# Region of Peel

## Regional Roads and Crossings Flood Vulnerability Assessment

Prepared by Toronto Region Conservation Authority

April 2025

# Flood Vulnerable Road and Crossing Hydraulic Capacity Assessment

Prepared for Region of Peel

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DATE: Wednesday, February 4, 2026

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**Attention: Christopher Despins, MSc., P.Eng., PMP**

**Advisor, Office of Climate Change and Energy Management**

**Regional Municipality of Peel**

Dear Mr. Despins,

**Subject: Region of Peel - Flood Vulnerable Road and Crossing Hydraulic Capacity Assessment**

We are pleased to submit our **FINAL** report that summarizes the methodology and results of the Regional Roads and Crossings Flood Vulnerability Assessment within Region of Peel and TRCA's jurisdiction.

The DRAFT report has been prepared in accordance with the tasks identified in the Project Charter and addresses all comments and questions from the Region that arose during the course of the study.

We trust the submission of this document meets your requirements. We wish to thank the Region staff for your invaluable assistance in acquiring the necessary information required to complete the study.

Should you have any comments or questions, please do not hesitate to reach out to us; we look forward to your response.

Yours sincerely,

Ying Qiao

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# EXECUTIVE SUMMARY

This report provides a detailed summary of the *Regional Roads and Crossings Flood Vulnerability Assessment,* an assessment and high-level screening exercise that was conducted to understand the vulnerability of the Region of Peel's (ROP's) regional roads and watercourse crossings (culverts and bridges) to riverine flooding under current and future climate conditions. This assessment was aimed at identifying the crossings and road segments that may be vulnerable to riverine flooding now and/or in the future because of climate change. The findings from this assessment are intended to inform capital planning and emergency vehicle route planning as part of the Region's response to climate change.

**STUDY LIMITATIONS**

As this study is intended to be a screening-level analysis, it was undertaken using Toronto and Region Conservation Authority's (TRCA's) currently available flood plain mapping without developing or updating hydrology and hydraulic models for the study area. While the confidence level in the available model outputs is appropriate for an initial identification of capacity constraint or flood vulnerability, further investigation and field verification are necessary prior to undertaking design upgrades.

**METHODOLOGY**

The Region of Peel retained the services of the TRCA to conduct the analysis within its jurisdiction, while Credit Valley Conservation (CVC) carried out a similar analysis within their jurisdiction.

- **Climate Change Return Period Shifts**

To incorporate future climate change scenarios in the assessments, TRCA developed an approach to "shift" return periods from the current Intensity-Duration-Frequency (IDF) curves based on future climate scenarios, providing updated return periods for the storms used in the baseline analysis. This involved shifting return periods based on current IDF curves to reflect future climate projections for mid-century (2031–2060) and end-of-century (2071–2100) to quantify changes in extreme rainfall event frequencies. Future IDF values were sourced from the ECCC Climate Data Portal, utilizing the SSP5-8.5 high-emission scenario to incorporate a conservative approach, reflecting the upper bounds of potential climate impacts. These updated return periods were used to assess the new frequencies of impacts on road segments and watercourse crossings for the future mid- and end-of-century climate periods in addition to current climate conditions (baseline) scenario.

- **Watercourse Crossing Assessment**

The methodology employed in the crossing capacity analysis involved extracting crossings information from existing hydraulic models and assessing their ability to meet various criteria specified in the Ministry of Transportation Ontario (MTO) Highway Drainage Design Standard (November 2023). A similar assessment was repeated for future climate change scenarios, i.e., mid- and end-of-century to assess the impact associated with the 'shifted' return periods.

Through this analysis a crossing was specified as either meeting or not meeting MTO's criteria under both current and future climate scenarios. If a crossing fails to meet the criteria presently, it is projected to remain non-compliant in future climate scenarios, given the shift of all return periods towards greater frequency.

- **Roads Assessment**

The roads assessment approach in this study evaluated the flood vulnerability of regional road segments by analyzing the depth of flooding and determining whether each road segment meets or did not meet Region of Peel's Level of Service (LOS) criteria under different storm events. This methodology leveraged hydraulic model outputs to assess road inundation during 25-year, 50-year, and 100-year storm events in the current climate, providing a clear picture of how extreme rainfall impacts transportation infrastructure.

**RESULTS AND CONCLUSIONS**

- **Climate Change Return Period Shifts**

Significant shifts in the return period (frequency) of storm events are projected under future climate conditions, with extreme rainfall events becoming more frequent. For example, the rainfall depth currently associated with the 100-year return period storm event (6-hour event) is projected to shift to a 23-year return period by mid-century, and further to an 8-year return period by the end of the century, based on median values. Design storm events that are currently considered rare are expected to occur more frequently by mid-century and even more so by the end of the century, underscoring the need for adaptive planning and resilient infrastructure design.

- **Watercourse Crossing Assessment Results**

In total there are 143 watercourse crossings on the regional roads within TRCA's jurisdiction in the ROP, of which the greatest number of crossings that don't meet the MTO design flow criterion in current climate condition are on King St., The Gore Rd., and Airport Rd respectively. Of the 143 crossings assessed, 13.3% failed to meet the MTO design flow criterion in all climate scenarios, while 35.7% successfully met the criterion across all scenarios. Overall, the watercourse crossings exhibited a high level of compliance in meeting the MTO's design flow criterion, with a total of 124 out of 143 crossings meeting the criteria under current climate conditions.

Fewer crossings were found to meet a more rigorous analysis that was performed using a broader suite of MTO criterion sourced from the MTO Highway Drainage Design Standard. When this more rigorous approach was applied 62% of the crossings did not meet the MTO criteria under any climate scenario, and only 4% of the crossings meeting all selected MTO criteria under all climate scenarios. This analysis found that many existing crossings do not meet current standards. This is due to these structures being constructed decades ago during which TRCA watersheds have gone through significant changes including urbanization and change of climate. These crossings may require remediation in the future to meet the current design standards proposed by the MTO and make them more resilient to climate change.

A key project finding is that the number of crossings meeting MTO criteria drops significantly in the future based on the climate change shift analysis used for this assessment. These findings underscore the importance of ensuring that crossings have sufficient capacity to manage increased flow volumes under future climate scenarios. Upgrading these crossings will help to reduce flood risks, enhance transportation network resilience, and support the Region's ability to maintain service levels during extreme weather events.

- **Roads Assessment Results**

Inundated road segments on various regional roads were assessed against the ROP's LOS criteria of maintaining one lane of travel free in each direction under the current climate scenario for three return periods: 25-year, 50-year, and 100-year events. A total of 398 inundated road segments were identified across all assessed regional roads within TRCA's jurisdiction, with 284 segments (71%) meeting the LOS for the 25-year return period, 269 segments (68%) for the 50-year return period, and 253 segments (64%) for the 100-year return period.

The four roads with the highest number of inundated segments are Airport Road, The Gore Road, Dixie Road, and King Street. Airport Road consistently exhibited the highest number of inundated segments across all return periods, with 48 of 82 segments (59%) meeting the LOS for the 25-year return period, 46 of 82 segments (56%) for the 50-year return period, and 38 of 82 segments (46%) for the 100-year return period. This was followed by The Gore Road, which had 40 inundated segments of 50 segments (80%) meeting the LOS for both the 25-year and 50-year return periods, and 39 of 50 segments (78%) for the 100-year return period. Dixie Road ranked the third, with 29 of 48 segments (60%) meeting the LOS for the 25-year return period, 24 of 48 segments (50%) for the 50-year return period, and 22of 48 segments (45%) for the 100-year return period. Finally, King Street had 23 of 37 inundated segments (62%) meeting the LOS for the 25-year return period, 21 of 37 segments (57%) for the 50-year return period, and 20 of 37 segments (54%) for the 100-year return period.

These results highlight that Airport Road and The Gore Road are the most affected by flooding but still manage a relatively high compliance rate with the LOS, while Dixie Road and King Street show moderate inundation levels. These findings suggest that these roads should be prioritized for detailed assessment and potential flood mitigation measures to enhance their resilience under extreme weather scenarios.

**RECOMMENDATIONS**

The following recommendations are provided to support the implementation of the findings from the *Regional Roads and Crossings Flood Vulnerability Assessment* as well as avenues for potential further study:

1. Conduct detailed assessments of crossings and road segments not meeting MTO criteria under current climate conditions.
2. Integrate urban stormwater for a more comprehensive analysis of flood risk from urban storm and riverine sources.
3. Address gaps in return period data for mid- and end-of-century scenarios.
4. Expand assessments to local roads to provide a more comprehensive assessment for emergency vehicle route planning; and
5. Prioritize upgrades based on road criticality and functionality.

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Toronto and Region Conservation Authority

# GLOSSARY

**1-D Hydraulic Model:**1D hydraulic models are suitable for situations where the flow direction is known, and the flow is well confined within the valley.

**2-D Hydraulic Model**: suitable for situations where the flow path of the water is not completely known, such as in floodplain spills or for detailed velocity analysis (e.g., hydraulics of flow around a bridge pier).

**AEP (Annual Exceedance Probability)**: The probability of a storm event exceeding a certain magnitude in a given year, helping to assess flood risk and inform decisions related to floodplain management engineering and policy. For example, a storm event that has a 1% chance of being exceeded in any one year is described as a 1% AEP event (commonly known as a 100-year storm).

**Clearance (Watercourse Crossing)**: A vertical measurement from the High-Water Level of the Design Flow to the lowest point on the soffit of a bridge or a culvert (2008 MTO Design Criteria).

**Climate Change Shift Approach**: A methodological framework for evaluating the performance of infrastructure, particularly watercourse crossings, under projected future climate conditions. This approach focuses on shifting the return periods for storms of equivalent intensities observed in current climate conditions, rather than redefining new intensities for the same return periods.

**Current Climate:** IDF curve data developed based on historical observed rainfall data between 1940 and 2021 at ECCC Toronto City Climate Station (Station ID: 6158355 – formerly known as the Bloor Street Station).

**Depth of Flow**: The computed depth of water at a cross-section of a watercourse or over a ground surface.

**End-of-Century Climate:** The projected climate conditions for the 30-yr period 2071 to 2100 under the SSP5-8.5 emissions scenario. Scaled Intensity-Duration-Frequency (IDF) curves for this period were derived from Environment and Climate Change Canada (ECCC) data, specifically for the Toronto City Climate Station, based on these projections.

**Future (Climate Change) Return Period Shifts:** An estimate of how return periods for extreme precipitation events may change due to projected climate. The shifts estimate how the annual exceedance probability (AEP) may change over time, e.g., a 100-year event under historical climate conditions might become more frequent under future climate conditions (i.e., shift to a 25-year event).

**Flood Extent**: A flood extent represents the geographical area or boundary of the flood which shows how far the floodwater has spread from the watercourse into surrounding areas including floodplains, roads, agricultural lands and urban environments.

**Flood Plain Spill Area**: A flood plain spill area exists where flood waters are not physically contained within the valley or stream corridor and exit into surrounding lands. Flood spill areas occur naturally or can occur as a result of downstream barriers to the passage of flood flows such as undersized bridges or culverts. TRCA will determine on a technical basis where flood spill zone policies are applicable in consultation with the affected municipality (2329_TheLivingCityPolicies_rev19_forWeb.pdf (trcaca.s3.ca-central-1.amazonaws.com)).

**Freeboard (Watercourse Crossing):** is measured vertically from the Energy Grade Line elevation (Desirable) or from the High-Water Level (Minimum) for the Design Flow to the edge of the travelled lane (2008 MTO Design Criteria).

**Gridded Outputs**: Gridded outputs are continuous surfaces with a uniform cell size across a computational domain. Gridded outputs, computed from 2D models or interpolated from cross-sectional results from 1D models, may depict water depth, WSE, velocity etc.

**HEC-RAS**: The U.S. Army Corps of Engineers River Analysis System (HEC-RAS) was developed by the Hydrologic Engineering Center. This software allows the user to perform one-dimensional steady flow, one and two-dimensional unsteady flow calculations, sediment transport/mobile bed computations, and water temperature/water quality modeling. More information can be found on the official website: https://www.hec.usace.army.mil/software/hec-ras/.

**Inundated Road Segment:** A section of road that is intersected by the flood extent for a given storm event. The extent of the road segment varies based on the storm event assessed (e.g., 2 -100 yr return period events and regulatory storm).

**IDF (Intensity Duration Frequency) Curve**: A graphical representation that illustrates the likelihood of specific rainfall intensities occurring over various durations and return periods. IDF curves are commonly used in engineering to design and evaluate infrastructure, such as culverts and bridges, to ensure they can accommodate flows of various extreme precipitation events. Appendix A4 outlines a methodology to assess the performance of existing culverts under future climate conditions.

**LiDAR** (**Light Detection and Ranging**): It is a remote sensing technology that uses laser light to measure distances and create detailed 3D representations of surfaces such as the Earth's topography, vegetations and man-made structures. ) LiDAR systems can be mounted on various platforms, including airplanes, drones, and ground-based systems, to capture high-resolution spatial data.

**Mid-Century Climate Projections**: The projected climate conditions for the 30-yr period 2031-2060 under the SSP5-8.5 emissions scenario. Scaled Intensity-Duration-Frequency (IDF) curves for this period were derived from Environment and Climate Change Canada (ECCC) data, specifically for the Toronto City Climate Station, based on these projections.

**MTO Design Criteria:** The Ministry of Transportation of Ontario (MTO) defines design criteria as the specific standards and guidelines used to guide the design process of transportation infrastructure projects. The manual provides technical and procedural guidance for planning, design and review of stormwater management practices

**Overtopping**: it is the rising of water exceeds the height of a barrier, such as a road crossing, a dam or a flood control structure.

**Regional Storm**: A rainfall actually experienced during a major storm such as the Hurricane Hazel storm (1954) or the Timmins storm (1961), transposed over a specific watershed and combined with the local conditions, where evidence suggests that the storm event could have potentially occurred over watersheds in the general area (MNRF, 2002).

**Regulatory Flood Line or Flood Plain**: The regulatory flood line or flood plain is the approved standard used in a particular watershed to define the limit of the area that would be flooded under a particular storm event for regulatory purposes. This standard is defined by the Ontario Ministry of Natural Resources and Forestry. Within TRCA's jurisdiction, the regulatory flood plain is based on the more severe of the Regional Storm (Hurricane Hazel), or the 100-year storm; whichever is greater.

**Return Period**: Return period, also known as a recurrence interval or repeat interval, is the estimated average time between occurrence of events such as floods, earthquakes, landslides, or river discharges, based on statistical analysis of historical data. It is inversely related to the **Annual Exceedance Probability (AEP)**, which is the probability of the event being exceeded in any given year. For example, a 100-year return period means there is a 1% chance (1/100) of the event being exceeded in any given year, but it does not imply the event will happen once every 100 years.

**SSP (Shared Socioeconomic Pathways)**: SSPs are climate scenarios developed to describe different future socioeconomic conditions, including factors like population growth, economic development, and technological change. They provide a narrative framework for understanding how human society might develop under different assumptions, which in turn influences future emissions levels. SSPs are often combined with RCPs (e.g., SSP5 8.5) to explore how different socioeconomic developments (e.g., high or low levels of economic growth or inequality) could impact the climate under various radiative forcing levels. For example, SSP1 envisions a world of sustainable development, while SSP5 describes a future of high fossil-fuel use and minimal climate policy.

**SSP5 – 8.5**: A high-end emissions scenario used in climate modeling and assessment, representing a future characterized by rapid economic growth, intensive energy use, and heavy reliance on fossil fuels. The "8.5" refers to the radiative forcing level (in watts per square meter) expected by the year 2100 under this pathway. SSP5-8.5 is often considered a "business-as-usual" scenario and is used to explore the potential impacts of minimal mitigation efforts and high greenhouse gas emissions on global climate systems.

**Riverine Flooding**: A type of flooding that occurs when rivers or streams overflow their banks due to heavy rainfall, snowmelt or other factors leading to flooding of the surrounding land.

**Urban Flooding**: Also known as pluvial flooding, this occurs when heavy rainfall overwhelms urban drainage systems (e.g., storm sewers), causing flooding in built environments like streets, homes, and infrastructure.

**Watercourse Crossing:** Structures that allow passage over a water body, such as a river, stream, or creek. Crossings are commonly bridges or culverts under roads that allow for the movement of people, vehicles or wildlife while maintaining the flow of water of the water body.

**WSE (Water Surface Elevation)**: The water surface elevation is the height of the water surface above a reference point (e.g. mean sea level).

# 1 INTRODUCTION

## 1.1 Background

Climate change hazards are projected to increase in the Region of Peel (ROP), including higher average temperatures and more intense precipitation events. These climate change hazards are expected to negatively impact the ROP's ability to meet levels of service targets under current and/or future climate conditions.

In response to the uncertainties and risks posed by climate change to the Region's assets and the level of service they provide, the ROP is currently assessing the impacts and risks posed by climate change on various infrastructure assets. One such asset being assessed is the Region's roads and its watercourse crossings. This report provides a detailed summary of the *Regional Roads and Crossings Flood Vulnerability Assessment,* an assessment and high-level screening exercise that was conducted to understand the vulnerability of the ROP's regional roads and crossings (culverts and bridges) to riverine flooding under current and future climate conditions. This assessment was aimed at identifying the crossings and road segments that may be vulnerable to riverine flooding now and/or in the future as a result of climate change, and for this information to be provided to decision-makers to be considered as part of capital planning activities.

The ROP retained the Toronto and Region Conservation Authority (TRCA) to undertake this project, with the aim of assisting the ROP in identifying:

- ROP watercourse crossings (culverts and bridges) that merit further attention as candidates for upsizing, based on hydraulic performance under current and future climate scenarios, to inform future capital plans with an aim of increasing resilience. This component of the project is termed "Crossing Assessment"; and,
- Roads that are vulnerable to flooding under different riverine flood scenarios (for both current and future climates) to inform future disaster route planning. This component of the project is termed "Roads Assessment".

As the stewards of riverine flooding information, including hydraulic modelling, Conservation Authorities are natural partners in this endeavor. Each Conservation Authority (CA) serves as the custodian of flood model data within its jurisdiction. TRCA developed a proposal to conduct the necessary analysis within its jurisdiction, while the Credit Valley Conservation Authority (CVC) carried out a similar analysis for ROP within its own jurisdiction. Depending on the available flood model data, each CA also developed unique workflows for the roads assessment component of this project.

## 1.2 Study Objectives

The objectives of the Flood Vulnerable Roads and Crossings Assessment are as follows:

- Develop a methodology to assess road flood vulnerability and crossing capacity under extreme rainfall, considering ROP's Level of Service for roads and MTO criteria for crossings.
- Develop an approach to "shift" return periods from the current IDF curves based on future climate scenarios, to support assessment of road flood vulnerability and crossing capacity under future extreme rainfall.

- Assess crossing capacity under current climate conditions based on MTO Criteria and ROP's Level of Service Criteria.
- Assess road flood vulnerability under current climate conditions based on ROP's Level of Service Criteria and crossing capacity under current and two plausible future climate scenarios (i.e., Mid-Century and End-of-Century) based on MTO Criteria.
- Conduct a literature review to investigate the factors influencing the criticality of roads.
- Generate a comprehensive report that summarizes methodologies, findings and recommendations.
- Compile all assessments into a GIS geo-database for each crossing and road assessment.

## 1.3 Scope of Work

### 1.3.1 Scope of Work

**Study area**

The study area includes the TRCA's riverine regulatory flood plain within the Region of Peel, covering portions of the Town of Caledon, the City of Brampton, and the City of Mississauga. It also encompasses the majority of the Etobicoke Creek watershed and parts of the Mimico Creek and Humber River watersheds **(Figure 1.1)**.

**Scope of work**

The study specifically focusses on riverine flooding, and the intent of the study has been to leverage TRCA's most current existing flood plain mapping and modelling files, without creating new hydrology & hydraulic models or model updates. Furthermore, the study only considers regional roads and crossings, while excluding Railway, Highways (MTO, 407 ETR), and local municipal roads and crossings.

The key tasks comprising this study are outlined below:

- Background data collection and review
- Model results extraction for crossings and inundated road segments
- Data analysis on the extracted datasets based on defined criteria
- Future climate change output incorporation
- Geodatabase compilation for crossings and road segments
- Preparation of a final report summarizing all technical work
- Preparation of final deliveries, including executive summary

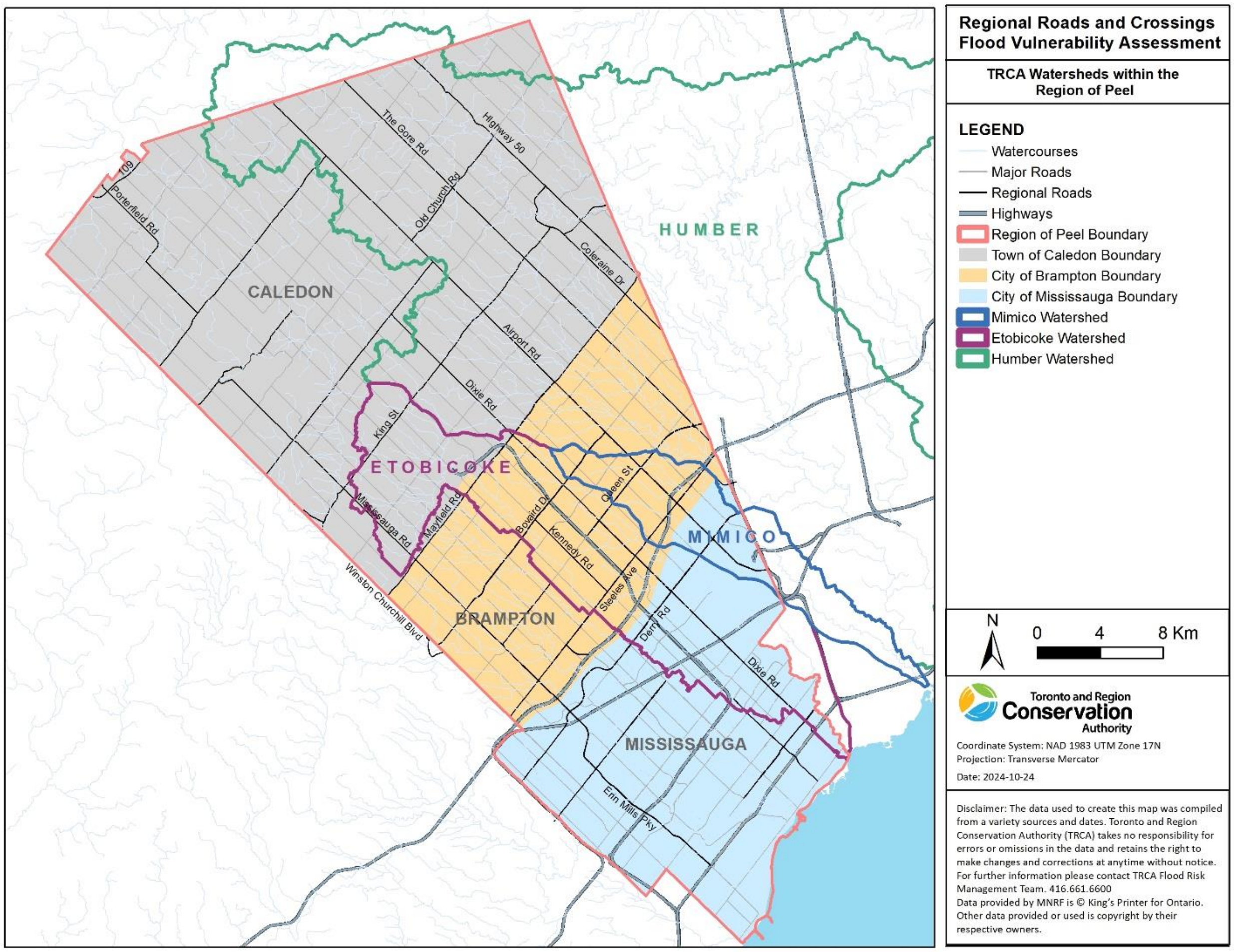


**FIGURE 1.1 TRCA WATERSHEDS WITHIN THE REGION OF PEEL**

### 1.3.2 Assumptions and Limitations

**Assumptions**

- The existing hydrology and hydraulic models offer sufficient accuracy for conducting a screening-level analysis for this study.
- The MTO criteria and ROP level of service criteria used to assess crossings and road segments under the current climate conditions were applied unchanged to future climate scenarios in this study.
- Future extreme precipitation data from climatedata.ca, scaled according to projected temperature increases, provides a reliable estimate of anticipated extreme precipitation.

**Limitations**

- The study relied on the latest hydrology and hydraulic model outputs developed as part of previous hydrology and flood plain mapping studies, without developing new models or rerunning existing ones for this study.
- The state of the current models only reflects the watershed conditions at the time they were developed. As such, any subsequent changes or new information – such as topographic grading, structure changes, land-use change, or recent storm events and stream gauge data are not incorporated into the models.
- The spills, that overflow from the creeks and travel through the floodplain or urban areas as overland flow, may not be captured in the flood extents as part of floodplain mapping studies except where 2D modeling approach was used to fully delineate these spills. Consequently, some regional roads and crossings along potential spill paths were not assessed in this study.
- The focus of this study is on riverine flooding, not urban flooding, which occurs when rainfall exceeds the capacity of local storm drainage infrastructure managed by municipalities.
- Updating IDF curves for the ROP is outside the scope of this study. Instead, an approach was applied by "shifting" return periods based on future climate scenarios using the current IDF curves. This method utilizes existing hydraulic models, which were run using current climate IDF values. As a result, we do not have information on the performance of the culverts beyond the rainfall depths originally modeled (i.e., for the current climate).
- This study is intended as a screening-level analysis, aiming to identify potential problem areas based on available data. The results are preliminary and should be further investigated, including through field assessments to validate the findings and gain a deeper understanding of any issues.

# 2 BACKGROUND DATA

The study utilized the most current hydrology and hydraulic models from TRCA, as well as road network data provided by the Region of Peel. The following subsections provide further details on these datasets.

## 2.1 TRCA Supplied Data

This section outlines the data provided by the TRCA that was used for the assessment. TRCA supplied hydraulic models for each of TRCA's watersheds in Peel Region, including Etobicoke Creek, Mimico Creek, and Humber River. The subsections below detail the scope of the data provided for each watershed, including the number of crossings modeled and the completion timelines for the models, which help indicate the currency of the model outputs.

### 2.1.1 Etobicoke Creek

A total of 249 crossings were modelled in Etobicoke Creek, of which 26 ROP crossings are within Region of Peel jurisdiction. **Table 2.1** presents an overview of the timelines for the completion of the various hydraulic and hydrological models pertaining to the Etobicoke Creek watershed.

TABLE 2.1 SUMMARY OF CURRENT MODELS IN THE ETOBICOKE CREEK WATERSHED AND THE NUMBER OF ROP CROSSINGS MODELED

| | Completion Date | | |
|---|---|---|---|
| Model Name | Hydrology Model | Hydraulic Model | ROP Crossings Modeled |
| Etobicoke Phase 1 | January 2013 | Jan 2015 | 8 |
| Etobicoke Phase 2 | | Aug 2016 | 3 |
| Etobicoke Extension | | Oct 2022 | 8 |
| Spring Creek (2D Model) | | Oct 2015 | 6 |
| Dixie-Dundas (2D Model) | | Jan 2015 | 1 |

### 2.1.2 Mimico Creek

The Mimico Creek watershed hydrology study was completed in December 2009, and the hydraulic models were completed in August 2020 (TABLE 2.2). A total of 112 crossings are modelled in Mimico Creek watershed, of which 8 ROP crossings are within Region of Peel.

TABLE 2.2 SUMMARY OF CURRENT MODELS IN THE MIMICO CREEK WATERSHED AND THE NUMBER OF ROP CROSSINGS MODELED

| | Completion Date | | |
|---|---|---|---|
| Model Name | Hydrology Model | Hydraulic Model | ROP Crossings Modeled |
| Mimico Creek | Dec 2009 | Aug 2020 | 5 |
| Steeles Airport (2D Model) | | Jun 2022 | 3 |

### 2.1.3 Humber River

The Humber River Hydrology study was completed in 2018. Due to the expansive nature of the Humber River watershed, it was divided into two distinct zones within the ROP, namely West Humber and Upper Humber for the purposes of hydraulic modelling. Separate hydraulic models using the HEC-RAS modelling platform were developed for each of these zones in 2018. Subsequently, in 2020, TRCA initiated an extension project for floodplain mapping within the headwaters of the Humber River. Additionally, dedicated HEC-RAS models were also created for the purposes of determining the Regulatory floodline within the Bolton Special Policy Area (SPA) and Humber River in the York Region. Thus, there are eight distinct HEC-RAS one-dimensional models for the Humber River watershed. Lastly, results were also extracted from a two-dimensional hydraulic model (MIKE Flood) for the area of Caledon East. In total, 916 crossings have been modelled in these six HEC-RAS models, of which there are 109 ROP crossings . The summary of the completion years of the hydrology/hydraulic models of the Humber River watershed has been provided in (TABLE 2.3).

TABLE 2.3 SUMMARY OF CURRENT MODELS IN THE HUMBER RIVER WATERSHED AND THE NUMBER OF ROP CROSSINGS MODELED

| Model Name | Completion Date | | |
|---|---|---|---|
| | **Hydrology Model** | **Hydraulic Model** | **ROP Crossings Modeled** |
| West Humber | Apr 2018 | June 2018 | 24 |
| West Humber Extension Zone 1 | | Sept 2023 | 16 |
| West Humber Extension Zone 2 | | Mar 2024 | 27 |
| Upper Humber | | June 2018 | 10 |
| Upper Humber Extension Zone 1 | | Mar 2023 | 14 |
| Upper Humber Extension Zone 2 | | May 2023 | 13 |
| Humber in York | | Dec 2019 | 1 |
| Bolton SPA | | Aug 2014 | 3 |
| Caledon East (2D Model) | | Apr 2018 | 1 |

### 2.1.4 TRCA GIS Datasets

In addition, TRCA utilized several internal GIS databases as follows:

- **Crossings Database:** This database included the locations of all crossings modeled by TRCA within ROP. It was used to identify crossings located on regional roads that were not included in the GIS database provided by ROP. Specifically, 56 out of 143 additional crossings were identified through this database.
- **Regulatory Floodplain Database:** This database was used for identifying inundated ROP road segments that would intersect with the Regulatory flood extents (higher of Hurricane Hazel or 100yr storm event).
- **Watershed Boundary, Municipality Boundary and Watercourse Database:** These databases were used for showing the boundaries around each watershed and municipality and distribution of watercourses in TRCA jurisdiction within ROP.

## 2.2 Region of Peel Supplied Data

The Region of Peel provided three sets of GIS databases, each essential for the project.

- **Crossing Database:** This database was used to verify the locations of all crossings on regional roads within the ROP. Additionally, it also helped to confirm that the structure type (e.g., culvert or bridge) matched the type modeled in the hydraulic models.
- **Storm Infrastructure Database:** This database included information on the locations of storm manholes and storm channels. Its primary purpose was to identify the road environment (urban vs. rural), which was essential applying the MTO Design Flow Criteria in the crossing analyses.
- **Streets Database:** This database provides detailed information about the street network within the ROP. It was used to extract the locations of regional roads and their number of lanes, which were critical for both crossing and road assessments in the project.

Detailed information about these databases has been provided in TABLE 2.4

TABLE 2.4:ROP SUPPLIED DATA AND THEIR APPLICATIONS

| Database Name | Shapefile Name | Shapefile Type and Description | Application |
|---|---|---|---|
| Crossings | trsBridge | Point shapefile representing the location of crossings | This shapefile was used as a reference to ensure all crossings were assessed. The crossing type in this shapefile was compared with the hydraulic model, and the Facility ID attribute was extracted for inclusion in the geodatabase table. |
| Streets | Streets | Polyline shapefile containing street data | The Spatial Join function was used to combine this with the Crossings layer, extracting required attributes (e.g., FULLSTNAME, ROPSTSEGID, NO_OF_LANES, etc.) for inclusion in the geodatabase table. |
| Storm Infrastructure Database | Storm_inlet | Point shapefile showing the storm inlets | This layer was used to classify the road environment: areas with storm inlets, storm mains and manholes were designated as Urban, while areas without these features were classified as Rural. The **RdEnv** attribute was then used to determine the appropriate design storm event for the crossings assessment. Additionally, the **Storm_Main** shapefile was utilized to extract the **StmMainID** attribute, which was required for the geodatabase table. |
| | Storm_Channel | Polyline shapefile depicting locations of ditches | |
| | Storm_Manhole | Point shapefile indicating of storm manholes | |
| | Storm_Main | Polyline shapefile representing locations of storm mains | |

# 3 METHODOLOGY

The following sections outline the methods used for the climate change shift approach, and the steps taken to extract the results from different hydraulic models, and to populate extracted results into worksheets, where analyses were performed to compare the hydraulic performance of the crossings against MTO criteria and to assess the vulnerability of road segments to flooding against ROP's criteria, and eventually to develop the Crossings Assessment Geodatabases and the Roads Assessment Geodatabase.

## 3.1 Climate Change Shift Approach

TRCA and CVC developed the climate change shift approach in consultation with ROP. The focus of the approach is to shift the return periods for storms with equivalent intensities in the current climate conditions, instead of new intensities for the same return periods, which are used to evaluate performance of watercourse crossings under projected future climate conditions assuming current MTO criteria is maintained the same. This led to the development of a table of shifted return periods under two future climate scenarios, mid-century (2031 to 2060) and end-of century (2071 to 2100). Climate data from the ECCC Toronto City Climate Station, using the SSP5-8.5 high-emissions scenario, informs these shifts, focusing on changes in 6-hour and 12-hour storm durations.

The method utilizes existing hydraulic models that were run using current climate IDF values. The assessment of future culvert capacity is constrained by the rainfall depths from the modeled IDF curves. Since modeling was only conducted up to the current 100-year event—equivalent to the mid-century's 25-year return period—it is not possible to evaluate culvert capacity for return periods beyond 25-years under future mid-century climate conditions. If additional model runs incorporating higher return period events (e.g., 350-year, 500-year) had been conducted, they could have provided estimates of culvert capacity beyond the 25-year period for the future mid-century.

Appendix A4 includes a technical memorandum, which details the methodology, process, and results of the climate shift analysis completed by TRCA in collaboration with CVC. For further details on data sources, assumptions, and calculations, please refer to the memorandum in Appendix A4.

## 3.2 Crossings Assessment

As an integral part of the ROP's transportation network, watercourse crossings, including culverts and bridges, serve as conduits for water beneath roadways, facilitating the smooth flow of streams and stormwater. The MTO, with its commitment to safety, sustainability, and efficient infrastructure, outlined a set of guidelines in Highway Drainage Design Standards Manual published in January 2008 (MTO HDDS, 2008), which have been considered in crossings assessment that are introduced in the following subsections. Additionally, the workflow of this comprehensive assessment is described, providing a clear understanding of the steps involved in evaluating the condition of the crossings.

The MTO, with its commitment to safety, sustainability, and efficient infrastructure, published a set of guidelines in the Highway Drainage Design Standards Manual (MTO HDDS, 2008), which served as the basis for the criteria assessed in this study. It should be noted that a new standard was released in 2023, which may include revised criteria. However, at the time this study was conducted, the 2008 standard was in place and was used as the foundation for the crossings assessment introduced in the following subsections.

It is important to note that the criteria in the 2023 standard may differ from those in the 2008 standard. As such, a review of the new standard and possibly a reassessment of compliance with its criteria would be necessary to align with the updated guidance. However, this task falls outside the scope of the current study and could be considered a topic for future investigation. The workflow of this comprehensive assessment, based on the 2008 standard, is described to provide a clear understanding of the steps involved in evaluating the condition of the crossings.

Furthermore, a GIS Crossings Assessment Database was developed by TRCA in consultation with CVC and ROP. A Crossings Assessment Excel spreadsheet was created first to generate the attributes for each crossing, which were then compiled into an Attribute Table for the final GIS Crossings Assessment Database. The final GIS crossing assessment attribute table and Metadata table of the GIS Attributes are provided in Appendix A2

The following sections describe the criteria that were used for the crossings assessment as well as the process that was followed in evaluating the condition of the crossings and developing attributes for the Crossings Assessment Database.

### 3.2.1 MTO Criteria

The MTO Highway Drainage Design Standards (MTO HDDS) was used to evaluate the hydraulic performance of the crossings based on criteria outlined in the document. The MTO HDDS was established for the design and rehabilitation of MTO highways, however other agencies use these standards to evaluate existing infrastructure. The MTO HDDS has similar criteria for bridges and culverts, however there are some differences. Criteria for relief flow conveyed over a road crossing is the same for bridges and culverts. **Table 3.1** and **Table 3.2** summarize the various MTO Standards (i.e., WC-1, WC-2, WC-7, WC-13) that were used to evaluate bridge crossings, culvert crossings, and relief flow. The detailed description of each standard is presented in the following sub-sections. For further details please refer to MTO Highway Drainage Design Standards.

