



User Guide for the Life-Cycle Costing Tool, version 2.0, December 2019

The water component of STEP is a collaborative of:





Overview

STEP is a multi-agency initiative developed to support broader implementation of sustainable technologies and practices within a Canadian context.

The water component of STEP is a conservation authority collaborative. Current partners are:



Lake Simcoe Region
conservation authority



Credit Valley
Conservation
inspired by nature



Toronto and Region
Conservation
Authority

Our key areas of focus are:

- Low Impact Development
- Erosion and Sediment Control
- Road Salt Management
- Natural Features Restoration

The STEP life-cycle costing tool: basic information

- Developed in 2013 to compare the life-cycle costs of LID BMPs, the STEP Life-Cycle Costing Tool allows users to estimate project costs based on model designs
- The tool's initial purposes was to compare life-cycle costs between LID BMPs, given a 2000 m² roof or road drainage area.
- The tool assumes that all drainage area inputs are fully impervious.
- The primary source for unit-cost data is RS Means. Research and conversations with suppliers and project managers inform the remaining unit costs
- The tool uses **model designs** to determine costs, which can be found below in the discussion of each BMP. Looking at these model designs can help users determine how to modify the tool for their own designs

Life-cycle costing tool 2.0: what's new

- Added wet pond to facilitate grey-green comparisons; added dry ponds as an LID practice
- Updated line costs to 2018 by using RS Means and through consultation with suppliers and project managers.
 - Note: unit costs are averaged for use across Ontario. To make the tool's unit costs more specific to your region, consult RS Means city adjustment rates and make the changes on the **Assumptions** sheet
- Refined algorithms to reflect line cost updates and standard construction practices
- Increased transparency and usability. Users can now access the tool's back-end to modify assumptions, unit costs, design defaults, etc.
- Added a land/opportunity cost option to all BMPs. This is to cover costs for land acquisition or LID, which is especially important for accurately estimating capital costs the opportunity costs forgone by using land for wet ponds.
 - The tool currently includes land cost options from an analysis done by LSCRA. Fill in the relevant types in the Assumptions sheet with land costs from your area. These fields default to "off" in the tool as downloaded from the STEP website

How to use the tool: general comments

- The tool is especially accurate when comparing costs between practices, whether between LID practices or between LID and more traditional wet and dry ponds, because it uses the same unit costs and methods for each
- The tool is completely open, so you can modify it to suit your needs. Take the time to review how it works. As your designs progress from conceptual to final, you can adjust the tool to increase its accuracy
- STEP conducted a sensitivity analysis using 6 completed projects. See the Life-Cycle Costing Tool Sensitivity Analysis for more information (available at sustainabletechnologies.ca)
- The tool is excellent for knowing whether a bid on a contract is reasonable or not. If the bid is too high, you may be overpaying, and if it's too low, you might not get what you were expecting.

Design guidance and using the tool

- Design defaults for each LID BMP align with latest guidance from the STEP WIKI Low Impact Development Planning and Design site (<https://wiki.sustainabletechnologies.ca>)
- Design defaults can be modified by users to align with their own project designs and objectives, but the defaults are kept in a separate column as a reference

Assumptions: key things to note

- The tool includes several assumptions. These assumptions can be altered on the **Assumptions** or **UnitCosts** sheets. Key assumptions to note:
 - Land costs
 - The current land costs are based on information collected from Lake Simcoe Region Conservation Authority. Because land values are specific to location and land-use type, STEP recommends updating these values to reflect local costs in your municipality or region. (Note: this assumption is found in the UnitCosts sheet, row 3)
 - Discount rate
 - Sound financial planning requires discounting future cash flows and expenditures. The tool default is 5 per cent, and the inflation rate is set at 3%, for a real discount rate of 2%. If your organization uses a different rate, you can easily change it on the **Assumptions** sheet.
 - Planning horizon
 - The planning horizon was set at 50 years. The tool also features an intermediate planning horizon which defaults to 30 years but can be adjusted. This latter number can be changed to fit your chosen planning window.
 - Maintenance
 - STEP has developed assumptions about maintenance for the BMPs in the tool. These include, e.g, frequency of watering over the first two years of a bioretention facility's life cycle, frequency and time required for infiltration testing for permeable pavers, and so on. If your organization uses different maintenance protocols, you can modify them on the **Assumptions** sheet

Overhead, profit, contingency, soft costs and mobilization

- RS Means unit costs include overhead and profit for the installing contractor. These rates are set at 10% of material costs, 10% of labour costs, 10 % of equipment costs, and additional labour burdens (e.g. employment insurance payments, pension, benefits)
- The LCCT adds an additional 10% to the subtotal of all construction costs to account for contingency and construction management. It does not calculate for design or engineering costs; these must be supplied by the user to develop full capital cost estimations.
- The LCCT does not calculate for other soft costs, e.g. permitting, administration, etc.
- Unit costs do not include mobilization and demobilization. The original tool assumes that the construction is greenfield. These costs can easily be added if required.
- The cost for retrofits is generally 16% higher than for greenfield development. This cost can be found on each BMP sheet in the Cost Summary section and can easily be added to construction totals.

Adjusting RS Means costs

- RS Means develops its unit costs by analyzing the American market
- LCCT costs are adjusted to Ontario values by using its City Cost Index. The tool defaults to an average of the adjustment rates given for all Ontario cities. To adjust the costs for your specific city or region, consult RS Means City Cost Index.

User feedback

- STEP welcomes user feedback. If you have a question, a concern, or a suggestion please let us know. We hope to make regular updates to the tool based on feedback from users and will list the changes made for each updated version.
- We also hope to do further sensitivity analyses, as time and resources permit.
- Primary contact: Kyle Menken at 905-670-1615 (ext. 389) or kyle.menken@cvc.ca

How to use the Life Cycle Costing Tool

Optimal Application for: Bioretention (showcase sheet),
Infiltration Trench, Permeable Pavers, Enhanced Grass Swales,
Rainwater Harvesting, and Wet and Dry ponds

Bioretention: showcase example on how best to use the tool

- Each design sheet has three main components: site and design information, capital costs, and maintenance and life-cycle costs
- Three site and design information comprise three sub-sections:
 - User inputs
 - Design defaults
 - Design calculations
- After explaining each sub-section you'll find a short tutorial on modifying construction and maintenance and life-cycle costs

Bioretention: user inputs

USER INPUTS		
Drainage area (DA)	2000	m ²
Native soil infiltration rate	15	mm/hr
Design type ¹	No Infiltration	Unitless
Drainage period	48	hours
BR surface area length to width ratio	8.125	Unitless
Does project land have an alternative 'best' use	No	Unitless

Drainage area for all BMPs in the tool is 100% impervious. For mixed pervious/impervious areas, calculate for total effective impervious area. The main point here is to make sure that the facility surface area is the same as the design.

Drainage period is calculated by dividing the ponding depth by the design infiltration rate

Design type: the Bioretention sheet can estimate costs for three model design types: full infiltration, partial infiltration, and no infiltration. See next three pages for model design details. You can easily modify the tool if your design departs from the model designs

Native soil infiltration rate: the design infiltration rate is determined using the native soil infiltration rate and the safety factor which is found in the design defaults section (see below)

The **length to width ratio** allows the tool to determine shape of the facility. This affects, e.g, the underdrain length required for the facility

Bioretention: land costs

USER INPUTS		
Drainage area (DA)	2000	m ²
Native soil infiltration rate	15	mm/hr
Design type ¹	No Infiltration	Unitless
Drainage period	48	hours
BR surface area length to width ratio	8.125	Unitless
Does project land have an alternative 'best' use	No	Unitless

