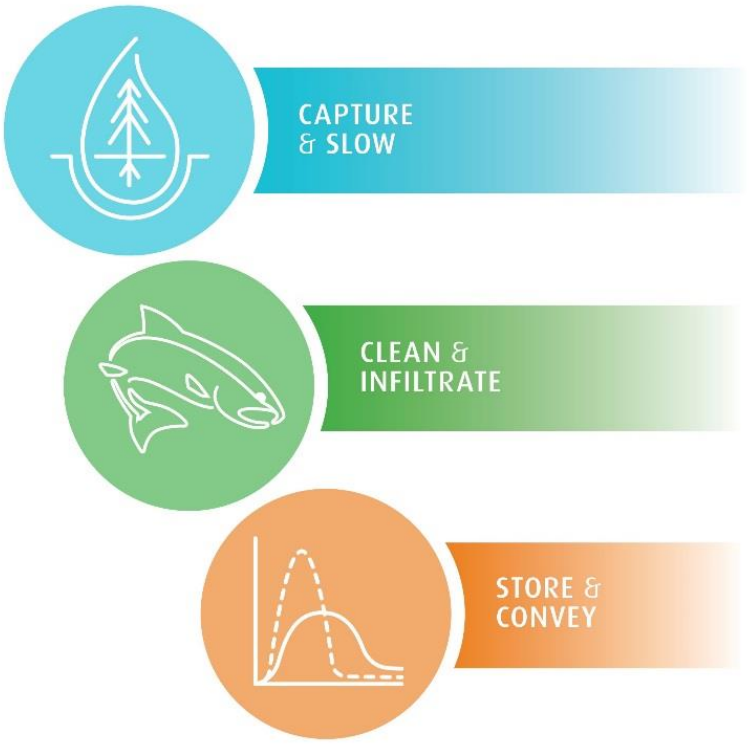

APPENDIX B - ABSORBENT LANDSCAPE

Green Stormwater Infrastructure Design Guidelines for the Capital Region

SPRING 2019

Absorbent Landscape[1]

Description

Most landscapes – either natural or manmade – act like a sponge to soak up, store and slowly release rainfall. In most natural wooded areas without paving and roof development, 90% of rainfall volume that lands on natural watersheds never becomes runoff, but is either soaked into the soils or evaporates. The trees, shrubs, grasses, surface organic matter, and soils all play a role in this absorbent landscape.

