



Calgary



**BOMA**  
CALGARY

# Stormwater Management: Better stormwater management for better buildings

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## AFFILIATIONS

Assistant Adjunct Professor, Department of Civil Engineering, University of Calgary

Adjunct Professor, Department of Civil Engineering, University of Alberta

Chair, Technical Committee, *Green Infrastructure for Stormwater*, CSA Group

Member, Technical Committee for *Flood Resilient Design for New Residential Communities*, CSA Group

Member, Technical Committee for *Flood Resilient Design for Existing Communities*, CSA Group

Member, Technical Committee for *Development, Interpretation and Use of Intensity-Duration-Frequency (IDF) information: Guideline for Canadian water resources practitioners*, CSA Group

Member, Water Task Force of the Natural Resources Strategic Steering Committee, CSA Group

Past President, Alberta Low Impact Development Partnership

Chair, Events & Activities Working Group, Alberta Low Impact Development Partnership

## PROFESSIONAL INTERESTS

Urban stormwater analysis, hydraulic design, sustainable development, water resources engineering





*Bert will discuss what happens to stormwater after it hits your property. He will provide an overview of on-site stormwater management and how it relates to the public drainage system, low impact development, pollution prevention and river health protection. Bert will provide information on management approaches and tools that can improve your site's stormwater management and will share the benefits of improved management including decreased risk of flooding and improved site aesthetics.*



- Presentation introduction
- What is stormwater?
- Types of flooding and what we do about it
- Water quality considerations
- The role of the property owner / manager
- Low Impact Development opportunities
- Wrap-up

How do we deal with water in our developed areas?

All municipalities will deal with three Lines of Service:

- 1) Potable Water
- 2) Wastewater
- 3) Stormwater





# What is Stormwater?





## What is Stormwater?

Stormwater is runoff from rain storms, and from melting snow and ice. If not properly managed, the impacts of stormwater include:

- localized flooding
- river and creek flooding
- pollution, and
- stream erosion

When managed properly, stormwater can add tremendous value to our communities





# How are the three Lines of Service different?

## Potable Water:

- Consistent composition
- Consistent temperature
- Highly treated
- Pressurized system
- “Constant” flow of water
- “Small” pipes
- Water Treatment Plant at start of system

## Wastewater:

- “Consistent” composition
- Consistent temperature
- Highly contaminated
- Gravity & pressurized system
- “Constant” flow of water
- “Medium”-size pipes
- Waste Water Treatment Plant at end of system

## Stormwater:

- Variable composition
- Variable temperature
- Contaminated
- Gravity system
- Intermittent, highly variable flow of water
- “Large” pipes + above ground component
- Many outfalls, with or without treatment

Highly controlled with respect to the quantity and quality to be provided (federal and provincial)

Controlled with respect to the quantity and quality being discharged into the public system (provincial and municipal)

Still evolving (provincial and municipal)

Stormwater comes from everywhere. As such, it is closely connected to what we do to our land





## This is what I heard re BOMA having an interest in stormwater management



- Concerns about damages due to flooding of property;
- Concerns about unaffordable or unavailable insurance; and
- Concerns as to how a changing climate may increase property damage risks.



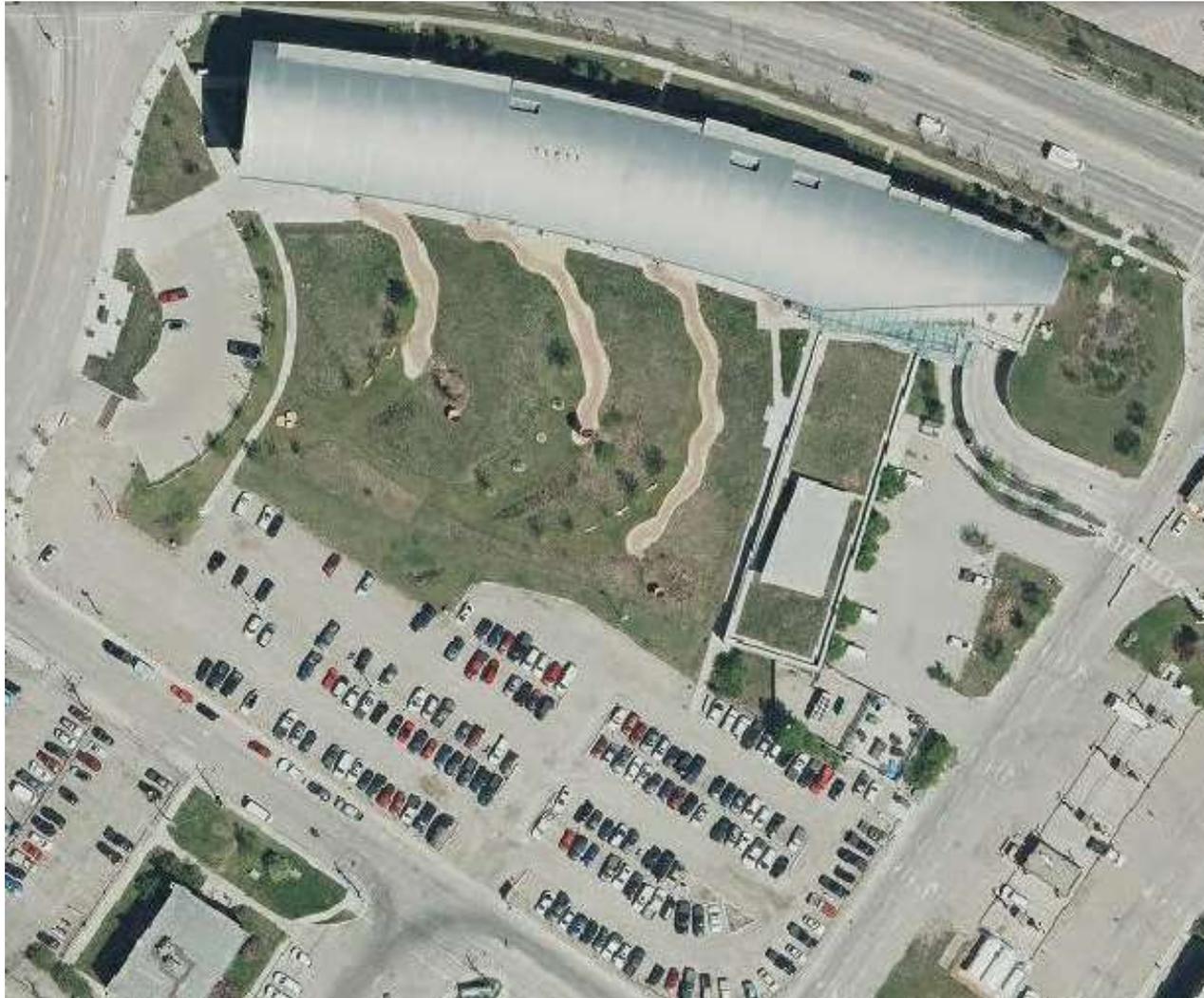
## And what I heard re key drivers for owners and operators of properties

- Meeting EH&S (environmental, health and safety) regulatory requirements
  - EH&S is “Good Business”
- Maximizing return on investment by
  - Minimizing life cycle expenditures;
  - Minimizing risk of damage;
  - Retaining tenants; and
  - Maximizing attractiveness of a property
- Maximizing BOMA BEST rating (under review)



