City of Poulsbo

Stormwater Facility
MAINTENANCE MANUAL

June 2014

The City of Poulsbo
acknowledges the following jurisdictions
for providing resource material for portions of this manual:

King County
Pierce County
City of Federal Way
City of Olympia
City of Port Orchard

NOTE TO USERS OF THIS MANUAL

The maintenance requirements of this manual apply to both private and public stormwater drainage facilities.

Sections 1.0, 4.0, and 5.0 provide information specific to owners of **private** stormwater drainage facilities.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

1.0 Introduction For Owners of Private Stormwater Facilities

The manual will assist the owners of private stormwater facilities on commercial or multi-family properties in performing proper inspection and maintenance of their facilities.

Stormwater facilities can include collection and conveyance systems, detention systems, retention systems, and treatment facilities, although not all sites have all of these elements. Stormwater facilities are typically a combination of landscape and structural components that slow, filter, detain and release, or retain/infiltrate stormwater runoff after a rainfall event.

City of Poulsbo Municipal Code Chapter 13.17 requires that private property owners are responsible for inspecting and maintaining their own stormwater facilities. Owners should have a maintenance program that addresses every component of the stormwater system to ensure the system does not lose its intended capability to manage stormwater.

Property owners with private systems are required to track inspection and maintenance of their stormwater facilities and submit an annual inspection and maintenance report to the City.

1.1 What is Stormwater Runoff?

When urban and suburban development covers the land with buildings, houses, streets and parking lots, much of the native topsoil, duff, trees, shrubs, and grass are replaced by asphalt and concrete. Rainfall that would have directly soaked into the ground before development now stays on the surface as stormwater runoff and makes its way into storm drains and eventually to our local creeks, Liberty Bay, and Puget Sound.

1.2 What is a Stormwater Facility and How Does It Work?

Stormwater facilities are sometimes called “storm drains” or “storm drainage systems”. The stormwater facility, or system, for most developed property includes components that carry, detain, cleanse, and release the stormwater. These components work together to reduce the impacts of development on the environment. These impacts can include flooding which results in property damage and blocked roads, erosion which can cause damage to salmon spawning habitat, and pollution which harms human and aquatic life and, sometimes, even drinking water supplies.

The storm drain system provides a safe method to collect stormwater in catch basins and carry it through pipes to the treatment and detention areas. Swales and ponds help filter some of the pollutants from the stormwater by physically settling out particles, chemically binding some of the pollutants to sediments, and biologically converting some of the pollutants to less-harmful compounds;

however, not all pollutants are captured. The ponds also detain or retain the treated water, releasing it gradually to a nearby stream or to groundwater.

The various components of storm drain systems are described in Section 3 of this manual. The number and type of components varies from property to property, but most properties have, at a minimum, a conveyance system of pipes and catch basins.

1.3 Why Manage Stormwater Runoff?

Stormwater runoff needs to be managed because it carries litter, oil, gasoline, fertilizers, pesticides, pet wastes, bacteria, metals, chemicals, sediments, and anything else that can float, dissolve, or be swept along by the moving water. Left untreated, polluted stormwater can reach nearby waterways where it can harm humans, wildlife, and aquatic life. In some cases, it can kill the aquatic life. It can also pollute groundwater to the extent that it must be treated before it can be used for drinking. Nationally, stormwater is recognized as a major threat to water quality.

Federal and State laws, as well as local ordinances, prohibit the discharge of pollutants to our waterways. Keeping stormwater facilities clean reduces flooding and the amount of pollutants reaching our waterways. ***Remember to keep everything out of storm drain systems except the rainwater they are designed to collect.***

1.4 How to Apply this Manual

Private property owners should review this manual to obtain an understanding of the general function of their stormwater management facilities and to identify which types of components shown in the manual are applicable to the property. After determining the type of components associated with his or her site, the owner should copy the applicable manual checklist for each component type and utilize them in facility inspection and maintenance.

It is important to note that there may be more than one component associated with your property. For example, a site may include catch basins, pipe, a bioswale, a detention pond, and a control structure/flow restrictor. In this case, all five checklists should be utilized for inspection and maintenance.

If your facilities include a proprietary component (e.g. Filterra® Bioretention System), refer to that unit's Operation and Maintenance manual for additional information and the manufacturer's inspection/maintenance form.

Although you are only required to send documentation of the annual dry-weather inspections to the City, all facilities have additional inspection frequencies which should be followed and then documented for your records.

1.5 Annual Inspection / Maintenance Process

A. Overview

Owners of commercial and multi-family properties within the City of Poulsbo are responsible for inspecting their drainage facilities as well as performing any maintenance required to bring the facilities up to City of Poulsbo and Washington State Department of Ecology standards. This may be done by either in-house staff or a vendor/contractor.

A reminder notice is sent to property owners every year. The annual *Private Drainage Facility Inspection & Maintenance Report* form, this manual, and other resource information are available by request and from the Public Works Stormwater pages on the City's website at:
http://cityofpoulsbo.com/publicworks/StormwaterQuality.htm

Property owners must complete the inspection and any required maintenance and return a completed, signed *Private Drainage Facility Inspection & Maintenance Report* form by the date specified in the annual notice. The City of Poulsbo will perform spot checks to evaluate the effectiveness of the program and property owner compliance.

B. Facility Identification

Identify the type and number of stormwater facility components on your property. To assist you in identifying components, refer to the descriptions and drawings in this manual. All facilities have conveyance components (pipe and catch basins). Many systems have components for flow control and treatment. Your stormwater system may have components that are in your landscaped areas as well as in your parking and driveway areas.

If you are unable to identify your system components we can help you if you call us to arrange a time to meet on your property with one of our staff.

C. Inspection

Inspect all facilities/components identified for your property. You may use in-house personnel or a vendor/contractor. A list of stormwater service providers is available on the City's website. The listed providers are not endorsed by the City and you are not required to use only a listed provider. Some service providers who clean catch basins don't inspect or maintain bioswales. If your site has a bioswale, be sure that it is inspected, maintained, and included on the report form.

Refer to this manual which describes the maintenance standard for each component and identifies defects with a defect code number and description.

Report the inspection results on the *Private Drainage Facility Inspection & Maintenance Report* form following the instructions included with the form. Download the current reporting form at:
http://cityofpoulsbo.com/publicworks/StormwaterQuality.htm

If your property includes any proprietary components (e.g. Filterra® Bioretention System) fill out the manufacturer's inspection/maintenance forms and submit a copy of that completed form with the *City of Poulsbo Inspection & Maintenance Report* form.

D. Maintenance Work

If maintenance is required, have the work performed by in-house personnel or a vendor. Report that maintenance has been completed on the *Private Drainage Facility Inspection & Maintenance Report* form following the instructions included on the form.

E. Certification

Provide the information indicated and sign under the certification section, certifying under penalty of perjury that the inspection has been performed, and either no maintenance needs were identified or the work was completed as indicated in the report form.

F. Submittal

Mail, fax, or hand deliver the completed *Private Drainage Facility Inspection & Maintenance Report* form to the City of Poulsbo Public Works Department (the address and fax number are at the end of the form). The Department of Public Works must receive the checklist by the date specified in the annual notice. **Both** the inspection and maintenance are to be completed before the due date.

G. Be Safe!

Use caution when entering or working around catch basins, tanks, vaults, or other structures, and conform to confined space entry laws. Most inspections can be performed above ground. If confined space entry is required, it is recommended that you contract with a qualified vendor with confined space entry experience.

Property owners are responsible for the safety of all persons, including in-house and vendor personnel, performing confined space entry on their property under Washington Administrative Code (WAC) 296-809, Confined Spaces. This responsibility may involve undergoing an assessment of the property to determine whether a permit is required for confined space entry (the permit is a self-generated checklist used to determine that all conditions are safe for entry).
For information and assistance, contact Washington State Labor & Industries at (800) 423-7233 or at: http://www.lni.wa.gov. This agency also offers educational workshops for the confined space program.

H. Tools of the Trade

Depending of the type of facility you have, some of the following tools may be of assistance in doing your own inspection:

TASK	TOOL
Opening manhole cover	• ½” Allen wrench
Opening stuck lids/grates	• crow bar / long bar • hammer
Measuring sediment depths	• measuring rod (an 8-foot length of aluminum conduit marked at 1-foot intervals works well for most systems) • tape or chalk
Measuring storage space/sediment depths	• tape measure (12 ft)
Lifting grates/lids	• manhole cover hook
Inspection from above ground	• mirror on a long handle
Probing for catch basins/moving heavy objects	• straight-pointed bar
Entry into confined spaces	• gas monitor/detector
General	• flashlight (6 volt lantern or halogen recommended) • flat screwdriver • Phillips screwdriver • shovel • trash rake (4/5 prong) • trash can • vise-grip pliers • 10” wrench • 15” wrench

I. Sediment Estimating.....the Most Common Task

The most common defect encountered is excessive sediment level in a Type I or Type II Catch Basin. Please refer to this manual for information on other defects.

<u>To check the sediment level in a Type I or Type II Catch Basin</u>:

A. Remove the manhole cover / grate

Using a ½-inch Allen wrench and a catch basin grate hook or crow bar.

B. Identify the sump depth (water level)

Using a probe or rod, identify the sump depth. This is done by inserting the rod through the water and sediment until it hits the bottom of the catch basin; water level will be visible for measurement upon removal. NOTE: Under normal conditions, the water level should be even with the outlet pipe. A higher level indicates a blockage in the outlet.

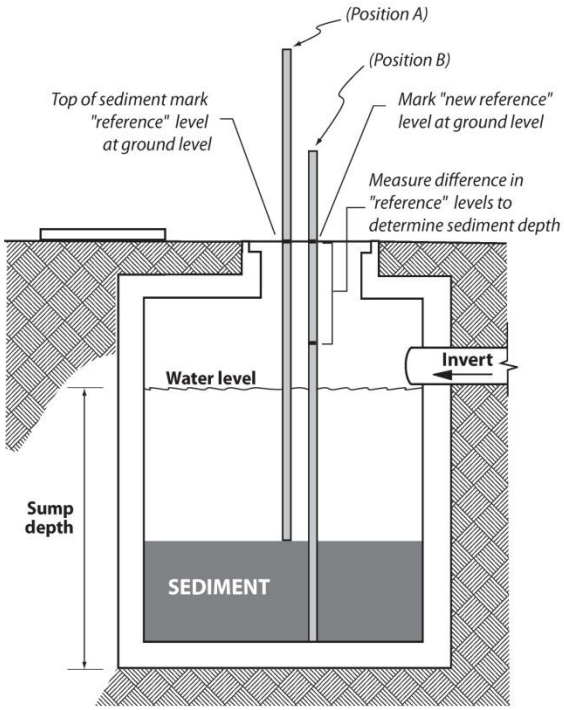


Diagram from King County Drainage Maintenance Standards

C. Identity the sediment level

1) Put the probe or rod in through the water until it touches the top of the sediment. Mark it with relation to a stationary point in the catch basin with tape or chalk (position A on the following diagram).

2) Put the probe or rod in through the water and sediment until it touches the bottom of the catch basin, and mark the probe with relation to the same stationary point as in item 1 above (Position B on the following diagram). The difference between the two marks is the **sediment depth**.

3) The water mark left on the rod is the “sump depth”. Measure the ratio of sediment depth to sump depth to determine the allowable amounts.

In Type I and Type II catch basins, the sediment must be removed if the sediment level exceeds 60% of the sump depth as measured from the bottom of the basin to the invert (inside bottom) of the pipe into or out of the basin, but in no case shall there be less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.

1.6 Frequently Asked Questions

Q1. I've never had to clean my storm drainage system before, so why now?

A1. Property ownership usually involves maintaining buildings, grounds, and other infrastructures. Keeping your storm drainage system clean and in proper working order preserves your assets as well as minimizes your impact to the natural environment.

Now, by Federal law, the State of Washington Department of Ecology has issued a stormwater discharge permit to certain cities and counties, including the City of Poulsbo. The permit requires the City to prevent "illicit discharges" (pollution) from entering the waters of the state, which includes our local creeks and Liberty Bay. ***An illicit discharge is anything not composed entirely of stormwater – so things like sediments, debris, chemicals, oils, and soaps or other cleaning materials must be prevented from entering the storm drain system.*** Properly maintaining your storm drainage facilities reduces or prevents illicit discharges. The City of Poulsbo and private property owners are required by law to prevent illicit discharges from entering the storm drainage system.

More information on the "Western Washington Phase II Municipal Stormwater Permit" and the City's Stormwater Management Program may be found on the City's Stormwater Management webpage at:

http://cityofpoulsbo.com/publicworks/publicworks_stormwater_management.htm

Q2. Why does it matter what goes into the storm drain - doesn't the storm drain water go to the sewer treatment plant?

A2. No - some of our storm drains discharge to a creek and then Liberty Bay and some of them discharge directly to Liberty Bay. In either case, the storm water is not treated directly before it enters a creek or the bay.

Although some stormwater management facilities have a treatment component, the pollutant removal capabilities are limited. After the stormwater leaves the facility it is mixed with water that is not treated before being discharged to a creek or the bay.

Frequently Asked Questions (continued)

Q3. Why can't I use soap or other cleaning products that say they are bio-degradable?

A3. Biodegradable means the product breaks down into its chemical components. Those chemicals can still be harmful to human, animal, and aquatic life.

Q4. How do I dispose of trash, debris, and sediment removed from the storm drainage system?

A4. Trash and Debris:

- Small amounts of trash and debris can be put into your solid waste container.
- Large amounts may require hiring a vendor to dispose of the material. If using a vendor, ensure that the vendor properly disposes of waste.

Sediment:

- Clean sediment may be used as landscape material or sent to yard waste recyclers.
- Sediment that does not appear to be heavily contaminated with oil or grease can be double bagged and put into your solid waste container.
- Material that appears to be heavily contaminated must be disposed of by a qualified vendor.

2.0 STORMWATER MANAGEMENT FACILITIES

To help understand stormwater facility maintenance requirements, it is useful to have a general knowledge of how they function. Some maintenance needs are common to all types of facilities, while others depend on the specific facility.

The three major components of stormwater management include stormwater collection/conveyance, stormwater quantity control (detention/retention) and stormwater quality control (treatment). This manual section describes general stormwater management theories and goals. Specific stormwater facility descriptions and maintenance requirements are provided in Section 3.0.

2.1 Collection and Conveyance Systems

Collection and conveyance systems intercept and transport stormwater and typically consist of inlets (catch basins) that collect water and pipes and/or open channels (ditches). Stormwater conveyance systems are designed to provide capacity for a specific maximum flow rate. Typical failures include reduced capacity due to clogged surface grates and pipes. Plugging commonly occurs due to sediment and large debris washed from adjacent surfaces. Reduced conveyance system capacity results in localized flooding and possible property damage. In addition, the inlets provide some stormwater quality control (treatment) by providing a sump for sediments and oils to collect in; however, lack of maintenance of these structures results in the discharge of pollutants from the property.

2.2 Stormwater Quantity Control (Flow Control / Detention Retention)

The intent of stormwater quantity control facilities is to slow down stormwater flow discharged to the environment from developed sites. Impervious surfaces, such as roads, roofs, and lawns, quicken the rate of stormwater runoff into natural streams which can create flooding. Stormwater quantity control facilities mitigate the increased runoff by providing temporary storage and controlling the release rate from the site to prevent flooding and erosion. Detention and retention facilities may be designed as ponds or underground facilities.

Detention facilities function by providing temporary storage of stormwater runoff to be released at a controlled rate. The intent of the detention facility is to match the pre-developed runoff rates for several specific storm events in the developed condition.

Retention facilities are typically located in areas where water soaks easily into the ground. Retention facilities provided temporary storage while allowing the water to soak into the ground, mimicking natural conditions. There is typically no release of stormwater to other pipes or water bodies.

2.3 Stormwater Quality Control (Treatment)

There are a several Best Management Practices (BMPs) utilized for stormwater quality control. These systems provide limited stormwater treatment through a combination of filtration, sediment settling, plant nutrient uptake, and physical separation. The most common treatment systems include biofiltration swales, filter strips, wet ponds, and sand filters. There are also some proprietary structural treatment systems including Stormfilters®, oil/water separators, and Vortech® treatment units. The intent of all stormwater treatment facilities is to help remove pollutants such as oils, chemicals, metals, and sediment from stormwater runoff prior to being discharged from the property.

Stormwater treatment facilities have a limited pollutant removal capability and are not intended to replace proper site management. The most effective technique for reducing pollutant discharge from the site is to provide good housekeeping through source control Best Management Practices (BMPs) as provided in "Volume IV – Source Control BMPs" of the Department of Ecology Stormwater Management Manual for Western Washington. The manual can be found on-line at:

http://www.ecy.wa.gov/programs/wq/stormwater/manual.html

3.0 Facility Descriptions and Maintenance Checklists

Each of the following subsections includes a facility description, illustrated exhibit (when appropriate) and maintenance checklist for 25 common stormwater facilities/components.

3.1 Catch Basin

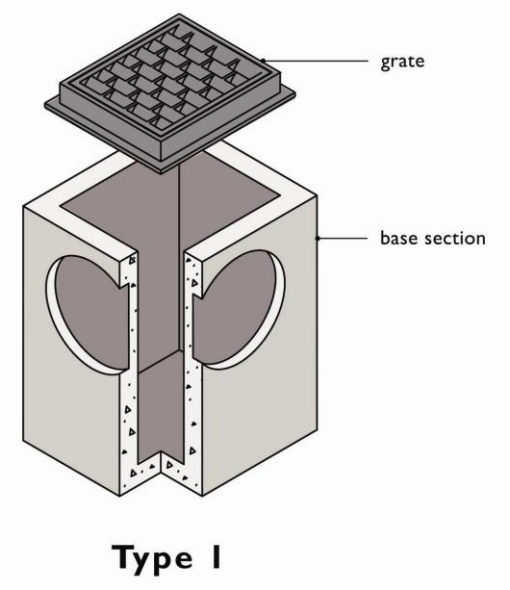
Catch basins are underground concrete structures typically provided with a slotted grate to collect stormwater runoff and route it through underground pipes. Catch basins can also be used as a junction in a pipe system and may have a solid lid. There are two catch basin types.

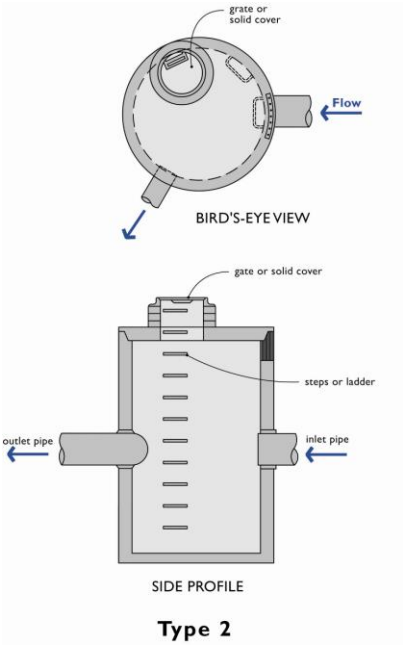
A Type 1 catch basin is a rectangular box with approximate dimensions of 3'x2'x5'. Type 1 catch basins are utilized when the connected conveyance pipes are less than 18 inches in diameter and the depth from the grate to the bottom of the pipe is less than 5 feet.

Type 2 catch basins, also commonly referred to as storm manholes, are round concrete structures ranging in diameter of 4 feet to 8 feet. Type 2 catch basins are used when the connecting conveyance pipe is 18 inches or greater or the depth from grate to pipe bottom exceeds 5 feet. Type 2 catch basins typically have manhole steps mounted on the side of the structure to allow for access.

Both catch basin types typically provide a storage volume (sump) below the outlet pipe to allow sediments and debris to settle out of the stormwater runoff. Some catch basins are also provided with a spill control device (a tee or inverted elbow on the outlet pipe) intended to contain large quantities of grease or oils.

The most common cleaning method for catch basins is to utilize a truck with a tank and vacuum hose (vactor truck) to remove sediment and debris from the sump. Catch basins may be an enclosed space where harmful chemicals and vapors can accumulate. Therefore, if the inspection and maintenance requires entering a catch basin, it should be conducted by an individual with training and certification in working in hazardous confined spaces.





Catch Basin Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General	A-1	Trash, debris. vegetation	Trash, or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No trash, debris, or vegetation located immediately in front of catch basin or on grate opening.
M, S	Grates	A-2	Trash & debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
M	General	A-3	Trash, debris, & sediment	Trash, debris, or sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash, debris, or sediment in the catch basin.
M	General	A-4	Trash, debris, & sediment	Trash, debris, or sediment in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash, debris, or sediment.
A	General	A-5	Structure damage to frame and/or top slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
A	General	A-6	Structure damage to frame and/or top slab	Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
A	General	A-7	Fractures or cracks in basin walls/ bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
A	General	A-8	Fractures or cracks in basin walls/ bottom	Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is re-grouted and secure at basin wall.
A	General	A-9	Settlement / misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
M	General	A-10	Contamination and pollution	Any evidence of oil, gasoline, contaminants, or other chemical pollutants (Notify the Public Works Department at 360-779-4078).	No contaminants or pollutants present.
A	Catch basin solid cover	A-11	Cover not in place	Cover is missing or only partially in place.	Any open catch basin requires maintenance. Catch basin cover is closed.

- checklist continued on next page -

Catch Basin Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	Catch basin solid cover	A-12	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is to keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
A	Ladder	A-13	Ladder rungs unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
A	Grates	A-14	Grate opening unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
A	Grates	A-15	Damaged or missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.
A	General		"Dump No Pollutants " stencil or marker not visible	Stencil or marker should be visible and easily read	Warning signs (e.g., "Dump No Waste/Drains to Stream") stencil or marker shall be adjacent to all storm drain inlets.

PENDING

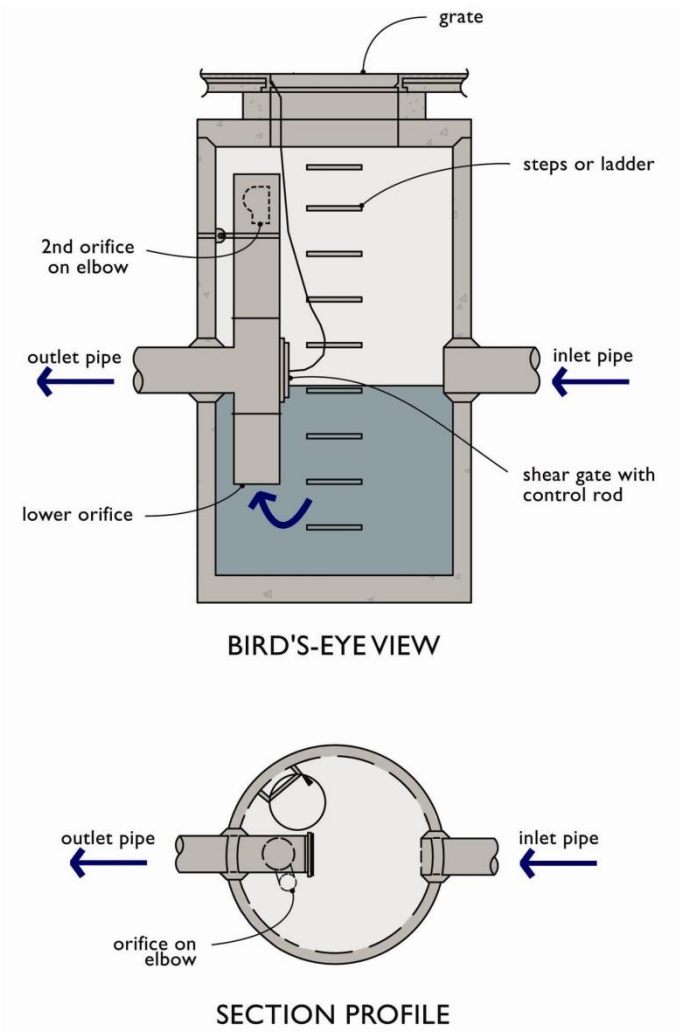
If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

<u>Key</u>:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.2 Control Structure/Flow Restrictor

Control structures/flow restrictors are located on the outlet pipe of a detention system. The control structure is typically within a Type 2 concrete catch basin (see Section 3.5 for catch basin description) with a riser (vertical pipe). This size of catch basin is also called a manhole. The control structure reduces the discharge rate of stormwater from a detention facility. The flow is regulated by a combination of orifices (holes with specifically sized diameters) and weirs (plates with a rectangular or vee shaped notch). Lack of maintenance of the control structure can result in the plugging of an orifice. This can result in flooding of the stormwater system and/or an increase in the rate of discharge from the site potentially damaging downstream property.