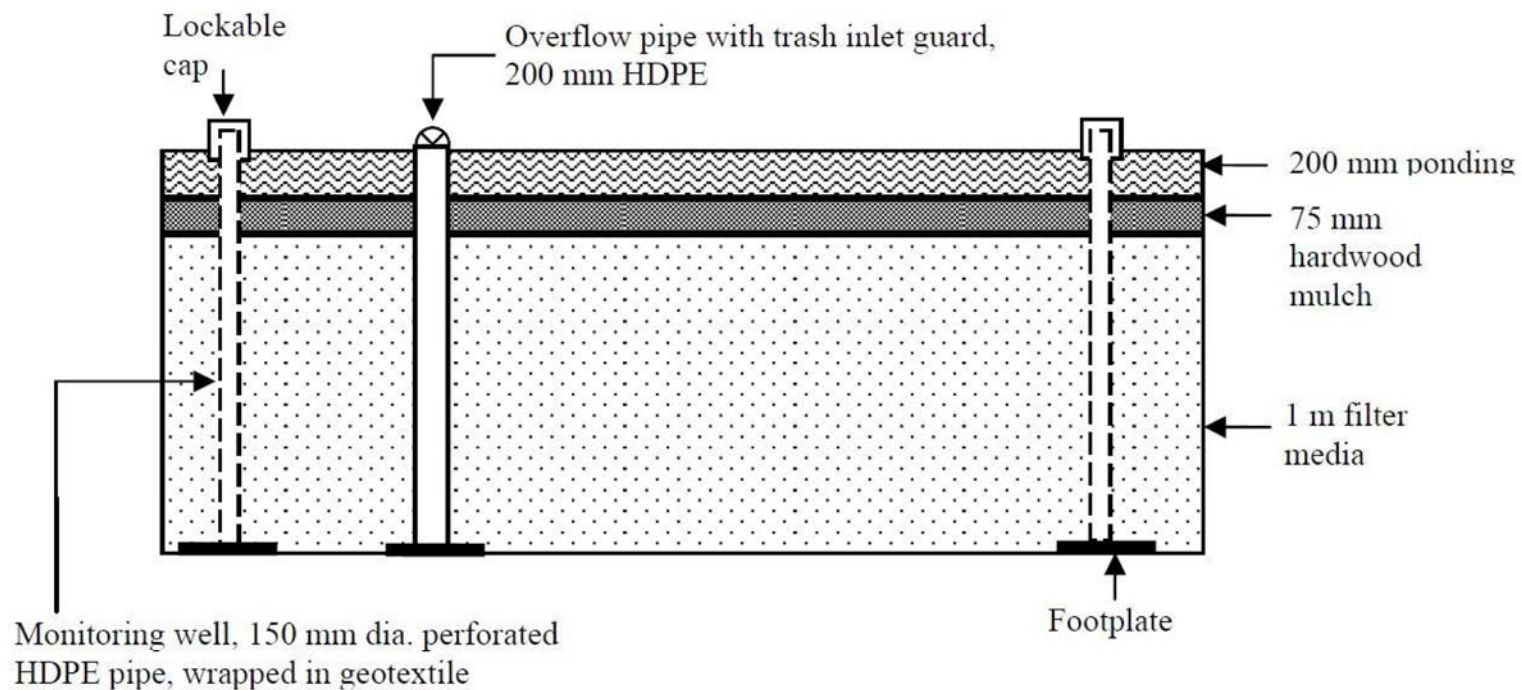
Does land have an alternative 'best' use: land costs can play a factor when : a) land needs to be purchased for a facility (capital expenditures) and b) that land has other possible uses (opportunity costs). The tool does not include land costs by default. To add land costs categories, use the land costs table on the **Assumptions** sheet.

Model designs

- The tool defaults to costing out model designs, developed in the initial report *Assessment of Life Cycle Costs for Low Impact Development Stormwater Management Practices*, released in 2013 and available at sustainabletechnologies.ca The following gives some of the plans, profiles and cross-sections from these designs to show what they look like; for the complete sets, see the original report. In some cases, design drawings given below or the original report.

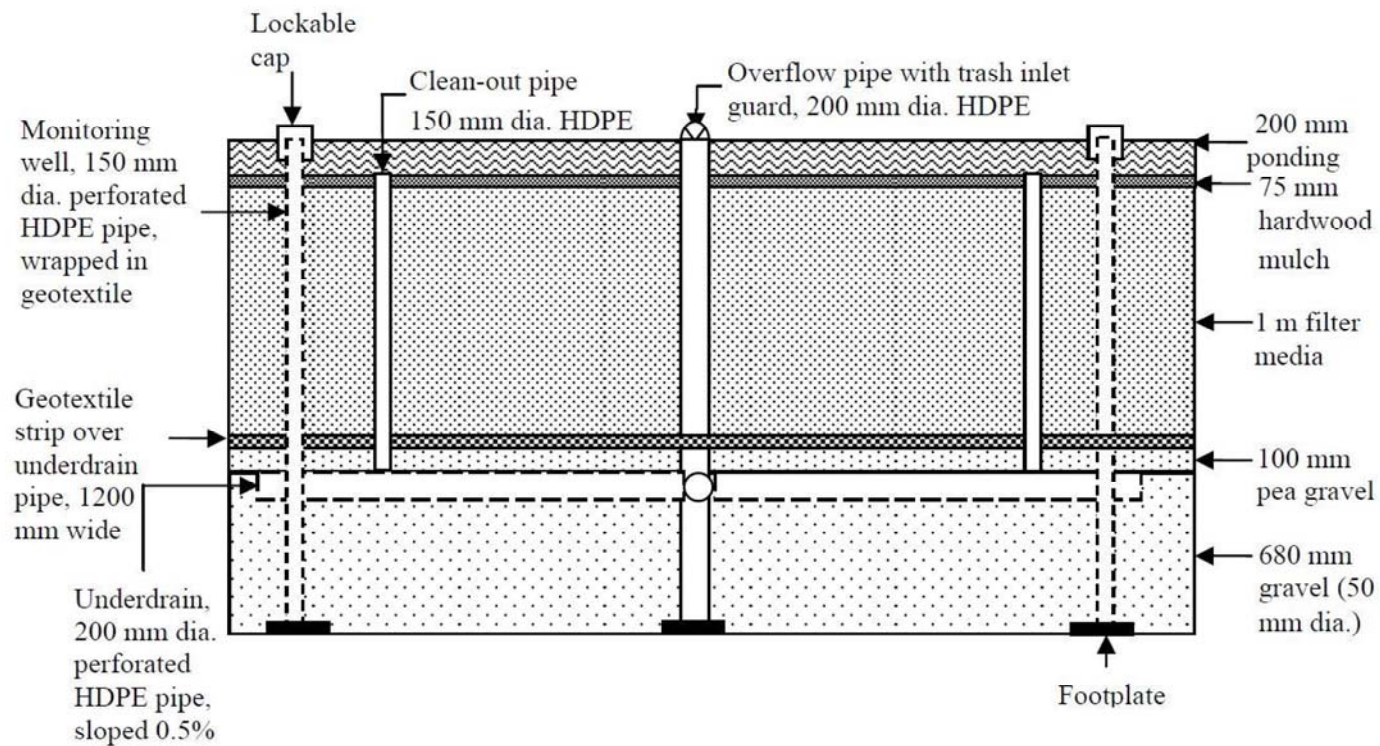
Bioretention: full infiltration

Full infiltration model. Because it lacks an underdrain and a gravel storage layer, it is the cheapest bioretention design.



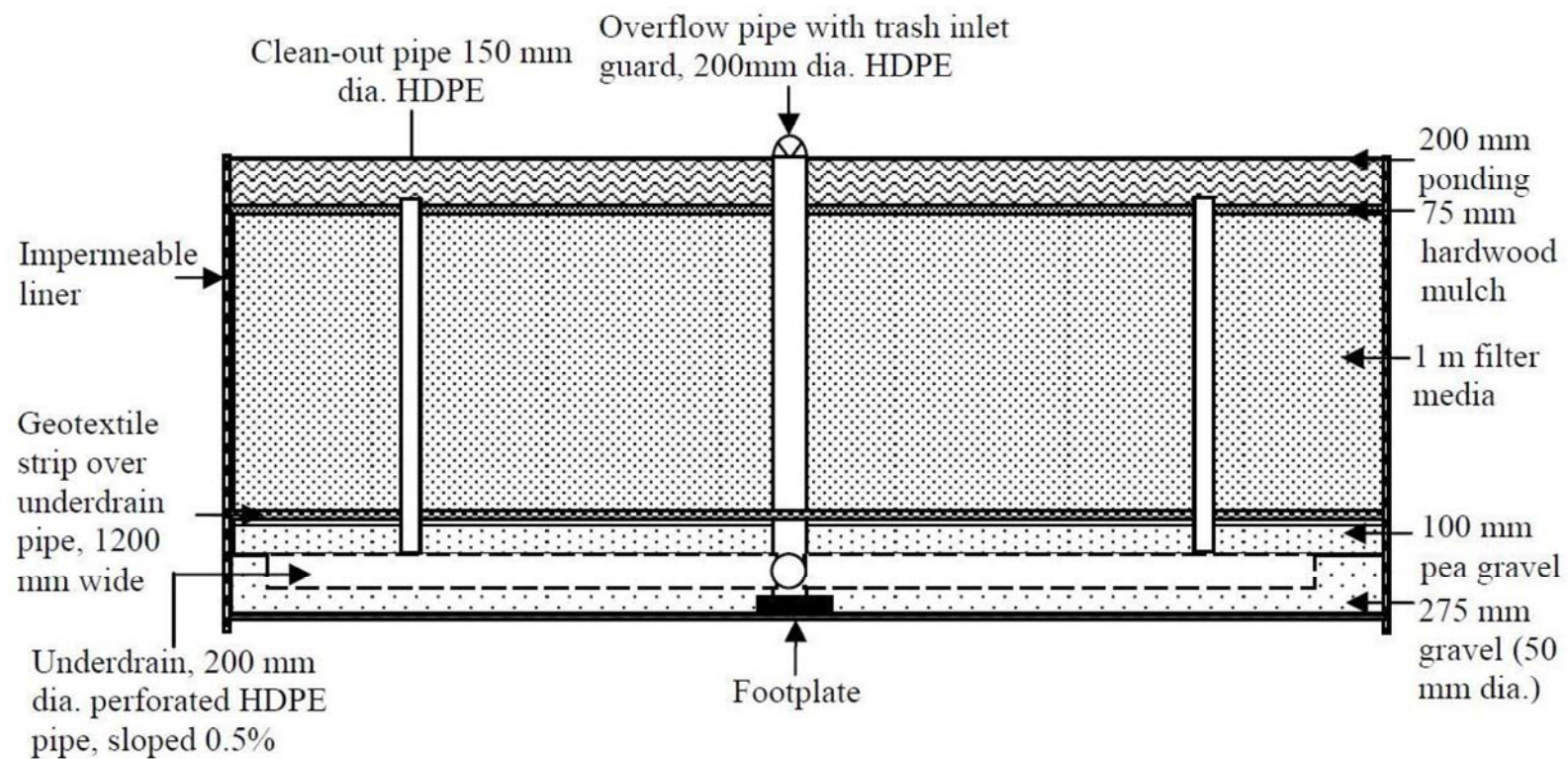
Bioretention: partial infiltration

Partial infiltration model design. Because it includes an underdrain and a gravel storage layer, it is typically the most expensive bioretention design type.



