

Operations & Maintenance Manual for Stormwater Management at Multnomah Antiques

Site address: 7776 SW Capitol Highway
Associated permit numbers: 10-199939-000-00-CO
Prepared for: Judith & James Tormey



Prepared by:
Sustainability consultant & engineering designer:
Maria Cahill
Green Girl Land Development Solutions
7345 SW 29th Avenue, Portland, OR 97219
503.3348634 greengirl@greengirlpdx.com



Reviewed by:
Engineer of Record: Gary Darling, P.E.
DL Design Group
14025 SW Farmington Road, Suite 270, Beaverton,
Oregon 97005
503.644.4628, gid@dleng.net

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I. Description

Understanding Your Stormwater Management System

This stormwater plan was designed to use resilient, easy-to-see approaches with redundancy to protect against flooding your own property and downstream neighbors in a variety of rainfall events as well as providing the required level of water quality treatment associated with new development in the City of Portland. These systems are easier to maintain than a number of alternatives that might have been allowed during the redevelopment, and *proper maintenance must be applied to ensure that the system continues to work well over time*. Without maintenance, water could back-up into your buildings or overflow to downstream neighbors in greater volumes than flowed there when this area was forested, which would violate Oregon drainage law.

On your re-developed property, you will find the following treatment and conveyance facilities (letters in parentheses correlate to the map):

Roofs (R): The roofs of your buildings generate runoff and convey it over its surface to downspouts.

Downspouts: The downspouts convey runoff to the flow-through basin.

Vegetated flow-through basin (VB): This facility delays and cleanses the runoff from all your roofs, which can have dirt/particulates, feces from birds, nitrogen, mercury, hydrocarbons, and any other pollutants found in air that will become stormwater pollutants every time it rains. Treatment of these pollutants occurs in the vegetated basin through three processes:

- Settling: Large particles will settle out of the stormwater as it ponds.
- Physical filtration: Smaller particles and some heavy metals are filtered in the first 12" of the soil as water passes through it.
- Microbial remediation: Hydrocarbons from smog and oils are "eaten" (i.e. decomposed) by microbes as the water passes through the soil.

As you can see, two out of the three means of treatment are a result of the water passing through the soil. In addition, plants play a crucial role these systems:

- The structure of the plant helps the water slow down to settle out more dirt.
- The roots of the plants provide robust habitat for microbes, which attach and multiply like crazy on the roots because the plant is pulling up the polluted water (microbe food) through roots
- Larger soil animals, like worms and nematodes, that protect against clogging by naturally aerating the soil will be more numerous where there are plant roots than where there are not.
- Plant roots hold soil to prevent it from polluting stormwater runoff.

Unfortunately, settling, soil, and plants don't do a great job of removing soluble pollutants including nitrogen, phosphorus, and heavy metals including zinc and copper. Prevention methods to manage stormwater for these pollutants are included here.

Because the vegetated basin is up against the building, this facility must be lined to protect the foundations. Since it must be lined, there must be a perforated pipe at the bottom to collect the water that flows through the soil so that the facility doesn't get waterlogged and kill all the plants. Only the first part of a storm is dirty, so overflows that don't pass through the soil are clean. Don't worry!

Berms (B): There are 2 berms that are vegetated and serve as weirs where stormwater slowly spills over after ponding: one underneath the bridge that causes water to pond for treatment before allowing excess runoff to pond to such a depth that it passes into the additional storage (aka rock moat) and one on the southwest side of the vegetated basin that overflows when both the vegetated basin and additional storage are full. These are vegetated because plants are a low maintenance, natural way to hold soil in the face of potentially erosive flows (i.e. flows that might loosen and carry sediment.)

Additional storage (AS): The additional storage (aka the moat) is not vegetated

because plants can't be easily sustained in so much shade underneath the bridge. The additional storage is lined with rock on the surface that you can see and is lined underneath with the same impermeable liner that's underneath the vegetated basin, to protect your buildings from water damage. Water flows through the rocks and slowly into the soil that's underneath the vegetated weir into the soil of the vegetated basin and finally into the perforated pipe mentioned above.

