TRIECA 2019 CONFERENCE

Thank you to our sponsors:

www.trieca.com

GOLD SPONSORS

AECOM

Credit Valley Conservation
inspired by nature

Stantec

AQUATECH

armtec
CANADACULVERT

CIVICA
Water Management Solutions

J. Lipani Turf

CROZIER
CONSULTING ENGINEERS

terrafix
geosynthetics inc.

UNILOCK
DESIGNED TO CONNECT.

GEMS

Hydro International

R&M
CONSTRUCTION

filtrexx
CANADA
let nature do it.

Profile
Solutions for your Environment

Lake Simcoe Region
conservation authority

York Region

MEDIA SPONSORS

Environmental Science & Engineering
MAGAZINE

WATER CANADA

PRINT SPONSOR

WARREN'S
WATERLESS PRINTING INC.

HOSTS

CANIECA
CANADIAN CHAPTER

Toronto and Region
Conservation
Authority

Credit Valley Conservation
inspired by nature

Risk and Return on Investment Tool (RROIT)

By Sakshi Saini
Water Resources Specialist
Credit Valley Conservation

Outline

- Current Challenges in Stormwater Management
- Federal and Provincial Recommendation and Requirements
- Risk and Return on Investment Tool
  - Objective and Tool Components
  - Technical Approach Overview
  - Tool Outputs

Current Challenges in Stormwater Management in Existing Urban Areas

Varying Level of Service within Existing Urban Areas– How do we set targets, what's feasible, what's reasonable?

City of Mississauga
25% receives quantity control
17% receives quality and quantity control

Town of Caledon
54% of Bolton settlement area receives quantity control
64% of ponds provide water quality and quantity control

Types of Flooding

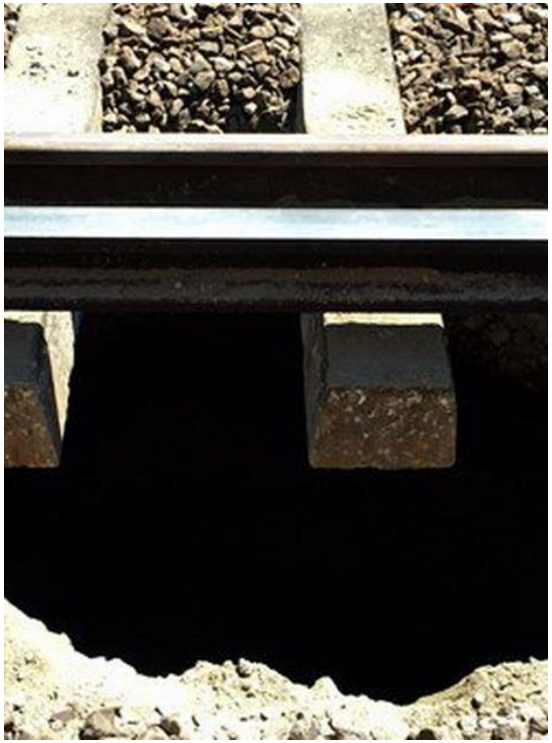
Riverine Flooding (surface)

Urban Flooding (overland)

Sanitary/Storm Sewer Backup

Source: Boston Water and Sewer Commission

Flooding isn't just stormwater pipes– there are municipal and community risks that need to be considered



News / GTA

Mississauga resident living in tent since flood

Ken Hills, 60, is one of hundreds living near Cooksville Creek displaced since last week's storm.

Tweet 32 G+1 0 reddit this!

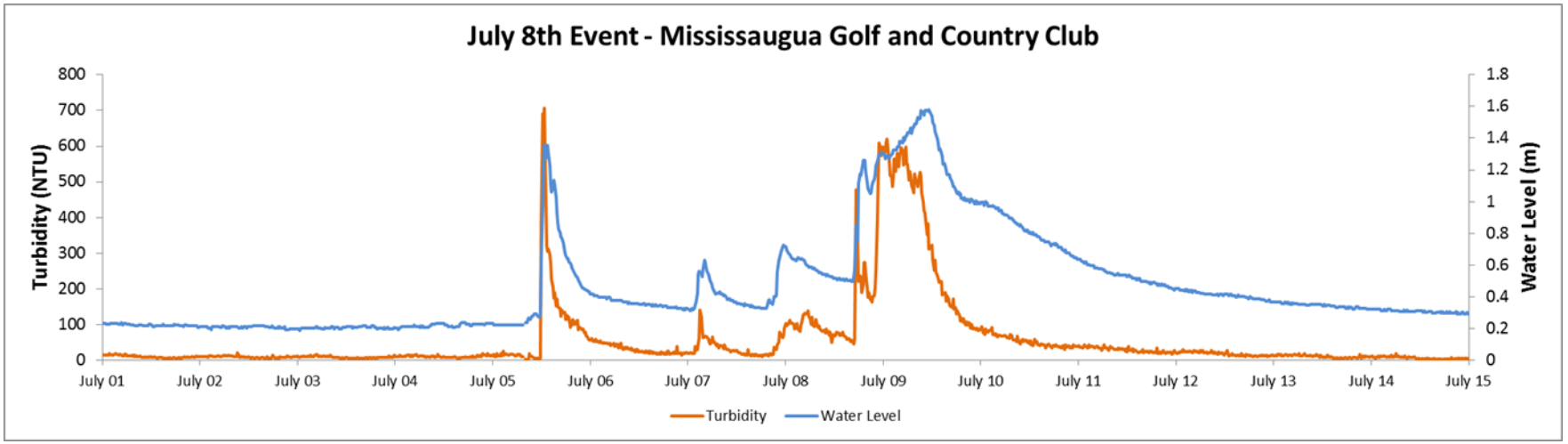
ALEX NINO GHECIU / TORONTO STAR Order this photo

Evacuation Plans do not consider flooding

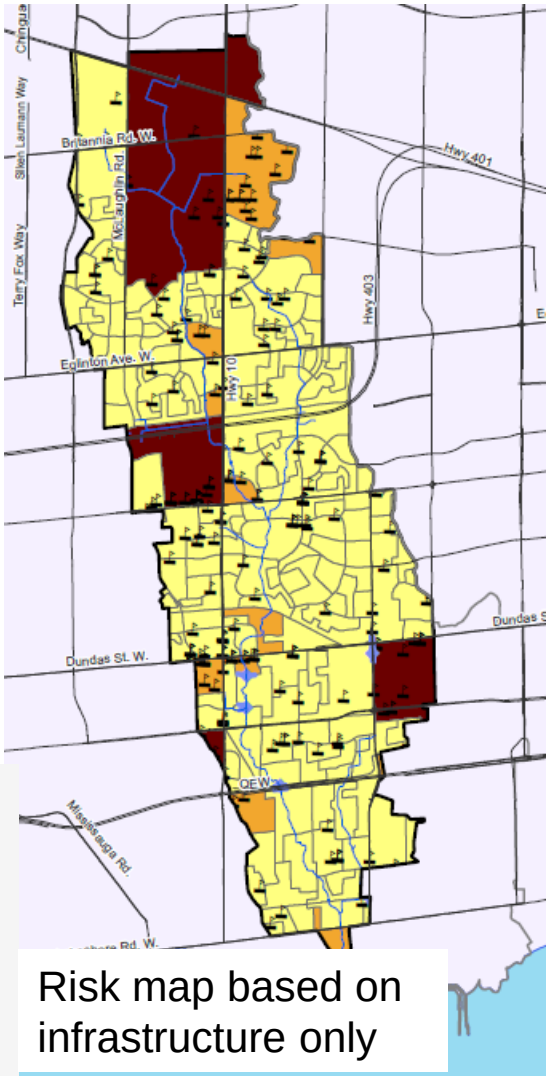
Critical Infrastructure failure poses potential threat to public

