downspout Planter

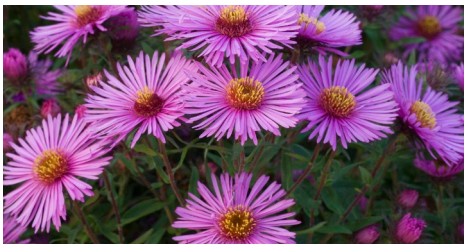
- Check the downspout planter after rainstorms to make sure that the water is soaking into the soil and not overflowing on the surface. If water is not draining, remove the underdrain valve from the lower rear side of the planter to check for clogs or blockages.
- Check the downspout connection into the downspout planter to ensure that nothing is dislodged following an intense storm.
- Inspect plants to evaluate health and replace if necessary.
- Prune and remove dead material from your downspout planter as you would with your garden. Ensure that floatable materials do not clog the overflow device.
- Maintain your roof gutters and downspouts to ensure that they function properly and convey stormwater to your green tool.

## Consider This!

- If you disconnect your downspout planter, ensure that the downspout is safely reconnected to the sewer and not draining to your property, your neighbor's property or the sidewalk.

## Plants

- There are three native plant mixes available. These plants were chosen based on their ability to live in dry and wet conditions, their stormwater management potential, and sun conditions. Plant selection will vary depending on the light requirements, season and availability. Unfortunately, we cannot accommodate specific requests, but all plants are complementary.



### Full Sun

- Smooth aster (perennial wildflower)
- Bee balm (perennial wildflower)
- Red switch grass (grass)



### Part Shade

- Feather reed grass (grass)
- Red switch grass (grass)
- Black-eyed susan (perennial wildflower)



### Full Shade

- Blue star (perennial wildflower)
- Feather reed grass (grass)
- Black-eyed susan (perennial wildflower)
- Spiderwort (perennial wildflower)

## Sizes:

The Rain Check metal downspout planters come in one standard size (the final height of the planter will be greater once it is placed on cinder blocks):

### H x W x L

2' x 2' x 4'  
*exact dimensions may vary*

### Storage Volume

+/- 78 gallons

For more information, frequently asked questions and price points, go to [www.pwdraincheck.org](http://www.pwdraincheck.org)



# Downspout Planter

## FABRICATION GUIDE

The following summary is provided to detail the fabrication of a 2 foot x 4 foot planter box constructed primarily of 5/4 inch x 6 inch lumber (5/4 x 6) to be used as the body of a downspout planter box for use in residential stormwater management. A list of tools required for construction, summary of materials needed, and the steps to build the planter box are provided below.

### Tool List

- Electric drill/driver with Phillips head drill bit
- Table saw or circular saw
- Chop saw (miter saw)
- Tape measure
- Square
- Clamps
- Marker and pencil

### Material List

Note: When using pressure treated lumber, it is recommended that the lumber be allowed to dry before fabrication to prevent shrinking and swelling of the lumber in a completed downspout planter.

Material	Quantity	Final cut sizes
3/4" exterior grade plywood	(1) sheet	(1) 24" x 48" - planter base
5/4" x6" pressure treated lumber	(8) 8' boards or (4) 16' boards	(4) 22" \\ (4) 24" \\ (4) 46" \\ (4) 48" /\ (2) 50 1/4" (with 45° angled edges) - skirt (2) 26 1/4" (with 45° angled edges) - skirt
5/4" x6" pressure treated lumber (ripped to 4 1/4" wide)	(2) 8' boards or (1) 16' board	(2) 51" (with 45° angled edges) - trim (2) 27"(with 45° angled edges) - trim
2"x2" pressure treated lumber	(3) 8' boards	(4) 22" - interior bracing (2) 20 1/2" - interior bracing for 4' planters (2) 42 1/2" - horizontal cleat (2) 18 1/2" - horizontal cleat (4) 3" pieces - skirt bracing
Deck (galvanized) screws	(100+) 2" and 3"	NA



### Fabrication Instructions

1. Take two 46"  $\frac{5}{4}$ " x 6"s and two 24"  $\frac{5}{4}$ " x 6"s and stand them on edge. Place the short and long pieces at right angles (perpendicular) to form a rectangular frame with the 46" lengths abutted inside the 24" lengths. Attach clamps to hold the pieces together on edge. The frame should measure 24"x48".
2. Lay the 24"x48" plywood piece on top of the frame. This will be the bottom of the box. Make sure the edges are all flush.
3. Starting in a corner, drill a pilot hole through the plywood into the frame.
4. Drive a deck screw into the pilot hole so the head of the screw is flush with the surface of the plywood. Continue this around the perimeter of the bottom. There should be four screws in each long side and three screws in each short side for a total of fourteen screws.



5. Create three additional rectangular frames from the remaining  $\frac{5}{4}$  x 6s. There will be no plywood component to these three frames. One of these additional frames will be constructed from two (46")  $\frac{5}{4}$ " x 6"s and two (24")  $\frac{5}{4}$ " x 6"s (as in Step

1), and the other two frames will be constructed from two (48")  $\frac{5}{4}$  x 6s and two (22")  $\frac{5}{4}$  x 6s. Drill pilot holes into each corner and secure with two 3" deck screws. Make sure each frame measures 24" by 48". This step requires (24) 3" deck screws.

6. Once the frames are stacked and flush, the corners of the planter box must be reinforced with the 22" 2x2s. One 2x2 should be attached to each corner of the box; 8 screws should be used to drill each 2x2 to the  $\frac{5}{4}$  x 6 frames of the box as shown in the photo. Be sure to pre-drill each hole as in the steps above. This step requires (32) 3"



deck screws. (An angled cut at the top edge of the 2x2 supports is shown). For the 2'x4' and 1.5 'x.4' boxes, insert a 20  $\frac{1}{2}$ " brace in the middle of each of the 4' sides.

7. The cleats should be drilled into the top interior of the planter using 2" screws and pilot holes.

### Trim Fabrication

1. The trim will be constructed using the  $\frac{5}{4}$ " x 6" boards that were ripped to  $4\frac{1}{4}$ " and cut to form (2) 51" and (2) 27" with 45° angled edges.
2. Lay the (2) 51" and (2) 27" pre-cut boards so they abut one another at right angles (perpendicular) to form a rectangular frame for the trim. Confirm that the boards line up properly.
3. Trim assembly will be attached to the planter during the liner and plumbing installation (see the Downspout Liner and Plumbing Guide) .
4. To reinforce strength of miter joints on trim assembly and to reduce risk of joints separating, joints should be secured using wood glue and either dowels, keys, biscuits, or splines. Sand joints as necessary to ensure smooth finish on the top side of the trim assembly.



### Skirt Fabrication

1. The  $\frac{5}{4}$ " x 6" boards that were cut to (2) 50  $\frac{1}{4}$ " and (2) 26  $\frac{1}{4}$ " with 45° angled edges will be used for the skirt.
2. Stand the two 51" boards and the two 27" boards on edge. Place them at right angles (perpendicular) to one another to form a rectangular frame.
3. Place a 3" 2x2 in each inside corner of the rectangular frame so it is flush with both boards and the base of the frame. There will be a gap between the top of the 2x2 and the top of the frame.
4. Starting in one corner, drill at least two pilot holes in both directions of the inner faces of the 2x2s (towards the long and short ends of the rectangular frame). This requires a total of four pilot holes per corner; two along each inner face. Evenly space the pilot holes along the length of the 2x2s to avoid interference during deck screw installations.

5. Drive deck screws into the pilot holes until the head of the screw is flush with the surface of the 2x2s. Continue this step for all pilot holes. There should be four total screws installed per corner (2 on each side). This requires a total of sixteen screws.
6. After skirt fabrication, follow the Downspout Planter Installation Guide for installation of the skirt.



Planter Box

Skirt

Trim



# Downspout Planter

## INSTALLATION GUIDE



[phillywatersheds.org/raincheck](http://phillywatersheds.org/raincheck)

### Tool List

- Power drill
- Measuring tape
- Digital camera
- Reciprocating saw ("Sawzall") and metal cutting blades
- Power grinder with metal cutting blade
- Level
- Masonry drill bit (if drilling into block or brick)
- Gardening hand tools
- Ladder
- Safety glasses
- Dust mask
- Work gloves

### Material List

#### Provided by PHS

- Pre-fabricated downspout planter and skirt
- Rain Check signage
- 6' garden hose
- Concrete Masonry Units (CMUs) or cinderblocks (for base)
- Drainage stone (pea gravel)
- WeedBlock landscape fabric
- Pre-mixed soil medium
- Plants
- Splash rock (mean 2" diameter)

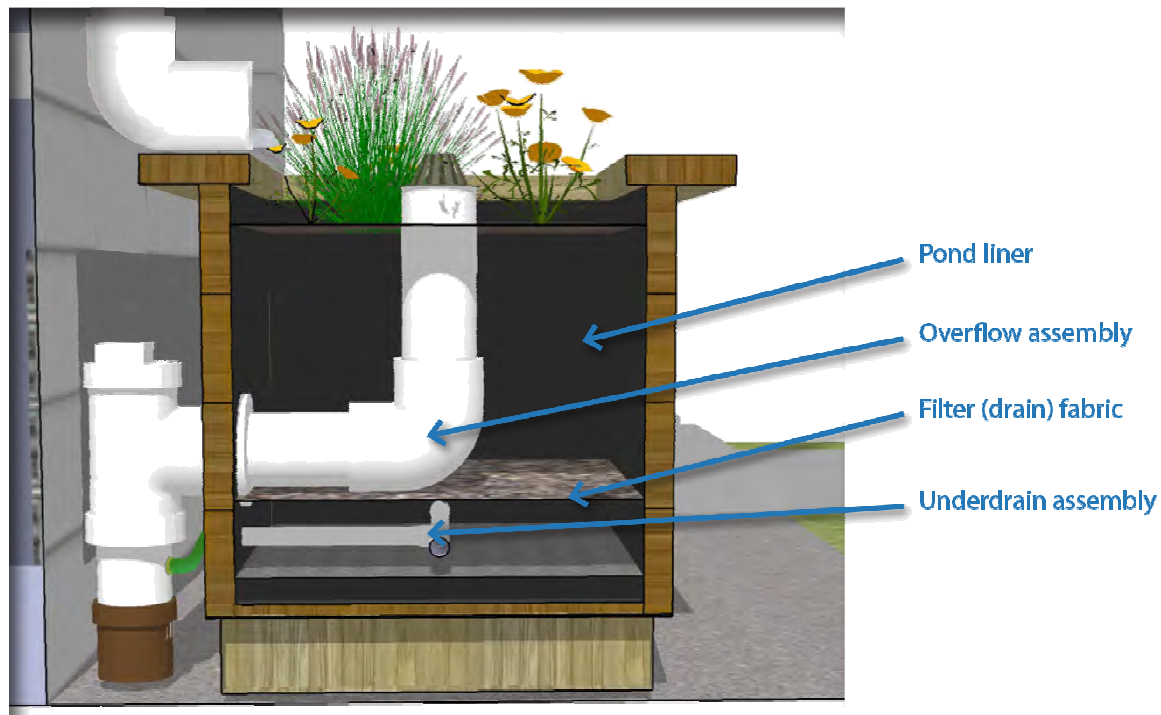
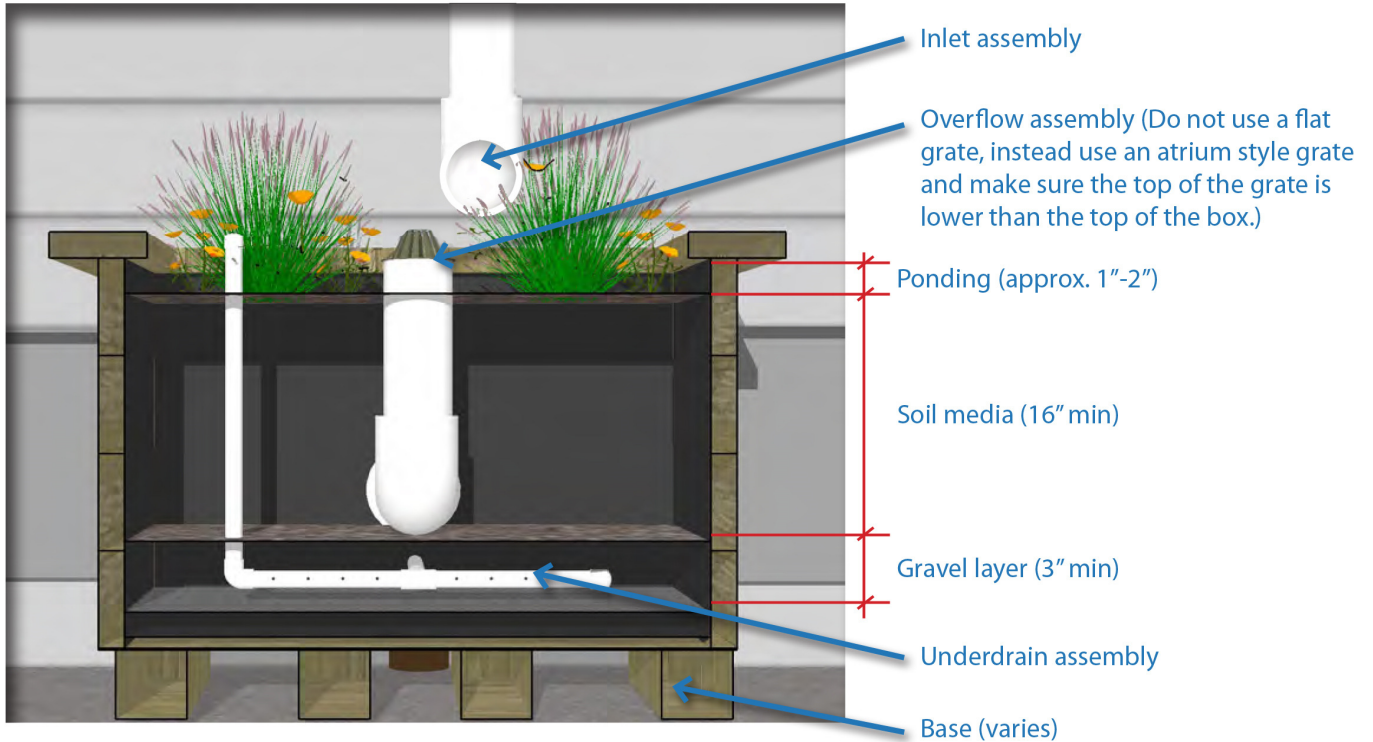
#### Provided by Contractor

- Exterior grade (composite) shims or other leveling material
- 1<sup>5</sup>/<sub>8</sub>" galvanized or stainless steel fasteners (decking screws)
- 1/2" or 5/8" stainless steel screws (white top gutter screws)
- Masonry screws and/or anchors
- 3/4" metal cutting drill bit (for hose)
- Assorted 3" and 4" plumbing pieces (straight, 45° elbow, 90° elbow, coupler, "Wye", cleanout cap, rubber boot, rubber cap, etc.)
- Assorted downspout pieces (3" or 4", round and rectangular, elbows, straights, diverters, braces, fasteners)



The Rain Check Program is funded by the Philadelphia Water Department and managed by the Pennsylvania Horticultural Society in partnership with the Sustainable Business Network.

### Anatomy of a Downspout Planter Box



## Initial Assessment

1. Consult assessment report and confer with participant to confirm location of installation.
2. Take a "Before" photo that includes the downspout.

## Placement

1. Using the nominal measurements of the planter, place CMUs or cinderblocks at ground level to create the base.



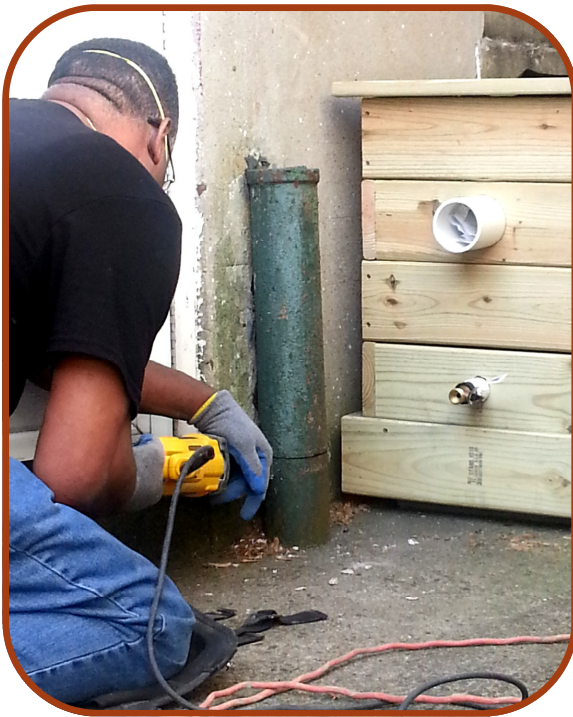
2. Use exterior grade composite shims (or other moisture-proof leveling material) to level the base. Shims should be placed to promote a fairly even distribution of weight. The base should be level in all directions.

3. Place the skirt on the ground, surrounding the base. The 2x2 braces in each corner of the skirt should be situated so that the gap is facing upwards.
4. Place the planter onto the base. Double check that the base is level – this will be the last chance to ensure level. Make sure the skirt will fit around bottom of planter by lifting it straight up. Adjust as necessary.
5. Lift the skirt so that the gap above the 2x2 braces are flush with the base of the planter and secure with 1<sup>5</sup>/<sub>8</sub>" decking screws. The skirt will be elevated above the ground.



## Plumbing

1. Cut the downspout at the appropriate height (there must be a slight downward slope from downspout to diverter outlet – at least  $\frac{1}{4}$ " per 4 linear feet). Add additional bracing to downspout, if necessary.



2. Using grinder and/or reciprocating saw, cut sewer riser to appropriate height, if necessary. From planter, all piping should maintain at least  $\frac{1}{4}$ " per every 4 feet of downward pitch for proper drainage. Exact height of riser cut will vary.

3. Connect garden hose to underdrain and connect to appropriate drainage location.
4. Connect overflow to appropriate drainage location using plumbing components. If tying drainage back into riser, install a removable cleanout cap (PVC "Wye" with cap). If riser pipe is being abandoned, install a rubber cap over opening of pipe. Exterior plumbing components should not be glued.



## Plumbing (Continued)

5. Configure downspout to enter planter. Planters located directly underneath or adjacent to downspout may use flexible “accordion-style” diverters as long as the planter is supporting the diverter. Any run of pipe that is not directly supported by the planter must use rigid downspout material. Ensure piping has a slight downward slope (at least ¼” per 4 linear feet) and is secure at both the downspout and at the outlet (fasten to trim assembly using downspout strapping, if necessary). Downspout should drain to area with splash rock and should not be directed to overflow drain.



## Filling & Planting

1. Make sure the horizontal portion of the underdrain is correctly sloped (towards drainage outlet). Fill the bottom of the planter with a minimum of 3” of clean washed drainage stone (pea gravel) to create a base drainage layer. Use just enough gravel to completely cover the horizontal portion of the underdrain.



2. Place WeedBlock filter fabric over base drainage layer. Tuck ends of fabric between gravel and the planter box liner to secure it.



3. Place soil medium into planter to a height 1-2” below overflow drain inlet (atrium grate).



## Filling & Planting (Continued)

4. Plant vegetation according to planting instructions provided with the plants. Taller species should be planted in the rear with shorter species in front. Grasses may be isolated. Be sure to water plants after planting is completed.



5. Place splash rock underneath the downspout diverter outlet to a depth of approximately 1" and covering around 1/3 of the soil. This will allow stormwater to disperse throughout the planter.



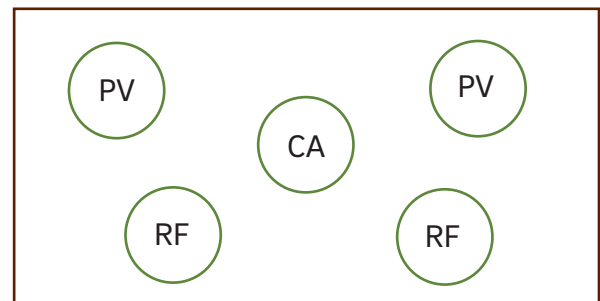
## Completion

1. Attach skirt to planter using 1-5/8" screws. Attach screws from the side (not the front) when possible.
2. Affix Rain Check signage to planter using 1/2" or 5/8" stainless steel fasteners (white top gutter screws preferred). Signage should be facing street or passersby.
3. Take "After" photos.



This section provides a series of examples, along with planting guides, of existing downspout planters. After installation of plants, install a 1-2 inch layer of shredded hardwood mulch or stone mulch (e.g., river pebbles) as a top dressing to cover this soil media. This will deter weeds from growing in the downspout planter and will also serve as an energy dissipater for incoming water.

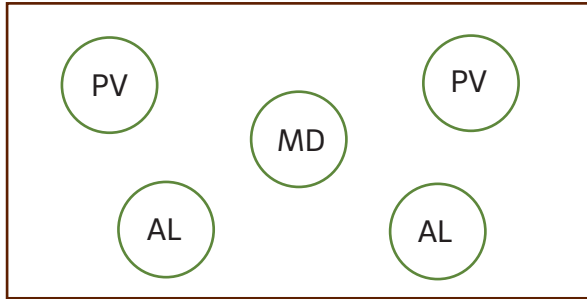
### Sun - Partial Shade



#### Plant Recommendations for Sun to Partial Shade

Symbol	Scientific Name	Common Name	Plant Form
CA	<i>Calamagrostis x acutiflora</i> 'Karl Foerster'	Feather Reed Grass	Grass
PV	<i>Panicum virgatum</i> 'Shenandoah'	Red Switch Grass	Grass
RF	<i>Rudbeckia fulgida</i> 'Goldstrum'	Black-eyed Susan	Perennial wildflower

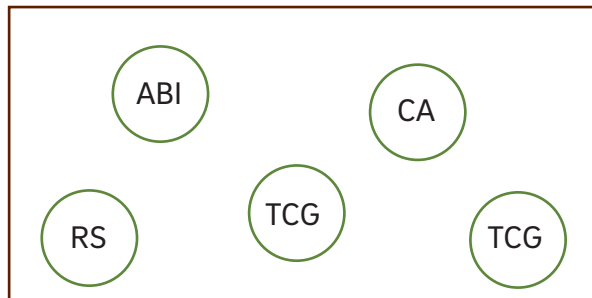
### Full Sun



#### Plant Recommendations for Full Sun

Symbol	Scientific Name	Common Name	Plant Form
AL	<i>Aster laevis</i>	Smooth Aster	Perennial wildflower
MD	<i>Monarda didyma</i>	Bee Balm	Perennial wildflower
PV	<i>Panicum virgatum</i> 'Shenandoah'	Red Switch Grass	Grass

### Shade



#### Plant Recommendations for Shade

Symbol	Scientific Name	Common Name	Plant Form
ABI	<i>Amsonia</i> 'Blue Ice'	Blue Star	Perennial wildflower
CA	<i>Calamagrostis x acutiflora</i> 'Karl Foerster'	Feather Reed Grass	Grass
RS	<i>Rudbeckia fulgida</i> var. <i>speciosa</i>	Black-eyed Susan	Perennial wildflower
TCG	<i>Tradescantia</i> 'Concord Grape'	Spiderwort	Perennial wildflower

### Additional Plant Options

#### Full Sun to Partial Sun Perennials

- \*Aster 'Raydon's Favorite'
- Aster 'Bluebird'
- \*Agastache foeniculum
- Calamintha 'White Cloud'
- Chelone lyonii 'Hot Lips'
- \*Panicum 'Shenandoah'-'Ruby Ri
- Pycnanthemum muticum
- Eupatorium 'Little Joe'
- Filipendula rubra
- Helenium cv.
- Hibiscus 'Fantasia'-'Kopper King'-'Robert Fleming'-'Plum Crazy'
- Iris ensata, Iris versicolor, Iris sibirica.
- \*Liatris spicata 'Kobold'
- \*Lobelia cardinalis
- \*Lobelia siphilitica
- Salvia nemerosa cv.
- Sedum 'Autumn Fire'
- \*Salidago 'Little Lemon'-'Golden Fleece'-'Fire-work's
- \*Vernonia lettermannii 'Iron Butterflies'

#### Full Sun to Partial Sun Grass Species

- Bouteloua gracilis 'Blond Ambition'
- Carex 'Prairie Fire'
- Chasmanthium latifolium
- \*Juncus effusus
- \*Schizachyrium cv.
- \*Panicum (short variey like 'Shenandoah' or 'Ruby Ribbons')

#### Partial Shade to Full Shade Perennials

- Aruncus aethusifolia
- \*Aster divaricatus 'Eastern Star'
- Chelone glabra
- Euphorbia amygdaloides var. robbiae
- \*Pycnanthemum muticum
- Hemerocallis cv.
- Heuchera 'Autumn Bride'
- \*Lobelia cardinalis
- \*Lobelia siphilitica
- Tricyrtis 'Sinonome'
- \*Veroniscastrum virginica

#### Partial Shade to Full Shade Grass Species

- Carex flacca 'Blue Zinger'
- Carex appalachica
- Carex 'Bunny Blue'
- Carex 'Oehme'
- \*Chasmanthium latifolium
- Sesleria autumnalis



\*indicates particularly hardy species

# Permeable Paver Pricing

Most projects cost between \$30 to \$50 per square foot (sf). Rain Check will contribute \$15 per sf for permeable pavers, up to a maximum of \$1,500

## What goes into a project's total cost?

- Material costs: pavers cost more than poured concrete
- Fair wages for employees
- Insurance
- Material disposal
- Contractors have completed specialized training

## Why are some projects more expensive than others?

- Location and travel time
- Size, scope, shape of project
- Number of employees required for project
- Ease of access to work site
- Parking conditions
- Complexity of design
- Brand, color, and style of permeable paver chosen
- Intended use of area to be paved (driveways are more costly than patios)
- Unknown factors: sometimes you don't know what you'll find until you dig



## Participant Cost

PWD subsidies cover paver cost only – other project components (like fencing) are paid for by the participant and are excluded from these totals.

After PWD subsidy of up to \$1,500, most participants have paid out of pocket \$2,000-\$8,000. Exact costs depend on site specific factors.

**See back for more →**

# Prepare for Your Consultation

Ask Yourself these questions to get the most out of your consultation

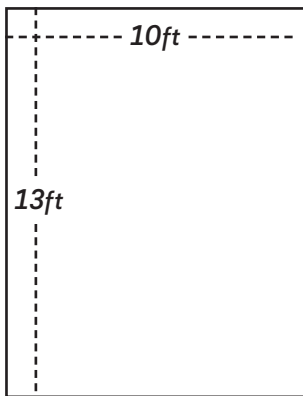
- What is your budget for this project?
- Will the whole area be permeable pavers?
- Will some of the area be left depaved for a garden area?
- What type of pavers do you want?

## Measuring the Project's Area

Knowing the size of your space can help you estimate the cost and help you plan your project.

Using a tape measure, measure the length and width of your area in feet.

**(length** of area in feet) x **(width** of area in feet) = **area** in square feet



*Square Foot Example:*

**13ft x 10ft = 130sf**

*Costs for 130sf example:*

**Project Cost: \$4,550 (\$35 sf)**

**Rain Check Subsidy: \$1,500**

**Your Final Cost: \$3,050**

*\*most projects cost \$30-\$50 per square foot (sf)*

### Own a Rowhome?

Keep in mind when measuring your space that the alleyway between two rowhomes is often not eligible for Permeable Pavers. The contractor can discuss regular pavers or other unsubsidized treatments with you.

## Example Projects:



### PATIO A - 153<sup>SF</sup>

**Paver Cost \$5,261**

**Participant Cost \$3,761**

**Cost per sf \$34.39**

153 sf of concrete removed and replaced with permeable pavers in a running bond pattern. Back portion of patio was depaved and finished with clean stone.

Access to site was **easy**.



### PATIO B - 149<sup>SF</sup>

**Paver Cost \$6,266**

**Participant Cost \$4,766**

**Cost per sf \$42.00**

149 sf of concrete removed and replaced with permeable pavers. This is an example of herring bone pattern pavers.

Access to site was **difficult**.



### DRIVEWAY - 170<sup>SF</sup>

**Paver Cost \$8,386**

**Participant Cost \$6,886**

**Cost per sf \$49.33**

170 sf of concrete removed and replaced with permeable paver driveway. Cost per sf reflects deeper excavation and stone base layer required to accommodate vehicle weight.

Access to site was **easy**.



**pennsylvania**

DEPARTMENT OF ENVIRONMENTAL PROTECTION

**EROSION AND SEDIMENT POLLUTION  
CONTROL PROGRAM MANUAL**

**FINAL**

**Technical Guidance Number  
363-2134-008**

**March 2012**

**BUREAU OF WATERWAYS ENGINEERING AND WETLANDS  
DIVISION OF WETLANDS, ENCROACHMENT AND TRAINING**

STILLING BASIN (Plunge Pool) - Stilling basins may be used at pipe outfalls where the discharge is at or near horizontal, and sufficient room exists to construct the basin between the pipe and the receiving watercourse. The size and shape of stilling basins is based upon the anticipated scour hole below a pipe outfall due to a design discharge. Experience has shown that the size and amount of the riprap required for a stilling basin are often less than would be required for a riprap apron.



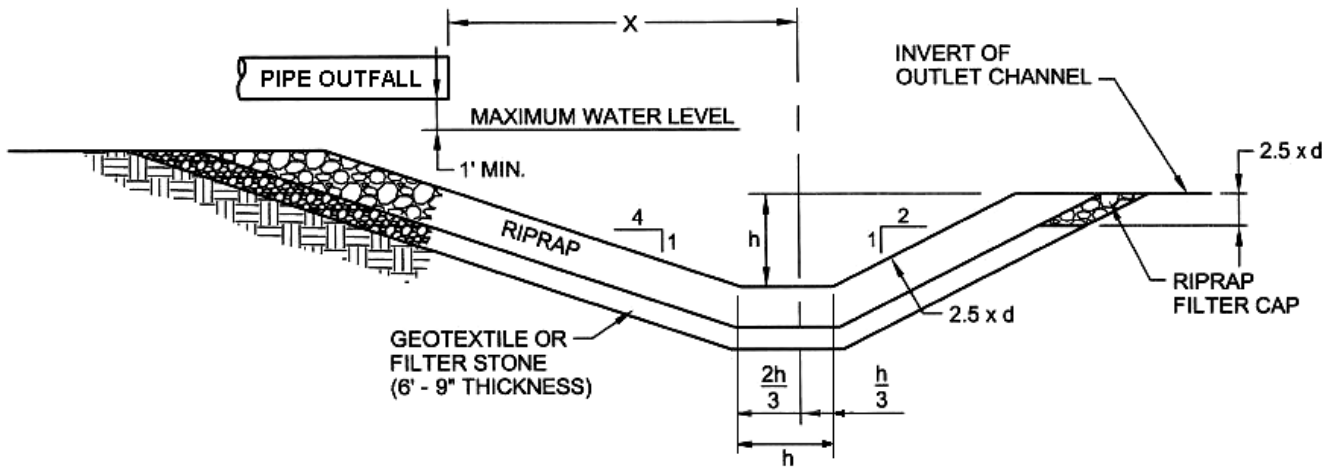
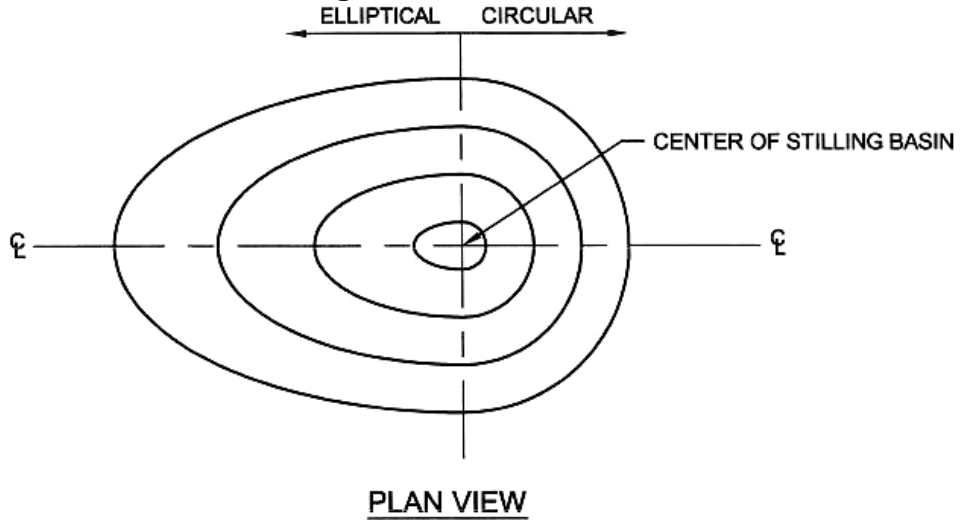
Vernon County Land and Water Conservation

Stilling basins should be designed and constructed according to the details shown in Standard Construction Detail # 9-4. Geotextile may be substituted for the filter stone underlayment.

The minimum vertical distance from the bottom of the pipe to the maximum water surface elevation is 12 inches.

# STANDARD CONSTRUCTION DETAIL # 9-4

## Stilling Basin



Adapted from USDOT, FHWA HEC 14

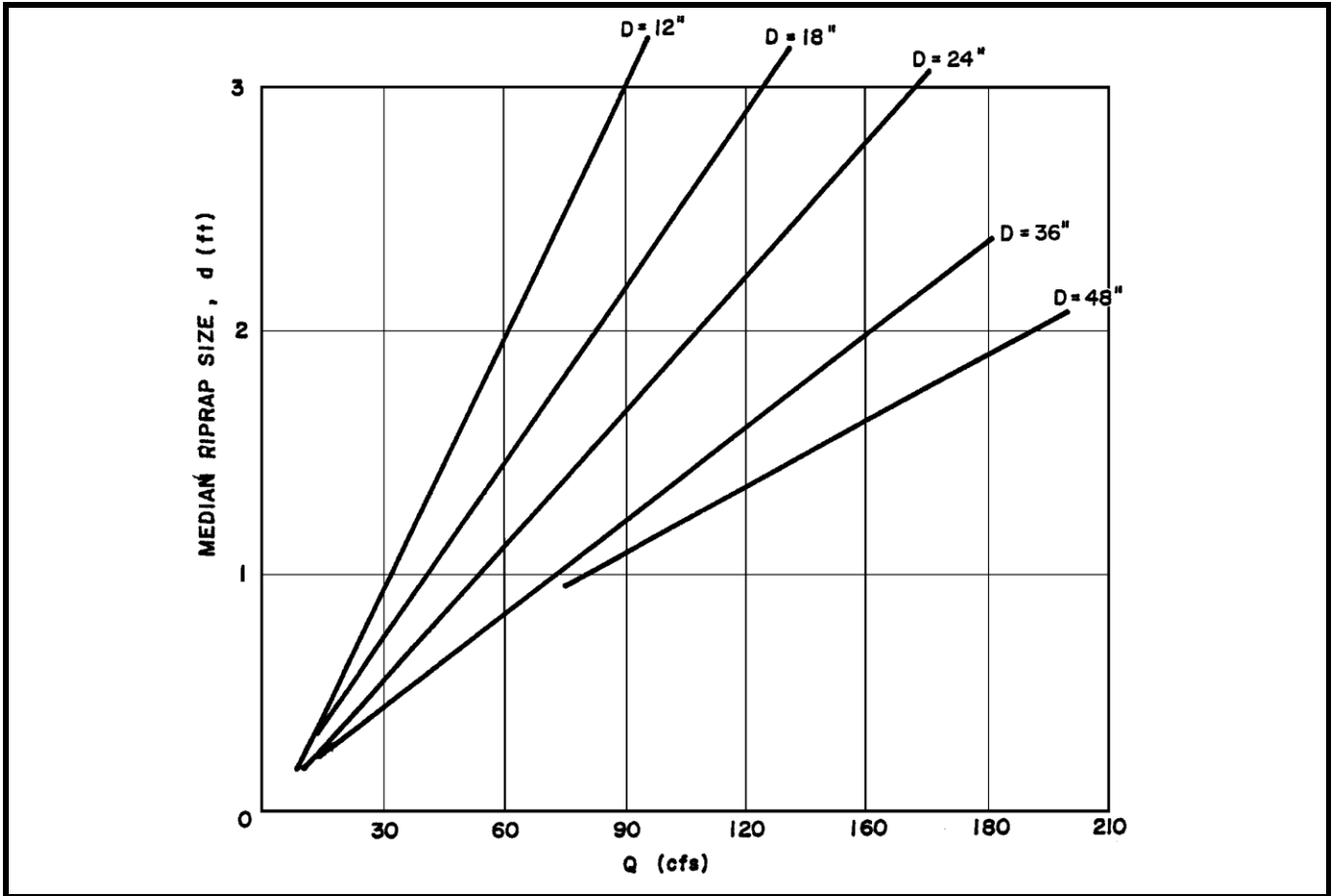
NOTE: This table is intentionally blank and should be filled in by the plan preparer.

OUTLET NO.	X (ft)	h (ft)	Riprap Size (R <sub>1</sub> )	d <sub>50</sub> Stone Size d (in)

**Riprap thickness shall be 1.5 times the maximum stone size.**

Determine the d<sub>50</sub> stone size (d) for the stilling basin from Figure 9.7 using the design discharge and the pipe diameter.

**FIGURE 9.7**  
**d<sub>50</sub> Stone Size for Stilling Basins**



Adapted from USDOT, FHWA HEC 14

Calculate the required basin depth (h) by the formula:

$$h = D^{1/3} \left[ 0.148 \frac{Q}{Dd^{1/2}} - 1.82 (d) \right]^{2/3}$$

- where: h = Basin depth (ft)  
 D = Inside diameter of the pipe (ft)  
 d = d<sub>50</sub> stone size of the riprap (ft)  
 Q = Design discharge (cfs)

Calculate the distance (X) in feet from the end of the discharge pipe to the "center" of the basin by using the following formula:  $X = (V^2/2g)^{0.5} \left[ 1 + m/p \right]^{0.5} + 1 + m/2p$

- where: v = Discharge velocity (fps)  
 g = Acceleration due to gravity (32.2 ft/sec<sup>2</sup>)  
 m = Depth of water (ft) in the basin during maximum pipe discharge (i.e. h + channel flow depth)  
 p = Vertical distance (ft) from inside crown of the pipe to the maximum water surface

PENNSYLVANIA

Stormwater BMP Manual

December 30, 2006

## BMP 6.6.2: Wet Pond/Retention Basin

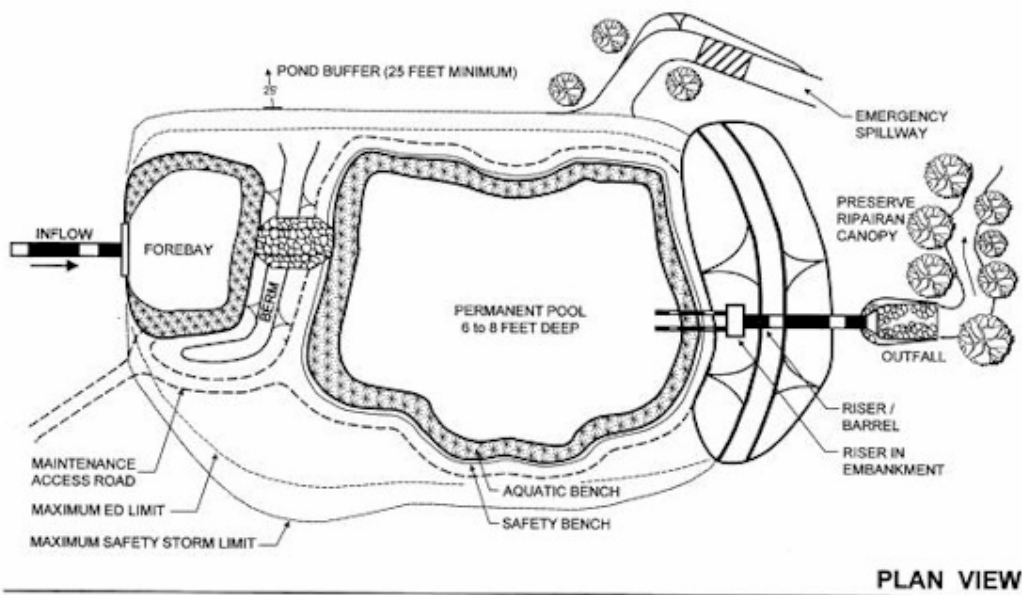


Wet Ponds/Retention Basins are stormwater basins that include a substantial permanent pool for water quality treatment and additional capacity above the permanent pool for temporary runoff storage.

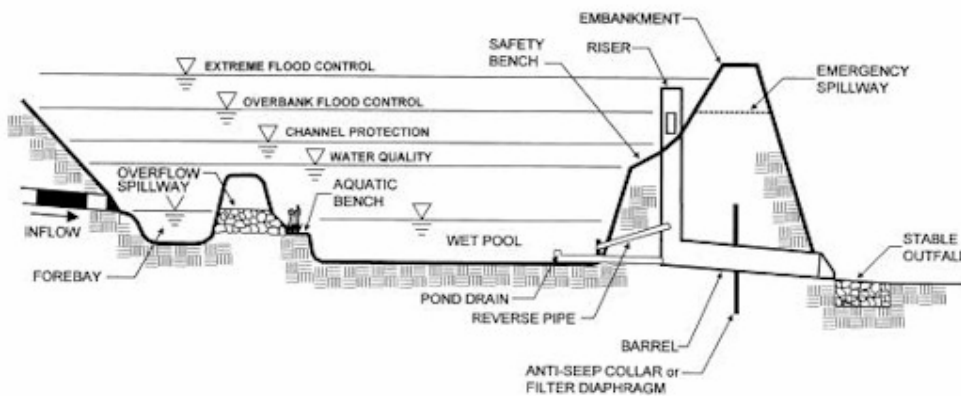
<p style="text-align: center;"><b><u>Key Design Elements</u></b></p> <ul style="list-style-type: none"> <li>▪ Adequate drainage area (usually 5 to 10 acres minimum) or proof of sustained baseflow</li> <li>▪ Natural high groundwater table</li> <li>▪ Maintenance of permanent water surface</li> <li>▪ Should have at least 2 to 1 length to width ratio</li> <li>▪ Robust and diverse vegetation surrounding wet pond</li> <li>▪ Relatively impermeable soils</li> <li>▪ Forebay for sediment collection and removal</li> <li>▪ Dewatering mechanism</li> </ul>	<p style="text-align: center;"><b><u>Potential Applications</u></b></p> <p>Residential: Yes                  Commercial: Yes                  Ultra Urban: Yes                  Industrial: Yes                  Retrofit: Yes                  Highway/Road: Yes</p>
	<p style="text-align: center;"><b><u>Stormwater Functions</u></b></p> <p>Volume Reduction: Low                  Recharge: Low                  Peak Rate Control: High                  Water Quality: Medium</p>
	<p style="text-align: center;"><b><u>Water Quality Functions</u></b></p> <p>TSS: 70%                  TP: 60%                  NO3: 30%</p>

### Description

Wet Detention Ponds are stormwater basins that include a permanent pool for water quality treatment and additional capacity above the permanent pool for temporary storage. Wet Ponds should include one or more forebays that trap coarse sediment, prevent short-circuiting, and facilitate maintenance. The pond perimeter should generally be covered by a dense stand of emergent wetland vegetation. While they do not achieve significant groundwater recharge or volume reduction, they can be effective for pollutant removal and peak rate mitigation. Wet Ponds (WPs) can also provide aesthetic and wildlife benefits. WPs require an adequate source of inflow to maintain the permanent water surface. Due to the potential to discharge warm water, wet ponds should be used with caution near temperature sensitive waterbodies. Properly designed and maintained WPs generally do not support significant mosquito populations (O'Meara).



PLAN VIEW



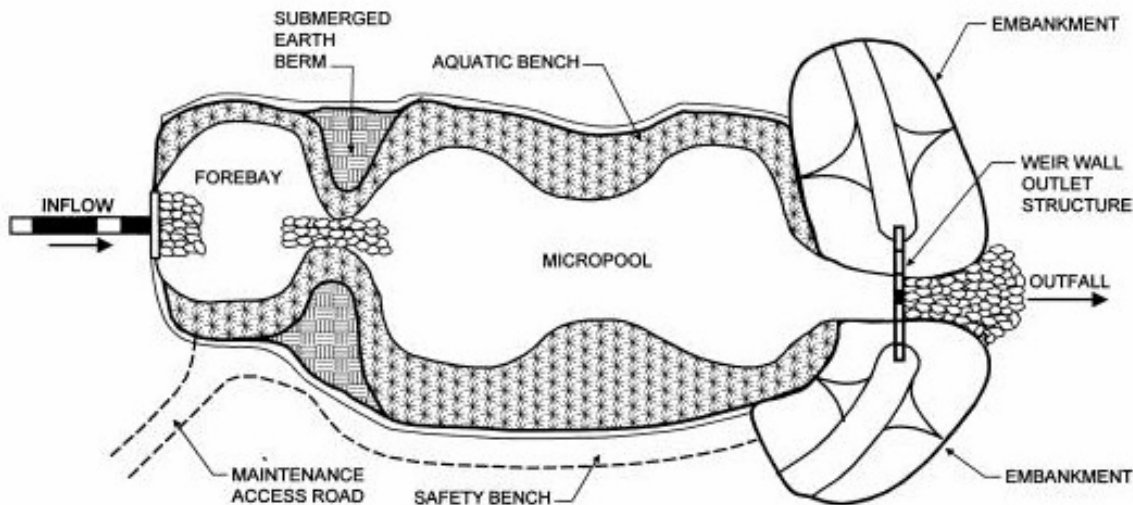
PROFILE

## Variations

Wet Ponds can be designed as either an online or offline facilities. They can also be used effectively in series with other sediment reducing BMPs that reduce the sediment load such as vegetated filter strips, swales, and filters. Wet Ponds may be a good option for retrofitting existing dry detention basins. WPs are often organized into three groups:

- Wet Ponds primarily accomplish water quality improvement through displacement of the permanent pool and are generally only effective for small inflow volumes (often they are placed offline to regulate inflow).
- Wet Detention Ponds are similar to Wet Ponds but use extended detention as another mechanism for water quality and peak rate control.
- Pocket Wet Ponds are smaller WPs that serve drainage areas between approximately 5 and 10 acres and are constructed near the water table to help maintain the permanent pool. They often include extended detention as well.

