FACT SHEET

Sustainable Technologies
EVALUATION PROGRAM

Bioretention

Inspection and Maintenance of Stormwater Best Management Practices

Bioretention is a general term that refers to vegetated stormwater best management practices (BMPs) that temporarily store rainwater or snowmelt from roofs or pavements (i.e., stormwater runoff) in depressed planting beds or other structures (e.g., concrete planters). Bioretention treats stormwater by slowing it down, filtering it through soil and plant roots, soaking it into the ground and evaporating it back to the atmosphere. Runoff water is delivered to the practice through inlets such as curb-cuts, spillways or other concrete structures, sheet flow from pavement edges, or pipes connected to catchbasins or roof downspouts. The planting bed and side slopes are typically covered with a mixture of plants, mulch and stone. Water in excess of its storage capacity overflows to another BMP or the municipal storm sewer. Filtered water is either infiltrated into the underlying soil to replenish groundwater, or collected by a sub-drain (i.e., underground perforated pipe) and discharged to the storm sewer system or another BMP. Depending on the permeability of the underlying soil or other constraints, it may be designed with no sub-drain for full infiltration, with a sub-drain for partial infiltration, or with an impermeable liner and sub-drain for a no infiltration practice. The sub-drain pipe may feature a flow restrictor (e.g., orifice cap or valve) for gradually releasing detained water and optimizing the amount drained by infiltration. Key components of bioretention practices for inspection and maintenance are described in Table 1 and Figure 2.

Key components of bioretention to pay close attention to are the inlets, filter bed surface and overflow outlets. Trash, debris and sediment builds up at these locations and can prevent water from flowing into or out of the practice.

RELATED TERMS

Bioretention cell: A flat-bottomed, depressed planting bed containing filter media soil, a gravel water storage layer and optional sub-drain pipe(s); Also known as a **rain garden**.

Stormwater planter: A bioretention cell contained within an engineered (e.g., concrete) structure.

Biofilter: Bioretention cell or swale with an impermeable liner or containment structure and sub-drain.

Bioretention swale: A gently sloping, linear oriented bioretention practice designed to be capable of conveying water across an elevation gradient. Also known as a **bioswale** or **dry swale**.

BENEFITS

- Reduce the quantity of runoff and pollutants being discharged to municipal storm sewers and receiving waters (i.e., rivers, lakes and wetlands);
- Replenish groundwater resources and keep the flow of water to our rivers and lakes cool for temperature-sensitive fish like trout and salmon;
- Can be adapted to fit into many contexts (e.g., roadways, parking lots, plazas, parks and yards);
- Can provide a convenient area for snow storage and snowmelt treatment; and
- Can provide aesthetic value as attractive landscaped features.

Figure 1. Bioretention in residential area

TIPS TO HELP PRESERVE BMP FUNCTION

- Maintain grading of the filter bed (or grass filter strip if present) at curb-cut inlets so at least 5 cm of the back of the curb is visible through regular sediment removal and regrading;
- To avoid over-compaction of the filter media soil, any maintenance tasks involving vehicle or foot traffic on the filter bed should not be performed during wet weather;
- For bioretention with sod (i.e., turf grass) as vegetation cover, maintain with a push mower or the lightest mulching ride mower available and core aerate and dethatch annually in the spring to help maintain permeability;
- Pruning of mature trees should be performed under the guidance of a Certified Arborist;
- Woody vegetation should not be planted or allowed to become established where snow will be piled/stored during winter; and
- Removal of sediment from the filter bed surface should be done with rake and shovel, or vacuum equipment to minimize plant disturbance. If a small excavator is to be used, keep it off the BMP footprint to avoid damage to side slopes/ embankments and over-compaction of the filter media.