Community and municipal service needs

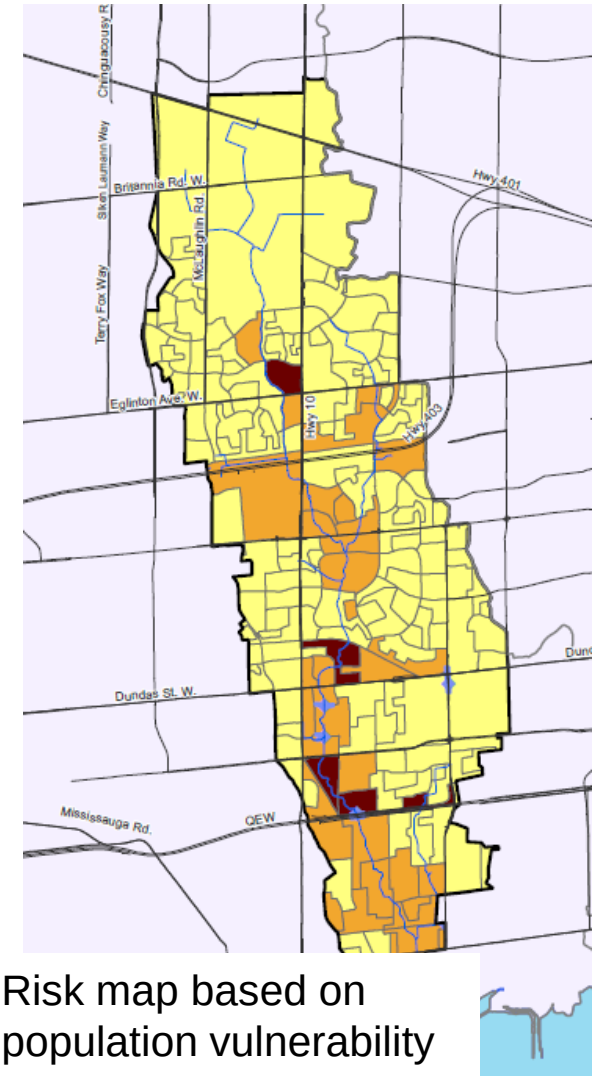
Water Quality Impacts of Flooding



Integrating Social Vulnerability into Risk Assessment and Decision Making



Risk map based on infrastructure only



Risk map based on population vulnerability

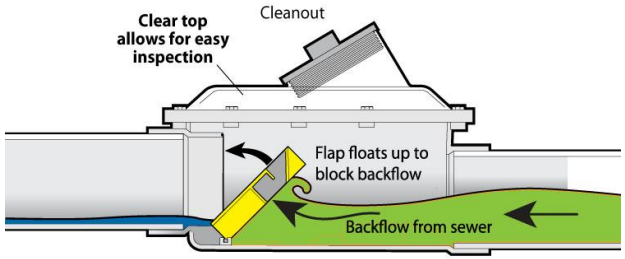
Vulnerable Priority Areas of Critical Infrastructure

- High Risk
- Medium Risk
- Low Risk
- Flooded Roads and Intersections
- Schools/Childcare/Early Learning Centres

Striking the Right Balance of Management Options

Land Acquisition along the floodplain

Top: Enhanced emergency outreach to address public health burden
Bottom: Sanitary backup prevention



Source: Canadian Plumbing Design and Installation, American Technical Publishers

Green Infrastructure to reduce urban flooding

Recommendations and Requirements

Key recommendations from the Natural Resources Canada State of Play Report (2017)

- Development of ... **Financial tools**, in partnership with Provinces and Territories that include processes to enable the integration of **climate change adaptation considerations into infrastructure decision making**, design and maintenance.
- Enhancement of risk-based prioritization tools to evaluate and **prioritize infrastructure needs**, to include consideration of **social vulnerabilities**.
- Development of standards to perform forensic accounting of extreme events in an effort to **build a database that includes financial and service risks and costs**.

Growth Plan for Greater Golden Horseshoe (2016)

- Reference to using vulnerability assessments to mitigate the risk associated with climate change
- Watershed studies to inform water, wastewater and stormwater master plans

Disaster Mitigation Action Funding (DMAF) Guidelines

- Require climate change risk assessment and return on investment for best management practices
- DMAF guidelines require:
  - Mitigation of economic, environmental, social impacts of Climate Change
  - Assessment of loss of lives; displaced/injured/ill population; local economic loss; population without essential services such as water supply, energy supply
  - Demonstration of mitigation measures that will reduce impact on Critical Infrastructure (CI); reduce amount of CI at high risk; reduce Health and Safety impacts; reduce cost of recovery and replacement; reduce impacts on Vulnerable regions

National Disaster Mitigation Program (NDMP) Stream 3

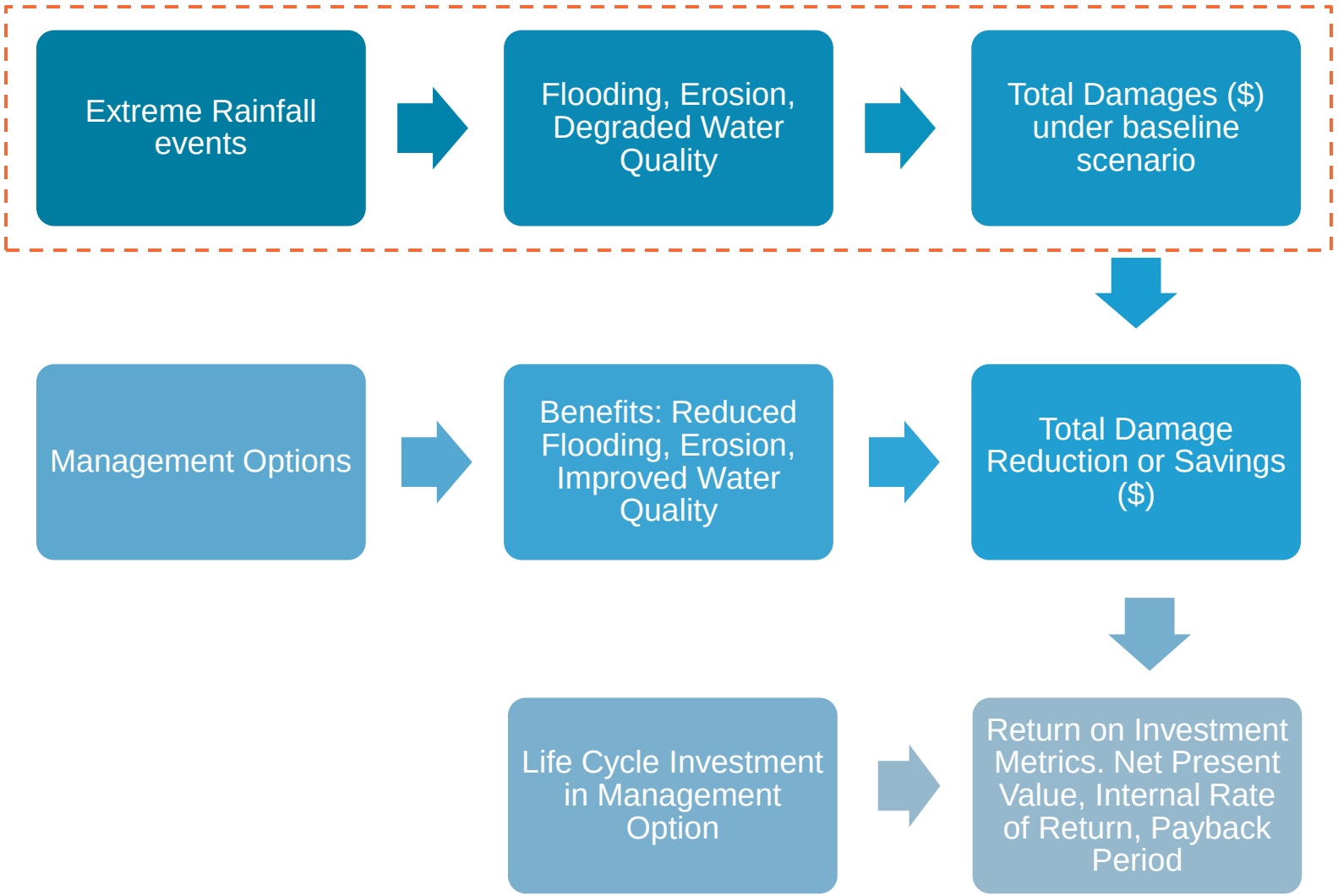
- Flood Mitigation Plans should consider climate change and should identify high risk areas (with consideration for municipal services and social vulnerability)

