



CLIMATE CHANGE vs. STORMWATER INFRASTRUCTURE

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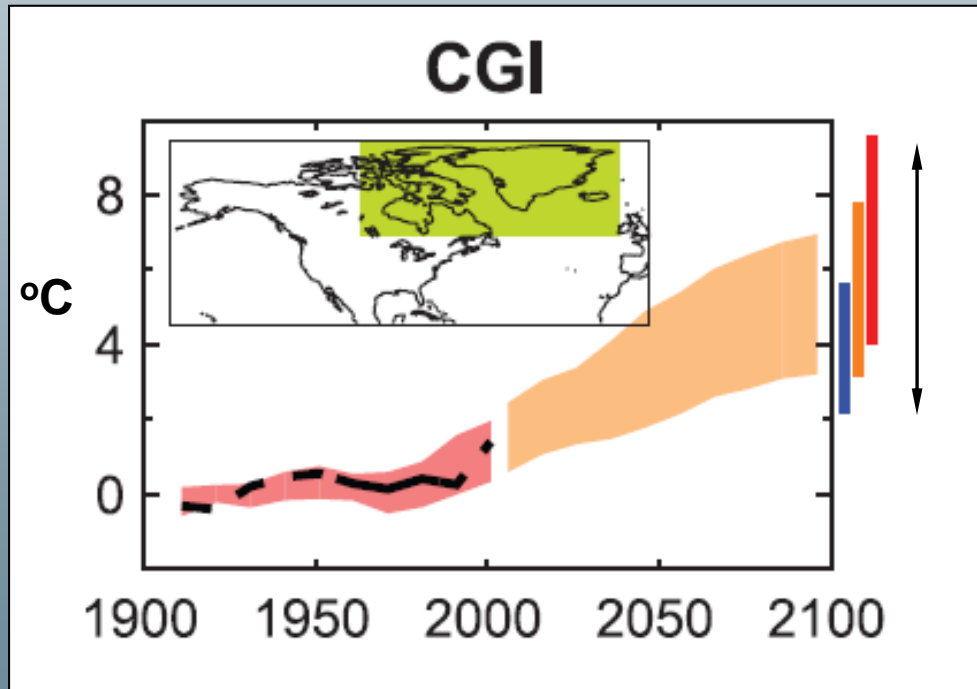
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OVERVIEW

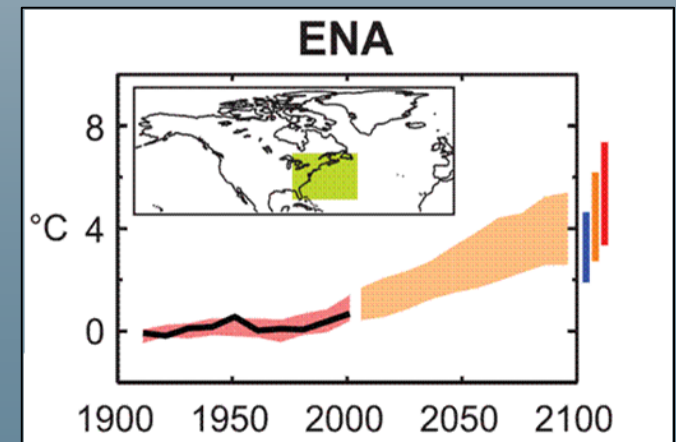
1. Climate change in Ontario
2. Analysis of historical rainfall in Canada
3. Brief history of stormwater management
4. Approaches to mitigate adverse impacts
5. Summary

CLIMATE CHANGE IN ONTARIO

General consensus that global average temperatures are increasing (IPCC, 2007).

