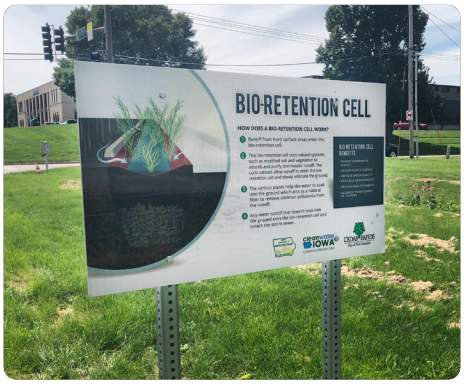

Inspection & Maintenance Guide for Stormwater BMPs

Ensuring Long-Term Function through Routine Inspection & Maintenance

Published February 2020

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This document is a publication of the Iowa Stormwater Education Partnership (ISWEP) and is made possible through partnerships with Iowa communities and organizations that are committed to improving the quality of Iowa's rivers, streams, creeks and lakes through local education and outreach efforts.

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ISWEP does not officially endorse any products, trade names, or services as named in this publication. This document serves as a general guide and does not include an exhaustive list of all inspection and maintenance points. Consult contract maintenance plans for more detailed information.

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SECTION 1. STORMWATER MANAGEMENT IN IOWA

Traditional stormwater management practices aim to drain the landscape of rainfall and snowmelt as quickly as possible. Runoff flows into the street, along the curb, and into a storm drain, where a system of underground pipes transports it to the nearest waterbody. This approach to stormwater management or "gray" infrastructure is commonly used in Iowa.

The majority of mid to large cities in Iowa have a storm sewer system that is separate from the sanitary sewer system, known as a Municipal Separate Storm Sewer Systems (MS4). Stormwater that reaches the storm sewer system in most communities is not treated before entering a waterway unlike the sanitary sewer system.

As stormwater moves across the landscape it collects pollutants such as bacteria, sediment, fertilizers, pesticides, salt, trash, gas, oils, yard waste, lead, and heavy metals. The resulting discharge into local waterbodies contains these contaminants that can have adverse impacts on aquatic life. The pollutants can cause fish kills, algae blooms, eutrophication, and beach closures due to bacteria contamination that is harmful to human health.

The amount of water being conveyed into local waterbodies is also a concern with traditional "gray" infrastructure. Increased runoff volume and peak flows contributes to streambank erosion and channel degradation through the destabilization of soil structure. Localized flash flooding is a direct result of less rainfall being absorbed by the landscape and more runoff being generated by impervious surfaces such as rooftops, driveways and streets. This increases the quantity at which runoff reaches the storm sewer system and consequently local waterways.

Managing stormwater is directly related to land use; as local development occurs and more land is converted to impervious surfaces, more stormwater will be generated and require management for quality and quantity. Likewise, urban and rural developments in the entire watershed, or the area that drains into a stream or river, alters the landscape's natural hydrology.

Innovations in stormwater treatment have expanded the number of best management practices (BMPs) to include more natural systems, also known as "green" infrastructure. These BMPs are designed to capture, infiltrate, cleanse, and detain rainfall as close to where it lands on the landscape. Through a combination of vegetation, soils, engineered structures, and other elements, stormwater BMPs attempt to restore the hydrological function of the landscape and soil. The more structural stormwater BMPs are designed by licensed engineers or landscape architects. Design professionals give special consideration to watershed size, soil types, local hydrological conditions, and the primary function of various BMPs when selecting the right practice for a certain landscape or water quality or quantity (i.e. flood control) problem.

Most stormwater BMPs are designed to add aesthetic and habitat value to the landscape. However, some also have recreational benefits. Ensuring the long-term function and acceptance of these practices requires routine inspection and maintenance.

SECTION 2. IMPORTANCE OF ROUTINE MAINTENANCE

All stormwater BMPs require maintenance over their intended life span. It is estimated that well maintained BMPs can have have a life span that ranges from 20-30 years depending on the type of BMP. Life span refers to the BMP's ability to adequately perform either water quality and/or quantity (flood control) functions and the condition of structural or material components.

Maintenance is not only critical for ensuring the intended functions of BMPs but also for aesthetics, safety, and financial investment. Since stormwater BMPs are landscape features, typical maintenance tasks (i.e. weeding and mowing) are required to prevent the landscape from becoming overgrown and untidy, which can determine how the public percieves the BMP.

Stormwater BMPs if not maintained properly can cause public safety concerns, especially those designed for flood management and stormwater conveyance. Some simple safety improvements might include replacing safety fences when damaged, visible and effective signage, and mowed borders around certain BMPs to improve visibility.

Maintenance protects the owner's financial investment of installing a BMP. Since some BMPs may be more expensive to install than others, routine inspections and subsequent maintenance actions prevent costly rehabilitation. Preventative maintenance actions should be planned to avoid correction repairs.

Preventative maintenance also includes monitoring systems for signs of illicit substances being discharged into the BMP. Sanitary wastewater, failing septic tank systems, and vehicle maintenance activities, among others, are sources of illicit discharges that should be monitored for entry into stormwater BMPs. Monitor inlets to the system during dry weather flows and contact municipal or county officials if an illicit discharge is evident.

Ways to ensure that BMPs are cared for over time is routine inspection and adoption of a maintenance plan that is agreed to by the owner of the practice. Maintenance plans should include a schedule for inspections, routine maintenance procedures, and local contact information for completing the work.

Other components of the plan may include directions for weed control and chemical use, manufacturer's recommendations for any proprietary devices installed, or safety requirements for those conducting the maintenance. The plan should include approved plan drawings and an as-built plan set. Staff should be trained on specific details associated with each BMP.

To assist maintenace workers with plant and weed identification for BMPs installed with native species, the Iowa Stormwater Education Partnership (ISWEP) has created a pocket-size field guide for quick reference. A complimentary mobile application is also available for download on all major platforms. Contact ISWEP to inquire about hard copies. More detailed information may be found in the Iowa Stormwater Management Manual.

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NATIVE LANDSCAPING

Native landscaping is the use of native prairie and woodland plants with deep root systems. It is often used in prairie reconstructions in large areas and as filter strips in smaller urban areas. Plant roots create pore space in the soil below and allow rainfall to percolate deep into the ground. Native plants are adapted to Iowa's climate and are tolerant of weather extremes. They create diverse habitat that attract birds, butterflies, and other wildlife. Most importantly, once established, they don't require fertilizer, pesticides, and supplemental water to survive.

If plants native to Iowa are strategically placed, it will enhance the landscape's ability to infiltrate and manage stormwater. Many of the other infiltration-based stormwater management practices use native plants to add functionality, beauty and habitat. Even though maintenance needs should reduce over time, routine maintenance is needed to prevent volunteer trees or other successional species from overtaking desired permanent vegetation.

INSPECTION CHECKLIST

- [ ] Inspect the entire native planting area (and perform maintenance as needed) quarterly during Year 1 through 3 after initial establishment (i.e. April, June, August, and October).
- [ ] Inspect for weeds. Competing weeds will outgrow native plants in the first two years of establishment. Consult the plan specifications to match vegetation with seed species design.
- [ ] Check height of competing vegetation to ensure native plants receive sunlight (no more than 6-9 inches in height).
- [ ] Consider weather and site conditions when planning a maintenance trip and schedule trips to maximize effectiveness of weed control and minimize damage to desired vegetation.
- [ ] Inspect the general health of native plants (vegetation color, die-off, pests, etc.).
- [ ] Inspect for areas of exposed or bare soil, which can indicate erosion or scouring.
- [ ] Document dates and types of activities performed.

MOWING GUIDELINES

General Recommendations

- Use string trimmers as needed in areas that are not accessible by mowing equipment.
- Mow weeds before they get to be 2 feet tall and try to mow before weeds generate seeds.
- Do not mow after weeds are 4 to 6 feet tall. At that point, it is better to not mow. Doing so will put a mat of material on the new emerging seedlings.
- Don't use herbicides. Spot mowing / trimming is preferred over chemical use for weed control.
- Chemical spot treatments of noxious weeds will also potentially kill native forbs.

First Year Requirements

- Scout the area in the fall to monitor plant establishment.
- Following dormant/early seeding or planting, perform initial mowing of the seeded/planted area when growth reaches 12 inches.
- For the first mowing, cut vegetation to a height of 3-4 inches.
- Mow native vegetation areas within the contract limits, likely designated as 2 to 3 times from June through July (depends on rainfall, mow before any weeds get "knee height").
- For subsequent mowings, mow down to approximately a 6-8 inch height.
- Do not mow after August 1.
- Ensure live plants receive adequate water.