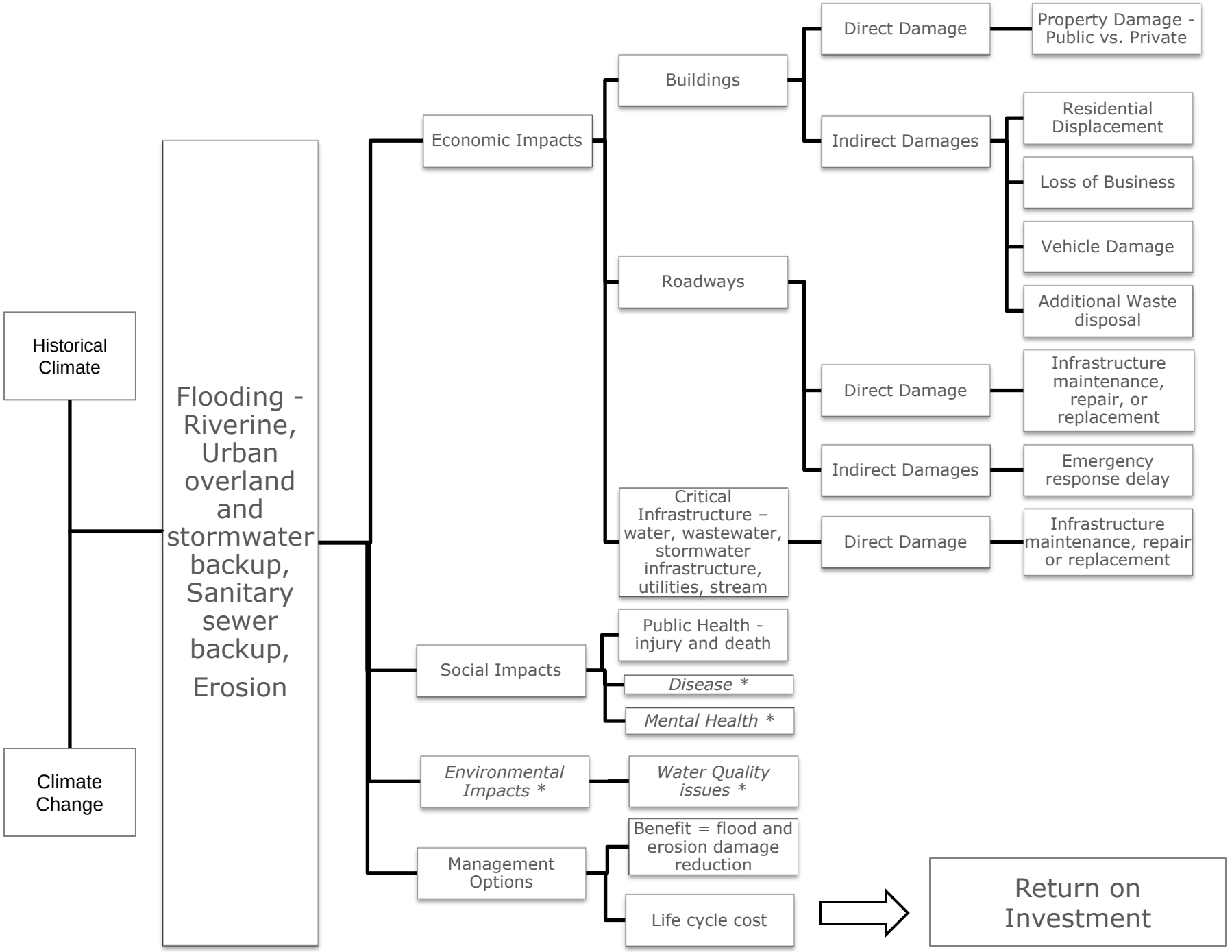
Risk and Return On Investment Tool

Objective

- Assess baseline flood & erosion risks associated with extreme rainfall events, and quantify the potential damages to private and public infrastructure, and vulnerable populations under current and future climate
- Evaluate and compare risk-reduction achievable by management options (e.g. grey and green stormwater infrastructure, land acquisition, flood proofing etc.)
- Perform a financial assessment of the return on investment associated with each or combination of management options by comparing life cycle costs to the benefits (i.e.: cost savings) achieved by reducing flood risk under various climate change scenarios
- Identification of high risk areas that considers social, health, infrastructure and environmental vulnerabilities.

RROIT Scope


Extreme Rainfall events
Flooding, Erosion, Degraded Water Quality
Total Damages ($) under baseline scenario
Management Options
Benefits: Reduced Flooding, Erosion, Improved Water Quality
Total Damage Reduction or Savings ($)
Life Cycle Investment in Management Option
Return on Investment Metrics. Net Present Value, Internal Rate of Return, Payback Period


Historical Climate
Climate Change
Flooding - Riverine, Urban overland and stormwater backup, Sanitary sewer backup, Erosion
Economic Impacts
Buildings
Direct Damage
Property Damage - Public vs. Private
Indirect Damages
Residential Displacement
Loss of Business
Vehicle Damage
Additional Waste disposal
Roadways
Direct Damage
Infrastructure maintenance, repair, or replacement
Indirect Damages
Emergency response delay
Critical Infrastructure – water, wastewater, stormwater infrastructure, utilities, stream
Direct Damage
Infrastructure maintenance, repair or replacement
Social Impacts
Public Health - injury and death
Disease *
Mental Health *
Environmental Impacts *
Water Quality issues *
Management Options
Benefit = flood and erosion damage reduction
Life cycle cost
Return on Investment

* Version 2.0

Direct Damages

- Direct Damages are those that occur immediately and can be directly attributed to the flood inundation. They include damage to both public infrastructure and private property (Natural Resources Canada, Public Safety Canada, 2017)
- Physical damage to infrastructure that results in repair or replacement
- RROIT has default unit costs for damage to roadways, railway track, buried utilities, buried pipes, and stream restoration

