Climate Resilient Transit Infrastructure Systems: Metrolinx and Flood Risk

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METROLINX

Mission

We connect our communities

Vision

Getting you there better, faster and easier

Values

Play as a team

Think forward

Serve with passion

REGIONAL TRANSIT NETWORK

LEGEND

- ▬ Subway
- ▬ Light Rail Transit (LRT)
- ▬ Bus Rapid Transit (BRT) / Regional Express Bus
- ▬ GO Rail - 15-min Two-Way All-Day
- ▬ GO Rail - Two-Way All-Day
- ▬ GO Rail - Peak Only
- ▬ UP Express

* map includes existing and in delivery rapid transit projects

OUR SERVICES

- Serve a population of more than seven million across more than 11,000 square km stretching from Hamilton and Kitchener-Waterloo in the west to Newcastle and Peterborough in the east, and from Orangeville and Beaverton in the north to Niagara Falls in the south.
- In operation since 1967, GO now accommodates more than 70 million customer journeys a year.

- PRESTO is the smart card fare payment system seamlessly connecting 11 transit agencies across the GTHA and Ottawa.
- PRESTO replaces the need for tickets, tokens, passes or cash and always gets you the lowest fare.
- Later this year we're launching PRESTO Mobile that will allow thousands of customers to load funds and passes onto their cards, often with no wait times.

- UP Express connects the country's two busiest transportation hubs: Toronto Pearson International Airport and Union Station in downtown Toronto, offering a 25-minute journey from end to end, with trains departing every 15 minutes.

BY THE NUMBERS 2018

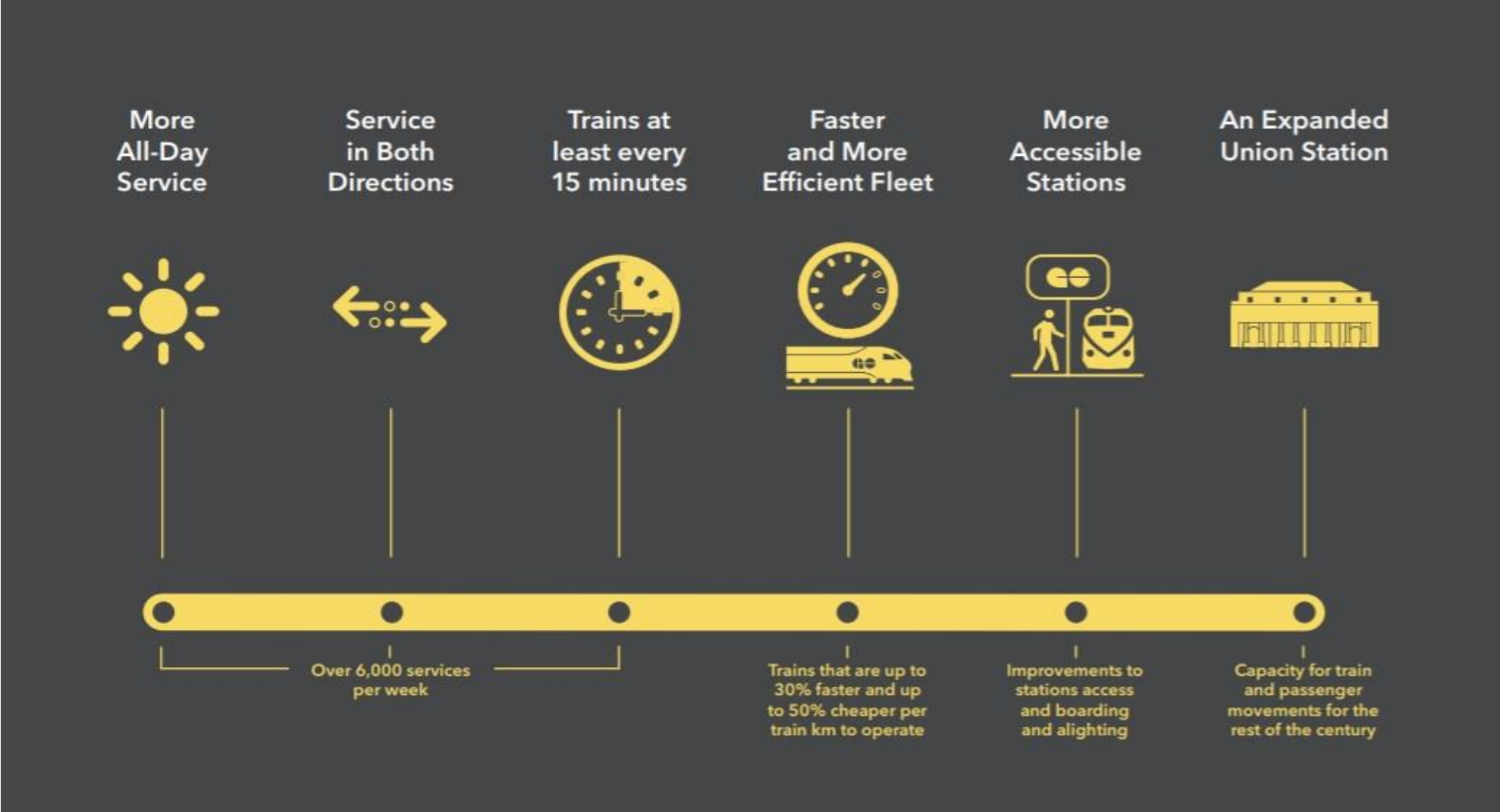|	GO RAIL	GO BUS	UP EXPRESS	PRESTO
RIDERSHIP/ CUSTOMER*	**56.5** million/yr 3.2% INCREASE **1968** Weekly Trips 15% INCREASE	**16.7** million/yr 0.9% DECREASE** **13,939** Weekly Trips 0.7% DECREASE	**3.5** million/yr 26.8% INCREASE **1,120** Weekly Trips 1.3% INCREASE	**2.2** million users **1 million** Daily Taps **349** million annual taps 36% INCREASE
PERFORMANCE	94%***	94.5%***	98.3%***	97.6%****
CUSTOMER SATISFACTION	77%	77%	72%	76%
LIKELY TO RECOMMEND	78%	78%	80%	83%

