OUR WORLD IS CHANGING
Health Impact of Extreme Events

- The stress faced by pregnant women during the 1998 Quebec ice storm = children at a greater risk to develop asthma, diabetes or obesity, similar results from Calgary flood
Global disaster damage
Annual insurance disaster claims, billions, adjusted for inflation

20 fold increase since 1970s!

If this strange and severe weather was once hard to imagine, it’s now hard to ignore…...Maclean’s Magazine
58% of Canadians think municipalities are upgrading systems to handle excess storm water
REALITY: 60-75% of GTA was built prior to flood control
Developing Areas

Despite meeting current MOE requirements with the use of ponds:

- Increasing trends in wet weather stream-flow - 90 times pre-development
- Increasing pollutant loading, temp and erosion, flood risks downstream
- Reduced dry weather streamflows impacting wastewater dilution, water takings from streams, fisheries
Despite ponds

Increasing trends in wet weather stream-flow - 90 times predevelopment
Despite ponds

Reduced dry weather streamflows
Pre-Development

40% Evapotranspiration

10% Runoff

50% Deep & Shallow Infiltration

Natural Ground Cover
Typical Annual Rainfall Frequency Distribution For Toronto, Ontario

- 90% of rainfall amount less than 25 mm
- Only 3-8 events above 25 mm

Bar chart showing:
- Avg. # of Events/yr for rainfall depth:
  - 0-25mm
  - 2-25mm
  - 10-25mm
  - 14-25mm
  - 18-25mm
  - 22-33mm
  - 26-33mm
  - 33-33mm

Rainfall Depth (mm)
Pre-Development

![Graph showing water flow before development with Q vs T axes.]

- 40% Evapotranspiration
- 10% Runoff
- 50% Deep & Shallow Infiltration

Natural Ground Cover
Urban Hydrology

Typical development: Stormwater management using End of Pipe SWM Pond

- 35% evapotranspiration
- 30% runoff
- 20% shallow infiltration
- 15% deep infiltration

SWM Pond delays and treats runoff but does not control increase in runoff volume

30-50% impervious cover
Runoff produced for more frequent storms

Change in Timing and Peak

Increased Runoff Volume-translates to longer periods of bankfull

Lower Baseflow
Total Phosphorus

Monthly 75th Percentile (1975-2009)

Conventional End of Pipe SWM
Rural Stream
CWQG
SWM Pond Performance

- More events produce runoff = pollutant loading more often
- Literature finds end-of-pipe facilities less effective than LID in removing finer particles
Water Temperature
Average winter air temperature:

2011: -5.4 °C
2012: -0.4 °C

After a cold winter...

After a warm winter...

Elevated nutrients impact Water Treatment Plant operations $$$, beach closures, and local business revenues

Increases in Cl impacts plume from Credit River, elevated nutrients at water in-take pipe- increasing WTP $$$

In-stream monitoring shows increasing temp and nutrient trends due to increased urbanization, climate change exacerbates
Urban Hydrology

Typical development: Stormwater management using End of Pipe SWM Pond

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LESS BASEFLOW
EXISTING CONDITIONS (15% URBANIZATION)

BUSINESS AS USUAL MANAGEMENT ALTERNATIVE (25% URBANIZATION)
• Watershed Perspective
• Infrastructure Types - W, WW, SW
• Governance/Policy/Legislation
• Upstream actions - downstream impacts
• Challenging!
Integrated Stormwater Management
(called LID- or Low Impact Development)

Treat it where it falls

Treat it along the path

Treat it before it goes to your Lake
Holistic Approach & Criteria

• When used together

Holistic SWM Approach vs. Criteria

Flood Control
Eorison
Water Quality
Infiltration

Effectiveness

LID
Traditional SWM
EXISTING CONDITIONS (15% URBANIZATION)

PREFERRED MANAGEMENT ALTERNATIVE (25% URBANIZATION)
Provincial Support for Treatment Train Approach

- PPS 2014
- Water Opportunities Act, Sustainability Planning
- Great Lakes Protection Strategy
- Lake Simcoe Protection Act
- MOE: SWM Policy Review In-light of Climate Change and MOE 2003 SWM Guidelines
- MOI: Building Together
Change is Risky?

“Playing it safe is the riskiest choice we can ever make.”
Sarah Ban Breathnach

Definition of Insanity: doing the same thing over and over again and expecting different results.
Albert Einstein
“Sometimes when you innovate, you make mistakes. It is best to admit them quickly, and get on with improving.”

Steve Jobs
Failures can lead to our greatest success and opportunities.
Top Stakeholder Priorities

1. Water quality and quantity performance of LID design in low infiltration soils

2. How multiple LID treats and manage stormwater

3. Performance of flood control, erosion control, water quality and natural heritage protection

4. Long term maintenance

5. Lifecycle costs
Road Right of Way – Performance Monitoring

- 90% of all rainfall events are absorbed by LID
- Only 3-12 rainfall events each year produce runoff
- For those 3-12 events, LID removed up to 99% of Total Suspended Solids and 84% Total Phosphorus
- Works during winter thaws
Elm Drive LID Site

July 8th 2013 Thunder Storm

Greater than 100 Year Event

Elm Drive LID Site
LID Performance

- LID reduced up to 60% of the peak runoff;
- LID reduced volume by 30% (30 mm)
- Delayed the timing of the peak by 20 minutes
# Erosion Control