Vegetated conveyance swale (CS): This is a 3' wide, shallow, vegetated "half-pipe" to convey stormwater from the rain garden and additional storage. By the time water reaches this facility, it should be clean, so any sediment that you find at the bottom of this will probably be from bare spots in the swale itself. This facility is also has a liner about 12" below the surface (the minimum depth of soil needed to grow grasses & flowers).

Perforated pipe (PP, DP): The perforated pipe from the vegetated basin daylight (i.e. "sees" the light of day) about 1/3 of the way down the swale where there should be a pile of rocks protecting it from UV radiation. There's another short perforated pipe starting at the bottom of the conveyance swale that drains whatever water collects and ponds at the weir wall (see below) to the V-shaped channel. This pipe is adequately protected from UV light by the finish grades of the soil and piling rocks here will cause water to back up in the V-shaped channel. (There are other perforated pipes around your foundation to drain groundwater, which shouldn't required any maintenance, but if they do, refer to guidance that may be provided by the architect, geotechnical engineer, or structural engineer.)

Weir wall (WW): The weir wall is a way for stormwater to transition between the vegetated component of its flow path and the V-shaped channel. (We would've liked to use a vegetated conveyance swale all the way down to the street, but this would put the perforated pipe at the low point of the site with no way to daylight stormwater to the street.) This wall settles out any dirt and mulch that might have gotten loose and accumulated at the bottom of the swale.

V-shaped channel (VC): The channel conveys runoff that overflows the weir wall, seeps out of the perforated pipe, and drains overland from the driveway.

Solid pipe (SP): The solid pipe is a way to transition between the v-shaped channel and the trench drain.

Trench drain (TD): The trench drain is a way to keep the runoff high so that we can finally drain it to the street at the bottom of the curb and to provide adequate drainage. The trench drain has a solid lid on it and it is used for conveyance through it only, and is not needed to drain the public sidewalk it passes through.

Asphalt driveway (AD): The asphalt driveway generates and conveys runoff. Since this runoff is polluted with all the stuff you might find on your roof plus anything that comes off your car, we designed this to drain to the vegetated filter strip.

Vegetated filter strip (VFS): This strip of landscape area receives overland (aka sheet) flows (versus the concentrated flows you see in your swale and channel) from the asphalt driveway. This strip has been amended with compost and planted to provide some sediment capture. Since the driveway isn't heavily traveled, maintenance activities to remove accumulated sediment shouldn't really be needed for a while.

Landscape areas (L): Landscape areas can be a significant source of pollution. Fertilizers, pesticides, herbicides, fungicides applied during "routine maintenance", and soil from bare spots can easily run off and enter our streams.

Vegetated wall (VW): This wall was designed to sustainably manage groundwater seeps that might flow to neighboring properties without needing a perforated pipe at the bottom that would trigger an expensive sewer extension in SW 34th. The plants play an important role in holding soil/preventing erosion.

Table identifying each stormwater facility, its size, the stormwater source to each facility, square footage treated, and discharge point.

See table on page 2 of Form 2, Operations & Maintenance, attached.

Identification of who will assume responsibility for ongoing operations.

Owner. See Form 2, Operations & Maintenance, attached, except for trench drain, which is in the public ROW. Owner will be responsible for keeping it clear of debris only.

Specific location of stormwater facilities.

See Figure 1, Site Map.

II. Schedule

Maintenance schedules are more of an art than a science, so keep a close eye on your system for the first two years to get a feel for when some activities might need to be done more often than these minimum suggestions. The Portland Stormwater management manual recommends: "For at least the first 2 years, inspections should be conducted with the facility drawings and the O&M Plan in hand to help the inspector understand how the facility is supposed to function. The O&M Plan will help the inspector recognize signs that indicate diminished performance (for example, sediment accumulation, vegetation die-off, or ponding water for more than 48 hours after a storm)."