Stormwater Variables of Absorbent Landscape

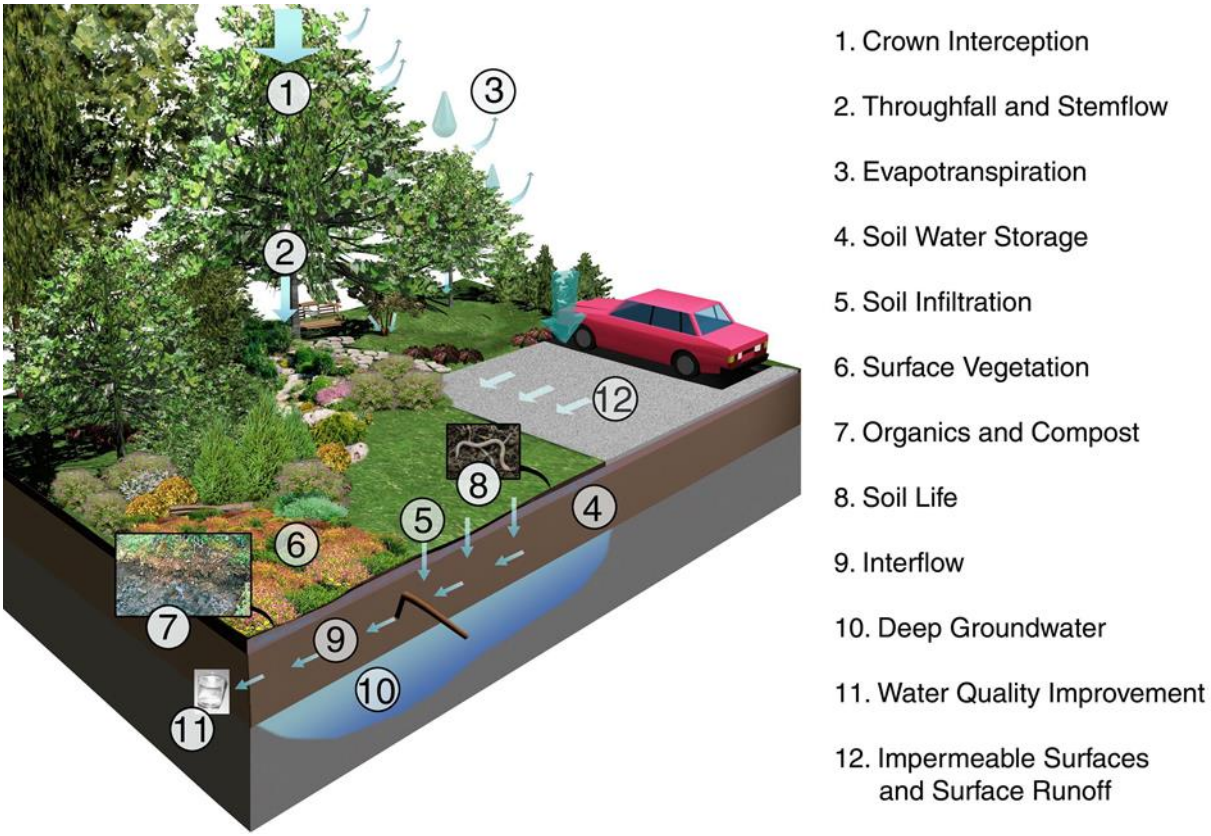

Figure 1 Shows a schematic representation of the 12 stormwater variables of absorbent landscape discussed below. Keeping these variables in balance is the key to successful stormwater source control using absorbent landscape.

[1] **Adapted with permission from Metro Vancouver.**
Original document: Metro Vancouver's Stormwater Source Control Design Guidelines 2012, primary author Kerr Wood Leidal Associates Ltd. with Lanarc Consultants Ltd and Goya Ngan, http://www.metrovancouver.org/services/liquid-waste/LiquidWastePublications/StormwaterSourceControlDesignGuidelines2012StormwaterSourceControlDesignGuidelines2012.pdf
Adaptations authored by: Opus International Consultants (Canada) Limited
Design guidelines drawings by: Kerr Wood Leidal Associates Ltd

Selection, Application and Limitations

- Top soil amendments have been found to have the greatest effect for managing stormwater during the heaviest rainfall events in the capital region.[2]
- Absorbent landscapes mimic the hydrologic function of undeveloped land on a development site. Its primary purpose is to absorb and infiltrate direct rainfall and has only limited capacity to accept and infiltrate runoff from impervious areas. Sites that drain large impervious areas into smaller areas risk overwhelming the absorbent capabilities of soil.
- Absorbent landscaping can accept runoff from disconnected roof leaders, sidewalks, and limited parking areas such as driveways. It may function best to achieve stormwater capture targets when combined with an overflow to an infiltration rock trench.
- Absorbent landscaping essentially consists of an absorbent layer of soil with vegetation. It differs from a rain garden in having:
  - no rock reservoir or subdrain
  - max. 2:1 ratio of impervious area to absorbent landscape
  - no ponding