Control Structure/Flow Restrictor Checklist

Inspection Frequency*	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	B-1	Trash, debris, sediment	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash, debris, or sediment removed.
A	General	B-2	Structural damage	Structure is not securely attached to manhole wall.	Structure securely attached to wall and outlet pipe.
A	General	B-3	Structural damage	Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
A	General	B-4	Structural damage	Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
A	General	B-5	Structural damage	Any holes, other than designed holes, in the structure.	Structure has no holes other than designed holes.
A	Cleanout gate	B-6	Damaged or missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
A	Cleanout gate	B-7	Damaged or missing	Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
A	Cleanout gate	B-8	Damaged or missing	Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
A	Cleanout gate	B-9	Damaged or missing	Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
A	Orifice plate	B-10	Damaged or missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
M,S	Orifice plate	B-11	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
M,S	Overflow pipe	B-12	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
A	Manhole	B-13	Cover not in place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
A	Manhole	B-14	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
A	Manhole	B-15	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
A	Manhole	B-16	Ladder rungs unsafe	Ladder is unsafe due to missing rungs, misalignment, rust, cracks, or not securely attached to wall.	Ladder meets design standards. Allows maintenance person safe access.

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

<u>Key</u>:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.3 Pipe / Culvert

Pipes and culverts are part of the conveyance system for stormwater. They may be constructed of concrete pipe (CP), corrugated metal pipe (CMP), or smooth wall high density polyethylene pipe (HDPP).

Pipe / Culvert Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	C-1	Sediment & debris	Accumulated sediment and/or debris that exceeds 20% of the diameter of the pipe.	Clean pipe of all sediment and debris.**
M	Vegetation	C-2	Overgrowth	Vegetation that reduces free movement of water through pipes.	Remove all vegetation so water flows freely through pipes.
A	Structural	C-3	Protective coating is damaged	Rust is causing more than 50% deterioration to any part of the pipe.	Repair or replace pipe.
A	Structural	C-4	Joints	Joints are visibly misaligned, or culvert alignment is disrupted.	Realign/reconnect affected culvert.
A	Structural	C-5	Damaged pipe	Any dent that decreases the cross section area of pipe by more than 20%.	Repair or replace pipe.

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **All items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

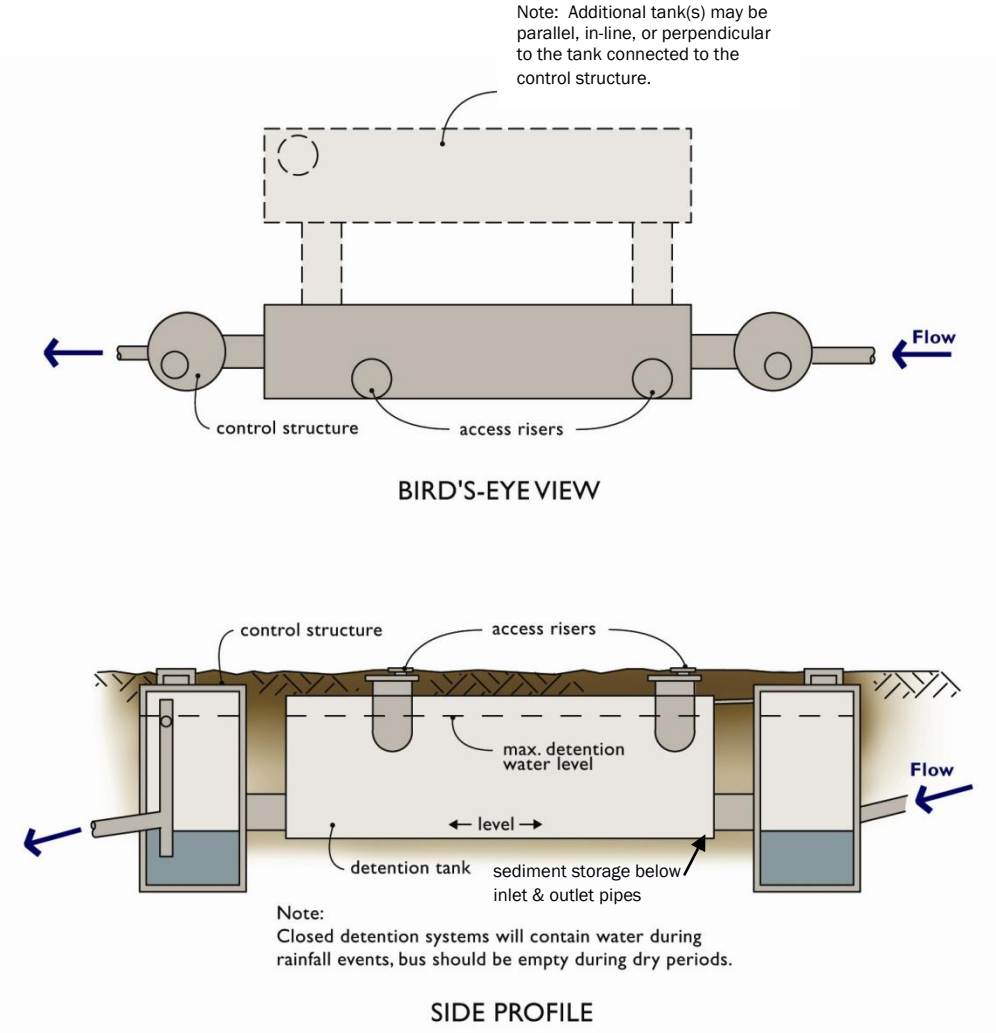
** Refer to the disposal guidelines in Section 1.3, Frequently Asked Questions, on disposal of trash, debris and sediment

Key:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.4 Detention Tank / Vault

Detention tanks and vaults function in a manner similar to detention ponds, with the temporary storage volume provided by an underground structure to regulate the storm discharge rate from the site. The structure is typically constructed of large diameter pipe (48" diameter or greater) or a concrete box (vault). These systems are typically utilized for sites that do not have space available for an above-ground system and are more commonly associated with commercial sites.

Underground detention systems are an enclosed space where harmful chemicals and vapors can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual with training and certification in working in hazardous confined spaces.



Detention Tank / Vault Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	Storage area	D-1	Plugged air vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
M	Storage area	D-2	Debris and sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for ½ length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
A	Storage area	D-3	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	Storage area	D-4	Tank pipe bent out of shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
A	Storage area	D-5	Vault structure includes cracks in wall, bottom, damage to frame and/or top slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks. (Will require engineering analysis to determine structural stability).	Vault replaced or repaired to design specifications and is structurally sound.
A	Storage area	D-6	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
A	Access Riser/Port; Connector Catch Basin/Man hole	D-7	Cover not in place	Cover is missing or only partially in place. Any open structure requires maintenance.	Structure is closed.
A	Access Riser/Port; Connector Catch Basin/Man hole	D-8	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.

- checklist continued on next page -

Detention Tank / Vault Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	Access Riser/Port; Connector Catch Basin/Manhole	D-9	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
A	Access Riser/Port; Connector Catch Basin/Manhole	D-10	Ladder rungs unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.

If you are unsure whether a problem exists, please contact a Professional Engineer.

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Key:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

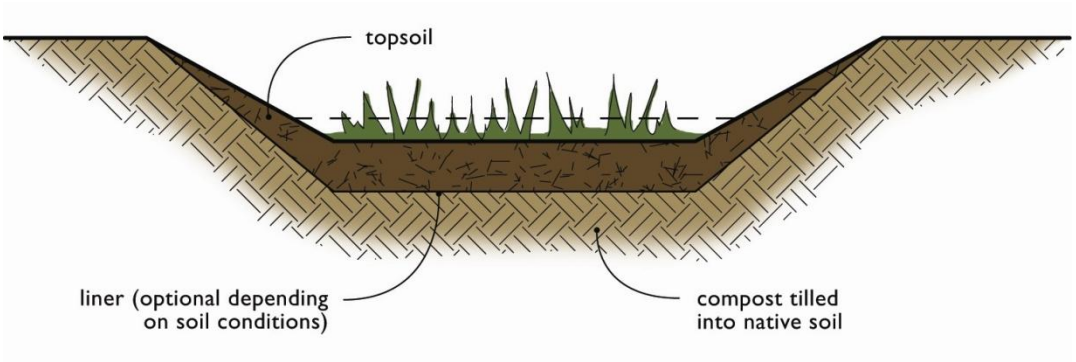
3.5 Biofiltration Swale

Biofiltration swales are engineered grass-lined open channels with moderate centerline slope similar in appearance to typical ditches.

Biofiltration uses vegetation in conjunction with slow and shallow-depth flow for runoff treatment. As runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration, and settling. These effects are aided by the reduction of the velocity of stormwater as it passes through the biofilter.

Biofiltration swales provide stormwater quality control (treatment), but do not provide stormwater quantity control (detention/retention).

The maintenance requirements of biofiltration swales differ from ditches.



Biofiltration Swale Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	E-1	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
M	General	E-2	Standing water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet biofiltration swale.
M	General	E-3	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
M	General	E-4	Constant baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
M	General	E-5	Poor vegetation coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
M	General	E-6	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.

- checklist continued on next page -

Biofiltration Swale Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	E-7	Excessive shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
M	General	E-8	Inlet/outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
M	General	E-9	Trash and debris accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from bioswale.
M	General	E-10	Erosion/scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.
M	Rock Pad	E-11	Missing or moved rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
M	Rock Pad	E-12	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.

If you are unsure whether a problem exists, please contact a Professional Engineer.

*** <u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or required inspections.**

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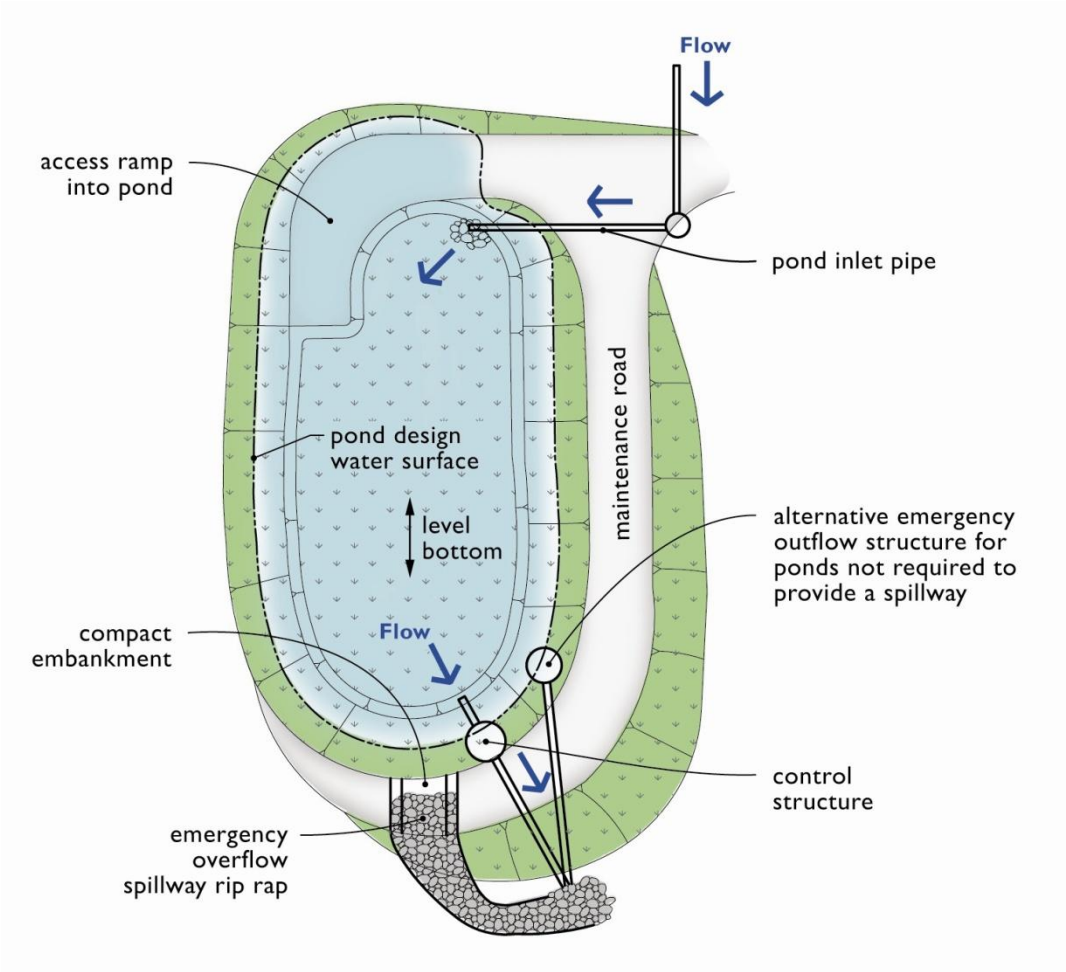
3.6 Detention Pond ("dry pond")

Stormwater detention ponds are open basins built by excavating below existing ground or by constructing above-ground berms (embankments). The detention pond temporarily stores stormwater runoff during rain events and slowly releases it downstream through an outlet (control structure) to prevent flooding and erosion. Detention ponds are typically designed to completely drain within 24 hours after the completion of a storm event. Components that are typically associated with a detention pond include the following: control structure/flow restrictor, debris barrier (e.g. trash rack), energy dissipaters, access road, and fence. Dry ponds generally have only one cell to hold the water.



Detention Pond Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General	F-1	Trash & debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
A	General	F-2	Poisonous vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
M,S	General	F-3	Contaminants and pollution	Any evidence of oil, gasoline, contaminants or other pollutants	No contaminants or pollutants present. (Notify Public Works Department before removal / cleanup).
M	General	F-4	Rodent holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
M	General	F-5	Beaver dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
A	General	F-6	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.
A	General	F-7	Tree growth and hazard trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove.	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood).

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Detention Pond Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	General	F-8	Unhealthy trees	If dead, diseased, or dying trees are identified (Use a certified arborist to determine health of tree or removal requirements).	Remove hazard trees
M	Side slopes of pond	F-9	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
M,S	Side slopes of pond	F-10	Erosion	Any erosion observed on a compacted berm embankment.	If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
M	Storage area	F-11	Sediment	Accumulated sediment that exceeds 10% (typically 6" to 12") of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
M	Storage area	F-12	Liner (If applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
A	Pond berms (dikes)	F-13	Settlement	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
A	Pond berms (dikes)	F-14	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair.)	Piping eliminated. Erosion potential resolved.

- checklist continued on next page -

Detention Pond Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	Emergency overflow / spillway	F-15	Tree growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
A	Emergency overflow / spillway	F-16	Unprotected spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
A	Emergency overflow / spillway	F-17	Erosion	See "Side slopes of Pond"	
A	Emergency Overflow/ Spillway and Berms over 4 feet in height.	F-18	Tree Growth	Tree growth on emergency spillways create blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
A	Emergency Overflow/ Spillway and Berms over 4 feet in height.	F-19	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Have a Geotechnical engineer inspect and evaluate discernible water flow conditions and recommend repairs).	Piping eliminated. Erosion potential resolved

If you are unsure whether a problem exists, please contact a Professional Engineer.

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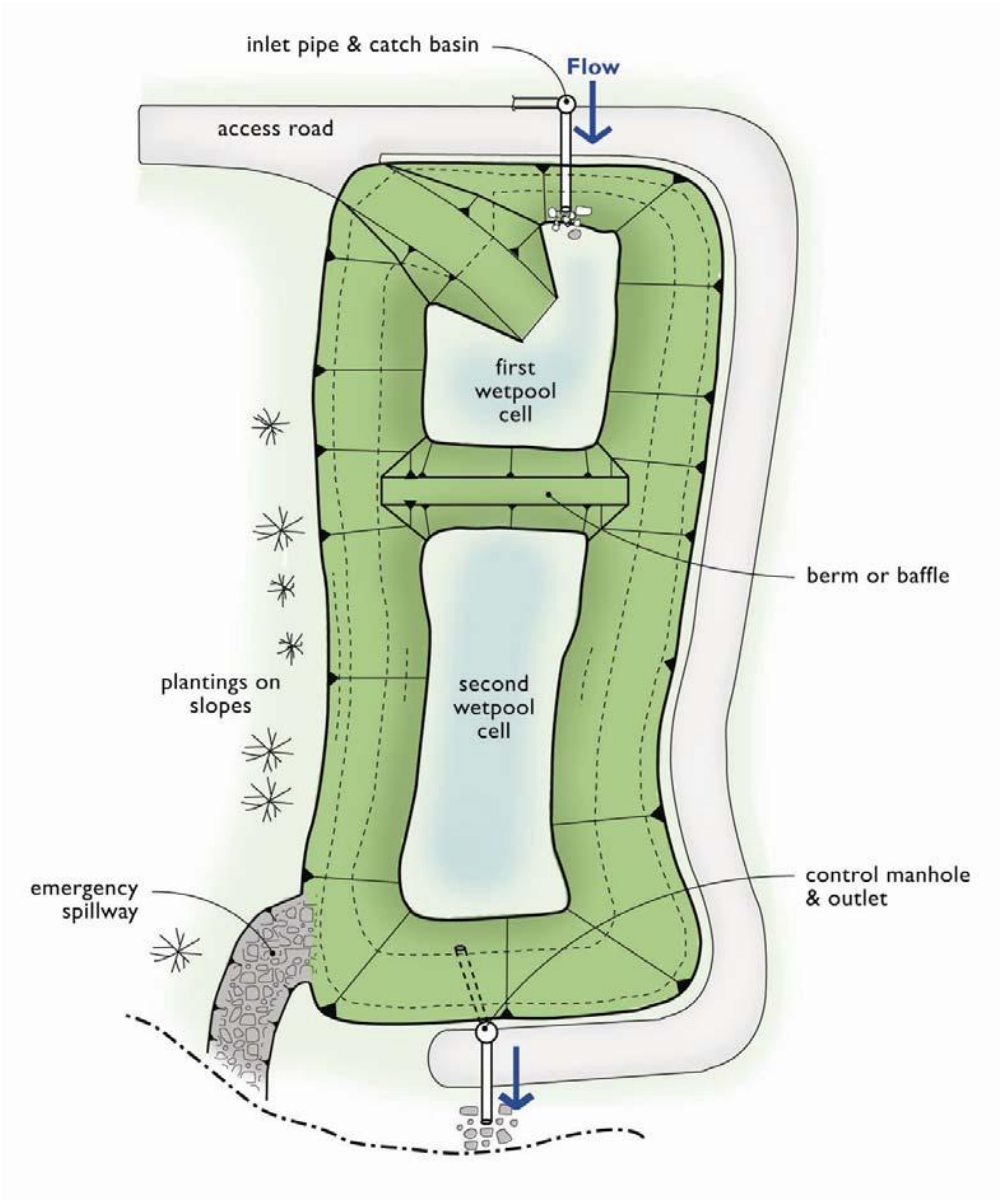
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.7 Wet Pond

A wet pond is an open basin that retains a permanent pool of water (wetpool) year round or only during the wet season. The volume of the wetpool allows sediment and other pollutants to settle out of the runoff. Wetland vegetation may be planted within the wet pond to provide additional treatment through nutrient (i.e. nitrogen) removal. Detention quantity control can be provided with additional temporary storage volume above the permanent pool elevation. Wet ponds have two cells with the first cell providing an opportunity for sediment to settle out. Water then migrates through and over the berm to the second cell where it continues to be detained as the flow is released through the control structure.



Wet Pond Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M, A	Pond area	G-1	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment re-suspension.
M, A	Pond area	G-2	Vegetation	Vegetation such as grass and weeds needs to be mowed when height exceeds 18 inches. Mowed vegetation should be removed from areas where it could enter the pond, either when the pond level rises, or by rainfall runoff. Trees, brush, and shrubs are impeding maintenance or flow.	Mow vegetation to 4-5 inches in height. Remove trees, bushes and shrubs where they are interfering with pond maintenance activities; that is, at the inlet, outlet and near engineered structures. Some wetland species may require harvesting or special maintenance rather than mowing.
M, A	Pond area	G-3	Algae mats	When algae mats develop over more than 10% of the water surface, they should be removed. Also remove mats in the dry season before fall rains.	Algae mats that cover more than 10% of the surface of any cell should be removed. A rake or mechanical device should be used to remove the algae. Removed algae can be left to dry on the pond slope above the 100-year water surface.*
M, A	Pond area	G-4	Trash and debris	Accumulation that exceeds 1 cubic foot per 1000 square feet of pond area.	Trash and debris removed from pond
M, A	Pond area	G-5	Sediment accumulation in pond bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone (typically 1 foot) plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
M, A	Pond area	G-6	Oil sheen on water, contaminants, or pollution	Prevalent and visible oil sheen or any evidence of gasoline, contaminants, or other pollutants.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil. No contaminants or pollutants present.
M, A	Inlet/outlet pipe	G-7	Trash and debris	Inlet/Outlet pipe clogged with sediment and/or debris material	No clogging or blockage in the inlet and outlet piping.
M, A	Inlet/outlet pipe	G-8	Floatables are captured	Floatable material is retained by outlet pipe or T-section.	Ensure outlet pipe or T-section retains floatables.
A	Pond area	G-9	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, which exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.

- checklist continued on next page -

Wet Pond Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	Pond dike	G-10	Settlement of pond dike/berm	Any part of these components which has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications
A	Internal dike/berm	G-11	Concentrated flow	Dike/berm dividing the cells should be level.	Dike/berm surface is leveled so that water flows evenly over entire length of dike/berm.
A	Overflow spillway	G-12	Rock missing	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.
A	Access ramp	G-13	Not in useable condition	Access ramp is capable of supporting trucks and maintenance equipment.	Repair ramp to support trucks and maintenance equipment.

If you are unsure whether a problem exists, please contact a Professional Engineer.