Bioretention: no infiltration

No infiltration model design. typically used when there are constraints on infiltration (corrodible pipes underneath the facility, groundwater contamination concerns). This model employs an impermeable liner and uses a smaller gravel storage layer than the partial infiltration model.



Bioretention: design defaults

DESIGN DEFAULTS	defaults	(values in col G can be changed)	
Maximum drainage area to surface area ratio	20	20	Unitless
Water Quality Volume Requirement	45	45	m ³ /ha
Filter Media Depth	1	1	m
Ponding depth	0.2	0.2	m
Safety factor	2.5	2.5	Unitless
Void ratio	40	40	%
Mulch depth	0.075	0.075	m

When using the STEP design defaults, the tool will price out a design made according to STEP design guidance, which users can find at wiki.sustainabletechnologies.ca. Altering the defaults changes the design calculations, which may or may not automatically affect price. For example:

- While STEP recommends a maximum 20:1 drainage area to practice surface area, space or financial constraints can dictate using even higher DA:SA ratios
 - Decreasing or increasing the drainage area to surface area ratio raises or lowers amount of excavation, filter media, gravel, etc., which in turn raises or lowers costs
- Water Quality Volume Requirement is set to 45 m³, which meets the MOECP's 2003 Stormwater Management Planning and Design Manual for 80% TSS removal for 100% impervious drainage areas
- Reducing the safety factor will increase the design infiltration rate. The default is set at 2.5. (STEP guidance suggests a value between 2 and 3.)
- Increasing the void ratio increases the water storage volume (see design calculations, next page), but does not change the type or price of gravel/crushed stone the tool uses. For more accurate results, users can change "UnitCostL84" to more closely meet material specifications
- Lowering the ponding depth (i.e., lowering the overflow pipe) reduces the maximum duration of ponding and also slightly lowers costs (by shortening the overflow pipe)

Bioretention: design calculations

DESIGN CALCULATIONS		
Pea gravel depth	0.10	m
Filter media depth	1.00	m
Gravel storage layer depth	0.68	m
Total depth ²	1.86	m
Underdrain diameter	0.20	m
Surface area (SA)	133.3	m ²
Length	32.9	m
Width	4.1	m
Maximum duration of ponding	50.0	hours
Water storage volume ³	98.9	m ³
Maximum rainfall captured	49.5	mm

You should verify that the calculations match your actual design as design details may vary from STEP BMP design guidance. Each design calculation cell can be altered to match your actual designs. However, **STEP recommends altering the defaults to provide the most accurate cost and to match the desired design outcomes.** The “Water storage volume” and “Maximum rainfall captured” outputs can aid designers with quantity targets in mind. [We should also add quality/volume alerts.]

DA/SA ratio is OK
Ponding period exceeds specified period, change ponding depth

If the ponding duration dictated by the design inputs is longer than the desired ponding duration, the tool flags this. Similarly for DA:SA ratio

Bioretention: capital costs

The "Capital Costs" sheet calculates pre-tax line costs by combining the design inputs with line costs pulled from the "Unit Costs" sheet. This table then adjusts these numbers using the "Cost adjustment" column on the right and tax is added

Capital cost line items can be adjusted by altering percentages in the "Cost adjustment" column. Users can also input additional costs in each sub-section

Land costs are turned "off" by default. To add land costs, modify the land cost table on the Assumptions page and turn land costs on in the User Input section (see above)

Not all sites will require curb-and-gutter with inlets around the circumference of the facility. Adjust this cost according to your designs for more accuracy

Most design sheets list multiple verification options, but usually only one is necessary. Note that only "Option #1: surface infiltration testing" is turned "on" as the default where that option exists.

Construction Costs

Construction Costs

Sales tax / HST (%)

13%

PRE-CONSTRUCTION		Unit	Cost	Cost
Test pits (2)	5	m ³	\$1,064	0%
Infiltration tests (2 per test pit)	4	tests	\$601	0%
Stakeout of utilities	1	visit	\$582	0%
Erosion and sediment controls:				
2" Submersible gas pump	3	days	\$104	0%
Silt sack in catchbasin	1	each	\$78	0%
Silt fence 2 m around excavation	50.6608	m	\$382	0%
Value of project land	100	m ²	\$0	0%
Add additional costs if necessary			\$0	
EXCAVATION				
Excavation	155.50	m ³	\$438	0%
Loading	15%	% of excavation cost	\$66	0%
Hauling	5.00	hours	\$1,021	0%
Safety fencing 6 m around excavation	89.00	m (1 week rental)	\$1,925	0%
Trenching for pipe to sewer	11.00	m	\$489	0%
Add additional costs if necessary			\$0	
MATERIALS & INSTALLATION				
Impermeable membrane	0.00	m ²	\$0	0%
Underdrain	10.00	m	\$734	0%
Clean out pipes (2 pipes)	2.25	m	\$77	0%
Overflow pipes	1.69	m	\$81	0%
Pipe to sewer	11.00	m	\$532	0%
Monitoring pipes	2.00	each	\$206	0%
Fittings (materials & labour)	Yes	\$	\$5,088	0%
Manhole adaptor	Yes	units	\$335	0%
Delivery	2.00	each	\$465	0%
Stone inlets	0.30	m ³	\$15	0%
Stone	56.00	m ³	\$2,809	0%
Pea gravel, including labour	10.00	m ³	\$597	0%
Geotextile	10.00	m ²	\$21	0%
Backfill	3.11	m ³	\$6	0%
Curbs & gutter with curb inlets	40.00	m	\$4,334	0%
Vegetation	66.67	m ²	\$6,334	0%
Wood mulch	7.50	m ³	\$99	0%
Filter media TOTAL	93.75	Lm ³	\$5,790	0%
Add additional costs if necessary			\$0	
INSPECTIONS				
Construction Inspections	5.00	visit	\$1,141	0%
Project Acceptance Inspections ⁴	2.50	visit	\$402	0%
Option #1: Surface infiltration testing	1.00	tests	\$316	0%
Option #2: Natural event testing	1.00	tests	\$0	-100%
Option #3: 6 months water level monitoring	1.00	tests	\$0	-100%
Add additional costs if necessary			\$0	
TOTALS				
Sub-total			\$36,136	
Overhead	10%		\$3,614	
Other	0%		\$0	
GRAND TOTAL			\$39,749	

The Top five construction costs are highlighted in red for each BMP sheet.

Bioretention: maintenance options

Maintenance and Life Cycle Costs

USERS: Choose your maintenance level. Defaults will populate the table below. Light green coloured cells can be modified.

Maintenance levels can be set at “high” or “low”. Depending on the design sheet, this can affect either the frequency of maintenance or its intensity – e.g., on the “high” option, core aeration is more frequent for vegetated filter strips, weeding costs are doubled for bioretention, etc.

Unit costs are calculated by taking user inputs (mostly facility size) and applying these inputs to per area costs, which are pulled from the **UnitCosts** and **Assumptions** sheets.

Users can change maintenance frequency by changing settings in the “Occurrence” column.

Select maintenance level -->	Low
Sales tax/HST (%)	13%

MAINTENANCE OPTIONS	Occurrence	Frequency (years)	Unit cost
Routine Operation Inspections	Periodic	1	\$343
Maintenance Inspections	Periodic	5	\$169
Performance Verification Inspections	Periodic	15	\$451
PV Option #1: Surface infiltration testing	Periodic	15	\$1,488
PV Option #2: Natural event testing	Ignore	15	\$0
PV Option #3: Simulated event testing	Ignore	15	\$0
PV Option #4: 6 months water level monitoring	Ignore	15	\$0
Watering - Year 1 only	Once	1	\$415
Watering - Year 2 only	Once	2	\$235
Annual watering - Starts in Year 3	Periodic	1	\$69
Drought watering	Periodic	5	\$6
Remove litter and debris	Periodic	1	\$71
Prune	Periodic	1	\$92
Weed	Periodic	1	\$65
Sediment removal - Starts Year 2	Periodic	1	\$302
Add mulch to maintain 75 mm - Starts Year 2	Periodic	2	\$971
Replace lost vegetation - Starts Year 2	Periodic	1	\$954
Unclog underdrain - Starts Year 2	Periodic	1	\$204
User added additional options	Periodic	n/a	\$0
User added additional options	Periodic	n/a	\$0
User added additional options	Periodic	n/a	\$0
User added additional options	Periodic	n/a	\$0
Rehabilitation	Periodic	25	\$11,812

For performance verification options, note again that only the first – “Surface infiltration testing” is “on” by default. All BMP sheets follow suit.