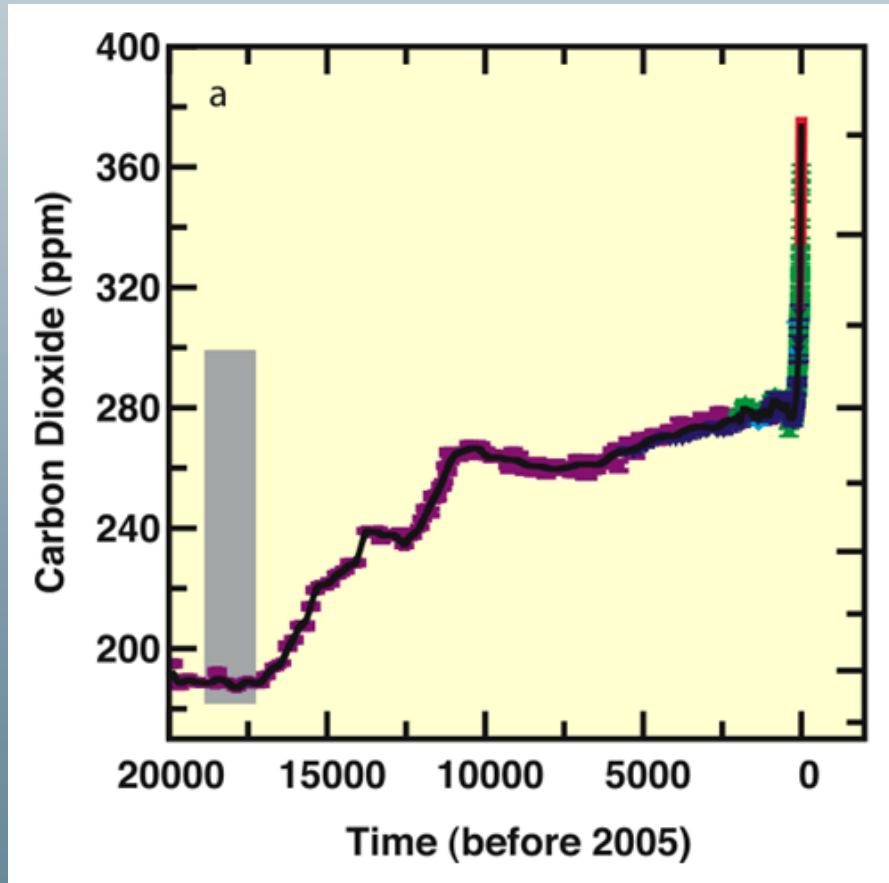


Intergovernmental Panel on Climate Change, 2007, *Climate Change 2007: The Physical Science Basis, Technical Summary*, IPCC, Geneva, Switzerland.



CLIMATE CHANGE IN ONTARIO

Why → Increase in green house gases



Intergovernmental Panel on Climate Change, 2007, ***Climate Change 2007: The Physical Science Basis, Technical Summary***, IPCC, Geneva, Switzerland.

CLIMATE CHANGE IN ONTARIO

What about precipitation?

