



Climate Change: A Risk Business.....

Photo: Rob Bieber

1

Peel Climate Change Partnership

The Partnership: We All Have a Role to Play

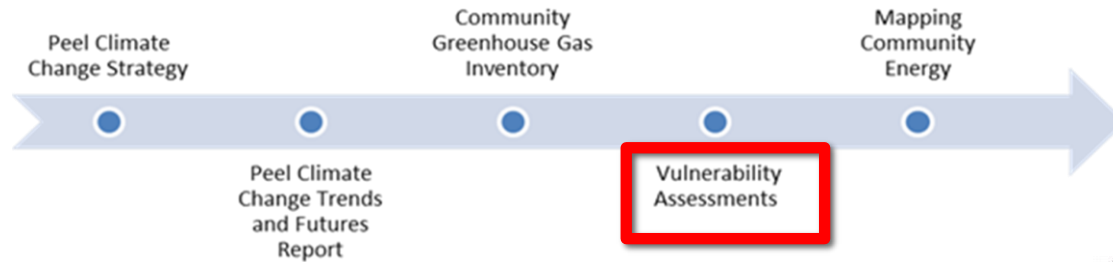


- In 2009, the Community Climate Change partnership was formed to develop an intergovernmental climate change strategy.



Partnership Deliverables

- In 2011, the partnership developed the Peel Climate Change Strategy.
- Project focused working groups, with representation from across the partnership, were formed to assist with the completion of *Peel Climate Change Strategy* actions noted below.



Polling Question #1

Has your municipality experienced a major flood in the last 15 years?

- a. Yes
- b. No

Shared Experiences



Evacuation Plans do not consider flooding



Critical Infrastructure failure poses potential threat to public



Community and municipal service needs

Extreme Rainfall #1 Climate Related Threat for Water Systems

Riverine Flooding



Source: Toronto Region Conservation Authority, 2019

Urban Overland Flooding



Source: Toronto.com, 2013

Sanitary Sewer Backup Flooding



Source: Minneapolis Basement Flood Damage Restoration

Groundwater Flooding



David Macdonald at home in Oxford, experiencing groundwater flooding at first hand.

Source: NERC, Natural Environment Research Council, 2017

Water Quality



Source: Saleh Sebti, 2013

Erosion



Source: Toronto Region Conservation Authority, 2017

Major Gaps Identified in Vulnerability Study

- Short Duration High Intensity Storms identified as posing the highest risk
- Multiple causes of flooding –multiple stakeholders
- Need for Integrated solutions between partners and departments (Planning, Public Works, Transportation, Emergency Preparedness, CVC/TRCA, Peel)
- No Common Standard for evaluating risk in existing urban areas under climate change
- No Financial Tools to evaluate mitigation measures (return on investment)

Polling Question #2

Does your municipal stormwater master plan and stormwater asset plan consider the impact of flooding on different municipal services such as emergency management, water and sanitary system?

- a. Yes
- b. No



buildbeautiful

Stormwater Master Plan

mississauga.ca/stormwater-master-plan



What is Level of Service?

What Level of Risk are we willing to accept?

**What Level of Service can we feasibly achieve in
older areas?**

What will Climate Change bring?

Federal and Provincial Requirements

Federal Infrastructure Funding

- Requires climate change risk assessment, ROI for best management practices including economic, social and critical infrastructure impacts

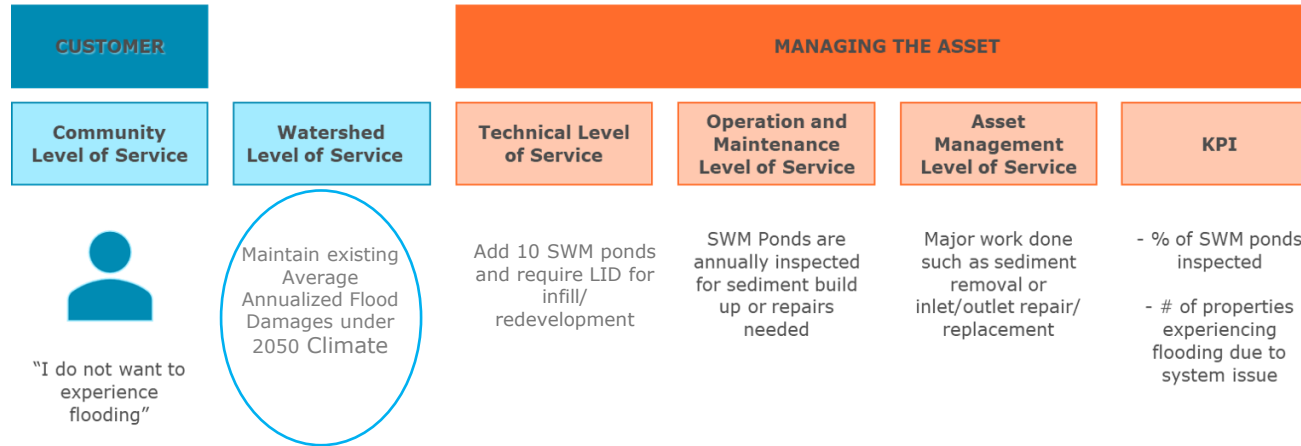
Growth Plan for GGH/ PPS (2019)

- Stormwater master planning informed by the relevant watershed/subwatershed plans

Ontario Reg 588/17 3(1) 5

- Asset management address Climate Change vulnerabilities

Defining Levels of Service and Acceptable Level of Risk



Example only



**What Level of Service are taxpayers
willing to bear?**

What areas do we prioritize?