Inspection Schedule: When and how often facilities will be inspected

According to the Portland Stormwater Management Manual, facilities must be inspected at least:

- Quarterly for the first 2 years
- Twice a year thereafter
- Within 48 hours of major rainfall events (more than 1 inch of rain over a 24-hour period)

Additional periods on the Inspection and Maintenance Form are:

- monthly
- once a year at a minimum
- as needed, which may mean very frequent or very infrequent depending on the situation and your own observations.

Watering Schedule: How-to establish your entire landscape

Since every plant on the site will reduce erosion by softening the blow of raindrops on soil and evaporate water from the soil, every plant on the soil can be considered an important part of the stormwater management strategy of the site, regardless of where it's located. This watering schedule applies to all the new plants on-site. To reduce irrigation and potential failures associated with trying to get plants established during the summer, planting will be done in the fall, after September. No irrigation will be needed until the following year, which is the First Year, in the discussions below.

Watering will be performed by watering truck service. Most of the site is accessible by a driveway. The company will have to drag a hose up to the vegetated basin to water it and the vegetated conveyance swale.

The rest of the guidance on spot watering has been adapted from Seattle Public Utilities documents *Practically Easy Landscape Maintenance* and *Landscape Maintenance Calendar & Guide*.

How to Water

"Run a hose at the base of a plant - uphill side is best -- or into a 2 to 5 gallon bucket with holes in the bottom! Use a garden soaker or shower-type wand (not a spray nozzle!) on the hose end to spread out the flow and reduce erosion. Turn the hose on softly (enough to fill a bucket to the 2 gallon/8 liter mark in 1 minute or so) and let it run for 30 seconds to 5 minutes (1/2 to 10 gallons), depending on the plant type and size. Spot watering takes more time, but really helps establish trees and large shrubs, which need more water to reach larger, deeper root systems, or to rescue drought-stressed plants at any time. Deep, infrequent watering that moistens the top 12 to 18 inch root zone is recommended to keep

plants alive and healthy and to promote deep roots. Deep roots help plants be drought tolerant. To know you're giving plants enough water, dig down an hour or so after watering to see if the top 12 to 18 inches of soil is moist. If not, add watering time until at least the top 12 inches is moistened."

Follow these additional recommendations for how to water:

- "Water deeply & infrequently, in morning or evening. Water evaporates during midday heat.
- Water where roots are: top 12-18 inches of soil for trees, shrubs, ground covers and perennials/annuals, and top 4 -6 inches for lawns.
- Plants are installed with a watering basin or saucer, a small earth berm or donut formed around each plant to hold water at its base. Keep watering basin intact, particularly for the first year!
- Do "pulsed" watering. Water 2 days in a row, or morning & evening on 1 day. Like a damp sponge, already moist soil allows more water to absorb deeper into the ground.

- Drill or poke holes into the bottom of a 5 gallon bucket. Put at the base of a tree or shrub, fill and let drain slowly into soil. Water 5-10 gallons per tree, and 3-5 gallons per shrub.
- Use soaker hoses and spot watering to water planting beds, instead of garden sprinklers and hand spraying. Drip irrigation systems apply water to individual plants and are water efficient but more complicated and expensive to properly design and install.
- Use a timer – either on the hose itself for soaker hoses, or a kitchen timer or stop watch for spot watering.
- For the first three years, deeply water plants once every 7 to 14 days in hot, dry weather. Small plants and flowers may need more frequent watering in hot weather – up to twice a week.
- Watch for stressed plants. When leaves wilt and don't perk up overnight, or evergreen needles start to fade, it's time to water!"

When to Water & How Much for Years 1 - 5

If a watering service is only be engaged for the first 2 years/summers of plant establishment, watering will be done by owner. Regardless of who is responsible, the following table is a recommended schedule:

Table 1: Watering Schedule

Months	Watering Guidance
Mar, Apr, & May	Year 1 through Long-term: If unusually hot dry weather causes plant to wilt, then water like it's SUMMER.
Jun, Jul & Aug	Year 1: see "Year 1 Watering Schedule for Summer" Years 2 – 4: During hot, dry periods, deep water stressed trees and shrubs every 2 weeks and groundcovers & flowers every 7 – 10 days Long term: Deep water stressed plants only.
Sept & Oct	Years 1 – 5: If rain soaks 12 – 18 inches deep, do nothing. If not, deep water plants, especially evergreens, to help plants resist drying from winter sun & wind. Long term: None usually needed.
Nov, Dec, Jan & Feb	No need to water ever during these months.