Indirect Damages

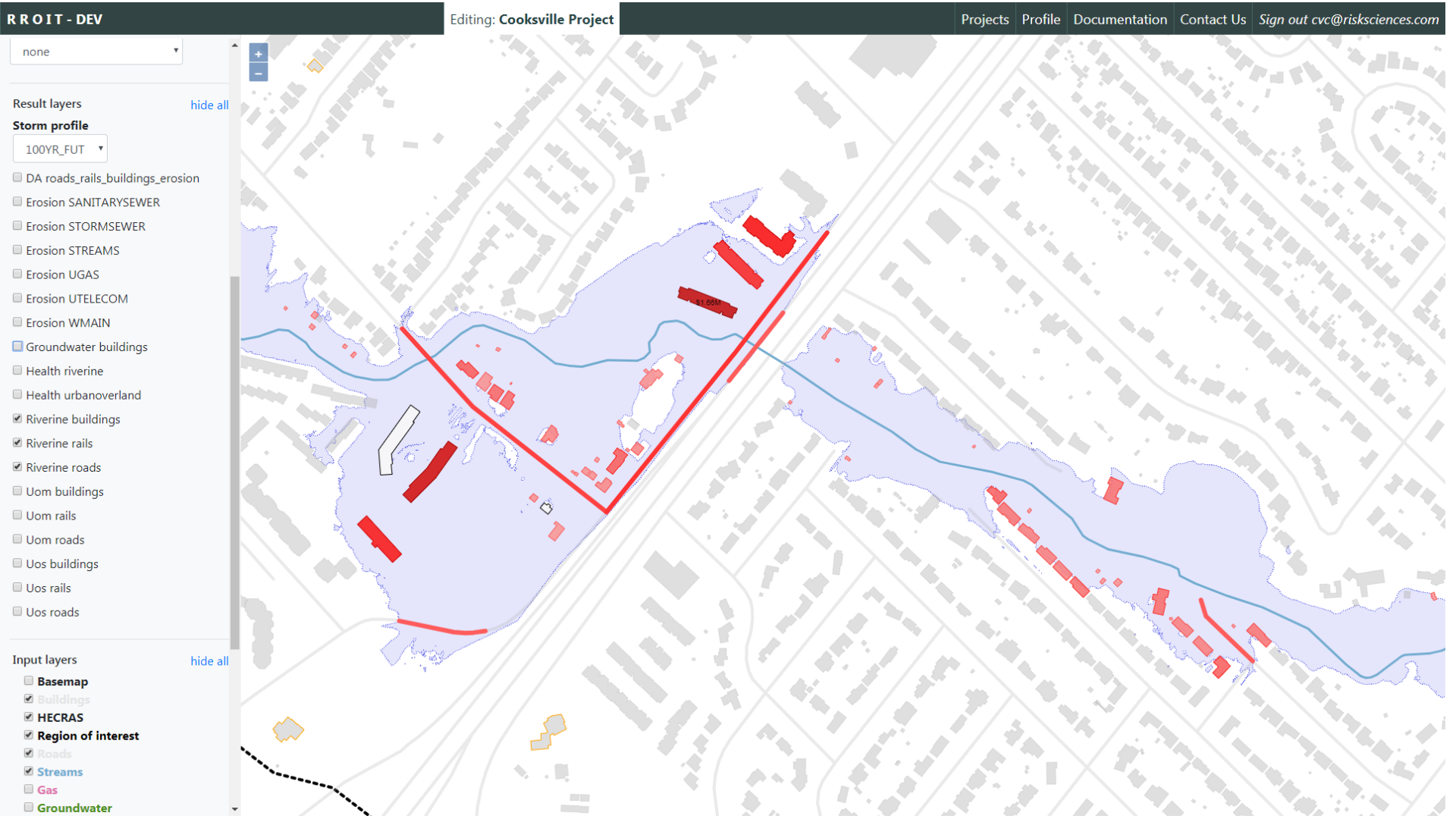
- Indirect damages occur as a result of direct flood impacts but they are also more difficult to quantify. They include reduced economic activity and individual financial hardship, and encompass disruptive impacts, including lost trading time and loss of market demand for products (Natural Resources Canada, Public Safety Canada, 2017)
- RROIT contains relationships built using CatIQ database for Residential Displacement, Loss of Business, Vehicle Damage
- Additional waste management cost is considered as a percentage of Direct Damage Cost

RROIT Inputs

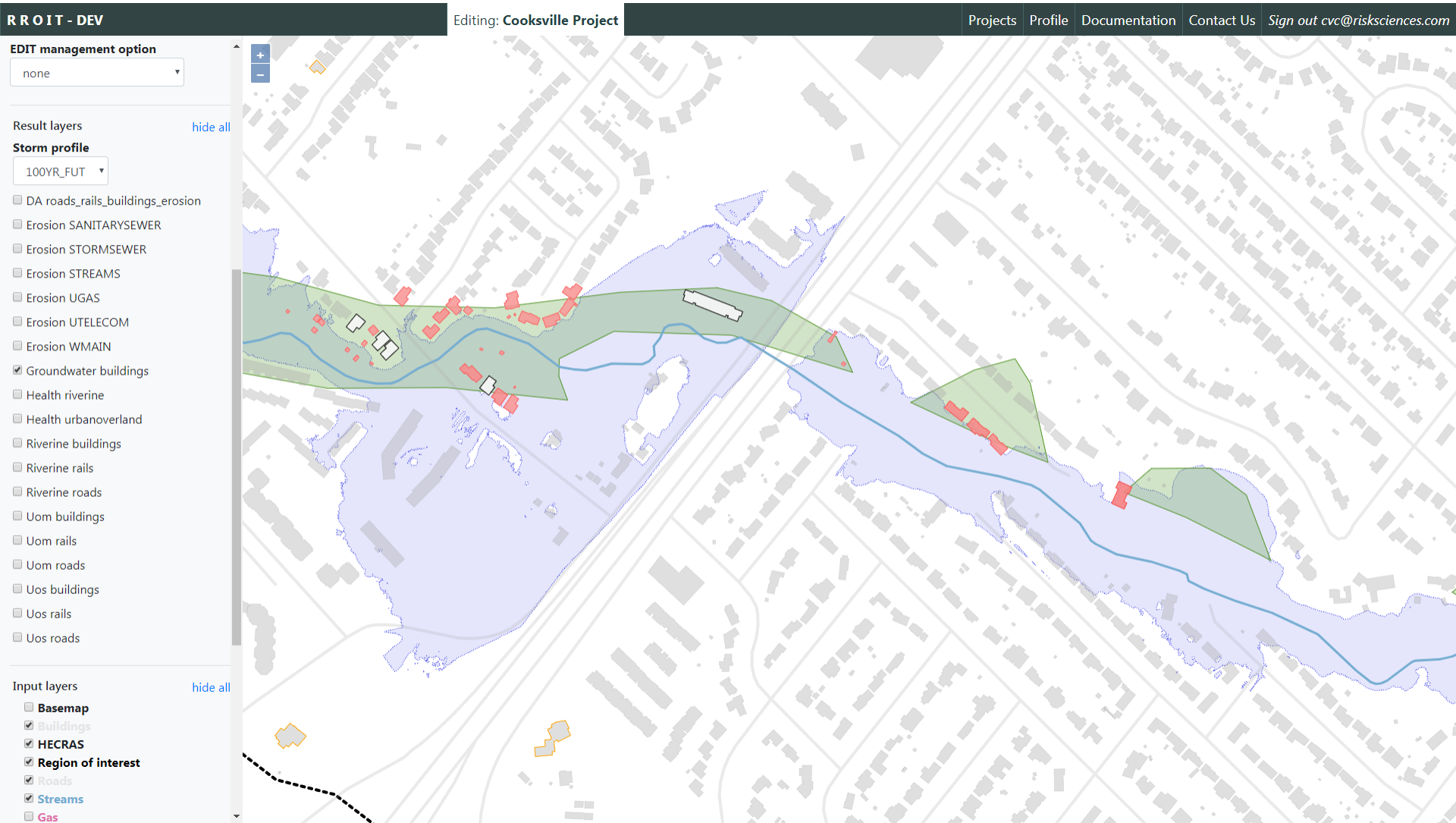
Inputs & Damages	Required	Optional
Digital Elevation Model (DEM)		x
Buildings (categorized into public and vulnerable buildings)	x	
Elevations of buildings where surveyed		x
Stream Network	x	
Road network and classification		x
Floodlines	x	
HEC-RAS files	x	
Stormwater model junctions and subcatchment		x
Overland flood areas		x
Sanitary backup areas	x	
Flood complaints/incidences		x
Surficial geology	x	
Population Demographics	x	
Social Vulnerability mapping	x	
Railway tracks		x
Telecommunication lines		x
Drinking watermain network		x
Drinking water pumping stations		x
Drinking Water Treatment Plant		x
Wastewater pumping station		x
Wastewater collectors (sewer network)		x
Waste Water Treatment Plant		x
Stormwater Sewers		x
Power infrastructure (buried hydro lines)		x
Buried gas lines		x