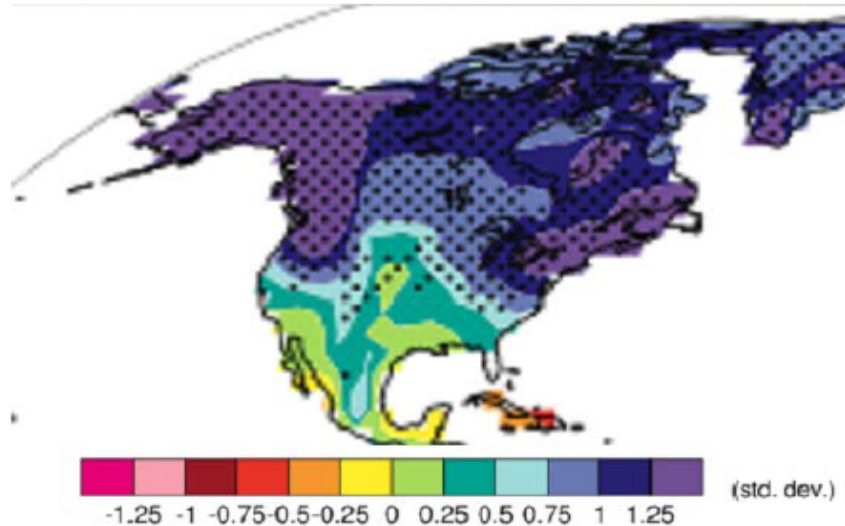


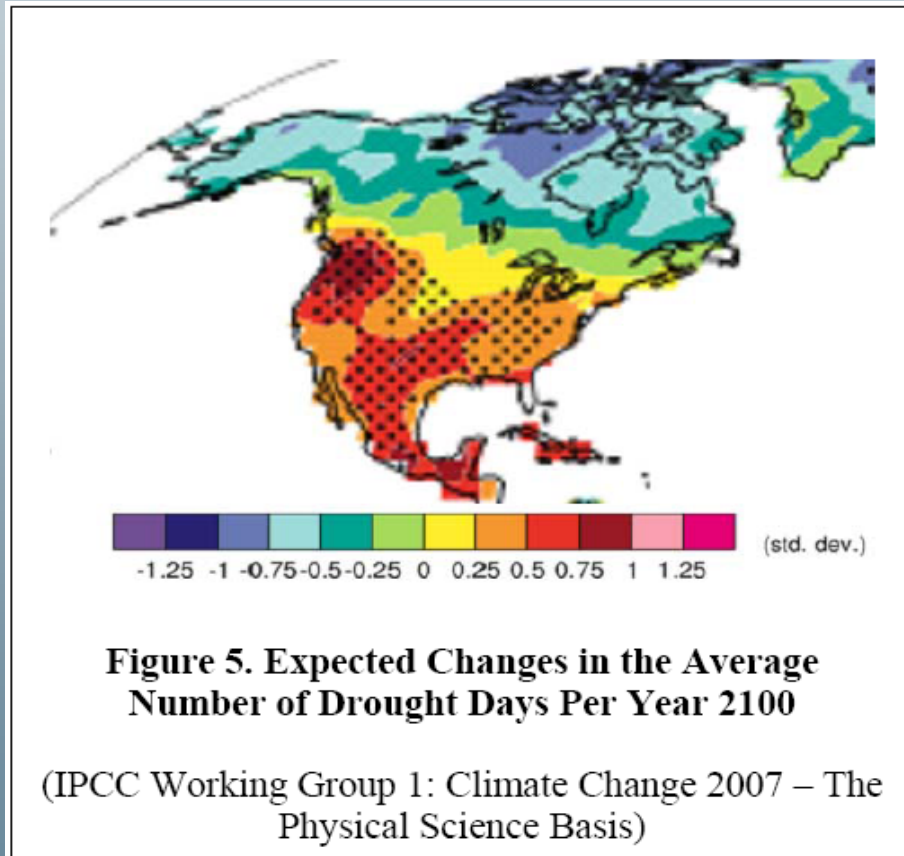
Figure 4. Expected Changes in the Ratio of Annual Precipitation to Number of Wet Days in the Year 2100

(IPCC Working Group 1: Climate Change 2007 – The Physical Science Basis)

Intergovernmental Panel on Climate Change, 2007, ***Climate Change 2007: The Physical Science Basis, Technical Summary***, IPCC, Geneva, Switzerland.

CLIMATE CHANGE IN ONTARIO

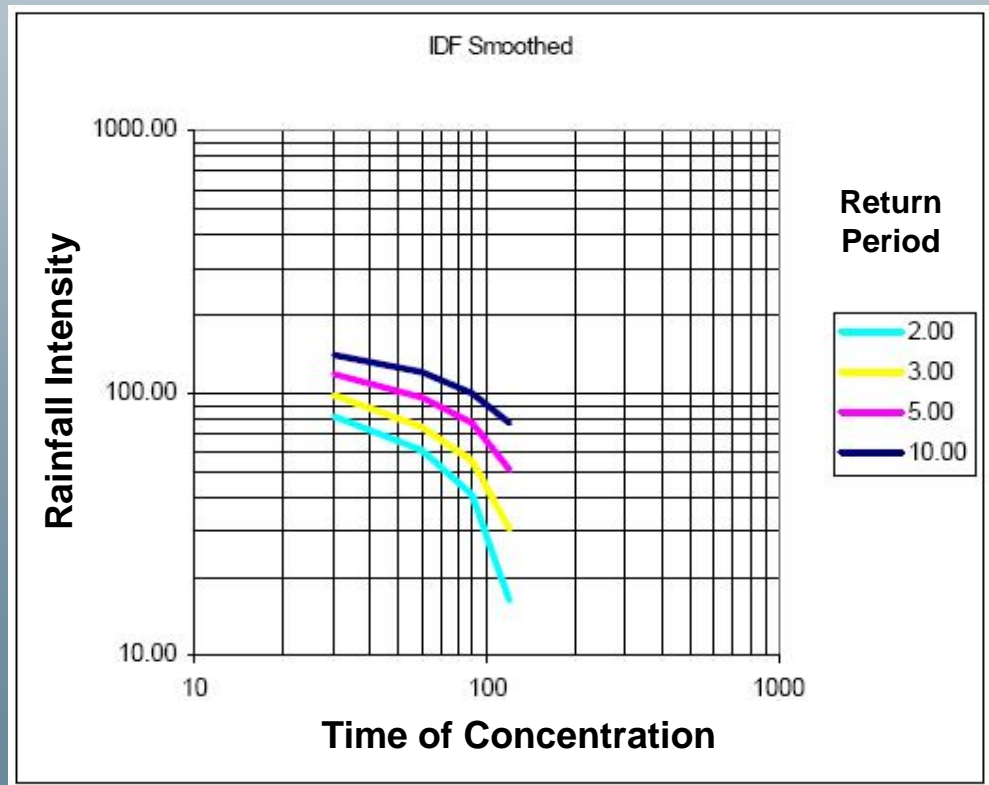
What about precipitation?



Intergovernmental Panel on Climate Change, 2007, ***Climate Change 2007: The Physical Science Basis, Technical Summary***, IPCC, Geneva, Switzerland.

