

# Rain Gardens

**Description:** Rain Gardens are a type of bioretention facility. They receive runoff from impervious surfaces via a pipe or swale. They are suitable for relatively flat sites (< 5% slope) and are often the best choice for single family residential sites. They are heavily planted with vegetation that is adapted to wet winter conditions and dry summer conditions. Rain Gardens can be integrated into most site designs due to their flexibility in form and relative ease of construction. The planting scheme can be formal or informal.

**Common Uses:** Rain Gardens can be used in all forms of development including single family residential, multi-family residential, commercial, institutional and parking lots. They are the most cost effective and versatile BMP for managing stormwater.

**Limitations:** Rain Gardens cannot be used in areas with a high water table or thin soils over bedrock. The water table must be at least 1.3 m below existing grade. At steeper grades Rain Gardens can be stepped but require additional geotechnical

engineering input. Rain Gardens cannot be installed over parking garages or other below ground structures.

**Size Factor:** The size factor for the Rain Garden is 0.17 (or 17%) based on the attached construction detail. In other words, an impervious area of 100 m<sup>2</sup> would require a Rain Garden 100 m<sup>2</sup> x 0.17 (or 17 m<sup>2</sup>) to manage the runoff. For sizing purposes, the area of the Rain Garden is calculated using the Rain Garden bottom dimensions (not extent of Rain Garden area).