Bioretention: average annual maintenance and rehabilitation costs

LIFE CYCLE COSTING INPUTS	
Inflation Rate (%)	3%
Discount Rate (%)	5%
Construction Costs	\$53,347
Life Cycle Costing Results (present value, 50 years)	
Life Cycle Cost of Rehabilitation	\$11,819
Average Annual Maintenance Cost	
50 Year evaluation period	\$8,737
30 Year evaluation period	\$6,188

The tool calculates average annual maintenance costs by taking the frequency of maintenance, adjusting for inflation, then discounting. Some costs occur periodically rather than annually. For example, watering during the first two years only occurs after construction or rehabilitation of the facility in years 1, 2, 30 and 31, given rehabilitation of the facility in year 30. In addition, some common maintenance activities will not be required to the same extent during the rehabilitation years (e.g., weeding). The **LifeCycleCosts** sheet performs these calculations.

All scheduled maintenance costs are adjusted to present values using the discount rate in the **Assumptions** sheet.

Bioretention: summary and life-cycle costs

Cost Summary

Total construction costs	\$190,287.39
Construction cost break down	
Pre-construction	\$79,863
Excavation	\$8,940
Materials & Installation	\$80,781
Inspections	\$3,404
Project mgmt, overhead & other	\$17,299

Life Cycle Totals	
50 YEAR EVALUATION PERIOD	
PV of maintenance & rehabilitation	\$168,644
PV of all costs	\$358,931
30 YEAR EVALUATION PERIOD	
PV of maintenance & rehabilitation	\$114,497
PV of all costs	\$304,784

Estimated Retrofit Cost	
Percentage of total cost	16%
Total	\$30,445.98

The tool discounts future expenditures by 5% for their present value. You can change the discount rate in the **Assumptions** sheet.

The tool assumes that construction is greenfield. For **retrofit projects**, add this 16 per cent to the total construction cost for increased accuracy.

Enhanced Grass Swale

If the design includes **check dams**, be sure to specify check dam type. Both need to be activated in order for the tool to calculate dam costs.

Longitudinal slope determines the distance between check dams and, together with facility length, their number. STEP recommends slopes of 1% or less where possible and strongly suggests check dams for slopes over 3%. If check dams are included, the tool automatically includes them at all slopes to encourage infiltration. You can remove this cost on the "Construction Costs" table.

Minimum bottom width and side slope recommendations are set at these values to lower cost. STEP guidance suggests gentler slopes and wider swales where possible.

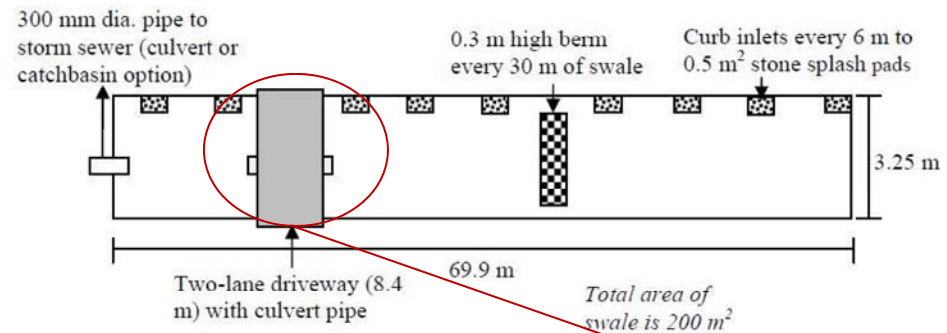
The tool automatically includes **curb and gutters** around the circumference of the facility. This is usually the highest line item cost. If your design does not include full curb-and-gutter, be sure to adjust it accordingly.

USER INPUTS			
Drainage area ¹	2000	m ²	
Option to stormsewer	Culvert	unitless	
Is there a driveway separating the EGS?	Yes		
Swale shape	Linear	unitless	
Longitudinal slope	1	%	
Check dams	Yes	unitless	
Check dam type	N/A	unitless	
Does project land have an alternative 'best' use	No	Unitless	
DESIGN DEFAULTS defaults (values in col G can be changed)			
Drainage area to swale area ratio ²	10	10	:1
Pipe to catchbasin length	5	5	m
Bottom width	0.75	0.75	m
Depth of swale	0.5	0.5	m
Side slopes	2.5	2.5	X:1
Driveway width	8.4	8.4	m
Compost depth	0.05	0.05	m
Driveway culvert diameter	0.03	0.3	m
TOOL RESULTS			
Check dam height	0.3	m	
Surface area at top	200	m ²	
Width at top	4.75	m	
Length of bottom	42.1	m	
Distance between check dams	30	m	
Number of check dams	1	unitless	

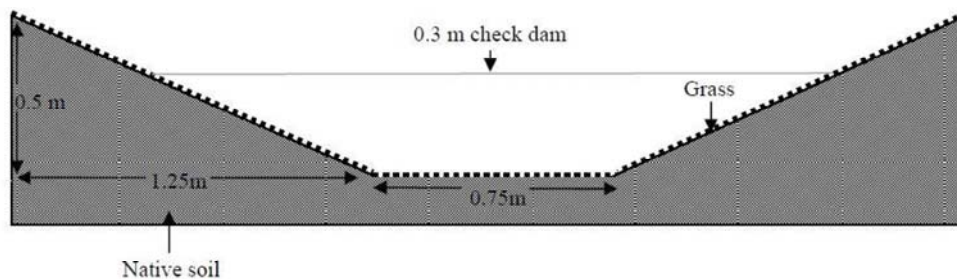
The tool assumes that the total volume of the enhanced grass swale (EGS) **requires excavation**. However, EGSs are often cost effective because they capitalize on existing swales or surface contours. Be sure to lower excavation costs on the **CapitalCosts** sheet if your swale requires less excavation.

Enhanced grass swale

Plan view



The too assumes one two lane driveway for each EGS. You can remove this cost, or add other driveways, in the capital costs table in the **EGSDesign** sheet.



Cross section

Vegetated filter strip

Minimum recommended flow length for a VFS is 5 metres, which is a default in the tool

This is a guideline only – in many cases, the tool will try to create a VFS much longer than is possible, given space constraints, than is included in the design. If you find this is the case for your design, increase this ratio

Vegetated filter strips do not have plans, profiles and sections for the model design, since they were not part of the initial 2013 study.

USER INPUTS			
Drainage area ¹	6000	m ²	
Longitudinal slope	1	%	
Outlet to storm sewer	Culvert	unitless	
Width	5.00	m	
Does project land have an alternative 'best' use	No	Unitless	
DESIGN DEFAULTS		defaults	(values in col G can be changed)
Maximum acceptable drainage area ratio	10	10.0	
Depth of swale	0.3	0.3	m
Compost depth	0.05	0.05	m
Pipe to catchbasin length	5	5.0	m
TOOL RESULTS			
Length		120.0	m
Drainage area to swale area ratio ²		10.00	:1
Surface area		600.0	m ²

Green roof

Building height determines what sort of crane is required, which determines this cost in the Construction Costs table.

The tool has two waterproof membrane options: EPDM (Ethylene Propylene Diene Monomer) and TPO (Thermoplastic Polyolefin)

The tool has is limited to green roof designs with 4 or 6 inch growth mediums.

Green roofs do not have plans, profiles and sections for the model design, since they were not part of the initial 2013 study.

The tool does not account for accessible green roofs, e.g. benches, pathways, etc.

USER INPUTS			
Building height		1 - 5	stories
Roof length		44	m
Roof width		44	m
Roof slope		2	%
Membrane		EPDM	unitless
Irrigation system		No	unitless
Growth medium		6	inches
Plants		mats	unitless
DESIGN DEFAULTS			
	defaults	(values in col G can be changed)	
Area of roof penetrations ¹	0.5	0.5	m ²
Vegetation-free zone width	0.5	0.5	m
TOOL RESULTS			
Roof drainage area		1936	m ²
Roof drains		5	each
Area of vegetation-free zones ²		116	m ²
Planted area		1820	m ²

Infiltration chambers

If the chambers take in road runoff, the tool will include an OGS unit for pre-treatment. For facilities receiving roof runoff only, OGS costs are not included. If you have sourced your own OGS costs or costs for another pre-treatment option, you can override the OGS costs or add the cost of alternative pretreatment method in additional costs cells in the “Construction Costs” table.

