TRIECA CONFERENCE

Great Lakes Chapter

Toronto and Region Conservation for The Living City

3rd Annual TRIECA Conference – March 25 & 26, 2014
www.trieca.com

Thank you to all of our TRIECA 2014 Sponsors!

AQUATECH DEWATERING COMPANY

CANADA GREEN BUILDING COUNCIL CHAPTER GREATER TORONTO

LAKE SIMCOE REGION CONSERVATION AUTHORITY

CIVICA

BRAMPTON Flower City

FILTREXX CANADA

GEOSTORM

Hanson HEIDELBERGCEMENT Group Hanson Pipe & Precast

RM CONSTRUCTION

GEMS

Minotaur stormwater services limited

PICKSEED good things growing...

NILEX CIVIL ENVIRONMENTAL GROUP Unearthing better results.

DYNEX CONSTRUCTION INC Since 1989

CVC a Leader for CleanWater

York Region

Media Partner

WATER CANADA THE COMPLETE WATER MAGAZINE

Practical Guidance on Inspecting and Maintaining Low Impact Development Stormwater Infrastructure

Dean Young
Toronto and Region Conservation Authority
Sustainable Technologies Evaluation Program

TRIECA 2014 Conference, Brampton
March 25-26, 2014

The Living City Foundation

Toronto and Region Conservation for The Living City

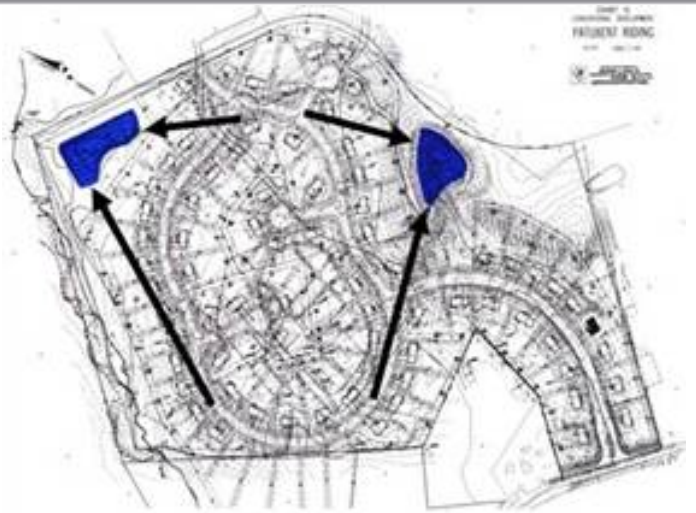
Sustainable Technologies Evaluation Program

- Multi-agency program led by TRCA
- Main program objectives:
  - ✓ Evaluate clean water and energy technologies;
  - ✓ Assess barriers to/opportunities for widespread implementation;
  - ✓ Develop knowledge transfer tools, guidelines and policy alternatives;
  - ✓ Education, advocacy, and technology transfer.
- Program web address: www.sustainabletechnologies.ca

Low Impact Development (LID) is a stormwater management approach that seeks to manage urban runoff and pollutants using distributed, small-scale controls.

The goal is to mimic a site's pre-development hydrology through:

- site designs that minimize impervious cover and preserve natural drainage features and patterns; and
- best practices that filter, harvest, evapotranspire, detain and infiltrate stormwater as close to its source as possible.



Conventional "end-of-pipe" approach

Low Impact Development approach

LID SWM Design Guidance Documents

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT PLANNING AND DESIGN GUIDE

Version 1.0

2010

CVC CREDIT VALLEY CONSERVATION

TORONTO AND REGION Conservation for The Living City

APPENDIX B

LANDSCAPE DESIGN GUIDE FOR LOW IMPACT DEVELOPMENT

VERSION 1.0

June 2010

CVC CREDIT VALLEY CONSERVATION

Available to download at www.sustainabletechnologies.ca

LID Structural SWM Best Practices

- Rainwater Harvesting;
- Green Roofs;
- Downspout Disconnection/ Absorbent Landscaping;
- Vegetated Filter Strips;
- Soakaways, Infiltration Trenches and Chambers;
- Bioretention/Rain Gardens;
- Permeable Pavement;
- Enhanced Grass Swales;
- Dry Swales/Bioswales;
- Perforated Pipe Systems.

But sound design is only half of the equation…

Early experiences have shown failures are often due to:

- Practices not constructed as designed or not with specified materials;
- Lack of attention to erosion sediment control during construction;
- Lack of rigorous inspection during construction and prior to project acceptance.

Inspection and Maintenance

Timely inspections and testing is critical to ensure stormwater BMPs are:

- Built according to approved plans and specifications;
- Installed at appropriate time and with adequate erosion and sediment controls;
- Fully operational at time of assumption (i.e. project acceptance)

Inspection and Maintenance

A proactive BMP inspection program will also:

- Identify maintenance issues before they affect BMP function;
- Help optimize stormwater infrastructure management programs by providing feedback needed to determine when structural repairs are needed or adjust frequencies of I&M tasks.

Municipal SWM Inspection and Maintenance – Common Challenges

- Lack of sustainable funding mechanisms;
- Lack of compliance and enforcement authority/access;
- Lack of dedicated program/ staff;
- Uncertainty of BMP locations;
- Inability to track responsible parties;
- Designs not conducive to easy maintenance/access;
- Owners unaware of maintenance responsibility.

LID BMP Inspection and Maintenance – New Challenges

- Lack of experience with LID BMPs;
- Distributed, decentralized, small-scale practices = more effort to track;
- Legal arrangements to ensure inspection/maintenance on private property;
- Lack of detailed guidance and tools/templates for program design and implementation.

LID Stormwater Inspection and Maintenance Guide

1. Provide guidance to municipalities and ICI property managers on planning and implement. of LID BMP I&M programs.

2. Establish standard protocols for inspection, testing and maintenance of LID BMPs in cold climates.

- Bioretention/Dry swales;
- Permeable pavements;
- Underground infiltration systems;
- Green roofs;
- Rainwater cisterns;
- Grass swales;
- Vegetated filter strips.