**What options have the greatest return
on investment?**

2

Risk and Return on Investment Tool

PARTNERS: Risk and Return on Investment Tool

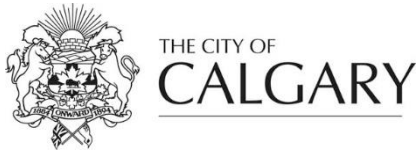


Public Safety
Canada

Sécurité publique
Canada



Credit Valley
Conservation
inspired by nature



Input Data Requirements

GIS Data Inputs

- Digital Elevation Model
- Region of Interest or Boundary
- Land use
- Watercourse
- Floodplain
- Buildings
- Infrastructure layers

Model Inputs

- Hec-ras outputs
- SWM model junctions/ catchments
- Sanitary model junctions/ catchments
- Hydrology catchments

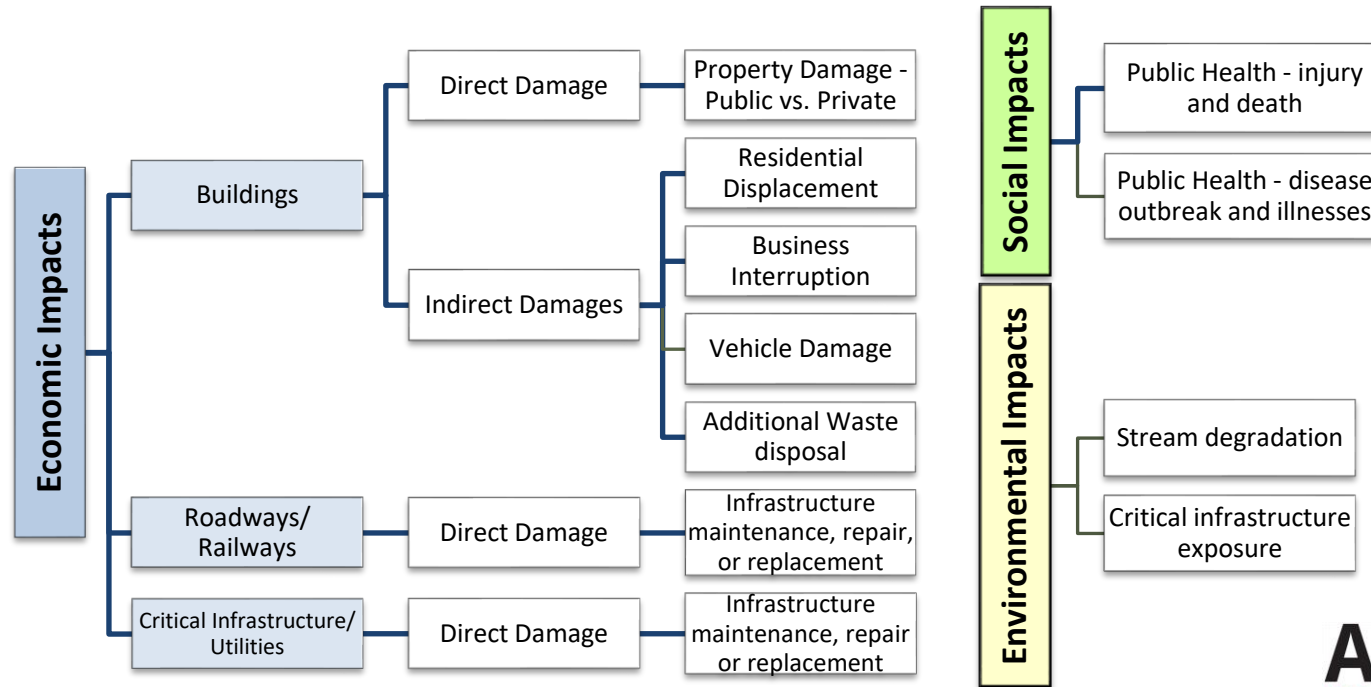
NOTE: Users can use defaults, or their own data. Users can run riverine, sanitary, and/or urban flooding and/or erosion and SWM pond maintenance modules independently

Built In Source Data

- National Water and Wastewater Benchmarking – Infrastructure Cost
- IBI Group – Building Depth-Damage Cost Curves, Spatial Index, Life Cycle Cost of Management Options
- Sustainable Technologies Evaluation Program (STEP) – Stormwater Management Ponds, and Low Impact Development Life Cycle Costing
- Life Cycle Costing for Natural Assets
- US Federal Emergency Management Agency/ Intact Standard – Damage Relationships
- Statistics Canada - Demographics
- Province of Ontario – Provincial Digital Elevation Model, Surficial Geology
- *Social Vulnerability Index Mapping*

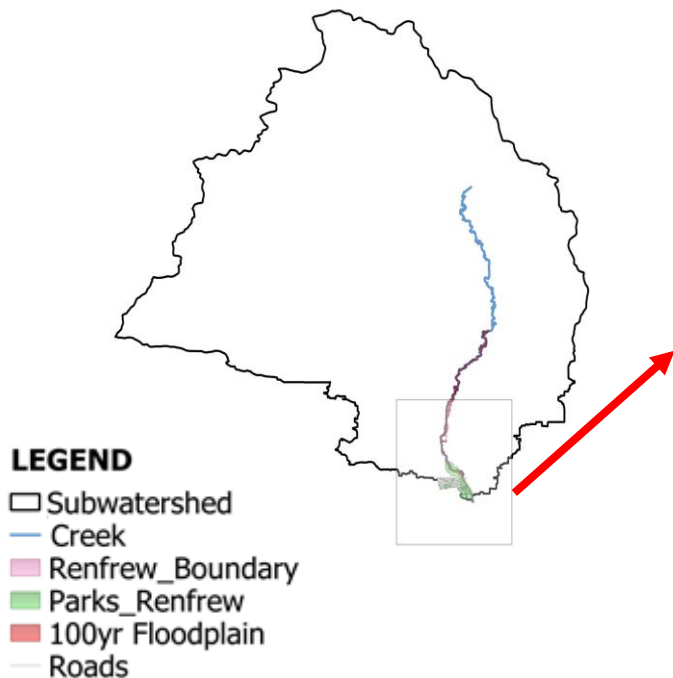
Conceptual Model

Impacts determined based on event based riverine flooding, urban overland flooding, groundwater flooding, sanitary sewer backup and erosion