This BMP focuses on Wet Detention Ponds as described above because this tends to be the most common and effective type of Wet Pond. For more information on other types of wet ponds, please consult the “References and Additional Resources” list.



## Applications

- **Wet Ponds**
- **Wet Detention Ponds**
- **Pocket Wet Pond**
- **Offline Wet Pond**
- **Retrofit for existing detention basins**



### Design Considerations

1. HYDROLOGY. Wet Ponds should be able to receive and retain enough flow from rain, runoff, and groundwater to ensure long-term viability. A permanent water surface in the deeper areas of the WP should be maintained during all but the driest periods. A relatively stable permanent water surface elevation will reduce the stress on vegetation in and adjacent to the pond. A WP should have a drainage area of at least 10 acres (5 acres for Pocket Wet Ponds) or some means of sustaining constant inflow. Even with a large drainage area, a constant source of inflow can improve the biological health and effectiveness of a Wet Pond while discouraging mosquito growth. Pennsylvania’s precipitation is generally well distributed throughout the year and is therefore suited for WPs.
2. UNDERLYING SOILS. Underlying soils must be identified and tested. Generally hydrologic soil groups “C” and “D” are suitable without modification, “A” and “B” soils may require modification to reduce permeability. Soil permeability must be tested in the proposed Wet Pond location to ensure that excessive infiltration will not cause the WP to dry out.
3. PLANTING SOIL. Organic soils should be used for shallow areas within Wet Ponds. Organic soils can serve as a sink for pollutants and generally have high water holding capacities. They will also facilitate plant growth and propagation and may hinder invasion of undesirable species.
4. SIZE AND VOLUME. The area required for a WP is generally 1 to 3 percent of its drainage area. WPs should be sized to treat the water quality volume and, if necessary, to mitigate the peak rates for larger events.
5. VEGETATION. Vegetation is an integral part of a Wet Pond system. Vegetation in and adjacent to a pond may enhance pollutant removal, reduce algal growth, limit erosion, improve aesthetics, create habitat, and reduce water warming (Mallin et al., 2002; NJ DEP, 2004; University of Wisconsin, 2000). Wet Ponds should have varying depths to encourage vegetation in shallow areas. The emergent vegetation zone (areas not more than 18" deep) generally supports the majority of aquatic vegetation and should include the pond perimeter. Robust, non-invasive, perennial plants that establish quickly are ideal for WPs. The designer should select species that are tolerant of a range of depths, inundation periods, etc. Monoculture planting should be avoided due to the risk from pests and disease. See local sources for recommended plant lists or Appendix B.

## 6. CONFIGURATION.

- a. General. Wet Ponds should be designed with a length to width ratio of at least 2:1 wherever possible. If the length to width ratio is lower, the flow pathway through the WP should be maximized. A wedge-shaped pond with the major inflows on the narrow end can prevent short-circuiting and stagnation. WPs should not be constructed within 10 feet of the property line or within 50 feet of a private well or septic system. Slopes in and around Wet Ponds should be 4:1 to 5:1 (horizontal:vertical) or flatter wherever possible (10:1 max. for safety/aquatic benches, see 6.d. below). Wet Ponds should have an average depth of 3 to 6 feet and a maximum depth of 8 feet. This should be shallow enough to minimize thermal stratification and short-circuiting and deep enough to prevent sediment resuspension, reduce algal blooms, and maintain aerobic conditions. Wet ponds should not be constructed within a natural watercourse.
  - b. Forebay/Inflows. Wet Ponds should have a forebay at all major inflow points to capture coarse sediment, prevent excessive sediment accumulation in the remainder of the WP, and minimize erosion by inflow. The forebays should contain 10 to 15 percent of the total permanent pool volume and should be 4 to 6 feet deep. They should be physically separated from the rest of the pond by a berm, gabion wall, etc. Flows exiting the forebay should be non-erosive to the newly constructed WP. Vegetation within forebays can increase sedimentation and reduce resuspension/erosion. The forebay bottom can be constructed of hardened materials to facilitate sediment removal. Forebays should be installed with permanent vertical markers that indicate sediment depth. Inflow channels should be fully stabilized. Inflow pipes can discharge to the surface or be partially submerged. Forebays should be offline (out of the path of higher flows) to prevent resuspension of previously collected sediment during large storms.
  - c. Outlet. Outlet control devices should draw from open water areas 5 to 7 feet deep to prevent clogging and allow the WP to be drained for maintenance and to provide for additional temperature benefits. Outlet devices are generally multistage structures with pipes, orifices, or weirs for flow control. A reverse slope pipe terminating 2 to 3 feet below the normal water surface, minimizes the discharge of warm surface water and is less susceptible to clogging by floating debris. Orifices, if used, should be at least 2.5 inches in diameter and should be protected from clogging. Outlet devices should be installed in the embankment for accessibility. If possible, outlet devices should enable the normal water surface to be varied. This allows the water level to be adjusted (if necessary) seasonally, as the WP accumulates sediment over time, if desired grades are not achieved, or for mosquito control. A pond drain should also be included which allows the permanent pool to be completely drained for maintenance within 24 hours. The outlet pipe should generally be fitted with an anti-seep collar through the embankment. Online facilities should have an emergency spillway that can safely pass the 100-year storm with 1 foot of freeboard. All outflows should be conveyed downstream in a safe and stable manner.
  - d. Safety/Aquatic Benches. All areas that are deeper than 4 feet should have two safety benches, totaling 15 feet in width. One should start at the normal water surface and extend up to the pond side slopes at a maximum slope of 10 percent. The other should extend from the water surface into the pond to a maximum depth of 18 inches, also at slopes no greater than 10 percent.
7. WET POND BUFFER. To enhance habitat value, visual aesthetics, water temperature, and pond health, a 25-foot buffer should be added from the maximum water surface elevation. The buffer should be planted with trees, shrubs, and native ground covers. Except in maintenance access areas, turf grass should not be used. Existing trees within the buffer should be preserved. If soils in the buffer will become compacted during construction, soil restoration should take place to aid buffer vegetation.

8. **MAINTENANCE ACCESS.** Permanent access must be provided to the forebay, outlet, and embankment areas. It should be at least 9 feet wide, have a maximum slope of 15%, and be stabilized for vehicles.
9. **PLAN ELEMENTS.** The plans detailing the Wet Ponds should clearly show the WP configuration, inlets and outlets, elevations and grades, safety/aquatic benches, and the location, quantity, and propagation methods of pond/buffer vegetation. Plans should also include site preparation techniques, construction sequence, as well as maintenance schedules and requirements.
10. **REGULATION.** Wet Ponds that have drainage areas over 100 acres, embankments greater than 15 feet high, or a capacity greater than 50 acre-feet may be regulated as a dam by PADEP (see Title 25, Chapter 105 of the Pennsylvania Code).



## Detailed Stormwater Functions

### Volume Reduction Calculations

Although not typically considered a volume-reducing BMP, Wet Ponds can achieve some volume reduction through infiltration and evapotranspiration, especially during small storms. According to the International Stormwater BMP Database, wet ponds have an average annual volume reduction of 7 percent (Strecker et al., 2004). Hydrologic calculations that should be performed to verify that the WP will have a viable amount of inflow can also predict the water surface elevation under varying conditions. The volume stored between the predicted water level and the lowest outlet elevation will be removed from the that design storm.

### Peak Rate Mitigation Calculations

Peak rate is primarily controlled in Wet Ponds through the transient storage above the normal water surface. See Section 8 for Peak Rate Mitigation methodology.

### Water Quality Improvement

Wet Ponds improve runoff quality through settling, filtration, uptake, chemical and biological decomposition, volatilization, and adsorption. WPs are relatively effective at removing many common stormwater pollutants including suspended solids, heavy metals, total phosphorus, total nitrogen, and pathogens. The pollutant removal effectiveness varies by season and may be affected by the age of the WP. It has been suggested that this type of BMP does not provide significant nutrient removal in the long term unless vegetation is harvested because captured nutrients are released back into the water by decaying plant material. Even if this is true, nutrients are usually released gradually and during the non-growing season when downstream susceptibility is generally low (Hammer, 1990). See Section 8 for Water Quality Improvement methodology, which addresses pollutant removal effectiveness of this BMP.

## Construction Sequence

1. Separate wet pond area from contributing drainage area:
  - a. All channels/pipes conveying flows to the WP should be routed away from the WP area until it is completed and stabilized.
  - b. The area immediately adjacent to the WP should be stabilized in accordance with the PADEP's *Erosion and Sediment Pollution Control Program Manual* (2000 or latest edition) prior to construction of the WP.
2. Clearing and Grubbing:
  - a. Clear the area to be excavated of all vegetation.
  - b. Remove all tree roots, rocks, and boulders.
  - c. Fill all stump holes, crevices and similar areas with impermeable materials.
3. Excavate bottom of WP to desired elevation (Rough Grading).
4. Install surrounding embankments and inlet and outlet control structures.
5. Grade and prepare subsoil.

6. Apply and grade planting soil.
  - a. Matching design grades is crucial because aquatic plants can be very sensitive to depth.
7. Apply erosion-control measures.
8. Seed, plant and mulch according to Planting Plan
9. Install any anti-grazing measures, if necessary.
10. Follow required maintenance and monitoring guidelines.

### **Maintenance Issues**

Wet Ponds should have a maintenance plan and privately owned facilities should have an easement, deed restriction, or other legal measure to prevent neglect or removal. During the first growing season or until established, vegetation should be inspected every 2 to 3 weeks. WPs should be inspected at least 4 times per year and after major storms (greater than 2 inches in 24 hours) or rapid ice breakup. Inspections should assess the vegetation, erosion, flow channelization, bank stability, inlet/outlet conditions, embankment, and sediment/debris accumulation. The pond drain should also be inspected and tested 4 times per year. Problems should be corrected as soon as possible. Wet Pond and buffer vegetation may need support (watering, weeding, mulching, replanting, etc.) during the first 3 years. Undesirable species should be carefully removed and desirable replacements planted if necessary.

Once established, properly designed and installed Wet Ponds should require little maintenance. Vegetation should maintain at least an 85 percent cover of the emergent vegetation zone and buffer area. Annual harvesting of vegetation may increase the nutrient removal of WPs; if performed it should generally be done in the summer so that there is adequate regrowth before winter. Care should be taken to minimize disturbance, especially of bottom sediments, during harvesting. The potential disturbance from harvesting may outweigh its benefits unless the WP receives a particularly high nutrient load or discharges to a nutrient sensitive waterbody. Sediment should be removed from the forebay before it occupies 50 percent of the forebay, typically every 5 to 10 years.

### **Cost Issues**

The construction cost of Wet Ponds can vary greatly depending on the configuration, location, site-specific conditions, etc. Typical construction costs in 2004 dollars range from approximately \$25,000 to \$50,000 per acre-foot of storage (based on USEPA, 1999). Costs are generally most dependent on the amount of earthwork and the planting. Annual maintenance costs have been reported to be approximately 3 to 5 percent of the capital costs although there is little data available to support this. In addition to the construction and maintenance costs, there is the cost or loss of value for the property involved.

### **Specifications:**

The following specifications are provided for information purposes only. These specifications include information on acceptable materials for typical applications, but are by no means exclusive or limiting. The designer is responsible for developing detailed specifications for individual design projects in accordance with the project conditions.

**1. Excavation**

- a. The area to be used for the WP should be excavated to the required depth below the desired bottom elevation to accommodate any required impermeable liner, organic matter, and/or planting soil.
- b. The compaction of the subgrade and/or the installation of any impermeable liners will follow immediately.

**2. Subsoil Preparation**

- a. Subsoil shall be free from hard clods, stiff clay, hardpan, ashes, slag, construction debris, petroleum hydrocarbons, or other undesirable material. Subsoil must not be delivered in a frozen or muddy state.
- b. Scarify the subsoil to a depth of 8 to 10 inches with a disk, rototiller, or similar equipment.
- c. Roll the subsoil under optimum moisture conditions to a dense layer with four to six passes of a sheepfoot roller or equivalent. The compacted layer shall be at least 8 inches thick.

**3. Planting Soil (Topsoil)**

- a. Use a minimum of 12 inches of topsoil in the emergent vegetation zone (less than 18" deep) of the pond. If natural topsoil from the site is to be used it must have at least 8 percent organic carbon content (by weight) in the A-horizon for sandy soils and 12% for other soil types.
- b. If planting soil is being imported it should be made up of equivalent proportions of organic and mineral materials.
- c. Lime should not be added to planting soil unless absolutely necessary as it may encourage the propagation of invasive species.
- d. The final elevations and hydrology of the vegetative zones should be evaluated prior to planting to determine if grading or planting changes are required.

**4. Vegetation**

- a. Plant Lists for WPs can be found locally. No substitutions of specified plants will be accepted without prior approval of the designer. Planting locations shall be based on the Planting Plan and directed in the field by a qualified wetland ecologist.
- b. All Wet Pond plant stock shall exhibit live buds or shoots. All plant stock shall be turgid, firm, and resilient. Internodes of rhizomes may be flexible and not necessarily rigid. Soft or mushy stock shall be rejected. The stock shall be free of deleterious insect infestation, disease and defects such as knots, sun-scald, injuries, abrasions, or disfigurement that could adversely affect the survival or performance of the plants.
- c. All stock shall be free from invasive or nuisance plants or seeds.
- d. During all phases of the work, including transport and onsite handling, the plant materials shall be carefully handled and packed to prevent injuries and desiccation. During transit and onsite handling, the plant material shall be kept from freezing and shall be kept covered, moist, cool, out of the weather, and out of the wind and sun. Plants shall be watered to maintain moist soil and/or plant conditions until accepted.
- e. Plants not meeting these specifications or damaged during handling, loading, and unloading will be rejected.
- f. Detailed planting specifications can be found locally, and in Appendix B.

**5. Outlet Control Structure**

- a. Outlet control structures shall be constructed of non-corrodible material.
- b. Outlets shall be resistant to clogging by debris, sediment, floatables, plant material, or ice.
- c. Materials shall comply with applicable specifications (PennDOT or AASHTO, latest edition)

## References

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- Caraco, D. and Claytor, R. *Stormwater BMP Design Supplement for Cold Climates*. 1997.
- Center for Watershed Protection and Maryland Department of the Environment. *2000 Maryland Stormwater Design Manual*. Baltimore, MD: 2000.
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- CH2MHILL. *Pennsylvania Handbook of Best Management Practices for Developing Areas*. 1998.
- Cummings and Booth, circa 2003. "Stormwater Pollutant Removal by Two Wet Ponds in Bellevue, Washington." Department of Civil and Environmental Engineering, University of Washington, Seattle, WA, 23 pp.
- "Effectiveness of Best Management Practices (BMPs) for Stormwater Treatment." City of Greensboro (NC), Water Resources Department, circa 2000. Available as of October 2004 at <http://www.greensboro-nc.gov/stormwater/Quality/bmpeffectiveness.htm>.
- Federal Highway Administration, *Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring*. "Fact Sheet – Detention Basins."
- Hammer, D.A. (editor). *Constructed Wetlands for Wastewater Treatment, Municipal, Industrial and Agricultural*. Ann Arbor, MI: Lewis Publishers, 1990.
- Mallin, M.; Ensign, S.; Wheeler, T.; and Mayes; D. "Pollutant Removal Efficacy of Three Wet Detention Ponds." *Journal of Environmental Quality* 31: 654-660 (2002).
- New Jersey Department of Environmental Protection. *New Jersey Stormwater Best Management Practices Manual*. 2004.
- O'Meara, G.F. "Mosquito Associated with Stormwater Detention/Retention Areas." University of Florida, Institute of Food and Agricultural Sciences.
- Strecker, E.W.; Quigley, M.M.; Urbonas, B.; and Jones, J. "Analyses of the Expanded EPA/ASCE International BMP Database and Potential Implications for BMP Design." Proceedings of the World Water and Environmental Resources Congress 2004, Salt Lake City, Utah.
- United States Environmental Protection Agency (USEPA). *Storm Water Technology Fact Sheet: Wet Detention Ponds* (EPA 832-F-99-048) 1999.

**INLET FILTER BAG - Sediment Removal Efficiency: MODERATE. This device is an ABACT for HQ but not EV watersheds.** Filter bags should be capable of trapping all particles not passing a No.40 Sieve.



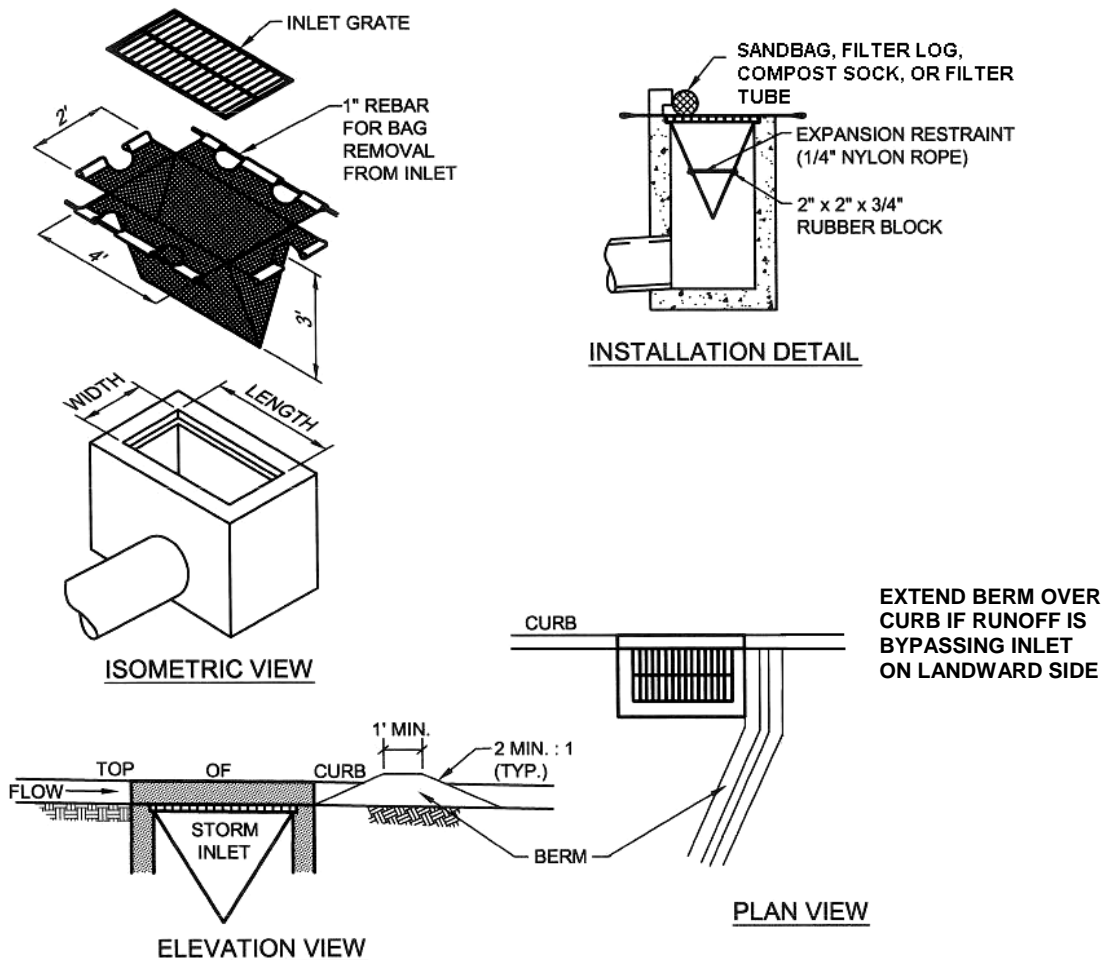
Northampton Conservation District

Wherever filter bags are used they should be installed according to the manufacturer's specifications. Typical installation details should be provided on the drawings. Standard Construction Details # 4-15 and # 4-16 are recommended. NOTE: Filter bags designed to fit over the inlet grate are not recommended for most storm sewer inlets. Use of such filter bags could result in a severe reduction of the inlet capacity resulting in flooding or runoff bypassing the inlet. Wherever such bags are used, they should be located at topographic low points and limited to ¼ acre maximum drainage areas. Inlet filter bags are not acceptable as the primary BMP to remove sediment from site runoff water.

Inlet filter bags should be inspected on a weekly basis and after each runoff event. Filter bags should be cleaned and/or replaced when the bag is half full or when flow capacity has been reduced so as to cause flooding or bypassing of the inlet. Accumulated sediment should be disposed in the approved manner. Bags that will be reused should be rinsed at a location where the rinse water will enter a sediment trap or sediment basin. Damaged filter bags should be replaced.

Needed repairs should be initiated immediately after the inspection.

**STANDARD CONSTRUCTION DETAIL # 4-15**  
**Filter Bag Inlet Protection - Type C Inlet**



Adapted from PennDOT RC-70, 2008 Edition

**Maximum drainage area = 1/2 acre.**

**Inlet protection shall not be required for inlet tributary to sediment basin or trap. Berms shall be required for all installations.**

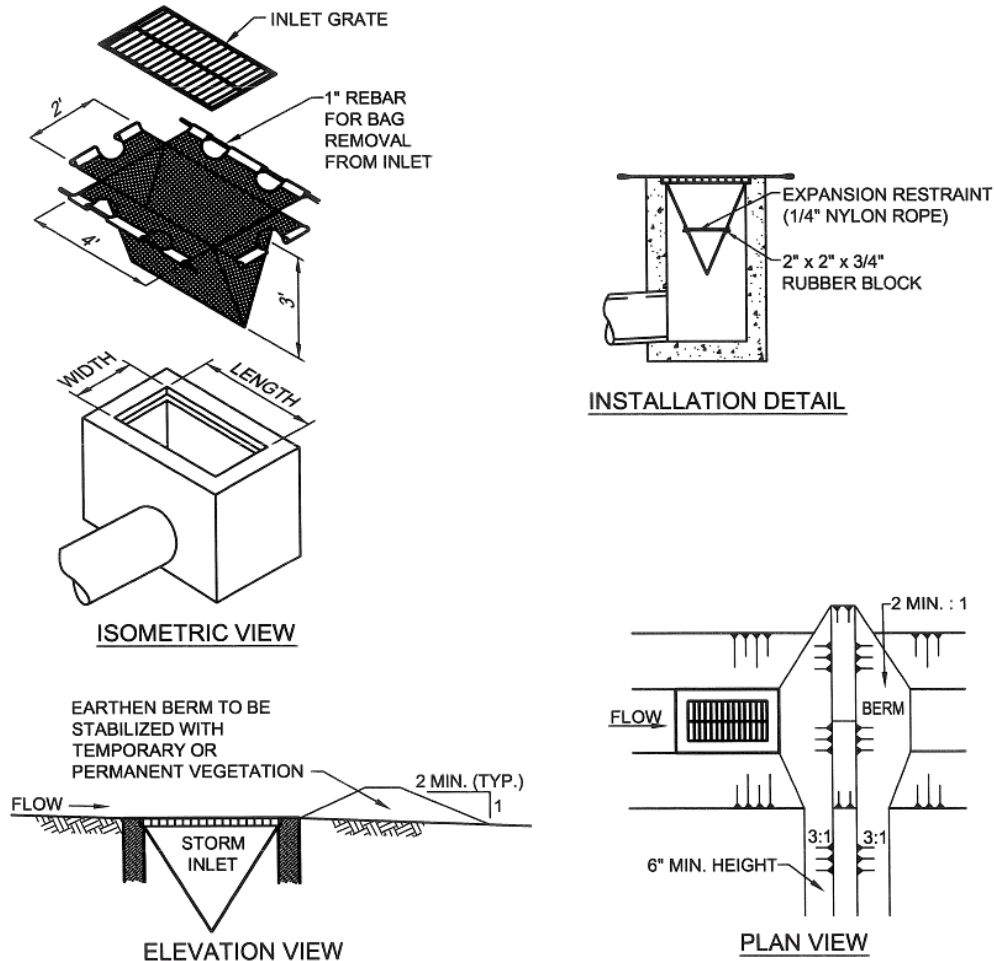
**Rolled earthen berm shall be maintained until roadway is stoned. Road subbase berm shall be maintained until roadway is paved. Six inch minimum height asphalt berm shall be maintained until roadway surface receives final coat.**

**At a minimum, the fabric shall have a minimum grab tensile strength of 120 lbs, a minimum burst strength of 200 psi, and a minimum trapezoidal tear strength of 50 lbs. Filter bags shall be capable of trapping all particles not passing a No. 40 Sieve.**

**Inlet filter bags shall be inspected on a weekly basis and after each runoff event. Bags shall be emptied and rinsed or replaced when half full or when flow capacity has been reduced so as to cause flooding or bypassing of the inlet. Damaged or clogged bags shall be replaced. A supply shall be maintained on site for replacement of bags. All needed repairs shall be initiated immediately after the inspection. Dispose of accumulated sediment as well as all used bags according to the plan notes.**

**DO NOT USE ON MAJOR PAVED ROADWAYS WHERE PONDING MAY CAUSE TRAFFIC HAZARDS.**

**STANDARD CONSTRUCTION DETAIL # 4-16  
Filter Bag Inlet Protection - Type M Inlet**



Adapted from PennDOT RC-70, 2008 Edition

**Maximum drainage area = 1/2 acre.**

**Inlet protection shall not be required for inlet tributary to sediment basin or trap. Berms shall be required for all installations.**

**Rolled earthen berm in roadway shall be maintained until roadway is stoned. Road subbase berm on roadway shall be maintained until roadway is paved. Earthen berm in channel shall be maintained until permanent stabilization is completed or remain permanently.**

**At a minimum, the fabric shall have a minimum grab tensile strength of 120 lbs., a minimum burst strength of 200 psi, and a minimum trapezoidal tear strength of 50 lbs. Filter bags shall be capable of trapping all particles not passing a No. 40 sieve.**

**Inlet filter bags shall be inspected on a weekly basis and after each runoff event. Bags shall be emptied and rinsed or replaced when half full or when flow capacity has been reduced so as to cause flooding or bypassing of the inlet. Damaged or clogged bags shall be replaced. A supply shall be maintained on site for replacement of bags. All needed repairs shall be initiated immediately after the inspection. Dispose accumulated sediment as well as all used bags according to the plan notes.**

**DO NOT USE ON MAJOR PAVED ROADWAYS WHERE PONDING MAY CAUSE TRAFFIC HAZARDS.**

# Pure Basin & Curb

## Inlet Filters

---

Pure basin and curb inlet filters are the preferred choice for permanent inlet protection and stormwater runoff control.

Constructed of versatile stainless steel, Pure inlet filters will fit any drainage structure and are available with site-specific filter bags providing various levels of filtration.

### Applications

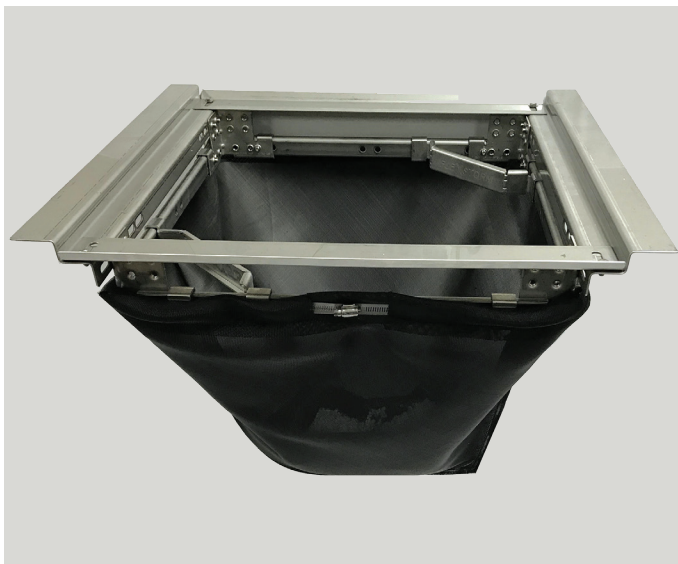
- Car washes
- Commercial
- Loading ramps
- Industrial
- Gas stations
- Parking lots
- Dock drains
- Maintenance

### Features

- Custom stainless steel frames are configured to fit into any drainage structure
- Flow and bypass rates meet specific inlet requirements
- Filter bags target site specific removal of trash, leaves, small particles, oil and grease
- Works below grade with bypass to drain area if bag is full
- Installs quickly and maintained with removal tool

### Features

- Stainless steel frame provides extended service life
- Replaceable filter bags handle loads with a safety factor of five
- Meets stringent removal requirements:
  - FX bags rated >80% removal efficiency of street sweep-size particles
  - PC/PC+ bags have been tested to 99% TSS removal of OK-110 US Silica Sand and 97% TPH (total petroleum hydrocarbon) removal



# Pure Inlet Filters Specification

## Identification

The installer shall inspect the plans and/or worksite to determine the quantity of each drainage structure casting type. The foundry casting number, exact grate size and clear opening size or other information will be necessary to finalize the part number and dimensions.

## Material and performance

The filter is comprised of a stainless steel frame and a replaceable geotextile filter bag attached to the frame with a stainless steel locking band. The filter bag hangs suspended below the grate that shall allow full bypass flow into the drainage structure if the bag is completely filled with sediment. The standard woven polypropylene FX filters bags are rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load. The post-construction PC filter bags are rated for 137 gpm/sqft and have been third-party tested at 99% TSS removal to 110 micron and 97% TPH removal of used motor oil hydrocarbon mix.

## Installation

Remove the grate and clean the ledge of the frame to ensure it is free of stone and dirt. Hang the inlet filter's suspension hangers firmly on the casting's inside ledge. Replace the grate and confirm it is elevated no more than  $\frac{1}{8}$ " (3 mm). For wall mount units, follow instructions for attaching the stainless steel mounting brackets using the provided concrete fasteners.

## Inspection Frequency

Construction site inspection should occur following each  $\frac{1}{2}$ " (12 mm) or more rain event. Post construction inspections should occur three times per year in areas with mild year round rainfall and four times per year in areas with summer rains. Industrial application site inspections should occur on a regular scheduled basis no less than three times per year.

## Maintenance guidelines

Empty the filter bag if more than half filled with sediment and debris or as directed by the engineer. Remove the grate, engage the lifting bars or handles with the removal tool and lift from the structure. Dispose of the sediment or debris as directed by the engineer or maintenance contract in accordance with EPA guidelines.

As an alternative, an industrial vacuum may be used to collect the accumulated sediment. Remove any caked-on silt from the sediment bag and reverse flush the bag with medium spray for optimal filtration. Replace the bag if torn or punctured to  $\frac{1}{2}$ " (12 mm) diameter or greater on the lower half of the bag. Post-construction PC/PC+ bags should be maintained prior to 50% oil saturation. The average 2'x2' PC filter bag will retain approximately 96 oz (2.8 l) of oil at which time it should be serviced or replaced. When utilizing the Cleartec Rubberizer Pouches in the PC+ bags note that these oil skimmers will gradually turn brown and solidify, indicating replacement is needed. Each pouch will absorb approximately 62 oz. (1.8 l) of oil before requiring replacement. The spent media may be recycled for its fuel value through waster to energy incineration. Dispose of oil-contaminated products in accordance with EPA guidelines.

## Filter bag replacement

Remove the bag by loosening or cutting off the clamping band. Take the new filter bag, which is equipped with a stainless steel worm drive clamping band and use a screwdriver to tighten the bag around the frame channel. Ensure the bag is secure and there is not slack around the perimeter of the band.



# Native Wetland Planting Guide

## Native Wetland & Aquatic Plants for:

- Restoration
- Storm Water Management
- Erosion Control
- Rain Gardens
- Ponds/Lakes/Streams
- Basins / Swales
- Bio-remediation

Simple Plug Spacing Chart – On Center				
Total sq. ft. of bed	12"	18"	24"	36"
50	50	22	13	6
100	100	44	25	11
250	250	110	63	28
500	500	220	125	55
1,000	1,000	440	250	110
5,000	5,000	2,200	1,250	550
10,000	10,000	4,400	2,500	1,100
Multiplier	(1)	(.44)	(.25)	(.11)

**Free Online Plant Search Database • Serving Installers, Designers, Educators & Engineers**

**Contract Growing - Plant Materials Grown To Specifications. • Email, fax, or call for a quote and availability**



## **Aquascapes Unlimited, Inc.**

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Fax: 215-766-8986

Email: [info@aquascapesunlimited.com](mailto:info@aquascapesunlimited.com)

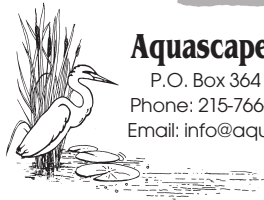
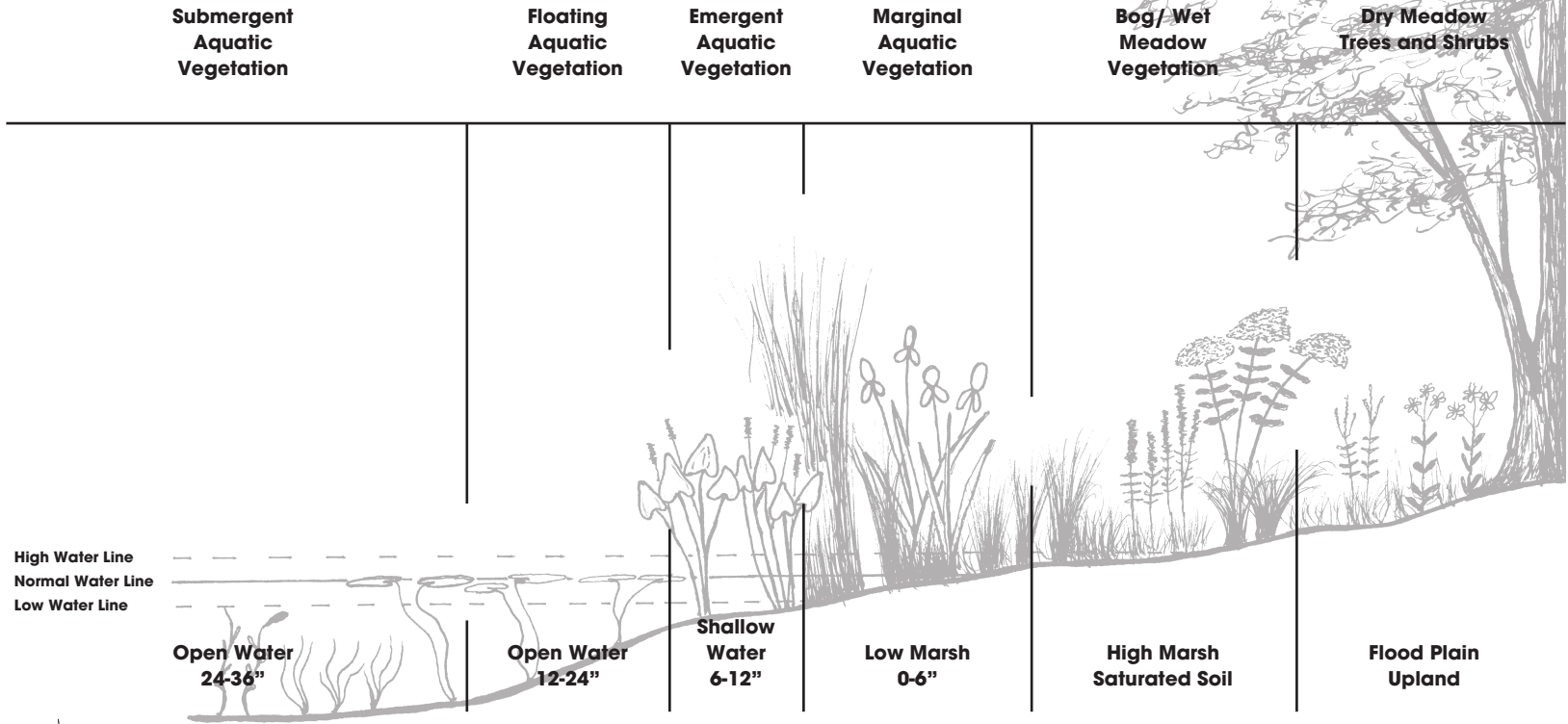
## **Website:**

[www.aquascapesunlimited.com](http://www.aquascapesunlimited.com)

## **Social Media:**

[www.facebook.com/wetlandperennials](http://www.facebook.com/wetlandperennials)

# Native Wetland Planting Guide



## Aquascapes Unlimited, Inc.

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**Social Media:** [www.facebook.com/wetlandperennials](https://www.facebook.com/wetlandperennials)

## Aquatic Plant List

### Shoreline Zone (Occasionally Inundated)

Bayonet rush (*Juncus bigel*)  
Rush family (*Juncus sp.*)  
Spike-rush (*Eleocharis R. Br.*)  
Northeastern bulrush (*Scirpus ancistrochaetus*)  
Three-way sedge (*Dulichium arundinaceum*)  
Great bulrush (*Schoenoplectus tabernaemontani*)

### Elevation Zero Zone (Always Inundated, water's edge)

Bayonet rush (*Juncus bigel*)  
Rush family (*Juncus sp.*)  
Spike-rush (*Eleocharis R. Br.*)  
Northern blue flag (*Iris versicolor*)  
Southern blue flag (*Iris virginica*)

### Obligate Zone (6-12" Depth)

Water star-grass (*Heteranthera dubia*)  
Mud plantain (*Heteranthera multiflora*)  
Mud plantain (*Heteranthera reniformis*)  
Pickerel-weed (*Pontederia cordata*)  
Arrow arum (*Peltandra virginica*)  
Spatterdock (*Nuphar advena*)  
Bur-reed (*Sparganium americanum*)  
American lotus (*Nelumbo lutea*)

# Shallow Wetland Basin

## Converting a farm pond

### Project Goals

1. To improve water quality and wetland habitat for wildlife.
2. To filter stormwater runoff and manage excess sediment and nutrient input into nearby Crum Creek.
3. To provide a living model demonstrating the wildlife habitat potential of a functioning stormwater management basin.

### Site

Hildacy Farm Preserve, owned by Natural Lands Trust  
Marple Township, Delaware County, PA

### Site History and Installation

The 8,000-square foot spring-fed pond below the farmhouse at the Hildacy Preserve was created approximately 40 years ago as a farm pond and, like most ponds in the area at the time, provided a water source for livestock and fire control. The pond drains into nearby Martin's Run, a tributary of Crum Creek. By 2002, the pond had become a sink for nutrient- and sediment-rich stormwater from surrounding slopes. During the warmer summer months, excess nutrient loads contributed to elevated algae and bacteria levels in the stagnant pond water, compromising water quality and habitat value not only in the pond, but also downstream in the watershed. Canada geese congregated on the mowed banks of the pond and their droppings further deteriorated the pond water.

To enhance and diversify wildlife habitat and to improve water quality in the pond and the Crum Creek watershed, Natural

Lands Trust (NLT) made plans to



Natural Lands Trust



before

Henry Carl



after

Molly Smyrl

convert the pond into a wetland basin. The restored wetland would provide shallow and deep water

niches for a variety of native plants and animals and also serve as a more effective stormwater drainage basin for NLT's expanded headquarters.

In the fall of 2002, the pond was drained and bottom sediment was excavated and replaced by dry soil that was better suited for contouring of the wetland basin. A sediment forebay (a small depression) was excavated just upslope of the wetland as a settling filter for sediments and potential pollutants draining into the basin from impervious surfaces. Shelves, small sinks, and gentle slopes were excavated in the basin to create a varied topography typical of a natural wetland habitat. Shallow mounds and slopes would support wetland herbs (pickerel weed, arrowhead) and shrubs (buttonbush, silky dogwood) while small depressions

would provide pools for mallards or wood ducks. We also positioned a log across the basin to attract basking turtles.

Natural Lands Trust staff planted the wetland basin and surrounding uplands in the spring of 2003 with wetland herbs and shrubs native to the immediate area including duck potato, joe-pye weed, winterberry, elderberry, and trees such as red maple, red ash, and blackgum that provide much-needed shade. Thanks to ideal growing conditions during that first summer, the entire wetland conversion at Hildacy Preserve took place over a period of only one year.

Water drains from the wetlands through a pipe at the bottom of the basin (where the water is coolest) that is connected to a water control structure. This structure was installed to allow for periodic adjustment of water levels to mimic the hydrological conditions of a natural wetland.

### Maintenance and Monitoring

We were fortunate that the wet spring and summer of 2003 provided optimal conditions during the first growing season after installation. Some restored wetland basins may need watering as plants become established in their new habitat. In severe conditions, it may be necessary to replant areas that become too dry.

In any soil disturbance or habitat restoration project, there is always a concern that invasive plant species will become established and outcompete the native (planted and volunteer) species.

In newly created wetlands, it is therefore important to monitor occurrences of invasive plants such as Phragmites or purple loosestrife and to control these species as soon as they appear.

### Results

In the years since the wetland basin was installed, we regularly observe damselflies and dragonflies, kingfishers, red-winged blackbirds, mallard ducks, and green herons in our restored habitat. The near shrill chorus of the spring peepers in the basin alerts us to the end of winter each year. We also know that cooler and cleaner water is entering the Crum Creek and improving aquatic habitat in the watershed.

### Estimated Project Cost

#### Installation Cost:

~\$30,000 for excavation, water control structure, plants, signage, NLT staff time.

#### Yearly Maintenance Cost:

<\$500 for invasive plant control and maintenance of water control structure.

### Funding

The wetland conversion at Hildacy Preserve was funded by a Growing Greener Grant from the Pennsylvania Department of Environmental Protection. Partners for Wildlife Program of the US Fish and Wildlife Service provided technical guidance in the design of the wetland basin.



David Streckel (all)

*Case studies describe stewardship projects completed by Natural Lands Trust in its more than 55-year history of managing natural areas. We hope these case studies inspire landowners to consider opportunities for land stewardship on their own properties.*

*The Center for Conservation Landowners was established to share Natural Lands Trust's knowledge and experience in land stewardship by offering educational outreach and consulting services to landowners.*

*For more information, contact:*

Natural Lands Trust  
Center for Conservation Landowners  
1031 Palmers Mill Road  
Media, PA 19063  
610-353-5587 ~ [www.natlands.org](http://www.natlands.org)

## Native Plant Materials

Nearly 1,600 vascular plant species are known to be native to the greater southeastern Pennsylvania region (the roughly 15 counties that lie south and east of Blue Mountain or Kittatinny Ridge). They include almost 1,350 herbaceous species (wildflowers, grasses, sedges, rushes, ferns), 133 shrubs, 102 trees, and 19 woody vines. Here we suggest a relatively small fraction of those species for use in natural land restoration and landscaping. For natural land restoration we highlight 134 wildflowers; 48 grasses, sedges, and rushes; 19 ferns; 68 shrubs; 62 trees; and 2 woody vines in tables on pages 173–190. A shorter list of plants that provide wildlife benefits and horticultural values can be found on pages 191–198. All species were selected for their ability to thrive under a range of environmental conditions and for their commercial availability (see sources of native plants on page 198), mainly from nurseries and seed suppliers who specialize in plants that are native to southeastern Pennsylvania and immediately adjacent areas of Pennsylvania, New Jersey, Delaware, and Maryland. Don't be discouraged if the availability of some of these plants is limited. Your interest will encourage nurseries to increase their supply.

The plants we recommend for restoration projects are sorted into three major habitat categories: *forest*, *shrubland*, and *meadow*. Within each major category are separate lists of trees, shrubs, and

herbaceous species, and each of those groups is further broken down into height classes, based on the maximum height that each species could attain under ideal growing conditions. Maximum height is particularly important in meadow plantings. Most native meadow species have low tolerance of shade and require full sun for at least a part of every day to survive. If species of markedly different heights are planted together, the shorter species are likely to fail due to shade suppression. In any given patch of meadow, the mix of species planted from seeds or plugs should range across no more than two consecutive size categories (the overall planting can be a mosaic of patches of different heights).

All of the shrub and herbaceous species listed under “Native Forest Plants” have intermediate to high tolerance of shade. The list of upper canopy trees includes a mixture of species with low, intermediate, and high shade tolerance, but all native upper canopy tree species—including those that are highly shade tolerant—should be planted where they will get at least some full sun every day. (Subcanopy trees species generally are more tolerant of shading, but will also benefit from some direct sun exposure while they become established; a few have low shade tolerance and thrive best in savannas or open woodlands, including pitch pine, Virginia pine, black jack oak, post oak, sassafras, and black willow.) Seedlings and saplings of even

the most shade tolerant tree species tend to grow extremely slowly or not at all in deep shade. Shade tolerance does not allow young trees of upper canopy species to grow to full size in the shade; it merely enables them to survive many years in a suppressed state until adult trees in the canopy above them die. The natural course of forest canopy renewal takes place when old trees fall or die, opening up a canopy gap that admits enough sunshine to fuel a growth spurt of the advance regeneration (established seedlings and saplings), which soon fill the gap. If the gap is large enough

to provide sufficient sunlight, it often becomes a race to fill the gap between shade tolerant tree species, which are already established and have a head start but have slower maximum growth rates, and shade intolerant tree species, which must start from seed but generally grow much more rapidly. Owners or managers of natural lands can choose the winners in this race by judicious weeding and by planting tree seedlings or saplings of upper canopy species far enough apart that none will shade or otherwise interfere with each other's growth.