Second Year Requirements

- Mow native vegetation areas at least once from June 15 through July 15.
- Evaluate the native vegetation area at the beginning of subsequent maintenance trips to see if additional mowing or trimming will be needed.
- Spot mowing may be needed in areas where weed pressure is still prevalent.

Third Year (and Beyond) Requirements

- Mow between July 15 and August 31 to reduce unwanted grass species and support establishment of forbs.
- Collect and remove trimmed materials (hay) from the mowed area.

Using a string trimmer

Handheld spot treatment

Waterloo / Cedar Falls Courier

Wild parsnip noxious weed

Unwanted volunteer trees

Mowed turf grass border

GENERAL MAINTENANCE GUIDELINES

Maintenance inspections may or may not coincide with mowing activities. The entire planting area should be inspected quarterly. Weed suppression may be needed by using string type trimmers to prevent weeds from developing seeds in areas where significant weed growth is noted, or areas that are not accessible by mowers. Refer to the Iowa Native Plants: Pull It or Keep It Field Guide to aid in plant identification.

Remove above-ground portion of previously treated dead or dying weeds or woody species from planting areas. Add topsoil and rake to areas where poor germination has allowed surface erosion to occur. Re-seed bare spots and apply mulch if needed.

Herbicide may be systematically hand wiped on invasive weeds and woody species where native plants are the dominant plant material taking care not to damage nearby native plants. If herbicides are used, follow all manufacturer's instructions for all herbicide applications. Herbicide application should be performed by certified applicators.

First Year after Seeding / Planting. Mow several times between June through July. After the initial mowing, no cutting or trimming shall be closer than 6 inches to ground surface.

Second Year. Inspection of the native vegetation area within the contract limit by mid-July should indicate a diverse mixture of natives, though the seeding may have a weedy appearance. Forbs should start to bloom. Perform weed suppression using string trimmers to cut portions of native planting areas where weeds comprise more than 1/4 of the plants within an area, to prevent weeds from developing seeds. No cutting or trimming shall be closer than 6 inches to ground surface. Limit herbicide use for weed control until year 3, if they are needed.

Marestail (horseweed) will often show up in the second year after seeding and planting. It usually will naturally decline as the prairie establishes, so no special measures are needed for its control. Ensure that patches of Canada thistle are mowed or trimmed at bud stage (June 15 to July 15). Giant Ragweed can be a very persistent weed. Remove any woody species.

Add topsoil and rake areas where poor germination occurred and has caused erosion. Reseed these bare areas and apply conventional hydromulch or bonded fiber matrix for erosion control. By July of the second year there should be a diversity of native plants species, with some weeds. Some of the forbs (flowers) will start to bloom from summer to early fall.

Third Year. From this year forward monitor the prairie planting several times during the growing season. Spot treat perennial weeds and invasive plants. Some of the invasive plants include: bush honeysuckle, garlic mustard, European buckthorn, multiflora rose, and reed canary grass. Areas of Canada thistle need to be mowed or trimmed at bud stage, before blooming, mid-June through mid-July. Spot spraying can be used with approved herbicides in areas where weeds dominate the plant stand. They can also be systematically hand applied in areas where prairie plants dominate the area. Unwanted woody species and be trimmed out and treated with approved herbicides.

BURNING, GRAZING, & SIGNAGE

Prescribed Burning. Prescribed burning is a useful tool that is part of the tall grass prairie ecosystem. Burning helps the control of unwanted trees, removes duff and stimulates the growth of native grasses and forbs.

Do not perform prescribed burning until at least year four after seeding / planting to improve establishment of forbs. Annual mowing may be omitted in areas when a prescribed burn has been completed. When conducting burns on acres enrolled in conservation programs, refer to program policy.

Prescribed burns need to be planned and executed in a careful and strategic manner. Prepare a prescribed burn plan, using the Prescribed Burning Iowa Job Sheet. The burn plan should include at least the following details:

- Firebreak locations
- Ignition plan
- Equipment needed
- Personnel needed
- Potential fire escape areas
- Potential damage risks (wood fence posts, plastic culverts or intakes)

May 1 to August 1 is the primary nesting season. Burning should be avoided during this period.

Iowa DNR periodically offers training: https://www.iowadnr.gov/Conservation/Forestry/Fire-Management

Grazing. Grazing can be used as an alternative to mowing or prescribed burns. Fencing is needed to keep animals within desired limits. Fencing may need to be moved periodically to rotate the area being grazed. Shelter, water and other general welfare needs of the animals need to be provided.

Signage. Physical signage at the native planting site is important for maintenance workers to understand the rules regarding spraying, mowing, and fertilizing. Signage can also explain the benefits of native prairie areas to the public. Replace vandalized or damaged signage as necessary.

Prescribed burn

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

Giant ragweed

ISU Extension & Outreach

Marestail (horseweed)

The Gazette / Goats on the Go

Goats can be used for grazing

Signage for prairie rules

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PRE-TREATMENT PRATICES & MECHANICAL SYSTEMS

Pre-treatment practices include forebays, filter strips, vegetated swales, stormwater sumps and manufactured stormwater BMPs that use filtration, separation, and settling techniques to remove pollutants. Sumps usually consist of a concrete box poured at the entrance to a BMP. Mechanical devices are commonly found in urban areas where space is not sufficient. Common proprietary devices are specialized inlets, pretreatment solutions, and hydrodynamic separators for capturing stormwater pollutants.

All proprietary systems are unique and will require specific inspection and maintenance tasks. Consult the manufacturer's recommendations for further guidance. However, there are common maintenance tasks that apply to most proprietary devices.

INSPECTION CHECKLIST

- [ ] Consult as-built plans for design details.
- [ ] Vegetated filter strips and swales require that vegetated areas be inspected for eroded areas, vegetation health, sediment and debris accumulation.
- [ ] Sumps should be inspected for sediment and debris accumulation. These practices often have limited capacity and will need to be cleaned frequently.
- [ ] For subsurface systems, ensure that proper certification and permitting is obtained prior to entering confined spaces (see page 33). Ensure proper ventilation and gas detection is in place prior to maintenance.
- [ ] Inspect inlet to mechanical system for trash or debris that may be restricting flow.
- [ ] Inspect filters routinely for capacity within manufactured practice.
- [ ] Inspect sediment, trash, or grit chambers for accumulation that may require removalInspect conveyance pipes for dirty slurry.
- [ ] Inspect outfall drain plug for signs of leakage or corrosion.

MAINTENANCE

Note: Maintenance should be scheduled during dry weather. A system should be cleaned when there is no flow of water. Block off all outlet pipes prior to maintenance to ensure debris or sediment from leaving the system. Upstream pipelines and pre-treatement unit should be cleaned first.

Sediment Pumping. It is recommended that if a pretreatment system reaches sediment build-up greater than 20 percent of the pipe's diameter, the system should be pumped as soon as possible.

Oil and Floatables Removal. Floating trash and debris can hand-picked or netted out to remove them from the chamber via a manhole connected to the access riser. Measure oil depth using a tape measure or dipstick to determine if pumping is required.

Inlet and Outlet Blockages. Remove any blockages that are restricting flow at the inlets, outlets, and weir plates. Repair structural elements if damaged.

Powerwashing. If necessary, rinse the system with a powerwasher and vacuum out remaining water.

Filter Replacement. For pretreatment practices and mechanical systems featuring a filter, ensure routine replacement occurs. Inspect filters after large rain events or if the system has experienced an unusual amount of silt and soil build up.

DEVICE EXAMPLES

Inlet & Pre-treatment Solutions

- Trash Guard™
- Curb Guard™
- Rain Guardian™
- FlexStorm™

Filtration Devices & Separators

- Stormfilter™
- Stormceptor™
- Vortech™
- BayFilter™

Visual inspection

Trash in sediment chamber

Debris blocking inlet

Inlet pretreatment filter

Stormwater filters

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RAIN GARDENS

A rain garden captures runoff from roofs, driveways or yards. It is a depression or a shallow bowl made in the landscape that is level from side to side and end to end. Runoff that travels to a rain garden is temporarily ponded - but it doesn't stay ponded for between 12 to 24 hours.

Rain gardens should be designed to percolate rainwater greater than 0.5 inches per hour. If percolation rates are slower, an enhanced rain garden with subsurface drainage should be utilized. Rain gardens should also have at least 6 inches of ponding depth at all times.