Tool Outputs

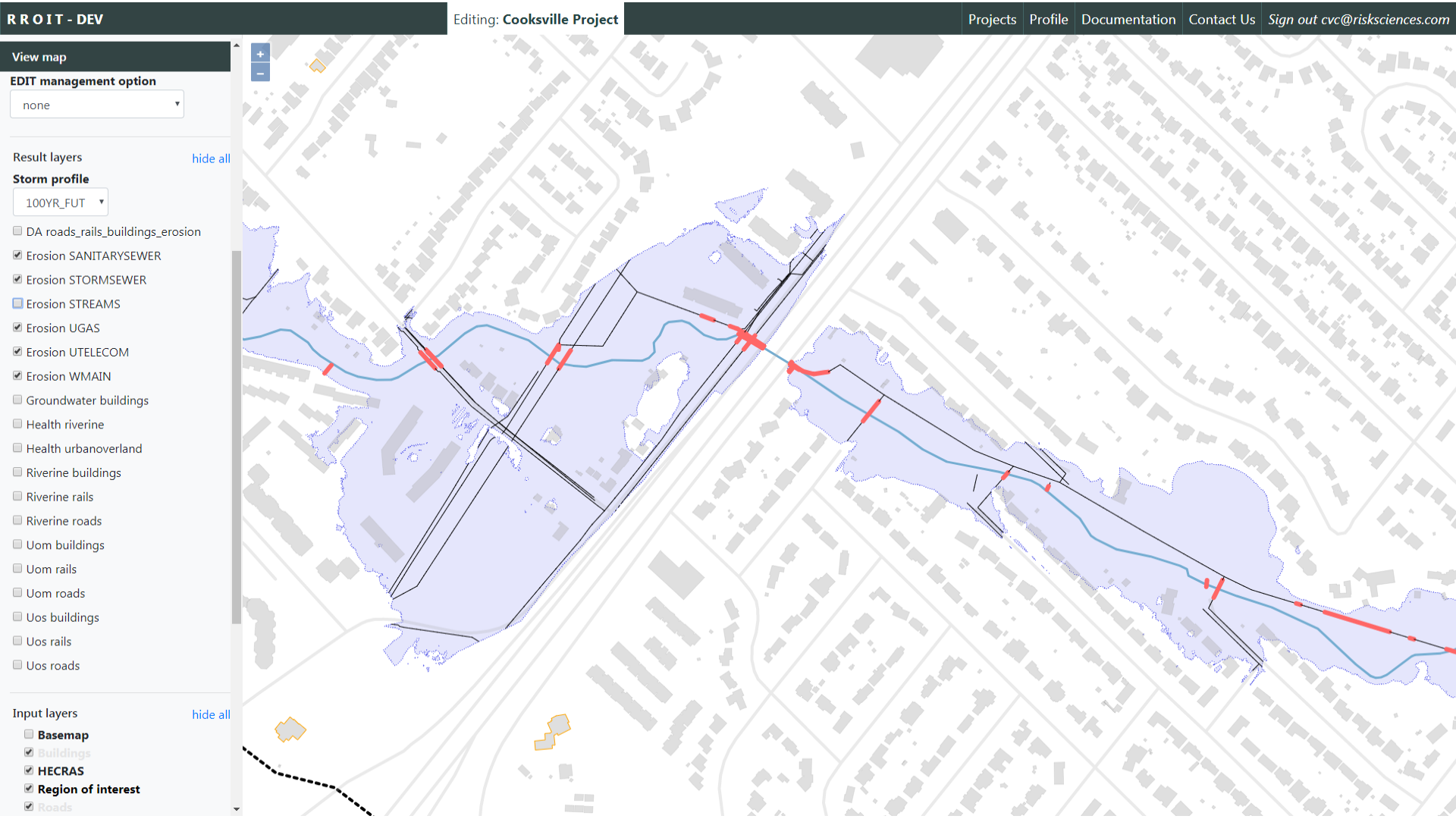
Highlighting all Infrastructure at risk of damage due to Riverine Flooding