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**Refer to the disposal guidelines in Section 1.3, Frequently Asked Questions, on disposal of trash, debris and sediment

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(M) Monthly from November through April.
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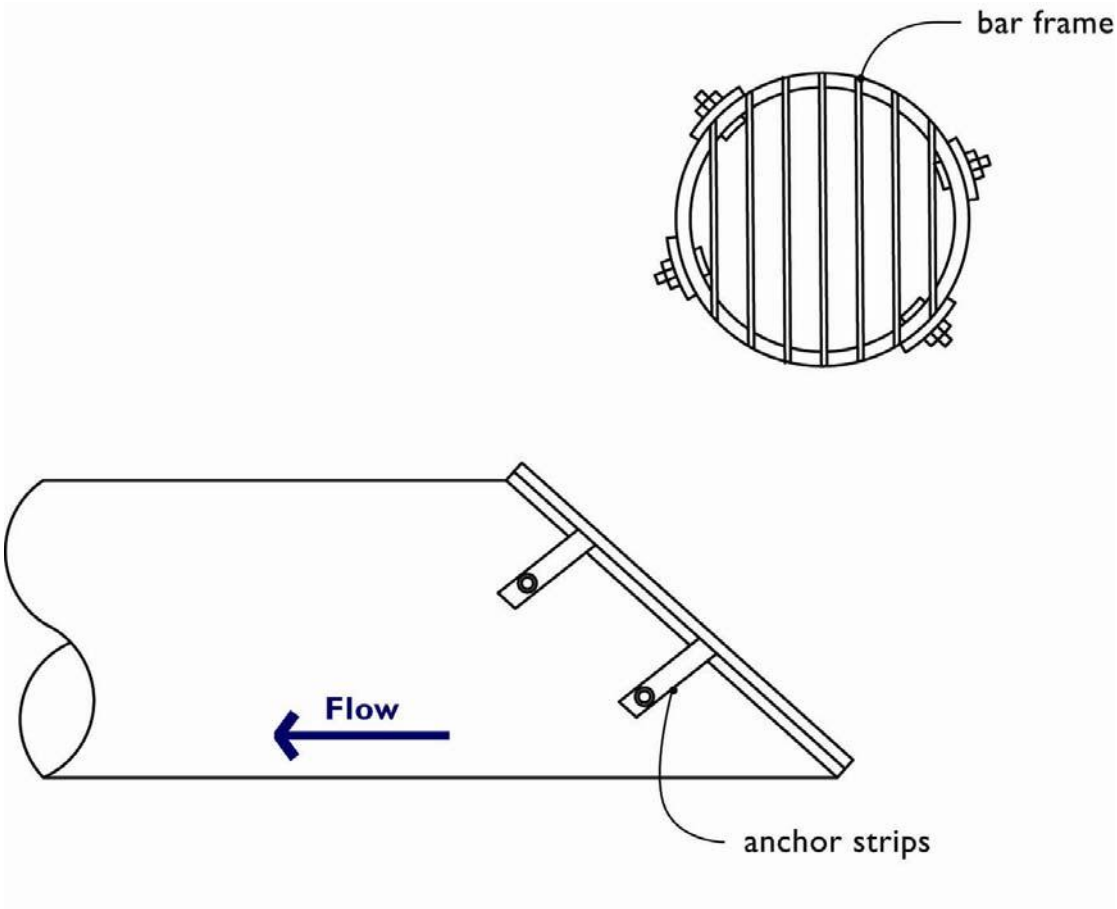
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.8 Debris Barrier

Debris barriers consist of bar grates over the open end of a culvert or conveyance pipe. The intent of a debris barrier is to prevent large materials from entering a closed pipe system. Debris barriers are typically located on the outlet pipe from a detention pond to the control structure. If a debris barrier is not located on the outlet pipe, one should be provided to prevent plugging of the control structure and possible flooding.

Access barriers are similar to debris barriers but are included on all pipe ends that exceed 18 inches in diameter. Their function is to prevent debris and unauthorized access into the storm conveyance pipe. When there is flow through the conveyance pipe removal of debris and maintenance of the debris barrier should be performed by qualified personnel only.



Debris Barrier Checklist

Inspection Frequency*	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General	H-1	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
A	General	H-2	Damaged/Missing Bars	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
A	General	H-3	Damaged/Missing Bars	Bars are missing or entire barrier missing.	Bars in place according to design.
A	General	H-4	Damaged/Missing Bars	Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
A	General	H-5	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe.	Barrier firmly attached to pipe.

If you are unsure whether a problem exists, please contact a Professional Engineer.

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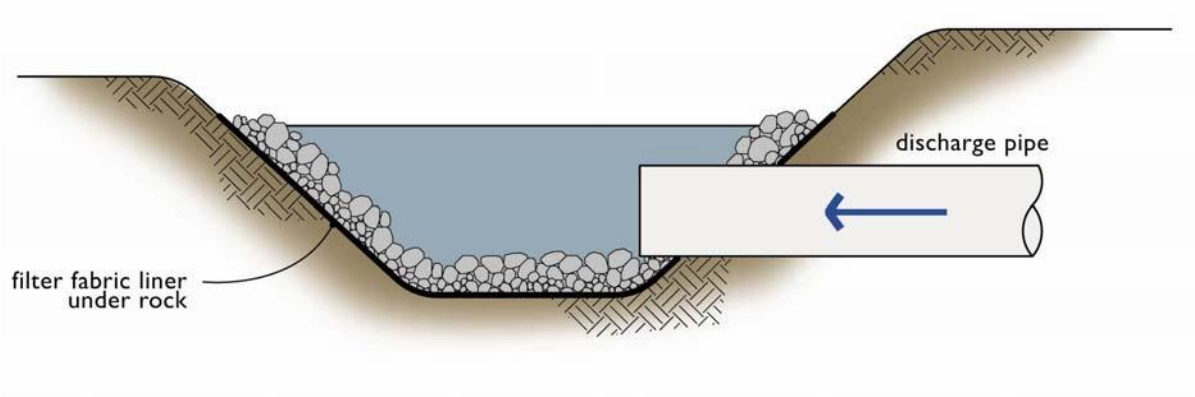
3.9 Energy Dissipater

Energy dissipaters are provided on the inlet and outlet to a closed pipe system to prevent erosion at these locations. Design of an energy dissipater can vary significantly from highly engineered systems (concrete or rock gabion structures) to the more commonly used rock pad. The rock pad is typically constructed of 4- to 12-inch diameter rocks a minimum of 12 inches thick and is often lined with filter fabric. The rock pad should extend above the top of the pipe a minimum of 1 foot.



Energy Dissipater Checklist

Inspection Frequency*	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	Rock pad or check dam	I-1	Missing or moved rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
M	Rock pad or check dam	I-2	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
M	Dispersion trench	I-3	Pipe plugged with sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.
M	Dispersion trench	I-4	Not discharging water properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
M	Dispersion trench	I-5	Perforations plugged	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
M	Dispersion trench	I-6	Water flows out top of "distributor" catch basin	Observation or report of water flowing out during any storm less than the design storm or it is causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
M	Dispersion trench	I-7	Receiving area over-saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
M	Manhole/ chamber	I-8	Worn or damaged post, baffles, side of chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
M	Manhole/ chamber	I-9	Trash& debris	Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
M	Manhole/ chamber	I-10	Trash& debris	Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
M	Manhole/ chamber	I-11	Trash& debris	Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g. methane).	No dead animals or vegetation present within the catch basin.

- checklist continued on next page -

Energy Dissipater Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	Manhole/ Chamber	I-12	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe. There shall be a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
A	Manhole/ Chamber	I-13	Structure damage to frame and/or top slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
A	Manhole/ Chamber	I-14	Structure damage to frame and/or top slab	Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
A	Manhole/ Chamber	I-15	Fractures or cracks in basin walls/ bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
A	Manhole/ Chamber	I-16	Fractures or cracks in basin walls/ bottom	Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is re-grouted and secure at basin wall.
A	Manhole/ Chamber	I-17	Settlement / misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
M	Manhole/ Chamber	I-18	Contamination and pollution	Any evidence of oil, gasoline, contaminants, or other pollutants (Coordinate removal/cleanup with the Public Works Department).	No contaminants or pollutants present.
A	Catch basin cover	I-19	Cover not in place	Cover missing or partially in place.	Any open catch basin requires maintenance. Catch basin cover is closed
A	Catch basin cover	I-20	Locking mechanism not working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
A	Catch basin cover	I-21	Cover difficult to remove	One maintenance person cannot remove lid after applying normal lifting pressure.	Cover can be removed by one maintenance person.

If you are unsure whether a problem exists, please contact a Professional Engineer.

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3.10 Fencing / Gates / Landscaping

Fencing and shrubbery screen are provided around open stormwater management facilities to limit unauthorized access for safety purposes and to minimize the visual impact of the facility. Gates typically consist of a chain link gate for fenced stormwater facilities to provide safety and allow vehicle and/or personnel access to the facility. Landscaping is an essential component of stormwater management. Bare soil areas generate higher levels of stormwater runoff and sedimentation in stormwater facilities.

Fencing / Gates / Landscaping Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	J-1	Missing or broken parts/dead shrubbery	Any defect in the fence or screen that permits easy entry to a facility.	Fence is mended or shrubs replaced to form a solid barrier to entry.
M,S	General	J-2	Erosion	Erosion has resulted in an opening under a fence that allows entry by people or pets.	Replace soil under fence so that no opening exceeds 4 inches in height.
M	General	J-3	Unruly vegetation	Shrubbery is growing out of control or is infested with weeds.	Shrubbery is trimmed and weeded to provide appealing aesthetics. Do not use chemicals to control weeds.
A	Fences	J-4	Damaged parts	Posts out of plumb more than 6 inches.	Posts plumb to within 1-1/2 inches of plumb.
A	Fences	J-5	Damaged parts	Top rails bent more than 6 inches.	Top rail free of bends greater than 1 inch.
A	Fences	J-6	Damaged parts	Any part of fence (including posts, top rails, and fabric) more than 1 foot out of design alignment.	Fence is aligned and meets design standards.
A	Fences	J-7	Damaged parts	Missing or loose tension wire.	Tension wire in place and holding fabric.
A	Fences	J-8	Damaged parts	Missing or loose barbed wire that is sagging more than 2-1/2 inches between posts.	Barbed wire in place with less than 3/4-inch sag between posts.
A	Fences	J-9	Damaged parts	Extension arm missing, broken, or bent out of shape more than 1-1/2 inches.	Extension arm in place with no bends larger than 3/4 inch.
A	Fences	J-10	Deteriorated paint or protective coating	Part or parts that have a rusting or scaling condition that has affected structural adequacy.	Structurally adequate posts or parts with a uniform protective coating.
M	Fences	J-11	Openings in fabric	Openings in fabric are such that an 8-inch diameter ball could fit through.	No openings in fabric.

- checklist continued on next page -

Fencing / Gates / Landscaping Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	Gates	J-12	Damaged or missing components	Gate is broken, jammed, or missing.	Pond has a functioning gate to allow entry of people and maintenance equipment such as mowers and backhoe. If a lock is used, make sure the City field staff has a key.
M	Gates	J-13	Damaged or missing components	Broken or missing hinges such that gate cannot be easily opened and closed by a maintenance person.	Hinges intact and lubed. Gate is working freely.
A	Gates	J-14	Damaged or missing components	Gate is out of plumb more than 6 inches and more than 1 foot out of design alignment.	Gate is aligned and vertical.
A	Gates	J-15	Damaged or missing components	Missing stretcher bands, and ties.	Stretcher bar, bands, and ties in place.
M	Landscape-General	J-16	Weeds (nonpoisonous)	Weeds growing in more than 20% of the landscaped area (trees and shrubs only).	Weeds present in less than 5% of the landscaped area.
M	Landscape-General	J-17	Insect hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
M,S	Landscape-General	J-18	Trash or litter	See Ponds Checklist.	See Ponds Checklist.
M,S	Landscape-General	J-19	Erosion of ground surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
A	Trees and shrubs	J-20	Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25% of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
M	Trees and shrubs	J-21	Damage	Trees or shrubs that have been blown down or knocked over.	Replant tree, inspecting for injury to stem or roots. Replace if severely damaged.
A	Trees and shrubs	J-22	Damage	Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Place stakes and rubber-coated ties around young trees/shrubs for support.

If you are unsure whether a problem exists, please contact a Professional Engineer.

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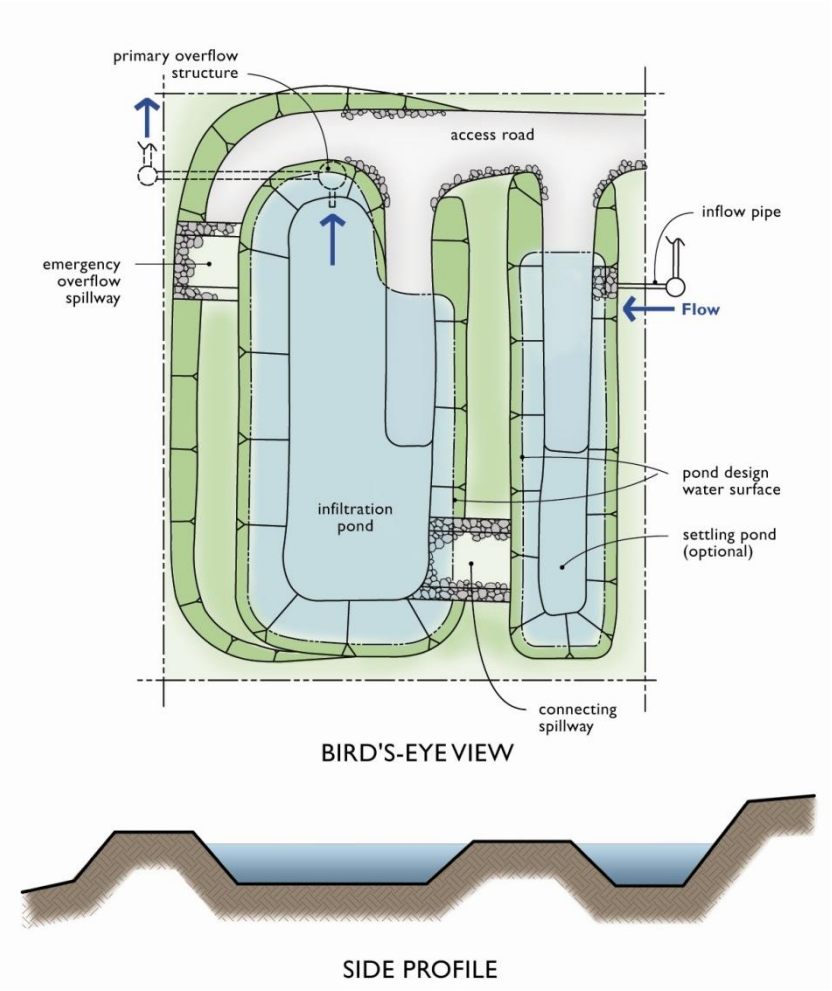
3.11 Infiltration Facility

Stormwater infiltration facilities are often open basins built by excavating below existing ground or by constructing above-ground berms (embankments). Like the detention pond, the infiltration pond temporarily stores stormwater runoff during rain events, but unlike the detention pond, the infiltration pond does not discharge to a downstream conveyance system or nearby surface water. Instead, the infiltration facility relies on the ability of the site's soils to absorb the stormwater into the ground. Components that are typically associated with a retention pond include the following: energy dissipaters, access road, and fence. Ponds have an overflow feature to direct the stormwater if the water volume in the pond exceeds the infiltration rate.

<u>Extreme care must be taken to not compact the soil of a pond bottom during maintenance activities.</u>

Infiltrations facilities can also be a buried pipe, chamber, or vault with an open bottom. For manufactured systems, also follow the manufacturer's maintenance protocols.



Infiltration Facility Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General	K-1	Trash & debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (equals amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping.	Trash and debris cleared from site. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.
A	General	K-2	Poisonous vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required.
M,S	General	K-3	Contaminants and pollution	Any evidence of oil, gasoline, contaminants or other pollutants	No contaminants or pollutants present. (Notify Public Works Department before removal / cleanup.)
M	General	K-4	Rodent holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
M	General	K-5	Beaver dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
A	General	K-6	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies.
M	Storage area	K-7	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
M	Filter bags (if applicable)	K-8	Filled with sediment and debris	Sediment and debris fill bag more than ½ full.	Filter bag is replaced or system is redesigned.
M,S	Rock filters	K-9	Sediment and debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.

- checklist continued on next page –

Infiltration Facility Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	Side slopes of pond	K-10	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized using appropriate erosion control measures (e.g. planting of grass, rock reinforcement, compaction.)
A	Pond berms (dikes)	K-11	Settlement	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
A	Pond berms (dikes)	K-12	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend inspection, evaluation, & recommendation for repair by a geo-technical engineer.	Piping eliminated. Erosion potential resolved.
A	Emergency overflow / spillway	K-13	Tree growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
A	Emergency overflow / spillway	K-14	Emergency overflow/ spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
M	Pre-settling ponds and vaults	K-15	Facility or sump filled with sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

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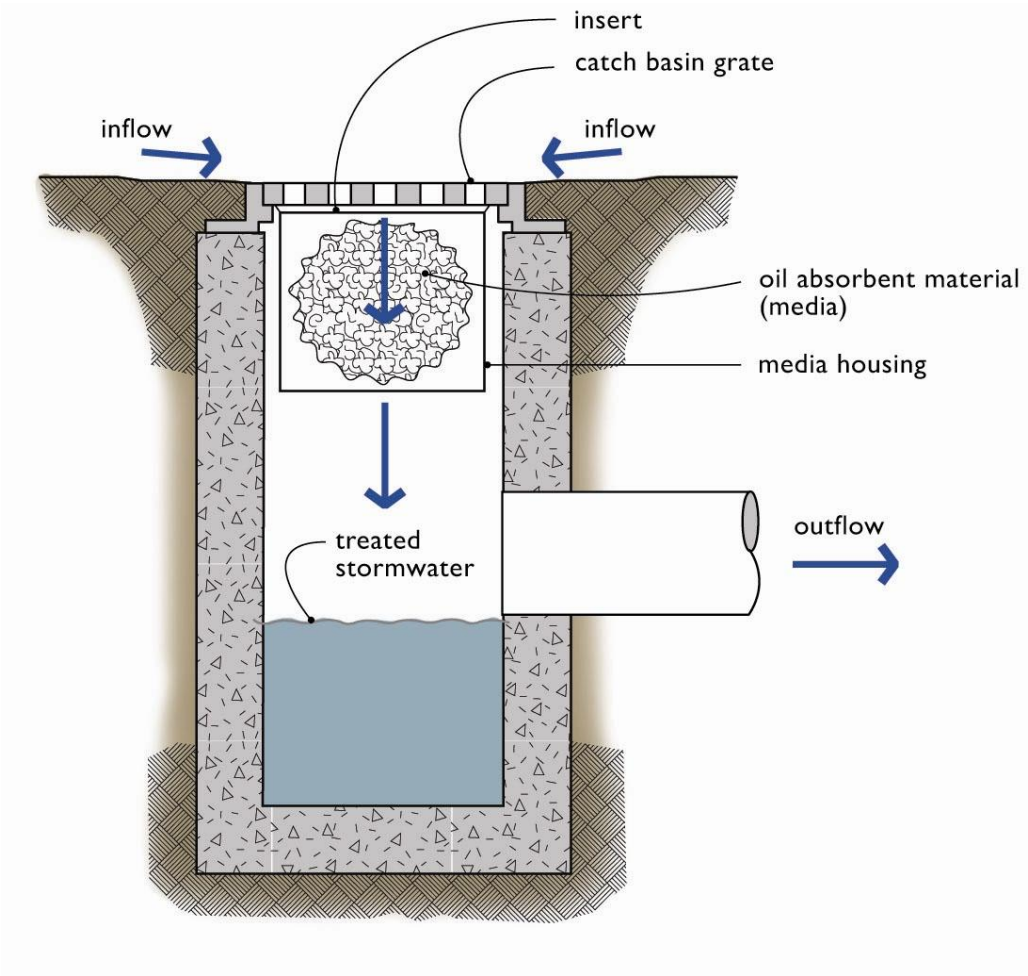
3.12 Catch Basin Insert

Catch basin inserts have been under development for many years in the Puget Sound region. They function similarly to media filtration except that they are typically limited by the size of the catch basin. They also are likely to be maintenance intensive.

Catch basin inserts typically consist of the following components:

- A structure (screened box, brackets, etc.) which contains a pollutant removal medium
- A means of suspending the structure in a catch basin
- A filter medium such as sand, carbon, fabric, etc.
- A primary inlet and outlet for the stormwater
- A secondary outlet for bypassing flows that exceed design flow



Catch Basin Insert Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	L-1	Sediment accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
M	General	L-2	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
M	General	L-3	Media insert not removing oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
M	General	L-4	Media insert water saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
M	General	L-5	Media insert-oil saturated	Media is oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
M	General	L-6	Media insert use beyond normal product life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.
A	General		Follow the manufacturer's maintenance procedure. Fill out the manufacturer's Inspection Report and Maintenance Report forms, if any, and submit completed copies with the City Inspection & Maintenance Checklist. Include the name of the manufacturer on the City Checklist.		

If you are unsure whether a problem exists, please contact a Professional Engineer.

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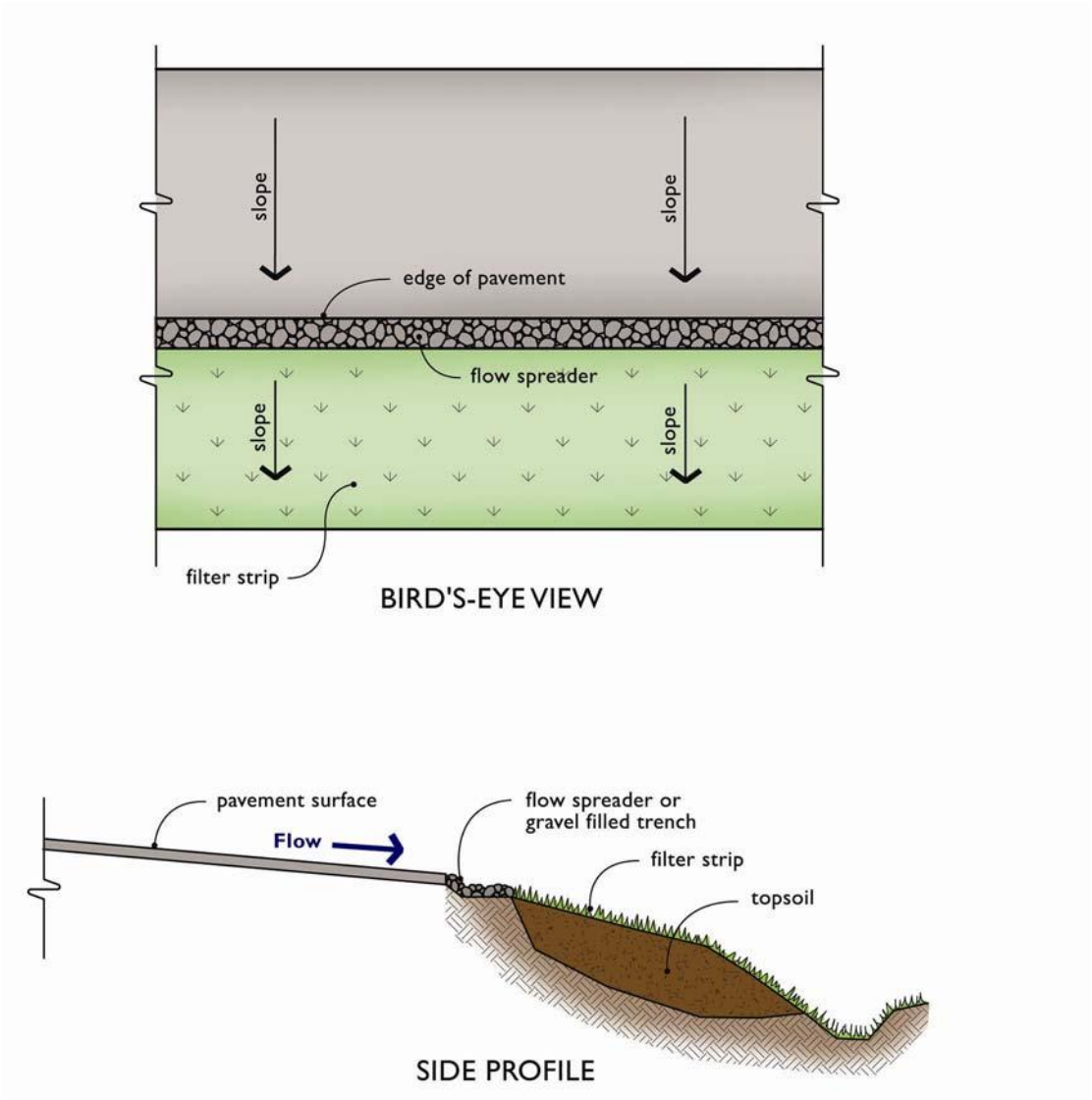
3.13 Filter Strip

A basic filter strip consists of a vegetated slope area that provides the same treatment functions as a biofiltration swale. Contaminated stormwater runoff is distributed as shallow flow across the top width of a biofilter strip through a level-spreader device or curb cuts at the edge of a paved area. The level-spreader device typically consists of a gravel trench with a board or concrete curb with a level top to evenly distribute the stormwater runoff across the entire length of the filter strip. Most filter strips have a collection ditch at its base to collect and route the treated runoff to a detention/retention facility or downstream conveyance system.