INSPECTION CHECKLIST

- [ ] Check for fallen leaves, debris, and litter accumulation during the growing season and after major storm events.
- [ ] Check entry points and pretreatment areas for excessive deposition of sediment and for erosion at the points of inflow or within the ponding area.
- [ ] Check for at least 50% percent vegetative cover upon establishment of the rain garden at the end of the first growing season, and at least 90% of specified vegetative cover after the end of the third growing season.
- [ ] Inspect for overall health of vegetation, including weed growth, wilting in young plants, and spread of invasive plants.
- [ ] Ensure all inlets, outlets, and overflows are free of debris to prevent backflow.
- [ ] Verify that mulch is evenly distributed throughout the rain garden to ensure mulch is not smothering plants.
- [ ] If a pea gravel diaphragm is installed, inspect for areas of erosion or lack of gravel.

MAINTENANCE

Debris Accumulation. Inspect for fallen leaves, debris, and litter accumulation. Maintain by removing these materials, especially before winter and in early spring. Remove sediment accumulations when it's a few inches deep or is impacting growth of vegetation.

Downspouts, Drainage Areas, Overflow or Outlet. Inspect to insure inlets, overflows, and outlets are free flowing and working properly. Check outlet of the subdrain if it daylights to ensure animal guard is in place and it is unrestricted and free flowing. Maintain by removing any sediment, debris and litter, repair or replace if damaged. Replace damaged animal guard and remove any restrictions to ensure it is free flowing.

Newly Established / Young Plants. You may have to keep the rain garden offline (disconnect the downspout or redirect runoff) until plants have sufficient growth. If kept offiline temporarily or during dry periods, ensure plants are receiving adequate watering. Inspect for at least 50 percent of specified vegetation cover at end of first growing season and at least 90 percent of specified vegetation cover after the end of the third growing season. Maintain by supplementing plantings to meet minimum cover objectives, weed undesired vegetation, and minimize herbicide use.

Established / Mature Plants and Trees. Inspect plant and tree health and for wilting or diseased plants, weeds, and undesirable plants spreading through the border into the rain garden. Maintain by removing undesirable plants, weeds, and tree saplings throughout the growing season by pulling or trimming, prune and thin out plants as needed. Replace plants when needed and limit use of herbicides.

Mulch. Inspect for lack of mulch or displacement that might smother plants or clog outlets. Maintain by adding addtional mulch to maintain a 3-inch layer, rake to redistribute. Use long-shredded hardwood mulch.

Function – Proper Drainage. Inspect to ensure the water infiltrates in a timely manner and that ponding does not occur for more than 12-24 hours. If drainage is too slow, you may have to till up and amend the soils with sand and compost. Another option would be to install a French drain in the bottom of the rain garden beneath the soil surface.

Removing sediment buildup

Drainpipe obstructions

Daylight out drainpipe

Spreading mulch evenly

Tilling and amending soils

3d

BIORETENTION CELLS

Bioretention cells are landscaped depressions that capture and infiltrate stormwater runoff from impervious surfaces. They are used to reduce water pollution and runoff volumes. Bioretention cells, and rain gardens, can have an engineered soil mixture to promote infiltration and establishment of vegetation. Bioretention cells should at a minimum be inspected twice yearly (Spring & Fall) and 24-48 hours after a rainfall of 1 inch or more during initial establishment. Monthly inspections may be required for weed control.

INSPECTION CHECKLIST

- [ ] Check any pretreatment devices for accumulated sediment and debris.
- [ ] Review the area upstream of the BMP to identify potential sources of sediment, debris, or other pollutants.
- [ ] Inspect inflow and outflow points to make sure they are free of clogs from debris, plant materials, or mulch.
- [ ] Inspect cleanouts or observation ports to estimate subsurface water levels.
- [ ] Check the bottom of the bioretention cell for excessive deposition of sediment, bare spots, and for erosion within the ponding area.
- [ ] Inspect to ensure the water infiltrates in a timely manner and that ponding does not exceed 12 hours. Standing water in the observation port may be a sign of hydraulic failure.
- [ ] Inspect for at least 50% of specified vegetation cover at end of first growing season and at least 90% of specified vegetation cover after the end of the third growing season.
- [ ] Evaluate the health of any trees and shrubs, and look for spread of weeds and undesirable plants.
- [ ] Inspect for mulch displacement that might smother plants or clog outlets.
- [ ] Inspect outlet of the subdrain if it daylights to ensure animal guard is in place and it is unrestricted and free flowing.

MAINTENANCE

Debris. Remove fallen leaves, debris, and litter accumulation from BMP and pretreatment area, especially before winter and in early spring. Remove sediment when debris is a few inches deep or is impacting growth of vegetation.

Pretreatment Filter Strips or Grass Channels. Remove sediment with a shovel, rake, or vacuum out. Stabilize any eroded areas using appropriate methods, (i.e. reseed or re-sodding). Schedule: spring and fall, monthly during growing season and after major storms.

Newly Established and Young Plants. Supplement plantings to meet minimum cover objectives and pull undesired vegetation. Watering and weeding are crucial in the establishment of new plants.

Established and Mature Plants and Trees. Remove undesirable or severely diseased plants and weeds throughout growing season by pulling or trimming, prune and thin out plants as needed. Replace plants in the spring and fall, and monthly during growing season. Herbicide use should be minimized.

Inlets and Outlets. Remove any sediment, debris and litter, repair or replace if damaged, replace damaged animal guard and remove any restrictions to ensure free flowing. Schedule: annually especially during spring and fall or after large rain events (2.5″ of rainfall or more).

Observation Ports (If Applicable). An evaluation of the cause for standing water is needed when there is standing water, modified soil may need to be replaced entirely or partially depending on the extent of plugging. Check tile and outlet to ensure water is free flowing.

Mulch. Replace mulch to maintain a 3-inch layer, rake to distribute evenly if eroded or excessive weed growth is present. Schedule: annually, spring or fall.

Function - Infiltration. Replace modified soil layer when ponding greatly exceeds design drawdown time as needed. Infiltrometers can be used to assess infiltration rates. In some cases, removing and replacing the upper few inches of soil may resolve the issue.

Erosion. Fix any erosion immediately. Take measures to stabilize erosion along drainage paths.

Sediment build up

Overflow at proper height

Evenly spread mulch

Low plant growth, scouring

Hyrdaulic failure, ponding

3e

BIOSWALES

Bioswales are sloped drainageways designed to convey stormwater runoff efficiently. A bioswale has an engineered subgrade with amended soil, aggregate and subsurface drain that is designed to treat the water quality volume (1.25" rainfall) and convey larger rainfall events typically to flood management practices (wetlands, retention or detention basins). They have check dams spaced between them. Bioswales are an effective option when water can be routed through a channel long enough to allow flow to pass at slow velocities for the desired residence time.

INSPECTION CHECKLIST

- ☐ Consult as-built plans for structural details an check any pretreatment devices for sediment and debris accumulation.
- ☐ Review the area upstream of the practice to determine potential sources of pollution.
- ☐ Ensure the water infiltrates in a timely manner and that ponding does not exceed 24 hours. Inspect cleanouts, riser pipe, or observation ports to estimate subsurface water levels. Some bioswales may be designed to have internal water storage, where a certain depth of saturation is normal.
- ☐ Examine upper soil profile by digging a shallow hole with a shovel and lower soil profile by pulling soil cores of greater than 1 foot in depth. Inspect profile for signs of mottling or odors.
- ☐ Inspect inlets, outlets, and overflow structures for clogging, debris accumulation, surface erosion, or sediment deposition. Ensure animal guard is in place if the tile daylights.
- ☐ Examine earthen or rock check dams for scouring or movement. Overflow on crest of dam should be level. Check secondary overflow structures for plugging or eroded areas. Inspect check dams for excessive deposition of sediment. Also inspect the choker layer of materials on rock checks.
- ☐ Inspect for at least 50% of specified vegetation cover at end of first growing season and at least 90% of specified vegetation cover after the end of the third growing season. Examine vegetation for bare spots, and for dead or dying plants.

MAINTENANCE

Debris Accumulation. Remove debris as needed, especially before winter and in early spring. Remove sediment if build up reaches more than a few inches deep or is impacting growth of vegetation. Maintenance should be scheduled monthly during the growing season and after all major storm events.

Pretreatment Filter Strips or Grass Channels. Remove sediment or debris with a shovel, rake, or vacuum out. Stabilize any eroded areas using appropriate methods (i.e. reseeding, hydromulch, resodding, erosion control blankets, erosion rock).

Check Dams. Replace rock and choker materials if eroded or clogged, including area around culverts. Sometimes rock materials in the front surface of check dams need to be removed and replaced to address sediment or debris buildup.

Newly Established Plants. Supplement plantings to meet minimum cover objectives. Pull out, prune or treat undesired vegetation as needed. Perform required maintenance of native planted areas (refer to "3a - Native Landscaping") for more details. Harvest and replace plants that are impacted by sediment deposition.

