



Natural Drainage Practices Maintenance Guidelines

INTRODUCTION

"Low impact development (LID) is a stormwater management strategy that emphasizes conservation and use of existing natural site features integrated with distributed, small-scale stormwater controls to more closely mimic natural hydrologic patterns in residential, commercial, and industrial settings."

Puget Sound Action Team 2005. Low Impact Development Technical Guidance Manual for Puget Sound, Washington State University Pierce County Extension.

Stormwater management can have substantial effects on the surrounding habitats and ecosystems. Bellevue's Natural Drainage Practices employs LID stormwater management controls that are dispersed throughout a site in order to manage, reduce, and treat stormwater. The goal is to reduce stormwater impact on Bellevue's environment and more closely mimic natural hydrologic processes.

Rain gardens, bioretention areas, amended soils, vegetated roofs, cisterns, porous pavement and pavers are all stormwater treatment systems that require regular maintenance to sustain their designed performances. These devices can reduce the area of impervious surfaces, the volume of stormwater runoff, sediment levels, and pollutants. They can also reduce the rate of runoff, contributing to a cleaner stormwater system, and further downstream, a healthier ecosystem.

Consistent maintenance is essential to ensure that the systems are efficient, long-lasting, and the prescribed performance levels (desired outcomes) are being achieved. In addition, regular inspection and maintenance regimes can assist in decreasing the chance of site flooding and ground water pollution. Regular maintenance, as with most things, is critical and is a smart and cost-saving practice over time. This document should be considered a guide to help ensure the performance and operations of a Natural Drainage Practices stormwater treatment system. It is designed to be used by Bellevue Inspectors or customized for use by private landowners.





Natural Drainage Practices Maintenance Guidelines

RAIN GARDENS AND STORMWATER PLANTERS

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Images	Notes
U-1-M1 Observation Ports		
<ul style="list-style-type: none"> Visually check observation ports at least two times per year. Check observation ports after 1-inch of rainfall in 24-hour period and record water level. 		<ul style="list-style-type: none"> Remove cap of observation port. Measure depth between observed water level and top of lid for port. Replace cap securely when done. Keep a record of measurements (including date) in maintenance log. Check O&M Manual for minimum distance between top of observation port and water surface level during dry and wet weather. During rainy weather, ponding will occur in the rain garden and the water level will rise. After the rain event is over, the water level at the observation port should drop as the water drains out. If water does not drain out of the observation port after 72 hours after the rain event has ceased, or ponding at surface does not dry out in 48 hours, then the rain garden system requires remediation. See "Ponding" in section on <i>Triggered Maintenance for rain gardens</i>.
U-1-M2 Inspect Inflow and Outflow Points for Clogging		
<ul style="list-style-type: none"> Monthly and as needed during wet season. 		<ul style="list-style-type: none"> If observed, remove sediment at surface, in pre-settling areas and at storm structure outfalls. Remove any accumulated debris from inflow/outflow points (curb cuts, pipes, trench drains, storm structures, etc.). Remove any vegetation that has grown around/blocking grate of storm structure or curb cut.



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Recommended Frequency	References and Images	Notes
U-1-M3 Cleanouts and Underdrains (if used)		
<ul style="list-style-type: none"> Visually check cleanouts and discharge points of underdrains pipes annually to determine if cleaning is necessary. 		<ul style="list-style-type: none"> Jet clean or rotary cut debris/roots from underdrains so that standing water is not present in pipes during dry weather.
U-1-M4 Watering During First and Second Growing Seasons		
<ul style="list-style-type: none"> In the first 6 weeks, plantings will require approximately 1 - inch of water twice per week to establish deep roots. After watering, confirm the soil is moist 3 to 6 inches below surface. Reduce watering frequency to once a week until the end of the first growing season (May-Sept). The second growing season will require approximately 1 inch of water once per week. 	<p>See WSU Pierce County Extension Rain Garden Handbook for Western Washington Homeowners for watering tips and schedule: http://www.pierce.wsu.edu/Water_Quality/LID/Raingarden_handbook.pdf</p> <p>See Watering to Establish your new Plant: http://www.ci.mercer-island.wa.us/Files/Watering%20Your%20New%20Plants.pdf</p>	<ul style="list-style-type: none"> Intent of watering is to keep plant material sustained through establishment. Monitor rainfall to determine irrigation/watering schedule. Water regularly during the first two growing seasons. Dry periods will need additional watering for establishing plants due to warmer temperatures and increased sunlight both of which can stress vegetation. Wilted leaves and drooping stems are all indications of stress caused by dry soils and hot temperatures. Optimal watering time is early in the morning or late in the evening to reduce evaporation. A preferred watering approach is to have repeated short cycles of watering and soaking into the ground. Follow manufacturer's guidelines for operations and maintenance of irrigation system and its components.



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U-1-M5 Dry Period Watering for Established Rain Gardens

<ul style="list-style-type: none"> Water infrequently but thoroughly: 1/2-inch to 1-inch every 2 weeks or when plants appear stressed. Monitor rainfall and check weather updates and adjust watering accordingly. 	<p>See Natural Lawn and Garden Handbook, Healthy Landscapes for a Healthy Environment - Smart Watering: http://www.ci.bellevue.wa.us/pdf/Utilities/Smart_Watering.pdf</p> <p>See The Plant List - A Companion to the Choosing the Right Plants Natural Lawn & Garden Guide: http://www.savingwater.org/docs/plantlist.pdf</p> <div style="text-align: center;">  </div>	<ul style="list-style-type: none"> Established (over 2 years) drought tolerant plants may need water during prolonged dry periods (possibly late July to mid-September). Inspect plantings during dry periods and look for signs of stress. Verify if any watering restrictions are in effect in the City for watering during dry periods/water shortages. If no restrictions, then note the following: Optimal watering time is early in the morning or late in the evening to reduce evaporation. Monitor rainfall to determine an irrigation schedule. Do not apply water faster than the soil can absorb it. Deeper and less frequent watering will encourage plants to develop a deep root system. If present, inspect irrigation system components for breaks and blockages and repair as necessary.
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U-1-M6 Leaf, Branch, and Organic Matter Removal

<ul style="list-style-type: none"> Inspect weekly for organic matter or debris that is blocking inflow points or structures and causing ponding of water. Schedule weekly leaf removal in fall. Bi-weekly mowing will be required from spring through mid July for turf raingardens. Monthly mowing will be required July through mid November for turf raingardens. 	<p>See Ecologically Sound Lawn Care for the Pacific Northwest - Integrated Pest Management: Preventive Health Care for Lawns (pages: 42-49): http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/ecological_200312021255394.pdf</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center; font-size: small;">Raingarden study SPU On-Call 04006</p>	<ul style="list-style-type: none"> To prevent clogging, larger pieces of biodegradable landscape debris should be mulched or collected for composting, green waste pick up, or disposal to a recycling facility. Maintaining a minimum height of 4 - inches for turf grass within rain gardens (turf) will reduce weed invasion and encourage deep root growth which strengthens drought resistance. Mow with a mulch mower. Sharpen mower blades frequently to reduce ragged cutting. A thick layer of leaves, branches, and trash can prevent water and light from getting to lawn and other landscaped areas. <u>Excessive</u> leaf litter around plantings can provide cover for pests and allow mildew growth. Mulching organic matter (leaves) is recommended to facilitate decomposition for both turf and vegetated raingardens.
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U-1-M7 Trash and Debris Removal

