

Vegetated Swales

Description: Vegetated Swales are a type of bioretention facility made of small Rain Gardens that are connected by rock lined swales or surface flow paths. They perform treatment, infiltration and conveyance functions. Vegetated Swales can be planted with evergreen and deciduous trees, shrubs, grasses, and ground cover species. To reduce the risk of erosion, check dams or weirs function to control flows and facilitate pooling of water in the 'Rain Garden' areas.

Common Uses: The Vegetated Swale is most applicable on sites with steeper slopes of 5 to 15% or sloped urban sites with land available for on-grade landscaping. This very flexible stormwater BMP can fit into most landscape designs. Numerous design configurations are possible. Vegetated Swales are the most cost effective and versatile BMP for sloped sites.

Limitations: As with Rain Gardens, Vegetated Swales cannot be used in areas with a high water table. The water table must be at least 1.2 m below existing grade. On slopes greater than 15%, Vegetated Swales require additional geotechnical engineering input. They are not suitable for installation over parking garages, below-ground structures, or on thin soils over bedrock.

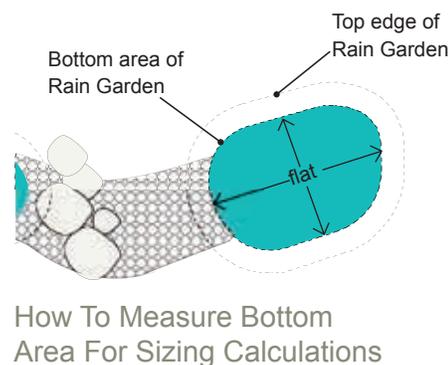
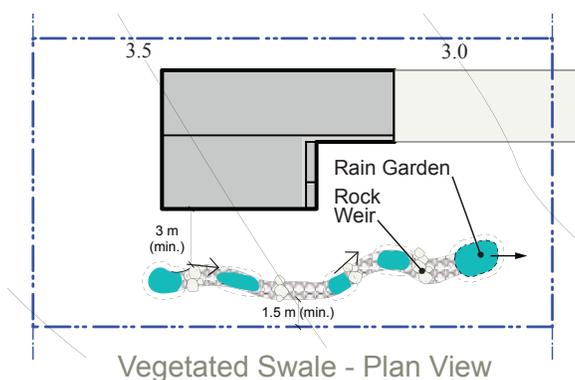
Size Factor: The size factor for the Vegetated Swale is 0.19 or (19%) based on the attached construction detail. In other words, an impervious area of 100 m² would require a Vegetated Swale of 19 m² to manage the runoff.



Street side Vegetated Swale
 High Street, Seattle



Vegetated Swale
 University of Victoria



Additional Expertise

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

Technical aspects provided by:



MATERIALS

- | | | |
|-------------------------------------|---|--------------------------------------|
| 1. Rock weir (300-400 dia.) | 5. Bioretention growing medium | 9. Overflow drain with beehive grate |
| 2. 25 mm - 25 mm dia drain rock | 6. 50% Sand/50% bioretention growing medium (mixed) | 10. 300 mm dia. (min) pipe |
| 3. 100 mm - 50-75 mm dia drain rock | 7. Scarified sub-soil | 11. Filter fabric |
| 4. 50 mm organic mulch | 8. Existing sub-grade | 12. 25 mm drain rock |
| | | 13. 100 mm dia. drain |