LID Stormwater Inspection and Maintenance Guide - Outline

Part 1: Designing an Effective LID I&M Program

1. Setting the program scope
2. Approaches to assigning responsibilities
3. Steps in program development
4. Key considerations during BMP design and plan review
5. Opportunities for public involvement

Part 2: Inspection and Maintenance of LID BMPs

1. Inspection and testing framework
2. BMP-specific inspection, testing and maintenance
3. Inspection and testing protocols

Designing an effective I&M program

Setting the program scope:

- How many/what types of BMPs to include?
- Who is responsible?
- What is the current status of legal tools for I&M?
- Who does routine maint. vs. structural repairs?
- In-house staff vs. contractors?
- How will I&M be tracked, verified and enforced?
- What "level of service" is desired or achievable?

Routine Maintenance	Structural Repairs
- Mowing, trimming, weeding vegetation - Removal of trash & debris - Replacing dead plants, seeding bare spots - Core aeration - Removal of sediment from pretreatment devices and inlets - Flushing pipes	- Clogged inlets, pipes, catchbasins, filter beds, outlets - Broken or missing parts - Extreme erosion or sedimentation requiring regrading or dredging - Landscaping that needs to be completely replaced

I&M Program Level of Service Matrix

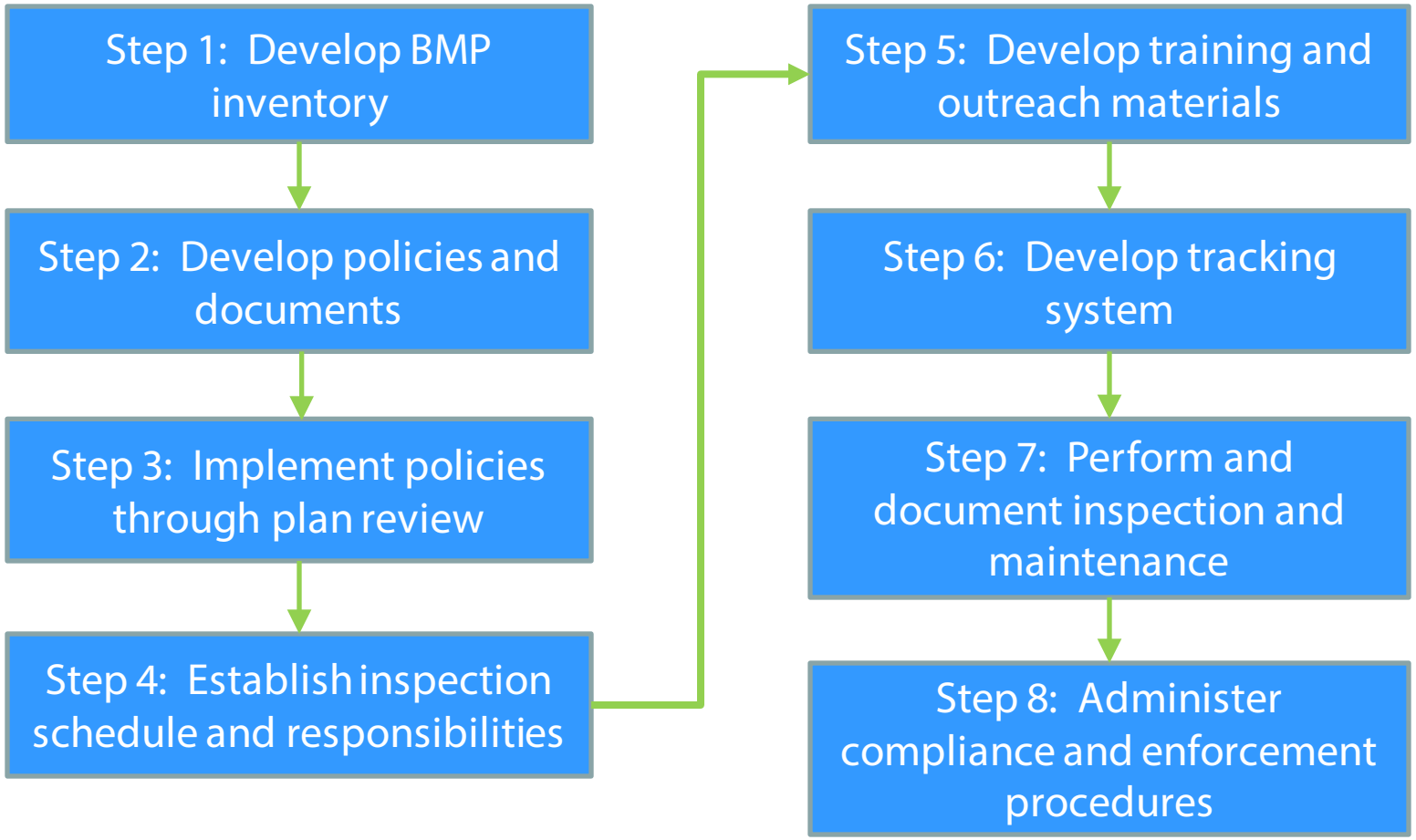
Level of Service	BMPs Included	Maintenance Tasks	Maintenance Frequency	Inspectors	Inspection Frequency	Feedback from Experience
LOWER	BMPs on public land and within rights-of-way	Repair immediate threats to public health and safety	React to complaints and emergencies	Rely on owners/ managers or their contractors to inspect, maintain and report to municipality	Complaint driven	Anecdotal
	+	+	+			+
	High priority, high visibility, and/or large BMPs on private land within easements and covered by agreements	Repair structural items: clogged or broken parts, erosion problems	Establish preset schedule for routine inspection and maintenance tasks	Public inspectors send report to responsible party	Every 3 years	Feedback used to modify list of acceptable BMPs based on maintenance burden
	+	+	+	Co-inspections with public inspector and responsible party	Annual or semi-annual	+
	All or most BMPs on private land within easements and covered by agreements	Routine mowing, weeding, remove trash and debris, replace vegetation	Conduct structural maintenance in response to routine and compliance/ performance verification inspections	Compliance/ performance verification inspections by public inspectors	More frequent for high priority/ visibility BMPs	Feedback is used to modify BMP design guidance to minimize maintenance burden
	+	+				
	Completely private BMPs	Includes retrofitting or reconstructing BMPs		System of certified private inspectors		
HIGHER						

