An Integrated Approach to become Climate Resilient

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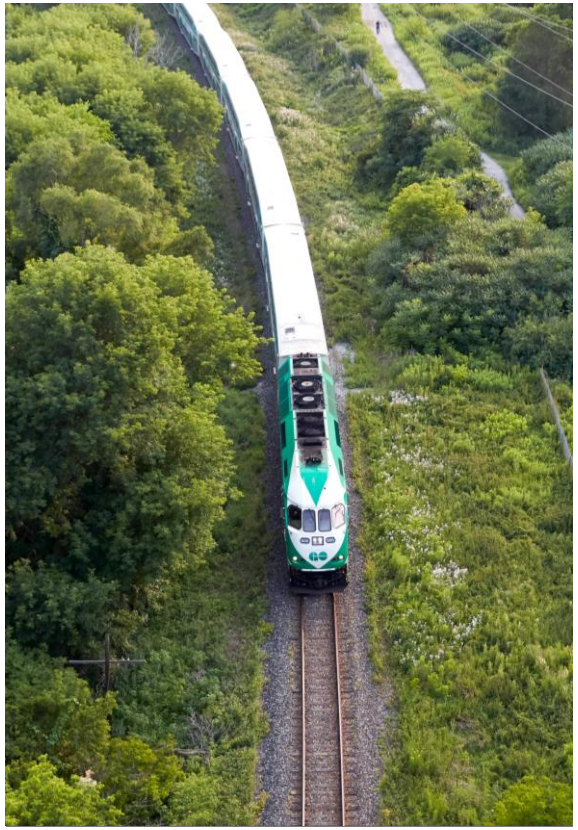
ONTARIO CLIMATE CONSORTIUM CLIMATE DATA TRAINING SESSION

APRIL 26, 2017

WHO IS METROLINX?

Plan

Build



Operate

GO PRESTO UP

Connect

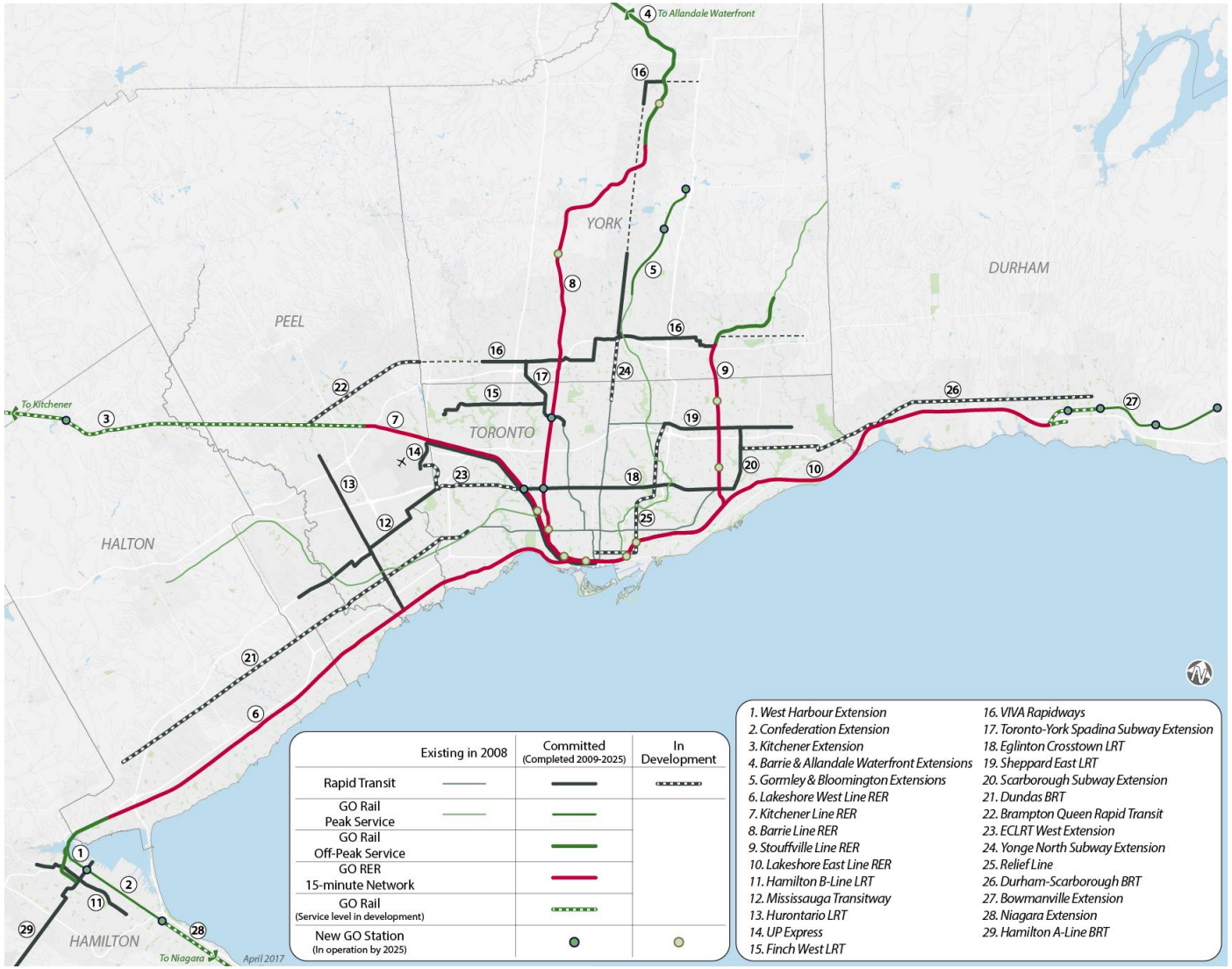
CURRENT SYSTEM AND ASSETS

ASSETS (March 31, 2016)*

Stations:	64
Route kms:	452
Route kms on owned corridor:	366
Active train sets:	52
Locomotives:	75
Bi-Level passenger railcars:	630
Bus Terminals:	15
Single-level buses:	383
Double-decker buses:	127
Parking spaces:	69,217
Park and Ride spaces:	3,418
Parking Structures:	10
Stations with Carpool Parking:	49
UP Express Stations:	4
Route kms:	25
Active train sets:	5
Diesel multiple unit railcars:	18

*2016-2017 Metrolinx Business Plan

REGIONAL TRANSPORTATION PLAN



- Since 2008, Metrolinx has been guided by its Regional Transportation Plan which is a multi-modal, long range plan for the GTHA
- Developed in consultation with municipalities, residents and many stakeholders across the region
- Provides strategic direction for planning, designing and building a regional transportation network that enhances our quality of life, our environment, and our prosperity
- Currently being updated