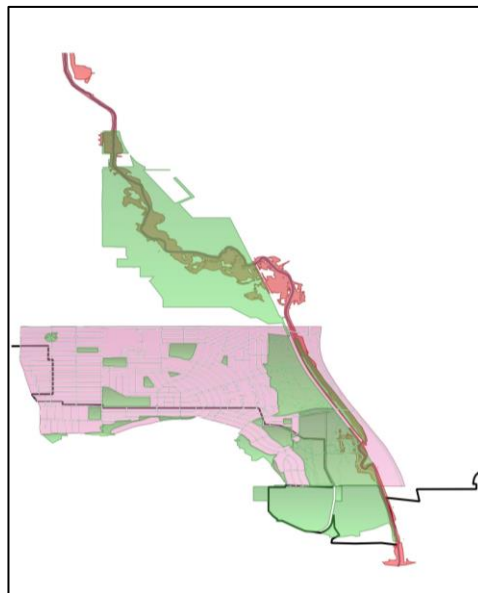


Assessment Can be done at different Scales

Watershed-wide Erosion assessment



Community-wide Urban flood risk



Other Assessments:

- Riverine Flooding
- Sanitary Sewer backup
- Groundwater flooding
- Health impacts

Economic Impact (Flood Damages, 100-year storm)

Case Study 1

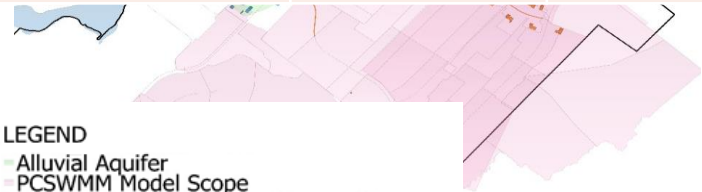
Flood Type	Flooded Buildings (100- yr)	Total Damages (\$)
Riverine flooding	150	\$21M
Urban flooding	2400	\$400M



- LEGEND
- Flooded Buildings (Riverine)
 - Flooded Buildings (Urban Overland)
 - Historic Flood Complaints
 - Transportation
 - Railway

Case Study 2

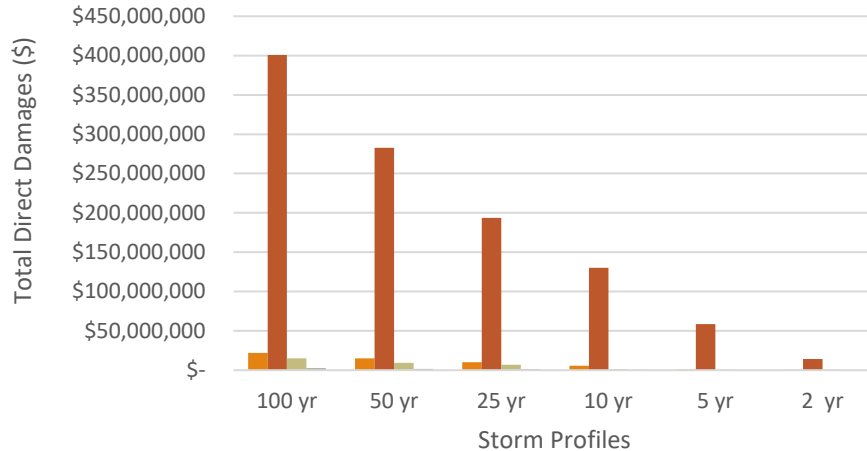
Flood Type	Flooded Buildings (100- yr)	Total Damages (\$)
Groundwater flooding	20	\$1.2M
Urban flooding	7	\$0.7M



- LEGEND
- Alluvial Aquifer
 - PCSWMM Model Scope
 - damage-groundwater-buildings-100_YEAR
 - damage-urbanoverland-buildings-100_YEAR
 - damage-urbanoverland-roads-100_YEAR
 - damage-riverine-roads-100_YEAR
 - Shaw's Creek
 - Railway
 - Roads
 - 100yr Floodplain

Event- based Damage Quantification (Public and Private)

Case Study 1



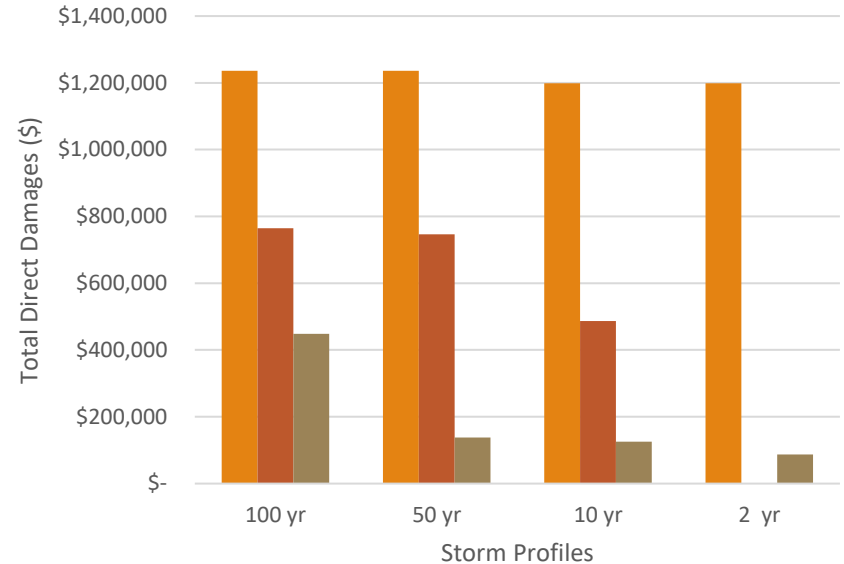
■ Flooded Buildings - Riverine

■ Flooded Buildings - Urban Overland Flooding and Storm Sewer Backup

■ Flooded Roads (Riverine & Urban)

■ Flooded Railways (Riverine and Urban)