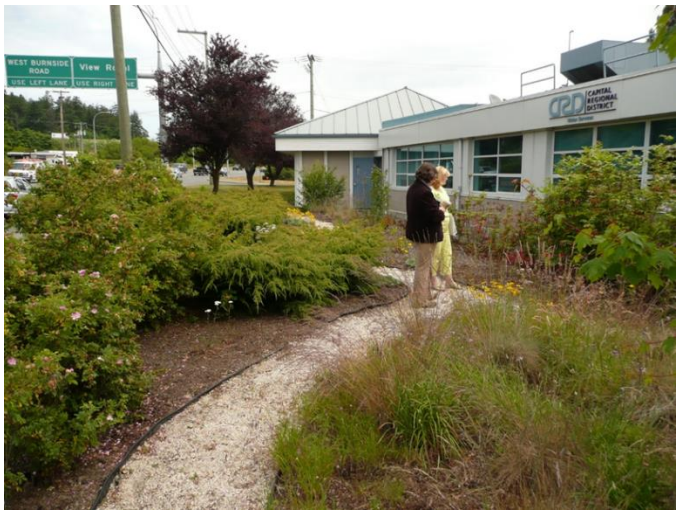

Figure 2 Absorbent landscaping at CRD office

- Where an impervious area is several times the area of an absorbent landscape, a rain garden should be considered instead.
- Absorbent landscapes need to be implemented properly to avoid conditions that would cause reduced infiltration at the surface due to sedimentation, excessive compaction, or lack of vegetative cover. Quality control is necessary regarding installed soil properties, erosion and sediment control, and establishment of vegetation.
- To meet typical performance targets (e.g., infiltrating the first 25–60 mm of rainfall), the amount of absorbent landscape area on a site or in a drainage basin must be balanced with the amount of impervious area. This will impact many aspects of urban design – e.g., by promoting building forms that minimize impervious building footprints, by placing landscape over parking or rooftops, or by designing narrower roads and larger landscape islands in parking areas.
- Trees in absorbent landscapes can greatly increase the absorption capacity of the area.
- A high level of scrutiny of any compost, growing media, amended soils or Bioretention Soil Mix brought to the site is highly recommended due to potential issues with invasive plant species.

[2] Chris Jenson, A Hydrologic Assessment of using Low Impact Development to Mitigate the Impacts of Climate Change in Victoria, BC, Canada, 2005 https://pics.uvic.ca/sites/default/files/uploads/publications/Jensen_Thesis.pdf

Design Guidelines

1. Detailed design requirements should be evaluated for each individual application based on site-specific constraints and objectives.
2. Follow all applicable federal, provincial and municipal regulations.
3. Geo-technical investigations are recommended with soil permeability testing being the minimum requirement for design. Advice from a professional engineer for design is recommended.
4. Maximize the area of absorbent landscape – either existing or constructed – on the site.

Figure 3 Pearkes Arena Absorbent Landscape, Photo Credit District of Saanich

5. Conserve as much natural forest land, existing trees and undisturbed soil as is compatible with the project. Provide temporary fencing of these protected areas during construction.
6. Minimize impervious area through such techniques as multi-storey buildings, narrower roads, minimum parking, larger landscape areas, green roof, and pervious paving.
7. Disconnect impervious areas from the storm sewer system, having them drain to absorbent landscape with only an overflow to the storm drainage system.
8. Generally, an absorbent landscape is designed to infiltrate the rain that falls on it and may infiltrate runoff from limited upstream impervious area; no more than 2:1 ratio of impervious area to absorbent landscape should be utilized.
9. Design absorbent landscape areas as gently sloping (2%), with overflow only occurring in large rain events.
10. Inflows from impervious area to absorbent landscape should be distributed sheet flow from pavement over a flat-panel curb, or through frequent curb cuts. A drop of 50 mm from the pavement or flat curb edge to the top of the absorbent landscape surface is required to accommodate sediment accumulation.
11. Where inflow is from curb cuts or point discharge (as in a disconnected roof leader/downspout), a transition area at the inflow point(s) should incorporate erosion control and flow dispersion to distribute flow to the full absorbent landscape area. Clean crushed rock or rounded river rock may be used. NOTE: not all municipalities allow for disconnected roof leader/downspout – check with municipality.
12. All designs should calculate the projected flows and water balance, and should provide for an overflow – surface or piped – to the major storm flood control system.
13. When planting, maximize the vegetation canopy cover over the site. Cover by multi-layered evergreen trees and shrubs is ideal, but deciduous tree cover also is beneficial for stormwater management.