CLIMATE CHANGE IN ONTARIO

Typically, how is precipitation information used for design of stormwater infrastructure? *Infamous Intensity-Duration-Frequency or IDF curves*



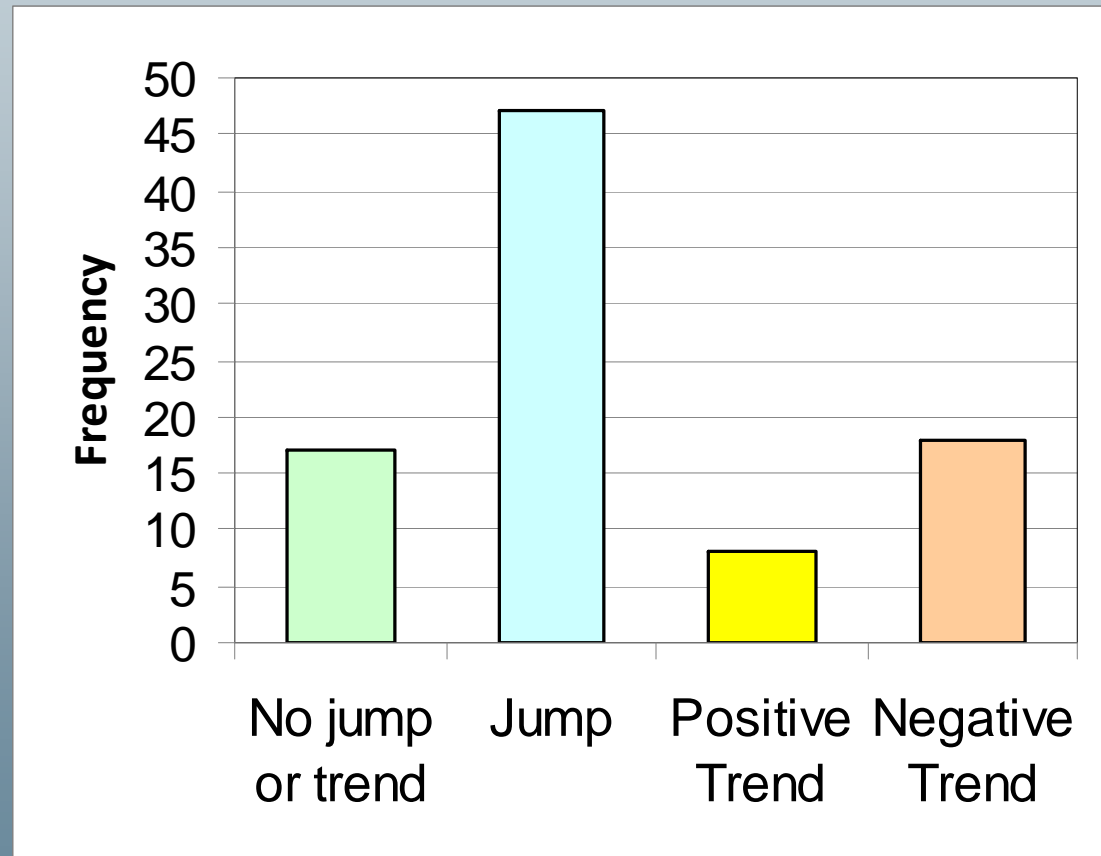
PRECIPITATION IN CANADA

Recent findings:

- Is there evidence of climate change in the historical precipitation records?
- Research addressed Intensity-Duration-Frequency rainfall design curves (RMC/Queen's/Environment Canada).
- Analyzed longest and strongest precipitation records across Canada.
- Rigorous methodology developed.
- Only location with statistically significant positive trend (rainfall) was Yellowknife.