## FOREST TREES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 70–140 feet or more (upper canopy)</i>		
<i>Acer rubrum</i>	red maple	dry to wet
<i>Acer saccharinum</i>	silver maple	moist to wet
<i>Acer saccharum</i>	sugar maple	dry to moist
<i>Betula lenta</i>	sweet birch, black birch	dry to moist
<i>Betula nigra</i>	river birch	moist
<i>Carya cordiformis</i>	bitternut hickory	moist
<i>Carya laciniosa</i>	shellbark hickory	moist to wet
<i>Carya ovata</i>	shagbark hickory	dry to moist
<i>Carya tomentosa</i>	mockernut hickory	dry to moist
<i>Celtis occidentalis</i>	common hackberry	dry to moist
<i>Fagus grandifolia</i>	American beech	moist
<i>Fraxinus americana</i>	white ash	moist
<i>Fraxinus pennsylvanica</i>	red ash, green ash	moist to wet
<i>Gleditsia triacanthos</i>	honeylocust	moist
<i>Juglans nigra</i>	walnut	moist
<i>Liquidambar styraciflua</i>	sweetgum	moist to wet
<i>Liriodendron tulipifera</i>	tuliptree	moist
<i>Nyssa sylvatica</i>	blackgum, sourgum, tupelo	dry to wet
<i>Pinus echinata</i>	shortleaf pine	dry

**FOREST TREES**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 70–140 feet or more (upper canopy)</i>		
<i>Pinus strobus</i>	white pine	dry to wet
<i>Platanus occidentalis</i>	American sycamore	moist to wet
<i>Prunus serotina</i>	black cherry	moist
<i>Quercus alba</i>	white oak	dry to moist
<i>Quercus bicolor</i>	swamp white oak	moist to wet
<i>Quercus coccinea</i>	scarlet oak	dry to moist
<i>Quercus falcata</i>	southern red oak	dry to moist
<i>Quercus montana</i> [= <i>Quercus prinus</i> ]	chestnut oak	dry
<i>Quercus palustris</i>	pin oak	moist to wet
<i>Quercus phellos</i>	willow oak	moist to wet
<i>Quercus rubra</i>	northern red oak	dry to moist
<i>Quercus velutina</i>	black oak	dry to moist
<i>Tilia americana</i>	basswood	moist
<i>Tsuga canadensis</i>	eastern hemlock	moist
<i>Ulmus americana</i>	American elm	moist to wet
<i>Ulmus rubra</i>	slippery elm	moist to wet
<i>maximum height: 30–65 feet (subcanopy)</i>		
<i>Amelanchier arborea</i>	shadbush, serviceberry, juneberry	dry to moist
<i>Amelanchier laevis</i>	shadbush, serviceberry, juneberry	dry to moist
<i>Aralia spinosa</i>	devil's walking-stick, Hercules'-club	moist
<i>Asimina triloba</i>	pawpaw	moist
<i>Carpinus caroliniana</i>	American hornbeam, musclewood	moist
<i>Cercis canadensis</i>	redbud	rich
<i>Cornus florida</i>	flowering dogwood	moist
<i>Diospyros virginiana</i>	persimmon	dry to moist
<i>Ilex opaca</i>	American holly	moist
<i>Juglans cinerea</i>	butternut	moist
<i>Magnolia virginiana</i>	sweetbay magnolia	moist to wet
<i>Malus coronaria</i>	sweet crabapple	dry to moist
<i>Morus rubra</i>	red mulberry	moist

**FOREST TREES**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 30–65 feet (subcanopy)</i>		
<i>Ostrya virginiana</i>	hop-hornbeam	dry to moist
<i>Pinus rigida</i>	pitch pine	dry
<i>Pinus virginiana</i>	Virginia pine	dry
<i>Quercus marilandica</i>	blackjack oak	dry
<i>Quercus stellata</i>	post oak	dry
<i>Salix nigra</i>	black willow	wet
<i>Sassafras albidum</i>	sassafras	dry to moist
<i>Viburnum lentago</i>	nannyberry	moist

**FOREST SHRUBS**

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 20–25 feet</i>		
<i>Alnus serrulata</i>	smooth alder	wet
<i>Amelanchier canadensis</i>	shadbush, juneberry, serviceberry	moist
<i>Cornus alternifolia</i>	alternate-leaved dogwood	moist
<i>Euonymus atropurpureus</i>	wahoo	moist to wet
<i>Prunus americana</i>	wild plum	moist
<i>Prunus virginiana</i>	choke cherry	dry to moist
<i>Viburnum prunifolium</i>	black-haw	wet
<i>maximum height: 10–15 feet</i>		
<i>Cephalanthus occidentalis</i>	buttonbush	wet
<i>Clethra alnifolia</i>	sweet pepperbush	wet
<i>Cornus amomum</i>	silky dogwood	wet
<i>Cornus racemosa</i>	gray dogwood	wet
<i>Cornus rugosa</i>	round-leaved dogwood	dry
<i>Corylus americana</i>	American filbert	dry to moist
<i>Corylus cornuta</i>	beaked hazelnut	dry to moist
<i>Hamamelis virginiana</i>	witch-hazel	dry to moist
<i>Ilex verticillata</i>	winterberry, black-alder	wet

**FOREST SHRUBS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 10–15 feet</i>		
<i>Kalmia latifolia</i>	mountain-laurel	dry to moist
<i>Lindera benzoin</i>	spicebush	moist
<i>Photinia melanocarpa</i> [= <i>Aronia melanocarpa</i> ]	black chokeberry	dry to wet
<i>Photinia pyrifolia</i> [= <i>Aronia pyrifolia</i> ]	red chokeberry	moist to wet
<i>Physocarpus opulifolius</i>	ninebark	moist to wet
<i>Rhododendron arborescens</i>	smooth azalea	moist
<i>Rhododendron maximum</i>	rosebay rhododendron	moist to wet
<i>Rhododendron periclymenoides</i>	pinxter-flower	dry to moist
<i>Rhododendron viscosum</i>	swamp azalea	wet
<i>Salix discolor</i>	pussy willow	moist to wet
<i>Sambucus canadensis</i>	American elder	moist to wet
<i>Sambucus racemosa</i>	red-berried elder	moist
<i>Staphylea trifolia</i>	bladdernut	dry to moist
<i>Vaccinium corymbosum</i>	highbush blueberry	dry to wet
<i>Viburnum cassinoides</i>	witherod	moist to wet
<i>Viburnum dentatum</i>	southern arrow-wood	wet
<i>Viburnum recognitum</i>	northern arrow-wood	wet
<i>Viburnum trilobum</i>	highbush-cranberry	wet
<i>maximum height: 5–7 feet</i>		
<i>Amelanchier stolonifera</i>	low juneberry, low shadbush	dry to moist
<i>Dirca palustris</i>	leatherwood	dry to moist
<i>Euonymus americanus</i>	hearts-a-bursting	moist
<i>Gaylussacia frondosa</i>	dangleberry	dry to wet
<i>Hydrangea arborescens</i>	sevenbark, wild hydrangea	dry to moist
<i>Ribes americanum</i>	wild black currant	moist to wet
<i>Rosa palustris</i>	swamp rose	wet
<i>Rubus idaeus</i>	red raspberry	dry to moist
<i>Rubus occidentalis</i>	black-cap, black raspberry	dry to moist
<i>Spiraea alba</i>	meadow-sweet	moist to wet

**FOREST SHRUBS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 5–7 feet</i>		
<i>Spiraea latifolia</i>	meadow-sweet	moist to wet
<i>Taxus canadensis</i>	American yew	moist
<i>Vaccinium stamineum</i>	deerberry	dry
<i>Viburnum acerifolium</i>	maple-leaved viburnum	moist
<i>maximum height: 2–4 feet</i>		
<i>Diervilla lonicera</i>	bush-honeysuckle	dry
<i>Gaylussacia baccata</i>	black huckleberry	dry to wet
<i>Spiraea tomentosa</i>	hardback, steeple-bush	moist to wet
<i>Vaccinium angustifolium</i>	low sweet blueberry	dry to moist
<i>Vaccinium pallidum</i>	lowbush blueberry	dry to moist

**FOREST VINES**

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>Lonicera sempervirens</i>	trumpet honeysuckle	moist
<i>Parthenocissus quinquefolia</i>	Virginia-creeper	moist

**FOREST PERENNIAL WILDFLOWERS**

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: tall (6–8 feet)</i>		
<i>Actaea racemosa</i> [= <i>Cimicifuga racemosa</i> ]	black cohosh	dry to moist
<i>Aralia racemosa</i>	spikenard	moist
<i>Polygonatum biflorum</i>	Solomon’s-seal	dry to moist
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Arisaema triphyllum</i>	jack-in-the-pulpit	moist
<i>Eurybia divaricata</i> [= <i>Aster divaricatus</i> ]	white wood aster	dry to moist

FOREST PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Eurybia macrophylla</i> [= <i>Aster macrophyllus</i> ]	bigleaf aster	dry to moist
<i>Eurybia schreberi</i> [= <i>Aster schreberi</i> ]	Schreber's aster	dry to moist
<i>Maianthemum racemosum</i> [= <i>Smilacina racemosa</i> ]	false Solomon's-seal, Solomon's plume	dry to moist
<i>Medeola virginiana</i>	Indian cucumber-root	moist
<i>Polygonatum pubescens</i>	Solomon's-seal	dry to moist
<i>Sanicula odorata</i>	yellow-flowered sanicle, fragrant snakeroot	moist
<i>Solidago caesia</i>	bluestem goldenrod	dry to moist
<i>Solidago flexicaulis</i>	zigzag goldenrod	moist
<i>Symphotrichum cordifolium</i> [= <i>Aster cordifolius</i> ]	blue wood aster	dry to moist
<i>Triosteum aurantiacum</i>	wild-coffee	moist
<i>maximum height: short (1½–3 feet)</i>		
<i>Actaea pachypoda</i>	doll's-eyes	dry to moist
<i>Allium tricoccum</i>	ramps, wild leek	dry to moist
<i>Aquilegia canadensis</i>	wild columbine	dry to moist
<i>Aralia nudicaulis</i>	wild sarsaparilla	dry to moist
<i>Aristolochia serpentaria</i>	Virginia snakeroot	dry to moist
<i>Caulophyllum thalictroides</i>	blue cohosh	dry to moist
<i>Dicentra eximia</i>	wild bleeding-heart	dry to moist
<i>Geranium maculatum</i>	wild geranium	dry to moist
<i>Hybanthus concolor</i>	green-violet	moist
<i>Hydrophyllum canadense</i>	Canadian waterleaf	moist
<i>Hydrophyllum virginianum</i>	Virginia waterleaf	moist
<i>Lysimachia quadrifolia</i>	whorled loosestrife	dry
<i>Mertensia virginica</i>	Virginia bluebells	moist
<i>Oclemena acuminata</i>	wood aster	moist
<i>Osmorhiza claytonii</i>	sweet-cicely	moist
<i>Osmorhiza longistylis</i>	anise-root	moist

**FOREST PERENNIAL WILDFLOWERS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: short (1½–3 feet)</i>		
<i>Phlox divaricata</i> ssp. <i>divaricata</i>	eastern wild blue phlox	dry to moist
<i>Podophyllum peltatum</i>	mayapple	moist
<i>Polemonium reptans</i>	spreading Jacob’s-ladder	moist
<i>Scutellaria serrata</i>	showy skullcap	moist
<i>Thalictrum dioicum</i>	early meadow-rue	moist
<i>Trillium cernuum</i>	nodding trillium	moist
<i>Trillium erectum</i>	purple trillium, wakerobin	moist
<i>Trillium flexipes</i>	declined trillium	moist to wet
<i>Trillium grandiflorum</i>	large-flowered trillium	moist
<i>Uvularia perfoliata</i>	bellwort	moist
<i>Uvularia sessilifolia</i>	bellwort	moist
<i>Zizia aptera</i>	golden-alexander	moist
<i>Zizia aurea</i>	golden-alexander	moist
<i>maximum height: very short (up to 1 foot)</i>		
<i>Asarum canadense</i>	wild ginger	moist
<i>Hydrastis canadensis</i>	goldenseal	moist
<i>Iris cristata</i>	dwarf crested iris	dry to moist
<i>Jeffersonia diphylla</i>	twinleaf	dry to moist
<i>Maianthemum canadense</i>	Canada mayflower	moist
<i>Mitchella repens</i>	partridge-berry	moist
<i>Sanguinaria canadensis</i>	bloodroot	dry to moist
<i>Thalictrum thalictroides</i>	rue anemone	dry to moist
<i>Tiarella cordifolia</i>	foamflower	moist

## FOREST GRASSES, SEDGES, AND RUSHES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: tall (6–8 feet)</i>		
<i>Scirpus cyperinus</i>	wool-grass	wet
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Carex crinita</i>	fringed sedge, short-hair sedge	wet
<i>Carex folliculata</i>	northern long sedge	wet
<i>Carex gynandra</i>	nodding sedge	wet
<i>Carex lurida</i>	lurid sedge, shallow sedge	wet
<i>Carex scoparia</i>	broom sedge	moist to wet
<i>Carex stipata</i>	stalk-grain sedge, owlfruit sedge	wet
<i>Carex tribuloides</i>	blunt broom sedge, bristlebract sedge	wet
<i>Chasmanthium latifolium</i>	Indian wood-oats	moist
<i>Elymus hystrix</i>	bottlebrush-grass	moist
<i>Glyceria canadensis</i>	rattlesnake mannagrass	wet
<i>Glyceria melicaria</i>	slender mannagrass	wet
<i>Glyceria striata</i>	fowl mannagrass	wet
<i>Leersia virginica</i>	whitegrass	moist to wet
<i>maximum height: short (1½–3 feet)</i>		
<i>Carex intumescens</i>	greater bladder sedge	wet
<i>Carex pensylvanica</i>	Pennsylvania sedge	dry to moist
<i>Carex plantaginea</i>	plaintain sedge	dry to moist
<i>Carex platyphylla</i>	broad-leaf sedge	dry to moist
<i>Carex vulpinoidea</i>	fox sedge, brown fox sedge	wet
<i>Cyperus esculentus</i>	yellow nutsedge	moist to wet
<i>Juncus tenuis</i>	path rush	dry to moist

## FOREST FERNS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Athyrium filix-femina</i>	lady fern	moist
<i>Dennstaedtia punctilobula</i>	hay-scented fern	moist
<i>Deparia acrostichoides</i>	silvery glade fern	moist
<i>Diplazium pycnocarpon</i>	narrow-leaved glade fern	moist
<i>Dryopteris goldiana</i>	Goldie's wood fern	moist
<i>Dryopteris marginalis</i>	marginal wood fern	moist
<i>Matteuccia struthiopteris</i>	ostrich fern	moist to wet
<i>Onoclea sensibilis</i>	sensitive fern	wet
<i>Osmunda cinnamomea</i>	cinnamon fern	wet
<i>Osmunda claytoniana</i>	interrupted fern	moist to wet
<i>Osmunda regalis</i>	royal fern	wet
<i>maximum height: short (1½–3 feet)</i>		
<i>Adiantum pedatum</i>	northern maidenhair fern	dry to moist
<i>Asplenium platyneuron</i>	ebony spleenwort	dry to moist
<i>Dryopteris carthusiana</i>	spinulose wood fern	moist to wet
<i>Dryopteris intermedia</i>	evergreen wood fern	moist
<i>Polystichum acrostichoides</i>	Christmas fern	dry to moist
<i>Thelypteris noveboracensis</i>	New York fern	moist to wet
<i>Woodwardia areolata</i>	netted chain fern	moist to wet

## SHRUBLAND TREES AND SHRUBS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 30–40 feet</i>		
<i>Aralia spinosa</i>	devil's walking-stick, Hercules'-club	moist
<i>Asimina triloba</i>	pawpaw	moist
<i>Betula populifolia</i>	gray birch	dry
<i>Cercis canadensis</i>	redbud	dry to moist
<i>Chionanthus virginicus</i>	fringetree	moist
<i>Cornus florida</i>	flowering dogwood	moist
<i>Juniperus virginiana</i>	eastern red-cedar	dry to moist
<i>Malus coronaria</i>	sweet crabapple	dry to moist
<i>Pinus pungens</i>	Table Mountain pine	dry
<i>Quercus marilandica</i>	blackjack oak	dry
<i>Rhus typhina</i>	staghorn sumac	dry
<i>Salix bebbiana</i>	long-beaked willow, gray willow	dry to moist
<i>Viburnum lentago</i>	nannyberry	moist
<i>maximum height: 20–25 feet</i>		
<i>Alnus serrulata</i>	smooth alder	wet
<i>Amelanchier canadensis</i>	shadbush, juneberry	moist
<i>Cornus alternifolia</i>	alternate-leaved dogwood	moist
<i>Euonymus atropurpureus</i>	wahoo	moist to wet
<i>Prunus americana</i>	wild plum	moist
<i>Prunus virginiana</i>	choke cherry	dry to moist
<i>Rhus copallina</i>	winged sumac, shining sumac	dry
<i>Salix eriocephala</i>	heart-leaf willow	moist to wet
<i>Salix exigua</i>	sandbar willow	wet
<i>Salix lucida</i>	shining willow	wet
<i>Viburnum prunifolium</i>	black-haw	wet
<i>maximum height: 10–15 feet</i>		
<i>Celtis tenuifolia</i>	dwarf hackberry, Georgia hackberry	dry
<i>Cephalanthus occidentalis</i>	buttonbush	wet
<i>Clethra alnifolia</i>	sweet pepperbush	wet
<i>Cornus amomum</i>	silky dogwood	wet

**SHRUBLAND TREES AND SHRUBS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 10–15 feet</i>		
<i>Cornus racemosa</i>	gray dogwood	moist to wet
<i>Cornus rugosa</i>	round-leaved dogwood	dry
<i>Corylus americana</i>	American filbert	moist
<i>Corylus cornuta</i>	beaked hazelnut	dry
<i>Hamamelis virginiana</i>	witch-hazel	moist
<i>Ilex verticillata</i>	winterberry, black-alder	wet
<i>Kalmia latifolia</i>	mountain-laurel	dry to moist
<i>Lindera benzoin</i>	spicebush	moist
<i>Photinia melanocarpa</i> [= <i>Aronia melanocarpa</i> ]	black chokeberry	dry to wet
<i>Photinia pyrifolia</i> [= <i>Aronia pyrifolia</i> ]	red chokeberry	moist to wet
<i>Physocarpus opulifolius</i>	ninebark	moist to wet
<i>Quercus ilicifolia</i>	scrub oak, bear oak	dry
<i>Quercus prinoides</i>	dwarf chestnut oak, dwarf chinkapin oak	dry
<i>Rhododendron maximum</i>	rosebay rhododendron	moist to wet
<i>Rhododendron viscosum</i>	swamp azalea	wet
<i>Rhus glabra</i>	smooth sumac	dry
<i>Salix discolor</i>	pussy willow	moist to wet
<i>Salix humilis</i>	upland willow, sage willow	dry to moist
<i>Salix sericea</i>	silky willow	wet
<i>Sambucus canadensis</i>	American elder	moist to wet
<i>Sambucus racemosa</i>	red-berried elder	moist
<i>Staphylea trifolia</i>	bladdernut	dry to moist
<i>Vaccinium corymbosum</i>	highbush blueberry	dry to wet
<i>Viburnum cassinoides</i>	witherod	moist to wet
<i>Viburnum dentatum</i>	southern arrow-wood	wet
<i>Viburnum recognitum</i>	northern arrow-wood	wet
<i>Viburnum trilobum</i>	highbush-cranberry	wet

**SHRUBLAND TREES AND SHRUBS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: 5–7 feet</i>		
<i>Amelanchier stolonifera</i>	low juneberry, low shadbush	dry to moist
<i>Comptonia peregrina</i>	sweet-fern	dry
<i>Dirca palustris</i>	leatherwood	dry to moist
<i>Euonymus americanus</i>	hearts-a-bursting	moist
<i>Gaylussacia frondosa</i>	dangleberry	dry to wet
<i>Hydrangea arborescens</i>	sevenbark, wild hydrangea	dry to moist
<i>Myrica pensylvanica</i>	bayberry	dry to moist
<i>Ribes americanum</i>	wild black currant	moist to wet
<i>Rosa palustris</i>	swamp rose	wet
<i>Rosa virginiana</i>	wild rose, pasture rose	moist
<i>Rubus idaeus</i>	red raspberry	dry to moist
<i>Rubus occidentalis</i>	black-cap, black raspberry	dry to moist
<i>Spiraea alba</i>	meadow-sweet	moist to wet
<i>Spiraea latifolia</i>	meadow-sweet	moist to wet
<i>Taxus canadensis</i>	American yew	moist
<i>Vaccinium stamineum</i>	deerberry	dry
<i>Viburnum acerifolium</i>	maple-leaved viburnum	dry to moist
<i>maximum height: 2–4 feet</i>		
<i>Diervilla lonicera</i>	bush-honeysuckle	dry
<i>Gaylussacia baccata</i>	black huckleberry	dry to wet
<i>Rosa carolina</i>	pasture rose	dry
<i>Spiraea tomentosa</i>	hardback, steeple-bush	moist to wet
<i>Vaccinium angustifolium</i>	low sweet blueberry	dry
<i>Vaccinium pallidum</i>	lowbush blueberry	dry

## MEADOW PERENNIAL WILDFLOWERS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: very tall (9–10 or more feet)</i>		
<i>Coreopsis tripteris</i>	tall tickseed	moist to wet
<i>Eutrochium fistulosum</i> [= <i>Eupatorium fistulosum</i> ]	hollow-stemmed joe-pye-weed, trumpetweed	moist to wet
<i>Helianthus giganteus</i>	swamp sunflower	wet
<i>Rudbeckia laciniata</i>	cutleaf coneflower	wet
<i>maximum height: tall (6–8 feet)</i>		
<i>Angelica atropurpurea</i>	purple-stemmed angelica	moist to wet
<i>Apocynum cannabinum</i>	Indian-hemp	moist to wet
<i>Asclepias incarnata</i>	swamp milkweed	wet
<i>Asclepias syriaca</i>	common milkweed	moist to wet
<i>Baptisia australis</i>	blue false-indigo	moist to wet
<i>Boltonia asteroides</i>	aster-like boltonia	moist to wet
<i>Eupatorium perfoliatum</i>	common boneset	wet
<i>Eutrochium purpureum</i> [= <i>Eupatorium purpureum</i> ]	joe-pye-weed, sweet-scented joe-pye-weed	dry to wet
<i>Filipendula rubra</i>	queen-of-the-prairie	moist
<i>Helenium autumnale</i>	common sneezeweed	moist to wet
<i>Helianthus divaricatus</i>	rough sunflower, woodland sunflower	dry
<i>Heliopsis helianthoides</i>	ox-eye	dry to wet
<i>Hypericum pyramidatum</i> [= <i>H. ascyron</i> ]	great St. John's-wort	moist to wet
<i>Lespedeza capitata</i>	round-headed lespedeza	dry
<i>Liatris spicata</i>	dense blazing-star	moist
<i>Lilium canadense</i>	Canada lily	moist to wet
<i>Lilium superbum</i>	Turk's-cap lily	moist to wet
<i>Lobelia cardinalis</i>	cardinal-flower	wet
<i>Lobelia siphilitica</i>	great blue lobelia	moist to wet
<i>Mimulus ringens</i>	Allegheny monkey-flower	wet
<i>Oenothera biennis</i>	common evening-primrose	dry to moist
<i>Penstemon digitalis</i>	tall white beard-tongue	dry to moist
<i>Polygonatum biflorum</i>	smooth Solomon's-seal	dry to moist

MEADOW PERENNIAL WILDFLOWERS, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: tall (6–8 feet)</i>		
<i>Rudbeckia triloba</i>	three-lobed coneflower	dry to moist
<i>Senna hebecarpa</i>	northern wild senna	dry to moist
<i>Senna marilandica</i>	southern wild senna	dry
<i>Solidago canadensis</i>	Canada goldenrod	dry to moist
<i>Solidago gigantea</i>	smooth goldenrod	moist to wet
<i>Solidago rigida</i> [= <i>Oligoneuron rigidum</i> ]	stiff goldenrod	moist
<i>Solidago rugosa</i>	wrinkle-leaf goldenrod	dry to wet
<i>Solidago speciosa</i>	showy goldenrod	dry to moist
<i>Symphotrichum lanceolatum</i> [= <i>Aster lanceolatus</i> , <i>A. paniculatus</i> , <i>A. simplex</i> ]	panicked aster	dry to wet
<i>Symphotrichum novae-angliae</i> [= <i>Aster novae-angliae</i> ]	New England aster	dry to moist
<i>Symphotrichum novi-belgii</i> [= <i>Aster longifolius</i> ]	New York aster	moist to wet
<i>Symphotrichum pilosum</i> [= <i>Aster ericoides</i> var. <i>pilosus</i> , <i>A. pilosus</i> ]	heath aster	dry to moist
<i>Verbena hastata</i>	blue vervain, simpler's-joy	moist to wet
<i>Verbesina alternifolia</i>	wingstem	moist
<i>Vernonia glauca</i>	Appalachian ironweed, tawny ironweed	dry
<i>Vernonia noveboracensis</i>	New York ironweed	moist to wet
<i>Veronicastrum virginicum</i>	Culver's-root	moist
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Asclepias purpurascens</i>	purple milkweed	dry to moist
<i>Eupatorium hyssopifolium</i>	hyssop-leaved thoroughwort	dry
<i>Gentiana andrewsii</i>	bottle gentian, prairie closed gentian	moist to wet
<i>Gentiana clausa</i>	meadow closed gentian, bottle gentian	moist
<i>Geum laciniatum</i>	herb-bennet, rough avens	wet
<i>Hypericum punctatum</i> [= <i>H. maculatum</i> ]	spotted St. John's-wort	moist

**MEADOW PERENNIAL WILDFLOWERS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Ludwigia alternifolia</i>	seedbox, false loosestrife	wet
<i>Monarda fistulosa</i>	horsemint, wild bergamot	dry to moist
<i>Monarda punctata</i>	spotted bee-balm	dry
<i>Physostegia virginiana</i>	false dragonhead	moist
<i>Pycnanthemum virginianum</i>	Virginia mountain-mint	moist to wet
<i>Rudbeckia fulgida</i>	eastern coneflower	moist
<i>Rudbeckia hirta</i>	black-eyed-susan	dry to moist
<i>Scutellaria incana</i>	downy skullcap	dry to moist
<i>Solidago bicolor</i>	silver-rod, white goldenrod	dry
<i>Solidago juncea</i>	early goldenrod	dry to moist
<i>Solidago nemoralis</i>	gray goldenrod	dry
<i>Symphotrichum laeve</i> [= <i>Aster laevis</i> var. <i>laevis</i> ]	smooth blue aster	dry
<i>Vicia americana</i>	purple vetch	moist
<i>maximum height: short (1½–3 feet)</i>		
<i>Allium cernuum</i>	nodding onion	dry
<i>Asclepias tuberosa</i>	butterfly-weed	dry
<i>Asclepias verticillata</i>	whorled milkweed	dry
<i>Chrysopsis mariana</i>	golden aster	dry
<i>Conoclinium coelestinum</i> [= <i>Eupatorium coelestinum</i> ]	mistflower, wild ageratum	dry to moist
<i>Dodecatheon meadia</i>	shooting-star, pride-of-Ohio	dry to moist
<i>Geranium maculatum</i>	wood geranium	moist
<i>Iris prismatica</i>	slender blue flag	moist
<i>Juncus tenuis</i>	path rush	dry to moist
<i>Lupinus perennis</i>	blue lupine	dry to moist
<i>Oenothera fruticosa</i>	sundrops, narrow-leaved evening-primrose	dry to moist
<i>Packera aurea</i> [= <i>Senecio aureus</i> ]	golden ragwort	moist
<i>Penstemon hirsutus</i>	northeastern beard-tongue	dry
<i>Phlox maculata</i>	wild sweet-william	moist to wet

**MEADOW PERENNIAL WILDFLOWERS**, *continued*

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: short (1½–3 feet)</i>		
<i>Phlox pilosa</i>	downy phlox, prairie phlox	moist to wet
<i>Pycnanthemum tenuifolium</i>	narrow-leaved mountain-mint	moist
<i>Sisyrinchium angustifolium</i>	narrow-leaved blue-eyed-grass	moist to wet
<i>Tradescantia ohioensis</i>	Ohio spiderwort, blue-jacket	moist
<i>Tradescantia virginiana</i>	spiderwort, widow's-tears, Virginia spiderwort	dry to moist
<i>Zizia aptera</i>	golden-alexander	moist
<i>Zizia aurea</i>	golden-alexander, golden zizia	moist to wet

**MEADOW PERENNIAL COOL-SEASON GRASSES**

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Calamagrostis canadensis</i>	Canada bluejoint	wet
<i>Deschampsia cespitosa</i>	tufted hairgrass	moist to wet
<i>Deschampsia flexuosa</i>	wavy hairgrass, common hairgrass	dry
<i>Dichanthelium clandestinum</i> [= <i>Panicum clandestinum</i> ]	deer-tongue, deer-tongue grass	moist
<i>Elymus canadensis</i>	Canada wild-rye	moist
<i>Elymus riparius</i>	riverbank wild-rye	moist to wet
<i>Elymus virginicus</i>	Virginia wild-rye	moist to wet
<i>Leersia oryzoides</i>	rice cutgrass	wet
<i>Poa palustris</i>	fowl bluegrass	wet
<i>maximum height: short (1½–3 feet)</i>		
<i>Danthonia compressa</i>	northern oatgrass	dry
<i>Danthonia spicata</i>	poverty grass, poverty oatgrass	dry
<i>Hordeum jubatum</i> [= <i>Critesion jubatum</i> ]	foxtail-barley	dry

## MEADOW PERENNIAL WARM-SEASON GRASSES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: <b>very tall</b> (9–10 feet or more)</i>		
<i>Andropogon gerardii</i>	big bluestem, turkeyfoot	dry to moist
<i>Tripsacum dactyloides</i>	gammagrass	wet
<i>maximum height: <b>tall</b> (6–8 feet or more)</i>		
<i>Andropogon glomeratus</i>	bushy bluestem, bushy broomsedge	moist to wet
<i>Andropogon virginicus</i>	broomsedge, Virginia broomsedge	dry
<i>Panicum virgatum</i>	switchgrass	dry to moist
<i>Sorghastrum nutans</i>	Indian-grass	dry to moist
<i>Spartina pectinata</i>	prairie cordgrass, freshwater cordgrass	moist to wet
<i>Tridens flavus</i>	purpletop	dry to moist
<i>maximum height: <b>intermediate</b> (3½–5 feet)</i>		
<i>Bouteloua curtipendula</i>	side-oats grama, tall grama	dry
<i>Muhlenbergia capillaris</i>	hairgrass, short muhly	dry
<i>Schizachyrium scoparium</i>	little bluestem	dry to moist
<i>Sporobolus cryptandrus</i>	sand dropseed	dry
<i>Sporobolus heterolepis</i>	prairie dropseed	dry
<i>maximum height: <b>short</b> (1½–3 feet)</i>		
<i>Andropogon gyrans</i>	Elliott's beardgrass	dry to moist
<i>Eragrostis spectabilis</i>	purple lovegrass, tumblegrass	dry

## MEADOW SEDGES AND RUSHES

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: tall (6–8 feet or more)</i>		
<i>Scirpus cyperinus</i>	wool-grass	wet
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Carex lurida</i>	lurid sedge, shallow sedge	wet
<i>Carex scoparia</i>	broom sedge	moist to wet
<i>Carex stipata</i>	stalk-grain sedge, owlfruit sedge	wet
<i>Carex tribuloides</i>	blunt broom sedge, bristlebract sedge	wet
<i>maximum height: short (1½–3 feet)</i>		
<i>Carex intumescens</i>	greater bladder sedge	wet
<i>Carex vulpinoidea</i>	fox sedge, brown fox sedge	wet
<i>Cyperus esculentus</i>	yellow nutsedge	moist to wet
<i>Juncus tenuis</i>	path rush	dry to moist

## MEADOW FERNS

SCIENTIFIC NAME	COMMON NAME(S)	SOIL MOISTURE PREFERENCE
<i>maximum height: intermediate (3½–5 feet)</i>		
<i>Dennstaedtia punctilobula</i>	hay-scented fern	dry to wet
<i>Onoclea sensibilis</i>	sensitive fern	wet
<i>Pteridium aquilinum</i>	northern bracken fern	dry

**NATIVE TREES AND SHRUBS FOR LANDSCAPING AND WILDLIFE**

**Large Trees**

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Acer rubrum</i>	red maple	Piedmont Coastal Plain	Height: 40'-60', Spread: same Habit is pyramidal in youth and rounded with age. Tolerant of most soils, but prefers slightly acid, moist conditions. Naturally occurs in wet area. Excellent fall color.	Buds, flowers, and leaves provide food for many birds and mammals. Chipmunks and squirrels eat seeds and some songbirds use twigs for nest building.
<i>Acer saccharinum</i>	silver maple	Piedmont Coastal Plain	Height: 50'-70', Spread: 40'-50' Has strong spreading branches which form a rounded crown. Tolerant of many soil types. One of the best trees for poor soils and wet conditions (often found on floodplains). Use of this tree should be limited to areas free of buildings and heavy human use as it is prone to internal decay and subsequent loss of branches. Provides fast shade.	See red maple.
<i>Acer saccharum</i>	sugar maple	Piedmont Coastal Plain	Height: 60'-70', Spread: 40'-50' Upright oval to rounded habit. Prefers moist, well drained soils. Tolerates some shade.	See red maple.
<i>Betula nigra</i>	river birch	Piedmont Coastal Plain	Height: 40'-70', Spread: 40'-60' Pyramidal in youth and rounded with age. Often grown multistemmed. Best adapted to moist soils (often found on floodplains). Used in areas that are alternately wet and dry.	Catkins are used by redpolls and pine siskins. Foliage is used by browsers.
<i>Betula lenta</i>	sweet birch	Piedmont Coastal Plain	Height: 40'-55'+, Spread: 35'-45' Pyramidal in youth, forming an irregular, rounded, sometimes wide-spreading crown at maturity. Best in deep, rich, moist, slightly acid soils, however, often found on rocky, drier sites. Flowers are catkins, 2" - 3" long. Yellow leaves in fall are best among birches.	See river birch.

Large Trees, *continued*

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Carya ovata</i>	shagbark hickory	Piedmont Coastal Plain	Height: 60'–80', Spread: 40'–60' Straight trunk with an oblong crown. Bark breaks up in thin plates. Difficult to transplant, start as seedling. Good for woodland border.	Leaves are used by browsers. Nuts are also consumed by deer, turkey, foxes, wood ducks, and squirrels.
<i>Celtis occidentalis</i>	common hackberry	Piedmont Coastal Plain	Height: 40'–60', Spread: same In youth weakly pyramidal; in old age the crown is a broad top of ascending-arching branches. Medium to fast growth. Prefers rich, moist soils, but grows in dry, heavy, or sandy, rocky soils; withstands acid or alkaline conditions; moderately wet or very dry areas; tolerates wind; full sun. Fruit is fleshy, orange to dark purple, ripening in September to October. Leaves are yellow to yellow-green in fall. Useful tree for adverse growing conditions.	Fruit is popular with winter birds, especially cedar waxwing, mockingbird, and robin.
<i>Fagus grandifolia</i>	American beech	Piedmont Coastal Plain	Height: 50'–70'+, Spread: same Often has short trunk with wide-spreading crown. Likes moist, well drained soils. Can grow well in full sun or shade.	Beechnuts are eaten by birds and mammals and are important food for chipmunks and squirrels.
<i>Fraxinus americana</i>	white ash	Piedmont Coastal Plain	Height: 50'–80', Spread: same Pyramidal in youth and later developing an open rounded crown. Grows best on deep, well drained soils and full sun.	Moderate importance to wildlife. Seeds eaten by wood ducks, finches, and cardinals.
<i>Fraxinus pennsylvanica</i>	red ash	Piedmont Coastal Plain	Height: 50'–60'+, Spread: 25'–30' Pyramidal in youth, developing upright, spreading habit at maturity. Grows quickly in full sun and in a wide range of soil conditions. Naturally found on moist bottomlands	See white ash.
<i>Gleditsia triacanthos</i>	common honeylocust	Piedmont Coastal Plain	Height: 30'–70', Spread: same Usually has short trunk with open, oval crown. Fast grower. Withstands a wide range of conditions but prefers rich, moist bottomlands (often found on floodplains).	Limited wildlife value.

**Large Trees**, *continued*

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Juglans nigra</i>	black walnut	Piedmont Coastal Plain	Height: 50'–75', Spread: same Well-formed trunk with an oval crown. Prefers rich, moist soils. Often found on bottomlands. Difficult to transplant; should be started as seedling. Produces toxins which are poisonous to many plants giving it an advantage in open field situations but creating problems for gardeners.	Nuts are eaten by woodpeckers, foxes, and squirrels.
<i>Juniperus virginiana</i>	eastern redcedar	Piedmont Coastal Plain	Height: 40'–50', Spread: 8'–20' Densely pyramidal when young and slightly pendulous in old age. Medium rate of growth. Tolerant of adverse conditions. Prefers deep, moist soils. Will tolerate shade only in youth. Handsome reddish brown bark. Produces small fleshy blue cones. Useful for windbreaks, shelter belts, hedges.	Twigs and foliage eaten by browsers. Seeds are eaten most extensively by cedar waxwings. Evergreen foliage provides nesting and roosting cover for sparrows, robins, mockingbirds, juncos, and warblers.
<i>Liquidambar styraciflua</i>	American sweetgum	Coastal Plain	Height: 60'–75'+, Spread: 40'–50' Pyramidal in youth, rounded crown at maturity. Likes deep, moist, acid soils. Occurs naturally on bottomlands.	Goldfinches and purple finches eat winged seeds.
<i>Liriodendron tulipifera</i>	tuliptree	Piedmont Coastal Plain	Height: 70'–90', Spread: 30'–50' Long, straight trunk with a narrow canopy. Fast grower. Plant in full sun and a well drained loam. Wood somewhat weak.	Moderate wildlife importance. The purple finch and cardinal are principal users.
<i>Nyssa sylvatica</i>	black gum	Piedmont Coastal Plain	Height: 30'–50', Spread: 20'–30' Pyramidal in youth and irregularly crowned at maturity. Prefers moist, well drained, acid soils. Full sun or semi-shade. Deep taproot.	Fruit is relished by many songbirds. Users include wood ducks, robins, woodpeckers, thrashers, flickers, and mockingbirds.

**Large Trees, continued**

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Pinus strobus</i>	eastern white pine	Piedmont Coastal Plain	Height: 50'-80'+, Spread: 20'-40'+ Pyramidal in youth, crown at maturity has several horizontal and ascending branches. Fast grower. Grows best on fertile, well drained soils but is very adaptable.	Provides valuable cover and nesting sites for songbirds and mammals. Needles are used as nesting material. Seeds are eaten by quail, chickadees, grosbeaks, nuthatches, and woodpeckers.
<i>Quercus alba</i>	white oak	Piedmont Coastal Plain	Height: 100', Spread: 50'-80' Pyramidal in youth, becoming broad and rounded with wide spreading branches. Transplant as small tree. Prefers moist, well drained soils. Difficult to obtain from nurseries. Sometimes available as seedling.	Oaks, in general, are of major importance to wildlife. Acorns are at the top of the food preference list for wood ducks, pheasants, grackles, jays, nuthatches, thrushes, woodpeckers, rabbits, foxes, squirrels, and deer.
<i>Quercus palustris</i>	pin oak	Piedmont Coastal Plain	Height: 60'-70', Spread: 25'-40' Strongly pyramidal with ascending branches. One of the faster growing oaks. Full sun. Found naturally in wet soils but is adaptable to many soil types.	See white oak.
<i>Quercus rubra</i>	red oak	Piedmont Coastal Plain	Height: 60'-75'+, Spread: 40'-50' Habit is round-topped and symmetrical. Full sun. Prefers loamy, well drained soils. Fast growing.	See white oak.
<i>Tilia americana</i>	American linden	Piedmont Coastal Plain	Height: 60'-80', Spread: 35'-50' Pyramidal in youth, assuming a rounded shape with age. Full sun or part shade. Prefers deep, moist soils, but is tolerant of heavier soils.	Limited wildlife value.
<i>Tsuga canadensis</i>	eastern hemlock	Piedmont Coastal Plain	Height: 40'-70', Spread: 25'-35' Pyramidal in youth becoming more pendulous with age. Likes moist, well drained soils. Plant in sheltered area. Tolerates shade. Relatively fast growing. Excellent for screens, hedges.	Provides excellent cover for deer and songbirds. Nesting site for several warblers. Seeds are eaten by juncos, chickadees, and siskins.

**Small Trees/Large Shrubs**

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Amelanchier arborea/laevis</i>	shadbush or shadblow serviceberry	Piedmont Coastal Plain	Height: 6'-20', Spread: 10' Erect stems, often clumped. Blends well on the forest edge.	Important berry producer during the early summer months. Fruit eaten by crows, bluebirds, cardinals, and tanagers. Foliage used by browsers.
<i>Cercis canadensis</i>	eastern redbud	Piedmont	Height: 20'-30', Spread: 25'-35' Small tree with rounded crown. Likes moist, well drained soils. Found naturally only on limestone or diabase soils in Pennsylvania. Full sun to light shade.	Limited wildlife value.
<i>Chionanthus virginicus</i>	white fringetree	Coastal Plain	Height: 12'-20', Spread: same Open habit, often wider than high. Prefers moist, fertile soils and full sun.	Limited wildlife value.
<i>Cornus florida</i>	flowering dogwood	Piedmont Coastal Plain	Height: 20', Spread: 15'-20' Small tree with flat-topped crown. Place in well drained soil. Full sun to partial shade. Has character in all four seasons.	Fruit is an important source for songbirds including evening grosbeak, cardinals, robins and cedar waxwings.
<i>Hamamelis virginiana</i>	common witchhazel	Piedmont Coastal Plain	Height: 20'-30', Spread: 20'-25' Small tree or multi-stemmed shrub. Prefers moist soils in full sun or partial shade.	Limited wildlife value.
<i>Ilex opaca</i>	American holly	Coastal Plain	Height: 15'-30', Spread: 18'-25' Dense, pyramidal in youth, opening up with age. Plant in moist, well drained soil. Full sun or partial shade. Use one male for every three females.	Used extensively by many songbirds including thrushes, mockingbirds, catbirds, bluebirds, and thrashers. Foliage provides cover for songbirds and mammals.
<i>Magnolia virginiana</i>	sweetbay magnolia	Coastal Plain	Height: 10'-20', Spread: same Multi-stemmed, open shrub. Likes wet, acid soils. Tolerates shade.	Wildlife value is low. Seeds are eaten by some mammals and birds. Foliage is used by several birds for nest building.

## Small Trees/Large Shrubs, *continued*

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Viburnum lentago</i>	nannyberry	Piedmont Coastal Plain	Height: 15'-18', Spread: 6'-10' Shrub or small tree with open habit. Adapts to a wide range of soil conditions. Sun or partial shade.	Used by grouse, brown thrasher, cedar waxwing, squirrels, and deer.
<i>Viburnum prunifolium</i>	blackhaw virburnum	Piedmont Coastal Plain	Height: 12'-15', Spread: 8'-12' Round-headed tree or multi-stemmed shrub. Adaptable to many soil types. Sun or shade.	See nannyberry.

## Shrubs

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Aronia arbutifolia</i>	red chokeberry	Piedmont Coastal Plain	Height: 6'-10', Spread: 3'-5' Upright multi-stemmed shrub, somewhat open and rounded. Adaptable to many soil types. Full sun to half shade.	Fruit eaten by grouse, chickadees, and other songbirds.
<i>Aronia melanocarpa</i>	black chokeberry	Piedmont Coastal Plain	See red chokeberry.	See red chokeberry.
<i>Clethra alnifolia</i>	summersweet clethra	Coastal Plain	Height: 3'-8', Spread: 4'-6' Oval, round-topped, erect, dense, leafy shrub. Transplant into moist organic soils. Full sun or shade. Good plant for wet areas and heavy shade.	Limited wildlife value.
<i>Cornus racemosa</i>	silky dogwood	Piedmont Coastal Plain	Height: 10'-15', Spread: 10'-15' Erect, multi-stemmed shrub with short spreading branches. Suckers profusely and forms large colonies. Very adaptable, withstanding wet or dry soils, but prefers moist, well drained conditions. Full sun or shade.	High wildlife value for fruit and browse. Used by a wide variety of mammals and songbirds, including cardinals, evening grosbeaks, robins, thrush, vireos, and cedar waxwings.
<i>Ilex glabra</i>	inkberry	Coastal Plain	Height: 6'-8', Spread 8'-10' Upright, multi-branched, rounded shrub. Prefers moist, acid soils.	Berries used by a wide variety of wildlife.

