

OUR WORLD IS CHANGING





Health Impact of Extreme Events

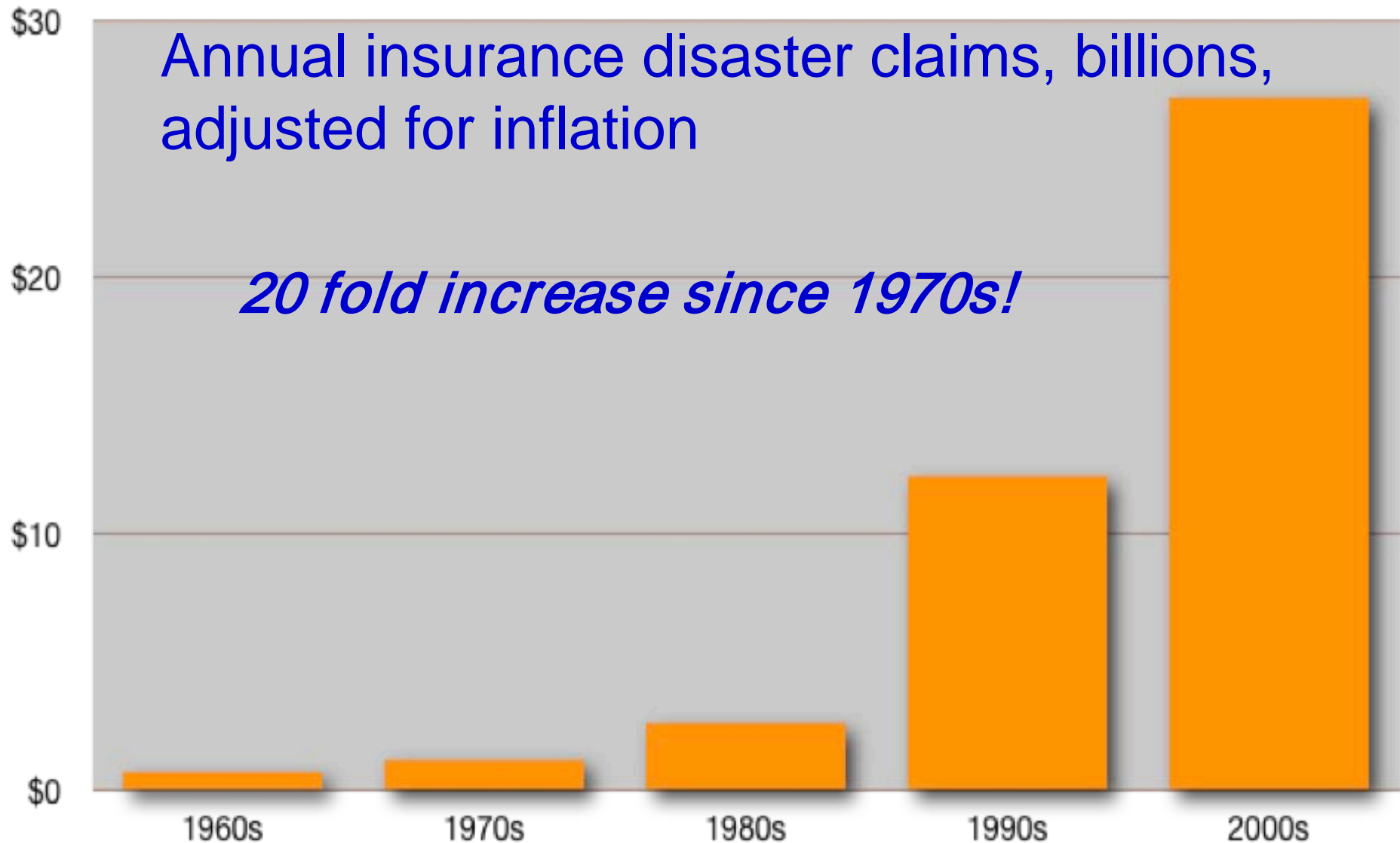
- The stress faced by pregnant women during the 1998 Quebec ice storm = children at a greater risk to develop asthma, diabetes or obesity, similar results from Calgary flood



..... If this strange and severe weather was once hard to imagine, it's now hard to ignore.....Maclean's Magazine

Annual insurance disaster claims, billions, adjusted for inflation

20 fold increase since 1970s!



**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

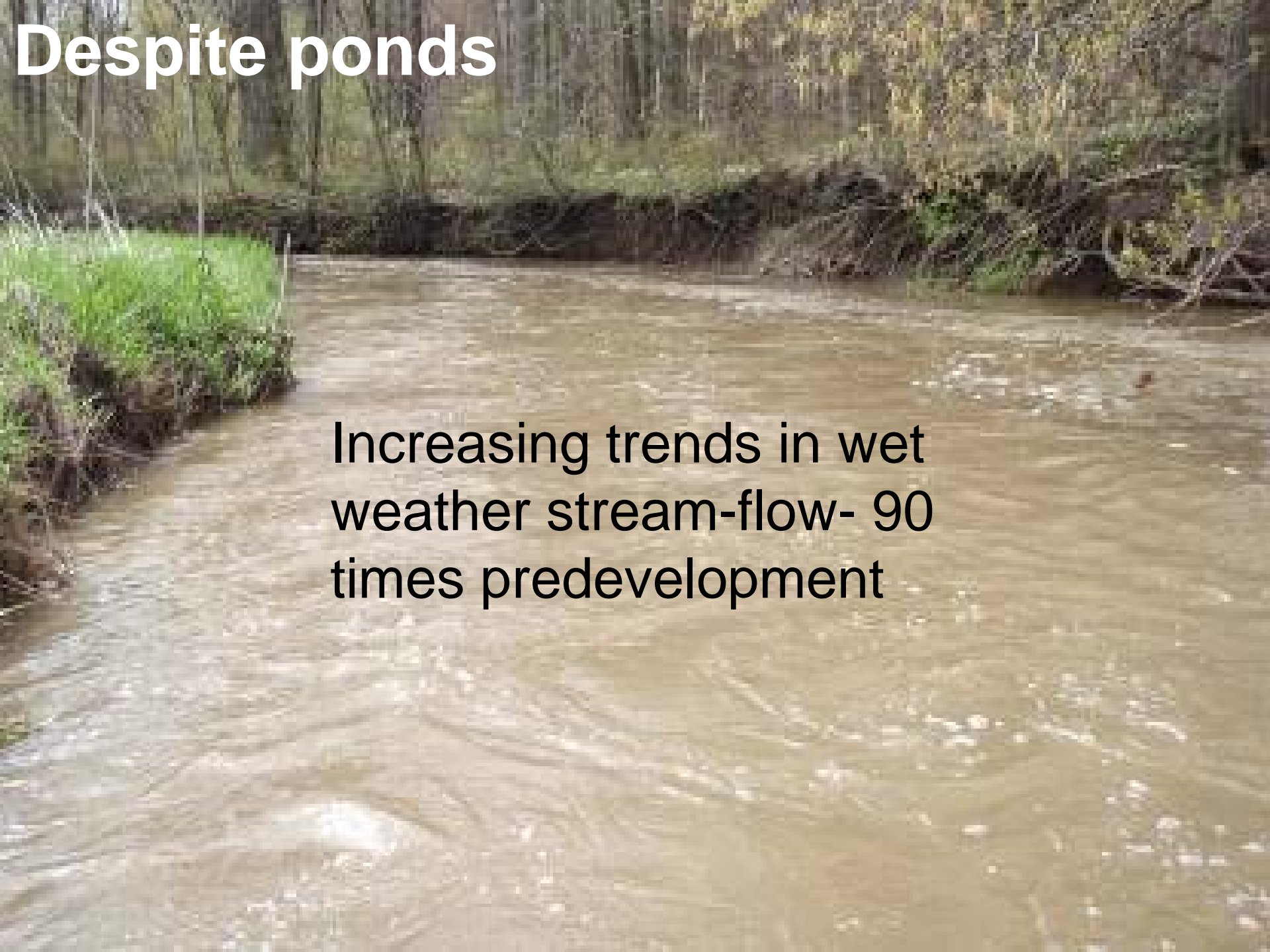
Despite meeting current MOE requirements with the use of ponds:

- 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



40% Evapotranspiration



10% Runoff

50% Deep & Shallow
Infiltration

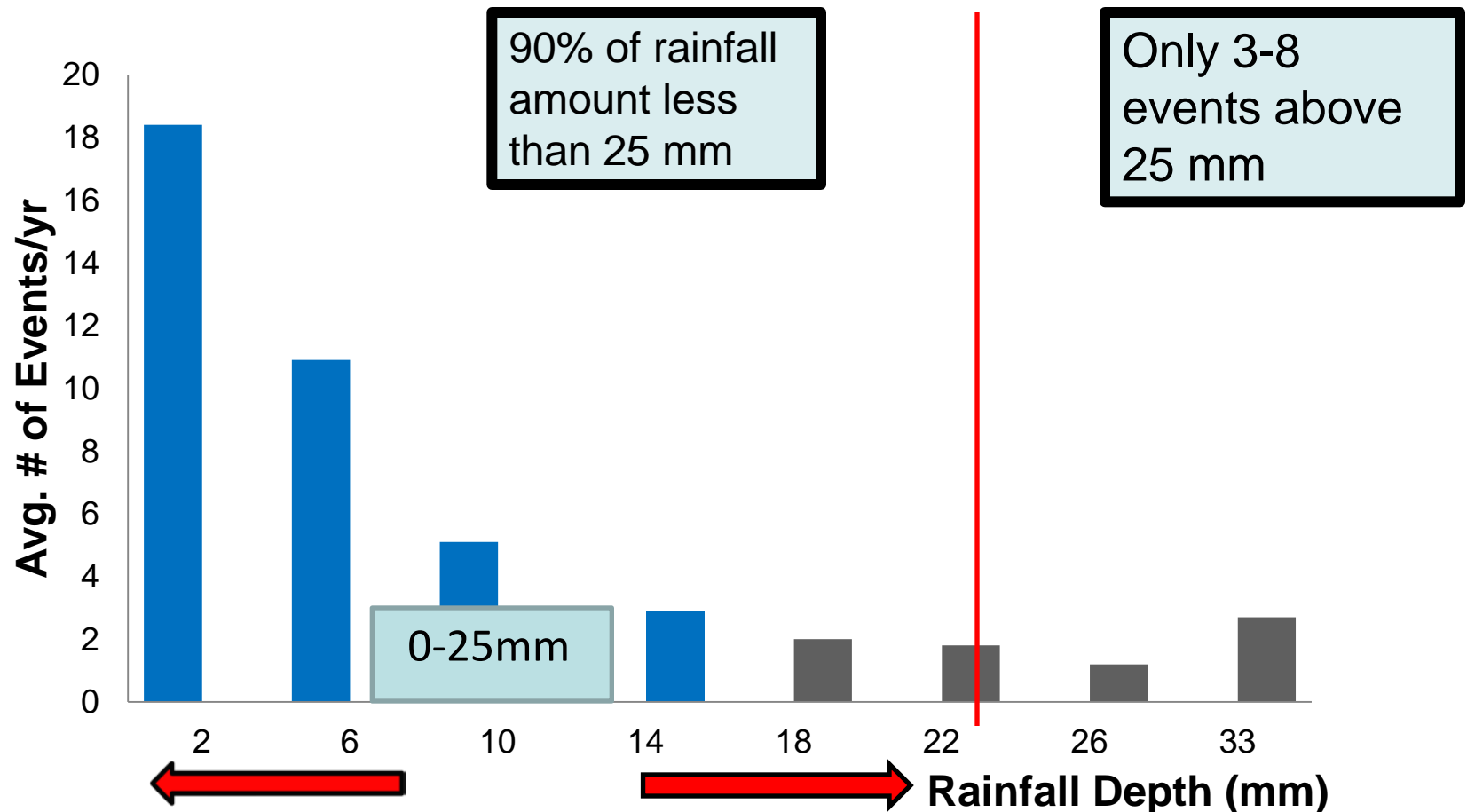
Natural Ground Cover





Credit Valley
Conservation

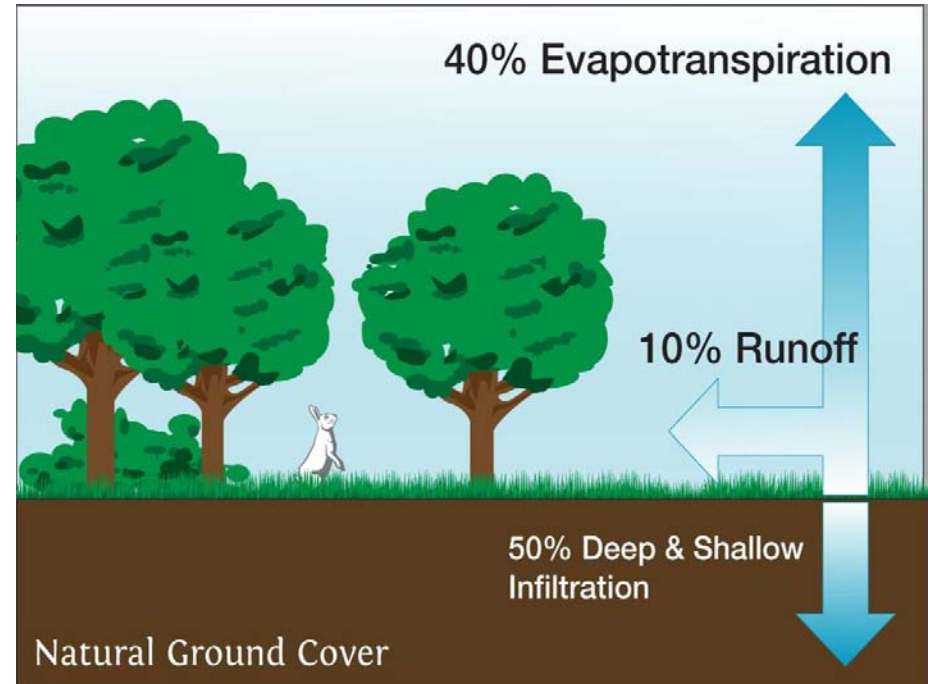
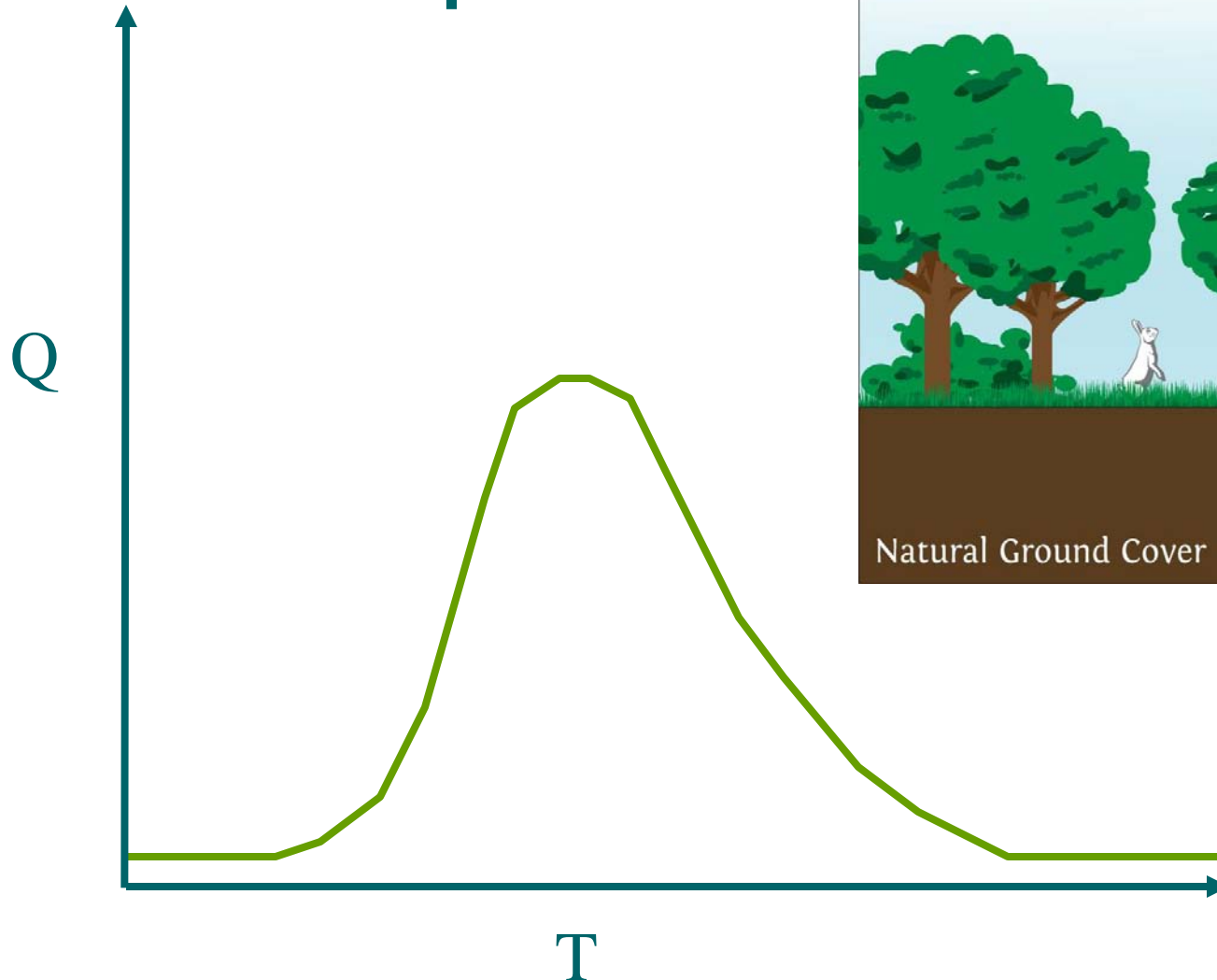
Typical Annual Rainfall Frequency Distribution For Toronto, Ontario