Established Plants and Trees. Remove undesirable or diseased plants and weeds throughout the growing season by pulling out the plants by the roots or trimming and treat. If desired, trim back plant vegetation in the fall and prune trees in late fall or early winter.

Inlets and Outlets. Repair or replace structures if damage is impeding flow. Remove debris and sediment and replace animal guards to ensure free flowing.

Function - Water Infiltration. Replace modified soil layer when ponding greatly exceeds the design drainage time. In some cases, removing and replacing the upper few inches of soil may resolve the issue. A can infiltrometer tests can be performed using a can on the soil surface with the addition of water to observe drainage times.

Entry point clear of sediment

Intact check dams & ECBs


Hand pruning tree sucker

Pretreatment zone


Can infiltrometer test

3f

VEGETATED SWALES

Vegetated swales are designed to primarily convey water across the landscape. Primary differences between vegetated swales and bioswales are that vegetated swales are for conveyance and they don't have an engineered subgrade that has amended soils, aggregate layer, and subsurface drainage system with observation ports. As such, these are used as a pretreatment measure. Vegetated swales are typically featured in low drainage points within residential subdivisions that should drain soon after rainfall events. Water conveyance in vegetated swales relies on gradual, long slopes that may lead to a retention or detention basin.

INSPECTION CHECKLIST

- ☐ Consult as-built plans to determine vegetation requirements and other features.
- ☐ Inspect area upstream of the bioswale to identify potential sources of stormwater pollution.
- ☐ Check for desired plant species and excessive weed growth throughout the entire swale. Spot check vegetation within the swale for signs of dead, diseased, or dying plants.
- ☐ Inspect any pre-treatment areas and the interior of the swale for sediment accumulation, trash, and debris.
- ☐ Walk the perimeter of the vegetated swale for signs of erosion such as rills forming along the side slopes. Inspect the bottom of the swale for signs of scouring or gulleys.
- ☐ If erosion control matting or reinforcement mats are used, inspect matting for even distribution along side slopes and bottom of swale.
- ☐ If check dams are installed, check for movement of rock materials. Overflow on crest of dam should be level.
- ☐ Check for sediment deposition or surface erosion at inlets and outlets.
- ☐ Ensure water is infiltrating properly; the bottom of the surface should not have ponded water more than 12 hours after a rainfall event. Look for debris lines or other evidence of high water levels.

MAINTENANCE

Debris and Sediment Accumulation. Remove debris as needed, especially before winter and in early spring. Remove accumulated sediment. Identify and control the source of excessive sediment.

Culverts. Replace revetment stone as needed and repair eroded areas surrounding the culvert if necessary.

Vegetation. Remove undesirable plants, weeds, and tree saplings throughout the growing season by pulling out the plants by the roots or trimming and treat. If desired, trim back plant vegetation in the fall and prune trees in late fall or early winter. Perform required maintenance of native planted areas (refer to "3a - Native Landscaping") for more details. Harvest and replace plants that are impacted by sediment deposition.

Mowing. Turf grass areas will need to be mowed during the growing season if desired to a minimum height of 3 inches.

Eroded Areas. Stabilize eroded or bare soil through various methods, including erosion control matting, sod, hydromulch, with permanent seeding and/or plants. Replace erosion control products when needed.

Rill and Gully Erosion. Identify the reason for rill and gully formation to determine repair methods. Rill and gully areas will need to be regraded. Then stabilization will need to be put in place and may include a combination of practices such as erosion control blankets, turf reinforcement mats, seeding, planting, and check dams.

Function - Water Conveyance. Swales have slope and should not have standing water for more than 12 hours depending on recurrence of rainfall events. Assess ponded areas after they have drained. There may be compacted soils or poorly drained soils. Depending on the severity and extent of the areas, they could be tilled then reseeded, sodded, or planted with native plants. More extensive areas with ponding may require subsurface drainage and tillage of soils.

Mowed turf swale

Black-eyed Susans in swale

MN Stormwater Manual

Erosion control matting

Mowing vegetated swale

Temperate Climate Permaculture

Standing water in swale

3g

TREE TRENCHES & STRUCTURAL CELLS

Tree trenches and structural cells provide several management processes. Trees intercept rainfall through their leaf canopies and stormwater is captured within the trench reservoir. Stormwater is filtered and temporarily stored as it moves through the modified soil mixture and the tree's root system. Structural cells, or suspended pavement, allow for, large, elongated subsurface areas where tree roots can expand, bioremediation, and temporary storage in uncompacted soil. Tree trenches are typically combined in series with other stormwater BMPs as part of a treatment train.

INSPECTION CHECKLIST

- [ ] Consult as-built plans for structural details.
- [ ] Inspect pre-treatment areas, inlets/outlets, and the planter surface for litter, sediment, fallen leaves, and weeds. Check for displacement of mulch at the base of the trench.
- [ ] Check for erosion or scouring at the inflow area and floor of the tree trench and for obstructions preventing free flowing stormwater.
- [ ] If the tree trench is planted with other perennial plants, ensure 50 percent growth at the end of the first year of establishment and at least 90 percent at the end of the second year.
- [ ] Inspect trench for standing water for 24 hours after rainfall event.
- [ ] Inspect trees for general health (i.e. damage from animals, leaf color and wilting, evidence of insect activity, water deficit, poor root health).
- [ ] Inspect nearby hardscape for cracking or signs of roots pushing to surface. Structural cells may be covered by permeable pavers that need to be inspected for clogging and debris.
- [ ] Inspect inlets, overflows, and outlets are all free flowing and working properly.

MAINTENANCE

Debris and Sediment Removal. Remove debris before winter and in the early spring. Remove sediment when two to three inches is accumulated in the pretreatment area or if sediment is impacting growth of trees or other vegetation. A rake, shovel, or vacuum can be used depending on the amount of sediment and size of trench. If an overflow drain is installed within the trench, ensure that debris is not prohibiting flow.

Vegetation Establishment and Weeding. Watering and weeding are key for vegetation establishment. After watering and weeding, then supplemental seeding can take place. Remove o undesireable weeds by hand pulling or pruning. Trim back plant vegetation in the fall or spring and prune trees during the fall or winter, depending on species requirements. Special attention should be made to quickly removing undesired tree saplings, which can severly degrade plant and tree health and can be unsightly.

Soil Replacement. If poor soil quality is the cause of standing water and poor infiltration, removal and replacement of modified soil media is necessary. Sometimes removal of only the upper few inches of soil is required to restore positive drainage.

Mulch. Ensure tree trench is completely covered in a three inch layer of mulch (when specified). Rake to redistribute. Maintenance of mulch should be completed annually, either in the spring or fall.

Erosion. The surface of the trench may need to be raked to repair rill erosion. Small rocks may need to be added to the drainage path to stabilize eroded areas. Any areas of bare soil should be revegetated and remulched.

Tree Removal and Replacement. Tree snags can pose increased risk of limb or tree failure and liability. Special attention should be given when removing street trees to ensure that structural cells, the modified soil mixture, and other vegetation is not damaged.

Underdrain. If an underdrain was specified, check surface water level through cleanouts or observations ports.

Signage and Safety Barrier. If signage is installed on site, clean and replace as needed. Repair safety fences immediately.

Minimal mulch or vegetation

Depression surrounding tree

Curb cut inlet to tree trench

Tree trench safety fence

Structural cell installation

3h

INFILTRATION BASINS

Infiltration basins are shallow dry basins that are usually vegetated with native plants suitable to the hydrologic conditions. Basins are designed to store and infiltrate runoff and are designed primarily for groundwater recharge and stormwater detention. They are typically located in areas with highly permeable subsurface soils often combined with pretreatment swales, forebays, or filter strips.

INSPECTION CHECKLIST

- [ ] Consult with as-built plans.
- [ ] Observe that runoff flows into intended pretreatment practice rather than around or across the BMP.
- [ ] View inlets and outlets in pretreatment practices and basin to check for sediment, leaves or other debris accumulation and scour. Metals grates may have to be removed from some of these practices to adequately monitor.
- [ ] Monitor any observation ports if they are present for ponded water.
- [ ] Inspect basin for standing water that is visible after 12 hours after a rainfall event. Note sediment and debris accumulations.
- [ ] Inspect for damage to sloped areas (i.e. sinkholes, erosion, scouring, animal burrows).
- [ ] Note vegetation and type and if it was or was not planned for in the bottom of the basin.
- [ ] Check basin slopes and bottom for trash, sediment, and debris.
- [ ] The bottom of the basin may need to be raked, smoothed, or regraded if low spots develop where water becomes focused or ponded after storm events. Without correction, this can minimize the area that is effectively used for infiltration.

