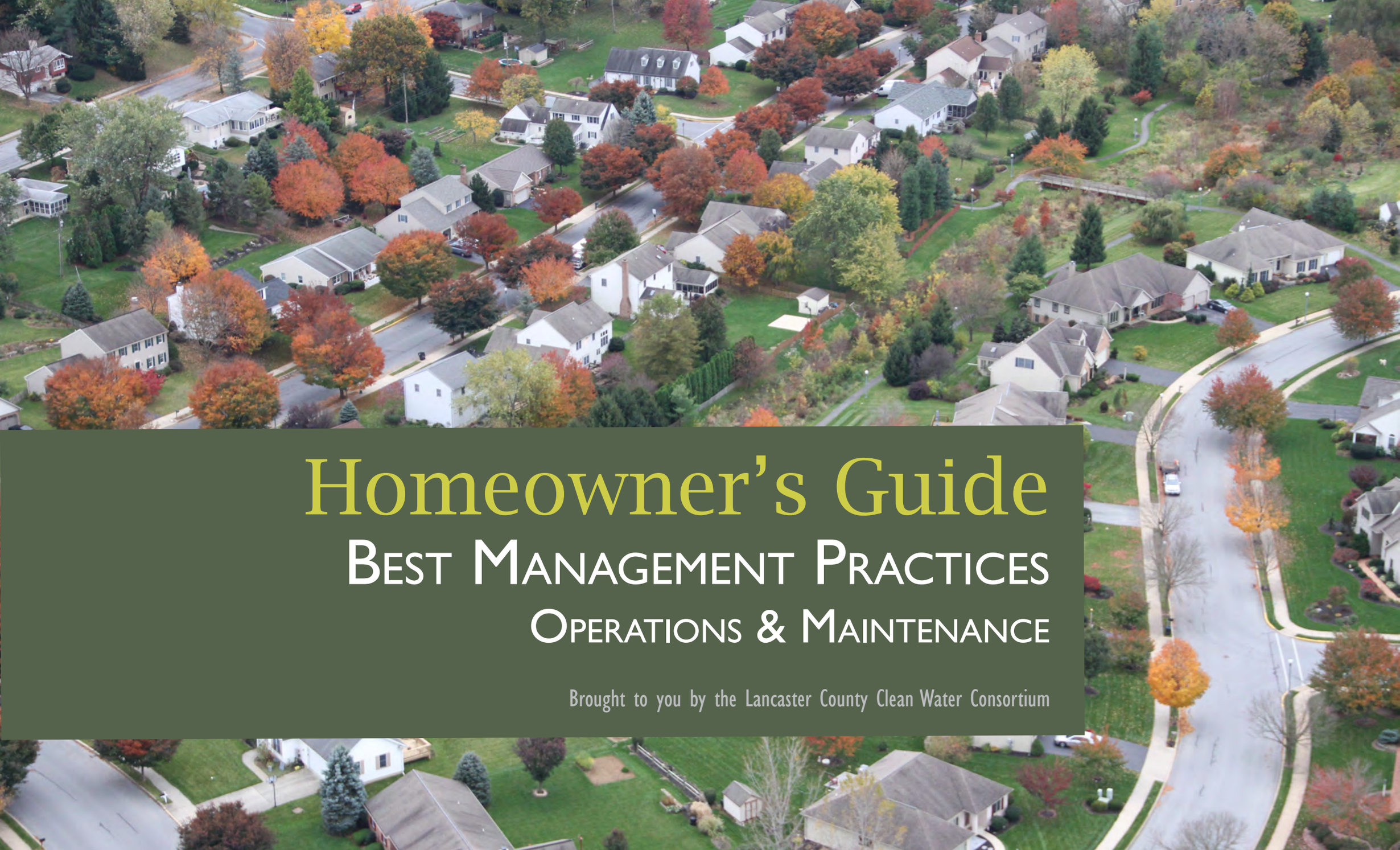

Homeowner's Guide

Best Management Practices

Operations & Maintenance

Brought to you by the Lancaster County Clean Water Consortium

LANCASTER COUNTY CLEAN WATER CONSORTIUM

WARWICK TOWNSHIP
Est. 1729 • Lancaster County, PA

Borough of Ephrata
location of choice

EAST HEMPFIELD TOWNSHIP

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Land Studies

The Homeowner's Guide to Best Management Practices Operations & Maintenance is brought to you by the Lancaster County Clean Water Consortium in partnership with Warwick Township, Ephrata Borough, East Hempfield Township, Lititz Borough and LandStudies, Inc.

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Contents

Introduction

Stormwater is water that is generated from rain and snow melt—which is commonly referred to as stormwater runoff. We generally do not think about stormwater runoff until an issue arises such as flooding or water enters your basement. However, the quality of water in stormwater runoff is an important consideration as stormwater can directly affect the quality of the drinking water supply, the health of local streams used for fishing or recreation, and overall atmosphere of a locality. In turn, we attempt to manage the stormwater runoff to protect the water quality and reduce the potential for damages associated with flooding. Stormwater management has consistently followed the same general concepts for centuries:

Collect ▸ Convey ▸ Discharge to nearby stream

Over the past few decades as flooding became more problematic and water quality degraded, the use of Best Management Practices—or BMPs—was introduced into the stormwater management mechanism. BMPs are structural and/or non-structural practices that are considered an effective and practicable set of means of preventing or reducing water pollution and potentially helping with flooding issues. As a result, the stormwater management concept has evolved into the following:

Collect ▸ Manage ▸ Discharge to nearby stream

The manage portion covers a gamut of tools. One of the most important tools is structural BMPs for stormwater management such as dry detention basins, rain gardens, and infiltration trenches. As suburban and urban areas are further developed or re-developed, BMPs are required for implementation to continually manage stormwater runoff and build upon the improvements that have occurred over the past 30+ years. The odds are good that you have a BMP on your property to manage stormwater if you have been provided this manual by your local municipality.

The Homeowner's Guide to BMP Operation and Maintenance includes detailed maintenance tables by different types of stormwater management BMPs, background considerations for your BMP's O&M Plan, and example pictures to help assist with your long-term maintenance activities.

Once a BMP is implemented, an important consideration is the long-term maintenance of the BMPs. BMPs are required to be maintained not only to preserve its function as filtering pollutants and improving water quality, but also as a regulatory requirement of your local municipality's (Township or Borough) Municipal Separate Storm Sewer System (MS4) Permit. This permit not only requires the BMP to be installed in strategic locations, but also to be maintained for the long-term.

A Municipal Separate Storm Sewer System Permit, or MS4 Permit, is a permit that establishes conditions your township or borough must meet for the quality and quantity of stormwater runoff to local streams.

The Homeowner's Guide to BMP Operation and Maintenance was developed to assist a homeowner, small business, or other local entity with maintenance of stormwater management BMPs they own. Maintenance requires periodic inspections and activities by the BMP's owner to ensure the BMP continues to function and manage stormwater as it was originally intended to—and as it was presented and approved for permit approvals.

Each BMP presented in the guide includes a maintenance table that outlines common or required indicators that would trigger a maintenance activity. The indicators are essentially the same issues, such as erosion, that your local municipality will be referring to if they inspect your BMP. Pictures of example common issues with a type of BMP are provided as well to help you identify issues that would need attention. Indicators are conditions that can lead to more problems or inhibit the BMP's ability to function, and include conditions such as erosion or blocked pipe openings.

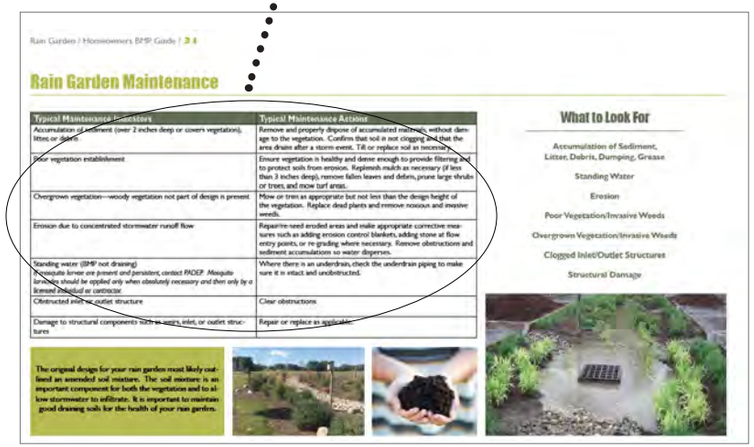
How to Use This Guide

The primary information in this guide is organized by BMP type. You will want to reference the sections that match your BMP. If you are unsure what BMP you have, contact your local municipality for assistance. Each BMP section is mainly focused on common maintenance issues and activities that need to be performed so the BMP functions as intended.

Each BMP section will generally have pictures for reference of certain issues that are more common than others listed in the Maintenance Table. The pictures are provided to assist you with inspections and determining if an issue is present that needs addressed.

Other supporting information (with several sections providing more guidance through pictures) is also located in the guide to assist with identifying types of plants that may found in your BMP, how to figure out what the vegetation in your BMP should be, where you can find information regarding inspections of your BMP and so on.

Each BMP section includes a **Maintenance Table** that outlines typical indicators of common issues and problems and the corresponding maintenance actions necessary to correct the problem.


Rain Garden / Homeowners BMP Guide / 34

Rain Garden Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Accumulation of sediment (over 2 inches deep or covers vegetation), litter, or debris	Remove and properly dispose of accumulated materials, without damage to the vegetation. Confirm that soil is not clogging and that the area drains after a storm event. Till or replace soil as necessary.
Poor vegetation establishment	Ensure vegetation is healthy and dense enough to provide filtering and to protect soils from erosion. Replenish mulch as necessary (if less than 3 inches deep), remove fallen leaves and debris, prune large shrubs or trees, and mow turf areas.
Overgrown vegetation—woody vegetation not part of design is present	Mow or trim as appropriate but not less than the design height of the vegetation. Replace dead plants and remove noxious and invasive weeds.
Erosion due to concentrated stormwater runoff flow	Repair/re-seed eroded areas and make appropriate corrective measures such as adding erosion control blankets, adding stone at flow entry points, or re-grading where necessary. Remove obstructions and sediment accumulations so water disperses.
Standing water (BMP not draining) *Mosquito larvae are present and persistent, contact PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Where there is an underdrain, check the underdrain piping to make sure it is intact and unobstructed.
Obstructed inlet or outlet structure	Clear obstructions
Damage to structural components such as weirs, inlet, or outlet structures	Repair or replace as applicable

What to Look For

Accumulation of Sediment, Litter, Debris, Dumping, Grease
Standing Water
Erosion
Poor Vegetation/Invasive Weeds
Overgrown Vegetation/Invasive Weeds
Clogged Inlet/Outlet Structures
Structural Damage

The original design for your rain garden most likely outlined an amended soil mixture. The soil mixture is an important component for both the vegetation and to allow stormwater to infiltrate. It is important to maintain good draining soils for the health of your rain garden.

Descriptions of the common issues are provided along with several recommendations to consider for maintenance. There are so many variations of a common issue that pictures of all possible variations could not be included in the guide.


Dry Detention Basin / Homeowners BMP Guide / 18

Common basin issues that should be addressed

Invasive Weeds/Poor Vegetation

- Invasive weeds can originate by inlet and outlet structures (left picture) that can inhibit flows into and from the basin.
- A few weeds can soon take over a basin (right picture) in under three years if the vegetation is not managed. **Invasive weeds should be removed on a frequent basis** and areas re-planted or re-seeded with the vegetation called out in the O&M Plan.
- Preferred weed removal technique is mechanical (i.e. remove by hand). Selective herbicides can be considered, but a professional consultant specializing in weed control in aquatic areas should be contacted if this approach is desired (or the basin has been overrun with invasive weeds).
- Refer to the invasive weed section of this guide for pictures of common weeds. If these weeds are encountered, they should be removed.

Blocked Inlet/Outlet

- Blocked inlet and outlet structures can cause flooding problems, create stagnant water, and generally cause the basin to degrade.
- **Monitor and remove leaves, trash, overgrown weeds, sediment filling in the pipe, or other debris that builds up on a frequent basis (recommended at least monthly or every time you mow).**
- Some inlet and outlet structures may have a "trash rack" (see left picture) to help capture debris and trash. These help minimize the debris and trash entering into the pipe. However, the debris (i.e. sediment, leaves, etc.) and trash built-up in these areas needs to be monitored and removed on a frequent basis as well.

The Native and Invasive Plants Picture section is provided to help you identify plants that are native to this region and are well adapted to the conditions found in BMPs. This list also includes noxious weeds or non-native and aggressive plants that pose a threat to the long-term function and aesthetics of the BMP.


Invasive Plants / Homeowners BMP Guide / 52

Narrow-Leaved cattail
Chinese Silvergrass
Common Velvet Grass
Reed Canary Grass
Parrot Feather Watermilfoil
Common Bamboo
Japanese Stilt Grass
Rough Bluegrass

Invasive Grasses

Cheatgrass
Common Reed
Ravenna Grass
Shattercane*

*noxious weed

Photo sources on pages 66-68

Common Maintenance Activities

Clearing Blocked Structures

Spraying

Weeding

Stabilization of Eroded Areas

Planting

Cleaning Debris

Mowing

Bioswale

A bioswale is a stormwater conveyance channel that is designed to infiltrate stormwater. Bioswales are planted with vegetation designed to absorb the stormwater, filter out pollutants, and slow storm-water flow during flooding events. Underneath the vegetation, bioswales often have some form of secondary filtration (i.e. gravel or rock). Bioswales are designed to treat large impervious areas, such as parking lots or roadways.

Bioswales contain inflow and outflow structures and some variation of infiltration media. Examples of different types of bioswales are shown in the photos on this page.