Filter Strip Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	M-1	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
M	General	M-2	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
M	General	M-3	Trash and debris accumulation	Trash and debris accumulated on the filter strip.	Remove trash and debris from filter.
M	General	M-4	Erosion/scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re- seeded. For smaller bare areas, overseed when bare spots are evident.
M	General	M-5	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width

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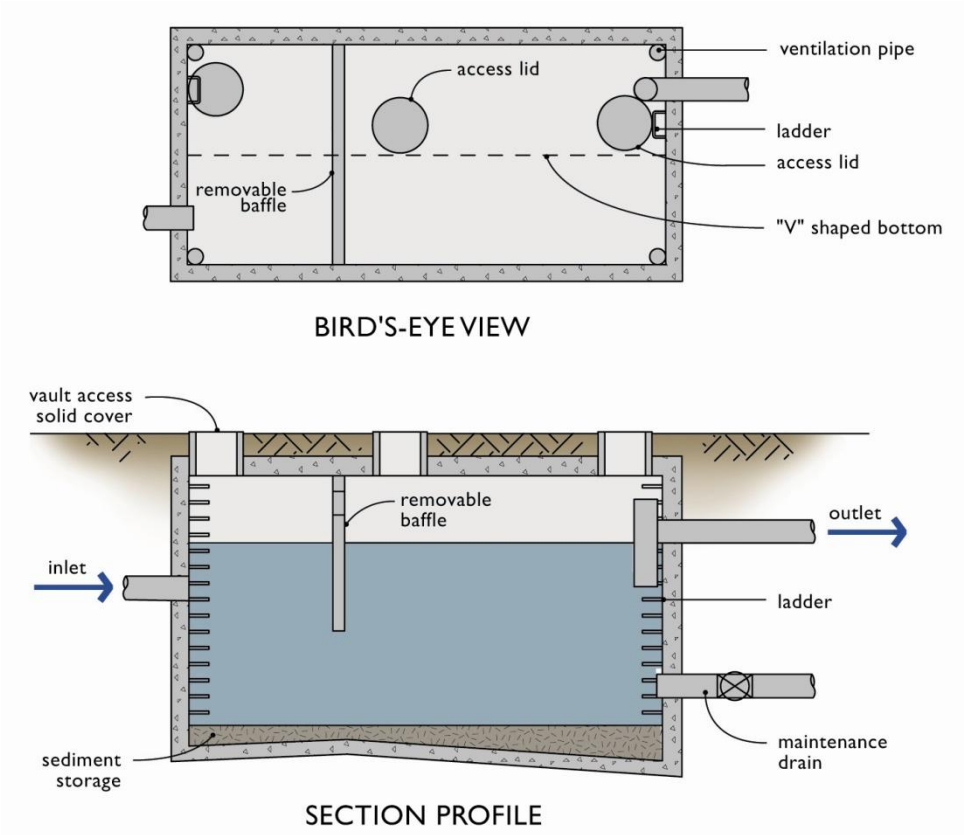
3.14 Wet Vault

A wet vault is an underground structure similar in appearance to a detention vault, except that a wet vault has a permanent pool of water (wetpool) which dissipates energy and improves the settling of sediment and other pollutants. Being underground, the wetvault lacks the nutrient removal ability of vegetation.

As discussed in the underground detention systems, wet vaults are a closed space where harmful chemicals and gasses can accumulate. Therefore, the inspection and maintenance of these facilities should be conducted by an individual with training and certification in working in hazardous confined spaces.



Wet Vault Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	N-1	Trash/debris accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
M	General	N-2	Sediment accumulation in vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
A	General	N-3	Damaged pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
A	General	N-4	Access cover damaged/not working	Cover cannot be opened or removed, especially by one person.	Cover repaired or replaced to proper working specifications.
M	General	N-5	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
A	Vault structure	N-6	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	Vault structure	N-7	Vault structure includes cracks in wall, bottom, damage to frame and/or top slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks. (Will require engineering analysis to determine structural stability).	Vault replaced or repaired to design specifications and is structurally sound.
A	Vault structure	N-8	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
A	Vault structure	N-9	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
A	Access ladder	N-10	Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements.

If you are unsure whether a problem exists, please contact a Professional Engineer.

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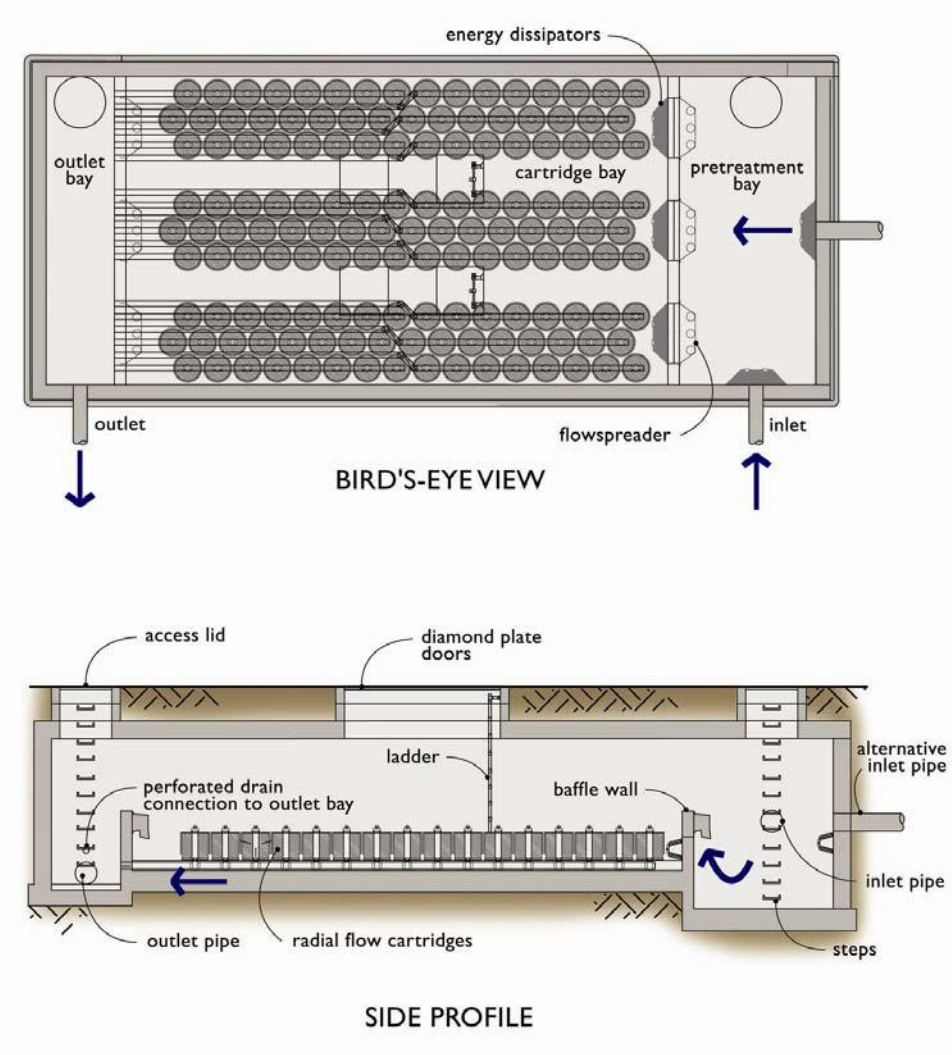
3.15 Stormfilter® Unit

This media filter technology has been under development in the Pacific Northwest since the early 1990s. During the early stages of development, leaf compost was used in fixed beds, replacing sand. Continued development of this technology is based on placing the media in filter cartridges (vertical media filters) instead of fixed beds.

The filter media can be housed in cartridge filters enclosed in concrete vaults or catch basin like structures. Assortments of filter media types are available from the manufacturer. The system functions by routing the stormwater through the filtering medium, which traps particulates and/or soluble pollutants.

Stormfilter® units are a proprietary manufactured system. See manufacturer's publications for additional maintenance information.



Stormfilter® Unit (Cast-In-Place, Precast, Linear and Catch Basin Units) Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M, S	Media filter vault	O-1	Sediment accumulation on top of filter cartridges	Sediment accumulation exceeds 0.25 inches on top of cartridges.	No sediment deposits on top of cartridges. Sediment on cartridges likely indicates that cartridges are plugged and require maintenance.
M, S	Media filter vault	O-2	Sediment accumulation in vault	Sediment accumulation in vault exceeds 2 inches. Look for other indicators of clogged cartridges or overflow.	Sediment in vault should be removed. Cartridges should be checked and replaced or serviced as needed.
M, S	Media filter vault	O-3	Trash and floatable debris accumulation	Trash and floatable debris accumulation in vault.	No trash or other floatable debris in filter vault.
S	Media filter vault	O-4	Filter cartridges submerged	Filter vault does not drain within 24 hours following storm. Look for evidence of submergence due to backwater or excessive hydrocarbon loading.	Filter media checked and replaced if needed. If cartridges are plugged with oil additional treatment or source control BMP may be needed.
A	Media filter vault	O-5	End of cartridge life cycle	Cartridges last from 1 to 3 years depending on site conditions, proper maintenance, and contamination from spills.	Replace cartridges every 1 to 3 years.
M, S	Forebay	O-6	Sediment accumulation	Sediment accumulation exceeds 6 inches or 1/3 of available sump.	Sediment accumulation less than 6 inches.
M, S	Forebay	O-7	Trash and floatable debris accumulation	Trash and/or floatable debris accumulation.	Trash and/or floatable debris should be removed during monthly inspections. Significant oil accumulation may indicate the need for additional treatment or source control.
A	Below ground vault	O-8	Access cover damaged/ not working	One maintenance person cannot remove lid after applying 80 pounds of lift, corrosion of deformation of cover.	Cover repaired to proper working specifications or replaced.
A	Below ground vault	O-9	Damaged pipes	Any part of the pipes are crushed or damaged due to corrosion and/or settlement.	Pipe repaired or replaced.
A	Below ground vault	O-10	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	Below ground vault	O-11	Vault structure includes cracks in wall, bottom, damage to frame and/or top slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks. (Will require engineering analysis to determine structural stability).	Vault replaced or repaired to design specifications and is structurally sound.

- checklist continued on next page -

Stormfilter® Unit (Cast-In-Place, Precast, Linear and Catch Basin Units) Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	Below ground vault	O-12	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
A	Below ground vault	O-13	Baffles	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to design specifications.
A	Below ground vault	O-14	Ladder rungs unsafe	Maintenance person judges that ladder is unsafe due to missing rungs, misalignment, rust, or cracks. Ladder must be fixed or secured immediately.	Ladder meets design standards and allows maintenance persons safe access.
A	General		Follow the maintenance procedure in the Stormfilter® O&M manual. Fill out the Stormfilter® Inspection Report and Maintenance Report forms and submit completed copies with the City Inspection & Maintenance Checklist.		

If you are unsure whether a problem exists, please contact a Professional Engineer

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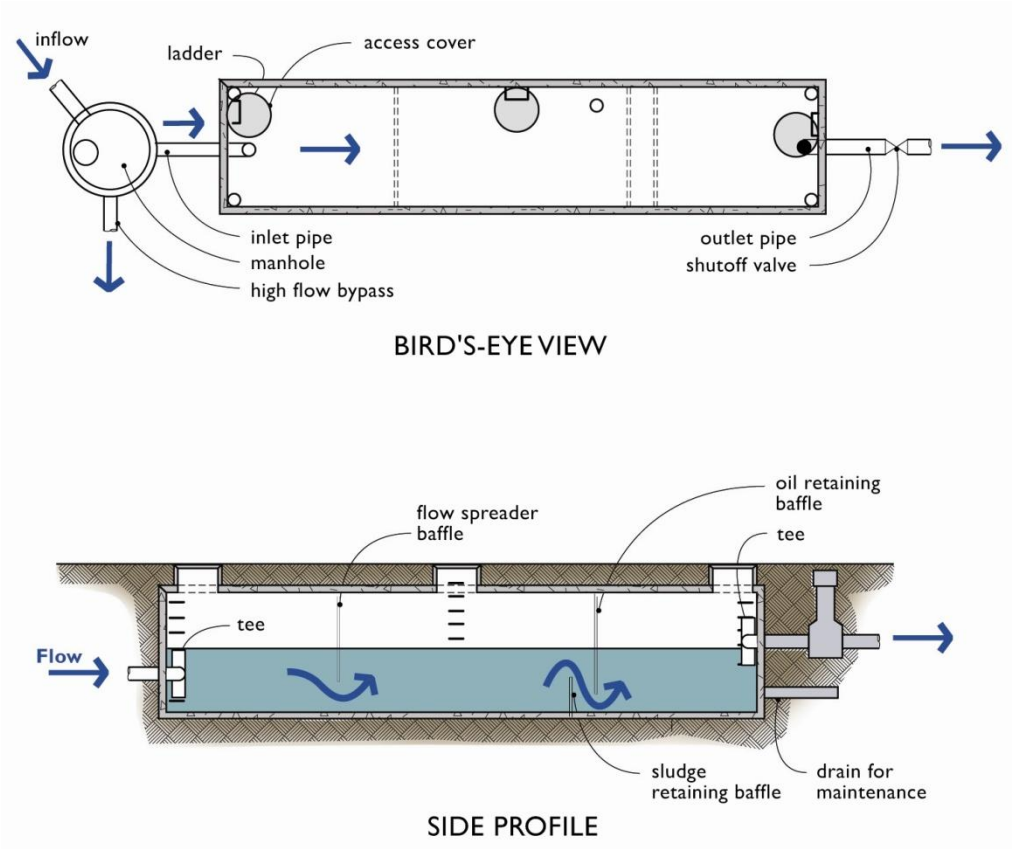
3.16 Baffle Oil / Water Separator (API Type)

American Petroleum Institute (API) oil water separators consist of an underground vault separated into three bays by a series of partial divider walls (baffles). The three bays consist of a forebay, separator section, and the afterbay. Oil/water separators are typically utilized in locations where high oil concentrations in the stormwater runoff are anticipated (i.e. service and fuel stations). Oil/water separators are most commonly used as the first pre-treatment facility in a series ("treatment train") of stormwater management facilities.



Baffle Oil / Water Separators (API Type) Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M,S	Monitoring	P-1	Inspection of discharge water for obvious signs of poor water quality.	Obvious oil sheen.	Effluent discharge from vault should be clear without thick visible sheen.
M,S	Monitoring	P-2	Sediment accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
M,S	Monitoring	P-3	Trash and debris accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
M,S	Monitoring	P-4	Oil accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
A	Structure	P-5	Damaged pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
A	Structure	P-6	Access cover damaged/not working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
A	Structure	P-7	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	Structure	P-8	Vault structure damage includes cracks in walls bottom, damage to frame and/or top slab	Crack wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks. Maintenance person judges that structure is unsound.	Vault replaced or repaired design specifications and is structurally sound.
A	Structure	P-9	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.

- checklist continued on next page -

Baffle Oil / Water Separators (API Type) Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	Structure	P-10	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure.	Baffles repaired or replaced to design specifications.
A	Structure	P-11	Access ladder damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

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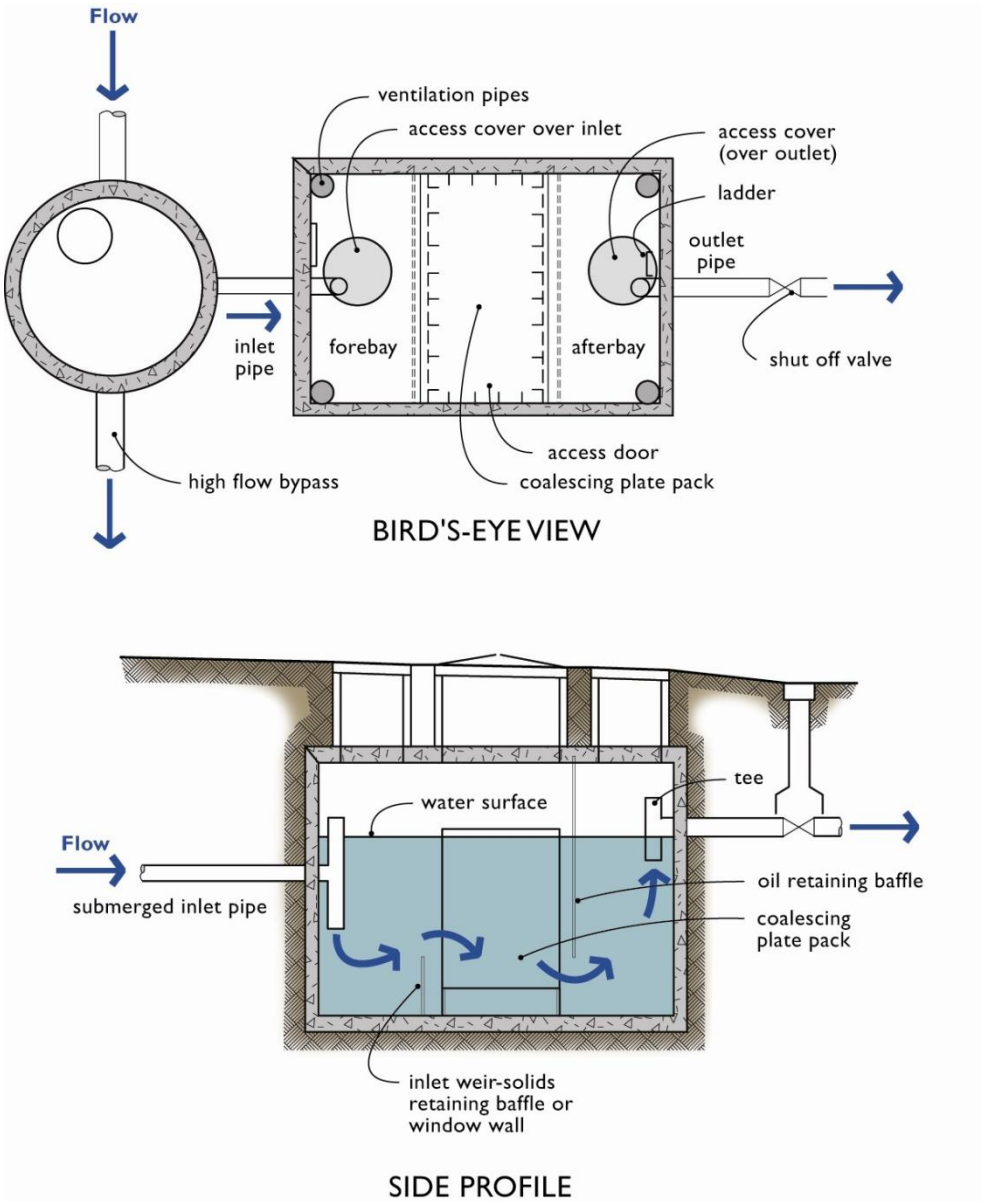
3.17 Coalescing Plate Oil / Water Separator

Coalescing plate oil water separators are generally the same as the API type. The main difference is that coalescing plate separators include a series of parallel plates in the separation bay (2nd bay) that increase the oil removal efficiency of the separator.



Coalescing Plate Oil / Water Separators Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M,S	General	Q-1	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
M,S	General	Q-2	Sediment accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
M,S	General	Q-3	Trash and debris accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
M,S	General	Q-4	Oil accumulation	Oil accumulation that exceeds 1-inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
A	Structure	Q-5	Damaged coalescing plates	Plate media broken, deformed, cracked, and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
A	Structure	Q-6	Damaged pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
A	Structure	Q-7	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
A	Structure	Q-8	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	Structure	Q-9	Vault structure damage - includes cracks in walls, bottom, damage to frame and/or top slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
A	Structure	Q-10	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
A	Structure	Q-11	Access ladder damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

If you are unsure whether a problem exists, please contact a Professional Engineer.

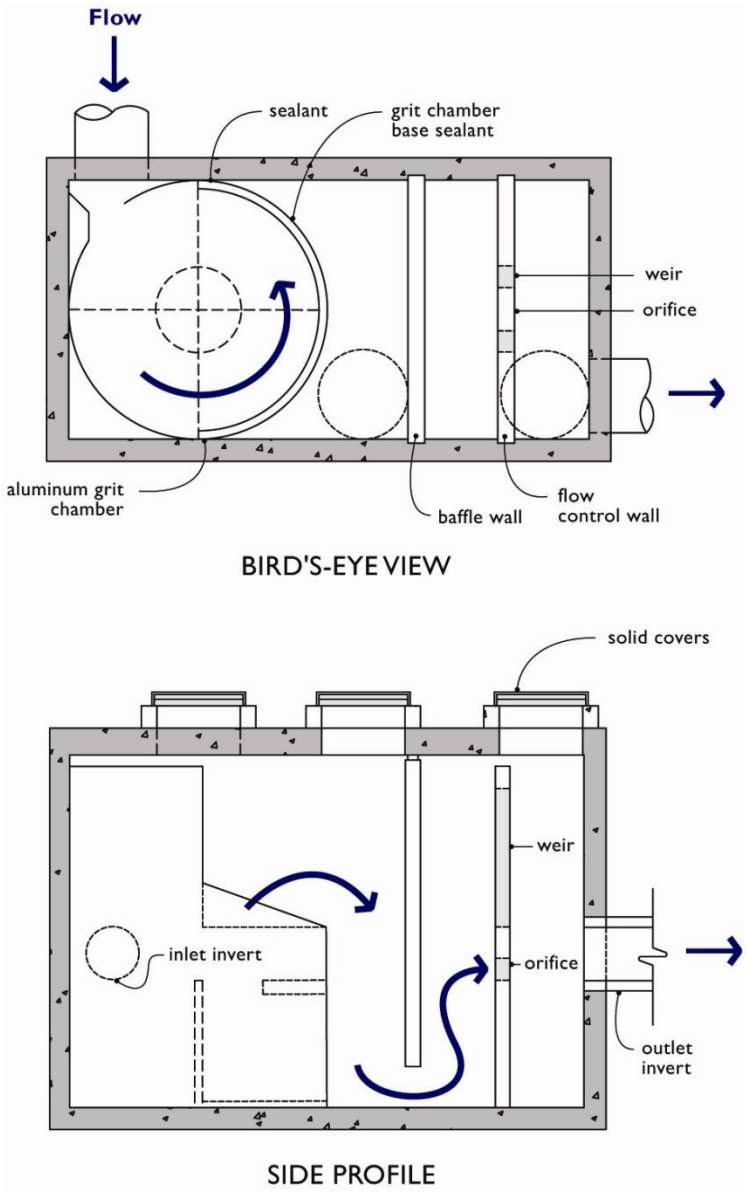
* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

<u>Key</u>:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.18 Vortechs® Stormwater Treatment System

Vortex-enhanced sedimentation is achieved using a cylindrical vessel where the inlet flow spirals around the perimeter in a vortex-type action causing the heavier particles to settle out of the stormwater. It uses a vortex-enhanced settling mechanism (swirl-concentration) to capture settleable solids, floatables, and oil and grease.