* The percentage difference for ridership/customers are a year-over-year comparison from 2016-17

** The decrease in bus ridership is due to the shift of customers to new all-day train services and the concurrent removal of train-bus services. The core regional GO bus services saw a ridership growth of 4.3% in the past year.

*** On-time performance

**** Reliability of card readers on the TTC in May 2018

MORE GO TRAINS, LRTS AND BUSES ACROSS THE REGION

More
All-Day
Service

Service
in Both
Directions

Trains at
least every
15 minutes

Faster
and More
Efficient Fleet

More
Accessible
Stations

An Expanded
Union Station

Over 6,000 services
per week

Trains that are up to
30% faster and up
to 50% cheaper per
train km to operate

Improvements to
stations access
and boarding
and alighting

Capacity for train
and passenger
movements for the
rest of the century

JULY 8TH 2013: A SEVERE WAKE UP CALL

BEST PRACTICES AND LESSONS LEARNED FROM THE UNITED STATES

BEST PRACTICES: MAPPING SEA LEVEL RISE AND STORM SURGES ALONG COASTAL REGIONS

Figure 2-8
Impacts of Sea-Level Rise on Public Transportation in Alameda Study Region of San Francisco Bay Area
Courtesy of Metropolitan Transportation Commission

Source: BCDC, Pacific Institute, AECOM, Georgrafika Consulting

San Francisco

Figure 2-10
Fixed Transit Guideways at Risk from Storm Surge at Elevations Currently Below 18 feet, Houston and Galveston, TX

Source: U.S. Department of Transportation, Impacts of Climate Change and Variability on Transportation Systems and Infrastructure: Gulf Coast Study, 2008
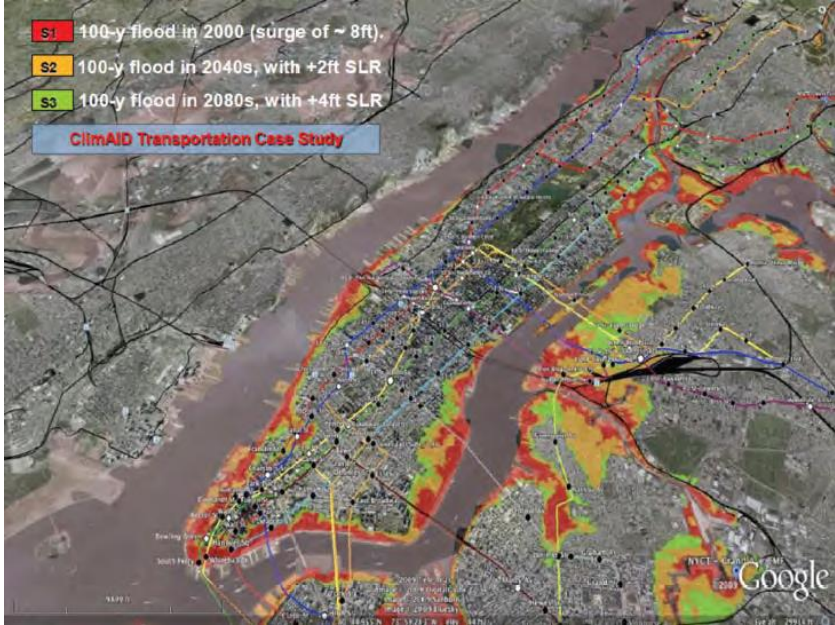
Houston
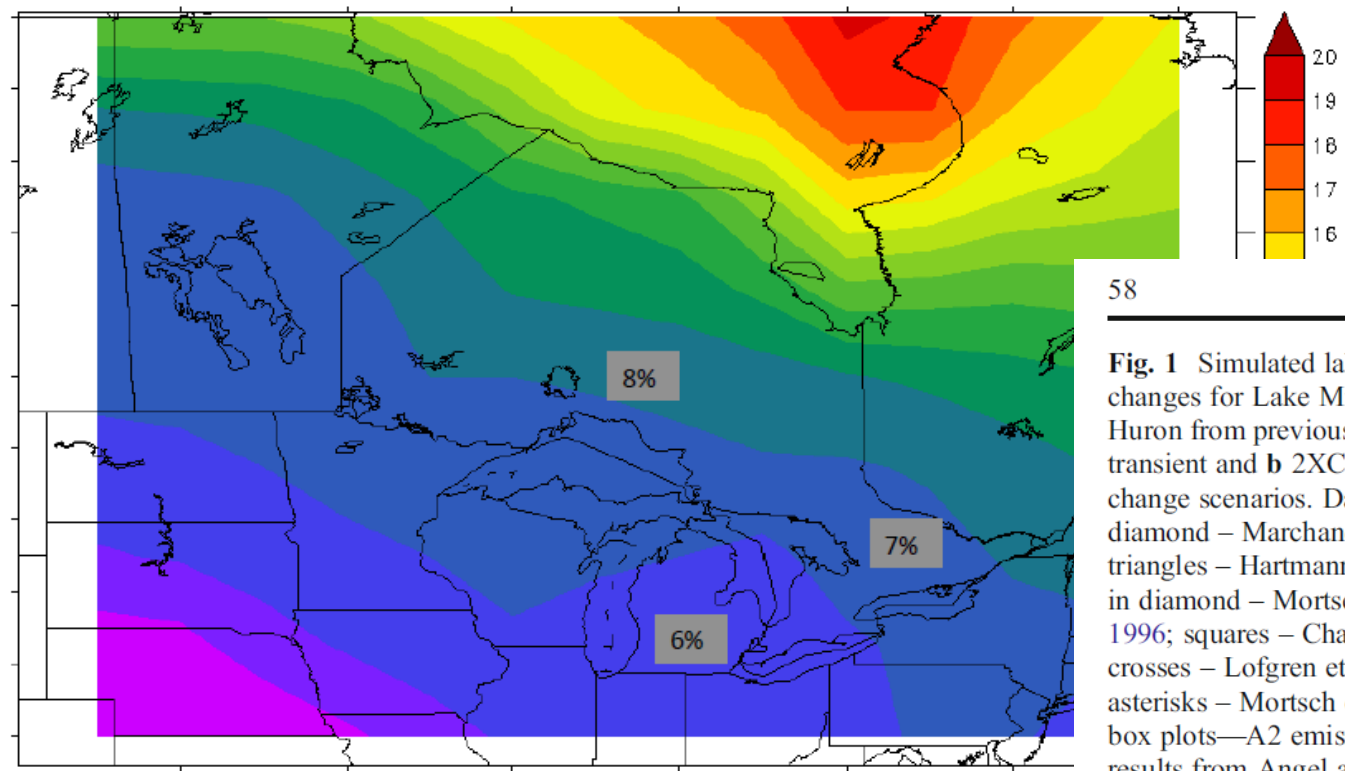
Figure 2-12: New York City Vulnerability to 2 to 4 feet of Sea-Level Rise with 100-year Storm Surge