Table 2: Year 1 Watering Schedule for Summer

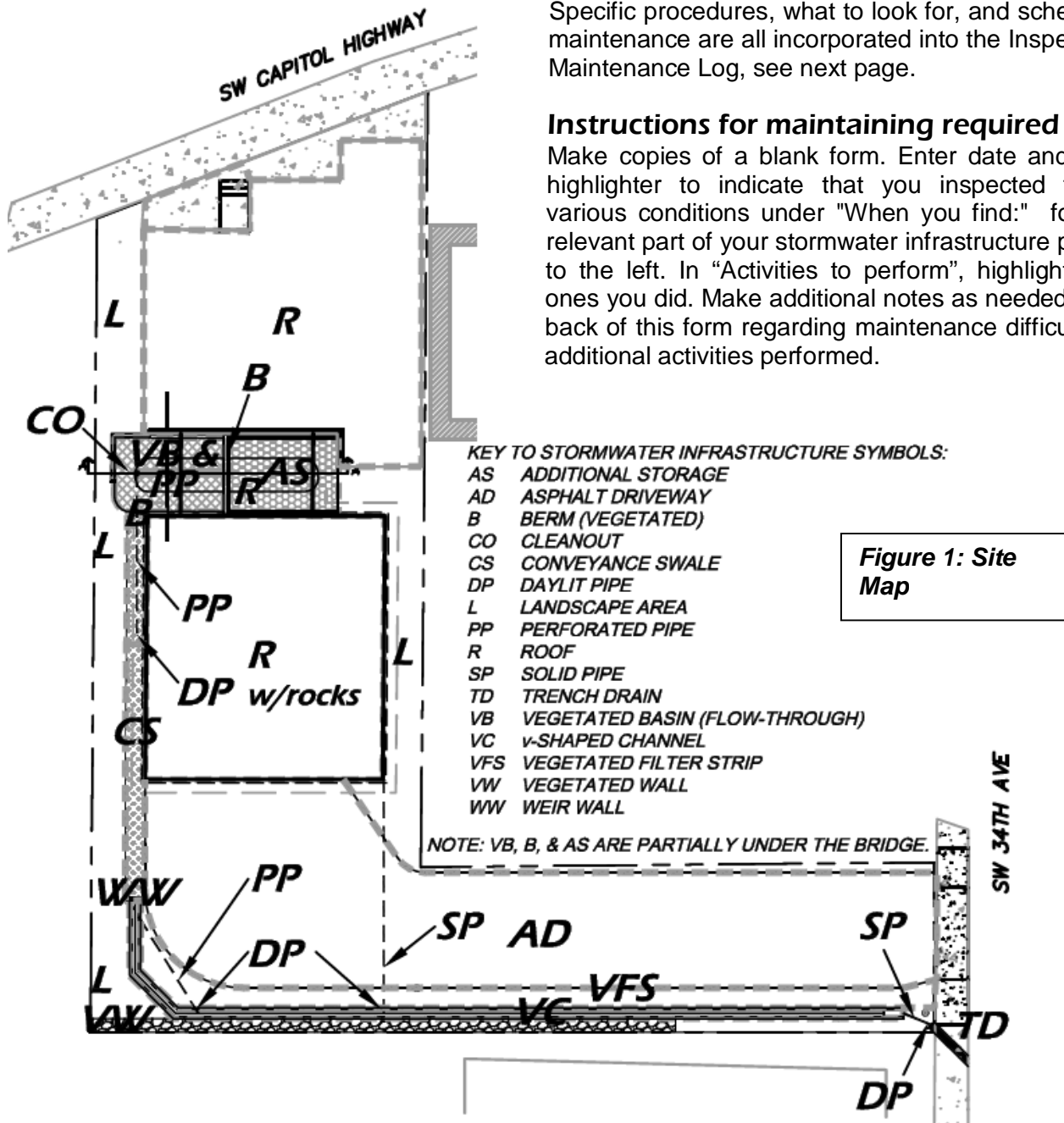
Plant Type	Amount of Water [gal]	Time for Spot Watering (at approx. 2 gal/min) [min]	Frequency for Year 1 [per week]
Tree	5 - 10	2.5 - 5	Once
Shrub	3 - 5	1.5 - 2.5	Once
Groundcover	1 - 2	0.5 - 1	Once or Twice
Perennial/Annual	½	15 - 20 seconds	Twice