<ul style="list-style-type: none"> Remove trash and debris. Inspect after large storm events (~over 1-inch of rainfall in 24 hours or heavy downpour). 		<ul style="list-style-type: none"> Collect and properly dispose of trash/litter. Pet waste is a serious concern and should not be left within a rain garden as it contains disease-causing organisms and flushes bacteria into the stormwater.
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U-1-M8 Pruning and Removal of Dead Material

<ul style="list-style-type: none"> In Spring, remove dead or old plant material from previous season. Mid summer and fall, inspect and cut back any plant material that blocks sidewalks and utilities. In fall, prune to maintain plant appearance. 	<div style="display: flex; justify-content: space-around;">   </div> <p style="margin-top: 10px;">See Plant Amnesty Pruning Guide: http://www.plantamnesty.org/pruning_guides/pg_northwest_pacific_maritime.htm</p>	<ul style="list-style-type: none"> Trim and thin vegetation from prior season's growth, leaving 6 to 8 -inches. Allow dormant vegetation and old flower stalks to remain in winter to provide food and cover for birds. For early blooming shrubs/trees, prune in spring following bloom. Plants may require pruning, pinching, and dead heading during the growing season to promote reflowering, direct growth, etc. Native and/or ornamental grasses may appear dead but generally these plants are dormant during the winter months. Do not remove, prune dry material in spring as new material emerges. If appear dead in mid-summer, remove and replace. Keep water inlets and outlets clear. Reduce shading of under-story plants if they require sun.
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U-1-M9 Weed Control of Invasive Vegetation/ Weeds

<ul style="list-style-type: none"> Remove as soon as observed. During three year establishment period, inspect at least once per month in growing season. Inspect at least three times per year once plants are established. 	<div style="display: flex; align-items: center;">  <div style="margin-left: 10px;"> <p>Invasive vegetation negatively impacts the health of landscaped areas by competing for sunlight, water, and nutrients, and should be kept under control.</p> <p>See WSU and King County Noxious Weeds Information at: http://gardening.wsu.edu/text/weed.htm http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds.aspx</p> </div> </div>	<ul style="list-style-type: none"> Pay special attention to nuisance and invasive vegetation before it establishes a foothold. Particular threats to wet areas are reed canary grass and Japanese knot weed. Other threats include clover, scotch broom, horsetail, morning glory, alder seedlings, English ivy, and blackberry. Watch for any signs of these plants and remove them, including root system. See following section "Weed Control of Non-Invasive Vegetation and Weeds" for additional information. Persistent and invasive vegetation that is located in a mass can be killed by covering the area with black plastic for several weeks during summer.
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U-1-M10 Weed Control of Non-Invasive Vegetation/ Weeds

- Inspect the full bed and remove weeds February, June and September.
- Minor weeding monthly.
- See mulch section of this manual for more information to reduce weed establishment.



Weeds negatively impact the health of landscaped areas by competing for sunlight, water, and nutrients, and should be kept under control.



Photos from City of Seattle

See the Natural Lawn & Garden Natural Pest, Weed and Disease Control for more information:

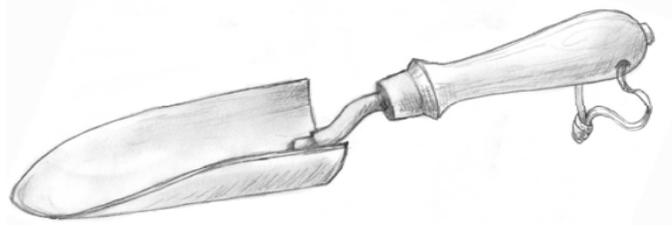
http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/naturalpe_200311261701589.pdf

Please refer to the King County Hazardous Waste - Natural Lawn care and IPM:

<http://www.govlink.org/hazwaste/house/yard/lawn/chemicals.html>

See Washington State University - Hortsense for additional information: <http://pep.wsu.edu/hortsense/weedmanage.html>

- Remove weeds manually before they go to seed by using pincer-type weeding tools, hoes, flame weeders, or hot water weeders. Remove the roots for best results.
- Weeds should be pulled when first observed and especially before they go to seed.
- Weeds need to be pulled in early spring so that the desired plants can thrive.
- Mulch immediately (no more than five days) following weeding to improve weed control.
- When dealing with invasive plant material/weeds, attempt all other physical methods to remove before considering a more aggressive method.
- It is important to note that chemicals can harm or kill beneficial or desirable plants, and also add pollutants to stormwater that can negatively impact water quality.





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U-1-M11 Bare Spots and Vegetation Removal and Replacement

<ul style="list-style-type: none"> Inspect for bare spots and areas of disturbed vegetation every 6 months. 	<div style="text-align: center;">  </div> <p style="text-align: center; margin-top: 10px;"> See Saving Water Partnership Plant List at: http://www.savingwater.org/docs/PlantList.pdf See King County Native Plant Resources at: http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden/native-plant-resources-nw.aspx </p>	<ul style="list-style-type: none"> Plants may die due to unsuitable conditions or microclimates, disease, pests, or other unforeseen issues. These plants must be removed/replaced to avoid the establishment of weeds in bare areas, the spread of disease, and the reduction in functionality. Reseed or replant bare areas and replace poor performing plants. Vegetation should cover 90% of rain garden. Replace vegetation with in-kind planting material or replace plants with high mortality rate with appropriate plants. Maintain 1- foot zone clear of vegetation around all inlets and outlets. Plants may be dormant during winter. Apply mulch to bare spots during winter and wait until spring to determine if plants need to be replaced.
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U-1-M12 Mulch

<ul style="list-style-type: none"> Add wood chip mulch in fall and/or spring. Replace or add wood chip mulch as needed to maintain 2 to 3 -inches depth. 	<div style="text-align: center;">  </div> <p style="text-align: center; margin-top: 10px;">Photo from City of Seattle</p>	<ul style="list-style-type: none"> 1 cubic yard of mulch will cover 100 square feet at a depth of 3 -inches. 1 cubic yard = 27 cubic feet. Commercial mulch products generally are available in 2 cubic foot bags. 13.5 bags = 1 cubic yard. Wood chip mulch helps to control weeds, conserve soil moisture, improve filtration, regulate soil temperatures and adds nutrients to the soil as it decomposes.
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U-1-M13 Sediment Removal		
<ul style="list-style-type: none"> Late fall and late spring. After heavy downpour and rain events of 1-inch or more precipitation in 24-hour period. 	 <p>Sediment will impact the ability of the water to be absorbed into the soil and can lead to standing water and/or slow draining rain garden/ stormwater planter. Remove sediment to maintain absorption and filtration into the underlying soils.</p>	<ul style="list-style-type: none"> If over 2-inch accumulation, remove sediment preferably when the rain garden/ stormwater planter is dry. Remove sediment manually, using shovels or rakes. Dispose of sediment in accordance with local requirements. Replace damaged or destroyed vegetation with in-kind plant material. Immediately try to determine source of sediment, regrade as necessary and stabilize area with vegetative cover. Place cobbles at inflow points, if necessary.
U-1-M14 Fertilizers		
<ul style="list-style-type: none"> Fertilizers should not be applied to a rain garden or stormwater planter. 	 <p>See The Natural Lawn and Garden Growing Healthy Soil for more information: http://www.ci.bellevue.wa.us/pdf/Utilities/Healthy_Soil.pdf</p>	<ul style="list-style-type: none"> Fertilizers wash off and pollute groundwater, streams, and other bodies of water. If additional nutrients are necessary, blend compost into soil to increase nutrients. Excessive fertilizing can produce weak plants that can lead to pest outbreaks and higher rates of disease. Rain garden soil mixes are rich in nutrients and when used with native plants or plants adapted to this region, fertilizers are not needed. Soil testing will indicate if soil is nutrient deficient. Additionally, the mulch layer contributes organic matter to the soil. Document fertilizer use in maintenance log.