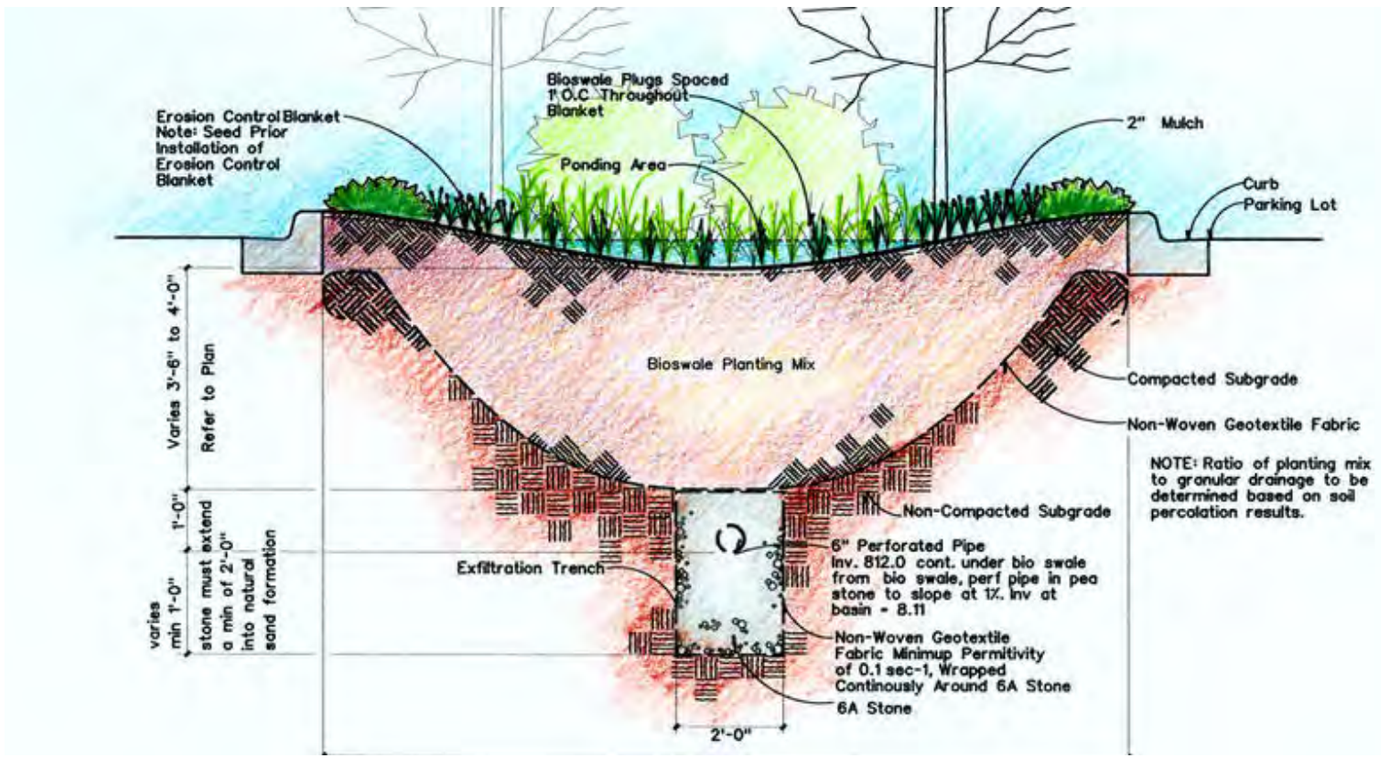


Photo: Ann Arbor District Library aadl.org

Bioswale Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Excessive Mowing	Depending on the bioswale design, taller native grasses and vegetation might be installed for filtration purposes and to slow flow in the conveyance channel; however, some landowners prefer to have shorter "lawn" vegetation. Proper mowing in accordance with the individual bioswale O&M plan should be implemented. Excessive mowing can reduce the efficacy of this stormwater BMP.
Poor vegetation establishment and bare spots	Re-seed, re-establish vegetation.
Overgrown vegetation and invasive weeds/plants	Strategically mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/plants section of the guide for pictures.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion (gullies formed on berms, basin bottom, and/or around inlet/outlet structures)	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Signs of rodents/animals (gopher holes)	Fill/repair/re-seed holes and make appropriate corrective measures to prevent rodent activity. May need to contact a professional pest control management company to assist.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash and landscape debris. Dredge accumulated sediment. This may be required every 5 to 15 years and more frequently if there are excess sources of sediment. Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment; and reestablishment of original design grades and sections. Permits may be required.
Standing water (BMP not draining) *If mosquito larvae are present and persistent, contact the PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Abate by filling holes in the ground in and around the basin and by insuring that there are no areas where water stands longer than 96 hours following a storm (or shorter timeframe). Filling and re-grading will most likely require re-seeding or re-establishing vegetation as well.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures; disconnected or failed pipes at structures	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/re-building a structural component.
General obstructions (trampolines, sporting equipment, stored boats, sheds, picnic tables, etc.)	Bioswales should be free of any general obstructions. This is critical for large and/or long rain events. Take the time to inspect and remove any general obstructions that may be present prior to forecasted rain.

What to Look For

Accumulation of Sediment, Litter, Debris

Standing Water

Erosion

Rodents/Animal Burrows (gopher holes)

Overgrown Vegetation/Invasive Weeds

Poor Vegetation Establishment/Bare Spots

Obstructed Inlet/Outlet

Structural Damage

Signs of Dumping

General Obstructions (lawn furniture etc.)

Bioswales are essentially a hybrid of an infiltration basin and a vegetate/grassed swale. Please refer to the guide sheets for infiltration basin and grass/vegetated swale for more information and tips for common issues and maintenance considerations.

Common Bioswale Issues

Blocked Inlet/Outlet Structures

- Refer to the invasive weed section of this guide for pictures of common weeds. If these weeds are encountered, they should be removed.
- Sediment, trash, etc. can build up at inlet and outlet structures. These obstructions can restrict the flow of stormwater.
- Vegetation can grow in built-up sediment and take over the structure. Excessive vegetation can inhibit the flow of stormwater and reduce the intended function of the overall facility.
- It is important to monitor for obstructions and overgrown vegetation at inlet and outlet structures. Obstructions, accumulated sediment, and any other debris blocking an inlet or outlet structure should be removed.

Lack of Appropriate Vegetation

- From time to time, bare spots in bioswale may generate. This could have been caused by a number of different factors including invasive vegetation and/or weeds that have squeezed out the original vegetation.
- Lack of (or dead) vegetation can create exposed soils or conditions that restrict the ability for the bioswale to infiltrate stormwater and result in other problems that can become more costly to deal with.
- It is important to check for bare spots and re-plant the vegetation (which are generally native plants with deep root systems) originally called out in the design for the bioswale.

Bioswale Considerations

Inlet/Outlet Structures

Stormwater can enter and exit bioswales through structural features referred to as inlet and outlet structures. At times, the stormwater entry or exit points may be a grassed swale. It is important to keep the entry and exit points free and clear of trash, debris, and accumulated sediment.

Trees

Unlike a majority of other stormwater BMPs, bioswales may have trees as part of the overall vegetation. Trees are exceptional performers when considering water uptake and play an important role in the overall infiltration processes that take place in a bioswale. Refer to the pictures of trees in the Native Plants section of this guide.

Spillway

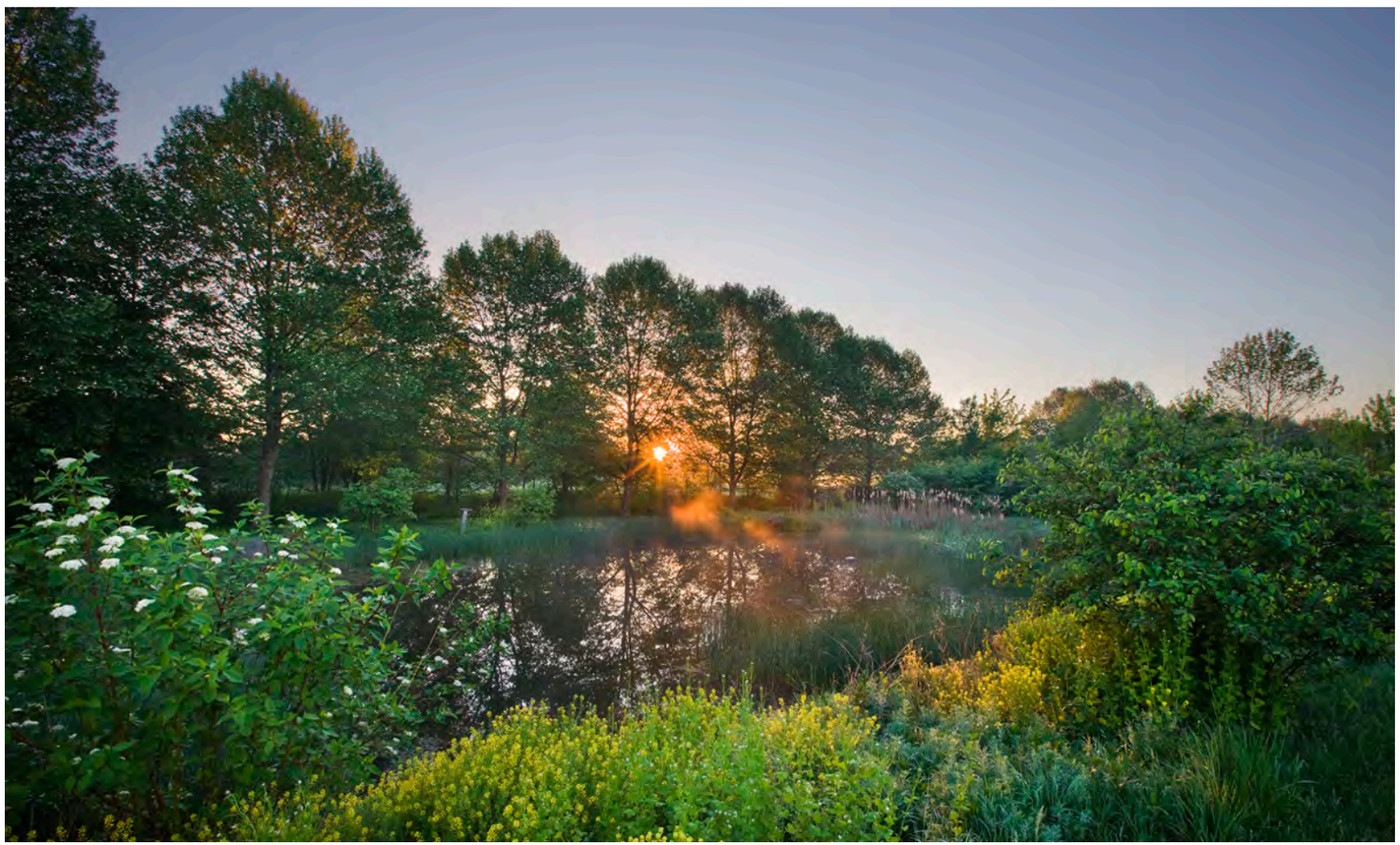
Bioswales may share features similar to a dry detention basin or infiltration basin. One such feature is a spillway that is generally a depressed area along a berm. Spillways should always remain clear of overgrown vegetation, debris, and other obstacles that could inhibit overflows.

Wetland Forebay

Some bioswales may have a wetland forebay to collect sediment, trash, debris, etc. carried by stormwater run-off. A healthy wetland forebay is one of the most important features when considering the forebay's ability to retain runoff and improve the quality of stormwater entering the BMP.

Constructed Wetland

According to the EPA, constructed wetlands are treatment systems that use natural processes involving wetland vegetation, soils, and associated processes to improve water quality. They filter pollutants from water that flow into and through the wetland before reaching the receiving streams or ponds. Vegetation slows the flow of stormwater, allowing sediment to settle and other pollutants to be taken up by the vegetation. Not only does this BMP serve as a filter, they are aesthetically pleasing and they create habitat for native animals.



Constructed Wetland Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Poor vegetation establishment/bare spots	Dependent on water level, may need to plant plugs or re-seed.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Rodents damage	Fill/repair/re-seed holes and make appropriate corrective measures to prevent rodent activity. May need to contact a professional pest control management company to assist.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash and landscape debris. Dredge accumulated sediment. This may be required every 5 to 15 years and more frequently if there are excess sources of sediment. Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment; and reestablishment of original design grades and sections. Permits may be required.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures; disconnected or failed pipes at structures	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/re-building a structural component.

What to Look For

Blocked Structures

Lack of Water Needed to Support Water Loving Plant Materials

Invasive Vegetation

Trash/Debris

Maintenance Considerations

- Regular inspections (can range in frequency depending on maintenance plan)
- Checks should include: inspecting inlet and outfall structures. Cleaning off surfaces where substances have accumulated and are preventing water flow.
- Removing nuisance and invasive species, and maintaining the appearance of the wetland
- May need to occasionally remove sediment accumulation in forbays
- Schedule for cleaning and maintaining inlet and outlet structures
- Depth of sediment accumulation before removal is required

Trash and debris is a common issue in wetlands and should be removed with frequent inspections

Dry Detention Basin

Dry detention basins are very common in Pennsylvania. They come in many sizes and shapes but are generally easy to spot as most can be described as bermed holes in the ground. They are built with the intent to collect and slow down stormwater runoff from areas upstream of the area treated by the basin. A detention basins purpose is to decrease flooding and damage that can occur from flooding.

Inlet Structure

- Stormwater entry points into a basin
- Concrete winged walls (endwalls) or grassed swales
- Some have debris (or trash) racks

Basin Berm

- Sloped mounds encircling the basin area
- Vegetation is generally turf grass that should be mowed on a regular basis (same frequency as the rest of your yard)

Basin Bottom

- Main basin area that stores collected stormwater
- Can either be turf grass or "low-mow" vegetation that resembles a meadow

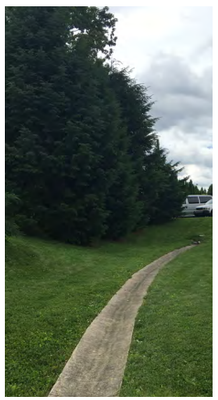
Outlet Structure

- Stormwater exit points from a basin
- Designed to control the rate of flow exiting the basin

Emergency Spillway

- Overflow point for large storm events
- Can be turf grass, concrete, or stone
- Generally a depressed area along the basin berm

Basin Variations




Low Flow Channels

- Some basins may have a concrete swale known as a "low-flow channel."
- Low-flow channels can be either concrete, grass, or stone. They generally connect entry points (inlet structures) to exit points (outlet structures).
- There should be no obstructions (i.e. trampolines) or build-up of debris (i.e. grass clippings) in low-flow channels. They can be carried to the outlet structures and clog up the system.


Low-mow Basins

- Certain basins may be designed as "low-mow" basins in lieu of turf grass in the basin bottom. This variation of a basin bottom generally attempts to establish meadow-like conditions.
- These basins are generally only mowed twice a year (once in the spring and once in the fall). Your O&M Plan should call out mowing frequency. Contact a professional consultant or your local municipality if you are unsure.
- The meadow-like conditions of a low-mow basin provide a greater water quality treatment function than a grassed basin. However, a common issue with low-mow basins is a high probability that invasive weeds/vegetation can take over the basin in a matter of a few weeks if the basin goes unchecked.


Outlet Structures

- Outlet structures come in various forms and sizes but all serve the same purpose – control the rate of stormwater exiting the basin.
- Some outlet structures have an overflow built into the same structure (right picture above). Others may be a concrete wing wall with the overflow behind the structure that appears to be an inlet/yard grate.
- A common tell-tale sign of an outlet structure is the presence of what is known as an "orifice plate" (left picture above) – a metal plate bolted to the concrete wall with a small pipe opening.


Spillways

- Spillways can be either grass, stone, or concrete.
- Grassed spillways may be difficult to find at first as the area can blend into the surrounding berms. If you stand in the basin, you can see the spillway profile as the spillway area will generally appear as a dip in the berm (see left picture above).
- If the spillway profile does not appear uniform (as in the left picture above), you should contact a professional engineer as repairs may be needed.
- The right picture above reveals a number of "no-no's" - spillway where grass clippings have been dumped, weeds and trees have taken over, original vegetation is dead leaving bare spots, and profile has been altered.

Basin Considerations

Rodents/Animals

Rodents and animals can burrow in berms or under concrete spillways jeopardizing the integrity of the structure area. Various rodents and related animals can make their home in pipes connected to inlet and outlet structures (see pictures). This may invite unwanted predators to the area but can also cause water quality and health concerns related to feces.

Basin Discharge

Every basin generally has a discharge point connected to the outlet structure that is located on the other side of the basin berm. This is the point where stormwater exits the area and may enter storm sewer system, swale, or directly into a stream. The components of this structure should be treated and maintained in a similar fashion as the inlet and outlet structures inside the basin (area free of debris and weeds, pipe opening free of clogs, no dumping, concrete is structurally sound, and so on).

Sinkholes

Sinkholes may be encountered in the basin bottom. Sinkholes can generally lead to more issues if not addressed. You should contact a professional engineer or your local municipality immediately after encountering a sinkhole.

Sediment Accumulation

Sediment will most likely accumulate in the basin bottom over time. This will require removal of the accumulated sediment at periodic intervals. A telltale sign (see picture) is when the ground is higher than the bottom of an inlet or outlet structure pipe, even if grass is still present. This maintenance will require "digging out" (also known as "dredging") the sediment and re-planting or re-seeding vegetation called out in the original plans or what was in place before. Contact a professional consultant or your local municipality if you are unsure about accumulated sediment or vegetation to be planted.