## How can damage to properties occur?

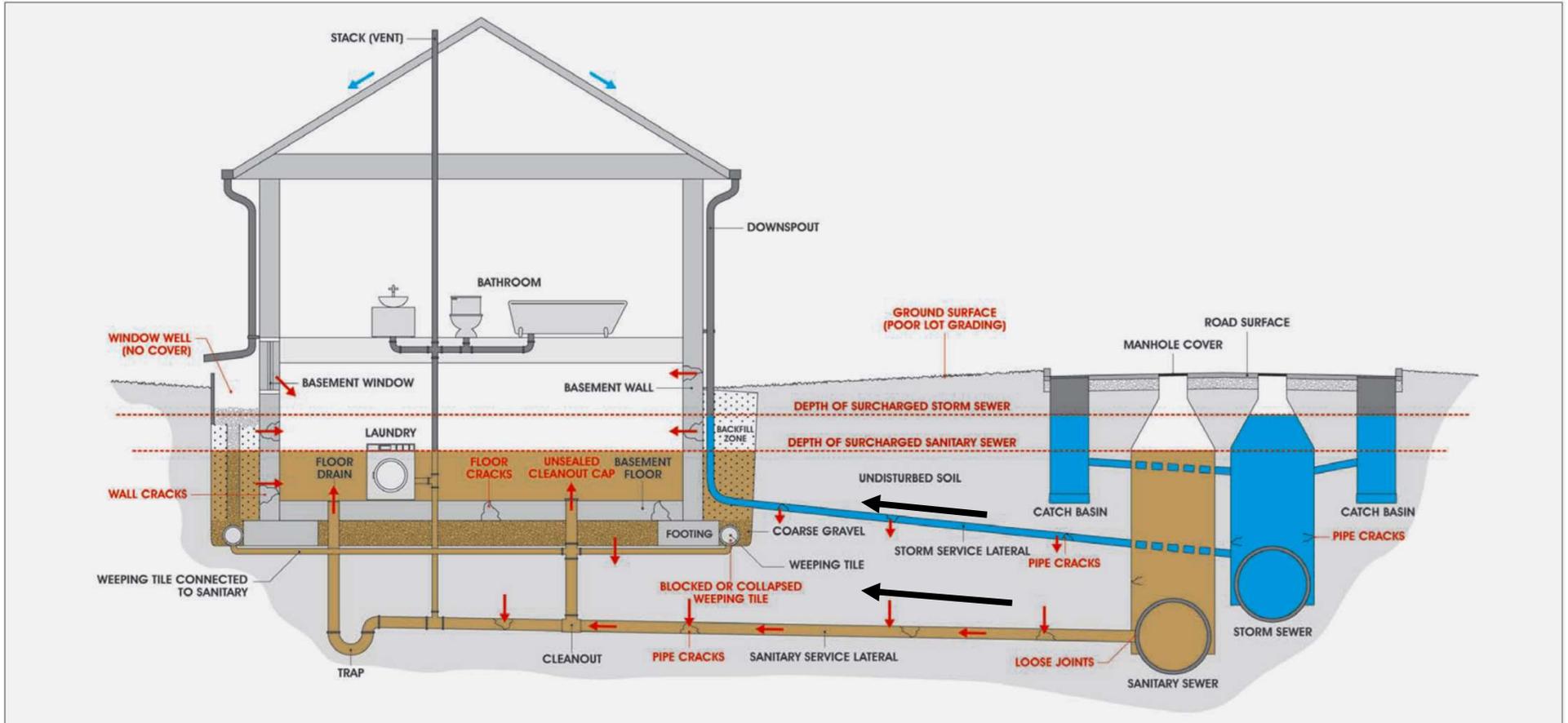
- Sewer system back-up (sanitary or storm);
- Seepage from groundwater;
- Overland flow from inside property boundary;  
or
- Overland flow from outside property boundary



From a stormwater management perspective we look at the entire site within the property boundary, including the buildings, parking lots and storage areas, landscaping, etc., and how they relate to the public infrastructure adjacent to the site as well as how they relate to one's neighbours



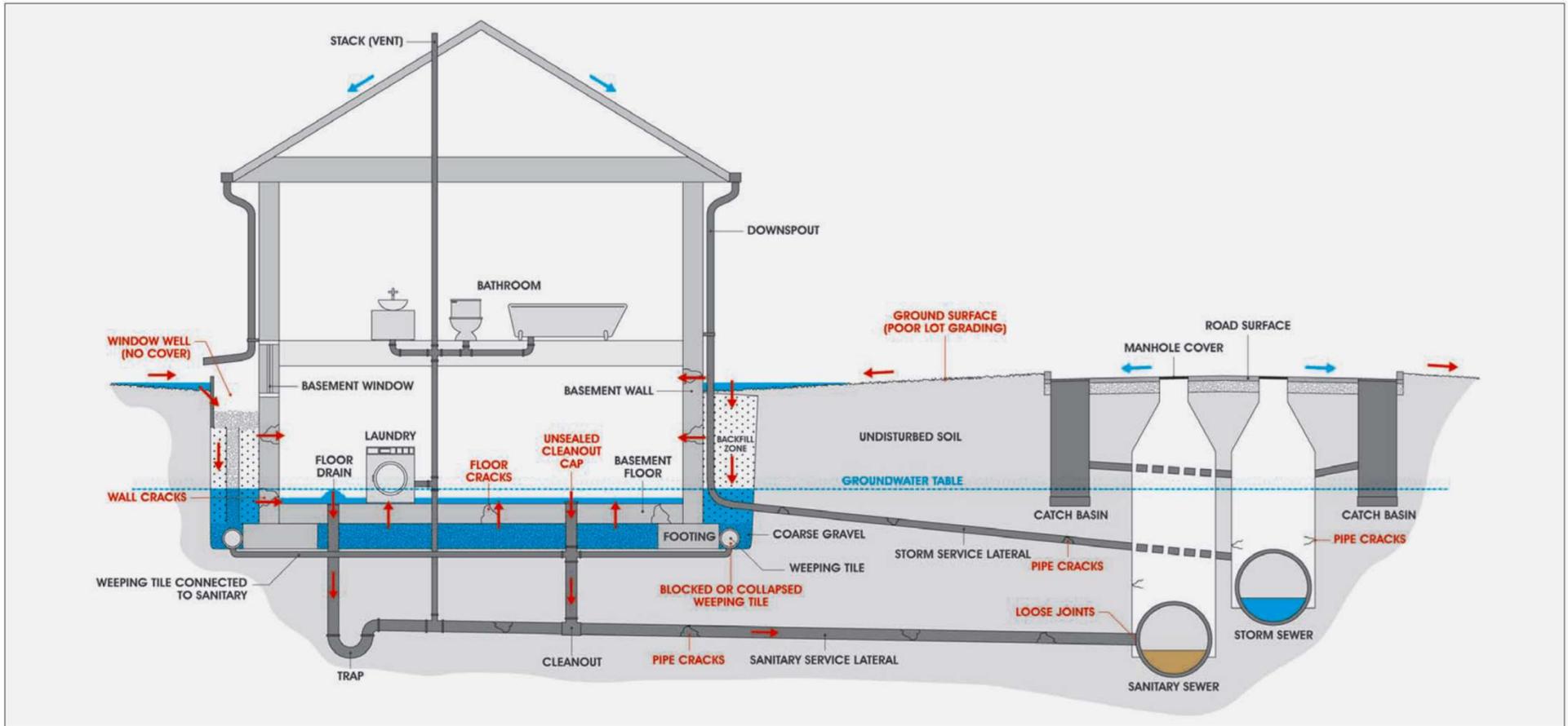
# Sewer System Back-Up



Source: Institute for Catastrophic Loss Reduction (2009). Handbook for Reducing Basement Flooding  
<https://www.iclr.org/wp-content/uploads/PDFs/handbook-for-reducing-basement-flooding.pdf>