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Recommended Frequency	References and Images	Notes
U-1-M15 Pesticides		
<ul style="list-style-type: none"> See references. 	<p>See King County Native Plant Resources at: http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden/native-plant-resources-nw.aspx</p> <p>Refer to Chapter 2 in the City of Bellevue Parks and Community Services Department's Best Management Practices Manual: http://bellevuewa.gov/pdf/Document%20Library/2006_EBMP_DS_Manual.pdf</p> <div style="display: flex; justify-content: space-around; align-items: center;">   </div> <p style="text-align: center; margin-top: 10px;">Photos from City of Seattle</p>	<ul style="list-style-type: none"> Prevention is the first step when dealing with garden pests. Identify pests before proceeding with any treatment. Creating healthy soils with mulch and compost, choosing drought and pest resistant plants, pulling weeds, and removing diseased/dead plant material all will help in preventing pest infestations. All non-chemical pest control options (physical, mechanical, and cultural) should be employed to keep pest populations low. Consider removing a plant that continues to require pest management tactics to avoid using pesticides. Replanting the area with native plant selections that are resistant or tolerant to common pests and diseases will reduce future pest maintenance requirements. Pesticides should only be used as a last resort and must be applied by a certified applicator. Limit area of treatment to areas infested with pests rather than treating the entire facility. Document pesticide use in maintenance log.



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Recommended Frequency	References and Images	Notes
U-1-M16 Herbicides		
<ul style="list-style-type: none"> See references. 	<div style="text-align: center;">  </div> <p>See the Natural Lawn & Garden Natural Pest, Weed and Disease Control for more information: http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/naturalpe_200311261701589.pdf</p> <p>See Washington State University - Hortsense for additional information: http://pep.wsu.edu/hortsense/weedmanage.html</p>	<ul style="list-style-type: none"> It is not recommended to apply conventional herbicides to weeds within rain gardens and landscape natural drainage practices systems. Herbicides should be used only as the last resort when dealing with invasive weeds and after all practical methods are tried. Herbicides can harm or kill beneficial plants and add pollutants to stormwater that can negatively impact water quality. Herbicide use requires a certified applicator. There are preventative measures and physical controls that should be used instead of resorting to herbicide use. Combining regular maintenance, manual weeding, and mulching (2 to 3-inch depth of wood chip mulch) should keep weed growth to a minimum. Dig up roots if infested. Refer to "weed control" within this document for physical solutions. All practical preventative measures and physical controls shall be tried before herbicides are used. Document herbicide use in maintenance log.
U-1-M17 Maintenance Log		
<ul style="list-style-type: none"> As needed to document all maintenance activities. 		<ul style="list-style-type: none"> Maintain a log documenting all inspections dates, observations and activities. The maintenance log shall be available upon request by the City.



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RAIN GARDENS AND STORMWATER PLANTERS

TRIGGERED MAINTENANCE

TRIGGERED MAINTENANCE		
Condition Observed	References and Images	Instructions
U-1-MT1 Ponding Water		
<ul style="list-style-type: none"> Water is standing/ponding in rain garden and not draining within 48 hours after the rain event has stopped. The facility is not functioning properly due to blockage of sediment and/or debris in the soil strata, underdrain or outlet structures. 		<ul style="list-style-type: none"> Check observation port to determine if underdrain pipe is blocked. Remove debris. Check surface overflow, outlet pipe or structure to determine if blocked. Remove debris. May need suction vacuum. The soil may also be blocked by fine sediments. Rake mulch layer aside and remove sediment from top surface layer, aerate soil, and respread mulch.
U-1-MT2 Erosion of Soils and Sediment Loading		
<ul style="list-style-type: none"> Two inch (or greater in depth) gullies/rills are present, washing out soils and mulch. Sediment washed downstream is clogging outlets and/or rock around outlet structures. 		<ul style="list-style-type: none"> Remove and store any desirable vegetation (to be used for replanting) from rain garden. Rake and remove fine sediments from surface. Add additional soil if necessary and regrade to direct water towards low point of rain garden, or level out bottom surface. Replant and/or replace vegetation and reapply mulch. If slopes have been compromised, remove vegetation (reserve for replanting), re-grade, and re-contour area by hand tools where practical. Replant vegetation and install 2 to 3 - inches of mulch. Clear away rocks, sediment and reinstall rock protection at structure inlets/outlets and add more rocks if needed. To avoid soil erosion, inspect system prior to the wet season and immediately after a large rain event. Fixing gullies will help discourage erosion and additional clogging and ponding.



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TRIGGERED MAINTENANCE

TRIGGERED MAINTENANCE		
Condition Observed	References and Images	Instructions
U-1-MT3 Stormwater Planter- Cracked/ Damaged Liner or Wall		
<ul style="list-style-type: none"> Water seeping out through wall or cracks. Planter appears unusually dry or one of the planters in a series appears dry. 		<ul style="list-style-type: none"> Repair/ seal waterproof liner in accordance with liner manufacturer's requirements. If planter wall is structurally damaged (cracks in wall or breakage of concrete), consult a professional Engineer, Utility Engineer and/or Division Water Resource Engineer to determine whether structure is compromised and to plan for repairs. Replace rain garden/stormwater planter soils, replant and remulch, if necessary.
U-1-MT4 Soil Settlement		
<ul style="list-style-type: none"> Soil has settled two or more inches below paving surface. 		<ul style="list-style-type: none"> Rake mulch aside for later use. Apply prepared rain garden soil mix (use soil mix design per original plans if possible or see reference below for information) to bring soil height within 1 to 2-inches of top of pavement. Add 1 to 2-inches of mulch to bring top of mulch flush with adjacent paving/surface. Replant if necessary to provide vegetative cover over exposed soil. See Rain Garden Handbook for Western Washington Homeowners for further information: http://www.pierce.wsu.edu/Water_Quality/LID/Raingarden_handbook.pdf
U-1-MT5 Pest Control		
<ul style="list-style-type: none"> Pests have been reported to cause extensive plant damage or death and have/could become a nuisance or public health concern. Mosquitoes can breed in shallow stagnant ponding water. 	<div style="display: flex; justify-content: space-around;">   </div> <p style="margin-top: 10px;">Above photos from: http://en.wikipedia.org</p> <div style="text-align: center; margin-top: 10px;">  </div> <p style="margin-top: 10px;">See References for resources for pest control.</p>	<ul style="list-style-type: none"> Remove all trash, fruit, and nuts that have fallen to the ground to avoid attracting rodents. Mosquito larvae look like "wiggling sticks" typically floating perpendicular to water's surface. Mosquitoes take 5-7 days to mature. Rain gardens are designed to drain out within 24-48 hours after the rain event has ceased. If stagnant ponding and larvae are observed, then remove ponding (see paragraph on "ponding"). See also Department of Ecology's website for more information on mosquito prevention: www.ecy.wa.gov/news/2003news/2003-046.html Where rodent holes are present, fill with soil and lightly compact soil around the holes.