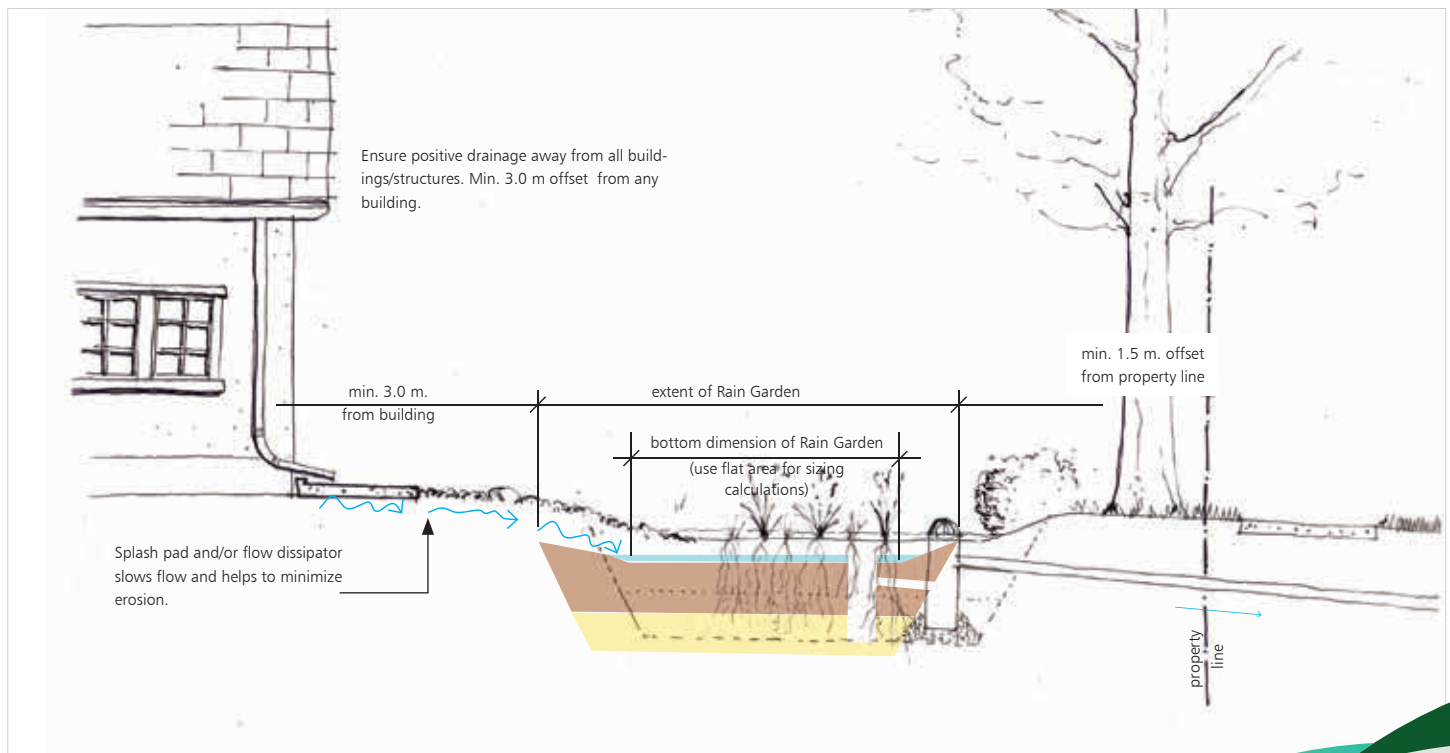
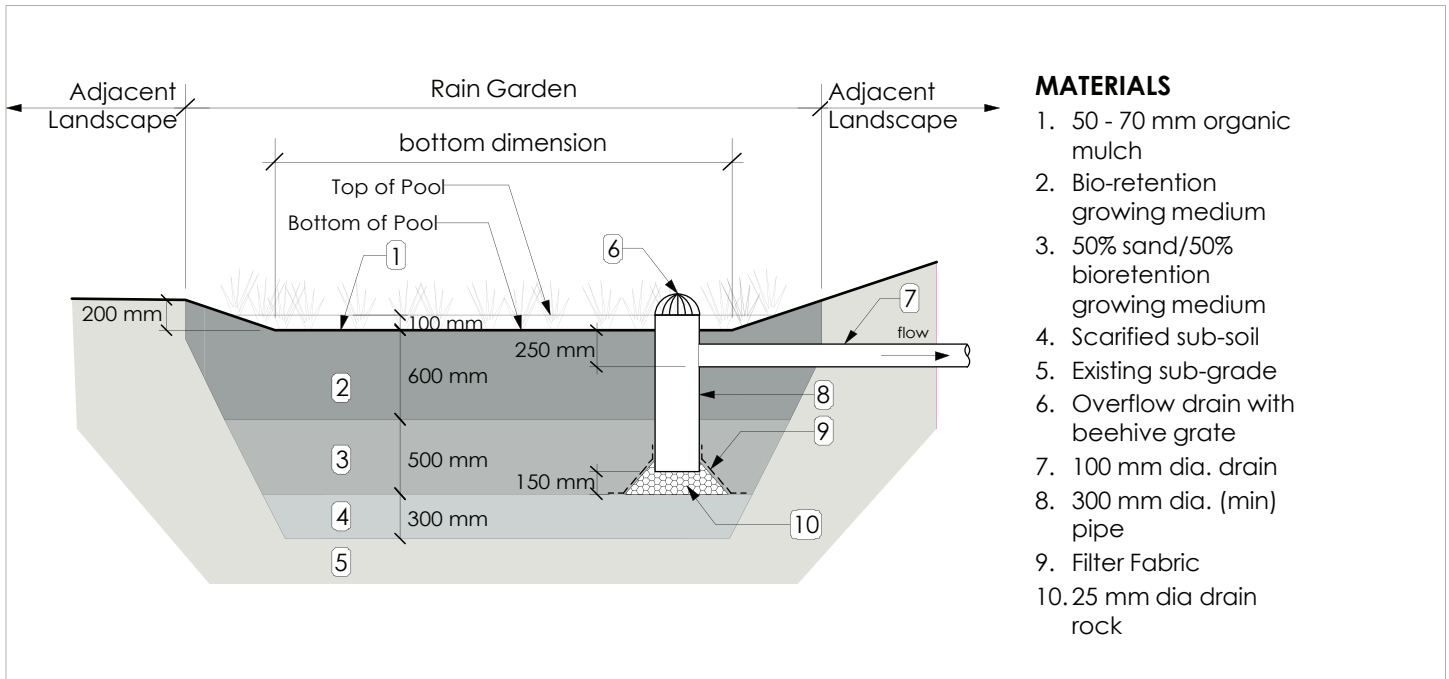


Figure 1. Residential Raingarden

Technical aspects provided by:





**MATERIALS**

1. 50 - 70 mm organic mulch
2. Bio-retention growing medium
3. 50% sand/50% bioretention growing medium
4. Scarified sub-soil
5. Existing sub-grade
6. Overflow drain with beehive grate
7. 100 mm dia. drain
8. 300 mm dia. (min) pipe
9. Filter Fabric
10. 25 mm dia drain rock