14. Use native planting species where feasible. Non-native plantings with similar attributes to native may be suitable in conditions where natives would grow too large or not meet other urban design objectives.
15. Ensure adequate growing medium depth for both horticultural and stormwater needs – generally a minimum of 150 mm depth for lawn areas, and 450 mm depth for shrub/tree areas. In wetter areas of the capital region, near the mountains with till subsoil, a minimum growing medium depth of 300 mm for lawn areas is required to store 60 mm of rainfall.
16. Additional depth of weed-free growing media will be required where pervious areas are draining onto absorbent landscape.
17. Test growing medium for physical and chemical properties, and amend it to provide approximately 8% organic matter for lawns, and 15% organic matter for planting beds, in the upper 200 mm of growing medium. Ensure that all growing media is well aged and weed free.
18. Do not over compact landscape subgrade or growing medium. Optimum compaction is firm against deep footprints (about 80% Proctor Density). Excessive compaction reduces infiltration rates. Rip or till subsoil that is excessively compacted. Aerate compacted surface soil.
19. Scarify subgrade surfaces prior to placing growing medium, and rototill through layers of growing medium to create a transition in soil texture rather than discrete soil layers. Do not install soils in layers of different textures, as this can create barriers to infiltration.
20. Provide vegetative cover (grass, groundcovers, shrubs, trees) or organic cover (mulch, straw, wood fiber) to absorbent landscape as early as possible in the construction process, and prior to winter storms, to avoid surface crusting from raindrop impact and to maintain surface permeability.
21. Provide effective erosion control during construction, including erosion control on upstream sites that may flow into the absorbent landscape. Delay installation of constructed absorbent landscape until sources of potential erosion in the upstream drainage area have been permanently stabilized.
22. When planting trees, tree pit diameter should be at least 600 mm greater than the diameter of the root ball and the sides of the tree pit should be scarified. See Table 3 for soil volumes considerations for when planting trees.
23. Consider installing root barriers where potential for interference with infrastructure.
24. See Table 1 for setbacks for absorbent landscapes.

Sizing Absorbent Landscapes

Sizing for an absorbent landscape alone is fairly straightforward and a simplified sizing approach has been developed that does not require water balance modelling or continuous simulation.

1. In general, absorbent landscape area is sized to infiltrate the rain that falls directly on it, and may be designed to infiltrate runoff from a limited area of upstream impervious surface. The maximum ratio of impervious area to pervious area (I/P ratio) allowed will be 2:1. Pervious area refers to the absorbent landscape and the I/P ratio will be zero (0) where no impervious area is treated by the absorbent landscape.

2. Sizing presented here is for infiltration of rain water for "capture" and prevention of site runoff. Sizing and design according to this guide will generally provide water quality treatment for the volume of water infiltrated. If "water quality" criteria volumes are larger than "capture" volumes, additional sizing may be required and a professional engineer should be consulted.
3. The sizing process assumes that the area of absorbent landscape is constrained by the site and is used to determine the depth of soil required.

Table 1 Absorbent Landscape Setbacks

Setback From	Distance (m)
Down Slope of Building Foundation	1.5
Property Line	3
Drinking Water Well	30
Septic Field	3
Active or inactive landfill or contaminated site	30
Maximum slope	2%

Sizing for Depth Capture Criteria: R mm in 24 hrs

See Appendix A, Table 1 to determine R mm of rain in 24 hrs for area-specific rainfall capture targets – confirm with respective municipality.

1. Determine I/P ratio for the Absorbent Landscape:

$$\text{I/P ratio} = \frac{\text{Impervious Tributary Area}}{\text{Absorbent Landscape Area}}$$

2. Determine the soil depth required:

$$D_S = \frac{R \times (I/P + 1) - Ks \times 24}{0.2}$$

Where:
D_S = Depth (thickness) of amended soil (mm)
R = Rainfall capture depth (mm)
Ks = Saturated hydraulic conductivity of subsurface soil (mm/hr), as measured during winter saturated soil conditions.
I/P = Ratio of impervious tributary area to absorbent landscape area (unitless)

3. Check whether the calculated soil depth is within the standard depth range of 150 mm to 450 mm. If calculated depth exceeds 450 mm:

- The soil depth may be acceptable upon consultation (i.e., 500 mm soil may be acceptable if landscape designers concur);
- The I/P ratio may be reduced by routing runoff from a portion of the contributing impervious area to another facility and the soil depth recalculated; or
- Overflow from the absorbent landscape could be directed to a secondary GSI facility such as a rain garden or infiltration rock trench.