**Shrubs, continued**

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Ilex verticillata</i>	winterberry	Piedmont Coastal Plain	Height: 6'-10', Spread: same Oval, rounded, deciduous shrub holly. Tends to form multi-stemmed clumps. Does well in light and heavy soils. Prefers moist, organic soils. Red fruit is beautiful in winter. A male plant is necessary for fertilization.	Used extensively by many songbirds, particularly thrushes, mockingbirds, robins, bluebirds, and thrashers.
<i>Itea virginica</i>	Virginia sweetspire	Coastal Plain	Height: 3'-5', Spread: 6'-8' Erect shrub with clustered branches. Prefers moist, fertile soils. Full sun or shade. Suited for wet areas. Excellent fall color.	Fruit capsules are used by some songbirds.
<i>Kalmia latifolia</i>	mountain laurel	Piedmont Coastal Plain	Height: 7'-15', Spread: same Large, robust shrub, becomes open with age. Requires moist, well drained soils in full sun or shade.	Mammals eat foliage and twigs. Utilized extensively by mammals and birds for winter shelter.
<i>Myrica pensylvanica</i>	northern bayberry	Coastal Plain	Height: 5'-12', Spread: same Tends to sucker to form large colonies. Deciduous to semi-evergreen. Upright, rounded, dense shrub. Adaptable to many soil conditions, including poor soils. Full sun to partial shade.	Fruit is eaten by a variety of birds in small quantities including tree swallows and myrtle warblers.
<i>Rhododendron maximum</i>	rosebay rhododendron	Piedmont Coastal Plain	Height: 4'-10', Spread: same Rounded, evergreen shrub. Plant in moist, well drained soil. Prefers partial shade.	Limited wildlife value except as browse for deer and winter cover for songbirds.
<i>Rhododendron periclymenoides</i>	pinxter-flower	Piedmont Coastal Plain	Height: 4'-6', Spread: 6'-8' Multi-stemmed, stoloniferous shrub. Adapted to dry, sandy, rocky soils. Useful for naturalizing.	Limited wildlife value except as browse for deer and grouse

**Shrubs, continued**

SCIENTIFIC NAME	COMMON NAME	PHYSIOGRAPHIC REGION	DESCRIPTION	WILDLIFE USERS
<i>Vaccinium corymbosum</i>	highbush blueberry	Piedmont Coastal Plain	Height: 6'-12', Spread: 8'-12' Upright, multi-stemmed shrub with spreading branches. Requires moist, well drained soils. Full sun or light shade.	Used heavily by grouse, scarlet tanager, bluebirds, thrushes, and other songbirds.
<i>Viburnum acerifolium</i>	maple-leaved viburnum	Piedmont Coastal Plain	Height: 4'-6', Spread: 3'-4' Low, sparsely branched shrub. Adaptable to dry soils. Extremely shade tolerant.	Twigs are eaten by deer and rabbits. Fruit is used by grouse.
<i>Viburnum dentatum</i>	southern arrow-wood	Piedmont Coastal Plain	Height: 6'-8', Spread: 6'-15' Multi-stemmed, dense, rounded shrub. Adaptable to most soil conditions, but prefers well drained. Suckers freely.	Used by grouse, brown thrasher, cedar waxwing, squirrels, and deer.

**SOURCES**
**Nurseries Specializing in Native Plants**

David Brothers Bean Road Nursery  
P.O. Box 123  
Whitehall and Bean Roads  
Worcester, PA 19490  
610-584-1550

Edge of the Woods Native Plant Nursery  
2415 Route 100  
Orefield, PA 18069  
610-395-2570  
[www.edgeofthewoodsnursery.com](http://www.edgeofthewoodsnursery.com)

Natural Landscapes  
354 North Jennersville Road  
West Grove, PA 19380  
610-869-3788

North Creek Nurseries, Inc.  
388 North Creek Road  
Landenberg, PA 19350  
877-ECO-PLUG  
[www.northcreeknurseries.com](http://www.northcreeknurseries.com)

Octoraro Farm and Gardens  
698 Lees Bridge Road  
Nottingham, PA 19362  
610-932-0225  
[www.octorarofarm.com](http://www.octorarofarm.com)

Octoraro Native Plant Nursery  
6126 Street Road  
Kirkwood, PA 17536  
717-529-3160  
[www.octoraro.com](http://www.octoraro.com)

Pinelands Nursery  
323 Island Road  
Columbus, NJ 08022  
609-291-9486  
[www.pinelandsnursery.com](http://www.pinelandsnursery.com)

Redbud Native Plant Nursery  
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Glen Mills, PA 19342  
610-358-4300  
www.redbudnativeplantnursery.com

Sylva Native Nursery and Seed Company  
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Glen Rock, PA 17327  
717-227-0486  
www.sylvanative.com

Temple University/Ambler Nursery  
580 Meetinghouse Road  
Ambler, PA 19002-3994  
215-283-1330  
(Wholesale only)

Yellow Springs Farm  
1165 Yellow Springs Road  
Chester Springs, PA 19425  
610-827-2014  
www.yellowspringsfarm.com

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145 Moon Road  
Chesapeake City, MD 21915  
800-803-TREE  
www.moonnurseries.com

Musser Forests  
1880 Route 119 North  
Indiana, PA 15701  
800-643-8319  
www.musserforests.com  
(Seedlings only)

New Moon Nursery  
13 Ways Lane  
Kennett Square, PA 19348  
888-998-1951  
www.newmoonnursery.com

Princeton Nurseries  
P.O. Box 185  
Allentown, NJ 08501  
800-916-1776  
www.princetonnurseries.com

Shemin Nurseries  
P.O. Box 649  
100 Green Tree Road  
Oaks, PA 19456  
610-666-0595  
www.sheminnurseries.com  
(Wholesale only)

### **Wildflower Sources**

Brandywine Conservancy  
Box 141  
Chadds Ford, PA 19317  
610-388-2700

Ernst Conservation Seeds  
9006 Mercer Pike  
Meadville, PA 16335  
800-873-3321  
www.ernstseed.com

Prairie Nursery  
P.O. Box 306  
Westfield, WI 53964  
800-476-9453  
www.prairienursery.com

Sandy Wilson  
Native Plants and Aquatic Nursery  
834 Church Road  
Harleysville, PA 19438  
610-584-6302

**Additional Sources for  
General Lists**

*Guide to Pennsylvania Nursery Stock*  
Pennsylvania Nurserymen's Association,  
Inc.

1924 North Second Street  
Harrisburg, PA 17102

New England Wild Flower Society, Inc.  
Garden in the Woods  
180 Hemenway Road  
Framingham, MA 01701  
508-877-7630

**Information Sources**

*Manual for Woody Landscape Plants*  
Michael Dirr  
Stipes Publishing Company, 1990

*American Wildlife and Plants: A Guide to  
Wildlife Food Habits*  
Alexander C. Martin, et. al.  
Dover Publications, 1951

*The Plants of Pennsylvania, An Illustrated  
Manual, 2nd Edition*  
Ann F. Rhoads and Timothy A. Block  
University of Pennsylvania Press, 2007

# Native Warm-Season Grass Meadow

*converting an abandoned field*



## PROJECT GOAL

To establish a native warm-season grass meadow on 8.4 acres of abandoned fields to improve habitat for rare grassland birds (e.g., Bobolinks, Eastern Meadowlarks).

Several species of grassland birds have declined in recent years as our landscape has become fragmented and farming practices have favored non-native cool-season grasses and early season mowing regimes, often disrupting breeding and foraging habitat. Warm-season grasses appear and thrive with the arrival of the summer months while cool-season grasses prefer the cooler temperatures of spring and fall. Big and little bluestem, Indian-grass, and switchgrass are warm-season grasses native to southeastern Pennsylvania and well adapted to the 4-season climate of this region. The clump-forming habit of warm-season grasses (cool-season grasses typically form dense mats) creates patches of bare ground that provide quality nesting sites and foraging corridors for grassland birds.



Native warm season grass meadows also produce highly nutritious seeds and attract a diversity of insects that serve as important food sources for birds.

### site

Goshen Road, *privately-owned parcel*  
Newtown Square, Delaware County, PA

### site preparation and installation

The most important step in creating a warm-season grass meadow is site preparation. Warm-season grasses prefer marginal soils with low nutrient content. Historic uses of a project site (e.g., crop farming) may have “improved” soil conditions to favor aggressive cool-season grasses and invasive species. It is important to eliminate these warm-season grass competitors before planting a meadow.

At the Goshen Road site, a contractor certified in herbicide application treated the abandoned field, primarily made up of cool-season grasses and invasive species, with an appropriate herbicide mix in early April of 2006. In late May, a no-till drill (specially designed to handle warm-season grass seed) was used to seed the field with four species of warm-season grasses: big and little bluestem, Indian-grass, and switchgrass. No-till seeding of warm-season grasses is less costly and more effective than traditional tilling methods because it limits soil disturbance, retains the protective surface thatch



June 2006 – one month after planting



September 2008

layer, reduces soil erosion, and limits nutrient and moisture loss. The light and fluffy seeds of warm-season grasses are also difficult to plant using traditional methods.

### **maintenance and monitoring**

The site was visited on a monthly basis during the first growing season following seeding to monitor the growth of warm-season grasses and competition from undesirable species. Canada thistle is a common invader of newly seeded meadows and spot mowing or herbicide application (most effective in late summer or early fall) may be necessary to control this problem species.

Native meadows require periodic disturbance (e.g., mowing, fire) to inhibit encroachment by shrubs and trees. Beginning with the second growing season after planting (2008), the meadow on this site will be mowed to a height of 8"–10" one or two times each year. Ground-nesting grassland birds depend on springtime cover in the meadow to protect their young, so the optimal times for mowing warm-season grass meadows are (1) early to mid-March, to limit the length of time without wildlife cover and to take advantage of the solid ground of that time of year, and (2) between late June and early July, to favor warm-season grasses and set back invasive plants, and to ensure dry surface conditions for mowing equipment. We often mow only parts of a meadow rather than an entire meadow area to ensure some undisturbed habitat is available as year-round shelter for wildlife. This patchwork effect better mimics natural habitat conditions.

Because wildflower seeds are expensive and often more difficult to cultivate than warm-season grass seeds, native wildflowers will not be introduced into the meadow until warm-season grasses are established at this site and the threat of invasive species is minimized. Wildflower seeds may be added in clearings or patches that have been mowed or burned within the warm-season grass mix.

### **results and lessons learned**

- Some warm-season grasses such as switchgrass and big bluestem are more aggressive than others, so it is best to keep these species at lower concentrations in the seed mix.
- If the phases of a meadow installation are kept to 20 acres or less, unexpected losses due to unique site conditions or unforeseen weather events will be minimized.
- Curved edges can give your meadow a more natural look.
- Trails can be mowed around or through meadows to provide inviting access for visitors.
- Areas of turf grass (requiring weekly mowing or more) that are converted to meadow (by reducing to one or two mowings annually) can provide considerable cost savings and important environmental and ecological benefits.



# From Mowing to Meadows... *Developing a Wilder Aesthetic*

Kirsten L. Werner, Natural Lands Trust

Converting part of your yard to meadow can save you time and money — think about less frequent mowing. And meadows help filter our groundwater, control flooding, add visual appeal and provide critical habitat for songbirds and pollinators. So sit back and watch the grass grow!



## Grass is Far from “Green”

Americans spend about \$30 billion every year to maintain more than 32 million acres of lawn—that’s about the size of Pennsylvania. We pour 270 billion gallons of water per week on our lawns and apply 10 times more fertilizer, herbicides and pesticides than farmers do to their crops.

A typical 3.5-horsepower gas lawn mower emits about the same amount of volatile organic compounds in an hour as a car driven 340 miles. On top of that, the EPA estimates that we spill 17 million gallons of fuel each year filling our mowers—more than the Exxon Valdez oil spill!

## Making Meadows

The easiest way to convert a portion of lawn to meadow is simply to mow only once or twice a year. Often the best areas to convert are those that are difficult to mow, such as wet or steep areas. Other ideal locations include transition areas between turf and woodlands, stream corridors and areas that aren’t often used by your family.

At first, your new meadow will be a new home to the species that originally made up the lawn: usually non-native, cool-season grass species such as Kentucky bluegrass, fescues and ryegrasses. With time, the vegetation diversifies. Native warm-season grasses—little and big bluestem and purpletop—will begin to appear.

Wildflowers will follow, depending on what species are seeded by local plants and by seeds in wildlife droppings. Species such as goldenrod, asters, black-eyed Susan, daisy, yarrow, Queen Anne’s lace and purple coneflower are common in meadows.

## Better Habitat for Wildlife

Over the last century, changes in agricultural technology and loss of land to development have caused a decline in the quantity and quality of grasslands habitats for wildlife. In particular, these changes have threatened the survival of birds—such as Eastern Meadowlark, Bobolink, Grasshopper Sparrow—that depend on large meadows (25+ acres).

While small meadows won’t provide breeding habitat for these threatened species, they do provide important resting and feeding areas along migratory pathways. And you’ll get to enjoy the sight of avian species such as Red-wing Blackbird, American Goldfinch, and various swallows and sparrows that are far less likely to frequent your manicured lawn.

## Beneficial Pollinators

Another benefit of allowing turf to evolve to meadow is the increased presence of pollinators. Many beneficial pollinators—bees, beetles, butterflies—are currently at risk from loss of habitat and pesticide use. This is especially troubling because pollinators are essential to the production of 75 percent of the staple crops that feed humans and for 90 percent of all flowering plants in the world.

Beneficial pollinators have very basic habitat requirements: flowers to forage, host plants for egg laying, and an environment free of pesticides. Grasslands and wildflower meadows offer these essentials in spades.

## Visual Appeal

Meadows offer a sensory experience every season of the year. A meadow of tall, waving grass is a beautiful sight on a breezy



Grasshopper Sparrow



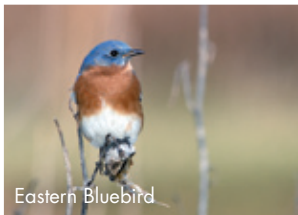
Eastern Meadowlark



Monarch Butterfly



American Goldfinch



Eastern Bluebird



Eastern Black Swallowtail

June day. In mid-summer, it's literally abuzz with activity. There's much to observe: a bird looking for a meal, bees flying from flower to flower, the iridescence of a butterfly, or the steady chatter of crickets. Many meadow wildflowers persist into fall and attract songbirds that feast on seed heads. Even in winter, the dried stalks of meadow grasses and flowers are striking.

To make clear that a meadow is intentional and managed, and not a landscaping oversight, maintain a mowed turf swath as a sharp edge around the borders. If your meadow is large enough, consider incorporating a trail network so you (and your senses) can get closer to the action!

### Meadow Maintenance

Mow your meadow at least once a year to keep it from reverting to a forest. But remember: timing is everything. Mowing between April 1 and early July is detrimental to wildlife because it removes nesting cover, destroys nests and eggs, and kills young birds and animals. Similarly, mowing between mid-July and late-October doesn't allow vegetation enough time to renew itself before winter, so it won't offer food and cover for wildlife until the following spring.

Mowing between March 1 and April 1 is ideal. Set your mower deck to a height of six to eight inches and mow away!

Keep an eye out for invasive plants that can quickly take over your new meadow. Eliminate invasives by spot mowing, selective spraying with an herbicide, or manual or mechanical pulling. Use only aquatic approved herbicides within 50 feet of streams.

Given the myriad of benefits of replacing turf with meadow, it's certainly worth considering. You can start small, but beware ... making meadows can be addictive! After a few seasons of observing the flourishing grasses and wildflowers, you'll never look at turf the same again. ♦

*Natural Lands Trust is dedicated to protecting forests, fields, streams and wetlands essential to the sustainability of life in eastern PA and southern NJ. Since 1953, it has preserved more than 100,000 acres, including 42 nature preserves. Millions of residents enjoy the healthy habitats, clean air and water, recreational opportunities, and scenic beauty provided by these preserved land. Visit [NatLands.org](http://NatLands.org).*





# Meadows

*in Southeastern Pennsylvania*



Bill Moses

**M**ost grasslands and meadows in eastern North America are short-lived ecosystems. Without repeated disturbance, woody cover (trees and shrubs) quickly returns. It is now believed that agriculture and burning by Native Americans, coupled with the more recent agriculture of European settlers, maintained extensive herbaceous openings in this region for thousands of years, and that feeding, wallowing, and trampling by now-extinct “megaherbivores”—mammoths, mastodons, giant ground sloths, horses, tapirs, peccaries, and others—created and maintained a patchwork of meadows and grasslands for millions of years before that, until their

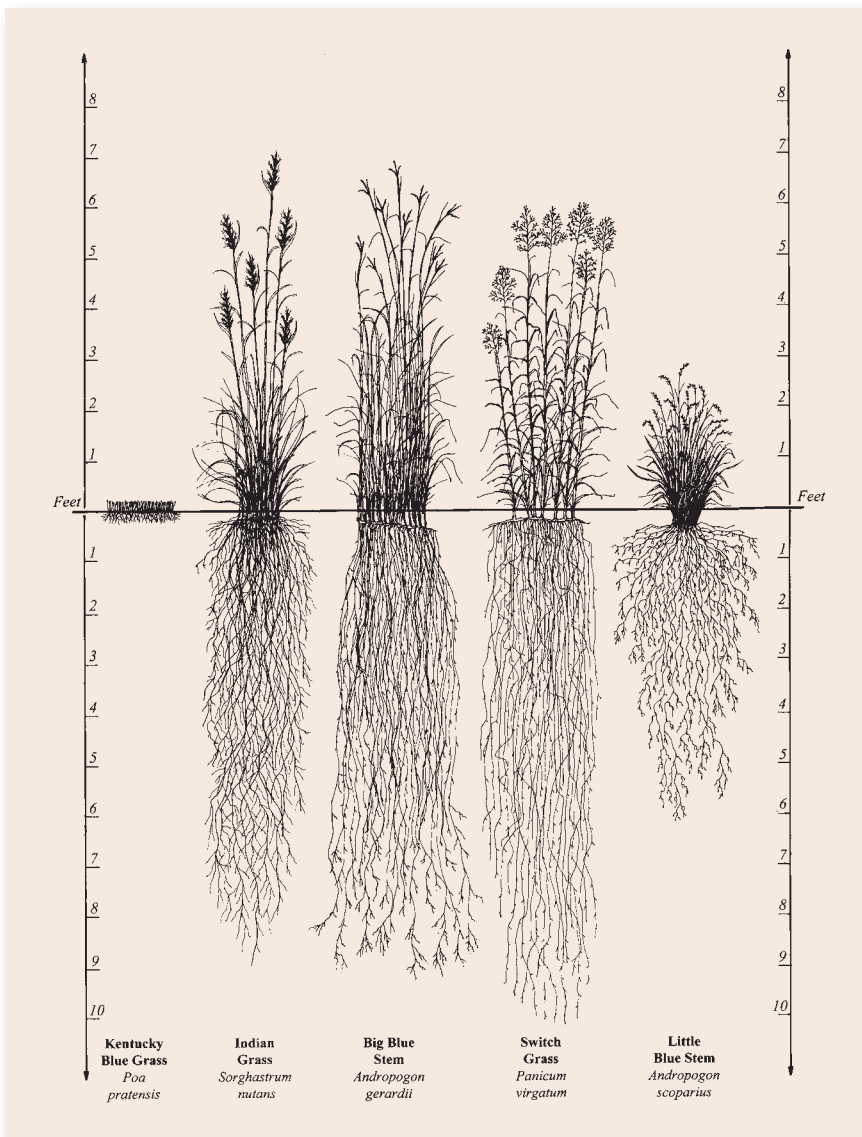
demise upon arrival of humans to our region about 13,000 years ago. As a result, numerous native plant and animal species, particularly birds and butterflies, are completely dependent upon these habitats and are now threatened as they decline.

Most meadows in southeastern Pennsylvania have an agricultural past—old hayfields or pasture—and are dominated by non-native cool-season grasses planted for centuries as fodder, such as tall fescue, perennial ryegrass, Kentucky bluegrass, orchard grass, and timothy. Cool-season grasses are so named because they grow best during spring and fall. Warm-season grasses grow mainly in the heat of the summer.

Although native meadows are attractive throughout the year, summer and early fall is the period when meadows exhibit their full glory. Between early July and late October, the warm-season species will dominate, creating lush foliage of varying shades of blue and green punctuated by wildflowers in a meadow tapestry. Common meadow wildflowers at this time include black-eyed Susan, sunflower, aster, and goldenrod. As winter sets in from November to March, the warm season grasses, which remain upright, will provide a

spectacle of color, often described as “wine-red, ash grey, steel blue, gold russet, ochre, copper and amethyst.”

Two misconceptions are widespread: one is that most cool-season grasses are non-native, and the other, that most native grasses are warm-season. Considering the state’s flora as a whole, the facts are somewhat the opposite. Of the 173 grasses (165 species, plus varieties and subspecies) native to Pennsylvania, 105 are cool-season grasses and 68 are warm-season grasses. The higher diversity of cool-season grasses also holds



**Unlike the shallow roots of turf grasses, the deep roots of native warm-season grasses like big bluestem (above) help them tolerate marginal soils and, in turn, protect these soils from water and wind erosion.**

when considering species only native to the Piedmont and Coastal Plain areas of southeastern Pennsylvania. There are a total of 149 grasses considered to be native to this region with 83 cool-season and 66 warm-season representatives.

The cool-season grasses' new leaves emerge in late winter or early spring and they generally flower and set fruit in spring or early summer. In warm-season grasses emergence is usually delayed until late spring or early summer and they generally flower and set fruit in late summer or fall. Native cool-season and warm-season grasses can perform well together in mixture because competition between grasses of the two types is reduced, due to differences in rooting depth (cool-season species tend to have shallower roots than warm-season species) and the separation of peak growth and photosynthesis to different parts of the growing season. Native warm-season grasses thrive on marginal soils and survive periods of low rainfall due to their deep, fibrous root systems, which can penetrate the soil to a depth of 5–10 feet. In native meadow plantings, a reasonable goal is to achieve 50–75% cover of warm-season grasses (e.g., little bluestem, big bluestem, Indian-grass, broomsedge, switchgrass), with the remainder in native cool-season grass and forb cover.

## WILDLIFE BENEFITS

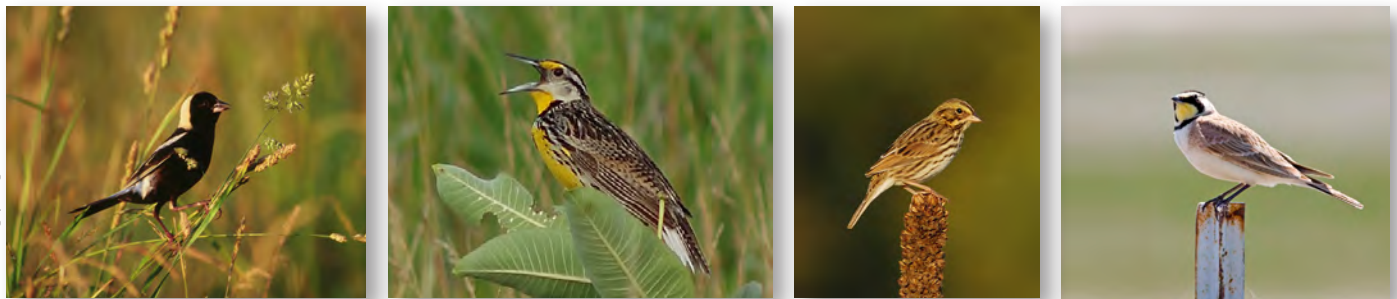
The beauty of native grasses and wildflowers is complimented by the wildlife attracted to them for food and shelter. Native grasslands and meadows are prime habitat for several threatened bird species

because this habitat has steadily declined in size and species diversity since European settlement.

Declines are especially devastating of *interior* grassland and meadow species, that is, those that need blocks of contiguous habitat, usually greater than 50 acres, where there are large areas at least 100 meters (about 300 feet) from any forest edge or other non-meadow land cover. Populations of birds such as bobolink, eastern meadowlark, grasshopper sparrow, savannah sparrow, vesper sparrow, upland sandpiper, and northern bobwhite have fallen off drastically in recent years due to the loss of habitat and the fragmentation of remaining habitat into pieces that are too small to meet their needs.

There is an ongoing effort by scientists and resource managers to better understand what makes ideal habitat for grassland and meadow birds. Over the past decade, there has been wide promotion of native warm-season grasses as the ideal habitat. Warm-season grasses are a key part of prime habitat for grassland birds because they are bunch grasses, in contrast to the sod-forming growth habit of the common non-native cool-season grasses, such as those planted for hay, pasture, or turf. This means that they grow upright with bare ground between clumps. This characteristic provides high-quality nesting sites and materials and allows grassland birds to move more easily and better protected from avian predators in their search for food. The open space between clumps also provides space for wildflowers to become established.

In spring, ground-nesting birds utilize the cover afforded by the grasses and wildflowers to brood and rear their young. Flowers attract insects, which



**Birds of large open landscapes: bobolink (far left) and eastern meadowlark (middle left) are two birds that prefer cool-season grasslands; savanna sparrows (middle right) prefer warm-season grasslands; and horned larks (far right) are “dirt birds,” using bare soil in cultivated fields.**

constitute the most important element in the diet of young birds. During the autumn months, native wildflowers and grasses produce highly nutritious seeds. These are relished by a variety of songbirds and will attract many migrants that stop over on their long journey south. Throughout the winter, the upright grasses provide food and cover for the resident birds to help them survive the winter months.

Despite the great benefits of native warm-season grasses, research is showing that they do not fit the needs of all grassland birds. While savannah and grasshopper sparrows prefer warm-season grasses, bobolink and meadowlark do best in cool-season grasslands. And some birds, e.g., horned larks, are full- or part-time “dirt” birds, using the bare soil created by traditional cultivation (moldboard plowing) and heavy grazing, which mimics the trampling, wallowing, and grazing by megaherbivores that occurred during most of the evolutionary history of native grassland and meadow plant and animal species. There is a growing consensus that a large open landscape (hundreds of acres) with diverse cover types in patches of various

sizes, including warm- and cool-season grasslands and forb-dominated meadows, is best. Agriculture (row crops, pasture, hay fields) without hedgerows can be a compatible economic land use within a mosaic of native grasslands and meadows intended to provide habitat for grassland-interior birds. Structural diversity—created by planting a patchwork of meadow types, each with a mix of species—produces preferred cover for the greatest variety of grassland and meadow wildlife species.

Little is known about the effects of declining native grassland habitat to other kinds of wildlife in Pennsylvania, including small mammals, snakes, lizards, turtles, insects and other arthropods, and various animals that live in the soil. But we can get some idea of the probable magnitude of the problem from surveys of one of the few groups that has been studied—moths—in the native grasslands of the State Line Serpentine Barrens along the southern borders of Chester and Lancaster Counties. These ancient grassland remnants harbor, according to discoveries so far, at least three dozen moth species listed as endangered, threatened, or rare in Pennsylvania.

Many butterfly species have also developed close relationships with native meadow wildflowers, which they use for the nectar (adults) and the leaves and stems (larvae). As our few remaining undisturbed habitats continue to be lost to suburban development, many native plants are becoming increasingly rare. The implications for butterflies are dire; with the loss of their host plants, some butterfly species are inching closer toward extinction. Unless native wildflowers and butterfly habitats are restored, we can expect to see further declines in overall butterfly populations and continued losses of rare and endangered species.



Gary Gimbert

## ESTABLISHMENT

Conversion to native grasses and forbs is best achieved by eliminating existing vegetation that can aggressively compete for nutrients and water, particularly turf grass species, trees, shrubs, and invasive vines. Trees and shrubs can also obstruct mowing and other future maintenance activities. If rapid conversion to native grasses is not an option for lack of funding or equipment, the landowner can

encourage a gradual change from exotic to native grass dominance through the timing of management. Certain bird species, particularly bobolinks and meadowlarks, can thrive in large open areas dominated by exotic turf grasses created simply by reducing the mowing frequency of turf, pasture, or hay field to once per year.

One of the challenges of meadow establishment and management is a tendency for the planted native grass species to become over-dominant. This is particularly true of the warm-season “tallgrasses,” notably big bluestem, Indian-grass, and switchgrass. It is best to mass forb plantings and separate them spatially from the tallgrass plantings. This type of patchiness is common in nature and should be imitated to the extent possible in new meadow



Paul Calkopoule (both)

**Meadow establishment through spraying (top) and then planting with a no-till drill (bottom).**

establishment. Grasses should be planted in rates not exceeding 1–2 pounds per acre in order to achieve high species diversity.

Initial failure of meadow and grassland plantings, especially of warm-season grasses, is not uncommon. Weather and other factors are beyond the control of even an experienced practitioner. Such setbacks are temporary and should not be a cause to give up on efforts to establish native meadow vegetation. Often, where initial plantings do not produce the desired result, a follow-up attempt a year later is successful.

## MANAGEMENT

Because a meadow is typically a short-lived successional stage, it must be periodically disturbed to prevent woody vegetation from becoming established. This can be accomplished either by mowing annually or prescribed burning every few years.

The frequency and timing of mowing has a dramatic affect on the composition of a meadow and its wildlife residents. When and how often to mow will depend upon your conservation priority and the environmental conditions of the grassland or meadow. In general it is best to mow when wildlife is



Jim Thompson

**Generally, an annual mowing is all that is needed to maintain a meadow, but sometimes a second mowing is needed during the growing season to control undesirable plants.**

## Recommended Mowing Regimen

ENVIRONMENTAL CONDITIONS	CONSERVATION PRIORITY	
	<i>Most Meadow Wildlife (&lt;50 acres of total habitat*)</i>	<i>Grassland/Meadow-Interior Birds (&gt;50 acres total contiguous habitat*)</i>
Dry or frozen in late winter/early spring	Mow in March	
Wet in late winter/early spring	Mow after first hard frost (mid-November)	
Heavy invasives	Mow entire area in March; mow one-third to one-half the area in mid- <b>July</b> , alternating in subsequent years	Mow entire area in March; mow one-third to one-half the area in mid- <b>August</b> , alternating in subsequent years

\* To determine the extent of meadow habitat, individual meadows must be connected on at least one side and can have no more than a few sparse trees (no shrubs or vines under the trees) in order to be connected enough to function as a single meadow.



Mark Eberle

Mowed edges and trails give meadows the appearance that they are intentional and managed, as well as encourage people to discover their beauty up close.

less vulnerable to disturbance, that is, during the non-growing season (roughly mid-November to mid-March in southeastern Pennsylvania). A late winter or early spring mowing (prior to April 1st) is best. Mowing at this time conserves winter cover for wildlife and avoids disturbing nesting and feeding wildlife (birds, small mammals, butterflies) in spring and summer. If wet soil conditions prohibit mowing in late winter/early spring a fall mowing (after the first hard frost) when these areas are dry or a winter mowing when the ground is frozen are other preferred options. Sometimes a second mowing is needed to control undesirable plants during the growing season; a mid-July to early August mowing will help control woody and invasive plants, encourage warm-season grasses, and provide sufficient time to establish winter cover. The only case where this would not be appropriate is in larger (>50 acres) grasslands and meadows (or smaller meadows in a larger open landscape), which can support threatened interior grassland and meadow birds. These birds can nest into mid-August. In this situation it is best to mow only one-third to one-half of the grassland or meadow each year to minimize disturbance of ground-nesting birds.



Dan Boring

Prescribed fire is an effective meadow management tool for discouraging invasion by woody plants and killing or setting back non-native and/or invasive species such as thistle, multiflora rose, oriental bittersweet, and Japanese honeysuckle.

It is best to mow meadows when the ground is dry or frozen. They should be cut at a height of 8–12 inches. Meadows must also be monitored for intrusion by invasive plants. Invasives in meadows can be eliminated by spot mowing, spot-spraying or wick application of an appropriate herbicide, or manual or mechanical pulling.

To emphasize that a meadow is intentional and managed, it is often beneficial to maintain a mowed turf swath around the public edges and consider incorporating a trail network. Well-maintained trails encourage people to get into the meadow and discover its beauty up close. However, care should be taken to minimize the extent of trails to prevent undue disturbance of wildlife. This is especially true in meadows that support grassland-interior birds where trails can fragment the habitat and provide easy access for predators.

Another tool for managing meadows is prescribed fire. Native Americans used fire to manage the landscape for thousand of years, which selected fire-adapted species to dominate native grasslands

and meadows. Periodic spring fires (with at least 3–5 years between burns in a given area), rotating among sections of the meadow landscape to maintain a refugium from which insects can re-colonize the treated area (for meadows less than 50 acres only 10–20% should be burned in any year; for larger meadows one-third to one-half can be treated), will effectively discourage invasion by woody plants. Prescribed burning should be done only by well-trained personnel and in accordance with federal, state, and local laws.

**Excerpted from Natural Lands Trust's *Stewardship Handbook for Natural Areas in Southeastern Pennsylvania* (2008). For a more detailed discussion of meadows and information on stewardship of natural areas in general, please consult the *Stewardship Handbook*, available for free download or purchase at [www.natlands.org/handbook](http://www.natlands.org/handbook).**

**For more information about meadow installation and management, contact Gary Gimbert at 215-699-1578.**



Hildacy Farm ~ 1031 Palmers Mill Road ~ Media, PA 19063 ~ 610-353-5587 ~ [www.natlands.org](http://www.natlands.org)

## Appendix F – BMP Research Summary Tables

### List of Practices:

[Green Roofs](#)

[Vegetated Filter Strips](#)

[Permeable Pavement](#)

[Drainage Swales](#)

[Bioretention](#)

[Water Quality Swales](#)

[Infiltration](#)

[Extended Detention Ponds](#)

[Filtering Practices](#)

[Stormwater Wetlands](#)

[Wet Ponds](#)

**GREEN ROOFS LITERATURE SUMMARY**

Study	Description	Pollutant Reductions	Runoff Reductions	Implications for Design
Banting et al, 2005  CitedRefs: Thompson, 1998 Liesecke, 1998 Zinco Roof Gardens, 1997			Thompson, 1998: 60-80%, depending on substrate depth  Liesecke, 1998: 40-45% for 2-4cm of media 60% for 10 cm of media  Zinco, 1997: 70-90% Summer 40-50% Winter	
DeNardo et al, 2005	7 rainfall events monitored on GR's with a media depth of 89 mm, 8% slope in State College, PA (PSU).		Avg Runoff reduction: 45% (range 19-98%). Rainfall 3.7-13.6mm (2 mo. period in Fall)  Tp delay: 1-3hrs Peak Flow reduction: 56%	Runoff reduction was higher during smaller rainfall events.  RR is not an annual average, but rather a two month average during Fall months. Expected RR would be higher during summer period.
DeNardo et al, 2005  CitedRefs: Miller (1998) and Scholz (2001)	3" media depth		38-45% 38-54%	

APPENDIX F – BMP Research Summary Tables

<p>Emilisson et al, 2007</p>	<p>Investigated nutrient runoff, storage, and plant uptake after fertilization of vegetated roof systems during simulated rainfalls over a 6 mo. Period in Sweden. Three levels of fertilizers were applied as either controlled release fertilizer (CRF), or combo CRF and conventional fertilizer. Conventional fertilizers yielded the highest runoff nutrient concentrations. Runoff concentrations decreased over time, but remained higher than CRF runoff conc. Nutrient leaching from established vegetation mats was lower than that from newly established surfaces.</p>			<p>Green roofs applied with low dose fertilizers exported less nutrients than those with conventional fertilizers.</p> <p>Conventional fertilizers should be avoided, or runoff water should be recycled or reused on the roofs or other vegetated surfaces, particularly during the first weeks following fertilization.</p>
<p>Farzaneh et al, 2005</p>	<p>89 mm thick media in beds were tested in a control greenhouse at Pennsylvania State University. The greenhouse temperatures were adjusted to simulate four seasonal climatic conditions, which correlated to the ambient season. 4 different models were used to calculate ET.</p>			<p>ET rates from vegetated beds averaged 0.61 mm/d (winter) and 1.12 mm/d (spring/fall)</p> <p>Vegetated beds lost 28% and 57% more water than unplanted beds in winter and spring, respectively.</p>
<p>Getter et al, 2007</p>	<p>Examined RR for GRs constructed on 2, 7, 15, and 25% slopes at MSU. All roofs</p>		<p>Avg: 80.8%</p> <p>For Light (&lt;2mm),</p>	<p>Green roofs constructed with lower slopes have the potential to retain more water</p>

APPENDIX F – BMP Research Summary Tables

	<p>contained a 6 cm media layer and 0.75 cm of a moisture retention fabric. Mean retention was least on the 25% slope (76.4%) and greatest at the 2% slope (85.6%). Overall average retention was 80.8% (P&lt;40mm, 62 events)</p> <p>CN for all roofs ranged from 84 (2% slope) to 90 (25% slope), for all rainfall events</p>		<p>Med (2-10mm) and Heavy (&gt;10mm) rainfall events on the 2% slope: 93.3, 92.2, 71.4 (mean 85.6)</p> <p>62 rain events 0&lt;P&lt;40mm</p>	
Hutchinson et al, 2003	<p>A GR in Portland Ore with a 4-5” media depth was monitored for hydrologic and water quality data.</p>	<p>TP export conc. was high, but showed a decreasing trend over course of 1 yr study.</p> <p>Pollutant load reductions were possible due to the large reduction in runoff vol.</p>	<p>69% average Rainfall over 15 mo. Period. Summer:92% Winter: 59%</p> <p>During dry season, removal approached 100%</p>	
Liptan and Strecker, 2003	<p>A GR in Portland, OR was monitored for hydrologic data. The roof was designed with 2-3” of topsoil and compost mix and planted with seven species of sedum. The roof slope was</p>		<p>Monthly retention ranged from &lt;10% for an 11 in. rainfall, to 100% in dry season months. Over a two year study,</p>	

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	~7%.		average annual retention was 28%.	
Long et al, 2007	Columns were filled with 4” of different GR mineral media: two grades of expanded shale, two expanded clays (one with nutrient additives), and an expanded slate. Rainfall was simulated using synthetic rainwater. The study is still ongoing, but preliminary conclusions indicate GR media can effectively buffer rainfall pH and remove heavy metals. The finer graded expanded shale was most effective in pH buffering and metal removal.			The authors forecast that the engineering of a green roof media for water quality improvement is possible.  It is recommended that expanded shale be used in green roof media mixes, due to the increase pollutant removal capabilities of this mix. To allow for proper drainage in the media, the fines should be mixed with medium grade materials. The mix ratio is still being studied.
Moran et al, 2005	Location: Kinston, Goldsboro, NC. Media depths and slope were 75mm (3 in ) and ~0% for Goldsboro, and 100 mm (4 in) and 7% for Raleigh. Rainfall monitored over 6 month pd.	Green roof drainage exhibited and increase in N and P conc. from rainfall	Average 63% (Goldsboro) and 55% (Raleigh)  For P>1.5”, C=0.50 Tp delay 2-4.5 hrs	Results of a related laboratory test showed that soil media with a lower compost content will leach less N and P from the GR runoff. Further, the amount of nutrient leached over time should decrease.
MSU Research 2001-2004	3 year study of plant survival and drought tolerance in Michigan. Sedum and native species were planted and evaluated. The roof was irrigated regularly during the first year; irrigation was reduced and then eliminated in the 2 <sup>nd</sup> and 3 <sup>rd</sup> years. Upon			All tested (9) varieties of <i>Sedum</i> and <i>A. cernuum</i> , <i>C. lanceolata</i> , and <i>T. ohioensis</i> were the most suitable for unirrigated roofs in the Upper Midwest.  Species of native plants could be used in GR applications so long as irrigation occurred regularly.

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	cessation of irrigation, most native plants died. Only Sedum species survived on natural rainfall.			
MSU Research 2001-2004	9 species of Sedum were planted at depths of 4.0, 7.0, and 10.0 cm on green roof platforms in autumn and spring			Spring plantings had better survival rates (81%) compared to autumn (23%).
MSU Research 2001-2004	Chlorophyll fluorescence ( $F_v/F_m$ ) measurements were taken on plant leaves to monitor plant stress. Chlorophyll fluorescence can indicate plant photosynthetic potential.			Water was required at least once every 14 days and 28 days to support growth in green roof substrates with 2 cm and 6 cm media depths respectively. Sedum vegetation was still viable after 88 days of drought
Teemusk and Mander, 2007	A study in Tartu, Estonia, compared runoff and WQ from a vegetated GR to a reference bituminous roof. Three rainfall events and two snow melt events were observed. The GR contained 100mm of media and 80 mm of rock wool (for additional water retention). The media layer consisted of a lightweight aggregate (LWA) (66%), humus (30%) and clay (4%).  The rainfall was characterized by low intensity.	TP: 12-65% TN: 7-19%  First number is avg during heavy storms ( $P < 12.1$ mm) and second number is avg during small storms ( $P < 2.5$ mm )	For $P < 2.5$ mm, 86% For $P > 12.5$ mm, 0%  During snow melt, pollutant concentrations were greater on the greenroof.  Greenroof runoff had higher sulphates and Ca-Mg salts conc., due to leaching from the LWA-material.	The quality of the runoff water varied based on rainfall amt, and the amt of pollutants accumulated on the roof.  GR effluent conc. of TN and TP were much lower than observed by Moran et al. (2003) or Liptan and Strecker (2003), because the Estonian greenroof did not contain compost  The composition of the media layer should be taken into consideration in selecting the soil mix.  P and N effluent concentration increased during heavy rainfall events; however, concentrations were still lower than those from the reference roof.
TRCA, 2005	Runoff from a GR was compared to control roof runoff in York, Toronto. Both roofs	Calculated Removal (GR compared to	RR: 54-76%	Fertilizers in the GR media were the primary source of phosphorus.

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	were constructed on 10% slopes. The GR was planted with wildflowers and contained 140 mm of growing media consisting of crushed volcanic rock, compost, blonde peat, cooked clay and washed sand.	control roof): TSS: 69% TP: negative TKN: negative Cu: 66% Zn: 18% EColi: negative Al: 18% PAHs: 83-89%		GR phosphorus concentrations decreased more than 50% over two consecutive monitoring years, likely a result of leaching out from the media.  Clearing of debris and bird feces from the GR should be done regularly to prevent clogging and decrease pollution export.
VanWoert et al, 2005	Compared RR of three roofs: gravel ballast (2 cm), extensive green roof without vegetation (2.5 cm media), and extensive green roof with vegetation (2.5 cm media) in East Lansing, MI (MSU)		Avg RR: Veg: 60.6% Media: 50.4% Gravel: 27.2%  0.08<P< 53.59 mm (83 events)	GRs with lower slopes and deeper media depth retained more rainfall  RR depended on rainfall depth. Overall, vegetated roofs were most effective in retaining rainfall For Light (<2mm), Medium (2-6mm) and Heavy (>6mm) storms, % retention, respectively: Veg: 96.2, 82.9, 52.4 Media: 99.3, 82.3, 38.9 Gravel: 79.9, 33.9, 22.2
Schueler and Brown, 2004 Appendix B, Manual 3				Not included

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**VEGETATED FILTER STRIP LITERATURE SUMMARY**

Study	Description	Pollutant Reductions (conc. based unless noted)	Runoff Reduction	Implications for Design
Abu-Zreig et al, 2003	20 filters with varying length (2 to 15 m), slope (2.3 and 5%), and vegetation cover, were evaluated for phosphorus removal efficiency. Runoff was produced by rainfall simulators. The average P trapping efficiency of vegetated filters was 61%, ranging from 31% in a 2-m filter to 89% in a 15-m filter. Filter length was found to be the largest factor in removal; inflow rate, vegetation type, and density vegetative coverage had secondary influences.	<b>MASS REMOVAL:</b> The average phosphorus trapping efficiencies of the 2, 5, 10, and 15-m-long strips were 32, 54, 67, and 79%, respectively		Short filters (2 and 5 m), which are somewhat effective in sediment removal, are much less effective in P removal.  For sediment trapping, increasing filter length beyond 15 m is not at all effective in increasing sediment removal but it is expected to further increase P removal.
Abu-Zreig et al, 2004	20 filters with varying length (2 to 15 m), slope (2.3 and 5%), and vegetation cover, were evaluated for sediment removal efficiency. Runoff was produced by rainfall simulators. TSS removal increased with increasing flowpath	For inflow rates of 0.3, 0.65 and 1.0 L/s TSS <b>mass removal rates</b> were 90%, 82% and 82%, respectively.	Water retention was related to filter length. WR ranged from 20% for the 2m filters to 62% in the 10m filters.	Greater vegetation cover increased TSS removal.  Optimum filter length for TSS removal was approximately 10m.

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	length up until 10m. Average TSS removal was 84%, ranging from 68% for a 2m filter to 98% for a 15m filter. No difference between the 10 m and 15m filters was observed.			
Barrett, 2005	Used data from the International Stormwater BMP database to analyze performance based on BMP design techniques			Vegetation coverage is important for pollutant removal. Little relationship between pollutant removal and vegetation height or type exists.
Barrett et al, 1998	Measured the efficiency of two highway runoff VFS in Austin, TX. Walnut creek and US 183 filters, respectively, had a centerline lengths of 1055 and 356 m, filter lengths of 7.8-8.1 and 7.5-8.8 m, 9.4% and 12.1% side slopes, 1.7% and 0.73% centerline slopes, 104,600 and 13,000 m <sup>2</sup> drainage areas, and 38% and 52% paved CDA.	<p><u>US 183:</u>  TSS: 87%  FC: neg  COD: 61%  TOC: 51%  Nitrate: 50%  TKN: 33%  TP: 44%  Zn: 91%  Pb: 41%  Fe: 79%</p> <p><u>Walnut Creek:</u>  TSS: 85%  FC: neg  COD: 63%  TOC: 53%  Nitrate: 23%  TKN: 44%  TP: 34%  Zn: 75%</p>	P avg = 25mm (median = 16mm) 8.4 mm	<p>Highway medians with a length of at least 8m, full vegetation, and slopes less than 12% are viable alternatives to structural controls to reduce highway pollutants and loads.</p> <p>Removal efficiencies of the two strips were similar, despite geometric and vegetative differences.</p> <p>Most pollutant removal occurred on the sides of the median, so a V-shaped median is recommended over a trapezoidal shape.</p>

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		Pb: 17% Fe: 75% Load reductions were slightly higher		
CALTRANS, 2004	Filter strips were sited, constructed, and monitored at three sites as a part of this study. CDA had I=100% for all locations.	TSS: 69% TP: neg TN: neg Total Cu: 85% Total Pb: 88% Total Zn: 72%  Load reductions were higher due to RR from infiltration	RR: 30% (range 14-80%)	Check that the specified vegetation provides a dense enough surface in the climate to stabilize the swale bottom provide effective pollutant removal.  Site in areas where sheet flow predominates.
CWP, 2007  NPRPD v.3	See table for WQ Swale			
Garabaghi et al, 2001	An experiment in Guelph, Ontario compared runoff treatment performance of perennial rye grass ( <i>Lolium perenne</i> L.) VFS under different flow and pollution load conditions. Effects of flowpath length and flow rate on performance was evaluated. The plots were 1.2 m wide, and parallel to each other with a slope of 5.1% to 7.2%.			About 50% of sediments were removed within the first 2.5 m of the filter. An additional 25% to 45% of sediments (depending on flow rate) were removed within the next 2.5 m of the filter.  Almost all of the aggregates larger than forty microns in diameter can be captured within the first five meters of the filter strip.
Goel et al, 2004	12 filter strips of 1.2 m width, 3% slope, different lengths (5, 10, 15 m), and different vegetation covers were studied.	Avg EMC removal for all filter strips: NO3-N: 21% PO4: 49% TP: 88%		Generally, denser vegetation and longer filter strips were more efficient in trapping different pollutants.