Case Study 2

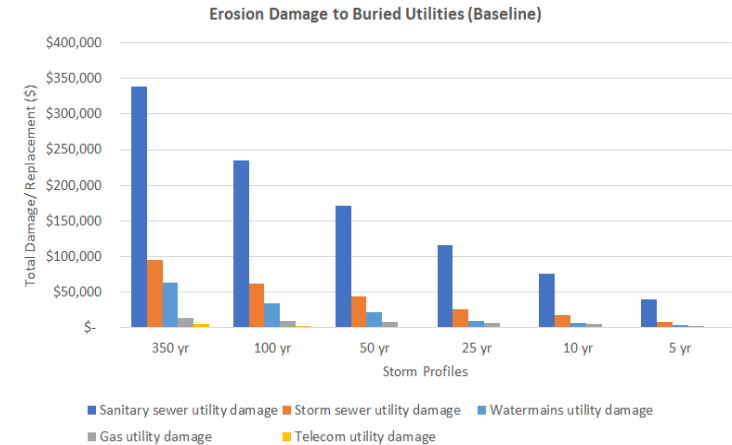
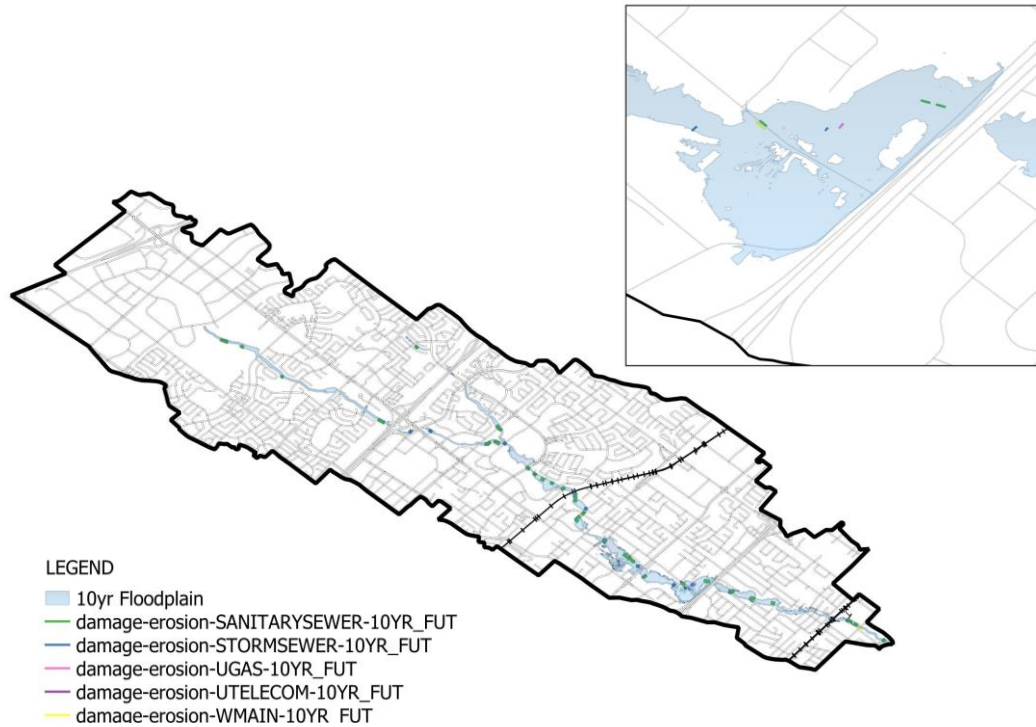


■ Groundwater Flooding

■ Urban Overland Flooding and Storm Sewer Backup

■ Roads

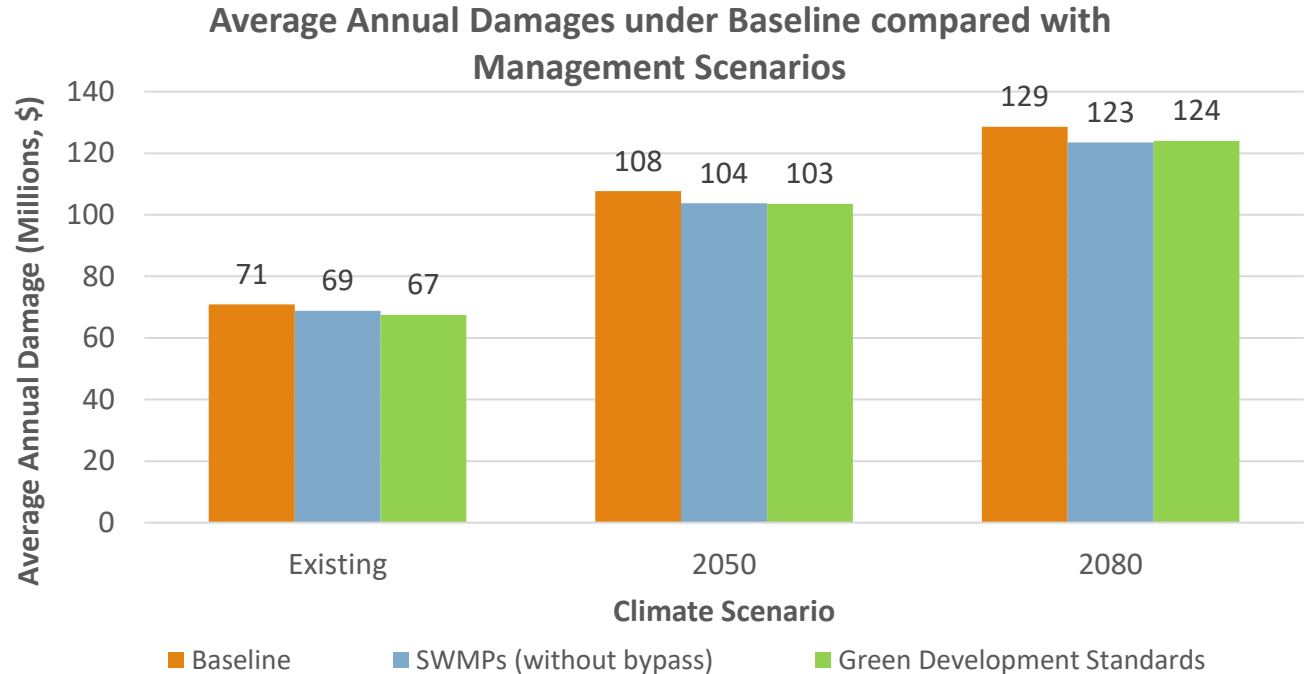
Erosion Damage to Critical Infrastructure