OVER $30B IN INVESTMENT IN THE GTHA'S RAPID TRANSIT NETWORK

EXPANDING GO TRAIN SERVICE

- **More service** on all lines
- Electric trains, **every 15 minutes or better** in both directions, for most GO customers
- **23 more stations** and **line extensions** to serve new markets

74 KM OF NEW LIGHT RAIL TRANSIT

Under construction:
- **Eglinton Crosstown**

In procurement:
- **Finch West**
- **Hurontario**
- **Hamilton B-Line**

In design / planning:
- **Sheppard East**

68 KM OF NEW BUS RAPID TRANSIT

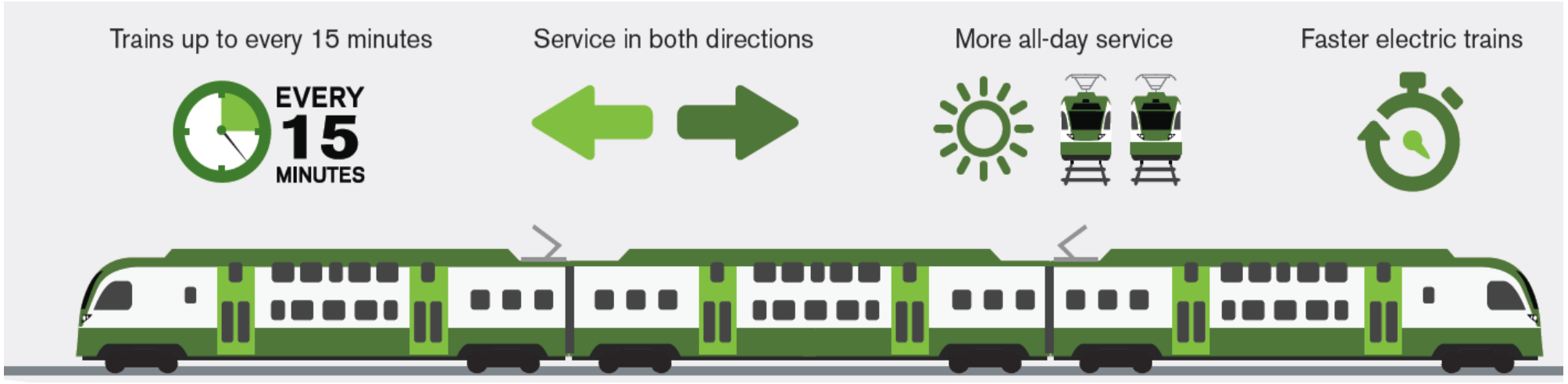
Partially in-service, with remainder under construction:
- **Viva** in York Region
- **Mississauga Transitway**

In design / planning:
- **Hamilton A-Line**

CONNECTING IT ALL TOGETHER

- Expanding and revitalizing **Union Station**, the heart of the regional network
- Completed **PRESTO** deployment on TTC

GO RAIL EXPANSION



- We are transforming GO Rail from primarily a 9-to-5 commuter service to a comprehensive regional transit option
  - Four times the number of trips outside of weekday rush-hour periods, including evenings and weekends
  - Twice the number of trips during weekday rush-hour periods
- Accompanied by electrification, new fleet and new train control technologies
- Over $13.5 billion commitment from provincial government to expand infrastructure to support more service

METROLINX IS EXPERIENCING CLIMATE CHANGE

2013

- 126 mm of rain in 2 hours
- 1,400 passengers stranded on flooded Richmond Hill GO train
- Washouts on Lakeshore W and Richmond Hill

2013

- Ice storm
- Blackouts across GTHA
- Widespread disruption in service

2015

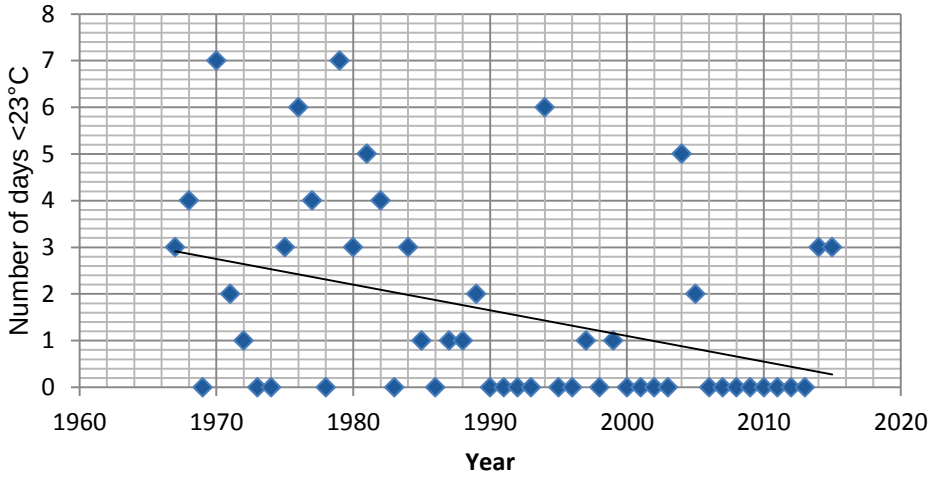
- 22 cm of snowfall overnight
- Widespread disruption in service

2016

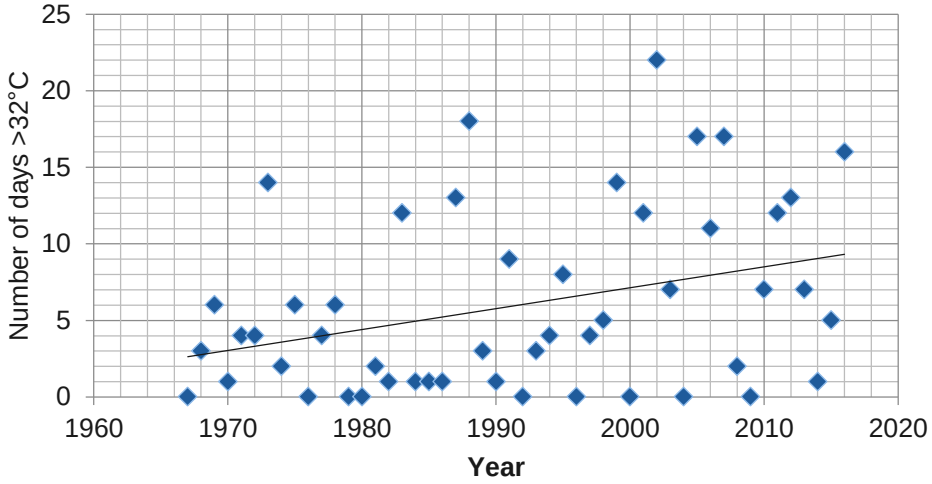
- 16 days >32ºC in 2016, the 5th highest year since 1967
- Risk of track warping, sun kinks and grass fires
- First September when slow order issued