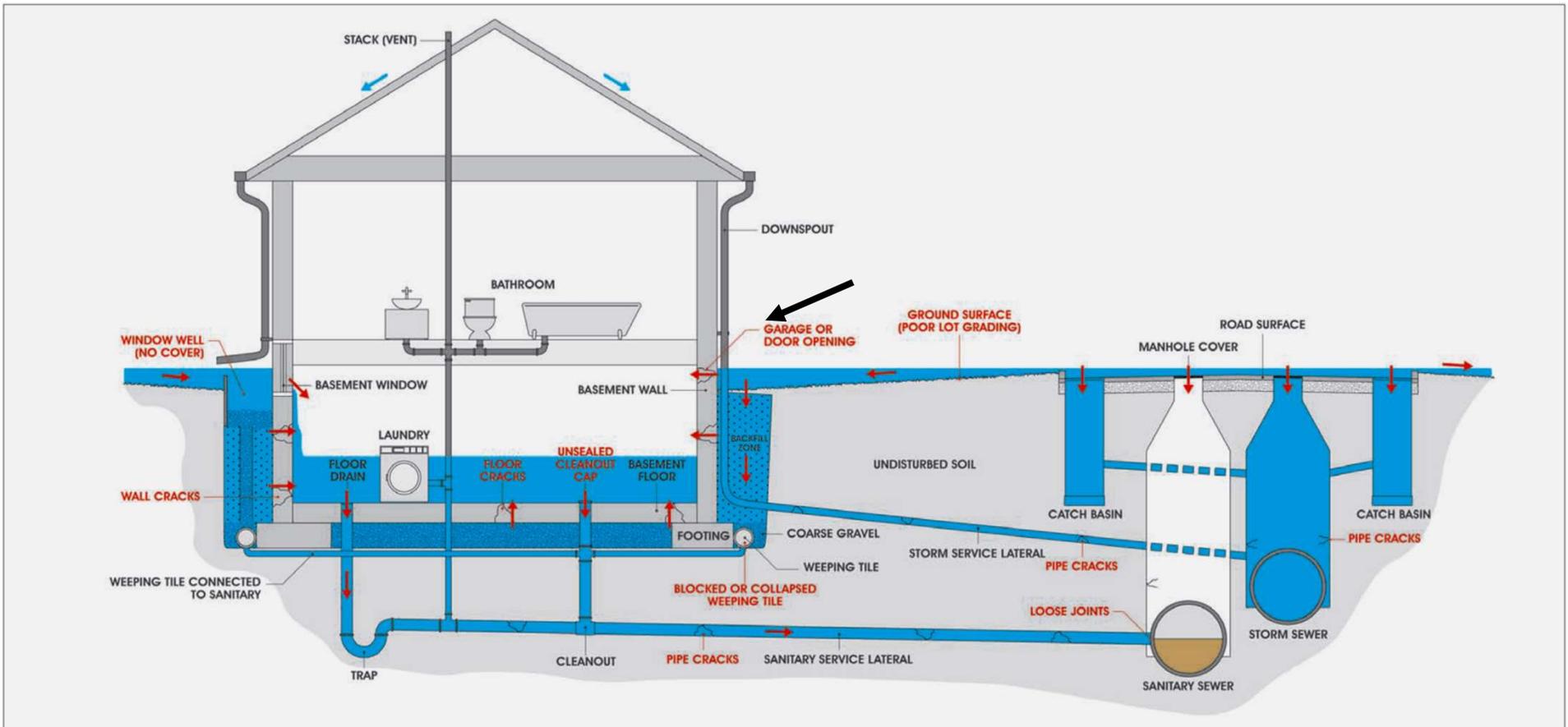


# Seepage



Source: Institute for Catastrophic Loss Reduction (2009). Handbook for Reducing Basement Flooding

# Overland Flow



Source: Institute for Catastrophic Loss Reduction (2009). Handbook for Reducing Basement Flooding

# Different Types of Flooding

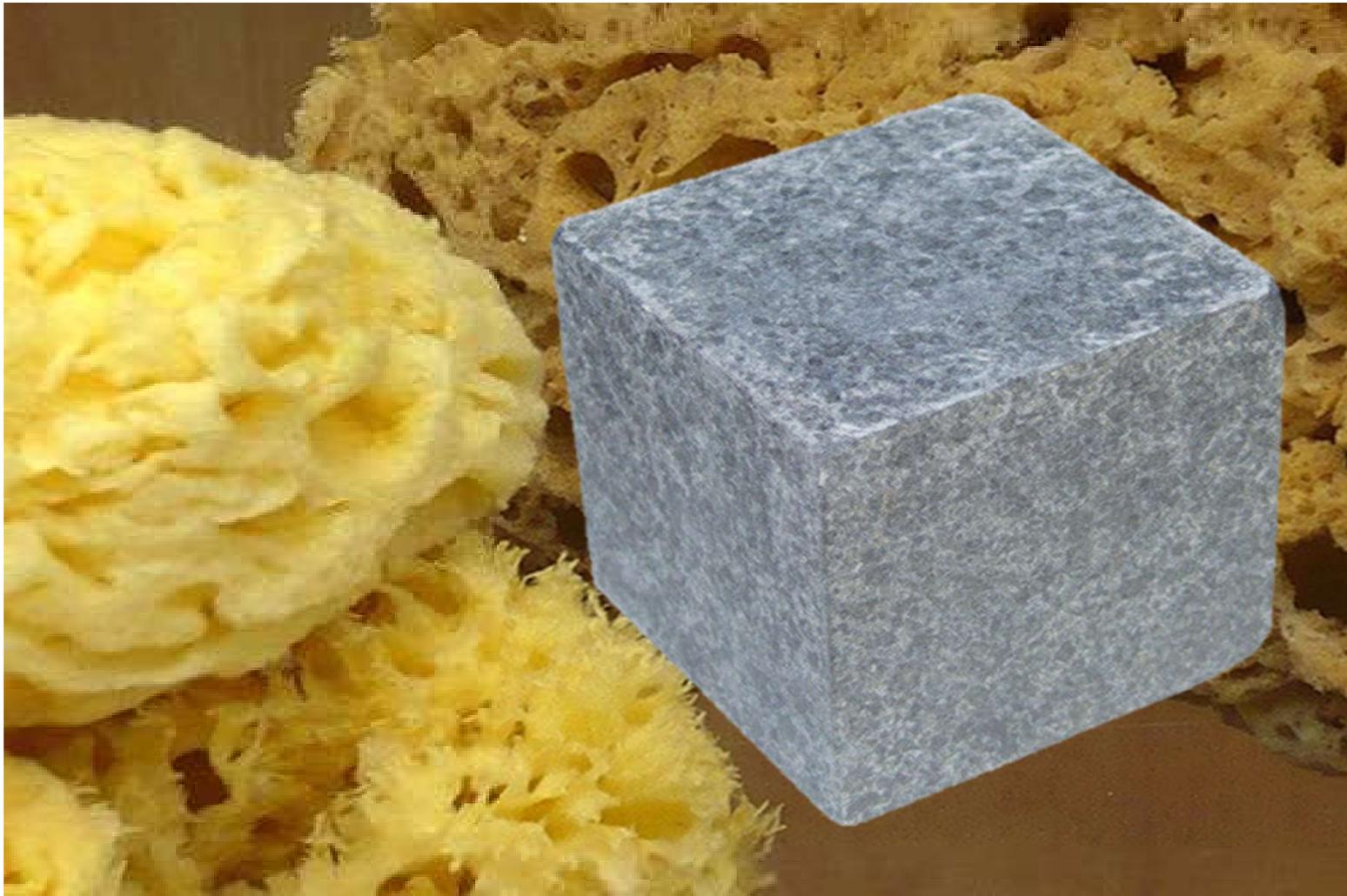


1. Riverine Flooding
2. Creek or Small Stream Flooding
3. Local Flooding caused by Summer Thunderstorms

(2) and (3) are a focus of Stormwater Management



Stormwater Management tries to address the consequences of what we do to the land when we develop it





Pre-Development



Post-Development

Question: How much more runoff?

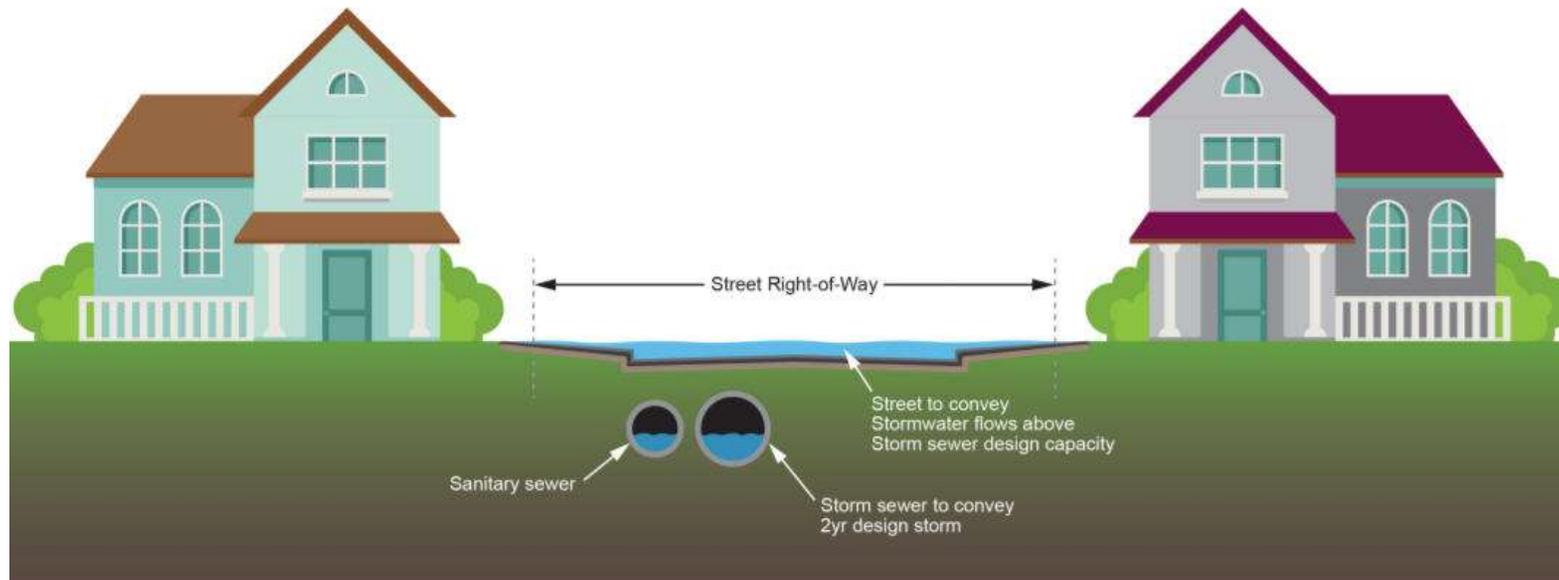
Answer: 10 to 50 times more, as a function of the amount of hard area