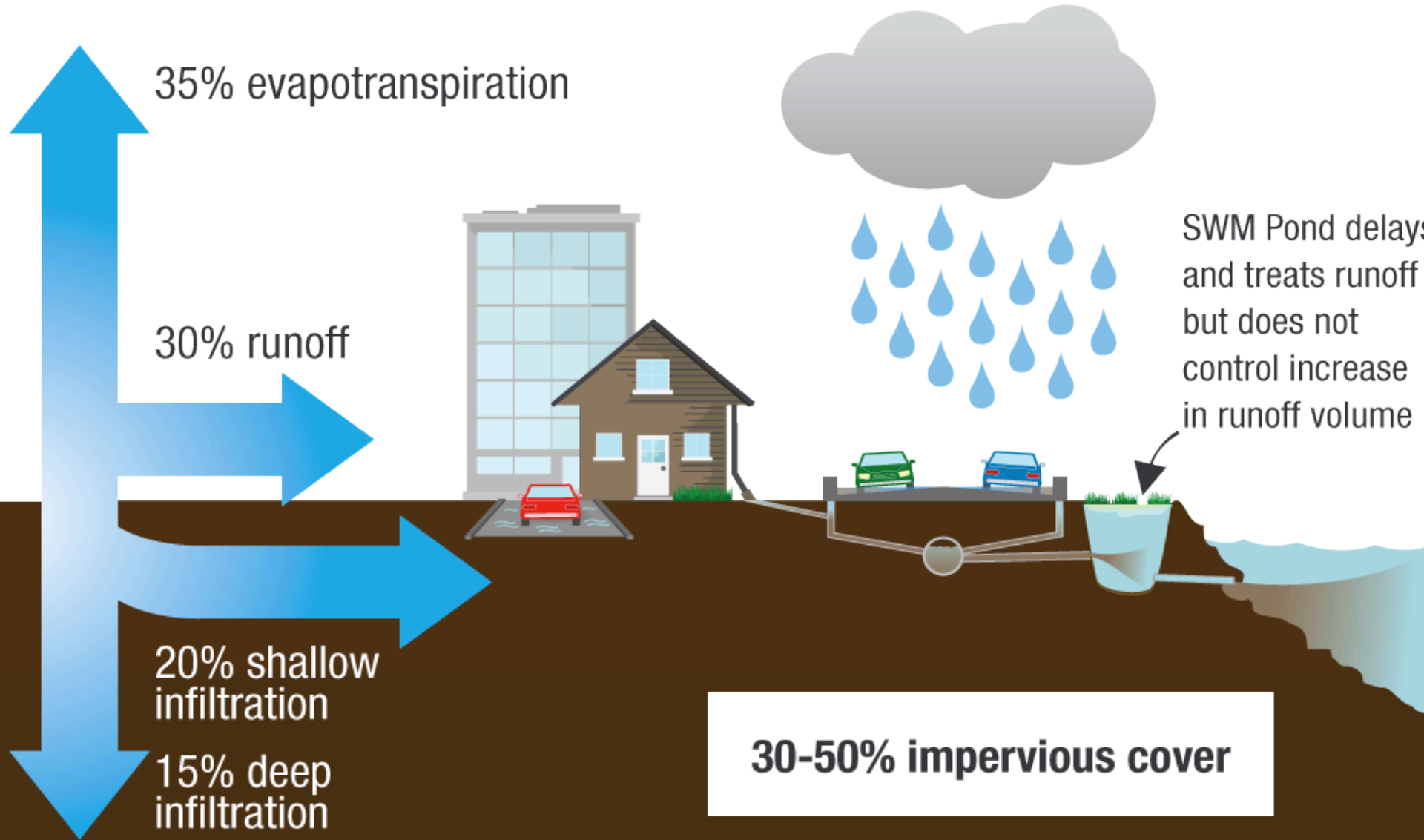
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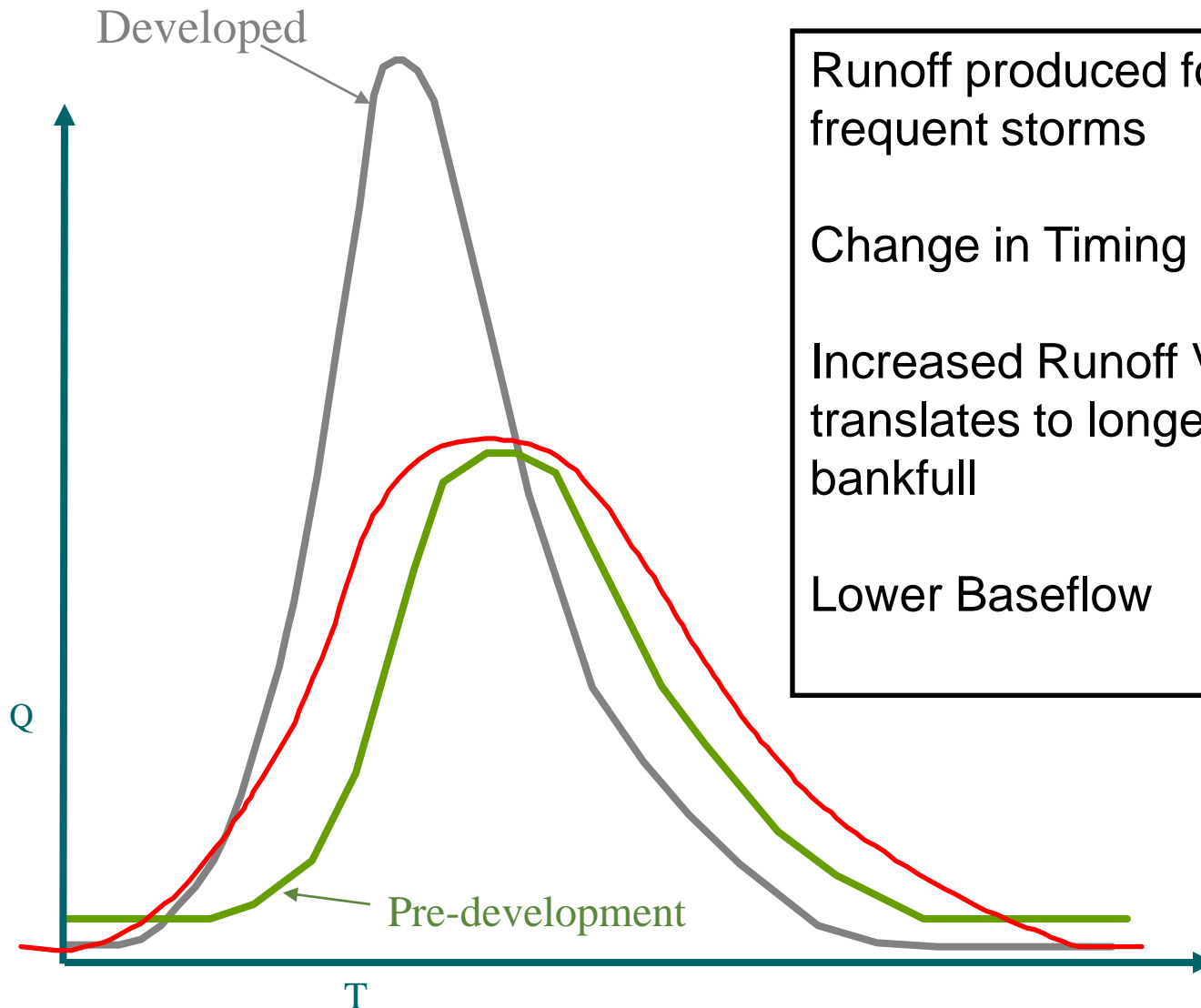
Pre-Development



Urban Hydrology

Typical development: Stormwater management using
End of Pipe SWM Pond





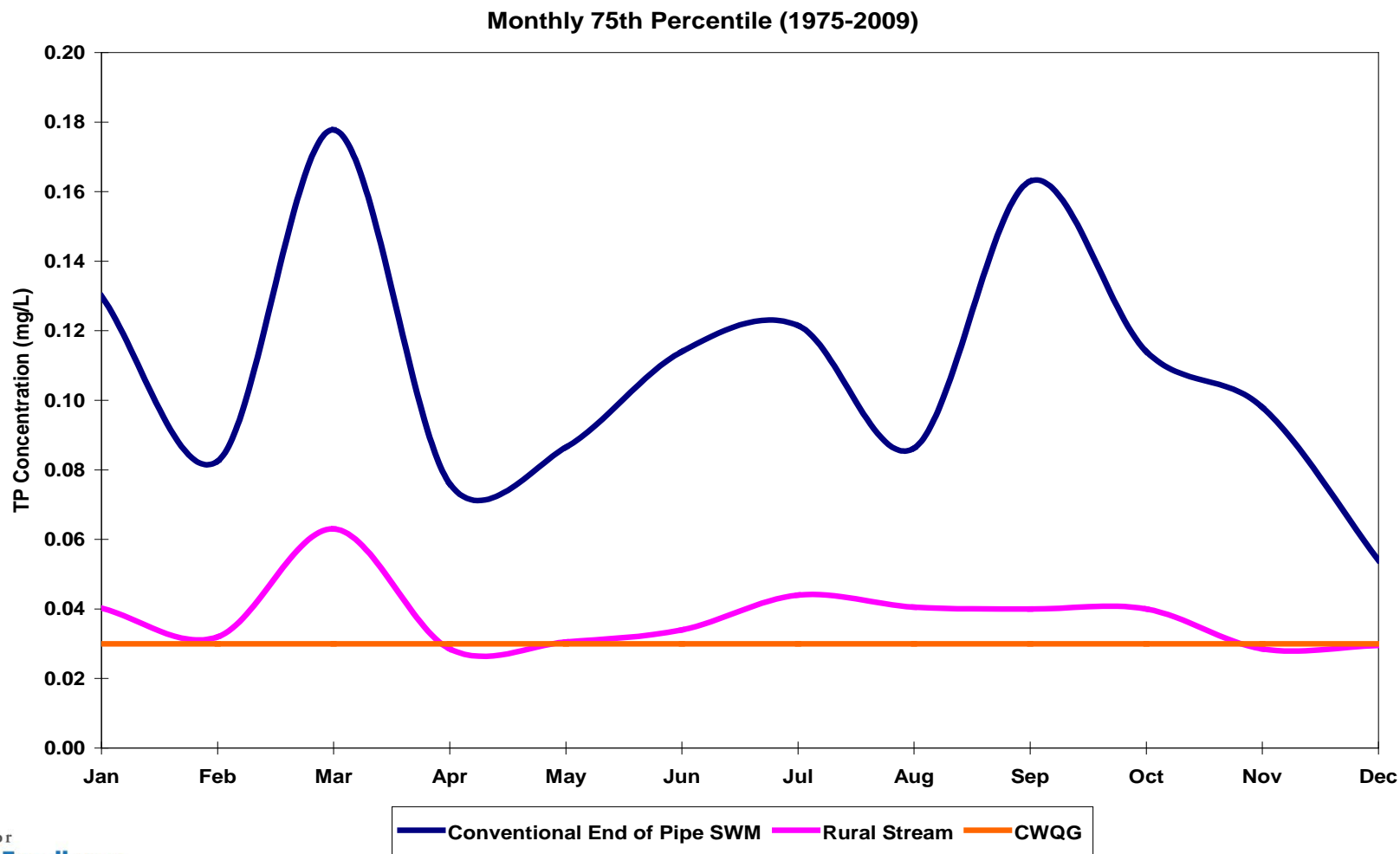
Runoff produced for more frequent storms

Change in Timing and Peak