CLIMATE HISTORY AND TRENDS: PAST 50 YEARS

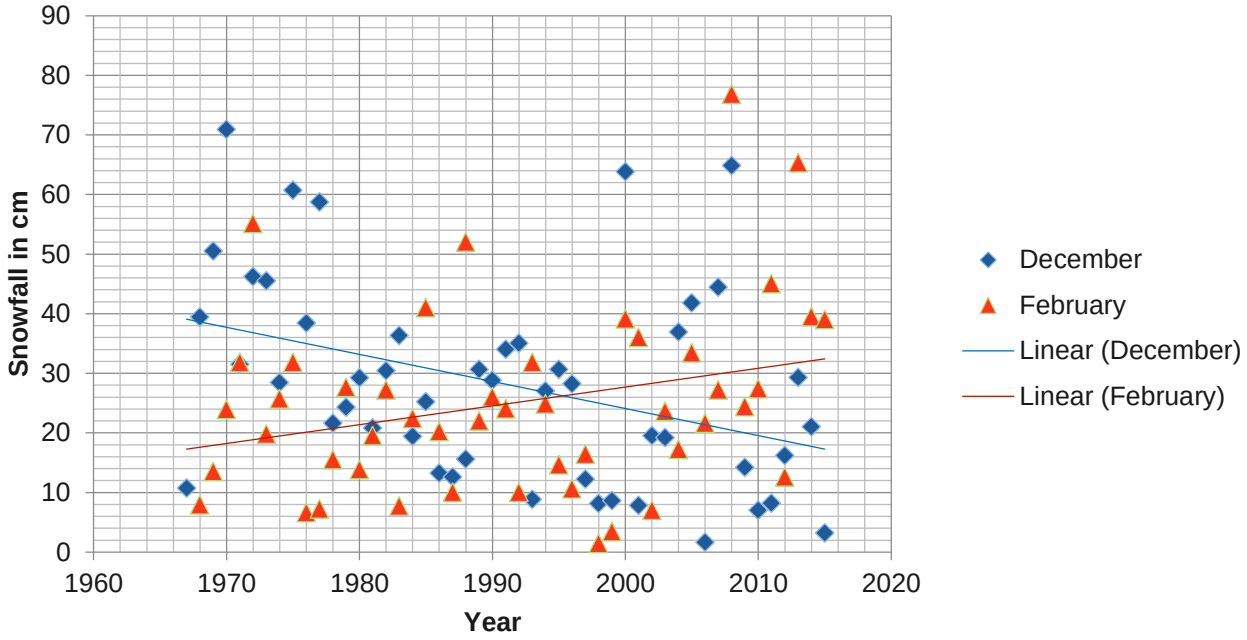
EXTREME COLD TEMPERATURES*



EXTREME HOT TEMPERATURES*



WINTER SNOWFALL*



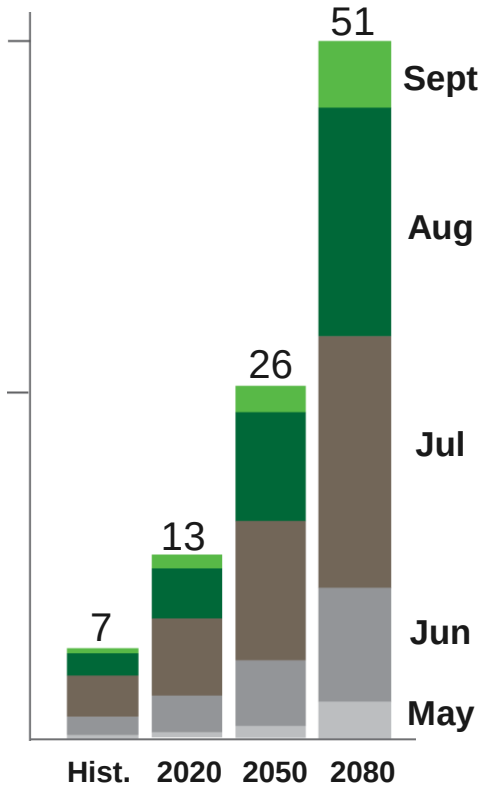
RECORDED FLOOD EVENTS SINCE 1979 ALONG THE LOWER DON RIVER**

1981, 2000, 2011, 2013, 2014, 2015

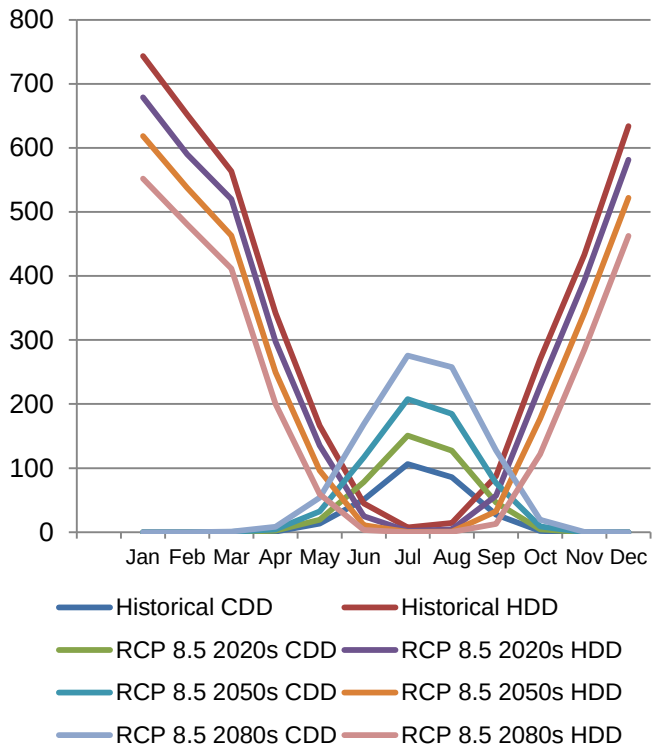
*RSI Climate Change Hazards Information Portal (CCHIP); ** Metrolinx