**Table 3.1 MTO Drainage Design Standards for Culverts**

| Item | Design Standard | Description | Standard Number | Section in MTO HDDS |
|---|---|---|---|---|
| 1 | Design Flow Storm | Identifies the design flow (25-year, 50-year, or 100-year) to be used for evaluation, based on road classification (rural/urban) and crossing span (less than or equal to 6.0 m/greater than 6.0 m) | WC-1 | 1.1.1 |
| 2 | Top of Road Freeboard (Min.) | >1.0m (Top of road low point - Design Flow Water Surface Elevation) | WC-2 | 3.1.2 |
| 3 | Top of Road Freeboard (Desired) | >1.0m (Top of road low point - Design Flow Energy Grade Line Elevation) | WC-2 | 3.1.1 |
| 4 | Relief Flow (Max. Depth over roadway) | Max. depth over roadway should not exceed 0.3m for Regulatory Storm | WC-13 | 3.2.1 |
| 5 | Relief Flow (Velocity x Depth) | Velocity x Depth should not exceed 0.8$m^2$/s for the Regulatory Storm | WC-13 | 3.2.2 |
| 6 | Soffit Clearance (Erodable Bottom) | >0.3m (Soffit Elevation - Design Flow Water Surface Elevation) | WC-7 | 3.4 |
| 7 | Flood Depth (HW/D,HW) (Non-Erodable Bottom) | If Rise <3.0m use HW/D<=1.5 ((Upstream WSE-Upstream Invert)/Rise)) | WC-7 | 3.5 |
| | | If Rise 3.0m to 4.5m use HW<=4.5m (Upstream WSE-Upstream Invert) | WC-7 | 3.5 |
| | | If Rise >4.5m use HW/D<=1.0 ((Upstream WSE-U/S Invert)/Rise)) | WC-7 | 3.5 |

**Table 3.2 MTO Drainage Design Standards for Bridges**

| Item | Design Standard | Description | Standard Number | Section in MTO HDDS |
|---|---|---|---|---|
| 1 | Design Flow Storm | Identifies the design flow (25-year, 50-year, or 100-year) to be used for evaluation, based on road classification (rural/urban) and structure span (less than or equal to 6.0 m/greater than 6.0 m) | WC-1 | 1.1.1 |
| 2 | Top of Road Freeboard (Min.) | >1.0m (Top of road low point - Design Flow Water Surface Elevation) | WC-2 | 3.1.2 |
| 3 | Top of Road Freeboard (Desired) | >1.0m (Top of road low point - Design Flow Energy Grade Line Elevation) | WC-2 | 3.1.1 |
| 4 | Relief Flow (Max. Depth over roadway) | Max. depth over roadway should not exceed 0.3m for Regulatory Storm | WC-13 | 3.2.1 |
| 5 | Relief Flow (Velocity x Depth) | Velocity x Depth should not exceed 0.8$m^2$/s for the Regulatory Storm | WC-13 | 3.2.2 |

| | | | | |
|---|---|---|---|---|
| 6 | Soffit Clearance | >1.0m (Soffit Elevation - Design Flow Water Surface Elevation) | WC-2 | 3.1.3 |
| 7 | Soffit Clearance (Nav. Waters) | >1.5m above 2-Year | NWPA | |
| Note: Soffit Clearance (Nav. Waters) is a Navigable Waters Protection Act (NWPA) standard and not required for this study | | | | |

### *3.2.1.1. **Design Flows***

This standard (WC-1) sets out the minimum Design Flow requirements needed to size bridges and culverts for flow conveyance on regulated and non-regulated watercourses. It also outlines how to handle regulatory flow in regulated watercourses and specifies the maximum allowable increase in flood levels upstream of a bridge or a culvert. TABLE 3.3 presents the WC-1 Design Flow Return Periods based on the road classification and total span of the watercourse crossings (i.e. culverts and bridges) that must be considered in their design.

TABLE 3.3 DESIGN FLOW RETURN PERIOD FOR BRIDGES AND CULVERTS - STANDARD ROAD CLASSIFICATIONS

| Functional Road Classification | Return Period of Design Flows (Years)[1,2,3] | | Check Flow for Scour |
|---|---|---|---|
| | Total Span less than or equal to 6.0 m | Total Span greater than 6.0 m | |
| Freeway, Urban Arterial | 50 | 100 | 130% of 100 year |
| Rural Arterial, Collector Road | 25 | 50 | 115% of 100 year |
| Local Road | 10 | 25 | 100% of 100 year |

Note:
1. The listed design flows apply to roads under the jurisdiction of the Ministry of transportation.
2. The Fish Passage Design Flow for culverts is defined in Standard WC-12 Fish Passage Requirements Through Culverts
3. Sometimes referred to as Normal Design Flow

### *3.2.1.2 **Freeboard and Clearance at Watercourse Crossings***

This standard (WC-2) defines the Freeboard and Clearance requirements for both culvert and bridge, and the maximum Flood Depth for culvert.

- **Top of the Road Freeboard**

MTO provides two criteria for freeboard, i.e.

1) The Desirable Freeboard: is the vertical distance from the Energy Grade Line elevation for the Design Flow to the edge of the traveled lane.

2) The Minimum Freeboard: is the vertical distance between the High-Water Level (i.e., WSE) for the Design Flow to the edge of the travelled lane.

TABLE 3.4 shows the Freeboard design standard (Desirable and Minimum) for culverts and bridges for different road types.

TABLE 3.4 TOP OF THE ROAD FREEBOARD FOR CULVERTS AND BRIDGES

| Standard Road Classification | Freeboard |
|---|---|
| Freeways, arterials, collectors | ≥ 1.0 m |
| Local Roads including Private Entrances | ≥ 0.3 m |

- **Soffit Clearance**

MTO HDDS defines Clearance as the measurement vertically from the High-Water Level for the Design Flow to the lowest point on the soffit. The Clearance design standard is only defined for bridges and Open-Footing Culverts with erodible bottoms, and for Open-Footing culverts the criterion is defined differently for rectangular cross sections and irregular cross-sections as follows:

1) For a straight soffit (rectangular cross-sections), the minimum Clearance shall be 0.3m for all types of roads.
2) For irregular cross sections such as High Span Arch, Low Span Arch and Concrete Span Open Footing Culverts, the minimum Clearance shall be measured 0.3m below the Effective Rise of the culvert, where:

   ER = Effective Rise of the culvert = TAFA/ES

   TAFA = Total available flow area of the structure in square meters; and

   ES = Span of the equivalent rectangular culvert in meters

It should be noted that as per MTO HDDS, there is no Clearance requirement for Closed-Footing Culverts and Open-Footing Culverts with non-erodible bottom, and instead Flood Depth standard has been defined for this type of culvert as discussed below.

- **Flood Depth at a Culvert**

The design standard for Flood Depth at the upstream face of a culvert is represented by the ratio of the Flood Depth at the upstream face to the diameter or rise of the culvert (HW/D) (TABLE 3.5) This criterion is applicable to both Closed-Footing Culverts and Open-Footing Culverts with a non-erodible bottom.

Table 3.5 Design Standard For Flood Depth at the Upstream Face of A Culvert

| Functional Road Classification | Design Flow | HW/D Ratio |
|---|---|---|
| Freeways, Arterials, Collectors | See Standard WC-1 | Culverts with diameter or rise < 3.0 m HW/D ≤ 1.5<br>Culverts with diameter or rise 3.0 to 4.5 m HW ≤ 4.5 m<br>Culverts with diameter or rise > 4.5 m HW/D ≤ 1.0 |
| Highway Ramps, Other Roads, and Private Entrances | See Standard SD-13 | |

#### *3.2.1.3* ***Relief Flow***

This standard addresses the control of flood flows conveyed over the roadway as Relief Flow at water crossings. It identifies the maximum depth and the maximum velocity of the flow over the roadway.

According to MTO HDDS in design of a water crossing, provision must be made for the passage of Relief Flow over the roadway if the Regulatory Flow surpasses the Design Flow capacity of a bridge or a culvert. However, there is no obligation to incorporate Relief Flow in the design when the Regulatory Flow must be conveyed through the structure.

As per MTO HDDS, if Relief Flow is implemented, the following conditions shall not be surpassed at a road cross-section during the Regulatory Flood:

- The depth of flow on the roadway shall not exceed 0.3 m; and
- The product of velocity and depth on the roadway shall not exceed 0.8 $m^2/s$.

### 3.2.2 Crossing Assessment Workflow

As described earlier, a geodatabase was created to assist with visualization of the output data from this assessment for the flood vulnerable crossings. A high-level flowchart illustrating the workflow used to create the crossings geodatabase is shown in Figure 3.1. A more detailed flowchart briefly describes the steps and tools used to extract and process the data is also provided in Appendix A1.

The primary software utilized throughout this study are HEC-RAS (including RAS Mapper) for the preparation and extraction of model results, Excel spreadsheets, and ESRI ArcGIS for data pre- and post-processing.

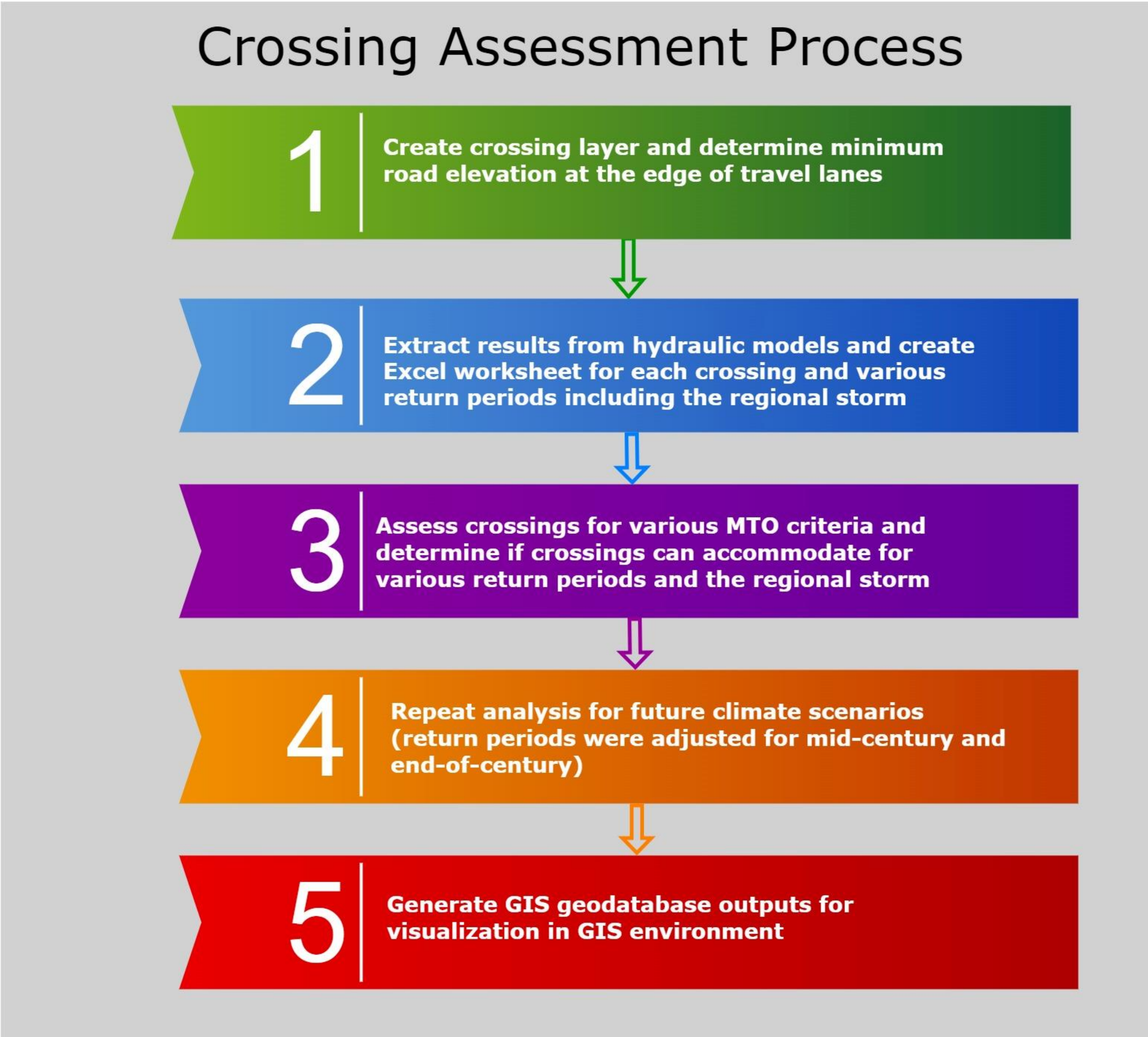


FIGURE 3.1 HIGH-LEVEL FLOWCHART ILLUSTRATING THE WORKFLOW APPLIED TO CREATE THE CROSSINGS ASSESSMENT GEODATABASE

In this project, the extraction of data was necessary for watercourse crossings modeled within the existing TRCA HEC-RAS models, as well as for roads inundated during diverse storm events, including Regional, and 2-year to 100-year return periods. The forthcoming subsections provide a comprehensive overview of TRCA's method, outlining how the extraction and processing of model results were undertaken for integration into the geodatabases for crossings.

#### *3.2.2.1* ***Crossing Assessment Process***

This section presents a detailed description of the five major steps on the crossing assessment process as indicated in **FIGURE 3.1**.

***Step 1: Create Crossing Layer and Determine Minimum Road Elevation***

The first step involved several sub-steps as described below:

*Step1a: Extract information from ROP and TRCA Sources as below:*

- TRCA Hydraulic Models (1D and 2D Hydraulic Models)
- Region of Peel (Crossing Database, Streets Database, Storm Infrastructure Database)

*Step 1b: Create a new crossing layer*

- Clip ROP crossing shapefile to remove all crossings located outside the TRCA jurisdiction.
- Identify missing crossings in ROP crossing shapefile by overlaying the ROP Street layer and TRCA Watercourse layer.
- Create a new crossing layer by intersecting the ROP Street layer and TRCA Watercourse layer to identify the crossing points where the regional roads intersect with the watercourse. The resulting dataset included crossing points at all locations where waterways intersect regional roads within the ROP jurisdiction.

*Step 1c: Intersect and Clip Road Layer with Regulatory Floodlines*

- Intersect the Road Network layer with the Regulatory floodlines and clip the road segments to be within the flood extents (see **FIGURE 3.2**).

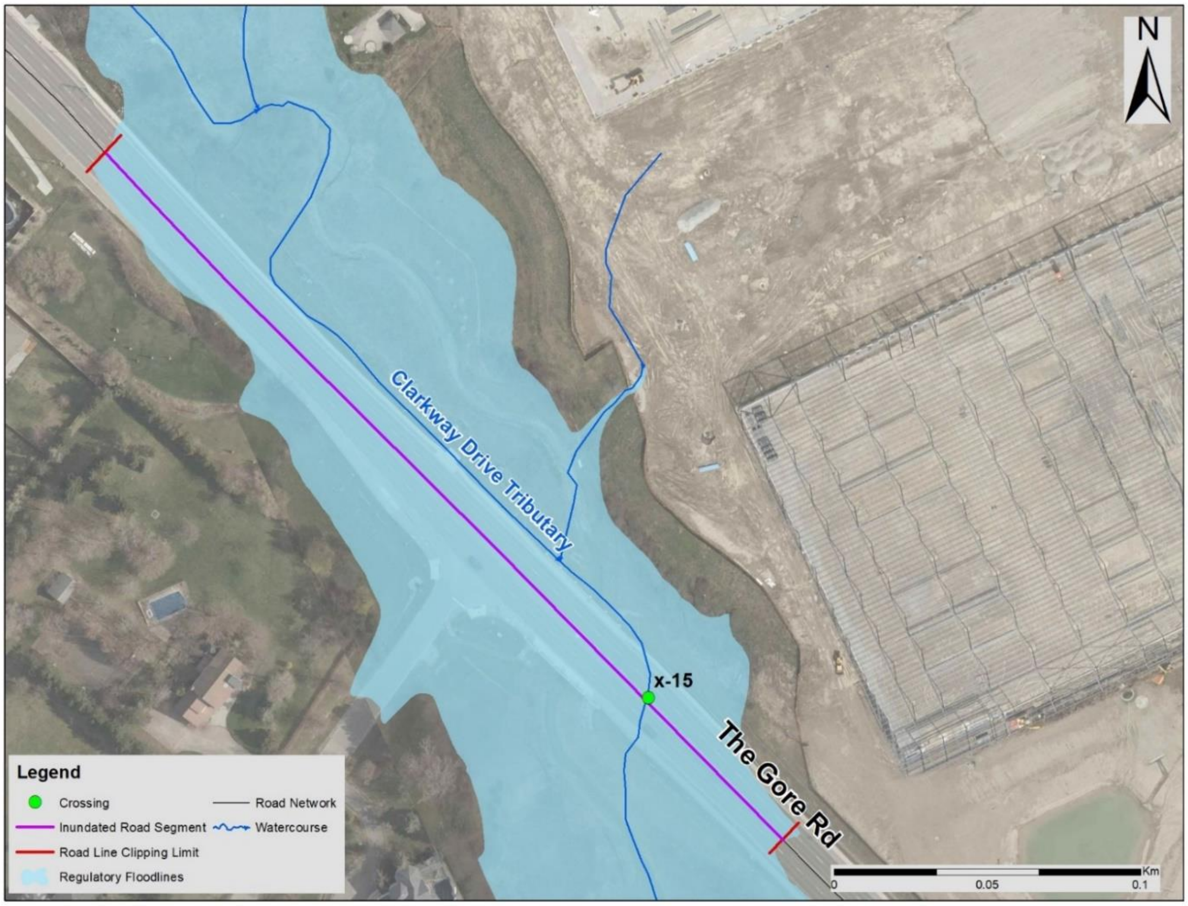


FIGURE 3.2 EXAMINING AND CLIPPING ROAD SEGMENTS TO MATCH FLOOD EXTENTS

*Step 1d: Delineate Road Edge Segments*

- Create a new polyline layer named Road Edge Lines, and then manually draw the road edge lines along the inundated road segment as illustrated in FIGURE 3.3.

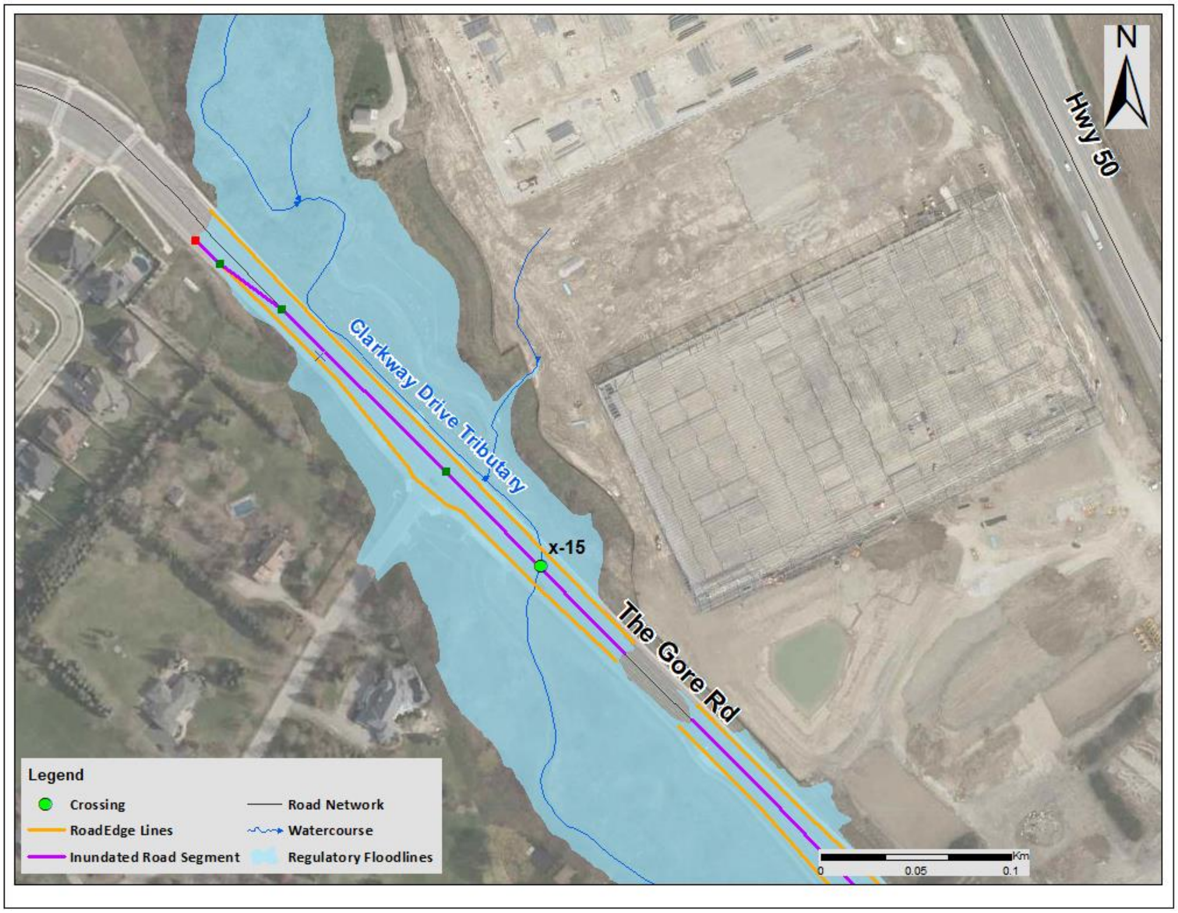


FIGURE 3.3 REDRAWING INUNDATED ROAD SEGMENTS TO ALIGN WITH THE ROAD EDGE

*Step 1e: Determine the Minimum Road Edge Elevation*

- The minimum elevation value along the road edge line was extracted from the topographic data by applying ArcGIS Zonal Statistics tool. This allowed for the identification of the lowest elevation point along the road edges.

***Step 2: Extract Results from Hydraulic Models and Create Worksheets***

This step was divided into the following two sub-steps:

*Step 2a: Extract Results from Hydraulic Models*

- Multiple detailed outputs were generated by HEC-RAS for each modeled crossing for various storm events including 2yr-100yr, and Regional events. The specific fields available depend on the type of crossing, whether it was a bridge or a culvert. TABLE 3.6 outlines the detailed output fields pertinent to this study, while FIGURE 3.4 and FIGURE 3.5 provide examples of typical HEC-RAS outputs for a culvert and a bridge, respectively.

**Table 3.6 List Of HEC-RAS Output Fields Relevant to the Study**

| Output Fields | Description | Note |
|---|---|---|
| Q Total | Total flow in a cross-section | Total flow in a cross-section immediately upstream of a crossing.<br><br>Not used for crossing capacity analysis but displayed to show peak flowrate for each storm event at each modelled crossing in a sub-table for the corresponding event. |
| W.S.US | Upstream water surface elevation upstream of bridge, culvert or weir | Used for crossing capacity analysis, and it is also included in a sub-table for the corresponding event. |
| E.G.US | Upstream energy grade elevation at bridge or culvert | Used for crossing capacity analysis. |
| Min El Weir Flow | Elevation where weir flow begins | Used for crossing capacity analysis. |
| Weir Avg Depth | Average depth over the weir | Average depth of flow over the road deck when road deck is overtopped. Empty in the HEC RAS output table means the road deck is not overtopped.<br><br>Used for crossing capacity analysis as Weir Max Depth is used for the analysis, but it is included in a sub-table for corresponding event. |
| Weir Max Depth | Max depth over the weir | Max. depth of flow over the road deck when road deck is overtopped. Empty in the HEC RAS output table means the road deck is not overtopped.<br><br>Used for crossing capacity analysis and included in the final master database as Max. depth of flow flooded by corresponding storm events. And it is also included in a sub-table for the corresponding event. |
| Weir Flow Area | Area of the flow going over a weir | |
| Wr Top Width | Total width of water over the weir | Total width of water over the road deck when road deck is overtopped. Empty in the HEC RAS output table means the road deck is not overtopped.<br><br>Used for crossing capacity analysis and included in the final master database as Road segment length flooded by the corresponding storm events. |
| Cul Vel US | Velocity in culvert at defined upstream | Velocity in entrance of culvert<br><br>Not used for crossing capacity analysis but included in a sub-table for the corresponding event as per request from Peel Region. |
| Cul. Inv El. US | invert elevation of the entrance of a crossing | |

| Output Fields | Description | Note |
|---|---|---|
| | | |
| BR Open Vel | Average velocity inside the bridge opening | Not used for crossing capacity analysis but included in a sub-table for the corresponding event as per request from Peel Region. |

Profile Output Table - Upper_Humber_Culverts

File Options Std. Tables User Tables Locations Help

HEC-RAS Plan: RevisedFlow_BC_April2023 | Reload Data

| River | Reach | River Sta | Profile | Q Total | W.S. US. | W.S. DS | Min El Weir Flow | Culv Inv El Up | Culv WS Inlet | Q Weir | Weir Avg Depth | Weir Max Depth | Wr Top Wdth | Culv Vel US | E.G. US. | Culv Area US | Weir Flow Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (m3/s) | (m) | (m) | (m) | (m) | (m) | (m3/s) | (m) | (m) | (m) | (m/s) | (m) | (m2) | (m2) |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | Regional | 5.19 | 285.40 | 285.29 | 285.33 | 283.83 | 284.73 | 4.57 | 0.07 | 0.23 | 154.09 | 0.98 | 285.40 | 0.64 | 10.53 |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | 100yr | 0.46 | 284.61 | 284.54 | 285.33 | 283.83 | 284.54 | | | | | 0.86 | 284.61 | 0.54 | |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | 50yr | 0.33 | 284.47 | 284.41 | 285.33 | 283.83 | 284.41 | | | | | 0.76 | 284.47 | 0.44 | |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | 25yr | 0.22 | 284.43 | 284.40 | 285.33 | 283.83 | 284.40 | | | | | 0.52 | 284.43 | 0.43 | |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | 10yr | 0.10 | 284.38 | 284.37 | 285.33 | 283.83 | 284.37 | | | | | 0.25 | 284.38 | 0.40 | |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | 5yr | 0.03 | 284.08 | 284.08 | 285.33 | 283.83 | 284.07 | | | | | 0.23 | 284.08 | 0.14 | |
| UpperHumberTrbL | Reach4 | 1026 hum_493 Culvert #1 | 2yr | 0.00 | 283.86 | 283.85 | 285.33 | 283.83 | 283.85 | | | | | 0.34 | 283.86 | 0.00 | |

Total flow in cross section.

**FIGURE 3.4 EXAMPLE OF TYPICAL HEC-RAS OUTPUT FOR A CULVERT**

Profile Output Table - Upper_Humber_Bridges

File Options Std. Tables User Tables Locations Help

HEC-RAS Plan: RevisedFlow_BC_April2023 | Reload Data

| River | Reach | River Sta | Profile | Q Total | W.S. US. | W.S. DS | Min El Weir Flow | Min El Prs | Prs/Wr WS | Q Weir | Weir Avg Depth | Weir Max Depth | Wr Top Wdth | BR Open Vel | E.G. US. | Weir Flow Area |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | (m3/s) | (m) | (m) | (m) | (m) | (m) | (m3/s) | (m) | (m) | (m) | (m/s) | (m) | (m2) |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | Regional | 8.08 | 256.66 | | 263.69 | 262.58 | | | | | | 0.89 | 256.68 | |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | 100yr | 3.12 | 256.29 | | 263.69 | 262.58 | | | | | | 0.63 | 256.31 | |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | 50yr | 2.74 | 256.25 | | 263.69 | 262.58 | | | | | | 0.61 | 256.26 | |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | 25yr | 2.37 | 256.20 | | 263.69 | 262.58 | | | | | | 0.57 | 256.21 | |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | 10yr | 1.88 | 256.13 | | 263.69 | 262.58 | | | | | | 0.52 | 256.14 | |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | 5yr | 0.22 | 255.77 | | 263.69 | 262.58 | | | | | | 0.81 | 255.77 | |
| UpperHumberTrbB | Reach2-DS-0 | 1666.61 hum_422 | 2yr | 0.13 | 255.72 | | 263.69 | 262.58 | | | | | | 0.61 | 255.72 | |

Total flow in cross section.

**FIGURE 3.5 EXAMPLE OF TYPICAL HEC-RAS OUTPUT FOR A BRIDGE**

*Step 2b: Create a Master Excel Worksheet*

- A master worksheet was created to include all the information extracted from hydraulic models for all modeled crossings within ROP.
- Additional parameters were added in the master worksheet which are required for crossing assessment, and these parameters are listed in TABLE 3.7.

TABLE 3.7 ADDITIONAL PARAMETERS ADDED TO THE MASTER WORKSHEET

| Parameter | Description |
|---|---|
| Cul. Rise | Opening height of a crossing |
| Cul. Span | Opening width of a crossing, and it is used as one of conditions to assign MTO flood criteria along with road function and road environment. |
| Open-Footing | Condition of the bottom of the culvert. If the bottom is defined by soil, rock or the watercourse channel, then it is defined as an Open-Footing culvert. |
| Effective Rise | As described in section 3.2.1.2 this is a parameter computed for open-footing culverts with irregular cross sections. |
| Soffit El. US | upstream soffit elevation – the top of opening elevation (i.e., invert of culvert entrance + culvert rise) |
| Pressurized (Y/N): | When water level upstream of a crossing is equal to or higher than top of opening elevation, a crossing is considered under pressure (i.e., Y); otherwise, it is set to N. |
| Overtopped (Y/N): | When water level upstream of a crossing is higher than minimum deck elevation, a crossing is considered overtopped (i.e., Y); otherwise, it is set to N (under this condition values in Weir Avg. depth/Weir Max. depth/Wr Top Width should be 0). |

TABLE 3.8 provides an example of Master Table used for culvert data processing in the Humber River Watershed. To enhance readability, the table has been divided into two separate tables placed sequentially, one below the other.

***Steps 3 & 4: Crossing Assessment for Various MTO Criteria Under Current and Future Climate Conditions***

As indicated in Section 3.2.1.1. Design Flows, the typical design flow criteria for crossings are 25-year, 50-year and 100-year depending on the road function and crossing span, and for future climate conditions these criteria were assumed to remain the same.

TABLE 3.9 summarizes the future equivalent return period storm events compared to the current climate scenario, and the shifted return periods were used for crossings assessment for future climate condition. As TABLE 3.9 indicated, a mid-century 25-year return period is equivalent to a current climate 100-year return period, and an end-of-century 8.4-year return period is equivalent to a current climate 100-year return period. For further details of Future Climate Change shift on data sources, assumptions, and calculations, please refer to the memorandum in Appendix A4.

Steps 3 and 4 were performed simultaneously and were divided into the following sub-steps.

TABLE 3.8 AN EXAMPLE OF MASTER TABLE USED FOR DATA PROCESSING

| River | Reach | River Sta | Profile | TRCA_ID | Structure Type | Q Total (m3/s) | W.S. US. (m) | W.S. DS (m) | Min El Weir Flow (m) | Culv Inv El Up (m) | Culv WS Inlet (m) | Q Weir (m3/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UpperHumberTrbO | Reach1 | 71.87 | 2yr | HUM_294 | Culvert | 0 | 276.26 | 276.26 | 279.23 | 275.96 | 276.26 | |
| UpperHumberTrbO | Reach1 | 71.87 | 5yr | HUM_294 | Culvert | 0.05 | 276.49 | 276.49 | 279.23 | 275.96 | 276.49 | |
| UpperHumberTrbO | Reach1 | 71.87 | 10yr | HUM_294 | Culvert | 0.18 | 276.62 | 276.62 | 279.23 | 275.96 | 276.62 | |
| UpperHumberTrbO | Reach1 | 71.87 | 25yr | HUM_294 | Culvert | 0.4 | 276.73 | 276.73 | 279.23 | 275.96 | 276.73 | |
| UpperHumberTrbO | Reach1 | 71.87 | 50yr | HUM_294 | Culvert | 0.61 | 276.82 | 276.81 | 279.23 | 275.96 | 276.81 | |
| UpperHumberTrbO | Reach1 | 71.87 | 100yr | HUM_294 | Culvert | 0.85 | 276.87 | 276.86 | 279.23 | 275.96 | 276.86 | |
| UpperHumberTrbO | Reach1 | 71.87 | Regional | HUM_294 | Culvert | 13.24 | 279.76 | 279.74 | 279.23 | 275.96 | 278.36 | 10.01 |

| Profile | TRCA_ID | Weir Avg Depth (m) | Weir Max Depth (m) | Wr Top Wdth (m) | Culv Vel US (m/s) | E.G. US. (m) | Weir Flow Area (m2) | Rise (m) | Span (m) | Open-bottom | Effective Rise (m) | Soffit El US (m) | Pressurized Y/N | Overtopped Y/N |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2yr | HUM_294 | | | | 0 | 276.26 | | 2.4 | 3 | Yes | 2.4 | 278.36 | N | N |
| 5yr | HUM_294 | | | | 0.03 | 276.49 | | 2.4 | 3 | Yes | 2.4 | 278.36 | N | N |
| 10yr | HUM_294 | | | | 0.09 | 276.62 | | 2.4 | 3 | Yes | 2.4 | 278.36 | N | N |
| 25yr | HUM_294 | | | | 0.17 | 276.73 | | 2.4 | 3 | Yes | 2.4 | 278.36 | N | N |
| 50yr | HUM_294 | | | | 0.24 | 276.82 | | 2.4 | 3 | Yes | 2.4 | 278.36 | N | N |
| 100yr | HUM_294 | | | | 0.31 | 276.87 | | 2.4 | 3 | Yes | 2.4 | 278.36 | N | N |
| Regional | HUM_294 | 0.28 | 0.53 | 50.07 | 0.45 | 279.76 | 14.08 | 2.4 | 3 | Yes | 2.4 | 278.36 | Y | Y |

**TABLE 3.9 IDF FUTURE CLIMATE CHANGE SHIFT**

| Return Period Current Climate | Return Period Mid-Century | Return Period End-of-Century |
|---|---|---|
| 2 | 1.2 | 0.7 |
| 5 | 2.6 | 1.3 |
| 10 | 4.4 | 2.1 |
| 25 | 8.7 | 3.6 |
| 50 | 14.2 | 5.5 |
| 100 | 25 | 8.4 |

*Steps 3&4 a: Create Template Worksheets*

- Two separate sheets were created, one for culverts and another for bridges, which were used to determine if MTO criteria are met. The main difference between the two tables is in the Flood Depth criterion that only applies to culverts as indicated in Section 3.2.1 MTO Criteria.

- Within these template worksheets, three Input Tables were created, and a Macro code was developed to automate the data transfer from the Master Table worksheet to Input Tables. These input tables played a key role in evaluating MTO criteria and identifying the key attributes for each crossing as presented in an example shown in **TABLE 3.10** and **TABLE 3.11** and explained in detail below.
    a) The input tables prepared for a culvert crossing on the Etobicoke Headwater North Tributary. In these tables the values in black are automatically calculated based on the input values in red.
    b) The values in red are either sourced from the HEC-RAS model or provided by the ROP, except for the Road Type, which is determined by CVC and TRCA.
    c) The TRCA classified roads as Urban or Rural using the StormDataBase shapefile provided by the ROP. Roads with storm manholes were classified as Urban, while those without were classified as Rural.
    d) The Road Type and structure span are used to determine the Design Flow for each crossing, following the MTO Highway Drainage Design Standard WC-1.

- Following this, a Summary Table was created to consolidate the results.
    a) Specific formulas were applied to its cells, enabling automatic calculations based on the data from the input tables.
    b) At the bottom of each sheet, a concise decision table summarized whether the criteria were met, displaying “Yes” or “No” accordingly.
    c) **TABLE 3.12** presented an example of the Summary Table. In this table the term 'Ex. Equiv. Storm' refers to the Existing Equivalent Storm values calculated based on IDF future climate change shift,

which are detailed in TABLE 3.9. For instance, if the Design Storm for a watercourse crossing is a 25-year event, TABLE 3.9 indicates that, under mid-century climate conditions, the 25-year storm corresponds to the intensity of a 100-year storm in the existing climate. Therefore, the Existing Equivalent Storm for a 25-year storm under mid-century climate condition is considered to be a 100-year storm.