4. To determine the absorbent landscaping area:

$$Area = \frac{\text{Impervious } TributaryArea}{I/P}$$

Guideline Specifications

Materials shall meet Master Municipal Construction Document 2009 requirements, and:

1. Growing media or Bioretention Soil Mix: As per Table 2, but with required minimum saturated hydraulic conductivity of 70 mm/hr. As with bioretention materials, compaction of soils and mulch should be avoided to allow water to infiltrate properly and the GSI facility to function for absorption. No manual compaction should be necessary. Allow for natural settlement up to 20%.
2. Seeding: to Section 32 92 20 Seeding or 32 92 19 Hydraulic Seeding (note – sodding will be required for erosion control in most instances).
3. Sodding: to Section 31 92 23 Sodding.
4. Plantings: see Supplemental 1: Plant Templates & Plant Lists.

Construction Practices shall meet Master Municipal Construction Document 2009 requirements, and:

1. Maintain grass areas to mowed height between 50 mm and 150 mm, Landscape Maintenance standards shall be to the Canada Landscape Standard, 1st Edition, Maintenance Level 4: Open Space / Play Area.

Bioretention Soil Medium

Composition of Bioretention Soil Medium (BSM) is an important factor in the performance of GSI facilities. Soil mixes for bioretention and vegetated infiltration facilities need to balance 3 primary design objectives for optimum performance:

- ✓ High enough infiltration rates to meet desired surface water drawdown and system dewatering.
- ✓ A growth media to support long term plant and soil health and water quality treatment capability.
- ✓ Infiltration rates that are not too high in order to optimize pollutant removal capability.

For the latest information on bioretention soil research see the Washington Stormwater Center's webpage on Bioretention http://www.wastormwatercenter.org/lid-bioretention/. Below are 2 local BSM suggested mixes.

Table 2 Absorbent Landscape Bioretention Soil Mix (BMS)[3]

	Absorbent landscape Lawn BMS	**Absorbent Landscape Vegetated BMS**
Minimum Total Depth	300 mm	450 mm
Minimum required saturated hydraulic conductivity	70 mm/hr.	
Component (Partial size classes)	Percentage by Dry Weight	
Gravel (greater than 2.5 mm)	0	0
Sand (greater than 0.05 mm and less than 2.5 mm) • Sand to be hard, granular sharp sand well washed and free of impurities, chemicals or organic matter. • 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 0.0500 mm sieve	65-80	50-70
Silt (greater than 0.002 mm and less than 0.05 mm)	5-10	5-10
Clay (less than 0.002 mm)	2-5	2-5
Organic Content (% dry weight) – ensure weed free • must be well aged organics weed-free, preferably manure-free and biosolid free.	5-20	15-20
Other Soil Considerations		
• **pH** of mixed materials between 6-8.5 • **Safe Soils:** The spread and proliferation of invasive species through many regions of the province comes from the re-distribution of invasive species laden soils. In 2016, a Soils and Invasive Species Sub-Working Group was developed to explore province-wide solutions regarding the movement of soil and related materials that may contain invasive species. This Sub-Working Group involves provincial and local government representation. Learn more: Provincial Response to the Resolutions of the 2016 Union of British Columbia Municipalities Convention FEBRUARY 2017 B113 SAFE SOILS PROGRAM (page 111) http://www.ubcm.ca/assets/Resolutions~and~Policy/Resolutions/Provincial_Responses-2016_UBCM_Resolutions.pdf		

[3] Source: Absorbent Landscape, Stormwater Best Management Practices, District of Saanich
http://www.saanich.ca/assets/Community/Documents/Absorbent%20Landscape.pdf

Table 3 Soil Volumes per Tree[4]

	Minimum Volume of Bioretention Soil Mix	
Tree Size	**Single Tree**	**3 or More Trees**
Small	15 m^3	10 m^3
Medium	20 m^3	15 m^3
Large	30 m^3	20 m^3

[4] Minnesota Stormwater Manual, Examples of jurisdictions with minimum tree soil volume requirements, https://stormwater.pca.state.mn.us/index.php/Examples_of_jurisdictions_with_minimum_tree_soil_volume_requirements

Absorbent Landscape Design Example for Capture of R mm / 24-hour Criteria

Scenario Description

A landscaped area with absorbent topsoil is proposed to capture a portion of the runoff from a patio area.