WHAT TO EXPECT FROM CLIMATE CHANGE*

Number of "Hot Days" (>32°C)**

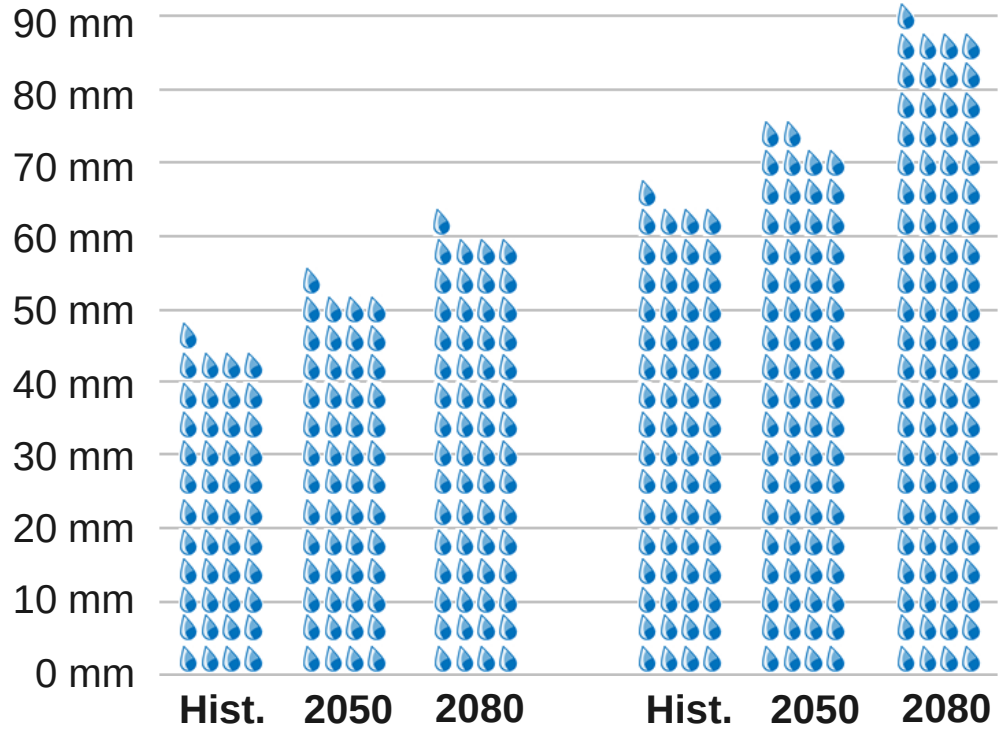


Cooling/Heating Degree Days**



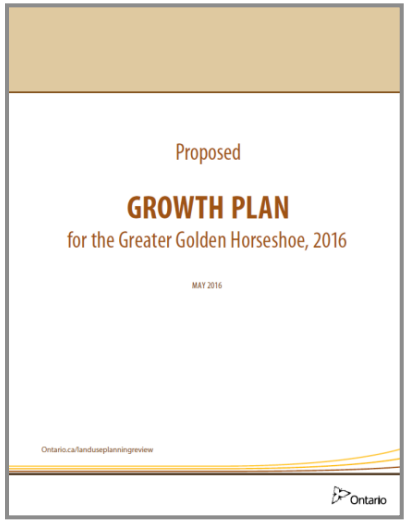
2-hour Rainfall Intensity***

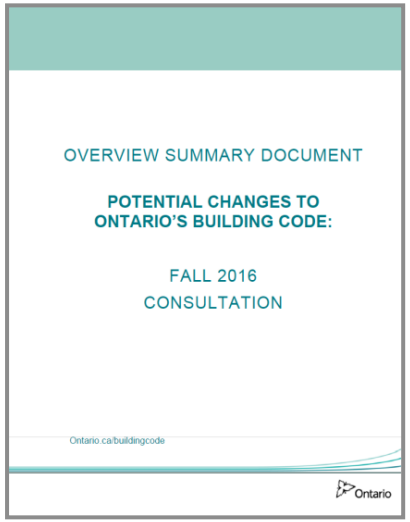
1 in 10-Year Storm

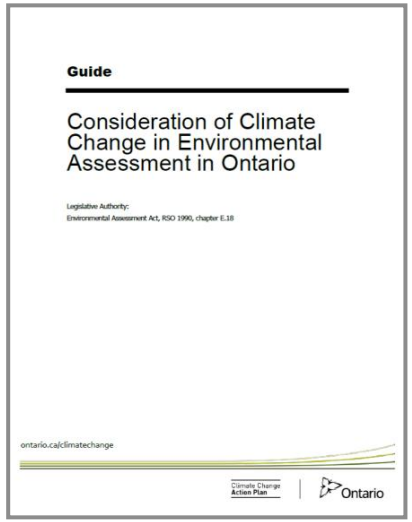


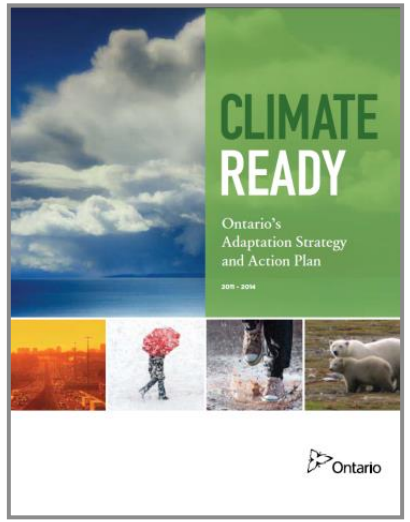
*Based on climate data and projections from Environment Canada, Western University and Risk Sciences International (RSI). **Toronto Pearson International Airport *** Toronto Island Airport