MAINTENANCE

Pretreatment, Forebay and Inlet. Clean pretreatment practice or forebay for trash, debris, and sediment in the spring and fall. Any blockages preventing flow into the primary treatment area should be removed immediately to prevent backflow or flooding.

Weeding and Plant Replacement. Remove unwanted (i.e. dead or diseased, invasive) vegetation as needed. Any presence of wetland plants (i.e. cattails) is an indicator that plugging may be occuring and maintenance is needed. Bare spots should be revegetated. If the basin is planted with native plants, refer to Native Landscaping requirements on page 6. Cut back native plants annually in the spring or fall or if possible conduct periodic prescribed burns.

Mowing. Mow the filter border strip, if present, to a height of three inches. If the infiltration basin is planted to turf grass, minimize mowing to minimize compaction and mulch grass clippings. Reseed or sod bare spots as necessary.

Function - Infiltration. Observe basin for proper infiltration of stormwater runoff. Inspections for infiltration should be completed during rainfall events. If stormwater is evident longer than the design storm, maintenance will be required.

If the infiltration basin will be used to treat parking lot runoff, ensure that salt tolerant and non-woody plant species are planted. Areas outside of the basin designed specfically for infiltration (i.e. pretreatment forebay) should be protected from excessive snow storage. Don't push in or store snow in basins or trenches.


MN Stormwater Manual

Basin before planting


MN Stormwater Manual

Native landscaping


City of Bellingham, Washington

Outlet structures to basin


The Construction Specifier

Temporary ponding


NJ Developer's GI Guide

Residential mowed basin

3i

INFILTRATION TRENCHES

An infiltration trench is a linear, narrow, stone aggregate-filled stormwater BMP that is usually 3-6 feet deep. Infiltration trenches are used for temporarily storing and infiltrating small amounts of stormwater. Stormwater is stored in the void spaces between stones and exfiltrates through the sides and bottom of the trench. Trenches are typically located in areas with highly permeable subsurface soils often combined with pretreatment swales, forebays, or filter strips.

INSPECTION CHECKLIST

- [ ] Consult as-built plans.
- [ ] Observe that runoff flows into intended pretreatment practice rather than around or across the BMP.
- [ ] Inspect trench for standing water that is visible after 12 hours after a rainfall event. Note sediment and debris accumulations.
- [ ] Remove lid from observation port, if present, and check for ponding. Note any other unusual observations.
- [ ] Inspect for damage from sinkholes, erosion, scouring, and animal burrows.
- [ ] Check side slopes and bottom for trash, sediment, and debris. Inlet and overflow outlets in infiltration trenches with metal grates will have to be removed to check for sediment, leaves and other debris.
- [ ] The rock in the bottom of the trench may need to be raked, smoothed, or regraded if low spots develop where water becomes focused or ponded after storm events.

The infiltration trench if used to treat parking lot runoff, should be protected from excessive snow storage. Don't push in or store snow in trenches. Try to avoid excessive salt use near trenches.

MAINTENANCE

Pretreatment Areas and Inlet. Clean filter trips, forebay and other pretreatment areas for trash, debris, and sediment in the spring and fall. Any blockages preventing flow into the primary treatment area should be removed immediately to prevent backflow or flooding.

Weeding. Remove weeds and tree saplings as needed. Any presence of wetland plants (i.e. cattails) is an indicator that plugging may be occurring and maintenance is needed.

Mowing. Mow the filter border strip, if present, to a height of three inches.

Function - Infiltration. Observe trench for proper infiltration of stormwater runoff. Inspections for infiltration should be completed during rainfall events. If stormwater is evident longer than the design storm, maintenance will be required.

Primary treatment area

Richard Burke Associates

Mowed buffer strip

Sustainable Stormwater Management

Trench and vegetated berms

Green Infrastructure Ontario

Trench with impervious liner

City of Nashville

Trench along parking lot

3j

SAND FILTERS

Sand filters are a water quality treatment practice with a sand bed, which is typically contained in an underground chamber where pollutant removal can occur through settling, filtration, and absorption. Stormwater needs to be directed to a pretreatment chamber that collect trash, debris, and coarse sediment. Water is then conveyed to the sand chamber (where treatment occurs) and consequently outletted through an underdrain or through subsurface percolation.

Sand filtration systems, although uncommonly installed in Iowa, are found in areas where metals, hydrocarbons, and liquid contaminants are expected. They can be found in "ultra-urban" areas with highly impervious surface areas (i.e. parking lots, street right-of-ways).

INSPECTION CHECKLIST

- [ ] Consult as-built plans for structural details. Use proper safety methods when accessing below-ground systems.
- [ ] Pull metal grates to inspect structural features such as vaults for cracking, erosion, or deterioriation.
- [ ] Check areas where sediment and debris is trapped to prevent clogging.
- [ ] Inspect surrounding vegetated areas twice weekly when establishing or restoring vegetation. Inspect for erosion, scouring, or spread of invasive weeds.
- [ ] Inspect the permeability of the sand filtration system at least twice annually to determine if the rate of infiltration has decreased over time.
- [ ] Inspect for standing water 12 hours after a rainfall event, which is a common sign that infiltration rates have been reduced.
- [ ] Ensure outlet is free of debris and flow is not prevented.

Ensure that there is adequate drainage in the practice. Drainage times should be less than 12 hours. The surface of the filter may need to be raked or replaced depending on the severity of plugging.

MAINTENANCE

Pretreatment. Remove sediment and accumulated debris from pretreatment devices. Vegetated filters of turf grasses will need to be mowed during the growing season.

Debris Removal. Trash and debris should be removed from the sand chamber and pretreatment area at least quarterly. Impervious areas draining to sand filter system should be swept by hand or with a street sweeper as needed.

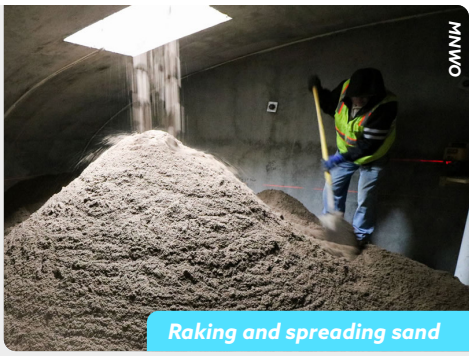
Oil and Grease Pumping. Oil and grease should be pumped from the sedimentation chamber at least once every one to three years.

Raking. Skim the upper crust layer to break up clumps at least once per year to maintain infiltration effectiveness. There is no need to dispose of sand during this maintenance task as microbial activity present can encourage some pollutant breakdown.

Sand Disposal and Replacement. Sand media should be removed from the chamber about every 3 years, depending on the current rate of infiltration and pollutant loads. If the sand filter fails to infiltrate a design storm as specfied in the as-built plans, sand removal is necessary. Removed material must be hauled to the landfill for proper disposal. Consult as-built plans when replacing sand to determine type of sand, minimum thickness of sand bed, and maximum storage above the sand bed.

Vegetation and Chemical Use. If applicable, perimeter turf grass should be mowed to a height of three inches. If sand filter is planted with vegetation, hand pull weeds as necessary. Use of fertilizers and pesticides is not receommended to prevent compromising the intended use of the sand filter.

Grates. Repair or replace broken grates and remove any accumulated debris from surface.



Raking and spreading sand

Underground filter chambers

Pumping filter chamber

Mowed border around filter

Removing grates at grade

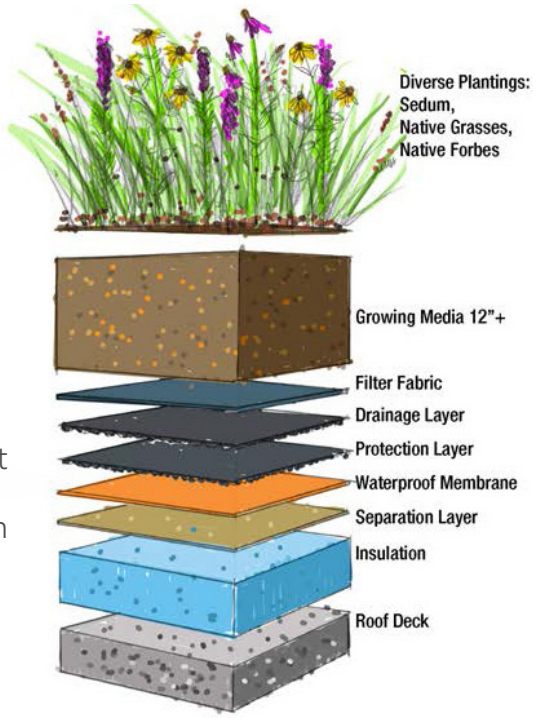
3k

GREEN ROOFS

Green roofs incorporate vegetation and soil media to capture rainfall and reduce runoff. They are underlain by root and waterproof barriers. Where applicable, green roofs can be to promote evapotranspiration and mitigate the urban heat island effect. Green roofs also absorb sound and reduce noise, create outdoor public spaces, and improve urban biodiversity. Both practices require special attention to the unique growing environment of the plants, structural constraints with the given building and rooftop, and consideration of accessibility for both the public and required maintenance tasks.