III. Procedures & Inspection & Maintenance Logs

Specific procedures, what to look for, and schedule of maintenance are all incorporated into the Inspection & Maintenance Log, see next page.

Instructions for maintaining required logs

Make copies of a blank form. Enter date and use a highlighter to indicate that you inspected for the various conditions under "When you find:" for each relevant part of your stormwater infrastructure pictured to the left. In "Activities to perform", highlight which ones you did. Make additional notes as needed on the back of this form regarding maintenance difficulties or additional activities performed.



Multnomah Antiques Inspection & Maintenance Form

How to Use This Form: Make copies of this blank form. Enter date and use a highlighter to indicate that you inspected for the various conditions under "When you find:" for each relevant part of your stormwater infrastructure. In "Activities to perform", highlight which ones you did. Make additional notes as needed on the back of this form regarding maintenance difficulties or additional activities performed.

Date: _____ Inspector Name: _____

Stormwater Infrastructure Components

as shown on map in Operations & Maintenance Manual. Highlight or circle each of the items with a Maintenance Frequency Key below to indicated you inspected them.

Maintenance Frequency Key:
 48 = within 48 hours of a major rainfall event (more than 1" of rain over a 24-hour period)
 M = monthly
 Q2 = quarterly for the first two years, and twice a year thereafter
 1 = at least once a year
 AN = as needed

Additional Storage	Asphalt Driveway	Berm	Cleanout	Conveyance Swale	Daylit Pipe	Gutter	Landscape	Perforated Pipe	Roof	Solid Pipe	Trench Drain	Vegetated Basin	V-Shaped Channel	Vegetated Filter Strip	Vegetated Wall	Weir Wall
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Activities to perform:	When you find:	AS	AD	B	CO	CS	DP	G	L	PP	R	SP	TD	VB	VC	VF	VW	W	
Proper Functioning of Stormwater Sytem																			
Rakes and/or shovel out accumulated sediment. Avoid damage to existing vegetation. If sediment is deep, plants may need to be removed in order to excavate sediment.	Sediment depth more than 3" or vegetation is buried by sediment.	Q2		Q2										Q2					
Shovel or scoop out accumulated sediment. Avoid damage to existing vegetation.	Sediment depth more than 1" or vegetation.					Q2	Q2						Q2		Q2	Q2			Q2
Reseed and/or replant and mulch disturbed areas to prevent erosion.	Bare soil.	Q2		Q2		Q2			Q2					Q2		Q2	Q2	Q2	Q2
Replace vegetation with a native plant at the same density shown on the landscape plans in the late fall or early spring so plants can establish during cool, rainy season. Replant	Vegetation appears unhealthy or has died.					1			1					1		1	1		
Pull plants by hand. Avoid using fertilizers, herbicides, or pesticides. Remove nuisance and invasive vegetation such as Himalayan blackberry, English ivy, and reed canarygrass before it goes to seed in the spring. Do additional weeding in the fall. A list of nuisance plants can be found in the Portland Plant List.	Nuisance or invasive plants (aka weeds) are present.	Q2		Q2		Q2		Q2	Q2				Q2	Q2	Q2	Q2	Q2		