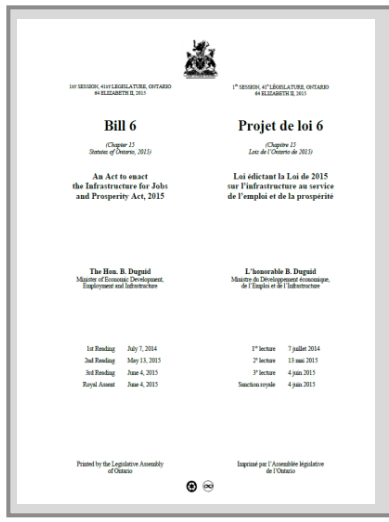
EVOLVING PROVINCIAL POLICY: EXPECTATIONS TO DEMONSTRATE RESILIENCY







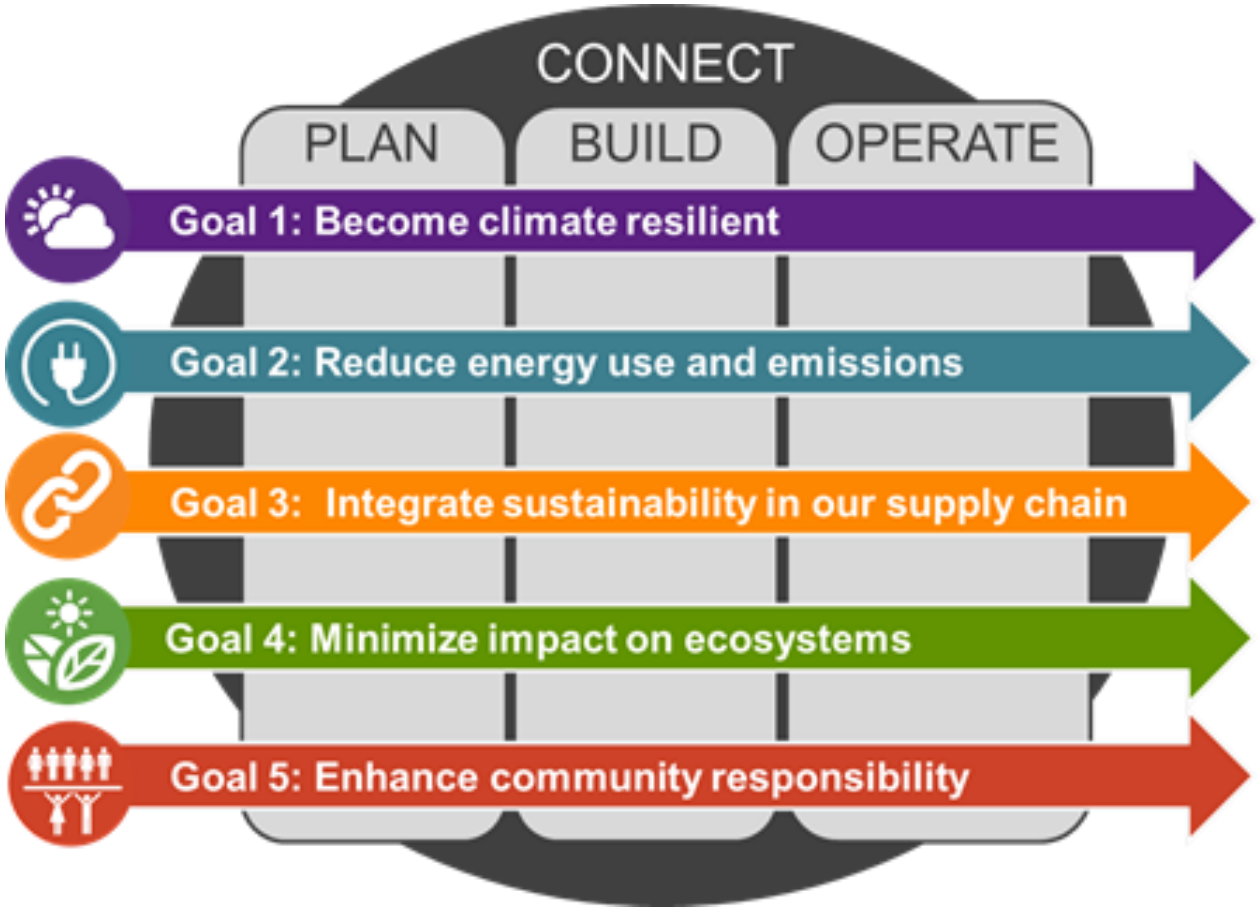




Bill 6: **"**Infrastructure planning and investment should minimize the impact of infrastructure on the environment and infrastructure… **should be designed to be resilient to the effects of climate change."**

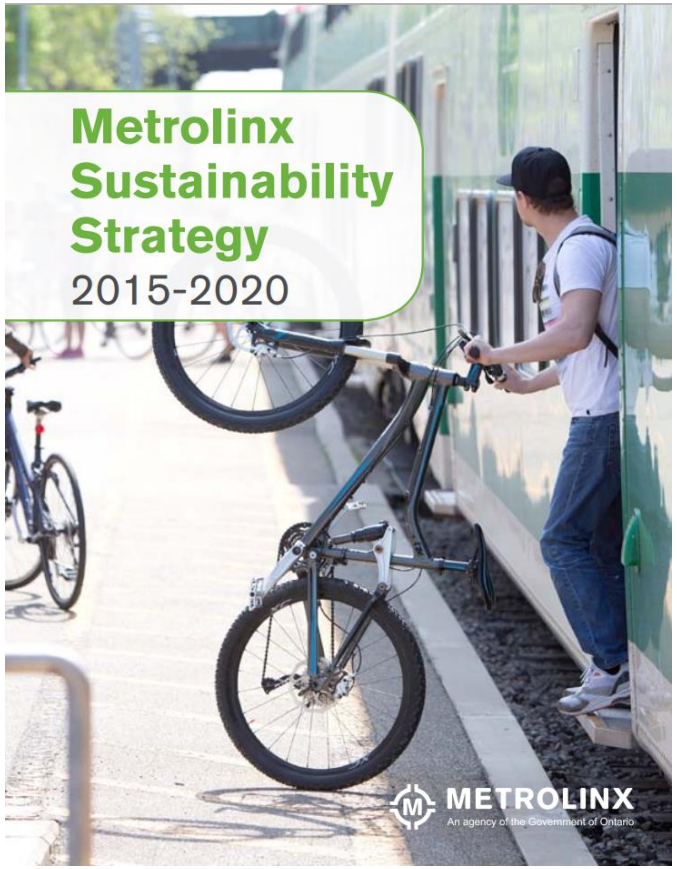
- Evolving policy landscape presents immediate challenges and opportunities:
  - Metrolinx actions on resiliency will be impacted by Provincial policy and/or guidelines (e.g. Building Code; Environmental Assessments; Infrastructure for Jobs and Prosperity Act 2016)
  - Metrolinx has provided input into future Provincial plans pertaining to climate resiliency (e.g. Proposed Growth Plan 2016; Climate Adaptation Plan 2017, Changes to the Building Code)