Striking the Right Balance

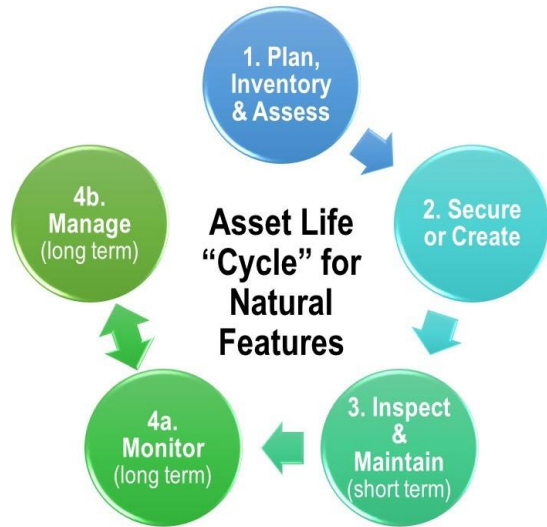


Tool allows Municipalities to Compare Solutions

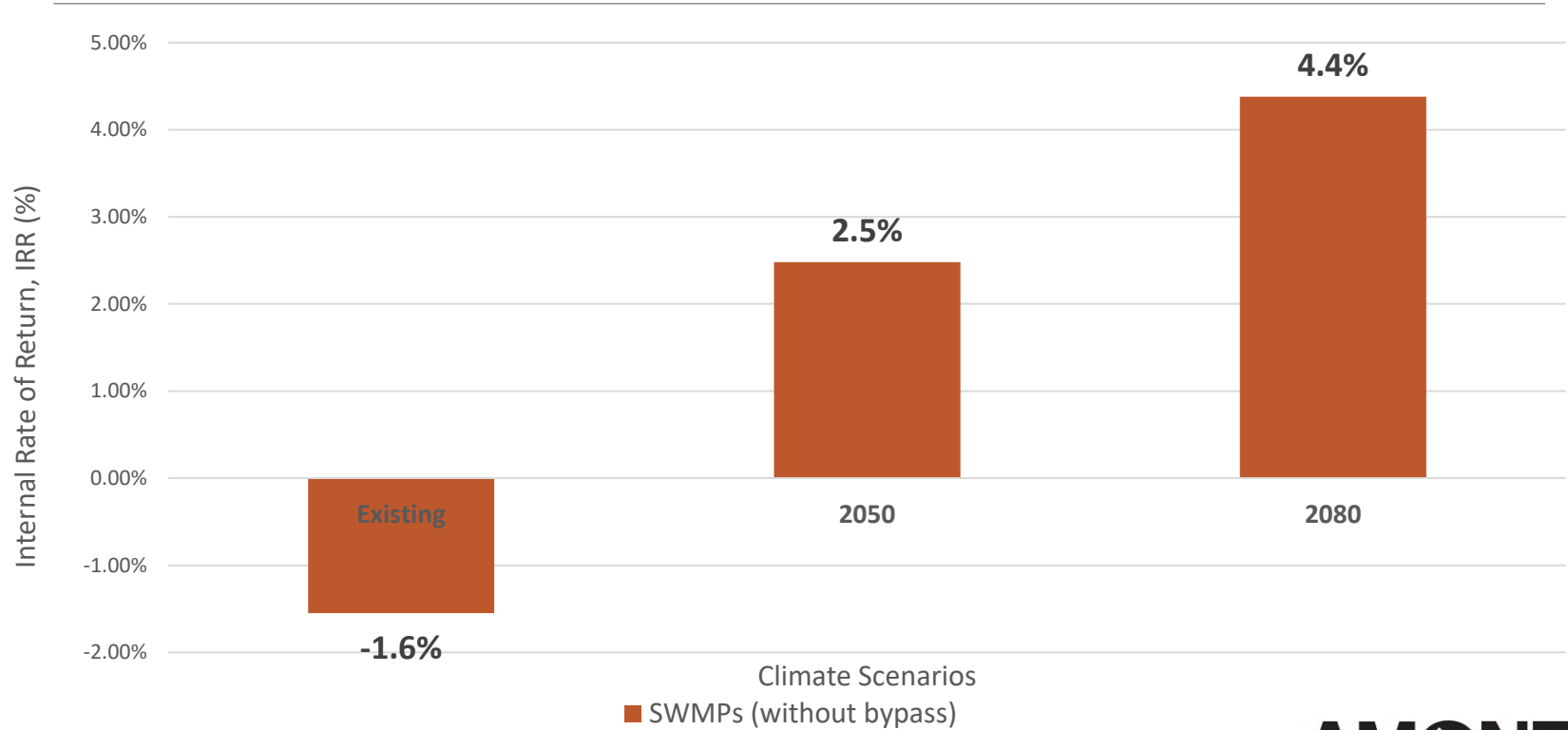


Sample output: comparing various solutions for their return on investment (in terms of damage reduction/avoidance)