Figure 2. Rain Garden Profile

**General Specifications:**

- 1) Provide protection from all vehicle traffic, equipment staging, and foot traffic in proposed infiltration areas prior to, during, and after construction.
- 2) Dimensions:
  - a) Depth of basin (from top of growing medium to overflow elevation); 100 mm.
  - b) Flat bottom width: 1.0 m - 3.0 m, desirably.
  - c) Length-width ration of 2:1.
  - d) Side slopes of basin: 3:1 maximum.
- 3) Setbacks (from midpoint of facility):
  - a) Infiltration basins must be minimum 3.0 m from foundations and 1.5 m. from property lines.
- 4) Overflow:
  - a) Overflow required.
  - b) Protect from debris and sediment with strainer or grate.
- 5) Inflow:
  - a) Grade the impervious area towards the Rain Garden. At point-source inlets, install river rock to transition from inlets and splash pad to growing medium.
  - b) Allow 100 mm freeboard between the inlet elevation and the maximum ponded elevation (overflow elevation).
- 6) Outlet piping: shall be PVC Sch.40. 100 mm min. Piping must have 2% grade and follow the Plumbing Code.
- 7) Sand:
  - a) Course Sand-see specifications.
  - b) Depth: 500 mm
- 8) Growing medium:
  - a) Bioretention Growing Medium-see Specifications.
  - b) Depth: 600 mm
- 9) Vegetation: See Planting Information, page 5.

**Additional Expertise**

CRITERIA	TECHNICAL EXPERT
Site slope > 15%	Geotechnical/Civil Engineer
Within 30 m of steep bank	Geotechnical Engineer

Technical aspects provided by:



# Rain Garden Material Specifications

**Growing Medium:** Bioretention growing medium is an organic, sandy soil with minimal amounts of clays and silts. The growing medium must support plant life, infiltrate water, and also resist compaction in the case of lawn areas. The following table identifies growing medium properties for the Rain Garden BMP.

Particle size classes	Percent of dry weight mineral fraction
Gravel (greater than 2.5 mm)	0
Sand (greater than 0.05 mm and less than 2.5 mm)	70-80
Silt (greater than 0.002 mm and less than 0.05 mm)	5-15
Clay (less than 0.002mm)	2-5
Organic Content (% Dry Weight)	10-15

Table 1. Growing medium specifications for bioretention

**Growing Medium Placement:** When backfilling the Rain Garden, growing medium should be placed in lifts 200 to 300 mm thick. Heavy equipment should only be used around the perimeter of the basin to supply growing medium and sand but not in the bioretention areas. Bioretention materials should be graded with light equipment such as a compact loader or a dozer/loader with marsh tracks.

**Growing Medium Compaction:** Over-compaction of the growing medium must be prevented by allowing time for natural compaction and settlement. No additional manual compaction of a growing medium should be necessary. Rake growing medium material as needed to level out. Overfill above the proposed surface invert to accommodate natural settlement to proper grade. Depending upon the growing medium material, up to 20% natural compaction may occur. For facilities designed with a liner, no scarification of the invert area is required. In order to speed up the natural compaction process, presoaking the placed growing medium may be performed. Significant settlement can occur after

the first presoak, and additional settlement may occur subsequent to the initial wetting. If time and construction scheduling permits, it is preferable to allow natural settlement to occur with the help of rain events to presoak the growing medium.

## Sand:

- 1) Sand to be hard, granular sharp sand well washed and free of impurities, chemicals or organic matter.
- 2) Particle size in sand to be:
  - a) 90-100% passing a 2.50 mm sieve
  - b) 0-65% passing a 0.500 mm sieve.
  - c) 0-5% passing a 0.050 mm sieve.

**Mulch:** Apply organic mulches at a depth of 50 mm. Use medium textured mulch that is not too large that it floats or too small that it reduces infiltration. In addition to BCSLA/BCLNA Landscape Standards (Current Ed.):

- Leaf mold, compost, shredded garden waste, well composted bark or mild, well composted manures can be used as mulches.
- Sawdust, fresh bark mulch and other pure wood products restrict soil development and deplete soil nutrients during decomposition. These are not suitable for use. Ensure mulches are weed free before application.