INSPECTION CHECKLIST

- ☐ Consult as-built plans for structural and operational details. Refer to any manufacturer's recommendations for inspection and maintenance guidelines.
- ☐ Inspect various green roof components of the green roof and traditional roofing system for signs of leakage.
- ☐ Inspect the drainage gutters for debris and sediment and ensure drains are working properly.
- ☐ Inspect vegetation for general plant health, including plant die-off. Irrigation and shade are major factors in plant health in green roof systems. Inspect the irrigation system for leaks or plugging.
- ☐ Inspect entire green roof for invasive weeds that can prohibit intended plant growth.
- ☐ Inspect non-vegetated areas; soil present in the walkways is a sign of erosion or inadequate vegetative cover.
- ☐ Maintain a record of all inspection and maintenance activities.



Type of green roof is dependent on depth of growing media. Between 2-6" is an Extensive system, 6-12" is a Semi Intensive system, and 12+" is an Intensive system (shown above).

MAINTENANCE

Weeding. Plant material should be maintained to provide 90 percent plant cover. Removal of undesirable weeds and tree seedlings should be conducted monthly during the growing season and more frequently during the first two years of establishment. Dead plants should be removed and replaced, exposed soil. Excessive weed growth can become a fire hazard if left uncontrolled.

Weeding should be completed without use of herbicides or pesticides by a professional knowledgeable of green roof systems. Use caution when weeding in shallow soil media depths to prevent tearing of membrane layers. Workers should bag weeds for disposal to prevent further spreading of invasive species.

Irrigation. Soil media used in green roofs is typically coarse and porous making the demand for water high. During plant establishment, weekly watering during the summer and early autumn will be necessary. Bi-weekly watering may be is required suring dry periods. Micro-sprinklers or spray stakes can be installed and automated to provide necessary water to roof top plants. Watering by hand is also an option.

Debris Removal. Regular cleaning of the drainage pipes, gutters, and downspouts should be conducted monthly during the growing season.

Fertilizer Use. Fertilizers should not be used if the green roof is designed as a stormwater BMP. If the rooftop system is not being used a water quality BMP, slow-release fertilizers can be used to promote plant growth. Use only as much fertilizer as needed to prevent overfertilization that can cause water pollution from nutrient runoff.

Soil Loss. Soil loss or significant shifts in soil can indicate a leak in one of the fabric or waterproof protection layers and become a structural concern for the rooftop itself. If a leak is not present, respread the soil evenly throughout the area and replace soil on an annual basis.

Access Points. Clean public walkways routinely and clearly mark "no-go zones" to ensure plants are not stepped over and for general public safety. If applicable, use maintenance access doors and anchor points for harnesses when maintaining roof edges and gutters. Consult building design plans for access points.

Weeds along perimeter

City of Iowa City

Roof top sedum installation

City of Cedar Rapids

Cistern system for irrigation

Drainage clear of debris

Roofing Solutions

Guide wire for harnesses

3I

PERMEABLE PAVEMENT

Permeable systems can consist of permeable pavers, porous asphalt, or pervious concrete. Rainfall will infiltrate through the surface into engineered layers of rock below the pavement. Rainfall then enters a perforated drain pipe installed in the rock chamber and is slowly discharged to the storm sewer system. Some water will percolate through subsurface soils. The movement of water through the rock layers filters out pollutants and slows the flow of runoff to the storm sewer system. Reducing peak flows helps maintain stable stream flows and reduce flood potential. Permeable pavements can also reduce the need for road salt because the snow melts more readily, drains from the hardscape, thus, reducing the potential for re-freezing.

INSPECTION CHECKLIST

- ☐ Consult as built plans to determine structural and operational details.
- ☐ Inspect for sediment, fallen leaves, debris, weeds, and litter accumulation at the site.
- ☐ Inspect pavers for differential settling, or where bricks have lifted above or sunken below adjacent bricks. Inspect for cracks.
- ☐ Inspect areas upstream of the system and where the impervious hardscape meets permeable system. Check nearby vegetated areas to ensure that sediment/dirt is not washing or being tracked into the system.
- ☐ Inspect permeable systems after rainfall events to ensure infiltration. Check infiltration rates in dry weather by pouring water across the surface and observing rates of infiltration.
- ☐ If installed, inspect observation ports and tile outfalls for indications of water levels and drainage. Also inspect inlets or manholes where control structures are located.
- ☐ Inspect void space between bricks to determine presence and condition of chip aggregate material.

MAINTENANCE

Street Sweeping and Vacuuming. Regardless of observations, it is recommended to vacuum the surface of the system at least twice annually (fall and spring). An air sweeper can be utilized for preventative maintenance. If not, sediment and gravel material within the void space will need be removed and replaced. A mechanical sweeper should be utilized in passes to clear the site of larger debris. A vacuum truck should be used for restorative purposes. Gravel chip material will need to be replaced into the void gaps. A simple infiltration test can be performed to determine if the system is infiltrating as designed.

Weeding. Small weeds and moss present in the void spaces should be removed. These are indicators that that the gaps between pavers are clogged with sediment or other small debris. The gaps should be cleaned out with a vacuum system and new chip materials replaced as needed. Alternatively, pavers may need to be removed to allow removal of sediments that have collected between gaps and in setting bed aggregate layers beneath pavers. Upper layers of aggregate may be removed (if needed) and replace to allow for reinstallation of pavers.

Snow Removal and Stockpile Planning. Sand as a de-icer must not be used on paver systems. Only use liquid de-icing agents. Properly installed level surfaces can typically be plowed with regular blades but some communities may opt to utilize rubber or similar-tipped blades.Snow stockpiles should not be placed upstream or on the surface of permeable pavement systems to avoid clogging from sediment and added maintenance. Communicate with contractors about where stockpiles should be located.

Cleaning Impervious Areas. Routine cleaning (i.e. blowing or sweeping grass clippings and leaves and removing trash and debris with a street sweeper) of impervious surfaces that drain to the permeable system will postpone maintenance. Special attention should be given to permeable areas beneath overhanging trees. Do not blow grass clippings/leave onto permeable pavers or into areas that drain onto the pavers.

Paver Replacement. Replace pavers that are cracked or damaged. If differential settling is occuring, remove pavers, add or remove base coarse to level, compact, and re-lay pavers. Pavers located along heavily trafficked areas may require more frequent replacement.

Vegetation and litter in gaps

Sediment accumulation

Impervious interface

Simple infiltration test

Handheld vacuum

3m

RETENTION & DETENTION BASINS

Retention basins, also known as "wet ponds", are typically used for flood control in subdivisions and on commercial properties to decrease peak flows and slowly release collected rainfall runoff over a longer period to reduce local flash flooding. Wet ponds can also be designed for "extended" storage, which detains water evenly above the permanent pool storage and then released over 24 hours. Detention basins, also known as "dry ponds", capture stormwater runoff for a determined period of time after a storm event. Water is temporarily impounded in a dry pond and then discharged.

INSPECTION CHECKLIST

- [ ] Inspect inlets and outlets for debris, sediment accumulation, or erosion, and look for signs that debris is impeding flow of water.
- [ ] Inspect forebays and pretreatment areas for debris buildup and sediment deposition.
- [ ] Look for signs of hydrocarbon buildup or oil sheens.
- [ ] Monitor wetland vegetation and emergence of invasive species throughout wetland and in non-marsh areas. Presence of cattails can indicate sediment deposition.
- [ ] Check for standing water in the bottom of the basin more than 48 hours after a rainfall event (in dry detention ponds).
- [ ] Inspect wet retention ponds for thick algal mats that cover a portion or all of the surface and examine the stability of shoreline, embankment, and safety benches.
- [ ] Inspect condition of auxillary spillway and riprap looking for signs of surface erosion or overtopping.
- [ ] Inspect the condition of rodent and/or trash guards on inlets and outlets. Look for signs of burrows, tree growth, damage, or debris. Also inspect upstream and downstream faces of the dam structure for similar issues.

MAINTENANCE

Mowing and Weeding. Turf grass in detention basins should be mowed regularly and include weed and tree management. Perform required maintenance of native planted areas (refer to "3a - Native Landscaping") for more details. Harvest and replace plants that are impacted by sediment deposition.