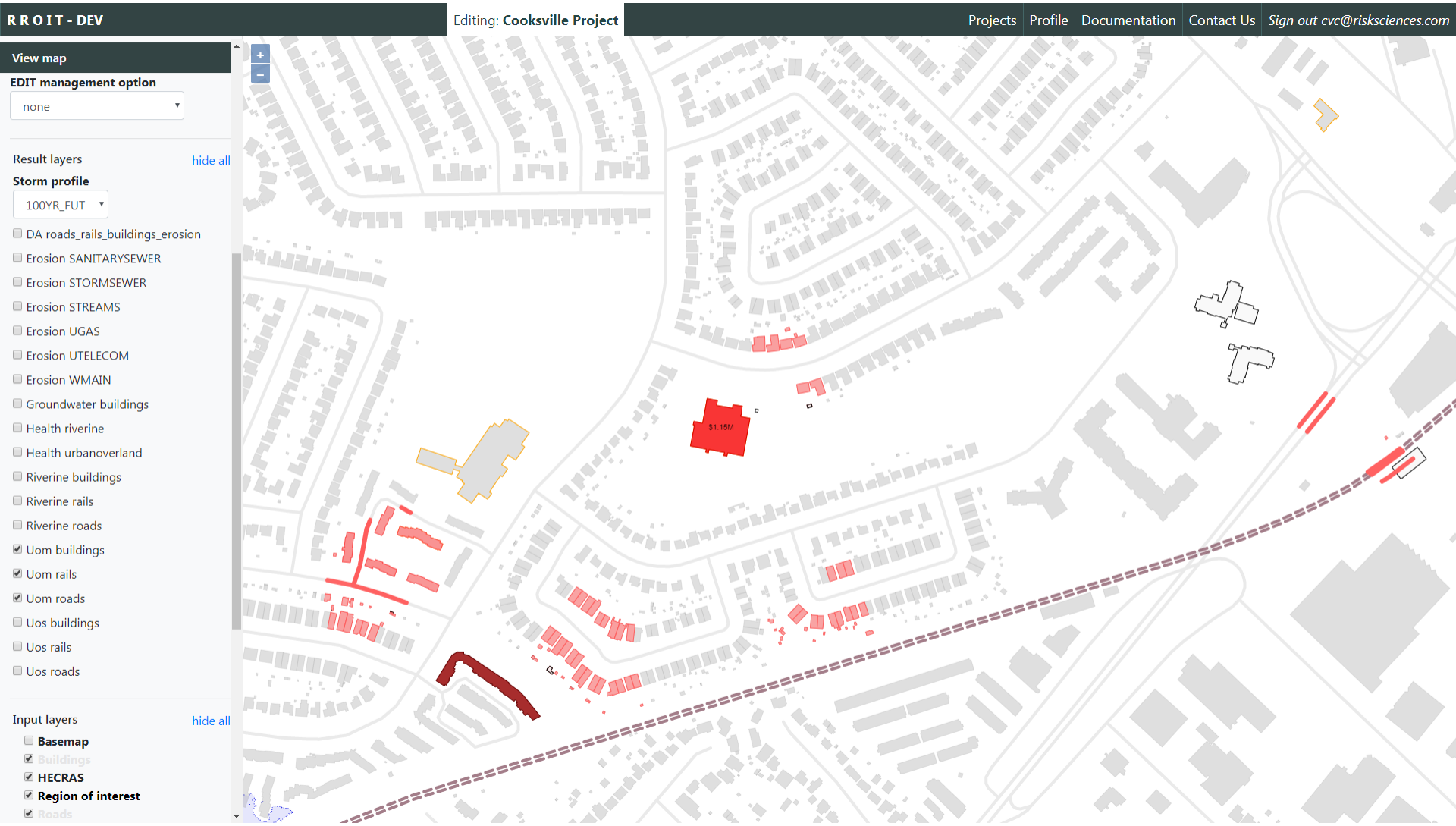
Buildings at risk of Groundwater Flooding due to high water levels in River-connected Alluvial Aquifer



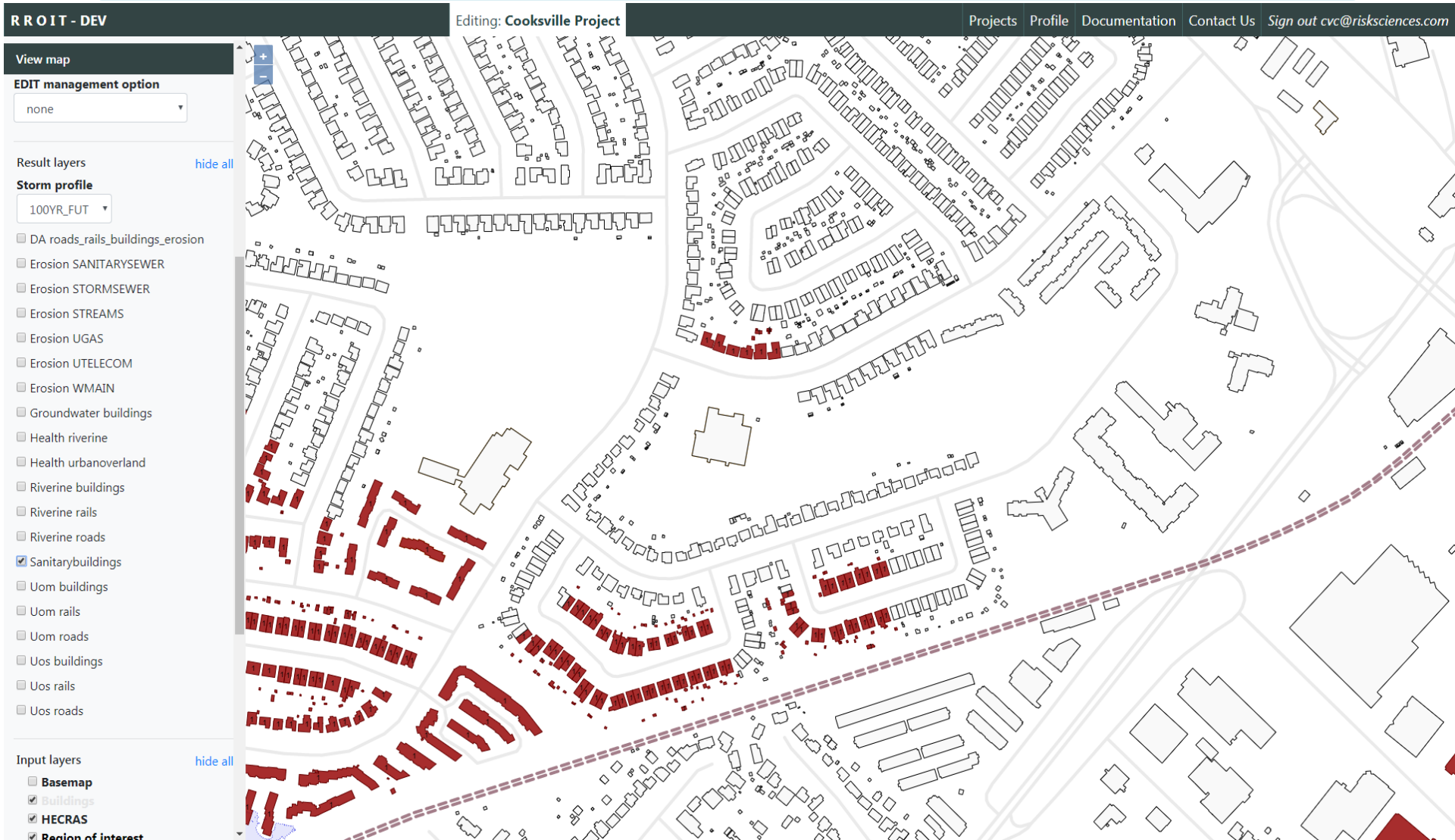
Buried Infrastructure at risk of exposure and damage due to Stream Erosion



Infrastructure at risk of damage from Urban Overland Flooding and Storm Sewer Backup