New York City

CLIMATE RESILIENT TRANSIT INFRASTRUCTURE SYSTEMS: METROLINX AND FLOOD RISK

GREAT LAKES: LAKE LEVEL RISE AND STORM SURGES NOT AS BIG A CONCERN

Annual Precipitation Change 2041-2070 Compared to Baseline

Projected Water Levels for LM-H

Fig. 1 Simulated lake level changes for Lake Michigan – Huron from previous studies for **a** transient and **b** 2XCO2 climate change scenarios. Data are from: diamond – Marchand et al. 1988; triangles – Hartmann 1990; Cross in diamond – Mortsch and Quinn 1996; squares – Chao 1999; crosses – Lofgren et al. 2002; asterisks – Mortsch et al. 2006, box plots—A2 emission scenario results from Angel and Kunkel 2010. Box plots indicate median, Inter-quartile range, and 5th and 95th percentiles
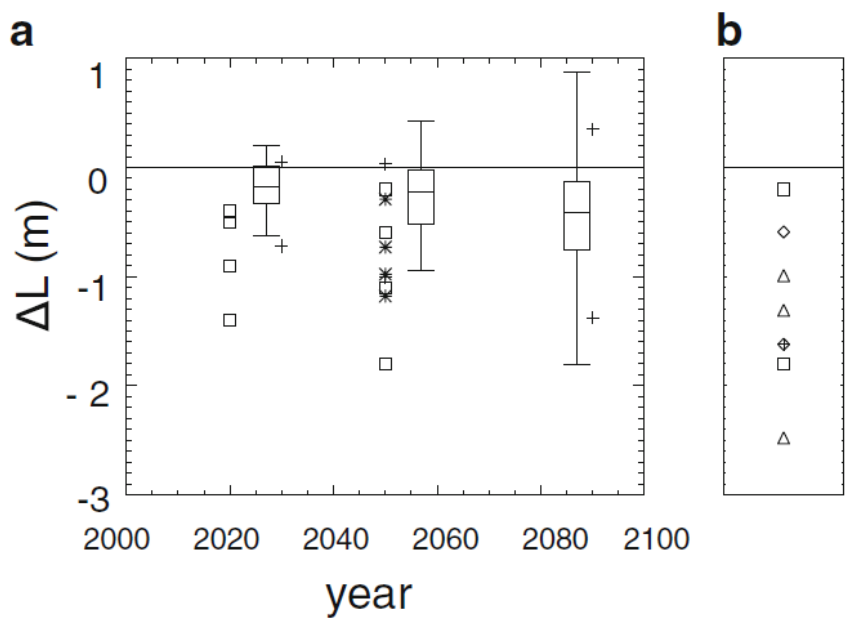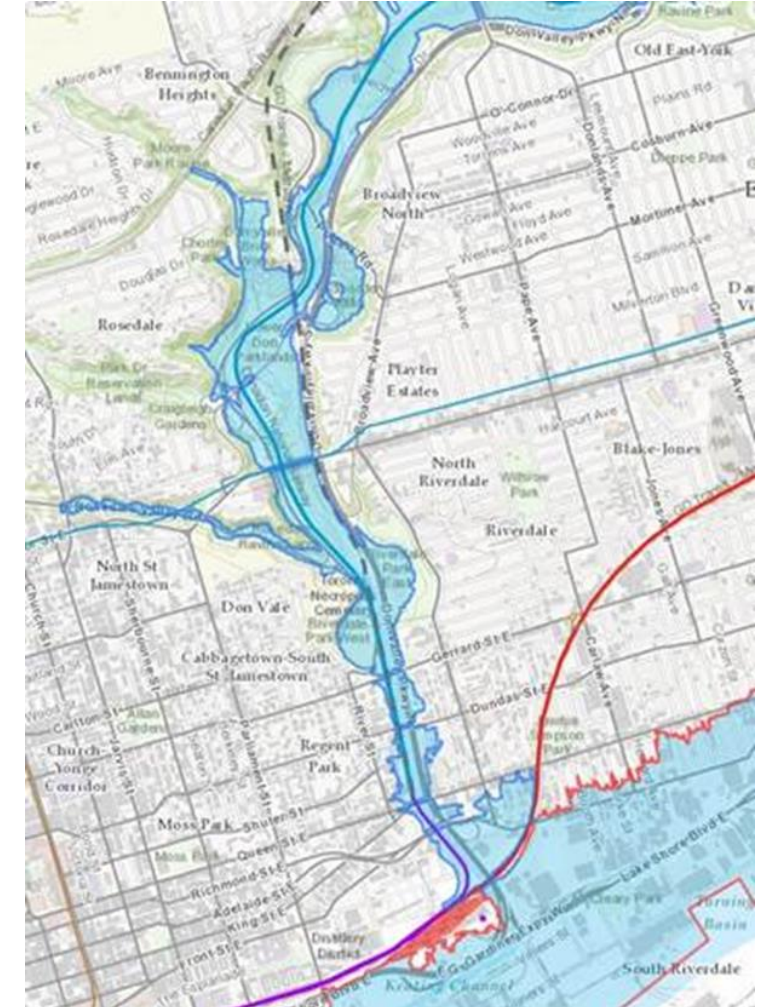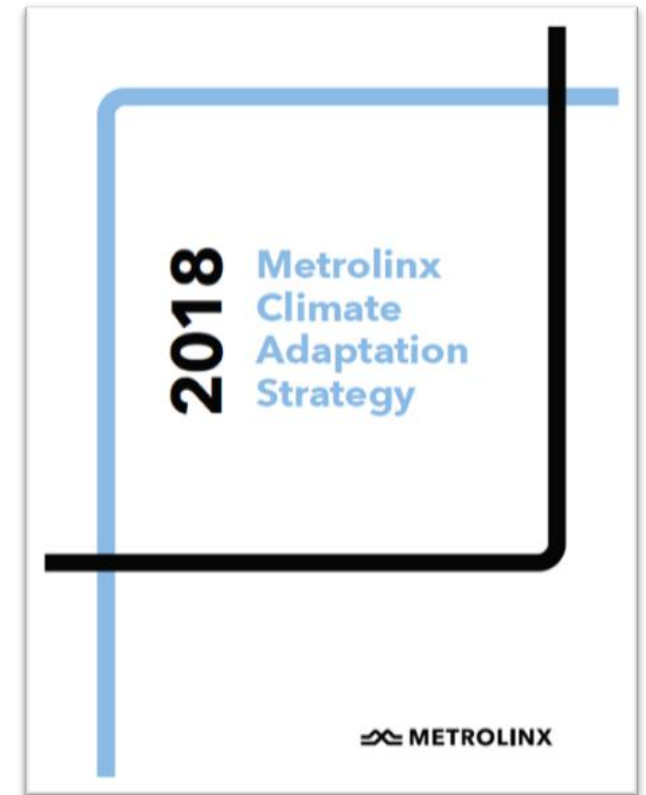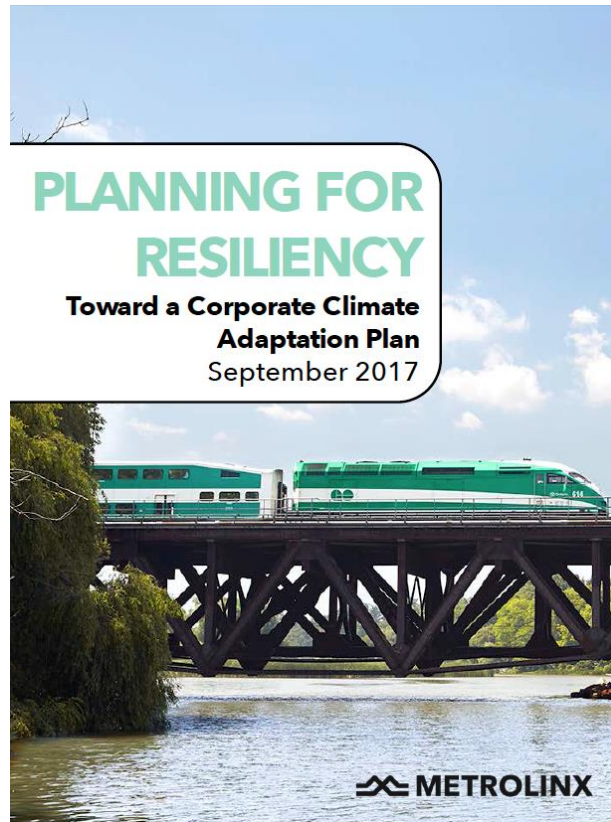
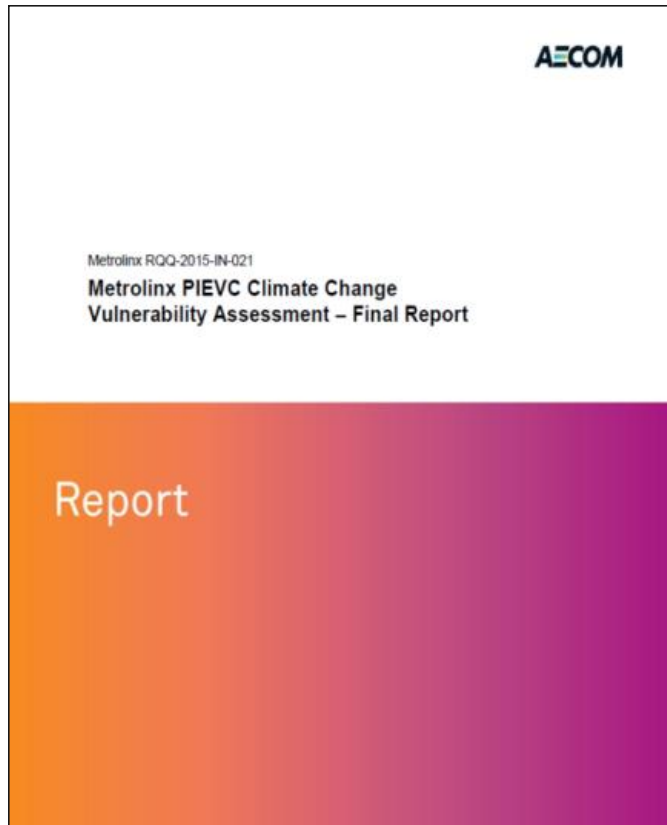# THE RISK TO RIVERINE FLOODING: TRCA EXAMPLE