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POROUS PAVEMENT

REGULAR MAINTENANCE

(Includes Porous Cement, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver Systems)

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Notes	Instructions
U-2-M1 Inspect Observation Ports		
<ul style="list-style-type: none"> Visually check observation ports at least two times annually. 		<ul style="list-style-type: none"> Remove cap of observation port. Measure depth between observed water level and top of lid for port. Replace cap securely when done. Keep a record of measurements (including date) in maintenance log. Check O&M Manual for minimum distance between top of observation port and water surface level during dry and wet weather. During rainy weather, the water level will rise within the observation port. However, after the rain event has ceased, the water level at the observation port will drop as the water drains out of the pavement section. If water does not drain out of the observation port after 72 hours after rain has ceased, then the pavement base materials may be clogged or the groundwater table is high.
U-2-M2 Inspect System for Clogging		
<ul style="list-style-type: none"> Inspect for ponding water (clogging) after heavy rain events (over 1-inch of rainfall in 24 hours). Inspect pavement in early fall. 		<ul style="list-style-type: none"> Check for clogging and reduced permeability. If clogged, clean pavement as described below. If inspecting during dry weather, spray water (e.g. use garden hose) onto areas that appear clogged. If water runs off and does not filter into the pavement, pavement may be clogged. Implement cleaning measures to remove sediment such as using dry broom, pavement vacuum sweepers, or other tools. Remove finer debris with vacuum equipment. Follow manufacturer guidelines for when vacuuming is most effective (e.g. when pavement is dry). With open-celled paver systems, remove debris as described above and replace gravel.



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POROUS PAVEMENT

REGULAR MAINTENANCE

(Includes Porous Cement, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver Systems)

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Notes	Instructions
U-2-M3 Manually Sweep Large Debris and Leaves - Porous Cement, Porous Asphalt, Permeable Pavers		
<ul style="list-style-type: none"> Once per year in fall or as needed. 		<ul style="list-style-type: none"> Sweep porous pavement manually to maintain appearance and remove large debris such as leaves from pavement. Sweep and rake leaves as soon as leaves drop, preferably when surface and debris is dry. Remove sediment with dry broom, vacuum system or using other equipment.
U-2-M4 Vacuum Sweep - Porous Cement, Porous Asphalt, Permeable Pavers		
<ul style="list-style-type: none"> Vacuum sweep twice per year. 	<div style="display: flex; justify-content: space-around;">   </div> <p style="text-align: center;">Photos from City of Olympia</p> <div style="display: flex; justify-content: space-around;">    </div> <p style="text-align: center;">Photos from City Bellevue</p>	<ul style="list-style-type: none"> Keep porous pavement surfaces clean to decrease sediment clogging. Vacuum sweep porous pavement to maintain appearance, remove sediment and provide positive infiltration through pavement. Sweep porous pavement to maintain appearance and remove leaves and other debris as required to maintain positive infiltration rate.



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U-2-M5 Mow - Vegetative Paver System		
<ul style="list-style-type: none"> As needed to maintain a height of 3 - inches (usually 1 time per week during summer). 		<ul style="list-style-type: none"> Mow with a mulching mower. Clippings can be left in place.
U-2-M6 Moss Removal - Porous Cement, Porous Asphalt, Permeable Pavers		
<ul style="list-style-type: none"> As needed if water is unable to infiltrate through the moss covering. 	 <p style="text-align: center;">Scrubber for cleaning Photos from City of Olympia</p>	<ul style="list-style-type: none"> Moss is a common occurrence in the Pacific Northwest. Some moss will not affect the overall performance of porous pavement; however, if it grows thick and covers a large area, it can possibly reduce infiltration rates. Test infiltration and removal techniques on a small area before proceeding. Use any of the following options: scrubber washing, weed burner, sweeping, vacuum sweeping or a combination of all.
U-2-M7 Weed - Vegetated Open-Celled Paver System		
<ul style="list-style-type: none"> Bimonthly from March through October. 	 <p>See the Natural Lawn and Garden Natural Pest, Weed and Disease Control for more information: http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/naturalpe_200311261701589.pdf</p>	<ul style="list-style-type: none"> Remove weeds with their roots manually using pincer-type weeding tools, or hot water weeders. Reseed bare spots resulting from weeding in lawn areas.



Natural Drainage Practices Maintenance Guidelines

POROUS PAVEMENT

REGULAR MAINTENANCE

(Includes Porous Cement, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver Systems)

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Notes	Instructions
U-2-M8 Weed - Permeable Pavers and Open-Celled Gravel Filled Paver Systems		
<ul style="list-style-type: none"> Bimonthly from March through October. 	 <p>See the Natural Lawn and Garden Natural Pest, Weed and Disease Control for more information: http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/naturalpave_200311261701589.pdf</p>	<ul style="list-style-type: none"> Remove weeds manually by their roots with pincer-type weeding tools, or hot water weeders.
U-2-M9 Trim Ground Covers along Porous Pavement Edge		
<ul style="list-style-type: none"> Bimonthly (minimum) from March through September. 	 <p>Where fast-spreading ground covers are planted adjacent to porous pavement, the ground cover may spread too aggressively and root in the pavement. Ground cover could reduce the pavement's infiltration function.</p>	<ul style="list-style-type: none"> Regularly trim plants along porous pavement edge. Time trimming as needed to keep plants from rooting in adjacent porous pavement. Replace invasive ground covers with non-invasives and re-establish plantings.
U-2-M10 Sweep Gravel - Permeable Pavers and Gravel Filled Open-Celled Paver System		
<ul style="list-style-type: none"> Once per month or as needed. 		<ul style="list-style-type: none"> Remove and dispose of litter/debris and sweep clean gravel back into gravel pavers areas.



Natural Drainage Practices Maintenance Guidelines

POROUS PAVEMENT

REGULAR MAINTENANCE

(Includes Porous Cement, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver Systems)

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Notes	Instructions
U-2-M11 Topdress Gravel - Gravel Filled Open-Celled Paver System		
<ul style="list-style-type: none"> As needed when gravel has worn away exposing grid cells of gravel pavers. Once per year (minimum). 		<ul style="list-style-type: none"> Refill cells with clean gravel per original designs to top of or slightly above geogrid surface. Follow manufacturer's guidelines for repair of structural components of pavement system grid.
U-2-M12 Refill Gravel - Permeable Pavers		
<ul style="list-style-type: none"> As needed when gravel has worn away exposing more than paver face. Once per year minimum. 		<ul style="list-style-type: none"> Refill paver voids with the clean gravel from the original design. Follow manufacturer's guidelines.
U-2-M13 Check for Cracking, Settlement, or Structure Damage for Open Celled and Paver Systems		
<ul style="list-style-type: none"> Inspect once per year or as needed. 		<ul style="list-style-type: none"> Replace the confinement cells if they are damaged. Follow manufacturer guidelines for replacing sections of cells. As necessary, replace clean crushed gravel for gravel filled sections or reseed for vegetative covered sections.
U-2-M14 Porous Pavement Restoration		
<ul style="list-style-type: none"> Five to thirty years. 	<p>Do not seal coat or black/white top, or overlay porous asphalt and porous cement concrete, since this will seal off permeable</p>	<ul style="list-style-type: none"> If wearing course needs to be replaced, remove wearing course and reinstall porous pavement section. Review with geotechnical engineer if original subbase can be reused for the pavement section or repair/replace as needed.