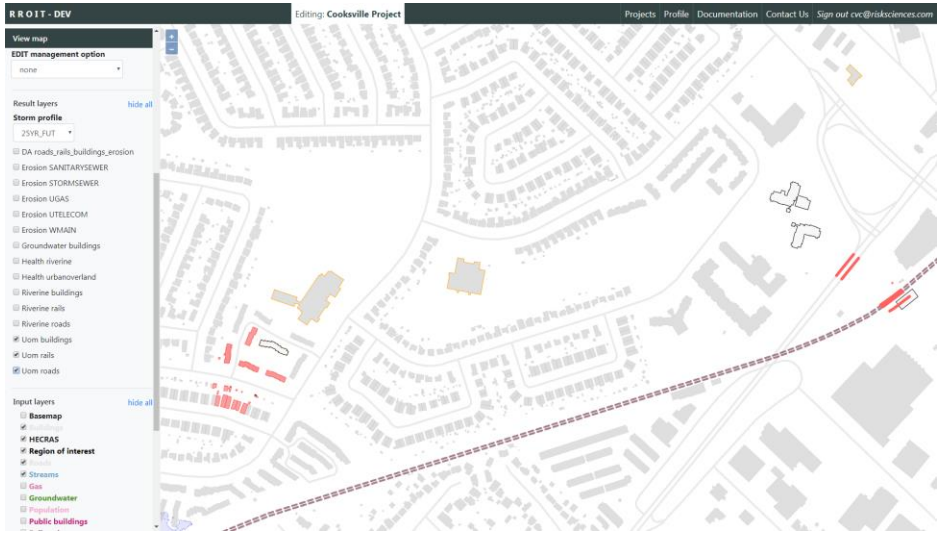


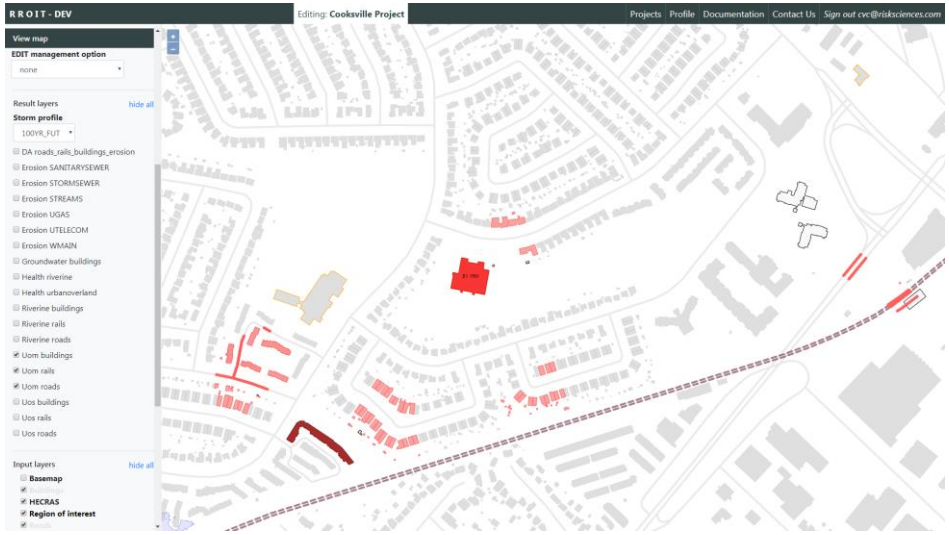
Buildings at risk of Sanitary Sewer Backup Flooding