Mapping of Flood Vulnerable Areas ("Hot Spots")
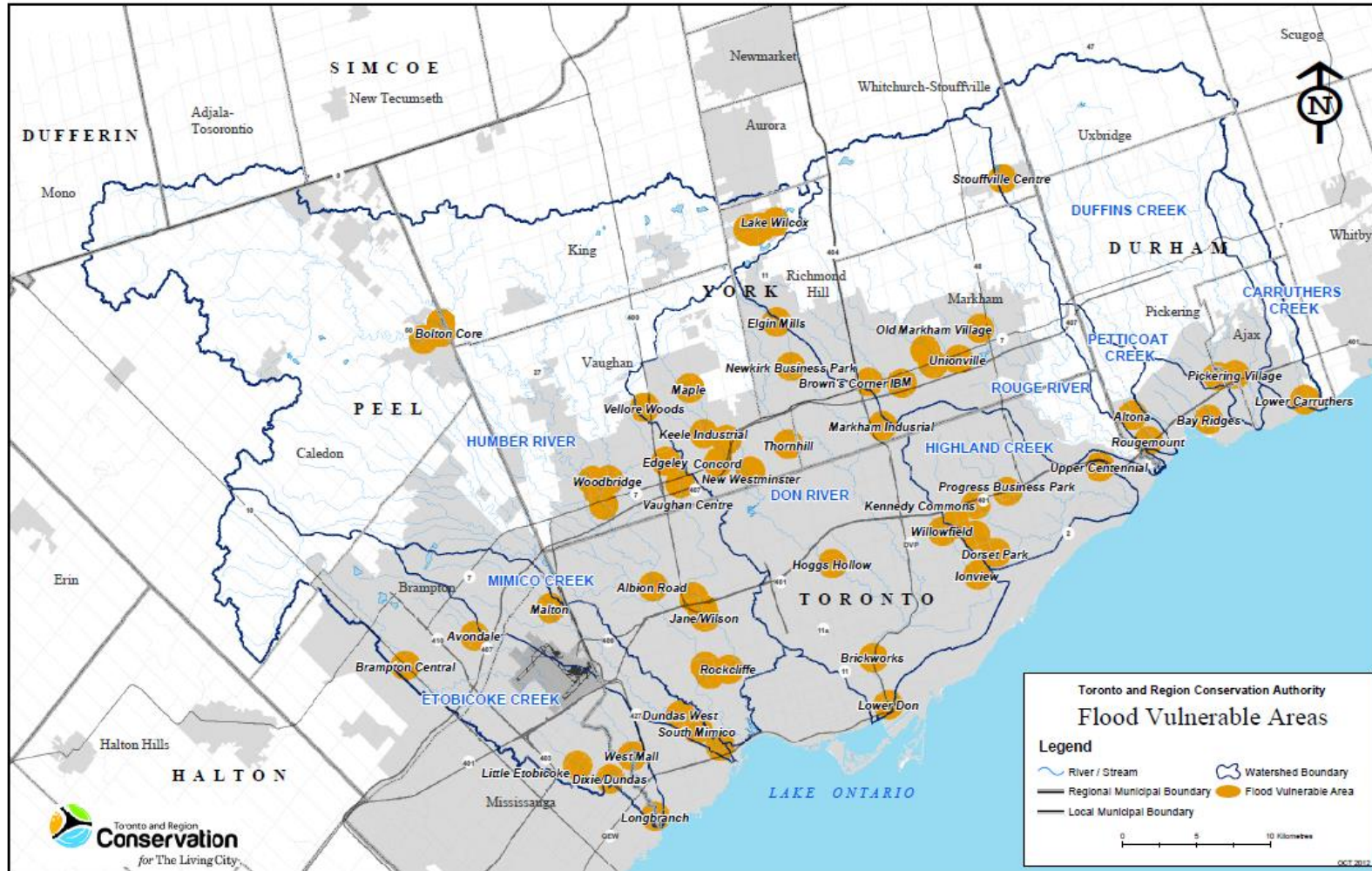
Publically Accessible Flood Maps