# There are two components to a well-functioning drainage conveyance system

## Storm System - Dual Drainage System Major (streets) and Minor (sewer pipes)

- Storm sewers (minor system) convey up to 1 in 2 year storms.
- Streets (major system) convey major storms that exceed the storm sewer capacity.
- Temporary ponding on streets is expected during major rain storms.



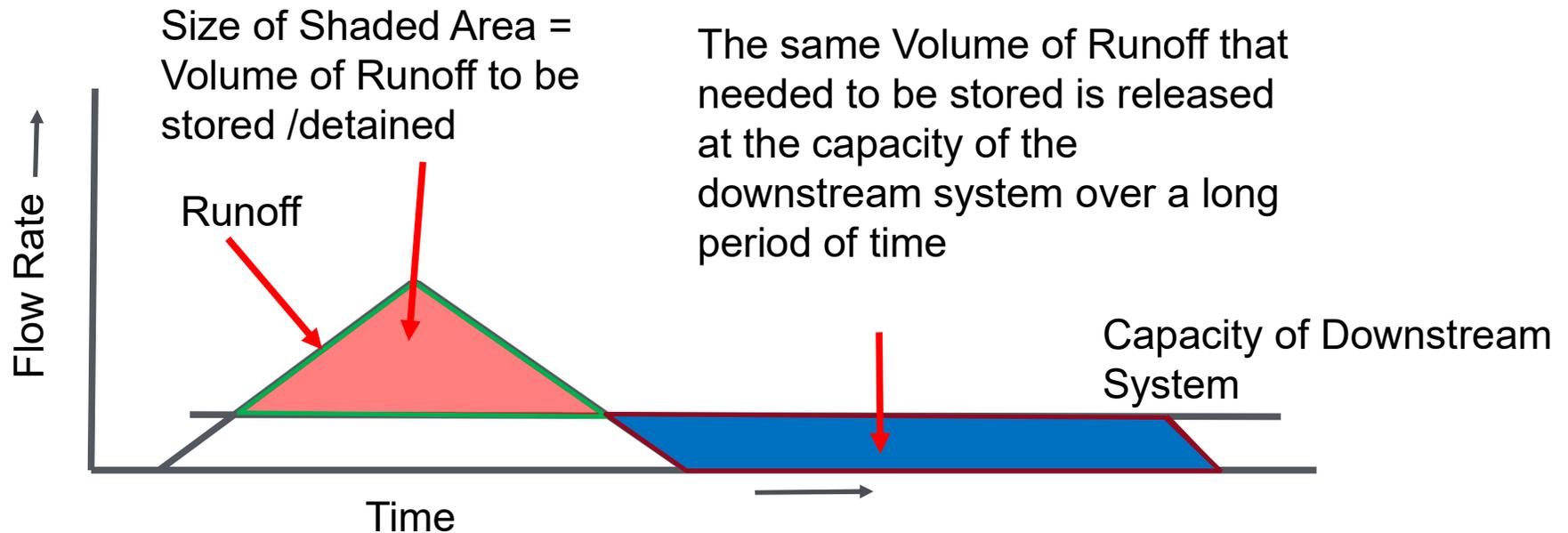


Unfortunately, especially in older communities, the drainage system at times gets overwhelmed





## Flattening of the Curve in Stormwater Management



One can control the rate of flow to the storm sewer system by:

- Installing flow controls in catchbasins or inlets; and
- Installing flow controls in the connecting pipe to the public storm sewer

In addition, the overland flow needs to be stored on-site



Storage can be above ground or below ground



Credit: <https://roof-solutions.com/>



The intent is that runoff

- (a) doesn't enter buildings;
- (b) inundates those areas that are deemed less important to a site; or
- (c) washes people away by the force of moving water



# The City of Calgary is responsible for storage areas that serve an entire subdivision



Dry Pond



Wet Pond

These ponds may address flooding within a community itself or help address the downstream creek or small stream flooding



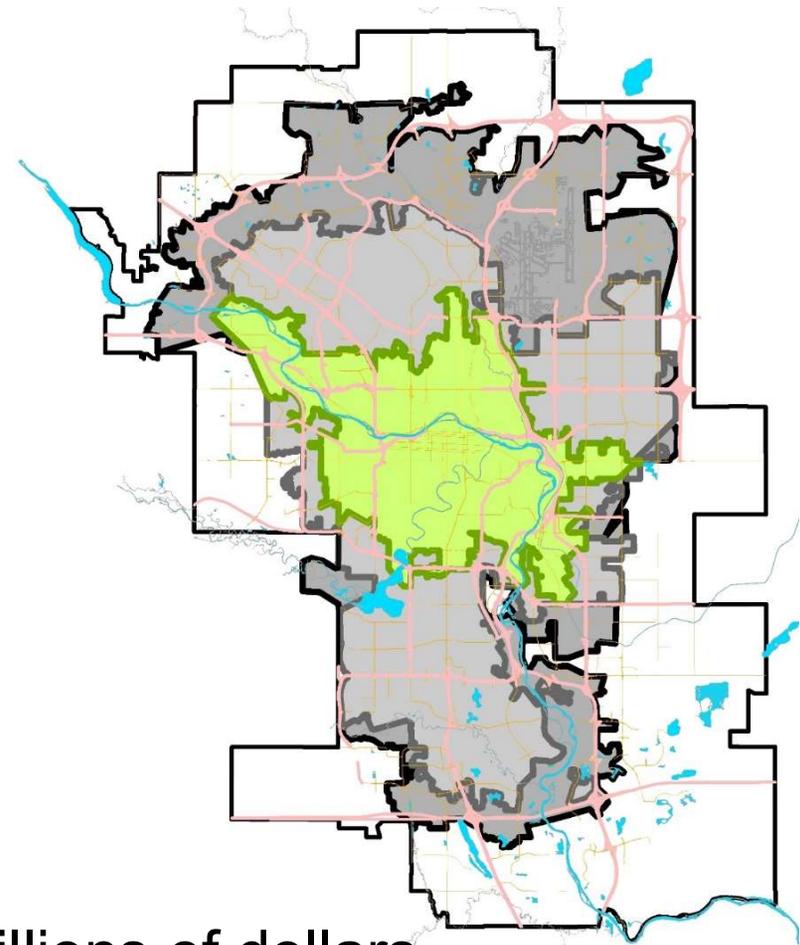
## What are your obligations?