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		TN: 90% E.Coli: 13% FC: 54% TSS: 88%		
Lim et al, 1998	Tested the effects VFS length on runoff concentrations from cattle-manure treated plots. Runoff was produced by rainfall simulators.	<b>MASS REMOVAL:</b> <u>6.1 m</u> TKN: 78% PO4: 74.5% TP: 76.1% TSS: 70% TS:23.6% FC: 100% <u>12.2 m</u> TKN: 89.5% PO4: 87.8% TP: 90.1% TSS: 89.5% TS: 40.8% FC: 100% <u>18.3 m</u> TKN: 95.3% PO4: 93% TP: 93.6% TSS: 97.6% TS: 69.8% FC: 100%	Runoff Reduction (from simulated rainfall): 98%	75% of TKN, TP, OPO4, and TSS, and 100% of fecal coliform, were removed in first 6.1m of the VFS.
Schueler and Holland, 2000  (Practice) Article 118 Yu et al, 1992	A study on the pollutant removal capacity of a level spreader/grass filter strip designed to capture approximately 0.4 watershed-inches of runoff from a 10-acre shopping center. Eight storms were monitored at distances of 75 and 150	<b>MASS REMOVAL:</b> 75 ft. Filter Strip TSS: 54% NOx: -27% TP: -25% Extractable Pb: -16% Extractable Zn: 47%  150 ft. Filter Strip TSS: 84%		Sparse vegetation and gulley erosion was cited as reasons for poor removal rates in the first 75 feet of the strip.  The authors recommend an optimal filter strip length of 80 to 100 feet with the level spreader.

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	feet. Removal of particulates increased greatly after 150 feet of treatment but removal of nitrate and total phosphorus was modest.	Nitrate+Nitrite: 20% TP: 40% Extractable Pb: 50% Extractable Zn: 55%		
Strecker et al, 2004	Review of 32 grassed swales and vegetated filter strip studies found in the International Stormwater BMP database	<b>Mass Removal:</b> TSS: 45-75% Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.	40% Runoff Reduction	PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.

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**PERMEABLE PAVEMENT LITERATURE SUMMARY**

<b>Study</b>	<b>Description</b>	<b>Pollutant Removal</b> (conc. based unless noted)	<b>Runoff Reduction</b>	<b>Implications for Design</b>
Andersen <i>et al.</i> , 1999;	Performed a <b>laboratory</b> study (simulated rainfall) to evaluate permeable pavement hydrological response. For PICP with a base course depth ranging from 30-70cm, a substantial portion of rainfall was retained under both dry and wet initial conditions.		Avg Rainfall Retention: Dry: 55% Wet: 30%  (for a 15mm/hr, one hour duration storm)	Evaporation, drainage and retention in the structures were found to be a function of the particle size distribution of the bedding material and water retention in the surface blocks  Pavements with smaller grain-sized substrate retained more water and increased attenuation.  Evaporation rates were greatest from pavements with the highest retention of water. Pavement systems constructed over subbase materials had higher evaporation rates than systems with no subbase.
Balades <i>et al.</i> , 1995	Field study on the clogging rates and effective maintenance of permeable pavements. Found that surface infiltration rates could be decreased by 50% after 2-3 years of use. Clogging was prevented by routine suction sweeping.			Clogging of permeable pavements occurs in the surface open void spaces, due to accumulating material that is retained on the permeable pavement surface.  Clogging was effectively prevented through suction sweeping. In cases where severe clogging had occurred, high infiltration rates could be restored via use of a costly high-pressure water jet.
Bean <i>et al.</i> , 2007a	Surface infiltration rates of 40 permeable pavement sites in NC, MD, VA, and DE were measured. PICP and PC in close proximity to disturbed soil sites had significantly lower surface infiltration rates than permeable pavements in			To sustain higher surface infiltration rates of CGP with sand, maintenance using a vacuum sweeper, should be performed at regular intervals. The top 13–18 mm of material accumulated within void spaces should be removed and replaced.  The location of permeable pavement sites plays an important role in surface clogging rates. PICP and PC

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	stable watersheds. Study concluded that the location of permeable pavements away from fines and disturbed sites, as well as maintenance of pavements, were critical to maintaining high surface infiltration rates.			sites should not be located adjacent to areas with disturbed soils
Bean, 2005, 2007b (in NPRPD)	In Goldsboro, NC, nutrient concentrations from PICP subsurface drainage were compared to those in adjacent asphalt runoff. In Cary, NC, PICP subsurface drainage was compared to rainfall. At both sites, NO <sub>3</sub> -N in the subsurface drainage was higher than the asphalt runoff and rainfall and NH <sub>4</sub> -N was lower. TP removal varied. In Swansboro, NC, a site was constructed and instrumented to monitor runoff flow and rainfall rates and collect exfiltrate and runoff samples from the permeable pavement lot; however, no site runoff resulted during the study period.	Calculated Removal: Goldsboro: TP: 65% OPO4: 50% TN: 36% NH <sub>4</sub> : 86% TKN: 55% NO <sub>3</sub> : -47% TSS: 72% Cu: 63% Zn: 88% Cary: TP: -54% OPO4: -100% TN: -2.2% NH <sub>4</sub> : 90.6% TKN: 52.4% NO <sub>3</sub> : -100%	Cary: 66% Swansboro: 100% (complete infiltration)	Increased concentrations of NO <sub>3</sub> -N in the PICP subsurface drainage were attributed to the probability that aerobic conditions occurred throughout the pavement that nitrified NH <sub>4</sub> -N to NO <sub>3</sub> -N.  At Cary site, the addition of TP was attributed to atmospheric deposition (dry).
Booth and Brattebo, 2003 (in NPRPD)	Examined long term effectiveness of 4 types of pervious pavement and asphalt with respect to hydrology, water quality, and structural	Calculated Removal: Gravelpave: Zn: 91.6% Cu: 88.8% Grasspave:	Runoff Reduction: 97-100%  Study	Permeable pavements can exhibit long term (5 yr) runoff and pollutant reductions  Hardness and conductivity levels were significantly higher in permeable pavement subsurface drainage

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	durability. All pavements endured structurally. PP drainage, as compared to asphalt, had significantly lower concentrations of Zn, Cu, and motor oil. Conversely, hardness and conductivity levels were significantly higher in pervious pavement drainage.	Zn: 38.9% Turfstone: Zn: 64.4% Cu: 83.3% Uni-Ecostone: Zn: 68.5% Cu: 89.2%	characterized by low rainfall intensities (avg intensity was less than 5mm/hr)	than asphalt runoff. Metals and motor oil concentrations were higher in asphalt runoff.  Among the permeable sections, hardness and conductivity were significantly higher in the concrete systems (PICP and CGP) than the plastic grid systems.
Collins, 2008a	Compared 4 types of permeable pavement (PC, PICP1 (12.9% voids), CGP, and PICP2 (8.5% voids)) and standard asphalt in clayey subsoils. PICP1 and CGP cells had the highest volume and peak flow reductions. CGP also had the highest volume of surface runoff. The response of the PICP1 cell was attributed to an increased subsurface storage volume resulting from an elevated outlet pipe; whereas, the CGP cell response was attributed to the properties of sand fill media		Runoff Reductions: 94 - 98%  Volume reductions: 32.1, 43.9, 66.3, 63.6, and 37.7% of rainfall volumes for asphalt, PC, PICP1, CGP, and PICP2, respectively.  56 monitored events, 3.1<P<88.9 mm Mean= 20.6 mm Median = 14.7 mm	Hydrologic differences among the permeable pavements, with respect to runoff reduction and peak flow mitigation, did exist mainly due to the properties of sand versus aggregate fill materials; however, they were small in comparison to the overall substantial improvements from asphalt.  Among permeable pavements evaluated, CGP generated the greatest runoff volumes, attributed to the lower hydraulic conductivity of the sand fill media, and the resulting lower surface infiltration rate of this section.  For the PICP sections, paver geometry seemed to influence surface runoff generation more than percent of open surface void space  The sand fill media in CGP likely retained the most runoff, and was most effective in mitigating peak rainfall intensities. Sand fill, which is often seen as a detriment because of increased surface runoff, appears to have the benefit of holding additional water, which then slowly leaks or evaporates.  If the installation of underdrains is recommended or

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				necessary, design of the subbase can be altered to increase detention time within the pavement subbase by raising the perforated underdrain pipe elevations to create an internal storage zone. Further, an ISZ may decrease total outflow volumes and delay time to peak for small-medium rainfall events
Collins, 2008b	Compared 4 types of permeable and standard asphalt in clayey subsoils. Permeable pavement drainage had higher NO <sub>3</sub> -N concentrations, and no difference in TP or TSS concentrations were observed. Permeable pavement drainage had lower NH <sub>4</sub> and TKN concentrations.	PC, which provided influent water the greatest contact time with cementitious materials, had the highest drainage pH values.  For CGP, TN removal: 25%	20 storm events  3.1<P<88.9 mm Mean= 22.1 mm Median = 14.0 mm	The PC cell was most effective in buffering rainfall pH, because it provided influent water the greatest contact time with cementitious materials. Permeable pavement pH values were such that the leaching of metals through the pavements would not be expected.  Authors suggest that permeable pavements with sand fill or bedding material may act similarly to a sand filter, and be efficient in TN removal.  TP was likely leached from underlying high P-index soils into underdrains. No liner separated the permeable pavements' subbase from the in-situ soils.  TSS (and TP) may be reduced by installing a permeable geo-fabric or raising the drainage pipe several inches above the underlying soils, encasing it in a washed aggregate layer.
Day <i>et al.</i> , 1981	<b>Laboratory</b> experiment (simulated rainfall) on three types of grid pavements and asphalt. Compared to asphalt, surface runoff was much lower from all three CGP systems. High removal rates of TP, organic phosphorus, and heavy metals were observed in CGP	For Monoslab, Grasscrete, Turfstone, respectively (overlying 1-2" gravel and 10-12" soil layer) TP: 70, 60, 59% OPO4: 40, 35, -285%	Runoff Reduction >99% for all CGP types.  10 simulated events: 0.9-3.5 in/hr, return pd <10	CGP systems dramatically reduce stormwater runoff.  High phosphorus removal rates in the CGP systems was attributed to P adsorption to the aggregate and soils in the subbase layers  Nitrate-nitrite removal rates were minimal; high leaching rates through the pavements were observed.

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	subsurface drainage	Org-P: 76, 86, 68% NOx: -928, -777, -593% NH4: 44, 34, 32% ON: 76, 57, 39% TOC: 45, 26, -50% Pb: 92, 94, 93% Zn: 77, 92, 93% Cr: 77, 80, 26%	year storm.	
Dierkes <i>et al.</i> 2002	<p><b>Field Study:</b> Investigation of clogging materials and their distribution in permeable pavement surface. Found that metal conc. in PP decrease rapidly with depth. Most heavy metals were captured in the top 2 cm of the void space fill media.</p> <p><b>Lab Study:</b> Evaluated heavy metal reduction efficiencies of four pavements: solid concrete block pavers with open infiltration joints, concrete block pavers with greened joints (topsoil fill with planted grass), pervious concrete pavers, and pervious concrete pavers with greened joints. All four pavements retained some amount of Cd, Cu, Pb, and Zn.</p>	<p><b>Lab results:</b> Specific removal values were not published by the authors of the study</p>		<p><b>Field Study:</b> Since metals are captured in top layers of the pervious pavement, through regular maintenance, where the top layer of fill media is removed and then refilled with new material, permeable pavements have the potential to remove heavy metals over long periods of time.</p> <p><b>Lab Study:</b> Systems with pervious concrete or greened joints demonstrated higher pollution retention capacities than those without. The permeable concrete pavers with greened joints had the highest pollutant trapping efficiency.</p>
Dreelin et al,	Compared performance of	For 7 of 9 sampled	RR: 93%	The majority of RR was attributed to infiltration into

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2006	plastic grid grass pavers with a conventional asphalt in Athens, GA. The in-situ soils had a relatively high clay content (35-60%). During the 2 of 9 storms when metal and nutrient concentrations could be detected, pollutants were higher at the asphalt, except for TN. Overall pollutant loadings were low due to minimal parking lot use.	rain events, metal and nutrient conc. were below the detection limit at both lots  Calculated Removal: Ca: 17% Zn: 80% Si: 50% TP: 11% TN: negative	when compared to asphalt lot  0.03<P<1.83 cm	the clay soils. The permeable pavements sited in clay soils effectively to reduce runoff during small storm events  It is likely that larger or intense storms would have decreased the pavement runoff reduction. The permeable pavement gravel subbase base storage capacity would be exceeded, and runoff from the practice would increase.
Fach and Geiger, 2005	<b>Laboratory</b> experiment to examine pollution removal rates of Cd, Zn, Pb, Cu for pervious concrete pavers, as well as for three variations of solid concrete block pavers; one with wide infiltration joints (29mm), another with narrow infiltration joints (3mm), and a third with narrow joints filled with crushed brick substrate. When set over a 4 cm crushed basalt or brick substrate roadbed and a 40 cm limestone base course, average pollution removal rates for all pavements and substructures were higher, ranging from 96 to 99.8% for all metals analyzed.	Calculated avg. heavy metal removal rate (Zn, Cu, Pb): solid concrete block pavers with brick substrate infill: 93, 92, 94% narrow joint spaces 59, 58, 79% wide joints spaces: 73, 77, 93% PC: 96, 96, 97%		No significant differences for pollution removal between the narrow and wide joint spacing were observed. PC had the highest pollutant removal rates, followed by the block pavers with substrate infill.
Gilbert and Clausen,	22 month study evaluated runoff EMC from three types of	<b>PP runoff:</b> Calculated removal:	Runoff Reduction:	Pollutant concentrations of permeable pavement runoff were significantly lower than asphalt runoff for

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2006	driveways: asphalt, crushed stone, and permeable pavement. Permeable pavement driveways had significantly lower concentrations of TP, TN, NO <sub>3</sub> -N, NH <sub>3</sub> -N, TKN, TSS, Cu, Pb, and Zn than runoff from asphalt driveways. Runoff from the crushed stone driveways was similar to that of asphalt.	TSS: 67% NO <sub>3</sub> : 50% NH <sub>4</sub> : 72% TKN: 91% TP: 34% Cu: 65% Pb: 67% Zn: 71%	72%  104 events. Median rainfall = 9mm/h, 3.5 hr duration. 90% of storms < 29mm/h , 10.75 hr duration.	all constituents evaluated.
Hunt et al, 2002	Study of CGP application in permeable soils. The authors conclude that if CGP is properly maintained, nearly all events less than one inch will not produce runoff.		For P>12.7 mm, runoff coefficients ranged from 0.15 - 0.30	Surface runoff from the CGP lot was dependent on rainfall intensity rather than volume.  The suggested required maintenance for this application was a street sweeper pass, about once every 9-12 months.
James and Gerritts, 2003	Studied clogging on an 8-year old installation of PICP in Canada.			Infiltration of water through permeable pavements decreased with increasing traffic loads, and also with increasing organic and fine matter in the open void spaces.  In low to medium traffic areas, removing the top 15-20 mm of permeable pavement fill material significantly improved the surface infiltration rate. In areas of higher traffic, infiltration rate improved when 20-25mm of the fill material was removed.
James and Shahin, 1998	<b>Laboratory</b> study that compared the quantity and quality of runoff from PICP and rectangular concrete pavers to	PICP drainage reduced the concentrations of heavy metals, oils,		The increase in NO <sub>3</sub> -N and a decrease in TKN was attributed to oxidation within the pavement subbase  The low concentrations of heavy metal, oils, grease,

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	runoff from a standard asphalt block. Compared to applied rain water concentrations, PICP subsurface drainage exhibited an overall increase in pH and NO <sub>3</sub> , and a decrease heavy metals, oils, grease, and TSS. No change in TP was observed.	grease, and TSS. An increase in NO <sub>3</sub> and pH was observed. Specific removal rates were not provided by the authors		and TSS, in the PICP drainage was likely due to adsorption or filtering by PICP open-graded aggregate base materials.  Total void size (not joint size) in the surfaces of permeable pavements was a controlling factor in the amount of surface runoff generated. Pavements with sand and sand/gravel joint fills generated more runoff than those with gravel fill.  Water drained faster through subgrades of gravel material compared to sand or a gravel/sand mixture subgrades.  Permeable pavements were effective at buffering acidic rainfall pH. The pH of permeable pavement drainage was such that leaching of metals would not be expected.
Jefferies, 2004	Monitoring summary of several SUDS practices in Scotland. Includes runoff reduction data on 2 permeable pavement applications, one having an impermeable liner.		RR (compared to rainfall): 78% with no underdrains, 53% for lined system	RR (compared to conventional surface): 50% with no underdrains, 5% for lined system
Karasawa <i>et al.</i> , 2006	Temperature study on PICP and standard asphalt.	Compared to asphalt, 15 PICP test stalls suppressed the temperature rise by 7.2 - 16.6°C the day after rain and at 33.8°C air temperature.		Generally, pavements having higher evaporation rates had lower road surface temperature.  Pavements with higher water content had a lower road surface temperature.  The lower temperatures were attributed to the removal of heat by the evaporation of moisture retained in

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				pavement blocks
Kresin <i>et al.</i> , 1996	Evaluated PICP installations of various ages for infiltration capacities			The effective surface infiltration rate of PICP decreases with increasing age and compaction.  By removing the top material of the block paver fill, surface infiltration rates can be improved.
Legret and Colandini, 1999	Compared porous asphalt (PA) drainage to conventional stormwater drainage. PA drainage had lower concentrations of TSS and heavy metals.	Concentrations of SS, Pb, Zn, and Cd were lower in permeable pavement drainage. Calculated removal: TSS: 65% Pb: 83% Cu: 0% Cd: 80% Zn: 73%	Runoff Red = 98-100%  12.7<P<52.1 mm	Samples taken from PA structure and underlying soils indicated that metals are retained in PA and that leaching to the underlying soils is low, even after 8 years of use.  Metal pollution concentrations were highest in the pavement surface clogging materials
Pagotto <i>et al.</i> , 2000	In Nantes, France, a section of asphalt highway was monitored for 1 year, which was then replaced with PA and monitored for another year. PA runoff yielded lower concentrations of TSS, TKN, hydrocarbons and heavy metals.	<b>PA runoff:</b> TSS: 81% COD: 0.3% TKN: 43% Hydro: 92% Pb: 78% Cu: 35% Cd: 69% Zn: 66% NO3: 69% Cl: 77% SO4: 23% NH4: 74%	Individual storm data not included (only annual summary)	Hydrocarbon and particulate metal removal were attributed to the filtration of fine particulates on the porous asphalt surface.  Dissolved metal removal was due to possible adsorption to pavement materials.
Pratt <i>et al.</i> 1989	4 pervious pavement stalls were fitted with underdrains and impermeable liners. The stalls		Total Vol. Reduction: 25-45% of	Pavements with subbase materials containing the greatest surface area were able to retain higher amounts of runoff.

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	consisted of various subbase materials: pea gravel, blast furnace slag, granite, and carboniferous limestone. All stalls retained some portion of rainfall. Peak flow reductions and time to peak delays were also observed.		rainfall retained (3 events: 19.5<P<34.8 mm)  Note: For P < 5 mm, retention = 100%	In areas of low soil permeability, the installation of underdrains in pervious pavement subsurface can still yield reductions in outflow volume and peak flow rate, and delay the time to peak flow.
Rushton, 2001	In Tampa, FL, three parking lot paving surfaces were compared, along with basins with and without swales. Pervious paving with a swale reduced runoff volumes and pollutant loads of metals and suspended solids.		RR: 50% for pervious paving with a swale. RR attributed to permeable paving alone was 32%	Increases in P were attributed to landscaping practices on the grassed swales.  Pervious pavement with swales was most effective in reducing runoff during small storms.
Schueler and Brown, 2004. Appendix B, Manual 3				Not included (assumed under infiltration practices)
Traver (2006)	A porous concrete (PC) demonstration walkway site was sampled from 2003-2006 at the Villanova campus in PA. The main traffic on the walkway is pedestrian. As such, pollutant loadings were low. The PC drainage had low loadings of nutrients and metals; however, chloride	<b>MASS REMOVAL:</b> TSS: 99.9% TN: 95% TP: 97% Cl: negative	RR: 94%	Some P leached out of the soil as runoff infiltrated, but this is predicted to decrease as the soil washes out.

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	loadings were high.			
Valavala et al, 2006	Rainfall events up to the 100 year frequency were simulated on unclogged PC pavement slabs ranging from 0-10% slopes. The slabs were 17 cm thick and underlain by a 15 cm thick sand bedding layer. Study determined that for unclogged PC with 16-27% porosity overlying a sand bedding layer, little to no runoff results from typical rainfall intensities.		Only during extremely high intensity events (21-47 cm/h) was runoff observed from the slabs with 10% slopes. For the same high rainfall intensities, no runoff resulted from the 2% sloped slabs	Unclogged PC can effectively reduce runoff volumes.  Runoff from high intensity storms was generated on steeply sloped slabs; the same intensities did not produce runoff from low sloping slabs.
Van Seters et al, 2006	In King City, Ontario, long term performance of permeable pavers and bioretention were monitored. Virtually no surface runoff left the permeable pavement surface. Initial monitoring data indicates that water infiltrating into pervious pavements has lower pollutants than runoff from conventional pavement.	TP: 33% TKN: 26% Cu: neg Zn: 55% Oil/Grease: 64% (preliminary results from 8 storm events)		
UNH, 2007	Summary of 2 year pollutant removal data for various LID practices, including a porous	% Removal: TSS:99 TP: 38%		

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	asphalt parking lot.	Zn: 96% TPH: 99%		
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**DRAINAGE SWALE LITERATURE SUMMARY**

Study	Description	Pollutant Reductions (conc. based unless noted)	Runoff Reduction	Implications for Design																																							
Barrett, 2005	Used data from the International Stormwater BMP database to analyze performance based on BMP design techniques	TSS: 50% Nutrient reductions were not observed.	RR: approaches 50% in a semi-arid climate with permeable soils or low initial moisture content.	Removal of mowed grass clippings may result in nutrient reductions.  Vegetation coverage is important for pollutant removal. Little relationship between pollutant removal and vegetation height or type exists.																																							
CALTRANS, 2004	Six swales were sited, constructed and monitored for this study. Each of the swales treated runoff from highways and had CDA I=0.9-0.95.	TSS: 49% TN: 30% TP: negative Total Cu: 63% Total Pb: 68% Total Zn: 77%  Higher load reductions were observed due to high RR though infiltration.	RR: avg 50% (range 33-80%)	Proposed sites should receive sufficient sunlight to support vegetation growth.  Check that the specified vegetation provides a dense enough surface in the climate to stabilize the swale bottom provide effective pollutant removal.																																							
Liptan, and Murase, 2000	This study compared the pollutant removal performance between a grass turf and native grass swale. Each swale was identical in geometric shape and soil type. The turf swale was mowed regularly and the native grass swale was allowed to grow naturally. Identical flow volumes were pumped into both from a 50-acre urban area. A total of six events over	<p><b>MASS BASED:</b></p> <table border="1"> <thead> <tr> <th></th> <th>Turf</th> <th>Native</th> </tr> </thead> <tbody> <tr> <td>Grass</td> <td></td> <td></td> </tr> <tr> <td>TSS:</td> <td>69%</td> <td>81%</td> </tr> <tr> <td>TP:</td> <td>38%</td> <td>50%</td> </tr> <tr> <td>Nitrate-N</td> <td>8%</td> <td>16%</td> </tr> <tr> <td>TKN:</td> <td>40%</td> <td>54%</td> </tr> <tr> <td>O-Phosphate-Phosphorus, diss</td> <td>-45%</td> <td>-75%</td> </tr> <tr> <td>Cu:</td> <td>53%</td> <td>65%</td> </tr> <tr> <td>Pb:</td> <td>62%</td> <td>72%</td> </tr> <tr> <td>Zn:</td> <td>63%</td> <td>76%</td> </tr> <tr> <td>Cu diss:</td> <td></td> <td></td> </tr> <tr> <td></td> <td>38%</td> <td>52%</td> </tr> <tr> <td>Pb diss:</td> <td></td> <td></td> </tr> </tbody> </table>		Turf	Native	Grass			TSS:	69%	81%	TP:	38%	50%	Nitrate-N	8%	16%	TKN:	40%	54%	O-Phosphate-Phosphorus, diss	-45%	-75%	Cu:	53%	65%	Pb:	62%	72%	Zn:	63%	76%	Cu diss:				38%	52%	Pb diss:			Native grass swale runoff attenuation: 41%  Grass turf swale runoff attenuation: 27%	There is larger runoff attenuation in native grass swale compared to grass turf swale, presumably from a better infiltration rate from more organic material and robust root systems.  Native grass performed better overall except for phosphorus, authors attributed this to accumulation of organic matter in the swale.  Pollutant removal efficiency better in warm seasons.
	Turf	Native																																									
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	two years were sampled.	Zn diss: 36% 53% 48% 64%		
Schueler and Brown, 2004  Appendix B, Manual 3				Swale should exceed WQv by more than 25%-50%  Use dry or wet swale designs  Longitudinal swale slope should be between 0.5 to 2.0%  Velocity within swale <1 fps during WQv storm  Soil infiltration rates should exceed 1.0 in/hr  Provide multiple cells with pretreatment  Provide off-line design w/ storm bypass
Schueler and Holland, 2000  (Practice) Article 113 Harper, 1988	This study compares surface and groundwater quality as runoff from an interstate highway flows through a vegetated wet and dry swale. Both had the same length (200 feet) but the wet swale had groundwater at the surface, wetland plants and zero infiltration. The dry swale had groundwater two feet below surface, sparse grass cover and high infiltration rate.	Wet Swale TSS: 81% BOD (5 day): 48% TN: 40% TP: 17% Nitrate-N: 52% Organic Nitrogen: 39% NH4: -11% Ortho-phosphorus: -30% Cd: 42% Cu: 56% Cr: 37% Pb: 50% Nickel: 32% Zn: 69%  Dry Swale	Dry Swale: 80% of runoff infiltrated before it reached outlet	The dry swale performed better based on the gentle slope and the fact that most of the runoff was infiltrated. The major pollutant removal process appeared to be infiltration and sedimentation.  The wet swale outperformed the dry swale in runoff that reached the outlet. The major pollutant removal process appeared to be settling and vegetative filtering.  Long swales are effective in treating urban stormwater and groundwater plays an important role when designing them in sandy, low-relief environment.

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	<p>Dry swale runoff that did reach the outlet had a higher pollutant load than the wet swale.</p> <p>Trace metals were trapped in surface soils. Dissolved metals were not removed as well as particulate – the sandy soils may not have provided enough binding sites to capture soluble metals. Soluble nutrients migrated into groundwater, especially from dry swale but overall had a modest impact on groundwater quality.</p>	<p>TSS: 87%          BOD (5 day): 69%          TN: 84%          TP: 83%          Nitrate-N: 80%          Organic Nitrogen: 86%          NH4: 78%          Ortho-phosphorus: 70%          Cd: 89%          Cu: 89%          Cr: 88%          Pb: 90%          Nickel: 88%          Zn: 90%</p>		
<p>Schueler and Holland, 2000           (Practice)          Article 114          Dorman et al, 1989</p>	<p>Pollutant removal performance of highway swales in Florida, Maryland and Virginia. Three swales of similar length (approx. 200 feet) but different slope, cover and soils. Florida - flat with sandy soils and high grass – had the best pollutant removal. Maryland - slope was moderate (3.2%) with short grass, experienced erosion, was a sediment exporter and had low pollutant removal rates.</p>	<p><b>MASS REMOVAL:</b>          Florida (#storms sampled: 8)          Sediment: 98%          Organic Carbon: 64%          TKN: 48%          Nitrate: 45%          TP: 18%          Cd: 29%– 45%          Cr: 51%– 61%          Cu: 62%– 67%          Pb: 67%– 94%          Zn: 81%</p> <p>Maryland (#storms sampled: 4)          Sediment: -85%</p>	<p>During small storms, no measurable flow detected in VA swale (infiltration of runoff)</p>	<p>Important factors for pollutant removal are higher and better grass cover, flat slope and soils with high infiltration rates.</p> <p>Since slope, soil type and cover can't always be controlled, designs should incorporate features such as sand layers, check dams, underdrains and diversions to off-line swales or pocket wetlands.</p>

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	Virginia had steepest slope (4.7%), better grass cover, minor erosion and moderate removal rates.	<p>Organic Carbon: 23% TKN: 9% Nitrate: -143% TP: 12% Cd: 85%-91% Cr: 22%-72% Cu: 14% Pb: 18%-92% Zn: 47%</p> <p>Virginia (#storms sampled: 9) Sediment: 65% Organic Carbon: 76% TKN: 17% Nitrate: 11% TP: 41% Cd: 12%-98% Cr:12%-16% Cu: 28% Pb: 41%-55% Zn: 49%</p> <p>Pollutant removal rates as % long term mass reduction.</p>		
Strecker et al, 2004	Review of 32 grassed swales and vegetated filter strip studies found in the International Stormwater BMP database	<b>Mass Removal:</b> TSS: 45-75% Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.	40% Runoff Reduction	PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.
Yu et al, 2001	Field tests were conducted in Taiwan and Virginia on the pollutant	<b>MASS REMOVAL:</b> 14 to 99% for TSS, COD, TN, and TP.		Grassed swales can be an effective storm-water BMP, particularly for areas subject to low intensity storms.

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	<p>removal rates of grassed swales. Virginia experiments tested a highway median swale (274.5 m length, 3% slope), while the Taiwan experiments tested an agricultural swale. (30m length, 1% slope)</p>			<p>Swales should be at least 75 m in long with a minimum longitudinal slope of 3%.</p> <p>Check dams can improve swale performance.</p>
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**BIORETENTION LITERATURE SUMMARY**

<b>Study</b>	<b>Description</b>	<b>Pollutant Reductions</b> (conc. based unless noted)	<b>Runoff Reductions</b>	<b>Implications for Design</b>
CWP, 2007  NPRPD v.3	Summary of performance for 10 bioretention practices	Removal Efficiency: Q1-Q3 (median) TSS: 15-74% (59) TP: -76-30 (5) SolP: -9-49% (-9) TN: 40-55% (46) NOx: 16-67% (43) Cu: 37-97% (81) Zn: 37-95% (79) Bacteria: N/A		Bioretention practices had relatively high TN, heavy metal removal rates
Davis et al., 2001	A detailed study on the removal of heavy metals (copper, lead, and zinc) and nutrients (phosphorus, total kjeldahl nitrogen, ammonium, and nitrate) from synthetic stormwater runoff. Batch, column and pilot-scale experiments found that bioretention areas provide significant reduction of heavy metals, moderate reduction of TP, TKN and NH <sub>3</sub> and poor reduction of NO <sub>3</sub> (in many cases, nitrate production was noted).	Cu: 92% ± 3% Pb: > 98% Zn: > 98% TP: 81% ± 4% TKN: 68% ± 27% NH <sub>3</sub> -N: 79% ± 11% NO <sub>3</sub> -N: 24% ± 102%  Higher mass removal was provided due to water retention within the bioretention areas.		The depth of bioretention areas was found to play a key role in providing phosphorus removal; soil adsorption was cited as the primary phosphorus removal mechanism.  Soil adsorption, through ion exchange, was cited as mechanisms that provided NH <sub>3</sub> removal. Organic matter (e.g. peat) is thought to increase removal of ammonia.  Confirms that the transformation of organic nitrogen (through mineralization and nitrification) and ammonia (through nitrification) occurs in bioretention areas, especially near the surface. Some denitrification (nitrogen removal) was found to occur toward the bottom of the bioretention areas.  The mulch layer was found to play a key role in metal removal; significant accumulation of heavy metals was found

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				within the mulch layer, while no heavy metal accumulation was observed within the soil.
Davis et al., 2003	An investigation using pilot-scale bioretention systems and two existing bioretention areas (one in Greenbelt, MD and one in Largo, MD). The study documents the effectiveness of bioretention areas in removing low levels of lead, copper and zinc from synthetic stormwater runoff. The laboratory results of Davis et al. (2001) are presented.	<p>Laboratory Cu: 92% ± 3% Pb: &gt; 98% Zn: &gt; 98%</p> <p>Field Greenbelt, MD: Cu: 97% ± 2% Pb: &gt; 95% Zn: &gt; 95%</p> <p>Largo, MD: Cu: 43% ± 11% Pb: 70% ± 23% Zn: 64% ± 42%</p> <p>Higher mass removal was provided due to water retention within the bioretention areas.</p>	Laboratory Avg. RR: 63% (range 19-99%) Attributed to ET loss	<p>As with the laboratory results presented in Davis et al. (2001) the mulch layer of field bioretention areas was found to play a key role in metal removal; significant accumulation of heavy metals was found at the top of the bioretention areas, especially within the mulch layers.</p> <p>Increased flow rates were not found to significantly affect the amount of heavy metal removal provided by the bioretention areas, unless mass removal is considered (due to overflow).</p> <p>The differences between the Greenbelt, MD and Largo, MD bioretention areas were explained by the differences in the filter bed media. The facility at Largo, MD was built with a filter bed consisting mainly of sand, while the facility at Greenbelt, MD was built with a higher percentage of topsoil and fines.</p>
Davis et al., 2006	This work provides an in-depth analysis of the ability of bioretention areas to remove nutrients from synthetic stormwater runoff. The study involves pilot-scale bioretention systems and two existing bioretention areas (one in Greenbelt, MD and one in Largo, MD). The laboratory results of	<p>Laboratory TP: 81% ± 4% TKN: 68% ± 27% NO<sub>3</sub>-N: 24% ± 102% TN: 60% ± 31%</p> <p>Field Greenbelt, MD: TP: 65% ± 8% TKN: 52% ± 7%</p>		<p>Increased flow rates were not found to significantly affect the amount of nutrient removal provided by the bioretention areas, unless mass removal is considered (due to overflow).</p> <p>The authors expected to find better nutrient removal at the Greenbelt, MD facility because the filter bed had a higher percentage of topsoil and fines, but this</p>

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	Davis et al. (2001) are presented.	<p>NO<sub>3</sub>-N: 16% ± 6% TN: 49% ± 6%</p> <p>Largo, MD: TP: 87% ± 2% TKN: 67% ± 9% NO<sub>3</sub>-N: 15% ± 12% TN: 59% ± 6%</p> <p>Higher mass removal was provided due to water retention within the bioretention areas.</p>		<p>was not found. The engineered media at the Largo, MD facility provided better nutrient removal.</p> <p>The depth of bioretention areas was not found to play as significant a role in the removal of TKN, with much of the removal occurring at the top of the bioretention areas within the mulch layer.</p> <p>TN removal was dominated by TKN removal, and little NO<sub>3</sub> removal was provided by the bioretention areas, except at the bottom, where the conditions necessary for denitrification may exist.</p>
Davis, 2008	In College Park, MD, 2 bioretention areas, each 28m <sup>2</sup> in size, were built to treat runoff from a 0.24 ha section of parking lot. One cell (B) was 0.9m deep with conventional drainage, and the other cell (A) was 1.2m deep and contained an anoxic zone to encourage denitrification. Both cells were lined and fitted <b>underdrains</b> for monitoring purposes. Hydrologic analyses found that both cells reduced runoff volumes and peak flow rates. Delays in peak flow were also observed.		<p>(49 rainfall events) Cell A: RR: median 77%, mean 52% Peak flow reduction: 63%</p> <p>Cell B; median 82%, mean 65% Peak flow reduction: 44%</p>	
Dietz and Clausen, 2005	A study on the pollutant removal capacity of two rain gardens constructed in Haddam, CT designed to capture the first inch of runoff from shingled rooftops.	<p><b>Mass Based Removal:</b> TP: -111% NH<sub>3</sub>-N: 85% NO<sub>3</sub>-N: 36% TKN: 31%</p>		The mechanisms responsible for NH <sub>3</sub> were nitrification and soil adsorption.

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	The rain gardens were found to be effective in providing peak flow rate reduction and in removing NH <sub>3</sub> , NO <sub>3</sub> , TKN and TN from rooftop runoff.	TN: 32%		
Dietz and Clausen, 2006 (in NPRPD)	A study on the pollutant removal capacity of two rain gardens ( <b>with underdrains</b> ) constructed in Haddam, CT designed to capture the first inch of runoff from shingled rooftops. The rain gardens were effective in reducing the concentrations of NH <sub>3</sub> , NO <sub>3</sub> , and TN in the rooftop runoff. However, TP concentrations were significantly increased by both of the rain gardens.	<b>Mass Based Removal:</b> TP: -108% NH <sub>3</sub> -N: 82% NO <sub>3</sub> -N: 67% TKN: 26% TN: 51%	Runoff Reduction: 99.2% Total Volume Reduction: 3.7% (assumed to be ET)  12 month P= 172.8cm	Mulch was found to play a significant role in the removal of TN and TP, as the concentrations of these pollutants increased over time.  The rain garden soils were found to be a source of TN and TP, as the concentrations of these pollutants decreased over time.  No significant changes in NO <sub>3</sub> -N concentrations occurred as a result of raising the underdrain to create a saturated zone at the bottom of one of the rain gardens in an attempt to increase denitrification.  The mulch layer was also found to play a key role in metal removal, as the concentrations of these pollutants increased over time.
Dougherty et al, 2007	A rain garden in Auburn, AL, was monitored for nutrient removal data. The garden was 1.2m deep and was filled with native soils mixed with shredded pine bark mulch to improve cell infiltration and the organic content. The cell was lined and	TP and SolP reductions from the bioretention cell were observed under both drainage configurations. TN removal. NH <sub>4</sub> was reduced significantly towards the end of the		Peak outflow rates gradually decreased over the entire study period, a probable result of media settlement and consolidation after construction.

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	fitted with an <b>underdrain</b> . Conventional drainage occurred for the first 2 months (8 runoff events) of monitoring, and then modifications were made to create an IWS zone in the cell (monitoring for 9 subsequent runoff events).	study for the configuration with an IWS zone.		
Ermilio, 2005 (in NPRPD)	A thesis completed at Villanova University and based on the bioretention traffic island built at Villanova University’s BMP demonstration park. Water quality results show a significant reduction in many common stormwater pollutants as a result of capturing and treating the first flush runoff of rainfall events.	TSS: 92% TDS: 38% Cu: 47% Pb: 55% Cr: 62% Zn: 17% TN: 48% TP: 1%  Higher mass removal was provided due to water retention within the bioretention areas.	Runoff Reduction: 86%  30 rain events 0.23<P<7.1in Mean=1.55 in	Although the bioretention area is designed to infiltrate stormwater runoff, it does not appear the quality of groundwater beneath the basin is being significantly affected.  TN and TP are retained during periods of increased plant activity in the summer and fall months and are released during periods of low plant activity in the winter and spring months.
Glass and Bissouma, 2005 (in NPRPD)	In this study, the ability of a bioretention area ( <b>with underdrain</b> ) to remove nutrients and heavy metals was evaluated over a period of 15 rain events. The results indicate that bioretention facilities can be moderately to very effective in removing heavy metals and nutrients from stormwater runoff.	Zn: 79% Cu: 81% Pb: 75% Cd: 66% Fe: 53% Cr: 53% Al: 17% As: 11% Higher mass removal was provided due to water retention within the bioretention areas.		Organic matter and plants were believed to be the dominant mechanisms that provided the removal of heavy metals within the bioretention area.  Lack of regular maintenance on the mulch layer of the bioretention area was cited as a reason for lower heavy metal removals than those found by Davis.