Notes: (+) means that services are cumulative (level of service includes all previous tasks too).
Adapted from CWP, 2008

Approaches to assigning responsibilities

Typical Program Characteristics	Strengths/Weaknesses
Private Approach	
➢ Property owner/manager responsible for most I&M tasks; ➢ Municipality responsible for legal tools to require/enforce maint. of regulated BMPs on private prop.; ➢ Municipality responsible for educating property owner/manager/association about BMP and I&M needs.	Strength: ➢ Least costly approach for mun. Weakness: ➢ Highest potential for non-compliance
Public Approach	
➢ Municipality responsible for most I&M tasks; ➢ BMPs required to meet regulatory standards should only be located on public property or in rights-of-way or easements	Strength: ➢ Avoids compliance/enforce. issues are avoided; Weakness: ➢ Most costly approach for mun.
Hybrid Approach	
➢ Municipality inspects and maintains BMPs on public land, in rights-of-way and easements on private property; ➢ Private property owner/manager resp. for some I&M tasks; ➢ Municipality resp. for legal tools to require/enforce I&M; ➢ Municipality resp. for educating about BMP and I&M needs	Strength: ➢ Maximum flexibility. Weakness: ➢ Potential for non-compliance if roles/resp. not made clear.

Steps in program development



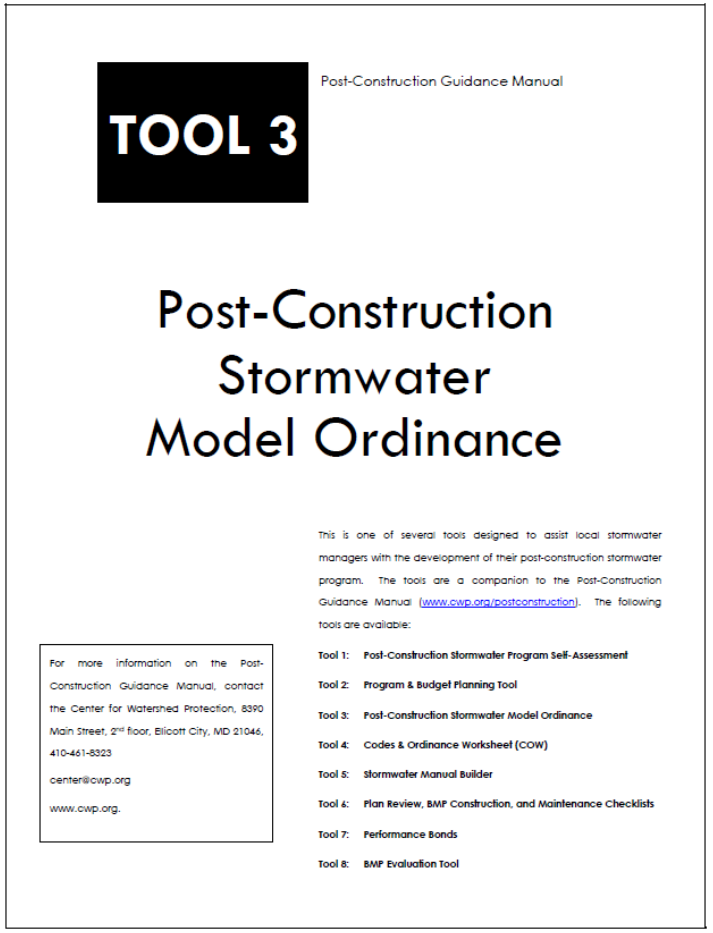
Step 1: Develop BMP inventory

- Informs decisions re: what BMPs to include in the program and level of service that can be provided;
- Includes compiling info. on physical and regulatory condition of each BMP;
- At minimum, captures all BMPs designed/installed to meet regulatory criteria;
- Include inventory of conveyances that deliver stormwater to/from the BMP.

Physical Condition	Regulatory Condition
➢ Location ➢ Type of BMP ➢ Design features ➢ Conveyance features ➢ Structural integrity ➢ Sediment/trash ➢ Inlet/outlet obstruction ➢ Standing water ➢ Vegetation status	➢ Public or private property ➢ Right-of-way or easement ➢ Adequate access for I&M ➢ Utility easements ➢ OMOE C of A or ECA ➢ Maintenance ageement & plan ➢ Historical I&M records

Step 2: Develop program policies and documents

- Municipal stormwater management policy that establishes the legal and administrative framework (e.g. official plan policy, stormwater utility by-law, etc.)
- Maintenance agreements;
- Maintenance easement conditions and specifications;
- I&M plan templates for each BMP type;
- Notice of violation letter;
- Schedule of penalties.



Center for Watershed Protection, 2008

Step 3: Implement policies through plan review

Maintenance agreements:

- Contract btwn. municipality and private owner/manager;
- Guarantee that specific I&M tasks are performed over the lifecycle of the BMP;
- Recorded with property deed;
- Specifies right-of-entry for inspections by mun. staff or contractors;
- Specifies enforcement actions for non-compliance.

Step 3: Implement policies through plan review

Inspection and maintenance plans:

- Tasks and frequencies depend on BMP type and local context;
- Set the schedule for inspections and routine maintenance tasks;
- Describes record keeping and reporting procedures;
- Standard template BMP specific I&M plans need to be developed by municipality to reflect how responsibilities are assigned.