Natural Drainage Practices Maintenance Guidelines
POROUS PAVEMENT
REGULAR MAINTENANCE

(Includes Porous Cement, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver Systems)

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Notes	Instructions
U-2-M15 Maintenance Log		
<ul style="list-style-type: none"> As needed to document all maintenance activities. 		<ul style="list-style-type: none"> Maintain a log documenting all inspections dates, observations and activities. The maintenance log shall be available upon request by the City.



Natural Drainage Practices Maintenance Guidelines

POROUS PAVEMENT

TRIGGERED MAINTENANCE

(Includes Porous Cement Concrete, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Cell Paver and Paver Systems)

TRIGGERED MAINTENANCE		
Condition Observed	References and Images	Instructions
U-2-MT1 Stockpiling Landscape Material on Porous Pavement		
<ul style="list-style-type: none"> Materials should not be stockpiled directly on porous surfaces as it will result in clogged pavement. 		<ul style="list-style-type: none"> Remove materials from porous surface and vacuum sweep area. To reduce additional clogging, ensure any potential runoff does not come into contact with porous pavement. Cover pavement with impermeable material (tarp or plastic) and place stockpile on tarp. Cover stockpiled material to prevent erosion, if not used immediately. Alternatively, stockpile material away from (not on) porous pavement.
U-2-MT2 Exposed soils upslope of porous pavement		
		<ul style="list-style-type: none"> Permanently stabilize exposed soils that may erode onto porous pavement. Till, plant/seed and mulch area immediately to avoid sediment overflow onto pavement caused by erosion. Remove accumulated sediment from the surface with dry broom, vacuum system or other tools.
U-2-MT3 Sediment Washouts		
<ul style="list-style-type: none"> Watch for washouts from planted areas where soil, mulch, or sediment is deposited on porous pavement. 		<ul style="list-style-type: none"> Clear soil/sediment/mulch immediately and vacuum sweep area. Stabilize adjacent landscape areas from erosion by maintaining full vegetative cover (plants/turf). Monitor washout occurrences to identify problem areas.

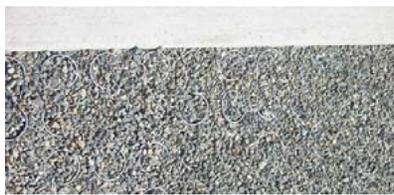


Natural Drainage Practices Maintenance Guidelines

POROUS PAVEMENT

TRIGGERED MAINTENANCE

(Includes Porous Cement Concrete, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver and Paver Systems)

TRIGGERED MAINTENANCE		
Condition Observed	References and Images	Instructions
U-2-MT4 Repairs/ Patching		
<ul style="list-style-type: none"> Damaged porous asphalt/ cement, or when utility cut needed. 		<ul style="list-style-type: none"> Implement measures to protect porous pavement to remain (such as covering adjacent landscaping areas with tarp, avoid stockpiling material on porous pavement, and vacuum to collect saw cut slurry during removal operations). Patch with same porous material including clean subbase material per original design. When needed, use temporary patch until full panel can be replaced. Determine source of breakage, (e.g. using pavement not as intended such as vehicles driving over sidewalk) and implement preventative measures to avoid future occurrences.
U-2-MT5 Damaged Permeable Pavers, and Open-Celled Paver System		
		<ul style="list-style-type: none"> Replace sections of confinement cells if they are damaged or uplifted. See manufacturer's repair recommendations. Restore with same porous pavement section as original design. Replace gravel (when 10% loss occurs) for gravel-filled sections or reseed for vegetative cover sections.
U-2-MT6 Cracked Porous Cement Concrete and Porous Asphalt		
		<ul style="list-style-type: none"> Determine source of breakage, (e.g., using pavement not as intended such as vehicles driving over sidewalk) and implement preventative measures to avoid future occurrences. Replace full panel, joint to joint, for substantial cracks. Provide protective cover for undamaged pavement section to remain. Patch with porous section per original design.



Natural Drainage Practices Maintenance Guidelines

POROUS PAVEMENT

TRIGGERED MAINTENANCE

(Includes Porous Cement Concrete, Porous Asphalt, Permeable Pavers, and Rigid/Flexible Open-Celled Paver and Paver Systems)

TRIGGERED MAINTENANCE		
Condition Observed	References and Images	Instructions
U-2-MT7 Snow Removal - Porous Asphalt, Porous Cement Concrete or Permeable Pavers		
		<ul style="list-style-type: none"> Do not apply sand on porous pavement. Sand can clog pavement. In the case of an emergency and sanding is required for safety measures, remove sand/sediment via vacuum sweeping or other measures as soon as road is dry. If using snow plow, test small area first and then adjust plow height as needed to minimize scarring of pavement. If possible, use a snow plow with skids or rollers to keep the blade slightly above the pavement surface. Restore or readjust pavers displaced by snow removal. During snow melt, if water is not draining through pavement then remove debris and sediment that is clogging pores via vacuum sweeping or other measures.
U-2-MT8 Washout of Fresh Concrete or Other Materials Spilling onto Pavement		
<ul style="list-style-type: none"> (e.g. Fresh concrete from a mixer truck is washed onto porous pavement.) 		<ul style="list-style-type: none"> Let material harden, then remove, and replace sections affected and reinstall with full pavement section per original design. Implement notification measures to workers in the area of location of permeable pavement prior to construction beginning. Porous pavements should not be used in areas with hazardous materials (e.g. fueling stations etc.). However, if oil or gas spills onto porous pavement, remove full section to depth of spill and dispose of contaminated material. Replace section in its entirety.