TABLE 3.10 INPUT TABLES – A CULVERT CROSSING ON ETOBICOKE HEADWATER NORTH TRIBUTARY

| Item | Value |
|---|---|
| **Road Name:** | King St |
| **TRCA ID:** | ETO_024 |
| **Peel ID:** | - |
| **StmMainID:** | STNDRR009-0563-STNDRR009-0564 |
| **Road Class:** | Arterial |
| **Road Ownership:** | ROP |
| **Municipality:** | Caledon |
| **Model Name:** | Etobicoke_Extension |
| **Design Storm** | 25-Year |
| **Min El Weir (m)** | 284.03 |
| **Low Point at Road Edge (m)** | 283.99 |
| **Soffit Low Point (u/s) (m)** | 283.97 |
| **Soffit High Point (u/s) (m)** | 283.97 |

| Item | Value |
|---|---|
| **Road Type:** | Rural |
| **Str. Type** | Culvert |
| **Span (m)** | 0.90 |
| **Rise (m)** | 0.90 |
| **Eff Rise (m)** | - |
| **U/S Invert (m)** | 283.07 |
| **Erodable Btm** | No |
| **River Sta** | 394.37 |
| **Reach Name** | North O3 |
| **Opening Area ($m^2$)** | - |
| **Regulatory Storm** | Regional |

TABLE 3.11 UPSTREAM SECTION FLOWS FROM HEC-RAS MODEL – A CULVERT CROSSING ON ETOBICOKE HEADWATER NORTH TRIBUTARY

| | Flow | Upstream WSEL+EG | | Road Overtopping | |
|---|---|---|---|---|---|
| **Storm** | **(m3/s)** | **WSEL (m)** | **EG (m)** | **Q Weir $m^3/s$** | **Q Area $m^2$** |
| **2-Year** | 0.88 | 284.01 | 284.02 | - | - |
| **5-Year** | 1.54 | 284.10 | 284.10 | 0.54 | 1.83 |
| **10-Year** | 2.05 | 284.12 | 284.12 | 1.07 | 3.05 |
| **25-Year** | 2.77 | 284.14 | 284.14 | 1.78 | 4.40 |
| **50-Year** | 3.34 | 284.16 | 284.16 | 2.30 | 5.28 |
| **100-Year** | 3.94 | 284.17 | 284.17 | 2.84 | 6.14 |
| **Regional** | 14.74 | 284.33 | 284.33 | 13.59 | 19.36 |

TABLE 3.12 SUMMARY TABLE – A CULVERT CROSSING ON ETOBICOKE HEADWATER NORTH TRIBUTARY

| Top of Road and Soffit Clearance Summary | | | | | | | | Ex-Climate | Mid-Century | End-Century |
|---|---|---|---|---|---|---|---|---|---|---|
| **Structure (Upstream Face)** | **Storm** | | | | | | | **Design Storm** | **Ex. Equiv. Storm** | **Ex. Equiv. Storm** |
| **Description** | **2-Year** | **5-Year** | **10-Year** | **25-Year** | **50-Year** | **100-Year** | **Regional** | **25** | **100** | **na** |
| Top of Road Freeboard (Min.), Relief Flow (m) | -0.02 | -0.11 | -0.13 | -0.15 | -0.17 | -0.18 | -0.34 | -0.15 | -0.18 | na |
| Top of Road Freeboard (Desired) | -0.03 | -0.11 | -0.13 | -0.15 | -0.17 | -0.18 | -0.34 | -0.15 | -0.18 | na |
| Top of Road Velocity (m/s) | na | 0.30 | 0.35 | 0.40 | 0.44 | 0.46 | 0.70 | | | |
| Top of Road Velocity x Depth ($m^2/s$) | na | 0.03 | 0.05 | 0.06 | 0.07 | 0.08 | 0.24 | | | |
| Flood Depth (HW/D,HW) (Non-Erodable Btm) | 1.04 | 1.14 | 1.17 | 1.19 | 1.21 | 1.22 | 1.40 | 1.19 | 1.22 | na |
| Soffit Clearance (Upstream) (m) (Pressurized) | -0.04 | -0.13 | -0.15 | -0.17 | -0.19 | -0.20 | -0.36 | -0.17 | -0.20 | na |

| Top of Road and Soffit Clearance Criteria Summary | | Ex-Climate | Mid-Century | End-Century |
|---|---|---|---|---|
| **Criteria** | **Criteria** | **Meets Criteria** | **Meets Criteria** | **Meets Criteria** |
| **Description** | **Storm** | **(Yes or No)** | **(Yes or No)** | **(Yes or No)** |
| Top of Road Freeboard (Min.) | **25-Year** | No | No | No |
| Top of Road Freeboard (Desired) | **25-Year** | No | No | No |
| Relief Flow (Max. Depth over roadway) | **Regional** | No | No | No |
| Relief Flow (Velocity x Depth) | **Regional** | Yes | Yes | Yes |
| Flood Depth (HW/D,HW) (Non-Erodable Btm) | **25-Year** | Yes | Yes | na |
| Design Flow | **25-Year** | No | No | No |

**Summary Table Notes:**
1) All values are automatically tabulated
2) Each color corresponds to a specific MTO criterion, as outlined in the MTO-Drainage Design Standards table located at the far right of the spreadsheet for easy reference.

*Steps 3&4 b: Automation Using Excel Macros*

- To streamline the process, an Excel Macro was developed.
- Depending on the type of crossings (i.e. culvert or bridge),
  a) the respective template sheet was selected, and a new worksheet was generated, and
  b) data from the Master worksheet was transferred into Input Tables including W.S.US, E.G.US, Q Weir, Weir Flow Area, Soffit El US, Rise/Effective Rise, Span, and
  c) automated calculations, performed within the cells of the Summary Table, determined which MTO criteria were met for the specific crossing. This resulted in the production of 142 worksheets, each designated for a different crossing.

*Steps 3&4 c: Create a Single Output Spreadsheet*

- For the final step of crossing assessment, another Excel Macro was developed to streamline the process,
- The Macro automated copy and paste of the final results from each worksheet into one single spreadsheet that would be used as the attribute table of the geodatabase deliverable.

***Step 5: Generate GIS geodatabase outputs for visualization in GIS environment***

- In the final step, all data analyzed from the previous steps was compiled into a comprehensive GIS geodatabase. This step involved creating an attribute table and spatial layer in ArcMap software, allowing for dynamic mapping and visualization. The generated geodatabase layer can be used for interactive map generation, detailed flood risk assessments, and planning for crossing and road infrastructure improvements. Additionally, the outputs facilitate the identification of critical crossings that require adaptive measures, thereby aiding long-term regional flood resilience strategies.

## 3.3 Roads Assessment

**Table 3.13** presents the criteria used for road assessment were based on Major System – Allowable Flow Spread on Regional Roads from Table 5.7.1 Section 5.3 ROP Public Works Stormwater Design Criteria and Procedure Manual (ROP, June 2019 version 2.1) specifically for Arterial Road Type. The following section discusses ROP criteria in detail.

**Table 3.13 Major System - Allowable Flow Spread on Regional Roads**

| Type of Road | Major System Design Criteria | Criteria to Follow |
|---|---|---|
| Collector | Greater than 10-year up to 100-year | The maximum depth of flow shall be the lesser of 10 cm above the crown of the road or the water level up to the right-of-way. |
| Arterial | Greater than 10-year up to 100-year | No barrier curb overtopping. [1] Flow spread must leave at least one lane free of water in each direction. |

| | | |
|---|---|---|
| | | Preferred Criteria: no greater than 150 mm under 100-year storm event. |
| Road underpass | Greater than 10-year up to 100-year | Since there is no overland flow route possible, water can be expected to accumulate for the event. [2] |

Notes:

1. When no barrier curb exists (i.e., ditches or LIDs), encroachment onto adjacent private property is not to occur (including under 100-year storm). Minimum freeboard of 300 mm under minor system design storm.

2. For road underpasses of importance and on a case-by-case basis alternate means such as pumping may be considered to increase the storm level of protection beyond the minor system capacity.

### 3.3.1 ROP Criteria

One of the fundamental assumptions underlying ROP criteria is the consideration of the crown of the road, which assumes the highest point of a road cross-section is in the center with the road sloping outward in both directions with a 2% crossfall. Furthermore, the criteria specified a lane width of 3.5 meters and that flow spread must leave at least one lane free of water in each direction during a storm event of greater than 10-year up to 100-year. Considering these assumptions, as shown in FIGURE 3.6, ROP suggested that the maximum flood depth should not exceed 15cm for a six-lane road (three lanes on each side of the road), 7cm for a four-lane road, and no inundation should occur for a two-lane road.

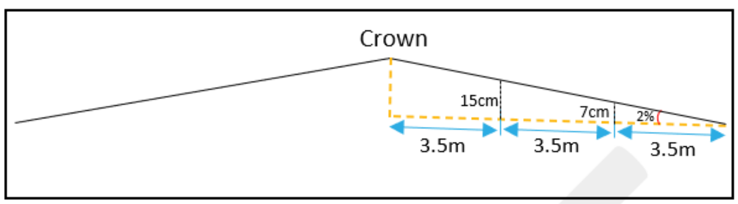


FIGURE 3.6 SCHEMATIC OF A ROAD CROSS-SECTION WITH MAXIMUM ALLOWABLE FLOOD DEPTHS BASED ON ROP CRITERIA

### 3.3.2 Road Assessment Workflow

Similar to the crossing assessment, A high-level flowchart and a detailed flowchart were created for the road assessment. A high-level flowchart illustrates the overall workflow of five major steps of the road assessment as shown in FIGURE 3.7, and a detailed flowchart provides a breakdown of these five major steps into the sequence of steps and decisions needed to perform road assessment process. The detailed flowchart is included in Appendix A1b.

There are several tools used to perform the road assessment process, which include HEC-RAS (including RAS Mapper) and GeoHEC-RAS for model results preparation and extraction, Excel spreadsheets and ESRI ArcGIS for data pre- and post-processing.

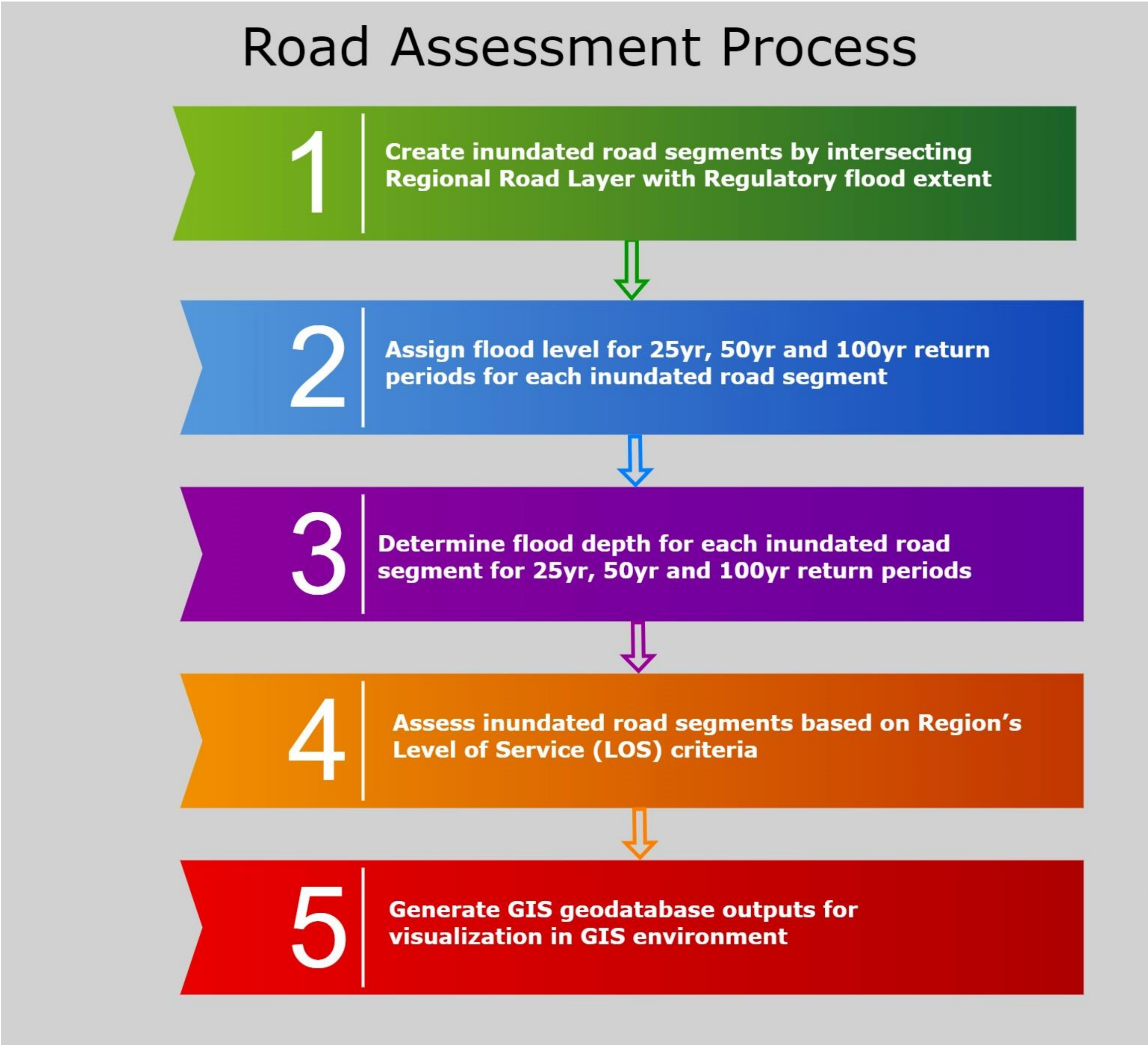


FIGURE 3.7 THE HIGH-LEVEL FLOWCHART OF OVERALL WORKFLOW FOR THE ROAD ASSESSMENT

#### 3.2.2.1 Road Assessment Process

This section presents a detailed description of the five major steps on the road assessment process as indicated in FIGURE 3.7.

***Step 1: Create Inundated Road Segments***

This step is divided into the following sub-steps:

*Step 1a: Delineate Road Edge Segments*

In this step, the clipped road segment lines that were generated in Section 3.2.2.1 were copied and redrawn to align precisely with the actual road edge lines delineated in the same section. This involved manually editing the road segment vertices to ensure perfect alignment with the road edge in both travel directions.

This approach was chosen because certain attributes were needed from the ROP Road Network attribute table, and delineating the road edge lines in this manner made it significantly easier to extract the required information than first creating road edge lines, clipping them to match the inundated segments, and then transferring the required attributes from the Road Network attribute table to the new Road Edge Lines layer. FIGURE 3.8 illustrates an example of redrawing the inundated road segment to align with the edge of the road.

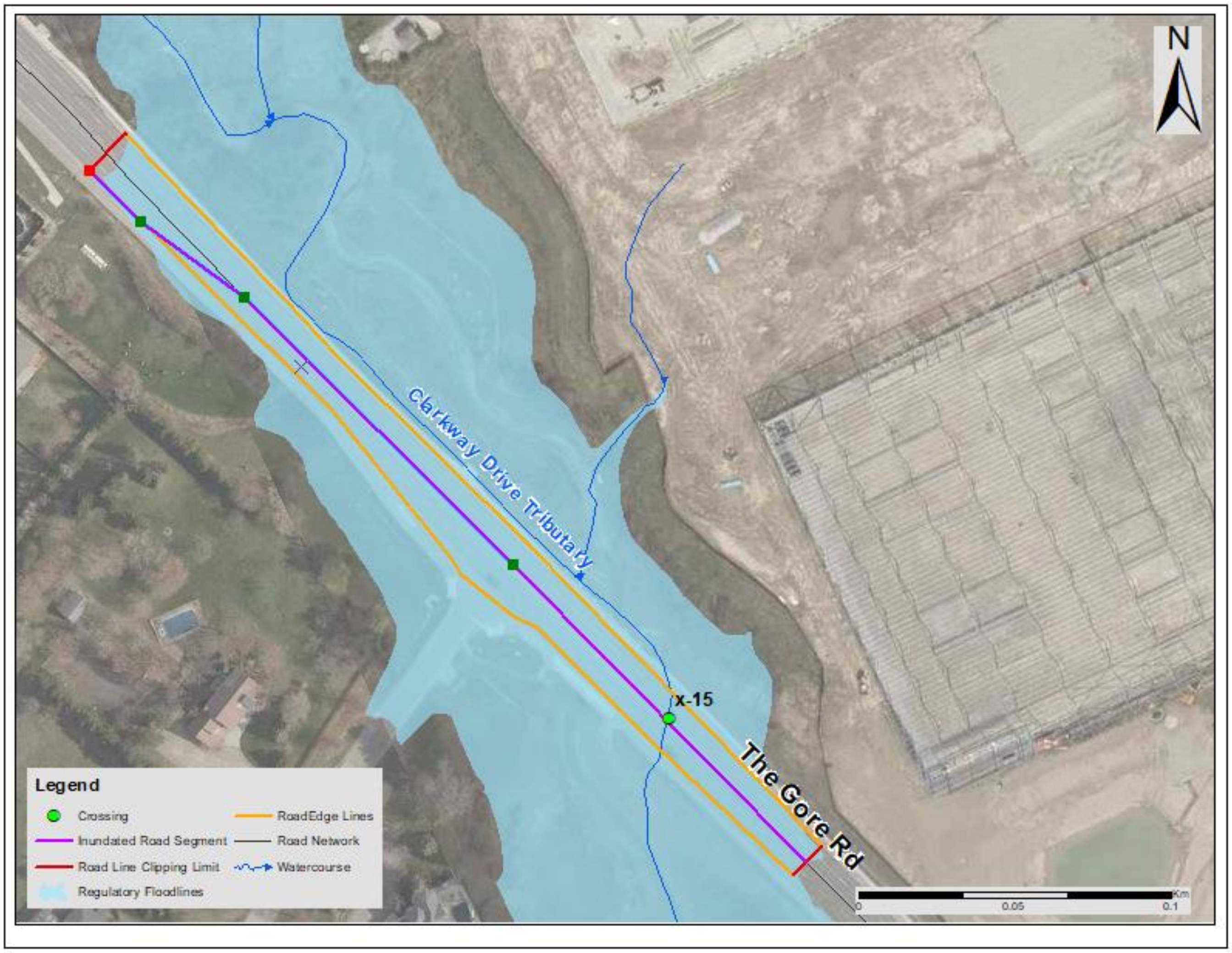


FIGURE 3.8 REDRAWING INUNDATED ROAD SEGMENTS TO ALIGN WITH THE ROAD EDGE

*Step 1b: Create Unique IDs for Road Segments*

To assign minimum road edge elevation, water surface elevation, and maximum flood depth values to each road edge segment using the Zonal Statistics tool in ArcMap, a unique ID for each road edge segment on each side of the road is required. Since the ROPSEGID attribute is the same for the road edge lines on both sides of the road, a unique identifier must be created. This is accomplished by adding the Dir attribute to determine the direction of travel (e.g., north, northwest, southeast) for each side of the road. A new attribute, ROPID_Dir, is then created by merging the contents of the ROPSEGID and Dir attributes. For example, a road segment with a ROPSEGID of 12005 and a Dir value of NW will have a ROPID_Dir value of 12005_NW. A sample of the attribute table is shown in FIGURE 3.9.

| FID | Shape * | CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir |
|---|---|---|---|---|---|---|---|
| 0 | Polyline | ETO_029 | Etobicoke Creek | Mississauga Rd | 20622 | NW | 20622_NW |
| 1 | Polyline | ETO_029 | Etobicoke Creek | Mississauga Rd | 20622 | SE | 20622_SE |
| 2 | Polyline | ETO_024 | Etobicoke Creek | King St | 9868 | NE | 9868_NE_1 |
| 3 | Polyline | ETO_024 | Etobicoke Creek | King St | 9868 | NE | 9868_SW_1 |
| 4 | Polyline | ETO_017 | Etobicoke Creek | King St | 9868 | SW | 9868_SW |
| 5 | Polyline | ETO_018 | Etobicoke Creek | King St | 21898 | SW | 21898_SW |
| 6 | Polyline | ETO_017 | Etobicoke Creek | King St | 9868 | NE | 9868_NE |
| 7 | Polyline | ETO_018 | Etobicoke Creek | King St | 21898 | NE | 21898_NE |
| 8 | Polyline | ETO_026 | Etobicoke Creek | King St | 21898 | SW | 21898_SW_1 |
| 9 | Polyline | ETO_023 | Etobicoke Creek | King St | 16889 | NE | 16889_NE |
| 10 | Polyline | ETO_023 | Etobicoke Creek | King St | 16889 | SW | 16889_SW |
| 11 | Polyline | ETO_049 | Etobicoke Creek | King St | 16889 | NE | 16889_NE_1 |
| 12 | Polyline | ETO_049 | Etobicoke Creek | King St | 16889 | SW | 16889_SW_1 |
| 13 | Polyline | Unassigned | Etobicoke Creek | Dixie Rd | 40156 | SE | 40156_SE |
| 14 | Polyline | Unassigned | Etobicoke Creek | Dixie Rd | 40157 | SE | 40157_SE |
| 15 | Polyline | Unassigned | Etobicoke Creek | Dixie Rd | 40587 | SE | 40587_SE |
| 16 | Polyline | Unassigned | Etobicoke Creek | Dixie Rd | 39870 | SE | 39870_SE |
| 17 | Polyline | Unassigned | Etobicoke Creek | Dixie Rd | 6627 | NW | 6627_NW |
| 18 | Polyline | Unassigned | Etobicoke Creek | Dixie Rd | 12005 | NW | 12005_NW |
| 19 | Polyline | ETO_224 | Etobicoke Creek | Bovaird Dr E | 41357 | SE | 41357_SE |
| 20 | Polyline | ETO_224 | Etobicoke Creek | Bovaird Dr E | 40158 | SE | 40158_SE |
| 21 | Polyline | ETO_224 | Etobicoke Creek | Bovaird Dr E | 40404 | SE | 40404_SE |
| 22 | Polyline | ETO_224 | Etobicoke Creek | Bovaird Dr E | 40032 | SW | 40032_SW |
| 23 | Polyline | ETO_224 | Etobicoke Creek | Bovaird Dr E | 40021 | SW | 40021_SW |

FIGURE 3.9 SAMPLE ATTRIBUTE TABLE SHOWING UNIQUE ROPID_DIR VALUES FOR ROAD EDGE SEGMENTS BY DIRECTION OF TRAVEL

### *Step 2: Assign flood level to each inundated road segment*

*Step 2a: Determine the Minimum Road Edge Elevation*

With the road edge segments accurately delineated, the next step is to determine the minimum road elevation along these segments. Zonal Statistics Tool from ArcMap is used with ROPID Dir as the identifier to calculate the minimum elevation. This involves analyzing elevation data to find the lowest point along each road edge segment, which is critical for assessing flood risk.

*Step 2b: Assign elevation to each inundated road segment*

The minimum road elevation determined in the previous step is then assigned to each inundated road segment. This is done by joining the output of the zonal statistics table to the shapefile using ROPID_Dir as the joining field. This step integrates the elevation data into the spatial dataset, ensuring that each road segment has an associated minimum elevation attribute.

*Step 2c: Assign flood level to each inundated road segment*

In this step, Water Surface Elevation (WSE) extracted from HEC-RAS models for the 25-year, 50-year, and 100-year storm events are assigned to each inundated road segment. This assignment is performed by joining the table containing water level values for each crossing with the shapefile attribute table of the road segments, using the unique identifier attribute (TRCA_ID) as the joining field.

***Step 3: Determine flood depth at each inundated road segment***

Determining the flood depth for each road segment involves several sub-steps. First, the inundation type is checked. If the type is “At Crossing” the WSE is extracted from the upstream cross-section (US Cross Section) based on the TRCA_ID. For segments with an “Adjacent” inundation type, the flood depth is obtained from the flood depth raster produced by the HEC-RAS model. In areas where 2D modeling is conducted, flood depths are extracted from the corresponding 2D model flood depth raster.

Next, the WSE and flood depth data are joined to the shapefile, integrating it with the road segment attributes. For road segments with an “At Crossing” inundation type, the flood depth is calculated by subtracting the WSE from the minimum road edge elevation. For segments with an "Adjacent" inundation type, the maximum flood depth extracted from the 1D and/or 2D model flood depth raster is used.

***Step 4: Assess Inundated Road segments based on ROP’s LOS***

The final step involves checking if the Level of Service (LOS) criteria are met for each road segment. The LOS is determined based on the number of lanes of the road segment and at least one lane free of water in each direction as indicated in Section 3.3 as described below:

- For 2 lanes, the LOS criterion is 0 cm, meaning no flooding is acceptable.
- For 3 and 4 lanes, the LOS criterion is 7 cm, allowing for a small amount of flooding.
- For 6 lanes or more, the LOS criterion is 15 cm, accommodating a higher tolerance for flooding.

These LOS criteria are then checked against the flood depth for different flood scenarios, including 100-year, 50-year, and 25-year flood events. This comparison helps in determining if the road segments meet the acceptable level of service during these flooding events. If the flood depth exceeds the LOS criterion, it indicates a failure to meet the required service level, highlighting areas where flood risk management measures need to be implemented to improve road resilience and safety.

***Step 5: Generate GIS geodatabase outputs for visualization in GIS environment***

In the final step, all data analyzed from the previous steps are compiled into a comprehensive GIS geodatabase. This step involves creating an attribute table and spatial layer in ArcMap software, allowing for dynamic mapping and visualization. The generated geodatabase layer can be used for interactive map generation, detailed flood risk assessments, and planning for road infrastructure improvements. Additionally, the outputs facilitate the identification of critical road segments that require adaptive measures, thereby aiding long-term regional flood resilience strategies.

# 4 RESULTS AND DISCUSSION

This section presents and discusses the assessment results of the hydraulic capacity of watercourse crossings and the vulnerability of regional roads to various flood events under current and future climate conditions. The assessment results are presented in two formats: summary tables and spatial geodatabases for GIS visualization.

It begins with an assessment of watercourse crossings under the current climate, examining their compliance with established MTO criteria and identifying any regional crossings that may require improvement to meet MTO criteria. The analysis then shifts to future climate scenarios, evaluating how watercourse crossings are projected to perform under anticipated mid-century and end-of-century climate changes, highlighting potential impacts and necessary adaptations to meet the MTO criteria assuming the current criteria remained the unchanged. Following this, the section examines the vulnerability of regional roads to various flood events in the current climate, assessing their compliance with ROP criteria and identifying areas that may need improvement.

It is important to note that the MTO criteria are standards that apply to new highway drainage infrastructure and to retrofit projects on existing roads and bridges that fall under the MTO jurisdiction. The standards may not always be applicable/achievable on retrofit projects due to site constraints, environmental considerations, existing infrastructure conditions, or other factors. In cases where the MTO standards are not achievable in retrofit projects and a crossing requires immediate attention, it is suggested that a thorough analysis needs to be carried out to assess the specific challenges and determine whether there are feasible alternative solutions.

## 4.1 Crossing Assessment

### 4.1.1 Current Climate Condition

#### *4.1.1.1. MTO **Design Flow Criterion***

**Overall Summary**

**FIGURE 4.1** Distribution of watercourse crossings assessed against MTO Design Flow criterion on ROP regional roads in current climate scenario illustrates the assessment results of watercourse crossings on regional roads against the MTO Design Flow criterion in the current climate condition, with 1) Green circles indicating crossings that meet the criterion and 2) Red circles indicating those that do not. As shown in the figure, most of the crossings meet the design flow criterion, accounting for nearly 87% of the total, while the remaining 13% that do not meet the criteria are dispersed throughout the region, with a notable concentration along King Street. To have a better view of the regions where the crossings are so close to each other and have formed a cluster, panels have been created which provide a zoomed-in view of these areas.

**Detailed Summary**

**TABLE 4.1** provides a detailed summary of the crossings that meet or do not meet the design flow criterion on each regional road in the current climate scenario. As inferred from this table, the greatest number of crossings are on four major regional roads as detailed below.

- King St leads with 26 crossings, of which 19 meet the design flow criterion while 7 do not. This indicates a high level of compliance but also highlights areas needing improvement.
- The Gore Rd follows with 24 crossings, showing strong performance with 21 meeting the criterion and 3 failing to do so, suggesting minor areas for enhancement.
- Mayfield Rd has 20 crossings with a commendable 19 meeting the criterion and only 1 not meeting it, indicating robust infrastructure planning.
- Airport Rd has 16 crossings, 14 of which meet the design flow criteria, while 2 do not, pointing to the potential need for improvement in specific areas.

The other regional roads generally exhibit strong compliance with the design flow criterion as summarized below.

- Hwy 50 with 12 crossings has 11 meeting the criterion and only 1 not, showing good overall performance.
- Dixie Rd with 9 crossings, also performs well, with 8 meeting the criterion and just 1 not meeting criteria.
- Queen St E and Steeles Ave E show similar trends, with 7 out of 8 crossings and 6 out of 7 crossings meeting the criterion, respectively.
- Roads like Bovaird Dr E, Derry Rd E, Emil Kolb Pky, King St E, Mississauga Rd, Queen St N, and Queensway E exhibit full compliance, with all their crossings meeting the design flow criterion. Old Church Rd shows strong performance with 4 out of 5 crossings meeting the criterion.

Overall, the roads exhibit a high level of compliance, with a total of 124 out of 143 crossings meeting the design flow criterion and only 19 not meeting.

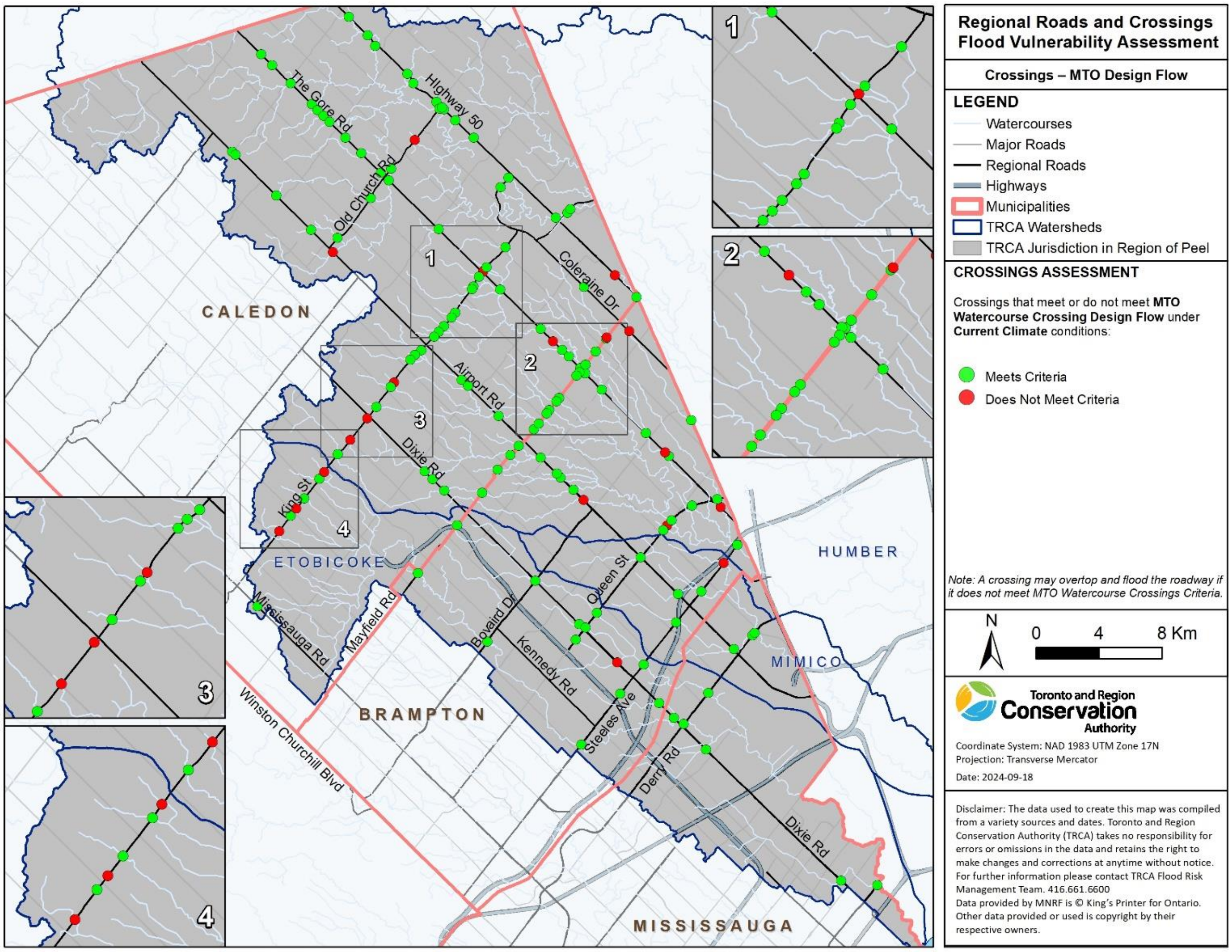


**FIGURE 4.1 DISTRIBUTION OF WATERCOURSE CROSSINGS ASSESSED AGAINST MTO DESIGN FLOW CRITERION ON ROP REGIONAL ROADS IN CURRENT CLIMATE SCENARIO**

**TABLE 4.1 SUMMARY OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW CRITERION IN CURRENT CLIMATE SCENARIO**

| Road Name | Total Number of Crossings | Number of Crossings that Meet Design Flow Criterion | Number of Crossings that Do Not Meet Design Flow Criterion |
|---|---|---|---|
| King St | 26 | 19 | 7 |
| The Gore Rd | 24 | 21 | 3 |
| Mayfield Rd | 20 | 19 | 1 |
| Airport Rd | 16 | 14 | 2 |
| Hwy 50 | 12 | 11 | 1 |
| Dixie Rd | 9 | 8 | 1 |
| Queen St E | 8 | 7 | 1 |
| Steeles Ave E | 7 | 6 | 1 |
| Old Church Rd | 5 | 4 | 1 |
| Derry Rd E | 4 | 4 | 0 |
| Bovaird Dr E | 2 | 2 | 0 |
| Emil Kolb Pky | 3 | 3 | 0 |
| King St E | 2 | 2 | 0 |
| Coleraine Dr | 2 | 1 | 1 |
| Mississauga Rd | 1 | 1 | 0 |
| Queen St N | 1 | 1 | 0 |
| Queensway E | 1 | 1 | 0 |
| **Total** | **143** | **124** | **19** |

#### *4.1.1.2 **All MTO Criteria***

**Overall Summary**

The hydraulic capacity assessment of watercourse crossings was conducted against Design Flow, Freeboard, Relief Flow and Soffit Clearance of MTO criteria) for the current climate condition. Among the four criteria, the Design Flow criterion is the minimum requirement and the most important. At a minimum, the crossing must be designed to handle the design flow. The other three criteria come into play when considering the site conditions, capital availability and safety/regulatory standards. The results of the assessment are illustrated in FIGURE 4.2, where Green circles denote crossings that meet all the criteria, whereas red circles indicate those that do not meet at least one criterion. As shown in this figure, around 62% of the crossings do not meet at least one criterion, whereas only 38% meet all the criteria. It is important to note that the assessment of all MTO criteria was conducted on certain structures built prior to the implementation of the current design standards. As a result, the design and construction methods of these older structures may not fully align with current standards, potentially affecting their performance. For details about the MTO criteria used in the assessment, please refer to Section 1.3.2 Assumptions and Limitations and Section 3.2.1 MTO Criteria.

**Detailed Summary**

TABLE 4.2 provides a detailed summary of assessment results of watercourse crossings against All MTO Criteria. The four major regional roads with the greatest number of crossings are summarized below:

- King St stands out with 8 crossings meeting the criteria, while 18 crossings require improvements to meet standards.
- The Gore Rd demonstrates moderate performance with 13 compliant crossings and 11 needing enhancement.
- Mayfield Rd has 9 crossings meeting the criteria and 11 needing improvement to meet standards.
- Airport Rd highlights areas for improvement, with only 5 crossings meeting standards out of 16.

The other regional roads generally exhibit moderate compliance with All MTO Criteria as summarized below.

- Highway 50 and Dixie Rd exhibit moderate compliance, with 4 and 2 crossings meeting the criteria, respectively, indicating room for improvement.
- Queen St E and Steeles Ave E perform reasonably well, with 3 and 5 compliant crossings, respectively.
- Old Church Rd, Derry Rd E, Bovaird Dr E, King St E, Mississauga Rd and Queen St N show opportunities for improvement, with all crossings benefitting from enhancements to meet standards.