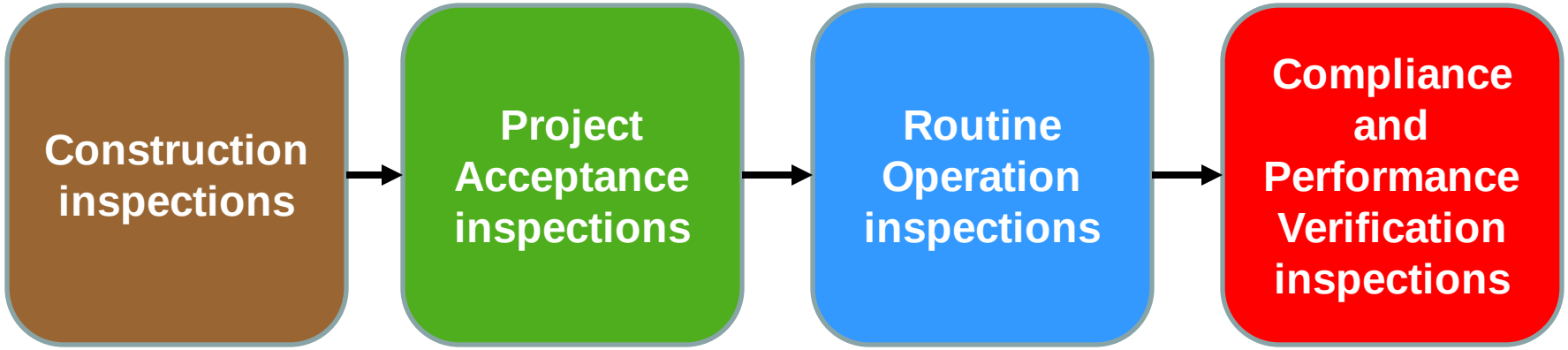
Step 3: Implement policies through plan review

Maintenance easements:

- Legal document granting municipality right-of-entry to a private property for BMP I&M purposes;
- Secured during plan review;
- Covers:
  - Footprint of the BMP;
  - Margin of land around all BMP components sufficient for access by maintenance/repair machinery
  - Access paths;
  - Conveyances and pretreatment devices associated with the BMP.

Step 4: Establish inspection schedule and responsibilities

Four types of inspections over a BMP life cycle



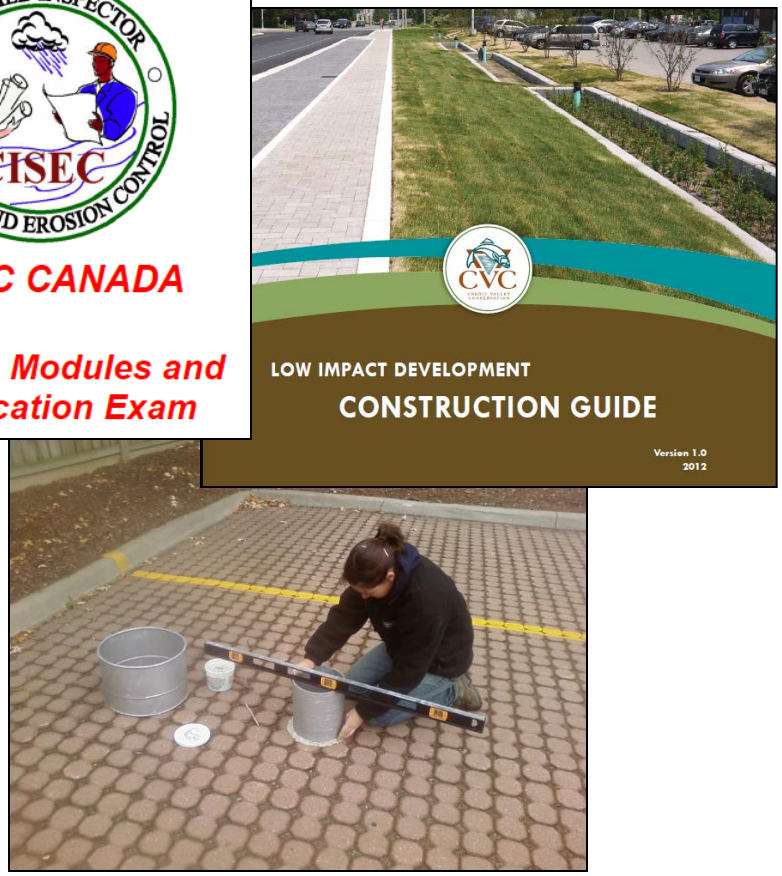
Description	Schedule	Responsibilities
Construction inspections		
Ensure built at appropriate time, as designed with specified materials; adequate E&SC	Several points in the construction sequence specific to BMP type; after any major storm event (e.g. 2 yr. return period 1 hour storm event, 25 mm in the GTA)	Trained professionals; options include existing mun. inspection staff, dedicated mun. SWM BMP inspectors, mun. contractors, developer/property owner/manager contractors
Project Acceptance inspections		
Confirm BMP was installed as designed with specified materials and is functioning properly	Soon after end of construction; vegetated BMPs should be inspected 2nd time after an establishment period, prior to end of warranty for plantings	Trained professionals; shared btwn. municipality and developer/property owner/ manager or their consultant
Routine Operation inspections		
Immediately address minor maint. Needs; determine when structural repairs or investigation into problems with BMP function are needed	Annually; twice annually for BMPs that are vegetated, in high priority/visibility locations or those with large drainage areas relative to BMP footprint area	Trained maintenance staff; property owner/manager (private approach), municipality (public approach) or shared (hybrid approach)
Compliance and Performance Verification inspections		
Ensure compliance with maint. agreement/plan and determine if still providing an acceptable level of treatment	Compliance inspection every 5 yrs.; Performance verification inspection every 10 yrs.	Trained professionals; options include existing mun. inspection staff, dedicated mun. SWM BMP inspectors, mun. contractors,

Step 5: Develop training and outreach materials – Inspector training

- What the BMP is, how it works, key components to be inspected;
- Erosion and sediment control plans for construction sites;
- Recommended construction sequence and installation techniques;
- Common pitfalls during construction;
- Inspection and testing indicators and procedures;
- Triggers for follow-up action