KEY COMPONENTS AND INSPECTION AND MAINTENANCE TASKS

Figure 2. Generalized plan and cross-section view of a bioretention cell showing key components

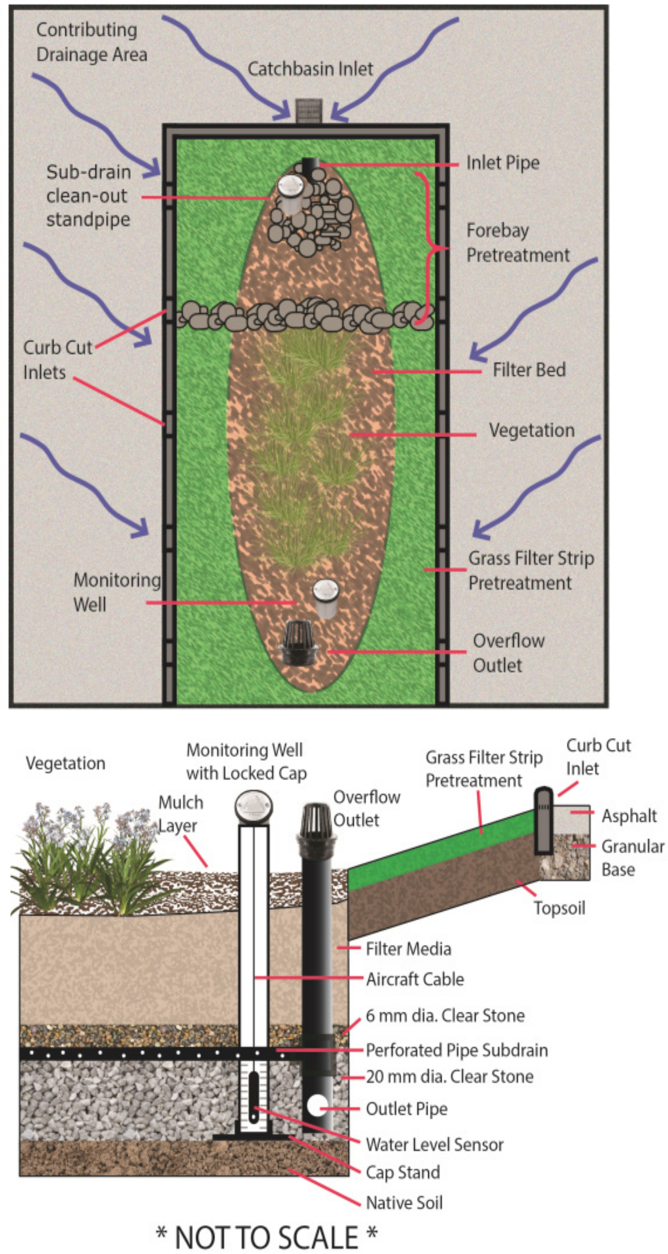

Figure 3. Biofilter swale retrofit within the road right-of-way

Table 1. Key components, descriptions and routine inspection and maintenance tasks.