The following parameters are known:

- Total patio area = 60 m^2
- Total landscaped area = 60 m^2
- 2-year 24-hour rain depth = 53 mm
- Capture target is 72% of 2-year 24-hour rain amount = 38 mm
- Native soil infiltration rate = 1.5 mm/hr

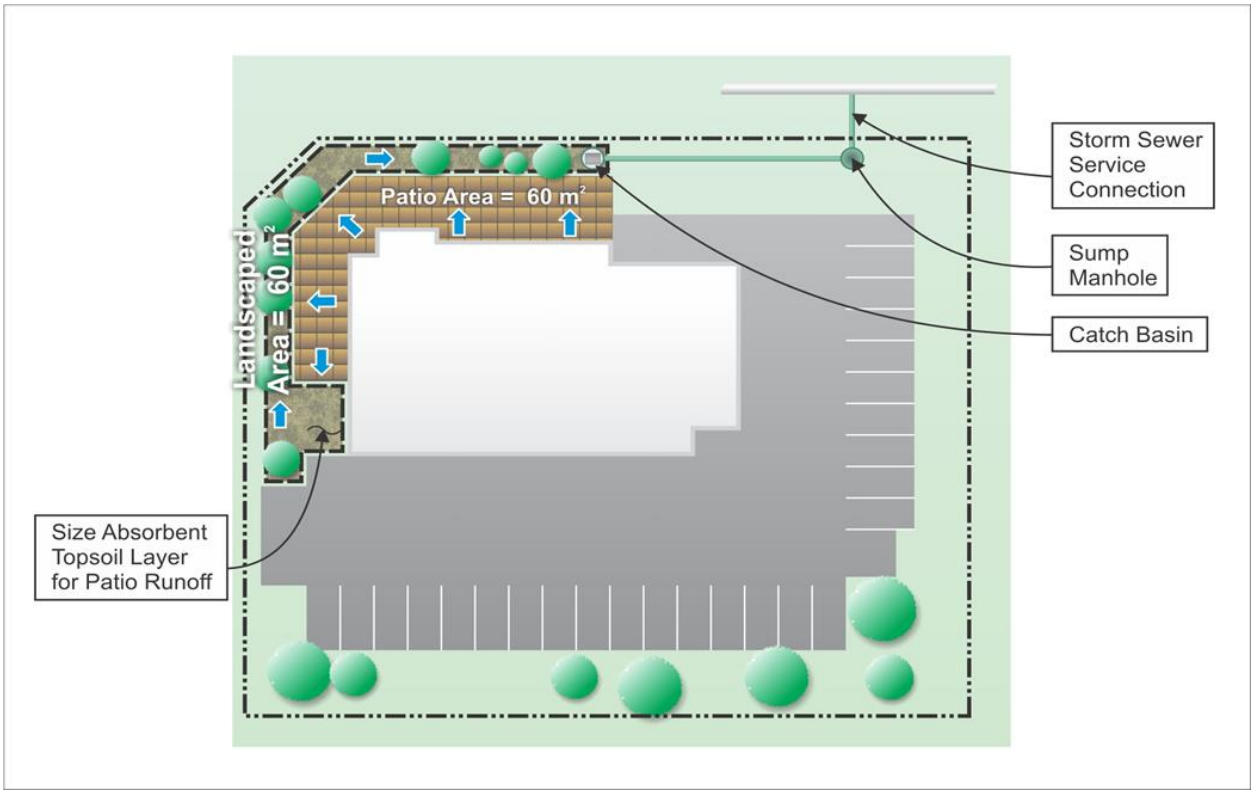

Figure 4 Example - Plan view of site with patio and landscape areas highlighted

Determine whether the landscaped area is large enough and the topsoil depth required.

Sizing

Determine the site I/P ratio:

$$I / P = \frac{60 sq.m}{60 sq.m} = 1.0$$

$$D_S = \frac{R \times (I / P + 1) - Ks \times 24}{0.2}$$

Where:

D_S = Depth (thickness) of amended soil (mm)

R = Rainfall capture depth (mm)

Ks = Saturated hydraulic conductivity of subsurface soil (mm/hr), as measured during winter saturated soil conditions

I/P = Ratio of impervious tributary area to absorbent landscape area (unitless)

$$D_S = \frac{38 mm \times 2 - (1.5 mm / hr \times 24)}{0.2} = 200 \text{ mm}$$

Hydraulic Components

- Inlet: The impervious patio runoff sheet flows onto the landscaped area.
- Overflow: The landscaped area grading must allow overland flow to a catch basin for minor flows and overland flow to the municipal major system (typically roadway surface) for any water that overwhelms the catch basin capacity.