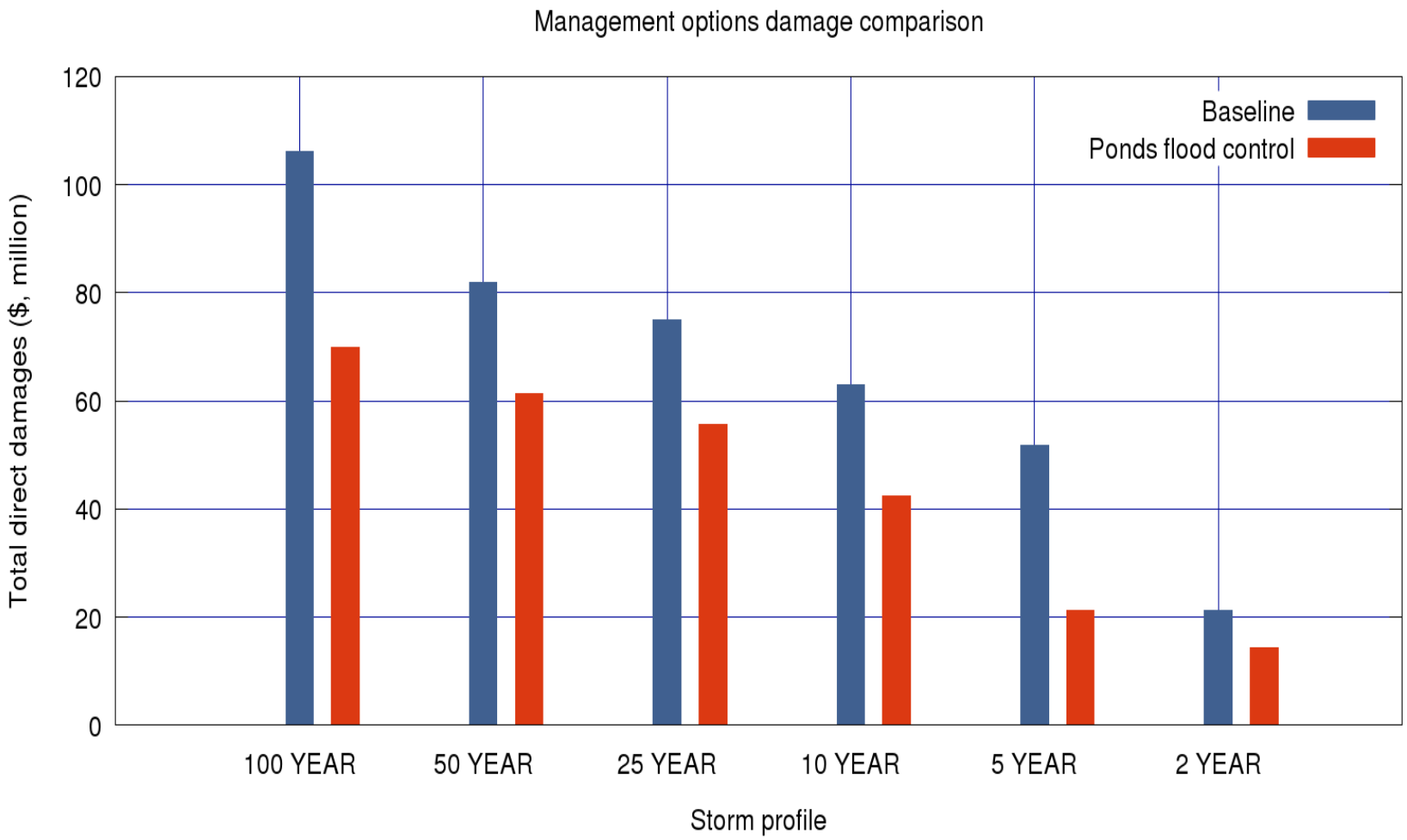
Future Climate Change - Projections

- Existing 25 yr Urban Flooding
- Future 25 yr Urban Flooding



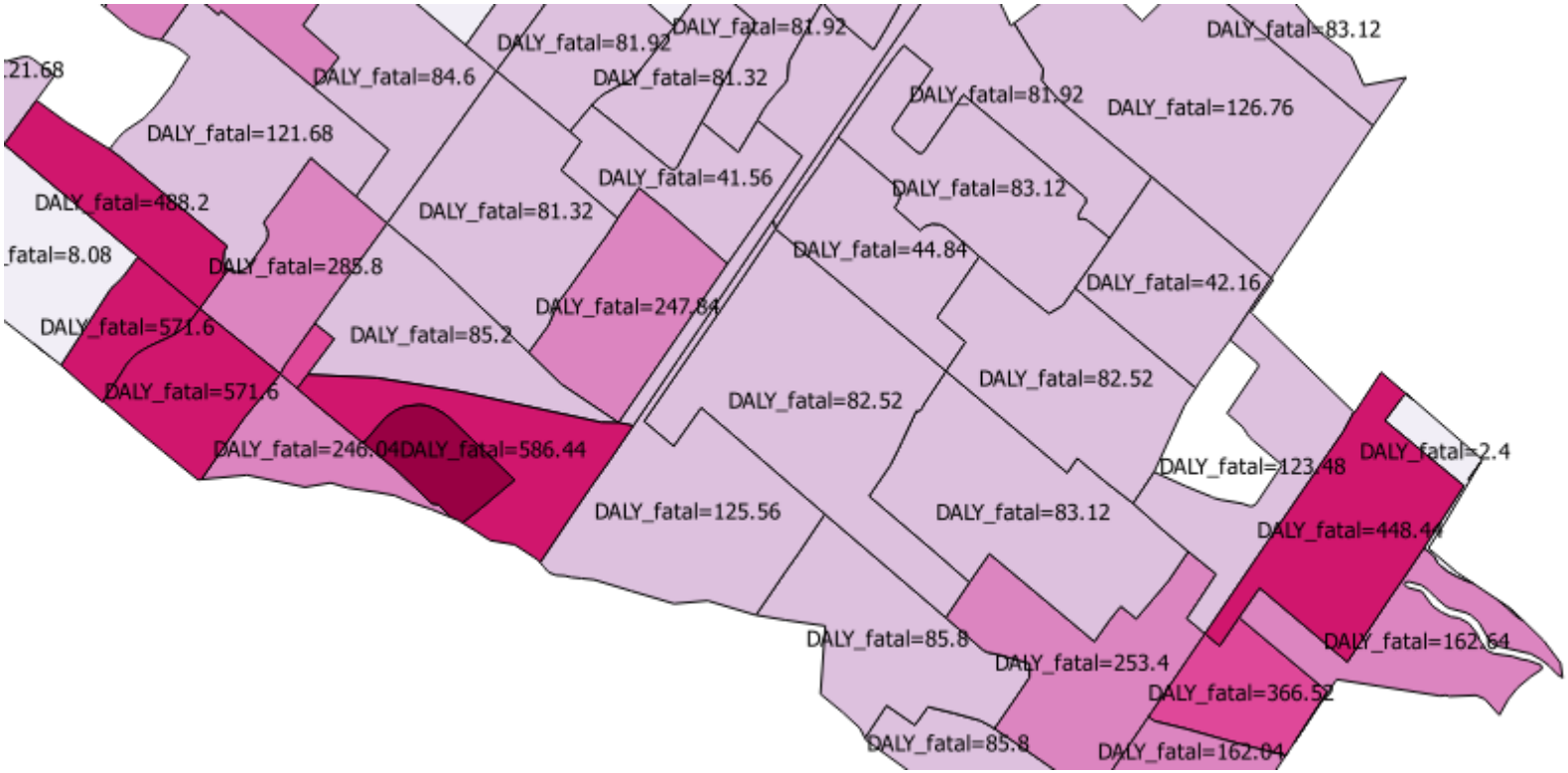


RROIT Output – Impact of Flooding under different management scenarios



RROIT Output - Priority Flood Risk Mapping

RROIT Output – Integrating Social impacts in Risk Assessment and Decision Making



The map above shows the health burden as a result of flooding and prioritizes socially vulnerable areas. The health impacts are determined for census dissemination areas as a function of depth and velocity of the flood event that can potentially result in death and injury.

DALY=Disability Adjusted Life Years is a metric of public health burden designed to capture both fatal and non-fatal outcomes, by expressing non-fatal outcomes in terms of partial years of life “lost” to disability.

RROIT Output – Financial Metrics

Metric	Baseline Climate	Future Climate
Potential Annual Damages (baseline)	$20.8 million	$49.8 million
Potential Annual Damages (SWM ponds)	$13.5 million	$33.2 million
Total Management Expenditure	$ 85.8 million	
Net Present Value *Damaged Averted	$69.4 million	$261 million
Internal Rate of Return	10.6%	30.0%
Payback Period	13.3 years	7.6 years

Integrating Damages from different return period storms

Total Annual Damages for baseline

Reduced Total Annual Damages with SWM ponds

Total Lifecycle Costs for SWMPs including Capital costs and O&M

NPV = Cash Inflow – Cash Outflow
** Should be a positive value*

IRR = Interest rate to result in NPV
** Should be > 3%*

PP = # of years until investment cost is covered through cash flows generated

RROIT Output: Return on Investment for different management scenarios

Management Option	Historical Climate	Future Climate (2040)
SWM Ponds + Land Acquisition	6.2%	18.8%
SWM Ponds + Land Acquisition + 20% uniform uptake of LID	5.4%	18.1%
SWM Ponds + Land Acquisition + 10% uptake by Industrial and Commercial*	5.8%	18.4%
SWM Ponds + Land Acquisition + Targeted Flood-prone residential areas	**7.7%**	**21.1%**

Partners

Ontario

Public Safety Canada / Sécurité publique Canada

Sustainable Technologies Evaluation Program

Region of Peel
working with you

Health Canada

Town of Caledon

Mississauga

OSWCA
Ontario Sewer & Watermain Construction Association

CatIQ™
www.catIQ.com

RSI

University of Guelph

University of Waterloo

Technical Review Team

Roger Phillips	Aquafor Beech Ltd.
Laura Twidle	Catastrophe Indices and Quantification Inc.
Bert Van Duin	City of Calgary
Chris Tse	City of Calgary
Deighen Blakely	City of Calgary
Michal Ubar	City of Calgary
Michael Chau	City of Calgary
Greg Frew	City of Mississauga
Muneef Ahmad	City of Mississauga
Amanjot Singh	Credit Valley Conservation
Christine Zimmer	Credit Valley Conservation
Gayle SooChan	Credit Valley Conservation
Tim Mereu	Credit Valley Conservation
Farshad Salehzadeh	Region of Peel - Water and Wastewater Infrastructure Planning
Imran Motala	Region of Peel - Water and Wastewater Infrastructure Planning
Louise Aubin	Region of Peel – Public Health
Mark Knuckle	Region of Peel
Syeda Banuri	Region of Peel – Transportation and Public Works
Adam Irawan	Risk Sciences International
Todd Ruthman	Risk Sciences International
Imtiaz Shah	Upper Thames River Conservation Authority
Hugh Whiteley	University of Guelph
Ed McBean	University of Guelph

inspired by nature

TRIECA 2019 CONFERENCE

Thank you to our sponsors:

www.trieca.com

GOLD SPONSORS

AECOM

Credit Valley Conservation
inspired by nature

Stantec

AQUATECH

armtec
CANADACULVERT

CIVICA
Water Management Solutions

J. Lipani Turf

CROZIER
CONSULTING ENGINEERS

terrafix
geosynthetics inc.

UNILOCK
DESIGNED TO CONNECT.

GEMS

Hydro International

R&M
CONSTRUCTION

filtrexx
CANADA
let nature do it.

Profile
Solutions for your Environment

Lake Simcoe Region
conservation authority

York Region

MEDIA SPONSORS

Environmental Science & Engineering
MAGAZINE

WATER CANADA

PRINT SPONSOR

WARREN'S
WATERLESS PRINTING INC.

HOSTS

CANIECA
CANADIAN CHAPTER

Toronto and Region
Conservation
Authority