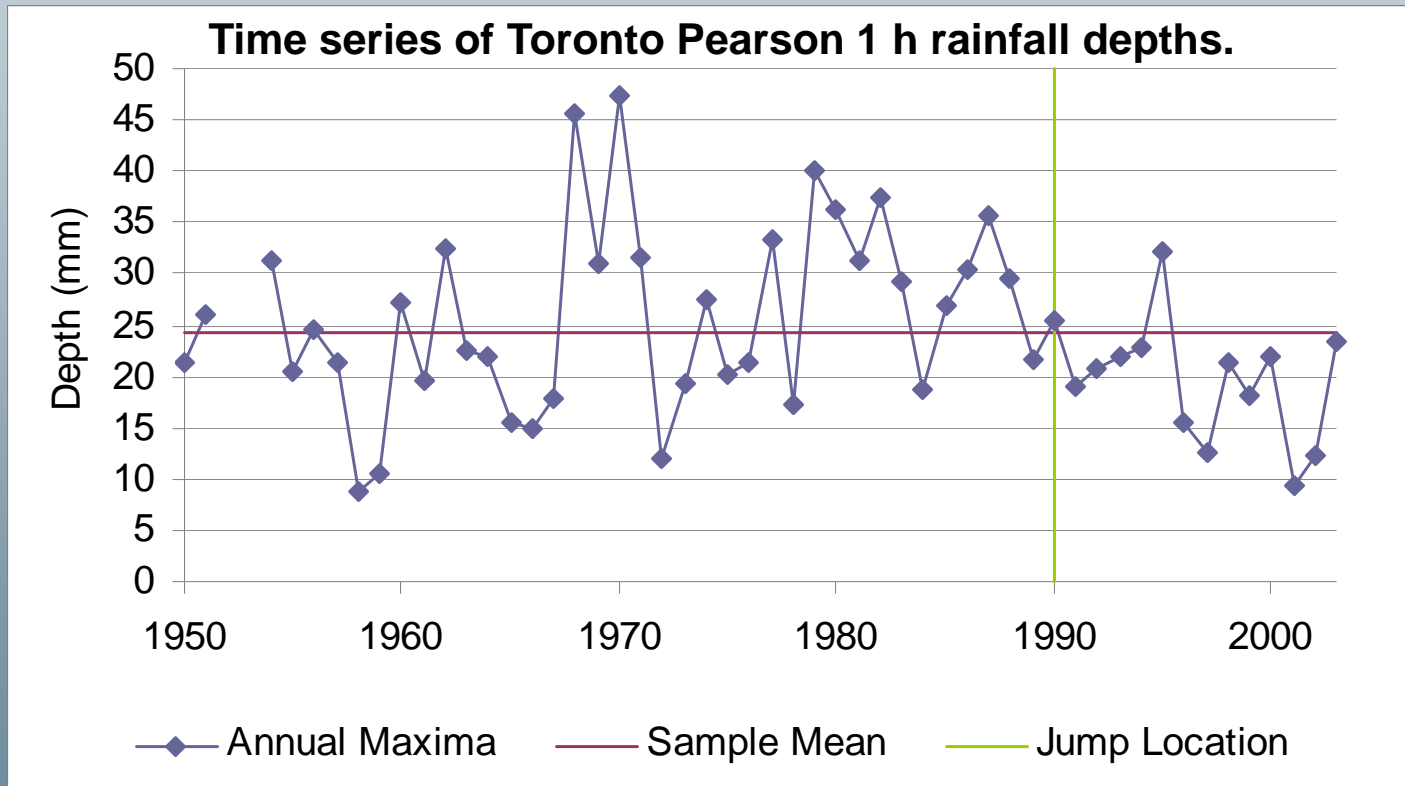
PRECIPITATION IN CANADA

Subjective Review of Historical Rainfall Records



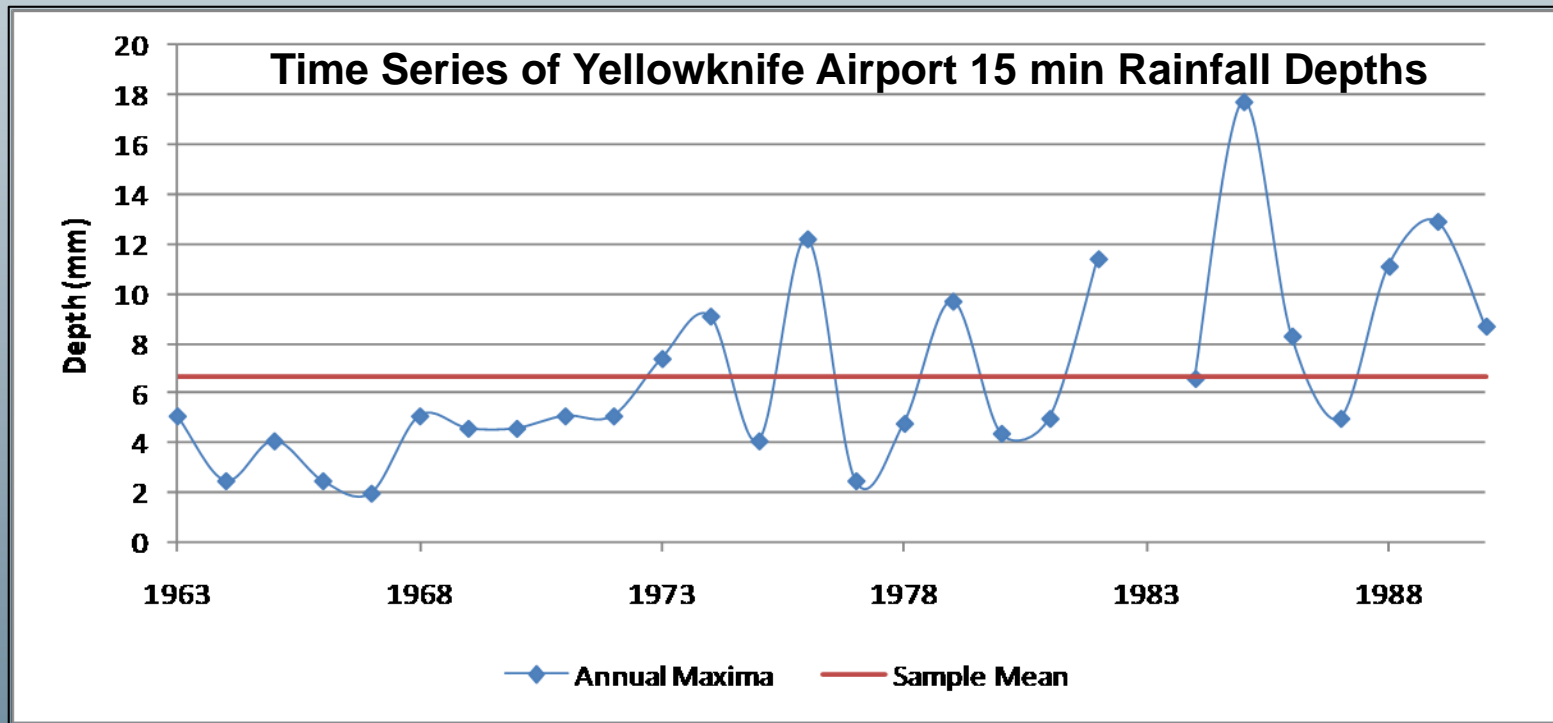