**Drain Rock:** Drain Rock to be round, inert, durable, well washed and free of fines, impurities, chemicals or organic matter. Particle size shall be a maximum of 19 mm and contain no material finer than 9 mm.

**Geotextiles:** Geotextiles shall consist of a non-biodegradable blanket or other filtering membrane that permits the flow of water but not fine soil particles.

- 1) Grab strength > 350N
- 2) Puncture strength > 200N
- 3) Apparent opening size <0.4 mm
- 4) Flow rate > 100 l/m/m<sup>2</sup>

**PLANTING INFORMATION**

Plant material must suit the conditions of the site, especially the soil moisture level. The cross section to the right illustrates the soil moisture zones and suitability for various stormwater management BMP's. Soil moisture levels are highest at the bottom of facilities and decrease as elevation increases. Plant zones have therefore been defined relative to the normal operating water level.

Bioretention gardens, for example, will require plant material from all soil moisture groups. Plant choices and quantities will be dependent on the size of the BMP, slope and the extent of each soil moisture zone.

Ornamental and native plant material can be used in the various BMP's provided they are adapted to the site and soil moisture conditions. Suggested native plant species for the BMP's and soil conditions can be found on the following table.

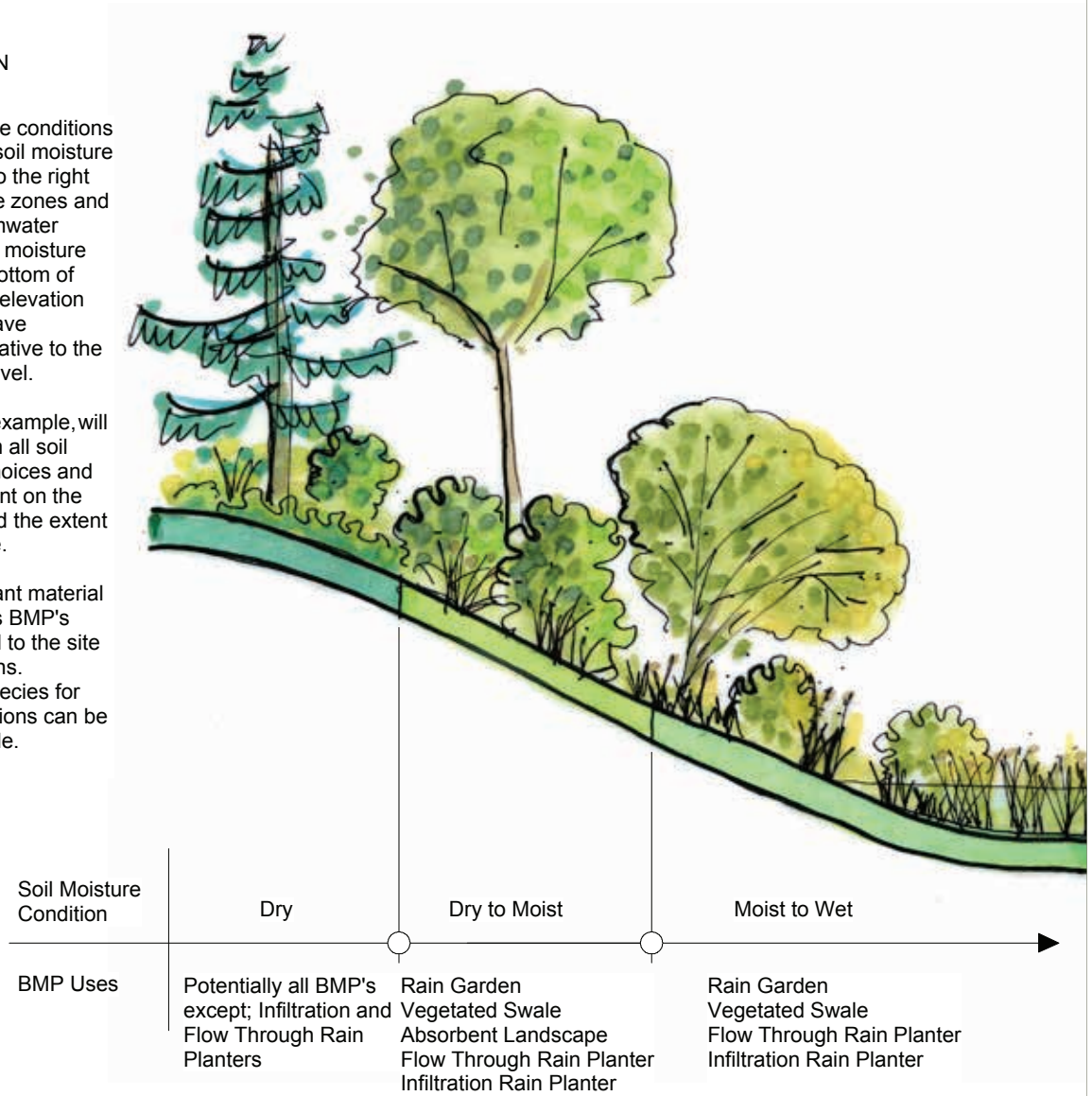


Figure 3. Rain Garden Planting Zones

## Rain Garden Planting Information

Plant material needs to fit the context and conditions of the site. Bioretention facilities are typically divided into 3 planting zones, the pool or wet zone, the side slope or dry to moist zone and the upper or dry zone (see Figure 3). The pool zone is inundated with water for extended periods of time during the winter, the side slope areas can see increase frequency of saturation as water levels rise in the winter, while the upper planting zone remains relatively dry throughout the year.