CISEC CANADA

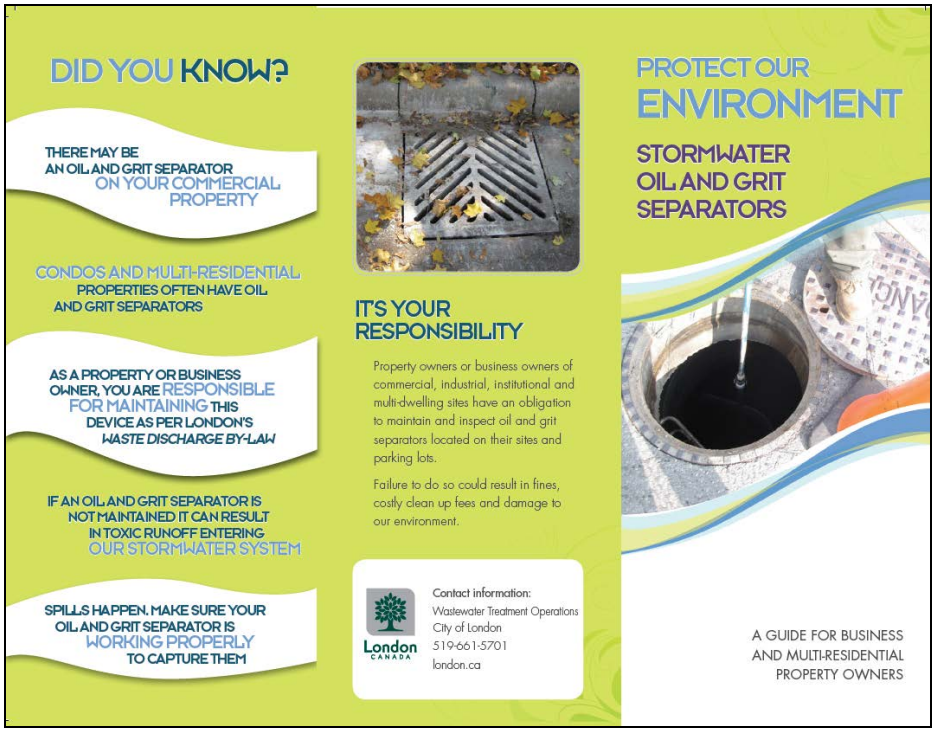
Training Modules and Certification Exam



Step 5: Develop training and outreach materials – Outreach education

Municipalities should offer resources to property owner/ managers after project acceptance:

- List of local contractors experienced with LID BMP I&M or repairs
- Estimating budgets for routine I&M tasks;
- Broadly accessible info. on BMP function, benefits, key components, I&M needs and reporting procedures (e.g. pamphlets, web resources)



Source: City of London

Step 6: Develop a tracking system

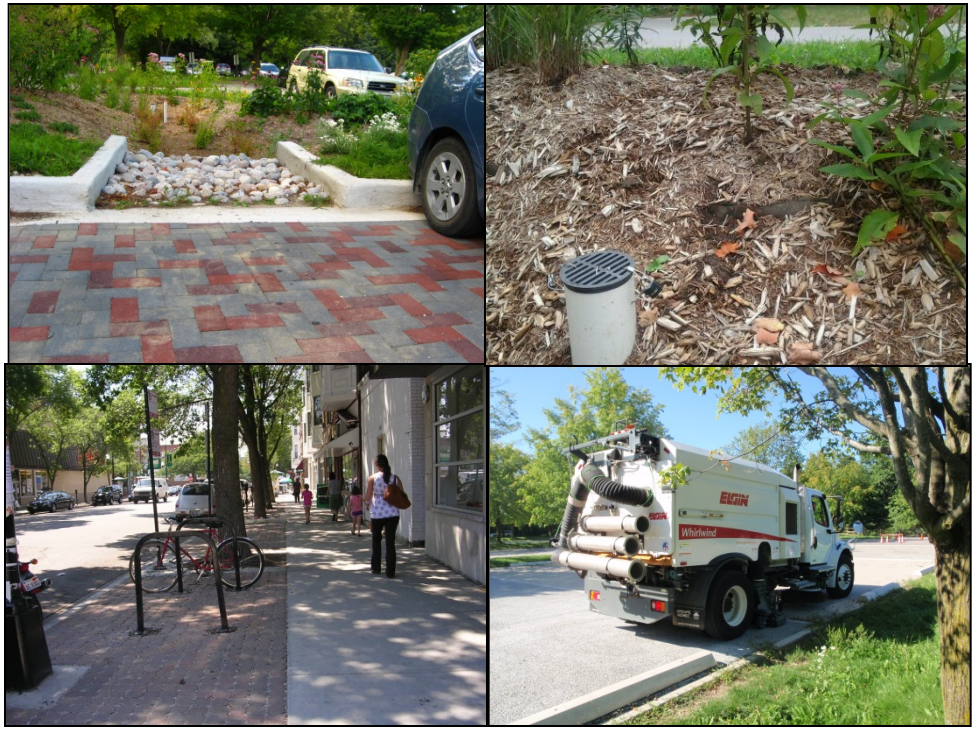
- In large municipality or property management org., investment in advanced database systems with links to GIS and GPS field data collection units may be warranted;
- Automated notification systems to send notices to responsible parties when reports or maint. is overdue;
- Mechanisms for tracking changes in property ownership

Step 7: Perform and document inspection and maintenance

- Require as-built drawings be submitted after project acceptance;
- Integrate construction inspections and plan review;
- Use standard forms for documentation of field activities;
- Take photographs and include them in I&M tracking database

Key considerations during BMP design

1. Provide pretreatment;
2. Include inspection and maintenance features (e.g. lockable standpipes/wells, valves for draining, traffic barriers, measuring tapes);
3. Include planting plans (common and species names);
4. Plan for sediment removal (access and disposal);
5. Design lower maintenance conveyances.