Dry Dentention Basin Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Poor vegetation establishment/bare spots	Re-seed, re-establish vegetation.
Overgrown vegetation and invasive weeds/plants	Mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/plants section of the guide for pictures.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion (gullies formed on berms, basin bottom, and/or around inlet/outlet structures)	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Signs of rodents/animals (gopher holes)	Fill/repair/re-seed holes and make appropriate corrective measures to prevent rodent activity. May need to contact a professional pest control management company to assist.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash and landscape debris. Dredge accumulated sediment. This may be required every 5 to 15 years, and more frequently if there are excess sources of sediment. Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment; and reestablishment of original design grades and sections. Permits may be required.
Standing water (BMP not draining) *If mosquito larvae are present and persistent, contact the PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Abate by filling holes in the ground in and around the basin and by insuring that there are no areas where water stands longer than 72 hours following a storm or as specified in your basin's O&M manual. Filling and re-grading will most likely require re-seeding or re-establishing vegetation as well.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures; disconnected or failed pipes at structures	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/rebuilding a structural component.
General obstructions (trampolines, sporting equipment, stored boats, sheds, picnic tables, etc.)	Basins should be free of any general obstructions. This is critical for large and/or long rain events. Take the time to inspect and remove any general obstructions that may be present prior to forecasted rain.

What to Look For

Accumulation of Sediment, Litter, Debris

Standing Water

Erosion

Rodents/Animal Burrows (gopher holes)

Overgrown Vegetation/Invasive Weeds

Poor Vegetation Establishment/Bare Spots

Obstructed Inlet/Outlet

Structural Damage

Signs of Dumping

General Obstructions (trampolines, etc.)

If you do not have an O&M Plan, either follow the recommendations outlined in this guide to develop a plan and frequencies recommended or contact a professional consultant to help develop an O&M Plan.

These items should be checked at least monthly. Review your O&M Plan for alternate frequencies that may have been approved in the Site Stormwater Management Plan.

Common basin issues that should be addressed

Invasive Weeds/Poor Vegetation

- Invasive weeds can originate by inlet and outlet structures (left picture) that can inhibit flows into and from the basin.
- A few weeds can quickly take over a basin (right picture) in three years or less if the vegetation is not managed. **Invasive weeds should be removed on a frequent basis** and areas re-planted or re-seeded with the vegetation called out in the O&M Plan.
- Preferred weed removal technique is mechanical (i.e. remove by hand). Selective herbicides can be considered, but a professional consultant specializing in weed control in aquatic areas should be contacted if this approach is desired (or the basin has been overrun with invasive weeds).
- Refer to the invasive weed section of this guide for pictures of common weeds. If these weeds are encountered, they should be removed.

Blocked Inlet/Outlet

- Blocked inlet and outlet structures can cause flooding problems, create stagnant water, and generally cause the basin to degrade.
- **Monitor and remove leaves, trash, overgrown weeds, sediment filling in the pipe, or other debris that builds up on a frequent basis (recommended at least monthly or every time you mow).**
- Some inlet and outlet structures may have a "trash rack" (see left picture) to help capture debris and trash. These help minimize the debris and trash entering into the pipe. However, the debris (i.e. sediment, leaves, etc.) and trash built-up in these areas needs to be monitored and removed on a frequent basis as well.

Clean Riprap

- Some basins may have piles of stone or rock in front of inlet and outlet structures (and at the basin discharge points) commonly known as riprap. This part of the structure is intended to help disperse stormwater flows and/or collect debris, trash, sediment, etc.
- **Riprap areas should be checked monthly and cleared of any debris, trash, invasive weeds, and landscape waste.** The pictures to the right are examples of riprap areas that need to be cleaned up. Periodically, collected sediment will need to be cleaned out (which may require re-setting the rock or stone).

Dead Vegetation/Bare Spots

- Lack of or dead vegetation (turf grass, native plants, etc.) can create exposed soil that can erode and clog the system, along with discharging excessive sediment to nearby streams.
- **Dead vegetation (including turf grass areas) should be replaced to match what was outlined in the original plans.**
- Dead vegetation areas can increase the probability of invasive weeds propagating and taking over the basin causing more headaches down the road.
- Steep berms are more susceptible to erosion from bare spots that generally evolve over time from mower tires (see right picture) running over the same spot every week. Consider alternating mowing patterns to minimize generation of bare spots.

Grass / Vegetated Swale

A grass or vegetated swale is a stormwater BMP that is similar to a bioswale; however, there is typically less of an emphasis on infiltration. In fact, grass or vegetated swales may not have any type of amended soils or specialized filter media underneath the vegetated surface. It is the plant material that plays the critical role for this BMP.

Grass or vegetated swales are planted with vegetation designed to absorb the stormwater, filter out pollutants, and slow flow during flooding events. These swales can be planted with turf grass or with native plants. In addition to vegetation, these swales contain an inflow and outflow structure. They may also include check dams or other structures designed to slow the flow of stormwater.

Photo: www.daa.com

Photo: www.harfordcountymd.gov

Photo: www.montgomerycountymd.gov

A common issue with swales (especially grassed swales) is poor vegetation and erosion. Chunks of the swale may erode away (similar to the picture to the right). This is common where turf has not fully established or the swale meets another stormwater management feature. These areas should be re-graded and vegetation re-established.

Grass / Vegetated Swale Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Excessive Mowing	Some vegetated swales are planted with taller native grasses and vegetation for filtration purposes and to slow flow in the swale; however, some landowners prefer to have shorter "lawn" vegetation. Proper mowing in accordance with the individual grass / vegetated swale O&M plan should be implemented. Excessive mowing can reduce the efficacy of this stormwater BMP.
Poor vegetation establishment/bare spots	Re-seed, re-establish vegetation.
Overgrown vegetation and invasive weeds/plants	Mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/ plants section of the guide for pictures.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion (gullies formed on berms, swale bottom, and/or around inlet/outlet structures)	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Signs of rodents/animals (gopher holes)	Fill/repair/re-seed holes and make appropriate corrective measures to prevent rodent activity. May need to contact a professional pest control management company to assist.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash and landscape debris. Dredge accumulated sediment. This may be required every 5 to 15 years and more frequently if there are excess sources of sediment. Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment; and reestablishment of original design grades and sections. Permits may be required.
Standing water (BMP not draining) *If mosquito larvae are present and persistent, contact the PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Abate by filling holes in the ground in and around the basin and by insuring that there are no areas where water stands longer than 72 hours following a storm or as specified in your swale's O&M manual. Filling and re-grading will most likely require re-seeding or re-establishing vegetation as well.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures; disconnected or failed pipes at structures	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/re-building a structural component.
General obstructions (trampolines, sporting equipment, stored boats, sheds, picnic tables, etc.)	Swales should be free of any general obstructions. This is critical for large and/or long rain events. Take the time to inspect and remove any general obstructions that may be present prior to forecasted rain.

What to Look For

Accumulation of Sediment, Litter, Debris

Standing Water

Erosion

Rodents/Animal Burrows (gopher holes)

Overgrown Vegetation/Invasive Weeds

Poor Vegetation Establishment/Bare Spots

Obstructed Inlet/Outlet

Structural Damage

Signs of Dumping

General Obstructions (lawn furniture, etc.)

Grass and vegetated swales can be lower cost stormwater BMPs if they are not specifically designed to include infiltration media. However, these swales may not be as effective as bioswales or other infiltratin practices at reducing runoff and filtering out pollutants. Nonetheless, these swales still provide valuable role in reducing runoff and limiting pollution.

Infiltration Basin

Infiltration basins are constructed impoundments that capture and temporarily store stormwater runoff. The temporarily stored runoff infiltrates into the permeable soil within 72 hours or as specified in your basin's O&M manual.

Infiltration basins contain inflow and outflow structures and some variation of infiltration media. Most infiltration systems are vegetated; however, the type of vegetation can vary from traditional lawn to native grasses and wildflowers. Examples of different types of infiltration systems are shown in the following photos.

Photo: https://www.flickr.com/photos/scpr/4949432301

Photo: stormwater.pca.state.mn.us

Photo: www.constructionspecifier.com

Infiltration Basin Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Poor vegetation establishment/bare spots	Re-seed, re-establish vegetation.
Overgrown vegetation and invasive weeds/plants	Mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/plants section of the guide for pictures.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion (gullies formed on berms, basin bottom, and/or around inlet/outlet structures)	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Signs of rodents/animals (gopher holes)	Fill/repair/re-seed holes and make appropriate corrective measures to prevent rodent activity. May need to contact a professional pest control management company to assist.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash and landscape debris. Dredge accumulated sediment. This may be required every 5 to 15 years, and more frequently if there are excess sources of sediment. Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment, and reestablishment of original design grades and sections. Permits may be required.
Standing water (BMP not draining) *If mosquito larvae are present and persistent, contact the PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Abate by filling holes in the ground in and around the basin and by insuring that there are no areas where water stands longer than 72 hours following a storm or as specified in your basin's O&M manual. Filling and re-grading will most likely require re-seeding or re-establishing vegetation as well.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures; disconnected or failed pipes at structures	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/re-building a structural component.
General obstructions (trampolines, sporting equipment, stored boats, sheds, picnic tables, etc.)	Basins should be free of any general obstructions. This is critical for large and/or long rain events. Take the time to inspect and remove any general obstructions that may be present prior to forecasted rain.

What to Look For

Accumulation of Sediment, Litter, Debris

Standing Water

Infiltration basins more typically have an issue with standing water / ponding than infiltration trenches or other types of infiltration systems.

Erosion

Rodents/Animal Burrows (gopher holes)

Overgrown Vegetation/Invasive Weeds

Poor Vegetation Establishment/Bare Spots

Obstructed Inlet/Outlet

Structural Damage

Signs of Dumping

General Obstructions (trampolines, etc.)

The intent of these infiltration practices is to absorb stormwater instead of discharging it and, therefore, reduce runoff. They also help to filter out pollutants in the stormwater. Infiltration basins are typically managed like detention basins, but with more emphasis on maintaining proper infiltration. Anything that could clog the base of the infiltration area can reduce the efficacy of this stormwater BMP.

Common Infiltration Basin Issues

Invasive Weeds/Poor Vegetation

- Invasive weeds can originate by inlet and outlet structures that can inhibit flows into and from the basin.
- A few weeds can quickly take over a basin if the vegetation is not managed. Invasive weeds should be removed on a frequent basis and areas re-planted or re-seeded with the vegetation called out in the O&M Plan.
- Refer to the invasive weed section of this guide for pictures of common weeds. If these weeds are encountered, they should be removed.

Standing Water

- Standing water is generally a sign of poor soil conditions, depressed areas/holes, and/or sediment accumulation has created pockets and lined the basin bottom that trap water and cannot infiltrate appropriately.
- Correcting areas that do not infiltrate in the appropriate amount of time or pond water generally requires re-grading and/or replacing some of the soils. Re-grading will most likely require re-seeding or re-establishing the vegetation in the approved plans.
- Mosquitos can become an issue with standing water if conditions are just right to allow larvae to be present.

Infiltration Basin Considerations

General Basin Components

Infiltration basins have many similar characteristics as a dry detention basin (refer to the dry detention basin guide sheets for more information and tips). Similar characteristics generally include a spillway, inlet/outlet structures, and berms. The primary difference is dry detention basins generally do not allow stormwater to infiltrate; whereas infiltration basins do just that—infiltrate. Through infiltration, basins provide better water quality treatment and reduce the volume of runoff to downstream areas than dry detention basins.

Inlet Structure

Outlet Structure

Spillway

Berm

Sinkholes

Sinkholes may be encountered in the basin bottom. Sinkholes can generally lead to more issues if not addressed. You should contact a professional engineer or your local municipality immediately after encountering a sinkhole.

Basin Discharge

Every basin generally has a discharge point connected to the outlet structure that is located on the other side of the basin berm. This is the point where stormwater that does not infiltrate (generally during large storm events) exits the area and may enter the storm sewer system or flow directly into a stream. The components of this structure should be treated and maintained in a similar fashion as the inlet and outlet structures inside the basin (area free of debris and weeds, pipe opening free of clogs, no dumping, concrete is structurally sound, and so on).

Infiltration Trench

Infiltration trenches are constructed impoundments that capture and temporarily store stormwater runoff. The temporarily stored runoff infiltrates into the permeable soil within 72 hours or as specified in your trench's O&M manual.

Infiltration trenches contain inflow and outflow structures and some variation of infiltration media. Many infiltration trenches are at least partially vegetated; however, some use pervious paving or other material instead of vegetation as the top infiltration surface. Examples of different types of infiltration systems are shown in the following photos.

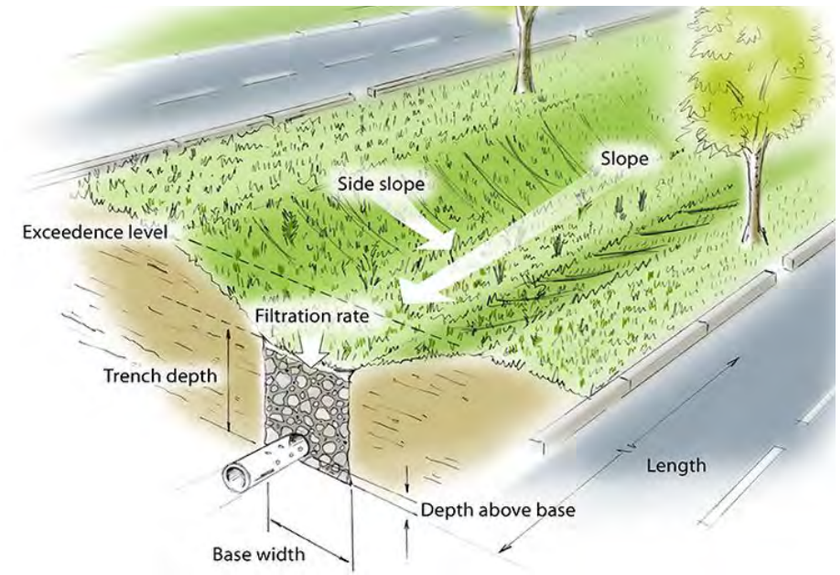


Photo: City of Lafayette

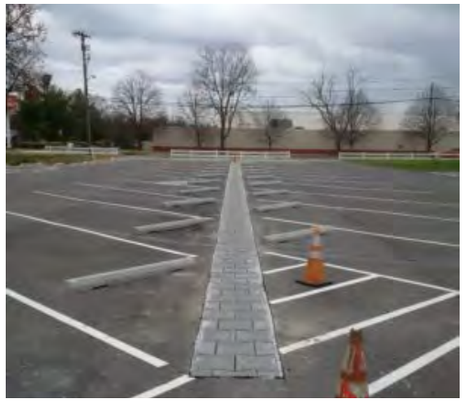


Photo: thecleanwaterpartnership.com

Photo: Acton Wakefield Watershed Alliance

Photo: stormwater.pca.state.mn.us

Photo: tour.thelivingcitycampus.com

Infiltration Trench Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Poor vegetation establishment/bare spots	Re-seed, re-establish vegetation.
Overgrown vegetation and invasive weeds/plants	Mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/plants section of the guide for pictures.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion (gullies formed on berms, trench bottom, and/or around inlet/outlet structures)	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Signs of rodents/animals (gopher holes)	Fill/repair/re-seed holes and make appropriate corrective measures to prevent rodent activity. May need to contact a professional pest control management company to assist.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash and landscape debris. Dredge accumulated sediment. This may be required every 5 to 15 years, and more frequently if there are excess sources of sediment. Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment; and reestablishment of original design grades and sections. Permits may be required.
Standing water (BMP not draining) *If mosquito larvae are present and persistent, contact the PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Abate by filling holes in the ground in and around the basin and by insuring that there are no areas where water stands longer than 72 hours following a storm or as specified in your trench's O&M manual. Filling and re-grading will most likely require re-seeding or re-establishing vegetation as well.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures; disconnected or failed pipes at structures	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/re-building a structural component.
General obstructions (trampolines, sporting equipment, stored boats, sheds, picnic tables, etc.)	Basins should be free of any general obstructions. This is critical for large and/or long rain events. Take the time to inspect and remove any general obstructions that may be present prior to forecasted rain.