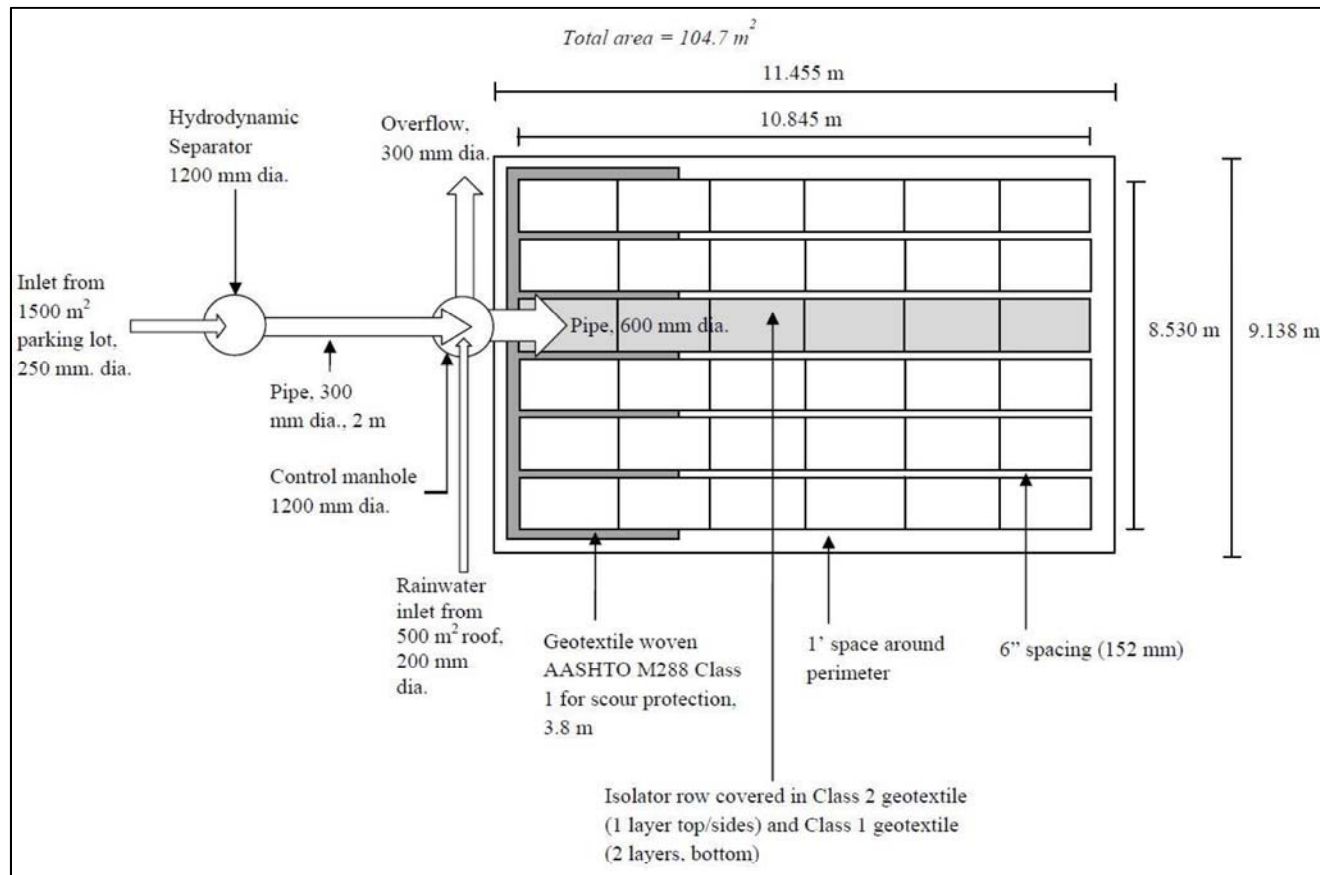
This sheet has two methods for determining sizing: a user specified DA:SA ratio or a rainfall capture requirement. If the rainfall capture version is chosen, the tool will calculate the DA:SA ratio in the “Tool Results” table. Similarly, if DA:SA is chosen, it will calculate the potential rainfall capture.

The default for land use is “no”. Because infiltration chambers are sub-surface, they are often compatible with other surface land uses – parking lots or lawns, for example. So, even when taking land acquisition or opportunity costs into the account, users might consider using a percentage of the land’s market value to reflect that sub-surface chambers are compatible with most other surface uses.

USER INPUTS		
Roof drainage area	5000	m²
Road drainage area	5000	m²
Maximum desired drainage period	48	hours
Inlet locations	1	Unitless
Infiltration rate of native soils	40	mm/hr
Length of the IC area (determines IC column length)	15	m
Design basis for sizing of facility	rainfall capture	Unitless
User specified DA:SA ratio	20	x:1
Rainfall captured	50	mm
Does project land have an alternative 'best' use	No	Unitless
DESIGN DEFAULTS		
	defaults	(values in col G can be changed)
Void ratio	40	40
Safety factor	2.5	2.5
Chamber height	0.762	0.762
Chamber width	1.295	1.295
Chamber length	2.169	2.169
Fill depth below asphalt	0.39	0.39
Asphalt base depth	0.3	0.3
Asphalt depth	0.05	0.05
Bedding depth below & above chambers, 50 mm	0.1524	0.1524
TOOL RESULTS		
Total drainage area (DA)	10000	m²
Drainage type	Road & Roof	Unitless
Storage volume of a single chamber	1.39	m³
Number of chambers recommended¹	228	Chambers
Total length of chamber installation area²	13.6	m
Total width of chamber installation area	55.5	m
Total depth of chambers & bedding	1.067	m
Surface area of excavation (SA)	755.5	m²
Total drainage area to surface area ratio (DA:SA)³	13	x:1
Water storage volume	512.36	m³
Potential rainfall capture	51.24	mm
Estimated drainage period	42.4	hours
Does this satisfy the drainage period target?	Yes	Yes/No

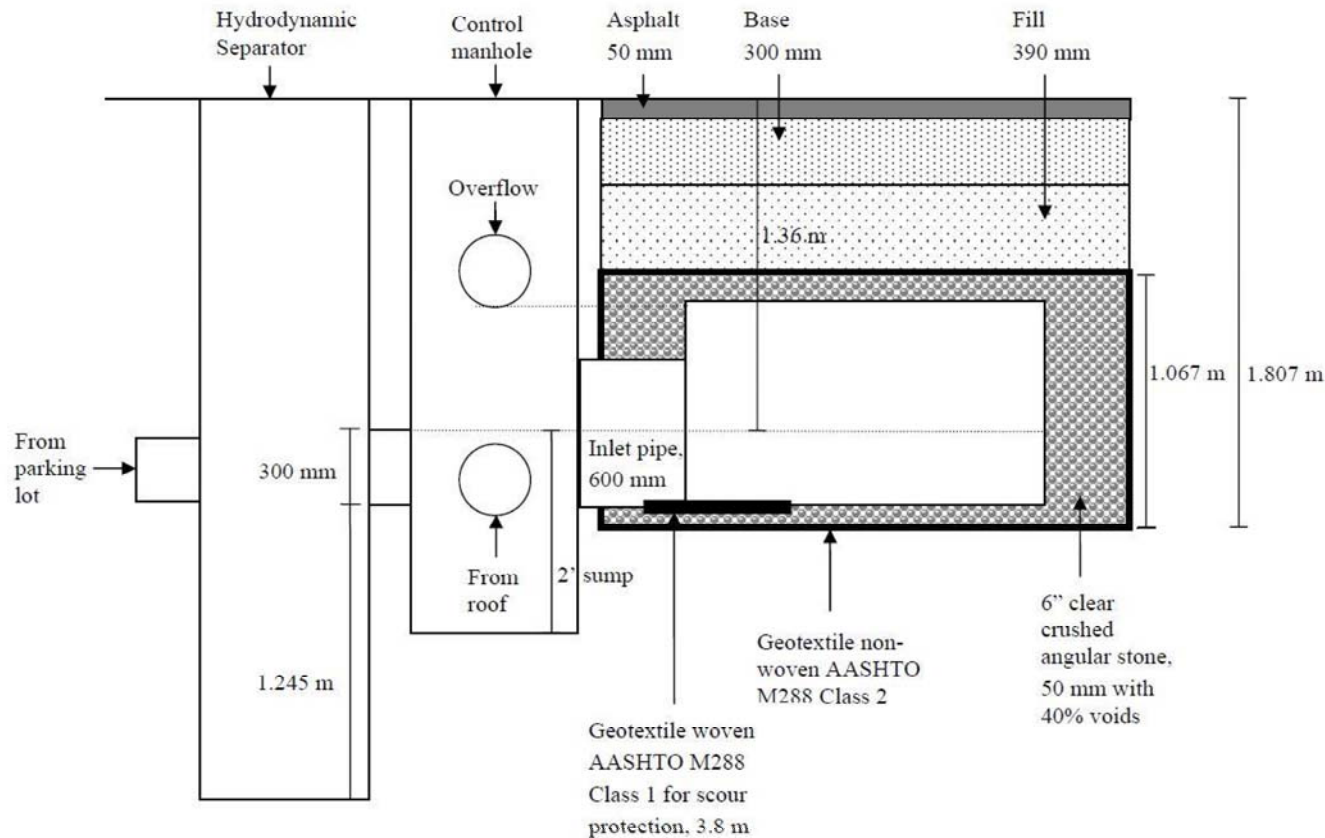
Infiltration chambers

Plan view for chambers receiving roof (1500 m²) and road (500 m²) runoff.