- You cannot remove or change flow control devices that control the rate of flow to the public storm sewer system;
- Remove or fill storage areas within your site;
- Prevent discharges onto neighboring properties (unless there are easements and written agreements in place); and
- Add storage if you add paved areas



The flooding risks are not identical across the entire city

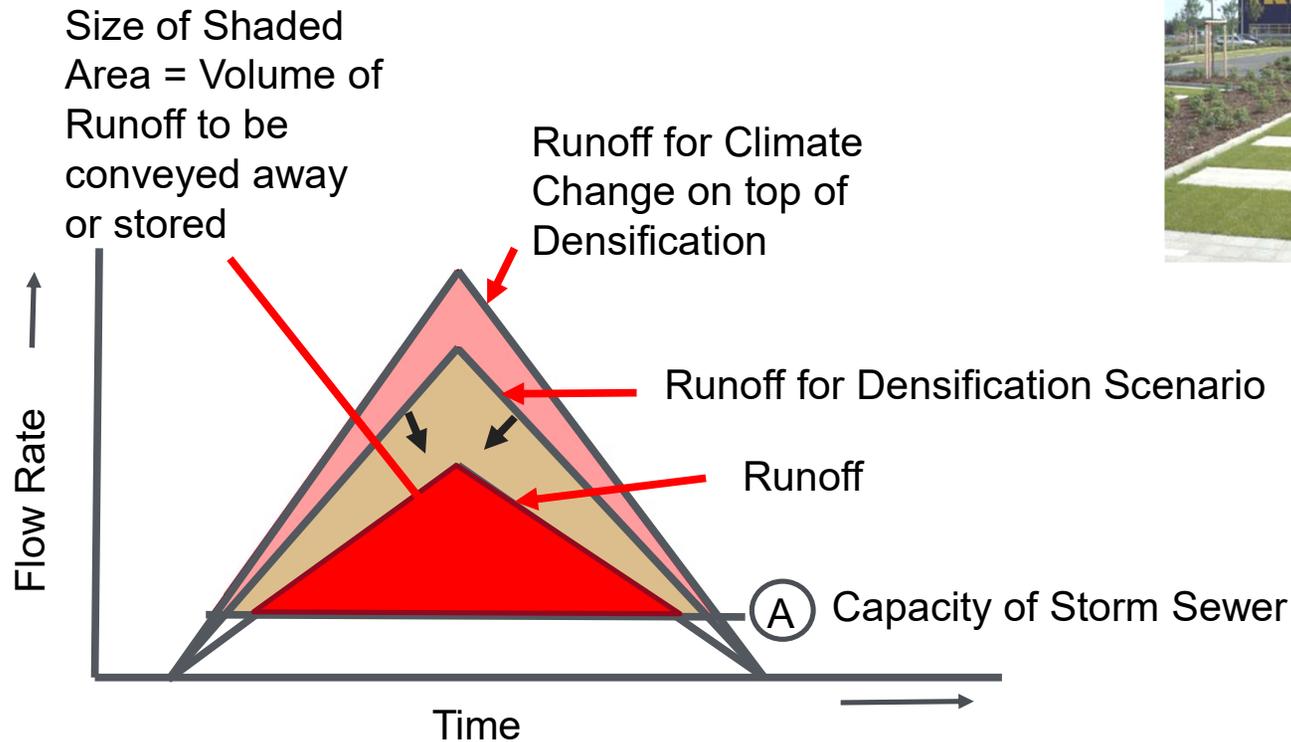
Year	Pre-1952	1952-1988	1988-2000	Post-2000
Color	Green	Grey	Black	
Dual Drainage Principle	No	No	Yes	Yes
Storm Sewer Design	1:2 Year Rational Method	1:5 Year Rational Method	1:5 Year Rational Method	1:5 Year Unit Area Release Rate
Ponds	No	No	Dry Ponds + Wet Ponds + Wetlands	Wet Ponds + Wetlands



The City has already spent hundreds of millions of dollars addressing capacity problems in older communities



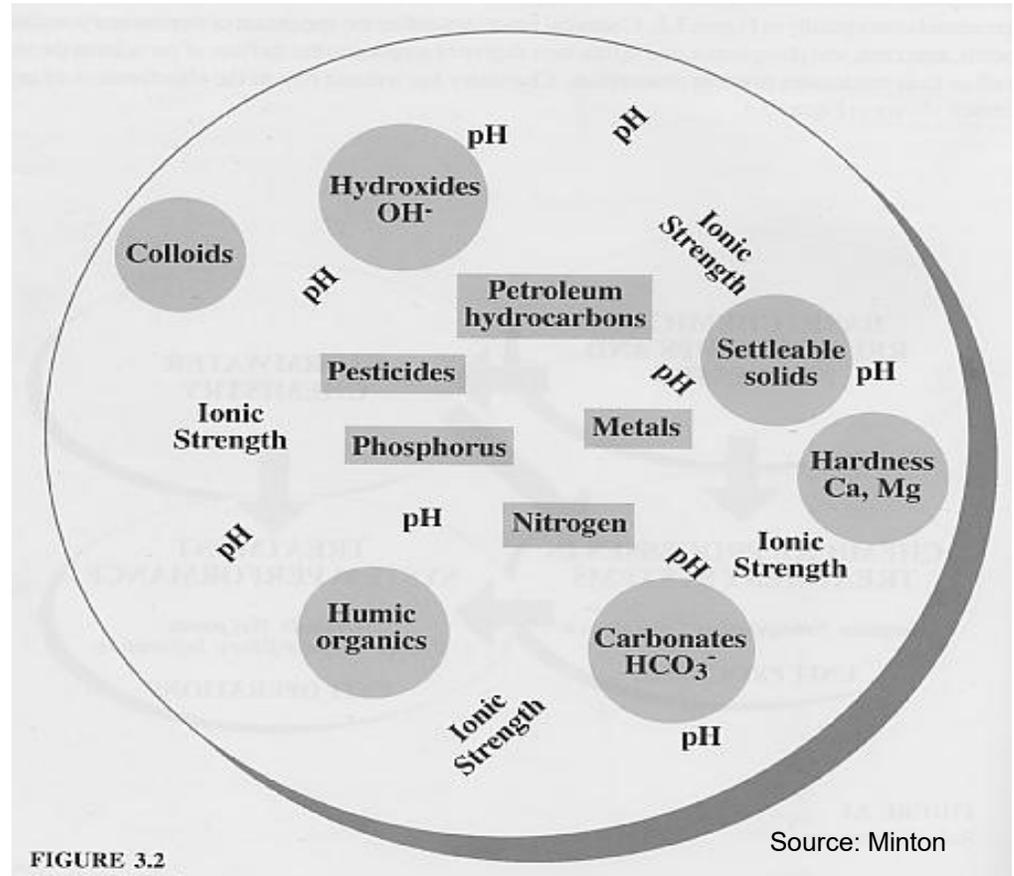
# Challenges due to Densification and Climate Change



Our Task: how can we deal with this extra runoff in a way that is cost-effective and provides maximum value to our communities?



But there is more in that stormwater is far from clean



Stormwater is like a nasty soup ... which doesn't go to our wastewater treatment plants

## Where do contaminants come from?

<b>Atmospheric Deposition</b>	Fine particles, nitrogen, phosphorous, metals, combustion products
<b>Litter and leaf fall</b>	Debris, BOD, nitrogen, phosphorous, organics, metals
<b>Landscape maintenance</b>	Nitrogen, phosphorous, pesticides and herbicides
<b>Urban wildlife and pets</b>	Bacteria, nitrogen, phosphorous,
<b>Transportation vehicles</b>	Fuels, brake/tire wear, fine particles, metals
<b>Pavement maintenance</b>	Temperature, petroleum derivatives
<b>Pavement deicing</b>	Chlorides, sulfates, coarse sediments
<b>Building exteriors</b>	Galvanized metals, paints, metals
<b>Industrial business</b>	Varies widely
<b>Commercial business</b>	Anything associated with vehicles, waste, metals, bacteria, N, P
<b>Land development</b>	Sediments, high pH from concrete, petroleum products from fresh asphalt, organics

*N = nitrogen; P = phosphorus; BOD = biological oxygen demand*

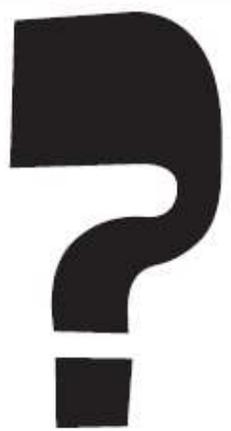
Adapted from Minton, 2002

Alberta Low Impact Development Partnership

ALIDP 

**WHOSE**  
STORMWATER  
are **YOU**  
**DRINKING** 

ALIDP 

**WHO'S**  
DRINKING  
**YOUR**  
STORMWATER 

Equipping Alberta's professionals to treat urban runoff, naturally.

A sobering thought, isn't it?