What to Look For

Accumulation of Sediment, Litter, Debris

Standing Water

Erosion

Rodents/Animal Burrows (gopher holes)

Overgrown Vegetation/Invasive Weeds

Poor Vegetation Establishment/Bare Spots

Obstructed Inlet/Outlet

Structural Damage

Signs of Dumping

General Obstructions (trampolines, etc.)

The intent of these infiltration practices is to absorb stormwater instead of discharging it and, therefore, reduce runoff. They also help to filter out pollutants in the stormwater. Infiltration trenches are typically managed like infiltration basins. Anything that could clog the base of the infiltration area can reduce the efficacy of this stormwater BMP.

Common Infiltration Trench Issues

Sediment and Debris Accumulation

- Clogging of the voids/open spaces (especially in stone-lined infiltration trenches) may result in stormwater not infiltrating or flowing over the trench and causing flooding problems.
- Sediment and debris will generally accumulate at inlet structures. Landscape debris and trash should be checked for and removed on a frequent basis. Sediment build-up will most likely need to be removed (dredged) every 5 years or so. More frequent maintenance may extend the need to dredge sediment out every 15 years or so.

Clogged Yard Inlet (subsurface infiltration only)

- Subsurface infiltration trenches (also known as subsurface infiltration beds) generally have a set of inlets in paved areas and in yard areas that collect and channel stormwater underground to an infiltration bed.
- Grass clippings, sediment, debris, and similar yard materials can enter the inlets and end up clogging the underground system. This can also result in stormwater backing up and flooding surrounding areas.
- Check yard inlets with every mowing and remove debris building up and adjacent to the inlets. Check for build-up of debris inside the inlet structure at least twice a year and remove the accumulated debris.
- Over time, turf can grow over the inlets in the yard area. Keep the structure (and inlet grate) clear of vegetation.

Infiltration Trench Considerations

Subsurface Infiltration Bed

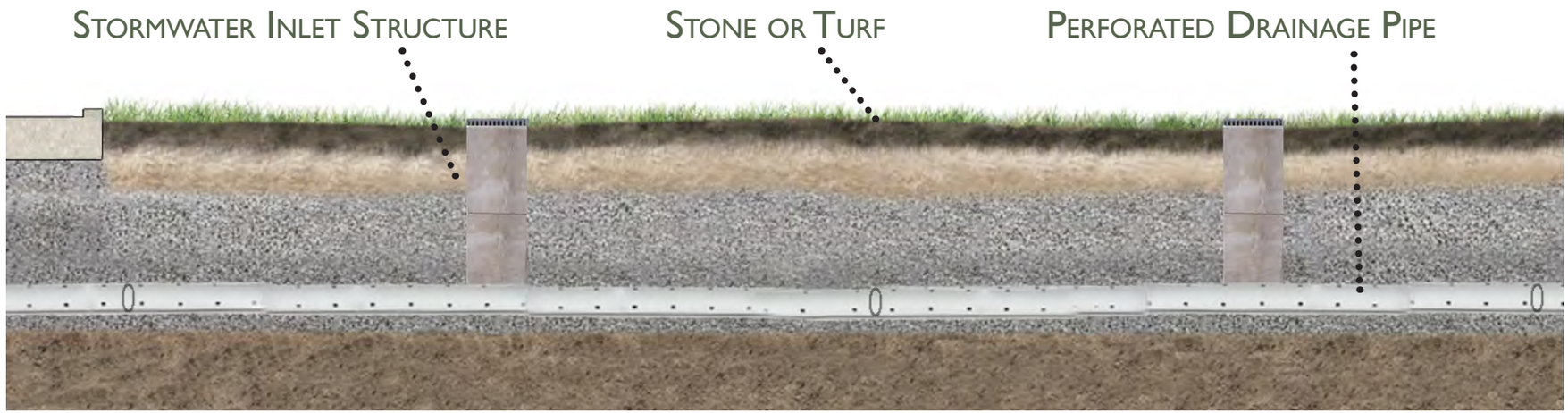
There are types of infiltration trenches that do not resemble a traditional trench. These can also be referred to as "Lawn Infiltration Trenches," "Trench Restoration for Lawns," or similar descriptions. These type of trenches are becoming more and more popular in recent years. They can be described better as an infiltration trench field, where yard inlets (and standard inlets) are connected to groups of perforated piping underground to allow stormwater to infiltrate better across the entire lawn area.

Stone Trench

A number of infiltration trenches can be simply stone-lined infiltration trenches. These were more common types of infiltration trenches in the past, but are still implemented today. Grassed swales or pipes would feed into these trenches, pool the stormwater, and allow the water to infiltrate.

Subsurface Infiltration

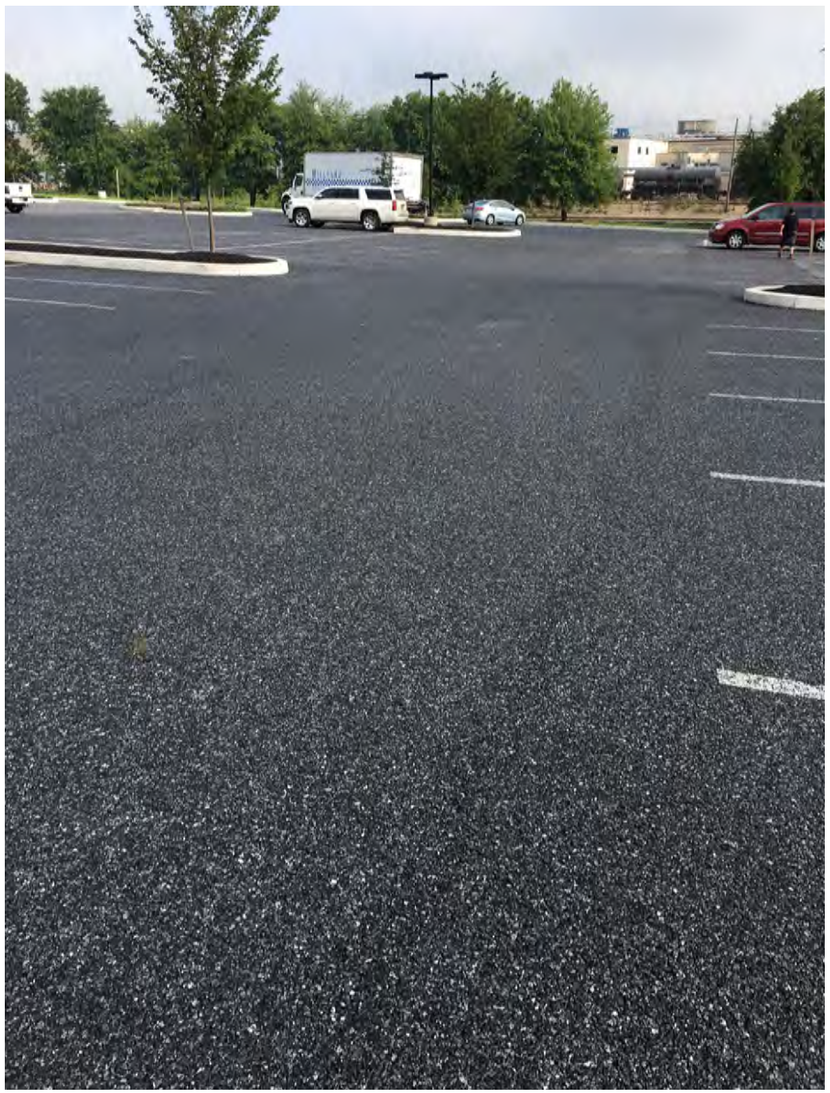
Subsurface infiltration is a type of infiltration trench. The primary difference between a subsurface infiltration bed and a conventional infiltration trench is stormwater is collected by inlet structures for subsurface infiltration and the water is channeled to underground infiltration components. Whereas for a conventional infiltration trench, stormwater is infiltrated through the ground to the infiltration components.



Porous Paving

Porous pavement is a hard paved surface that resembles asphalt roads, driveways, etc. It is generally found in parking lots or driveways—generally areas with light vehicular traffic. Porous paving allows significant amounts of stormwater to infiltrate through the paving and into the ground.

You can generally tell the difference between porous paving and standard asphalt paving when the two types of pavement are immediately next to each other.



Asphalt-based porous paving is the most common type of porous paving. However, other types of aggregates from concrete to stone can be used for porous paving. No matter the aggregate type, all porous paving is designed to allow stormwater to infiltrate in lieu of running off into the storm sewer.

Porous Paving Maintenance and Common Issues

Typical Maintenance Indicators	Typical Maintenance Actions
Accumulation of sediment, litter, or debris on surface of porous pavement, as applicable	Remove and properly dispose of accumulated materials. **Surface vacuuming should be conducted at least twice a year to allow the BMP to function as intended.**
Standing water in permeable paving area	Flush fine sediment from paving and subsurface gravel. Ensure that sediment is not washed off-site. **Surface vacuuming would be more ideal as power washing could clog the surface.**
Damage to permeable paving surface resulting in reduced storm water intake capacity	Repair or replace damaged surface as appropriate.

What to Look For

Accumulation of Sediment, Litter, Grease, etc.

Standing Water

Structural Damage

Photo: pavementinteractive.org

Photo: ldaengineering.com

Built-up sediment, debris, etc. is a common problem with porous paving. Sediment tends to fill in and clog the pavement thus taking away the ability for the paving to allow stormwater to infiltrate. Dumpsters and landscaping materials (sand, mulch, dirt, etc.) should never be stored or located on porous pavement. Stored landscaping materials easily clog porous paving, and dumpsters can leak hazardous materials that infiltrate into the ground and affect the drinking water supply.

Rain Garden (bio-retention)

Rain gardens are bio-retention facilities very similar to infiltration basins, but generally on a smaller scale. They can be found from the back yards of homes to along the side of a street. A rain garden collects immediate stormwater runoff and infiltrates in a ponding zone in the middle of the BMP.

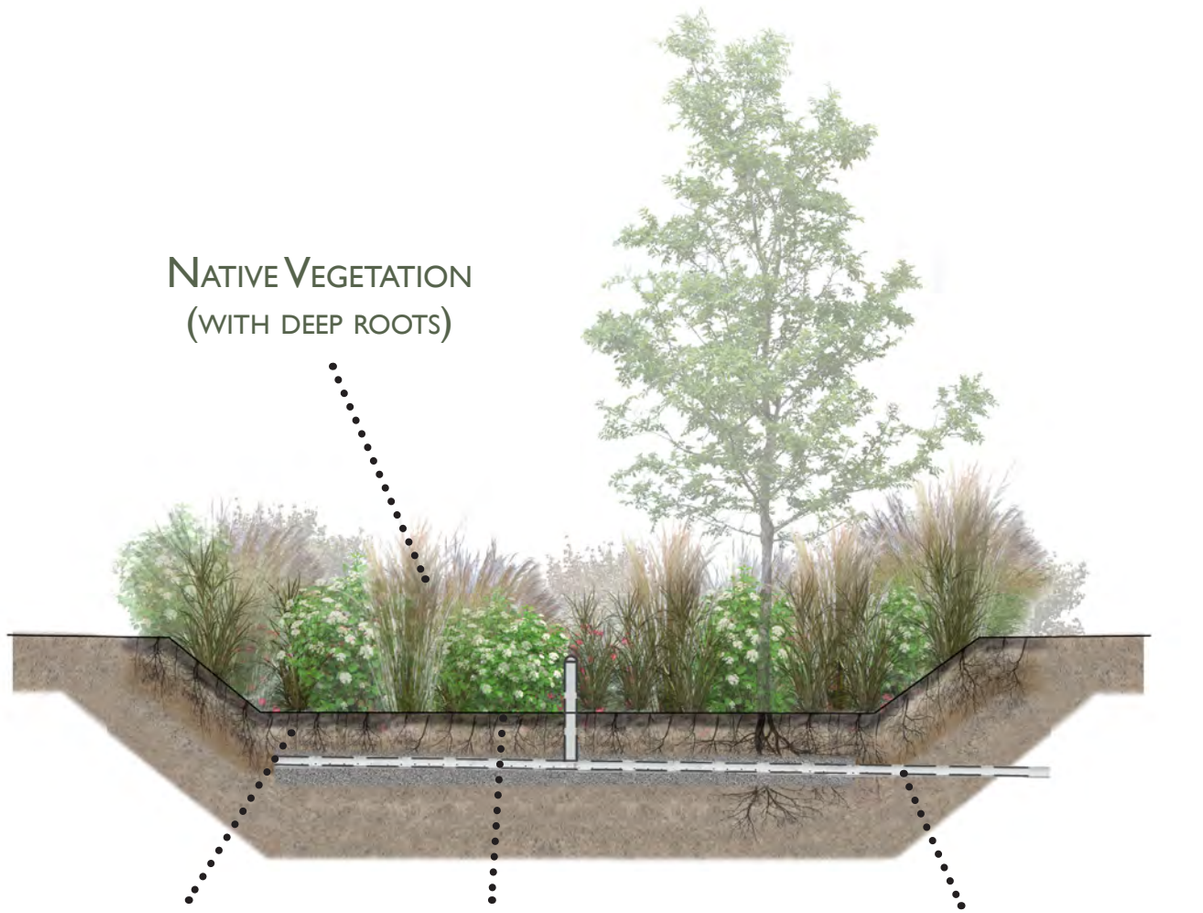
Photo: DIYNetwork.com

Stone Dissipator

Native Plant

Overflow Structure

Soil Mixture



Rain Garden Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Accumulation of sediment (over 2 inches deep or covers vegetation), litter, or debris	Remove and properly dispose of accumulated materials, without damage to the vegetation. Confirm that soil is not clogging and that the area drains after a storm event. Till or replace soil as necessary.
Poor vegetation establishment	Ensure vegetation is healthy and dense enough to provide filtering and to protect soils from erosion. Replenish mulch as necessary (if less than 3 inches deep), remove fallen leaves and debris, prune large shrubs or trees, and mow turf areas.
Overgrown vegetation—woody vegetation not part of design is present	Mow or trim as appropriate but not less than the design height of the vegetation. Replace dead plants and remove noxious and invasive weeds.
Erosion due to concentrated stormwater runoff flow	Repair/re-seed eroded areas and make appropriate corrective measures such as adding erosion control blankets, adding stone at flow entry points, or re-grading where necessary. Remove obstructions and sediment accumulations so water disperses.
Standing water (BMP not draining) *If mosquito larvae are present and persistent, contact PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Where there is an underdrain, check the underdrain piping to make sure it is intact and unobstructed.
Obstructed inlet or outlet structure	Clear obstructions.
Damage to structural components such as weirs, inlet, or outlet structures	Repair or replace as applicable.

The original design for your rain garden most likely outlined an amended soil mixture. The soil mixture is an important component for both the vegetation and to allow stormwater to infiltrate. It is important to maintain good draining soils for the health of your rain garden.