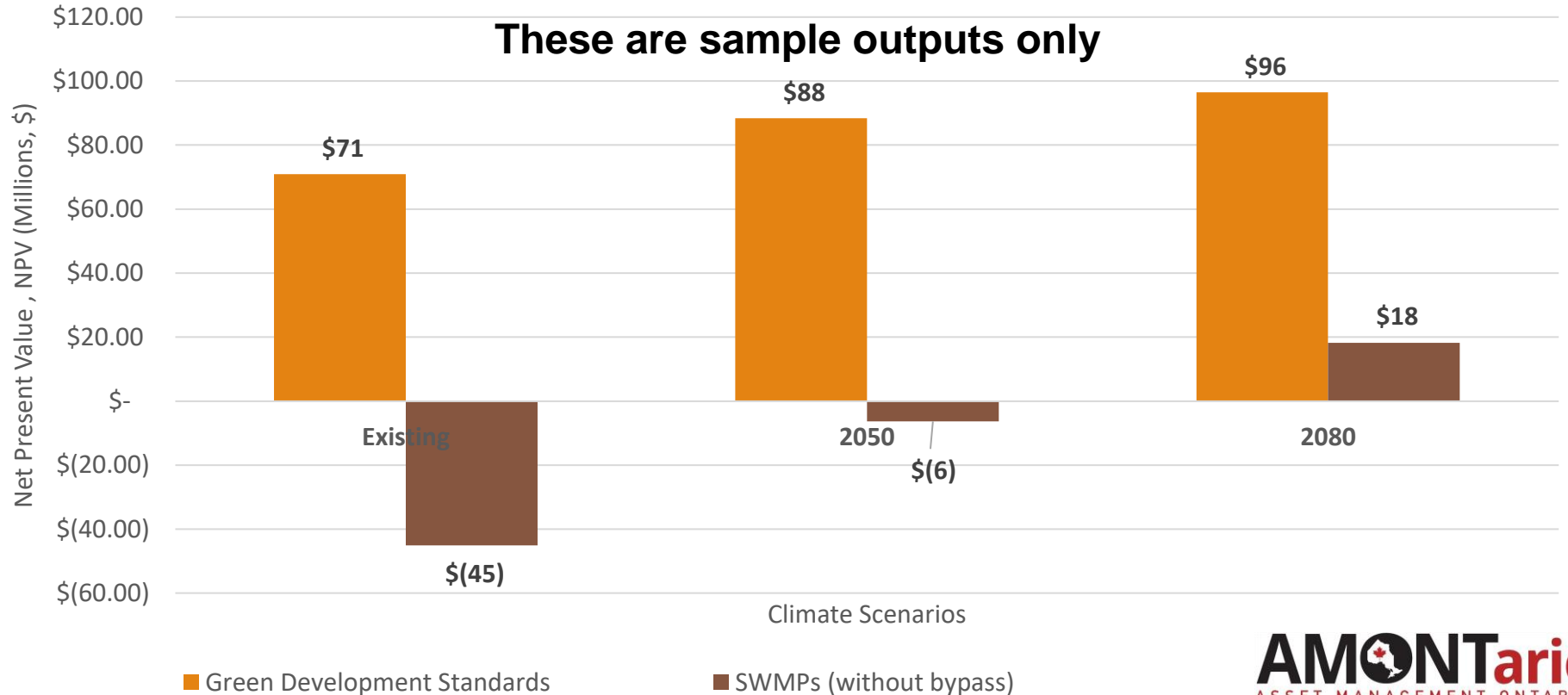
Natural Assets Life Cycle Costing Database



Return on Investment (Internal Rate of Return, IRR)

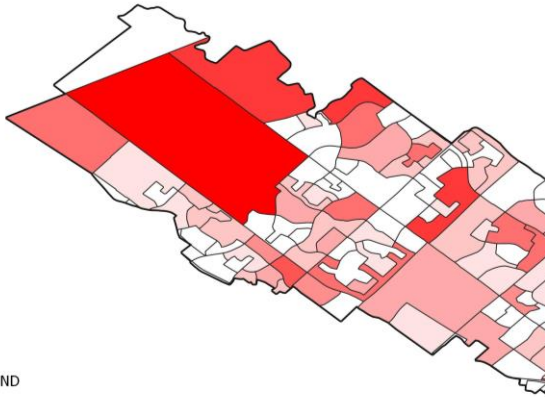


Return on Investment (Net Present Value, NPV)



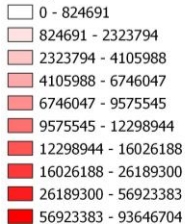
Priority Assets for Infrastructure Upgrades