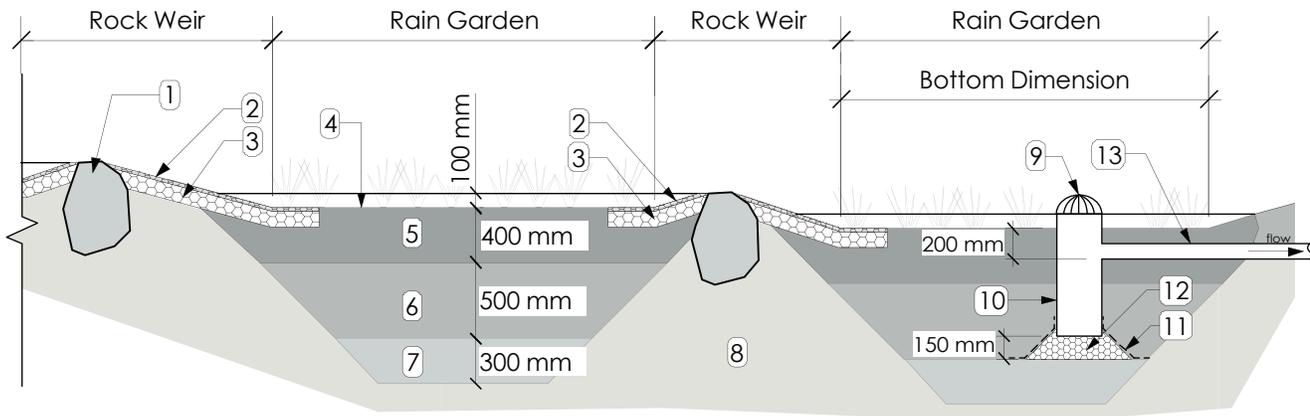


Figure 1. Vegetated Swale Profile

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) Width of Swale: 600 mm - 900 mm.
 - b) Depth of swale : 100 mm ponding depth
 - c) Longitudinal slope of entire swale: max. 15%
 - d) Slope of Rain Garden area: <0.5%
 - e) Side slopes of swale: 3:1 maximum.
- 3) Setbacks:
 - a) Rain Garden portion of swale must be 3.0 m downslope 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. Provide erosion control to avoid introducing sediment into the garden.
 - b) At point-source inlets, river rock to transition from inlets and splash pad to growing medium.
- 6) Outlet piping: shall be PVC Sch.40. 100 mm. 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 - specifications to follow.
 - b) Depth: 400 mm
- 9) Vegetation: Planting Information to follow.
- 10) Rock weirs: Shall be placed according to facility design. Rock weirs must span the bottom of the swale. An additional 300 mm of the side slope must be armoured to ensure flows to not end cut around the rock weir. Rock weir height can vary and will vary with design and site conditions. Height will be less than 450 mm. The crest of the downstream rock weir should be equal to or higher than the base of the rock weir immediately upstream (see profile). This will ensure rock weir stability during all flows.

Vegetated Swale 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 Vegetated Swale 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 Vegetated Swale, 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) a) Grab strength > 350N
- 1) b) Puncture strength > 200N
- 1) c) Apparent opening size <.4 mm
- 1) d) Flow rate > 100 l/m/m²

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.