What to Look For

Accumulation of Sediment, Litter, Debris, Dumping, Grease

Standing Water

Erosion

Poor Vegetation/Invasive Weeds

Overgrown Vegetation/Invasive Weeds

Clogged Inlet/Outlet Structures

Structural Damage

Common Rain Garden Issues

Poor Vegetation/Invasive Weeds

- The designed vegetation for a rain garden is critical for the BMP's function and performance. With poor vegetation cover, the rain garden does not perform as intended.
- New rain gardens that are poorly maintained will result in invasive weeds quickly taking over (or, as in the case with example pictures, crabgrass or other similar weeds will take over and inhibit the BMP's function).
- Invasive weeds and dead vegetation should be removed and replaced with the original designed vegetation. A rain garden should be monitored at least monthly during the growing season to ensure invasive weeds are not taking over.
- Refer to the invasive weed section of this guide for pictures of common weeds. If these weeds are encountered, they should be removed.

Standing Water/Poor Drainage

- Standing water in a rain garden is generally a sign of poor soil mixture (filter media). A number of factors could have caused such an issue, but this indicator generally means that the soil mixture needs to be replaced.
- Standing water can create a mosquito breeding ground, so rain gardens should be checked after rain events to ensure it is draining properly.
- Standing water may kill vegetation and thus leading to more problems with clogged overflow structures, erosion, and sediment accumulation that will need to be dealt with in addition to the poor soil mixture.

Rain Garden Considerations

Overflow Structures

Most rain gardens are intended to infiltrate a portion of the stormwater runoff. However, and for larger storm events, rain gardens will have an overflow structure for the runoff to go somewhere instead of flooding the immediate area.

Overflow structures come in all shapes and sizes. Most overflow structures are set just a few inches higher than the bottom of the rain garden to allow the runoff to be captured and treated.

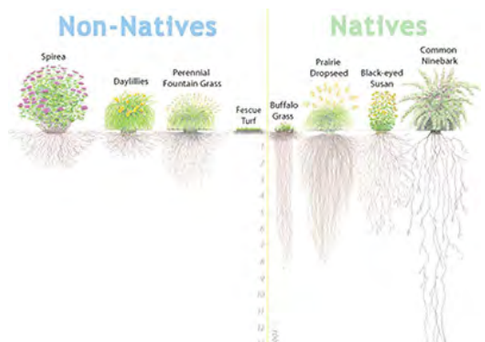
Overflow structures should be free of debris, clogs, and defects. These structures perform an important role when considering flooding and the overall health of the rain garden and should be checked at least twice a year.

Inlet Points

Stormwater runoff can enter rain gardens either through a very defined point or over a broad area (for "sheet flows").

Defined entry points or broad entry areas are generally identifiable by stone in the area. The stone serves the purpose of a "dissipator" that is intended to capture larger debris and sediment before entering the treatment area of the BMP.

Stone areas of a rain garden should be checked periodically for trash, sediment, and other large debris; and such debris should be removed.



Vegetation

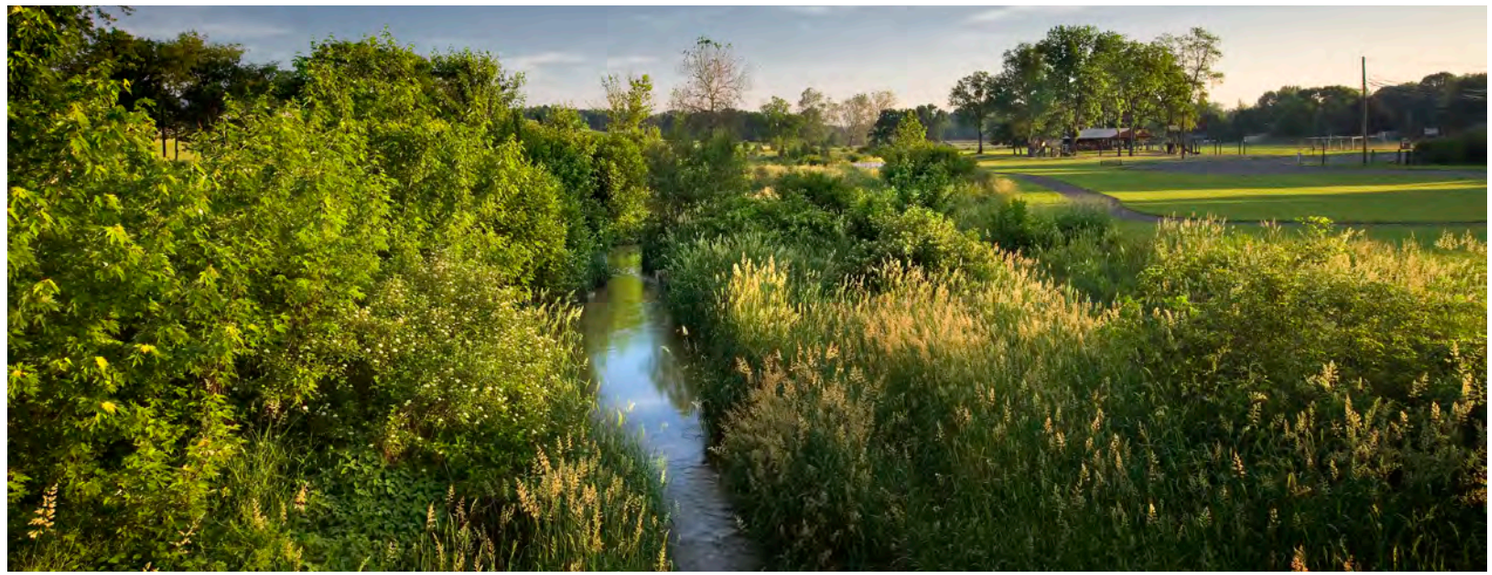
The vegetation for a rain garden is critical for the performance and function of the BMP. It is important to maintain deep-rooted native vegetation (with proper soils) that was most likely in the original design for the rain garden. Mulch coverage should always be present to protect the root systems. Invasive weeds and non-native plants can push out the deep-rooted native vegetation—so keep them out with consistent weeding!

Riparian Buffer - Land Next to the Stream

A riparian buffer is simply vegetation along streams and waterbodies. While many riparian buffers exist naturally, the planting of riparian buffer vegetation along waterways is a commonly used stormwater BMP to help stabilize streambanks and minimize streambank erosion. The riparian buffer vegetation also filters out pollutants in the stormwater runoff.

Riparian buffer plantings can include trees, shrubs, grasses, wildflowers and other vegetation that are suited for riparian habitats. When riparian buffers are installed as stormwater BMPs, native plants are often used since the native vegetation is accustomed to the local conditions. Another advantage of using native vegetation is that it provides habitat for native wildlife.

Operations and Maintenance Plans for a riparian buffer installed for stormwater management purposes should show the boundary of the riparian buffer area. Riparian buffers are typically at least 35 feet wide on both sides of the stream to maximize the streambank stabilization. If unsure about the area of your riparian buffer, contact your local municipality or professional consultant for assistance.



Riparian Buffer Maintenance

What to Look For

Invasive plants

Erosion

Survival rate of planted vegetation

If plants are dying, try to determine why:

- Invasive plants out-competing planted vegetation?
- Deer eating the leaves and / or are rodents feeding on the roots?
- Tree shelters and stakes not properly maintained in an upright position; etc?

Typical Maintenance Indicators	Typical Maintenance Actions
Invasive weeds / plants	Mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/plants section of the guide for pictures.
Erosion, poor vegetation establishment	Re-seed, re-establish vegetation.
Planted trees and shrubs are not upright	Stabilize trees and shrubs with stakes and shelters (if applicable); Ensure that tree shelters are properly secured to the tree stake and in the ground.
Dead or dying vegetation	Replant vegetation as needed.
Accumulation of litter or debris	Remove and properly dispose of accumulated trash or debris as these materials can damage the planted vegetation.

Erosion

Invasive Mile-A-Minue taking over native vegetation

Photo: Go Native Long Island

Tree may die if not upright

Photo: Whitescarver Natural Management, LLC

Common Riparian Buffer Issues That Should Be Addressed:

Invasive Weeds / Plants

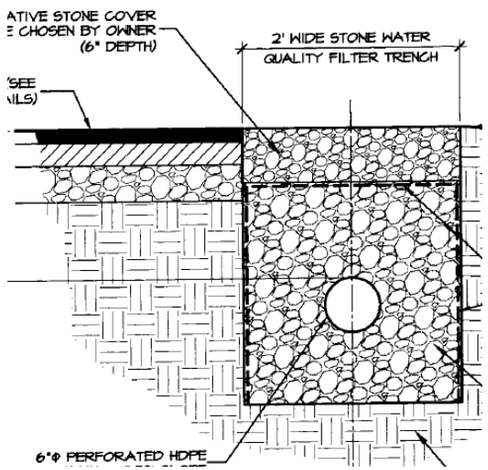
- Many invasive plant species are transported by water and are therefore, quickly able to establish along streambanks. Invasive plant species are aggressive and can outcompete and grow over riparian buffer plantings. Many invasive plant species can kill-off other vegetation and completely overtake streambanks. Invasive species are often less effective at streambank stabilization and erosion control than the variety of native vegetation planted for a riparian buffer stormwater BMP.
- The preferred invasive plant removal technique is mechanical (i.e. remove by hand). Selective herbicides can also be effective but should be implemented only by a professional consultant specializing in invasive plant control in aquatic areas.
- Refer to the invasive weed section of this guide for pictures of common weeds. If these weeds are encountered, they should be removed.

Stone Filter Trench

A stone filter trench is similar to an infiltration trench, but the underground perforated pipe in the trench is connected to storm sewer pipes instead of allowing stormwater runoff to purely infiltrate into the ground. As the name implies, the purpose of a filter trench is to collect stormwater runoff and filter out pollutants prior to discharge into the storm sewer system.

Deco Stone

- Stone bed on top of trench helps filter large particles and debris, while providing an aesthetically-pleasing landscape
- There is no absolute one type of rock that needs to be used for the stone bed. In turn, your filter trench can have a different type of rock, stone, or similar material.



Detail courtesy of ELA Group

Underground Piping

- Stormwater is filtered through the stone layers and collected by the underground perforated pipe connected to the storm sewer system.
- The underground pipe can be checked/inspected via the cleanout access points.

Cleanout

- Connection and access point to the underground piping in the trench.
- Point at which debris can be cleaned from underground piping and/or observe that water is draining from the trench area to the storm sewer piping.

Stone Filter Trench Maintenance

What to Look For

Invasive plants/weeds

Clogged piping

Debris (leaves, trash, etc.)

Standing water

Important Fact Regarding Filter Trenches

With proper maintenance, the life span of a filter trench should be around 30-35 years. Based on influences from the surrounding area, the life span could be shorter or longer than the average. At the end of the life cycle, you may need to consider re-building the trench or installing a different BMP.

Signs of invasive weeds, accumulation of debris, and standing water should be checked at least monthly. Inspecting underground piping via the cleanouts can be performed annually.

Review your O&M Plan for alternate frequencies that may have been approved in the Site Stormwater Management Plan.

Typical Maintenance Indicators	Typical Maintenance Actions
Overgrown vegetation and invasive weeds/ plants	Remove invasive plants and/or vegetation. Selective herbicides can be used if in accordance with local, state, and federal laws. Stone filter trenches should not have any vegetation growing in the stone areas. Presence of vegetation is also a sign that a significant amount of sediment has most likely accumulated in the deco stone and may be clogging the facility.
Signs of dumping (grease, piles of grass clippings, discolored grass, etc.)	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Clogged piping	Pull debris from pipe via the cleanouts. If standing water is encountered in the pipes, there may be a clog at the connection from the perforated piping to the storm sewer system. Contact your local municipality regarding next steps to unclog a connection, which may entail a forced flushing if approved.
Accumulation of sediment, litter, or debris	Remove and properly dispose of accumulated materials such as trash, dirt, and landscape debris (leaves, etc.). Frequent accumulation and/or infrequent maintenance will require periodic replacement of the decorative stone and top of filter fabric (every 3-4 years).
Standing water (BMP not draining or runoff flows over the BMP and does not infiltrate) *If mosquito larvae are present and persistent, contact the PADEP. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.*	Underground piping or stone is most likely clogged with debris, sediment, or other materials, or the rock under the deco stone has been compacted. Check and clean clogged piping or deco stone areas. If the rock has been compacted, the trench will need to be re-built.

Common Stone Filter Trench Issue That Should Be Addressed:

Accumulation of Debris and Sediment

- The deco stone in a filter trench is intended to capture debris, sediment/dirt, and other landscape waste to filter out the stormwater runoff. This built-up debris and waste (leaves, sediment, etc.) should be cleaned out periodically (annually at a minimum).
- Clogging of the voids/open spaces between the stones may result in stormwater ponding or flowing over the trench and causing flooding problems.
- Excessive debris may require removing the stones, cleaning out the debris and sediment, and re-setting the stones. If this is needed, the top layer of filter fabric should also be replaced (be careful not to compact the layer of rock under the filter fabric).

Streambank Restoration

A streambank restoration is a stormwater BMP used for streams that are prone to significant streambank erosion and/or have a substantial build-up of sediment along the water's edge. Streams that have these issues often have not maintained their natural channel design and therefore can have major erosion problems during storm events (or otherwise).

Streambank restoration projects are extremely effective at minimizing erosion and reducing sediment and other pollutants from discharging into the waterways.

Streambank restoration projects are designed specific to the project site since each stream is different and there are different causes of streambank erosion and sediment issues. Most streambank erosion projects involve the regrading of portions of the streambank and then stabilization of the streambank. Stabilization typically includes planting native vegetation and the establishment of a riparian buffer area (see the Riparian Buffer BMP for details). Stabilization may also include the installation of rocks and/or boulders to protect certain sections of stream. Stabilization may also require the modification of existing stormwater culverts or other inlet/outlet structures along the streambank.

Not all streams are in need of a "streambank restoration." A stormwater professional can assist you with evaluating if a streambank restoration would be an effective stormwater BMP on your property.

Streambank Restoration Maintenance

Typical Maintenance Indicators	Typical Maintenance Actions
Poor vegetation establishment/bare spots	Re-seed, re-establish vegetation.
Overgrown vegetation and invasive weeds/plants	Mow or trim as appropriate and remove invasive plants. Selective herbicides can be used if in accordance with local, state, and federal laws. Refer to invasive weeds/plants section of the guide for pictures.
Signs of dumping	Contact your local municipality to report a potential illicit discharge/illegal dumping.
Erosion	Repair/re-seed eroded areas (may need added measures such as erosion control blankets or stone at flow entry points), may include re-grading areas.
Accumulation of sediment	Remove and properly dispose of accumulated materials such as trash and landscape debris. As part of the permit requirements for a streambank restoration, a detailed post construction monitoring plan is required. Areas of sediment accumulation should be closely monitored and managed in accordance with the O&M Plan for the project.
Damage to structural components	Remove any debris or sediment that could plug the outlets. A professional contractor or consultant may be required to assist with re-establishing/re-building a structural component.
General obstructions	Flow channel should be free of any general obstructions. This is critical for large and/or long rain events. Take the time to inspect and remove any general obstructions that may be present prior to forecasted rain.

What to Look For

Accumulation of Sediment, Litter, Debris

Standing Water

Erosion

Overgrown Vegetation/Invasive Weeds

Poor Vegetation Establishment/Bare Spots

Structural Damage

Signs of Dumping

General Obstructions (log jams, etc.)

Other BMPS

Dry Well/Seepage Pit

- A dry well (also known as a seepage pit) collects and stores runoff generally from rooftops and ultimately infiltrates the storm-water.
- A common issue with dry wells is pipe clogging, especially if gutters go un-checked and un-cleaned and the debris clogs into the pipe. This can be a headache especially if the clog is underground.
- Check the actual dry well at least four times per year. Accumulated sediment, debris, etc. in the well should be removed and disposed of on a regular basis.