Increased Runoff Volume-translates to longer periods of bankfull

Lower Baseflow

Total Phosphorus





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SWM Pond Performance

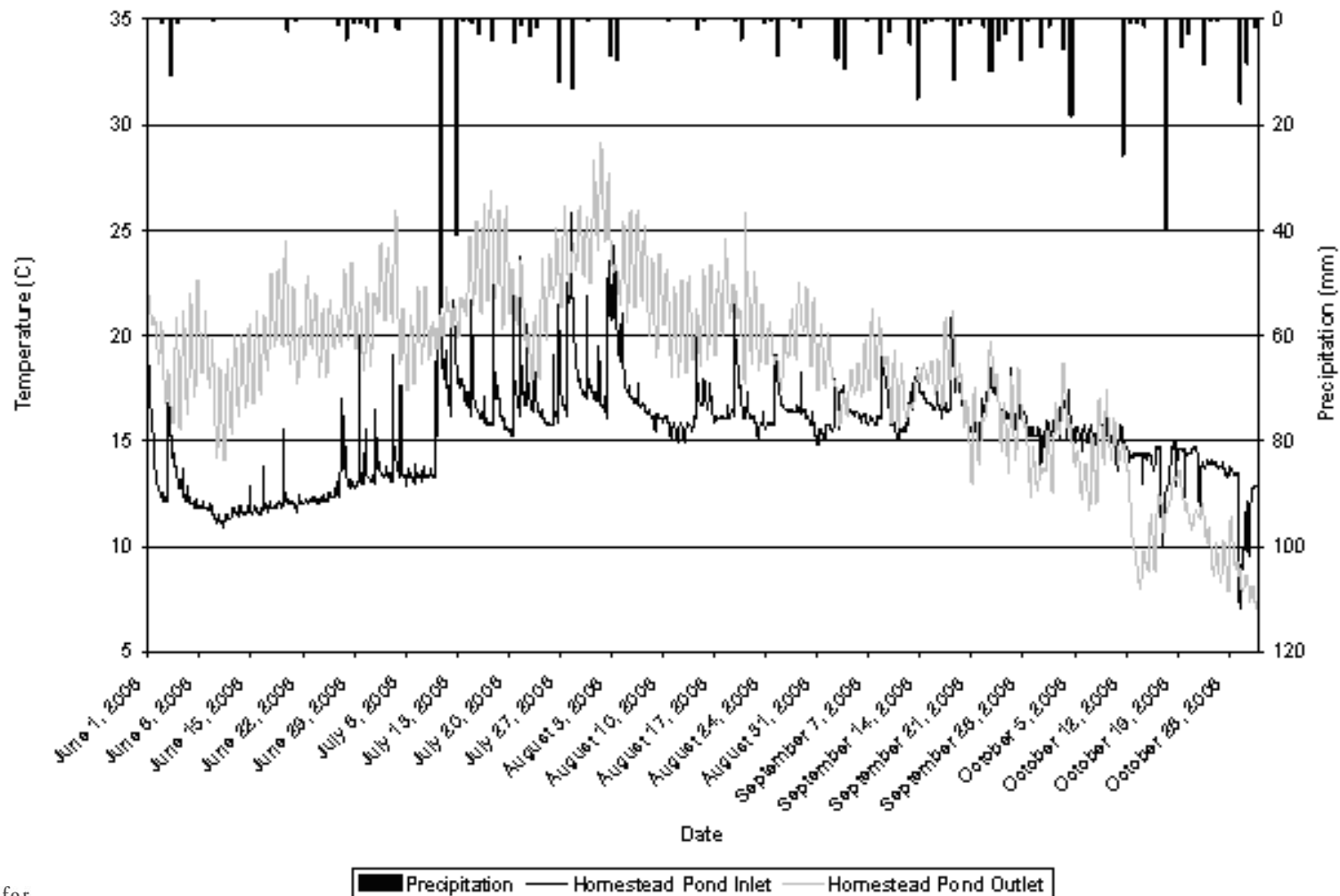
- More events produce runoff= pollutant loading more often
- Literature finds end-of-pipe facilities less effective than LID in removing finer particles