Vortechs® treatment units are a proprietary manufactured system. See the manufacturer's publications for additional maintenance information.



Vortechs® Stormwater Treatment System Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
B,S	General	R-1	Sediment accumulation	Sediment depth is within 12-18" of dry weather water surface elevation.	Accumulated sediment should be removed.
B,S	General	R-2	Trash and debris accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault, and inlet/outlet piping.
B,S	General	R-3	Oil accumulation, petroleum spills	Oil accumulation that exceeds 1-inch at the water surface. Visible spills of oil/petroleum products	Oil is extracted from vault using absorbent pads or vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
A	Structure	R-4	Damaged pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
A	Structure	R-5	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
A	Structure	R-6	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	Structure	R-7	Vault structure damage - includes cracks in walls, bottom, damage to frame and/or top slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
A	Structure	R-8	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
A	General		Follow the maintenance procedure in the Vortechs® O&M manual. Fill out the Vortechs® Inspection Report and Maintenance Log forms and submit completed copies with the City Inspection & Maintenance Checklist.		

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

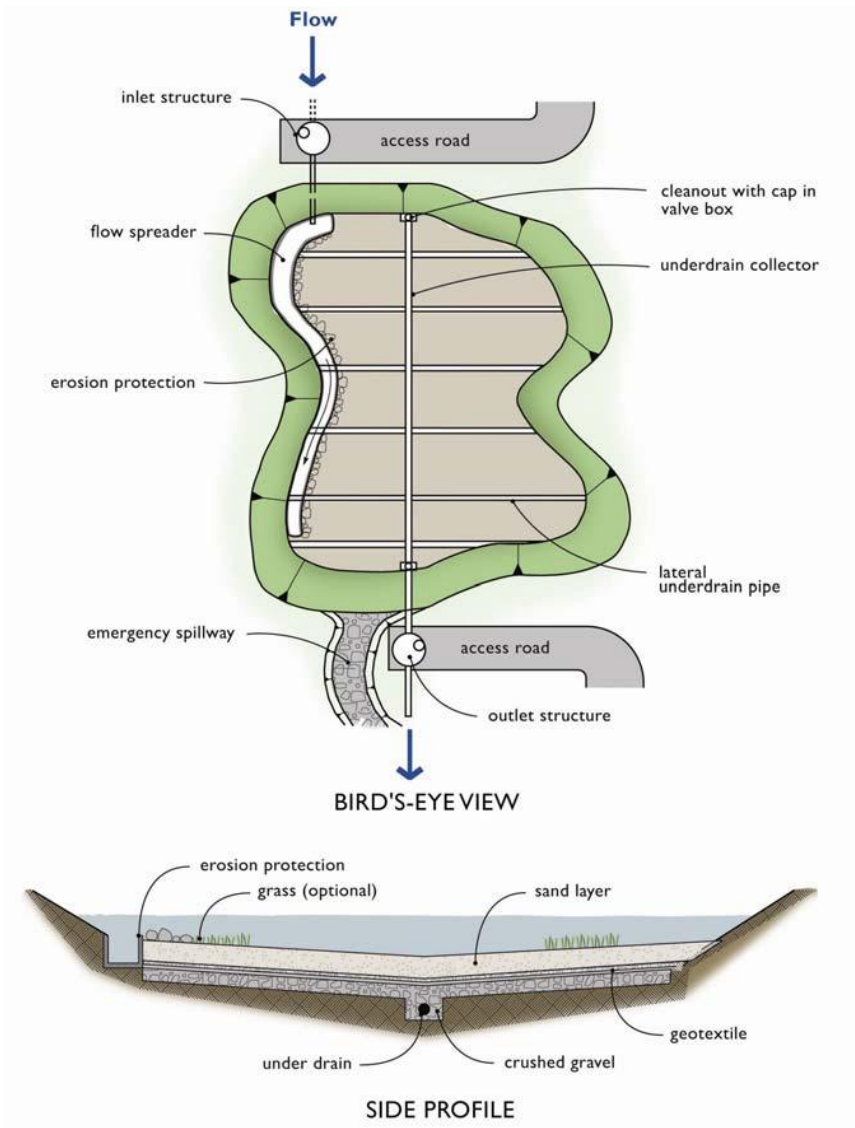
<u>Key</u>:

(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.19 Sand Filter (Above Ground / Open)

Sand filters function by filtering stormwater runoff through a sand bed typically 18 inches in depth. The treated runoff is collected in the underdrain system and routed to a detention/retention facility or a downstream conveyance system. A typical sand filtration system consists of, a pretreatment system for removing larger sediment and debris from the runoff, a flow spreader, a sand bed, and an underdrain piping. The sand filter bed typically includes a woven (geotextile) fabric between the sand bed and the underdrain system.

Open, above-ground sand filters have a physical appearance similar to a detention pond with the main difference being the sand lined bottom.



Sand Filter (Above Ground / Open) Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	S-1	Sediment accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
M	General	S-2	Trash and debris accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
M	General	S-3	Sediment/ debris in clean-outs	When the clean-outs become fully or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
M	General	S-4	Sand filter media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
M	General	S-5	Prolonged flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention facilities.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
M	General	S-6	Short circuiting	When flows become concentrated over one section of the sand filter rather than dispersed.	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.
M	General	S-7	Erosion damage to slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
A	General	S-8	Rock pad missing or out of place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.

- checklist continued on next page -

Sand Filter (Above Ground / Open) Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	S-9	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
M	General	S-10	Damaged pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

If you are unsure whether a problem exists, please contact a Professional Engineer.

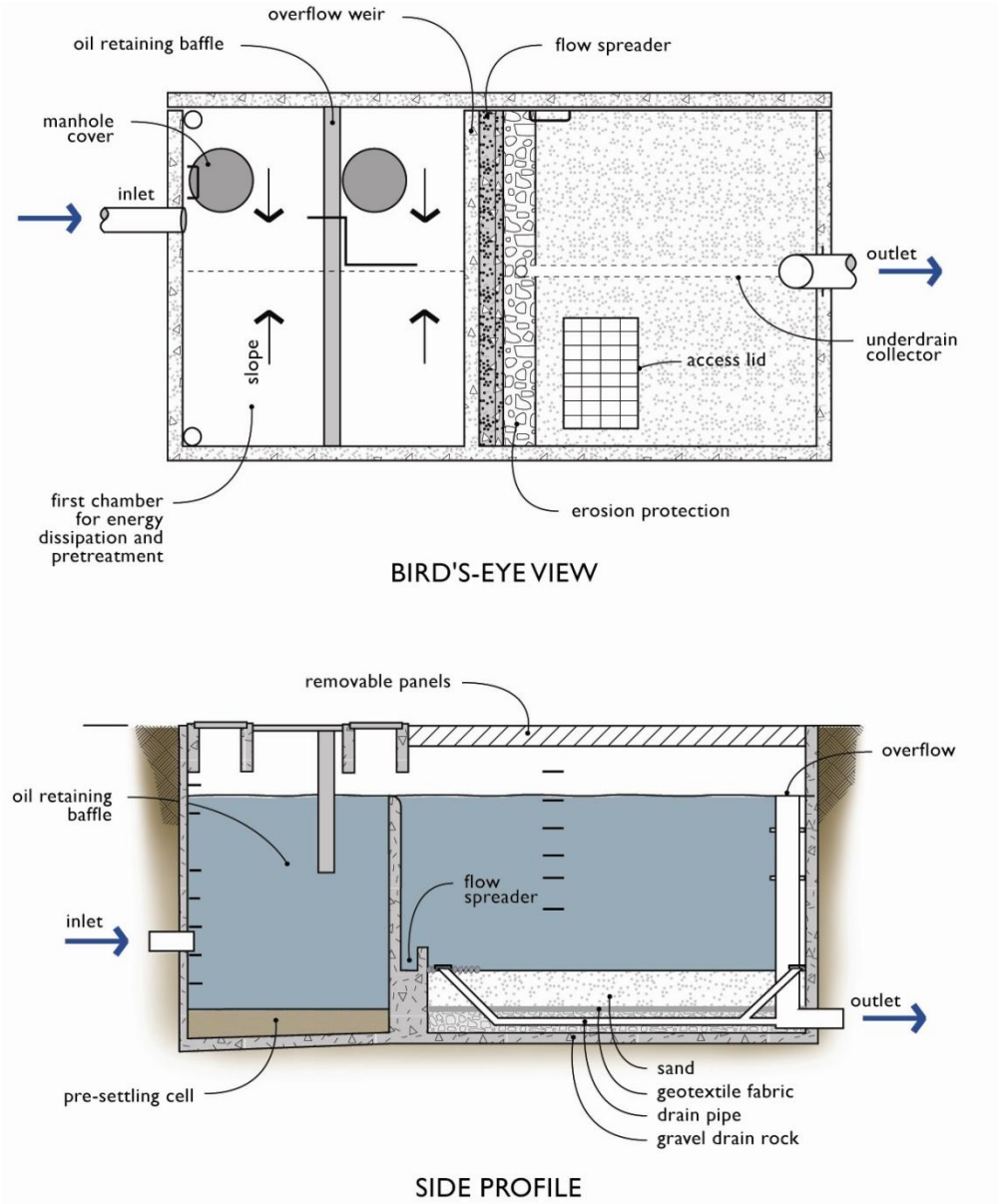
*** All items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

Key:

(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.20 Sand Filter (Below Ground / Enclosed)

A sand filter vault is similar to an open sand filter except that the sand layer and underdrains are installed below ground in a vault. It consists of presettling and sand filtration cells and functions by filtering stormwater runoff through a sand bed. Treated runoff is collected in the underdrain system and routed to a detention/retention facility or a downstream conveyance system.



Sand Filter (Below Ground / Enclosed) Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	T-1	Sediment accumulation on sand media section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
M	General	T-2	Sediment accumulation in pre-settling portion of vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
M	General	T-3	Trash/debris accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
M	General	T-4	Sediment in drain pipes/cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
M	General	T-5	Short circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
A	General	T-6	Damaged pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
A	General	T-7	Access cover damaged/not working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
M	General	T-8	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
A	General	T-9	Openings or voids in walls	Any openings or voids through the walls which allow soil particles or any other material to be transported into the facility through the walls.	All openings, voids, and joints sections are repaired.
A	General	T-10	Cracks, openings, or voids at pipe penetrations	Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls	No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
A	General	T-11	Vault structure damaged; includes cracks in walls, bottom, and damage to frame and/or top slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.

- checklist continued on next page -

Sand Filter (Below Ground / Enclosed) Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
A	General	T-12	Baffles/internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
A	General	T-13	Access ladder	Damaged Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

If you are unsure whether a problem exists, please contact a Professional Engineer.

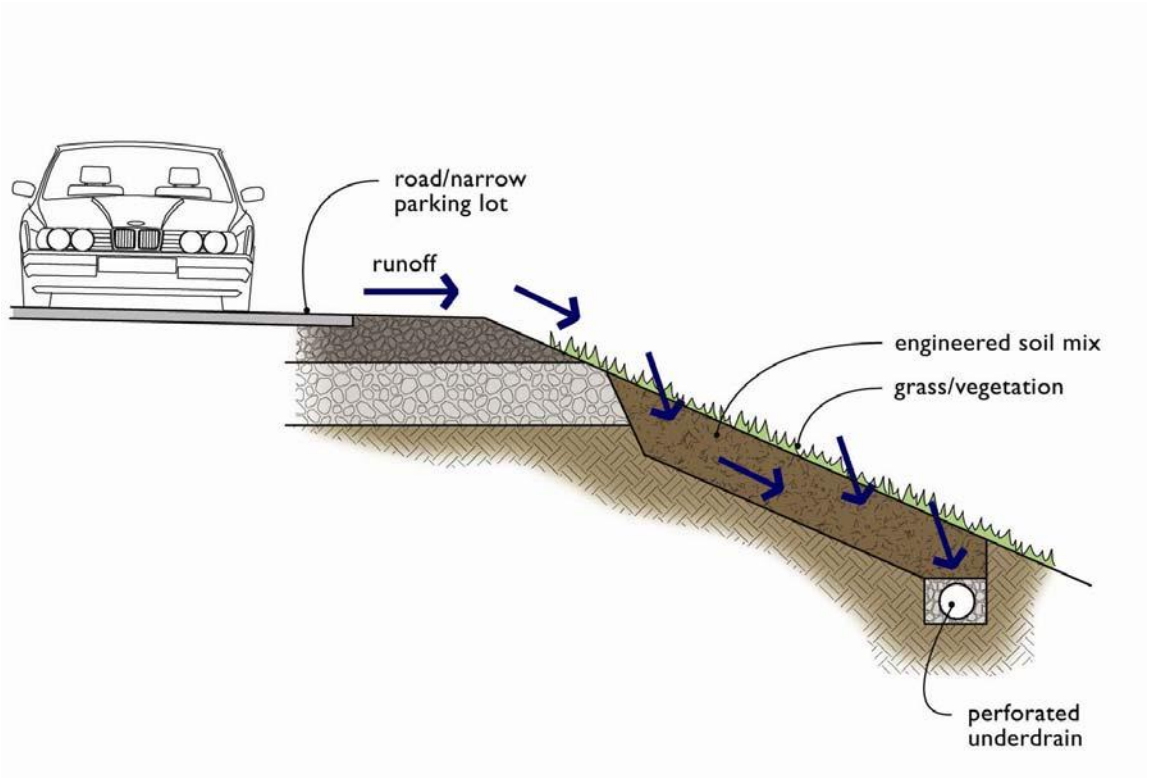
*** All items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

Key:

(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.21 Ecology Embankment

Ecology embankment is a filter strip designed for impervious areas with flow paths of 30 feet or less that can drain along their widest dimension to grassy areas. Typical applications of ecology embankments are for roads with limited right-of-way widths or for narrow parking strips.



Ecology Embankment Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	No vegetation zone adjacent to pavement	U-1	Erosion, scour, or vehicular damage	No vegetation zone is uneven or clogged so that flows are not uniformly distributed.	Level the area and clean so that flows are spread evenly.
M	No vegetation zone adjacent to pavement	U-2	Sediment accumulation on edge of pavement	Flows no longer sheeting off of roadway. Sediment accumulation on pavement edge exceeds top of pavement elevation.	Remove sediment deposits such that flows can sheet off of roadway.
M	Vegetated filter	U-3	Sediment accumulation on grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through Ecology Embankment.
M	Vegetated filter	U-4	Excessive vegetation or undesirable species.	When the grass becomes excessively tall; when nuisance weeds and other vegetation starts to take over or shades out desirable vegetation growth characteristics.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height that encourages dense even herbaceous growth.
M	Vegetated filter	U-5	Erosion, scour, or vehicular damage.	Eroded or scoured areas due to flow channelization, high flows, or vehicular damage.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with suitable topsoil. (The grass will creep in over the rock in time). If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re- seeded. For smaller bare areas, overseed when bare spots are evident.
M	Media bed	U-6	Erosion, scour, or vehicular damage.	Eroded or scoured areas due to flow channelization, high flows, or vehicular damage.	For ruts or areas less than 12 inches wide, repair the damaged area by filling with suitable media. If bare areas are large, generally greater than 12 inches wide, the media bed should be re-graded.
M	Media bed	U-7	Sediment accumulation on media bed.	Sediment depth inhibits free infiltration of water.	Remove sediment deposits, re-level so slope is even and flows pass freely through Media Bed.
M	Underdrain	U-8	Sediment	Depth of sediment within perforated pipe exceeds 0.5”.	Flush underdrains through access ports and collect flushed sediment.

- checklist continued on next page -

Ecology Embankment Checklist (continued)

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	U-9	Trash and Debris Accumulation	Trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Remove trash and debris.
M	General	U-10	Flows are bypassing Ecology Embankment	Evidence of significant flows down-slope (rills, sediment, vegetation damage, etc.).	Remove sediment deposits, re-level so slope is even and flows pass evenly through Ecology Embankment. If completely clogged it may require more extensive repair or replacement.

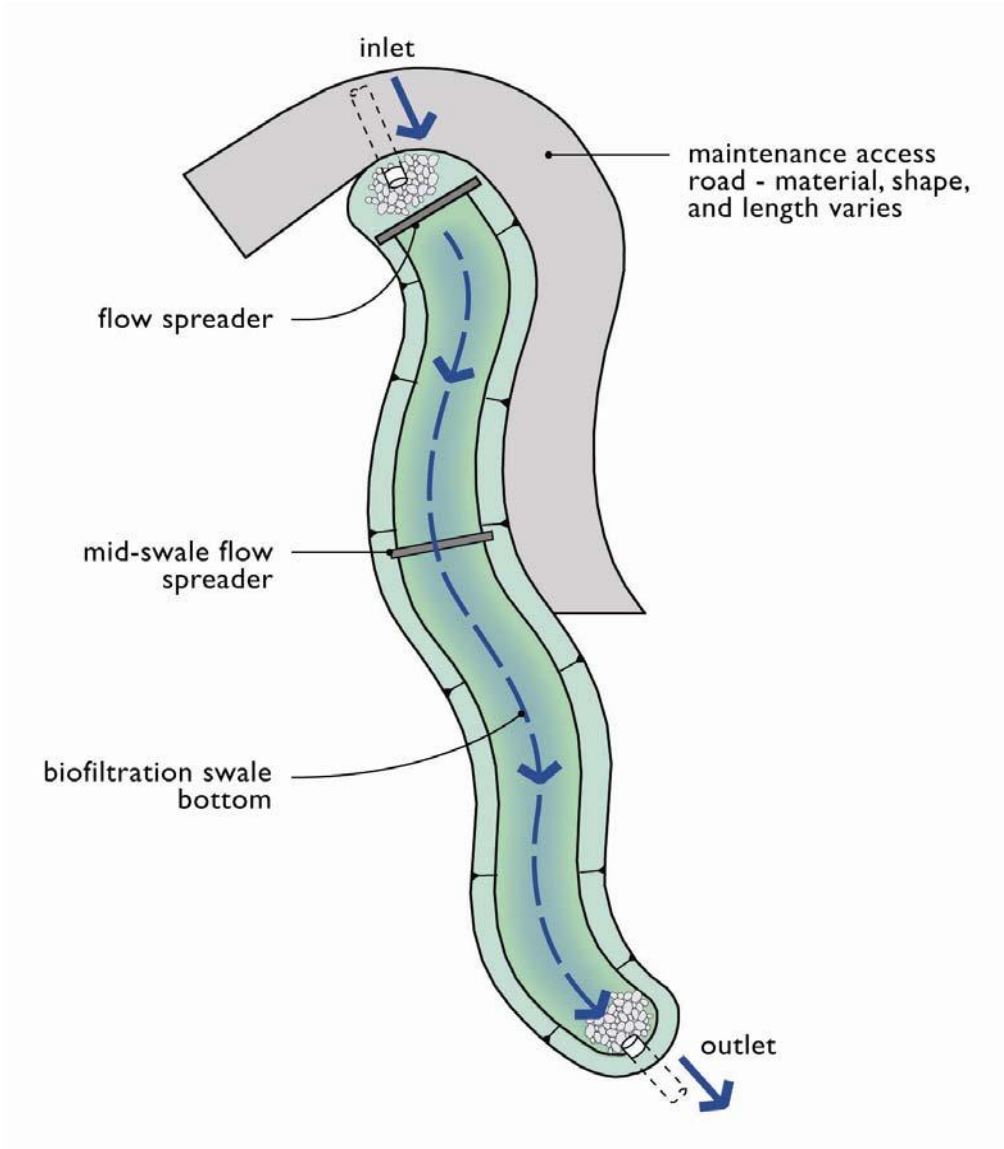
If you are unsure whether a problem exists, please contact a Professional Engineer.

*** All items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

Key:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.22 Wet Biofiltration Swale

A wet biofiltration swale is a variation of a basic biofiltration swale for use where the centerline slope is slight, groundwater tables are high, or a continuous low base flow is likely to result in wet soil conditions for long periods of time. Where continuously wet soil conditions exceeds about 2 weeks, typical grasses will die. Thus, vegetation specifically adapted to wet soil conditions is needed. Different vegetation in turn requires modification of several of the design and maintenance requirements from the basic biofiltration swale.



Wet Biofiltration Swale Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	V-1	Sediment accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
M	General	V-2	Water depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
M	General	V-3	Wetland vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
M	General	V-4	Inlet/outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
M	General	V-5	Trash and debris accumulation	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (this is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Remove trash and debris from wet swale.
M	General	V-6	Erosion/scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

<u>Key</u>:

(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.23 Ditch

Ditches are part of the conveyance system. They may be U-shaped or trapezoidal with a flat bottom. They may be rock-lined. A ditch is not the same as a bioswale.

Ditch Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	W-1	Trash & debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet of ditch and slopes.	Clear trash and debris from ditch. **
M	General	W-2	Sediment	Accumulated sediment that exceeds 20% of the design depth.	Clean/flush ditch of all sediment and debris so that it matches design. **
M	Vegetation	W-3	Overgrowth	Vegetation that reduces free movement of water through ditch (vegetation taller than 8 inches or trees such as alders).	Remove vegetation so that water flows freely through ditch.
M	Side slopes	W-4	Erosion damage to slope	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Stabilize slopes by using appropriate erosion control measure(s): for example, rock reinforcement, planting of grass, erosion control blankets, bonded-fiber matrices or compaction.
M	Check dams	W-5	Sedimentation	Silt deposition causes standing water behind check dam	Replace check dam; remove silt. **
M	Rock-lined ditch	W-6	Failure of rock-lined ditch	Erosion or failure of rock slopes of ditch line.	Replace/repair rock lining to reestablish ditch cross-section.

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

** Refer to the disposal guidelines in Section 1.3, Frequently Asked Questions, on disposal of trash, debris and sediment.

<u>Key</u>:
(M) Monthly from November through April.
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline)

3.24 Access Road

Access roads are used to access control structures or other facility components. They are a minimum of 12 feet wide and may be constructed of asphalt, concrete, rock, or other approved material.

Access Road Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M	General	X-1	Subgrade failure	Access road is capable of supporting trucks and maintenance equipment.	Repair road to design standards.
M	General	X-2	Road surface failure	Any surface defect that exceeds 6 inches in depth and 6 square feet in area or hinders or prevents maintenance access.	Repair road surface to be uniformly smooth with no settlement, potholes, soft spots, or ruts.
M	General	X-3	Trash and debris	Trash and debris exceeds 1 cubic foot per 1,000 square feet; i.e., trash and debris would fill up one standard-sized garbage can.	Clear trash and debris from site.**
M	General	X-4	Trash and debris	Debris that could damage vehicle tires (glass or metal).	Remove debris so that roadway is free of debris that could damage tires.**
M	General	X-5	Contaminants	Presence of any chemical pollutants, flammable materials, or a build-up of sediments mildly contaminated with petroleum hydrocarbons.	Remove contaminants so that none are present.**
M	General	X-7	Obstructions	Any obstructions or vegetation that reduces clearance above road surface to less than 14 feet.	Remove obstructions or vegetation so that roadway overhead is clear to 14 feet high.
M	General	X-8	Obstructions	Any obstructions or vegetation restricting the access to a 10- to 12-foot width for a distance of more than 12 feet or at any point restricting access to less than a 10-foot width.	Remove obstructions to allow at least a 12-foot access.
M	Vegetation	X-9	Vegetation control	Trees growing or vegetation in excess of 6 inches high or less than 6 inches apart within a 400 square foot area.	Remove trees, remove/mow access road surface.