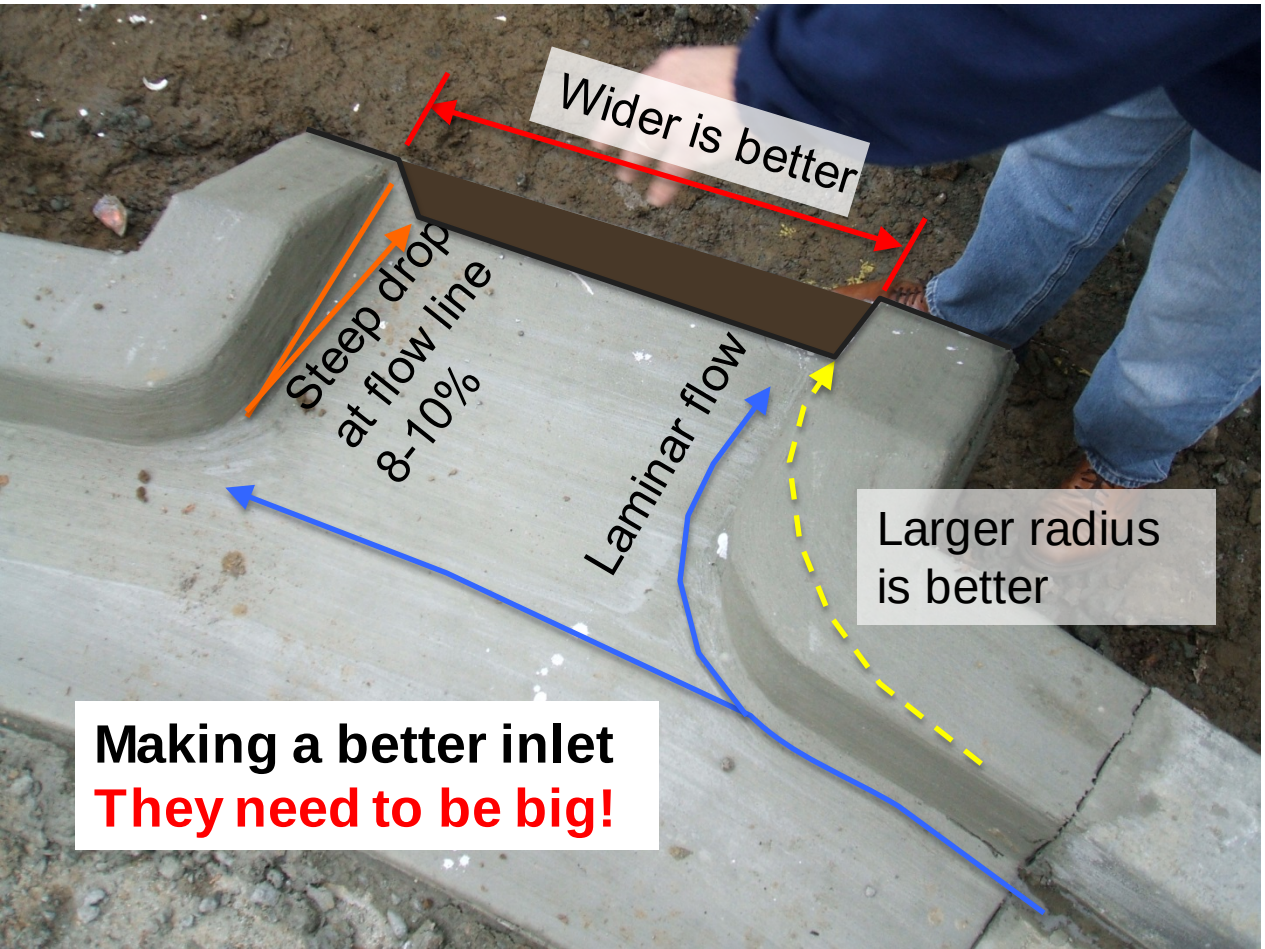
Source: James Urban, 2013

Lower maintenance inlet design:

Turning the water into the BMP

Water does not want to turn 90°

Use gravity and / or laminar flow to get it around the corner




Cheater curbs


Too low and narrow


Too narrow

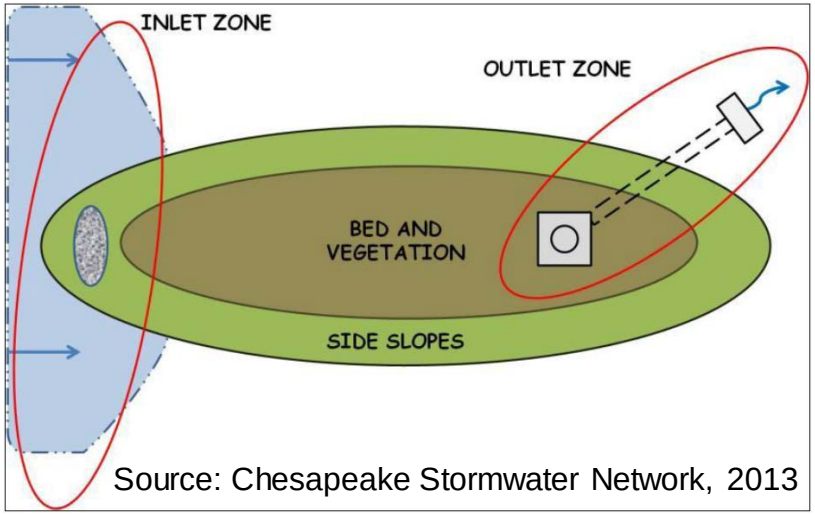
Part 2: Inspection and Maintenance of LID Practices

INSPECTION AND TESTING FRAMEWORK

Indicator	Inspection Type			
	Construction	Project Acceptance	Routine Operation	Compliance/ Performance Verfication
Visual (37 indicators)	X	X	X	X
Soil characterization testing	X	X		
Sediment accumulation testing	X	X	X	X
Surface infiltration rate testing		X	Performance Verfication inspection only	X
Natural or synthetic storm event testing		X		X
Continuous water level monitoring		X		X

BMP-specific inspection, testing and maintenance

1. BMP overview (what is it?; how does it work? benefits, key components)
2. Inspection and testing indicators and schedule
3. Critical timing of construction inspections;
4. Inspection field data form;
5. Routine maintenance tasks and frequencies;
6. Structural repair tips;
7. Lifecycle cost of I&M