Infiltration chambers

Cross section for chambers receiving roof (1500 m²) and road (500 m²) runoff.



Infiltration trench

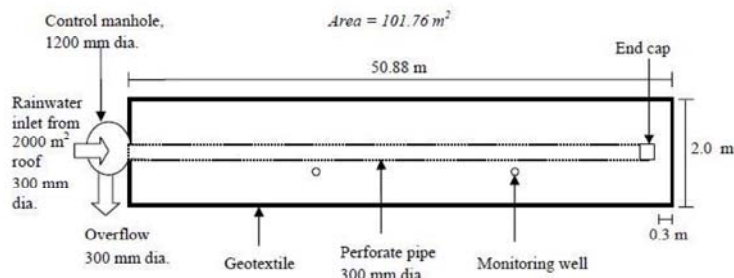
If the trench take in road runoff, the tool will include an OGS unit for pre-treatment. For facilities receiving roof runoff only, OGS costs are not included. If you have sourced your own OGS costs or costs for another pre-treatment option, you can override the OGS costs or add the cost of alternative pretreatment method in additional costs cells in the "Construction Costs" table. Non road runoff sources should be inputted as coming from roof source.

Decreasing the drainage period increases trench length but decreases trench depth, and vice versa. The longer the drainage period, the lower the cost.

Increasing the rainfall capture target increases trench length, which increases cost.

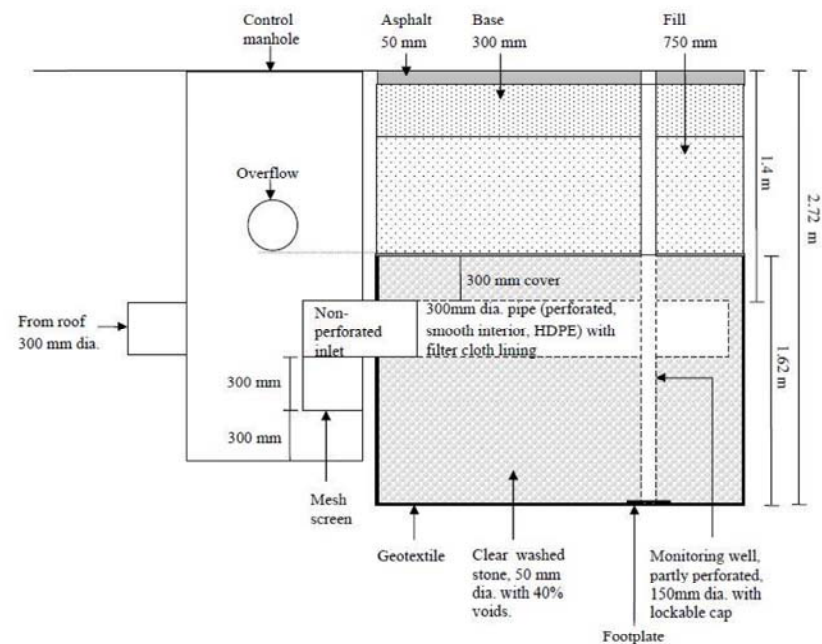
USER INPUTS			
Roof drainage area		1000	m2
Road drainage area		1000	m2
Drainage period		36	hours
Inlet locations (manholes)		1	Unitless
Infiltration rate of the subgrade		15	mm/hr
Rainfall capture target		25	mm
Does project land have an alternative 'best' use		No	Unitless
DESIGN DEFAULTS		defaults	(values in col G can be change)
Safety factor	2.5	2.5	Unitless
Void ratio	40	40	%
Width of trench	2	1.00	m
Maximum acceptable drainage area ratio	20	20.0	x:1
Asphalt base depth	0.3	0.3	m
Asphalt	0.05	0.05	m
TOOL RESULTS			
Total drainage area (DA)		2000	m2
Drainage type		Road & Roof	Unitless
Depth of trench 1		0.22	m
Length of trench		388.2	m
Surface area of trench		388	m2
Drainage ratio		5.15	x:1
Rainfall captured		25	mm
Total drainage area to surface area ratio (DA:SA)2		5.2	x:1, unitless
Water storage volume		50.0	m3

Infiltration trench: roof only

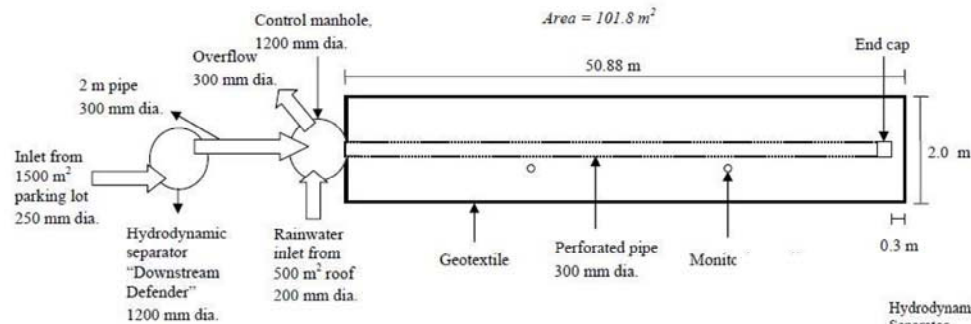


Roof runoff only – plan view

Roof runoff – cross section

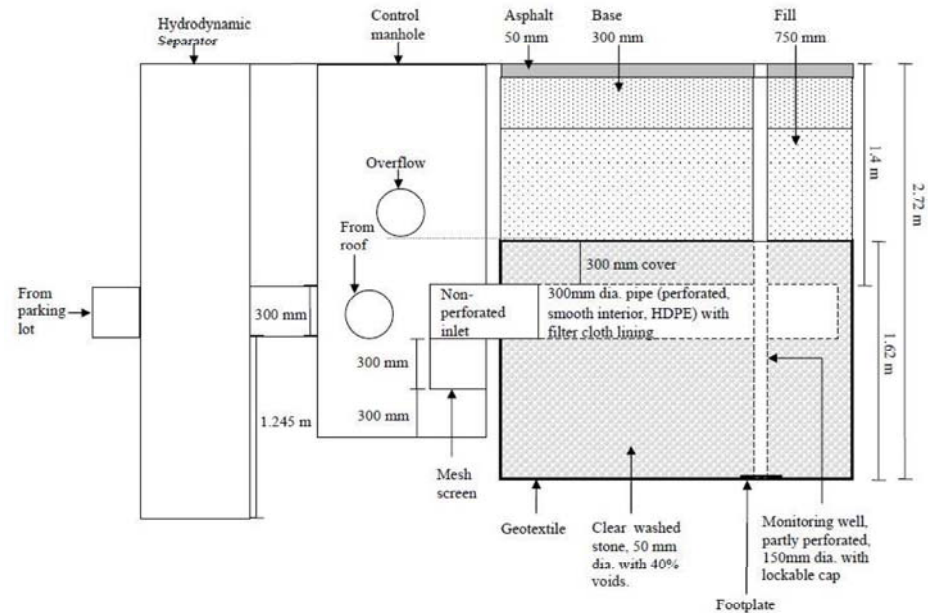


Infiltration Trench – roof and road runoff



Plan view

Cross section



Permeable pavers

Drainage area and impermeable area are not additive – the drainage area input gives the total area, of which the impermeable area is a part

The three model designs (full, partial, and no infiltration) are found below. Full is cheapest, partial is in the middle, and no infiltration more expensive