<table>
<thead>
<tr>
<th>Design Goal for Elm</th>
<th>To the extent possible</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CVC Stormwater Management Criteria</strong></td>
<td>As a minimum, on site detention of 5 mm. For sites w. a SWM Pond, detain the 25 mm event for 48 hrs</td>
</tr>
<tr>
<td><strong>Observed Performance</strong></td>
<td>Volume of the 25 mm event is absorbed reduced by 100% going well beyond criteria. <strong>Performance exceeding all criteria</strong></td>
</tr>
</tbody>
</table>
## Water Balance

<table>
<thead>
<tr>
<th>Design Goal for Elm</th>
<th>None</th>
</tr>
</thead>
</table>
| **CVC Stormwater Management Criteria** | Minimum of 3 mm of groundwater recharge per event.  
(Low Volume Groundwater Recharge Area) |
| **Observed Performance** | All runoff is exfiltrated for events under 25 mm.  
Up to 13 mm is recharged for events of this size.  
For larger events where discharge was observed:  
11-16 mm of recharge provided |

**Performance exceeding all criteria**
Monitoring Suggests

• LID offers “quick-win” opportunities in flood prone areas while larger scale SWM measures are being designed, constructed
• Data supports International BMP database (BMPDB) and National Stormwater Quality Database (NSQD), and STEP;
• City of Mississauga passes Resolution to look at all capital roads projects for LID feasibility
CVC’s Infrastructure Performance & Risk Assessment Program

Top Stakeholder Priorities

1. Water quality and quantity performance of LID design in low infiltration soils

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4. Long term maintenance

5. Lifecycle costs
“Your most unhappy customers are the greatest source of learning.”

Bill Gates
LID Options - Right Design for the Right Location

City Centre Showcase Area
Well maintained by city as with other landscaping beds in showcase areas

Neighbourhood with high ownership rate
– will be adopted by owners and maintained

High rental rate / ongoing maintenance concerns
– low maintenance grass option preferred
KNOW YOUR AUDIENCE
“Everything is either an opportunity to grow or an obstacle to keep you from growing. You get to choose.”
Wayne Dyer
No additional maintenance is required at parks with LID.

- Tad Makula and Rich Hurren, City of Mississauga
PERCEPTION: Can’t do LID because of road salt
County Court Road Retrofit – City of Brampton

- Impermeable liner will protect groundwater
- Monitor performance to support implementation in groundwater sensitive areas
Kitchener, Ontario

Shut-off grates installed at inlets during winter months to prevent salt contamination
PERCEPTION: Doing something for the environment comes at a cost
Savings of 25% compared to conventional practices
The Economic Side of LID: Local Green Jobs

LID projects built through CVC’s Showcasing Water Innovation grant help to raise the profile of LID. Local business are seeing an increase in their services related to LID. One local business reported that 40% of new work has been driven by LID and that net revenue is expected to grow by $900,000 over the next five years.\textsuperscript{xxii} With stronger profitability, companies are also able to train and hire more employees.
This project will remedy a number of challenging maintenance issues and reduce our operating costs over the long term.

- Nancy Cole, IMAX
Commercial areas with green features have higher occupancy and enhanced property value.
People will pay more for real estate with green features
# Cost Benefit Comparison for Retrofit Scenarios

### Direct Benefit Rating:
- High
- Moderate
- Low
- None

## Boulevard bioretention units and permeable paver driveway:

**Direct benefits:**
- Volume reduction

**Indirect benefits:**
- Climate change mitigation & adaptation
- Groundwater recharge
- Street greening

**Risks and liabilities:**
- Impaired function from owner encroachment or lack of maintenance

## Curb-and-gutter with stormwater management pond:

**Direct benefits:**
- Volume reduction
- Erosion control
- Water quality
- Flood control

**Indirect benefits:**
- Protect Great Lakes
- Increase amenity value
- Street greening
- Open space amenity

**Risks and liabilities:**
- Long-term maintenance liability
- Increased erosion control costs
- Pond sediment clean out

## Conventional road reconstruction (curb-and-gutter) with no SWM:

**Direct benefits:**
- Volume reduction
- Erosion control

**Indirect benefits:**
- Maintains traditional road aesthetic

**Risks and liabilities:**
- Downstream flood risk
- Increased erosion control costs
- Harm to fisheries

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**Best value: $895,000**

**High cost, moderate benefits: $1,090,000**
Funding Opportunities for LID

- MOI Building Together
  - MOE Water Sustainability Plans – require integration of Water, Wastewater and Stormwater
  - Gas Tax – up to 30% of projects can be SWM

- SWM Fees (Halton Hills, Mississauga)
- Insurance rebates for home/business??
- Roofing contractor rebates
Grey to Green Guides and Case Studies

Grey to Green Enhanced Stormwater Management Master Planning:
Guide to Optimizing Municipal Infrastructure Assets and Reducing Risk

Enhanced Stormwater Master Planning

IMAX Parking Lot Retrofit
Location: Mississauga
Constructed: 2013

Business and Multi-Residential

Project Objectives, Design and Performance
- Design and construct a better functioning parking lot that utilized stormwater management infrastructure with modern infrastructure innovations
- Ensure that rainwater harvesting technologies are integrated into the IMA parking lot, including permeable pavements, rain gardens, bioswales, and rainwater harvesting systems
- Conduct infrastructure performance assessment to directly address knowledge gaps impacting the scale of stormwater technologies in OH

Overcoming Barriers and Lessons Learned
- Challenges and conditions were encountered on site requiring a collaborative design that provides sufficient storage infrastructure and structural support
- Problems and solutions designed in collaboration with the client, contractor, and project team
- To ensure that stormwater management and infrastructure projects benefit the local community, they are designed and implemented in a way that is welcoming and accessible for all community members