- checklist continued on next page -

Access Road Checklist

on Freq	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
M*	Vegetation	X-10	Vegetation control	Weeds and brush exceed 18 inches in height or hinders maintenance access.	Cut weeds and brush to 2 inches in height, or clear in such a way as to allow maintenance access.
M	General	X-11	Erosion damage	Erosion within 1 foot of the roadway more than 8 inches wide and 6 inches deep.	Repair shoulder. Compact soil and stabilize surface to prevent further erosion.

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

** Refer to the disposal guidelines in Section 1.3, Frequently Asked Questions, on disposal of trash, debris and sediment

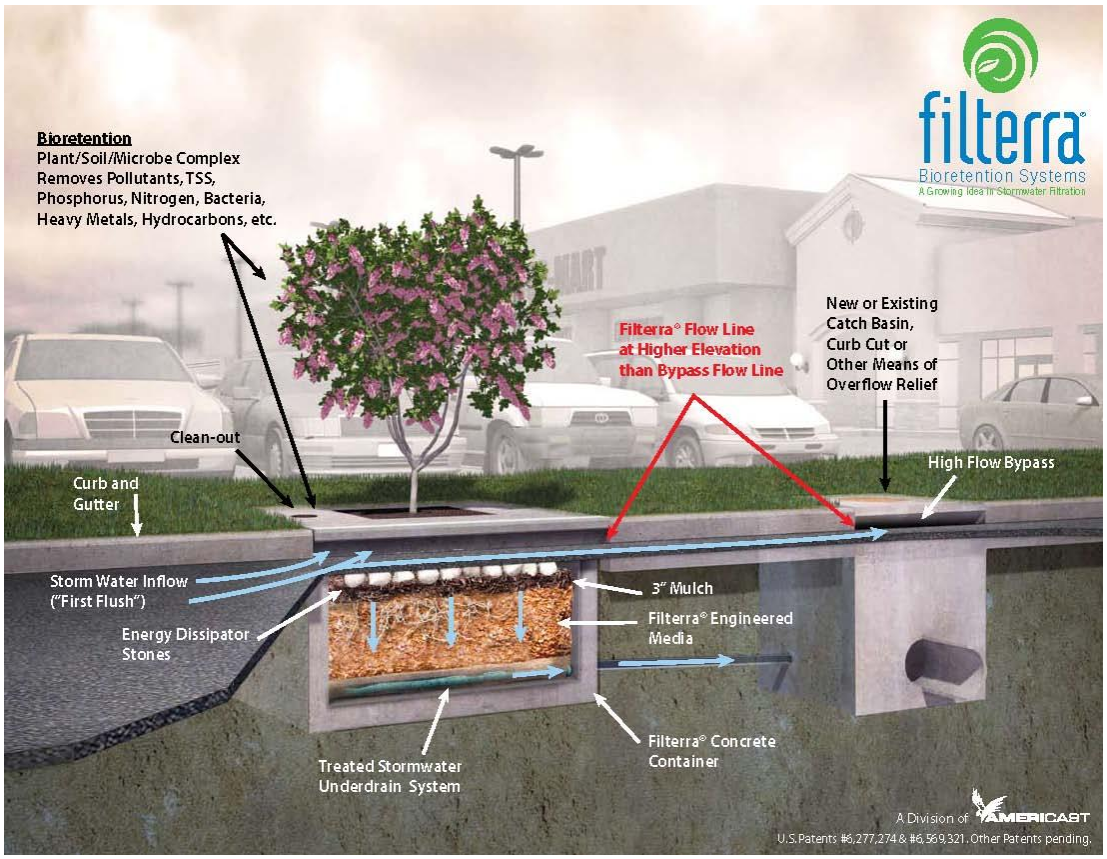
<u>Key</u>:
(M) Monthly from November through April. (* during growing season)
(A) Once in dry season
(S) After any major storm (use 1-inch in 24 hours as a guideline).

3.25 Filterra® Bioretention System

Filterra® is similar in concept to bioretention in its function and applications, with the major distinction that Filterra® has been optimized for high volume/flow treatment and high removal efficiencies for many pollutants such as petroleum, heavy metals, phosphorus, nitrogen, TSS and bacteria.

Filterra® has a specially designed filter media mixture contained in a landscaped concrete container. The filter media captures and immobilizes pollutants; those pollutants are then decomposed, volatilized and incorporated into the biomass of the Filterra® system's micro/macro fauna and flora. Stormwater runoff flows through the media and into an underdrain system at the bottom of the container, where the treated water is discharged. Higher flows bypass the Filterra® via a downstream inlet structure, curb cut or other appropriate relief.

Filterra® bioretention units are a proprietary manufactured system. See the manufacturer's publications for maintenance information.



Filterra® Bioretention System Checklist

Inspection Frequency *	Drainage System Feature	Defect Code	Problem	Conditions to Check For	Conditions That Should Exist
B, S	Inlet	Y-1	Excessive sediment or trash accumulation.	Accumulated sediments or trash impairing free flow of water into unit.	Inlet should be free of obstructions allowing free distributed flow of water into unit.
B, S, F	Mulch Cover	Y-2	Trash and floatable debris accumulation.	Excessive trash and/or debris accumulation.	Minimal trash or other debris on mulch cover. Trash and debris should be removed and mulch cover raked level. Do NOT use bark nugget mulch.
B, S	Mulch Cover	Y-3	"Ponding" of water on mulch cover.	"Ponding" in unit could be indicative of clogging due to excessive find sediment accumulation or spill of petroleum oils.	Stormwater should drain freely and evenly through mulch cover. Recommend contact manufacturer and replace mulch as a minimum.
B	Mulch Cover	Y-4	Mulch replacement.	Manufacturer's recommended replacement schedule.	Replace mulch twice per year.
B	Soil Media	Y-5	Insufficient engineered oil media	Media depth per Filterra® O&M manual.	Proper depth of engineered soil media per Filterra® O&M manual. Use ONLY Filterra® engineered soil media.
B, S	Vegeta-tion	Y-6	Plants not growing or in poor condition.	Soil/mulch too wet, evidence of a spill. Incorrect plant selection. Pest infestation. Vandalism to plants. Irrigation when necessary.	Plants should be healthy and pest free. Contact manufacturer for advice.
B, S	Vegeta-tion	Y-7	Plant growth excessive.	Plants should be appropriate to the species and location of the unit.	Trim/prune plants in accordance with typical landscaping and safety needs.
B, S	Structure	Y-8	Damage to structure.	Cracks wider than 1/2 inch or evidence of soil particles entering the structure through the cracks.	Repair structure.
B, S	Per Filterra® O&M manual.	Y-9	Any other item required by the Filterra® O&M manual.	Per Filterra® O&M manual.	Per Filterra® O&M manual.
B, S	General		Follow the maintenance procedure in the Filterra® O&M manual. Fill out the Filterra® Structure Maintenance Report and submit a completed copy with the City Inspection & Maintenance Checklist.		

If you are unsure whether a problem exists, please contact a Professional Engineer.

* **<u>All</u> items must be inspected annually, once in dry season, in addition to any other frequency listed or any other required inspections.**

<u>Key</u>:
(B) Spring and dry season
(S) After major storms (use 1-inch in 24 hours as a guideline)
(F) After leaves drop in the fall

4.0 Developing a Maintenance Program for Private Stormwater Drainage Facility Owners

A stormwater maintenance program is essential to ensure that the facilities continue to function as designed to prevent possible flooding and property damage. The maintenance program consists of inspections and repairs as detailed in the maintenance checklists provided in Section 3.0.

Stormwater management facilities are not intended to replace good housekeeping procedures. Good housekeeping includes educating facility users of proper storage and disposal of chemicals and potential pollutants, procedures for spill cleanup, proper use of fertilizers and other lawn care products, and maintenance of equipment to prevent release of pollutants to the stormwater system.

4.1 Who Should Perform Maintenance Duties?

Private stormwater facility owners are responsible for ensuring that the facilities are maintained and continue to function as designed. Some activities such as litter removal and mowing can be effectively undertaken by facility owners, however, it is usually worth the cost to have a professional do the more difficult tasks.

Some landscaping tasks, such as filling eroded areas or reseeding or re-planting vegetation may best be done by a professional landscaping firm. If these tasks are not performed properly, erosion may occur resulting in accelerated sedimentation of stormwater facilities.

Sediment removal from drainage structures are tasks that are usually best left to professional contractors with the equipment and experience to safely perform the task and who are also able to identify potential problems early when it is most cost effective to make repairs or alterations.

4.2 Working with Maintenance Contractors

Selecting and working with a maintenance contractor can be an intimidating process for many private facility owners. The following is a guideline for researching and choosing a qualified contractor to meet your maintenance needs.

Start your search for a contractor the right way - be informed. The information provided below will help you in your search for the right contractor for your job.

- Landscape maintenance contractors are typically capable of providing most routine maintenance for stormwater ponds. Special, non-routine maintenance may require an earthwork contractor or vactor company. There is an increasing number of contractors who specialize in stormwater facility maintenance. Private owners can choose to hire contractors when individual maintenance needs arise or enter into annual maintenance

agreements where the contractor monitors and provides routine maintenance throughout the year as needed.

- Develop a list of potential contractors. Look in the Yellow Pages and/or ask friends, neighbors, relatives, and coworkers who they have used. Find out if their experiences were good or bad and why. Ask if they would use the contractor again.

- Ask contractors for references. Call your potential contractors and ask for a list of their customers or locations of completed jobs. Call references and ask whether they were satisfied with the job done, if the contractor kept to the agreed upon schedule, and whether they would hire the same contractor again.

- Ask to which trade associations the contractor belongs. Membership in a professional association is one sign the contractor recognizes the responsibilities of being a professional.

- Make sure to obtain and evaluate bids. Ask for a free written estimate of the work you want done. Be sure everyone is bidding on the same exact scope of work and including the exact materials you want. Be sure all quotes include everything you want and that there is a clear understanding of work to be performed by owner and work to be performed by contractor.

- Remember "you get what you pay for." A higher bid may be worth the price for better workmanship and contractor reliability.

- Make sure you understand the different types of bids you may receive. Be careful about hiring a contractor on an hourly time-and-materials, or cost-plus basis. Although the price may seem high at first, a fixed-price bid may give you the best protection and price. Also beware of "special deals," "demonstration projects," or "a great deal from a friend of a friend." Completely review and understand the contract prior to authorizing work.

Questions to Ask Before Hiring a Contractor

- What experience, expertise and/or certification do you have? Do you specialize?

- Who will be doing the actual work: you personally, your employees, or subcontractors?

- Who will oversee the day-to-day job? (You may really like the contractor, but that person may not be the one performing or supervising the work.)

- How many other jobs will you be working on at the same time as mine? (If there are several, yours may not get the attention you want. On the other hand, the contractor's business may be large and he may be able to handle several jobs.)

- How long will the job take? What kind of mess, noise, and inconvenience should I expect? What problems may come up? (Asking questions before the job starts helps to prevent surprises later.)

- Where will you dispose of material removed from storm drainage facilities? Is there an extra fee for contaminated materials?

- Does hiring this contractor feel right? (Use intuition - if you do not feel comfortable, find someone else.)

- Do I have rapport with this contractor? Am I confident in his expertise and ideas? Does he care about my concerns? Will he be reliable, keep his appointments, and return my telephone calls?

- Can I communicate with this person? Does he seem honest and forthright? (The contractor may be top-notch at the trade, but if the final product is not what you expected, you will not be happy.)

- Am I willing to be reasonable about unexpected costs that arise and to let my contractor make a profit?

- Am I ready for the unexpected, such as digging into solid rock, major replacement, etc.?

- Can I be flexible when the job takes longer than expected?

- Are my expectations so high that I will never be satisfied with my contractor?

4.3 How much will it Cost to Maintain a Stormwater System?

Specific maintenance costs depend on the characteristics of the facility, such as the type and number of facility components, the site, and the area that contributes runoff to the facility. Routine, scheduled maintenance can help keep overall costs down by addressing problems before they require major attention.

Costs can vary depending on the types and level of maintenance practices used. For example, the cost and intensity of maintenance activities are usually higher during a period when new plants are being established.

You should determine how you will finance your maintenance needs. Routine maintenance is on-going. Non-routine maintenance may not occur every year, but your maintenance costs will, of course, be higher in those years. A healthy reserve should be put into place for both capital maintenance procedures (e.g., facility replacement and non-routine maintenance such as sediment removal, facility component repair or replacement, major replanting, or safety structure construction) and operating maintenance procedures (routine activities such as facility inspection, debris removal, and vegetation management).

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5.0 ADDITIONAL INFORMATION/RESOURCES

- For more information on the operation and maintenance of private stormwater drainage facilities contact:

  City of Poulsbo Public Works Department
  200 NE Moe St.
  Poulsbo, WA 98370

  Phone: 360-779-4078

  Email: publicworks@cityofpoulsbo.com

- The current *Private Facility Inspection and Maintenance Report* form for private facility owners, this manual, and additional information about stormwater management and pollution prevention is available for download from the City's website at:

  http://cityofpoulsbo.com/publicworks/StormwaterQuality.htm

6.0 GLOSSARY

100-Year Storm – A storm having a 1% (one percent) chance of being equaled or exceeded in any given year.

Berm - A constructed barrier of compacted earth.

Best Management Practice (BMP) - Physical, structural, and/or managerial practices approved by the Department of Ecology (DOE) that, when used singly or in combination, prevent or reduce pollution of water.

Biofilter - A designed, vegetated treatment facility where the more or less simultaneous processes of filtration, infiltration, adsorption and biological uptake of pollutants in stormwater takes place during the conveyance of concentrated or sheet flowing stormwater.

Biofiltration - The process of reducing pollutant concentrations in water by filtering the polluted water through biological materials.

BMP - Best Management Practice.

Channel - A surface feature that conveys surface water and is open to the air.

Check Structure - A dam (e.g. rock, earthen, log) used in channels to reduce water velocities, promote sediment deposition, and/or enhance infiltration.

Compaction - The condensing of fill by mechanical means.

Constructed Wetland - Those wetlands intentionally created on sites previously without wetlands for the primary purpose of stormwater treatment and managed as such. Constructed wetlands are normally considered as part of the stormwater collection and treatment system and are subject to maintenance requirements. (These wetlands are not the same as wetlands created for mitigation purposes, which are typically viewed in the same manner as natural, regulated wetlands).

Conveyance - A mechanism for transporting water from one point to another, including pipes, ditches, channels, culverts, gutters, manholes, weirs, man-made and natural channels, water quality filtration systems, dry wells, etc.

Conveyance System - The drainage facilities, both natural and man-made, which collect, contain, and provide for the flow of surface and stormwater from the highest points on the land down to a receiving water.

Culvert - Pipe or concrete box structure which drains open channels, swales, or ditches under a roadway or embankment. Typically with no catch basins or manholes along its length.

Glossary (continued)

Dead Storage - The volume available in a depression in the ground below any conveyance system, or surface drainage pathway, or outlet invert elevation that could allow the discharge of surface and stormwater runoff.

Detention Facility - A facility (e.g. pond, vault, pipe) in which surface and stormwater is temporarily stored and released at a controlled rate.

Ditch - A long narrow excavation dug in the earth for drainage with its top width less than 10 feet at design flow.

Drainage - Refers to the collection, conveyance, containment, and/or discharge of surface and storm water runoff.

Drainage Easement - A legal encumbrance that is placed against a property's title to reserve specified privileges for the users and beneficiaries of the drainage facilities contained within the boundaries of the easement.

Dry Pond - A detention facility which drains dry after a storm.

Earthwork - Any operation involving the excavation, grading, filling, or moving of earth materials.

Easement - The legal right to use a described piece of land for a particular purpose. It does not include fee ownership, but may restrict the owner's use of the land. Easements are legally recorded with the County Auditor.

Easement, Private - An interest in the land of someone else, usually for the benefit of one or more individuals, and constitutes an encumbrance on another's land.

Embankment - A structure of earth, gravel, or similar material raised to form a pond bank or foundation for a road, building pad, or similar fill for a particular use.

Energy Dissipater - Any means by which the total energy of flowing water is reduced. In stormwater design, they are usually mechanisms that reduce velocity prior to, or at, discharge from an outfall in order to prevent erosion. They include rock splash pads, drop manholes, concrete stilling basins or baffles, and check dams.

Erosion - Detachment of soil or rock fragments by water, wind, ice and/or gravity.

Erosion/Sedimentation Control - Any temporary or permanent measures taken to reduce erosion, control siltation and sedimentation, and ensure that sediment-laden water does not leave the site.

Filter Fabric - A woven or non-woven, water-permeable material, generally made of synthetic products such as polypropylene and used in stormwater management and erosion and sediment control applications to trap sediment or prevent the clogging of aggregates by fine soil particles.

Glossary (continued)

Filter Fabric Fence - A temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts and entrenched. The filter fence is constructed of stakes and synthetic filter fabric with a rigid wire fence backing where necessary for support.

Flow Control Manhole - A manhole with a flow regulating device or system such as weirs and orifice plates.

Freeboard - The vertical distance between the design water surface elevation and the elevation of the barrier which contains the water.

Grading - Any excavating, filling, clearing, or creating of impervious surfaces or combination thereof.

Groundwater - The underground water usually found in aquifers. Groundwater usually originates from infiltration. Wells tap the groundwater for water supply uses.

Grubbing - The removal and disposing of all unwanted vegetative matter from underground, such as sod, stumps, roots, buried logs, or other debris.

Gully - A channel caused by the concentrated flow of surface and stormwater runoff over unprotected erodible land.

Illicit Discharge - All non-stormwater discharges to stormwater drainage systems that cause or contribute to a violation of state water quality, sediment quality or ground water quality standards.

Impervious Surface - A hard surface area which either prevents or retards the entry of water into the soil mantle as under natural conditions prior to development. A hard surface area which causes water to run off the surface in greater quantities or at an increased rate of flow than the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to, roof tops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, gravel roads, gravel parking lots, or other surfaces which similarly impede the natural infiltration of stormwater. Open, uncovered retention/detention facilities shall not be considered as impervious surfaces.

Infiltration - The downward movement of water from the surface to the subsoil.

Infiltration Facility (or System) - A drainage facility designed to use the hydrologic process of surface and stormwater runoff soaking into the ground, commonly referred to as percolation, to dispose of surface and stormwater runoff.

Inlet - A form of connection between the surface of the ground and a drain for the admission of surface and stormwater runoff.

Live Storage - The amount of storage in a detention facility that is intended to completely drain after a storm event.

Glossary (continued)

Non-Stormwater Discharge – Any discharge to the storm drain system that is not composed entirely of storm water.

Nutrients - Essential chemicals needed by plants or animals for growth. Excessive amounts of nutrients can lead to degradation of water quality and the growth of excessive numbers of algae. Some nutrients can be toxic at high concentrations.

Off-site - Any area lying upstream of a property that drains onto the property and any area lying downstream of the property to which the property drains.

Oil Water Separator - A structure or device used to remove oil and greasy solids from water.

On-site - The area within a property's boundaries.

Orifice - An opening with closed perimeter, usually sharp-edged, and of regular form in a plate, wall, or partition through which water may flow, generally used for the purpose of measurement or control of such water.

Outfall - The point where water flows from a manmade conduit, channel, or drain into a water body or other natural drainage feature. (See Natural Channel)

Professional Engineer - A professional civil engineer, currently licensed by the State of Washington.

Retention/Detention Facility - A facility (e.g. pond) with an outlet to surface water but which is intended to primarily discharge to groundwater and/or evaporation.

Retention Facility - A facility with no outlet to surface water and which is intended to discharge to groundwater and/or evaporation.

Riprap - A facing layer or protective mound of stones placed to prevent erosion or sloughing of a structure or embankment due to flow of surface and stormwater runoff.

Runoff - Water originating from rainfall and other precipitation that is found in drainage facilities, rivers, streams, springs, seeps, ponds, lakes and wetlands as well as shallow ground water.

Sediment - Fragmented material that originated from weathering and erosion of rocks or unconsolidated deposits, and is transported by, suspended in, or deposited by water.

Site - For the purpose of this manual: a property having a storm drainage facility located within the property boundaries.

Storm Drainage Facility – A component, or combination of components, consisting of a man-made drainage feature designed and constructed to perform one or more particular functions to manage stormwater. A facility may be either publicly or privately owned.

Glossary (continued)

Storm Drain System – Constructed and/or natural features which function together as a network to collect, convey, channel, retain, detain, infiltrate, divert, treat, or filter stormwater from surrounding lands to a point of final outlet, such as creeks, bays, or Puget Sound. A stormwater system may include, but not be limited to, pipes, catch basins, retention or detention ponds, channels, ditches, gulches, gullies, culverts, gutters creeks, and lakes. A system can be publicly owned as with the City's municipal separate storm sewer system or privately owned, serving an individual, private property.)

Storm Drains - The enclosed conduits that transport surface and stormwater runoff toward points of discharge (sometimes called storm sewers).

Stormwater - That portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water body or a constructed infiltration facility.

Stormwater Management Manual for the Puget Sound Basin - The manual as prepared by the Department of Ecology (DOE) that contains BMPs to prevent, control or treat pollution in stormwater.

Structure - A catch basin, manhole, or other manufactured unit (in reference to a storm drainage facility or system.)

Suspended Solids - Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles (and associated pollutants) as well as solids in stormwater.

Swale - A shallow drainage conveyance with relatively gentle side slopes, generally with flow depths less than one foot.

Treatment (or Water Quality) BMP - A BMP that is intended to remove pollutants from stormwater.

Water Quality - The chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water Quantity BMP - A BMP specifically designed to control the quantity of runoff.

Watershed - A geographic region within which water drains into a particular river, stream, or body of water.

Wetlands - An area inundated or saturated by ground or surface water at a frequency and duration sufficient to support, and that under normal conditions do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Wet Pond - A stormwater treatment pond designed to maintain a continuous or seasonal water level below the pond outlet elevation.

7.0 APPENDIX

Maintenance of Low Impact Development Facilities

Extracted Sections from *Guidance Document – Western Washington Low Impact Development (LID) Operation and Maintenance (O&M)* as prepared for the Washington State Department of Ecology Water Quality Program

Extracted Page #	Section
11	All LID BMPs (Best Management Practices)
15	Bioretention Facilities
33	Rain Gardens
41	Permeable Pavement
57	Vegetated Roofs

All LID BMPs

The maintenance recommendations included in this section are applicable to all LID BMPs.

Maintenance Standards and Procedures

Table 1 provides the recommended maintenance frequencies, standards, and procedures for spill prevention, spill response, and pest management actions common to all LID BMP facilities included in this guidance document.