METROLINX'S JOURNEY TOWARDS BECOMING CLIMATE RESILIENT

METROLINX CLIMATE ADAPTATION STRATEGY: KEY ACTIONS RELATED TO FLOOD RISK – HIGHLIGHTED IN THE CITY OF TORONTO'S FIRST RESILIENCY STRATEGY

Key Action	Activity	Status
1.3.1 Engage Conservation Authorities to Obtain flood mapping data for the GTHA in GIS format and assess flood risk for existing and planned infrastructure assets across the Metrolinx network	Flood Exposure Study	Completed
1.3.2 Engage municipalities to estimate urban flood risk from different storm events and climate change projections, as well as estimates of the urban heat island effect	City of Toronto Flood Mitigation Working Group Lower Don Flood Mitigation Study	In Progress Kick-Off January 21st, 2019
3.1.2 Prioritize culverts, bridges and embankments most vulnerable to climate extremes for increased monitoring and maintenance	CPG engagement of AECOM, taking projected climate changes in IDF statistics (25% increase)	Completed

# ADDRESSING FLOOD RISK IS A SHARED RESPONSIBILITY

Breaking Down Silos through Partnership

Building resilience is fundamentally about creating and expanding partnerships. To find and implement solutions to Toronto's biggest challenges, we must partner across City divisions, silos, disciplines, and sectors. This image maps out the partnerships the Resilience Office made with 82 organizations to deliver 19 projects as part of creating the Resilience Strategy.

We worked with:
- 27 City divisions, agencies, boards, and corporations
- 33 non-profit organizations
- 13 companies
- 5 universities
- 4 non-City of Toronto government bodies

We used this map to look around the room, ask "who is not here", and invite them to be a part of discussions, plans, and projects on resilience. We challenge resilience leaders across Toronto to do the same.
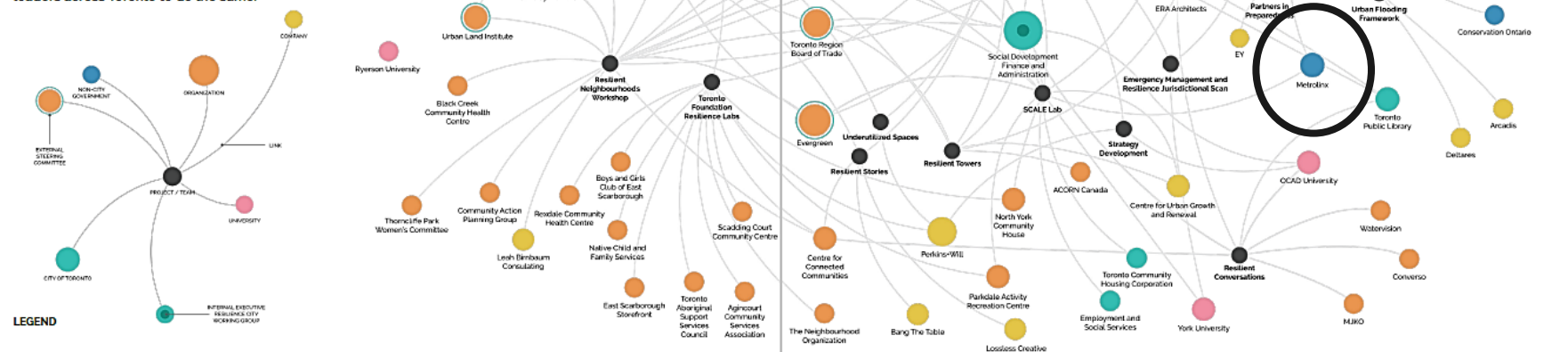
MEMBER OF THE CITY OF TORONTO'S FLOOD RESILIENCE WORKING GROUP