OUR COMMITMENT TO BECOMING CLIMATE RESILIENT



GOAL 1: BECOME CLIMATE RESILIENT

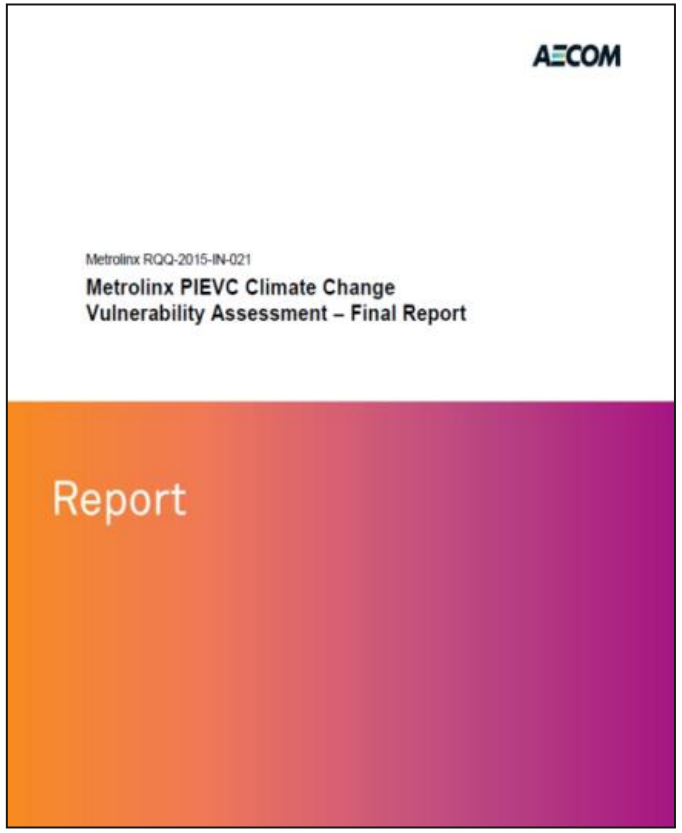
2 Key Actions to achieve Goal 1 in the Sustainability Strategy:

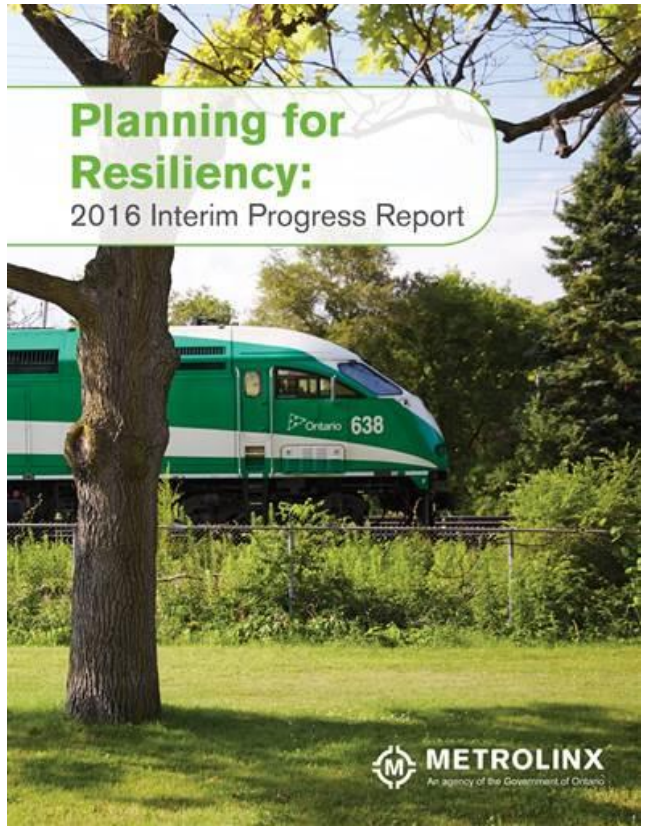


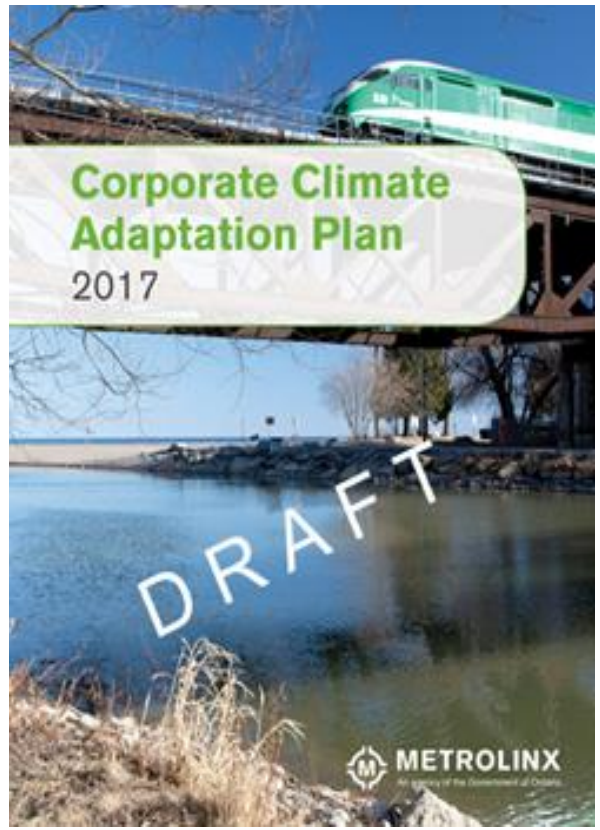
1.1 Finalize our corporate Climate Adaptation Plan. This includes strategies to ensure that capital assets that are designed, built, and delivered by Metrolinx are resilient to the impacts of climate change.

1.2 Develop climate resilience requirements for inclusion within technical standards, manuals, guidelines, Alternative Finance Procurement (AFP) project agreements, and project specific output specifications.