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Water Temperature





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

Increases in CI 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

35% evapotranspiration

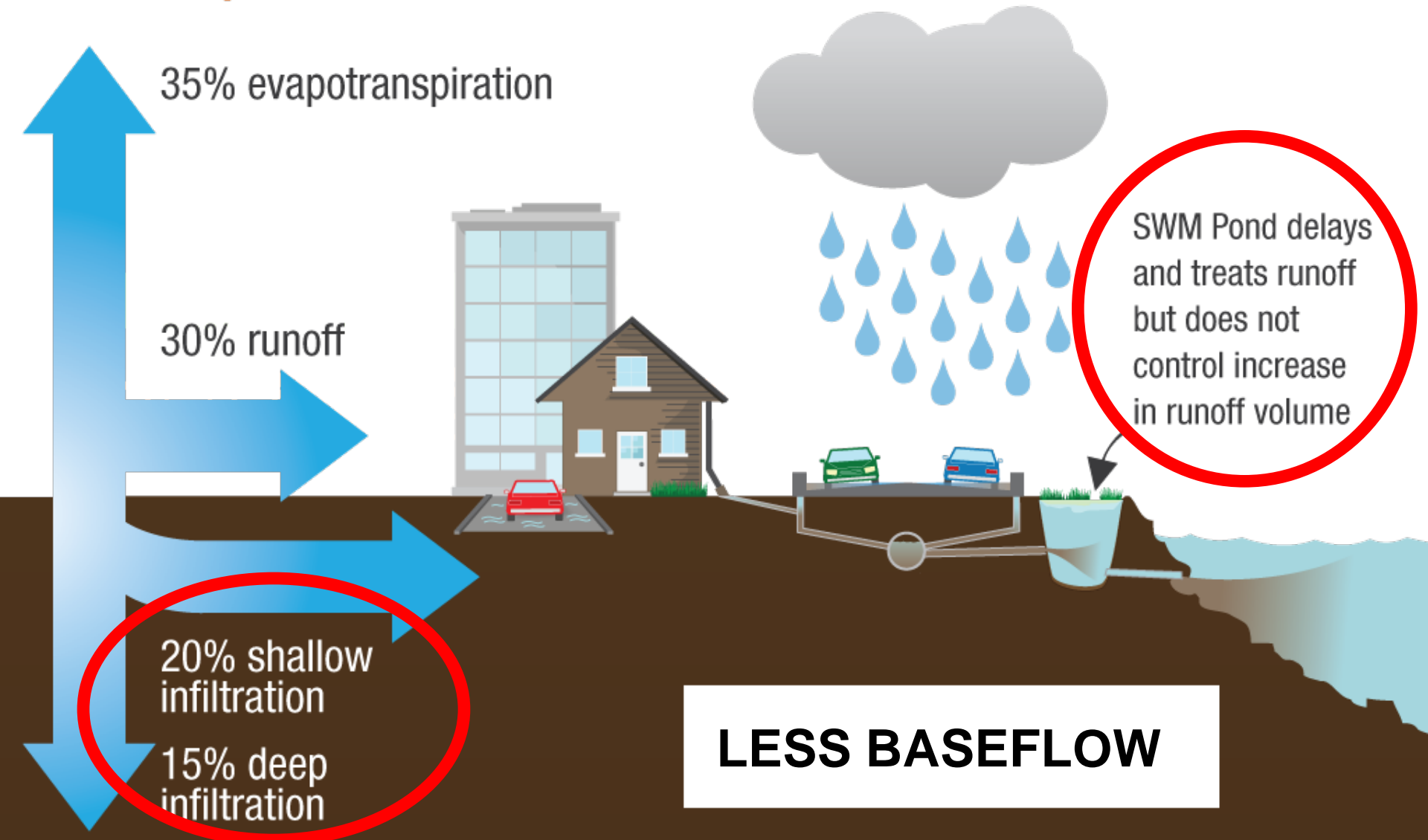
30% runoff

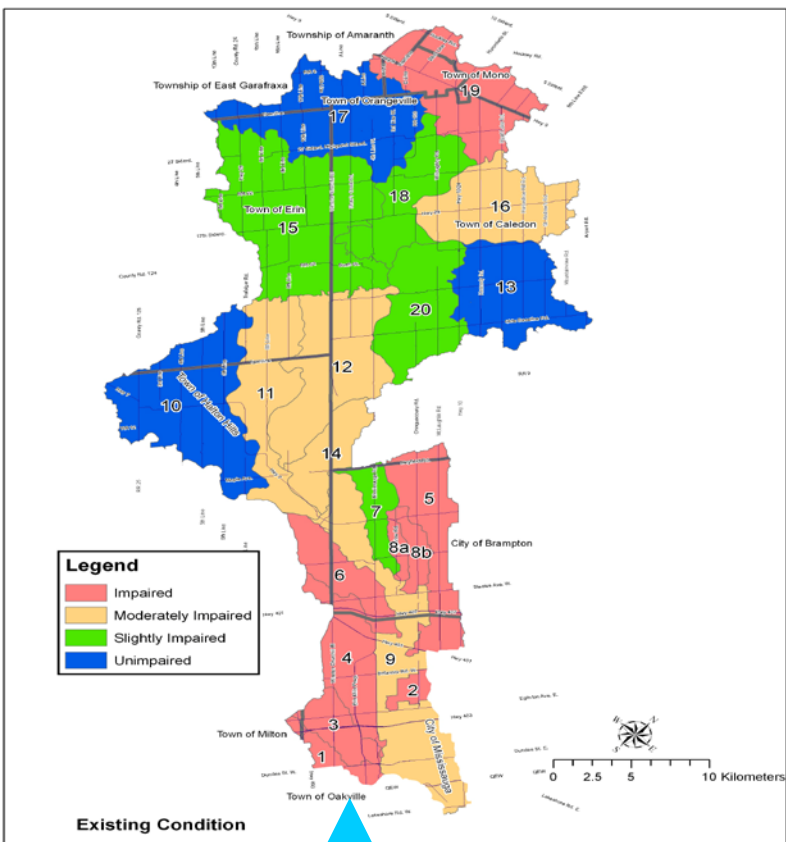
20% shallow
infiltration

15% deep
infiltration

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

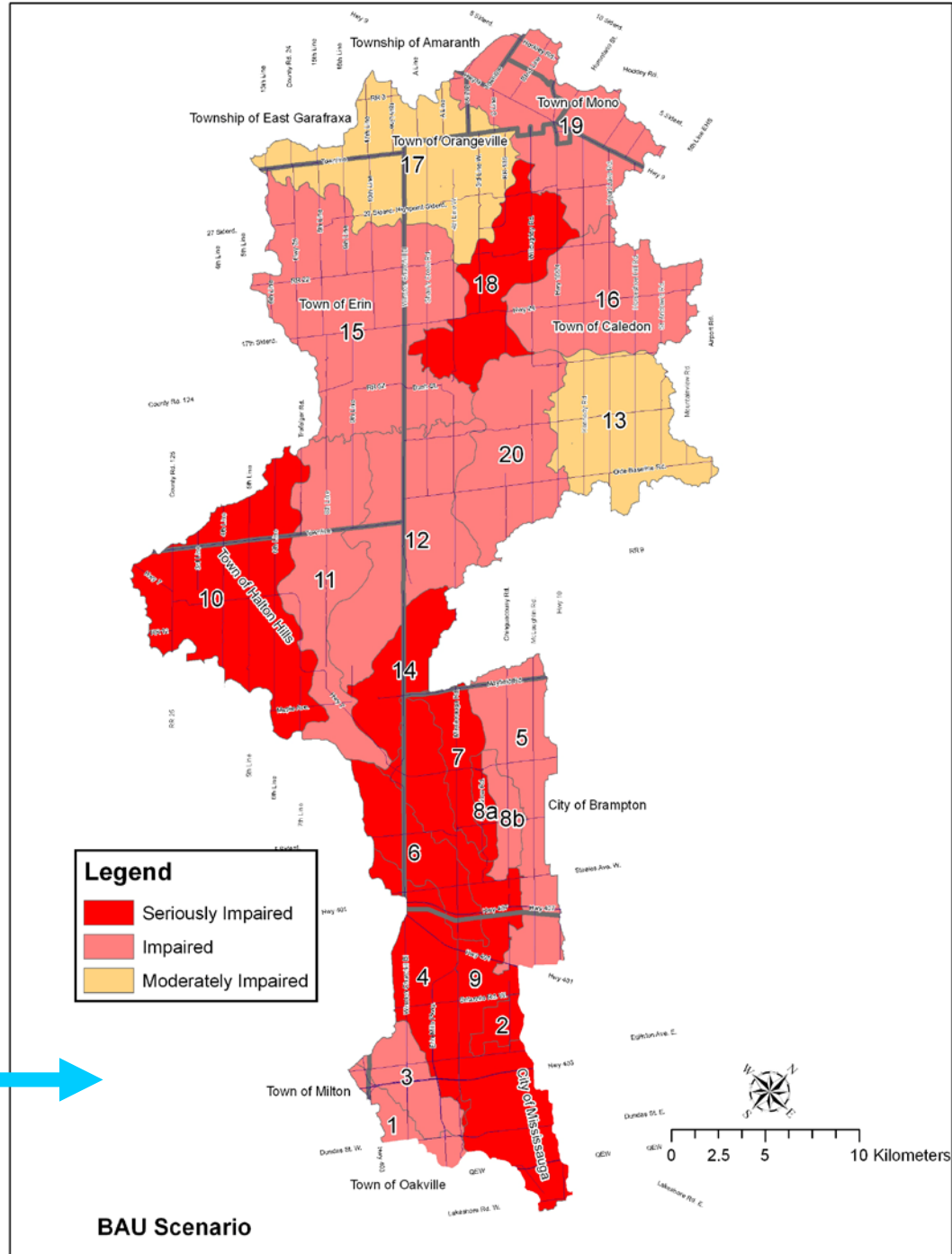
LESS BASEFLOW

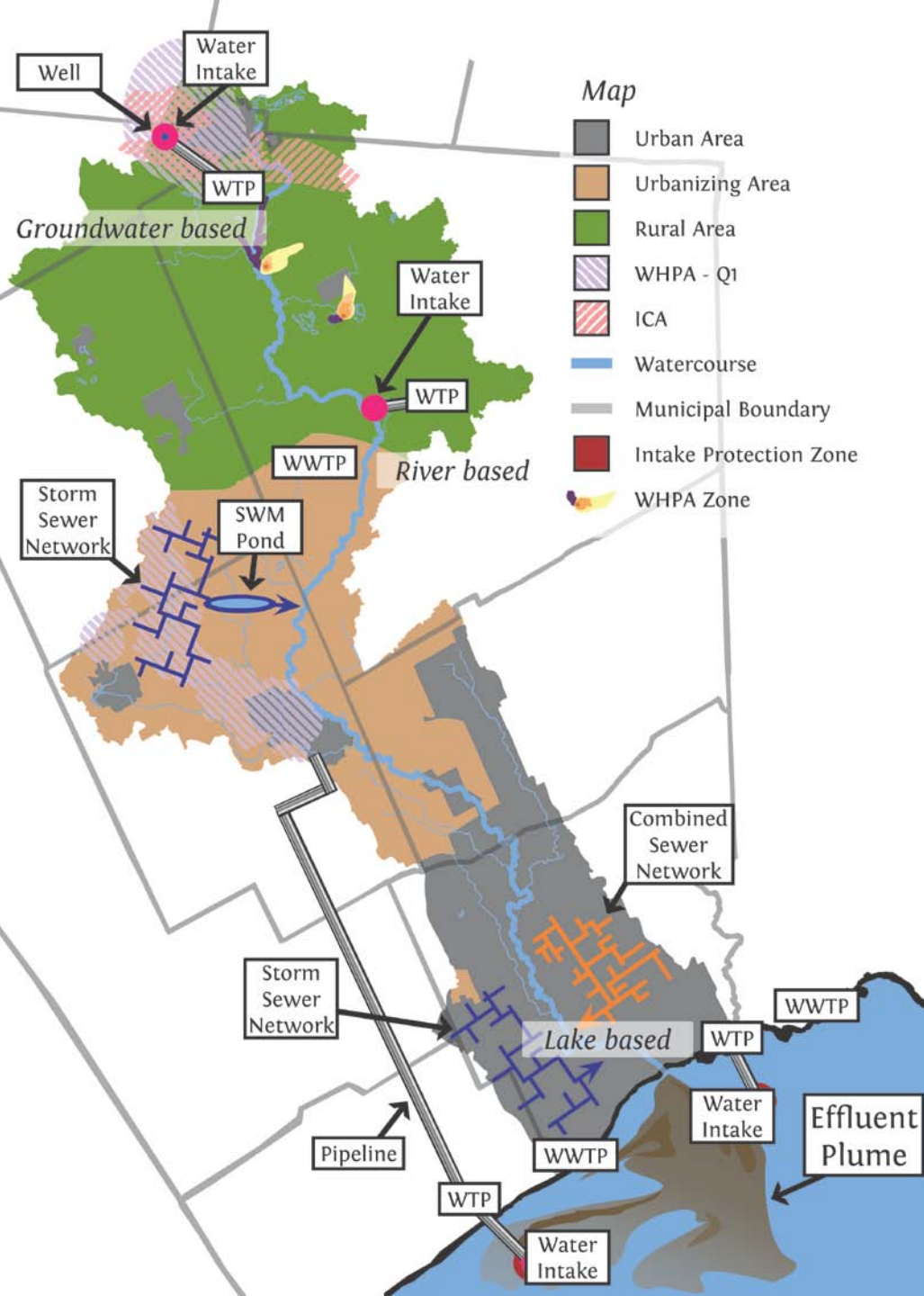




EXISTING CONDITIONS
(15% URBANIZATION)

BUSINESS AS USUAL
MANAGEMENT ALTERNATIVE
(25% URBANIZATION)





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Conservation**

- Watershed Perspective
- Infrastructure Types - W, WW, SW
- Governance/Policy/Legislation
- Upstream actions - downstream impacts
- Challenging!

*Integrated Water Resources Management:
The Emperor's New Clothes or Indispensable Process?*

"IWRM is easy to talk about but hard to implement." – a practitioner



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Integrated Stormwater Management

(called LID- or Low Impact Development)