Natural Drainage Practices Maintenance Guidelines

VEGETATED ROOF

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE

Recommended Frequency	References and Notes	Instructions
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U-3-M1 Observation Ports

<ul style="list-style-type: none"> Visually check observation ports at a minimum twice per year in fall and spring. 		<ul style="list-style-type: none"> Inspect for ponding water. Check and clean out debris from drains and overflow systems. During rainy weather, ponding may occur on the vegetated roof. After the rain event, the water level in the Observation Port should go down if the system is functioning properly.
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U-3-M2 Weed Control

<ul style="list-style-type: none"> New (less than 3 years) vegetated roofs require intensive monitoring and inspection. Inspect for weeds every two weeks. To control weeds within an established vegetated roof, inspect and remove weeds at least four times per year (March, May, July, and September). 	 <p>See the Natural Lawn and Garden Natural Pest, Weed and Disease Control for more information: http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/naturalpe_200311261701589.pdf See Washington State University - Hortsense for additional information: http://pep.wsu.edu/hortsense/weedmanage.html Please refer to the King County Hazardous Waste - Natural Lawn care and IPM: http://www.govlink.org/hazwaste/house/yard/lawn/chemicals.html</p>	<ul style="list-style-type: none"> Prune and manually weed to maintain appearance. Remove all plant waste. The inspector may adjust inspection frequency in accord with seasonal variations in weed growth, but at no time should the interval be long enough to allow for any weed to flower and set seed. Weeds need to be pulled as early in spring as possible so that the desired plants can thrive. When dealing with invasive plants material/weeds, attempt all other physical methods to remove before considering a more aggressive method. It is important to note that chemicals can harm or kill beneficial or desirable plants, and also add pollutants to stormwater that can negatively impact water quality. The need for herbicides is a sign of weeding too infrequently.
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Natural Drainage Practices Maintenance Guidelines

VEGETATED ROOF

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE

Recommended Frequency	References and Notes	Instructions
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U-3-M3 *Inspect and Replace Diseased/Dead Vegetation*

<ul style="list-style-type: none"> Inspect vegetated roof for missing plants or thin areas twice per year. 	 <p>Exposed areas (missing vegetation) will increase evaporation rates and potentially allow weeds to establish.</p>	<ul style="list-style-type: none"> Vegetation should cover the vegetated roof as per original design. If planting is thinning, replant per original design.
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U-3-M4 *Inspect Vegetated Roof for water damage*

<ul style="list-style-type: none"> Inspect roof ceiling for water damage which will be an indication of leakage. Inspect structural components per design / manufacturer's guidelines. 	 <p>Please refer to the Low Impact Development Center's "Quality Assurance for Nonpoint Source Best Management Practices": http://www.lowimpactdevelopment.org/qapp/greenroofs_maintain.htm</p>	<ul style="list-style-type: none"> Contact manufacturer or installation company for repair of torn waterproof membrane. Follow manufacturer's guidelines for review of roof. Roofs can leak from drainage backups or root puncture or if the correct waterproofing membrane system, root barrier, and/or drainage layer were not selected or installed. Most roofing companies, including those that install green roofs, will provide a warranty for the waterproofing integrity of the roof membrane(s) that they have installed, including green roof membranes.
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U-3-M5 *Inspect Growing Medium for Ponding or Excessive Moisture*

<ul style="list-style-type: none"> Inspect monthly from October through March. Inspect midsummer. 		<ul style="list-style-type: none"> Check that water infiltrates within time specified per original design. If it doesn't infiltrate, clear blocked drains (pipes and structures) and till soils as needed. Check conditions of irrigation system for leaks in the irrigation network.
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Natural Drainage Practices Maintenance Guidelines

VEGETATED ROOF

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Notes	Instructions
U-3-M6 Inspect Growing Medium for Erosion (water and/or wind scour)		
<ul style="list-style-type: none"> Inspect monthly from October through March. Inspect once in July. 	<ul style="list-style-type: none"> If continuous, consult with professional installer to determine cause of erosion and remedy. 	<ul style="list-style-type: none"> Check for erosion and fill any gullies/rills that are more than 2 - inches deep with specified roof soil medium. Restore soil section and plantings per original design.
U-3-M7 Inspect Growing Medium for Crusting, Dry or Shrinking Medium		
<ul style="list-style-type: none"> Inspect growing medium early summer and early fall. 		<ul style="list-style-type: none"> Amend soils and rake as needed to restore texture and filtration capabilities. If condition persists, consult professional installer for additional information.
U-3-M8 Clear Drains and Overflow System		
<ul style="list-style-type: none"> Inspect and clean drains, downspouts and/or scuppers, of debris and/or sediment monthly during the rainy season. Inspect drains and overflows in fall after deciduous leaves have fallen, or as needed. 		<ul style="list-style-type: none"> Clear out all debris and sediment to maintain free drainage.



Natural Drainage Practices Maintenance Guidelines

VEGETATED ROOF

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE

Recommended Frequency	References and Notes	Instructions
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U-3-M9 Watering

<ul style="list-style-type: none"> During the plant establishment period (first three months) the vegetation will require watering. Consult manufacturer's guidelines for frequency. Generally, new vegetated roofs may require watering (season dependent) 2 to 3 times per week to achieve approximately 1-inch of water per week. Consult manufacturer's guidelines for frequency. Once vegetation is established, irrigation requirements are reduced. Consult manufacturer's guidelines for frequency. 	 <p style="margin-top: 10px;">See Watering to Establish Your New Plant: http://www.ci.mercer-island.wa.us/Files/Watering%20Your%20New%20Plants.pdf</p>	<ul style="list-style-type: none"> Intent of watering is to keep plant material sustained through establishment. Monitor rainfall to determine irrigation/watering schedule. Dry periods will require additional watering (especially during plant establishment) due to warmer temperatures and increased sunlight, both of which can stress vegetation. Wilted leaves and drooping stems are all indications of stress caused by dry soils and hot temperatures. Optimal watering time is early in the morning or late in the evening to reduce evaporation. For vegetated roofs with automatic irrigation systems - follow irrigation system manufacturer's guidelines for specific system's operations and maintenance.
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U-3-M10 Maintenance Log

<ul style="list-style-type: none"> As needed to document all maintenance activities. 		<ul style="list-style-type: none"> Maintain a log documenting all inspection dates, observations, and activities. List repairs and contractors. The maintenance log shall be available upon request by the City.
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Note: Vegetated roof structural components shall be operated and maintained per manufacturer's instructions.



Natural Drainage Practices Maintenance Guidelines

RAIN RECYCLING

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE

Recommended Frequency	References and Images	Instructions
U-4-M1 Sediment Removal		
<ul style="list-style-type: none"> Inspect early fall and late spring and clean out as necessary. 		<ul style="list-style-type: none"> Inspect cistern or rain barrel and remove any accumulated sediment in the bottom.
U-4-M2 Inspect Gutters and Downspouts, Downspout Screens, Rain Barrel Screens		
<ul style="list-style-type: none"> Inspect and remove debris in late spring and early fall. Check screen weekly in late summer for insects and mosquito larvae. Inspect connections in early spring and late fall. 		<ul style="list-style-type: none"> Downspouts which supply water to rain barrels must be kept clear and clean of debris. Inspect for any leaks, debris, and blockages. Screens should be maintained in good condition. Mosquito larvae look like "wiggling sticks" floating perpendicular to water's surface. Inspect and ensure overflow is clear and in working order.
U-4-M3 Close the Outlet Pipe Valve		
<ul style="list-style-type: none"> Mid-spring but begin to monitor overflow weekly. 		<ul style="list-style-type: none"> Close the valve on the outlet pipe midspring to harness rainwater for irrigation during dry summer months.
U-4-M4 Open the Outlet Pipe Valve		
<ul style="list-style-type: none"> Mid-fall. 		<ul style="list-style-type: none"> Open the valve on the outlet pipe to slowly release stored rain and disperse it over the landscape area. Keep valve open during winter to avoid water back up.