Component	Description	Inspection and Maintenance Tasks
Contributing drainage area (CDA)	Area(s) from which runoff directed to the BMP originates; includes both impervious and pervious areas.	• Remove trash, debris and sediment from pavements (biannually to quarterly) and eavestroughs (annually); • Replant or seed bare soil areas as needed.
Pretreatment	Devices or features that retain trash, debris and sediment; help to extend the operating life cycle; examples are eavestrough screens, catchbasin inserts and sumps, oil and grit separators, geotextile-lined inlets, gravel trenches, grass filter strips, forebays.	• Remove trash, debris and sediment annually to biannually or when the device sump is half full; • Measure sediment depth or volume during each cleaning, or annually to estimate accumulation rate and optimize frequency of maintenance.
Inlets	Structures that deliver water to the BMP (e.g., curb-cuts, spillways, pavement edges, catchbasins, pipes).	• Keep free of obstructions; • Remove trash, debris and sediment biannually to quarterly; • Measure sediment depth or volume during each cleaning or annually to estimate accumulation rate and optimize frequency of maintenance; • Remove woody vegetation from filter bed at inlets annually.
Perimeter	Side slopes or structures that define the BMP footprint; may be covered by a mixture of vegetation, mulch and stone with slopes up to 2:1 (H:V), or concrete or masonry structures with vertical walls.	• Confirm the surface ponding footprint area dimensions are within ±10% of the design and that maximum surface ponding depth meets design specifications; • Check for side slope erosion or damage that compromises water storage capacity.
Filter bed	Flat or gently sloping area composed of a 0.5 to 1 m deep layer of filter media soil covered by a mixture of vegetation, mulch and stone where surface ponding and filtration of runoff occurs.	• Check for standing water, barren/eroded areas, sinkholes or animal burrows; • Remove trash biannually to quarterly; • Rake regularly to redistribute mulch and prevent sediment crusts; • Maintain 5 to 10 cm of mulch or stone cover to prevent weed growth and soil erosion; • Repair sunken areas when ≥ 10 cm deep and barren/eroded areas when ≥ 30 cm long; • Remove sediment when > 5 cm deep or time to drain water ponded on the surface exceeds 48 hours.
Vegetation	A mixture of deep rooting perennial plants, tolerant to both wet and dry conditions and salt (if receiving pavement runoff); can include grasses, flowers, shrubs and trees; roots uptake water and return it to the atmosphere; provide habitat for organisms that break down trapped pollutants and help maintain soil structure and permeability.	• Routine maintenance is the same as a conventional perennial garden bed; • In the first 2 months water plantings frequently (biweekly in the absence or rain) and as needed (e.g., bimonthly) over the remainder of the first growing season; • Remove weeds and undesirable plants biannually to quarterly; • Replace dead plantings annually to achieve 80% cover by the third growing season; • Do not apply chemical fertilizers.
Overflow Outlet	Structures that convey overflows to another BMP or municipal storm sewer.	• Keep free of obstructions; • Remove trash, debris and sediment biannually to quarterly.
Sub-drain	Optional component; perforated pipe(s) surrounded by gravel and may be wrapped in geotextile filter fabric; installed below the filter media soil layer to collect and convey treated water to an adjacent drainage system; may also include a flow restrictor.	• Include standpipes or access points to provide means of flushing the perforated pipe; • Keep pipe and flow restrictor free of obstructions by flushing annually; • Inspect flow restrictor frequently (e.g., biannually to quarterly).
Monitoring well	Perforated standpipe that extends from the bottom of the BMP to above the invert of the overflow outlet. Allows measurement of subsurface water level to track drainage performance over time.	• Standpipes should be securely capped on both ends and remain undamaged.

Figure 4. Urban bioretentions

REHABILITATION

Table 2. Key components, typical problems and rehabilitation tasks.

Component	Problem	Rehabilitation Tasks
Inlets	Inlet is producing concentrated flow and causing filter bed erosion	Add flow spreading device or re-grade existing device back to level. Rake to regrade damaged portion of the filter bed and replant or restore mulch/stone cover. If problem persists, replace some mulch cover with stone.
Filter bed	Local or average sediment accumulation ≥ 5 cm in depth	At inlets remove stone and use vacuum equipment or rake and shovel to remove sediment. For large areas or BMPs, use of a small excavator may be preferable. Restore grades with filter media that meets design specifications. Test surface infiltration rate (one test for every 25 m^2 of filter bed area) to confirm it is > 25 mm/h. Replace stone, mulch and plant cover (re-use/transplant where possible). If problem persists, add pretreatment device(s) or investigate the source(s).
	Surface ponding remains for > 48 hours or surface infiltration rate is <25 mm/h.	Remove sediment as described above. Core aerate (for sodded bioretention); or remove stone, sediment, mulch, and plant cover and till the exposed filter media to a depth of 20 cm; or remove and replace the uppermost 15 cm of material with filter media that meets specifications. Test surface infiltration rate (one test for every 25 m^2 of filter bed area) to confirm it is > 25 mm/h. Replace stone, mulch and plants (re-use/transplant where possible).
	Damage to filter bed or slide slope is present (e.g., erosion rills, animal burrows, sink holes, ruts)	Regrade damaged portion by raking and replant or restore mulch/stone cover. Animal burrows, sink holes and compacted areas should be tilled to 20 cm depth prior to re-grading. If problems persist, consider adding flow spreading device to prevent erosion or barriers to discourage foot or vehicular traffic.
Vegetation	Vegetation is not thriving AND filter media is low in organic matter (<3%) or extractable phosphorus (<10 mg/kg)	Remove stone, mulch and plant cover and uppermost 5 cm of filter media, spread 5 cm of yard waste compost, incorporate into filter media to 20 cm depth by tilling. Replace stone, mulch and plants (re-use/transplant where possible).
Sub-drain	Sub-drain perforated pipe is obstructed by sediment or roots	Schedule hydro-vac truck or drain-snaking service to clear the obstruction.