## Impacts of Impermeable Surfaces on our Rivers, Creeks, Lakes and Wetlands

The larger the area of impermeable (hard) surfaces, the greater the runoff, and the greater the impact on:

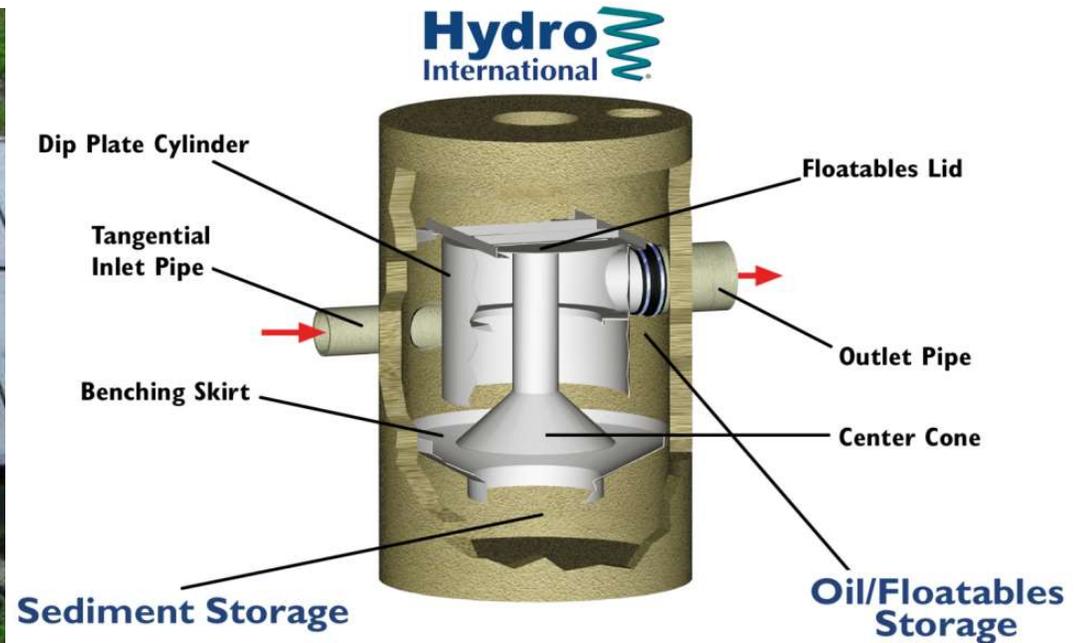
- Fish habitat & health
- River water quality
- Vegetation health



Impacts due to high urbanization  
Lake Hallett, Minnesota



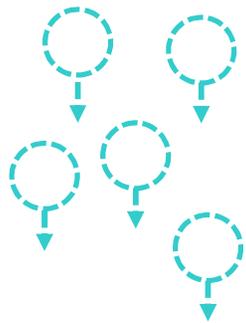
# What can we do about this?



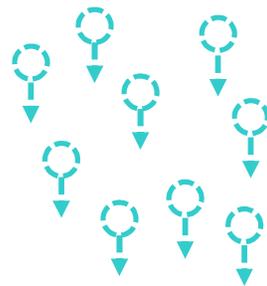
Implementation of Oil-Grit Separators and Sedimentation Tanks  
 These devices will help address both water quality during day-to-day operations and when a spill occurs



Similar to wet ponds, the primary removal mechanism of these devices is settling out of sediment particles by gravity



Heavier/larger particles settle quickly  
(e.g. sand, gravel)

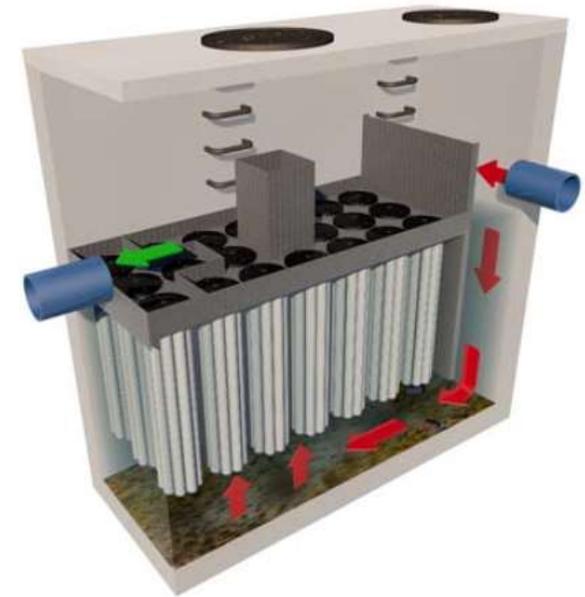


Lighter/smaller particles may take days to weeks  
(e.g. silt, clay)





# Examples of more advanced systems



## Example of system used by City of Calgary





## What are your obligations?

- You cannot remove or change stormwater treatment systems that treat the runoff prior to discharge to the public storm sewer system;
- Ensure you remain to have proper access to these treatment systems;
- You need to keep these treatment systems in good operating condition; and
- If you change your operations or add hard areas you may need to change or add treatment systems



Intended operation during the summer months. Seems all OK, doesn't it?



Actual operation last winter with the drain pipe frozen and an ice lake having formed. This happens to be near a ramp to a garage. A major potential hazard!



The stormwater management system also needs to deal with the “waste” products from our winter de-icing operations (e.g., sand, gravel, salt)





## Why would an owner or property manager have an interest in LID?



### Remember?

- Meeting EH&S (environmental, health and safety) regulatory requirements.
- Maximizing return on investment by
  - Minimizing life-cycle expenditures;
  - Minimizing risk of damage;
  - Retaining tenants; and
  - Maximizing attractiveness of a property
- Maximizing BOMA BEST rating



# Example Water Centre



# Example Water Centre



**Secondary Benefits:**

- Reduced tree mortality – in fact, bigger and healthier trees
- Reduced conventional on-site detention capacity (e.g., smaller storage tanks)
- Reduced potable water demand
- Enhanced biodiversity
- Reduced urban heat island effect
- Improved air quality
- Aesthetical interest

**Stormwater Benefits:**

- Rate reduction for summer thunderstorms through detention (storage) in soil cell media
- Volume reduction through infiltration and evapotranspiration
- Water quality enhancement through capture of particulate and dissolved contaminants

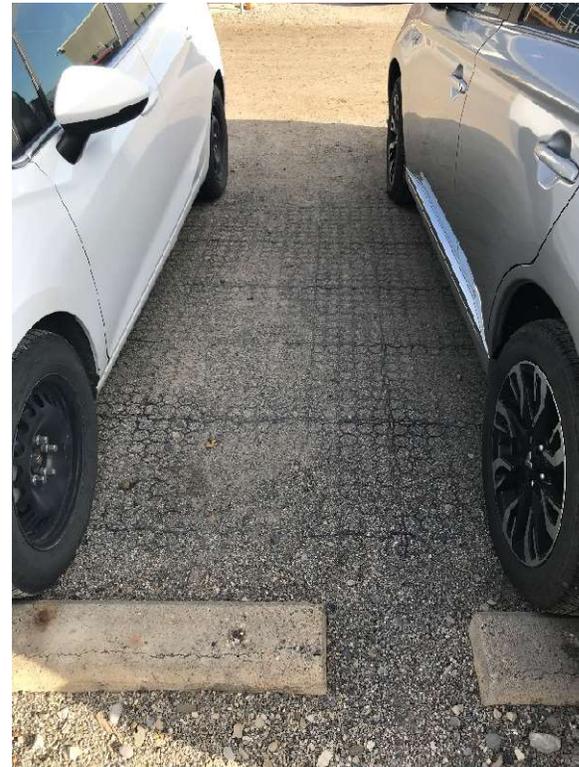


## Secondary Benefits:

- Reduced conventional on-site detention capacity (e.g., smaller storage tanks)
- **Less icy in winter months**
- Aesthetical interest

## Stormwater Benefits:

- Rate reduction through detention (storage) in pavement structure
- Volume reduction through infiltration into subsoils
- Water quality enhancement through capture of sediments and reduced use of deicing compounds