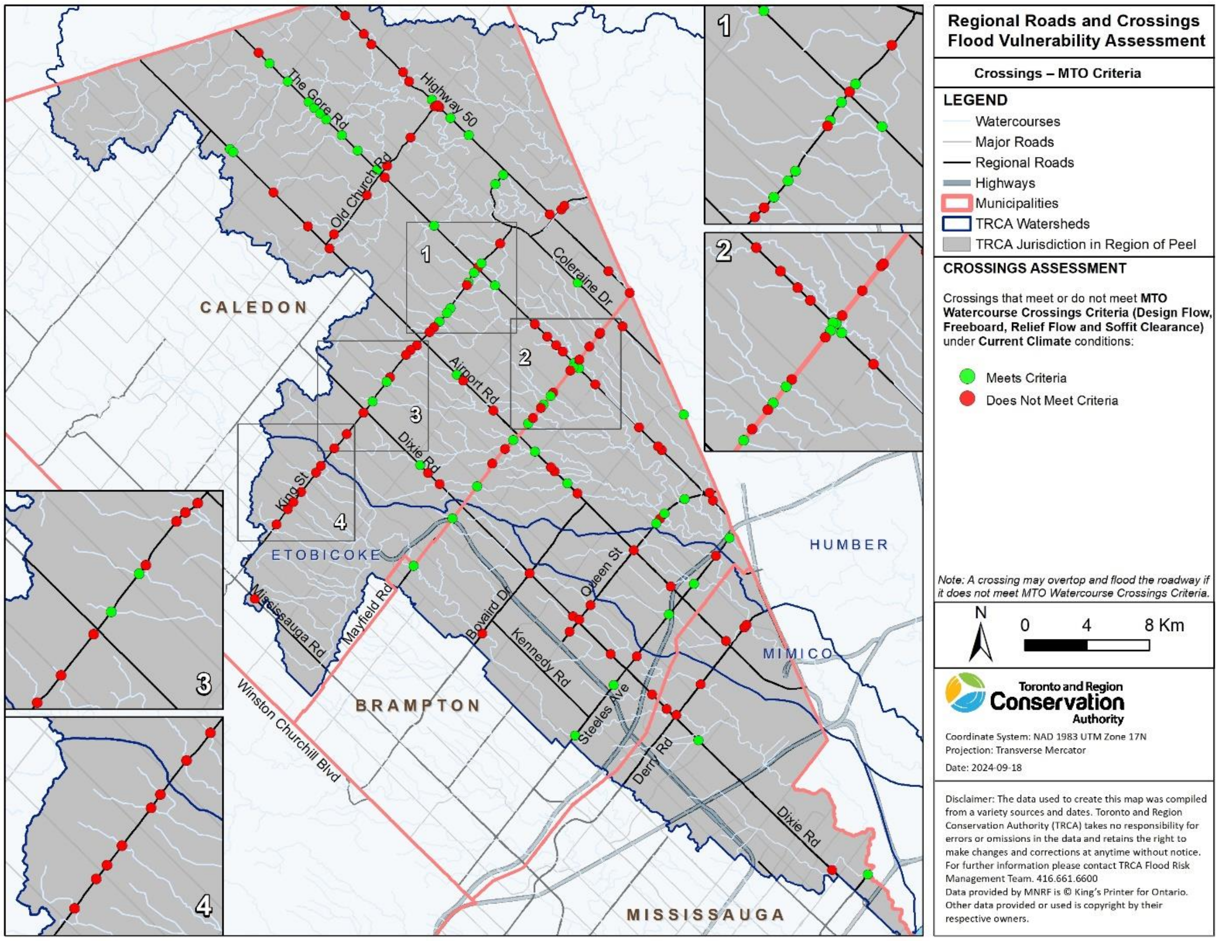


**FIGURE 4.2 DISTRIBUTION OF WATERCOURSE CROSSINGS ASSESSED AGAINST MTO DESIGN FLOW, FREEBOARD, RELIEF FLOW AND SOFFIT CLEARANCE CRITERIA ON ROP REGIONAL ROADS IN CURRENT CLIMATE SCENARIO**

**TABLE 4.2 SUMMARY OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW, FREEBOARD, RELIEF FLOW AND SOFFIT CLEARANCE CRITERIA IN CURRENT CLIMATE SCENARIO**

| Road Name | Total Number of Crossings | Number of Crossings that Meet All MTO Criteria | Number of Crossings that Do Not Meet All MTO Criteria |
|---|---|---|---|
| King St | 26 | 8 | 18 |
| The Gore Rd | 24 | 13 | 11 |
| Mayfield Rd | 20 | 9 | 11 |
| Airport Rd | 16 | 5 | 11 |
| Hwy 50 | 12 | 4 | 8 |
| Dixie Rd | 9 | 2 | 7 |
| Queen St E | 8 | 3 | 5 |

| Road Name | Total Number of Crossings | Number of Crossings that Meet All MTO Criteria | Number of Crossings that Do Not Meet All MTO Criteria |
|---|---|---|---|
| Steeles Ave E | 7 | 5 | 2 |
| Old Church Rd | 5 | 0 | 5 |
| Derry Rd E | 4 | 0 | 4 |
| Bovaird Dr E | 2 | 0 | 2 |
| Emil Kolb Pky | 3 | 3 | 0 |
| King St E | 2 | 0 | 2 |
| Coleraine Dr | 1 | 1 | 1 |
| Mississauga Rd | 1 | 0 | 1 |
| Queen St N | 1 | 0 | 1 |
| Queensway E | 1 | 1 | 0 |
| **Total** | **143** | **54** | **89** |

#### *4.1.1.3 **Comparison of Crossings that Meet Design Flow Criterion and All MTO Criteria***

**Table 4.3** and the bar chart in **Figure 4.3** shows a comparison of the number of crossings assessed against both Design Flow criterion and All MTO criteria. With All MTO criteria including additional criteria such as Freeboard, Clearance etc., the comparison shows:

- On King St, The Gore Rd, Mayfield Rd, Airport Rd, Hwy 50, Dixie Rd and Queen St E where greatest number of crossings are present, around 50% of crossings meet Design Flow criterion but do not comply with All MTO Criteria.
- On Steeles Ave E, Emil Kolb Pky, Coleraine Dr and Queensway E, all crossings meet both Design Flow Criterion and All MTO Criteria, showing high compliance with the standards.
- On Old Church Rd, Derry Rd E, Bovaird Dr E, King St E, Mississauga Rd and Queen St N, none of crossings meet All MTO Criteria but they all meet Design Flow Criterion.

**TABLE 4.3 COMPARISON OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW AND ALL MTO CRITERIA IN CURRENT CLIMATE SCENARIO**

| Road Name | Total Number of Crossings | Number of Crossings that Meet Design Flow Criterion | Number of Crossings that Meet all MTO Criteria |
|---|---|---|---|
| King St | 26 | 19 | 8 |
| The Gore Rd | 24 | 21 | 13 |
| Mayfield Rd | 20 | 19 | 9 |
| Airport Rd | 16 | 14 | 5 |
| Hwy 50 | 12 | 11 | 4 |
| Dixie Rd | 9 | 8 | 2 |
| Queen St E | 8 | 7 | 3 |
| Steeles Ave E | 7 | 6 | 5 |
| Old Church Rd | 5 | 4 | 0 |
| Derry Rd E | 4 | 4 | 0 |
| Bovaird Dr E | 2 | 2 | 0 |
| Emil Kolb Pky | 3 | 3 | 3 |
| King St E | 2 | 2 | 0 |
| Coleraine Dr | 2 | 1 | 1 |
| Mississauga Rd | 1 | 1 | 0 |
| Queen St N | 1 | 1 | 0 |
| Queensway E | 1 | 1 | 1 |
| **Total** | **143** | **124** | **54** |

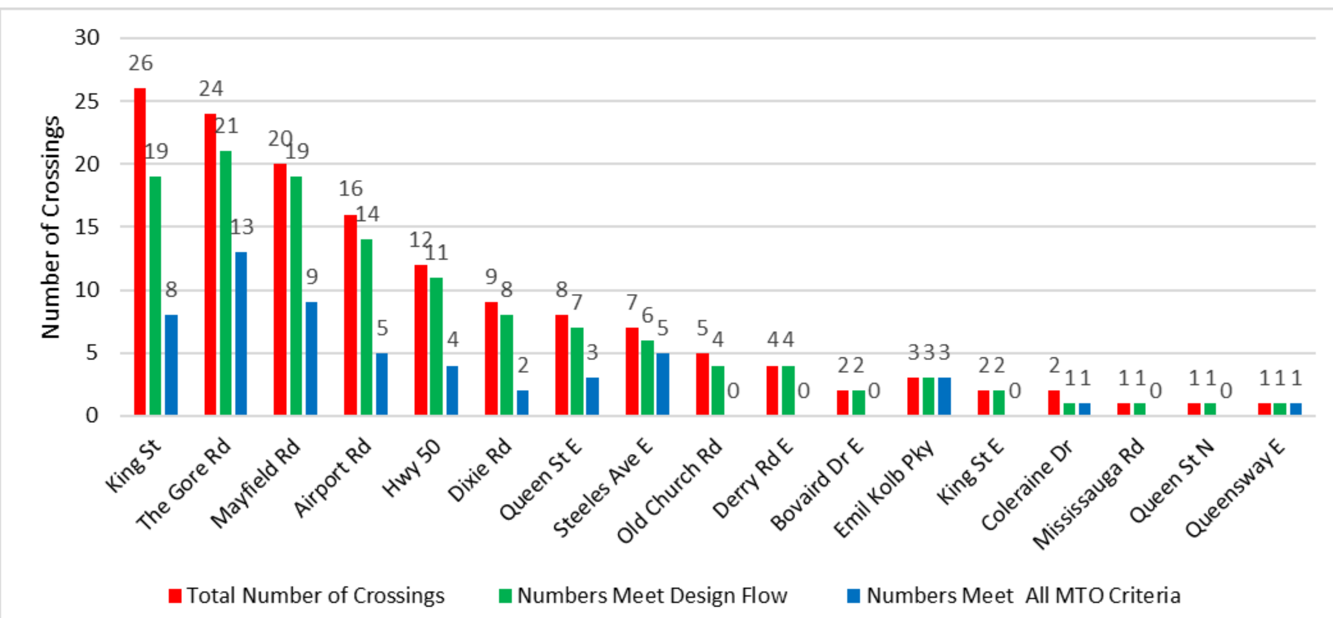


**FIGURE 4.3 COMPARISON OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW AND ALL MTO CRITERIA IN CURRENT CLIMATE SCENARIO**

#### 4.1.1.4 ***Crossing Overtopping***

**Overall Summary**

FIGURE **4.4** shows the results of the analysis of crossing overtopping, indicating the starting storm event when the crossing is overtopped in current climate condition. The crossings have been color-coded to show their vulnerability to different storm events as follows:

- Dark red indicating crossings likely to be overtopped in a 2-year storm,
- Light red for 5-year storms,
- Orange for 10-year storms,
- Yellow for 25-year storms,
- Medium apple for 50-year storms,
- Green for 100-year storms,
- Leaf green for Regulatory storms, and
- Tarragon green for those unlikely to be overtopped in any storm event

The maps reveal that most of the crossings can withstand the Regulatory and greater than Regulatory storms, and only a small portion of them are vulnerable to storm events smaller than 50-year. It should be noted that mapping for the crossing overtopping was not produced for future climate conditions, due to challenges visualizing the data, however, the crossings are predicted to overtop more frequently with climate change. To view the frequency of future storm events, refer to TABLE **3.9** for the return periods of mid- and end-of-century storm events.

TABLE **4.4** presents a detailed analysis of the vulnerability of watercourse crossings, categorized by the starting storm event at which each crossing is overtopped. The data indicates both the number and percentage of crossings overtopped at various storm return periods, providing insights into the overall resilience of the region's infrastructure.

According to this table, the majority of the crossings demonstrate high resilience to storm events.

- Specifically, 67 crossings, representing 46.8% of the total, can withstand a Regulatory storm before being overtopped.
- Additionally, 51 crossings, accounting for 35.7% of the total, are resilient to even greater than regional storm events. Combined, these two categories indicate that 82.5% of the crossings are highly resilient to significant storm events, reflecting robust infrastructure in much of the Region of Peel.

However, the remaining 17.5% of the crossings display varying degrees of vulnerability to smaller storm events.

- 4 crossings (2.8%) are overtopped at a 100-year storm event, while 5 crossings (3.5%) can withstand only up to a 50-year storm event.
- An additional 6 crossings (4.2%) each are overtopped at 25-year and 10-year storm events, respectively.
- The least resilient crossings include 2 that are overtopped at a 5-year storm event (1.4%) and 2 at a 2-year storm event (1.4%).

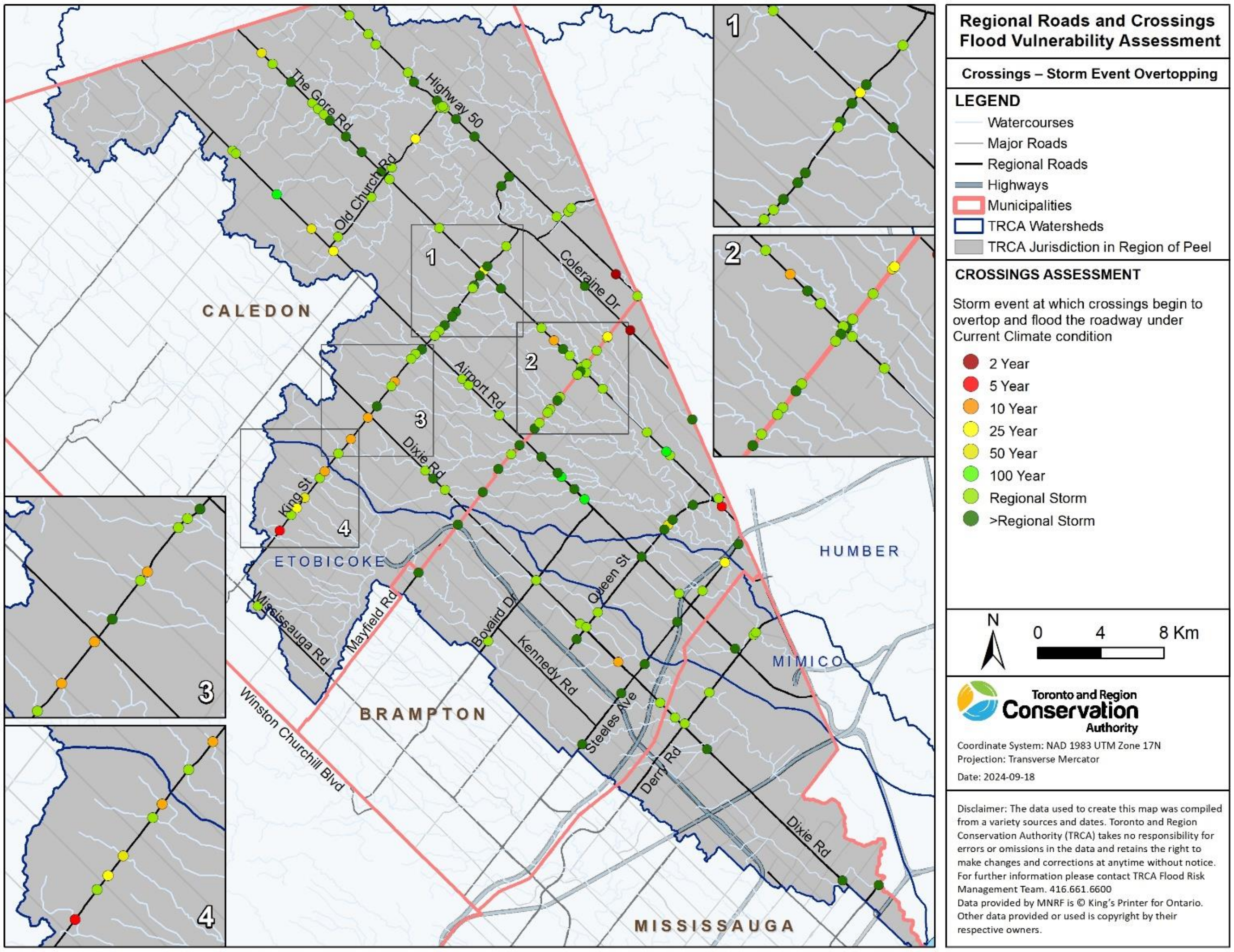


**FIGURE 4.4 DISTRIBUTION OF WATERCOURSE CROSSINGS BASED ON THE STARTING STORM EVENT THAT THEY OVERTOP ON ROP REGIONAL ROADS IN CURRENT CLIMATE SCENARIO**

**TABLE 4.4 SUMMARY OF NUMBER OF WATERCOURSE CROSSINGS THAT OVERTOP IN EACH STORM EVENT IN CURRENT CLIMATE SCENARIO**

| Starting Storm Event at which a Crossing is Overtopped | Number of Crossings | Proportion of Crossings (%) |
|---|---|---|
| >Regional | 51 | 35.7% |
| Regional | 67 | 46.8% |
| 100-year | 4 | 2.8% |
| 50-year | 5 | 3.5% |
| 25-year | 6 | 4.2% |
| 10-year | 6 | 4.2% |
| 5-year | 2 | 1.4% |
| 2-year | 2 | 1.4% |
| **Total** | **143** | **100%** |

**Detailed Summary**

TABLE 4.5 provides a detailed summary of crossings overtopping on each regional road in current climate conditions. As inferred from this table:

- King St features a significant number of crossings that can withstand more extreme events such as 8 crossings can pass Reginal storm without overtopping and 10 crossings are overtopped only during Regional storm. However, it also has the highest number of crossings that overtop during 5-year storm events (4 crossings), suggesting frequent flood risks compared to other streets. This implies that while King St has crossings that can manage Regulatory storms, frequent overtopping during 5-year storm events also indicates moderate flood risk to the road itself.
- The Gore Rd boasts the highest number of regional crossings (13 crossings) and a substantial count of >Regional crossings (7 crossings). This road has one crossing each for 50-year, 10-year, and 5-year storm events, highlighting the need for targeted flood management strategies. Thus, while The Gore Rd has a significant number of crossings meeting Regulatory and >Regional storm criteria, occurrences during lower return period events indicate some vulnerability.
- Mayfield Rd features an equal number of >Regional and regional crossings (9 each), reflecting a balanced infrastructure profile. It includes 2 crossings that overtop during 50-year and 25-year storm events, suggesting relatively lower flood risks to the road.
- Airport Rd has a moderate number of >Regional (5 crossings) and regional crossings (6 crossings). Notably, it includes 3 crossings in the 100-year storm category, suggesting potential for significant infrequent flooding events, which poses some risk to the road.

Other roads exhibit a varied range of flood risk categories and infrastructure levels.

- Hwy 50, for instance, maintains a balanced profile with 5 >Regional and 6 regional crossings and minimal occurrences in higher flood risk categories, indicating a generally lower risk to the road.
- Dixie Rd and Queen St E show occasional flood risk incidents, impacting road safety to a limited extent.
- Steeles Ave E features fewer regional crossings but presence in the 10-year storm category, which poses some risk to the road infrastructure.
- Roads like Old Church Rd, Derry Rd E, Bovaird Dr E, and Emil Kolb Pky have fewer crossings overall, indicating lower traffic and reduced flood risk impacts on the road infrastructure.

Overall, this analysis underscores the importance of targeted infrastructure enhancements and flood risk management, especially for heavily trafficked roads such as King St and The Gore Rd.

- Roads like King St, despite having crossings capable of withstanding Regulatory storms, exhibit frequent overtopping during 5-year storm events, indicating moderate flood risk to the road itself.
- Similarly, The Gore Rd, with its significant number of crossings conveying Regulatory and >Regional storm events, faces occasional overtopping in lower return period events, suggesting moderate vulnerability.
- In contrast, roads like Mayfield Rd and Hwy 50 show a balanced infrastructure profile with fewer instances of flood risk across all storm categories, indicating relatively safer conditions.
- However, Airport Rd's occurrences in the 100-year storm category highlight potential risks to the road during significant flooding events.
- For Dixie Rd, Queen St E, Steeles Ave E, Old Church Rd, Derry Rd E, Bovaird Dr E, and Emil Kolb Pky, while they exhibit lower overall crossings and lesser traffic, some level of flood risk persists, particularly impacting road safety in Regulatory storm scenarios.

Therefore, addressing these varied levels of flood risk with targeted flood protection measures is crucial to enhancing the safety and resilience of the road infrastructure across the region.

**TABLE 4.5 SUMMARY OF CROSSINGS OVERTOPPING ON EACH REGIONAL ROAD IN CURRENT CLIMATE SCENARIO**

| Road Name | Storm Event | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | >Regional | Regional | 100-year | 50-year | 25-year | 10-year | 5-year | 2-year |
| King St | 8 | 10 | 0 | 1 | 2 | 4 | 1 | 0 |
| The Gore Rd | 7 | 13 | 1 | 1 | 0 | 1 | 1 | 0 |
| Mayfield Rd | 9 | 9 | 0 | 1 | 1 | 0 | 0 | 0 |
| Airport Rd | 5 | 6 | 3 | 1 | 1 | 0 | 0 | 0 |
| Hwy 50 | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 1 |
| Dixie Rd | 3 | 5 | 0 | 0 | 0 | 1 | 0 | 0 |
| Queen St E | 4 | 3 | 0 | 1 | 0 | 0 | 0 | 0 |

| Road Name | Storm Event | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | >Regional | Regional | 100-year | 50-year | 25-year | 10-year | 5-year | 2-year |
| Steeles Ave E | 5 | 1 | 0 | 0 | 1 | 0 | 0 | 0 |
| Old Church Rd | 0 | 4 | 0 | 0 | 1 | 0 | 0 | 0 |
| Derry Rd E | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bovaird Dr E | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Emil Kolb Pky | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| King St E | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coleraine Dr | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Mississauga Rd | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Queen St N | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Queensway E | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **51** | **67** | **4** | **5** | **6** | **6** | **2** | **2** |

### 4.1.2 Future Climate Conditions

#### *4.1.2.1 **MTO Design Flow Criterion***

**Overall Summary**

FIGURE **4.5** presents the analysis results of watercourse crossings based on their ability to meet the design flow criterion under mid-century and end-of-century climate scenarios. Similarly, the crossings have been color-coded to show their compliance as described below:

- Green circles signify crossings that meet the design flow criterion in both mid-century and end-of-century scenarios.
- Yellow circles with black crosses indicate crossings that meet the criterion in the mid-century scenario but cannot be assessed for the end-of-century scenario.
- Red circles denote crossings that do not meet the criterion in either climate scenario.
- White circles with black crosses signify crossings that "**cannot be assessed**" in either the mid-century or end-of-century scenarios.

The term "**cannot be assessed**" in this context refers to crossings for which compliance cannot be assessed under future climate scenarios due to limitations in the available hydraulic data as indicated in Section 1.3.2 Assumptions and Limitations, i.e., there is no information on the performance of the culvert beyond the rainfall depths originally modeled under current climate, which normally includes design storms ranging from 2-year to 100-year events and the Regional storm, but it lacks information for storm events in between 100-year and Regional storm events. According to TABLE 3.9, the current 100-year storm event becomes equivalent to a 25-year event in mid-century and an 8.4-year event in the end of the century scenarios. As per the assumption that MTO Criteria used for current climate conditions remained the same, watercourse crossings must, at a minimum, accommodate a 25-year design storm. Therefore, only crossings designed for the 25-year storm event can be assessed under mid-century conditions. Crossings with higher design storms (e.g., 50-year or 100-year) cannot be evaluated for compliance under future climate conditions due to the lack of corresponding storm event data. For details, please refer to Section 1.3.2 Assumptions and Limitations and Appendix 4 Climate Change Memo.

The figure shows:

- Approximately 35.7% of watercourse crossings meet the design flow criterion in both mid-century and end-of-century scenarios.
- Additionally, 18.2% of crossings meet the criterion in the mid-century scenario but cannot be assessed for the end-of-century scenario.
- 17.5% of crossings do not meet the design flow criterion in either scenario.
- 28.6% of crossings cannot be assessed in both mid-century and end-of-century scenarios.

These findings highlight the need for proactive infrastructure planning and adaptive strategies to increase the percentage of crossings that meet the design flow criterion. Additionally, efforts should focus on addressing data gaps and conducting further assessments for crossings currently categorized as "cannot be assessed" to ensure comprehensive evaluation and resilience in the face of evolving climate conditions.

**Detailed Summary**

TABLE 4.6 provides a detailed summary of crossings on each regional road against the design flow criterion for the future mid- and end-of-century climate conditions. The table shows:

- King St, with the greatest number of crossings (26), has 8 crossings meeting the design flow criterion in both mid- and end-of-century scenarios, 10 meeting the criterion in the mid-century but not assessed in the end-of-century, and 8 do not meet the criterion in both scenarios. This highlights variability in performance and the need for selective upgrades.
- The Gore Rd has 24 crossings, where 7 meet the criterion in both scenarios, 7 meet the criterion in the mid-century but cannot be assessed at the end-of-century, 4 do not meet the criterion in both scenarios, and 6 cannot be assessed in either scenario, emphasizing the need for targeted infrastructure improvements.
- Mayfield Rd, with 20 crossings, has 9 meeting the criteria in both scenarios, 2 meeting the criterion in the mid-century but not assessed in the end-of-century, 2 do not meet the criterion in both scenarios, and 7 that cannot be assessed. This indicates a mix of adequate performance and areas for improvement.

- Airport Rd has 16 crossings, with 5 meeting the criterion in both scenarios, 3 meeting it in the mid-century but not assessed in the end-of-century, 5 do not meet the criterion in both scenarios, and 3 that cannot be assessed, suggesting potential capacity issues that may require further review.

For other roads, a range of performance is observed which is briefed below:

- Hwy 50, with 12 crossings, shows a split performance: 5 crossings meet the criterion in both scenarios, 2 meet it in the mid-century but not assessed in the end-of-century, 1 does not meet the criterion in both scenarios, and 4 cannot be assessed.
- Dixie Rd, with 9 crossings, has 3 meeting the criterion in both scenarios, none meeting it in the mid-century only, 1 does not meet in both scenarios, and 5 that cannot be assessed, highlighting areas for further review for possible improvement
- Queen St E has 8 crossings, where 4 meet the criterion in both scenarios, none meet it in the mid-century only, 1 does not meet in both scenarios, and 3 cannot be assessed, indicating a mix of adequacy and areas for improvement.
- Steeles Ave E shows strong performance, with 5 out of 7 crossings meeting the criterion in both scenarios, 1 meeting it in the mid-century but not assessed in the end-of-century, and 1 does not meet criterion in both scenarios.
- Old Church Rd has 5 crossings, none of which meet the criterion in both scenarios, while 1 meets it in the mid-century but not assessed in the end-of-century, 1 does not meet criterion in both scenarios, and 3 cannot be assessed.
- Derry Rd E, with 4 crossings, has none meeting the criterion and 4 that cannot be assessed.
- Bovaird Dr E and King St E, with 2 crossings each, that both meet criteria in either scenario. For King St E, all crossings fall into the "cannot be assessed" category.
- Coleraine Dr has 2 crossings, with 1 meeting the criterion in both scenarios and the other does not meet criteria in both scenarios.
- Emil Kolb Pky performs well, with all crossings meeting the criterion in both scenarios.
- Mississauga Rd, Queen St N, and Queensway E have very few crossings but show mixed results, with some crossings meeting the criterion and others falling into the "cannot be assessed" category.

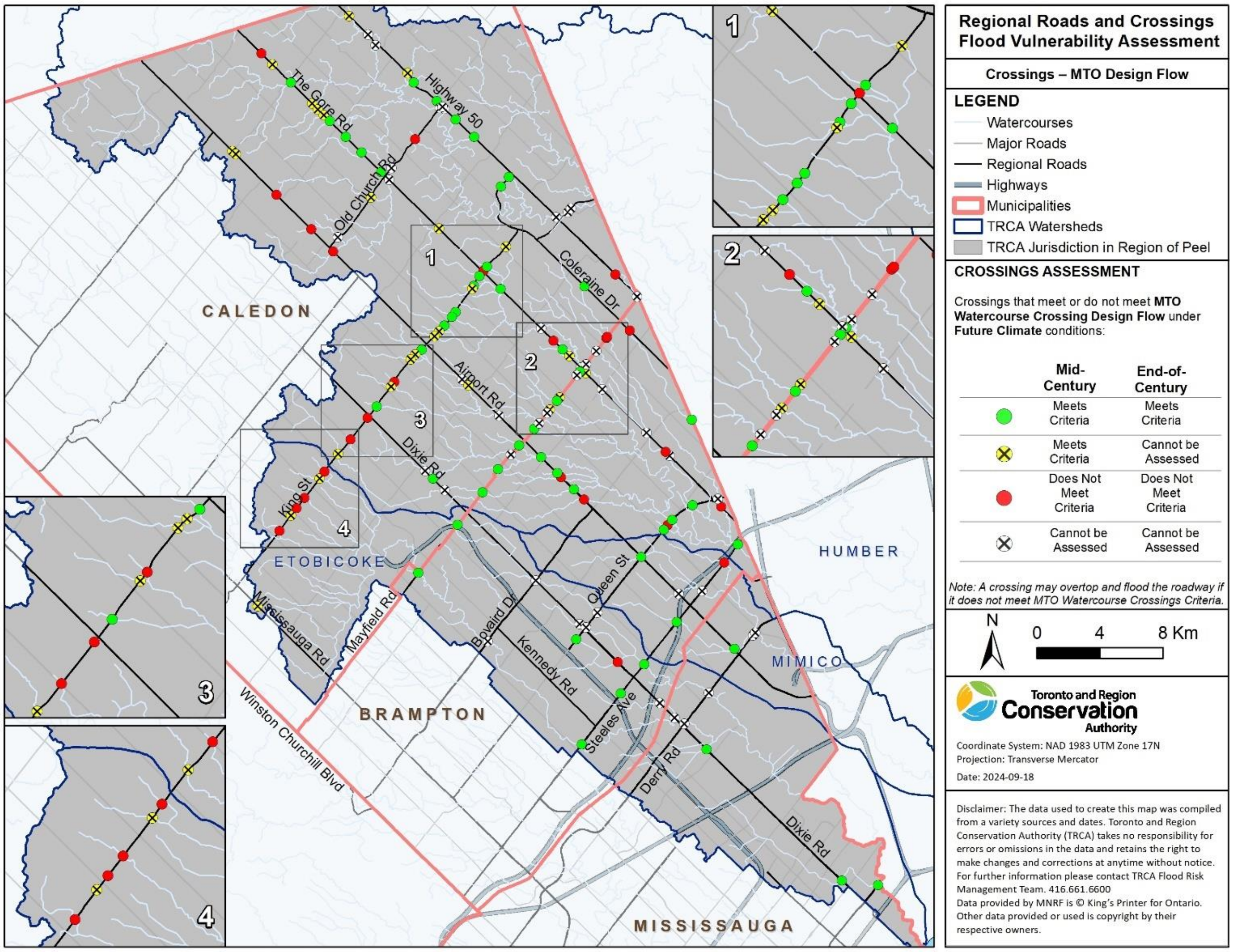


**FIGURE 4.5 DISTRIBUTION OF WATERCOURSE CROSSINGS ASSESSED AGAINST MTO DESIGN FLOW CRITERION ON ROP REGIONAL ROADS IN MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

**TABLE 4.6 SUMMARY OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW CRITERION IN MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

| Road Name | Total Number of Crossings | Number of Crossings that Meet MTO Design Flow Criterion Both in Mid and End-of-Century | Number of Crossings that Meet MTO Design Flow Criterion in Mid but Cannot Be Assessed in End-of-Century | Number of Crossings that Do Not Meet in Mid and End-of-Century | Number of Crossings that Cannot Be Assessed in Mid and End-of-Century |
|---|---|---|---|---|---|
| King St | 26 | 8 | 10 | 8 | 0 |
| The Gore Rd | 24 | 7 | 7 | 4 | 6 |
| Mayfield Rd | 20 | 9 | 2 | 2 | 7 |
| Airport Rd | 16 | 5 | 3 | 5 | 3 |
| Hwy 50 | 12 | 5 | 2 | 1 | 4 |
| Dixie Rd | 9 | 3 | 0 | 1 | 5 |
| Queen St E | 8 | 4 | 0 | 1 | 3 |
| Steeles Ave E | 7 | 5 | 0 | 1 | 1 |
| Old Church Rd | 5 | 0 | 1 | 1 | 3 |
| Derry Rd E | 4 | 0 | 0 | 0 | 4 |
| Bovaird Dr E | 2 | 0 | 0 | 0 | 2 |
| Emil Kolb Pky | 3 | 3 | 0 | 0 | 0 |
| King St E | 2 | 0 | 0 | 0 | 2 |
| Coleraine Dr | 2 | 1 | 0 | 1 | 0 |
| Mississauga Rd | 1 | 0 | 1 | 0 | 0 |
| Queen St N | 1 | 0 | 0 | 0 | 1 |
| Queensway E | 1 | 1 | 0 | 0 | 0 |
| **Total** | **143** | **51** | **26** | **25** | **41** |

#### *4.1.2.2 **All MTO Criteria***

**Overall Summary**

FIGURE 4.6 depicts the flood vulnerability assessment of road crossings in the Region of Peel, evaluated under mid-century and end-of-century climate scenarios. Crossings are categorized based on their ability to meet the All MTO Criteria, which include Design Flow, Freeboard, Relief Flow, and Soffit Clearance. Similarly, the crossings have been color-coded to show their compliance as indicated below:

- Green circles represent crossings that meet all MTO criteria in both mid- and end-of-century climate scenarios.
- Green circles with black crosses indicate crossings that meet all criteria in the mid-century but cannot be assessed for the end-century.
- Red circles represent crossings that do not meet the criteria in both the mid-century and end-of-century scenarios.
- White circles with black crosses denote crossings that cannot be assessed in either the mid-century or end-of-century scenarios.

The figure shows a significant number of crossings (almost 66%) do not meet the criteria, particularly highlighted by the red circles, suggesting areas that would benefit from further attention and potential improvements. The map reveals that approximately 4% of the crossings satisfy all MTO criteria for both mid-century and end-of-century scenarios. Additionally, 16% of the crossings meet the criteria for the mid-century but cannot be assessed fall in the end-century, while 14% cannot be assessed in either period.

**Detailed Summary**

TABLE 4.7 presents the performance of crossings on various roads against All MTO Criteria. Four major regional roads with greatest number of crossings show mixed performance of crossings as summarized below:

- On King St, none of the crossings meet the criteria in both mid-century and end-of-century. Only 6 crossings meet the criteria in the mid-century but cannot be assessed for the end-century, while a significant 20 crossings do not meet the criteria in both periods. This suggests a considerable need for improvements on King St to ensure the crossings can handle future climate scenarios.
- The Gore Rd shows that none of the crossings meet the criteria in both periods. Eleven crossings meet the mid-century criteria but cannot be assessed for the end-century. In contrast, 12 crossings do not meet the criteria in both periods, and 1 crossing cannot be assessed in either period. This suggests that while some crossings are adequate in the mid-century, there are still some benefits from further assessment.
- On Mayfield Rd, none of the crossings meet the criteria in both periods. Four crossings meet the criteria in the mid-century but not in the end-century. Meanwhile, 11 crossings do not meet the criteria in both periods, and 5 cannot be assessed at all. This distribution indicates a mixed performance and highlights the potential for targeted improvements to enhance the infrastructure's resilience.

  Airport Rd shows a concerning trend where none of the crossings meet the criteria in both periods. Only 2 crossings meet the mid-century criteria, 13 do not meet the criteria in both periods, and 1 is not assessable. These points to potential capacity concern that may require attention to help prevent future infrastructure challenges. On other regional roads, a various range of performance presents as briefed below:
- Hwy 50 has 1 crossing meeting the criteria in both mid- and end-of-century, 2 meeting mid-century criteria only, 8 do not meet in both periods, and 1 cannot be evaluated.
- Dixie Rd has 7 crossings that do not meet criteria in both periods, and 2 that cannot be evaluated.

- Queen St E has 5 crossings do not meet criteria and 3 that cannot be evaluated, while Steeles Ave E has 2 crossings do not meet criteria and 5 that cannot be evaluated.
- Old Church Rd and Derry Rd E each have all their crossings not meeting the criteria.
- Bovaird Dr E’s crossings both do not meet criteria, while 1 crossing on Emil Kolb Pky meets the criteria in both periods, and 2 cannot be evaluated.
- Coleraine Dr has 2 crossings, of which 1 does not meet the criteria and 1 cannot be evaluated.
- King St E’s crossings both do not meet the criteria. Mississauga Rd, Queen St N, and Queensway E each have 1 crossing; Mississauga Rd and Queen St N do not meet criteria, while Queensway E meets the criteria.

In summary, out of 143 crossings, 6 meet the criteria in both mid- and end-of-century, 23 meet the mid-century criteria but cannot be assessed for the end-century, 94 do not meet criteria in both periods, and 20 are not assessable, underscoring the need for targeted infrastructure upgrades to enhance the resiliency of crossings to future climate conditions.