Flooodplain/Stream Restoration

- Floodplain Restoration (FPR) is considered the "King of BMPs." It is generally a regional BMP treating runoff from multiple or large properties.
- Over the long run, floodplain restoration generally requires the least maintenance of all BMPs. It is important to keep invasive weeds out for the first 3-5 years to allow the native vegetation to establish and build resistance to invasive vegetation.
- Floodplain restoration projects typically require a significant amount of site analysis and permitting prior to construction; therefore, it is important to select a professional with expertise in floodplain restoration if you are interested in pursuing floodplain restoration opportunities on your property.

Landscape Restoration

- Landscape restoration includes restoration of a forest and/or a meadow from turf.
- Revegetation should include only native plants, and it should not require significant chemical maintenance (i.e. fertilizers, pesticides, or herbicides)
- This creates a system with healthy soils that absorb and filter a higher volume of stormwater runoff.
- Mowing should only occur two times per year.

Site Drainage System

- While not necessarily considered a true BMP, a site drainage system (inlets, pipes, etc.) is just as important as the actual BMPs the system may be conveying stormwater to.
- A series of pipes, inlets, etc. are generally more common on commercial/business properties than on residential properties. However, some sub-divisions may have yard inlets connected to the MS4 on individual properties.
- It is important to keep inlet structures to the drainage system clear of debris such as leaves, trash, and other landscape debris.
- Inspect the bottom of inlet structures twice a year and remove accumulated debris, trash, etc. Check for settling of soils and the structural integrity of the inlet structure. Contact your local municipality for guidance if a structure is crumbling or caving in.

Soil Amendments

- Your stormwater management plan may have included Soil Amendments (also known as Soil Restoration) as one of the implemented BMPs.
- Soil amendments are implemented to improve overall drainage conditions and generally involves ripping up existing compacted soils and tilling in a mixture with additives such as compost.
- The restoration process will most likely need to be repeated over time due compaction (especially in high traffic areas).
- Soil tests should be conducted every few years to gauge the nature of the soils and if a repeat of the soil restoration process is necessary.

Stormwater Quality Filter

- The snout is a BMP that helps control debris and trash entering into waterways from impervious surfaces.
- The snout is designed to keep trash, debris and oil out of the waterways. When it enters the well of a stormwater inlet, trash and oil float to the top while debris and other heavy materials settle to the bottom. This allows clean water to exit through the middle and into the waterways.
- The snout should be checked after significant rainfall events to prevent damage and to monitor general wear and tear.

Illicit Discharge/Dumping

Stormwater runoff starts on your roof, lawn, and driveway, as well as on local roads and business parking lots. From there it enters storm drains that ultimately discharge into our streams and creeks. Along the way to the streams, stormwater runoff can pick up pollutants and debris, or debris can clog the system and cause stormwater runoff to pond up and cause flooding problems. The pollutants and debris can affect the quality of the water, including:

- Increased cost in treating drinking water
- Algal blooms that can harm aquatic wildlife
- Chemical pollutants that kill plants and animals
- Unsightly streams with unpleasant odors
- Expensive fines from the DEP and the EPA to fix the problems

Photo: nctcog.org

Illicit Discharge/Dumping

Your municipality was issued a Municipal Separate Storm Sewer System (MS4) Permit that requires your municipality to implement control measures to protect water quality and reduce the potential for the previously listed problems. An MS4 is made up of a series of inlets/storm drains, storm sewer pipes, swales, and outfalls that collect and convey storm-water. Most likely, your stormwater management facility or BMP is connected to the MS4. In turn, stormwater that exits your BMP will most likely end up in local streams.

It is important to keep your BMP free of debris and with stable vegetation to help allow the entire system to function appropriately. Dumping or storing landscape debris (grass clippings, leaves, soil/dirt, etc.) or hazardous materials (oils, grease, etc.) in and around BMPs is not allowed. Pet waste should be cleaned up promptly in a BMP as well. Intermingling of these materials with stormwater can generate polluted discharges or result in an illicit discharge.

If you see something suspicious (soapy suds or unusually colored water flowing into or within a local waterway (or in your BMP), someone dumping material like leaves, grass clippings, trash, or liquids near your BMP or into a local waterway, etc.), please call your municipality.

Photo: fairfaxcounty.gov

Native Plants

Native plants include any plant species that occurred in the area before the region was colonized by Europeans. Native plants are critical to a balanced, healthy ecosystem. Native plants can also be more resistant to drought and disease and tolerate the local climate better than non-native plants. From a stormwater management prospective, many native plants are more effective than their non-native counterparts at stabilizing soil and therefore, minimize runoff. The list of native plants herein is not an exhaustive list of native plants in this region; however, these plants represent some of the common native plants observed in various stormwater BMPs in the area.

For more information on native plants, go to Pennsylvania Department of Conservation and Natural Resources Wild Plants or Pennsylvania Native Plant Society.

www.dcnr.pa.gov/Conservation/WildPlants/LandscapingwithNativePlants/Pages/default.aspx

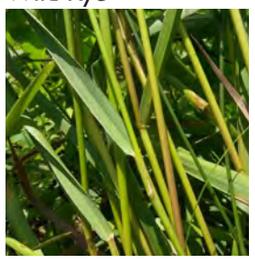
www.panativeplantsociety.org

Native Grasses

Big Bluestem

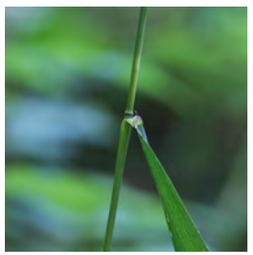

Indian Grass


Wild Rye

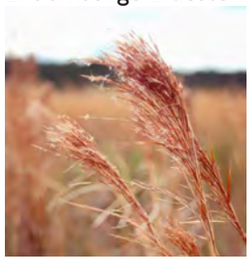



Bee-balm


Bottlebrush Grass




Broomsedge Bluestem




Native Herbs

Adam's-needle Yucca


Blazing Star


Photo sources on pages 64-65

Blue Vervain


Blue-eyed Grass


Boneset


Bottle Gentian


Brown Eyed Susan


Cardinal Flower


Common Sneezeweed


Creamy Violet


Culver's Root


Flat-topped Aster


Golden Ragwort


Goldenrod


Photo sources on pages 64-65

Great Blue Lobelia


Joe-Pye Weed


Marsh Marigold


Monkey Flower


Green-headed Coneflower


Maple-Leaved Waterleaf


Meadow Phlox


New England Aster


Hairy Woodrush

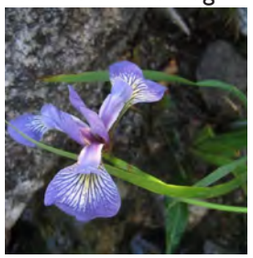

Marginal Woodfern


Meadowsweet


New York Ironweed


Photo sources on pages 64-65

Northern Blue Flag




Oxeye


Purple Bergamot

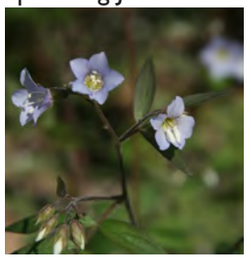

Sea Lavender


Sea Thrift


Sensitive Fern


Spiderwort


Spreading Jacob's Ladder




Swamp Milkweed


Swamp Rose Mallow


Tall Meadow Rue

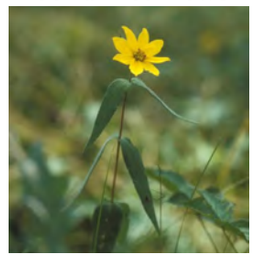

Tall Sunflower


Photo sources on pages 64-65

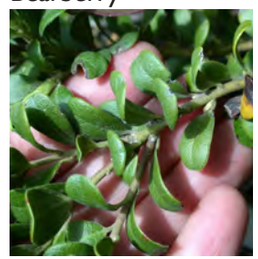
Tall Tickseed


White Bergamot


Woodland Sunflower



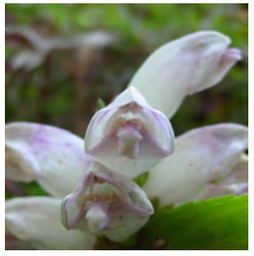

Bearberry




Native Shrub

Virginia Bluebells


White Turtlehead




Arrowwood


Blueberry/Cranberry


White Beardtongue


Wild Geranium


Bayberry


Chokeberry


Photo sources on pages 64-65

Common Elderberry


Mockorange


Silky Dogwood

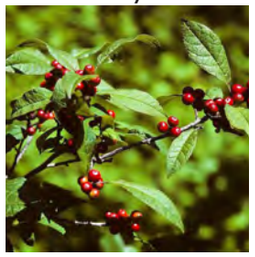

Wild Hydrangea


Gray Dogwood


Ninebark


Snowberry or Coralberry


Winterberry




Inkberry


Rosebay Rhododendron


Spicebush


Photo sources on pages 64-65

Native Trees

Bald Cypress


Boxelder


Green Ash


Kentucky Coffeetree


Black Gum


Cherry Birch


Hackberry


Larch


Blue Spruce


Eastern Redcedar


Jack Pine


Red Oak


Photo sources on pages 64-65

Serviceberry


Sumac


Sweetbay Magnolia


White Ash


White Oak


White Spruce


Willow


Witchhazel


Photo sources on pages 64-65

Invasive Plants

An invasive plant is a species that is often, but not always, a non-native plant that is introduced into an area and then grows so aggressively that it overtakes the area and displaces most of the other vegetation that was growing in the area. Since many invasive species are not native to an area, they do not have the natural predators or other controls in place to limit their growth. So, these species invade the area and can form "monocultures." Invasive plants can cause significant damage to native ecosystems. Invasive plants can adversely impact agriculture, cause damage to human infrastructure, and can pose health risks. Once established, invasive species can be extremely difficult and expensive to control. So, it is critical to remove invasive species as soon as they are detected. The photos below are not an exhaustive list of the invasive plants found in Lancaster County.

Pennsylvania developed a Noxious Weed Control Law and Noxious Weed Control List that is administered by the Pennsylvania Department of Agriculture. The species on this list are extremely aggressive and pose significant risks to the environment and/or human health. The invasive species with an asterisk(*) herein are included on the Noxious Weed List. Property owners with stands of these noxious weeds are supposed to remove them from their property. Many municipalities have ordinances under this law that mandate the control of these weeds. For more information, see:

www.agriculture.pa.gov/Protect/PlantIndustry/NIPPP/Documents/NoxiousWeedLawSummary.pdf

Invasive Aquatic Plants

Brazilian Waterweed


Curly Pondweed

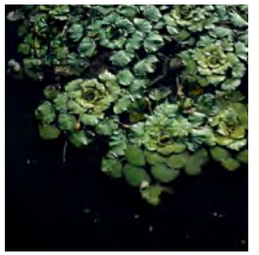

Eurasian Water-milfoil


Floating Primrose-willow


Carolina Fanwort


Didymo


European Water Chestnut

Hydrilla


Photo sources on pages 66-68

Narrow-Leaved Cattail


Chinese Silvergrass


Common Velvet Grass


Reed Canary Grass


Parrot Feather Watermilfoil


Common Bamboo


Japanese Stilt Grass


Rough Bluegrass


Invasive Grasses

Cheatgrass


Common Reed


Ravenna Grass

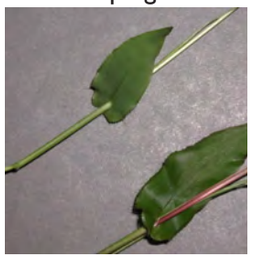

Shattercane*


*noxious weed

Photo sources on pages 66-68

Invasive Herbs

Small Carpetgrass




Tall Fescue


Wavyleaf Basketgrass


Beefsteak Plant


Black, Brown and Spotted Knapweed


Bristled Knotweed


Bull Thistle*


Canada Thistle*


Crown Vetch


Dame's Rocket


Garlic Mustard


Giant Hogweed*


*noxious weed

Photo sources on pages 66-68

Goat's Rue*


Goutweed


Greater Celandine

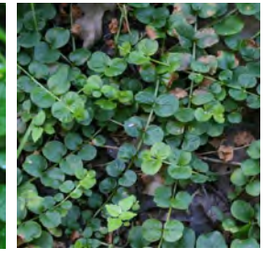

Japanese and Giant Knotweed


Japanese Pachysandra


Jimsonweed*


Lesser Celandine


Moneywort

Musk Thistle*


Narrowleaf Bitercress


Orange Daylily


Poison Hemlock


*noxious weed

Photo sources on pages 66-68

Invasive Shrub

Purple Loosestrife*


Wild Chervil


Burning Bush


Doublefile Viburnum


Smallflower and Hairy Willow-herbs


Wild Parsnip


Butterfly Bush


Glossy Buckthorn


Star-of-Bethlehem


Yellow Flag Iris


Common Buckthorn


Guelder Rose


*noxious weed

Photo sources on pages 66-68

Japanese and European Barberry


Japanese Spiraea


Jetbead


Linden Viburnum


Multiflora Rose*


Privets


Russian and Autumn Olive


Shrub Honeysuckles


Shrub Lespedezas


Wineberry (Wine Raspberry)


Invasive Trees

Amur Maple


Bee-Bee Tree


*noxious weed

Photo sources on pages 66-68

Bradford Pear


European Black Alder


Norway Maple


Sycamore Maple


Cork-Trees


Japanese Angelica Tree


Paper Mulbery


Tree of Heaven


Empress or Princess Tree


Mimosa


Siberian Elm

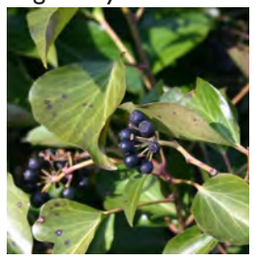

White Mulberry


Photo sources on pages 66-68

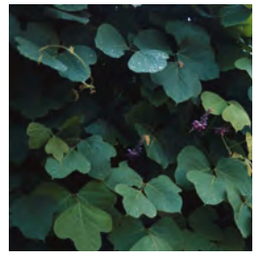
Invasive Vines

Chinese and Japanese Wisteria


English Ivy




Kudzu*

Pale and Black Swallow-Worts


Chocolate Vine


Japanese Honeysuckle


Mile-a-Minute*


Porcelain Berry


Common and Bigleaf Periwinkle


Japanese Hops


Oriental Bittersweet


Winter Creeper


*noxious weed

Photo sources on pages 66-68

Where to Find Your BMP Maintenance Requirements

When your house or place of business was built or an addition/improvement was completed, chances are high that design plans—that included your stormwater management BMPs—were submitted to the local municipality for approval. The municipality will consider long term maintenance of the BMP before approving the design plans. The conditions of maintenance are usually explained in these plans. The section of the plans that includes the BMPs is generally referred to as the "PCSM Plan," "Stormwater Management Plan," or something similar. These plan sheets will show an overview of the entire property with locations of the BMPs and a plan sheet with details of individual BMPs and corresponding notes regarding a BMP.

There are two primary sets of notes you will want to locate and review. The "General Notes" will either be on the very first plan sheet or the plan sheet showing the overview of locations of BMPs on your property. The general notes will call out items such as who will maintain the stormwater BMPs after construction has ended (which will most likely be the property owner). Another common general note is the property owner shall take time to make a visual inspection after all storm events and at least once every three months of the stormwater BMPs to ensure they are functioning appropriately.