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		<p><b>Mass Based Removal:</b>  TSS: 98%  Zn: 80%  Cu: 75%  Pb: 71%  Cd: 70%  Fe: 51%  Cr: 42%  Al: 17%  NH<sub>3</sub>-N: 65%  NO<sub>3</sub>-N: 27%  PO<sub>4</sub>-P: 3%</p>		
Hsieh and Davis, 2005a	<p>In this study, a bioretention test column was set up and subjected to regular testing once a week for 12 weeks to investigate the ability of bioretention areas to treat frequent storm events. All 12 tests demonstrated that improvements in stormwater quality and excellent removal efficiencies for TSS, oil/grease, and lead were found.</p>	<p><b>Mass Based Removal:</b>  TSS: 91%  Pb: &gt; 98%  TP: 63%  NH<sub>3</sub>-N: 13%  NO<sub>3</sub>-N: -16%  Oil/Grease: &gt; 97%</p>		<p>Most of the TSS in the stormwater runoff was removed by the top (mulch) layer of the bioretention test column. This helped prevent clogging within the rest of the test column.</p> <p>Organic matter and Ca content of the filter bed was found to increase during testing. This may have increased the ability of the bioretention test column to remove phosphorus through precipitation and adsorption (ion exchange).</p>
Hsieh and Davis, 2005b	<p>The objective of this study was to provide insight on the filter media characteristics that define the pollutant removal performance of bioretention areas. Eighteen bioretention test columns and six existing bioretention facilities were evaluated using synthetic stormwater runoff. In the laboratory studies, two types of sand and three types of soil with</p>	<p><b>Mass Based Removal:</b>  Field  TSS: 72% - 99%  Pb: 80% - 98%  TP: 37% - 99%</p>		<p>Removal of metals, TSS, and oil/grease were not affected by the chemical properties of the filter bed media. This is not surprising given that these pollutants are removed through filtration, which is a physical, not chemical or biological, process. Permeable sands were found to provide the best overall removal of these pollutants, although all fill media performed well.</p> <p>Although TP removal was expected to</p>

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	<p>various physical and chemical properties were used. The field experiments were conducted in Maryland (one in Greenbelt, MD, two in Hyattsville, MD, and three in Landover, MD).</p>			<p>correlate with the chemical properties of the filter bed media (e.g. P content, organic matter, and CEC), based on the laboratory results these characteristics were not found to have a significant statistical correlation with TP removal. In the field, however, a good correlation between TP removal and filter bed depth and organic matter content were found.</p> <p>Filter bed media with higher levels of fines and organic matter were found to provide greater removal of TN.</p> <p>A filter bed media with a coarse sand/sandy soil mixture appears to provide the best overall pollutant removal performance within bioretention areas.</p>
Hunt and White, 2001	<p>This profile sheets contains a good description of the pollutant removal mechanisms at work within bioretention areas and offers guidance on the sizing and design of bioretention areas, with variations for clayey and sandy soils. Contains no performance data, but does provide cost data.</p>			<p>Bioretention areas installed in clayey soils need to be provided with an underdrain and provided with engineered filter bed media.</p> <p>Bioretention areas installed in sandy soils do not need an underdrain do not require the use of an underdrain, provided that the infiltration rate of the native soils is greater than 1.0 in/hr.</p>
Hunt, 2003	<p>Provides a summary of bioretention research conducted at the University of Maryland, Pennsylvania State University and in North Carolina. Summarizes pollutant removal</p>			<p>If a bioretention area is being designed for metals removal, a deep filter bed may not be needed because of the significance of the mulch layer to remove heavy metals.</p> <p>Anaerobic zones appear to develop within</p>

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	data presented by Davis et al. (2001) and Davis et al. (2003).			bioretention areas regardless of the drainage configuration of the design cell (although they may be dependent upon the filter bed media) and there does not appear to be a need for the use of engineered saturated zones to increase NO <sub>3</sub> removal.
Hunt et al., 2006 (in NPRPD)	The pollutant removal and runoff reduction abilities of three bioretention areas in North Carolina (Two in Greensboro, NC and one in Chapel Hill, NC) were examined. Sufficient flow data and water quality samples were only collected for two of the bioretention areas (one in Greensboro and one in Chapel Hill). Both bioretention areas were designed with conventional <b>underdrains</b> . The field studies found high heavy metals and total nitrogen removal rates in the two conventional bioretention area (e.g. without engineered saturated zones). High TP removal for the cell with a low P-index was observed.	<p><b>Mass Based Removal</b> Greensboro (G2): P-Index 86-100 (high) TSS: -170% Zn: 98% Cu: 99% Pb: 81% TN: 40% NH<sub>3</sub>-N: -1% NO<sub>3</sub>-N: 75% TKN: -5% TP: -240% PO<sub>4</sub>-P: -9%</p> <p><b>Mass Based Removal</b> Chapel Hill: P-index 4-12 (low) TN: 40% NH<sub>3</sub>-N: 86% NO<sub>3</sub>-N: 13% TKN: 45% TP: 65% PO<sub>4</sub>-P: 69%</p>	RR: 52-56% (personal communication)	<p>Small saturated, anaerobic zones were found within the Greensboro cell, perhaps created by the presence of clay soils within the fill media. These isolated zones were though to provide the conditions necessary for denitrification, which would explain the high level of NO<sub>3</sub> removal. Similar conditions were not found in the Chapel Hill bioretention cell.</p> <p>The P-index of the fill media used in the Greensboro cell was very high (86 to 100), indicating that the media was saturated with phosphorus. Comparatively, the P-index of the fill media used in the Chapel Hill cell was low (4 to 12), indicating that the media could accept more phosphorus. A lower P-index, along with high amount of cation exchange sites (provided by organic matter), enhances the removal of phosphorous through adsorption.</p> <p>The impact of drainage configuration on TN removal was not statistically significant (e.g. Cell G1 was designed with a saturated zone), which suggests that engineered saturated zones are not needed to increase NO<sub>3</sub> removal. Fill soil content may play a more important role in</p>

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				providing the conditions necessary for denitrification.
Hunt et al, 2008	Bioretention cell with underdrain	TN: 38% TP: 32%		
Hunt and Lord, 2006	<p>This profile sheet presents information on the performance of bioretention cells installed in Greensboro, NC, Chapel Hill, NC, Louisburg, NC, and Charlotte, NC. The bioretention cells were found to provide moderate to high removal of nutrients and other stormwater pollutants. Summarizes the pollutant removal data presented by Hunt et al. (2006) and includes some additional data.</p> <p>Pollutant specific design guidance, guidelines for selecting fill soil and vegetation, and information about maintenance are also provided within the profile sheet.</p>	<p><b>Mass Based Removal</b> Greensboro (G1) <b>(underdrain)</b>: TN: 33% - 40% TP: -39% - (-240%) Soil P-Index: 86 - 100 Cu: 65% - 99% Zn: 65% - 99%</p> <p><b>Mass Based Removal</b> Greensboro (G2) (IWS): TN: 43% TP: 9% Soil P-Index: 35 - 50 Cu: 56% - 86% Zn: 56% - 86%</p> <p><b>Mass Based Removal:</b> Chapel Hill <b>(underdrain)</b>: TN: 40% TP: 65% Soil P-Index: 4 - 12</p> <p><b>Mass Based Removal:</b> Louisburg (L1) <b>(underdrain)</b>: TN: 64% TP: 66% Soil P-Index: 1 - 2</p> <p><b>Mass Based Removal:</b></p>	<p>Runoff Reduction: 33% - 50% Attributed to exfiltration and ET.</p>	<p>Phosphorus removal can be enhanced with proper fill soil selection. As the pollutant removal rates show, using low P-Index soils increases TP removal, while high P-Index soils decrease performance. The recommended P-Index for fill soils is between 10 - 30.</p> <p>Fill soils with a relatively high cation exchange capacity (CEC) are recommended to increase TP removal. While a minimum CEC is not provided, soils with CECs exceeding 10 are expected to provide better pollutant removal.</p> <p>Deeper bioretention cells (36 inches or more) and fill soils with lower infiltration rates are recommended to enhance TN removal and reduce runoff temperature. The addition of fines to the fill soil will help reduce infiltration rates and may promote the formation of small anaerobic zones within the fill soil to remove NO<sub>3</sub>.</p> <p>Bioretention cell surfaces should be planted with less vegetation to allow promote bacteria removal through exposure to sunlight.</p> <p>Cleaner stormwater runoff appears to decrease pollutant removal efficiency. Of</p>

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		<p>Louisburg (L2) (<b>underdrain</b>): TN: 68% TP: 22% Soil P-Index: 1 - 2</p> <p><b>Mass Based Removal</b> Charlotte (<b>underdrain</b>): TN: 65% TP: 68% Bacteria: &gt;90% Soil P-Index: 7 – 14</p>		<p>the cells that had low P-Index soils, bioretention cell L2, which treated stormwater runoff with the lowest TP concentrations, provided the lowest TP removal.</p> <p>Addition of an IWS zone may reduce effluent temperature and reduce TN concentrations. Tests for TN reduction in these systems did not produce statistically significant results.</p>
Kim et al., 2003	<p>This study systematically evaluated a reengineered concept of a bioretention area designed to promote nitrogen removal via microbial denitrification. An engineered saturated zone was built into bioretention test columns. Inorganic and organic substrates, as electron donors, were mixed with sand and used to fill continuously submerged <b>anaerobic zones</b> at the bottom of the bioretention columns. Overdrains were provided to ensure that the anaerobic zones remained saturated. The test columns demonstrated good removal of NO<sub>3</sub>.</p>	<p><b>Mass Based Removal:</b> NO<sub>3</sub>-N: 70% - 80%</p>		<p>A saturated, anaerobic zone provided at the bottom of the bioretention cell may help improve nitrogen removal.</p> <p>An electron donor (organic or inorganic substrate) is needed to drive the denitrification process. Denitrifying bacteria (<i>nitrosomonas</i> and <i>nitrobacter</i>) require both an electron donor substrate and a carbon source as they synthesize by converting NH<sub>3</sub> to N<sub>2</sub>. This study found newspaper to be the most effective electron donor, but wood chips and small sulfur particles were also identified as potentially viable substrates.</p>
McCuen and Okunola, 2002	<p>This research extends the widely used Natural Resources Conservation Service TR-55 design procedures for use on microwatersheds. Specifically,</p>		<p>Runoff Reduction: <b>underdrains:</b> 19% Infiltration:</p>	<p>Based on the methods presented within this study, bioretention areas able to fully contain all of the runoff from a given design storm (e.g. infiltration-based bioretention) provide a runoff reduction of</p>

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	<p>the graphical peak discharge estimation method is extended so that it can be used for catchments with times of concentration as small as 0.02 h. The kinematic-wave time of concentration estimation method is made applicable for multiple-section sheet flow, and a new pond-and-swamp adjustment procedure enables the design and evaluation of small on-site bioretention areas. Estimates of the hydrologic benefits of bioretention areas are provided.</p>		38%	<p>about 38%, while those only able to partially contain the runoff (e.g. underdrained bioretention) provide a runoff reduction of about 19%.</p>
<p>Passeport et al, 2008</p>	<p>Evaluated 2 grassed bioretention areas in NC (depths = 0.75 and 1.05m), both having an expanded slate fill media and internal storage zones. The system efficiently reduced nutrients loads and EMCs. Removal was highest during warmer months.</p>	<p>TKN: 49, 59 NH4: 70, 84 NO3: 33, - TN: 54, 54 TP: 63, 58 OPO4: 78, 74 FC: 95, 85</p>	RR: 20-50%	<p>The deeper media depth did not increase nutrient EMC removal.</p> <p>The grass vegetated bioretention cells performed favorably to conventionally vegetated (trees, shrubs and mulch) bioretention cells studied in North Carolina.</p>
<p>Perez-Pedini et al., 2005</p>	<p>A distributed hydrologic model of an urban watershed was developed and combined with an algorithm to determine the optimal location of infiltration-based BMPs. Model results show that optimal location of infiltration-based BMPs can provide a significant reduction of runoff.</p>		Runoff Reduction: 30%	

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<p>Schueler and Brown, 2004</p> <p>Manual 3 (Appendix B)</p>				<p>Pollutant removal can be increased by designing the filter to treat a larger WQv .</p> <p>Filter media should be tested and have a P Index less than 30.</p> <p>If possible, bioretention areas should be placed in permeable soils, eliminating the need for an underdrain. If underdrain is necessary, putting an upflow pipe can help remove more pollutants.</p> <p>The filter bed should be deeper than 30 inches for additional pollutant removal.</p> <p>A two cell design with pretreatment is recommended.</p> <p>Bioretention cell SA should be more than 5% of CDA.</p>
<p>Sharkey, 2006</p>	<p>Evaluated 2 field sites in NC and performed a laboratory simulation to evaluate nutrient removal and hydrologic response of bioretention cells. The laboratory results showed that a 91% sandy soil was unable to reduce phosphorus concentrations at all P-Index levels.</p>	<p>TN: 62% TP: 66%</p>	<p>RR: 20-29%</p>	<p>The P-Index for bioretention fill soil should be no greater than 40 and contain between 75% and 85% sand.</p>
<p>Smith and Hunt, 2006 (in NPRPD)</p>	<p>This study evaluated the performance of two bioretention cells, vegetated with bermuda grass and containing IWS zones, in removing nitrogen, phosphorus, metals and sediment. The two cells that were tested</p>	<p>Calculated Removal: Graham (N): TSS: 63% Cu: 9% Zn: 37% TN: 61% TKN: 65%</p>	<p>Graham (N): Runoff Reduction: 40%</p> <p>Graham (S): Runoff</p>	<p>Higher pollutant removal efficiency was associated with the cell that had deeper filter media and well-drained (S) underlying soils.</p>

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	(both located in Graham, NC) had filter beds with different depths. Sufficient flow data and water quality samples were only collected for one of the bioretention cells (N). The other cell (S) did not produce any measurable outflow on many occasions.	NH <sub>3</sub> -N: 79% NO <sub>3</sub> -N: 43% TP: 8% PO <sub>4</sub> -P: -127% Bacteria: 97%  Higher mass removal was provided due to water retention within the bioretention areas. <b>Mass Based Removal:</b> TN: 70-80% TP: 35-50% FC: 97%	Reduction: 60%  12 events 0.19<P<1.88in	
UNHSC, 2005	The performance of a bioretention cell in Durham, NH was evaluated.	<b>Mass Based Removal:</b> TSS: 97% Zn: 99% NO <sub>3</sub> -N: 44% TPH-D: 99%	Peak Flow Red'n: 85%	Design of the bioretention cell was based upon the guidance provided in the New York State Stormwater Management Design Manual.
Van Seters et al., 2006	The performance of a bioretention area (located in King City, ON) was evaluated. The bioretention area showed that it was effective in reducing peak flows and in improving water quality from parking lot runoff.  Three equal-sized parking lot sections were monitored. The first consisted of porous pavement, the second was conventional asphalt (control section), while the third was conventional asphalt but was treated by a bioretention area.		Runoff Reduction: 40%	

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	The porous pavement and bioretention sections were effective at infiltrating stormwater runoff and reducing peak flow.			
Yu and Stopinski, 2001 (in NPRPD)	This study monitored the field performance of four ultra-urban stormwater BMPs: three oil and grit separators (Isoilater, Stormceptor™, and Vortechs Stormwater Treatment System™) and a bioretention area located in Charlottesville, VA. Storm sampling data for each site were analyzed to calculate the removal efficiency for each constituent monitored.	TSS: 53% TP: 13% Oil/Grease: 66%		TSS removal in the bioretention area was found to be affected by rainfall depth. Small-to-medium storms yielded positive removal efficiencies, while large storms yielded negative removal efficiencies.

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**WATER QUALITY SWALE LITERATURE SUMMARY**

Study	Description	Pollutant Reductions (conc. based unless noted)	Runoff Reduction	Implications for Design
Barrett et al, 1997	In Austin, TX, a swale was constructed with an underdrain. Influent runoff EMCs were compared to infiltrated runoff EMCs from the swale underdrain.	TSS: 74% BOD:46% COD: 35% NO3: 59% TP: 31% Oil and Grease: 88% Cu: 49% Fe: 79% Pb: 35% Zn: 74% Reductions in pollutant load were even higher due to a large volume of infiltrated runoff.	RR: 90%	
CWP, 2007 NPRPD v.3	Summary of the performance of 17 open channel practices, including 3 grass channels, 12 dry swales, and 2 wet swales.	Removal Efficiency: Q1-Q4 (median) TSS: 69-87% (81) TP: (-15-46% (34) SolP: -94-26% (-38) TN: 40-76% (56) NOx: 14-65% (39) Cu: 45-79% (65) Zn: 58-77% (71) Bacteria:-63 to -25% (-25)		Bacteria removal rates were negative, while removal rates for metals, and TSS tended high.
Horner et al, 2003				
Fletcher et al, 2002	In Brisbane, Australia, pollutant removal rates of a residential swale (65m long, 1.6% longitudinal slope, 1:13 side slopes,	TSS: 83 (73-94)% TP: 65 (58-72)% TN: 52 (44-57)%		TSS removal decreased with increasing flow rate, reflecting the importance of physical processes (sedimentation and filtration) in TSS removal.

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	and catchment area of 1.03ha, triangular cross section, 67% vegetative cover). Synthetic rainwater was tested. High concentration reductions were observed for TSS, TP, and TN.			TN and TP removal were less dependent on flow, reflecting more importance of chemical processes (e.g. soil sorption).  TSS removal also increased with increasing swale length. TP and TN concentrations decreased rapidly in the first quarter of the swale length
Jefferies, 2004	Monitoring summary of several SUDS practices in Scotland. Includes runoff reduction data on 2 swales compared to runoff from a car tarmac. The runoff reduction values are for surface runoff only, and do not include flow through the underlying pipes		RR (compared to conventional surface): 85%	
Schueler and Brown, 2004  Appendix B, Manual 3				Should exceed target WQv by more than 50%  Use dry or wet swale design  Should exceed target WQv by more than 25%  Longitudinal swale slope between 0.5 to 2.0%  Velocity within swale < 1 fps during WQ storm  Measured soil infiltration rates should exceed 1.0 in/hr  Use multiple cells with pretreatment  Use off-line design w/ storm bypass
Schueler and	The purpose of this study	200-foot		Authors suggest the following design criteria

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<p>Holland, 2000  (Practice) Article 112 Seattle Metro, 1992</p>	<p>was to determine the pollutant removal capability of a 200-foot long, trapezoidal biofilter and test the performance after its length was reduced to 100 feet. Six storm events were monitored for both lengths. The study took place in the Pacific Northwest.</p>	<p>TSS: 83% TPH: 75% Total Zinc: 63% Diss Zn: 30% Total Pb: 67% Total Aluminum: 63% Total Cu: 46% TP: 29% Nitrate-N: negative</p> <p>100-foot TSS: 60% TPH: 49% Total Zn: 16% Diss Zn: negative Total Pb: 15% Total Aluminum: 16% Total Cu: 2% TP: 45% Nitrate-N: negative</p>		<p>based on both monitoring and field experience. One additional improvement would be to place more biofilters off-line to treat the water quality design storm.</p> <p>Key Biofilter design criteria:</p> <ul style="list-style-type: none"> <li>• geometry (gentle slopes, parabolic or trapezoidal shape, sideslopes no greater than 3:1)</li> <li>• longitudinal slope (2 to 4%, check dams should be installed if slopes exceed 4% and underdrains installed if slopes are less than 2%)</li> <li>• swale width (no more than 8 feet unless structural measures are used to ensure uniform spread of flow)</li> <li>• maximum residence time (hydraulic residence time for the 6 month 24 hour storm of about 9 or 10 minutes)</li> <li>• maximum runoff velocity (no more than 0.9 fps for 6 month, 24 hour storm, and no more than 1.5 fps for 2 year storm event)</li> <li>• manning's n value (use 0.20 for design)</li> <li>• mowing (routine mowing to keep grass in active growth phase and maintain dense cover)</li> <li>• grass height (should be at least two inches above design flow depth)</li> <li>• biofilter soils (sandy loam topsoil layer, with an organic matter content of 10 to 20%, and no more than 20% clay.)</li> <li>• water table (if seasonal groundwater table is within a foot of the bottom of the biofilter, then select wetland species.)</li> <li>• plant selection (grass species that produce a uniform cover of fine-hardy vegetation that</li> </ul>
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				<p>can withstand the prevailing moisture condition. <i>Juncus</i> and <i>Scirpus</i> may be used if drainage is poor.)</p> <ul style="list-style-type: none"> <li>• landscaping (other plant material can be integrated into biofilter; but care should be taken to prevent shading or leaf fall into swale.</li> <li>• Construction (use of manure mulching or high fertilizer hydroseeding to establish ground cover should be avoided during construction, as these can result in nutrient export.)</li> </ul>
<p>Schueler and Holland, 2000  (Practice) Article 116</p>	<p>Sixteen historical performance monitoring studies of grass swales were reanalyzed based on the open channel classification (drainage channel, grass channel, dry swale and wet swale).</p>	<p>(includes a summary of pollutant removal capabilities of 10 drainage channels and 6 water quality channels)</p>		<p>Open channels should be designed to increase the volume of runoff that is retained or infiltrated within the channel.</p> <p>Designs should be based on water quality volume not flow.</p> <p>Key design criteria for dry swale:</p> <ul style="list-style-type: none"> <li>• Design to retain full water quality volume over entire length</li> <li>• Pretreatment is required. For pipe inlets, 0.1 inch per contributing acre should be temporarily stored behind a checkdam. For lateral flows, gentle slopes or a pea gravel diaphragm can be used.</li> <li>• Modify soils to improve infiltration rate. Use 30-inch filter bed composed of 50% sand and 50% silt loam.</li> <li>• Filter beds are drained by perforated pipes to keep swale dry after storm events</li> <li>• Parabolic or trapezoidal shapes with gentle side slopes (3:1 or less), and bottom widths ranging from 2 – 8 feet.</li> </ul>

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				<ul style="list-style-type: none"> <li>Determine location of water table. If water table is within 2 feet of proposed swale bottom , a dry swale is not feasible.</li> </ul>
<p>Schueler and Holland, 2000</p> <p>(Practice) Article 117 Goldberg, 1993</p>	<p>Two studies of biofilters in Seattle: one was a biofilter retrofit (Dayton Ave.) and one was designed as a conveyance channel but was constructed with dimensions similar to a wet biofilter (Uplands). Eight storm events were sampled for Dayton Ave. and 17 events for the Uplands.</p>	<p>Dayton Ave. TSS: 68% TP: 4.5% Soluble Reactive Phosphorus: 35% Bio-Active Phosphorus: 32% Nitrate-Nitrogen: 31% Total Pb: 62% Total Cu: 42% Diss Cu: 21% FC: -264 Oil/Grease: not detected</p> <p>Uplands TSS: 67% TP: 39% Soluble Reactive Phosphorus: -45% Bio-Active Phosphorus: -31% Nitrate-Nitrogen: 9% Total Pb: 6% Total Cu: -35% Total Pb: 6% Total Zn: -3%</p>	<p>Dayton Ave.: 30 – 80% of runoff infiltrated into soil</p>	<p>Pets and beavers were cited as source of bacteria in the Dayton Ave. biofilter.</p> <p>Poor design, construction and maintenance are cited as reasons for reduced pollutant removal</p> <p>Require performance bonds for biofilters to make sure they are correctly installed, vegetated and protected from construction sediment.</p> <p>Key design criteria:</p> <ul style="list-style-type: none"> <li>Require pretreatment at upper end of biofilter</li> <li>Limit longitudinal slopes to 1% or greater, unless it is intentionally designed as a wet biofilter.</li> <li>Develop more specific design criteria for wet biofilters that govern ponding, wetland stabilization, check dams and other criteria.</li> <li>Require stringent geo-technical testing prior to design and construction.</li> <li>Train public works crews on the best techniques for maintaining the long-term performance of biofilters.</li> </ul>
<p>Stagge, 2006</p>	<p>Evaluated highway grass swales with a grass filter strip pretreatment area in Maryland.</p>	<p>EMC removal: TSS: 41-52% NO3: 56-66% Zn: 30-40% Pb: 3-11%</p>	<p>RR: 46-54% of total volume 22 rainfall events over 1.5 years</p>	

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		Cu: 6-28%  Swales exported Chloride, and did not significantly effect nutrient concentrations		
Strecker et al, 2004	Review of 32 grassed swales and vegetated filter strip studies found in the International Stormwater BMP database	<b>Mass Removal:</b> TSS: 45-75% Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.	40% Runoff Reduction	PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.

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**INFILTRATION LITERATURE SUMMARY**

(include applications of pervious pavement that demonstrate complete infiltration of runoff (no underdrains))

Study	Description	Pollutant Reductions (PR) (conc. based unless noted)	Runoff Reduction (RR)	Implications for Design
Barraud <i>et al.</i> , 1999	Examined subsoil pollution concentrations from a newly installed infiltration basin and a 30 year old basin in a similar catchment area.	<b>MASS BASED:</b> Newer application: Zn: 54-88% Pb: 98% Older Application: Zn: 31% Cd: 29.5%		Over time there is a slight spread of pollution downward through underlying soils  Older basin had detectable pollutant concentrations up to depths of 1m.
Bright, T 2007	Two field dune infiltration systems were installed in Kure Beach, NC to capture ocean outfall runoff from up to 1.3 cm of rainfall. Data was collected from 25 storms (rainfall 4-105mm). Runoff samples were compared to groundwater samples underneath DIS.	Calculated PR: FC: 99.3-100% E.Coli: 87-100%  Note: For 23% of storms GW samples exceeded State bacteria standards. Lab Study: lower infiltration rates decreased E.coli conc. in effluent	Site L: 100% Site M: 95.9% (over entire study period)	For effective FC treatment, DIS system should be designed to treat runoff from smaller watersheds (<16 ac) and lower intensity storms
CWP, 2007 NPRPD v.3	Summary of the performance of 12 infiltration practices, including 3 infiltration trenches and 9 pervious pavement studies	Removal Efficiency: Q1-Q3 (median) TSS: 62-96% (89) TP: 50-96% (65) SolP: 55-100% (85) TN: 2-65% (42) NOX: -100 -82% (0) Cu: 62-89% (86) Zn: 63-83% (66%)		Infiltration removal efficiencies are high, mainly due to the large amounts of runoff reduction provided by these practices

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		Bacteria: N/A	
Schueler and Brown, T.E. (2004).  Appendix B, Manual 3			<p>Pollutant removal can be increased by designing the filter to treat a larger WQv .</p> <p>Ideal tested infiltration rates for infiltration practices should be between 1.0 and 4.0 in/hr.</p> <p>Pretreatment practices, preferably two, prior to runoff infiltration is recommended.</p> <p>CDA should be nearly 100% impervious (with few fines or disturbed areas) and less than 1.0 acre in size.</p> <p>Design should be off-line and include cleanout pipes.</p> <p>When possible, underdrains or filter fabric on trench bottom should be avoided.</p>
Schueler and Holland, 2000  (Practice) Article 101 Galli, 1993	A field survey on the performance of over 60 infiltration trenches and basins in MD.		<p>Regular maintenance is important and should be performed regularly (particularly sump cleanout)</p> <p>Adequate pretreatment helps reduce clogging of trenches</p> <p>Setting a maximum ponding depth can reduce basin compaction</p> <p>Geotechnical and groundwater investigations for good soils and low water tables may increase infiltration performance.</p>
Schueler and Holland, 2000	Survey of 23 infiltration basins in Puget Sound Basin of the Pacific Northwest. Basin soils had high infiltration rates and		<p>Pretreat runoff to reduce sediment clogging in infiltration basins.</p> <p>Avoid installing basins in areas with a high water</p>

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(Practice) Article 102 Gaus, 1993	low clay contents. Most sites had experienced regular maintenance and inspections.			table.  Basins located in coarse, gravelly soils demonstrated subsoil metal migration, potentially a source of GW contamination
Schueler and Holland, 2000  (Practice) Article 104 Pitt et al, 1994	Three year study of infiltration basins to evaluate potential GW contamination risks.			Pretreatment may lower GW contamination potential for several stormwater pollutants, particularly heavy metals, pesticides, and other organic compounds.  Due to potential for GW contamination, runoff from CSOs, impervious area snowmelt, manufacturing and construction sites should be directed away from infiltration practices.  Runoff from gas stations, vehicle maintenance operations, and large parking lots should be adequately pretreated prior to being infiltrated
UNH, 2007	Summary of 2 year pollutant removal data for various LID practices, including an ADS water quality and infiltration unit	% Removal: TSS: 99% TP: 81% Zn: 99% TPH: 99%		

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**EXTENDED DETENTION LITERATURE SUMMARY**

<b>Study</b>	<b>Description</b>	<b>Pollutant Reductions</b> (conc. based unless noted)	<b>Runoff Reductions</b>	<b>Implications for Design</b>
Barrett, 2005	Used data from the International Stormwater BMP database to analyze performance based on BMP design techniques			No relationship between basin depth and TSS removal was observed in the data set. Total metals removal was high. Little effect on bacteria and nutrient removal was observed. Percent reductions (if observed) were highly dependent on influent concentrations.
CALTRAN S, 2004	Five extended detention basins were sited as part of this study, 4 unlined earthen and 1 lined concrete basin. All sites were located within the highway right-of-way and collected runoff exclusively from the highway.	<p>Unlined only:                      TSS: 72%                      TN: 14%                      Particulate P: 39%                      TP: 39%                      Total Cu: 58%                      Total Pb: 72%                      Total Zn: 73%</p> <p>Percent removal in unlined basins was higher on a load basis due to RR through infiltration.</p> <p>Lined:                      TSS: 40% (ns)                      TN: 14% (ns)                      TP: 15% (ns)</p>	40 % in unlined ED basins	<p>Contributing watershed area should be at least 2 ha to reduce fixed costs and minimize clogging small orifices.</p> <p>Due to lower initial cost and better pollutant removal, use earthen (unlined) basins where possible and groundwater conditions allow.</p>
CWP, 2007 NPRPD v3	Summary of the performance of 10 dry Ponds, including 3 quality control ponds and 7 dry ED ponds	Removal Efficiency Q1-Q3 (median) TSS: 18-71% (49) TP: 15-25% (20)		Dry ponds appear to be efficient at removing bacteria and TSS.

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		<p>Sol P: -8-8% (-3)                  TN: 5-31% (24)                  NOx: -2-36% (9)                  Cu: 22-42% (29)                  Zn: 1-59% (29)                  Bacteria: 83-92% (88)</p>		
Hathaway et al, 2007a,b.	<p>Two dry detention basins were monitored in Charlotte, NC. The basins treated runoff from commercial office parks, parking lots, and landscaped areas. The University basin had 5.9 ac CDA and I = 0.7. The Morehead basin had 3.8 ac CDA and I = 0.7</p>	<p><u>University:</u>                  BOD: 22%                  COD: neg                  NH4: 29%                  NOx: 31%                  TKN: 2%                  TN: 13%                  TP: neg                  TSS: 39%                  Cu: 11%                  Zn: 32%</p> <p><u>Morehead:</u>                  BOD: 18%                  COD: 33%                  NH4: 14%                  NOx: -11%                  TKN: 20%                  TN: 10%                  TP: -13%                  TSS: 65%                  Cu: 17%                  Fe: 68%                  Mn: 56%                  Zn: 34%</p>		<p>Pollutant removal efficiency was high for TSS, but lower for nutrients. Low TP removal was attributed to clean inflow.</p> <p>Based on these results, ED is recommended for TSS removal credit, but not nutrient removal credit in NC.</p> <p>Sedimentation is considered the dominant pollutant removal mechanism</p>
Harper et al., 1999	<p>Monitoring study of a dry ED pond with CDA=23.86 ac and</p>	<p>TN: neg%                  TP: 34%</p>	<p>9% ET. 71% infiltrated.</p>	<p>Migration through the filter system provided little additional removal for most parameters, with the</p>

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<p>(NPRPD v3)</p>	<p>single-family residential land use (I=37%) in DeBary, FL. Pond contained a small filter system near the outfall structure. Concentration pollutant removal efficiencies of the pond measured 30-90% except for dissolved organic nitrogen, particulate nitrogen, total nitrogen, and BOD. Load removals were higher due to volume seepage to GW. The filter system reduced concentrations of ON and Particulate N, but increased concentrations of NH4-N, NO3-N, TP, OPO4, and Particulate P. TN concentrations were reduced 37% within the filter system.</p>	<p>TSS: 90%                  FC: 97%                  Metals: 33-76%  <b>Mass removal:</b>                  TN:86%                  TP: 84%                  TSS: 99%                  BOD: 82%                  Heavy metals: 88-96%                  Large mass removal efficiencies were attributed to high runoff reduction through pond bottom seepage.</p>	<p>Individual rainfall events ranged from 0.03-4.70 cm (0.01-1.85 in), with avg of 0.9 cm (0.36 in) per rain event. 35 storm events monitored.</p>	<p>exception of TN.</p>
<p>Middleton and Barrett, 2006</p>	<p>In Austin, TX, the outlet of an existing detention basin was modified to allow for batch treatment of runoff and control over the hydraulic residence time. Significant reductions for TSS, total metals, COD, nitrate and nitrite, and TKN were observed, while an increase in dissolved copper and dissolved phosphate occurred.</p>	<p>Total Cu: 46%                  Total Pb:63%                  Total Zn:48%                  COD: 23%                  NOx: 70%                  DP:-12%                  TP: 7%                  TKN: 28%                  TSS: 91%</p>	<p>Sampled 5 storm events                  2.3&lt;P&lt;10.5mm</p>	
<p>Schueler and Brown, 2004                  Manual 3</p>				<p>Design should be a Wet ED or contain multiple cells.                  Pollutant removal can be increased by designing</p>

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(appendix B)			<p>the ED pond to treat a larger WQv.</p> <p>Design should be off-line and not intersect with groundwater.</p> <p>Design should contain a sediment forbay and include constructed wetland elements.</p> <p>The flow path should be greater than 1.5:1( not less than 1:1).</p> <p>The pond SA/CDA ratio should be greater than 2%</p>
<p>Schueler and Holland, 2000</p> <p>(Practice) Article 76</p> <p>Borden et al, 1997</p>	<p>Monitoring study of pollutant removal performance for 2 wet ED ponds in NC piedmont: one in a rural watershed (Davis), and one in an industrial watershed with 2x the impervious cover (Peidmont). Each CDA~ 2 sq.mi. Monitored storm and baseflow inflow/outflow for TSS, nutrients, TC, COD, bacteria and metals.</p> <p>Residence time of the Davis pond ~ 60 hrs and Piedmont pond ~ 8hrs</p>	<p><b>MASS REMOVAL:</b></p> <p>Davis:</p> <p>TSS: 60%</p> <p>TOC: 22%</p> <p>TP: 46%</p> <p>OPO4: 58%</p> <p>TN: 16%</p> <p>NO3: 18%</p> <p>FC: 48%</p> <p>Cu: 15%</p> <p>Pb: 51%</p> <p>Zn: 39%</p> <p>Piedmont</p> <p>TSS: 20%</p> <p>TOC: 27%</p> <p>TP: 40%</p> <p>OPO4: 15%</p> <p>TN: 30%</p> <p>NO3: 66%</p> <p>FC: neg</p>	<p>Davis pond (rural watershed) had higher algal production, which allowed for more nutrient uptake during the summer months, but then exported nutrients in the winter months. The longer residence time in this basin allowed for greater removal of TSS.</p> <p>The Piedmont basin had stormwater pretreatment</p>

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<p>Schueler and Holland, 2000  (Practice) Article 77 Stanley, 1994</p>	<p>A dry ED basin was monitored in NC coastal plain. 200 ac CDA (I=0.29). Designed to treat 0.5” of runoff. The basin demonstrated high removal rates of particulate nutrients, but low removal rates of soluble nutrients.</p>	<p>(0.5”&lt;P&lt;2”) TSS: 71% TN: 17% TP: 23% Cd: 0% Cr: 60% Cu: 35% Pb: 63% Zn: 40%</p>	<p>30% from a 9.8” event.</p>	<p>Pollutant removal during the large event was still positive, despite the large volume of overflow. This suggests that treating the first 0.5” of runoff is still effective, even during large events.  Dry ED ponds can effectively remove particulate pollutants, but not soluble pollutants.</p>
<p>Strecker et al, 2004</p>	<p>Review of 24 detention basins found in the International Stormwater BMP database</p>	<p>Mass based: TSS: 55-75% Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.</p>	<p>RR:30%</p>	<p>PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.</p>

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**FILTRATION LITERATURE SUMMARY**

Study	Description	Pollutant Reductions (conc. based unless noted)	Runoff Reductions	Implications for Design
Aulenbach and Chan (1988)	Laboratory experiment that examined sand filtration removal rates of TOC, TP, and heavy metals from applied wastewater. (3.8 d x 100 cm long sand packed glass column). Phosphorous removal rates were very high. For trails where 2.0<pH<11.0, releases of metals from the filters were observed.	TOC: 20% TP: 99% Cd: 15% Cu: 25% Pb: 35% Zn: 45%  Addition of CaCo3 increased pollutant removal to ~50% (excluding Zn)		Mechanism responsible for P removal is primarily chemical precipitation.  Sand filters should not be used to treat acid or base spills, due to the potential for metal leaching.
Barrett, 2003	Evaluated performance of 5 retrofitted Austin sand filters in southern CA in small watersheds (<1.1ac) with high impervious cover (56-100% I). Flow weighted composite samples were collected for storm events (no characterization of storms included in ref). Using linear regression techniques, effluent EMC was found to be <i>independent</i> of the influent EMC.	TSS: 90% NO3: -74% TN: 22% TP: 39% Cu: 50% Pb: 87% Zn : 80% *TPH: 25-30% *FC: 65% * grab sample, not EMC		Percent removal may not be an accurate characterization of sand filter performance, particularly for runoff with high influent pollutant concentrations. Author suggests it may be better to characterize performance by an “expected effluent concentration.”
CWP, 2007 NPRPD v.3	Summary of performance for 18 filtration practices: 7 organic filters and 11 sand	Removal Efficiency Q1-Q3 (median) TSS:80-92% (86)		Filters are very effective at reducing TSS and heavy metals, but do tend to export nitrates (although not TN).

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	filters.	TP: 41-66% (59) solP: -11-63% (3) TN: 30-47% (32) NOx: -70-21% (-14) Cu: 33-67% (37) Zn: 71-91% (87) Bacteria: 36-70% (37)		
Nielsen <i>et al.</i> , 1993	A laboratory study that evaluated pollution removal in sand filter columns.	30-45% nitrogen removal and 40-60% phosphorous sequestration. 70-90% phosphorous sequestration rates were achieved by sands containing natural iron compounds		Removal of P was determined to be the result of chemical precipitation.
Schueler and Brown, 2004. Appendix B, Manual 3				<p>Pollutant removal can be increased by designing the filter to treat a larger WQv.</p> <p>Filters can be used to treat severe pollution sites or hotspots.</p> <p>For additional pollutant removal (not N/P), an organic media can be used in filter bed.</p> <p>A wet pretreatment practice (for at least 25% WQv) is recommended.</p> <p>Filter bed should be exposed to sunlight and sized as &gt;2.5% CDA.</p> <p>Design should be off-line and include storm bypass and an easy maintenance access.</p>

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				Designs should be above ground (except MCTT).
Schueler and Holland, 2000  (Practice) Article 105 City of Austin, 1990	Performance review of various types of sand filters.	High removal rates (> 75%) of TSS, TOC, Pb, Zn, and ON, and variable removal rates (20-75%) of FC, NH4, OPO4, and Cu have been documented TP: 19-80% TN: 31-71%		Pollutant removal can be improved by adding an organic layer to the filter bed.  Designing an anaerobic zone in the bottom of a filter bed may promote denitrification, and potentially increase nitrate removal.  Sand filters must be regularly maintained to prevent clogging and failure.
Schueler and Holland, 2000  (Practice) Article 106 COA, 1997 LCRA, 1997 Leif, 1999 Davis et al, 1998	Review of peat sand and organic sand filters.	Basic sand filter removal rates (no peat or compost) TSS: 80% TP: 40% Metals: 60% Barton Creek sediment/sand system TSS: 89% TN: 17% TP: 59% 2 peat systems: TSS: 88, 84% TN: 51, 30% TP: 47, 48% NO3: negative Compost Filter: TSS: 43% TP: neg Soil/Mulch filter (MASS BASED): TP: 65%		Organic filter media can effectively reduce hydrocarbons and metals, and should be considered for treatment of hotspot runoff. Decomposition of this layer can export NO3 and OPO4.  TP removal can be boosted to 60-70% removal by using soil filtration. Peat filters can potentially remove up to 50% of TP.  Vertical sand filters should be avoided, due to rapid clogging rates.

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<p>Schueler and Holland, 2000</p> <p>(Practice) Article 107 Horner, 1995 Bell et al, 1995</p>	<p>Assessment of a DE sand filter performance.</p>	<p>TN: 49%</p> <p>Concentration removal for 2 Seattle filters: TSS: 83, 8% Oil and Grease: 84, 69% Hydro: 84%, 55% TP: 41, 20% Zn: 33, 69% Cu:22, 31%</p> <p><b>Mass removal rates:</b> for a filter in Alexandria, VA TSS: 79% TOC: 66% TP: 63% OPO4: 63% TN: 47% NOx: -53% TKN:71% Zn: 91% Cu:25%</p>		<p>A relationship exists between pollutant removal efficiency and inflow pollutant concentrations.</p> <p>The sand layer in a filter system should be designed with positive drainage to prevent areas from becoming anaerobic and releasing previously captured phosphorus.</p> <p>If runoff contains TOC, increased N removal may be possible by designing a layer of flooded gravel below the sand filter.</p> <p>When possible, sand filters should treat runoff from 100% IC watersheds, to reduce possibility of failure due to clogging.</p>
<p>Schueler and Holland, 2000</p> <p>(Practice) Article 109 Stewart, 1992</p>	<p>Performance review of an organic leaf compost filter.</p>	<p>TSS: 95 TDS: -37% COD: 67% TP: 41% OPO4: negative ON: 56% NO3: -34% Zn: 88% Hydro: 87% Cr: 61%</p>		<p>Higher pollutant removal rates may be attained by increasing SA or storage volume of filter.</p> <p>Compost should be removed and replaced annually.</p>

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		Cu: 67% Pb, Cd: no difference		
Schueler and Holland, 2000  (Practice) Article 111 Pitt, 1996	MCTT design utilizes screening, settling, and filtering in underground chambers to effectively treat pollutants in hotspot runoff.	<b>Mass Based:</b> TSS: 85-98% TP:50-84% Zn: 71-93% Cu: 43-89%		MCTT can be used to treat runoff in areas where there is limited space for surface filters. Tests have shown high removal rates of TSS, nutrients, metals, and hydrocarbons.  The screening process does not remove pollutants, but rather captures larger materials to reduce maintenance concerns.
Strecker et al, 2004	Review of 30 media filter studies found in the International Stormwater BMP database	<b>Mass Based:</b> TSS: 80-90% Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.	No runoff reduction	PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.

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**STORMWATER WETLANDS LITERATURE SUMMARY**

Study	Description	Pollutant Reductions (conc. based unless noted)	Runoff Reduction	Implications for Design
CWP, 2007  NPRPD v.3	Evaluation of 40 wetland studies, including 24 shallow marshes, 4 ED wetlands, 10 pond/wetland systems, and 2 submerged gravel wetlands	Removal Efficiency: Q1-Q3 (median) TSS: 46-86% (72) TP: 16-76% (48) SolP: 6-53% (25) TN: 0-55% (24) NOx: (22-80% (67) Cu: 18-63% (47) Zn: 31-68% (42) Bacteria: 67-88% (78)		
Hathaway et al, 2007a	A 0.32 ac stormwater wetland was analyzed for pollutant removal performance in Charlotte, NC. CDA was 15.8 ac, I=0.6	FC: 70% Oil and Grease: 15% NH4: 55% NOx: 20% TKN: 35% TN: 35% TP: 45% TSS: 55% Cu:5% Zn: 55%	RR: Negative	Overland flow may have contributed to additional pollutant loadings to wetland. The pollutant removal rates represent the best estimates.  TSS removal ranged between 50 and 66%, with an estimated reduction of 55%, well below the state standard of 85% TSS removal.  According to authors, 85% TSS removal is a likely an overestimation of what <i>any</i> BMP can reliably remove.
Hathaway et al, 2007b.	A 0.5 ac wetland with an avg depth of 1.5 ft in Charlotte, NC, was monitored for pollutant removal performance. The drainage watershed Mainly consisted of single family homes.	FC: 99% E-coli: 92% BOD: 82% COD: 63% NH4: 62% NOx: 62% TKN: 41% TN: 45% TP: 45% TSS: 15%	RR: negligible	The observed 45% TN and 45% TP removal was at or above the NC State standard for these nutrients.

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		Cu: 57% Fe: neg Zn: 71% Pb: 32%		
Li et al, 2007	A laboratory study investigated the TSS removal in 4 wetland cells: three having different densities of well-established vegetation, and one without any vegetation. All cells contained a 0.4 m thick sandy loam layer. A simple non-linear two-parameter regression model is defined for prediction of TSS trapping efficiency in constructed stormwater wetlands.			Confirmed that sediment concentration decreases exponentially with distance travelled.  TSS removal was not dependent on vegetation density, flow turbulence, or shear flow velocity.  Particle diameter, and flow characteristics (flow rate and velocity) had the greatest influence on TSS removal.
Schueler and Brown, 2004  Appendix B, Manual 3				Use pond-wetland or multiple cell design  Should exceed target WQv by more than 50%  Use complex wetland micro-topography  Should exceed target WQv by more than 25%  Flow path should be greater than 1.5 to 1  Wooded wetland design is a benefit  Off-line designs preferred
Schueler and Holland, 2000  (Practice)	A study comparing the pollutant removal performance between two stormwater wetlands in the coastal plain of	<b>MASS BASED:</b> TSS: 65.0% OPO4: 68.7% Total Diss Phosphorus:		Authors expected better overall removal rates and attributed it to the fact that the sand substrate did not contain enough organic matter to trap pollutants.

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<p>Article 89 Athanas and Stevenson, 1991</p>	<p>Maryland – one site had been planted with wetland vegetation and the other had volunteer colonization.</p>	<p>44.3% Total OP: -5.7% TPP: 7.2% TP: 39.1% NOx: 54.5% NH4: 55.8% Total ON: -5.4% Total Particulate Nitrogen: -5.0% TN: 22.8%</p> <p>Numbers are from the planted site only. Percent mass reduced for both storm and baseflow events over 23 months</p>		<p>The planted species survived well but invasive species did appear. The volunteer site was completely dominated by cattail and phragmites. It appears that intentional planting has value.</p>
<p>Schueler and Holland, 2000  (Practice) Article 90 OWML and GMU, 1990</p>	<p>A study on the performance of a small stormwater wetland (created within an existing detention basin) over a 2-year period. Storm event and baseflow monitoring were performed and biomass was examined for nutrient dynamics.</p>	<p><b>MASS BASED:</b> Small Storms: OPO4: 59% Total Soluble Phosphorus: 66% TP: 76% NH4: 68% TSS: 93% TKN: 81% NOx: 68% TN: 76%</p> <p>All Storms: OPO4: -5.5% Total Soluble Phosphorus: -8.2% TP: 8.3% NH4: -3.4% TSS: 62.0%</p>		<p>The wetland was found to be effective in removing nutrients and sediment during small storm events (runoff volumes &lt; 0.1 watershed inches of storage provided by the wetland) but ineffective during larger storms.</p> <p>Stormwater wetlands need an appropriately sized treatment volume to remove pollutants from larger storm events.</p> <p>Sediment forebays help to prevent sediment deposition and resuspension.</p> <p>A wide range of depth zones promotes rapid establishment of diverse wetland species.</p>

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		TKN: 15.0% NOx: 1.2% TN: -2.1%		
		Smaller storms had higher mass removal. Larger storms had smaller or negative removal rates.		
Schueler and Holland, 2000  (Practice) Article 91 Hey et al, 1994 Mitsch et al, 1995	Two independent studies were done to analyze the ability of off-line wetlands to remove sediment and nutrient levels from river runoff. Four wetlands were constructed in the floodplain of the Des Plaines River, located near Chicago. Water from the river was pumped into the wetlands and sampling occurred at the inlet and outlet of each wetland. Summarizes pollutant removal data presented by Hey et al., 1994a and Mitsch et al., 1995.	These numbers show the range over two years and represent percent removal efficiency based on <b>mass balance</b> and flux. TSS: 77%-99% Nitrate-N: 39%-99% TP: 53%-99%		In the first two years the pollutant removal efficiency was high. The third year yielded lower phosphorus removal rates prompting the question of whether wetlands have a limited life span for pollutant removal. Need to continue long-term monitoring.  The off-line riverine wetlands were found to be beneficial for pollutant removal and wildlife habitat. Consideration must be given to designing these systems so they don't raise local flood elevations. Also, they will require maintenance and power to pump water to and from the river.
Schueler and Holland, 2000  (Practice) Article 97 Egan et al, 1995	In this study, the ability of crushed concrete and granite rock wetland cells to remove pollutants was evaluated for 15 simulated storm events. The cells were part of a larger treatment train, the first components providing some pretreatment. The results indicate that these cells can be an effective enhancement to	<b>MASS REMOVAL:</b> TSS: 81% TOC: 38% TKN: 63% NO3: 75% TN: 63% OPO4: 14% TP: 82% Cd: 80% Cr: 38% Cu: 21%		The rock surfaces were believed to be the key factor in pollutant removal by creating substrate area for epilithic algae and microbes, reducing flow rates and providing more contact surfaces.  Recycled crushed concrete cells performed better than granite rock perhaps due to the higher pH promoting greater epilithic algae and bacterial growth.  To prevent clogging or sediment deposition, the

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	stormwater wetland designs, especially in coastal regions where greater nitrogen removal is desired.	Pb: 73% Zn: 55% FC: 78%		cells should be located off-line and protected by pretreatment cells.
Strecker et al, 2004	Review of 29 wetland basins found in the International Stormwater BMP database	Mass based: TSS: 70-75% Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.	RR: 5%	PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.