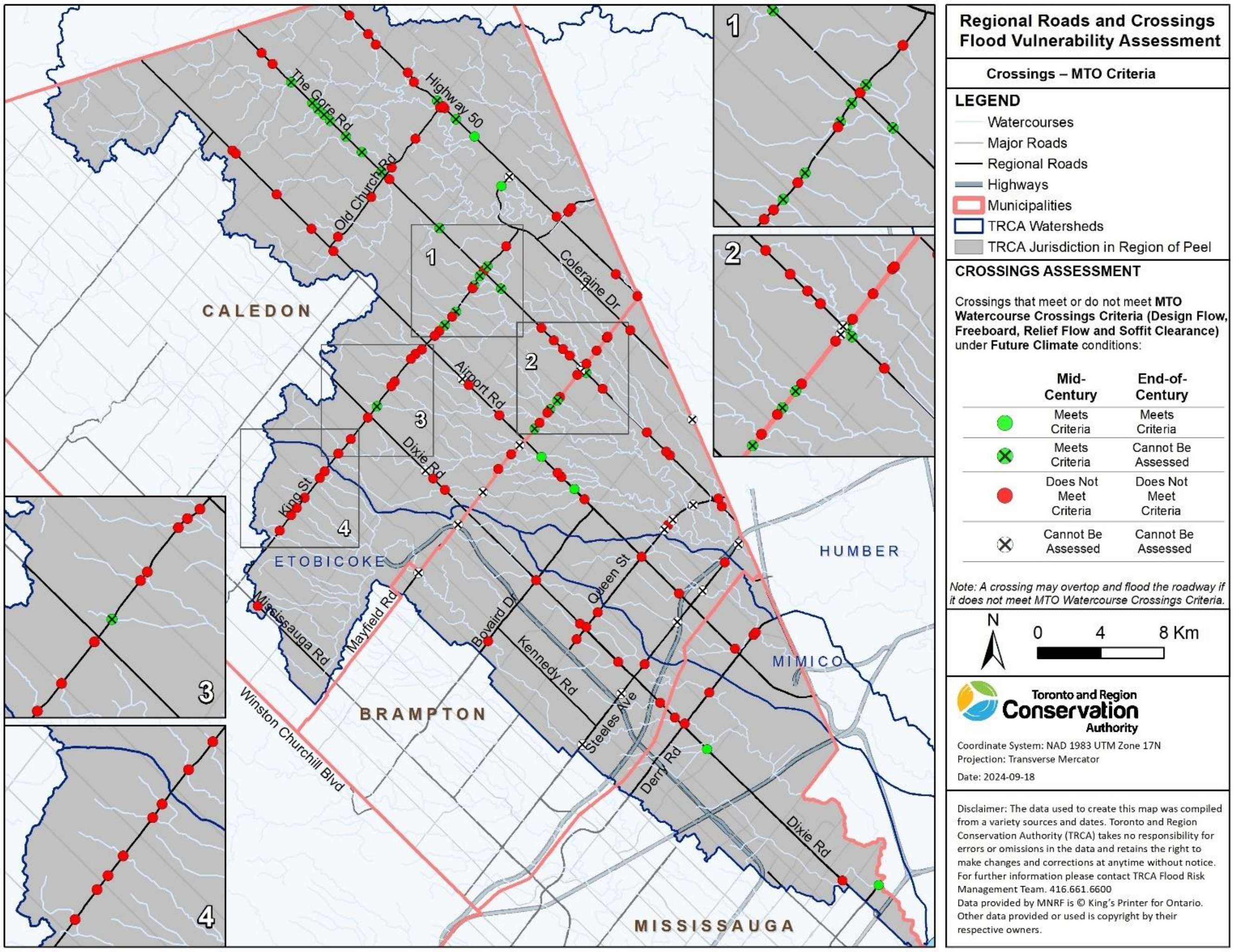


**FIGURE 4.6 DISTRIBUTION OF WATERCOURSE CROSSINGS ASSESSED AGAINST MTO DESIGN FLOW, FREEBOARD, RELIEF FLOW AND SOFFIT CLEARANCE CRITERIA ON ROP REGIONAL ROADS IN MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

**TABLE 4.7 SUMMARY OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW, FREEBOARD, RELIEF FLOW AND SOFFIT CLEARANCE CRITERIA IN MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

| Road Name | Total Number of Crossings | Number of Crossings that Meet All MTO Criteria in Both Mid and End Century | Number of Crossings that Meet All MTO Criteria in Mid But Cannot Be Assessed in End Century | Number of Crossings that Does not Meet All MTO Criteria in Mid & End Century | Number of Crossings that Cannot Be Assessed in Mid & End Century |
|---|---|---|---|---|---|
| King St | 26 | 0 | 6 | 20 | 0 |
| The Gore Rd | 24 | 0 | 11 | 12 | 1 |
| Mayfield Rd | 20 | 0 | 4 | 11 | 5 |

| Road Name | Total Number of Crossings | Number of Crossings that Meet All MTO Criteria in Both Mid and End Century | Number of Crossings that Meet All MTO Criteria in Mid But Cannot Be Assessed in End Century | Number of Crossings that Does not Meet All MTO Criteria in Mid & End Century | Number of Crossings that Cannot Be Assessed in Mid & End Century |
|---|---|---|---|---|---|
| Airport Rd | 16 | 2 | 0 | 13 | 1 |
| Hwy 50 | 12 | 1 | 2 | 8 | 1 |
| Dixie Rd | 9 | 1 | 0 | 7 | 1 |
| Queen St E | 8 | 0 | 0 | 5 | 3 |
| Steeles Ave E | 7 | 0 | 0 | 2 | 5 |
| Old Church Rd | 5 | 0 | 0 | 5 | 0 |
| Derry Rd E | 4 | 0 | 0 | 4 | 0 |
| Bovaird Dr E | 2 | 0 | 0 | 2 | 0 |
| Emil Kolb Pky | 3 | 1 | 0 | 0 | 2 |
| King St E | 2 | 0 | 0 | 2 | 0 |
| Coleraine Dr | 2 | 0 | 0 | 1 | 1 |
| Mississauga Rd | 1 | 0 | 0 | 1 | 0 |
| Queen St N | 1 | 0 | 0 | 1 | 0 |
| Queensway E | 1 | 1 | 0 | 0 | 0 |
| **Total** | **143** | **6** | **23** | **94** | **20** |

### 4.3.1 Comparison of Results for Current Climate and Future Climate Scenarios

#### *4.1.3.1 **MTO Design Flow Criterion***

**Overall Summary**

The previous two sections discussed the assessment of the crossings under current climate (Section 4.1.1) and future climate (Section 4.1.2), whereas this section looks comprehensively across both current and future climate conditions. **Figure 4.7** illustrates the results of the analysis of watercourse crossings concerning their ability to meet design flow criteria across current, mid-century, and end-of-century climate scenarios. Similarly, the crossings have been color-coded to show whether they meet Design Flow criterion as described below:

- Green circles indicate the crossings that meet the design flow criterion along all climate scenarios.
- Green circles with a black cross represent crossings that meet the design flow criterion in current and mid-century scenarios but cannot be assessed in end-of-century projections.
- Yellow circles with a black cross indicate crossings that meet the design flow criterion in current conditions but cannot be assessed in mid- and end-of-century projections.
- Orange circles signify crossings that meet the design flow criterion only in current climate conditions, and

- Red circles indicate crossings that do not meet the design flow criterion in any climate scenario.

According to this figure:

- 35.7% of watercourse crossings meet the design flow criterion across all climate scenarios.
- 18.2% of crossings meet the design flow criterion in current and mid-century scenarios but do not meet it in end-of-century projections
- 28.6% of crossings meet the design flow criterion in current but cannot be assessed in mid- and end-of-century projections.
- 4.2% of crossings meet the design flow criterion in current but do not meet in mid- and end-of-century projections.
- 13.3% of crossings do not meet the design flow criteria in either current, mid- and end-of-century scenarios.

**Detailed Summary**

As presented in TABLE 4.8, the four crossings with the greatest number of crossings show the various performances as described below:

- King St has 26 crossings, showing significant variability. Eight crossings meet the design flow criterion across all climate scenarios, and ten meet it under current and mid-century scenarios but cannot be assessed for the end-of-century scenario. Seven crossings do not meet the criteria under any climate scenario. This underscores the need for upgrades to enhance future resilience in specific sections.
- The Gore Rd has 24 crossings, also displaying mixed performance. Seven crossings meet the criterion across all scenarios, and seven meet it in current and mid-century scenarios but are unassessed for the end-of-century. Three crossings do not meet the criteria under any climate scenario, suggesting targeted improvements are necessary.
- Mayfield Rd performs well among its 20 crossings. Nine meets the criterion across all scenarios, while two meet it in current and mid-century scenarios but are unassessed for the end-of-century. Seven crossings meet the criterion only in the current scenario, and one does not meet criterion under all scenarios. This indicates that while the road is largely prepared, certain crossings might benefit from further study to evaluate potential improvements.
- Airport Rd has 16 crossings with mixed results. Five crossings meet the criterion across all scenarios, while three meet it in current and mid-century scenarios but are unassessed for the end-of-century. Three crossings meet the criterion only under the current scenario, and two do not meet criterion under all scenarios. This highlights the opportunity for improvements in specific sections to ensure long-term readiness.

Other roads also show a variety of performances as detailed below:

- Hwy 50 has 12 crossings, with five meeting the criterion across all scenarios, two meeting it under current and mid-century scenarios but unassessed for the end-of-century, and one does not meet criterion under all scenarios.
- Dixie Rd has nine crossings, with three meeting the criterion across all scenarios, five meeting it only in the current scenario, and one does not meet criteria entirely.
- Queen St E has eight crossings, with four meeting the criterion across all scenarios and three meeting it only under the current scenario. One crossing does not meet criterion under all scenarios.
- Steeles Ave E has seven crossings, with five meeting the criterion across all scenarios, one meeting it only under the current scenario, and one does not meet criterion under all scenarios.
- Old Church Rd has five crossings, with none meeting the criterion across all scenarios, one meeting it in the current scenario, and one does not meet criteria entirely.
- Derry Rd E and Bovaird Dr E exhibit similar challenges, with none of their crossings meeting the criterion across all scenarios. However, four crossings on Derry Rd E and two crossings on Bovaird Dr E meet the criterion only under the current scenario.
- Emil Kolb Pky stands out with three crossings, all of which meet the criterion across all scenarios.
- Coleraine Dr has two crossings, one of which meets the criterion across all scenarios, while the other does not meet criteria.
- Mississauga Rd, Queen St N, and Queensway E each have a single crossing. The crossing on Queensway E meets the criterion across all scenarios, while the other two crossings do not meet criterion under all scenarios.

In summary, the results of the analysis show that:

- King St, The Gore Rd, and Airport Rd exhibit significant variability. Many of these crossings appear to be strong candidates for potential upgrades to meet future climate demands.
- Mayfield Rd performs well overall but still has sections that may benefit from improvement.
- Hwy 50 and Dixie Rd demonstrate mixed results, with some crossings that may benefit from a closer look.
- Queen St E and Steeles Ave E largely meet criteria but may face challenges under future scenarios.
- Old Church Rd, Derry Rd E, and Bovaird Dr E can be further assessed for upgrades to meet future demands.
- Conversely, Emil Kolb Pky, Coleraine Dr, and Queensway E show strong readiness across all scenarios.

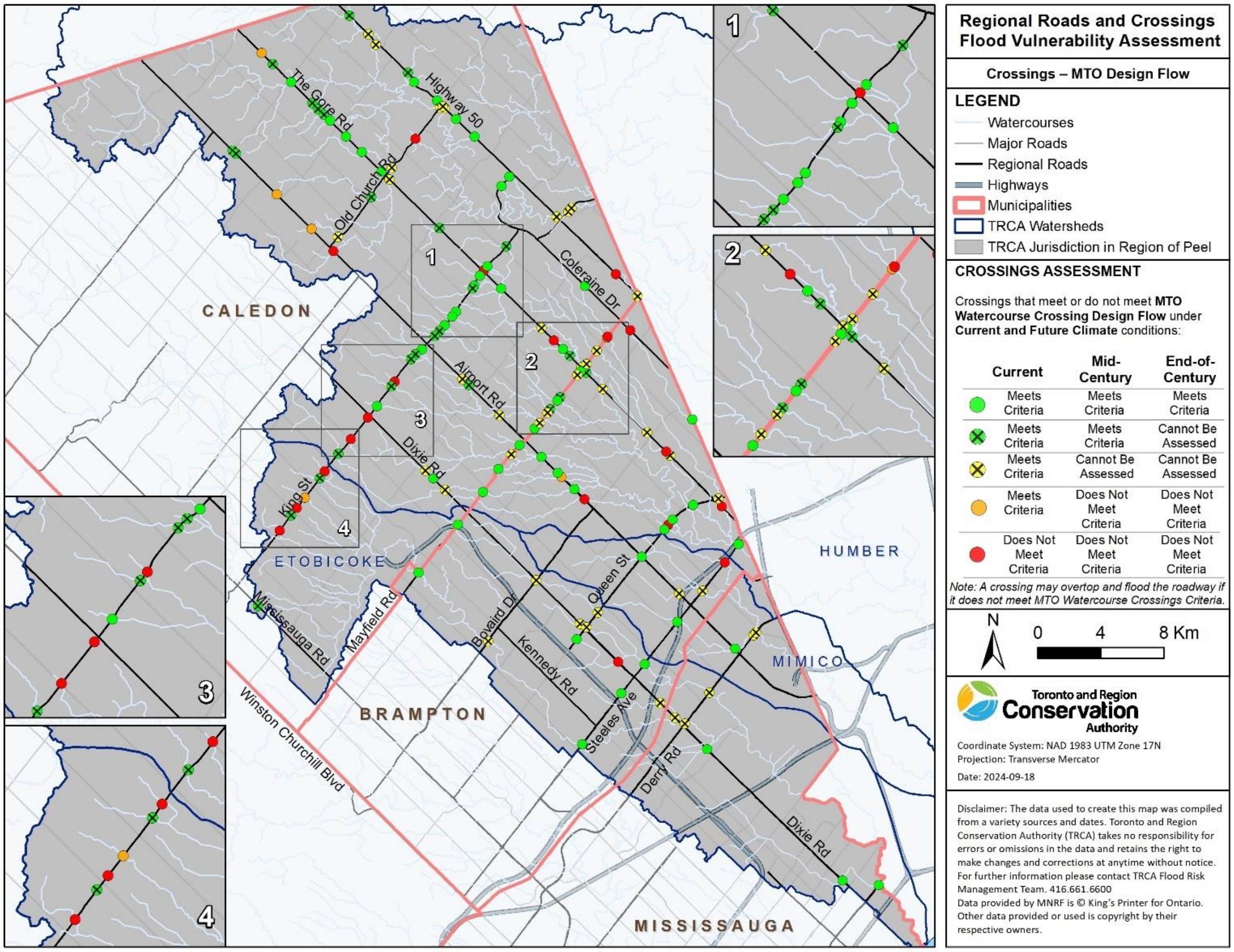


**FIGURE 4.7 DISTRIBUTION OF WATERCOURSE CROSSINGS ASSESSED AGAINST MTO DESIGN FLOW CRITERION ON ROP REGIONAL ROADS IN CURRENT, MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

**TABLE 4.8 SUMMARY OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW CRITERION IN CURRENT, MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

| Road Name | Total Num. of Crossings | Num. of Crossings Meets Design Flow Criterion in All Climate Scenarios | Num. of Crossings Meets Design Flow Criterion in Current, and Mid Century but Cannot Be Assessed in End-of-Century | Num. of Crossings Meets Design Flow Criterion in Current but Cannot Be Assessed in Mid & End-of-Century | Num. of Crossings Meets Design Flow Criterion Only in Current Climate Scenario | Num. of Crossings Does Not Meet Design Flow Criterion in Neither of Climate Scenarios |
|---|---|---|---|---|---|---|
| King St | 26 | 8 | 10 | 0 | 1 | 7 |
| The Gore Rd | 24 | 7 | 7 | 6 | 1 | 3 |
| Mayfield Rd | 20 | 9 | 2 | 7 | 1 | 1 |
| Airport Rd | 16 | 5 | 3 | 3 | 3 | 2 |
| Hwy 50 | 12 | 5 | 2 | 4 | 0 | 1 |
| Dixie Rd | 9 | 3 | 0 | 5 | 0 | 1 |
| Queen St E | 8 | 4 | 0 | 3 | 0 | 1 |
| Steeles Ave E | 7 | 5 | 0 | 1 | 0 | 1 |
| Old Church Rd | 5 | 0 | 1 | 3 | 0 | 1 |
| Derry Rd E | 4 | 0 | 0 | 4 | 0 | 0 |
| Bovaird Dr E | 2 | 0 | 0 | 2 | 0 | 0 |
| Emil Kolb Pky | 3 | 3 | 0 | 0 | 0 | 0 |
| King St E | 2 | 0 | 0 | 2 | 0 | 0 |
| Coleraine Dr | 2 | 1 | 0 | 0 | 0 | 1 |
| Mississauga Rd | 1 | 0 | 1 | 0 | 0 | 0 |
| Queen St N | 1 | 0 | 0 | 1 | 0 | 0 |
| Queensway E | 1 | 1 | 0 | 0 | 0 | 0 |
| **Total** | **143** | **51** | **26** | **41** | **6** | **19** |

#### *4.1.3.2 **All MTO Criteria***

**Overall Summary**

FIGURE 4.8 illustrates the outcomes of the watercourse crossing hydraulic capacity assessment based on All MTO Criteria (i.e., Design flow, Relief flow, Freeboard and Soffit clearance criteria) under current, mid-century, and end-of-century climate scenarios. Crossings are marked with different colored circles to represent their compliance with the MTO criteria:

- Green circles with black crosses indicate crossings that meet the criteria in current and mid-century climates but cannot be assessed in end-of-century climate scenario,
- Yellow circles with black crosses represent those that meet the criteria for current climate but cannot be assessed in mid and end-of-century climates,
- Orange circles signify crossings that only meet the criteria under current conditions, and
- Red circles denote crossings that do not meet the criteria in any of the assessed climate scenarios.

The panel maps for areas 1, 2, 3, and 4 offer a closer look at specific regions within ROP, providing more detailed information on the vulnerability and compliance status of crossings in these areas.

TABLE 4.9 evidently shows:

- Around 62% of the crossings do not meet the All MTO criteria under any climate scenario. Certain crossings may require further assessment to determine the need for upgrade to align with the most up-to-date MTO design standards. Such upgrades would help ensure that the crossings are better equipped to handle future climate conditions.
- Approximately 4% of the crossings meet the All MTO criteria under all climate scenarios, demonstrating robust infrastructure capable of withstanding projected changes in future climate scenarios.
- Furthermore, around 16% of the crossings meet the All MTO criteria under current and mid-century climate conditions but cannot be assessed under end-of-century climate projections. This suggests that further analysis may be required to evaluate the compliance of certain crossings under the end-of-century climate scenario.
- Additionally, 14% of the crossings meet the All MTO criteria under current climate conditions but cannot be assessed under mid- and end-of-century climate projections. Lastly, 4% of the crossings meet the All MTO criteria only under current climate conditions but do not meet the All MTO criteria under mid- and end-of-century climate projections. This highlights certain areas where further assessment may be required to evaluate compliance with future climate scenarios.

TABLE 4.9 CROSSINGS THAT MEET OR DO NOT ALL MEET MTO WATERCOURSE CROSSINGS CRITERIA (DESIGN FLOW, FREEBOARD, RELIEF FLOW, AND SOFFIT CLEARANCE) UNDER CURRENT AND FUTURE CLIMATE CONDITIONS WITH CORRESPONDING PERCENTAGE OF EACH CATEGORY

| Current Climate | Mid-Century Climate | End-of-Century Climate | Description | Proportion of Crossings (%) |
|---|---|---|---|---|
| Meets Criteria | Meets Criteria | Meets Criteria | Crossings meet All MTO criteria in all climate scenarios | 4% |
| Meets Criteria | Meets Criteria | Cannot Be Assessed | Crossings meet All MTO criteria in current and mid-century conditions but cannot be assessed for end-century. | 16% |

| | | | | |
|---|---|---|---|---|
| Meets Criteria | Cannot Be Assessed | Cannot Be Assessed | Crossings meet All MTO criteria in the current scenario but cannot be assessed for future conditions. | 14% |
| Meets Criteria | Does Not Meet Criteria | Does Not Meet Criteria | Crossings meet All MTO criteria only in the current scenario. | 4% |
| Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria | Crossings do not meet All MTO criteria under all scenarios. | 62% |

**Detailed Summary**

TABLE 4.10 provides a detailed summary of road crossings based on their performance in meeting the All MTO criteria across current, mid-century, and end-of-century climate scenarios as described below:

- King St shows a various performance with 26 crossings. Six crossings meet All MTO criteria in both current and mid-century scenarios but cannot be assessed for the end-of-century scenario. Two crossings meet the All MTO criteria only under current conditions, while 18 crossings do not meet the All MTO criteria in any scenario. This indicates that many of King St's crossings may require improvements to remain compliant with All MTO criteria in the future.
- The Gore Rd demonstrates a better performance with 24 crossings. Eleven crossings meet the All MTO criteria in both current and mid-century scenarios, while 1 crossing meets All MTO criteria only in the current scenario. However, 11 crossings do not meet the All MTO criteria in any of the climate scenarios, suggesting that while The Gore Rd performs relatively well, there are still areas that may benefit from attention to address future demands.
- Mayfield Rd has 20 crossings, with 4 meeting All MTO criteria in both current and mid-century scenarios but not assessed for the end-of-century scenario. Additionally, 4 crossings meet All MTO criteria only under current conditions, and 12 crossings do not meet All MTO criteria in any scenario. This highlights that while Mayfield Rd is somewhat prepared for future conditions, a significant number of crossings may require upgrades to meet future design flow standards.
- Airport Rd features 16 crossings, with only 1 meeting the All MTO criteria for current and mid-century conditions. 3 crossings meet the All MTO criteria only under current conditions, 1 crossing meets All MTO criteria only in the current climate scenario, and 11 crossings do not meet All MTO criteria in all scenarios. This indicates that most of the crossings on Airport Rd may require enhancements to meet future design needs.

For the remaining roads, the table shows a range of performances as detailed below:

- Hwy 50 has 1 crossing meeting All MTO criteria in both current and mid-century scenarios, 1 meeting All MTO criteria only in the current scenario, and 8 crossings do not meet All MTO criteria in all scenarios.

- Dixie Rd has no crossings meeting All MTO criteria for current and mid-century conditions, with 2 crossings meeting only under current conditions and 7 do not meet All MTO criteria.
- Queen St E has 3 crossings meeting the All MTO criteria only in current conditions, and 5 crossings do not meet All MTO criteria in any scenario.
- Steeles Ave E shows that 5 crossings meet All MTO criteria in the current scenario but not in mid or end-century, with 2 crossings do not meet All MTO criteria.
- Other roads such as Old Church Rd, Derry Rd E, Bovaird Dr E, Emil Kolb Pky, and King St E have all or most crossings do not meet All MTO criteria across different scenarios, indicating that many roads will benefit from future enhancements to address both current and future design flow requirements.

In summary:

- King St, The Gore Rd, and Airport Rd face some challenges for future climate scenarios, indicating that improvements maybe beneficial.
- Mayfield Rd and Hwy 50 show mixed performance, with several crossings that may require upgrades to ensure flood resilience in the face of future climate challenges.
- Dixie Rd, Queen St E, and Steeles Ave E also have some areas of concern, with some crossings currently only meeting MTO criteria under current climate conditions but may require further attention to address future climate impacts.
- Old Church Rd, Derry Rd E, Bovaird Dr E, and King St E have several crossings that may need to be improved to remain flood-resilient under both current and future climate conditions.

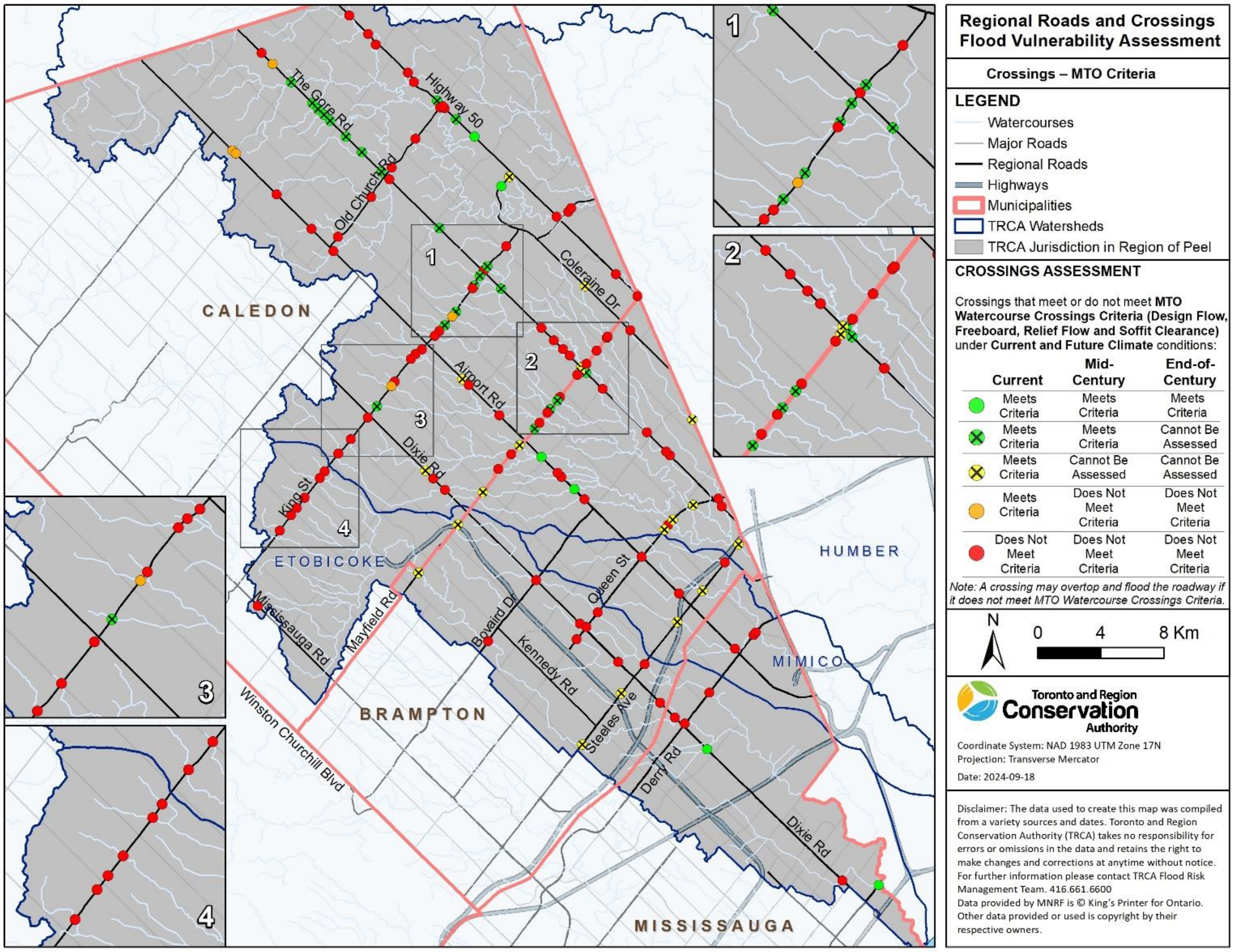


**FIGURE 4.8 DISTRIBUTION OF WATERCOURSE CROSSINGS ASSESSED AGAINST MTO DESIGN FLOW, FREEBOARD, RELIEF FLOW AND SOFFIT CLEARANCE CRITERIA ON ROP REGIONAL ROADS IN CURRENT, MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

**TABLE 4.10 SUMMARY OF THE NUMBER OF CROSSINGS ON EACH REGIONAL ROAD ASSESSED AGAINST MTO DESIGN FLOW, FREEBOARD, RELIEF FLOW AND SOFFIT CLEARANCE CRITERIA IN CURRENT, MID-CENTURY AND END-OF-CENTURY CLIMATE SCENARIOS**

| Road Name | Total Num. of Crossings | Num. of Crossings Meets All MTO Criteria in All Climate Scenarios | Num. of Crossings Meets All MTO Criteria in Current, and Mid Century But Cannot Be Assessed in End-of-Century | Num. of Crossings Meets All MTO Criteria in Current But Cannot Be Assessed in Mid & End-of-Century | Num. of Crossings Meets All MTO Criteria Only in Current Climate Scenario | Num. of Crossings Does Not Meet All MTO Criteria in Neither of Climate Scenarios |
|---|---|---|---|---|---|---|
| King St | 26 | 0 | 6 | 0 | 2 | 18 |
| The Gore Rd | 24 | 0 | 11 | 1 | 1 | 11 |
| Mayfield Rd | 20 | 0 | 4 | 5 | 0 | 11 |
| Airport Rd | 16 | 2 | 0 | 1 | 2 | 11 |
| Hwy 50 | 12 | 1 | 2 | 1 | 0 | 8 |
| Dixie Rd | 9 | 1 | 0 | 1 | 0 | 7 |
| Queen St E | 8 | 0 | 0 | 3 | 0 | 5 |
| Steeles Ave E | 7 | 0 | 0 | 5 | 0 | 2 |
| Old Church Rd | 5 | 0 | 0 | 0 | 0 | 5 |
| Derry Rd E | 4 | 0 | 0 | 0 | 0 | 4 |
| Bovaird Dr E | 2 | 0 | 0 | 0 | 0 | 2 |
| Emil Kolb Pky | 3 | 1 | 0 | 2 | 0 | 0 |
| King St E | 2 | 0 | 0 | 0 | 0 | 2 |
| Coleraine Dr | 2 | 0 | 0 | 1 | 0 | 1 |
| Mississauga Rd | 1 | 0 | 0 | 0 | 0 | 1 |
| Queen St N | 1 | 0 | 0 | 0 | 0 | 1 |
| Queensway E | 1 | 1 | 0 | 0 | 0 | 0 |
| **Total** | **143** | **6** | **23** | **20** | **5** | **89** |

## 4.2 Roads Assessment

### 4.2.1 ROP's Level of Service

**Overall Summary**

Inundated road segments on various regional roads were assessed against the ROP's LOS under the current climate scenario for three return periods: 25-year, 50-year, and 100-year events. The ROP's LOS specifies that at least one lane be free of water in each direction during a storm event of greater than 10-year up to the 100-year event. To meet this LOS criteria maximum flood depths were established based upon the width of the road ROW. These flood depths are illustrated in FIGURE 4.9 and summarized in TABLE 4.11. For a more detailed description about ROP's LOS please refer to Section 3.3.1.

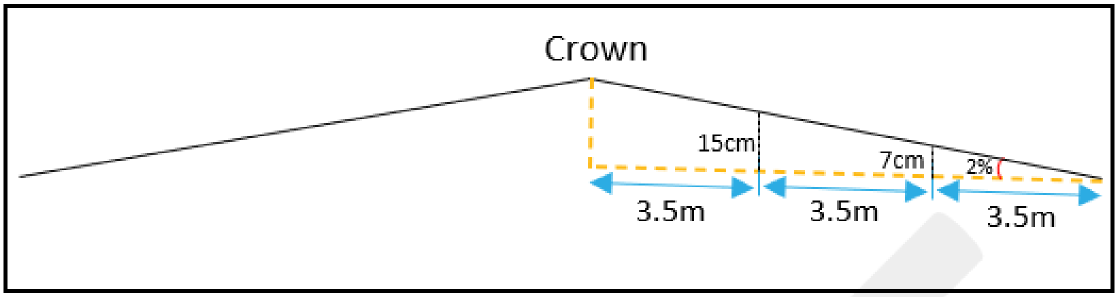


FIGURE 4.9 SCHEMATIC OF A ROAD CROSS-SECTION WITH MAXIMUM ALLOWABLE FLOOD DEPTHS BASED ON ROP CRITERIA

TABLE 4.11 SUMMARY OF ROP'S LEVEL OF SERVICE

| Number of Lane | Flood Spread Depth Allowance (cm) |
|---|---|
| 2 | 0 |
| 4 | 7 |
| 6 | 15 |

As per ROP criteria, for Arterial Roads the major flow design criteria were defined to handle storm events that are greater than 10-year up to 100-year. Based on the discussion with ROP, it was determined to perform the roads assessment only for the 100-year storm event, i.e., the assessment focused on the performance of the regional roads to handle extreme weather conditions that have a 1% probability of occurring each year. However, as stated in Section 3.1, due to the inability to project the 100-year storm event for mid-century and end-of-century climate scenarios, given this study's limitations and in discussion with ROP it was agreed that the assessment was performed only for the current climate scenario, and in lieu of the 100-year storm event for mid-century and end-of-century conditions, the assessment would be also provided for the 25-year and 50-year storm events under the current climate scenario to provide a more detailed assessment of road conditions as they stand today.

TABLE 4.12 and FIGURE 4.10 provide summaries of number of inundated road segments assessed, and below presents the number of road segments that meet specific return period criteria, i.e., 25-year, 50-year, and 100-year return periods:

- Total Inundated Road Segments: 398 road segments were assessed for three flooding events.
- Return Period Assessed:
    a) 25-Year Return Period: 284 road segments met the LOS criteria for this event.
    b) 50-Year Return Period: 269 road segments met the LOS criteria for this event.
    c) 100-Year Return Period: 253 road segments met the LOS criteria for this event.
- Non-Mutually Exclusive Counts: the road segments that meet the LOS criteria for the different return periods are not mutually exclusive. This means that a given road segment may meet the criteria for more

than one return period (e.g., a segment may meet both the 25-year and the 50-year criteria). Therefore, the total number of affected segments (398) should not be added together for each return period, as there will be overlaps.

**Detailed Summary**

As TABLE 4.12 and FIGURE 4.10 indicate that the four roads with the highest number of inundated segments are Airport Road, The Gore Road, Dixie Road, and King Street, and a detailed summary for each is presented as follow:

- Airport Road consistently exhibited the highest number of inundated segments across all return periods, with 48 segments meeting the LOS for the 25-year return period, 46 segments for the 50-year return period, and 38 segments for the 100-year return period.
- The Gore Road ranked in the second, which had 40 inundated segments meeting the LOS for both the 25-year and 50-year return periods, and 39 segments for the 100-year return period.
- Dixie Road ranked the third, with 29 segments meeting the LOS for the 25-year return period, 24 for the 50-year return period, and 22 for the 100-year return period.
- Finally, King Street had 23 inundated segments meeting the LOS for the 25-year return period, 21 for the 50-year return period, and 20 for the 100-year return period.

These results highlight that Airport Road and The Gore Road are the most affected by flooding but still manage a relatively high compliance rate with the LOS, while Dixie Road and King Street show moderate inundation levels. Based on the findings it suggests that certain road sections, like Airport Rd between Derry Rd and Steeles Ave and The Gore Rd between Queen St and Steeles Ave, are particularly vulnerable to flooding. Prioritizing these areas for detailed assessment and flood mitigation measures is an important step toward enhancing their resilience, especially under extreme weather scenarios. Here are some possible flood mitigation measures that could be considered to address flooding:

- Structural measures: flood protection structures, channel widening and crossing upsizing.
- Non-structural measures: flood forecasting and early warning, land use planning, emergency management, and community engagement and education.

FIGURE 4.11 illustrates results of the inundated road segments assessed against ROP's LOS for selected return periods. Since the scale of flooded road segments relative to the total length of the road network is quite small, 28 panels have been placed across the index map which provide more detailed view of the flooded road segments. These panels are presented as 7 separate panel maps, each containing 4 panels. For detailed information on the panel maps, please refer to Appendix A6.

As the figure shows, the inundated road segments are color-coded to indicate their level of compliance with the ROP's LOS for the specific return periods.

- Road segments colored green meets the LOS for a 100-year return period, indicating the highest level of flood resilience.
- Yellow road segments meet the LOS for a 50-year return period, reflecting moderate resilience.

- Orange road segments meet the LOS for a 25-year return period, signifying limited resilience.
- Road segments marked in red do not meet the ROP's LOS under any of the evaluated return periods, highlighting areas of potential concern where road infrastructure is most vulnerable to flood impacts.

According to this figure, most of the road segments meet the ROP's LOS for a 100-year return period. However, in several areas along King Street, Dixie Road, and Airport Road, clusters of road segments do not meet the ROP's LOS, underscoring areas for targeted improvement. These regions, where infrastructure is most susceptible to flood damage, are priority areas for adaptive flood risk management strategies.