Table 1. Maintenance Standards and Procedures for All LID BMPs.				
Category	Recommended Frequency		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
General				
Facility presence	All visits		None (ongoing inspections)	Inspect to ensure the facility is present on site as shown on the as-built (or record drawings) and previous photos.
Spill Prevention and Response				
Spill prevention	Ongoing		None (ongoing inspections)	All sites must implement BMPs to prevent hazardous or solid wastes or excessive oil and sediment from contaminating stormwater.
Spill cleanup	As needed		Release of pollutants	• Call your local or regional hotline number to report any spills or other illicit discharges • Clean up spills as soon as possible to prevent contamination of stormwater • Restore BMP facility design and function per the record drawings
Pests				
Pest management	As needed		Pest of concern is present and impacting BMP facility function	• Pesticide use should be generally discouraged, even conditionally prohibited in some cases • Pesticides include the following: herbicides, fungicides, insecticides, rodenticides, and pediculicides • If pesticide use is planned in or near LID BMPs, make sure to check the following current regulations: 1) Federal- Environmental Protection Agency (EPA) Federal Insecticide and Rodenticide Act 2) State- Ecology, Washington State Department of Agriculture, Washington Department of Fish and Wildlife, Natural Resources Conservation Services 3) Local city or county ordinances/codes, and/or applicable Integrated Pest Management (IPM) plan • For the protection of health and safety, check the following: 1) Washington State Department of Labor & Industries 2) Washington State Department of Health (local branch if applicable)

Equipment and Materials

Table 2 includes recommendations for equipment and materials common to all LID BMPs included in this guidance document.

Table 2. Equipment and Materials List for All LID BMPs.
☐ **Camera**
☐ **Safety gear/equipment (including boots, long sleeves and pants, gloves, eye and ear protection, and/or high visibility safety vest)**
☐ **Shovel (to check depth and condition of soils)**
☐ **Measuring tape**
☐ **Photos, reports, and/or checklists from past maintenance visits (to help identify changes such as thinning plants and changing pavement conditions)**
☐ **Copy of the site's O&M manual or maintenance plan**
☐ **O&M checklist**
☐ **As-built (i.e., record) drawings of the facility, including site drawings with facility location(s)**
☐ **Manufacturer information (if applicable)**

Skills

The required skills common to maintenance of all LID BMPs are listed in the text box to the right.

Skills Needed for Maintenance of all LID BMPs

- Understanding of as-built (or record) drawings of the facility
- Understanding of facility design and intent (to identify issues that would inhibit function)
- General labor (manual tool skills)

Bioretention Facilities

Bioretention facilities are engineered facilities that store and treat stormwater by filtering it through a specified soil profile. Water that enters the facility ponds in an earthen depression or other basin (e.g., concrete planter) before it infiltrates into the underlying bioretention soil. Stormwater that exceeds the surface storage capacity overflows to an adjacent drainage system. Treated water is either infiltrated into the underlying native soil or collected by an underdrain and discharged. Bioretention facilities are considered Stormwater Treatment and Flow Control BMPs/Facilities when used to help meet Minimum Requirements #6 (treatment), #7 (flow control), or both.

Key Maintenance Considerations

The main components of bioretention facilities are listed below with descriptions of their function and key maintenance considerations.

- **Inlet**: Stormwater can flow into a bioretention facility in a number of ways including: dispersed flow across vegetated areas, sheet flow across impervious areas, or concentrated flow through curb cuts and/or piped flow inlets. Inlets must be maintained to be unobstructed to ensure that stormwater enters the facility as designed. Erosion control measures must also be maintained in areas of concentrated flows (e.g., pipes inlets or narrow curb cuts).
- **Facility footprint**: The facility footprint is typically an earthen depression or another type of basin (e.g., concrete planter box) that provides surface storage for stormwater before it infiltrates into the underlying bioretention soil. If the facility is located on a slope, low permeability check dams may be included (oriented perpendicular to the slope) to encourage ponding. Key maintenance considerations for the facility footprint include the following:
    - The integrity of earthen berms and basin walls must be maintained, soil areas must be protected from erosion, and accumulated sediment must be removed.
    - Bioretention facilities are designed to infiltrate all ponded water within a 24- to 48-hour “drawdown” time after the end of a storm. This allows the soil to dry out periodically in order to restore the hydraulic capacity of the system and prevent conditions supportive of mosquito breeding. Slower drawdown times may indicate that the underdrain (if present) is plugged or the bioretention soil is overly compacted, clogged, or does not meet design specifications. Corrective maintenance may include clearing underdrain obstructions or partial or complete replacement of bioretention soil to restore bioretention facility function.
- **Bioretention soil**: Infiltration of stormwater through the engineered bioretention soil mix provides water quality treatment. All maintenance activities must be performed in a manner to prevent compaction of the bioretention soil.
- **Mulch**: The bioretention soil is covered by a layer of mulch, comprised of arborist wood chips, compost, and/or rocks. Mulch reduces weed establishment. Organic

mulches regulate soil temperatures and moisture, and add organic matter to soil. The mulch layer must be supplemented regularly.

- **Vegetation**: Bioretention systems rely on vegetation (i.e., grasses, shrubs, and sometimes trees) to intercept, uptake, and evapotranspire stormwater. In addition, plant roots improve soil structure and increase infiltration capacity. Regular maintenance activities associated with vegetation include weeding and pruning. Plants also require irrigation during the first 2 to 3 years of establishment and during extended dry periods.
- **Overflow**: Flows exceeding the capacity of the facility are discharged via an overflow structure (e.g., pipe, curb cut, earthen channel). It is important to maintain clear outlet pipes and overflow structures to ensure that stormwater can be safely conveyed to a designated discharge point (e.g., storm drain system).
- **Underdrains (optional)**: Underdrains are optional components of a bioretention facility that may be included in bioretention systems where, for example, infiltration to underlying soil is not prudent or feasible. Underdrains are installed under the bioretention soil layer to collect and convey treated water. An underdrain system can be comprised of perforated or slotted pipe, wrapped in an aggregate blanket. It is important to maintain clear drains so that water moves through system as designed. Maintenance may include occasional cleaning to remove plant roots or debris. If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be inspected and cleaned regularly.

Nutrient sensitivity of the receiving water is also an important maintenance consideration, particularly in watersheds draining to phosphorous limited water bodies. The addition of excess fertilizers to the system and/or systems operating in bypass, can increase the potential for export of phosphorous found in bioretention soil or compost and increase nutrient loads to downstream receiving waters.

Key Operations to Preserve Facility Function

For a bioretention system to function properly, stormwater must infiltrate freely through the bioretention soil. The soil infiltration rate can be reduced if the soil is subject to compaction (e.g., foot and vehicle traffic loads). To limit the likelihood of corrective maintenance (e.g., bioretention soil replacement), the facility footprint area should be protected from external loads. Because the risk of compaction is higher when soils are saturated, any type of loading in the bioretention facility (including foot traffic) should be avoided during wet conditions.

Signage can also be used to identify the vegetated area as a stormwater BMP and inform maintenance crews and the general public about protecting the facility's function.

Maintenance Standards and Procedures

Table 3 provides the recommended maintenance frequencies, standards, and procedures for bioretention facility components. The level of routine maintenance required and the frequency of corrective maintenance actions may increase for facilities subject to high sediment loads from the contributing drainage area.

Table 3. Maintenance Standards and Procedures for Bioretention Facilities.				
Component	**Recommended Frequency [a]**		**Condition when Maintenance is Needed (Standards)**	**Action Needed (Procedures)**
	Inspection	**Routine Maintenance**		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	• Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) • For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. • Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3 inches (relative to undisturbed sections of berm)	Restore to design height
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	• Eradicate rodents (see "Pest control") • Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	• Repair/ seal cracks • Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility Area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is reduced (see “Ponded water”) or surface storage capacity significantly impacted	• Remove excess sediment • Replace any vegetation damaged or destroyed by sediment accumulation and removal • Mulch newly planted vegetation • Identify and control the sediment source (if feasible) • If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low Permeability Check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting
	A		Grade board or top of weir damaged or not level	Restore to level position

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

ISA – International Society of Arboriculture

Table 3 (continued). Maintenance Standards and Procedures for Bioretention Facilities.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint (cont'd)				
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Determine cause and resolve in the following order: 1) Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2) Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3) Check for other water inputs (e.g., groundwater, illicit connections). 4) Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Inlets/Outlets/Pipes				
Bioretention soil media	As needed		Bioretention soil media protection is needed when performing maintenance requiring entrance into the facility footprint	• Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. • Never drive equipment or apply heavy loads in facility footprint. • Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. • Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. • If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm is forecasted	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	• Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM – Integrated Pest Management

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Table 3 (continued). Maintenance Standards and Procedures for Bioretention Facilities.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Inlets/Outlets/Pipes (cont'd)				
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	• Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water")	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	• Determine cause of poor vegetation growth and correct condition • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the LID Technical Guidance Manual for Puget Sound). • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	• Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See Pacific Northwest Plant Disease Management Handbook for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by species)	Pruning as needed	• Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques • All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	• Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. • Remove trees and shrubs, if necessary.
	Fall and Spring		Standing dead vegetation is present	• Remove standing dead vegetation • Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather/planting season) • If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. • Determine cause of dead vegetation and address issue, if possible • If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

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Table 3 (continued). Maintenance Standards and Procedures for Bioretention Facilities.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Trees and shrubs (cont'd)	Fall and Spring		Planting beneath mature trees	• When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). • Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	• Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage • Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. • Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. • Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	• Maintain appropriate height for sight clearance • When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. • Remove or transplant if continual safety hazard • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (cont'd)				
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	• Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	• Leave dry foliage for winter interest • Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	• Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring • Clean, rake, and comb grasses when they become too tall • Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March - October)	Listed noxious vegetation is present (refer to current county noxious weed list)	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions • Apply mulch after weed removal (see "Mulch")

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

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Table 3 (continued). Maintenance Standards and Procedures for Bioretention Facilities.				
Component	**Recommended Frequency [a]**		**Condition when Maintenance is Needed (Standards)**	**Action Needed (Procedures)**
	Inspection	**Routine Maintenance**		
Vegetation (cont'd)				
Weeds		M (March – October, preceding seed dispersal)	Weeds are present	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid- May and once in early- to mid- September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	• Edge or trim groundcovers and shrubs at facility edge • Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks • While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
Excessive vegetation (cont'd)	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	• Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics • Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) • Remove plants that are weak, broken or not true to form; replace in-kind • Thin grass or plants impacting facility function without leaving visual holes or bare soil areas • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	• Remove vegetation and sediment buildup
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) • Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	• Follow manufacturer's instructions for O&M
	A		Sprinklers or drip irrigation not directed/located to properly water plants	• Redirect sprinklers or move drip irrigation to desired areas

Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	• 10 to 15 gallons per tree
				• 3 to 5 gallons per shrub
				• 2 gallons water per square foot for groundcover areas
				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ○ Pulse water to enhance soil absorption, when feasible
				  ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
				• Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

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Table 3 (continued). Maintenance Standards and Procedures for Bioretention Facilities.				
Component	**Recommended Frequency [a]**		**Condition when Maintenance is Needed (Standards)**	**Action Needed (Procedures)**
	Inspection	**Routine Maintenance**		
Watering (cont'd)				

Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	• 10 to 15 gallons per tree
				• 3 to 5 gallons per shrub
				• 2 gallons water per square foot for groundcover areas
				• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist
				• Use soaker hoses or spot water with a shower type wand when irrigation system is not present
				  ○ Pulse water to enhance soil absorption, when feasible
				  ○ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff

Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	• Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear • Water during drought conditions or more often if necessary to maintain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti)
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	• Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) • Remove pet waste regularly • For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	• Reduce hiding places for pests by removing diseased and dead plants • For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols)

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Equipment and Materials

Table 4 includes recommendations for equipment and materials commonly used to maintain bioretention facilities. Some of the equipment and materials will be used for routine maintenance activities, while other equipment and materials will be necessary for specialized maintenance.

Table 4. Bioretention Equipment and Materials List.

Landscaping equipment	*Landscaping materials**
☐ Gloves	☐ Plants
☐ Weeding tool	☐ Stakes and ties
☐ Soil knife	*Erosion control material**
☐ Pruners	☐ Rock or cobbles for rock pad
☐ Loppers	☐ Erosion control matting
☐ Stakes and guys	*Mulch*
☐ Manual edger	☐ Arborist wood chip mulch
☐ Line trimmer (also known as a string trimmer, weed eater, or weed whacker)	☐ Coarse compost mulch
☐ Rototiller	☐ Rock mulch
☐ Hoe	*Pipe/structure inspection and maintenance equipment*
☐ Rake	☐ Hand tools
☐ Wheelbarrow	☐ Wrench or manhole lifter (for opening manhole lids, grates, etc.)
☐ Shovel	☐ Flashlight
☐ Push broom	☐ Mirror (for viewing pipes without entering structure)
☐ Hand tamper	☐ Garden hose
☐ Blade sharpeners	☐ Plumbing snake
☐ Tarp/ Buckets (to remove leaf litter/debris)	☐ Measuring tape or ruler
☐ Garbage bags (for disposal of trash/noxious weeds)	*Specialized equipment**
☐ Bark and mulch blower	☐ Mini excavator
☐ Boards to stand on during maintenance to prevent soil compaction (if maintenance is necessary during periods when Bioretention media is wet)	☐ Vactor truck
Watering equipment	☐ Manual seed broadcaster
☐ Soaker hose	☐ Soil monitoring equipment (T handle core sampler, soil auger, soil nutrient test kit)
☐ Hose/shower-type wand	☐ Flame weeder or hot water weeder
☐ Sprinklers	☐ Water jet or root saw (Vactor truck tools) for clearing roots from underdrains
☐ Tree watering bags	☐ Equipment for infiltration testing
☐ Buckets	*Bioretention Soil**
☐ Keys for irrigation boxes	☐ Bioretention soil per design specifications
☐ Water source (e.g., watering truck), if necessary	

* Items not required for routine maintenance

Rain Gardens

Rain gardens are non-engineered, shallow, landscaped depressions with compost-amended soils and adapted plants. The depression temporarily stores stormwater runoff from adjacent areas. Some or all of the influent stormwater passes through the amended soil profile and into the underlying native soil. Stormwater that exceeds the storage capacity is designed to overflow to an adjacent drainage system.

Key Maintenance Considerations

The main components of rain gardens (and the associated maintenance considerations) are very similar to those listed for bioretention facilities. However, rain gardens do not require an engineered soil mix (native soils may be amended) and usually do not have underdrains or other control structures.

Fertilizer use should be avoided in rain gardens, particularly those located in watersheds draining to phosphorous limited water bodies.

Key Operations to Preserve Facility Function

As explained for bioretention facilities, rain gardens must be protected from foot traffic, vehicles and other loads, particularly during wet conditions, to prevent compaction of the amended soil and preserve infiltration capacity.

Signage can also be used to identify the vegetated area as a stormwater BMP and inform maintenance crews and the general public about protecting the rain garden's function (e.g., no walking in the garden).

Maintenance Standards and Procedures

Table 6 provides the recommended maintenance frequencies, standards, and procedures for rain garden components. For guidance on underdrains, check dams and other control structures, see "Bioretention Facilities".

Table 6. Maintenance Standards and Procedures for Rain Gardens.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Rain Garden Footprint				
Earthen side slopes	B (during the wet season)		Persistent soil erosion on slopes	If erosion persists, water may be flowing into the garden too rapidly. In this case, the slope of the pipe or swale directing water to the garden, or the amount of water may need to be reduced (see "Erosion control at inlet")
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Rain garden footprint		B	Trash and debris present	Clean out trash and debris
Rain garden bottom area	A		Visible sediment deposition in the rain garden that reduces drawdown time of water in the rain garden	• Remove sediment accumulation • If sediment is deposited from water entering the rain garden, determine the source and stabilize the area
		During/after fall leaf drop	Accumulated leaves in rain garden (may reduce infiltration capacity of rain garden or clog overflow)	Remove leaves
Ponded water	B, S		Excessive ponding water: Ponded water remains in the basin more than 3 days after the end of a storm	Confirm leaf, debris or sediment buildup in the bottom of the rain garden is not impeding infiltration. If necessary, remove leaf litter/debris/sediment. If this does not solve the problem, consultation with a professional with rain garden expertise is recommended to evaluate the following: • Check for other water inputs (e.g., groundwater, illicit connections) • Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased • Determine if the soil is clogged by sediment accumulation at the surface or if the soil has become overly compacted

[a] Frequency: A = Annually; B = Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

Table 6 (continued). Maintenance Standards and Procedures for Rain Gardens.				
	Recommended Frequency [a]			
Component	Inspection	Routine Maintenance	Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the rain garden and away from the building	Reconfigure/ repair blocks to direct water to the rain garden and away from building
Pipe inlet/ outlet	A		Pipe capacity is reduced by sediment or debris (can cause backups and flooding)	Clear pipes of sediment and debris
Pipe inlet/outlet (cont'd)	A		Damaged/cracked drain pipes	• Repair/seal cracks • Replace when repair is insufficient
Erosion control at inlet	A		Rock or cobble is removed or missing and concentrated flows are contacting soil	Maintain a cover of rock or cobbles to protect the ground where concentrated water flows into the rain garden from a pipe or swale
Vegetation				
Vegetation		As needed	Dying, dead, or unhealthy plants	• Maintain a healthy cover of plants • Remove any diseased plants or plant parts and dispose of in commercial landfill to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • Re-stake trees if they need more support, but plan to remove stakes and ties after the first year • Cars can damage roots – protect root areas of trees and plants from vehicle traffic
		As needed	Vegetation inhibits sight distances and sidewalks	Keep sidewalks and sight distances on roadways clear
		As needed	Broken, dead, or sucker vegetation is present	Remove broken or dead branches and suckers
		As needed	Vegetation is crowding inlets and outlets	Keep water inlets and outlets in the rain garden clear of vegetation

[a] Frequency: A = Annually; B = Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

Table 6 (continued). Maintenance Standards and Procedures for Rain Gardens.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Vegetation (cont'd)		As needed	Broken, dead, or sucker vegetation is present	Remove broken or dead branches and suckers
		As needed	Vegetation is crowding inlets and outlets	Keep water inlets and outlets in the rain garden clear of vegetation
	One time March through June		• Yellowing: possible Nitrogen (N) deficiency • Poor growth: possible Phosphorous (P) deficiency • Poor flowering, spotting or curled leaves, or weak roots or stems: possible Potassium (K) deficiency	• Test soil to identify specific nutrient deficiencies • Consult with a professional knowledgeable in the area of natural amendments or refer to Natural Lawn and Garden Care resources and avoid synthetic fertilizers • Consider selecting different plants for soil conditions
Weeds		As needed, preceding seed dispersal	Problem weeds are present	• Remove weeds by hand, especially in spring when the soil is moist and the weeds are small • Dig or pull weeds out by the roots before they go to seed • Apply mulch after weeding (see "Mulch")
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	• Supplement mulch with hand tools to a depth of 2 to 3 inches • Use coarse compost in the bottom of the rain garden and arborist wood chips on side slopes and rim (above typical water levels) • Keep all mulch from being in contact with woody stems.

[a] Frequency: A = Annually; B = Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

Table 6 (continued). Maintenance Standards and Procedures for Rain Gardens.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Watering				
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Tree, shrubs and groundcovers in first year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present • Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present
Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Tree, shrubs and groundcovers in second or third year of establishment period	• 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	• Water during drought conditions or more often if necessary to maintain plant cover • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different rain garden species and water immediately after initial signs of stress appear

[a] Frequency: A = Annually; B = Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

Table 6 (continued). Maintenance Standards and Procedures for Rain Gardens.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti)

[a] Frequency: A = Annually; B = Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

Additional Maintenance Resources

In addition to the resources listed for bioretention, useful guidance for rain gardens can be found in the Rain Garden Handbook for Western Washington Homeowners (http://www.wastormwatercenter.org/low-impact/). These resources are supplemental and do not supersede guidance provided in the Standards and Procedures tables.

Equipment and Materials

Table 7 includes recommendations for equipment and materials commonly used to maintain rain gardens. Some of the equipment and materials will be used for routine maintenance activities, while other equipment and materials will be necessary for specialized maintenance.

Table 7. Rain Garden Equipment and Materials List.

Landscaping equipment	*Watering equipment*
☐ Gloves	☐ Soaker hose
☐ Weeding tool	☐ Hose/shower-type wand
☐ Soil knife	☐ Sprinklers
☐ Pruners	☐ Tree watering bags
☐ Loppers	☐ Buckets
☐ Stakes and guys	*Mulch*
☐ Manual edger	☐ Arborist wood chip mulch
☐ Line trimmer (also known as a string trimmer, weed eater, or weed whacker)	☐ Coarse compost mulch
☐ Rototiller	☐ Rock mulch
☐ Hoe	*Landscaping materials**
☐ Rake	☐ Plants
☐ Wheelbarrow	*Erosion control materials**
☐ Shovel	☐ Rock or cobbles for rock pad
☐ Push broom	☐ Erosion control matting
☐ Hand tamper	*Soil**
☐ Blade sharpeners	☐ Compost (for soil amendment)
☐ Tarp/Buckets (to remove leaf litter/debris)	☐ Bioretention soil mix
☐ Garbage bags (for disposal of trash/noxious weeds)	

* Items not required for routine maintenance

Permeable Pavement

Permeable pavement is a paving system which allows rainfall to percolate through the surface into the underlying soil or an aggregate bed, where stormwater is stored and infiltrated to underlying subgrade, or removed by an overflow drainage system. Permeable pavement facilities are considered Stormwater Treatment and Flow Control BMPs and can be used to meet Minimum Requirements #6 (treatment), #7 (flow control), or both. To satisfy Minimum Requirement #6, stormwater must be infiltrated into underlying soils that meet Ecology's soil treatment requirements or filtered through an engineered treatment layer included in the pavement section.

Key Maintenance Considerations

The main components of permeable pavement facilities are listed below with descriptions of their function and key maintenance considerations.

- **Wearing course**: The surface layer of any permeable pavement system is the wearing course. Categories of wearing courses include:
    - Porous asphalt**:** A flexible pavement similar to standard asphalt that uses a bituminous binder to adhere aggregate. However, the fine material (sand and finer) is reduced or eliminated, resulting in the formation of voids between the aggregate in the pavement surface that allows water to infiltrate to the underlying aggregate base.
    - Pervious concrete**:** A rigid pavement similar to conventional concrete that uses a cementitious material to bind aggregate together. However, the fine aggregate (sand) component is reduced or eliminated in the gradation, resulting in the formation of voids between the aggregate in the pavement surface that allows water to infiltrate to the underlying aggregate base.
    - Interlocking concrete paver blocks: Solid, precast, manufactured modular units. Pavements constructed with these units create joints that are filled with permeable aggregate and installed on an open-graded aggregate base.
    - Aggregate Pavers (or Pervious Pavers): Modular precast paving units made with uniformly sized aggregates and bound with Portland cement concrete using a high strength adhesive. Unlike concrete paver blocks, these pavers are permeable. Pavements constructed with these units create joints that are filled with permeable aggregate and installed on an open-graded aggregate base.
    - Open-celled paving grid with gravel**:** Concrete or plastic grids that are filled with permeable aggregate. The system can be installed on an open-graded aggregate base.
    - Open-celled paving grid with grass**:** Concrete or plastic grids that are filled with a mix of sand, gravel, and topsoil for planting vegetation. The cells can be planted with a variety of non-turf forming grasses or low-growing groundcovers. The system can be installed on an open-graded aggregate base.

A critical component of a successful maintenance program is regular removal of sediment and debris, excessive moss from the facility surface to prevent clogging of the permeable wearing course.