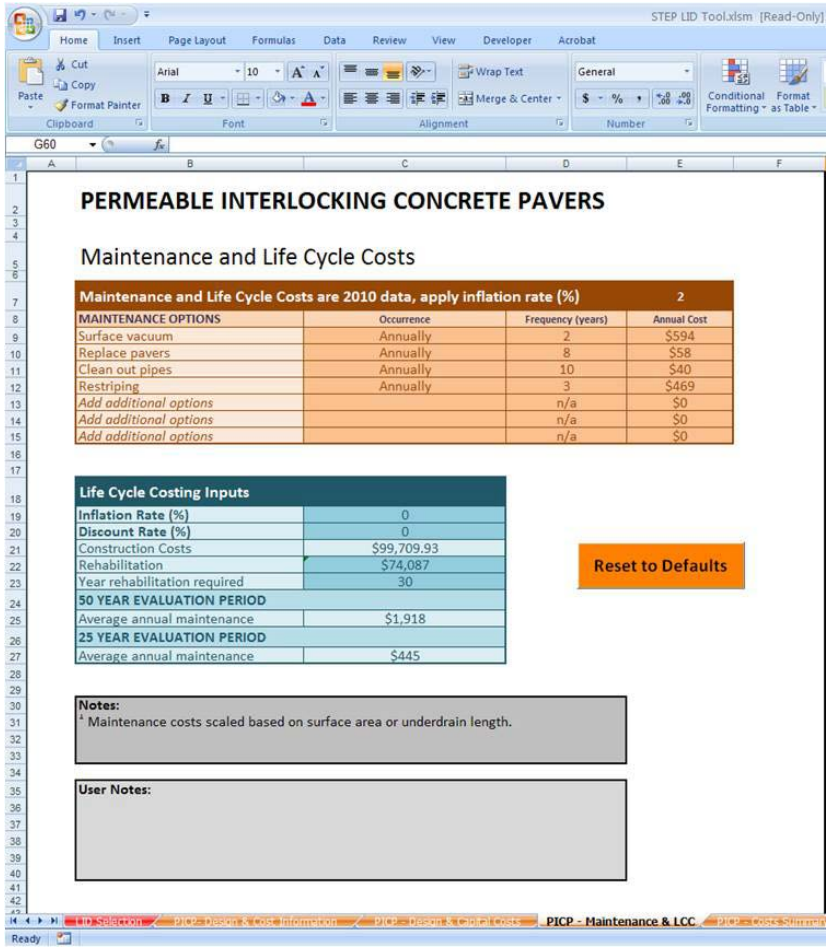
Source: Chesapeake Stormwater Network, 2013

LID BMP Life Cycle Cost Study

- Collaborative project with University of Toronto, completed 2013
  - Mariko Uda and Chris Kennedy - Civil Engineering Department
- Evaluates **capital** and **life cycle I&M** costs over 50 years based on:
  - Ontario input costs from RS Means and industry surveys
  - LID designs from local guides
- **Life Cycle Costing Tool** for planning stage estimates
  - Spreadsheet decision support tool

Available to download at www.sustainabletechnologies.ca

LID BMP Life Cycle Costing Tool



PERMEABLE INTERLOCKING CONCRETE PAVERS

Maintenance and Life Cycle Costs

Maintenance and Life Cycle Costs are 2010 data, apply inflation rate (%)			2
MAINTENANCE OPTIONS	Occurrence	Frequency (years)	Annual Cost
Surface vacuum	Annually	2	$594
Replace pavers	Annually	8	$58
Clean out pipes	Annually	10	$40
Restriping	Annually	3	$469
Add additional options		n/a	$0
Add additional options		n/a	$0
Add additional options		n/a	$0

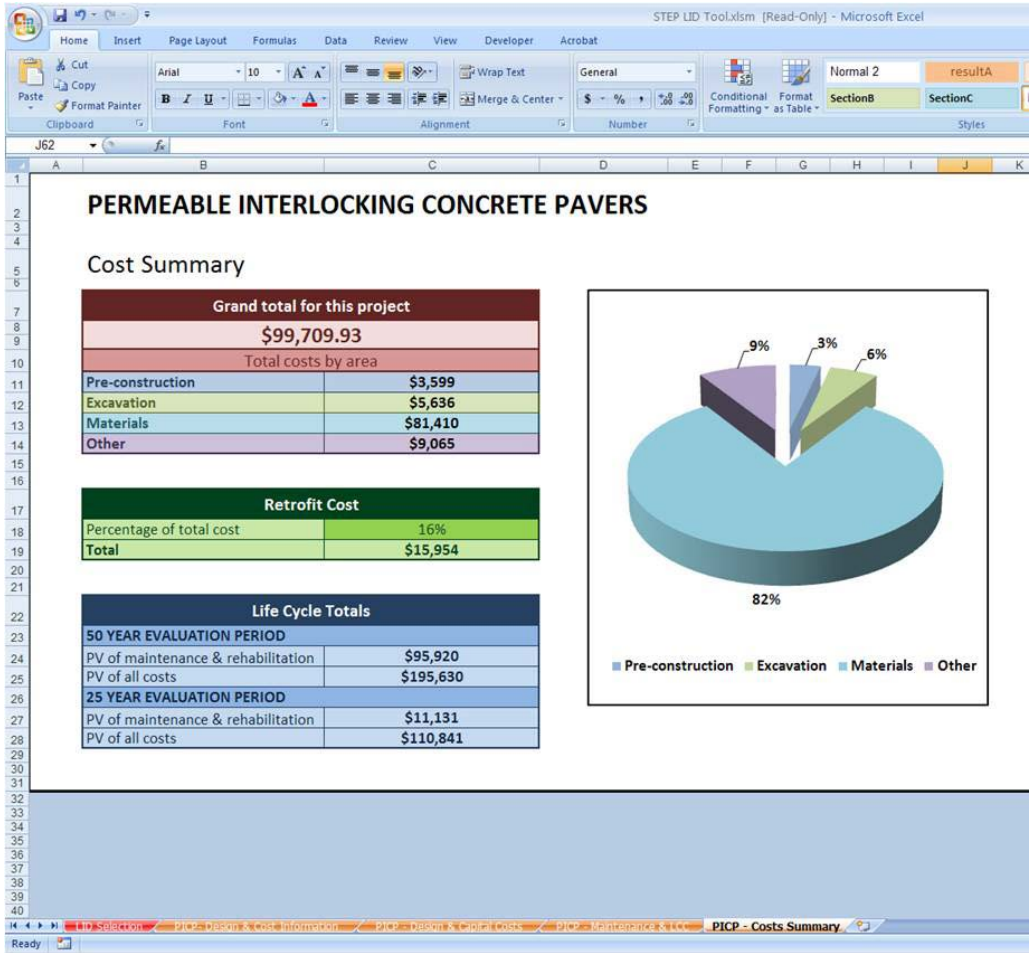
Life Cycle Costing Inputs	
Inflation Rate (%)	0
Discount Rate (%)	0
Construction Costs	$99,709.93
Rehabilitation	$74,087
Year rehabilitation required	30
50 YEAR EVALUATION PERIOD	
Average annual maintenance	$1,918
25 YEAR EVALUATION PERIOD	
Average annual maintenance	$445