WORK TO DATE: CLIMATE VULNERABILITY AND RISK

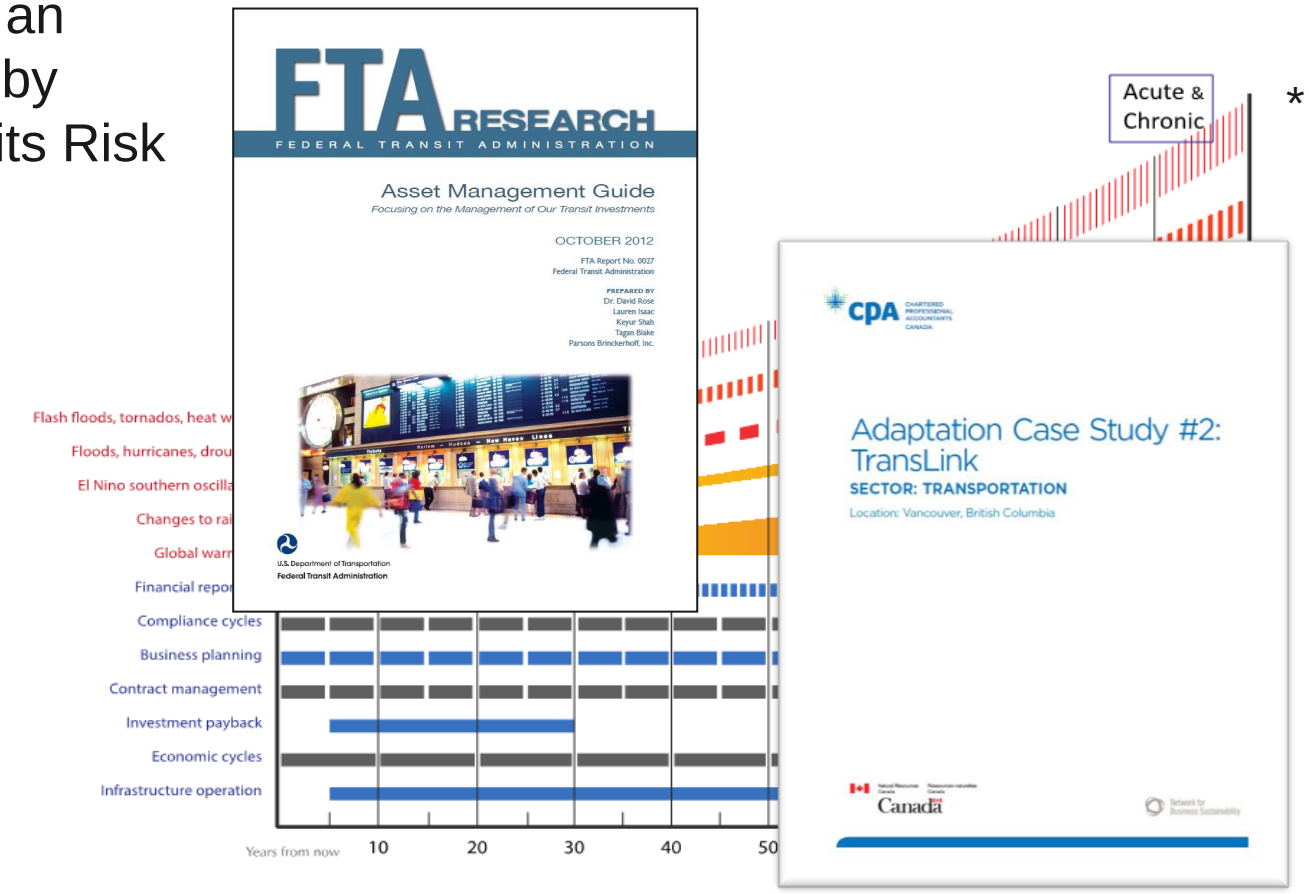






BEST PRACTICES: RISK AND ASSET MANAGEMENT

- As a large public organization, Metrolinx has an opportunity to protect its growing asset base by embedding climate resiliency measures into its Risk and Asset management practices.
- Best practices show that climate resiliency is linked to strategic, operational, financial, reputational, regulatory, and safety risks.
  - FTA Asset Management Guide
  - TransLink CPA Adaptation Case Study
  - City of TO created a Chief Resiliency Officer position in 2016



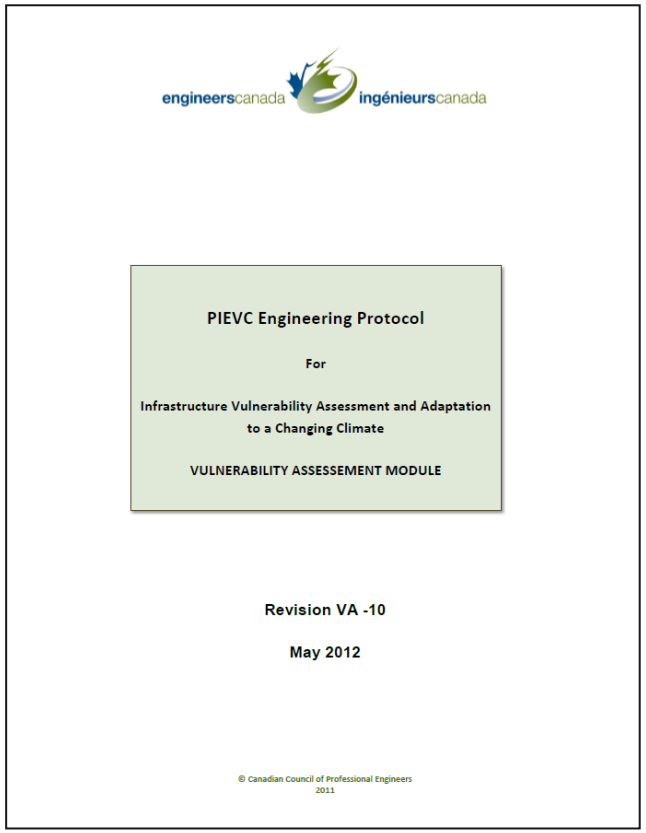
* Mott MacDonald 2015

ASSESSING CLIMATE VULNERABILITY AND RISK

- In 2016, with assistance of a consultant, we completed a PIEVC vulnerability assessment of six key assets representative of the network

AECOM
RSI
TRCA

Workshop:
~40 internal and external experts/ stakeholders



Step 1: Project Definition

Step 2: Data Gathering

Step 3: Risk Assessment

Step 4: Engineering Analysis

Step 5: Conclusions and Recommendations

SIX ASSETS:

- Segments of two rail corridors
- Two GO stations
- Two maintenance facilities
  - Bus
  - Rail

CLIMATE DATA AND PARAMETERS

1. Identify climate parameters that may impact the asset (i.e., high temperature, wind, snowfall);
2. Identify the threshold(s) at which the particular climate parameter may become a concern for the asset (i.e., temperature over 40°C, wind gusts over 120 km/hr); and
3. Estimate the probability that the climate parameter will exceed the threshold during the study period

Parameter	Reason for Inclusion
Extreme Temperatures	Design parameters for HVAC systems, Occupational Health and Safety for staff
Temperature Range	Expansion/contraction of rail
Reduced Visibility	Minimum sight distances for trains
Frost Penetration	Frost heave, damage to pads, foundations
High Winds (gusts)	Structural damage to buildings and other above ground infrastructure; debris
Horizontal Rain	Penetration into HVAC, cladding, other building envelope concerns; passenger safety
Tornadoes	High impact, low probability events, potential for severe impacts to assets
Heavy Rain	Overland flooding impacts, rail washout, riverine flooding
Freezing Rain	OHS of staff, switch gear, falling ice, incoming power
Snow	Impacts to service, access to sites
Hail	Damage to equipment, vehicles in parking lots
Lightning	Communications, electrical systems