Total

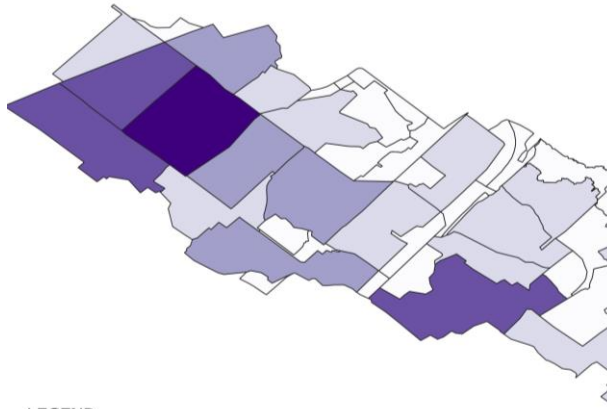


LEGEND

damage-DA-dominant-buildings-roads-rails-erosion-ci-bridges-350YR_FUT

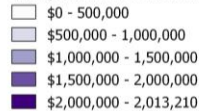


Riverine

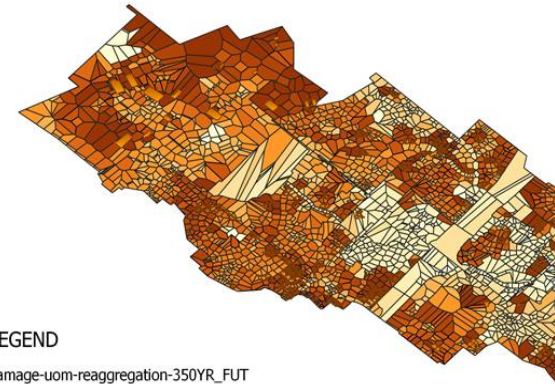


LEGEND

damage-riverine-reattributed-100YR_FUT

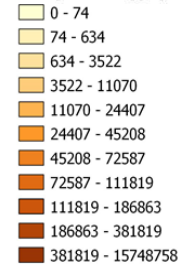


Urban



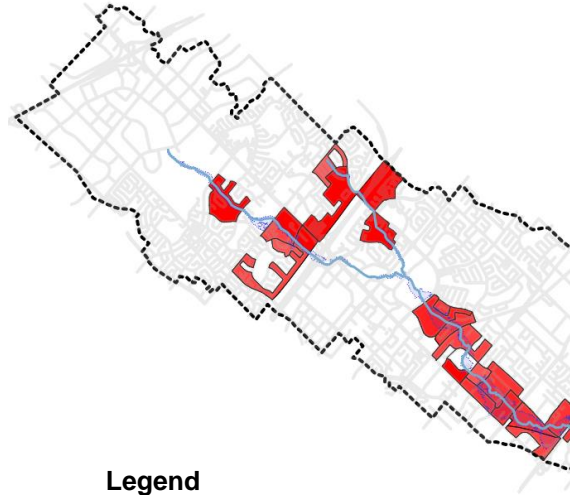
LEGEND

damage-uom-reaggregation-350YR_FUT



Prioritizing Action to Address Social Vulnerability and Pollutant Hot Spots

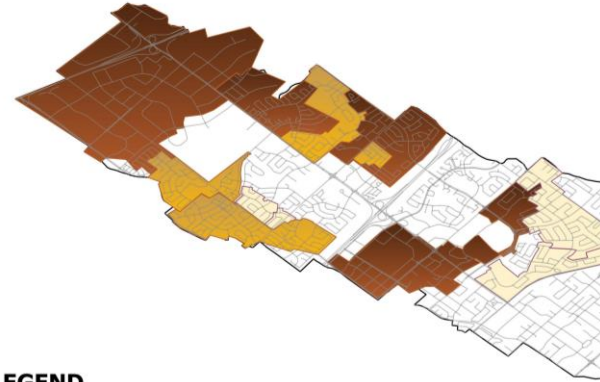
Health



Legend

- Red square: 'Hot Spots' for health impacts (injury, illness)

High Maintenance BMPs

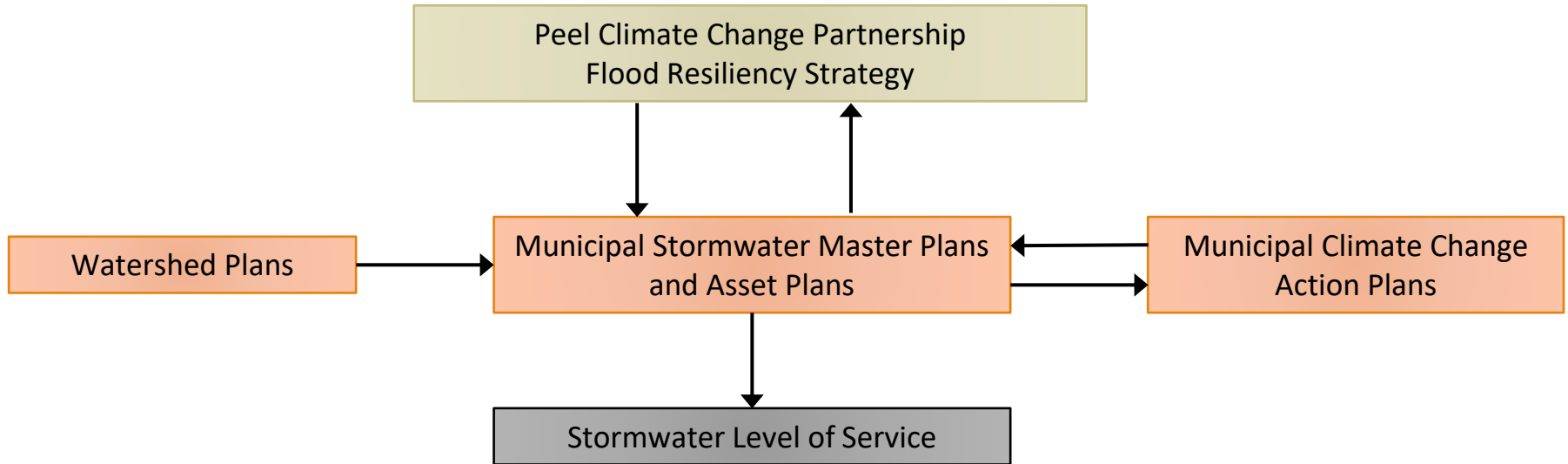


LEGEND

- Gray line: Roads
- Brown square: Yrs to Next Maintenance 7.2 - 14.2
- Yellow square: 14.2 - 20.3
- Light yellow square: > 20.0

These are sample outputs only

Putting It All Together



Where in the world is Caledon?

- Most northern of three municipalities in the Region of Peel
- Predominantly rural with a mix of urban areas, villages, and hamlets
- Covers nearly 700 km²
- Population: 71,600 (2017 census) and anticipated to grow by 2031
- Major flood in Bolton (2019)