Natural Drainage Practices Maintenance Guidelines

AMENDED SOILS

REGULAR MAINTENANCE

REGULAR / ROUTINE MAINTENANCE		
Recommended Frequency	References and Images	Instructions
U-5-M1 Protect from Compaction and Erosion		
<ul style="list-style-type: none"> Ongoing monitoring. Aerate lawns yearly. Turn over landscape areas in late spring and early fall. 		<ul style="list-style-type: none"> Protect amended areas and landscaped areas from vehicle access, maintenance equipment, and excessive foot traffic to prevent compaction. Boulders, shrubs, ground covers, and fencing can be used to limit traffic in the amended area. Install stepping stones if foot traffic is not preventable.
U-5-M2 Maintain Landscape Areas and Pervious Footprint for Site		
<ul style="list-style-type: none"> Inspect yearly. 		<ul style="list-style-type: none"> Avoid converting landscape areas and permeable pavements to impervious areas. Landscaped areas with amended soils can restore soil water infiltration and storage capacities, as well as decrease surface water runoff and erosion.
U-5-M3 Add Compost Mulch and Allow Plant Debris to Remain on Soil		
<ul style="list-style-type: none"> Spring and Fall. 	<p>Compost helps to control weeds, conserves soil moisture, improves filtration, regulates soil temperatures, and adds nutrients.</p> <p>See The Natural Lawn and Garden- Growing Healthy Soils: http://www.ci.bellevue.wa.us/pdf/Utilities/Healthy_Soil.pdf</p> <p>See Building Soil-Guidelines and Resources for Implementing Soil Quality and Depth: http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf</p>	<ul style="list-style-type: none"> In vegetative areas, apply 2 to 3-inches of compost layer carefully to avoid smothering and damaging plants. Allow plant debris to remain on soil to replenish organic matter. For areas in rain gardens, see maintenance section on <i>Rain Gardens and Stormwater Planter</i>. In turf areas, consider aerating then applying 1/2 to 1-inch of fine screen compost and over seed.



EQUIPMENT AND MATERIALS

The following equipment is recommended for use (purchase or rental) by maintenance personnel to ensure efficient and proper maintenance.

Power Equipment*

- Riding Mulch Mower - to be used for lawn areas where feasible.
- Walk-behind Power Mulch Mower - to be used for lawn areas where a riding mower is not practical or accessible (small areas, steeper slopes).
- Power Trimmer - to be used for cutting grass where a mower cannot reach.
- Power Edger - for redefining lawn edge along walks, driveways and planted areas.
- Power Core Aerator - to be used for aeration of lawn areas.
- Power Lawn Vacuum - for vacuuming up aeration plugs in lawn areas. It may be possible to locate a multi-purpose vacuum for both hard surface and lawn applications.
- Power Overseeder - for applying lawn seed following aeration.
- Power Thatcher - for thatch removal of lawn areas.
- Chipper – For breaking down woody material to be composted on-site or hauled away as green waste.
- Golf Cart - for moving crews and equipment between areas.
- Vacuum Sweeper - for vacuuming debris and sediment from porous paving areas. Equipment can be rented or the tasks contracted to an outside maintenance provider.

* It is recommended to use equipment that minimizes pollution generation. When available, consider using equipment that meets stricter clean air and noise requirements equivalent to State of California.



Natural Drainage Practices Maintenance Guidelines

EQUIPMENT AND MATERIALS

The following equipment is recommended for use (purchase or rental) by maintenance personnel to ensure efficient and proper maintenance.

Manual Equipment

- Blade Sharpeners.
- Bypass Pruner - for shrub and perennial pruning and deadheading. Look for $\frac{3}{4}$ - inch to 1 - inch curved blades.
- Cultivator/fork - for turning material at on-site compost facility.
- Gloves - leather and cloth.
- Hand Tamper – for compacting NDS soils in drainage swales.
- Long-reach Pruners - for areas not easily accessible. Choose pruners with a 4 to 5 - foot long handle and cut and hold feature.
- Loppers - for pruning shrubs and smaller tree branches. Look for 24 to 36 - inch handles and 2 - inch curved blades.
- Manual Edger – for redefining lawn edge where power edger is not possible.
- Manual Seed Broadcaster - for applying lawn seed following aeration, in place of power overseeder.
- Pincer-type Weeders – long-handled weeder for pulling weeds with their roots.
- Short handled pick or Japanese sickle tool.
- Pruner Grease or Lubricant.
- Push Broom.
- Rakes - metal construction, seeding rakes and lawn rakes, including narrow width for raking in planted areas.
- Shovels - flat, spade, transplanting spade. Various widths and lengths.
- T-handle Soil Core Sampler or Soil Augur – for collecting samples in lawn areas for monitoring soil texture, color, compaction and running pH tests.
- Tree Pruner - for trimming branches. Choose pruners with a 10 to 14 - foot long handle, and saw blade and lopper combo.
- Wheelbarrow – for transporting soil, mulch, plants and other landscape materials as needed.

Other Equipment/ Specialty Items

- Flame Weeders - a set of propane flames that are used to burn weeds. They are best used over paved or larger weedy areas and are not appropriate for planted areas where they can potentially cause damage to plants. Small, single-flame weeders may be appropriate for use in lawn and planted areas.
- Hot water weeders - for hand weeding of lawn and bed areas.
- Small on-site composting bins – these are bins similar to those used at local P-patches. They are larger than residential bins, but small enough that they do not require large yard spaces, anything more than manual turning or regulation.



Natural Drainage Practices Maintenance Guidelines

REFERENCES AND ADDITIONAL RESOURCES

Building Soil: Guidelines and Resources for Implementing Soil Quality and Depth BMP T5.13 in WDOE Stormwater Management Manual for Western Washington 2007 Edition

http://www.soilsforsalmon.org/pdf/Soil_BMP_Manual.pdf

City of Bellevue Utilities Natural Drainage Practices Pilot Project Training Materials Dec. 2006

City of Bellevue Parks and Community Services Department's Best Management Practices Manual (See Chapter 2)

http://bellevuewa.gov/pdf/Document%20Library/2006_EBMP_DS_Manual.pdf

City of Portland 2008 Stormwater Management Manual

<http://www.portlandonline.com/bes/index.cfm?c=47952&>

High Point Community Right of Way and Open Space Landscape Maintenance Guidelines Dec. 2006 by SvR Design Company

<http://www.svrdesign.com/docs/High%20Point%20ROW%20and%20Landscape%20Maintenance%20Guidelines%20-%202012-21-06.pdf>

Low Impact Development: Technical Guidance Manual for Puget Sound Jan. 2005 by Puget Sound Action Team and WSU Pierce County Extension

http://www.psparchives.com/publications/our_work/stormwater/lid/LID_manual2005.pdf

Maintenance of Low Impact Development Facilities Revised Jan. 2007 by WSU Pierce County Extension and AHBL for Puget Sound Action League

http://www.psparchives.com/publications/our_work/stormwater/lid/D_RevisedMaintenanceofLIDFacilities.pdf

The Natural Lawn and Garden- *Growing Healthy Soil*

http://www.ci.bellevue.wa.us/pdf/Utilities/Healthy_Soil.pdf

The Natural Lawn and Garden- *Natural Pest, Weed & Disease Control*

http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/naturalpe_200311261701589.pdf

The Natural Lawn and Garden- *Choosing the Right Plants for a Trouble-Free Garden*

http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/choosingt_200311261701525.pdf

Rain Garden Handbook for Western Washington Homeowners by WSU Pierce County Extension

http://www.pierce.wsu.edu/Water_Quality/LID/Raingarden_hand

Quality Assurance for Nonpoint Source Best Management Practices by The Low Impact Development Center

http://www.lowimpactdevelopment.org/qapp/greenroofs_maintai



Natural Drainage Practices Maintenance Guidelines

REFERENCES AND ADDITIONAL RESOURCES

ADDITIONAL RESOURCES

King County Resources

King County Solid Waste Division- Composting and Soils

<http://www.metrokc.gov/soils>

King County Public Health Rodent Control

<http://www.kingcounty.gov/healthservices/health>

King County Northwest Yard and Garden

<http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden.aspx>

King County Noxious Weeds

<http://www.kingcounty.gov/environment/animalsAndPlants/noxious-weeds.aspx>

Integrated Pest Management in King County

<http://www.govlink.org/hazwaste/interagency/ipm/index.cfm>

Water Saving in the Garden. Some basic facts about cisterns and rainbarrels.