FLOOD RESILIENCE WORKING GROUP

CITY DIVISIONS
- Toronto Water
- Environment and Energy
- City Planning
- Transportation Services
- Engineering and Construction Services
- Toronto Building
- Resilience Office
- Facilities

AGENCIES
- Toronto Transit Commission
- Toronto Hydro

- Metrolinx
- Toronto and Region Conservation Authority

PROVINCIAL MINISTRY/ASSOCIATION
- Ministry of Environment, Conservation and Parks
- Conservation Ontario

PRIVATE SECTOR/ACADEMIA
- Institute for Catastrophic Loss Reduction
- Intact Centre on Climate Adaptation
- University of Toronto

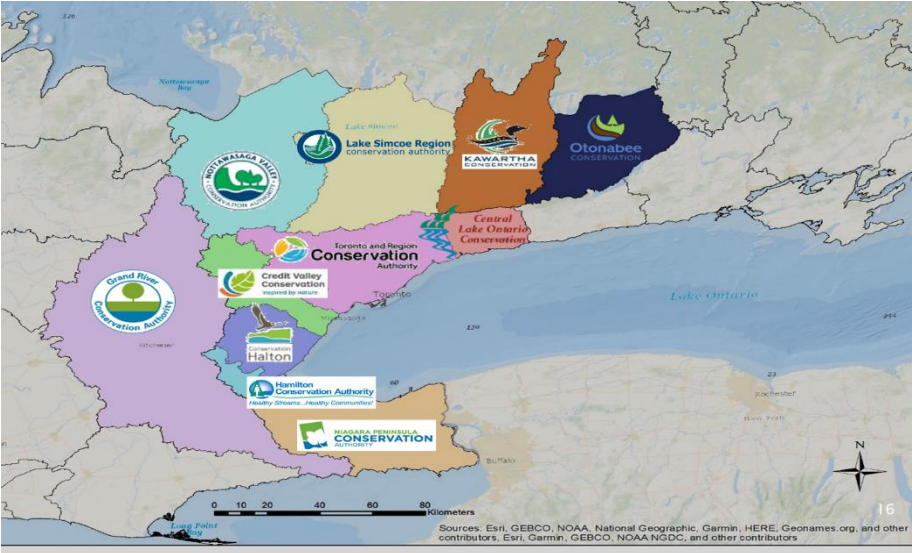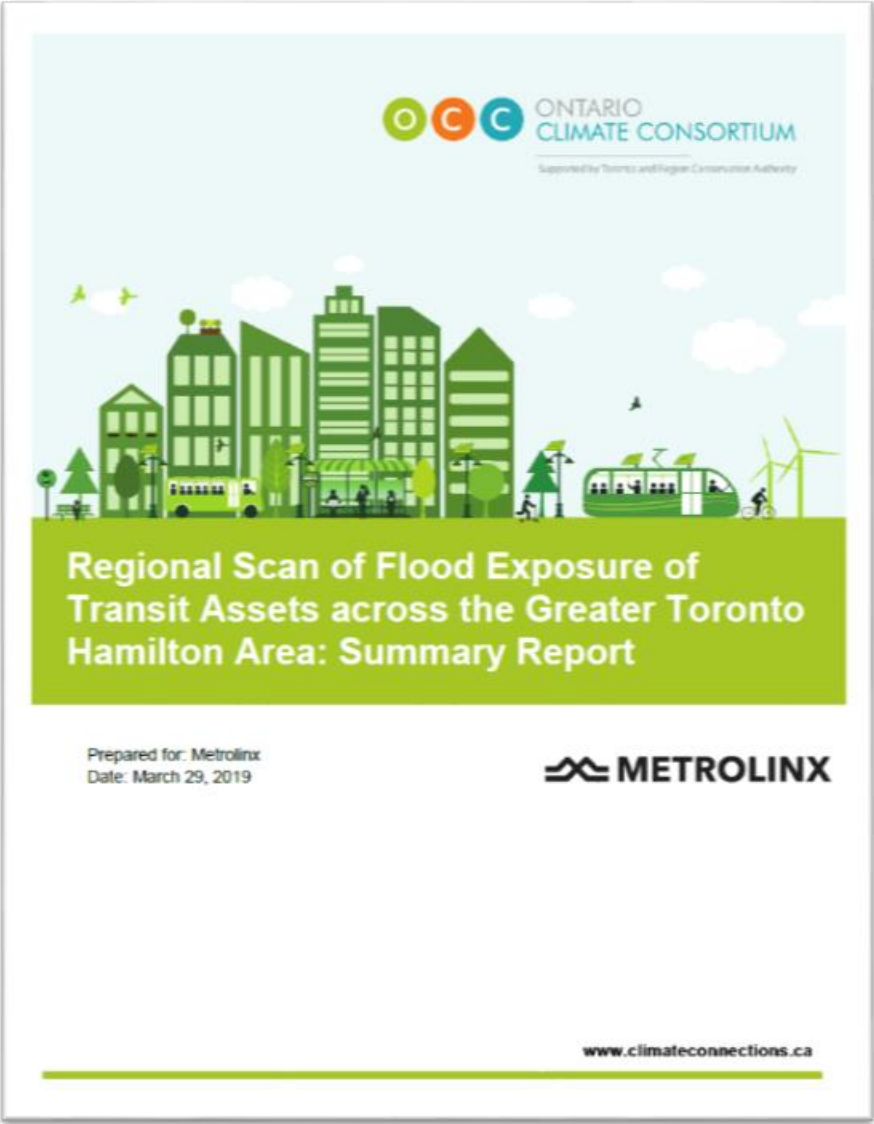# METROLINX IS A SIGNATORY OF THE FLOOD RESILIENT TORONTO CHARTER