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**WET PONDS LITERATURE SUMMARY**

Study	Description	Pollutant Reductions (conc. based unless noted)	Runoff Reduction	Implications for Design
Barrett, 2005	Used data from the International Stormwater BMP database to analyze performance based on BMP design techniques			<p>Emergent vegetation around the pond perimeter is responsible for a small percentage of overall nutrient and metal removal (&lt;5%).</p> <p>Larger permanent pools (Sized to capture 4-6x the runoff from mean rainfall events) reduce dissolved P, but had little effect on other pollutants.</p> <p>Removal of N and P tends to decline in winter months.</p>
CALTRANS, 2004	One wet basin was sited as part of this study. The site was located within the highway right-of-way and had CDA of 1.7 ha, I=0.47, collected highway runoff.	<p>Storm Reductions:                      TSS: 94%                      NO3: 77%                      TN: 51%                      TP: 5% (ns)                      Total Cu: 80%                      Total Pb: 76%                      Total Zn: 41%</p> <p>Baseflow Reductions:                      TSS: 21% (ns)                      TN:43%                      TP: 49% (ns)                      Total Cu: 54% (ns)                      Total Pb: 62% (ns)                      Total Zn: 62%</p>		<p>Locate, size, and shape wet basins relative to topography and provide extended flow paths to maximize pollutant removal potential.</p>
CWP, 2007 NPRPD v.3	Summary of 46 wet pond studies, including 12 wet ED ponds, 1 multiple pond system, and 30 wet ponds.	<p>Removal Efficiency:                      Q1-Q3 (median)                      TSS: 60-89% (80)                      TP: 39-76% (52)                      SolP: 41-74% (64)                      TN: 16-41% (31)</p>		

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		NOx: 24-67% (45) Cu: 45-74% (57) Zn: 40-72% (64) Bacteria: 52-94% (70)		
Guo, 2007	An existing detention basin in NJ was retrofitted to an extended detention basin-surface wetland system, to have flood control and pollutant removal functions. Performance was field monitored, and the system was found to be effective.	TSS: 48% TP: 51%  Influent TSS concentrations were low, which resulted in lower TSS removal efficiency.	7 monitored storm events 7.4<P<76.5mm	The extended detention- wetlands system effectively removed TSS and TP from stormwater runoff.  The system required no or minimal maintenance over a long period of time.
Hathaway et al, 2007a	Monitoring was performed on a residential pond in Charlotte, NC, estimated to be 50-70 years old. CDA was 120 ac of commercial and residential development. Pond was 1 ac with avg. depth 3-6 ft.	BOD: 45% COD: 42% NOx: 45% TN: 23% TP: 41% TSS: 56% Cu: 40% Mn: negative Zn: 49% Pb: 26%	negligible	The studied pond removed TN and TP with efficiencies of 23% and 41%, respectively. TSS removal was 56%, lower than the state of NC recommended 85%.  85% TSS removal is unlikely for ponds sited in clayey watersheds  Aged ponds are able to provide substantial stormwater treatment for various nutrients, sediment, pathogens, and metals.  The establishment of a diverse, dense plant community around the perimeter of the pond may increase nutrient removal. This may also discourage water fowl activity, potentially reducing organic nutrient and pathogen inputs.
Hathaway et al, 2007b	In Charlotte, NC, performance of an urban wet pond was studied. The CDA of the pond	NH4: 22% NOx: 74% TKN: negative TN:19%	negligible	Removal efficiencies of TSS, TN, and TP were 63%, 19%, and 15%, respectively.  TSS removal was lower than the 85% removal

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	was 27.3 ac and consisted of commercial, residential, and transportation land uses. I=0.86. Wet pond was 0.6 ac with an average depth of 3 ft.	TP: 15% TSS: 63% Cu: 63% Fe: 49% Zn: 49% Pb: 18%		credit assigned to wet ponds by the state of NC.
Mallin et al, 2002.	Monitored performance of 3 wet ponds in Wilmington, NC for 29 months. One pond had high pollutant removal. The other two ponds were less effective; one experienced additional overland inflow which short-circuited pollutant contact time, and the other had high pollutant inflow from a golf course in the CDA.	Calculated removal: TN: 40% TP: 57% FC: 86%		A high length-to-width ratio and establishment of a diverse vegetation community is recommended to obtain better pollutant removal by maximizing inflow contact time with vegetation and organic sediments.
Rushton et al, 2002 (NPRPD v3)	Studied pollutant removal and runoff reduction of a wet detention pond in an agricultural basin in Ruskin, FL over a 4-year period. Influent runoff received pretreatment from a roadside ditch. The watershed was 85 ha and the pond was 5.8 ha. Influent and effluent samples were obtained to determine differences for event EMCs.	For 1998, 1999, 2000, and 2001, resp. TP: 37%, 63%, 52%, 46% TN: 28%, neg, 28%, 44% TSS: neg, neg, neg, 85%  Load reductions were higher due to runoff reduction in the basin.	25% RR (45% if rainfall is considered as an input) 8% loss due to evaporation, 15% to seepage	Runoff coefficient was 0.4 for storms greater than 2.0 in.  TP effluent concentrations, although lower than influent, were still above national standards.
Schueler and				Use wet ED or multiple pond design

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<p>Brown, 2004</p> <p>Appendix B, Manual 3</p>			<p>Should exceed target WQv by more than 50%</p> <p>Should exceed target WQv by more than 25%</p> <p>Use off-line design</p> <p>Flow path should be greater than 1.5 to 1</p> <p>Use sediment forebay at major outfalls</p> <p>Wetland elements should cover at least 10% of surface area</p>
<p>Schueler and Holland, 2000</p> <p>(Practice) Article 73 Wu, 1989</p>	<p>In this study, the role of permanent pool volume on pollutant removal performance is examined. Investigators found that the pond with the larger permanent pool volume performed better than the smaller pond with &gt;80% removal of TSS and some metals. However, the performance of the larger pond in removing nutrients was modest, only 10% higher. It was speculated that a large population of geese at the larger pond could have reduced its efficiency. Short-circuiting and low inflow concentrations were also cited as reasons. Dry weather</p>	<p><b>Mass Removal:</b></p> <p>Lakeside Pond Drainage area: 65 acre Volume: 38.8 acre-ft Mean Depth: 7.9 ft Equiv. watershed storage: 7.1 inches TSS: 93% TP: 45% TKN: 32% Zn: 80% Fe: 87%</p> <p>Runaway Bay Drainage area: 437 acre Volume: 12.3 acre-ft Mean Depth: 3.8 ft Equiv. watershed storage: 0.33 inches TSS: 62% TP: 36% TKN: 21%</p>	<p>Satisfactory pollutant removal performance could be achieved if wet ponds were sized to be at least 2% of the contributing drainage area, with an average depth of six feet.</p> <p>Treatment volume alone does not guarantee good performance – need to provide good internal geometry and pondscaping to discourage large geese populations.</p>

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	<p>sampling yielded higher nutrient levels than during storm events.</p> <p>Eleven storm events were monitored, ranging from 0.5” - 3.6” of rainfall.</p>	<p>Zn: 32% Fe: 52%</p>		
<p>Schueler and Holland, 2000  (Practice) Article 72 Urbonas et al, 1994</p>	<p>A study of the pollutant removal performance of a stormwater pond/wetland system. The watershed draining to the system was 550 acres. Runoff entered the wet pond then exited over a spillway and into a series of six cascading wetland cells. In general the combined system worked effectively with the bulk of the pollutant removal coming from the pond. The wetland cells provided pollutant removal during dry periods where the pond tended to be an exporter.</p> <p>Thirty six storm events were samples over a three year period during the growing season (May to September).</p>	<p><b>Mass Removal:</b> By Wetpond- TP: 49% Dissolved P: 32% Nitrate-Nitrogen: -85% Organic- Nitrogen: 32% TN: -12% Total Copper: 57% Diss Cu: 53% Total Zn: 51% Diss Zn: 34% TSS: 78%</p> <p><b>Mass Removal:</b> By Wetland- TP: 3% Diss P: 12% Nitrate-Nitrogen: 5% Organic- Nitrogen: -1% TN: 1% Total Cu: 2% Diss Cu: -1% Total Zn: 31% Diss Zn: -5% TSS: -29%</p> <p><b>Mass Removal:</b></p>		<p>Greater pollutant removal rates are achieved by having multiple and redundant treatment systems.</p> <p>Dry weather sampling should not be neglected in pond systems serving large drainage areas.</p>

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		<p>By System                      TP: 51%                      Diss P: 40%                      Nitrate-Nitrogen: -76%                      Organic- Nitrogen:                      31%                      TN: 19%                      Total Cu: 57%                      Diss Cu: 58%                      Total Zn: 66%                      Diss Zn: 30%                      TSS: 72%</p>		
<p>Schueler and Holland, 2000                       (Practice)                      Article 70                      Leersnyder, 1993</p>	<p>A study on the pollutant removal capacity of a pond/marsh system at an industrial site in New Zealand. The system was found to be very effective in the removal of sediment, nutrients and metals. However it was an exporter of ammonia and ineffective in removing COD. Six storm events were monitored.</p>	<p><b>Mass Removal:</b>                      TSS: 78%                      TP: 79%                      Sol. Reactive Phosphorus: 75%                      Nitrate: 62%                      NH4: -43%                      COD: 2%                      Total Cu: 84%                      Total Pb: 93%                      Total Zn: 88%</p>		<p>A large treatment volume and good design features (oil trap at inlet, long flow path, submerged berm, shallow marsh zone, micropool at outlet) were cited as the reasons for effective pollutant removal.</p>
<p>Strecker et al, 2004</p>	<p>Review of 33 retention ponds found in the International Stormwater BMP database</p>	<p><b>Mass based:</b>                      TSS: 60-95%                      Average effluent concentrations were published for Cu, TP, Zn, but no PR rate was specified.</p>	<p>RR: 7%</p>	<p>PR variability was high for all BMPs in the database; however, effluent quality was less variable. PR appeared to be dependent on the quality of the influent runoff.</p>
<p>Taylor et al, 2001</p>	<p>A wet pond in San Diego County, CA, was</p>	<p>TSS: 94%                      NO3-N: negative</p>		<p>Vegetation in and around the basin provides for enhanced solids, and potentially dissolved</p>

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	<p>constructed as a retrofit project to treat highway stormwater runoff from a 4.2 ac CDA. The pond was designed to capture the 1-yr, 24hr rainfall event (1.34 in) and have a 24 hr drawdown time (orifice d=3in). The wet pond demonstrated high removal of TSS and metals, and low nutrient removal, particularly for nitrate. Nitrate and TN concentrations did decrease in the dry flows.</p>	<p>TKN: 44%                  TN: negative                  TP: 29%                  Total Cu: 99%                  Total Pb: 99%                  Total Zn: 93%                  Diss Cu: 27%                  Diss Pb: 94%                  Diss Zn: 33%                  TPH-oil: 21%                  TPH-diesel: 92%                  FC: 100%</p>		<p>metal removal.</p> <p>Vegetation re-growth was most rapid after a harvest.</p> <p>The 3 in orifice remained submerged to avoid clogging by floating debris. There were no clogging problems observed during this one-year study.</p>
<p>Teague and Rushton, 2005 (in NPRPD)</p>	<p>A filter pond treated parking garage and throughfare runoff a from 10.4 ac watershed. N and P concentrations were reduced in the system, but effluent concentrations remained above water quality standards.</p>	<p>The effluent filtration system was effective in reducing metals and suspended solid loads, but not successful in reducing soluble nutrients.</p>	<p>negligible</p>	<p>Provide some pre-treatment to further reduce metals, oils, and greases.</p> <p>Clean out the concrete lined sedimentation basin and vacuum out underdrain pipes at least once a year to remove pollutants.</p> <p>Restrict mowing too close to littoral zone vegetation.</p> <p>Use material in the filter system designed to remove nutrients.</p>

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# PHILADELPHIA PARKS & RECREATION

## Philadelphia Park Friends Group Toolkit

A Guide for Beginning and Sustaining Park Friends Groups

JANUARY 2018



**FAIRMOUNT PARK**

**CONSERVANCY**

# Philadelphia Park Friends Group Toolkit

## A Guide for Beginning and Sustaining Park Friends Groups

### PREFACE

This document is the second edition of the Friends Group Toolkit originally created by Philadelphia Parks & Recreation in 2013. It aims to provide current and potential park stewards with important information on how to begin and grow their stewardship (“Friends”) group. It is a living document that will continually evolve to meet the needs of our park volunteers. It is with extreme gratitude that we acknowledge Philadelphia’s Park Friends, whose invaluable work has helped inform this document.

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## Section 1: Beginning Your Friends Group



### What is a “Friends Group”?

Friends groups are community-based volunteer groups made up of at least three people that are officially affiliated with Philadelphia Parks & Recreation. These recognized City volunteer groups are established to support and advocate for a specific park area in the Philadelphia Parks & Recreation system. They are public community groups, where membership is open and accessible to all park users. Friends groups work in close partnership with staff at Parks & Recreation (PPR) and the Fairmount Park Conservancy (FPC) to create welcoming community green spaces and positive experiences with nature at the neighborhood level and in the watershed parks. Successful Friends groups also engage with residents, community organizations, and external partners to achieve these goals and serve as the “community voice” for the park.

Typical Friends group activities include:

- Park cleanup and beautification days
- Fundraising events
- Organizing recreational and educational programming
- Advocating for park improvements
- Publicizing important park issues

Philadelphia Parks & Recreation has a rich tradition of engaged citizens and active park groups. Currently there are more than 100 active Friends groups of varying capacity, ranging from large 501(c)(3) organizations with several hundred members, to grassroots community entities consisting of a smaller number of committed neighbors. PPR promotes all civic engagement and actively works with FPC to provide service, resources and training.

Philadelphia Parks & Recreation is committed to preserving and enhancing public green space throughout Philadelphia, which we believe can only be achieved through sustained civic engagement and park stewardship.

## The value of Stewardship – why Friends groups exist

Parks provide significant aesthetic, economic, environmental and social benefits to the City of Philadelphia and committed citizens are increasingly becoming involved in park stewardship. Philadelphia’s beautiful public spaces are accessible to everyone and are enjoyed on a daily basis by thousands of city residents and visitors alike. This level of usage coupled with the large number of parks presents a challenge to keeping the city’s parks “Safe, Clean and Ready to Use” which is PPR’s aspiration for each of its many amenities. Park Stewards, more commonly known as “Friends” groups, are essential to the health, cleanliness and vitality of the City’s parks. Friends groups invest time and resources to create healthy and welcoming green spaces that connect neighbors, build community identity and provide positive experiences. Through service projects, fun events, and commitment, Friends groups enhance their community’s quality of life through their neighborhood park.

## My park doesn’t have a Friends Group—how can I start one?

The first step in forming new Friends groups or re-activating a dormant group is to contact the *Stewardship Office of Philadelphia Parks & Recreation*. We will readily assist you in forming a Friends group as well as discuss your ideas for the park.

Elisa Ruse-Esposito  
Stewardship Manager  
Tel: (215) 683 – 3679  
Email: [Elisa.Ruse-Esposito@phila.gov](mailto:Elisa.Ruse-Esposito@phila.gov)

There are a few questions to keep in mind when considering if and how you’re going to form a Friends group:

- Is your group forming in response to a specific problem within the park or around a specific goal?
- Are you going to address a wide range of issues, and if so, which ones take priority?
- How are you going to involve the community and work together to care for your park?

PPR staff will guide you through the formation process, beginning with a meeting to discuss your goals for the park. Together we will plan your next steps, including a meeting to engage the broader community.

## Gathering community input

Understanding the needs of the park in combination with the needs of your community is an essential element in creating a Friends group. Community members who already frequent the park are a good place to start building your initial “core” Friends group membership (i.e., the people who attend group meetings and are responsible for planning and implementing projects).

It is also important to reach out to the broader community in order to have an inclusive perspective and ensure your group’s goals are in line with other community development efforts. You can do this either through a *community meeting*, a *neighborhood survey*, or both. Once you’ve reached out to your community, be sure to share the feedback with the PPR Stewardship Office so together, we can assess the information and establish next steps.

Quick tips for holding community meetings:

- Choose a **central space** within the community, such as a rec center, school or church, and make sure the meeting is timed to fit people’s work schedules.
- Use a **variety of methods** to spread the word about your meeting—post flyers in your neighborhood rec center, coffee shops, grocery stores, laundromats, and of course in the park! If possible, have it announced in the local newspaper. Online social media (such as Facebook, Nextdoor and Twitter) can also be effective. And always remember to include your contact information!
- **Reach out** to other community groups, such as Civic Associations, CDCs and others, to let them know about your meeting and ask them to spread the word to their members.
- Invite a representative from Parks and Recreation’s Office of Stewardship to help facilitate discussions and answer community questions.
- Create a clear list of the park issues or goals your group wants to address.
- Have a **“solutions” brainstorming session** for the group with guidelines to ensure that everyone is respectful, and encourage everyone to practice active listening when others are speaking.
- **Take notes!** It’s the best way to remember all the great ideas that will come out of the meeting.
- Have a **sign-up sheet** with contact information so the meeting notes/minutes can be shared with all in attendance. This can also serve as a recruitment list for future members of the Friends group.
- **Announce the date** for the next Friends group meeting – letting people know future dates (for meetings, events, service days) allows them to fit it into their own schedule and let other folks know when they can be involved!

Quick tips for a neighborhood survey:

- Make your questions **concise** to avoid a lengthy survey that might deter people, and make your questions **fair** so people feel comfortable answering honestly.
- Devise a **clear system** to collect and analyze the responses. Having a simple report format is an easy way to see the overall survey trends.

- **Encourage** respondents to attend future Friends group meetings so they can voice their opinions in person. Include the scheduled date for your next meeting, or pick a standing date (e.g., 3<sup>rd</sup> Wednesday of the month at 7 pm).
- **Provide survey results** to all persons/households that were requested to complete the survey.

## Writing your mission statement

Every Friends group should have a mission statement. The group mission statement is a product of focused community meetings. It is an easy and effective way to communicate the purpose of your Friends group, both to the community you serve and to the entire city. The mission statement is a group effort and an assurance that all your “Friends” are in agreement when it comes to the purpose and goals of the group.

Here are a few examples of Philadelphia Friends groups’ mission statements:

### Friends of Mifflin Square

To promote a healthy, safe, clean space for the diverse communities in South Philly, and to preserve access to peaceful space for physical fitness.

### Friends of Vernon Park

Keeping Vernon Park, ‘The Emerald of Germantown’, healthy, green, and engaged in the community.

### Friends of Campbell Square

The Friends of Campbell Square are dedicated to the revitalization and preservation of the oldest public square in Port Richmond for the benefit of the entire community and future generations.

Each of these statements is concise, expresses the purpose of the Friends group, and helps keep its work in line with its defined goals. Answering the following questions will help simplify your mission statement construction process:

1. **Purpose.** What are the opportunities or needs you want to address?
2. **Business.** How will you address those opportunities or needs?
3. **Values.** What principles or beliefs guide your work?
4. **Goals.** Does the mission statement incorporate both short- and long-term goals?
5. **Actions.** Will the future actions of the group reflect the words of the mission statement?



## Group structure

Established leadership roles can benefit your Friends group and help you stay organized; however it does not have to be your first priority of business. We recommend that newly organized volunteers work together first before they consider having elections or creating a more formal structure. Keep your group focused on establishing a common vision, setting goals that are attainable, and actually working together to implement small projects during your first year or “outdoor season.” This will allow you to get to know each other better and to determine the skills, contacts and resources that each volunteer brings to the table. Once you have achieved small successes and have a steady and committed group of volunteers working together toward a common vision, then you are in a better position to formalize the group structure and fill important leadership roles for continued success.

Once your group is ready for a more formal structure, PPR does not require a “set format,” but we find that many of our Friends groups successfully use a basic leadership format such as:

- President (or chair)
- Vice President (co-chair)
- Treasurer
- Secretary

You may also want to consider organizing by committees based on the interests or expertise of your volunteers. Some typical examples of committees include: gardening and cleanup committee, programming and events, fundraising, PR and social media, and other permanent or ad hoc committees as particular needs arise.

As groups grow and more residents and partners get involved, some groups establish a “board of directors” that serves as the main decision-making group. This board reports to and regularly communicates with the larger membership group.

The leadership structure is up to you, whatever will work best for your park and community. Once you do establish a structure, it should be clearly defined in writing and all members should be aware. You should also determine how often you will “vote” on leadership roles in your group and what that process entails.

## How do we plan our first project?

Although the work you do is informed by the community, the planning will fall to the core Friends group working in coordination with Philadelphia Parks & Recreation and the Fairmount Park Conservancy. Your first project could be a cleanup workday, a community program or a physical improvement project. A successful event takes time and substantial planning, so the sooner you begin the better!

**Start small and do it well** – having one small successful project is better than multiple half-completed projects. Most importantly, make sure *everyone* in the community knows about the project! Even if only a third of the people you tell actually come to the event, you are still getting word out about your Friends group and the goals you are working to accomplish.



## Service Days

Service days are essential because they keep the park beautiful, are fairly easy to organize, and are an opportunity to engage your fellow community members. Everyone benefits from a clean, safe park, and everyone's help is needed to keep your park in that condition! The more frequent your service days, the more obvious the positive impact your group is creating in the community and with experience the more significant the projects your group can undertake. A Stewardship staff person can work with your group to help plan your first service day and may also be available to work with you on the day of the service. Basic tools and supplies are available for you to borrow from the Office of Stewardship.

### Prior to the Service day:

- Conduct a park inventory to identify the highest priority projects. Make a list of all the necessary tools and materials you will need and decide how you will secure the supplies.
- Notify PPR about the date, time and scope of your service day so that we can arrange to support your efforts as resources allow (e.g., schedule a trash pick-up for your park).
- Draw on community connections for in-kind donations, such as snacks and water for volunteers, tools, materials and any other items your group needs for the workday.
- Compile a list of potential volunteers (from the contact information you've collected) and notify them about the upcoming service day two or three weeks ahead of time.
- Get the word out to the rest of the community using social media (e.g. Facebook, NextDoor, etc) and by putting up flyers in the park, nearby rec centers, local businesses, community centers, schools and religious institutions. Also send out a calendar listing for the event to your local newspaper.
- Send an email blast to potential volunteers the day before to remind them about the service day and to wear appropriate attire (clothes they don't mind getting dirty, closed-toe shoes, etc.).
- Plan to have a "Welcome Station" where a group member can greet folks as they arrive, register them with the sign-in sheet (Section 4) and distribute membership materials for your group.

### Day of the Event Reminders:

- Arrive with enough time to prepare the site for the day's events – nothing worse than volunteers arriving with no one to greet them!
- Set up your “Welcome Station” with sign-in sheet and Friends Group information,.Be sure to use the sign-in sheet attached in Section 4, which includes a liability waiver and space to record contact information of all volunteers.
- Once everyone has arrived, explain the details of your project and delegate tasks. Let volunteers know your approximate finish time and where to meet once they're done working.
- Inform volunteers of the location for restroom facilities and hydrations stations.
- Explain safety protocols and then direct volunteers toward the designated tool area.
- **Take lots of pictures!! Post them on social media and send them to us at [volunteer@loveyourpark.org](mailto:volunteer@loveyourpark.org)!**
- Once the work is completed or it is time to stop for the day, round up all trash and equipment, and return all tools to the tool area.
- At the end of the day, remember to **thank all your volunteers** for their hard work. Let them know when your next workday or meeting will be and encourage them to stay connected to the park.
- Congratulate yourselves on a successful workday.

## Community Programs and Fun Events

Programming and events are a proven way to attract community members to your park. While not everyone in the neighborhood may volunteer to pull weeds or rake leaves, few can say no to a festival, farmers market or concert. At every event, **be sure to have a Welcome Table with information on your group, when you meet and your goals for the park.** Certain events take more planning, and if this is your first time organizing a park event, it is a good idea to start small. A neighborhood potluck dinner or picnic is a great way to get people into the park and collect their information with minimal planning on your part. Once introduced to your group, these community members will be connected to future park events.



### Important Considerations for Events:

- **Demographics:** what type of event would be most appropriate for your community?
- **Timing:** is your event scheduled when the most people can attend?
- **Permits:** which group member will fill out and submit the Special Events Permit Application (Section 4) for PPR approval?
- **Frequency:** is it a one-time event, or do you want to have an ongoing series of events (e.g., monthly concerts in the park, farmer's markets, etc.)?
- **Budget:** what is needed and how will you secure the funding?

Your events are also fundraising opportunities. The Health Department allows folks to sell bottled drinks and packaged snacks without any vending license. Having an information table for your Friends group at the event with a sign-up sheet, snacks to sell and a donation bucket are all great ways to build your membership and add to your treasury. Raffles and 50-50 drawings are also easy fundraising tools. If you have a small budget to work with, consider purchasing small giveaways (magnets, pens, etc.) that list your email, Facebook page or phone # to make it easy for people to stay in touch. Raising money at events enables you to fund more events in the future, recruit more volunteers and help your group reach its goals. Be sure to always carefully record any and all funds raised and spent, especially as your group

treasury begins to grow. For more fundraising ideas and grant opportunities for programming, read on to Section 2.

## Physical Improvement Projects

While regular service days and cleanup efforts are essential and easy-to-organize projects, nothing captures the attention of the community and gets a Friends group more notice than a positive physical change in your park. It doesn't have to be a huge change; small but thought out improvements can really help to spark community interest and attract new support for your group.

Some examples of physical improvement projects include:

- Gardens or improved landscape
- Signage
- Community bulletin board
- Installation of water sources
- Site furnishings

## Our first project was such a success! What now?

Successful service days and events are fantastic, and it is important to do everything possible to keep up the progress. Make your community aware of your success; advertise your accomplishments in the neighborhood newspaper, put it on your Facebook page and share the good news through an email to other organizations working in your community. Don't forget to share with your Stewardship Coordinator and your partners FPC.

To have a lasting impact on your park, you must think in the long-term. New projects will regularly arise, and you want to make sure you have a reliable base of volunteers. Schedule regular meetings for your Friends group to which everyone can comfortably commit. Most importantly, as you grow and expand the reach of your goals, Parks & Recreation and the Fairmount Park Conservancy will continue to be a resource for your group.

*Read on to Section 2 for further tips on expanding and sustaining your newly formed Friends group.*

## Section 2: Growing Your Friends Group



### Becoming part of the Parks Stewardship Program network

Philadelphia Parks & Recreation (city), the Fairmount Park Conservancy (nonprofit) and more than 100 volunteer Park Friends groups (citizens) work collaboratively to steward parks across the city. This collaborative partnership is called the *Parks Stewardship Program*.

Effective partnerships require regular communication and a strong working relationship. There are several ways for Friends groups to stay in touch with your city and nonprofit partners.

- Participate in annual *LOVE Your Park (LYP)* activities, which are city-wide service and program events held seasonally throughout the year. Refer to Section 3 for further details on *LYP*.
- Join fellow Friends group representatives at *Park Friends Network Meetings* held four times a year: February, May, August, and November. In addition to receiving updates from PPR and FPC, this is an opportunity to network with other Friends groups to discuss issues and share information. Registered Friends groups receive notice of upcoming meetings.
- Visit the *LOVE Your Park* website often. This site is dedicated to the promotion and support of Park Friends groups throughout the city and is a simple and effective way to get partnership updates.
- Join the *Friends of Philly Parks* Facebook Group. It's a place where Friends Group members can share resources, tips, questions, and more! Join us at [www.facebook.com/groups/FriendsofPhillyParks](http://www.facebook.com/groups/FriendsofPhillyParks).
- Post entries on social media (Facebook and/or Twitter) year-round to share your community work with fellow Friends groups and all Philadelphians.
- Submit and track your volunteer hours.
- Invite your program partners to park events you are hosting so they can see first-hand the work your community is doing.

## Promoting your park

The more familiar people are with your park, the more attention and involvement you will garner from both inside and outside the community. Hosting community events and regular service days are a great way to heighten awareness of your park and Friends group.

### Back to Basics

While technology and social media help immensely in reaching people, and we strongly recommend those avenues, there is still nothing better than good old fashioned canvassing. Canvassing is going door-to-door, engaging directly with your neighbors. It puts a friendly face to your Friends group and helps neighbors understand what your Friends group is all about.

To assist in your canvassing efforts, the PPR Stewardship Team can provide your group with a large quantity of pre-printed color “door hangers” that can be used to get the word out to nearby residents and organizations. The pre-printed message on the door hanger provides general information and answers the question “What is a Friends Group?” There is also a blank space on the hanger for your group to “personalize” your message to people; for example, you can include the date, time and location of your next event or meeting. Similar to the door hanger, we can also provide your group with large quantities of pre-printed “rack cards” that can be distributed at park events or service days. These are similar to the door hanger but with no hole to hang.

If you are interested in obtaining door hangers or rack cards for your group, please contact the Stewardship Office at 215-683-3679 and we will make arrangements to get them to you.

Helpful canvassing tips:

- Be safe! Always take a partner with you and try not to canvass at night
- Bring paper and pens in case you meet someone in your neighborhood who is interested in joining your Friends group
- Do not tape anything to your neighbor’s door
- Don’t put your flyers in any mailboxes
- Have fun meeting all your neighbors and getting them interested in your park!

### Social Media

With today’s ever-growing use of social media, another effective and *crucial* means of promotion is through the internet. Because everyone has the opportunity to be online now, putting your group out there via the internet is a great choice!

**If your Friends group is not inclined toward this form of communication but would like to be, we encourage you to let us know. We will assist you to recruit a volunteer member who could help your group with its internet presence.**

Here are the primary forms of internet communication. At the very least, we feel it is imperative for every Friends group to have a generic email to maintain contact with your local and Parks Stewardship Program partners.

- **Email:** A generic email address is the *best* choice for your group because it simplifies communication with Friends group members and other park volunteers, it protects your personal contact information, and more than one group member can monitor and manage emails. As an additional perk, email addresses through Gmail are completely free! Creating a generic [friendsofXXXXpark@gmail.com](mailto:friendsofXXXXpark@gmail.com) address is an efficient way to manage communication with your members and make your group contact information available to potential volunteers.
- **Facebook:** Social media is an extremely effective way to communicate with a large number of people. Creating a Facebook page for your group takes minimal effort and allows you to post upcoming events and successes, and have other “Friends” post their thoughts on your “wall.” A Facebook page will also show up if anyone does a Google search for your park, so it’s a good first step if you’re considering your own website. If you have a Facebook page, find and join the *Friends of Philly Parks* Facebook group!
- **Twitter:** Twitter is an online social networking service that enables users to send and read short 140-character messages called “tweets.” This is a great way to promote events in your park! Follow us at @loveyourpark, @PhilaParkandRec and @myphillypark
- **Blogging:** Your own park blog is a great way to let people know about events and post pictures along with stories for people to read. In addition, look to the *LYP* website ([www.loveyourpark.org](http://www.loveyourpark.org)) to share your pictures and stories and to see what other parks are doing.
- **Building a Website:** If you have the time and resources, you can create your *own* website with your park name as the address (i.e., *Yourparkgroup.org*). A website can be as simple or complex as you’d like it to be, and there are a variety of self-built (and often free) sites.

Additionally, any Friends group that has a Facebook page or website can be listed on the PPR public website. This City webpage will provide a direct link to your website or Facebook page, helping your Friends group gain more exposure. Visit <http://www.phila.gov/parksandrecreation> and click on the “Volunteer” tab to see how and where your group could be listed.

Please also join our new Neighborhood Park Stewardship Network Facebook Group! “Friends of Philly Parks” <https://www.facebook.com/groups/FriendsofPhillyParks/> This is a place where we can all come together to share resources, tips, questions, etc.

Finally, if you do not have access to a computer or the internet, Parks & Recreation can help. We operate many public computer labs in our recreation centers called **KEYSPOTS**. To learn of a KEYSPOt location near you, please call the Stewardship Office at 215-683-3679.

## Sustaining community involvement

People want to be involved in projects that are interesting and meaningful. Finding the right balance of fun and productivity is critical if you want to keep your community involved. Organizing service days and community events in your park on a regular basis will go a long way in keeping your group active and volunteers coming back.

## Service Days

Service Days should be planned well in advance to provide volunteers plenty of notice and to allow your group organizers time to secure tools and materials. Refer back to Section 1 for a guide to organizing a successful Service Day.

Use the Volunteer Service Day Sign-In form (Section 4) to capture your volunteers' contact information. Add all new volunteers to your general membership email list so they will receive future notice about service days, events and Friends group meetings. Volunteers can fill many roles for the group.



Identifying a range of activities will allow volunteers more opportunities to be involved. Some examples include picking up trash, tending a garden, staffing the welcome table, supplying refreshments or updating your Facebook page.

It is important to document the impact of your work and your volunteer hours. Keep track of your volunteer efforts with the “Monthly Volunteer Hour Registration” form (attached Section 4-Forms). This tool will assist you to record your history and help document the impact of your work for grants and other funding sources.

Volunteers will be more willing to come back if the impact of their work is tangible – *We picked up how many bags of trash? We planted how many flowers?* – and appreciated. Use your email list to inform volunteers what was accomplished during the service day. **Never underestimate the value of a heartfelt “thank you” at the end of the day.** Be sure to acknowledge everyone’s hard work and let them know how much they have done to help the park. Taking it a step further, some Friends groups plan an annual “thank you” event for their members as a time to get together without working. Two examples: a group pizza party in the park or an outing to a local restaurant that supports the park. Keep in mind that, like you, volunteers willingly contribute their free time to the park. The more thanks and information they receive from you, the more likely they are to stay involved.

## Events and Programs

Successful community events and programs require substantial planning. However, the rewards for the park are equally substantial. Events are typically a one-day activity, whereas programs are usually more consistent activities that occur regularly on a weekly, bi-monthly or monthly basis. Many programs are also organized seasonally; for example, a summer concert series. Many Friends groups start planning their spring and summer events and programs as early as January. Some groups even plan their entire year in January and publish an annual calendar so the community knows well in advance. However your group decides to plan events and programs, the key is to allow ample time to promote and advertise your activities in order to capture the largest audience.

Please note: All park events and programs require a Special Events permit from Parks & Recreation. (attached Section 4-Forms). The *Friends and Community Groups Special Events Permit* application can be downloaded from the Philadelphia Parks & Recreation website or emailed by contacting the Stewardship Office at 215-683-3679. Your Stewardship Coordinator can also provide access to the permit application.

Events and programs create the opportunity to draw NEW neighbors and partners to the park. Be sure to take advantage of these opportunities to recruit more members from the audiences you draw. During the event: set up a Friends group table, display visuals and make announcements to draw attention to your group. Work the crowd: introduce yourself, talk to folks and make more “Friends”!

Notify the local newspaper about your event and invite them to come and do a story. Always invite your local elected officials. Even if they don’t come, you should always send the invitation to their office so they are aware of your activities. Be sure to take your own photos and then share them: put them on your Facebook page, send them to your Stewardship Coordinator, post them on your website, etc. Also keep in mind that you get to have fun as well. The more fun you and your fellow Friends have at the event, the more fun others will have too.

## Creating successful partnerships

Outside of your partnership with PPR and FPC, there are a numerous opportunities for your Friends group to collaborate with other organizations. Start with local businesses, schools, religious institutions, civic associations and community development corporations who are already part of your community. Whether the local grocery store donates candy for your Halloween bash or the dog-walking group brings folks out to the next service day, every potential partner has something to contribute.

Strong partnerships are the result of a shared vision developed from everyone doing as much listening as they do speaking. Learning about your partner’s interests, concerns and limitations is the first step towards understanding how you can work together. A successful partnership requires a large upfront investment of both time and effort. Each group or organization has its own perspectives, interests and methods of accomplishing its goals, and it is important to keep them all in mind. Beneficial collaboration creates its own energy and produces its own rewards.

Quick tips for effective partnerships:

- Remain committed, patient and flexible
- Focus on shared goals and how to best accomplish them
- Keep communication channels open and dialogue honest
- Never underestimate the value of “Thank you!”
- Hard work deserves celebration – always make time to publicly acknowledge all your partners

## Building relationships with City Council

### Who Is My City Councilperson?

There are two easy ways to find this information!

1. **Find online:** Type PhiladelphiaVotes.com in your search engine and place pointer over **voter** until dropdown menu appears. Scroll down to **Who Are My Elected Officials?** and click on it. At the very top of the page, you will see a section asking you to enter your address; type in your address and hit the Enter key. To the left of the page, click on the link titled **Local** (right under **Find Your Elected Officials**) and scroll down to **District Council Member**.
2. Call the Voter Registration Office at **(215) 686-1590**.

### Why Should My Friends Group Be Involved with Our District Councilperson?

Developing a relationship with your District Councilperson can be very beneficial to a Friends Group with advantages such as:

#### **Resources**

*(1) Your Councilperson determines how Philadelphia Activity Fund grants are allocated in their district. Your park group is eligible for this grant.*

*(2) Your Councilperson can connect you to other community groups in the district to expand your group's local network.*

#### **City Support Services**

*Your Councilperson can assist with park issues and provide support for special projects.*

#### **Capital Funding**

*Your Councilperson can help with funding for park improvements and building enhancements.*

### How Should My Friends Group Be Involved With Our District Councilperson?

#### **Friendly Introduction**

Contact your Councilperson to introduce your Friends Group. Inform them of your group's good work along with the positive benefits that your group provides to both their District and their constituents. Ask your District Councilperson about their goals for your park and identify ways in which you can work together. Also, be sure to introduce yourself to the Councilperson's constituent service representative; it's always wise to have more than one way to get information to your Councilperson.

#### **Friendly Relationship**

Build your relationship with your Councilperson by keeping them in the know about the park. Invite them to your meetings, involve them in your special events and acknowledge their support in your newsletter or on

your Facebook page. In general, show them what an asset your Friends Group is to them, the park and the community as a whole.

### **Friendly Reminders**

Consistent communications is very important! Stay in touch with your Councilperson so they are both aware of and fully understand your needs. This will prove invaluable should any park issue arise.

**Note:** Please keep your Parks and Recreation Stewardship Coordinator in the loop. Copy them on all correspondence that you have with the councilperson's office so they can appropriately respond to any related inquiries from the Councilperson.

## **Fundraising – finding the financial means to support your work!**

Fundraising is an integral part of an effective Friends group. Group funds allow you to purchase necessary items for park beautification, physical improvement projects and special events. Fundraising often begins in the community you serve. The most important part is to have confidence in the value of your work so that others will see it as well.

When you approach a potential funder, you should have a specific project or program in mind, what you would like them to donate and what they will get in return. Have a plan in writing, including a detailed budget. Consider preparing a Sponsorship Package for businesses with various levels of donations to raise funds for a specific event or series of events. For example, ten local businesses could help fund a summer concert series and have their names displayed on a park banner as well as other promotional materials.

Where and how do we begin fundraising?

- **Individuals:** Don't be afraid to ask family, friends and neighbors for contributions; the worst they can do is say no. Consider a "membership mailing" to the community asking them for a small donation (\$5 - \$25) to become members of the Park Friends group. If people can't donate money, perhaps they can volunteer their time.
- **Community Institutions:** Begin with neighborhood organizations such as religious institutions, banks, colleges and hospitals. Also take note of which groups frequent the park most often since they are already invested in the life of the park.
- **Local Businesses:** Approach all local businesses for cash donations or in-kind services. Sometimes receiving snacks or tools for a workday can be as beneficial as a cash contribution. A clean, safe and vibrant local park provides a positive benefit to their business.
- **Fundraising Events:** Special events are a great way to raise money, to generate publicity, and to have fun in the park. These events can be as varied as the diversity and interests of the community. Fundraising events are also good opportunities for recruiting new volunteers.
- **Government Officials:** Government officials, such as city councilpersons, state representatives, and even members of Congress, have access to funds that may be available for neighborhood projects. They can also help facilitate relationships between your group and grant-making organizations.

## What about grants?

Grant funding may be available from foundations, nonprofit organizations, city, state and national agencies. Before approaching an organization for a grant, you must do some research. Grant-making organizations usually have specific areas of focus, and you must be sure that your project is a good fit for their mission. They may accept proposals only at certain times of the year, and you must follow their guidelines and meet all deadlines. Communicate your intentions to apply for grants to your program partners. As the landowner, PPR must also approve all grant project proposals.

**Align project to an appropriate grant:** Grant-making organizations usually have **specific areas of focus** and you may have to do some searching before finding grants applicable to your park. Make sure that your project fits the grant's mission!

**Be aware of deadlines:** Grant organizations may accept proposals only at certain times of the year, and you must follow their guidelines and meet all deadlines.

**Keep PPR and your community partners in the loop:** Communicate intentions of applying for grants with your community and program partners, they may prove to be a resource in the proposal process! As the landowner, PPR must also approve all grant project proposals. In addition, PPR and your other partners can provide a letter of support to strengthen the application.

### Annual grants available to Park Friends groups

The following two grants are currently available to all Park Friends groups on an annual basis. We strongly recommend you take advantage of these opportunities.

#### Growing the Neighborhood Parks Grant Program

The Fairmount Park Conservancy's Growing the Neighborhood grant program offers funding for park programs and events.

The goal of this grant program is to support and enhance the good work of Park Friends groups to improve the safety, beauty and vibrancy of city parks. Funds raised by the Fairmount Park Conservancy during *Love Your Park Week* make this annual program possible.

This grant is available for Park Friends groups that:

- Are registered with Philadelphia Parks & Recreation (see Section 4)
- Consist of three or more people and have neighborhood-based leadership
- Participate in the Parks Stewardship Program network including Park Friends Network meetings and *Love Your Park* events.

There is an annual application process for FPC's Growing the Neighborhood grant. All registered Friends groups will be notified via email when the grant application is available. Your Stewardship Coordinator will also inform you of this grant opportunity. At your Friends groups meetings, discuss what project ideas and programs you would like to offer so that you are ready when the application becomes available.

## Philadelphia Activities Fund

The Philadelphia Activities Fund, Inc. is a nonprofit corporation that offers financial support to programs and organizations that use educational programming to promote athleticism, value for the arts and healthy living. The Philadelphia Activities Fund's goal is to assist nonprofit organizations in Philadelphia and to serve diverse segments of the community, and Park Friends groups are prime candidates for this fund.

Applications for the Philadelphia Activities Fund Grant are available at city recreation centers, playgrounds, Police Athletic League centers, libraries, City Council offices located in City Hall and the Parks & Recreation Central Office at 1515 Arch Street, 10th Floor.

**Applications timeline:** Available typically sometime in April and are due back in June.

The maximum for all grants is \$6,500. Nonprofit organizations that have received the Philadelphia Cultural Fund Grant and the Anti-Drug Initiative Grant are disqualified from the Philadelphia Activities Grant.

### Additional Grant Resources:

#### **Look to Businesses**

Learn about corporations, banks, utility companies, fuel companies and Philadelphia industries that could have charitable foundations. Their websites give their areas of interest and explain guidelines for the grant-application process. Philadelphia local business directory website:

<http://businessdirectory.bizjournals.com/philadelphia>

#### **Visit Your Local Library**

The Free Library main branch offers access to the Regional Foundation Center (<http://libwww.freelibrary.org/rfc/>) an extensive grant-finding database. This database can connect you to a wide range of potential funding opportunities.

You can also always use a local library computer lab or a KEYSPOT to surf the web for grant-finding sites and anything else you need to accomplish on the internet if you don't have access at your home:

<http://www.phillykeyspots.org/>

#### **Grant Writing: Basic Tips**

When writing a grant proposal, **follow instructions** precisely and **adhere to deadlines**.

Funders may eliminate proposals that do not contain the necessary information or meet their guidelines.

**Supplemental materials** can add credibility to your application.

Supporting information: project costs, letters of recommendation in support of the project, any publicity that your group has received. Please note that every foundation may have different conditions regarding supporting materials.

Gather information before beginning. Here are some **general questions often asked** on grant applications:

- Who is applying for the grant? What is the group's mission?
- What is your group asking for? (Try to be as specific as possible.)
- How will your group accomplish the task? (Be as detailed as possible.)
- Who are the group's partners?
- What is the impact of this project on the community?
- How does your organization evaluate its projects?

### **How do we leverage our resources?**

“Leveraging” is the process of using current resources to gain more resources. In other words, money raised can be used to raise even more money. If your group secures a grant from a foundation or corporation, it serves as an important “stamp of approval” that will help you make your case as you solicit funds from others.

Two examples of leveraging tools are “challenge grants” and “matching funds.” With a challenge grant, one grantor pledges money to your organization with the stipulation that the money will be granted only if your organization can raise a specified amount from other sources. A matching grant awards a specified amount for each dollar raised elsewhere.

Community support is another resource to leverage, and documentation of this support is crucial when making your case to funders. Use statistics from park events and celebrations to make your case. If *you don't count*, you *don't count* in the eyes of potential funders! Keep track of the number of people who use the park daily, who volunteer at workdays or any other figures that can illustrate how much your community values the park. Use the *Monthly Volunteer Hours Registration* form to document your impact.

Section 3: Love Your Park

# LOVE your PARK

Clean, Green & Celebrate Philly Parks



**PHILADELPHIA  
PARKS &  
RECREATION**

**FAIRMOUNT PARK**

**CONSERVANCY**

### *Spring Love Your Park Week*

is an nine-day, city-wide celebration of parks featuring service projects, fun events, educational programs, family activities and more. With the leadership of volunteer Park Friends groups across the city, we kick off the week with a citywide cleanup at 100 parks with 2,000 volunteers.

**Save the date! May 13<sup>th</sup>-21<sup>st</sup>, 2018**

### *Fall Love Your Park Day*

In early-November, 100 volunteer Park Friends groups come out to rake leaves, plant trees and put the parks to bed for the winter.

With the support of Philadelphia Parks & Recreation, all leaves are taken to the Recycling Center to be composted. Together we keep 6 tons of material out of our local landfills!

**Save the Date: November 10<sup>th</sup>, 2018**

**SAVE the DATE**  
**LOVE YOUR PARK WEEK**

**MAY 12-20, 2018**  
**KICK-OFF SERVICE DAY:  
SATURDAY, MAY 12**

Join us for nine days of cleaning, greening and celebrating Philly's parks!  
**LOVEYOURPARK.ORG**

*Save the Date!*

**LOVE your PARK**

**#loveyourpark**

**FALL SERVICE DAY**  
**SAT. NOVEMBER 10, 2018**

**loveyourpark.org**

## Section 4: Supplementary Information and Forms

This section includes the following documents, as valuable tools needed to support your Friends group.