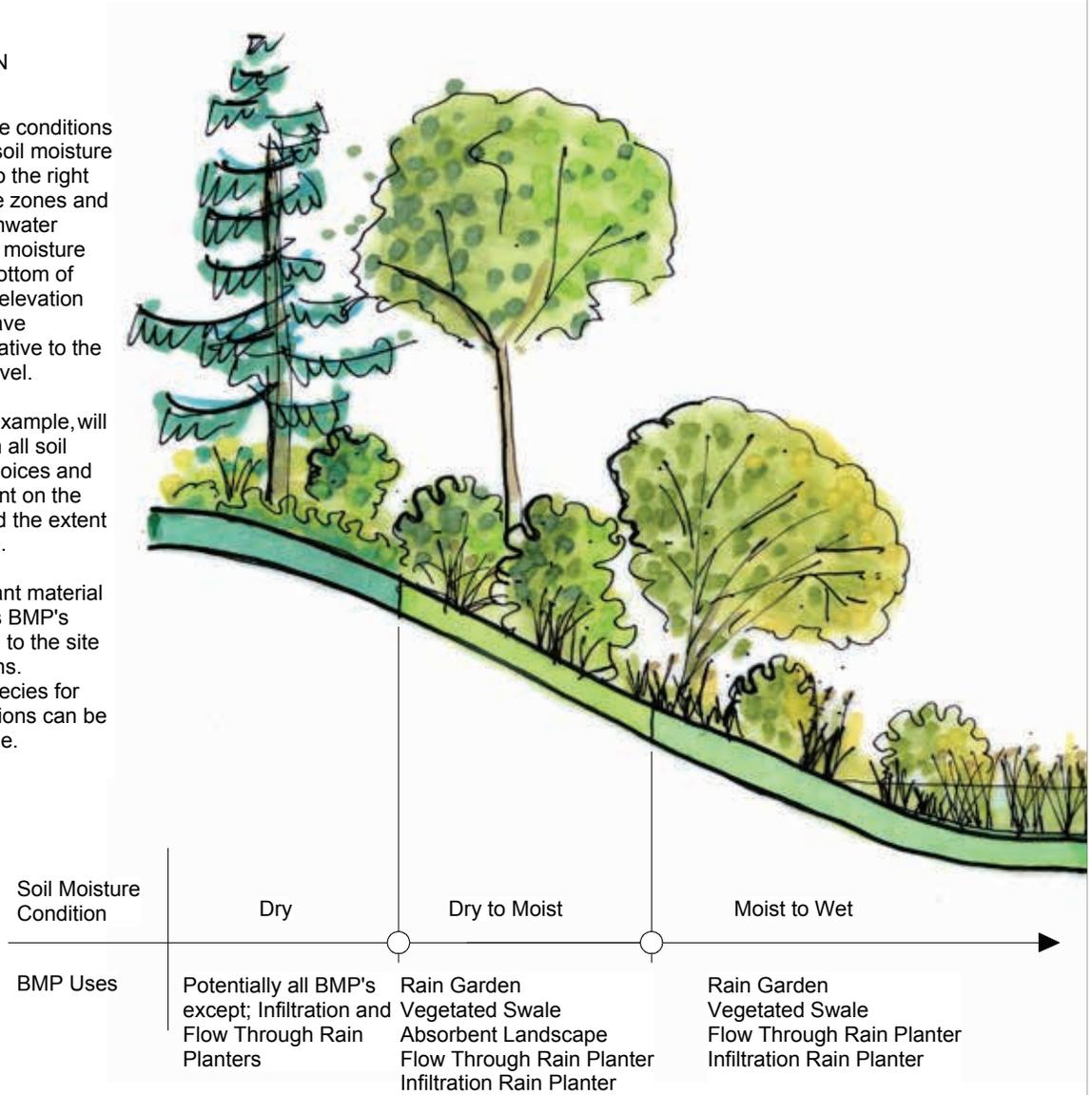


Figure 2. Bioretention Planting Zones

Vegetated Swale 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 green 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.



Oceanspray

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*, *Koeleruteria 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 *Fragaria chiloensis*, *Arctostaphylos uva-ursi*, and *Oxalis oregano*.



Red Flowering Currant

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
Groundcovers		<i>Philadelphus lewisii</i>	Mock Orange
<i>Armeria maritima</i>	Sea Thrift	<i>Polystichum munitum</i>	Sword Fern
<i>Arctostaphylos uva-ursi</i>	Kinnickinnick	<i>Pteridium aquilinum</i>	Bracken Fern
<i>Gaultheria shallon</i>	Salal	<i>Ribes sanguineum</i>	Red Flowering Currant
		<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
Groundcovers		<i>Salix lucida (lasiandra)</i>	Pacific Willow
<i>Aruncus dioicus</i>	Goat's Beard	<i>Salix scouleriana</i>	Scouler's Willow
<i>Athyrium filix-femina</i>	Lady Fern	<i>Salix sitchensis</i>	Sitka Willow
<i>Blechnum spicant</i>	Deer Fern	<i>Sambucus racemosa</i>	Red Elderberry
<i>Oxalis oregana</i>	Oxalis or Sorel	<i>Spiraea douglasii</i>	Hardhack
<i>Polystichum munitum</i>	Sword Fern	<i>Vaccinium ovatum</i>	Evergreen Huckleberry

Table 2. Plant recommendations for dry, dry to moist, and moist to wet zones in typical Vegetated Swales.

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
Groundcovers		<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		
Notes:			
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
2. 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 Vegetated Swales.