For vehicle use, 80 mm is the minimum thickness

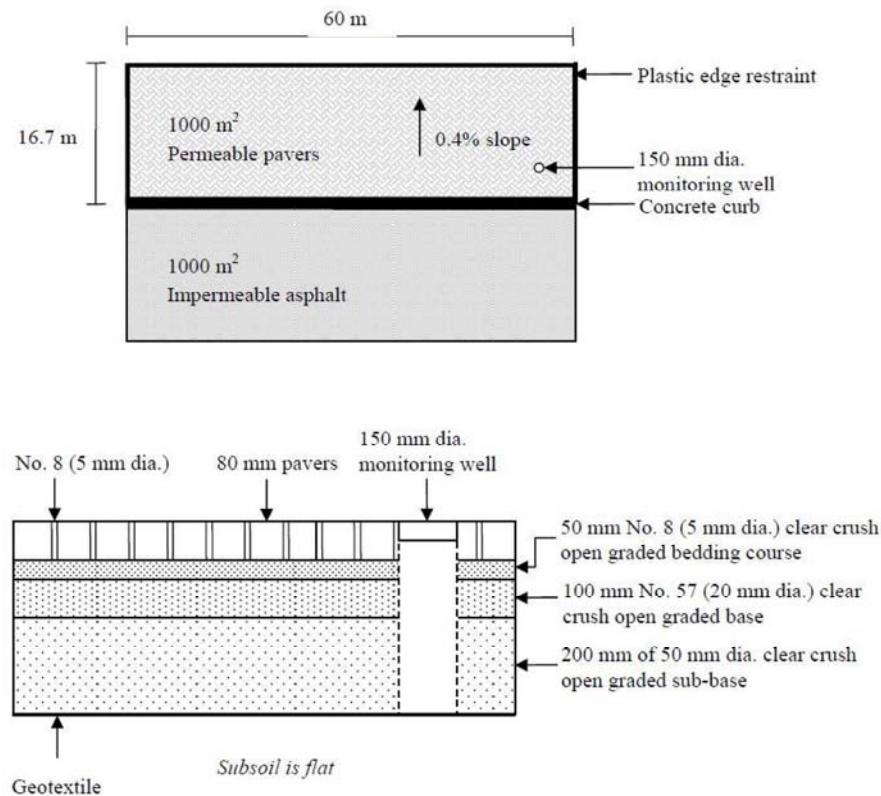
Land costs are not included for this BMP, since the paved area presumably has a non-stormwater function which precludes analysis base on opportunity cost

USER INPUTS			
Drainage area		10000	m ²
Impermeable portion of area draining to pavers		0	m ²
Native soil infiltration rate		40	mm/hr
Design type ¹ :		Partial Infiltration	Unitless
Drainage period		60	hours
Total length of permeable area		30	m
DESIGN DEFAULTS			
	defaults	(values in col G can be changed)	
Time to fill stone bed	2	2	hr
Bedding depth (2-5 mm dia clear stone)	50	50	mm
Base depth (20 mm dia clear stone)	100	100	mm
Underdrain Diameter	150	150	mm
Safety factor	2.5	2.5	Unitless
Void ratio	40	40	%
Height of pavers	80	80	mm
Minimum sub-base depth (50 mm dia clear stone)	200	400	mm
Rainfall depth: Pearson 2 yr event	56	56	mm
TOOL RESULTS			
Permeable pavement area within drainage area		10000	m ²
Ratio of contributing to permeable area		0.00	Unitless
Total width		333.3	m
Underdrain diameter		150	mm
Sub-base depth (50 mm dia clear stone)		400	mm
Total depth		0.63	m
Max reservoir depth		2400	mm
Water storage volume		2247	m ³

Paver costs are by far the highest material cost component for this practice. The LCCT uses costs sourced from Unilock (see UnitCosts, L143). To ensure accurate results, use unit costs sourced from your supplier.

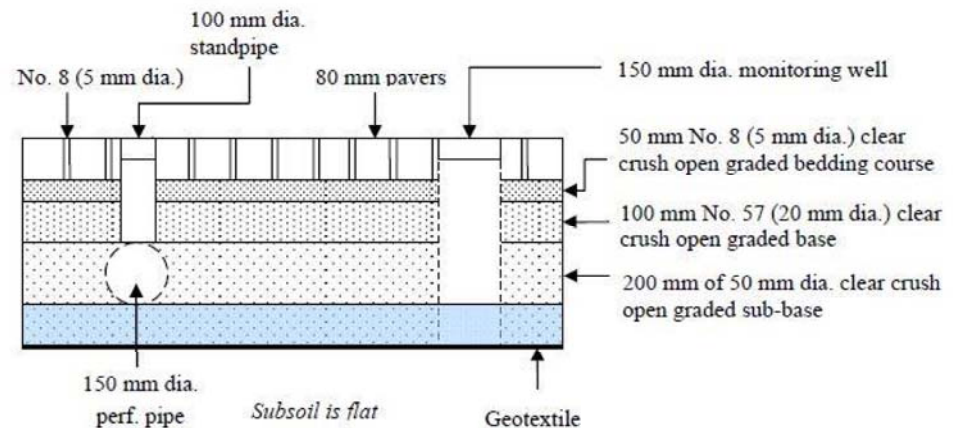
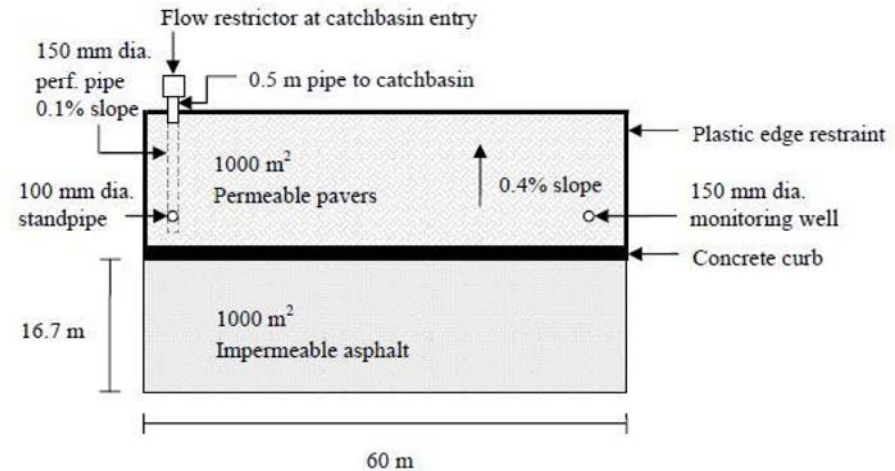
Permeable pavers: full infiltration

Plan view (above) and cross section (below). This design is typically the least costly.



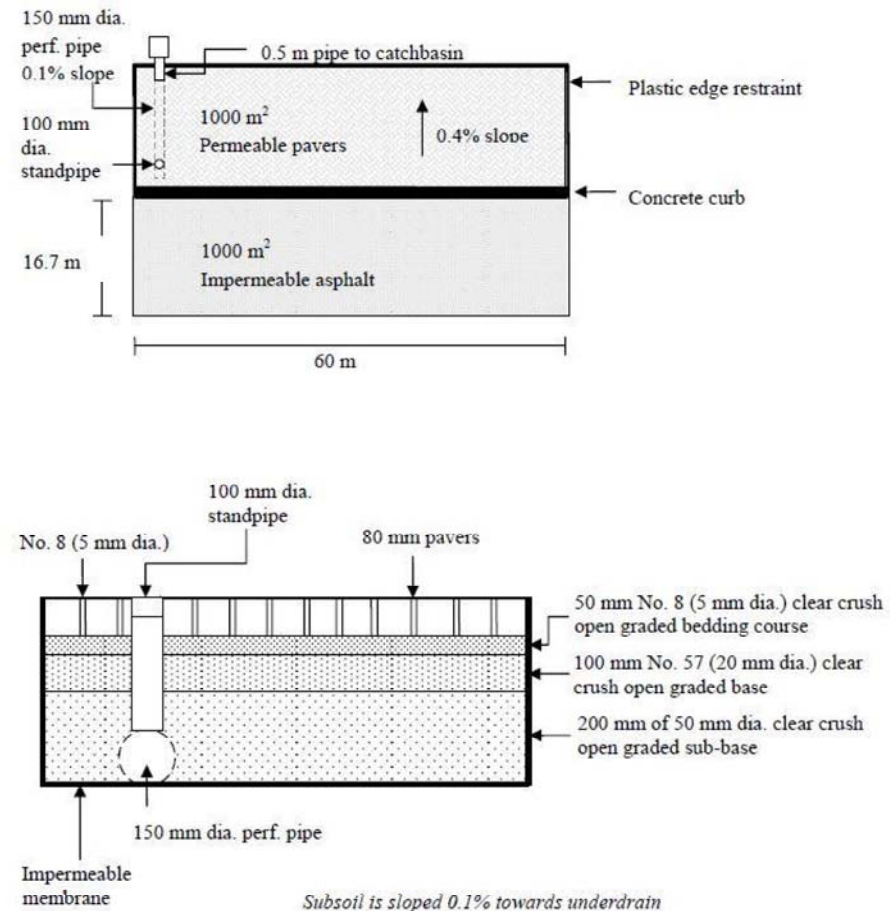
Permeable pavers: partial infiltration

Plan view (above) and cross section (below). This design type is more costly than full infiltration designs.



Permeable pavers: no infiltration

Plan view (above) and cross section (below).
This is the most costly permeable paver design.