- The **2018 Permit Application Guideline**, to explain the application process step by step.
- The **2018 Special Events Permit Application for Park Friends and Community Groups**. A Special Events permit is required for all organized events in the park. This document is specifically designed for the above user groups that want to host public events in their local park. All permit applications are available to download via the PPR website.
- The **Special Event Liability Application** form. All park events are required to obtain a certificate of insurance naming the City of Philadelphia as additionally insured. Insurance may be purchased through the City's Office of Risk Management using this application form. Registered Friends Groups who do not already have liability insurance are eligible for coverage through Parks and Recreation by submitting this form for every permit application.
- The **Volunteer Service Day Sign-In** is a form your group should utilize for every service day you organize. The sign-in sheet includes PPR's liability waiver, and helps to build your Friends group volunteer contact database.
- The **Meeting Sign-In Form** is a form your group should utilize for every meeting to track attendance and collect any new contact information. It also documents your meeting history.
- The **Monthly Volunteer & Friends Group Activities Tally Sheet** is a form your group should utilize to track the number of hours of service your group donates to the park each month. This is an important tool that can be used for your fundraising efforts because it allows you to put a monetary value to your time. Make sure to share this information with your stewardship coordinator on a monthly basis.

We have also included Police Districts contact information; and City Council contact information. We hope to facilitate communication and encourage you to stay connected with your police district's Community Relations Officer and council representative.



# PHILADELPHIA PARKS & RECREATION

Office of Stewardship 1515 Arch St. – 10th floor  
Philadelphia, PA 19102  
215-683-3679 phone  
215-683-3593 fax  
parksandrecpermits@phila.gov

## Friends & Community Groups Special Event Permit Process

*A step-by-step guide for Friends Groups and local community groups to apply for a permit to host a community event in a Philadelphia Parks & Recreation park.*

*Updated February 2018*

- **Contact** the Stewardship Office to **check for availability of dates** at specific park location(s).
- **Download Friends & Community Groups permit application** from:  
<http://www.phila.gov/ParksandRecreation/aboutus/Pages/PermitsandForms.aspx>
- **Complete** the permit application and **submit with the \$25 application fee** to the Stewardship Office by mail or in person.
- **Community groups** must also submit a **security deposit** (the deposit is waived for registered Friends Groups).
- If city support services are requested, those fees should also be included at the time of application. **No services will be scheduled until payment is received.**
- **To schedule the Showmobile**, contact Barry Bessler for availability at Barry.Bessler@phila.gov or (215) 683-0203. A separate invoice will be issued for use of the Showmobile.
- **A series of like events** can be applied to an **individual permit with one application fee.** To qualify as a series, each event **must have the same name** (ex. Summer Jazz Nights).
- **It is the event organizer's responsibility to secure any additional permits, approvals or services from other departments in City government.** Contact information for these

agencies is included in the Friends and Community Groups permit application resource packet at: <http://www.phila.gov/ParksandRecreation/aboutus/Pages/PermitsandForms.aspx>

- **If approved** you will be issued a permit prior to your event.
- **Event organizer should inform the Stewardship Office if you need to cancel your event due to weather or other circumstances.**
- **Event organizer should have both** the Friends & Community Groups permit as well as the insurance certificate **on hand during the scheduled event.**

### **Insurance is required for all events:**

- **All events are required to submit a certificate of insurance** with minimum limits of \$1,000,000 per occurrence naming the City of Philadelphia as additionally insured to the Stewardship Office **with the permit application.**
- **Insurance may be purchased through the City's Office of Risk Management.** Insurance applications must be submitted **with your permit application** and are found in the Friends and Community Groups permit application resource packet at: <http://www.phila.gov/ParksandRecreation/aboutus/Pages/PermitsandForms.aspx>
- **Registered Friends Groups** who do not have insurance **are eligible for coverage through Parks & Recreation;** however an **insurance application must be completed for every permit application.**
- **A Certificate of Insurance will be mailed to the event organizer directly from the Office of Risk Management.**

## EVENT PERMIT APPLICATION FOR FRIENDS AND COMMUNITY GROUPS



PHILADELPHIA  
PARKS & RECREATION

**Jim Kenney**  
Mayor  
City of Philadelphia

**Kathryn Ott Lovell**  
Commissioner  
Philadelphia Parks & Recreation

# Philadelphia Parks & Recreation

## Event Permit Application

### Friends and Community Groups

# 2018



*Movie Night Series at Penn Treaty Park*

Updated February 2018

Please email [parksandrecpermits@phila.gov](mailto:parksandrecpermits@phila.gov)  
with questions about your event.

**Philadelphia Parks & Recreation**  
Office of Stewardship  
1515 Arch Street, 10<sup>th</sup> Floor  
Philadelphia, PA 19102  
215-683-3679  
[www.phila.gov/ParksandRecreation](http://www.phila.gov/ParksandRecreation)

This application is intended for the exclusive use of *"Friends of Park"* groups and community groups conducting non-ticketed public events with fewer than 1,000 attendees. This application should not be used for athletic events such as races, walks, 5K runs, yoga, or soccer.

1. **"Friends of Park" groups** are those park volunteer groups officially registered with the Philadelphia Parks & Recreation Stewardship Office.
2. **Community Groups** are any agency or organization whose primary mission is to support the general business, commercial or residential interests of the community surrounding the PPR property, (e.g. community development organizations, churches, civic associations, school groups, town watches, and other similar organizations).

**All other entities must submit an *"Events and Festival"* application, also available on our website.**



# EVENT PERMIT APPLICATION FOR FRIENDS AND COMMUNITY GROUPS

Complete this application, sign and submit to the Office of Stewardship along with a **\$25 application fee made payable to "Philadelphia Parks & Recreation"** at least 30 days in advance of the planned event. Applications submitted **less than 30 days prior to the event require an application fee of \$50**. NO applications will be accepted less than 10 days prior to an event. Application fees are non-refundable.

## Event Information

Event Name \_\_\_\_\_ Estimated Attendance \_\_\_\_\_

Park Name \_\_\_\_\_ Exact Location in the park \_\_\_\_\_

Detailed description of the event \_\_\_\_\_

Which of the following terms best describe your event? (check all that apply)  Music  Movie  Family  Concert Series  Cultural  Holiday  Market  Other

## Organizational Information

Name of Friends or Community Group \_\_\_\_\_ Organizational Phone Number ( \_\_\_\_\_ )

Official Organizational Mailing Address \_\_\_\_\_

City \_\_\_\_\_ State \_\_\_\_\_ ZIP \_\_\_\_\_

Is your organization a registered non-profit organization?  Yes  No

## Event Contact Information

Event Coordinator Name (Coordinator will be on site the day of event) \_\_\_\_\_

Daytime Phone Number ( \_\_\_\_\_ ) Cell Phone ( \_\_\_\_\_ )

Email address \_\_\_\_\_ Fax Number ( \_\_\_\_\_ )

## Requested Schedule

Day(s) and Date(s) of event \_\_\_\_\_ Rain date request\* \_\_\_\_\_

Setup Time Start \_\_\_\_\_ Event Start Time \_\_\_\_\_ Event Finish Time \_\_\_\_\_ Breakdown Time End \_\_\_\_\_

## Additional Information

Will you be renting portable toilets?  Yes  No (All portable toilets must be placed on cement surfaces) If yes, how many? \_\_\_\_\_

Will you be selling or distributing food or merchandise at the event?  Yes  No

Do you plan on using amplified sound?  Yes  No

If yes, please reference the **Other Agencies and Services** section on page 4 of the application *Amplified sound is subject to the City of Philadelphia Noise Ordinance. Amplified sound is not permitted before 9 am or after 9 pm and is limited to no more than six hours. PPR does not provide sound systems. Sound cannot leave the boundaries of the park. Speakers must be turned away from residences. Use of amplified sound may impact the cost of insurance.*

\*Applicant may indicate one rain date per event. Rain dates for Saturdays must be the next day. Applicant will be notified if the proposed rain date is not available.



# EVENT PERMIT APPLICATION FOR FRIENDS AND COMMUNITY GROUPS

## SECURITY DEPOSIT AND STAFF SUPPORT SERVICES

Special Events may require professional support services. These services, along with related fees, are outlined below. Fees for the selected services must be submitted at the same time as the application fee and, if you are a Community group, the security deposit. Please check the box for any service(s) required for your special event. **All staff support services are optional. Payment must be received at the time of application in order to schedule any staff services.**

### Cancellation Policy

All cancellations or reschedules for reasons other than weather must be made at least 48 hours in advance of the date of the event.

### Required Security Deposit for Community Groups

A security deposit is required for events being hosted by community groups. It is fully refundable upon successful post-event cleanup and no report of damages. The fee is determined by the scope of your event. Refunds will be issued within 60 days of your event. Please check the appropriate rate for your event where any of the listed criteria apply.

<input type="checkbox"/> <b>Permit Level 1: \$250 security deposit:</b>	<input type="checkbox"/> <b>Permit Level 2: \$500 security deposit:</b>	Amount included
<ul style="list-style-type: none"> <li>Fewer than 200 people</li> <li>No performance staging</li> </ul>	<ul style="list-style-type: none"> <li>200 people or more</li> <li>Performance Staging</li> </ul>	\$

### Electricity Services (optional)

Weeknights & Saturdays	Sundays	Requested Days & Times for PPR-provided electricity	Amount included
<ul style="list-style-type: none"> <li>Up to four (4) hours = <b>\$180</b> <i>Maximum 3-hour event</i></li> <li>Over 4 hours = <b>\$360</b> <i>For up to two consecutive days</i></li> </ul>	<ul style="list-style-type: none"> <li>Up to four (4) hours = <b>\$240</b> <i>Maximum 3-hour event</i></li> <li>Over 4 hours = <b>\$480</b> <i>For up to two consecutive days</i></li> </ul>		\$

### Grounds Maintenance Fees (optional)

Weeknights & Saturdays	Sundays	Requested Days & Times for PPR-provided maintenance	Amount included
Up to 4 hours = \$160 Over 4 hours = \$320	Up to 4 hours = \$215 Over 4 hours = \$430		\$

*For official PPR staff use only – Checks Received*

Check#		Amount	
Check#		Amount	
		Total Received	



## EVENT PERMIT APPLICATION FOR FRIENDS AND COMMUNITY GROUPS RULES & REGULATIONS

Please initial next to every item to signify that you agree to the terms & conditions.

- Permit fees are non-refundable and permits are non-transferable (to future dates or other user groups). Cancellations must be reported promptly. Failure to use the Park or report cancellations will result in revocation of the permit.
- Permit-holders are required to KEEP PERMIT WITH THEM AT ALL TIMES DURING PARK USE.
- Applicant shall submit a Certificate of Insurance evidencing General Liability insurance covering the use of City property with minimum limits of \$1,000,000 per occurrence, naming the City of Philadelphia, its officers, employees and agents as additional insured's on the General Liability policy.
- AUTHORIZED GROUP REPRESENTATIVE MUST OVERSEE THE EVENT FROM START TO FINISH. The authorized representative(s) will remain until all participants and vendors have left and all trash has been collected and properly removed.
- Permit-holder must leave the property in the same degree of cleanliness as found. Permit-holder shall be responsible for enforcement of this requirement on its guests and/or invitees.
- AUTHORIZED REPRESENTATIVE IS RESPONSIBLE TO PROVIDE HEAVY-DUTY TRASH BAGS FOR THE EVENT and to ensure proper cleanup after the event. Bagged trash may be placed next to any park trash receptacle or otherwise pre-designated area.
- VEHICLES ARE NOT PERMITTED IN THE PARK. If heavy materials or equipment must be taken into the park for an event, you must get APPROVAL IN ADVANCE and it must be noted on the permit. If approved, vehicle may enter for loading and unloading purposes ONLY and must be on paved areas. NO VEHICLES ARE PERMITTED ON THE GRASS AT ANY TIME.
- USE OF SOUND AMPLIFICATION EQUIPMENT MUST BE APPROVED IN ADVANCE and VOLUME LEVELS MUST BE RESPECTFUL OF NEIGHBORING RESIDENCES. PP&R, or their duly authorized representative including the Police Department, has the authority to determine the appropriate volume level of equipment. All sound equipment must be directed away from private residences.
- PPR cannot provide portable restrooms for your event, however bathrooms facilities should be considered in your event planning. Do not place toilets on grass. Use pathways and sidewalks.
- BARBEQUING is permitted in the park, however coals/briquettes must be disposed of properly. Do not dump coals on the grass or sidewalks.
- LOUD, VULGAR, CONFRONTATIONAL LANGUAGE is not permitted on facility grounds or in its immediate vicinity. Permit-holder is fully responsible for conduct of all spectators, as well as participants, and will be required to provide identifiable adult supervision/security upon request by Parks & Recreation personnel.
- ALCHOLIC BEVERAGES ARE PROHIBITED in all areas of Park and Recreation facilities and grounds
- No tobacco product may be used on any land or facility under the jurisdiction of PPR and the permit holder is responsible to ensure that all event participants and spectators are in compliance throughout the time of the event(s).
- I will notify the stewardship office of any postponement due to inclement weather by 9:00pm the night before the date of the event. Philadelphia Parks & Recreation reserves the right to cancel an event due to weather.

Event Coordinator  
Signature

\_\_\_\_\_ Date \_\_\_\_\_

Name (Print)

\_\_\_\_\_ Title / Position \_\_\_\_\_

# Insurance & Other Services

## Insurance

**All events are required to obtain a certificate of insurance with minimum limits of \$1,000,000 per occurrence**, naming the City of Philadelphia, its officers, employees and agents as additional insured. Applicants must submit insurance application with permit application.

## Other Agencies and Services

**Please note:** Any event may require additional permits, approvals or services from other departments in City government. Listed below is contact information for the various services that may be required.

- **Health Department – Office of Food Protection** 215-685-7490  
[www.phila.gov/health/foodprotection](http://www.phila.gov/health/foodprotection). Any event planning to distribute, sell or sample food must get a Health Department permit.
- **Licenses & Inspections – 3-1-1 Call Center** [www.phila.gov/li](http://www.phila.gov/li)  
Any event with tents\*, vendors, sales, structures or generators of any kind must have a permit or license from The Department of Licenses and Inspections. \* Any single tent or canopy measuring over 100 square feet (10' x 10') requires a permit from the city of Philadelphia's Department of Licenses and Inspections.
- **Police - we recommend that you share event information with your local police district.**
- **Showmobile** - For information about the Showmobile, you must contact Barry Bessler at (215) 683-0203 or [Barry.Bessler@phila.gov](mailto:Barry.Bessler@phila.gov). A separate invoice will issued for use of the Showmobile.
- **Philadelphia Parks & Recreation Approved Food Vendors**  
Contact the Office of Stewardship at (215) 683-3679 for a current list of licensed food vendors approved by Philadelphia Parks & Recreation



**SPECIAL EVENT LIABILITY APPLICATION**

**A. INSURED INFORMATION**

1. Insured Company Name (Applicant): \_\_\_\_\_
2. Contact Name: \_\_\_\_\_
3. Address: \_\_\_\_\_
4. City: \_\_\_\_\_ State: \_\_\_\_\_ Zip Code: \_\_\_\_\_
5. Phone: \_\_\_\_\_ Fax: \_\_\_\_\_ E-mail: \_\_\_\_\_

**B. EVENT INFORMATION (Attach a copy of event brochure and/or flyer to this Application)**

6. Event Name: \_\_\_\_\_  
Event Website: \_\_\_\_\_  
Event Description: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
7. Venue Name: \_\_\_\_\_  
Venue Address: \_\_\_\_\_  
City/State/Zip Code: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_
8. Event Start Date: \_\_\_\_\_ Event End Date: \_\_\_\_\_
9. Coverage Start Date: \_\_\_\_\_ Coverage End Date: \_\_\_\_\_  
  
If the coverage start date is more than 5 days before the event start date OR the coverage end date is more than 5 days after the event end date, please explain:  
  
\_\_\_\_\_  
\_\_\_\_\_
10. Is the Event Outdoors? Yes No
11. How many years has this event be held under the present management (if never, enter 0)? \_\_\_\_\_
12. During this time has the insured had any claims regarding this event? Yes No

If Yes, please provide amount of loss and details regarding the incident(s):

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13. Type of Event: \_\_\_\_\_

14. If Concert, please provide Name of Performer(s):

---

15. Is seating assigned? : Yes No

16. Please describe event type:

---



---



---

**(Event description details are required. Please provide a complete description of events and activities associated with the insured event. The more comprehensive the information provided, the quicker the quote process will be).**

17. Maximum Daily Attendance: \_\_\_\_\_ Total Attendance: \_\_\_\_\_

Gross Revenue: \$ \_\_\_\_\_ Expenses: \$ \_\_\_\_\_

18. Will any of the events include any of the following? Please check all that apply indicating whether the applicant, vendor, or subcontractor will be the responsible party.

	<b>Applicant</b>	<b>Vendor/Exhibitor</b>	<b>Subcontractor</b>
Aircraft	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Animals (other than pet contests)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Camping	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cattle Drives	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Childcare Operations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Firearms or Ammunition	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fireworks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Food Vendor	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Inflatables	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Knives/Cutlery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Mechanical Amusement Rides	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Motorsports	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Open Water Exposure	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Paintball	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Parade	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rock Climbing Walls	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rodeos	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tattooing/Body Piercing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Temporary skating/skiing/skateboarding structures	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Trail Rides	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

19. Do you require all Vendors/Exhibitors managing any of the above indicted activities to have their own liability insurance in place listing you as Additional Insured? Yes No
20. Will any of the events occur in a bar or nightclub? Yes No  
If Yes, are those events occurring in a bar of nightclub open to the public? Yes No
21. Does the applicant hire any subcontractors for these insured event(s)? Yes No
22. Do these subcontractors carry their own insurance naming you as Additional Insured? Yes No
23. Will there be security at the insured event(s)? Yes No
24. Who is responsible for providing the security? Venue Applicant Other  
If Other: Does the security company carry its own insurance naming you as Additional Insured?  
Yes No  
If No, please explain: \_\_\_\_\_
25. Required Limits:  
 \$1M Per Occurrence / \$2M Aggregate  
 \$2M Per Occurrence / \$2M Aggregate  
 \$3M Per Occurrence / \$3M Aggregate  
 \$4M Per Occurrence / \$4M Aggregate  
 \$5M Per Occurrence / \$5M Aggregate

If larger limits are required, please specify: \_\_\_\_\_

**C. LIQUOR LIABILITY COVERAGE:**

\* Please note, if Insured is not either serving or selling the liquor, the additional liquor coverage is NOT required. Host Liquor Liability is provided in the standard General Liability policy.

26. Is Liquor Liability Required? Yes No (If Yes, please fill out section below)

Will alcohol be served by a licensed bartender? Yes No

If No, who will be serving the alcohol? \_\_\_\_\_

Describe training and/or experience of persons serving the alcohol: \_\_\_\_\_  
\_\_\_\_\_

Average age of attendees: \_\_\_\_\_

What measures are in place to prevent the service of alcohol to minor and/or intoxicated persons?  
\_\_\_\_\_  
\_\_\_\_\_

Does the Applicant have a valid liquor license? Yes No

Will there be an open bar? Yes No

Will alcohol be sold by the drink? Yes No

Is BYOB (bring your own bottle) allowed? Yes No

Estimated alcohol gross receipts? \$ \_\_\_\_\_

**D. HIRED/NON-OWNED AUTO COVERAGE:**

27. Is Hired/Non-Owned Auto Required? Yes No (If Yes, please fill out section below)

Check here if you are required by contract to acquire Hired/Non-Owned Auto **and you are not being loaned, rented or leased any vehicles** (If checked, please do not complete the rest of this section)

Amount being charged to rent or lease the vehicle(s) \$ \_\_\_\_\_

Are all drivers at least 25 years of age? Yes No

Do all drivers have a valid United States driver's license? Yes No

Do any of the hired vehicles seat more than 12 people? Yes No

What will the vehicles be used for? \_\_\_\_\_

**E. ADDITIONAL INSURED(S):**

28. Are Additional Insured(s) Required? Yes No (If Yes, please fill out section below)

1. Additional Insured Name: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_

State: \_\_\_\_\_

Zip: \_\_\_\_\_

2. Additional Insured Name: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_

State: \_\_\_\_\_

Zip: \_\_\_\_\_

**F. WAIVER OF SUBROGATION:**

29. Does your contract require a "waiver of subrogation"? Yes No (If Yes, please fill out section below)

What is the name of the entity requesting the waiver of subrogation? \_\_\_\_\_

\_\_\_\_\_

What is their involvement in the event? \_\_\_\_\_

\_\_\_\_\_

**G. INLAND MARINE COVERAGE:**

30. Is Inland Marine coverage required? Yes No (If Yes, please fill out section below)

What type of property do you need coverage for? \_\_\_\_\_

\_\_\_\_\_

What is the value for this property? \$ \_\_\_\_\_

Will the property be stored overnight? Yes No

If Yes, please provide details on how it will be stored: \_\_\_\_\_

\_\_\_\_\_

Will the Insured be responsible for transporting the property? Yes No

If Yes, please describe how it is transported: \_\_\_\_\_

\_\_\_\_\_

If No, who is transporting the property: \_\_\_\_\_

Will the property stay in the possession of the Insured at all times prior to returning to rental company?

Yes No

If No, please explain: \_\_\_\_\_

\_\_\_\_\_

**NOTICE TO APPLICANTS:** ANY PERSON WHO KNOWINGLY AND WITH INTENT TO DEFRAUD ANY INSURANCE COMPANY OR OTHER PERSON FILES AN APPLICATION FOR INSURANCE OR STATEMENT OF CLAIM CONTAINING ANY MATERIALLY FALSE INFORMATION OR, CONCEALS, FOR THE PURPOSE OF MISLEADING, INFORMATION CONCERNING ANY FACT MATERIAL THERETO, COMMITS A FRAUDULENT ACT, WHICH IS A CRIME AND MAY SUBJECT SUCH PERSON TO CRIMINAL AND CIVIL PENALTIES.

**NOTICE TO ARKANSAS AND NEW MEXICO APPLICANTS:** ANY PERSON WHO KNOWINGLY PRESENTS A FALSE OR FRAUDULENT CLAIM FOR PAYMENT OF A LOSS OR BENEFIT, OR KNOWINGLY PRESENTS FALSE INFORMATION IN AN APPLICATION FOR INSURANCE IS GUILTY OF A CRIME AND MAY BE SUBJECT TO FINES AND CONFINEMENT IN PRISON.

**NOTICE TO COLORADO APPLICANTS:** IT IS UNLAWFUL TO KNOWINGLY PROVIDE FALSE, INCOMPLETE, OR MISLEADING FACTS OR INFORMATION TO AN INSURANCE COMPANY FOR THE PURPOSE OF DEFRAUDING OR ATTEMPTING TO DEFRAUD THE COMPANY. PENALTIES MAY INCLUDE IMPRISONMENT, FINES, DENIAL OF INSURANCE, AND CIVIL DAMAGES. ANY INSURANCE COMPANY OR AGENT OF AN INSURANCE COMPANY WHO KNOWINGLY PROVIDES FALSE, INCOMPLETE, OR MISLEADING FACTS OR INFORMATION TO A POLICYHOLDER OR CLAIMANT FOR THE PURPOSE OF DEFRAUDING OR ATTEMPTING TO DEFRAUD THE POLICYHOLDER OR CLAIMANT WITH REGARD TO A SETTLEMENT OR AWARD PAYABLE FROM INSURANCE PROCEEDS SHALL BE REPORTED TO THE COLORADO DIVISION OF INSURANCE WITHIN THE DEPARTMENT OF REGULATORY AUTHORITIES

**NOTICE TO DISTRICT OF COLUMBIA APPLICANTS:** WARNING: IT IS A CRIME TO PROVIDE FALSE OR MISLEADING INFORMATION TO AN INSURER FOR THE PURPOSE OF DEFRAUDING THE INSURER OR ANY OTHER PERSON. PENALTIES INCLUDE IMPRISONMENT AND/OR FINES. IN ADDITION, AN INSURER MAY DENY INSURANCE BENEFITS IF FALSE INFORMATION MATERIALLY RELATED TO A CLAIM WAS PROVIDED BY THE APPLICANT.

**NOTICE TO FLORIDA APPLICANTS:** ANY PERSON WHO KNOWINGLY AND WITH INTENT TO INJURE, DEFRAUD, OR DECEIVE ANY INSURER FILES A STATEMENT OF CLAIM OR AN APPLICATION CONTAINING ANY FALSE, INCOMPLETE OR MISLEADING INFORMATION IS GUILTY OF A FELONY IN THE THIRD DEGREE.

**NOTICE TO KENTUCKY APPLICANTS:** ANY PERSON WHO KNOWINGLY AND WITH INTENT TO DEFRAUD ANY INSURANCE COMPANY OR OTHER PERSON FILES AN APPLICATION FOR INSURANCE CONTAINING ANY MATERIALLY FALSE INFORMATION, OR CONCEALS FOR THE PURPOSE OF MISLEADING, INFORMATION CONCERNING ANY FACT MATERIAL THERETO, COMMITS A FRAUDULENT INSURANCE ACT, WHICH IS A CRIME.

**NOTICE TO LOUISIANA APPLICANTS:** ANY PERSON WHO KNOWINGLY PRESENTS A FALSE OR FRAUDULENT CLAIM FOR PAYMENT OF A LOSS OR BENEFIT OR KNOWINGLY PRESENTS FALSE INFORMATION IN AN APPLICATION FOR INSURANCE IS GUILTY OF A CRIME AND MAY BE SUBJECT TO FINES AND CONFINEMENT IN PRISON.

**NOTICE TO MAINE APPLICANTS:** IT IS A CRIME TO KNOWINGLY PROVIDE FALSE, INCOMPLETE OR MISLEADING INFORMATION TO AN INSURANCE COMPANY FOR THE PURPOSE OF DEFRAUDING THE COMPANY. PENALTIES MAY INCLUDE IMPRISONMENT, FINES OR A DENIAL OF INSURANCE BENEFITS.

**NOTICE TO NEW JERSEY APPLICANTS:** ANY PERSON WHO INCLUDES ANY FALSE OR MISLEADING INFORMATION ON AN APPLICATION FOR AN INSURANCE POLICY IS SUBJECT TO CRIMINAL AND CIVIL PENALTIES.

**NOTICE TO NEW YORK APPLICANTS:** ANY PERSON WHO KNOWINGLY AND WITH INTENT TO DEFRAUD ANY INSURANCE COMPANY OR OTHER PERSON FILES AN APPLICATION FOR INSURANCE OR STATEMENT OF CLAIM CONTAINING ANY MATERIALLY FALSE INFORMATION, OR CONCEALS FOR THE PURPOSE OF MISLEADING, INFORMATION CONCERNING ANY FACT MATERIAL THERETO, COMMITS A FRAUDULENT INSURANCE ACT, WHICH IS A CRIME, AND SHALL ALSO BE SUBJECT TO A CIVIL PENALTY NOT TO EXCEED FIVE THOUSAND DOLLARS AND THE STATED VALUE OF THE CLAIM FOR EACH SUCH VIOLATION.

**NOTICE TO OHIO APPLICANTS:** ANY PERSON WHO, WITH INTENT TO DEFRAUD OR KNOWING THAT HE IS FACILITATING A FRAUD AGAINST AN INSURER, SUBMITS AN APPLICATION OR FILES A CLAIM CONTAINING A FALSE OR DECEPTIVE STATEMENT IS GUILTY OF INSURANCE FRAUD.

**NOTICE TO OKLAHOMA APPLICANTS: WARNING:** ANY PERSON WHO KNOWINGLY, AND WITH INTENT TO INJURE, DEFRAUD OR DECEIVE ANY INSURER, MAKES ANY CLAIM FOR THE PROCEEDS OF AN INSURANCE POLICY CONTAINING ANY FALSE, INCOMPLETE OR MISLEADING INFORMATION IS GUILTY OF A FELONY (365:15-1-10, 36 §3613.1).

**NOTICE TO PENNSYLVANIA APPLICANTS:** ANY PERSON WHO KNOWINGLY AND WITH INTENT TO DEFRAUD ANY INSURANCE COMPANY OR OTHER PERSON FILES AN APPLICATION FOR INSURANCE OR STATEMENT OF CLAIM CONTAINING ANY MATERIALLY FALSE INFORMATION OR CONCEALS FOR THE PURPOSE OF MISLEADING, INFORMATION CONCERNING ANY FACT MATERIAL THERETO COMMITS A FRAUDULENT INSURANCE ACT, WHICH IS A CRIME AND SUBJECTS SUCH PERSON TO CRIMINAL AND CIVIL PENALTIES.

**NOTICE TO TENNESSEE AND VIRGINIA APPLICANTS:** IT IS A CRIME TO KNOWINGLY PROVIDE FALSE, INCOMPLETE OR MISLEADING INFORMATION TO AN INSURANCE COMPANY FOR THE PURPOSE OF DEFRAUDING THE COMPANY. PENALTIES INCLUDE IMPRISONMENT, FINES AND DENIAL OF INSURANCE BENEFITS.

### DECLARATION

To the best of my knowledge and belief the information provided in this application, whether in my own hand or not, is true and I have not withheld any material facts. I understand that non-disclosures or misrepresentation of a material fact will entitle the company to void the Insurance. I understand that signing this Application does not bind me to complete the insurance but agree that should an insurance policy be issued, this Application and the statements made therein shall form the basis of the insurance policy.

\_\_\_\_\_  
PRINT NAME OF APPLICANT

\_\_\_\_\_  
TITLE

\_\_\_\_\_  
SIGNATURE OF APPLICANT

\_\_\_\_\_  
DATE

\_\_\_\_\_  
SIGNATURE OF BROKER

\_\_\_\_\_  
DATE







For event planning purposes, we recommend contacting your local police headquarters and informing the Community Relations Office (CRO) of your event plans. All information available at [www.phillypolice.com/districts](http://www.phillypolice.com/districts)



**1st District**

24th St. and Wolf St.  
[police.co\\_01@phila.gov](mailto:police.co_01@phila.gov)  
215-686-3010

**2nd District**

Harbison Ave. and Levick St.  
[police.co\\_02@phila.gov](mailto:police.co_02@phila.gov)  
215-686-3020

**3rd District**

11th St and Wharton St.  
[police.co\\_03@phila.gov](mailto:police.co_03@phila.gov)  
215-686-3030

**5th District**

Ridge Ave and Cinnaminson St.  
[police.co\\_05@phila.gov](mailto:police.co_05@phila.gov)  
215-686-3050

**6th District**

235 N 11th St.  
[police.co\\_06@phila.gov](mailto:police.co_06@phila.gov)  
215-686-3060

**7th District**

Bustleton Ave. and Bowler St.  
[police.co\\_07@phila.gov](mailto:police.co_07@phila.gov)  
215-686-3070

**8th District**

Academy Rd. and Red Lion Rd.  
[police.co\\_08@phila.gov](mailto:police.co_08@phila.gov)  
215-686-3080

**9th District**

401 N. 21st St.  
[police.co\\_09@phila.gov](mailto:police.co_09@phila.gov)  
215-686-3090

**12th District**

65th St. and Woodland Ave.  
[police.co\\_12@phila.gov](mailto:police.co_12@phila.gov)  
215-686-3120

**14th District**

Haines St & Germantown Ave.  
[police.co\\_14@phila.gov](mailto:police.co_14@phila.gov)  
215-686-3140

**15th District**

Harbison Ave and Levick St.  
[police.co\\_15@phila.gov](mailto:police.co_15@phila.gov)  
215-686-3150

**16th District**

39th St and Lancaster Ave.  
[police.co\\_16@phila.gov](mailto:police.co_16@phila.gov)  
215-686-3160

**17th District**

20th St and Federal St.  
[police.co\\_17@phila.gov](mailto:police.co_17@phila.gov)  
215-686-3170

**18th District**

55th St and Pine St.  
[police.co\\_18@phila.gov](mailto:police.co_18@phila.gov)  
215-686-3180

**19th District**

61st St and Thompson St.  
[police.co\\_19@phila.gov](mailto:police.co_19@phila.gov)  
215-686-3190

**22nd District**

17th St and Montgomery Ave.  
[police.co\\_22@phila.gov](mailto:police.co_22@phila.gov)  
215-686-3220

**24th District**

3901 Whitaker Ave.  
[police.co\\_24@phila.gov](mailto:police.co_24@phila.gov)  
215-686-3240

**25th District**

3901 Whitaker Ave.  
[police.co\\_25@phila.gov](mailto:police.co_25@phila.gov)  
215-686-3250

**26th District**

E. Girard Ave & Montgomery Ave  
[police.co\\_26@phila.gov](mailto:police.co_26@phila.gov)  
215-686-3260

**35th District**

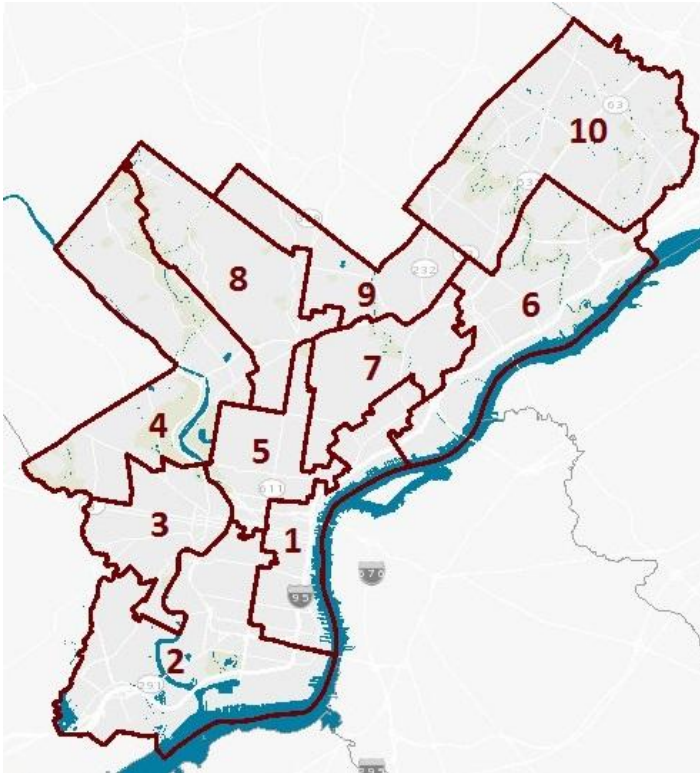
N Broad St and Champlost St.  
[police.co\\_35@phila.gov](mailto:police.co_35@phila.gov)  
215-686-3350

**39th District**

2201 W. Hunting Park Ave.  
[police.co\\_39@phila.gov](mailto:police.co_39@phila.gov)  
215-686-3390

# Philadelphia City Council Members

Refer to page 16 of your Toolkit for information on building relationships with City Council



## Philadelphia County District Map

1. Locate Your Park
2. The # on the map tells indicates the Council District.
3. Match the District # with your Council Person!

Or visit [www.phlcouncil.com](http://www.phlcouncil.com)  
Click on "Find my Council Member" near the bottom of the Homepage.



### Mark Squilla

#### District 1

City Hall, Room 332  
Philadelphia, PA 19107  
(215) 686-3458  
(215) 686-3459  
FAX: (215) 686-1931



### Kenyatta Johnson

#### District 2

City Hall, Room 580  
Philadelphia, PA 19107  
(215)686-3412  
(215)686-3413  
FAX: (215)686-1932



### Jannie Blackwell

#### District 3

City Hall, Room 408  
Philadelphia, PA 19107  
(215) 686-3418  
(215) 686-3419  
FAX: (215) 686-1933



### Curtis Jones, Jr.

#### District 4

City Hall Room 404  
Philadelphia, PA 19107  
(215) 686-3416  
(215) 686-3417  
FAX: (215) 686-1934



**Darrell L. Clarke**  
**District 5**  
**Council President**  
City Hall, Room 313  
Philadelphia, PA 19107  
(215) 686-3442  
(215) 686-3443  
FAX: (215) 686-1901



**Bobby Henon**  
**District 6**  
City Hall, Room 484  
Philadelphia, PA 19107  
(215) 686-3444  
(215) 686-3445  
FAX: (215) 686-1935



**Maria D. Quiñones-Sánchez**  
**District 7**  
City Hall, Room 319A  
Philadelphia, PA 19107  
(215) 686-3448  
(215) 686-3449  
FAX: (215) 686-1936



**Cindy Bass**  
**District 8**  
City Hall, Room 312  
Philadelphia, PA 19107  
(215) 686-3424  
(215) 686-3425  
FAX: (215) 686-1937



**Cherelle Parker**  
**District 9**  
City Hall, Rom 577/584  
Philadelphia, PA 19107  
(215) 686-3454  
(215) 686-3455  
FAX: (215) 686-1938



**Brian J. O'Neill**  
**District 10**  
City Hall, Room 562  
Philadelphia, PA 19107  
(215) 686-3422  
(215) 686-3423  
FAX: (215) 686-1939

## City Council At-Large

Philadelphia has 7 City Council members who serve At-Large, meaning they represent the entire city. Contact them, as well, for support, services, and your special events!



**Blondell Reynolds Brown**

**Majority Whip**

City Hall, Room 581  
Philadelphia, PA  
19107

(215) 686-3438

(215) 686-3439

FAX: (215) 686-1926



**Allan Domb**

City Hall, Room 316  
Philadelphia, PA 19107

(215) 686-3414

(215) 686-3415

FAX: (215) 686-1928



**Derek Green**

City Hall, Room 594  
Philadelphia, PA 19107

(215) 686-3450

(215) 686-3451

FAX: (215) 686-2013



**William K. Greenlee**

City Hall, Room 508  
Philadelphia, PA 19107

(215) 686-3446

(215) 686-3447

FAX: (215) 686-1927



**Helen Gym**

City Hall, Room 592  
Philadelphia, PA 19107

(215) 686-3420

(215) 686-3421

FAX: (215) 686-1930



**David Oh**

City Hall, Room 319  
Philadelphia, PA 19107

(215) 686-3452

(215) 686-3453

Fax: (215) 686-1925



**Al Taubenberger**

City Hall, Room  
582/586

Philadelphia, PA 19107

(215) 686-3440

(215) 686-3441

Fax: (215) 686-1929

We hope that you have found this information helpful. As the *Parks Stewardship Program* continues to develop, we will update and revise this toolkit. Please feel free to reach out to the Parks & Rec Stewardship Office with any questions.

Philadelphia Parks & Recreation  
Office of Stewardship  
1515 Arch Street, 10<sup>th</sup> floor  
Philadelphia, PA 19102  
Elisa Ruse-Esposito  
Tel: (215) 683-3679  
Email: [Elisa.Ruse-Esposito@phila.gov](mailto:Elisa.Ruse-Esposito@phila.gov)

**Township Wide Stormwater and BMP Recommendation**

Priority <sup>1</sup>	SWM & BMP Recommendations	Spring	Summer	Fall	Winter	Who could implement? <sup>2</sup>	Private Property	Township Land	Institutional Land	Programming	Other
<b>Limit Introduction of Soaps, Fertilizer and Other Chemicals</b>											
1	Educate residents about phosphorous free soaps. Organize giveaways of sample size at Twp events.					EAB					
1	Educate residents about fertilizers and herbicides. Encourage lawn reduction.					EAB, STC					
<b>Reduce the Goose Population</b>											
1	Educate residents about the role geese play in water pollution. Encourage them not to feed or welcome them.					EAB					
1	Reduce mowed lawn areas. Plant more trees, shrubs, and tall grasses.					Staff, EAB, STC					
3	Consider more aggressive management techniques such as addling, dogs or decoys.					Staff or Contractor					
<b>Increase Dissolved Oxygen</b>											
1	Provide shade over water by planting riparian buffers along streams and pond edges.					Staff, EAB, STC, Volunteers					
2	Educate residents about the role of animal waste (dogs and geese).					EAB					
3	Install aquatic plants and aerators in ponds.					Contractors					
<b>Reduce Sediment Levels in Water System</b>											
3	Retrofit existing basins with forebays					Staff, consultants and contractors					
1	Implement riparian buffers along streams					Staff, STC, EAB					
1	Educate and encourage residents to disconnect their downspouts and redirect water away from the public sewer system					EAB					

**Township Wide Stormwater and BMP Recommendation**

<b>Priority<sup>1</sup></b>	<b>SWM &amp; BMP Recommendations</b>	<b>Spring</b>	<b>Summer</b>	<b>Fall</b>	<b>Winter</b>	<b>Who could implement?<sup>2</sup></b>	<b>Private Property</b>	<b>Township Land</b>	<b>Institutional Land</b>	<b>Programming</b>	<b>Other</b>
1	Educate residents about stormwater management and stream health					Staff, EAB					
2	Create demonstration rain gardens in parks, with educational signage and programming					Staff, EAB, STC, Volunteers, Contractors					
2	Identify partner organizations or sponsor a program which designs and implements rain gardens on residential properties					Staff, EAB, Consultants, Contractors					
2	Identify partners or sponsr programs which provide rain barrels to residents					Staff, EAB, Partner Orgs					
1	Encourage residents to plant more trees on their properties, to absorb stormwater					STC, EAC					
2	Create Friends Groups for each park, or township wide, with an emphasis on water quality, quantity and stewardship					EAC, Staff					
3	Install and maintain a limited number of inlet filter bags					Staff or Contractor					

McCarthy Park Stormwater and BMP Recommendation						
Priority <sup>1</sup>	SWM & BMP Recommendations	Spring	Summer	Fall	Winter	Who could implement? <sup>2</sup>
<b>Increase Tree Cover</b>						
1	Plant additional shade trees around the perimeter of the basin to eventually provide shade					STC, Volunteers
2	Plant more trees within basin to shade, infiltrate and provide habitat					Contractors
<b>Reduce Mowed Grass Areas</b>						
1	Modify mowing schedule to mow less frequently, possibly only once or twice annually					Staff
2	Expand existing meadows west of the basin					Staff, EAB, Consultants, Contractors
3	Establish shrub layer by implementing original landscape plan					Staff or Contractor
<b>Improve Existing Swales</b>						
1	Monitor existing swales during and after major storm events to see conditions					Staff, EAB, Volunteers
2	Design and implement new vegetated swales to handle all runoff					Staff, consultants, contractors
2	Plant existing swales with hardy native perennials such as black eyed susans, coneflowers or other easy to recognize and maintain plants					EAB, Contractors, Volunteers

Miles Park Stormwater and BMP Recommendation						
Priority <sup>1</sup>	SWM & BMP Recommendations	Spring	Summer	Fall	Winter	Who could implement? <sup>2</sup>
<b>Install New Structural BMP's</b>						
1	Design and implement new rain garden with trees, shrubs and perennials to capture flow off parking lot					Contractors, volunteers, STC, EAB
1	Assess existing inlet and pipes as it appears to be undersized. Resize as appropriate in new rain garden.					Twp eng, contractors, staff
2	Survey and redesign existing parking lot to incorporate a linear center stormwater island, with trees, shrubs and groundcovers					Consultants, contractors
<b>Install New Stormwater Plantings</b>						
1	Install riparian buffre plantings along existing intermittent stream between baseball and soccer fields					Staff, EAAB, STC, Volunteers
2	Modify mowing schedule to allow existing turf swale to grow into a vegetated swale; or					Staff, EAB, Consultants, Contractors
2	Plant existing turf swale with appropriate native grasses and perennials, to slow, filter and infiltrate stormwater.					Staff or Contractor

Valley green Park Meadow Recommendation						
Priority	SWM & BMP Recommendations	Spring	Summer	Fall	Winter	Who could implement? <sup>2</sup>
<b><i>Establish Mowing and Maintenance Schedule</i></b>						
1	Mow entire meadow once annually during November to March to a height of 8-12 inches					Contractors, staff
1	1/3 - 1/2 of the meadow can be mowed a second time in July to help control invasive plants					Contractors, staff
2	Additional targeted mechanical and herbicide control of invasive plants					Staff, contractors
<b><i>Install New Native Planting Areas (Step by Step)</i></b>						
1	Clear invasive plants and other non-native plants in desired area					Staff, Contractors
2	In the spring or fall, add plugs or seed mix					Staff, Contractors
3	Plugs: Mow once annually					Staff, Contractors
3	Seed mix: whenever plants reach a height of 12-18 inches, mow back to a height of 8 inches					Staff, Contractors
4	Spot control invasive species					Staff, contractors

Woodbine Way Basin and Field						
Priority	SWM & BMP Recommendations	Spring	Summer	Fall	Winter	Who could implement? <sup>2</sup>
<b>Basin Maintenance</b>						
1	Cut and/or remove vines from fence and canopy					Contractors, staff, volunteers
1	Mow basin bottom annually					Contractors, staff
2	Conduct comprehensive plant study and inventory					Consultants
<b>Convert Lawn to Neighborhood Park</b>						
2	Create a master plan for a neighborhood park w/ public input and professional design					Staff, Contractors, Consultants
1	Remove invasive Callery Pears which existing along Woodbine Way					Staff, STC, Contractors
1	Replace Pears with native shade tree species; plant a double row for swm					Staff, STC, Contractors
1	Reduce mowing or establish meadow with seed mix					Staff, Contractors
2	Design and implement vegetated swales and rain gardens					Staff, contractors
1	Plant native species street trees along cul-de-sac					Staff, STC, Contractors

Koontz Park						
Priority	SWM & BMP Recommendations	Spring	Summer	Fall	Winter	Who could implement? <sup>2</sup>
<b>Basin Maintenance</b>						
1	Assess retaining wall annually (after freeze/thaw); maintain as necessary					Contractors, staff
2	Mow basin bottom annually					Contractors, staff
1	Cut and/or remove vines					Contractors, staff, volunteers