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.

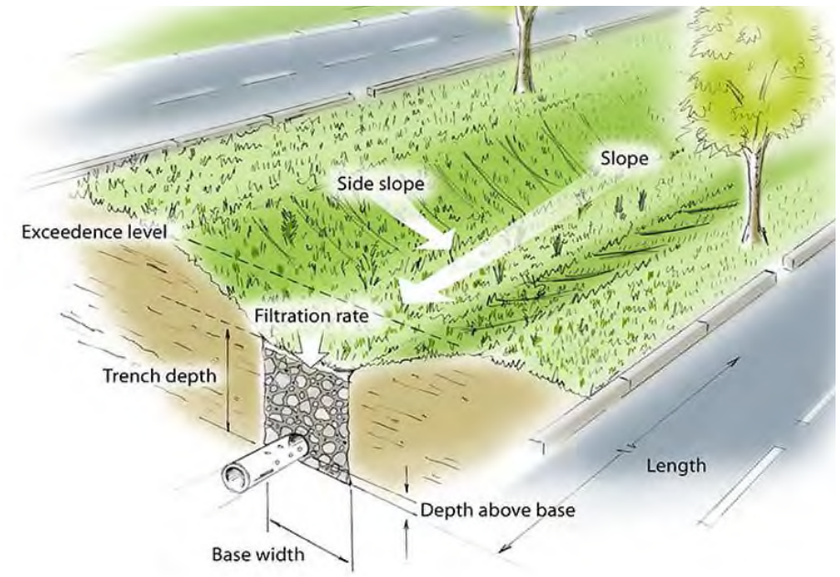

Photo: City of Lafayette

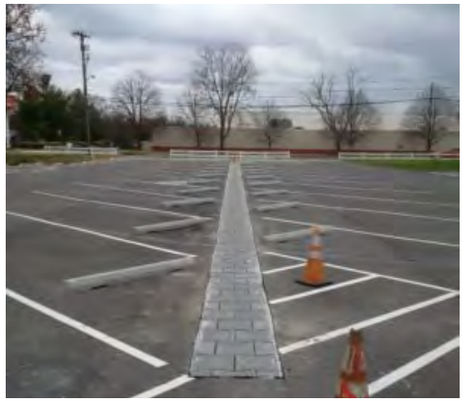

Photo: thecleanwaterpartnership.com

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.

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Overgrown Vegetation/Invasive Weeds

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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.