TABLE 4.12 SUMMARY OF THE NUMBER OF INUNDATED ROAD SEGMENTS ASSESSED AGAINST ROP'S LOS IN CURRENT CLIMATE SCENARIO

| Road Name | Total Number of Inundated Road Segments | Number of Inundated Road Segments that Meet ROP's LOS for 25-Year Return Period | Number of Inundated Road Segments that Meet ROP's LOS for 50-Year Return Period | Number of Inundated Road Segments that Meet ROP's LOS for 100-Year Return Period |
|---|---|---|---|---|
| King St | 37 | 23 | 21 | 20 |
| The Gore Rd | 50 | 40 | 40 | 39 |
| Mayfield Rd | 22 | 17 | 16 | 16 |
| Airport Rd | 82 | 48 | 46 | 38 |
| Hwy 50 | 28 | 19 | 18 | 18 |
| Dixie Rd | 48 | 29 | 24 | 22 |
| Queen St E | 29 | 26 | 26 | 23 |
| Steeles Ave E | 9 | 5 | 5 | 5 |
| Old Church Rd | 10 | 8 | 8 | 8 |
| Derry Rd E | 17 | 15 | 13 | 12 |
| Bovaird Dr E | 22 | 22 | 22 | 22 |
| Finch Ave | 4 | 4 | 4 | 4 |
| King St E | 20 | 11 | 9 | 9 |
| Coleraine Dr | 2 | 0 | 0 | 0 |
| Emil Kolb Pky | 0 | 0 | 0 | 0 |
| Mississauga Rd | 2 | 2 | 2 | 2 |
| Queen St N | 14 | 13 | 13 | 13 |
| King St W | 2 | 2 | 2 | 2 |
| **Total** | **398** | **284** | **269** | **253** |

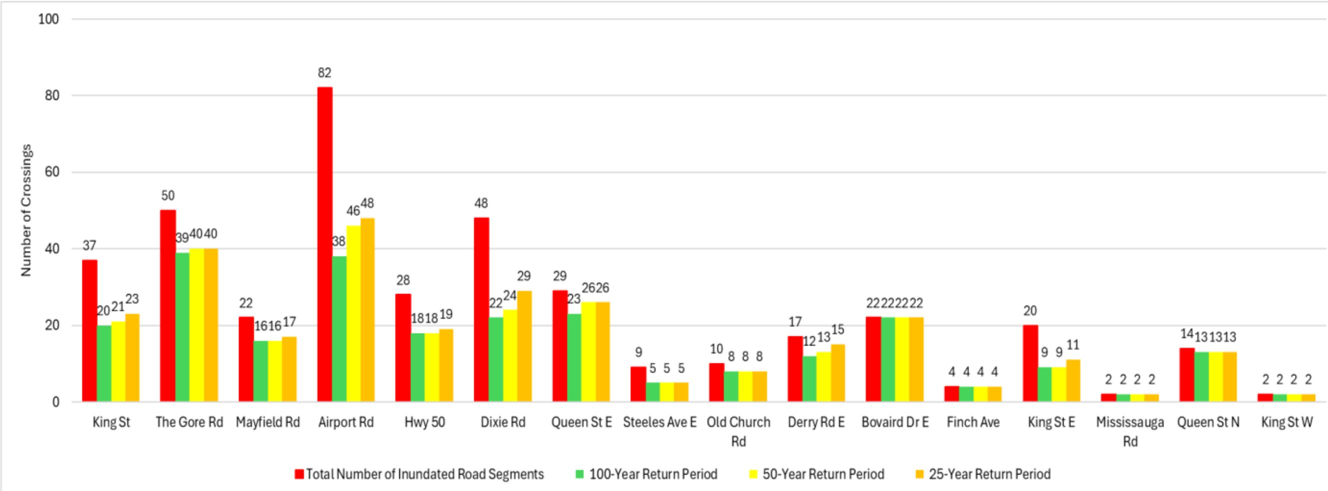


**FIGURE 4.10 SUMMARY OF INUNDATED ROAD SEGMENTS THAT MEET ROP'S LOS FOR 25-YEAR, 50-YEAR AND 100-YEAR RETURN PERIOD STORM EVENTS UNDER CURRENT CLIMATE CONDITIONS (THE NUMBERS AT THE TOP OF EACH BAR REPRESENT THE TOTAL NUMBER OF INUNDATED ROAD SEGMENTS)**

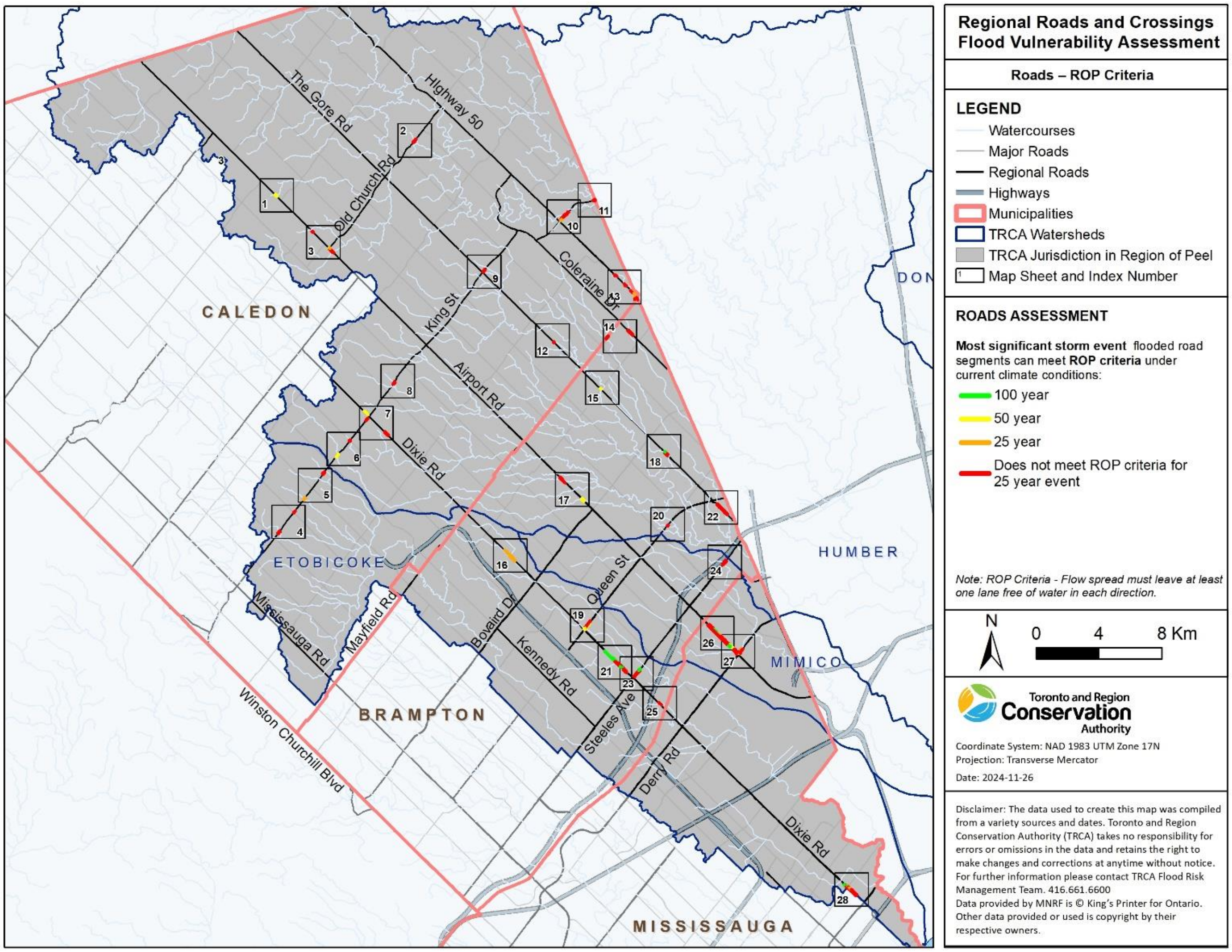


**FIGURE 4.11 RESULTS OF INUNDATED ROAD SEGMENTS AGAINST ROP'S LOS FOR SELECTED RETURN PERIODS**

## 4.2.2 Maximum Flood Depth

**FIGURE 4.12** depicts the maximum flood depths on inundated road segments for a 100-year return period storm event. Similar to **FIGURE 4.11**, 28 panels have been placed across the map to provide a more detailed view of the affected road segments, and these panels are presented as 7 separate panel maps, each containing 4 panels. For detailed information on the panel maps, please refer to Appendix A6.

As the figure shows, road segments are color-coded based on their maximum flood depth during the event as summarized below:

- Green road segments represent areas where flood depths range from less than 0.07m, indicating minimal flooding.
- Yellow segments correspond to flood depths between 0.07m and 0.15m,
- Orange segments represent depths of 0.15m to 0.3m, reflecting increasing levels of flooding.

- Darker shades of red indicate more severe flooding, with flood depths ranging from 0.3m to over 1.5m. Segments marked in dark red experience flood depths exceeding 1.5m, signaling potential areas where road functionality and safety are highly compromised during flood events.

The map highlights that while many road segments experience relatively shallow flooding, some areas along Dixie Road and Airport Road are subject to higher flood depths, posing higher risk to road accessibility and safety during a 100-year return period event. These zones are priority areas for flood mitigation measures, as road segments in these regions are highly vulnerable to prolonged disruptions and damage. Implementing targeted interventions to reduce flooding in these road segments will be essential for enhancing the overall resilience of the road network within the ROP jurisdiction.

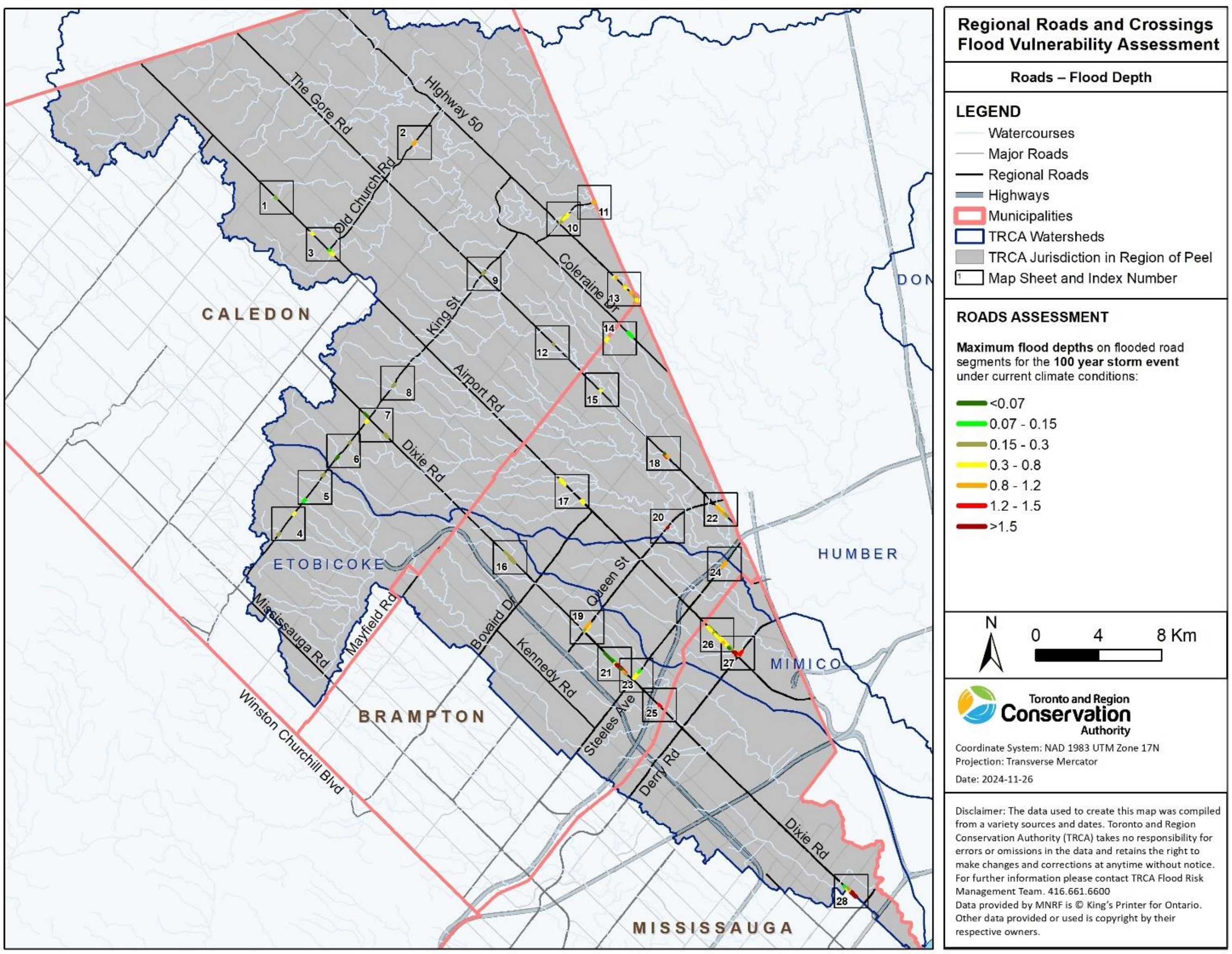


**FIGURE 4.12 THE MAXIMUM FLOOD DEPTHS ON ROAD SEGMENTS FOR A 100-YEAR RETURN PERIOD**

## 4.3 Assessment Deliverable Summary

In addition to the tables, figures and discussion above, the outputs from this assessment were also captured in a variety of additional formats. Table 4.13 presents a summary of the key deliverables provided to Peel as part of this project. These deliverables include Excel worksheets, Geodatabase GIS file, Map sheets and technical report. The table outlines the specific items delivered, their purpose, and how they align with the project objectives.

Table 4.13 Summary of Results Output

| Deliverable | Nature | Description | Purpose |
|---|---|---|---|
| Excel Worksheet | Table (Excel file) | Compiled dataset with analyzed results and summaries | Provides structured data for further review and analysis |
| Geodatabase | GIS File | Spatial database containing georeferenced project data | Facilitates spatial analysis and mapping |
| Map Sheets | Map Documents (GIS and PDF) | Series of detailed maps illustrating key findings | Visual representation of analyzed data |
| Technical Report | Word Document | Comprehensive documentation of methodologies and results | Provides a detailed account of project findings |

# 5 SUMMARY AND RECOMMENDATION

## 5.1 Summary

This study provides a detailed assessment of the hydraulic capacity of the watercourse crossings under current and future climate scenarios and flood vulnerability of regional roads under current scenarios in TRCA jurisdiction within the Region of Peel. This study was focused on riverine flooding and utilized existing hydrological and hydraulic models within TRCA's jurisdiction, ensuring the analysis reflects the most up-to-date data available without developing new models or re-running existing models for this study.

Over 140 watercourse crossings and associated regional road segments were evaluated against established criteria, including All MTO criteria which are Design Flow, Freeboard, Relief Flow, and Soffit Clearance for the crossings and ROP's Level of Service for regional roads. The project employed methodologies that included results extraction into two types of data formats - Excel and Geodatabase - for data analysis, and the project also used GIS-based mapping to visualize and prioritize areas of concern.

Also, the study incorporated future climate projections for crossing analysis, employing an approach that was applied by "shifting" the return periods of rainfall depths modelled from existing model outputs, based on projected IDF values from ECCC (ECCC, IDF). These analyses anticipate the effects of increased storm intensity and frequency, providing insights into the adaptability of existing infrastructure to future climate conditions.

## 5.2 Key findings

This study leverages various existing datasets, including hydraulic modeling outputs, to systematically analyze the compliance of 143 watercourse crossings and 398 inundated road segments with relevant standards under both current and future climate scenarios. The findings provide the Region of Peel with a comprehensive understanding of the flooding risks associated with its watercourse crossings and road infrastructure. These insights are critical for identifying vulnerabilities and will inform the prioritization and implementation of measures aimed at enhancing the resilience of the Region's transportation network in the face of climate change.

Below provides a summary of key findings and the following section outlines high-level recommendations to guide the next steps in addressing these risks.

### 5.2.1 Current Climate Scenario

Key findings reveal that 62% of crossings do not meet at least one of the MTO criteria under current climate conditions. Also, 36% of road segments do not meet ROP's LOS under current conditions, 66% of crossings do not meet at least one MTO criterion under future climate conditions, while only 4% of crossings fully comply with all MTO criteria. The status of the remaining 30% requires new hydraulic simulations, which are beyond the scope of the current study.

Under the current climate conditions, the key findings on the hydraulic capacity of watercourse crossings and flood vulnerable road assessment are as follows:

**Crossing Assessment:**

1) **Crossing Overtopping**
   - 46.8% of the crossing can withstand a Regulatory storm before being overtopped.
   - 35.7% of the crossings are resilient to even greater than regional storm events.
   - 17.5% of the crossings display varying degrees of vulnerability to smaller storm events.
   - 2.8% are overtopped at a 100-year storm event, while 3.5% can withstand only up to a 50-year storm event.
   - 4.2% each are overtopped at 25-year and 10-year storm events, respectively.
   - The least resilient crossings include 2 that are overtopped at a 5-year storm event (1.4%) and 2 at a 2-year storm event (1.4%).
2) **Design Flow Criterion**
   - 13% of crossings do not meet the required MTO design flow criterion.
   - 87% of crossings meet the required MTO design flow criterion.
3) **All MTO Criteria**
   - 62% of crossings do not meet at least one MTO criteria.
   - 38% of crossings meet all MTO criteria.

**Road Assessment:**

- 36% of road segments do not meet the ROP's Level of Service (LOS).
- 64% of road segments meet the ROP's Level of Service (LOS).

### 5.2.2 Future Climate Scenario

Under future climate conditions, the key findings on the hydraulic capacity of watercourse crossings are as follows:

1) **Design Flow Criterion**
   - 35.7% of crossings meet the design flow criterion in both mid-century and end-of-century scenarios.
   - 18.2% of crossings meet the design flow criterion in the mid-century scenario but cannot be assessed for the end-of-century scenario.
   - 17.5% of crossings do not meet the design flow criterion in either scenario.
   - 28.6% of crossings cannot be assessed in both mid-century and end-of-century scenarios.
2) **All MTO Criteria**
   - Approximately 66% of crossings do not meet at least one MTO criteria.
   - 4% of crossings fully meet all MTO criteria for both mid-century and end-of-century scenarios.
   - 16% of crossings meet all MTO criteria for the mid-century scenario but cannot be assessed for the end-of-century scenario.
   - 14% of crossings cannot be assessed in either scenario.

## 5.3 Recommendations

The following recommendations are provided based upon the project findings and/or to address the gaps in this study:

1. Consider further assessment of Regional Roads and crossings that do not meet MTO criteria under current climate conditions. For instance:
   - Identify crossings where upgrades may be interlinked with upgrades to other structures,
   - Identify crossings where upgrades may not be possible due to certain constraints,
   - Characterize the hydraulic constraints of identified crossings (undersized crossings, unsized channel conveyance, low points on the road/banks, etc.), and
   - Prioritize the crossings based on criticality of the road.
2. Consider integration of urban flood risk into the assessment for a more comprehensive investigation of overall flood risk (i.e., fluvial and pluvial aspects).
3. Consider addressing the 'cannot be assessed' crossings for mid-century and end-of-century, which involves re-running hydrologic and hydraulic models with future rainfall projections, to address the gap in data for return period storms between the 100-year and Regional storm under future climate conditions.
4. Consider collaborating with area municipalities to have them lead a similar assessment of local roads to provide a more comprehensive assessment for emergency vehicle route planning.
5. Consider incorporating road criticality (road ranking) to consider how critical a particular road is alongside whether it is at risk of current and future flooding based on a selected suite of indicators such as Annual Average Daily Traffic (AADT), Function of Roads, Goods Movement Routes, Designated Transit Routes etc.

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# 7 APPENDICES

## A1: Detailed workflows

## A2: Crossing Assessment Results

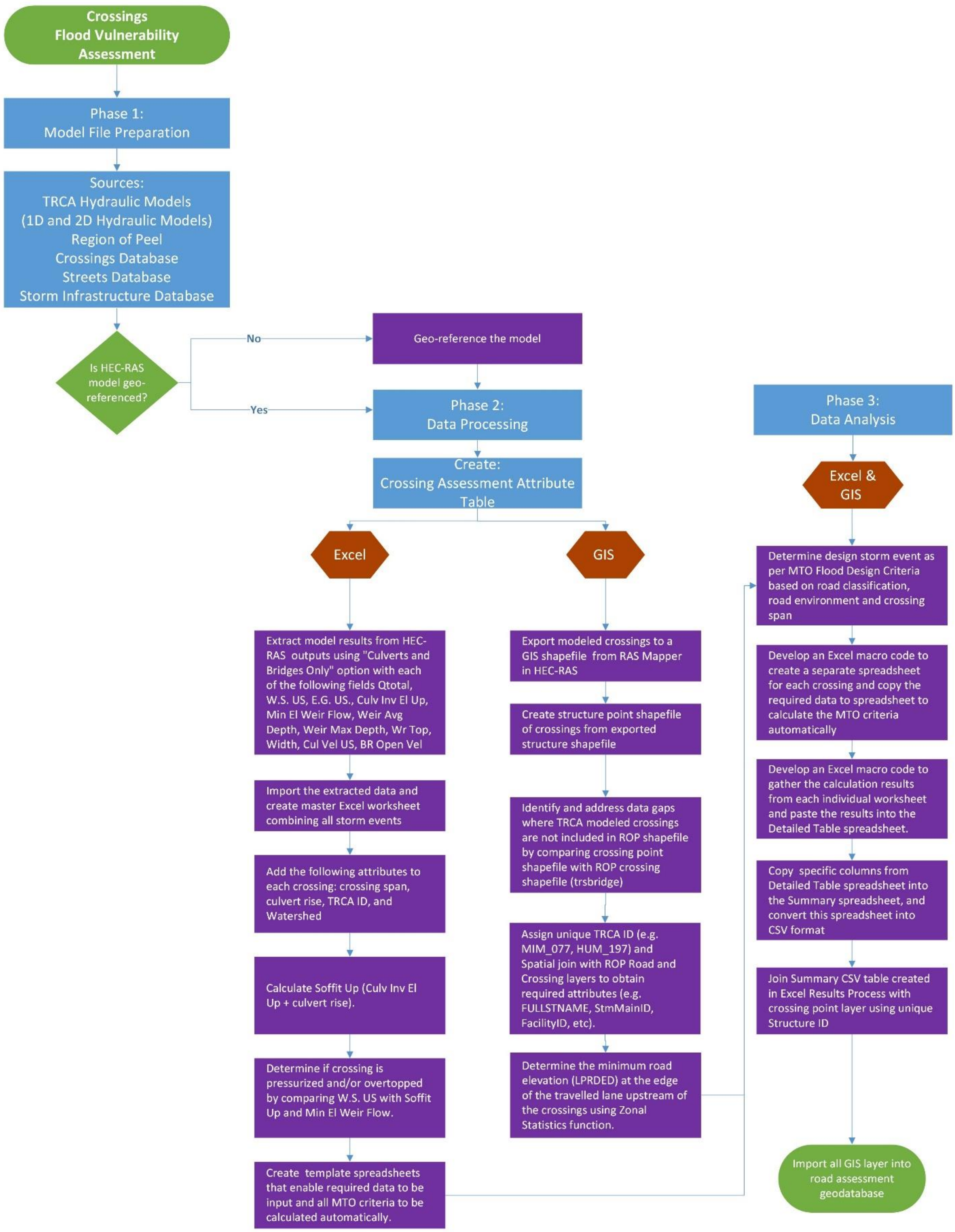
## A3: Road Assessment Results

## A4: Climate Change Memo

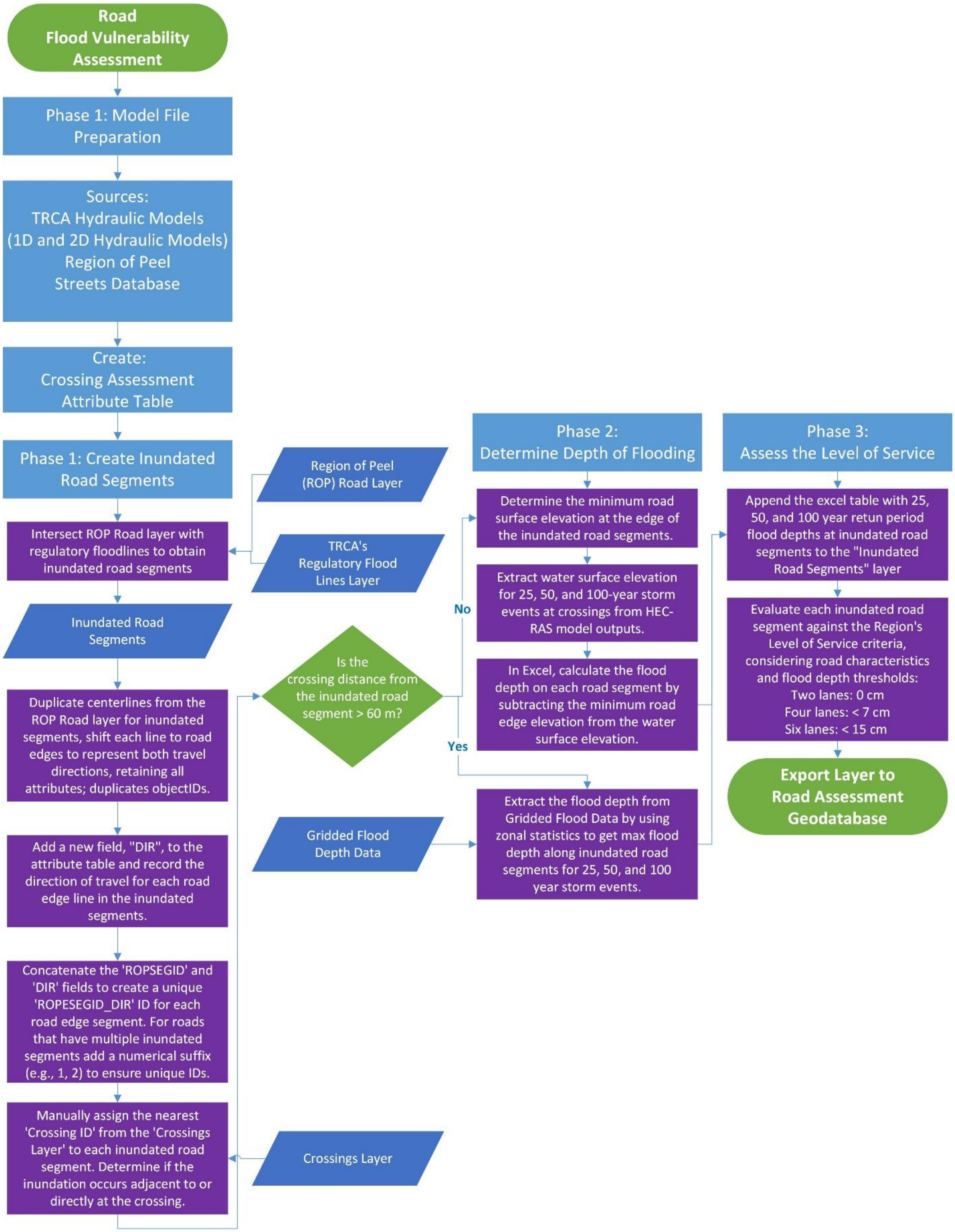
## A5: Criticality Ranking Factors

## A6: Panel Maps

# Appendix A1:
# Detailed workflows




**Note: Please refer to A2-2, Crossing Assesment Metadata for detailed explanations of the items mentioned in this flow chart.**




**Note: Please refer to A3-2, Road Assessment Metadata for detailed explanations of the items mentioned in this flow chart.**

# Appendix A2:
# Crossing Assessment Results

## A2-1: Crossing Assessment Results Tables

**Table A2-1: Master Map Results for Crossing Assessment**

| FacilityID | StmMainID | CA_ID | Struc_Type | FULLNAME | RiverName | PrSTMEC | OTSTMEC | MAXSTMEC | WC1_DFEC | WC2MinEC | WC2DesEC | WC2SofEC | WC7_1EC | WC7_2EC | WC13_1EC | WC13_2EC | WC1_DF50 | WC1_DF80 | MTOMetEC | MTOMET50 | MTOMET80 | PrSTMCC50 | OTSTMCC50 | MAXSTMCC50 | PrSTMCC80 | OTSTMCC80 | MAXSTMCC80 | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | STNDRR009-0535-STNDRR009-0536 | ETO_017 | Culvert | King St | Eto Hdwtr N TrbN | 25 | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | Y | N/A | N | N | N | 8.65 | Reg | 25 | 3.64 | Reg | 8.39 | N/A |
| - | STNDRR009-0523-STNDRR009-0524 | ETO_018 | Culvert | King St | Eto Hdwtr N TrbL | 10 | 25 | 10 | N | N | N | N/A | N/A | Y | Y | Y | N | N | N | N | N | 4.44 | 8.65 | 4.44 | 2.07 | 3.64 | 2.07 | N/A |
| - | STNDRR009-0817-STNDRR009-0818 | ETO_023 | Culvert | King St | Eto Hdwtr N TrbA | 25 | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | 8.65 | Reg | 25 | 3.64 | Reg | 8.39 | N/A |
| - | STNDRR009-0563-STNDRR009-0564 | ETO_024 | Culvert | King St | Eto Hdwtr N TrbO | 2 | 5 | 2 | N | N | N | N/A | N/A | Y | N | Y | N | N | N | N | N | 1.18 | 2.61 | 1.18 | 0.68 | 1.32 | 0.68 | N/A |
| - | STNDRR009-0509-STNDRR009-0510 | ETO_026 | Culvert | King St | Eto Hdwtr N | 25 | 50 | 25 | Y | N | N | N/A | N/A | Y | N | Y | N | N | N | N | N | 8.65 | 14.24 | 8.65 | 3.64 | 5.54 | 3.64 | N/A |
| - | STNDRR001-0328-STNDRR001-0329 | ETO_029 | Culvert | Mississauga Rd | Eto Hdwtr S TrbH | 2 | Reg | 100 | Y | Y | Y | N/A | N/A | N | Y | Y | Y | N/A | N | N | N | 1.18 | Reg | 25 | 0.68 | Reg | 8.39 | N/A |
| RR014-1110 | - | ETO_031 | Culvert | Mayfield Rd | Spring Creek | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR009-0829-STNDRR009-0830 | ETO_049 | Culvert | King St | Eto Hdwtr N TrbF | 5 | 10 | 5 | N | N | N | N/A | N/A | N | N | Y | N | N | N | N | N | 2.61 | 4.44 | 2.61 | 1.32 | 2.07 | 1.32 | N/A |
| RR014-1560-01 | - | ETO_163 | Bridge | Mayfield Rd | Etobicoke Creek | Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | N/A | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR107-1252-01 | - | ETO_167 | Bridge | Bovaird Dr E | Etobicoke Creek | Reg | Reg | 100 | Y | Y | Y | Y | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR015-1160 | - | ETO_183 | Bridge | Steeles Ave E | Etobicoke Creek | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR004-1480-03 | - | ETO_189 | Bridge | Dixie Rd | Etobicoke Creek | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | Y | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR005-0630-03 | - | ETO_190 | Bridge | Derry Rd E | Etobicoke Creek | 100 | Reg | 100 | Y | N | N | N | N/A | N/A | N | N | N/A | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| RR015-0880 | - | ETO_200 | Culvert | Steeles Ave E | EtobicokeCreek | 25 | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | 8.65 | >Reg | Reg | 3.64 | >Reg | Reg | N/A |
| RR004-1540 | - | ETO_206 | Bridge | Dixie Rd | EtobicokeCreek | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR004-1290 | - | ETO_218 | Bridge | Dixie Rd | Etobicoke Creek | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR004-2350 | - | ETO_224 | Culvert | Bovaird Dr E | EtobicokeCreek | 10 | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | N | N/A | N/A | N | N | N | 4.44 | Reg | 25 | 2.07 | Reg | 8.39 | N/A |
| RR107-0805 | - | ETO_232 | Bridge | Queen St E | Etobicoke Creek | Reg | Reg | 100 | Y | Y | Y | Y | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR004-2080 | - | ETO_245 | Culvert | Dixie Rd | Etobicoke Creek | 50 | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | N/A | N/A | N | N | N | 14.24 | Reg | 25 | 5.54 | Reg | 8.39 | N/A |
| RR107-0882 | - | ETO_246 | Culvert | Queen St E | Etobicoke Creek | 5 | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | N/A | N/A | N | N | N | 2.61 | Reg | 25 | 1.32 | Reg | 8.39 | N/A |
| - | STNDRR107-0210-STNDRR107-0211 | ETO_261 | Culvert | Queen St E | Etobicoke Creek | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | N | Y | Y | Y | N | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR004-1843-01 | - | ETO_271 | Culvert | Dixie Rd | Etobicoke Creek | >Reg | 10 | 5 | N | N | N | N/A | N/A | Y | N | N | N | N | N | N | N | >Reg | 4.44 | 2.61 | >Reg | 2.07 | 1.32 | N/A |
| RR015-0710 | - | ETO_275 | Culvert | Steeles Ave E | Etobicoke Creek | Reg | >Reg | Reg | Y | Y | Y | N/A | N | N/A | Y | Y | Y | Y | N | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR005-0430 | - | ETO_281 | Bridge | Derry Rd E | Spring Creek | Reg | Reg | 100 | Y | Y | N | N | N/A | N/A | N | N | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR004-0440-02 | - | ETO_307 | Bridge | Dixie Rd | Little Etobicoke Creek | 100 | >Reg | Reg | Y | N | N | N | N/A | N/A | Y | Y | Y | Y | N | N | N | 25 | >Reg | Reg | 8.39 | >Reg | Reg | N/A |
| RR020-0000S | - | ETO_310 | Bridge | Queensway E | Little Etobicoke | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| - | STNDRR009-0121-STNDRR009-0122 | HUM_148 | Culvert | King St | Lindsay East | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR009-0153-STNDRR009-0154 | HUM_153 | Culvert | King St | Lindsay E TribB | 10 | 25 | 10 | N | N | N | N/A | N/A | N | Y | Y | N | N | N | N | N | 4.44 | 8.65 | 4.44 | 2.07 | 3.64 | 2.07 | N/A |
| - | STNDRR009-1084-STNDRR009-1085 | HUM_155 | Culvert | King St | Lindsay E TribA | Reg | >Reg | Reg | Y | Y | Y | N/A | Y | N/A | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR009-0800-STNDRR009-0801 | HUM_158 | Culvert | King St | Lindsay W TribA | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR008-1470 | - | HUM_162 | Culvert | The Gore Rd | Lindsay East | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR009-0747 | - | HUM_163 | Culvert | King St | Lindsay W TribB | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR009-0177-STNDRR009-0178 | HUM_165 | Culvert | King St | Lindsay West | 25 | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | 8.65 | Reg | 25 | 3.64 | Reg | 8.39 | N/A |
| - | STNDRR009-0205-STNDRR009-0206 | HUM_172 | Culvert | King St | WHNorth TribB | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR009-0918 | - | HUM_175 | Culvert | King St | W HUMber North | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR009-0970 | - | HUM_176 | Culvert | King St | W HUMber South | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR009-0239-STNDRR009-0240 | HUM_177 | Culvert | King St | WHSouth TribB | Reg | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR008-0539-STNDRR008-0540 | HUM_179 | Culvert | The Gore Rd | WH5C | 10 | 10 | 5 | N | N | N | N/A | N/A | N | Y | Y | N | N | N | N | N | 4.44 | 4.44 | 2.61 | 2.07 | 2.07 | 1.32 | N/A |