**Pool Planting Zone:** The planting strategy for this zone is to provide a year round pool bottom with plant material that facilitates water infiltration and occasional sediment removal activities. Plants must be adapted to prolonged periods of water inundation in the winter and summer drought condition. Roughly 80-90% of the planter bottom should be evergreen sedges and rushes with site adapted shrubs filling in the remainder. Appropriate evergreen sedges and rushes include *Juncus patens* 'Carmen's Gray' and other cultivars, *Carex obnupta*, and *Scirpus microcarpus*. Use of the native *Juncus effusus* is not advised due to its larger size and maintenance issues. *Juncus* cultivars are smaller, less aggressive and easier to maintain.

Shrubs suitable to this environment include *Spiraea douglasii*, *Myrica gale*, *Cornus sericea* cultivars, and *Physocarpus capitus*.

Tree species used in bioretention facilities must be adapted to winter water inundation and summer drought conditions (e.g., *Acer* spp., *Ginkgo biloba*, *Koelreuteria paniculata*, *Liquidamber styraciflua*, *Nyssa sylvatica*, *Quercus robur*, and *Tilia cordata*).

**Upper and Side Slope Planting Zone:** The strategy for this zone in the urban environment is to help delineate the edge of the rain planter from other uses. Recommended species include Dwarf cultivars of *Cornus sericea* ('Kelseyii', 'Arctic Fire'), *Spiraea japonica* spp., *S. bumalda* 'Goldflame', *Philadelphus lewisii*, *Myrica californica*, and *Vaccinium ovatum*. Groundcover should be incorporated into the edge of the planters to help suppress weed growth and to transition the planter into the surrounding landscape. Recommended groundcovers include *Frageria chiloensis*, *Arctostaphylos uva-ursi*, and *Oxalis oregano*.



Red Flowering Currant



Oceanspray

Technical aspects provided by:



Dry (>1.0 m above high water)			
Trees		Shrubs and Perennials	
<i>Acer glabrum</i>	Rocky Mountain Maple	<i>Amelanchier alnifolia</i>	Saskatoon
<i>Acer macrophyllum</i>	Bigleaf Maple	<i>Corylus cornuta</i>	Beaked Hazelnut
<i>Quercus garryana</i>	Garry Oak	<i>Gaultheria shallon</i>	Salal
<i>Sorbus sitchensis</i>	Sitka Mountain Ash	<i>Holodiscus discolor</i>	Oceanspray
<i>Thuja plicata</i>	Western Red Cedar	<i>Mahonia nervosa</i>	Dull Oregon Grape
		<i>Oemleria cerasiformis</i>	Indian Plum
		<i>Philadelphus lewisii</i>	Mock Orange
Groundcovers		<i>Polystichum munitum</i>	Sword Fern
<i>Armeria maritima</i>	Sea Thrift	<i>Pteridium aquilinum</i>	Bracken Fern
<i>Arctostaphylos uva-ursi</i>	Kinnickinnick	<i>Ribes sanguineum</i>	Red Flowering Currant
<i>Gaultheria shallon</i>	Salal	<i>Rosa gymnocarpa</i>	Baldhip Rose
		<i>Rosa nutkana</i>	Nootka Rose
		<i>Rubus parviflorus</i>	Thimbleberry
		<i>Vaccinium membranaceum</i>	Black Huckleberry
Dry to Moist (0.5 to 1.0 m above high water)			
Trees		Shrubs and Perennials	
<i>Acer glabrum</i>	Rocky Mountain Maple	<i>Cornus sericea</i> (+cultivars)	Red-osier Dogwood
<i>Alnus rubra</i>	Red Alder	<i>Lonicera involucrata</i>	Black Twinberry
<i>Crataegus douglasii</i>	Black Hawthorn	<i>Physocarpus capitatus</i>	Pacific Ninebark
<i>Populus trichocarpa</i>	Black Cottonwood	<i>Pteridium aquifinum</i>	Bracken Fern
<i>Rhamnus purshiana</i>	Cascara	<i>Rubus parviflorus</i>	Thimbleberry
<i>Thuja plicata</i>	Western Red Cedar	<i>Rubus spectabilis</i>	Salmonberry
		<i>Salix hookeriana</i>	Hooker's Willow
		<i>Salix lucida (lasiandra)</i>	Pacific Willow
Groundcovers		<i>Salix scouleriana</i>	Scouler's Willow
<i>Aruncus dioicus</i>	Goat's Beard	<i>Salix sitchensis</i>	Sitka Willow
<i>Athyrium filix-femina</i>	Lady Fern	<i>Sambucus racemosa</i>	Red Elderberry
<i>Blechnum spicant</i>	Deer Fern	<i>Spiraea douglasii</i>	Hardhack
<i>Oxalis oregana</i>	Oxalis or Sorel	<i>Vaccinium ovatum</i>	Evergreen Huckleberry
<i>Polystichum munitum</i>	Sword Fern		

Table 2. Plant recommendations for dry, dry to moist, and moist to wet zones in typical Rain Gardens.

Moist to Wet Soils- (0.5 above high water to 0.3 m deep) * locate in upper third of zone			
Trees		Shrubs and Perennials	
<i>Crataegus douglasii</i> *	Black Hawthorn	<i>Acer circinatum</i>	Vine Maple
<i>Malus fusca</i>	Pacific Crab Apple	<i>Cornus sericea</i>	Red-osier Dogwood
<i>Populus trichocarpa</i> *	Black Cottonwood	<i>Lonicera involucrata</i> *	Black Twinberry
<i>Prunus emarginata</i>	Bitter Cherry	<i>Lysichiton americanum</i>	Skunk Cabbage
<i>Rhamnus purshiana</i> *	Cascara	<i>Physocarpus capitus</i>	Pacific Ninebark
		<i>Rubus spectabilis</i> *	Salmonberry
		<i>Salix hookeriana</i>	Hooker's Willow
<b>Groundcovers</b>		<i>Salix lucida (lasiandra)</i>	Pacific Willow
<i>Asarum caudatum</i> *	Wild Ginger	<i>Salix scouleriana</i>	Scouler's Willow
<i>Carex mertensii</i>	Merten's Sedge	<i>Salix sitchensis</i>	Sitka Willow
<i>Carex obnupta</i>	Slough Sedge	<i>Sambucus racemosa</i> *	Red Elderberry
<i>Carex rostrata</i>	Beaked Sedge	<i>Spiraea douglasii</i>	Hardhack
<i>Carex sitchensis</i>	Sitka Sedge		
<i>Carex stipata</i>	Sawbeak Sedge		
<i>Juncus effusus</i>	Common Rush		
<b>Notes:</b>			
1. The following species should not be used due to their invasive nature:			
<i>Crataegus laevigata</i>	English hawthorne	<i>Phalaris arundinacea</i>	Reed canary grass
<i>Hedera helix</i>	English ivy	<i>Polygonum cuspidatum</i>	Japanese Knotweed
<i>Hypericum perforatum</i>	St. John's-Wort	<i>Daphne laureola</i>	Spurge-laurel
<i>Iris pseudacorus</i>	Yellow flag	<i>Vinca minor</i>	Periwinkle
1. Ornamental species may be used provided they are adapted to the site and BMP soil moisture conditions. The goal is to design a landscape that will require little if any irrigation once established.			