Example General Notes from Plan

1. XYZ DEVELOPMENT, INC,. HEREINAFTER REFERRED TO AS "OWNER" SHALL OWN, MAINTAIN AND BE RESPONSIBLE FOR ALL STORMWATER MANAGEMENT AND PERMANENT CONTAINMENT FACILITIES (IE. CULVERTS, OUTLET STRUCTURES, STORMWATER BASIN, FOREBAYS, INFILTRATION BED, ETC.) THAT ARE LOCATED OUTSIDE OF THE STREET RIGHT-OF-WAYS AS PROPOSED ON THE POST CONSTRUCTION STORMWATER MANAGEMENT PLAN (PCSM).
2. THE OWNER SHALL CONDUCT A VISUAL INSPECTION OF ALL STORMWATER MANAGEMENT AND PERMANENT STORAGE FACILITIES AT LEAST ONCE EVERY THREE MONTHS AND IMMEDIATELY AFTER STORM EVENTS. SUCH VISUAL EXAMINIATION SHALL AT LEAST INVOLVE AN EXAMINATION OF THE STORMWATER COLLECTION AND CONVEYANCE SYSTEMS FOR DEBRIS DEPOSITION (SUCH DEBRIS MAY INCLUDE, BUT NOT BE LIMITED TO AGGREGATE MATERIAL, LEAVES, GRASS CLIPPINGS, SOIL AND TRASH), AND AN EXAMINATION OF THE PERMANENT STORAGE STRUCTURES FOR SOIL AND STRUCTURAL SETTLEMENT, DEPRESSIONS, SINKHOLES, SEEPS, TANK LEAKAGE, STRUCTURAL CRACKING, ANIMAL BURROWS, EXCESSIVE VEGETATION, CLOGGING, EROSION AND FOUNDATION MOVEMENT.
3. THE OWNER SHALL REMOVE ANY ACCUMULATION OR DEBRIS AND REPAIR ANY DAMAGE TO THE STORMWATER MANAGEMENT AND PERMANENT STORAGE FACILITIES. REPAIRS SHALL BE MADE USING MATERIAL THAT MEETS OR EXCEEDS THE SPECIFICATIONS PROVIDED ON THE PCSM PLAN.

The second set of notes for a BMP in the design plans (generally found with the details of individual BMPs) will include "Operation and Maintenance Notes." These notes call out specific maintenance that needs to occur for an individual BMP. Most of the operation and maintenance notes for an individual BMP are covered in other sections of this guide. However, there may be more specific maintenance requirements in the design plan that you should be aware of and will want to follow.

Example "Operations and Maintenance Notes" in a PCSM Plan

OPEN CHANNEL SWALE

- THE OPEN CHANNEL SWALE SHALL BE INSPECTED ANNUALLY AND AFTER MAJOR STORM EVENTS. INSPECTIONS SHALL BE IN WET WEATHER TO DETERMINE IF FACILITY IS FUNCTIONING.
- REPAIR EROSIONS AND MAINTAIN ACCESS SURFACE IN GOOD CONDITION
- CHECK FOR DEWATERING WITHIN 48 HOURS OF RAINFALL, NOTICEABLE ODORS, WATER STAINS ON THE FILTER SURFACE OR AT THE OUTLET AND PRESENCE OF ALGAE OR AQUATIC VEGETATION.
- REMOVE AND REPLACE FILTER MEDIA AS NEEDED.
- THE OPEN CHANNEL SWALE SHALL BE MOWED TO MAINTAIN A MAXIMUM GRASS HEIGHT OF LESS THAN 6 INCHES.
- MONITOR CHECK DAMS AND WEIRS FOR FLOW GOING AROUND STRUCTURE,
- EROSION AT THE DOWNSTREAM TOE AND STRUCTURAL DETERIORATION.

STORM WATER BASIN

- FACILITY SHOULD BE INSPECTED ANNUALLY AND AFTER MAJOR STORM EVENTS. INSPECTION SHALL BE PERFORMED DURING WET WEATHER TO DETERMINE IF POND IS FUNCTIONING PROPERLY.
- CHECK FOR WOODY VEGETATION ON DAM AND WITHIN 25 FEET OF RISER.
- VISIBLE SIGNS OF EROSION IN THE POND AS WELL AS THE RIPRAP STONES OUTLET AREA SHALL BE REPAIRED.
- STRUCTURAL COMPONENTS OF THE POND SUCH AS THE DAM, RISER AND PIPES SHALL BE REPAIRED UPON DETECTION OF ANY FAILURE. CHECK FOR MISSING MANHOLE COVERS OR GRATES; CONDITIONS OF CONCRETE AND METAL; OVERALL STRUCTURAL INTEGRITY. GRASS SHOULD BE MAINTAINED AND IN GOOD CONDITION AND BE LESS THAN 12" IN MOWING HEIGHT.
- DEBRIS AND LITTER SHALL BE REMOVED FROM POND WHEN 30% OF STORAGE LOSS HAS BEEN ACHIEVED OR WHEN NECESSARY FOR AESTHETIC REASONS.

Another Example of Operations and Maintenance Notes

§ PERVIOUS PAVEMENT

Pervious pavement should be vacuumed biannually with a commercial cleaning unit. Pavement washing systems or compressed air units are not recommended.

Planted areas adjacent to pervious pavement should be well maintained to prevent soil washout into the pavement. If any washout does occur it should be cleaned off the pavement immediately to prevent further clogging of the pores. If any bare spots or eroded areas are observed within the planted areas, they should be replanted and/or stabilized immediately.

Do not allow construction staging, hazardous materials storage, or soil/mulch storage on unprotected pervious pavement surface.

Do not use sand, cinders, or other abrasives on pervious pavement for winter maintenance.

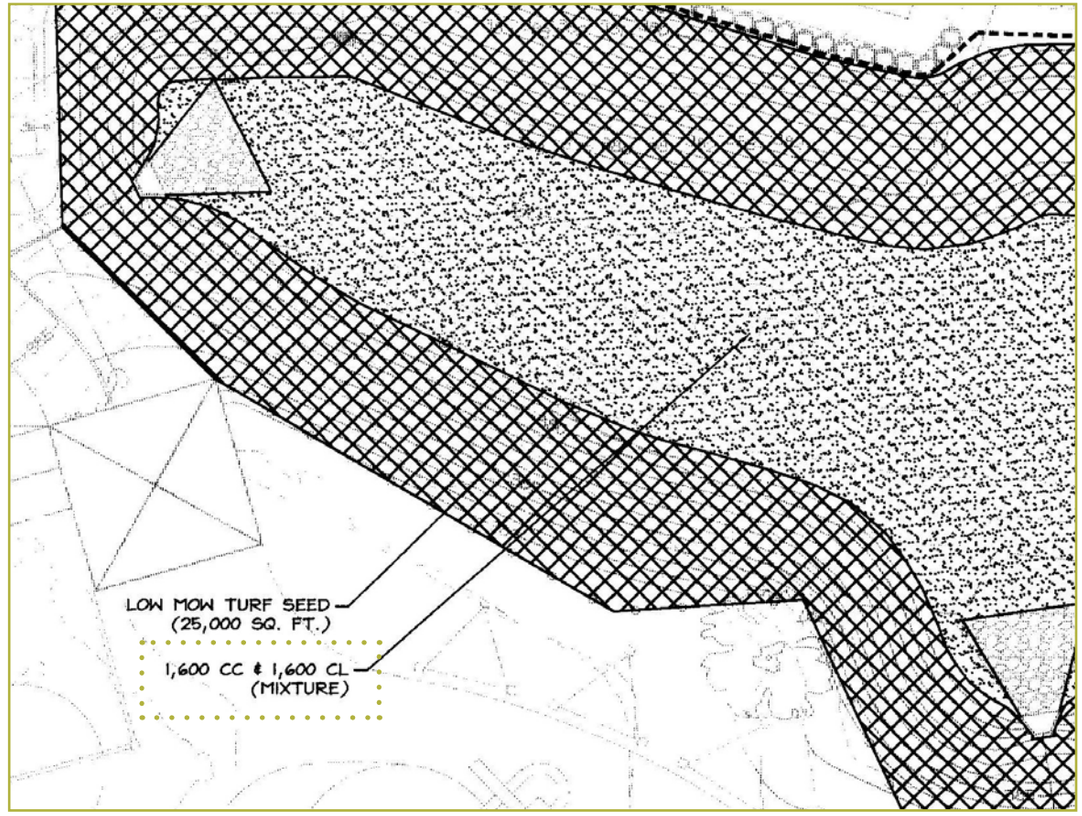
Do not seal coat any portion of the pervious pavement surface for any reason.

Another plan sheet in the design plans that are related to the BMPs and sometimes overlooked is the "Landscape Plan" (sometimes referred to as the "Planting Plan" or a similar name). The Landscape Plan will show what the permanent vegetation and conditions should be for a BMP. The permanent vegetation may be turf grass, a type of perennial plant, or a combination. Conditions shown in the plan may include how much mulch or types of soil amendments that should be in place or added at periodic intervals.

If you do not have a copy of the design plans for your property, you can contact your local municipality to see if they can provide a copy for you. If a copy is not available or conditions have changed, you can build your own maintenance plan (see the "How to Build Your Own Maintenance Plan" section in this guide). It is also a good idea to use both the tips outlined in this guide together with the design plan notes to help make sure all considerations are covered.

The **Homeowner's Guide to Best Management Practice Operations & Maintenance** was developed to help owners understand, locate, or develop the maintenance requirements necessary for a fully functioning stormwater management BMP.

Example Planting Plan for an Infiltration Basin



Exact Types of Vegetation/plants That Should Be in Basin per example above

QTY.	KEY	BOTANICAL NAME	COMMON NAME
1,600	CC	Carex crinita	Fringed Sedge
1,600	CL	Carex lurida	Lurid Sedge

How to Build Your Own Maintenance Plan

A maintenance plan for your BMPs can be very comprehensive or simple. It is more about "styles vs. standards." The standard is a maintenance plan is a very good idea. The style of the maintenance plan is up to you. A maintenance plan should outline the who, what, when, where, and how for an individual BMP. At the end of the day, you want to spell out the details behind inspections and maintenance activities.

The **Homeowner's Guide to Best Management Practices Operation & Maintenance** was developed specifically to assist BMP owners with maintaining their stormwater management facilities. Details, common issues, and considerations for individual types of BMPs are included in the guide. Each individual BMP type also includes a Maintenance Table outlining "typical maintenance indicators" and corresponding "typical maintenance actions." The Maintenance Table can be used as your master checklist for inspections and guiding maintenance activities if an issue or poor conditions are encountered. In reality, the conditions described in the Maintenance Table are generally the same conditions your local municipality will be observing if your BMP is inspected.

The Who?

List who will be responsible for inspections and maintenance activities. You may perform most maintenance yourself but need help with one or two of your BMPs. For example, one of your BMPs may be porous paving. Most homeowners or small business owners do not own a vacuum truck to clean the paving area twice a year. In turn, list who will vacuum the porous paving area.

The What?

List what you are inspecting and what maintenance activities will need to occur. Refer to the guide sheets and corresponding Maintenance Tables for individual BMPs.

The When?

The Operation and Maintenance Notes in the original design plans should tell you when you should inspect and when certain maintenance activities should occur. If there are no design plans, follow the tips in the guide sheets for individual BMPs. At a minimum, you should consider inspecting once every season. Specific actions such as replacing mulch media might need to occur every spring. If this is the case, note it.

The Where?

This is simply the locations of all your BMPs that need to be inspected and maintained. It is a good idea to also outline where removed trash, debris, or landscape waste will be disposed.

The How?

Outline how you will maintain certain features. As an example, one item that needs focus may be keeping invasive vegetation out of your BMP. You could either remove by hand or apply approved and allowed herbicides,or perhaps a combination.

To build your own maintenance plan, you generally want to start with the Operation and Maintenance Notes in the original and approved design plans (see the "Where to Find Your BMP's Maintenance Requirements" section). These will provide the over-arching maintenance considerations you should be concerned with. Generally, the notes will spell out when you should be inspecting your BMPs. If the original design plans cannot be found or do not describe maintenance activities, then use the guide sheets for individual BMPs to outline maintenance activities.

You can always contact a professional to help with your maintenance plan if you feel unsure about the exact maintenance needed for your BMPs.

Building your maintenance plan for a BMP example:

Your BMP is a detention basin, and the Operation and Maintenance Notes in the design plans may indicate "vegetation shall be re-established in scoured or eroded areas where the vegetation did not successfully establish or died."

Next, look at the planting or landscape plan in the design plans for the vegetation that should be observed in the basin (if you are unsure what the vegetation looks like, refer to the Plant Picture section in the guide). Make a note of the required vegetation. Most likely, a Plant List will be on the Planting Plan that spells out the exact vegetation/plants.

Refer to the individual BMP information sheet for Dry Detention Basins in the **Homeowner's Guide to Best Management Practices Operation & Maintenance.** Per the Maintenance Table, you will need to re-seed or re-establish vegetation in bare spot areas. Pictures are provided in the common issues section of examples of poor vegetation coverage that you should look for. When you inspect your basin, you will be looking for similar types of conditions as shown in the pictures. If these conditions are encountered, you will need to perform maintenance and re-plant/re-seed the required vegetation.

Native Plant Photo Sources

Adam's-needle Yucca
Rebekah D. Wallace, University of Georgia, Bugwood.org

Robert Vidéki, Doronicum Kft., Bugwood.org

Arrowwood
Troy Evans, Great Smoky Mountains National Park, Bugwood.org

James H. Miller & Ted Bodner, Southern Weed Science Society, Bugwood.org

Bald Cypress
Paul Wray, Iowa State University, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Bayberry
coldstreamfarm.net

K M, NC State Extension, plants.ces.ncsu.edu

Bearberry
Mary Ellen (Mel) Harte, Bugwood.org

Dave Powell, USDA Forest Service (retired), Bugwood.org

Bee-balm
Charles T. Bryson, USDA Agricultural Research Service, Bugwood.org

Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org

Big Bluestem
Chris Evans, University of Illinois, Bugwood.org

Pat Sauer, Iowa Stormwater Education Partnership, Bugwood.org

Black Gum
Chris Evans, University of Illinois, Bugwood.org

Franklin Bonner, USFS (ret.), Bugwood.org

Blazing Star
Becca MacDonald, Sault College, Bugwood.org

Beverly Turner, Jackson Minnesota, Bugwood.org

Blue Spruce
Paul Wray, Iowa State University, Bugwood.org

Robert Vidéki, Doronicum Kft., Bugwood.org

Blue Vervain
Ohio State Weed Lab, The Ohio State University, Bugwood.org

Ohio State Weed Lab, The Ohio State University, Bugwood.org

Blueberry/Cranberry
Chris Schnepf, University of Idaho, Bugwood.org

Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Blue-eyed Grass
David Stephens, Bugwood.org

Dave Powell, USDA Forest Service (retired), Bugwood.org

Boneset
Rob Routledge, Sault College, Bugwood.org

Bottle Gentian
Katy Chayka, www.minnesotawildflowers.info, Bugwood.org

Steven Katovich, USDA Forest Service, Bugwood.org

Bottlebrush Grass
Chris Evans, University of Illinois, Bugwood.org

Rob Routledge, Sault College, Bugwood.org

Box Elder
Paul Wray, Iowa State University, Bugwood.org

Robert Videki, Doronicum Kft., Bugwood.org

Broomsedge Bluestem
John M. Randall, The Nature Conservancy, Bugwood.org

James H. Miller, USDA Forest Service, Bugwood.org

Brown Eyed Susan
Peter Dziuk, Minnesota Department of Agriculture, Bugwood.org

Cardinal Flower
John D. Byrd, Mississippi State University, Bugwood.org

Cherry Birch
Richard Webb, Bugwood.org

Rob Routledge, Sault College, Bugwood.org

Chokeberry
xinyiflowers.com

www.rhs.org.uk

Common Elderberry
Peter M. Dziuk, minnesotawildflowers.info

Common Sneezeweed
Beverly Turner, Jackson Minnesota, Bugwood.org

Elmer Verhasselt, Bugwood.org

Creamy Violet
illinoiswildflowers.info

Culver's Root
Pat Sauer, Iowa Stormwater Education Partnership, Bugwood.org

David Cappaert, Bugwood.org

Eastern Redcedar
Paul Wray, Iowa State University, Bugwood.org

Flat-topped Aster
Peter Dziuk, Anoka County, https://www.minnesotawildflowers.info