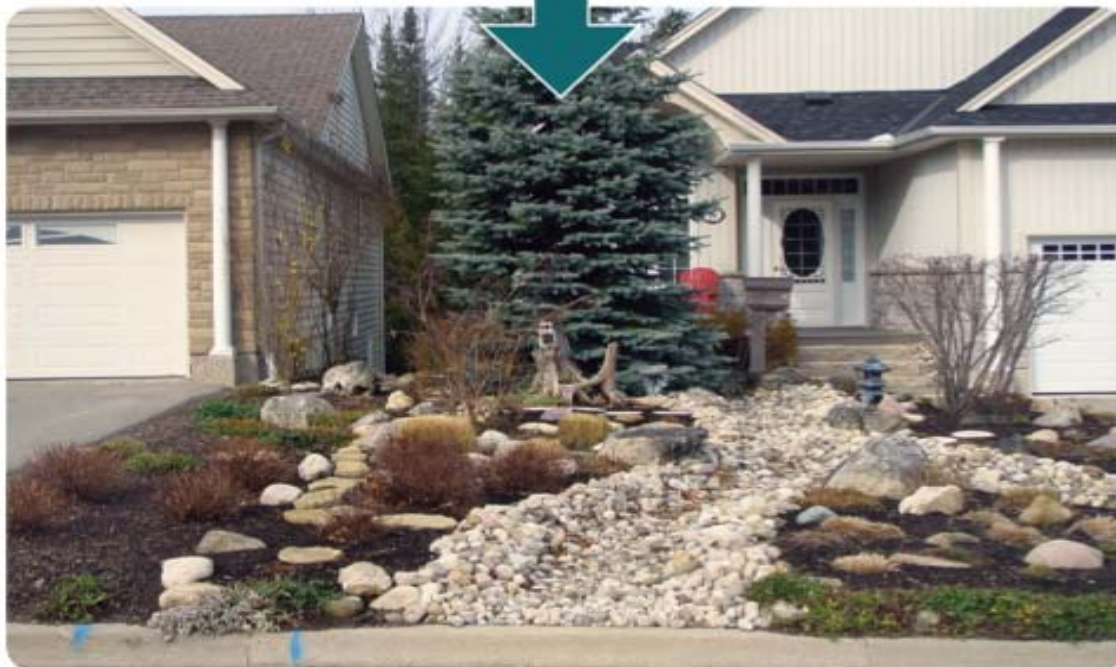
Treat it where it falls

Treat it along the
path

Treat it before it
goes to your Lake







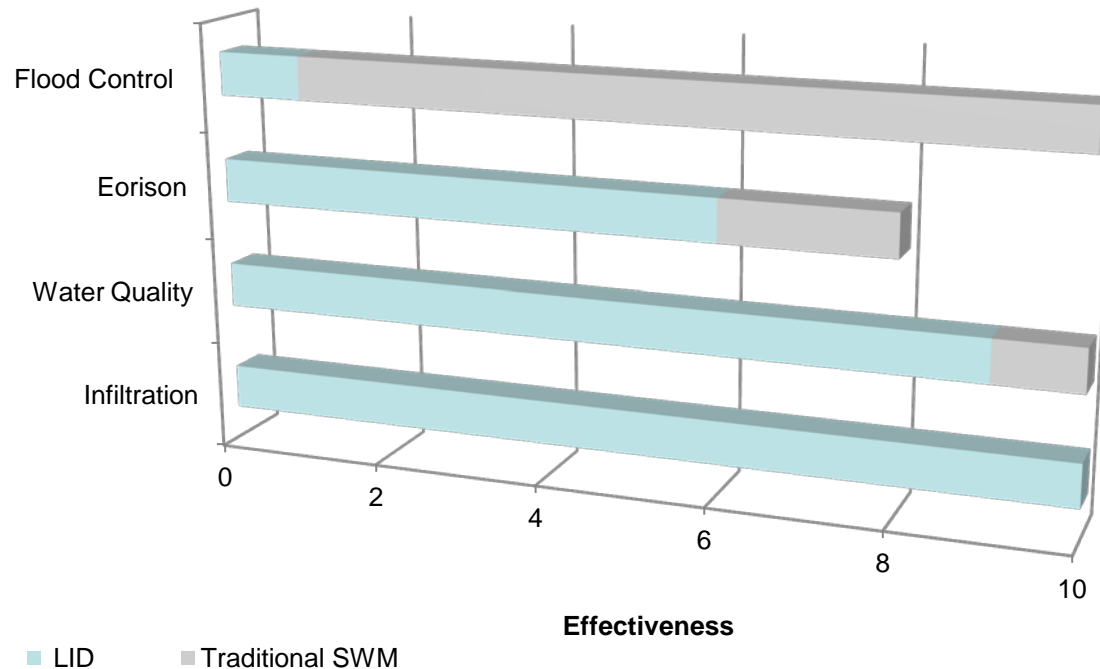




Holistic Approach & Criteria

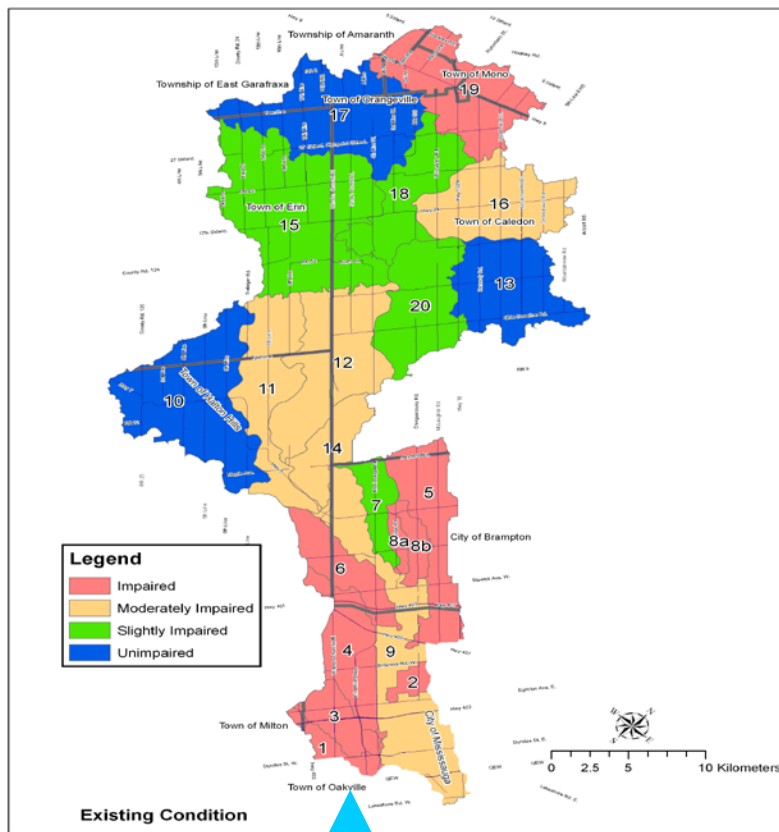
- When used together

Holistic SWM Approach vs. Criteria



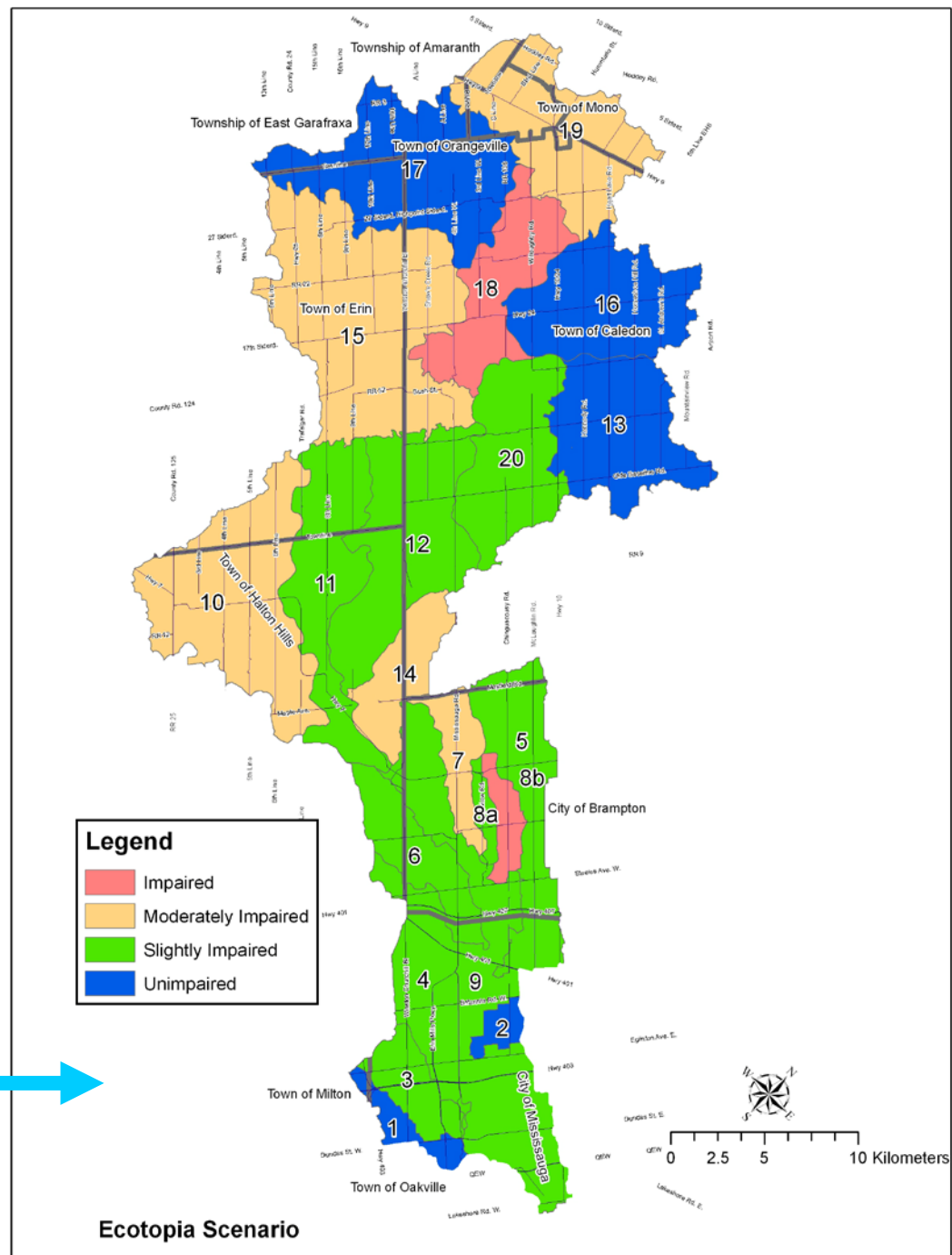
■ LID

■ Traditional SWM



EXISTING CONDITIONS (15%
URBANIZATION)

PREFERRED MANAGEMENT
ALTERNATIVE (25%
URBANIZATION)



Ecotopia Scenario



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



LOW IMPACT DEVELOPMENT CONSTRUCTION GUIDE

Version 1.0
2012

Top Stakeholder Priorities

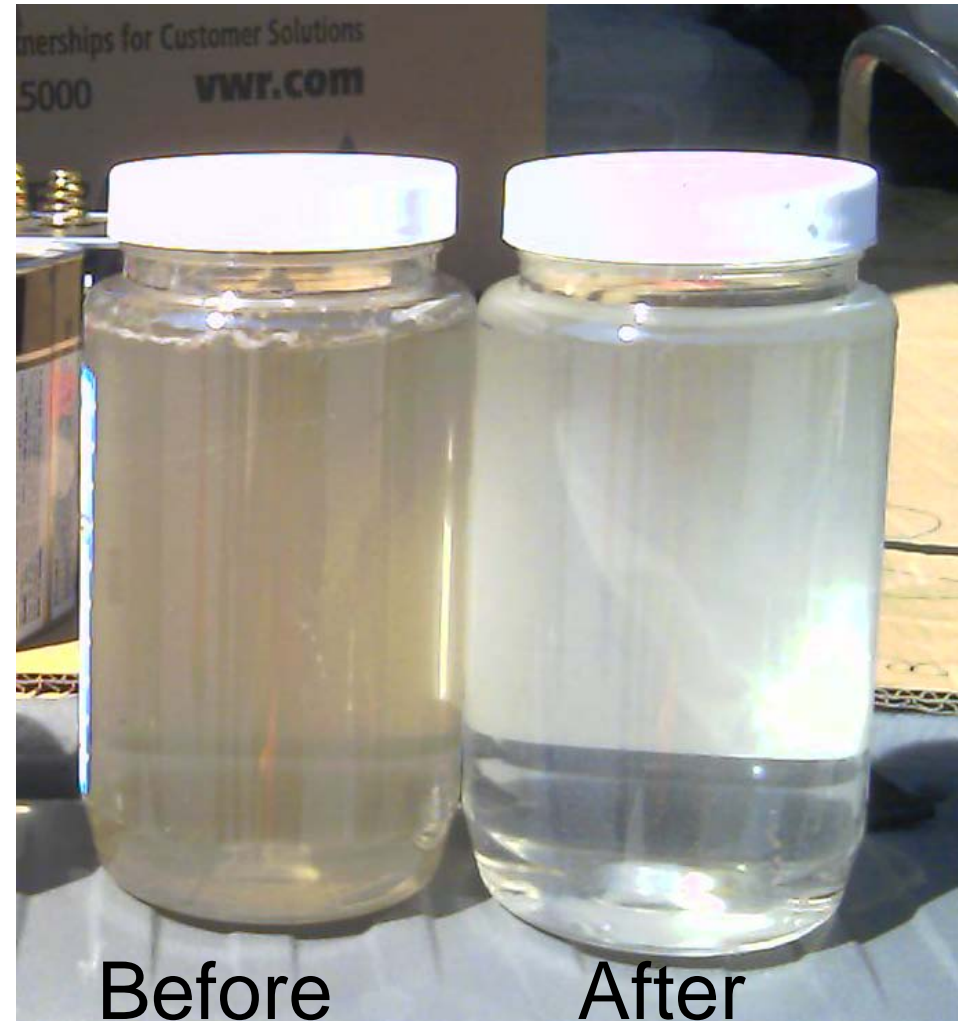
- 1. Water quality and quantity performance of LID design in low infiltration soils**
- 2. How multiple LID treats and manage stormwater**
- 3. Performance of flood control, erosion control, water quality and natural heritage protection**
4. Long term maintenance
5. Lifecycle costs



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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