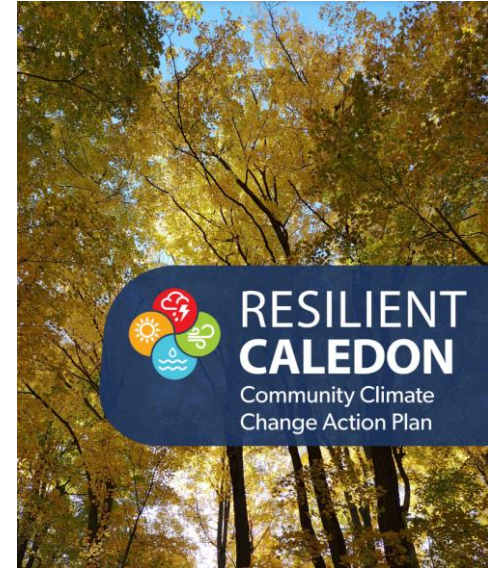
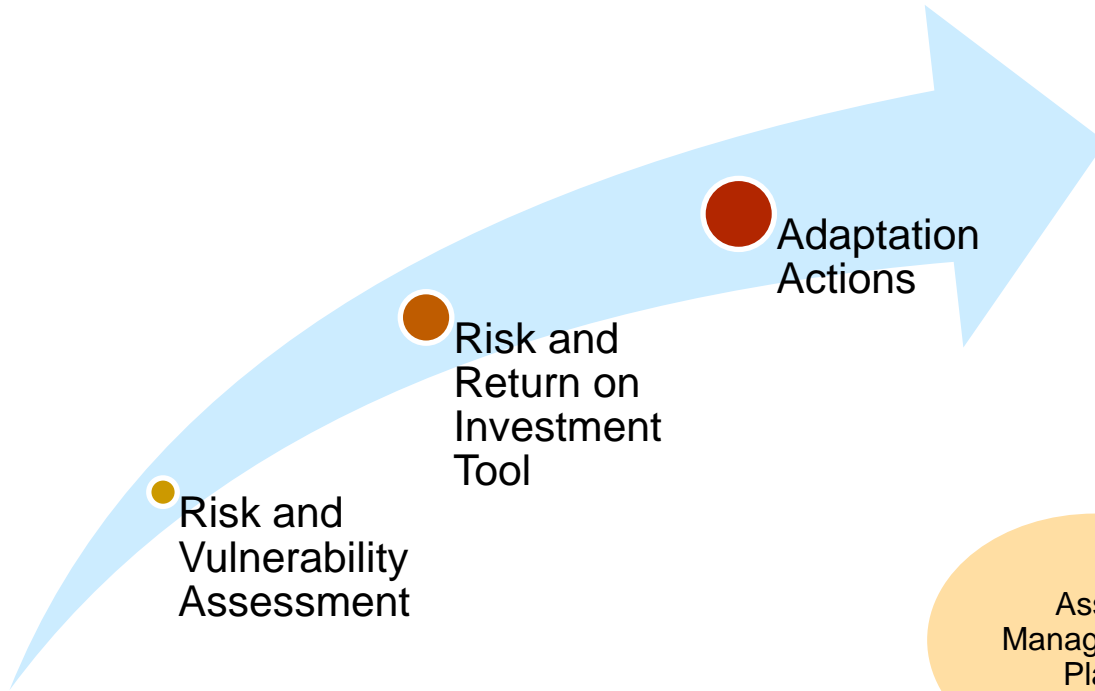
Greater Toronto Area



Bolton Flood 2019



Integrating Risk, Asset Management and Climate Change



Major Findings

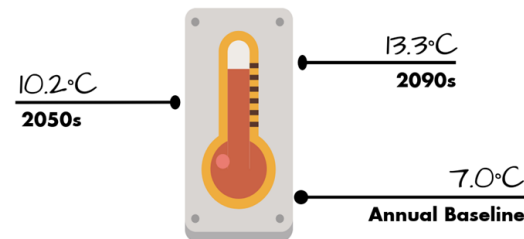
The climatic threats impacting infrastructure relate mostly to **changes in temperature and precipitation**

3 of the 4 highest ranking impacts were **related to Town-owned infrastructure**

Highest ranking impact is **stress on stormwater management infrastructure**

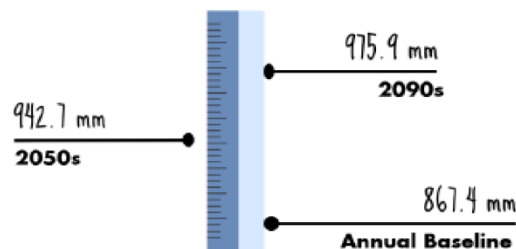
Impacts cause damage and wear on built infrastructure, **causing aging faster than expected**

More frequent and high intensity rainfall events means infrastructure is **likely under more stress than anticipated during its design**



ANNUAL MEAN TEMPERATURES

Mean, minimum & maximum daily temperatures are projected to significantly increase in every season.



MEAN PRECIPITATION

Winter and Spring are projected to get significantly wetter.



Max 1-day: 37mm

Max 5-day total: 59.2mm



Max 1-day total: 40.6mm

Max 5-day total: 63.4mm



Max 1-day total: 44.1mm

Max 5-day total: 70mm

PRECIPITATION EVENTS

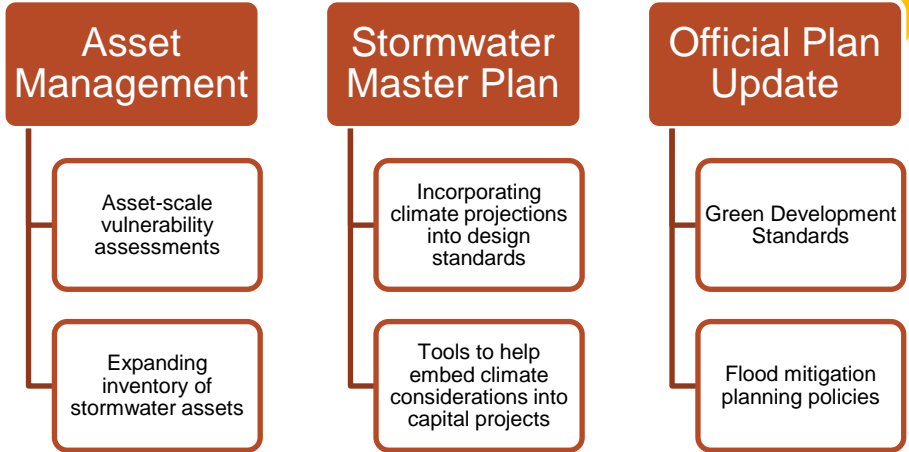
Precipitation events in general are projected to become more intense and extreme.



RESILIENT CALEDON

Community Climate
Change Action Plan

Opportunities



**“The future depends on what you do
today”**

Mahatma Gandhi



Closing Remarks

- CVC and partners are working on releasing the Tool more broadly including training on the Tool in 2022
- If you are interested in the Tool or participating in the Watershed Level of Service Project, please contact Christine Zimmer christine.zimmer@cvc.ca and Amna Tariq amna.tariq@cvc.ca
- Stay Tuned for further information on training and virtual tour of the Tool

Polling Question #3

Is property flooding due to high groundwater an issue in your municipality?

- a. Yes
- b. No

Polling Question #4

Have you included natural assets within your asset management plan

- a. Yes
- b. No