K. Chayka taken, Anoka County, https://www.minnesotawildflowers.info

Golden Ragwort
newmoonnursery.com

piedmontgardener.com

Goldenrod
Karan A. Rawlins, University of Georgia, Bugwood.org

Richard A. Howard, hosted by the USDA-NRCS PLANTS Database

Gray Dogwood
Les Mehrhoff, discoverlife.org

Sheryl Pollock, discoverlife.org

Great Blue Lobelia
Rob Routledge, Sault College, Bugwood.org

Katy Chayka, www.minnesotawildflowers.info, Bugwood.org

Green Ash
Kara A. Rawlins, University of Georgia, Bugwood.org

Franklin Bonner, USFS(ret.), Bugwood.org

Green-headed Coneflower
swcoloradowildflowers.com

Hackberry
Paul Wray, Iowa State University, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Hairy Woodrush
Peter M. Dziuk, minnesotawildflowers.info

Indian Grass
Karan A. Rawlins, University of Georgia, Bugwood.org

Amy Kay, City of Cedar Falls, Bugwood.org

Inkberry
Chris Evans, University of Illinois, Bugwood.org

Jack Pine
Joseph OBrien, USDA Forest Service, Bugwood.org

Paul Wray, Iowa State University, Bugwood.org

Joe-Pye Weed
rocksolidlandscape.com

Kentucky Coffeetree

Larch
Bill Cook, Michigan State University, Bugwood.org

Maple-leaved Waterleaf
R.W. Smith, Wildflower Center Digital Library, wildflower.org

http://botanicallyinclined.org

Marginal Wood Fern
Chris Evans, University of Illinois, Bugwood.org

Marsh Marigold
Joseph OBrien, USDA Forest Service, Bugwood.org

Meadow Phlox
mountvenusnursery.com

Gijs Haverkamp, esveld.nl

Meadowsweet
Rob Routledge, Sault College, Bugwood.org

Mock Orange
Dow Gardens, Dow Gardens, Bugwood.org

Richard Webb, Bugwood.org

Monkey Flower
Peter Dziuk, Minnesota Department of Agriculture, Bugwood.org

New England Aster
Pennsylvania Department of Conservation and Natural Resources - Forestry, Bugwood.org

Harlan B. Herbert, Bugwood.org

New York Ironweed
Karan A. Rawlins, University of Georgia, Bugwood.org

Ninebark
Rob Routledge, Sault College, Bugwood.org

Richard Webb, Bugwood.org

Northern Blue Flag
Rob Routledge, Sault College, Bugwood.org

Elmer Verhasselt, Bugwood.org

Oxeye
Karan A. Rawlins, University of Georgia, Bugwood.org

Purple Bergamot
Harlan B. Herbert, Bugwood.org

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Red Oak
Paul Wray, Iowa State University, Bugwood.org

Rosebay Rhododendron
Chris Evans, University of Illinois, Bugwood.org

Dow Gardens , Dow Gardens, Bugwood.org

Sea Lavender
Joy Viola, Northeastern University, Bugwood.org

Sea Thrift
Joy Viola, Northeastern University, Bugwood.org

Dow Gardens, Dow Gardens, Bugwood.org

Sensitive Fern
Chris Evans, University of Illinois, Bugwood.org

Serviceberry
Doug Doohan, Ohio State University/ OARDC, Bugwood.org

John Ruter, University of Georgia, Bugwood.org

Silky Dogwood
Will Cook, carolinanature.com

Snowberry or Coralberry
Dave Powell, USDA Forest Service (retired), Bugwood.org

Spicebush
Vern Wilkins, Indiana University, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Spiderwort
Karan A. Rawlins, University of Georgia, Bugwood.org

Spreading Jacob's Ladder
Chris Evans, University of Illinois, Bugwood.org

Sumac
missouribotanicalgarden.org

Robert Vidéki, Doronicum Kft., Bugwood.org

Swamp Milkweed
David Cappaert, Bugwood.org

Ohio State Weed Lab, The Ohio State University, Bugwood.org

Swamp Rose Mallow
Rebekah D. Wallace, University of Georgia, Bugwood.org

Sweetbay Magnolia
Charles T. Bryson, USDA Agricultural Research Service, Bugwood.org

T. Davis Sydnor, The Ohio State University, Bugwood.org

Tall Meadow Rue
Chris Evans, University of Illinois, Bugwood.org

Tall Sunflower
Joseph LaForest, University of Georgia, Bugwood.org

Tall Tickseed
Rob Routledge, Sault College, Bugwood.org

James H. Miller & Ted Bodner, Southern Weed Science Society, Bugwood.org

Virginia Bluebells
David Cappaert, Bugwood.org

Charles T. Bryson, USDA Agricultural Research Service, Bugwood.org

White Ash
Paul Wray, Iowa State University, Bugwood.org

Keith Kanoti, Maine Forest Service, Bugwood.org

White Beardtongue
Pat Sauer, Iowa Stormwater Education Partnership, Bugwood.org

White Bergamot
Vern Wilkins, Indiana University, Bugwood.org

White Oak
Paul Wray, Iowa State University, Bugwood.org

White Spruce
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Joseph OBrien, USDA Forest Service, Bugwood.org

White Turtlehead
James Henderson, Golden Delight Honey, Bugwood.org

Wild Geranium
Patricia M. Ciesla, Forest Health Management International, Bugwood.org

Karan A. Rawlins, University of Georgia, Bugwood.org

Wild Hydrangea
John Ruter, University of Georgia, Bugwood.org

Charles T. Bryson, USDA Agricultural Research Service, Bugwood.org

Wild Rye
www.illinoiswildflowers.info

Willow
Paul Wray, Iowa State University, Bugwood.org

Winterberry
David Lee, Bugwood.org

Richard Webb, Bugwood.org

Witchhazel
Paul Wray, Iowa State University, Bugwood.org

Bill Cook, Michigan State University, Bugwood.org

Woodland Sunflower
Catherine Herms, The Ohio State University, Bugwood.org

Rebekah D. Wallace, University of Georgia, Bugwood.org

Invasive Plant Photo Sources

Amur Maple
Dow Gardens, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Bee-Bee Tree
Pat Breen, Oregon State University, http://oregonstate.edu/dept/ldplants/index.htm

Beefsteak Plant
Marisa Williams, University of Arkansas, Fayetteville, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Black, Brown and Spotted Knapweed
Rob Routledge, Sault College, Bugwood.org

Bradford Pear
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Chuck Bargeron, University of Georgia, Bugwood.org

Brazilian Waterweed
Graves Lovell, Alabama Department of Conservation and Natural Resources, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Bristled Knotweed
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Bull Thistle
John Cardina, The Ohio State University, Bugwood.org

Britt Slattery, US Fish and Wildlife Service, Bugwood.org

Burning Bush
Richard Gardner, UMES, Bugwood.org

Butterfly Bush
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Dow Gardens, Dow Gardens, Bugwood.org

Canada Thistle
Jan Samanek, Phytosanitary Administration, Bugwood.org

Carolina Fanwort
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Cheatgrass
Tom Heutte, USDA Forest Service, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Chinese and Japanese Wisteria
James H. Miller & Ted Bodner, Southern Weed Science Society, Bugwood.org

Joseph LaForest, University of Georgia, Bugwood.org

Chinese Silvergrass
Chris Evans, University of Illinois, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Chocolate Vine
James H. Miller, USDA Forest Service, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Common and Bigleaf Periwinkle
Dan Tenaglia, Missouriplants.com, Bugwood.org

James H. Miller, USDA Forest Service, Bugwood.org

Common Bamboo
Chuck Bargeron, University of Georgia, Bugwood.org

Common Buckthorn
Jan Samanek, Phytosanitary Administration, Bugwood.org

John M. Randall, The Nature Conservancy, Bugwood.org

Common Reed
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Caleb Slemmons, National Ecological Observatory Network, Bugwood.org

Common Velvet Grass
Forest and Kim Starr, Starr Environmental, Bugwood.org

John M. Randall, The Nature Conservancy, Bugwood.org

Cork-Trees
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Crown Vetch
Dan Tenaglia, Missouriplants.com, Bugwood.org

UAF Cooperative Extension, University of Alaska - Fairbanks, Bugwood.org

Curly Pondweed
Chris Evans, University of Illinois, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Dame's Rocket
Richard Gardner, UMES, Bugwood.org

David Cappaert, Bugwood.org

Didymo
Mark S. Hoddle, University of California - Riverside, Bugwood.org

David Perez, Bugwood.org

Doublefile Viburnum
Denise Ellsworth, The Ohio State University, Bugwood.org

Dow Gardens, Dow Gardens, Bugwood.org

Empress or Princess Tree
Jil Swearingen, USDI National Park Service, Bugwood.org

Great Smoky Mountains National Park Resource Management, USDI National Park Service, Bugwood.org

English Ivy
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

James H. Miller, USDA Forest Service, Bugwood.org

Eurasian Water-milfoil
Chris Evans, University of Illinois, Bugwood.org

European Black Alder
Robert Videki, Doronicum Kft., Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

European Water Chestnut
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Floating Primrose-willow
John M. Randall, The Nature Conservancy, Bugwood.org

Graves Lovell, Alabama Department of Conservation and Natural Resources, Bugwood.org

Garlic Mustard
Chris Evans, University of Illinois, Bugwood.org

Giant Hogweed
Robert Vidéki, Doronicum Kft., Bugwood.org

USDA APHIS PPQ - Oxford, North Carolina, Bugwood.org

Glossy Buckthorn
Rob Routledge, Sault College, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Goat's Rue
USDA APHIS PPQ - Oxford, North Carolina, Bugwood.org

Steve Dewey, Utah State University, Bugwood.org

Goutweed
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Greater Celandine
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Guelder Rose
Dow Gardens, Dow Gardens, Bugwood.org

Hydrilla
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Japanese and European Barberry
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Japanese and Giant Knotweed
Chris Evans, University of Illinois, Bugwood.org

Jan Samanek, Phytosanitary Administration, Bugwood.org

Japanese Angelica Tree
John Ruter, University of Georgia, Bugwood.org

T. Davis Sydnor, The Ohio State University, Bugwood.org

Japanese Honeysuckle
Chris Evans, University of Illinois, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Japanese Hops
Chris Evans, University of Illinois, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Japanese Pachysandra
Rob Routledge, Sault College, Bugwood.org

Karan A. Rawlins, University of Georgia, Bugwood.org

Japanese Spiraea
UConn Plant Database, Bugwood.org

James H. Miller, USDA Forest Service, Bugwood.org

Japanese Stilt Grass
Chuck Bargeron, University of Georgia, Bugwood.org

Bruce Ackley, The Ohio State University, Bugwood.org

Jetbead
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Jimsonweed
Bruce Ackley, The Ohio State University, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Kudzu
David J. Moorhead, University of Georgia, Bugwood.org

David J. Moorhead, University of Georgia, Bugwood.org

Lesser Celandine
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Linden Viburnum
Doug Manning, National Park Service, Bugwood.org

Dave Powell, USDA Forest Service

Mile-a-Minute
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Mimosa
Lesley Ingram, Bugwood.org

Chuck Bargeron, University of Georgia, Bugwood.org

Moneywort
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Multiflora Rose
Rob Routledge, Sault College, Bugwood.org

James H. Miller, USDA Forest Service, Bugwood.org

Musk Thistle
Dan Tenaglia, Missouriplants.com, Bugwood.org

Narrowleaf Bitercress
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Narrow-Leaved cattail
Theodore Webster, USDA Agricultural Research Service, Bugwood.org

Rob Routledge, Sault College, Bugwood.org

Norway Maple
Jan Samanek, Phytosanitary Administration, Bugwood.org

Orange Daylily
Dan Tenaglia, Missouriplants.com, Bugwood.org

Britt Slattery, US Fish and Wildlife Service, Bugwood.org

Oriental Bittersweet
Nancy Loewenstein, Auburn University, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Pale and Black Swallow-Worts
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Theodore Webster, USDA Agricultural Research Service, Bugwood.org

Paper Mulbery
John Ruter, University of Georgia, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Parrot Feather Watermilfoil
Nancy Loewenstein, Auburn University, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Poison Hemlock
Ohio State Weed Lab, The Ohio State University, Bugwood.org

John D. Byrd, Mississippi State University, Bugwood.org

Porcelain Berry
Jil Swearingen, USDI National Park Service, Bugwood.org

Privets
Karan A. Rawlins, University of Georgia, Bugwood.org

Richard Webb, Bugwood.org

Purple Loosestrife
John D. Byrd, Mississippi State University, Bugwood.org

Bernd Blossey, Cornell University, Bugwood.org

Ravenna Grass
Joseph M. DiTomaso, University of California - Davis, Bugwood.org

The Nature Conservancy, The Nature Conservancy, Bugwood.org

Reed Canary Grass
Chris Evans, University of Illinois, Bugwood.org

Mark Frey, The Presidio Trust, Bugwood.org

Rough Bluegrass
Graham Calow, Sapcote, Naturespot.org

wildseed.co.uk

Russian and Autumn Olive
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Paul Wray, Iowa State University, Bugwood.org

Shattercane
Howard F. Schwartz, Colorado State University, Bugwood.org

Forest and Kim Starr, Starr Environmental, Bugwood.org

Shrub Honeysuckles
Chris Evans, University of Illinois, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Shrub Lespedezas
James H. Miller, USDA Forest Service, Bugwood.org

Chris Evans, University of Illinois, Bugwood.org

Siberian Elm
Tom DeGomez, University of Arizona, Bugwood.org

John M. Randall, The Nature Conservancy, Bugwood.org

Small Carpetgrass
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Smallflower and Hairy Willow-herbs
Karan A. Rawlins, University of Georgia, Bugwood.org

Rob Routledge, Sault College, Bugwood.org

Star-of-Bethlehem
Richard Gardner, UMES, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Sycamore Maple
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Tall Fescue
James Miller & Ted Bodner, Southern Weed Science Society, www.invasive.org

www.forestventure.com

Tree of Heaven
Chuck Bargeron, University of Georgia, Bugwood.org

Richard Gardner, UMES, Bugwood.org

Wavyleaf Basketgrass
Rebekah D. Wallace, University of Georgia, Bugwood.org

Kerrie L. Kyde, Maryland Department of Natural Resources, Bugwood.org

White Mulberry
John M. Randall, The Nature Conservancy, Bugwood.org

Ohio State Weed Lab, The Ohio State University, Bugwood.org

Wild Chervil
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Wild Parsnip
Ohio State Weed Lab, The Ohio State University, Bugwood.org

Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Wineberry (Wine Raspberry)
Leslie J. Mehrhoff, University of Connecticut, Bugwood.org

Winter Creeper
James H. Miller, USDA Forest Service, Bugwood.org

Yellow Flag Iris
Todd Pfeiffer, Klamath County Weed Control, Bugwood.org

Nancy Loewenstein, Auburn University, Bugwood.org

Additional Resources/Other Sources

Pennsylvania Stormwater Best Management Practices Manual
www.elibrary.dep.state.pa.us/dsweb/View/Collection-8305

Lancaster County Clean Water Consortium
www.lccwc.com

United States Environmental Protection Agency
www.epa.gov

Pennsylvania Department of Environmental Protection
www.dep.pa.gov

Lancaster County Conservation District
www.lancasterconservation.org

LandStudies, Inc.
www.landstudies.com

Photography
Photos are by LandStudies, unless otherwise noted