PRECIPITATION IN CANADA

Jump Example:



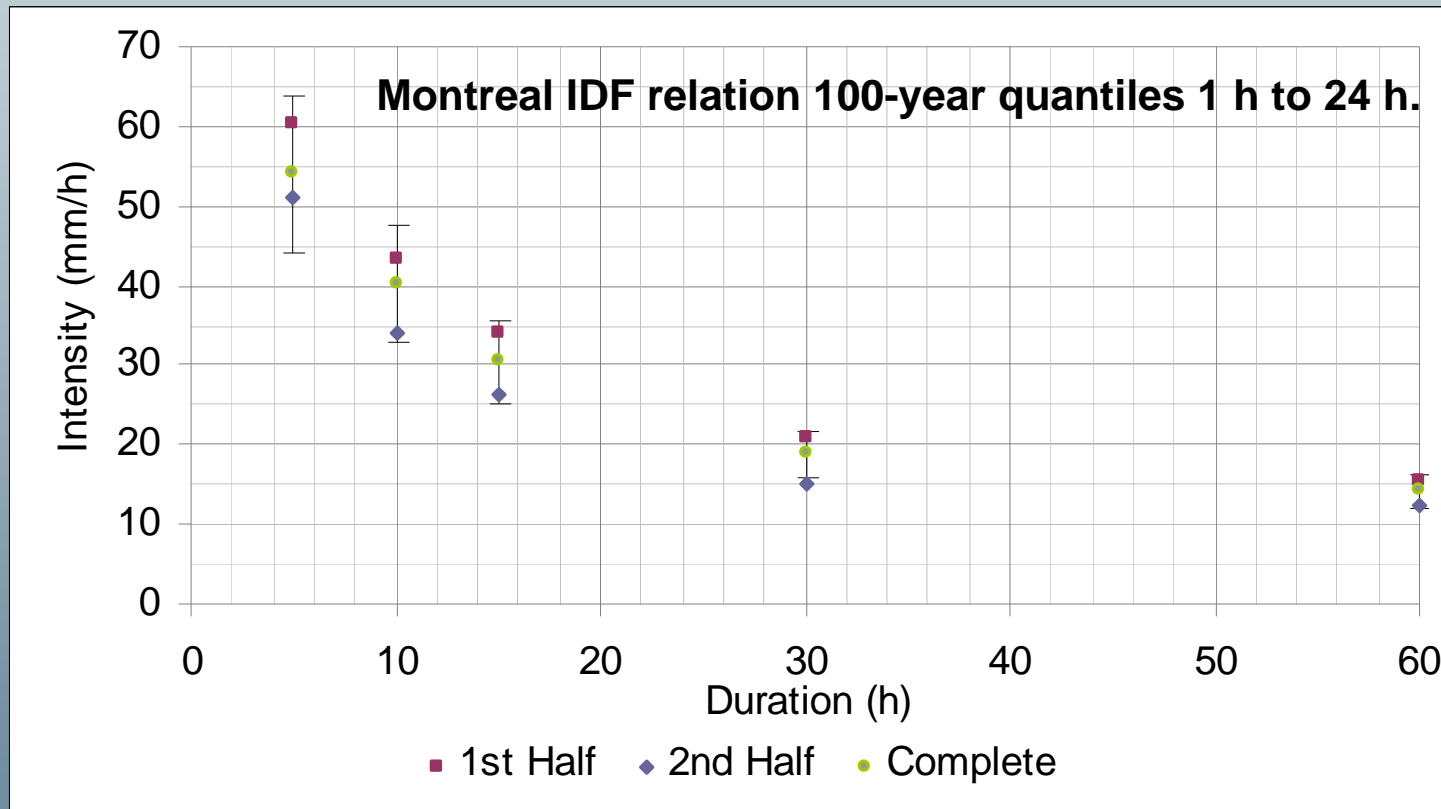
PRECIPITATION IN CANADA

Trend Example:



PRECIPITATION IN CANADA

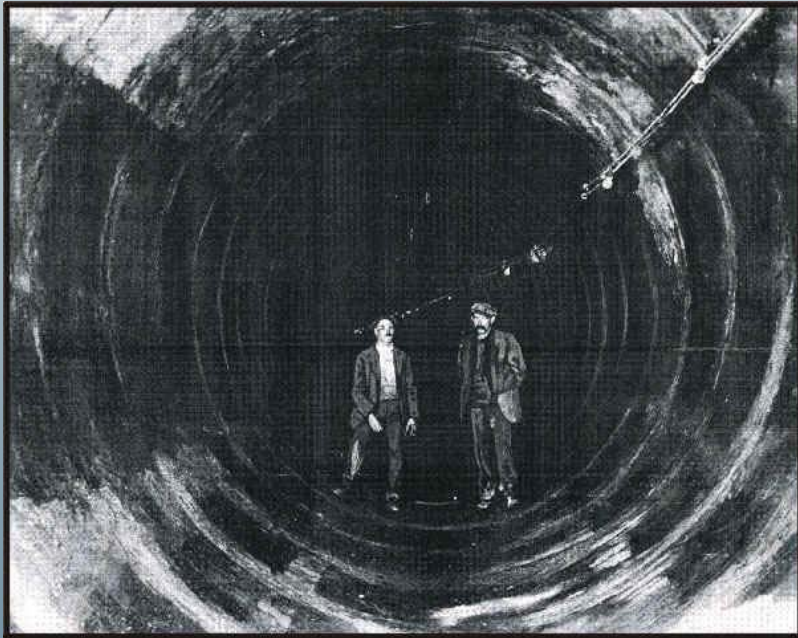
What about Split-Sample-Analysis?



Finding → not worth the effort.

STORMWATER MANAGEMENT

Storm Sewer Era (~1880-1970)



Newark, NJ



Vancouver (~1900)

STORMWATER MANAGEMENT

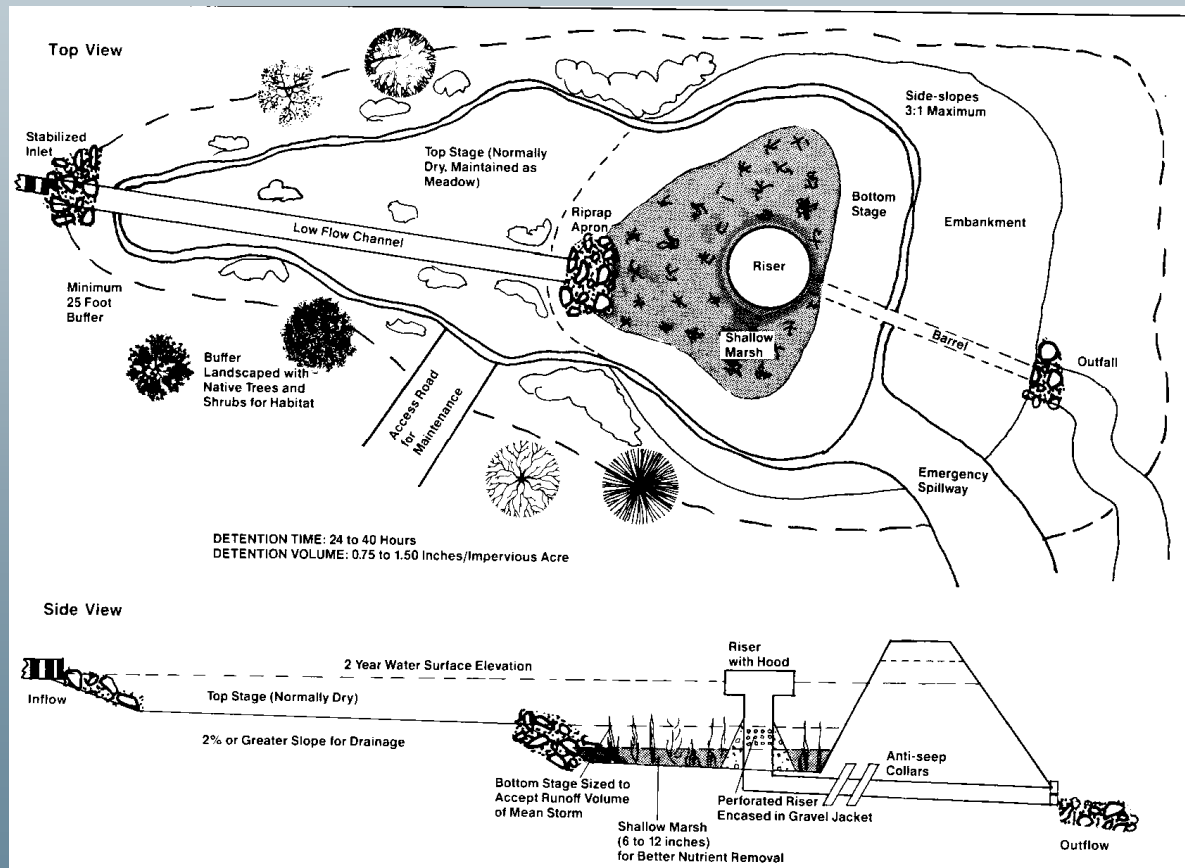
SWM Era (~1970-1990)