TYPES OF INSPECTIONS

Routine Operation: Regular inspections (twice annually, at a minimum) done as part of routine maintenance tasks over the operating phase of the BMP life cycle to determine if maintenance task frequencies are adequate and determine when rehabilitation or further investigations into BMP function are warranted.

Maintenance and Performance Verification: Periodic inspections done every 5 years (Maintenance Verifications) and every 15 years (Performance Verifications) post-construction over the operating phase of the BMP life cycle to ensure compliance with maintenance agreement (e.g., Environmental Compliance Approval permit) conditions, evaluate functional performance and determine when rehabilitation or replacement is warranted.

INSPECTION TIME COMMITMENTS AND COSTS

Estimates are based on a typical partial infiltration bioretention design (i.e., includes a sub-drain); estimates for other designs (i.e., full infiltration and no-infiltration) are described in the Low Impact Development (LID) Stormwater Management Practice Inspection and Maintenance Guide available at https://sustainabletechnologies.ca.

Table 3. Time commitments and costs for inspection

Bioretention	**Routine Operation**	**Maintenance Verification**	**Performance Verification**
Tasks to complete	18	15	15
Visits (per year)	2	1 every 5 years	1 every 15 years
Time (hours per m^2 BMP area)	0.012	0.010	0.010
Cost	$1.33	$0.66	$2.31
Performance Verification Options ($ per m^2 BMP area)			
Surface infiltration rate testing: $5.48, 5 tests			
Simulated storm event testing: $15.70			
Natural storm event testing: $15.00, 2 months monitoring			

Figure 5. Sediment removal in Spring

Table 4. Task cost estimates for maintenance and rehabilitation of a partial infiltration bioretention

Bioretention	**Costs per m^2 of BMP area**	
Tasks	**Min.**	**High**
Watering - first year only	$3.67	$3.67
Watering - second year only	$1.24	$1.51
Annual watering - Starts in year 3	$0.37	$0.73
Drought watering	$0.19	$0.19
Remove litter and debris	$0.33	$0.63
Prune shrubs or trees	$0.45	$0.45
Weeding	$0.31	$0.61
Sediment removal - starts year 2	$1.36	$2.71
Add mulch to maintain 5 to 10 cm - starts year 2	$3.77	$3.77
Replace dead plantings - starts year 2	$3.35	$6.69
Flush sub-drain - starts year 2	$0.59	$0.59
Rehabilitation (every 25 years)	$59.46	$59.46

Figure 5. Leaves clogging inlet to bioretention

For a detailed description of construction, inspection, maintenance and rehabilitation cost assumptions see section 7.1.7 of the LID Stormwater Management Practice Inspection and Maintenance Guide. To generate BMP-specific cost estimates use the LID Life Cycle Costing Tool available at https://sustainabletechnologies.ca.

Table 2. Construction and life cycle cost estimates

Bioretention	Costs per m^2 of BMP area + CDA	
	Minimum	High
Construction	$17.02	
LIFE CYCLE COSTS		
25 year evaluation period		
Average annual maintenance	$0.75	$1.08
Maintenance and rehabilitation	$21.33	$28.36
50 year evaluation period		
Average annual maintenance	$0.70	$0.98
Maintenance and rehabilitation	$39.09	$53.25

Figure 6. Continuous water level monitoring in a bioretention

Figure 7. Overflow pipe in bioretention

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For more detailed information on inspection, testing and maintenance of bioretention and a field data form (checklist) to use for collecting and recording inspection results, please refer to Appendix D of the Low Impact Development Stormwater Management Practice Inspection and Maintenance Guide, available at **https://sustainabletechologies.ca**.

For more information about STEP and other resources and studies related to stormwater management, visit our website or email us at **STEP@trca.on.ca**.

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