Rainfall Distribution of July 8th, 2013 Storm Event Lower Credit River Watershed

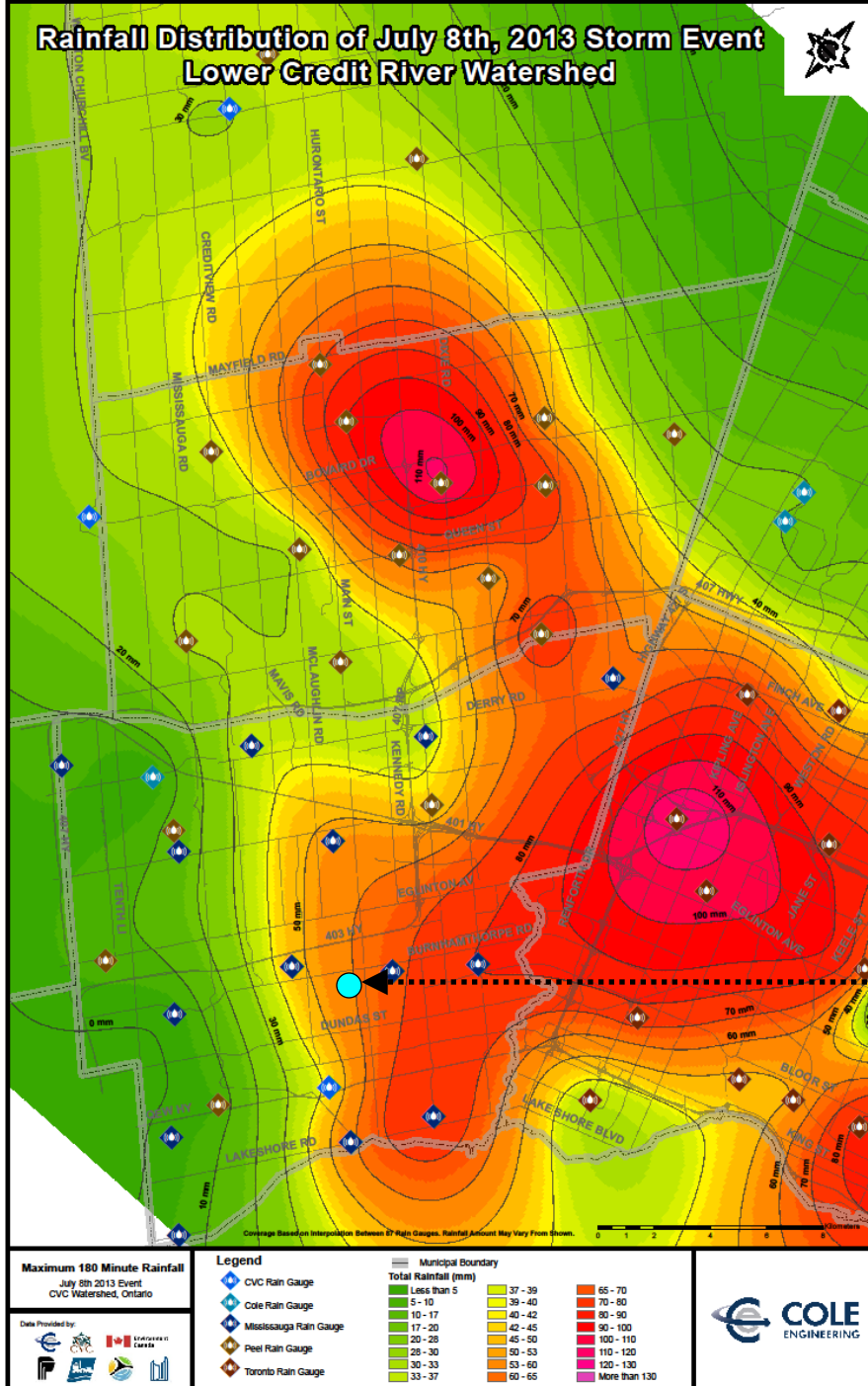


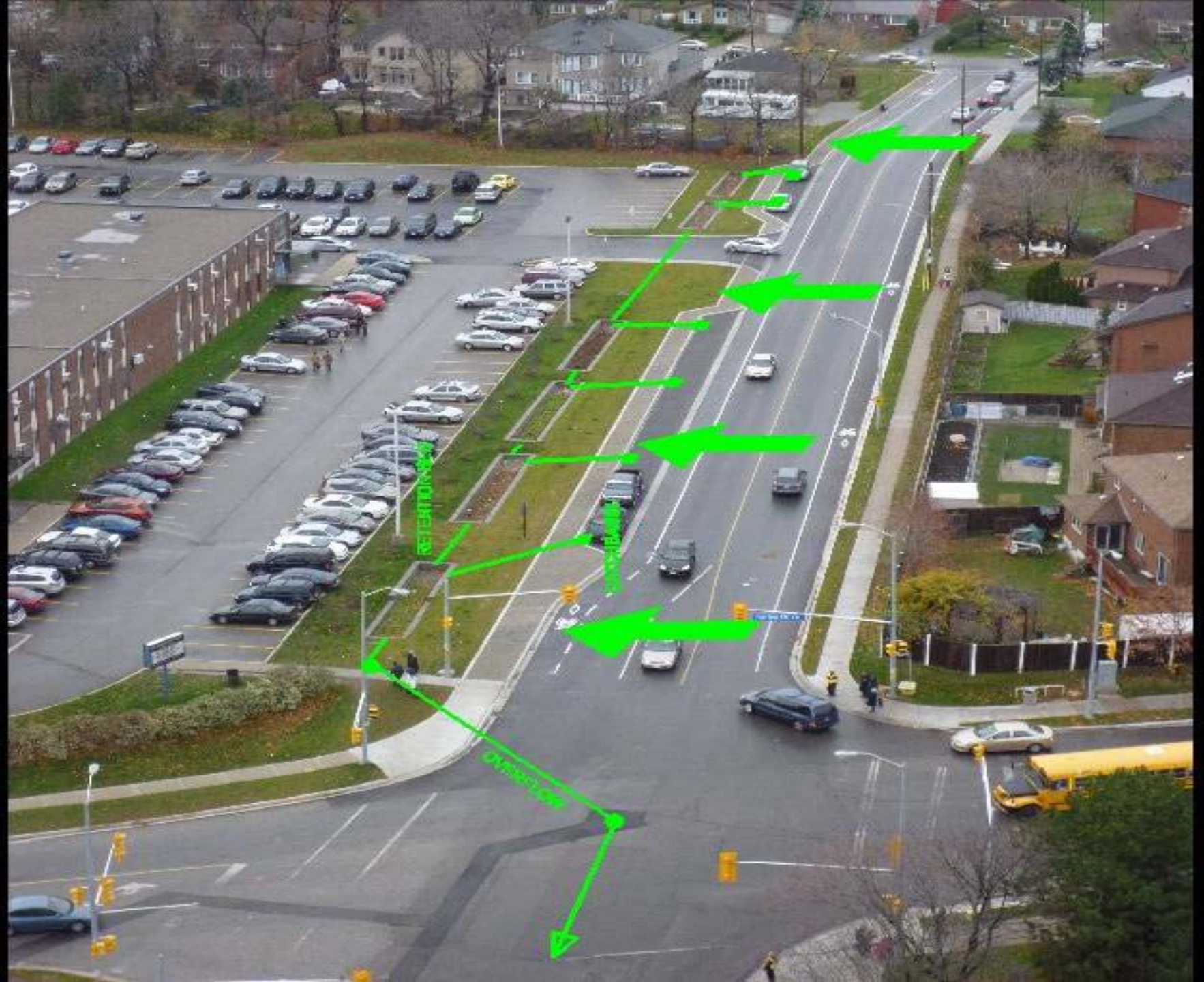
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July 8th 2013 Thunder Storm

Greater than 100 Year Event

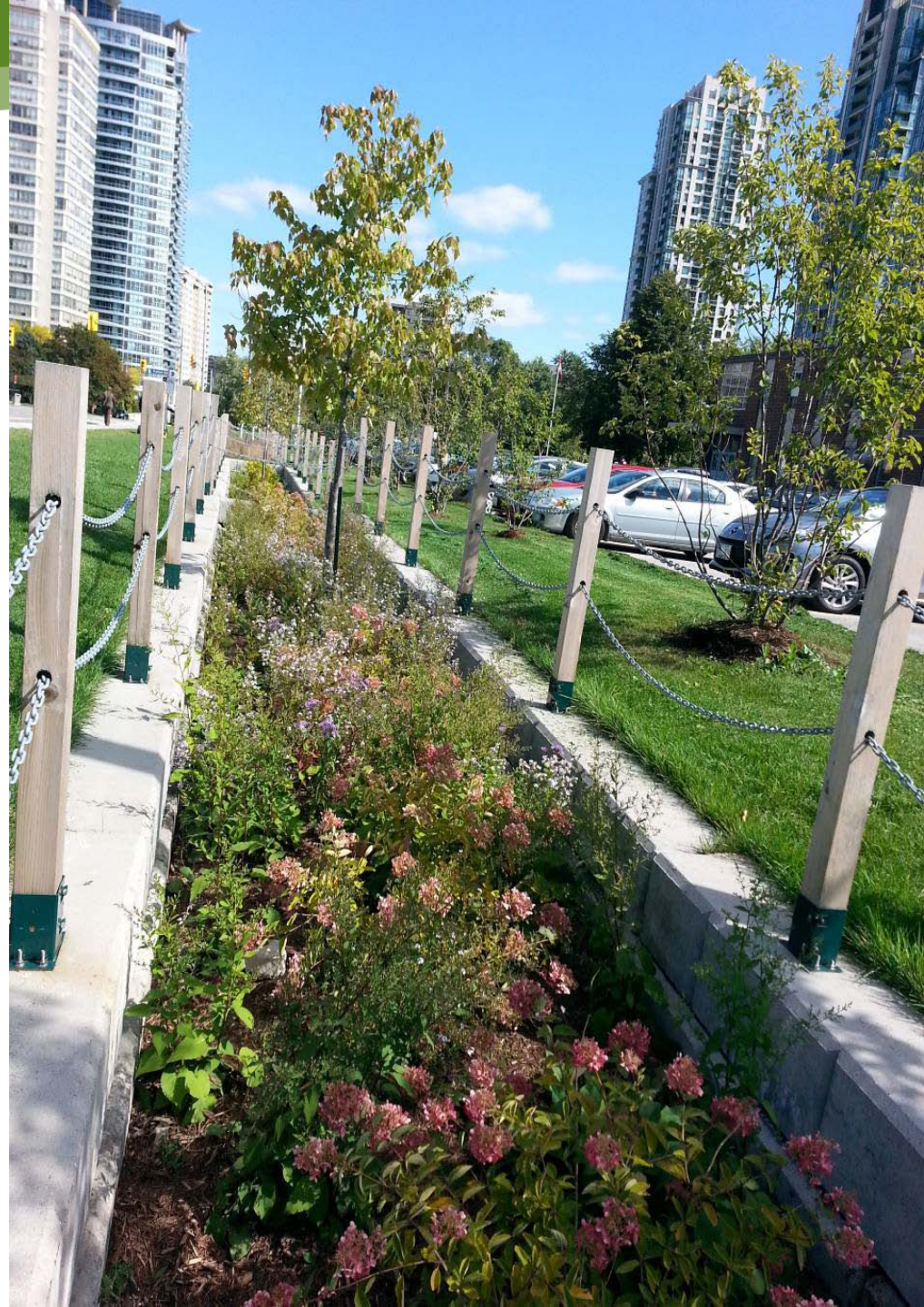
Elm Drive LID Site





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

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

Water Balance

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

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
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**