### Stormwater Benefits:

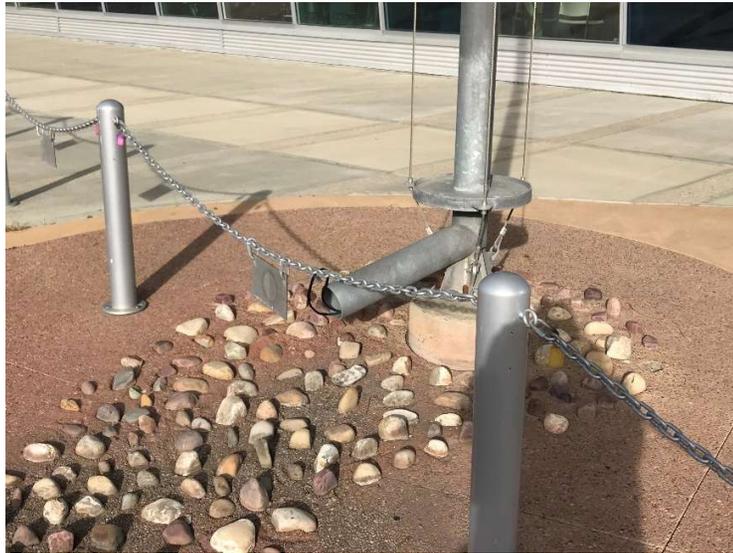
- Rate reduction for summer thunder storms through detention (storage) in soil and rain garden depressions
- Volume reduction through infiltration and evapotranspiration
- Water quality enhancement through capture of particulate and dissolved contaminants

### Secondary Benefits:

- Reduced conventional on-site detention capacity (e.g., smaller storage tanks)
- Reduced potable water demand
- **Reduced risk of icing of sidewalks or pathways**
- Reduced need for biocides (pesticides and herbicides)
- Reduced maintenance for mowing
- Enhanced biodiversity
- Reduced urban heat island effect
- Improved air quality
- Aesthetical interest



# Water Centre – Rainwater Harvesting and Stormwater Capture



## Secondary Benefits:

- Reduced potable water demand

## Stormwater Benefits:

- Rate reduction for all kinds of storm events through retention (storage) in cisterns and ponds
- Volume reduction through use of rainwater or stormwater for e.g. irrigation or other non-potable uses
- Water quality enhancement through capture of particulate and dissolved contaminants





### Stormwater Benefits:

- Rate reduction for summer thunder storms through detention (storage) in green roof media
- Volume reduction through infiltration into green roof media and evapotranspiration
- Water quality enhancement through capture of particulate and dissolved contaminants

### Secondary Benefits:

- Increased life-span of roofing materials (e.g., temperature fluctuations or hail)
- Reduced conventional on-site detention capacity (e.g., smaller storage tanks)
- Reduced risk of icing of sidewalks or pathways
- Reduced maintenance
- Enhanced biodiversity
- Reduced urban heat island effect
- Improved air quality
- Aesthetical interest



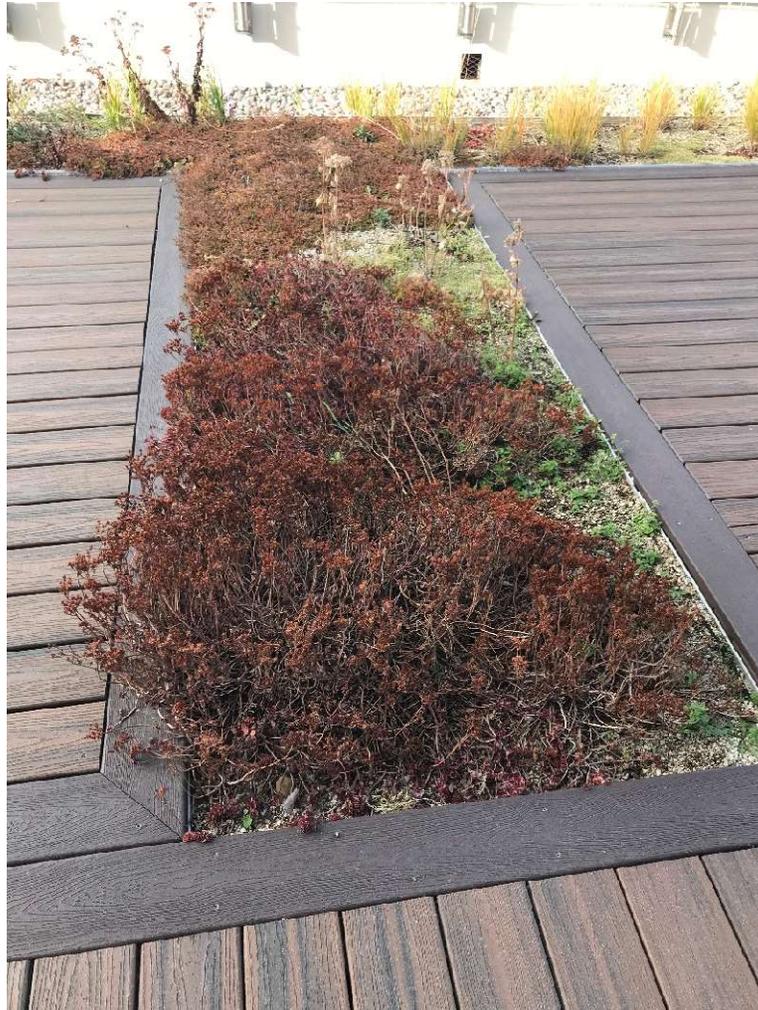
## How can these concepts be used elsewhere?



With some simple modifications it's amazing how many stormwater management benefits can be accomplished even in this space



## How can these concepts be used elsewhere?



*Green space on the roof is great for our tenants, it improves the marketability of the space ...*

*Upkeep is fairly simple ...*



## Are these merely our thoughts?

### 5.5 Considerations for natural infrastructure and low impact development (LID) measures:

*The strategic use of natural infrastructure, LID measures and grey infrastructure to manage flood risk in new residential communities should be considered in the planning and design of new residential communities.*

*LID measures should be planned and designed to retain, infiltrate, evapotranspire, or filter runoff close to its source and in the conveyance system so that discharges from frequent events are treated and runoff volumes are minimized.*

#### PREVENTING DISASTER BEFORE IT STRIKES:

DEVELOPING A  
CANADIAN STANDARD FOR  
NEW FLOOD-RESILIENT  
RESIDENTIAL COMMUNITIES

20 BEST PRACTICES

The Canadian Standards Association has issued a standard on this same topic by in December 2019



## 4.4 Selected Physical Interventions to Reduce Flood Risk:

*Maintain natural infrastructure (e.g., wetlands and watercourse corridors) and consider low impact development practices to complement grey infrastructure solutions for stormwater management.*



### WEATHERING THE STORM:

DEVELOPING A CANADIAN STANDARD FOR FLOOD-RESILIENT EXISTING COMMUNITIES

NATALIA MOUDRAK AND DR. BLAIR FELTMATE  
INTACT CENTRE ON CLIMATE ADAPTATION  
JANUARY 2019



*Similarly, landscape design features such as berms, swales, rain gardens and permeable pavements can provide a range of benefits, including flood attenuation, biodiversity improvements and aesthetic benefits.*



**INTACT CENTRE**  
ON CLIMATE ADAPTATION

# AHEAD OF THE STORM

<https://www.intactcentreclimateadaptation.ca/wp-content/uploads/2019/10/Ahead-of-the-Storm-1.pdf>

Developing Flood-Resilience Guidance

for Canada's Commercial Real Estate

SUPPORTED BY:

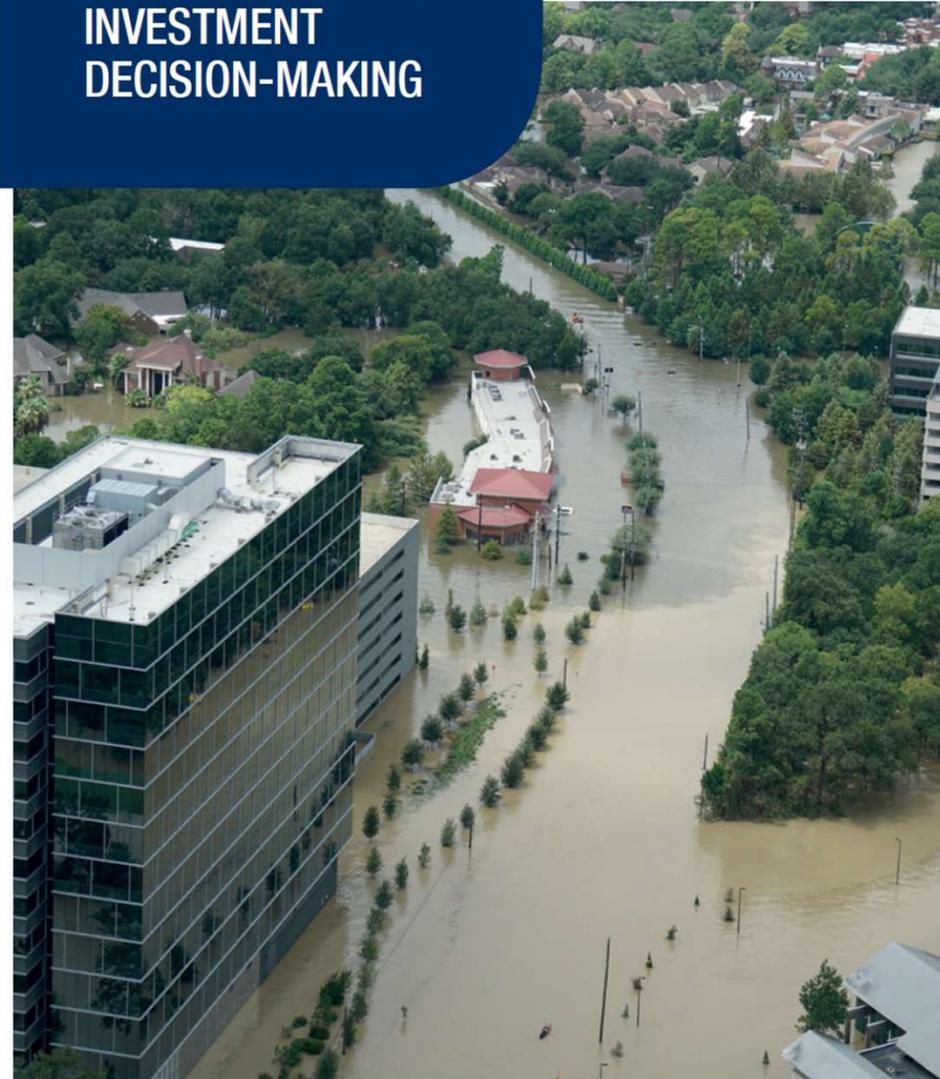


Natalia Moudrak and Dr. Blair Felmate  
Intact Centre On Climate Adaptation

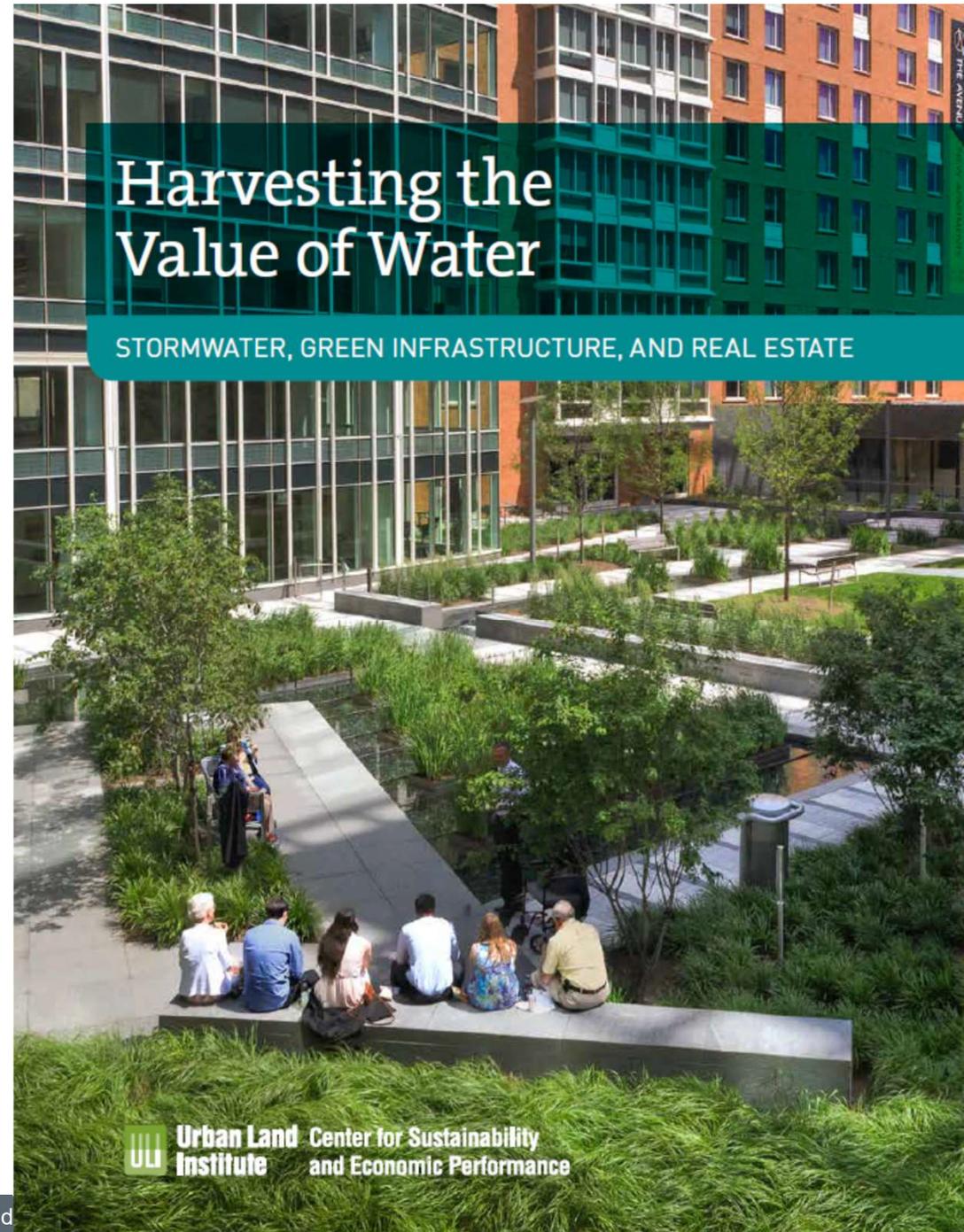
## Miami Case Study:

*ULI commended the city's incremental approach and its sense of urgency and recommended several enhancements to the existing program – more integrated planning, more blue and green infrastructure to complement the pumps and pipes, and more strategic communications.*

## CLIMATE RISK AND REAL ESTATE INVESTMENT DECISION-MAKING



*After outlining the reasons that stormwater management is important to cities, this report introduces a series of real estate case studies, and a range of stormwater policies. The case studies come from locations across the United States and present both innovations in stormwater management and positive financial, operational, or design outcomes.*



# Harvesting the Value of Water

STORMWATER, GREEN INFRASTRUCTURE, AND REAL ESTATE



## Concluding Remarks

- Stormwater impacts are directly related to the amount of hard area and what we do on our properties
- Stormwater Management is a joint responsibility of all Calgarians
- There are many “grey” and “green” approaches to manage runoff
- These green / LID approaches are not new to property owners and managers, see e.g., BOMA BEST:
  - There are definite (financial) benefits to property management
  - Many tenants desire something green
  - Every little bit will help in addressing our impacts on the environment, and reducing the risks from extreme weather
  - In conclusion: **LID and EH&S are Good Business**



## Where to go if you are looking for information about your particular site

- Various Stormwater Management Reports are available for purchase through City Online, see <https://cityonline.calgary.ca/>
- Historical Development Site Servicing Plans (DSSPs) should be available from the Planning Services counter on the 3<sup>rd</sup> floor at the Municipal Building, see also <https://www.calgary.ca/development/contacts.html>
- Call 311



- General, see <https://www.calgary.ca/water/stormwater/drainage-system.html>
- 2011 Stormwater Management & Design Manual (being updated), see <https://www.calgary.ca/content/dam/www/pda/pd/documents/urban-development/bulletins/2011-stormwater-management-and-design.pdf>
- 2018 Development Site Servicing Plan guidance, <https://www.calgary.ca/content/dam/www/pda/pd/documents/urban-development/publications/dssp-design-guidelines.pdf>
- LID Modules, see <https://www.calgary.ca/water/stormwater/low-impact-development.html>
- Stormwater Management approval process, see <https://www.calgary.ca/development/home-building/water-development-process.html>
- Lot Drainage Guidance, see <https://www.calgary.ca/content/dam/www/uep/water/documents/water-documents/guide-to-lot-drainage.pdf>



## Future Presentations:

- Wednesday April 5, 2023 – Stormwater Pollution Prevention
- Fall 2023 – Flood Preparedness Planning



Thank you for your  
time, attention and  
interest!!

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This presentation was prepared for general informational  
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