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Immediately remove vegetation that is clogging or impeding flow into the facility by removing entire plant and replacing with something more suitable or pruning. Remove potentially large and deep-rooted trees or bushes when they might impede the flow path or compromise facility structures.	Vegetation is compromising the facility's structure by blocking inlets or outlets, or roots are intruding into a component of the facility.	Q2		Q2		Q2	Q2				Q2	Q2	Q2	Q2	Q2	Q2
Remove dropped leaves and debris.	Dropped leaves and other debris are contributing to sediment accumulation or are blocking water from flowing as intended.	Q2	Q2	Q2	Q2	Q2	Q2				Q2	Q2	Q2	Q2		Q2
Use clean, weed- and pollutant-free mulch to inhibit weed growth, retain moisture, and add nutrients. Replenish when needed. Ensure that mulch does not inhibit water flow in the flow path.	Compost mulch has decomposed such that there is less than 1" of material to protect soil.						1									
Irrigate plants.	For the first 2 years and when plants look dry or are drooping in Jul, Aug, & Sep			AN			AN					AN		AN	AN	
Walk the site before you do maintenance. Look for nests, burrows, and animals in the facility. Reroute around animal areas by at least a few yards.	Birds and other wildlife.	AN		AN	AN		AN					AN		AN	AN	
Rake or otherwise carefully move rocks back in place.	Rocks moved out of place by water flows.	48			48							48				

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Prevent ponding water by removing sediment and aerating soil as discussed in this column of activities to perform in addition to cleaning out your gutters. Do not apply pesticides!	Mosquito larvae in any system with open, slow, or non-moving waters, especially during warmer weather. (Larvae look like tiny wiggling sticks floating perpendicular to the water's surface.)	1			1	1	1	1			1	1	1	1	1	
You may choose to do nothing outside of the VB, AS, & CS. Burrowing animals are good for your soil and may not damage your plants. In the VB, AS, & CS, remove debris that may be providing shelter, block up any areas in building where animals appear to be sheltering, and fill in burrow holes with dirt and revegetate.	Nutria, rat, and other animal droppings year round. Also check for structural indicators such as rodent holes and burrows.	Q2		Q2			AN					Q2		AN	AN	
Perform maintenance activities when it's not raining or fix hazard with mechanical means.	Slipping hazards.		AN													
Always make sure that appropriate safety gear (e.g., harness, gloves, face shields, safety line) is used.	Hazardous conditions or jobs such as climbing ladders.	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
Inspect point at which stormwater daylight and unclog them by mechanical, not chemical, means. The perforated pipe under the vegetated basin is accessible via a cleanout.	Clogged pipes.			Q2	Q2			Q2		Q2	Q2					
Throw out trash & debris.	Trash & debris.	M	M	M		M	M	M	M		M	M	M	M		

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<p>Identify the source of trash, debris, or pollutants, such as a spill, leak, or illicit discharge. Store hazardous material under cover. Ensure garbage bins are closed on solid waste containers. If there is evidence of a spill or leak, contact a professional laboratory or sampling firm to assess whether the material needs specialized removal, treatment, and disposal. Use trained professional staff for any cleanup and remediation.</p>	<p>Unusual or unpleasant smells from sources, such as natural plant decay or algae, a spill or leak (e.g., gasoline or sewage) or visible pollution, such as sheens, turbid (cloudy) water, access, discoloration, other pollutants on the surface of the water.</p>	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN	AN
Pollution Prevention																
<p>Cover solid pipes back up with soil or asphalt, whichever used to be there. In the case of the solid pipe under the driveway, cover is necessary to protect the structural integrity of the pipe, so hire a professional to fix this.</p>	<p>Exposed solid pipes.</p>									AN						
<p>Sweep paved areas on the property regularly.</p>	<p>Excessive dust and dirt.</p>		Q2													
<p>Keep materials, trash bins, and other sources of pollution covered. Don't stockpile materials in stormwater treatment or conveyance areas.</p>	<p>Chemical and waste storage areas exposed to rainfall and runoff.</p>	AN	AN				AN		AN		AN	AN	AN	AN		
<p>Use erosion control measures such as biobags (available at Parr Lumber). Consult a professional if you don't know how to prevent erosion during periods of where soil is bare because plants are establishing.</p>	<p>Do not let water from washing vehicles or equipment drain to the stormwater facility.</p>	AN	AN	AN			AN				AN	AN	AN	AN		