Debris and Litter Control. Regular removal of debris and trash can maintain the aesthetics of the basin and reduce conditions suitable for algal growth. Debris can limit the capacity of inlet and outlet structures. Ensure that inlets, outlets, and emergency overflow structures are not clogged and remove blocking materials if necessary.

Stablization. Bare spots on banks that have eroded over time should be raked, backfilled, covered with topsoil, seeded and covered with mulch or erosion control blankets. Eroded areas near inlets and outlets need to be repaired using the same methods or include more durable armoring. Riprap that has significantly shifted over time or is consistently below the permanent pool line should be replaced or adjusted.

Insect and Animal Control. For detention basins, the best practice for controlling undesirable insects is to ensure that stagnant pools of water do not develop. In dry basins, identify any areas where stagnant water is ponding with depths of less than 24 inches. Stocking a retention basin with fish can help control mosquito larvae. Inspect outlets for signs of cracking, sink holes, and undercutting, which may be exacerbated by animals.

Major Repair - Sediment Removal. When forebays are 1/2 full, sediment should be removed (or at least every 5 years). Basins without forebays may have reduced storage over time, which may require more extensive efforts to remove sediment from within the basin to maintain desired storage volume. Sediment removal in retention ponds is needed when volume is reduced by 25 percent or when the pond becomes eutrophic. Estimated time for sediment removal is every 10 to 20 years. Sediment evacuated from basins that do not receive runoff from designated hotspots are not considered toxic or hazardours material and may be taken to the landfill. Sediment may have to be tested prior to disposal if a hotspot landuse is present.

Mowed detention basin

Clogged stormwater outlet

Unstabilized, bare slope

Animal burrow hole


Dredging retention basin

3n

UNDERGROUND DETENTION SYSTEMS

Underground detention systems function similar to above ground detention basins in that stormwater is temporarily stored, then released at a rate to minimize localized flooding. They may consist of subgrade metal or plastic pipes, plastic or concrete chambers, or a set of molded plastic structures stacked on top of each other, that are connected to the storm sewer system. Stormwater enters through surface inlets, which directs water into the subsurface chambers. These systems are typically placed on top of aggregate underlain by a geotextile fabric. There may be access ports at the ground surface at regular intervals for inspection and maintenance. Some systems feature pretreatment chambers or use hydrodynamic separators or other systems to provide pretreatment.

Underground detention is typically utilized in scenarios where above ground detention basins are not feasbile due to space constraints. An underground storage system is used for flood control. It can be used in series with other water quality BMPs (usually in upstream locations) to improve water quality that is released to nearby rivers, lakes, or streams. Common applications include: parking lots, roadways, and commercial and industrial areas where land surface area for stormwater management is minimal.

INSPECTION CHECKLIST

- ☐ Consult as-built plans prior to visiting the site. Use a flashlight, camera, or mirror mounted on a pole to further view the system.
- ☐ All structures should be inspected annually. Pretreatment areas may need to be inspected more frequently. Open all manhole access ports and look for debris and sediment accumulation. Use a stadia rod to measure sediment depths.
- ☐ Consult manufacturer's recommendations for additional inspection of proprietary filters and traps. Inspect for debris trapped on grates and sediment accumulation near the inlets and outlets.
- ☐ Check for damage such as cracks and eroded areas to any visible structures.
- ☐ Consult as-built plans for the design drawdown time. Monitor ponding depths by looking through access ports if they are available and note the time since the most recent rainfall event and any remaining ponding in the pipes, cells or chambers.

MAINTENANCE

Vaults and Control Structures. Trash and sediment can accumulate within the concrete control structure and clog the trash rack. Sediment build up can be removed mechanically with vaccum-type equipment.

Most underground storage systems are proprietary solutions that require specific maintenance and repairs to traps and filters according to manufacturer's recommendations. Structural repairs should be addressed in a timely manner or on an as-needed basis.

Inlets and Outlets. These should be inspected for trash that can impede stormwater from entering and exiting the underground storage system. If the outlet discharges directly to a receiving water and is surrounded by rip-rap, check for erosion and scouring. Remove trash and sediment accumulation as needed. Inlet protection products, such as wattles, should be used temporarily if construction is actively occuring near the inlet.

Impervious Surface Areas. Maintenance of underground storage is minimized if the impervious surfaces that drain to the system are cleaned routinely. Sweeping can reduce the amount of floatables and sediment loading to the underground storage facility.

Due to the confined nature of underground storage systems, maintenance of these systems requires specialized training and may require a permit to enter the space. The Occupational Safety and Health Administration (OSHA) requires permit for spaces that include underground vaults, tanks, storage bins, manholes, pits, silos, underground utility vaults and pipelines. For more information, please visit: https://www.osha.gov/SLTC/confinedspaces/

Other Resources

ADS StormTech O&M Manual: http://bit.ly/2oDrQZs
Prinsco Chamber I&M Manual: http://bit.ly/2D8YOVe

Trash buildup

Inlet to underground storage


Modular stormwater system

Metal system being installed

Pre-cast concrete chamber

30

CONSTRUCTED WETLANDS

Stormwater wetlands are used to manage stormwater quality and quantity. They are often sited in ares with hydric soils, poor infiltration rates, or where groundwater or sump pump discharges provide a continuous flow of water. Features include deep and shallow pool zones along a serpentine flow path. There is a diversity of vegetation and habitat provided by the wetlands. This type of wetland should not be confused with a natural wetlands, which are protected by federal law and should not be used to treat urban stormwater runoff.

INSPECTION CHECKLIST

- [ ] Consult as-built plans for specific site features.
- [ ] Inspect forebay and pretreatment areas for debris and sediment accumulations as well as settling, exposed or eroded areas.
- [ ] Recognize that there may be several vegetated zones, inspect wetland and upland areas for vegetation diversity, plant health, bare spots, and weed invasion (i.e. cattails).
- [ ] Inspect the embankment, inlet and outlet structures, and auxillary spillway for scour, seepage, tunneling, and bypass, debris and sediment accumulations, and animal burrows.
- [ ] Inspect channel or stream near or downstream of outfall for stability, and stability of shoreline and safety benches around deeper pool areas.
- [ ] Inspect valves, stop logs, and related water control devices for leakage, stability, and plugging.
- [ ] Monitor pool areas for stability, sediment accumulation, and depth. Note any oil sheens or other potential pollutants floating on the surface of the pools.
- [ ] Monitor for aquatic rodents such as beavers by looking for evidence of dams, canals, and lodges. Inspect rodent guards for damage or debris.
- [ ] Inspect the upstream and downstream faces of the dam structure. Look for signs of animal burrows or tree growth.

MAINTENANCE

Trash and Debris. Clean and remove accumulated debris and sediment from forebays, inlets and outlets. When a forebay is ½ full or more remove sediment. Try to identify and eliminate sources of sediment if excessive sediment accumulations continuously occur. This is usually done by stabilizing exposed soils. Maintenance should be completed at least three times annually and after rainfall events of 1.25" or greater.

Soil Stabilization. Reseed or replant bare or exposed area. Erosion controls such as mulch or blankets may be needed. Repair undercut or eroded areas when observed by re-grading and using erosion control products such as erosion control blanket, turf reinforcement mats, rip rap and related products.

Weeding. Remove weeds and invasive plants and trees as well as dead, dying, or diseased plants. Limit use of herbicides near the pooled areas. Limit spread of single species to maintain biodiversity. Handwipe aquatic herbicides directly to invasive species.

Mowing or Prescribed Burning. Mow or use prescribed vegetative burns to maintain wetland species diversity and suppress weed growth. Perform required maintenance of native planted areas (refer to "3a - Native Landscaping") for more details. Harvest and replace plants that are impacted by sediment deposition.

Extensive Maintenance. Widespread maintenance (every 10-20 years) is usually necessary when total pool and marsh volume has been significantly reduced (~25%) by sediment accumulation, when plants are "choked" with sediment, or the wetland becomes excessively eutrophic. Excessive algal mats and cyanobacteria are signs of eutrophication. Sediments removed from stormwater wetlands that do not receive runoff from hotspots are likely not considered toxic or hazardous and can usually be safely disposed of by either land application or at a permitted landfill. Sediment testing may be required prior to sediment disposal when a hotspot land use is present.