Table 2 cont'd. Plant recommendations for dry, dry to moist and moist to wet zones in typical Rain Gardens.

# Rain Garden Maintenance Recommendations

**Irrigation:** Plants should be selected to be tolerant of the Rain Garden's particular conditions. Watering should not be required after establishment (about 2 to 3 years). However, watering may be required during prolonged dry periods after plants are established. Water should be restricted to once per week during dry summer conditions.

**Erosion Control:** Inspect flow entrances, ponding area, and surface overflow areas periodically. Replace soil, plant material, and/or mulch in areas where erosion has occurred. Erosion problems should not occur with proper design except during extreme weather events. If erosion problems do occur, the following issues should be re-assessed: flow volumes from the contributing drainage area and Rain Garden size; flow velocities and gradients within the Rain Garden; flow dissipation and erosion protection methods in the pretreatment and in-flow areas. If sediment is deposited in the Rain Garden, immediately determine the source, remove excess deposits, and correct the problem.

**Plant Material:** Depending on plants selected and aesthetic requirements, occasional pruning and removal of dead plant material may be necessary. Replace all dead plants. However, if specific plants consistently have a high mortality rate, assess the cause and replace with appropriate species. Periodic weeding is necessary until groundcover plants are established. Weeding should become less frequent if an appropriate plant density has been used.

**Nutrients and Pesticides:** Growing Medium should be selected for optimum fertility, plant establishment, and growth within the particular conditions of each Rain Garden. Nutrient and pesticide inputs should NOT be required and will degrade the pollutant processing capability of the Rain Garden, as well as contribute to additional pollutant loading to receiving waters. By design, Rain Gardens are typically specified in watersheds where phosphorous and nitrogen levels are often elevated. Therefore, these should not be limiting nutrients with regard to plant health. If in question, have the soil analyzed for fertility.

**Mulch:** Replace mulch from bottom of fore-bay bi-annually where heavy metal deposition is likely (e.g., drainage areas that include commercial/industrial uses, parking lots, or roads). In residential or other settings where metal deposition is not a concern, replace or add mulch as needed to maintain a 2 to 4 inch depth at least once every two years. Soil mixes for Rain Gardens are designed to maintain long-term fertility and pollutant processing capability. Estimates from metal attenuation research indicate that metal accumulation should not present a toxicity concern for at least 20 years in Rain Gardens (USEPA 2000). Further, replacing mulch where heavy metal deposition is likely provides an additional factor of safety for prolonged bioretention performance. If in question, have soil analyzed for fertility and pollutant levels.



Maintenance Practices													
Procedure	Schedule (Month)											Frequency	
	J	F	M	A	M	J	J	A	S	O	N		D
Fertilize			*				*			*			3 times per year as per soil test
Mulch/Cultivate				/					/				Biannually
Plant		*	*	*	*					*	*		As required
Prune		*									*		As required
Repair	*	*	*	*	*	*	*	*	*	*	*	*	As required
Transplant	*	*	*								*	*	As required
Water				**	**	**	**	**	**	**	**		As required (see Municipal bylaws)
Weed Control			**	**	**	**	**	**	**	**	**	**	Remove weeds
Erosion Repair	*	*	*				*			*	*	*	As required
Sediment Removal				/									Annually
Mulch-maintain 50 mm depth				/					/				Bi-annually
Clean Inlets	**	**	**	*	*	*	*	*	*	**	**	**	As required
Clean Catch Basin					*								As Required
	J	F	M	A	M	J	J	A	S	O	N	D	

/ indicates required maintenance procedures \* indicates maintenance procedures to be done if necessary

Table 3. Recommended maintenance schedule for bioretention facilities and extensive green roofs for dry, dry to moist and moist to wet zones in typical Rain Gardens.

**Disclaimer:** To the best of their ability, the authors have ensured that the material presented in this factsheet is accurate and reliable. The design of engineered facilities, however, requires considerable judgment on the part of the designer. It is the responsibility of the Qualified Professional to ensure that techniques utilized are appropriate for a given situation.

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