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Remove moss with mechanical means such as light scraping. Don't power wash, apply zinc or copper based chemicals or other fungicides. On areas other than your roof, you may do nothing. Remove moss on your roof according to your roofing manufacturer guidance.	AN	AN						AN		AN							AN
Don't use coal-tar based asphalt sealants.		AN															
Refer to the full Operations & Maintenance Manual for additional information.	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2	Q2



7345 SW 29th Avenue Portland, OR 97219
 p 503.334.8634
 f 503.892.2321
 greengirl@greengirlpdx.com
 www.greengirlpdx.com

This maintenance form was created by Maria Cahill of Green Girl Land Development Solutions for Multnomah Antiques at 7776 SW Capitol Highway, Portland, OR. Do not use this maintenance form for other sites. Feel free to contact me with questions.

Additional Information & Notes:

IV. Additional Resources

Catch basin cleaning, material handling, and other best management practices:

Bureau of Environmental Services, Industrial Stormwater Section
www.portlandonline.com/bes/index.cfm?c=34618

Hazardous waste:

DEQ 503-229-5913, email hw@deq.state.or.us,
www.deq.state.or.us/wmc/hw/hw.htm

Sediment removal:

Look in yellow pages under “Sewage” or “Waste Disposal.”

City of Portland resources:

Naturescaping courses, native and invasive plant posters:
www.portlandonline.com/bes/index.cfm?c=dcbec

Portland Plant List (native and nuisance plants)

www.portlandonline.com/shared/cfm/image.cfm?id=58951

Plant identification:

Native Plant Society: 503-460-3198
www.npsoregon.org/

Master Gardeners:

www.orst.edu/extension/mg/

Native plant nurseries:

Plant Native: www.plantnative.org

Rats and mosquitoes:

Multnomah County Vector Control
Online: www.mchealth.org/vector
Phone: 503-988-3464
email: vector.nuisance@co.multnomah.or.us

Other wildlife:

Oregon Department of Fish and Wildlife
Online: www.dfw.state.or.us/wildlife/
Main Phone 503-947-6000 or
800-720-ODFW (6339)

Confined space entry:

OR-OSHA (confined space entry requirements)
503-229-5910
www.orosha.org/subjects/confined_spaces.html

Asphalt Maintenance:

Use an alternative to coal tar driveway sealants. Use any one of these alternatives to coal tar asphalt sealants: http://www.ci.austin.tx.us/watershed/coaltar_altproducts.htm.

Paying for Maintenance

Specific maintenance costs depend on the characteristics of the facility, the site, and the area draining to the facility. The general rule of thumb is that annual maintenance costs will be 5 to 10 percent of the facility's total capital cost. Routine, scheduled maintenance can help keep overall costs down by addressing problems before they require major attention.

Financing Maintenance

Clearly designate the entity responsible for long-term operations and maintenance. Determine how to finance maintenance needs. A facility maintenance fund is recommended 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). For homeowner associations, this could be a portion of homeowner fees or a specific assessment.

How Much to Save

- An average of 5 to 10 percent per year of the facility's capital cost for annual routine maintenance.
- A percentage of the non-routine maintenance costs per year (e.g., for sediment removal, vegetation replacement), based on the needed frequency. For example, if the facility is designed to need mechanical sediment removal every five years, 20 percent of the total cost should be put aside each year.
- An additional 3 to 5 percent of the facility's capital cost per year for eventual facility replacement (based on the facility's life expectancy). Most of these facilities have a life expectancy of 25 to 50 years.

Vegetated Facilities

- Most required routine maintenance (excluding major repair and replacement) is estimated to have an annual cost of \$200 to \$600 dollars per acre of facility, above current landscape maintenance costs. Costs can vary, depending on the types and level of maintenance practices used.
- The cost and intensity of maintenance activities are usually higher during the 2-year plant establishment period. During that time, plants will need additional watering, and plants that die will need to be replaced.