APPLICATION TO DETERMINE VULNERABILITY AND RISK

Climate Parameter	Threshold	Annual Probability		Prob. of Occurrence for Study Period (2015-2050)
		Historical	2050s	
Extreme Temperatures	40°C	~0.01 per year	1-7 days per year	~100%
	32°C	6.5 days per year	27.5 days per year	100%
	-30°C	0.05 days per year[1]	<0.01 days per year	<70%
	-23°C	1.1 days per year	0.1 days per year	100%
Temperatures Range	60°C in one year	0.1 days per year	<0.01 events per year	<90%
Reduced Visibility *(e.g., fog, blowing snow)*	400 m (or ¼ mile)	49 hours per year, 15.1 days per year	**strong trend ↓, stable recent period**	100%
	200 m	33 hours per year, 11.9 days per year	**strong trend ↓, stable recent period**	100%
Frost Penetration	1.2 m or below	0.17[4] per year	**Trend ↓ but some conflicting factors**	>90%
High Winds (Gusts)	90 km/h	2 per year	>2.5 per year	100%
	120 km/h	0.05 days per year	**Likely ↑**	~85% or higher
Tornadoes	EF1 +	1-in-6,000	**Unknown[3]**	~0.6%
Overland Flood/Heavy Rainfall	≥25 mm in 2 hour	~ 0.8 events per year	**Very likely ↑**	100%
	≥60 mm in 2 hours	≤ 0.03 events or less per year	**Very likely ↑**	~70%
Freezing Rain	≥ 10 mm	~0.2 days per year	~0.3 days per year	~100%
	≥ 25 mm	0.06 days per year	>0.09 days per year	>95%
Snow	Blowing snow	7.8 days per year	**Trends not significant to scoring**	100%
	≥ 20 cm in one day	0.1 days per year	**Conflicting trends, likely remaining similar**	>95%
	Design Loads (snow-water equivalent)	184 mm (Willowbrook/ Port Credit[7])	**No observed trend, some factors indicate ↑**	~20%
		153 mm (Streetsville[5])		~40%
		133 mm (Oakville[5])		~40%
Hail *(Mississauga Area example)*	"Golf ball" / 45 mm or larger	0.07 per year	**Unknown**	>90%
Horizontal Rain	Gusting 50 km/h + >25 mm rain	1.8 days per year	**Slight trend ↑**	100%
Lightning	Direct strikes	~0.3% per year	**Likely ↑**	>99%

INFRASTRUCTURE COMPONENTS

RAIL CORRIDORS
TRACK
Rail
Road bed
Turnouts

STRUCTURES
Culverts
Bridge superstructure
Bridge substructure
Signal bridges

SIGNALS AND COMMUNICATIONS
Switches
Track circuits
Wayside signals
Bungalows and cabinets
Radio towers
Electrical power supply

FACILITIES
ROOFS
Building
Roof canopies
Green roofs
Solar Panels

FACILITIES
WALLS
Solid
Glass

FACILITIES
SITE
Parking lots
Street access
Back-up power

STATIONS
ROOFS
Main building
Roof canopies

STATIONS
WALLS
Solid
Glass
Mechanical (elevator, sprinkler systems)

STATIONS
SITE
Platforms
Platform canopies
Parking lots
Parking structures
Street access
Back-up power

POTENTIAL RELEVANCE TO STANDARDS AND SPECIFICATIONS

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ELECTRIFICATION
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FACILITIES
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FACILITIES
WALLS
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Glass

FACILITIES
SITE
Parking lots
Street access
Back-up power

STATIONS
ROOFS
Main building
Roof canopies
Enclosures

STATIONS
WALLS
Solid
Glass
Mechanical (elevator, sprinkler systems)

STATIONS
SITE
Platforms
Platform canopies
Parking lots
Parking structures
Street access
Back-up power

OTHER
Hydrogen fuel cells

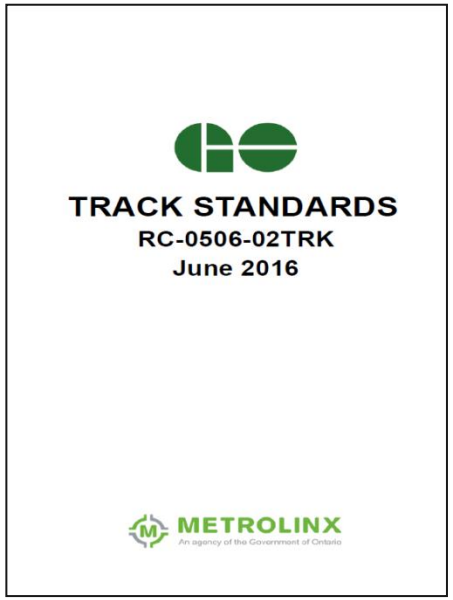
DEVELOP CLIMATE RESILIENCE REQUIREMENTS

Examples of where we have begun to integrate climate resilience language:

GO Design Excellence Guidelines

GO Design Requirements Manual

GO Track Standards Manual



- Alternative Finance Procurement Project Agreements
- Project Specific Output Specifications
- Request for Proposals
- Transit Project Assessment Process
  - RER Projects
  - RT Projects

KNOWLEDGE AND INFORMATION GAPS

- Standards development funded by Infrastructure Canada
  - National Research Council
  - Canadian Standards Association
  - Standards Council of Canada
- City of Toronto Resilient City Working Group
  - Interdependencies with Stormwater Infrastructure and Electricity Infrastructure
- Flood risk mapping: Riverine and Overland/Urban – TRCA, other CA's and Municipalities
- Urban Heat Island mapping: Regions and Municipalities
- Other climate parameters at the micro scale

NEXT STEPS

- Working with business units to develop Corporate Climate Adaptation Plan
  - e.g. Operations, Enterprise Asset Management, Risk Management and Insurance, System Planning, Emergency Response Planning, Business Continuity Planning, Communications
  - Capital Projects Group
    - Climate resilience requirements
- Address knowledge gaps on vulnerability and risk
- Explore options for applying TBL or C/B analysis to help prioritize resiliency/adaptation measures
- Consider applying evaluation tools (e.g. ENVISION) to help manage climate resiliency and risk in infrastructure projects


METROLINX