Trash removal from wetland

Limit spread of cattails

Measuring sediment depth

Algal mat in wetland pool

Drained sediment forebay

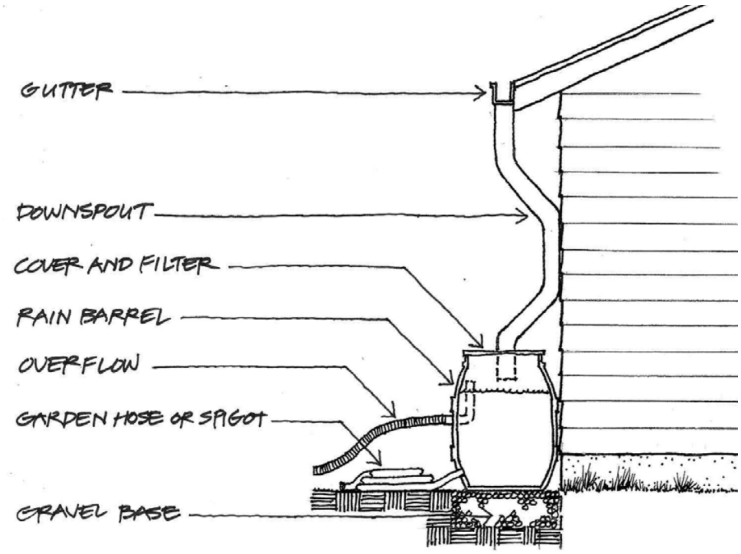
3p

RAINWATER HARVESTING

Rainwater harvesting is the process of capturing rainwater by connecting a building's downspout system to a rain barrel, cistern, or underground storage tank. Collected rainwater can be used for a variety of uses, including irrigation for landscaping or for toilet flushing or other sanitary uses if connected to the building's water system. Rain barrels are commonly used in residential scenarios and typically constructed with 55-gallon plastic drums. Cisterns are more commonly utilized in industrial and commercial settings and vary widely in volume capacities.

INSPECTION CHECKLIST

- ☐ Inspect the rain barrel during rainfall events to ensure the system is working properly on an annual basis.
- ☐ Inspect top of barrel or cistern for standing water, which is a sign the overflow outlet is not working properly.
- ☐ Inspect foundation and surrounding areas for signs of erosion or water that is being directed toward the building's foundation.
- ☐ Inspect the inlet filter to determine if a new filter is required.
- ☐ Inspect all connected components for leaks or corrosion.
- ☐ Inspect the interior of the rain barrel or cistern for cracks or holes.
- ☐ Monitor the water level of the tank prior to a heavy rainfall event. Drain the rain barrel if the capacity is greater than 75 percent to prevent overflow during the rainstorm.



Basic residential rain barrel diagram. Source: Florida Field Guide to Low Impact Development.

MAINTENANCE

Downspout Diversion Connections. Replace metal or plastic connections if leaks are occuring.

Inlet Filter. In order to protect collected rainwater from leaves, debris, and animals, an inlet filter should be installed and replaced if the filter is restricting flow into the tank.

Mosquito Protection. A secondary filter or mesh netting should also be installed to prevent mosquitos from breeding inside the tank.

Overflow. Ensure overflow outlet is free of debris that could restrict flow. Redirect hose attached to overflow if directed to the foundation of the building or if signs of erosion are present where water is being discharged.

Foundation. Rain barrels and cisterns should be placed on a level, sturdy foundation. If foundation has eroded or become damaged over time, repair as needed.

Rinsing and Scrubbing. A rain barrel should be rinsed if sediment build up is obscuring the bottom of the barrel. Drain the barrel and use a pressure washer or hose to thoroughly clean the interior of the tank. A handheld brush or broom can be used to scrub the interior walls. Non-toxic cleaners like vinegar can be used as deeper cleaning solutions.

Patching. Cut a thin piece of plastic to over the hole in the tank. Place a piece of drywall adhesive and spread waterproof sealant over the plastic. Allow the sealant to cure over time according to the manufacturer's recommendations.

Gutters. Preventative maintenance through cleaning the building's gutter system will extend the lifespan of the barrel and prolong the time between maintenance actions.

Winterizing. Drain, leave the valve open, or redirect downspouts away from the system during the winter to prevent freeze damage. Rain barrels should be disconnected in early winter and re-installed in early spring. Once disconnected, add a downspout connection to the spout that previously led to the rain barrel and redirect flow to a nearby garden.

Diverter and overflow

Clean inlet filter


Downspot diverted to garden


Stacked rainwater cisterns

Installing mosquito screen

SECTION 4. GLOSSARY OF TERMS

As-Built Plan. 2-D plan of stormwater practice created after construction is completed that includes detailed drawings and structural details.

Conveyance. A pipe, ditch, swale or other means of moving water through or over a landscape.

Best Management Practice (BMP). A method or combination of effective and practical methods used for reducing stormwater pollution through treatment and minimizing the impacts of localized flooding.

Biodiversity. Variety of plant, animal and aquatic species in a particular habitat or ecosystem.

Daylight Out (pipes). End of subdrain pipe sticking out of the ground through continuation of designed slope or grade.

Deposition. Build-up of eroded soil particles that are transported in runoff from site of origin to treatment system, waterbody, or other ground surfaces.

Forebay. Artificial pool, mechanical device, or chamber designed for pretreatment of stormwater before entering primary treatment area or body of water.

Gulley. A water-worn ravine or depression.

Headcut (erosion). Abrupt step or vertical drop in a stream channel profile due to erosion.

Impervious Surface. Artificial structures (i.e. roads, sidewalks, rooftops, parking lots) that are covered by water-resistant materials.

Infiltration. Process by which water on the ground enters the soil.

Infiltrometer. Device used to measure the rate of water infiltration into soil.

Level Spreader. Erosion control device designed to mitigate impacts of high-velocity surface runof through even distribution of water.

Percolation. Rate at which water is absorbed into soil.

Permeability. A material's ability to allow fluids to pass through it.

Rill (erosion). Removal of soil by concentrated water running through small "rills", or headcuts.

Sapling. A young tree less than four inches tall.

Sedimentation (treatment). Process by which suspended solids are removed from water over time through gravity.

Scouring (erosion). Process by which soil or rock is displaced through water forcefully flowing over something.

Stormwater. Result of precipitation that flows overland to streams and other bodies of water.

Swale. Natural or man-made depression in the landscape with a shallow channel and gently sloping sides.

Underdrain. Concealed drain constructed in subgrade which allows water to be conveyed to a storm sewer system or, if perforated, allow water to be infiltrated into subsoils.

Volunteer Tree. plant that grows on its own, rather than being deliberately planted.

SECTION 5. REFERENCES

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INSPECTION & MAINTENANCE OF EXISTING STORMWATER CONTROL PRACTICES
REPORTING FORM

Site Name	Date	Inspector Name

Location of Stormwater Control Practice	BMP #	Estimated Age of Practice

Specify Stormwater Control Practice

- ☐ Rain Garden
- ☐ Bioretention Cell
- ☐ Bioswale / Vegetated Swales
- ☐ Native Landscaping
- ☐ Pretreatment & Mechancial Systems
- ☐ Soil Quality Restoration / Green Space
- ☐ Sand Filter
- ☐ Green Roof
- ☐ Tree Trench / Structural Cell
- ☐ Infiltration Basin / Trench
- ☐ Extended Retention / Detention Basin
- ☐ Retention or Detention Basin
- ☐ Pervious Concrete / Porous Asphalt
- ☐ Permeable Pavement

Structural Check	Compliant?	Action Needed?	Date Completed
Are there signs of settling, cracking, bulging, mis-alignment, or other deterioration?	Yes / No		
Do embankments, spillways, side slopes, inlets, outlets, show signs of erosion or slumping?	Yes / No		
Is the outlet plugged, damaged or not functioning properly?	Yes / No		
Do impoundment and inlet areas show erosion, low spots, or lack of stabilization?	Yes / No		
Are trees or saplings present if not meant to be part of BMP?	Yes / No		
Are animal burrows present?	Yes / No		
Are contributing areas unstabilized with evidence of erosion?	Yes / No		
Do grassed areas require mowing and/or are there excessive clippings present?	Yes / No		
Does native vegetation require fire or cutting management?	Yes / No		
Are there unwanted vegetation/weeds in the control practice? Indicate type of vegetation.	Yes / No		

Working Conditions	Compliant?	Action Needed?	Date Completed
Does the depth of sediment or other factors suggest a loss of storage volume?	Yes / No		
Is there standing water in inappropriate areas after a dry period?	Yes / No		
Does the infiltration practice pond water for >48 hours indicating hydraulic failure?	Yes / No		
Is there an accumulation of debris and/or trash?	Yes / No		

Additional Inspection Items	Compliant?	Action Needed?	Date Completed
Evidence of enroachment or improper use of BMP areas?	Yes / No		
Signs of vandalism?	Yes / No		
Fence, gate, lock or other safety devices need repair?	Yes / No		
Evidence of illicit discharge such as oil, grease, auto fluids, paint entering system?	Yes / No		