GSI Driver Effectiveness – Runoff Reduction and Contaminant Removal

Absorbent landscapes consist of an absorbent layer of soils, mulch, and vegetation which slow the flow of stormwater runoff. Its primary purpose is to absorb and infiltrate rainfall and imperious area runoff (roof leaders, sidewalks and driveways). Up to 20% additional runoff can be reduced using an absorbent landscape versus a traditional pervious surface. As runoff passes through the vegetation, pollutants are removed through the combined effects of filtration, infiltration and settling. Estimates of facility effectiveness of runoff reduction and pollutant removal efficiencies are shown in Table 4.

Table 4 Absorbent Landscape: Runoff Reduction and Contaminant Removal

GSI Driver	Approximate % Reduction or Removal*
Capture & Slow – Volume Runoff Reduction	High to moderate
Store & Convey – Rate Control Delay Peak	High to moderate
Clean & Infiltrate – Water Quality Treatment	High to moderate
Total Phosphorus	25-98
Total Nitrogen	15
Trace metals	80
Hydrocarbons	80

Note:*performance will vary based upon site characteristics (i.e., parcel size, percentage of watershed, native soil type and depth, depth of amend soil/BSM, type and vegetation cover).

Sources:

http://www.lid-stormwater.net/bio_benefits.htm
http://www.deq.virginia.gov/fileshare/wps/2013_DRAFT_BMP_Specs/
https://stormwater.pca.state.mn.us/index.php/Information_on_pollutant_removal_by_BMPs
http://your.kingcounty.gov/dnrp/library/water-and-land/stormwater/juanita-retrofit/appendix-d-removal-rates.pdf
http://www.bmpdatabase.org/

Maintenance of Absorbent Landscapes

Maintenance of absorbent landscaping areas may include regular mowing, irrigation, and pruning. As well, re-grading may be necessary to reshape the absorbent landscaping area as sediments collect and form pools.

Further detailed maintenance tasks are listed in the procedures and checklists that follow.

Operation and Maintenance Procedures

The main tasks of maintenance and operations are to:

- Weed and replace dead plants once in the spring and once in the fall
- Inspect overflow monthly and keep free of debris
- Ensure stormwater is flowing to and through the absorbent landscaping areas
- Prevent or remove channelization, rilling, and erosion of the soils
- Maintain vegetation by removing weeds and replacing dead plants
- Remove accumulated sediment and debris
- Aerate soil profile by coring and de-thatching annually
- Test the infiltration capacity if there is a visible problem or once every 5 years
- Use watering bags for newly installed trees. Provide 90 litres of water once per week during normal conditions and 90 litres of water twice per week during drought conditions. Refer to municipal guidelines for more details.

The most intensive period of maintenance for absorbent landscaping areas is the first 2 years during plant establishment. During this period, regular watering, weed removal, and replanting may be required. As well, large loads of sediment could affect plant growth, particularly in areas with construction activity. After the vegetation is well established, the maintenance checklist should be used for 3 inspections per year; 1 in the spring, 1 in the mid-summer, and 1 in the fall.

Debris, if not removed, can be unsightly and block inlets; therefore, debris should be removed between inspections whenever it is observed on site. Lastly, inspections are recommended following large storm events to ensure the overall performance of the absorbent landscaping areas as well as to check for scouring.

Operation and Maintenance Inspection Checklist

The impervious patio runoff sheet flows onto the landscaped area?

- ❑ Is sediment accumulating at inflow points?
- ❑ Is there erosion at the flow dispersion device or other structures?
- ❑ Has there been damage due to vehicle or pedestrian traffic?
- ❑ Is there evidence of dumping (e.g., building waste)?
- ❑ Is the vegetation in satisfactory condition (e.g., density, weeds)?
- ❑ Is replanting required?
- ❑ Is mowing required?

NOTE: No Design Figures included in this Appendix