**“Your most unhappy
customers are the greatest
source of learning.”**

Bill Gates

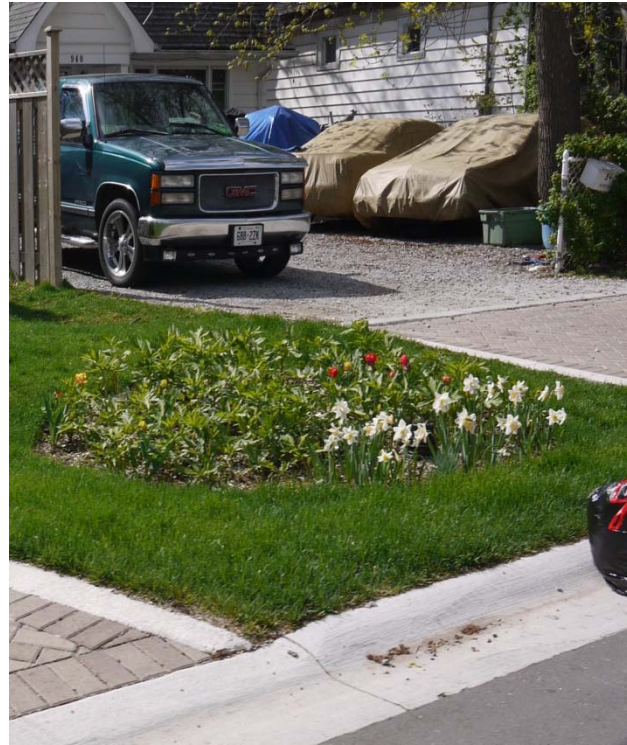


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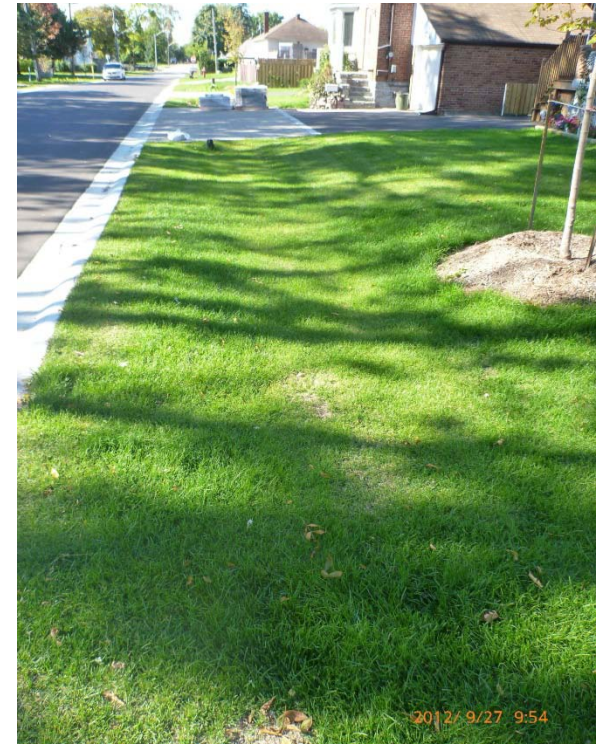
LID Options - Right Design for the Right Location



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



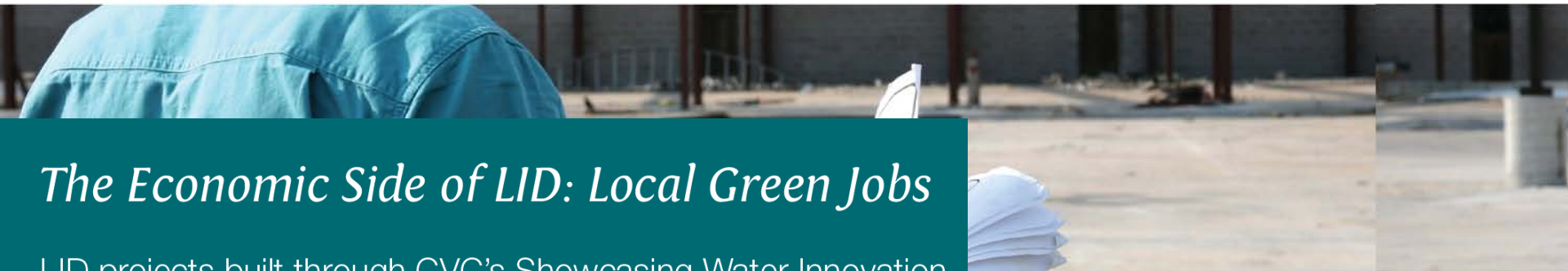
Shut-off grates installed
at inlets during winter
months to prevent salt
contamination



PERCEPTION:
**Doing something for
the environment
comes at a cost**

A photograph of a landscaped area. In the foreground, there is a flower bed with many yellow flowers and some purple ones. A concrete sidewalk runs along the right side of the flower bed. To the left of the sidewalk is a paved road. In the background, there are trees and a building.

**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.^{xxii} With stronger profitability, companies are also able to train and hire more employees.



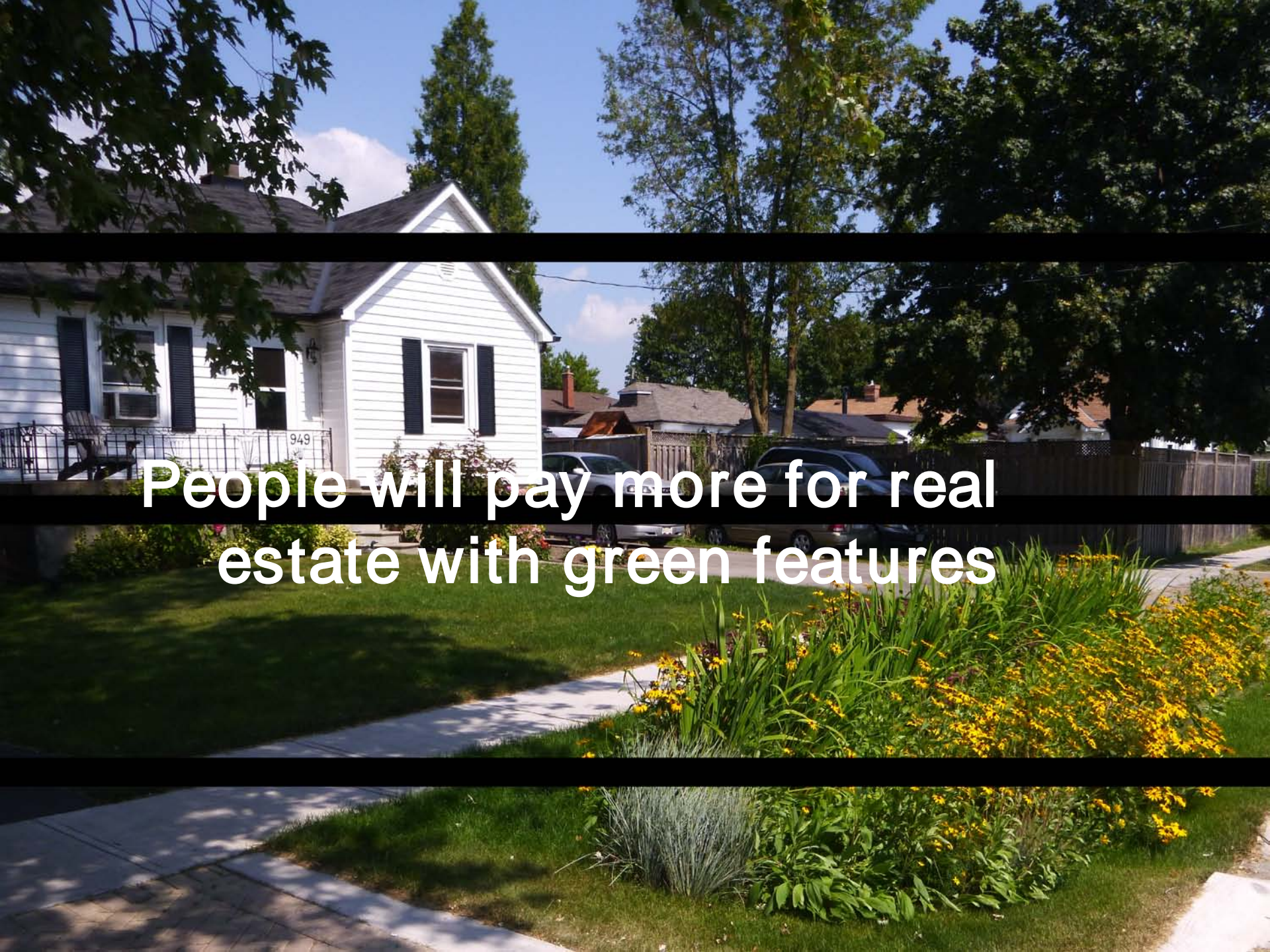




**This project will
remedy a number of
challenging
maintenance issues
and reduce our
operating costs over
the long term**

- Nancy Cole, IMAX





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:

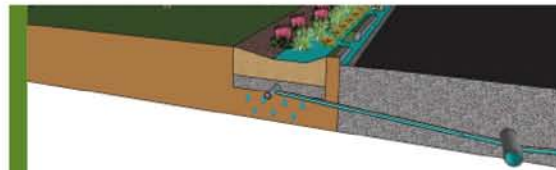
- Volume reduction

Indirect benefits:

- ✓ Climate change mitigation & adaptation
- ✓ Groundwater recharge
- ✓ Excess flow

Risks and liabilities:

- ✗ Impaired function from owner encroachment or lack of



- Erosion control
- Water quality
- Flood control

- ✓ Protect Great Lakes
- ✓ Increase amenity value
- ✓ Street greening

- ✓ Improve baseflow
- ✓ Helps to meet or exceed environmental strategic plan objectives

maintenance

Best value \$895,000



Curb-and-gutter with stormwater management pond:

Direct benefits:

- Volume reduction
- Erosion control
- Water quality

Indirect benefits:

- ✓ Maintains traditional road aesthetic
- ✓ Protect Great Lakes
- ✓ Help meet environmental strategic plan objectives
- ✓ Open space amenity

Risks and liabilities:

- ✗ Long-term maintenance liability
- ✗ Increased erosion control costs
- ✗ Harm to fisheries
- ✗ No groundwater recharge
- ✗ Pond sediment clean out



- Flood control

High cost, moderate benefits \$1,090,000



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
- ✗ No groundwater recharge

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

Frank Look, Mississauga News



Enhanced Stormwater Master Planning



**Credit Valley
Conservation**



IMAX Parking Lot Retrofit

Location: Mississauga
Constructed: 2013

Case Study



Business and Multi-Residential

Project Objectives, Design and Performance

- Design and construct a better functioning parking lot that upgraded stormwater management infrastructure with modern low impact development (LID) features.
- Benefit from project partnerships to enable a variety of innovative stormwater management technologies to be integrated into the IMAX parking lot including permeable pavers, Arjiforbi Filter, bioswales and Geotextile Media.
- Conduct infrastructure performance assessment to directly address knowledge gaps impacting the wide-scale adoption of LID technologies in Ontario.

Overcoming Barriers and Lessons Learned

- Challenging soil conditions were encountered on-site requiring a conservative design that provides sufficient drainage infrastructure and structural support.
- Coordination and a transparent design process between CVC, product suppliers, the design team and academic experts ensured the successful integration of performance assessment infrastructure into the IMAX parking lot.
- Contractor and IMAX staff worked together to ensure that IMAX could conduct business as usual during the construction phase.
- To ensure that construction is performed properly and proceeds on time, it was to have an individual experienced in LID construction and design as a great asset on the job site. They act as a resource and liaison between the contractor, client and other stakeholders.

Practices Implemented



Barriers and Issues Encountered



NEW