| FacilityID | StmMainID | CA_ID | Struc_Type | FULLNAME | RiverName | PrSTMEC | OTSTMEC | MAXSTMEC | WC1_DFEC | WC2MinEC | WC2DesEC | WC2SofEC | WC7_1EC | WC7_2EC | WC13_1EC | WC13_2EC | WC1_DF50 | WC1_DF80 | MTOMetEC | MTOMET50 | MTOMET80 | PrSTMCC50 | OTSTMCC50 | MAXSTMCC50 | PrSTMCC80 | OTSTMCC80 | MAXSTMCC80 | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RR009-1117 | STNDRR009-0377-STNDRR009-0378 | HUM_180 | Culvert | King St | Salt TribQ | Reg | >Reg | Reg | Y | Y | N | N/A | N/A | Y | Y | Y | Y | Y | N | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR009-0251-STNDRR009-0252 | HUM_181 | Culvert | King St | WHSouth TribA | Reg | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR008-0557-STNDRR008-0558 | HUM_187 | Culvert | The Gore Rd | WH5C TribB | 50 | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | N | Y | Y | Y | N | N | N | 14.24 | >Reg | Reg | 5.54 | >Reg | Reg | N/A |
| - | STNDRR008-0575-STNDRR008-0576A | HUM_190 | Culvert | The Gore Rd | WH5C TribA | Reg | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR009-0283-STNDRR009-0284 | HUM_191 | Culvert | King St | Salt TribU | 25 | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | Y | N/A | N | N | N | 8.65 | Reg | 25 | 3.64 | Reg | 8.39 | N/A |
| RR009-1183 | - | HUM_192 | Culvert | King St | Salt Creek | 50 | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | 14.24 | Reg | 25 | 5.54 | Reg | 8.39 | N/A |
| - | STNDRR014-0186-STNDRR014-0187 | HUM_194 | Culvert | Mayfield Rd | WH5A TribD | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR008-0627-STNDRR008-0628 | HUM_195 | Culvert | The Gore Rd | WH5A TribD | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | N/A | N/A | Y | N/A | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR007-2090 | - | HUM_197 | Culvert | Airport Rd | Salt Creek | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | N/A | N/A | Y | N/A | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR009-0329-STNDRR009-0330 | HUM_198 | Culvert | King St | CamTribJ North | 10 | 10 | 5 | N | N | N | N/A | N/A | N | N | Y | N | N | N | N | N | 4.44 | 4.44 | 2.61 | 2.07 | 2.07 | 1.32 | N/A |
| - | STNDRR008-0633-STNDRR008-0634 | HUM_202 | Culvert | The Gore Rd | WH5A TribC | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | Y | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR014-0194-STNDRR014-0195 | HUM_203 | Culvert | Mayfield Rd | WH5A TribC | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR014-0810-02 | - | HUM_204 | Culvert | Airport Rd | Salt Creek | 100 | Reg | 100 | Y | Y | N | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| - | STNDRR014-0248-STNDRR014-0249 | HUM_206 | Culvert | Mayfield Rd | WHTribA North A | 10 | Reg | 100 | Y | N | N | N/A | N/A | N | N | Y | Y | N/A | N | N | N | 4.44 | Reg | 25 | 2.07 | Reg | 8.39 | N/A |
| - | STNDRR009-0341-STNDRR009-0342 | HUM_209 | Culvert | King St | CamTribJ North B | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR014-0550 | - | HUM_211 | Culvert | Mayfield Rd | WHTribA North | >Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR014-0585 | STNDRR014-0294-STNDRR014-0295 | HUM_212 | Culvert | Mayfield Rd | WHTribA South | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | Y | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR009-1444 | - | HUM_217 | Culvert | King St | CamTribJ South | >Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| - | STNDRR009-0377-STNDRR009-0378 | HUM_219 | Culvert | King St | CamTribS West | 10 | 10 | 5 | N | N | N | N/A | N/A | N | Y | Y | N | N | N | N | N | 4.44 | 4.44 | 2.61 | 2.07 | 2.07 | 1.32 | N/A |
| - | STNDRR014-0302-STNDRR014-0303 | HUM_221 | Culvert | Mayfield Rd | WHTribA South A | 2 | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | N/A | N/A | N | N | N | 1.18 | Reg | 25 | 0.68 | Reg | 8.39 | N/A |
| - | STNDRR014-0332-STNDRR014-0333 | HUM_230 | Culvert | Mayfield Rd | Salt TribD | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR009-0389-STNDRR009-0390 | HUM_233 | Culvert | King St | Campbell TribA | 10 | 10 | 5 | N | N | N | N/A | N/A | N | N | Y | N | N | N | N | N | 4.44 | 4.44 | 2.61 | 2.07 | 2.07 | 1.32 | N/A |
| RR014-0810-02 | - | HUM_244 | Culvert | Mayfield Rd | Campbell TribD | >Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR009-1680 | - | HUM_254 | Culvert | King St | Campbell's Crk | 10 | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | 4.44 | Reg | 25 | 2.07 | Reg | 8.39 | N/A |
| - | STNDRR014-0793-STNDRR014-0794 | HUM_262 | Culvert | Mayfield Rd | Campbell TribF | Reg | >Reg | Reg | Y | N | N | N/A | N/A | Y | Y | Y | Y | Y | N | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STMHRR004-0684-STNDRR004-0394 | HUM_263 | Culvert | Dixie Rd | Campbell TribR | >Reg | >Reg | Reg | Y | N | N | N/A | N/A | Y | Y | Y | Y | Y | N | N | N | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR150-0530-02 | STMHRR150-0063-STNDRR150-0266 | HUM_275 | Culvert | Coleraine Dr | Clarkway TribD | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR014-0100-STNDRR014-0101 | HUM_277 | Culvert | Mayfield Rd | Clarkway TribB | 10 | 50 | 25 | Y | N | N | N/A | N/A | N | N | Y | N | N | N | N | N | 4.44 | 14.24 | 8.65 | 2.07 | 5.54 | 3.64 | N/A |
| - | STNDRR008-0055-STNDRR008-0056 | HUM_288 | Culvert | The Gore Rd | CoffeyCreekTrbE | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR050-2980 | - | HUM_294 | Culvert | Hwy 50 | UpperHumberTrbO | Reg | Reg | 100 | Y | Y | Y | N/A | Y | N/A | N | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | - | HUM_316A | Culvert | The Gore Rd | UpperHumberTrbP | 10 | 50 | 25 | Y | N | N | N/A | N/A | N | Y | N | N | N | N | N | N | 4.44 | 14.24 | 8.65 | 2.07 | 5.54 | 3.64 | N/A |
| - | STNDRR150-0076-STNDRR150-0075 | HUM_31C_2R | Culvert | Coleraine Dr | River 4 | 2 | 2 | <2 | N | N | N | N/A | N/A | N | Y | Y | N | N | N | N | N | 1.18 | 1.18 | <2 | 0.68 | 0.68 | <2 | N/A |
| RR050-0578-01 | - | HUM_325 | Culvert | Hwy 50 | West Rainbow | Reg | >Reg | Reg | Y | Y | Y | N/A | Y | N/A | Y | Y | Y | Y | Y | N/A | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR050-0454-STNDRR050-0453 | HUM_327 | Culvert | Hwy 50 | UpperHumberTrbL | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR050-0446-STNDRR050-0445 | HUM_336 | Culvert | Hwy 50 | UpperHumberTrbL | 2 | >Reg | Reg | Y | Y | Y | N/A | N/A | N | Y | Y | Y | Y | N | N | N | 1.18 | >Reg | Reg | 0.68 | >Reg | Reg | N/A |
| - | STNDRR050-0416-STNDRR050-0415 | HUM_346 | Culvert | Hwy 50 | UpperHumberTrbK | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR008-0077-STNDRR008-0078 | HUM_352 | Culvert | The Gore Rd | CoffeyCreekTrbC | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | Y | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR008-0087-STNDRR008-0088 | HUM_359 | Culvert | The Gore Rd | CoffeyCreekTrbC | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | Y | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR008-0095-STNDRR008-0096 | HUM_366 | Culvert | The Gore Rd | CoffeyCreekTrbC | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | Y | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR008-0101-STNDRR008-0102 | HUM_373 | Culvert | The Gore Rd | CentrevilleTrbF | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR008-0131-STNDRR008-0132 | HUM_384 | Culvert | The Gore Rd | CentrevilleTrbF | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |

| FacilityID | StmMainID | CA_ID | Struc_Type | FULLNAME | RiverName | PrSTMEC | OTSTMEC | MAXSTMEC | WC1_DFEC | WC2MinEC | WC2DesEC | WC2SofEC | WC7_1EC | WC7_2EC | WC13_1EC | WC13_2EC | WC1_DF50 | WC1_DF80 | MTOMetEC | MTOMET50 | MTOMET80 | PrSTMCC50 | OTSTMCC50 | MAXSTMCC50 | PrSTMCC80 | OTSTMCC80 | MAXSTMCC80 | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| - | STNDRR022-0117-STNDRR022-0118 | HUM_388 | Culvert | Old Church Rd | UpperHumberTrbH | 10 | 25 | 10 | N | N | N | N/A | N/A | N | N | Y | N | N | N | N | N | 4.44 | 8.65 | 4.44 | 2.07 | 3.64 | 2.07 | N/A |
| - | STNDRR007-0577-STNDRR007-0578 | HUM_399 | Culvert | Airport Rd | CoffeyCreek | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR008-2330 | - | HUM_407 | Culvert | The Gore Rd | CentrevilleTrbI | Reg | >Reg | Reg | Y | Y | Y | N/A | Y | N/A | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | - | HUM_409 | Culvert | Airport Rd | CoffeyCreekTrbG | 50 | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | N | N | 14.24 | Reg | 25 | 5.54 | Reg | 8.39 | N/A |
| - | STNDRR150-0179-STNDRR150-0180 | HUM_421 | Culvert | Emil Kolb Pky | UpperHumberTrbB | 50 | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | 14.24 | >Reg | Reg | 5.54 | >Reg | Reg | N/A |
| RR150-0440 | - | HUM_422 | Bridge | Emil Kolb Pky | UpperHumberTrbB | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| - | STNDRR007-0513-STNDRR007-0514 | HUM_433 | Culvert | Airport Rd | CentrevilleTrbJ | 25 | 100 | 50 | Y | Y | Y | N/A | N/A | N | Y | Y | N | N | N | N | N | 8.65 | 25 | 14.24 | 3.64 | 8.39 | 5.54 | N/A |
| RR022-0510 | - | HUM_436 | Culvert | Old Church Rd | CentrevilleTrbJ | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | Y | Y | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR008-1850 | - | HUM_446 | Culvert | The Gore Rd | UpperHumberTrbA | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | N/A | Y | Y | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR007-0449-STNDRR007-0450 | HUM_447 | Culvert | Airport Rd | CentrevilleTrbA | 25 | 50 | 25 | Y | N | N | N/A | N/A | Y | Y | Y | N | N | N | N | N | 8.65 | 14.24 | 8.65 | 3.64 | 5.54 | 3.64 | N/A |
| - | - | HUM_459 | Culvert | Hwy 50 | RobinsonCreek | 2 | 2 | <2 | N | N | N | N/A | N/A | N | N | N | N | N | N | N | N | 1.18 | 1.18 | <2 | 0.68 | 0.68 | <2 | N/A |
| RR014-0002 | - | HUM_461 | Culvert | Mayfield Rd | RobinsonCreek | Reg | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| - | STNDRR014-0202-STNDRR014-0203 | HUM_512 | Culvert | Mayfield Rd | WH5A TribC | 100 | Reg | 100 | Y | N | N | N/A | N/A | Y | Y | Y | N/A | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| RR107-0290-01 | STMHRR107-0209-STMHRR107-0203 | HUM_522 | Culvert | Queen St E | WH TribB | 5 | 50 | 25 | N | N | N | N/A | N/A | N | N | N | N | N | N | N | N | 2.61 | 14.24 | 8.65 | 1.32 | 5.54 | 3.64 | N/A |
| RR050-2188 | - | HUM_533 | Culvert | Hwy 50 | UpperHumberTrbI | >Reg | >Reg | Reg | Y | Y | Y | N/A | Y | N/A | Y | Y | Y | Y | Y | Y | Y | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| - | STNDRR008-0221-STNDRR008-0222 | HUM_539 | Culvert | The Gore Rd | CentrevilleTrbI | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR050-0392-STNDRR050-0391 | HUM_622 | Culvert | Hwy 50 | UpperHumberTrbJ | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| - | STNDRR107-0297-STNDRR107-0298 | HUM_801 | Culvert | Queen St E | WH TribD | 25 | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | 8.65 | >Reg | Reg | 3.64 | >Reg | Reg | N/A |
| RR050-1690E-01 | - | HUM_802 | Bridge | Queen St N | Humber River | Reg | Reg | 100 | Y | N | N | Y | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR009-0140 | - | HUM_803 | Bridge | King St E | Humber River | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR009-0120 | - | HUM_804 | Bridge | King St E | Humber River | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR005-0140-02 | - | MIM_075 | Bridge | Derry Rd E | West Branch Mimico Creek | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR007-0430 | - | MIM_077 | Bridge | Airport Rd | West Branch Mimico Creek | >Reg | >Reg | Reg | Y | N | N | N | N/A | N/A | Y | Y | Y | Y | N | N | N | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR015-0480 | - | MIM_105 | Culvert | Steeles Ave E | West Mim Creek | 100 | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | 25 | >Reg | Reg | 8.39 | >Reg | Reg | N/A |
| RR005-0120-02 | - | MIM_124 | Bridge | Derry Rd E | East Branch Mimico Creek | 100 | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| RR015-0290-02 | - | MIM_135 | Culvert | Steeles Ave E | East Mim Creek | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | Y | Y | N/A | N/A | Y | N/A | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR007-0770 | - | MIM_140 | Culvert | Airport Rd | East Mim Trib B | 10 | Reg | 100 | Y | N | N | N/A | N/A | Y | N | Y | N/A | N/A | N | N | N | 4.44 | Reg | 25 | 2.07 | Reg | 8.39 | N/A |
| RR007-1010 | - | MIM_160 | Culvert | Airport Rd | East Mim Creek | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | N | Y | Y | Y | N | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR015-0130-02 | - | MIM_194 | Culvert | Steeles Ave E | East Mim Trib A | 5 | 25 | 10 | N | N | N | N/A | N/A | N | N | N | N | N | N | N | N | 2.61 | 8.65 | 4.44 | 1.32 | 3.64 | 2.07 | N/A |
| RR050-2371-01 | - | x-103 | Culvert | Hwy 50 | Upper Humber | Reg | Reg | 100 | Y | Y | Y | N/A | N | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR022-0010-02 | - | x-105 | Bridge | Old Church Rd | Upper Humber | Reg | Reg | 100 | Y | Y | Y | Y | N/A | N/A | N | N | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR050-2380-01 | - | x-106 | Culvert | Hwy 50 | Upper Humber | Reg | Reg | 100 | Y | Y | Y | N/A | Y | N/A | N | N | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR008-2770 | - | x-113 | Culvert | The Gore Rd | Coffey Creek | Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | N/A | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR050-2800-02 | - | x-119 | Bridge | Hwy 50 | Upper Humber | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | N | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR050-2870-02 | - | x-120 | Bridge | Hwy 50 | Upper Humber | Reg | Reg | 100 | Y | Y | Y | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR014-0300 | - | x-124 | Culvert | Mayfield Rd | Gore Road Trib | 100 | Reg | 100 | Y | N | N | N/A | N | N/A | N | Y | N/A | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| RR008-0063 | - | x-15 | Bridge | The Gore Rd | Clarkway Trib | 10 | 5 | 2 | N | Y | Y | N | N/A | N/A | N | Y | N | N | N | N | N | 4.44 | 2.61 | 1.18 | 2.07 | 1.32 | 0.68 | N/A |
| RR107-0145-01 | - | x-16 | Culvert | Queen St E | Gore Road Trib | >Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR015-0040N-02 | - | x-2 | Bridge | Steeles Ave E | West Humber | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR007-1350-02 | - | x-23 | Bridge | Airport Rd | Tributary A | 10 | 100 | 50 | N | N | N | N | N/A | N/A | N | N | N | N | N | N | N | 4.44 | 25 | 14.24 | 2.07 | 8.39 | 5.54 | N/A |
| RR107-0020-01 | - | x-25 | Culvert | Queen St E | Clarkway Trib | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | N | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |

| FacilityID | StmMainID | CA_ID | Struc_Type | FULLNAME | RiverName | PrSTMEC | OTSTMEC | MAXSTMEC | WC1_DFEC | WC2MinEC | WC2DesEC | WC2SofEC | WC7_1EC | WC7_2EC | WC13_1EC | WC13_2EC | WC1_DF50 | WC1_DF80 | MTOMetEC | MTOMET50 | MTOMET80 | PrSTMCC50 | OTSTMCC50 | MAXSTMCC50 | PrSTMCC80 | OTSTMCC80 | MAXSTMCC80 | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RR014-1090-02 | - | x-30 | Culvert | Mayfield Rd | Campbell's Crk | >Reg | >Reg | Reg | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR004-2920 | - | x-32 | Culvert | Dixie Rd | Campbell's Crk | Reg | Reg | 100 | Y | Y | Y | N/A | N/A | Y | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR007-1380-02 | - | x-33 | Bridge | Airport Rd | Campbells Crk | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR007-1430-02 | - | x-39 | Culvert | Airport Rd | Campbells TribC | 25 | 100 | 50 | Y | N | N | N/A | N/A | Y | N | N | N | N | N | N | N | 8.65 | 25 | 14.24 | 3.64 | 8.39 | 5.54 | N/A |
| RR007-1455-01 | - | x-42 | Culvert | Airport Rd | Campbells TribB | Reg | >Reg | Reg | Y | Y | Y | N/A | N | N/A | Y | Y | Y | Y | N | N | N | Reg | >Reg | Reg | Reg | >Reg | Reg | N/A |
| RR004-3043 | - | x-44 | Culvert | Dixie Rd | Campbell's TribA | Reg | Reg | 100 | Y | Y | Y | N/A | Y | N/A | Y | Y | N/A | N/A | Y | N/A | N/A | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR007-1640-03 | - | x-50 | Bridge | Airport Rd | Campbell's TribA | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | Y | Y | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR008-0410-01 | - | x-53 | Bridge | The Gore Rd | Gore Road Trib | 100 | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| RR014-0890-02 | - | x-55 | Culvert | Mayfield Rd | Campbell's TribA | Reg | Reg | 100 | Y | Y | Y | N/A | N | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR008-0440-01 | - | x-58 | Bridge | The Gore Rd | Gore Road Trib | 100 | 100 | 50 | N | N | N | N | N/A | N/A | N | N | N | N | N | N | N | 25 | 25 | 14.24 | 8.39 | 8.39 | 5.54 | N/A |
| RR008-0560-01 | - | x-66 | Bridge | The Gore Rd | Gore Road Trib | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR014-0700-01 | - | x-68 | Bridge | Mayfield Rd | Salt Creek | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR107-0260-022 | - | x-7 | Bridge | Queen St E | WH TribB | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR007-1900 | - | x-72 | Bridge | Airport Rd | Salt Creek | Reg | Reg | 100 | Y | Y | Y | N | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR008-0830 | - | x-74 | Bridge | The Gore Rd | West Humber | 100 | Reg | 100 | Y | N | N | N | N/A | N/A | N | N | N/A | N/A | N | N | N | 25 | Reg | 25 | 8.39 | Reg | 8.39 | N/A |
| RR014-0380 | - | x-79 | Culvert | Mayfield Rd | West Humber | Reg | Reg | 100 | Y | Y | Y | N/A | Y | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR014-0150 | - | x-80 | Culvert | Mayfield Rd | Clarkway Trib | 10 | 25 | 10 | N | N | N | N/A | N | N/A | N | N | N | N | N | N | N | 4.44 | 8.65 | 4.44 | 2.07 | 3.64 | 2.07 | N/A |
| RR008-1217 | - | x-82 | Culvert | The Gore Rd | West Humber | Reg | Reg | 100 | Y | Y | Y | N/A | Y | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR007-2940 | - | x-86 | Culvert | Airport Rd | Centreville Creek | 5 | 25 | 10 | N | N | N | N/A | N/A | N | N | Y | N | N | N | N | N | 2.61 | 8.65 | 4.44 | 1.32 | 3.64 | 2.07 | N/A |
| - | STNDRR022-0083-STNDRR022-0084 | x-91 | Culvert | Old Church Rd | CentrevilleTrbA | Reg | Reg | 100 | Y | Y | N | N/A | N/A | Y | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR150-0260 | - | x-94a | Bridge | Emil Kolb Parkway | Upper Humber | >Reg | >Reg | Reg | Y | Y | Y | Y | N/A | N/A | Y | Y | Y | Y | Y | N/A | N/A | >Reg | >Reg | Reg | >Reg | >Reg | Reg | N/A |
| RR008-2160 | - | x-96 | Bridge | The Gore Rd | Centreville Crk | Reg | Reg | 100 | Y | N | N | N | N/A | N/A | N | N | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |
| RR022-0350-02 | - | x-97 | Bridge | Old Church Rd | Centreville Crk | Reg | Reg | 100 | Y | Y | Y | Y | N/A | N/A | N | Y | N/A | N/A | N | N | N | Reg | Reg | 25 | Reg | Reg | 8.39 | N/A |

## A2-2: Crossing Assessment Metadata

| Item | Attribute | Description |
|---|---|---|
| 1 | FacilityID | Region of Peel Facility ID |
| 2 | StmMainID | Region of Peel Storm Main ID |
| 3 | CA_ID | Conservation Authority Structure ID |
| 4 | Watershed | Conservation Authority watershed name |
| 5 | Struc_Type | Structure Type provided by the ROP |
| 6 | CUR_RDCLS | Road classification |
| 7 | REG_ROAD | Ownership of roads |
| 8 | FULLNAME | Road name plus suffix of roads plus direction (if any) |
| 9 | MUNC | Name of Municipality |
| 10 | RiverName | River Name assigned in CVC hydraulic model |
| 11 | ReachName | Reach Name |
| 12 | River_Sta | Structure River Station |
| 13 | RdEnv | Based on MTO criteria for defining urban and rural road sections |
| 14 | Struc_Span | Total span of all openings at a crossing |
| 15 | PrSTMEC | The starting storm event at which a crossing is pressurized for the existing climate "EC". |
| 16 | OTSTMEC | The starting storm event at which a crossing is overtopped for the existing climate "EC". |
| 17 | ERDBTM | Indicate if the crossing has an erodable bottom or not: (Y/N) |
| 18 | MAXSTMEC | The max storm at which a crossing is not overtopped (max storm being conveyed by the crossing) for the existing climate "EC". |
| 19 | WC1_DFC | Design flow based on MTO HDDS, Jan 2008 |
| 20 | WC2MinC | Top of road freeboard (min) criteria from MTO HDDS, Jan 2008 |
| 21 | WC2DesC | Top of road freeboard (desired) criteria from MTO HDDS, Jan 2008 |
| 22 | WC2SofC | Soffit clearance for a bridge criteria from MTO HDDS, Jan 2008 |
| 23 | WC7_1C | Soffit Clearance for a Clvt with Erodable Bottom from MTO HDDS, Jan 2008 |
| 24 | WC7_2C | Flood depth for a Clvt with a non-erodable bottom criteria from MTO HDDS, Jan 2008 |

| Item | Attribute | Description |
|---|---|---|
| 25 | WC13_1C | Relief Flow, m (Max Depth over Roadway) criteria for a Regulatory Storm from MTO HDDS, Jan 2008 |
| 26 | WC13_2C | Relief Flow, m2/s (Vx D) criteria for a Regulatory Storm from MTO HDDS, Jan 2008 |
| 27 | Rise | Rise (m) |
| 28 | Eff_Rise | Effective Rise (m). Irregular culverts with erobable bottom. |
| 29 | WSE | Design Storm Water Surface Elevation (m) |
| 30 | EGLEL | Design Storm Energy Gradeline Elevation (m) |
| 31 | LPRDED | Low Point at Road Edge (m) |
| 32 | TRDFBM | Top of Road Freeboard (Min.), Relief Flow (m) for the criteria storm |
| 33 | TRDFBD | Top of Road Freeboard (Desired) for the criteria storm |
| 34 | TRDV | Top of Road Velocity (m/s) for the Regulatory storm |
| 35 | TRDVD | Top of Road Velocity x Depth (m2/s) for the Regulatory storm |
| 36 | SLPU | Soffit Low Point Elevation (Upstream) (m) or the Effective Soffit Elevation (Upstream) (m) |
| 37 | SCU | Soffit Clearance (Upstream) (m) for the criteria storm |
| 38 | WC1_DFEC | "Y" if MAXSTM is larger than WC1_DFC and "N" if MAXSTM is smaller than WC1_DFC for ex climate ("EC") |
| 39 | WC2MinEC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC" |
| 40 | WC2DesEC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC". |
| 41 | WC2SofEC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC". |
| 42 | WC7_1EC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC". |
| 43 | WC7_2EC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC". |
| 44 | WC13_1EC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC". |
| 45 | WC13_2EC | "Y" if meets criterion and "N" if it does not meet this criterion for the existing climate "EC". |
| 46 | WC1_DF50 | Identify if the maximum storm a crossing conveys meets or exceeds MTO WC-1_DFC design flow; "Y" if MAXSTM is larger than WC1_DFC, and "N" if MAXSTM is smaller than WC1_DFC for mid century RCP 8.5. |
| 47 | WC2Min50 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 48 | WC2Des50 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 49 | WC2Sof50 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 50 | WC7_150 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 51 | WC7_250 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 52 | WC13_150 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 53 | WC13_250 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 54 | WC1_DF80 | Identify if the maximum storm a crossing conveys meets or exceeds MTO WC-1_DFC design flow; "Y" if MAXSTM is larger than WC1_DFC, and "N" if MAXSTM is smaller than WC1_DFC for end-of-century RCP 8.5. |
| 55 | WC2Min80 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 56 | WC2Des80 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 57 | WC2Sof80 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 58 | WC7_180 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 59 | WC7_280 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 60 | WC13_180 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 61 | WC13_280 | If a crossing meets this criterion: "Y", and "N" if it does not meet this criterion, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 62 | MTOMetEC | Y if meets all MTO criteria, N if does not meet one or more of the criteria for the existing climate ("EC") |
| 63 | MTOMET50 | Y if meets all MTO criteria, N if does not meet one or more of the criteria, or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 64 | MTOMET80 | Y if meets all MTO criteria, N if does not meet one or more of the criteria, or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 65 | PrSTMCC50 | Starting storm when crossing is pressurized - under Climate Change conditions - mid century RCP 8.5 |
| 66 | OTSTMCC50 | Starting storm when crossing is overtopped - under Climate Change conditions - mid century RCP 8.5 |
| 67 | MAXSTMCC50 | Actual level of service a crossing provides, i.e., max. storm at which a crossing is not overtopped-under Climate Change conditions-mid century RCP 8.5 |
| 68 | PrSTMCC80 | The starting storm event at which a crossing is pressurized - under Climate Change conditions - end of century RCP 8.5 |
| 69 | OTSTMCC80 | The starting storm event at which a crossing is overtopped - under Climate Change conditions - end of century RCP 8.5 |
| 70 | MAXSTMCC80 | Actual level of service a crossing provides, i.e., max. storm at which a crossing is not overtopped-under Climate Change conditions-end century RCP 8.5 |
| 71 | Notes | Notes (if any) |
| 72 | Model | HEC-RAS Model |

# Appendix A3:
# Road Assessment Results

## A3-1: Road Assessment Results Tables

**Table A3-1: Master Map Results for Road Assessment**

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETO_024 | Etobicoke Creek | King St | 9868 | NE | 9868_NE_1 | Caledon | Eto Hdwtr N TrbO | North O3 | 394.37 | Culvert | - | STNDRR009-0563-STNDRR009-0564 | At Crossing | Etobicoke_Extension | 2 | 0.000 | 5 | 284.170 | 284.160 | 284.140 | 283.970 | 0.200 | 0.190 | 0.170 | | | | | | | N | N | N |
| ETO_024 | Etobicoke Creek | King St | 9868 | NE | 9868_SW_1 | Caledon | Eto Hdwtr N TrbO | North O3 | 394.37 | Culvert | - | STNDRR009-0563-STNDRR009-0564 | At Crossing | Etobicoke_Extension | 2 | 0.000 | 5 | 284.170 | 284.160 | 284.140 | 283.990 | 0.180 | 0.170 | 0.150 | | | | | | | N | N | N |
| ETO_018 | Etobicoke Creek | King St | 21898 | SW | 21898_SW | Caledon | Eto Hdwtr N TrbL | North L4 | 774 | Culvert | - | STNDRR009-0523-STNDRR009-0524 | Adjacent | Etobicoke_Extension | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 287.970 | 0.460 | 0.460 | 0.460 | | | | | | | N | N | N |
| ETO_026 | Etobicoke Creek | King St | 21898 | SW | 21898_SW_1 | Caledon | Eto Hdwtr N | North 6 | 1777 | Culvert | - | STNDRR009-0509-STNDRR009-0510 | At Crossing | Etobicoke_Extension | 2 | 0.000 | 50 | 285.950 | 285.900 | 285.730 | 285.800 | 0.150 | 0.100 | -0.070 | | | | | | | N | N | Y |
| ETO_049 | Etobicoke Creek | King St | 16889 | NE | 16889_NE_1 | Caledon | Eto Hdwtr N TrbF | North F1 | 807 | Culvert | - | STNDRR009-0829-STNDRR009-0830 | At Crossing | Etobicoke_Extension | 2 | 0.000 | 10 | 288.000 | 287.990 | 287.960 | 287.840 | 0.160 | 0.150 | 0.120 | | | | | | | N | N | N |
| ETO_049 | Etobicoke Creek | King St | 16889 | SW | 16889_SW_1 | Caledon | Eto Hdwtr N TrbF | North F1 | 807 | Culvert | - | STNDRR009-0829-STNDRR009-0830 | At Crossing | Etobicoke_Extension | 2 | 0.000 | 10 | 288.000 | 287.990 | 287.960 | 287.770 | 0.230 | 0.220 | 0.190 | | | | | | | N | N | N |
| Unassigned | Etobicoke Creek | Dixie Rd | 40587 | SE | 40587_SE | Brampton | EtobicokeCreek | Reach1a | 23.751 | N/A | N/A | N/A | Adjacent | Etobicoke_Phase2 | 4 | 0.070 | N/A | -999.000 | -999.000 | -999.000 | 238.220 | 0.160 | 0.070 | 0.000 | | | | | | | N | N | Y |
| Unassigned | Etobicoke Creek | Dixie Rd | 39870 | SE | 39870_SE | Brampton | EtobicokeCreek | Reach1a | 23.753 | N/A | N/A | N/A | Adjacent | Etobicoke_Phase2 | 4 | 0.070 | N/A | -999.000 | -999.000 | -999.000 | 238.940 | 0.100 | 0.030 | 0.000 | | | | | | | N | Y | Y |
| Unassigned | Etobicoke Creek | Dixie Rd | 6627 | NW | 6627_NW | Brampton | EtobicokeCreek | Reach1a | 23.757 | N/A | N/A | N/A | Adjacent | Etobicoke_Phase2 | 4 | 0.070 | N/A | -999.000 | -999.000 | -999.000 | 238.990 | 0.200 | 0.120 | 0.010 | | | | | | | N | N | Y |
| Unassigned | Etobicoke Creek | Dixie Rd | 12005 | NW | 12005_NW | Brampton | EtobicokeCreek | Reach1a | 23.751 | N/A | N/A | N/A | Adjacent | Etobicoke_Phase2 | 4 | 0.070 | N/A | -999.000 | -999.000 | -999.000 | 238.220 | 0.190 | 0.110 | 0.030 | | | | | | | N | N | Y |
| ETO_246 | Etobicoke Creek | Queen St E | 10183 | NE | 10183_NE | Brampton | Etobicoke Creek | Dixie Tributary | 2642.84 | Culvert | RR107-0882 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | Regional | 213.880 | 213.590 | 213.400 | 213.490 | 0.390 | 0.100 | -0.090 | | | | | | | N | Y | Y |
| ETO_246 | Etobicoke Creek | Queen St E | 41331 | NE | 41331_NE | Brampton | Etobicoke Creek | Dixie Tributary | 2642.84 | Culvert | RR107-0882 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | Regional | 213.880 | 213.590 | 213.400 | 213.560 | 0.320 | 0.030 | -0.160 | | | | | | | N | Y | Y |
| ETO_246 | Etobicoke Creek | Queen St E | 39452 | SW | 39452_SW | Brampton | Etobicoke Creek | Dixie Tributary | 2642.84 | Culvert | RR107-0882 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | Regional | 213.880 | 213.590 | 213.400 | 213.060 | 0.820 | 0.530 | 0.340 | | | | | | | N | N | N |
| ETO_246 | Etobicoke Creek | Queen St E | 40169 | SW | 40169_SW | Brampton | Etobicoke Creek | Dixie Tributary | 2642.84 | Culvert | RR107-0882 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | Regional | 213.880 | 213.590 | 213.400 | 213.590 | 0.290 | 0.000 | -0.190 | | | | | | | N | Y | Y |
| ETO_271 | Etobicoke Creek | Dixie Rd | 2246 | NW | 2246_NW | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 189.720 | 1.350 | 1.350 | 1.350 | | | | | | | N | N | N |
| ETO_271 | Etobicoke Creek | Dixie Rd | 40968 | NW | 40968_NW | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 194.700 | 0.040 | 0.040 | 0.040 | | | | | | | Y | Y | Y |
| ETO_271 | Etobicoke Creek | Dixie Rd | 6170 | NW | 6170_NW | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | 10 | 197.170 | 197.080 | 198.800 | 195.300 | 1.870 | 1.780 | 3.500 | | | | | | | N | N | N |
| ETO_271 | Etobicoke Creek | Dixie Rd | 19565 | NW | 19565_NW | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 196.790 | 0.110 | 0.090 | 0.050 | | | | | | | Y | Y | Y |
| ETO_271 | Etobicoke Creek | Dixie Rd | 43486 | SE | 43486_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 202.310 | 0.050 | 0.040 | 0.000 | | | | | | | Y | Y | Y |
| ETO_271 | Etobicoke Creek | Dixie Rd | 43437 | SE | 43437_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 198.660 | 0.060 | 0.040 | 0.000 | | | | | | | Y | Y | Y |
| ETO_271 | Etobicoke Creek | Dixie Rd | 40174 | SE | 40174_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 197.040 | 0.030 | 0.020 | 0.000 | | | | | | | Y | Y | Y |
| ETO_271 | Etobicoke Creek | Dixie Rd | 41237 | SE | 41237_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | 10 | 197.170 | 197.080 | 198.800 | 196.730 | 0.440 | 0.350 | 2.070 | | | | | | | N | N | N |
| ETO_271 | Etobicoke Creek | Dixie Rd | 41238 | SE | 41238_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | 10 | 197.170 | 197.080 | 198.800 | 196.570 | 0.600 | 0.510 | 2.230 | | | | | | | N | N | N |
| ETO_271 | Etobicoke Creek | Dixie Rd | 40465 | SE | 40465_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | At Crossing | Spring Creek 2D Modeling | 6 | 0.150 | 10 | 197.170 | 197.080 | 198.800 | 195.300 | 1.870 | 1.780 | 3.500 | | | | | | | N | N | N |
| ETO_271 | Etobicoke Creek | Dixie Rd | 41074 | SE | 41074_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 195.000 | 0.020 | 0.020 | 0.020 | | | | | | | Y | Y | Y |

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ETO_271 | Etobicoke Creek | Dixie Rd | 2246 | SE | 2246_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 189.760 | 0.950 | 0.950 | 0.950 | | | | | | | N | N | N |
| ETO_271 | Etobicoke Creek | Dixie Rd | 40176 | SE | 40176_SE | Brampton | Etobicoke Creek | Channel1 | 4093 | Culvert | RR004-1843-01 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | 10 | -999.000 | -999.000 | -999.000 | 190.600 | 0.160 | 0.160 | 0.160 | | | | | | | N | N | N |
| ETO_275 | Etobicoke Creek | Steeles Ave E | 9685 | SW | 9685_SW | Brampton | Etobicoke Creek | Spring Creek Reach1 | 6677.07 | Culvert | RR015-0710 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 187.060 | 0.670 | 0.640 | 0.600 | | | | | | | N | N | N |
| ETO_275 | Etobicoke Creek | Steeles Ave E | 9685 | NE | 9685_NE | Brampton | Etobicoke Creek | Spring Creek Reach1 | 6677.07 | Culvert | RR015-0710 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 187.130 | 0.340 | 0.310 | 0.270 | | | | | | | N | N | N |
| ETO_275 | Etobicoke Creek | Steeles Ave E | 41213 | SW | 41213_SW | Brampton | Etobicoke Creek | Spring Creek Reach1 | 6677.07 | Culvert | RR015-0710 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 188.080 | 0.130 | 0.040 | 0.000 | | | | | | | Y | Y | Y |
| ETO_275 | Etobicoke Creek | Steeles Ave E | 538 | SW | 538_SW | Brampton | Etobicoke Creek | Spring Creek Reach1 | 6677.07 | Culvert | RR015-0710 | - | Adjacent | Spring Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 188.170 | 0.110 | 0.030 | 0.000 | | | | | | | Y | Y | Y |
| ETO_206 | Etobicoke Creek | Dixie Rd | 41272 | NW | 41272_NW | Brampton | EtobicokeCreek | Reach2e1 | 29.17 | Bridge | RR004-1540 | - | At Crossing | Etobicoke_Phase2 | 6 | 0.150 | Regional | 180.870 | 180.730 | 180.580 | 179.630 | 1.240 | 1.100 | 0.950 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 35080 | NW | 35080_NW | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 119.010 | 0.110 | 0.100 | 0.100 | | | | | | | Y | Y | Y |
| ETO_307 | Etobicoke Creek | Dixie Rd | 41702 | SE | 41702_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 119.090 | 0.130 | 0.120 | 0.110 | | | | | | | Y | Y | Y |
| ETO_307 | Etobicoke Creek | Dixie Rd | 35082 | SE | 35082_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 118.990 | 0.240 | 0.220 | 0.220 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 35081 | SE | 35081_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 118.280 | 0.360 | 0.310 | 0.270 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 36329 | SE | 36329_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 117.610 | 0.370 | 0.320 | 0.290 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 11403 | SE | 11403_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 115.940 | 0.320 | 0.290 | 0.260 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 35076 | SE | 35076_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 115.490 | 0.370 | 0.340 | 0.310 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 35074 | SE | 35074_SE | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 108.620 | 4.470 | 4.410 | 4.350 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 35079 | NW | 35079_NW | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 118.260 | 0.160 | 0.150 | 0.150 | | | | | | | N | N | Y |
| ETO_307 | Etobicoke Creek | Dixie Rd | 36328 | NW | 36328_NW | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 117.710 | 0.230 | 0.210 | 0.190 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 11403 | NW | 11403_NW | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 115.940 | 0.220 | 0.180 | 0.140 | | | | | | | N | N | Y |
| ETO_307 | Etobicoke Creek | Dixie Rd | 36327 | NW | 36327_NW | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 115.470 | 0.310 | 0.270 | 0.240 | | | | | | | N | N | N |
| ETO_307 | Etobicoke Creek | Dixie Rd | 19507 | NW | 19507_NW | Mississauga | Little Etobicoke Creek | Little Etobicoke | 6643.9 | Bridge | RR004-0440-02 | - | Adjacent | Dixie - Dundas 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 108.620 | 4.470 | 4.410 | 4.350 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 18221 | NW | 18221_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 170.590 | 0.220 | 0.150 | 0.110 | | | | | | | N | N | Y |
| MIM_077 | Mimico Creek | Airport Rd | 38797 | NW | 38797_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 172.570 | 0.300 | 0.270 | 0.250 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 12043 | NW | 12043_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 172.290 | 0.230 | 0.190 | 0.160 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 39131 | NW | 39131_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 172.000 | 0.060 | 0.050 | 0.050 | | | | | | | Y | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 38666 | NW | 38666_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 171.640 | 0.030 | 0.020 | 0.000 | | | | | | | Y | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 4703 | NW | 4703_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 169.240 | 0.440 | 0.410 | 0.380 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 38667 | NW | 38667_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.920 | 0.750 | 0.700 | 0.670 | | | | | | | N | N | N |