Reset to Defaults

Notes:
[4] Maintenance costs scaled based on surface area or underdrain length.

User Notes:

PICP - Maintenance & LCC



PERMEABLE INTERLOCKING CONCRETE PAVERS

Cost Summary

Grand total for this project
$99,709.93
Total costs by area

Pre-construction	$3,599
Excavation	$5,636
Materials	$81,410
Other	$9,065

Retrofit Cost	
Percentage of total cost	16%
Total	$15,954

Life Cycle Totals	
50 YEAR EVALUATION PERIOD	
PV of maintenance & rehabilitation	$95,920
PV of all costs	$195,630
25 YEAR EVALUATION PERIOD	
PV of maintenance & rehabilitation	$11,131
PV of all costs	$110,841

PICP - Costs Summary

Inspection and testing protocols

9.1.3 INLET OBSTRUCTION

Construction Inspection | Project Acceptance ✓ | Routine Maintenance and Inspection ✓ | Compliance Verification ✓ | INLET

Look for any objects that may obstruct the stormwater flow from entering the facility. An obstruction can be structural, vegetation or sediment.

Rain Gardens/Bioretention Cells/Dry Swales

PASS: There are no objects obstructing the inlet and stormwater can freely flow into the BMP.

FAIL: There are leaves and sediment obstructing the inlet, preventing the full potential of stormwater to enter the BMP.

MAINTENANCE TRIGGER: Sediment/trash/debris is ≥5 cm deep and/or blocking inflow over one third (33%) of the inlet width or area and is impairing its function.

FOLLOW-UP TASKS: Remove the obstruction and investigate the CDA for potential sources of the obstruction. Place an apron of stone or concrete inside or at the entrance of the inlet to prevent vegetation from establishing.

Enhanced Swales

PASS: There are no objects obstructing the inlet or inlet area and stormwater can freely enter the BMP. (CITATION).

FAIL: There is sediment and vegetation accumulation at the inlet, obstructing the potential volume of stormwater entering the BMP.

MAINTENANCE TRIGGER: Sediment/trash/debris is ≥5 cm deep and/or blocking inflow over one third (33%) of the inlet width or area and is impairing its function.

FOLLOW-UP TASKS: Remove the obstruction and investigate the CDA for potential sources of the obstruction. Place an apron of stone or concrete inside or at the entrance of the inlet to prevent vegetation from establishing.

Vegetated Filter Strips/Topsoil Depth and Quality

PASS: There are no objects obstructing the inlet area of the vegetated filter strip, as the boundary with the road is completely clear. (CITATION).

FAIL: The topsoil is compacted and behaves as an impervious surface, thereby preventing stormwater from infiltrating. (CITATION).

MAINTENANCE TRIGGER: Sediment/trash/debris is ≥5 cm deep and/or blocking inflow over one third (33%) of the inlet width or area and is impairing its function. The soil is compacted and very dry, while the vegetation it supports is unhealthy or dead.

FOLLOW-UP TASKS: Clear the inlet or inlet area from any obstruction and assess the CDA for possible sources. Decompact and amend the topsoil to allow for stormwater infiltration and establishment of healthy vegetation cover,

Underground Infiltration Systems

PASS: There are no objects obstructing the inlet and stormwater can freely enter the BMP.

FAIL: Leaves and sediment are obstructing the inlet, significantly reducing the volume of stormwater entering the BMP. (CITATION).

MAINTENANCE TRIGGER: Sediment/trash/debris is ≥5 cm deep and/or blocking inflow over one third (33%) of the inlet width or area and is impairing its function.

FOLLOW-UP TASKS: Remove the obstruction and investigate the CDA for potential sources of the obstruction. Assess the required frequency for clean up if the obstruction will be an ongoing maintenance issue.

Inspection and testing protocols

Soil characterization testing:

- Sampling methods and equipment;
- Grain size distribution test method and specs.;
- Organic matter content test method and specs.;
- pH test method and specs;
- Cationic exchange capacity test method and specs.;

Inspection and testing protocols

Sediment accumulation testing:

- Test methods and equipment;
- Triggers for follow-up action.

Surface infiltration rate testing:

- Test pit (percolation time) method;
- Infiltrometer method;
- Permeameter method;
- Triggers for follow-up action.

Natural or synthetic storm event testing:

- Water level data loggers

Next steps…

- Consultation on first draft with Project Advisory Committee;
- Publication of final guide;
- Develop LID inspector training courses;
- Updates to LID Planning and Design Guide.

Project supporters

Ontario
Ministry of the Environment

Government of Canada / Gouvernement du Canada
GREAT LAKES SUSTAINABILITY FUND
FONDS POUR LA DURABILITÉ DES GRANDS LACS

York Region

Region of Peel
Working for you

TORONTO

City of MISSISSAUGA
Leading today for tomorrow

Thank you

Dean Young
Phone: 289-268-3904
Email: dyoung@trca.on.ca

STEP website:
www.sustainabletechnologies.ca
TRCA website:
www.trca.on.ca

Toronto and Region Conservation for The Living City

Sustainable Technologies Evaluation Program