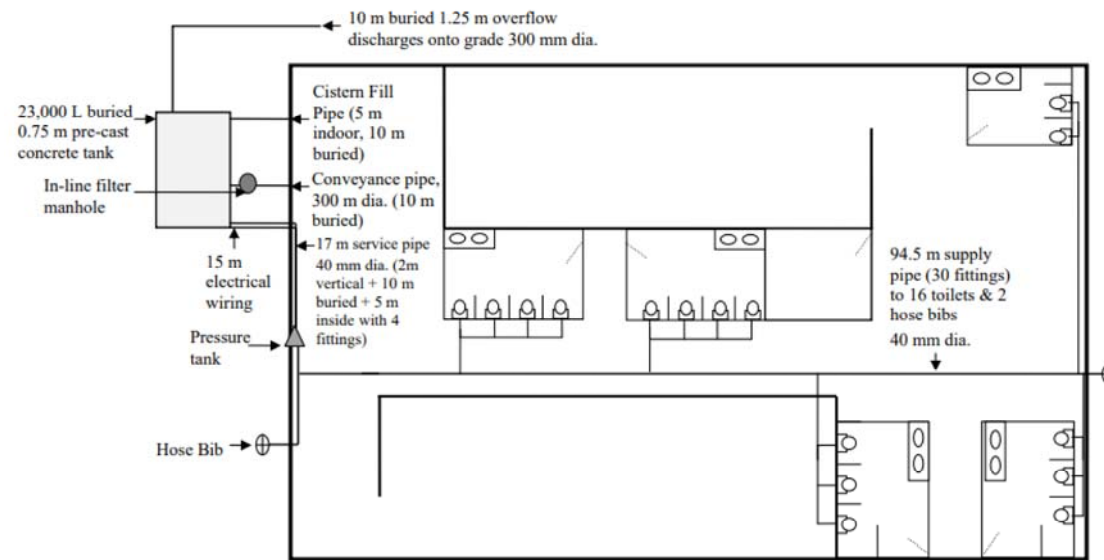


Rainwater harvesting

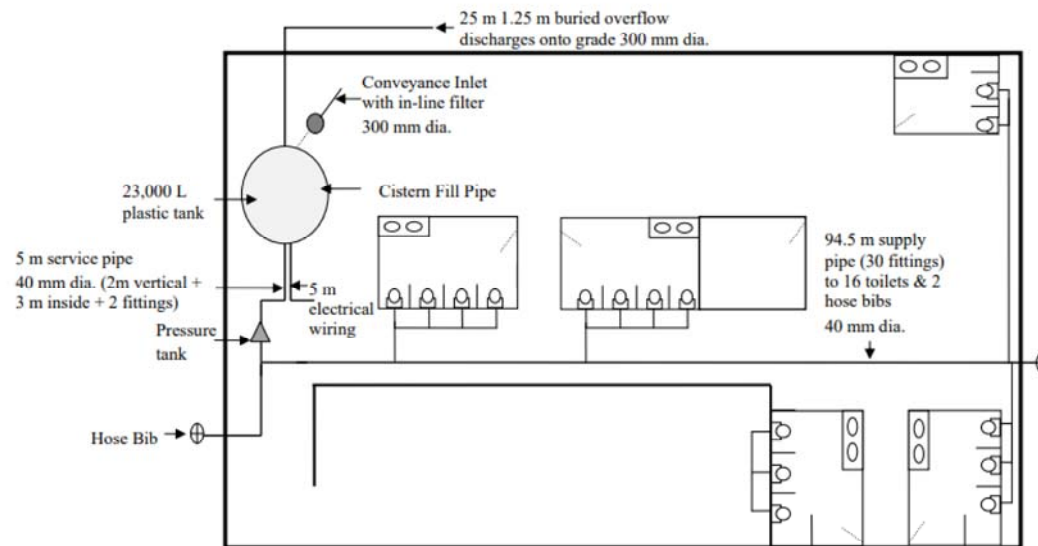
USER INPUTS			
Roof drainage area		3000	m ²
Tank type:		Below-ground Concrete	unitless
Above-ground tank location		N/A	unitless
Total daily water usage (indoor & outdoor)		3,000	L/day
User specified storage tank requirement ¹	Optional		L
User specified tank length ²	Optional		m
User specified tank width ²	Optional		m
User specified tank height ²	Optional		m
Does project land have an alternative 'best' use		No	Unitless
DESIGN DEFAULTS			
	defaults	(values in col G can be changed)	
Conveyance pipe length	10	10	m
Service pipe length	17	17	m
Supply pipe length	94.5	94.5	m
Top-up pipe interior length	5	5	m
Top-up pipe exterior length	10	10	m
TOOL RESULTS (user inputs override tank calculations)			
Estimated storage tank capacity ¹		15000	L
Tank length ²		3.2	m
Tank width ²		2.2	m
Tank height ²		3.0	m

This sheet takes from STEP's **Rainwater Harvesting Design and Costing Tool**, which is intended as an aid for residential rainwater harvesting. This means it can only cost out a tank with a 3000 m² drainage area or a maximum daily usage of 3000 L per day.

Rainwater Harvesting: buried concrete tank



Rainwater harvesting: indoor plastic tank



Wet ponds

Wet ponds model designs were built using the 2003 MOECC's Stormwater Management Planning and Design Manual. No design drawings were created for this type of project.

Site and Design Information

USER INPUTS			
Drainage area ¹	7.5	ha	
Impervious drainage area	30%	%	
W/Q Protection Level ²	normal		
Wetland area in pond	25%	% of permanent pond area	
Soil	Common earth		
Forebay berm structure	Riprap	m	
Clay liner required	no		
Project land value classification	None	Unitless	
DESIGN DEFAULTS			
	defaults	(values in col G can be changed)	
Extended detention storage requirement	40	40	m ³ /ha
Width of side buffer	10	10	m
Width of end buffer	10	10	m
Forebay volume	20%	20%	%
Forebay depth	1.5	1.5	m
Clearance above forebay berm to permanent pool	0.2	0.2	m
Forebay berm top width	0.3	0.3	m
Pond Length-to-Width Ratio	4	4	:1
Forebay Length-to-Width Ratio	4	4	:1
Wet pond permanent pool depth	1.5	1.5	m
Wetland depth	0.2	0.2	m
Active storage depth	1.5	1.5	m
Freeboard	0.3	0.3	m
Inlet pipe diameter	450	450	mm
Inlet pipe length	15	15	m
Conveyance pipe diameter	200	200	mm
Conveyance orifice control diameter	100	100	mm
Conveyance pipe length to flow control structure (manhole)	5	5	m
Maintenance pipe diameter	300	300	mm
Outlet pipe from manhole to receiving water - diameter	450	450	mm
Outlet pipe from manhole to receiving water - length	25	25	m
Side slope, buffer (width:depth)	6	6	:1
Side slope, forebay, berm and permanent pool (width:depth)	3	3	:1
Depth of clay liner for permanent pool	0.3	0.3	m
Tree and shrub planting	50%	50%	% of area above permanent
TOOL RESULTS			
Total water quality storage volume		536.1	m ³
Extended detention storage volume		300.0	m ³
Forebay volume		47.2	m ³
Permanent pool volume		188.9	m ³
Detention time		27.3	hr
Overall pond length		67.3	m
Overall pond width		27.9	m
Pond enclosure length		87.3	m
Pond enclosure width		47.9	m
Pond enclosure area		0.4	ha
Active storage surface area		1444.25	m ²
Permanent pool + forebay surface area		316.39	m ²
Planted area		3363.76	m ²

Dry ponds

Dry pond model designs were built using the 2003 MOECC's Stormwater Management Planning and Design Manual. No design drawings were created for this type of project.

While not traditionally considered and LID BMP, dry ponds work well when designed as part of a treatment train as the volume-control component

Site and Design Information

USER INPUTS			
Drainage area ¹		5	ha
Impervious drainage area		30%	%
Forebay volume		20%	% of pond volume
Soil		Common earth	m
Pretreatment		Forebay	m
Clay liner required		no	
Project land value classification		None	Unitless
DESIGN DEFAULTS		defaults	(values in col G can be changed)
Extended detention storage requirement		40	40 m ³ /ha
Width of side buffer		10	m
Width of end buffer		10	m
Forebay depth		1.5	m
Freeboard above forebay weir		0.1	m
Pond Length-to-Width Ratio		4	:1
Forebay Length-to-Width Ratio		4	:1
Dry pond depth		2	m
Freeboard		0.3	m
Pond inlet pipe diameter (for forebay or no pretreatment)		450	450.0 mm
Pond inlet pipe length (for forebay or no pretreatment)		15	15.0 m
Outlet pipe diameter		450	450 mm
Outlet orifice control diameter		100	100 mm
Outlet pipe length to flow control structure (manhole)		5	5 m
Maintenance pipe diameter		300	300 mm
Pipe from manhole to receiving water - diameter		450	450 mm
Pipe from manhole to receiving water - length		25	25 m
Side slope, forebay and dry pond (Width:depth)		4	x:1
Depth of clay liner for permanent pool		0.3	0.3 m
Tree and shrub planting		50%	50% % of area above pond
TOOL RESULTS			
Total storage volume		286.7	m ³
Forebay volume		57.3	m ³
Storage surface area		446.8	m ²
Forebay surface area		38.2	m ²
Detention time		5.1	hr
Overall pond length (includes OGS area)		55.4	m
Overall pond width		14.0	m
Pond enclosure length		75.4	m
Pond enclosure width		34.0	m
Pond enclosure area		0.26	ha
Planted area		2525.50	m ²



For more information:

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