<http://dnr.metrokc.gov/wlr/pi/pdf/cistern-water-saving.pdf>

King County Hazardous Waste - Natural Lawn care and IPM

<http://www.govlink.org/hazwaste/house/yard/lawn/chemicals>

King County Native Plant Resources

<http://www.kingcounty.gov/environment/stewardship/nw-yard-and-garden/native-plant-resources-nw.aspx>

ADDITIONAL RESOURCES

Washington State University Resources

WSU Extension Master Gardener Program

<http://gardening.wsu.edu/>

WSU Cooperative Extension - Stewardship Gardening

<http://gardening.wsu.edu/stewardship>

WSU Extension - Weeds

<http://gardening.wsu.edu/text/weed.htm>

WSU Pierce County Extension *Rain Garden Handbook for Western Washington Homeowners*

WSU King County Extension Watering and Mulching Fact Sheet

<http://king.wsu.edu/gardening/documents/11WateringandMulching.pdf>



Natural Drainage Practices Maintenance Guidelines

REFERENCES AND ADDITIONAL RESOURCES

WSU Extension - Native Plants: Identifying, Propagating and Landscaping

<http://gardening.wsu.edu/nwnative/>

WSU - Hortsense:

<http://pep.wsu.edu/hortsense/weedmanage.html>

Plant Resources

Washington Native Plant Society

<http://www.wnps.org>

Native Plant Nurseries in Washington

http://www.plantnative.org/nd_wa.htm

Plant Amnesty Pruning Guide

http://www.plantamnesty.org/pruning_guides/pg_northwest_pacific_maritime.htm

Native Plant Salvage Foundation

<http://nativeplantsalvage.org>

The Plant List - A Companion to the Choosing the Right Plants Natural Lawn and Garden Guide:

<http://www.savingwater.org/docs/plantlist.pdf>

Water Conservation and Water-wise Landscaping

Saving Water Partnership

<http://www.savingwater.org>

Watering to Establish your New Plants (Saving Water Partnership)

<http://www.ci.mercer-island.wa.us/Files/Watering%20Your%20New%20Plants.pdf>

Natural Lawn and Garden Handbook, Healthy Landscapes for a Healthy Environment - Smart Watering

http://www.ci.bellevue.wa.us/pdf/Utilities/Smart_Watering.pc

Natural Yard Care

Natural Yard Care: Five steps to make your piece of the planet a healthier place to live.

http://www.ci.bellevue.wa.us/pdf/Utilities/Five_easy_steps.pc

El cuidado natural del jardín: Cinco pasos para hacer su pedazo del planeta un lugar más sano para vivir.

http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/spu01_002254.pdf



Natural Drainage Practices Maintenance Guidelines

REFERENCES AND ADDITIONAL RESOURCES

Ecologically Sound Lawn Care for the Pacific Northwest - Integrated Pest Management: Preventive Health Care for Lawns (pages: 42-49)

http://www.seattle.gov/util/stellent/groups/public/@spu/@csb/documents/webcontent/ecological_200312021255394

Department of Ecology: Mosquito Prevention. "Preparing for W. Nile virus needn't harm the environment."

www.ecy.wa.gov/news/2003news/2003-046.html

Porous Pavement

City of Olympia Maintenance reports for Porous Pavement

www.olympiawa.gov/cityutilities/stormwater/scienceandinnovations/porouspavement

National Ready Mixed Concrete Association & Pervious Concrete web page

www.nrmca.org <http://www.perviouspavement.org/>

City of Portland 2008 Stormwater Management Manual, Chapter 3: "Simplified Operations and Maintenance Specifications Pervious Pavement"

<http://www.portlandonline.com/bes/index.cfm?c=47952&>

See also manufacturers' guidelines for proprietary paver and open-celled porous pavement systems for O&M recommendations



DEFINITIONS

Term	Definition
Bioretention	"Shallow landscaped depressions with a designed soil mix and plants adapted to local climate and soil moisture conditions that receives stormwater from a small contributing area." (LID Technical Guidance Manual for Puget Sound by PSAT and WSU Pierce County Extension, Jan 2005)
Cleanout	A vertical pipe with a cap at the surface. Vertical pipe is connected to a horizontal pipe with a slope. Cleanouts are access points for cleaning pipes.
Filtration	Water flowing through amended soils, vegetation, and other media.
Gullies	A ditch/channel is created as a result of running water (such as during a heavy downpour) eroding and wearing away the soil and vegetation. Gullies may be either shallow or deep in depth.
Infiltration	Water seeps into native soils
Natural Drainage Practices (NDP)	Small-scale stormwater controls that incorporate vegetation, infiltration, and evapotranspiration to mimic the hydrologic performance of natural land surfaces.
Natural Drainage System (NDS)	A drainage system that uses a combination of grass-lined and vegetated swales, pervious/porous paving, downspout disconnects, rainwater gardens, tree preservation and bioretention to manage stormwater runoff. Emphasis is on decentralizing stormwater collection and dispersal to many areas to maximize infiltration of water back into the soil.



DEFINITIONS

Term	Definition
Observation Port	A vertical pipe buried in the ground used to determine the water level beneath the surface. The pipe will have a cap/lid at the surface (similar to a cleanout) for observation access. Small slots are cut along the length of the pipe. The bottom of the pipe is not capped and is set in the undisturbed soil. See City of Bellevue's standard detail of an Observation Port for further information and the Storm As-Built Plan or Operations and Maintenance Agreement Form for location of the Observation port(s).
Porous, Permeable, Pervious Pavements	Terms are used interchangeably. Pavement that allows water to filter through the pavement section via voids in the pavement material and clean crushed gravel subbase.
Stormwater	The rainfall runoff from rooftops, streets, parking lots and other impervious surfaces that flows to waterways.
Structure	A precast structure used to collect rain water such as area drain, catch basin, cleanout, grate, inlet, culvert pipe.
Swale	An open and gently sloping vegetated channel designed for treating and conveying stormwater runoff.
Underdrain	A pipe with holes or slots along the length of the pipe to allow water to flow into pipe and be conveyed away. The pipe is set in rock at the bottom of an infiltrating NDP such as rain garden or porous pavement.
Water Quality	The chemical and physical characterization of water, the primary bases of which are parameters relating to potability, safety of human contact and health of ecosystems.