- **Inlet (optional):** While permeable pavement facilities often manage only the rain falling directly on the pavement surface, they may also be designed to accept stormwater runoff from additional areas (e.g., adjacent impervious areas, nearby rooftops). Runoff can be directed to the facility by two main methods:
    - Sheet flow to the surface: Surface areas of the facility receiving runoff contributions will likely be prone to clogging due to sediment inputs, particularly in areas of concentrated inflow. These areas should be carefully inspected and corrective maintenance should be performed as necessary to maintain the function of the pavement at these sites. In addition, the source of the sediment loads should be evaluated to determine if modifications to features in the drainage area landscape (e.g., stabilization of adjacent planted areas) would help to prevent clogging.
    - Piped flow into the aggregate base: Pipes dispersing water into the aggregate bed should be designed with cleanout access to allow pipe maintenance. Runoff that is piped into the aggregate base should be pretreated for sediment removal (e.g., screens, sumps) to protect the subbase from sedimentation and clogging. The pretreatment system must be maintained to remove accumulated sediment.
- **Aggregate Base / Storage Reservoir:** Stormwater passes through the wearing course to an underlying aggregate storage reservoir where it is stored prior to infiltration into the underlying soil. This aggregate bed also provides the structural function of supporting design loads (e.g., vehicle loading) for flexible pavement systems. To allow inspection of the aggregate course, some facilities have an observation port (typically installed during construction) that allows monitoring of the water levels in the aggregate bed to determine if the facility is draining properly.
- **Overflow:** Unless designed to provide full infiltration of stormwater, permeable pavement facilities have an overflow. Facility overflow can be provided by subsurface slotted drain pipe(s) (elevated in the aggregate bed) routed to an inlet or catch basin structure or by lateral flow through the storage reservoir to a daylighted drainage system.
- **Underdrain with flow restrictor (optional):** A slotted drain pipe with flow restrictor assembly may be installed at the bottom of or elevated within the aggregate storage reservoir. Permeable pavement facilities with underdrains and flow restrictors operate as underground detention systems with some infiltration.

Key Operations to Preserve Facility Function

There are several permeable pavement operational actions that can limit the likelihood of corrective maintenance actions or replacement including the following:

- Prohibiting use of sealant on porous asphalt
- Protecting from construction site runoff with proper temporary erosion and sediment controls and flow diversion measures
- Modifying utility cut procedures for permeable pavements. Protocols should *recommend* restoring permeable pavement section in-kind, where feasible, and *require* restoring permeable pavement section in-kind where replacement with conventional pavement would impact overall facility function. Replacing permeable pavement with conventional pavement is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function.
- Modifying snow removal procedures such as:
    - Using a snow plow with skids or rollers to slightly raise the blade above permeable pavers or open-celled paving grid systems to prevent loss of top course aggregate and damage to paver blocks or grids
    - Avoiding stockpiling plowed snow (i.e., dirty snow) directly on top of permeable pavement
    - Avoiding application of sand to pervious pavement and adjacent streets where vehicles may track it onto the pervious pavement. If sand is applied, on an emergency basis during snowy conditions, vacuum sweep surface as soon as possible after the sand is no longer needed.
    - Use alternative deicers in moderation (e.g., salt, molasses-based and chemical deicers).
- Protecting the surface from stockpiles of landscaping materials (e.g., mulch, soil, compost) being used for adjacent pervious areas
- Stabilizing adjacent landscaped areas to avoid eroding soil and clogging surfaces or sloping adjacent landscaped areas away from permeable pavement , if possible

Signage or pavement marking can also be used to identify permeable pavement as a stormwater BMP and inform maintenance crews and the general public about protecting the facility's function (e.g., no stockpiling of soils or mulch on pavement surface).

Maintenance Standards and Procedures

Table 8 provides the recommended maintenance frequencies, standards, and procedures for permeable pavement components. The level of routine maintenance required and the frequency of corrective maintenance actions may increase for facilities receiving high sediment loads (e.g., sanding) or facilities subject to extended wet, shady conditions where moss may accumulate.

Table 8. Maintenance Standards and Procedures for Permeable Pavement.

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course				
Permeable Pavements, all	A, S		Runoff from adjacent pervious areas deposits soil, mulch or sediment on paving	• Clean deposited soil or other materials from permeable pavement or other adjacent surfacing • Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place) • Mulch and/or plant all exposed soils that may erode to pavement surface
Porous asphalt or pervious concrete		A or B	None (routine maintenance)	Clean surface debris from pavement surface using one or a combination of the following methods: • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Vacuum/sweep permeable paving installation using: ○ Walk-behind vacuum (sidewalks) ○ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ○ ShopVac or brush brooms (small areas) • Hand held pressure washer or power washer with rotating brushes Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.
	A[b]		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	• Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, but not less than 1 test per 2,500 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods: • Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate. • Hand held pressure washer or power washer with rotating brushes • Pure vacuum sweepers Note: If the annual/biannual routine maintenance standard to clean the pavement surface is conducted using equipment from the list above, corrective maintenance may not be needed.
	A		Sediment present at the surface of the pavement	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding then see above. • Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Pressure wash, vacuum sweep, or use a combination of the two for cleaning moss from pavement surface. May require stiff broom or power brush in areas of heavy moss.
	A		Major cracks or trip hazards and concrete spalling and raveling	• Fill potholes or small cracks with patching mixes • Large cracks and settlement may require cutting and replacing the pavement section. Replace in-kind where feasible. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function. • Take appropriate precautions during pavement repair and replacement efforts to prevent clogging of adjacent porous materials

[a] Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.

Table 8 (continued). Maintenance Standards and Procedures for Permeable Pavement.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course (con't)				
Interlocking concrete paver blocks and aggregate pavers		A or B	None (routine maintenance)	Clean pavement surface using one or a combination of the following methods: • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Vacuum/sweep permeable paving installation using: ○ Walk-behind vacuum (sidewalks) ○ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ○ ShopVac or brush brooms (small areas) • Note: Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.
	A [b]		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)]	• Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, but not less than one test per 2,500 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. • Clogging is usually an issue in the upper 2 to 3 centimeters of aggregate. Remove the upper layer of encrusted sediment, and fines, and/or vegetation from openings and joints between the pavers by mechanical means and/or suction equipment (e.g., pure vacuum sweeper). • Replace aggregate in paver cells, joints, or openings per manufacturer's recommendations
	A		Sediment present at the surface of the pavement	• Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding, then see above. • Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	• Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Vacuum sweep or stiff broom/power brush for cleaning moss from pavement surface
	A		Paver block missing or damaged	Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations
	A		Loss of aggregate material between paver blocks	Refill per manufacturer's recommendations for interlocking paver sections
	A		Settlement of surface	May require resetting
Open-celled paving grid with gravel		A or B	None (routine maintenance)	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A [b]		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)]	• Use vacuum truck to remove and replace top course aggregate • Replace aggregate in paving grid per manufacturer's recommendations
	A		Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace gravel • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Loss of aggregate material in paving grid	Replenish aggregate material by spreading gravel with a rake (gravel level should be maintained at the same level as the plastic rings or no more than 1/4 inch above the top of rings). See manufacturer's recommendations.
		A	Weeds present	• Manually remove weeds • Presence of weeds may indicate that too many fines are present (refer to Actions Needed under "Aggregate is clogged" to address this issue)

[a] Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.

Table 8 (continued). Maintenance Standards and Procedures for Permeable Pavement.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course (con't)				
Open-celled paving grid with grass		A or B	None (routine maintenance)	• Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) • Follow equipment manufacturer guidelines for cleaning surface.
	A b		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)]	• Rehabilitate per manufacturer's recommendations.
	A		Paving grid missing or damaged	• Remove pins, pry up grid segments, and replace grass • Replace grid segments where three or more adjacent rings are broken or damaged • Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	• May require resetting
	A		Poor grass coverage in paving grid	• Restore growing medium, reseed or plant, aerate, and/or amend vegetated area as needed • Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible
		As needed	None (routine maintenance)	• Use a mulch mower to mow grass
		A	None (routine maintenance)	• Sprinkle a thin layer of compost on top of grass surface (1/2" top dressing) and sweep it in • Do not use fertilizer
		A	Weeds present	• Manually remove weeds • Mow, torch, or inoculate and replace with preferred vegetation
Inlets/Outlets/Pipes				
Inlet/outlet pipe	A		Pipe is damaged	Repair/replace
	A		Pipe is clogged	Remove roots or debris
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged drawdown period)	• Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Raised subsurface overflow pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain	• Jet clean or rotary cut debris/roots from under-drain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Outlet structure	A, S		Sediment, vegetation, or debris reducing capacity of outlet structure	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages

[a] Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.

Table 8 (continued). Maintenance Standards and Procedures for Permeable Pavement.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course (con't)				
Overflow	B		Native soil is exposed or other signs of erosion damage are present at discharge point	Repair erosion and stabilize surface
Aggregate Storage Reservoir				
Observation Port	A, S		Water remains in the storage aggregate longer than anticipated by design after the end of a storm	If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Vegetation				
Adjacent large shrubs or trees		As needed	Vegetation related fallout clogs or will potentially clog voids	• Sweep leaf litter and sediment to prevent surface clogging and ponding • Prevent large root systems from damaging subsurface structural components
		Once in May and Once in September	Vegetation growing beyond facility edge onto sidewalks, paths, and street edge	Edging and trimming of planted areas to control groundcovers and shrubs from overreaching the sidewalks, paths and street edge improves appearance and reduces clogging of permeable pavements by leaf litter, mulch and soil.
Leaves, needles, and organic debris		In fall (October to December) after leaf drop (1-3 times, depending on canopy cover)	Accumulation of organic debris and leaf litter	Use leaf blower or vacuum to blow or remove leaves, evergreen needles, and debris (i.e., flowers, blossoms) off of and away from permeable pavement

[a] Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.

Equipment and Materials

Table 9 includes recommendations for equipment and materials commonly used to maintain permeable pavement. Some of the equipment and materials will be used for routine maintenance activities, while other equipment and materials will be necessary for specialized maintenance.

Table 9. Permeable Pavement Equipment and Materials List.

Equipment to address clogging of wearing course, such as:	*Weed / vegetation removal equipment, such as:*
☐ Hand held pressure washer or power washer with rotating brushes (not recommended for open-celled aggregate-filled systems) ☐ Walk-behind vacuum (sidewalks) ☐ Pure vacuum sweeper ☐ ShopVac (small areas) ☐ Combined higher pressure wash and vacuum system	☐ Weeding tools ☐ Weed burner ☐ Edging and trimming equipment to control groundcover and other vegetation from extending onto pavement surface
Equipment to remove sediment, debris, and leaf litter, such as:	*Additional equipment for grass-filled open-celled grid systems*
☐ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ☐ Push broom (can also be used to spread and clean aggregate in gravel-filled open-celled grid and permeable paver systems) ☐ Brush broom (course bristled broom) to remove moss ☐ Leaf blower	☐ Mower or mulch mower ☐ Topdress grass seed ☐ Compost ☐ Replacement grid segments
*Erosion control equipment (to stabilize adjacent landscaped areas and protect pavement from sediment inputs)**	*Additional equipment for gravel-filled open-celled grid systems*
☐ Erosion control matting ☐ Rocks ☐ Mulch ☐ Plants ☐ Landscaping tools ☐ Tarps (to protect pavement in area of landscaping from clogging, e.g., mulch stockpiles)	☐ Rakes and shovels ☐ Aggregate to replace material after vacuuming or to replenish material in high use areas ☐ Replacement grid segments ☐ Wheelbarrow (for transporting replacement aggregate)
Pipe/structure inspection and maintenance equipment	*Additional equipment for permeable paver systems*
☐ Hand tools ☐ Wrench or manhole opener (for opening manhole lids, grates, etc.) ☐ Flashlight ☐ Mirror (for viewing pipes without entering structure) ☐ Garden hose ☐ Plumbing snake ☐ Measuring tape or ruler	☐ Rakes and shovels ☐ Extra pavers and bedding material ☐ Aggregate to replace materials between pavers after vacuuming ☐ Wheelbarrow (for transporting replacement aggregate)
	Snow removal equipment, such as:
	☐ Plow with skids to prevent damage to permeable pavement ☐ Snow blower

* Items not required for routine maintenance

Vegetated Roofs

Vegetated roofs (also known as ecoroofs and green roofs) are thin layers of engineered soil and vegetation constructed on top of a conventional roof. Vegetated roofs consist of four basic components: a waterproof membrane, drainage layer, lightweight growth medium, and vegetation. Deeper installations, referred to as "intensive" roofs, are comprised of at least 6 inches of growth media and are planted with groundcovers, grasses, shrubs and sometimes trees. These intensive systems require regular landscape maintenance. Shallower installations, referred to as "extensive" roofs, are comprised of less than 6 inches of growth media and use a planting palette of drought-tolerant, low maintenance groundcovers. The procedures outlined below focus on extensive roof systems, and different procedures for intensive roofs are noted.

Key Maintenance Considerations

The main components of vegetated roof facilities are listed below with descriptions of their function and key maintenance considerations. Components are listed in the order of installation from the roof deck upwards.

- **Waterproof membrane**: Waterproof membranes are installed on the roof deck below the vegetated roof system. Systems also include a protection layer and root barrier to preserve the integrity of the waterproof membrane. These components are not visible, so inspection is typically not possible unless a leak detection system is installed. During maintenance, sharp tools, lawn staples, and stakes should be avoided to prevent damage to membrane.

- **Drainage layer**: All vegetated roofs have a drainage component that routes excess water to the roof drain system. Usually this takes the form of a manufactured drain mat or granular drainage media. A separation layer (e.g., filter fabric) is typically installed above the drainage mat or granular drainage media to prevent fine components of the growth media from being washed into the roof drain system. This component is also not visible, so inspection is difficult. During maintenance, sharp tools, lawn staples, and stakes should be avoided to prevent damage to the drainage layer.

- **Growth media**: Vegetated roofs use a light-weight growth medium with adequate fertility and drainage capacity to support plant growth and allow infiltration and storage of water. In general the media is composed of porous and lightweight mineral aggregates such as pumice, lave rock, expanded shale and expanded slate. The growth media may be covered by a mat (or other erosion control measure) to prevent surface erosion due to rain and wind scour before plants are established.

- **Vegetation**: The plants on vegetated roofs are typically succulents, grass, herbs, and/or wildflowers adapted to the harsh conditions (minimal soils, seasonal drought, high winds, and strong sun exposure) prevalent on rooftops. A wider variety of vegetation types may be used on intensive roofs, but these typically require additional maintenance. Regular maintenance activities associated with vegetation include

weeding and pruning. Plants also require watering during establishment and extended dry periods.

- **Structural drainage elements**: The roof drainage system routes water from the vegetated roof drainage layer to a nearby drainage system. It is important to maintain unobstructed outlet pipes and structures to ensure that stormwater is safely conveyed from the roof to a discharge point. There are also other structural components of a roof that may interface with the vegetated roof (e.g., flashing, roof ventilation points, utilities).
- **Border zone:** This zone forms an area, composed of gravel and devoid of vegetation, around the perimeter of the vegetated roof, typically used as a fire prevention method and to prevent water damage.
- **Gravel stops:** These are sheet metal edges, typically installed outside of the border zone, along the perimeter of the roof to prevent growth medium from blowing or washing off of the roof.

Key Operations to Preserve Facility Function

For vegetated roofs to function properly, stormwater must filter through several layers. Similar to bioretention facilities, filtration can be reduced if the growth media is subject to compaction (e.g., foot traffic). To limit the likelihood of corrective maintenance (e.g., growth media), the planted area of the vegetated roof should be protected from external loads. The risk of compaction is higher when soils are saturated, therefore any type of loading in the planted areas of the vegetated roof (including foot traffic) should be avoided or minimized during wet conditions.

Signage is recommended to identify the planted areas of the vegetated roof as a stormwater BMP and educate maintenance crews and the general public about protecting the facility's function (e.g., no walking on the facility). Clear walkways or pathways should be present to discourage foot traffic on the planted portions of the vegetated roof.

Maintenance Standards and Procedures

Table 11 provides the recommended maintenance frequencies, standards, and procedures for vegetated roof components.

Each vegetated roof installation will have specific O&M guidelines provided by the manufacturer and installer. The following guidelines provide a general set of standards for prolonged vegetated roof performance. Note that some maintenance recommendations are different for extensive versus intensive vegetated roof systems. The procedures outlined below focus on extensive roof systems, and different procedures for intensive roofs are noted.

Table 11. Maintenance Standards and Procedures for Vegetated Roofs.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Growth medium area				
Growth medium	A [b]		Water does not permeate growth media (runs off soil surface) or crusting is observed	Aerate (e.g., rake) or replace medium taking care not to damage the waterproof membrane
	A		Growth medium thickness is less than design thickness (due to erosion and plant uptake)	Supplement growth medium to design thickness
	B, W		Fallen leaves or debris are present	Remove/dispose
	A, W, S		Growth media erosion/scour is visible (e.g., gullies)	• Take steps to repair or prevent erosion • Fill, hand tamp, or lightly compact, and stabilize with additional soil substrate/growth medium (similar in nature to the original material) and additional plants
Erosion control measures	B [c]		Mat or other erosion control is damaged or depleted during plant establishment period	• Repair/replace erosion control measures until 90% vegetation coverage attained • Avoid application of mulch on extensive vegetated roofs
System Drainage and Structural Components				
Roof drain	B, S		Sediment, vegetation, or debris reducing capacity of inlet structure	• Clear blockage • Identify and correct any problems that led to blockage
	A		Pipe is clogged	Remove roots or debris
	A		Inlet pipe is in poor condition	Repair/replace

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

[b] Inspection should occur during storm event.

[c] Inspection should occur during plant establishment period (typically first 2 years).

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Table 11 (continued). Maintenance Standards and Procedures for Vegetated Roofs.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
System Drainage and Structural Components (cont'd)				
Border zone	A		Vegetation is encroaching into border zone aggregate	Remove and dispose of weeds and transplant desirable vegetation to growth medium area
Flashing, gravel stops, utilities, or other structures on roof	A		Flashing, utilities or other structures on roof are deteriorating (can serve as source of metal pollution in vegetated roof runoff)	Repair (e.g., recoat) or replace to eliminate potential pollutant source. Note that any work done around flashings and drains should be done with care to protect the waterproof membrane.
Access and safety	B		Insufficient egress/ingress routes and fall protection	• Maintain egress and ingress routes to design standards and fire codes • Ensure appropriate fall protection
Vegetation				
Plant coverage	B		Vegetative coverage falls below 90% (unless design specifications stipulate less than 90% coverage)	• Plant bare areas with vegetation • If necessary, install erosion control measures until percent coverage goal is attained
Sedums	A	A (first 2 years in Spring); As needed (after first 2 years)	Extensive roof with low density sedum population	• Mulch mow sedums- creating cuttings from existing plants to encourage colonization
Dead plants	Fall and Spring		Dead vegetation is present	Normally dead plant material can be recycled on the roof; however, specific plants or aesthetic considerations may warrant removing and replacing dead material (see manufacturer's recommendations).
Trees and shrubs–intensive vegetated roof		All pruning seasons (timing varies by species)	Pruning as needed	All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.
[c] Inspection should occur during plant establishment period (typically first 2 years).
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Table 11 (continued). Maintenance Standards and Procedures for Vegetated Roofs.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Trees and shrubs– intensive vegetated roof		All pruning seasons (timing varies by species)	Pruning as needed	All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
Fertilization– extensive vegetated roof	A		Poor plant establishment and possible nutrient deficiency in growth medium	• Allow organic debris to replenish and maintain long-term nutrient balance and growth medium structure • Conduct annual soil test 2-3 weeks prior to the spring growth flush to assess need for fertilizer. Utilize test results to adjust fertilizer type and quantity appropriately. • Apply minimum amount slow-release fertilizer necessary to achieve successful plant establishment. • Apply fertilizer only after acquiring required approval from facility owner and operator. Note that extensive vegetated roofs are designed to require zero to minimal fertilization after establishment (excess fertilization can contribute to nutrient export)
Fertilization– intensive vegetated roof	A		Fertilization may be necessary during establishment period or for plant health and survivability after establishment	• Conduct annual soil test 2-3 weeks prior to the spring growth flush to assess need for fertilizer. Utilize test results to adjust fertilizer type and quantity appropriately. • Apply minimum amount slow-release fertilizer necessary to achieve successful plant establishment. • Apply fertilizer only after acquiring required approval from facility owner and operator. • Intensive vegetated roofs may require more fertilization than extensive vegetated roofs

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.
[c] Inspection should occur during plant establishment period (typically first 2 years).
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Table 11 (continued). Maintenance Standards and Procedures for Vegetated Roofs.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Vegetation (cont'd)				
Weeds		M (March – October, preceding seed dispersal)	Weeds are present	• Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate • Follow IPM protocols for weed management (see "Additional Maintenance Resources" for more information on IPM protocols)
Noxious weeds		M (March – October, proceeding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	• By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately • Reasonable attempts must be made to remove and dispose of class C noxious weeds • It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions
Irrigation System (or Watering)				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	Follow manufacturer's instructions for operation and maintenance
Summer watering – extensive vegetated roof		Once every 1-2 weeks as needed during prolonged dry periods	Vegetation in establishment period (1-2 years)	Water weekly during periods of no rain to ensure plant establishment (30 to 50 gallons per 100 square feet)
		As needed	Established vegetation (after 2 years)	Water during drought conditions or more often if necessary to maintain plant cover (30 to 50 gallons per 100 square feet)

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).
[b] Inspection should occur during storm event.
[c] Inspection should occur during plant establishment period (typically first 2 years).
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Table 11 (continued). Maintenance Standards and Procedures for Vegetated Roofs.				
Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Irrigation System (or Watering) (cont'd)				
Summer watering – intensive vegetated roof		Once every 1-2 weeks as needed during prolonged dry periods	Vegetation in establishment period (1-2 years)	• Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system not present
		As needed	Established vegetation (after 2 years)	Water during drought conditions or more often if necessary to maintain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	• Identify the cause of the standing water and take appropriate actions to address the problem (e.g., aerate or replace medium, unplug drainage) • Manually remove standing water and direct to storm drainage system • Do not use pesticides or *Bacillus thuringiensis israelensis* (Bti)
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	• Reduce site conditions that attract nuisance species • Place predator decoys • Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" in Bioretention Facilities section for more information on IPM protocols)

[a] Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

[b] Inspection should occur during storm event.

[c] Inspection should occur during plant establishment period (typically first 2 years).

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Equipment and Materials

Table 12 includes recommendations for equipment and materials commonly used to maintain vegetated roofs. Some of the equipment and materials will be used for routine maintenance activities, while other equipment and materials will be necessary for specialized maintenance.

Table 12. Vegetated Roof Equipment and Materials List.

General gardening and landscaping equipment	***Gardening and landscaping materials***
☐ **Gloves**	☐ **Plants/seeds**
☐ **Weeding tool**	☐ **Growing media**
☐ **Soil knife**	☐ **Fertilizer (encapsulated, slow release)**
☐ **Hand tamper**	***Erosion control material****
☐ **Hoe**	☐ **Mulch (intensive roofs)**
☐ **Rake**	☐ **Erosion control matting**
☐ **Push broom**	***Equipment and materials for subsurface or drip irrigation system repairs***
☐ **Buckets**	☐ **Soaker hose**
☐ **Garbage bags (for disposal of noxious weeds)**	☐ **Hose/shower-type wand**
Additional equipment for intensive roofs:	☐ **Sprinklers**
☐ **Pruners**	☐ **Tree watering bags**
☐ **Loppers**	☐ **Buckets**
☐ **Manual edger**	☐ **Water source, if necessary**
☐ **Line trimmer (also known as a string trimmer, weed eater, or weed whacker)**	***Safety equipment***
☐ **Wheelbarrow**	☐ **Fall protection as applicable**
☐ **Shovel**	
☐ **Stakes and guys**	

* Items not required for routine maintenance