Cataraqui Pond, Kingston

STORMWATER MANAGEMENT

Urban Stormwater BMP Era (~1990-2007)



STORMWATER MANAGEMENT

Today (2010) and Tomorrow ?



Portland, OR



York University

STORMWATER INFRASTRUCTURE

- Sensitivity of SW infrastructure to CC depends on magnitude of expected change & type of infrastructure

NEW INFRASTRUCTURE

- Design pipe diameter will increase if design rainfall increases.
- Required live storage of quantity control structures may increase.
- Required storage volume of quality control may increase.
- Size of CSO abatement structures may change.

STORMWATER INFRASTRUCTURE

EXISTING INFRASTRUCTURE

- May be under-designed.
- More frequent maintenance may be required.
- Retrofitting opportunities.

Frazil ice flood event on the
Moira River, Belleville



STORMWATER INFRASTRUCTURE

OTHER FACTORS INFLUENCING DESIGN

- Changing guidelines and standards.
- Financing models.
- Public expectations.
- Population growth.

All of the above may have as great an impact on design requirements as climate change.

SOLUTION

1. Examine design criteria & methodology

- Design return periods have not changed in many years & may not reflect current or future risk of damage.
- In many cases, methodology does not reflect advances in science or best available technology.
- (*Adapting to Climate Change in Ontario, Report of the Expert Panel on Climate Change, 2009, Goals for Government, Recommendation 14*)

SOLUTION

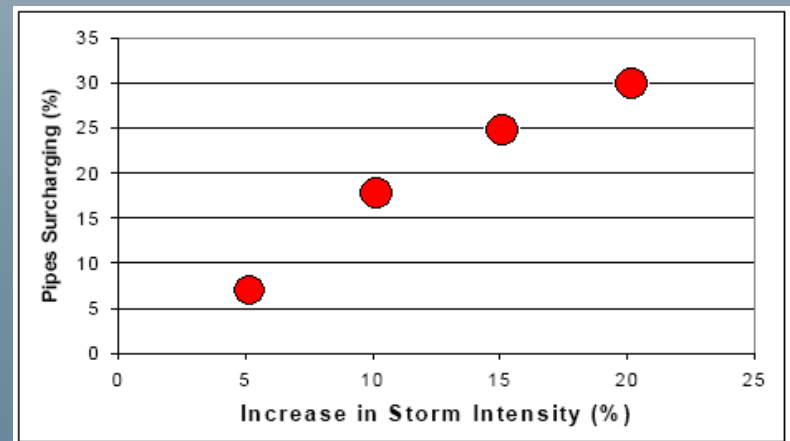
2. View climate change as an additional uncertainty

- Consider potential impacts of climate change as one of several uncertainties.
- Other uncertainties include future population growth, new standards, new financing models, changing public expectations, evolving attitudes towards the natural environment

SOLUTION

3. Relate design criteria to uncertainty

- In other civil engineering fields, design criteria are explicitly related to uncertainty, e.g. safety factors.
- In stormwater management, design criteria are fixed regardless of uncertainty level.
- Why? Is this appropriate?



SOLUTION

4. Consider adaptive planning & design

- In Insofar as possible, maintain flexibility.
- Facilitate revision of design criteria.
- Revise plans as design criteria and methodology evolve.
- Provide some overcapacity as a hedge against increased rainfall.

SUMMARY

- Accept a non-stationary climate.
- Review of historical rainfall records in Canada indicates that the only significant trend (positive) in event rainfall is in Yellowknife.
Analysis should be repeated.
- Review design standards and view climate change as an additional uncertainty.