FLOOD RESILIENT TORONTO CHARTER

1. Guide city planning, projects and programs based on greatest risk. Risk, taking vulnerability and impact into account, is to be assessed based on a social cost-benefit analysis considering physical flood hazards, social vulnerabilities and critical infrastructure.

2. Use city-wide modelling to identify probability and impact of flooding, and map critical infrastructure, physical and social vulnerabilities. Produce an intuitive map that can be applied by multiple stakeholders.

3. Use risk mapping and forecasting to guide funding and deployment of operational resources. Operations staff and technology should be assigned geographically and funded based on return on investment versus flood risk and achievable level of service.

4. Plan and fund capital projects based on the outputs of flood risk modelling, aligning investment with a social cost-benefit analysis accounting for return on investment and achievable level of service.

5. Encourage new partnerships and innovative technical approaches; shift thinking towards flood resilience.

6. Collaborate locally, nationally and internationally, and demonstrate leadership in flood resilience.

7. Communicate flood risk to the public and stakeholders, and encourage residents and businesses to take action.

INFORMATION TO IMPROVE UNDERSTANDING AND INFORM DECISION MAKING

Type of Flood Risk	Geographical Scope	Assets
Flood Exposure: Riverine Flooding/Regulatory Storm Event	Network Wide	Existing and Future
Flood Risk: Changing Climate	Network Wide	Rail Corridors: culverts, bridges and embankments
Risk from Riverine and Urban/Stormwater Flooding: Changing Climate	Lower Don River	Bala Subdivision/Richmond Hill Rail Corridor
Risk from Urban/Stormwater Flooding: Changing Climate	Downtown Toronto	Union Station
Risk from Urban/Stormwater Flooding and Riverine Spills: Changing Climate	**Network Wide**	**35 Asset Groups Existing and Future**

FLOOD EXPOSURE: EXISTING AND FUTURE ASSETS

Regional Scan of Flood Exposure of Transit Assets across the Greater Toronto Hamilton Area: Summary Report

Prepared for: Metrolinx
Date: March 29, 2019

METROLINX

www.climateconnections.ca

Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org, and other contributors, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Asset Groups and Classes

1. General	4. Structures	6. Right of Way	8. Signals
• Maintenance & Layover Facilities	• Pedestrian Tunnel	• At Grade Crossing	• Wayside Inspection Unit
• GO Train Stations	• Signal Bridge	• Catch Basin	• Warning Device
• Parking Lot	• Retaining Wall	• Ditch	• Hazard Detector
	• Rail Bridge	• Fence	• Switch Machine
2. Power and Communications	• Pedestrian Bridge	• Inlet	• Snow Clearing Device
	• Culvert	• Operation Sign	• Signal Mast
• Traction Power Facility Parcels			• Signal
• Communications Tower			• JU2 (Underground Cable Junction Case)
3. Track	**5. Other**	**7. Mapped but not Tabled**	• Electric Lock
• Track Segmentation (0.1 Mile)	• GO Route	• MX Office Locations	• Ducts
• Turnout	• GO Service Stop	• Generator	• Bungalow
		• Transformer	
		• Wheel Impact Load Detector/Monitor	
		• SCADA Sensor	
		• Pumping Station	
		• Automatic Equipment Reader	

WHAT DOES FLOOD EXPOSURE MAPPING PROVIDE METROLINX?

For historical development

Identify where historical development is exposed to riverine flooding, where enhanced O & M, asset management, and monitoring may be

For future development

Guide future development away from areas where assets will be exposed to riverine flooding

For design standards

GO Design Requirements Manual
GO-DRM-STD-2017-Rev1
January 2017

Identify where increased design standards are required for new infrastructure assets that need to be constructed within the

POTENTIAL USES FOR FLOOD EXPOSURE INFORMATION

- Can quickly inform (triage) what assets may require additional assessment or review based on flooding

- Can guide review of design, O & M plans, and Asset Management Plans to ensure that flood mitigation requirements

  and measures are being applied to assets

  located within the flood plain

- Flood exposure metrics could be used to

  support the business case for reducing

  flood risk in future work

LESSONS LEARNED SO FAR

- Bringing information together in a GIS platform enables useful spatial analysis now and in the future

- Riverine flooding is a starting point for more comprehensive flood risk/vulnerability assessments

- Disseminate flood exposure information among Metrolinx staff as they use, require and interpret information from CAs (e.g. flood plain data)

- Building relationships now will make engagement easier in the future

NEXT STEPS

- Engage GGH Municipalities to assess overland/urban/stormwater flood risk

- Take into account interdependencies

- Address implications for Safety, Infrastructure Investment, Service Delivery

- Consider increased flood risk from a changing climate