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIM_077 | Mimico Creek | Airport Rd | 39127 | NW | 39127_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.850 | 0.800 | 0.750 | 0.720 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 4004 | NW | 4004_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 169.170 | 0.480 | 0.440 | 0.410 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 722 | NW | 722_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.810 | 0.170 | 0.130 | 0.110 | | | | | | | N | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 1067 | NW | 1067_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.660 | 0.140 | 0.110 | 0.100 | | | | | | | Y | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 18751 | NW | 18751_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.400 | 0.140 | 0.110 | 0.090 | | | | | | | Y | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 18614 | NW | 18614_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.120 | 0.160 | 0.130 | 0.110 | | | | | | | N | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 42702 | NW | 42702_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | At Crossing | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | 166.022 | 165.931 | 165.849 | 165.430 | 0.590 | 0.500 | 0.420 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 18575 | NW | 18575_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 165.150 | 0.370 | 0.000 | 0.000 | | | | | | | N | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 38798 | SE | 38798_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 173.690 | 0.340 | 0.320 | 0.310 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 38796 | SE | 38796_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 172.630 | 0.510 | 0.490 | 0.470 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 39132 | SE | 39132_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 172.290 | 0.450 | 0.430 | 0.420 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 39133 | SE | 39133_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 172.000 | 0.330 | 0.320 | 0.320 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 39134 | SE | 39134_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 171.620 | 0.300 | 0.300 | 0.290 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 38794 | SE | 38794_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 170.420 | 0.570 | 0.550 | 0.550 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 38791 | SE | 38791_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 169.720 | 0.630 | 0.620 | 0.610 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 44487 | SE | 44487_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 169.390 | 0.510 | 0.460 | 0.420 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 39128 | SE | 39128_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.820 | 0.910 | 0.860 | 0.830 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 39129 | SE | 39129_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.780 | 0.890 | 0.840 | 0.810 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 38788 | SE | 38788_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 169.140 | 0.500 | 0.450 | 0.420 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 38786 | SE | 38786_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 168.820 | 0.050 | 0.030 | 0.020 | | | | | | | Y | Y | Y |
| MIM_077 | Mimico Creek | Airport Rd | 38782 | SE | 38782_SE | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | At Crossing | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | 166.022 | 165.931 | 165.849 | 163.660 | 2.360 | 2.270 | 2.190 | | | | | | | N | N | N |
| MIM_077 | Mimico Creek | Airport Rd | 21280 | NW | 21280_NW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | 3549.59 | Bridge | RR007-0430 | - | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | >Regional | -999.000 | -999.000 | -999.000 | 163.900 | 1.570 | 1.200 | 1.170 | | | | | | | N | N | N |
| Unassigned | Mimico Creek | Derry Rd E | 38707 | S | 38707_S | Mississauga | West Branch Mimico Creek | West Mimico Trib B | N/A | N/A | N/A | N/A | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | N/A | -999.000 | -999.000 | -999.000 | 164.820 | 0.670 | 0.220 | 0.000 | | | | | | | N | N | Y |
| Unassigned | Mimico Creek | Derry Rd E | 42701 | S | 42701_S | Mississauga | West Branch Mimico Creek | West Mimico Trib B | N/A | N/A | N/A | N/A | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | N/A | -999.000 | -999.000 | -999.000 | 164.130 | 1.210 | 0.760 | 0.260 | | | | | | | N | N | N |
| Unassigned | Mimico Creek | Derry Rd E | 38706 | SW | 38706_SW | Mississauga | West Branch Mimico Creek | West Mimico Trib B | N/A | N/A | N/A | N/A | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | N/A | -999.000 | -999.000 | -999.000 | 164.870 | 0.600 | 0.160 | 0.020 | | | | | | | N | N | Y |
| Unassigned | Mimico Creek | Derry Rd E | 19113 | N | 19113_N | Mississauga | West Branch Mimico Creek | West Mimico Trib B | N/A | N/A | N/A | N/A | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | N/A | -999.000 | -999.000 | -999.000 | 165.200 | 0.370 | 0.000 | 0.000 | | | | | | | N | Y | Y |
| Unassigned | Mimico Creek | Derry Rd E | 2460 | N | 2460_N | Mississauga | West Branch Mimico Creek | West Mimico Trib B | N/A | N/A | N/A | N/A | Adjacent | Mimico Creek 2D Modeling | 6 | 0.150 | N/A | -999.000 | -999.000 | -999.000 | 163.980 | 1.230 | 0.780 | 0.270 | | | | | | | N | N | N |

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MIM_194 | Mimico Creek | Steeles Ave E | 40714 | SW | 40714_SW | Brampton | East Mim Trib A | East A1 | 2504.32 | Culvert | RR015-0130-02 | - | At Crossing | Mimico | 6 | 0.150 | 25 | 172.630 | 172.560 | 172.480 | 171.750 | 0.880 | 0.810 | 0.730 | | | | | | | N | N | N |
| ETO_026 | Etobicoke Creek | King St | 21898 | NE | 21898_NE_1 | Caledon | Eto Hdwtr N | North 6 | 1777 | Culvert | - | STNDRR009-0509-STNDRR009-0510 | At Crossing | Etobicoke_Extension | 2 | 0.000 | 50 | 285.950 | 285.900 | 285.730 | 285.820 | 0.130 | 0.080 | -0.090 | | | | | | | N | N | Y |
| MIM_194 | Mimico Creek | Steeles Ave E | 40714 | NE | 40714_NE | Brampton | East Mim Trib A | East A1 | 2504.32 | Culvert | RR015-0130-02 | - | At Crossing | Mimico | 6 | 0.150 | 25 | 172.630 | 172.560 | 172.480 | 171.810 | 0.820 | 0.750 | 0.670 | | | | | | | N | N | N |
| x-39 | Humber River | Airport Rd | 39916 | SE | 39916_SE | Brampton | Campbells TribC | Reach1 | 601.752 | Culvert | RR007-1430-02 | - | At Crossing | West_Humber | 4 | 0.070 | 100 | 212.800 | 212.630 | 212.510 | 211.980 | 0.820 | 0.650 | 0.530 | | | | | | | N | N | N |
| x-23 | Humber River | Airport Rd | 39967 | SE | 39967_SE | Brampton | Tributary A | Reach1 | 305.183 | Bridge | RR007-1350-02 | - | At Crossing | West_Humber | 6 | 0.150 | 100 | 205.750 | 205.390 | 205.030 | 205.330 | 0.420 | 0.060 | -0.300 | | | | | | | N | Y | Y |
| x-58 | Humber River | The Gore Rd | 40590 | SE | 40590_SE | Brampton | Gore Road Trib | Reach1 | 1407.144 | Bridge | RR008-0440-01 | - | At Crossing | West_Humber | 4 | 0.070 | 100 | 193.150 | 192.910 | 192.820 | 191.930 | 1.220 | 0.980 | 0.890 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 5289 | SE | 5289_SE | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | At Crossing | Caledon East 2D Modeling | 2 | 0.000 | 25 | 288.670 | 288.630 | 288.590 | 288.300 | 0.370 | 0.330 | 0.290 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 6043 | SE | 6043_SE | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | At Crossing | Caledon East 2D Modeling | 2 | 0.000 | 25 | 288.670 | 288.630 | 288.590 | 288.100 | 0.570 | 0.530 | 0.490 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 17189 | SW | 17189_SW | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | At Crossing | Bolton SPA | 2 | 0.000 | Regional | 213.180 | 213.050 | 212.920 | 212.870 | 0.310 | 0.180 | 0.050 | | | | | | | N | N | N |
| HUM_545 | Humber River | Hwy 50 | 6776 | NW | 6776_NW_1 | Caledon | RobinsonCreek | Reach1 | 2353.47 | Culvert | RR050-1227 | STMHRR050-0274-STMHRR050-0273 | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 100 | 228.860 | 228.710 | 228.550 | 228.530 | 0.330 | 0.180 | 0.020 | | | | | | | N | N | Y |
| HUM_233 | Humber River | King St | 5942 | SW | 5942_SW_1 | Caledon | Campbell TribA | Reach6 | 2056.47 | Culvert | - | STNDRR009-0389-STNDRR009-0390 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 284.700 | 284.680 | 284.670 | 284.480 | 0.220 | 0.200 | 0.190 | | | | | | | N | N | N |
| HUM_233 | Humber River | King St | 19953 | SW | 19953_SW_1 | Caledon | Campbell TribA | Reach6 | 2056.47 | Culvert | - | STNDRR009-0389-STNDRR009-0390 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 284.700 | 284.680 | 284.670 | 284.530 | 0.170 | 0.150 | 0.140 | | | | | | | N | N | N |
| HUM_254 | Humber River | King St | 5942 | SW | 5942_SW | Caledon | Campbell's Crk | Reach1 | 4458.71 | Culvert | RR009-1680 | - | At Crossing | West_Humber_Z1 | 2 | 0.000 | Regional | 277.770 | 277.520 | 277.310 | 277.760 | 0.010 | -0.240 | -0.450 | | | | | | | N | Y | Y |
| HUM_459 | Humber River | Hwy 50 | 2166 | SE | 2166_SE | Caledon | RobinsonCreek | Reach1 | 3662.2 | Culvert | - | - | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 2 | 238.780 | 238.760 | 238.720 | 238.000 | 0.780 | 0.760 | 0.720 | | | | | | | N | N | N |
| x-80 | Humber River | Mayfield Rd | 9938 | SW | 9938_SW | Brampton/Caledon | Clarkway Trib | Reach2 | 1514.331 | Culvert | RR014-0150 | - | At Crossing | West_Humber | 2 | 0.000 | 25 | 223.320 | 223.260 | 223.170 | 223.000 | 0.320 | 0.260 | 0.170 | | | | | | | N | N | N |
| x-15 | Humber River | The Gore Rd | 14272 | NW | 14272_NW | Brampton | Clarkway Trib | Reach2 | 1502.127 | Bridge | RR008-0063 | - | At Crossing | West_Humber | 4 | 0.070 | 5 | 176.030 | 175.970 | 175.910 | 175.390 | 0.640 | 0.580 | 0.520 | | | | | | | N | N | N |
| HUM_522 | Humber River | Queen St E | 39415 | SW | 39415_SW | Brampton | WH TribB | Reach1 | 498.29 | Culvert | RR107-0290-01 | STMHRR107-0209-STMHRR107-0203 | At Crossing | West_Humber_Z1 | 6 | 0.150 | 50 | 176.620 | 176.290 | 175.770 | 175.490 | 1.130 | 0.800 | 0.280 | | | | | | | N | N | N |
| HUM_388 | Humber River | Old Church Rd | 4521 | SW | 4521_SW | Caledon | UpperHumber TrbH | Reach3 | 253.93 | Culvert | - | STNDRR022-0117-STNDRR022-0118 | At Crossing | Upper_Humber_Z2 | 2 | 0.000 | 25 | 271.380 | 271.340 | 271.290 | 270.340 | 1.040 | 1.000 | 0.950 | | | | | | | N | N | N |
| HUM_433 | Humber River | Airport Rd | 9014 | SE | 9014_SE | Caledon | CentrevilleTrbJ | Reach7 | 772.02 | Culvert | - | STNDRR007-0513-STNDRR007-0514 | At Crossing | Upper_Humber_Z1 | 2 | 0.000 | 100 | 375.490 | 374.500 | 373.340 | 375.370 | 0.120 | -0.870 | -2.030 | | | | | | | N | Y | Y |
| HUM_461 | Humber River | Mayfield Rd | 18208 | SW | 18208_SW | Caledon | RobinsonCreek | Reach1 | 1984 | Culvert | RR014-0002 | - | At Crossing | Upper_Humber_Z2 | 2 | 0.000 | Regional | 225.740 | 225.640 | 225.530 | 225.040 | 0.700 | 0.600 | 0.490 | | | | | | | N | N | N |
| HUM_543 | Humber River | Hwy 50 | 6776 | NW | 6776_NW | Caledon | RobinsonCreek | Reach1 | 2743.61 | Culvert | - | STNDRR050-0211-STNDRR050-0212 | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 5 | 232.070 | 232.040 | 231.980 | 231.440 | 0.630 | 0.600 | 0.540 | | | | | | | N | N | N |
| HUM_542 | Humber River | Hwy 50 | 1106 | NW | 1106_NW | Caledon | RobinsonCreek | Reach1 | 2800.26 | Culvert | - | STNDRR050-0213-STNDRR050-0214 | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 5 | 232.760 | 232.700 | 232.650 | 231.730 | 1.030 | 0.970 | 0.920 | | | | | | | N | N | N |
| x-15 | Humber River | The Gore Rd | 18344 | NW | 18344_NW | Brampton | Clarkway Trib | Reach2 | 1502.127 | Bridge | RR008-0063 | - | At Crossing | West_Humber | 4 | 0.070 | 5 | 176.030 | 175.970 | 175.910 | 175.480 | 0.550 | 0.490 | 0.430 | | | | | | | N | N | N |
| HUM_802 | Humber River | Queen St N | 293 | SW | 293_SW | Caledon | Humber River | Bolton Reach | 9.153 | Bridge | RR050-1690E-01 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 214.610 | 0.510 | 0.370 | 0.250 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 1476 | SW | 1476_SW | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 214.500 | 0.540 | 0.410 | 0.280 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 4503 | SW | 4503_SW | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 213.540 | 0.170 | 0.100 | 0.060 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 6059 | SE | 6059_SE | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 288.570 | 0.370 | 0.340 | 0.320 | | | | | | | N | N | N |

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x-86 | Humber River | Airport Rd | 6180 | SE | 6180_SE | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 288.200 | 0.500 | 0.470 | 0.430 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 16244 | SW | 16244_SW | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 213.590 | 0.180 | 0.100 | 0.060 | | | | | | | N | N | N |
| x-39 | Humber River | Airport Rd | 40476 | SE | 40476_SE | Brampton | Campbells TribC | Reach1 | 601.752 | Culvert | RR007-1430-02 | - | Adjacent | West_Humber | 4 | 0.070 | 100 | -999.000 | -999.000 | -999.000 | 211.910 | 0.470 | 0.340 | 0.250 | | | | | | | N | N | N |
| x-74 | Humber River | The Gore Rd | 12030 | NW | 12030_NW | Brampton | West Humber | Reach5A | 1302.253 | Bridge | RR008-0830 | - | Adjacent | West_Humber | 4 | 0.070 | Regional | -999.000 | -999.000 | -999.000 | 210.000 | 0.310 | 0.000 | 0.000 | | | | | | | N | Y | Y |
| x-86 | Humber River | Airport Rd | 4737 | SE | 4737_SE | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 289.550 | 0.190 | 0.160 | 0.130 | | | | | | | N | N | N |
| Unassigned | Humber River | King St E | 4974 | W | 4974_W | Caledon | Cold Creek | Reach1 | 1008 | Bridge | - | STMHRR009-0052-STMHRR009-0053 | At Crossing | Humber in York | 2 | 0.000 | >Regional | 210.690 | 210.620 | 210.560 | 209.790 | 0.900 | 0.830 | 0.770 | | | | | | | N | N | N |
| HUM_31C_2R | Humber River | Coleraine Dr | 9107 | NW | 9107_NW | Brampton | River 4 | Reach 1 | 24.475 | Culvert | - | STNDRR150-0076-STNDRR150-0075 | At Crossing | Rainbow Creek | 2 | 0.000 | >2 | 223.110 | 223.100 | 223.040 | 223.010 | 0.100 | 0.090 | 0.030 | | | | | | | N | N | N |
| HUM_447 | Humber River | Airport Rd | 8235 | NW | 8235_NW | Caledon | CentrevilleTrbA | Reach2 | 1467.88 | Culvert | - | STNDRR007-0449-STNDRR007-0450 | Adjacent | Upper_Humber_Z2 | 2 | 0.000 | 50 | -999.000 | -999.000 | -999.000 | 313.820 | 0.390 | 0.350 | 0.280 | | | | | | | N | N | N |
| x-23 | Humber River | Airport Rd | 10745 | NW | 10745_NW | Brampton | Tributary A | Reach1 | 305.183 | Bridge | RR007-1350-02 | - | At Crossing | West_Humber | 6 | 0.150 | 100 | 205.750 | 205.390 | 205.030 | 205.330 | 0.420 | 0.060 | -0.300 | | | | | | | N | Y | Y |
| x-15 | Humber River | The Gore Rd | 14272 | SE | 14272_SE | Brampton | Clarkway Trib | Reach2 | 1502.127 | Bridge | RR008-0063 | - | At Crossing | West_Humber | 4 | 0.070 | 5 | 176.030 | 175.970 | 175.910 | 175.210 | 0.820 | 0.760 | 0.700 | | | | | | | N | N | N |
| x-58 | Humber River | The Gore Rd | 19062 | NW | 19062_NW | Brampton | Gore Road Trib | Reach1 | 1407.144 | Bridge | RR008-0440-01 | - | At Crossing | West_Humber | 4 | 0.070 | 100 | 193.150 | 192.910 | 192.820 | 192.150 | 1.000 | 0.760 | 0.670 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 5289 | NW | 5289_NW | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | At Crossing | Caledon East 2D Modeling | 2 | 0.000 | 25 | 288.670 | 288.630 | 288.590 | 288.300 | 0.370 | 0.330 | 0.290 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 6043 | NW | 6043_NW | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | At Crossing | Caledon East 2D Modeling | 2 | 0.000 | 25 | 288.670 | 288.630 | 288.590 | 287.910 | 0.760 | 0.720 | 0.680 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 17189 | NE | 17189_NE | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | At Crossing | Bolton SPA | 2 | 0.000 | Regional | 213.180 | 213.050 | 212.920 | 212.850 | 0.330 | 0.200 | 0.070 | | | | | | | N | N | N |
| HUM_459 | Humber River | Hwy 50 | 2166 | NW | 2166_NW | Caledon | RobinsonCreek | Reach1 | 3662.2 | Culvert | - | - | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 2 | 238.780 | 238.760 | 238.720 | 238.040 | 0.740 | 0.720 | 0.680 | | | | | | | N | N | N |
| HUM_542 | Humber River | Hwy 50 | 1106 | SE | 1106_SE | Caledon | RobinsonCreek | Reach1 | 2800.26 | Culvert | - | STNDRR050-0213-STNDRR050-0214 | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 5 | 232.760 | 232.700 | 232.650 | 231.580 | 1.180 | 1.120 | 1.070 | | | | | | | N | N | N |
| HUM_543 | Humber River | Hwy 50 | 6776 | SE | 6776_SE | Caledon | RobinsonCreek | Reach1 | 2743.61 | Culvert | - | STNDRR050-0211-STNDRR050-0212 | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 5 | 232.070 | 232.040 | 231.980 | 231.400 | 0.670 | 0.640 | 0.580 | | | | | | | N | N | N |
| HUM_545 | Humber River | Hwy 50 | 6776 | SE | 6776_SE_1 | Caledon | RobinsonCreek | Reach1 | 2353.47 | Culvert | RR050-1227 | STMHRR050-0274-STMHRR050-0273 | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 100 | 228.860 | 228.710 | 228.550 | 227.850 | 1.010 | 0.860 | 0.700 | | | | | | | N | N | N |
| x-80 | Humber River | Mayfield Rd | 9938 | NE | 9938_NE | Brampton/Caledon | Clarkway Trib | Reach2 | 1514.331 | Culvert | RR014-0150 | - | At Crossing | West_Humber | 2 | 0.000 | 25 | 223.320 | 223.260 | 223.170 | 222.950 | 0.370 | 0.310 | 0.220 | | | | | | | N | N | N |
| HUM_522 | Humber River | Queen St E | 39415 | NE | 39415_NE | Brampton | WH TribB | Reach1 | 498.29 | Culvert | RR107-0290-01 | STMHRR107-0209-STMHRR107-0203 | At Crossing | West_Humber_Z1 | 6 | 0.150 | 50 | 176.620 | 176.290 | 175.770 | 175.100 | 1.520 | 1.190 | 0.670 | | | | | | | N | N | N |
| HUM_388 | Humber River | Old Church Rd | 4521 | NE | 4521_NE | Caledon | UpperHumber TrbH | Reach3 | 253.93 | Culvert | - | STNDRR022-0117-STNDRR022-0118 | At Crossing | Upper_Humber_Z2 | 2 | 0.000 | 25 | 271.380 | 271.340 | 271.290 | 270.280 | 1.100 | 1.060 | 1.010 | | | | | | | N | N | N |
| HUM_433 | Humber River | Airport Rd | 9014 | NW | 9014_NW | Caledon | CentrevilleTrbJ | Reach7 | 772.02 | Culvert | - | STNDRR007-0513-STNDRR007-0514 | At Crossing | Upper_Humber_Z1 | 2 | 0.000 | 100 | 375.490 | 374.500 | 373.340 | 375.310 | 0.180 | -0.810 | -1.970 | | | | | | | N | Y | Y |
| x-39 | Humber River | Airport Rd | 18090 | NW | 18090_NW | Brampton | Campbells TribC | Reach1 | 601.752 | Culvert | RR007-1430-02 | - | At Crossing | West_Humber | 4 | 0.070 | 100 | 212.800 | 212.630 | 212.510 | 212.030 | 0.770 | 0.600 | 0.480 | | | | | | | N | N | N |
| HUM_233 | Humber River | King St | 5942 | NE | 5942_NE_1 | Caledon | Campbell TribA | Reach6 | 2056.47 | Culvert | - | STNDRR009-0389-STNDRR009-0390 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 284.700 | 284.680 | 284.670 | 284.420 | 0.280 | 0.260 | 0.250 | | | | | | | N | N | N |
| HUM_461 | Humber River | Mayfield Rd | 18208 | NE | 18208_NE | Caledon | RobinsonCreek | Reach1 | 1984 | Culvert | RR014-0002 | - | At Crossing | Upper_Humber_Z2 | 2 | 0.000 | Regional | 225.740 | 225.640 | 225.530 | 224.810 | 0.930 | 0.830 | 0.720 | | | | | | | N | N | N |
| x-15 | Humber River | The Gore Rd | 18344 | SE | 18344_SE | Brampton | Clarkway Trib | Reach2 | 1502.127 | Bridge | RR008-0063 | - | Adjacent | West_Humber | 4 | 0.070 | 5 | -999.000 | -999.000 | -999.000 | 175.350 | 1.130 | 1.050 | 0.970 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 293 | NE | 293_NE | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 214.620 | 0.260 | 0.130 | 0.000 | | | | | | | N | N | Y |

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUM_803 | Humber River | King St E | 1476 | NE | 1476_NE | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 214.560 | 0.220 | 0.100 | 0.000 | | | | | | | N | N | Y |
| HUM_803 | Humber River | King St E | 4503 | NE | 4503_NE | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 213.520 | 0.390 | 0.310 | 0.270 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 6059 | NW | 6059_NW | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 288.560 | 0.320 | 0.290 | 0.260 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 6180 | NW | 6180_NW | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 288.120 | 0.550 | 0.510 | 0.470 | | | | | | | N | N | N |
| HUM_803 | Humber River | King St E | 16244 | NE | 16244_NE | Caledon | Humber River | Bolton Reach | 9.093 | Bridge | RR009-0140 | - | Adjacent | Bolton SPA | 2 | 0.000 | Regional | -999.000 | -999.000 | -999.000 | 213.550 | 0.460 | 0.380 | 0.350 | | | | | | | N | N | N |
| Unassigned | Humber River | King St E | 4974 | E | 4974_E | Caledon | Cold Creek | Reach1 | 1008 | Bridge | - | STMHRR009-0052-STMHRR009-0053 | At Crossing | Humber in York | 2 | 0.000 | >Regional | 210.690 | 210.620 | 210.560 | 209.710 | 0.980 | 0.910 | 0.850 | | | | | | | N | N | N |
| HUM_459 | Humber River | Hwy 50 | 12862 | NW | 12862_NW | Caledon | RobinsonCreek | Reach1 | 3662.2 | Culvert | - | - | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | 2 | 238.780 | 238.760 | 238.720 | 237.880 | 0.900 | 0.880 | 0.840 | | | | | | | N | N | N |
| HUM_31C_2R | Humber River | Coleraine Dr | 9107 | SE | 9107_SE | Brampton | River 4 | Reach 1 | 24.475 | Culvert | - | STNDRR150-0076-STNDRR150-0075 | At Crossing | Rainbow Creek | 2 | 0.000 | >2 | 223.110 | 223.100 | 223.040 | 223.020 | 0.090 | 0.080 | 0.020 | | | | | | | N | N | N |
| HUM_447 | Humber River | Airport Rd | 8235 | SE | 8235_SE | Caledon | CentrevilleTrbA | Reach2 | 1467.88 | Culvert | - | STNDRR007-0449-STNDRR007-0450 | Adjacent | Upper_Humber_Z2 | 2 | 0.000 | 50 | -999.000 | -999.000 | -999.000 | 313.870 | 0.510 | 0.470 | 0.390 | | | | | | | N | N | N |
| x-86 | Humber River | Airport Rd | 4737 | NW | 4737_NW | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 289.650 | 0.050 | 0.000 | 0.000 | | | | | | | N | Y | Y |
| x-86 | Humber River | Airport Rd | 1901 | NE | 1901_NE | Caledon | Centreville Creek | Branch 4 | 13.663 | Culvert | RR007-2940 | - | Adjacent | Caledon East 2D Modeling | 2 | 0.000 | 25 | -999.000 | -999.000 | -999.000 | 289.530 | 0.110 | 0.050 | 0.000 | | | | | | | N | N | Y |
| x-58 | Humber River | The Gore Rd | 40600 | NW | 40600_NW | Brampton | Gore Road Trib | Reach1 | 1407.144 | Bridge | RR008-0440-01 | - | At Crossing | West_Humber | 4 | 0.070 | 100 | 193.150 | 192.910 | 192.820 | 193.100 | 0.050 | -0.190 | -0.280 | | | | | | | Y | Y | Y |
| HUM_198 | Humber River | King St | 1329 | SW | 1329_SW | Caledon | CamTribJ North | Reach3 | 240.7 | Culvert | - | STNDRR009-0329-STNDRR009-0330 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 279.140 | 279.120 | 279.110 | 278.920 | 0.220 | 0.200 | 0.190 | | | | | | | N | N | N |
| HUM_198 | Humber River | King St | 1329 | NE | 1329_NE | Caledon | CamTribJ North | Reach3 | 240.7 | Culvert | - | STNDRR009-0329-STNDRR009-0330 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 279.140 | 279.120 | 279.110 | 278.960 | 0.180 | 0.160 | 0.150 | | | | | | | N | N | N |
| Unassigned | Humber River | Dixie Rd | 4841 | NW | 4841_NW | Caledon | CamTribS West | Reach1 | 1666.47 | - | - | - | Adjacent | West_Humber_Z1 | 2 | 0.000 | - | -999.000 | -999.000 | -999.000 | 282.720 | 0.020 | 0.000 | 0.000 | | | | | | | N | Y | Y |
| Unassigned | Humber River | Dixie Rd | 16320 | NW | 16320_NW | Caledon | CamTribS East | Reach1 | 112.47 | - | - | - | Adjacent | West_Humber_Z1 | 2 | 0.000 | - | -999.000 | -999.000 | -999.000 | 277.760 | 0.190 | 0.180 | 0.160 | | | | | | | N | N | N |
| Unassigned | Humber River | Dixie Rd | 16320 | SE | 16320_SE | Caledon | CamTribS East | Reach1 | 112.47 | - | - | - | Adjacent | West_Humber_Z1 | 2 | 0.000 | - | -999.000 | -999.000 | -999.000 | 277.760 | 0.190 | 0.180 | 0.160 | | | | | | | N | N | N |
| HUM_461 | Humber River | Mayfield Rd | 41076 | SE | 41076_SE | Caledon | RobinsonCreek | Reach1 | 1984 | Culvert | RR014-0002 | - | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | Regional | 225.740 | 225.640 | 225.530 | 225.330 | 0.410 | 0.310 | 0.200 | | | | | | | N | N | N |
| HUM_461 | Humber River | Mayfield Rd | 45267 | SE | 45267_SE | Caledon | RobinsonCreek | Reach1 | 1984 | Culvert | RR014-0002 | - | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | Regional | 225.740 | 225.640 | 225.530 | 225.490 | 0.250 | 0.150 | 0.040 | | | | | | | N | N | Y |
| x-15 | Humber River | The Gore Rd | 14557 | SE | 14557_SE | Brampton | Clarkway Trib | Reach2 | 1502.127 | Bridge | RR008-0063 | - | Adjacent | West_Humber | 4 | 0.070 | 5 | 176.030 | 175.970 | 175.910 | 174.430 | 0.810 | 0.750 | 0.700 | | | | | | | N | N | N |
| x-15 | Humber River | The Gore Rd | 14557 | NW | 14557_NW | Brampton | Clarkway Trib | Reach2 | 1502.127 | Bridge | RR008-0063 | - | Adjacent | West_Humber | 4 | 0.070 | 5 | 176.030 | 175.970 | 175.910 | 174.500 | 0.290 | 0.220 | 0.170 | | | | | | | N | N | N |
| HUM_461 | Humber River | Hwy 50 | 39334 | SE | 18208_SE | Caledon | West Robinson | Reach4 | 1984 | Culvert | RR014-0002 | - | At Crossing | Upper_Humber_Z2 | 4 | 0.070 | Regional | 225.740 | 225.640 | 225.530 | 225.300 | 0.440 | 0.340 | 0.230 | | | | | | | N | N | N |
| HUM_153 | Humber River | King St | 807 | SW | 807_SW | Caledon | Lindsay E TribB | Reach1 | 748.99 | Culvert | - | STNDRR009-0153-STNDRR009-0154 | At Crossing | West_Humber_Z2 | 2 | 0.000 | 25 | 262.430 | 262.430 | 262.410 | 262.250 | 0.180 | 0.180 | 0.160 | | | | | | | N | N | N |
| HUM_153 | Humber River | King St | 807 | NE | 807_NE | Caledon | Lindsay E TribB | Reach1 | 748.99 | Culvert | - | STNDRR009-0153-STNDRR009-0154 | At Crossing | West_Humber_Z2 | 2 | 0.000 | 25 | 262.430 | 262.430 | 262.410 | 262.210 | 0.220 | 0.220 | 0.200 | | | | | | | N | N | N |
| HUM_219 | Humber River | King St | 19953 | SW | 19953_SW | Caledon | CamTribS West | Reach1 | 1251.67 | Culvert | - | STNDRR009-0377-STNDRR009-0378 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 281.100 | 281.090 | 281.080 | 280.650 | 0.450 | 0.440 | 0.430 | | | | | | | N | N | N |
| HUM_219 | Humber River | King St | 19953 | NE | 19953_NE | Caledon | CamTribS West | Reach1 | 1251.67 | Culvert | - | STNDRR009-0377-STNDRR009-0378 | At Crossing | West_Humber_Z1 | 2 | 0.000 | 10 | 281.100 | 281.090 | 281.080 | 280.750 | 0.350 | 0.340 | 0.330 | | | | | | | N | N | N |
| HUM_179 | Humber River | The Gore Rd | 12494 | NW | 12494_NW_1 | Caledon | WH5C | Reach1 | 502.6 | Culvert | - | STNDRR008-0539-STNDRR008-0540 | At Crossing | West_Humber_Z2 | 2 | 0.000 | 10 | 235.560 | 235.540 | 235.500 | 235.340 | 0.220 | 0.200 | 0.160 | | | | | | | N | N | N |

| CA_ID | Watershed | FULLSTNAME | ROPSTSEGID | ST_DIR | ROPID_Dir | MUNC | River Name | ReachName | River_Sta | Struc_Type | FacilityID | StmMainID | Inun_Type | Model | NO_OF_LANE | LOS | OTSTMEC | WSE_100yr | WSE_50yr | WSE_25yr | MinRdElev | EC_D_100 | EC_D_50 | EC_D_25 | CC50_D_100 | CC50_D_50 | CC50_D_25 | CC80_D_100 | CC80_D_50 | CC80_D_25 | EC_C_100 | EC_C_50 | EC_C_25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HUM_179 | Humber River | The Gore Rd | 12494 | SE | 12494_SE_1 | Caledon | WH5C | Reach1 | 502.6 | Culvert | - | STNDRR008-0539-STNDRR008-0540 | At Crossing | West_Humber_Z2 | 2 | 0.000 | 10 | 235.560 | 235.540 | 235.500 | 235.310 | 0.250 | 0.230 | 0.190 | | | | | | | N | N | N |

## A3-2: Road Assessment Metadata

| Item | Attribute | Description |
|---|---|---|
| 1 | CA_ID | Conservation Authority Structure ID defined as first three letter of watershed plus 3 digits, e.g. ETO_001 |
| 2 | Watershed | CA watershed name |
| 3 | FULLSTNAME | Road name plus suffix of roads plus direction (if any) |
| 4 | ROPSTSEGID | Region of Peel ID for road segments |
| 5 | ST_DIR | Direction of travel of the roads (e.g. Northwest (NW), South East (SE), etc) |
| 6 | ROPID_Dir | Region of Peel ID for road segments and direction of travel merged together (e.g. 11499NW) |
| 7 | MUNC | Name of municipality |
| 8 | RiverName | River Name assigned in CA hydraulic model |
| 9 | ReachName | Reach Name assigned in CA hydraulic model; may be blank for 2D models which may only have River Name |
| 10 | River_Sta | River Station assigned in CA hydraulic model |
| 11 | Struc_Type | Structure Type provided by the ROP (BRIDGE or CLVRT (for culvert)); use BridgeType attribute from trsBridge shapefile. Classify as culvert for all StmMain structures |
| 12 | FacilityID | Region of Peel Facility ID - if the inundated road segment is at a crossing |
| 13 | StmMainID | Region of Peel Storm Main ID - if the inundated road segment is at a crossing |
| 14 | Inun_Type | Determine whether the inundation happens at the crossing and adjacent to the crossing. |
| 15 | Model | Name of model. Can also use this space to identify if it was a 2D model. Model year also to be inclulded |
| 16 | NO_OF_LANE | Number of lanes in each road segment provided in the Region of Peel's shapefile |
| 17 | LOS | Level of Service of the road segment. Assign 0 cm for 2 lanes, 7 cm for 3 and 4 lanes, and 15 cm for 6 or more lanes |
| 18 | OTSTMEC | The starting storm event at which a crossing is overtopped for the existing climate "EC". |
| 19 | WSE_100yr | Water surface elevation for the 100-year storm event at the upstream cross section. Note that this field may report "-999" if the WSE step was bypassed and Max Depth was directly determined from the model raster outputs. |
| 20 | WSE_50yr | Water surface elevation for the 50-year storm event at the upstream cross section. Note that this field may report "-999" if the WSE step was bypassed and Max Depth was directly determined from the model raster outputs. |
| 21 | WSE_25yr | Water surface elevation for the 25-year storm event at the upstream cross section. Note that this field may report "-999" if the WSE step was bypassed and Max Depth was directly determined from the model raster outputs. |
| 22 | MinRdElev | Minimum road edge elevation at each road segment which is extracted from LiDAR (using zonal statistics) |
| 23 | EC_D_100 | Maximum flood depth on the road segment for the 100-year storm event (WSE_100yr minus MinElev) under existing climate. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 24 | EC_D_50 | Maximum flood depth on the road segment for the 50-year storm event (WSE_50yr minus MinElev) under existing climate. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 25 | EC_D_25 | Maximum flood depth on the road segment for the 25-year storm event (WSE_25yr minus MinElev) under existing climate. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |

| Item | Attribute | Description |
|---|---|---|
| 26 | CC50_D_100 | Maximum flood depth on the road segment for the 100-year storm event (WSE_100yr minus MinElev) or N/A if insufficient data is available to make a determination for mid century RCP 8.5. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 27 | CC50_D_50 | Maximum flood depth on the road segment for the 50-year storm event (WSE_50yr minus MinElev) or N/A if insufficient data is available to make a determination for mid century RCP 8.5. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 28 | CC50_D_25 | Maximum flood depth on the road segment for the 25-year storm event (WSE_25yr minus MinElev) or N/A if insufficient data is available to make a determination for mid century RCP 8.5. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 29 | CC80_D_100 | Maximum flood depth on the road segment for the 100-year storm event (WSE_100yr minus MinElev) or N/A if insufficient data is available to make a determination for end of century RCP 8.5. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 30 | CC80_D_50 | Maximum flood depth on the road segment for the 50-year storm event (WSE_50yr minus MinElev) or N/A if insufficient data is available to make a determination for end of century RCP 8.5. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 31 | CC80_D_25 | Maximum flood depth on the road segment for the 25-year storm event (WSE_25yr minus MinElev) or N/A if insufficient data is available to make a determination for end of century RCP 8.5. For locations modelled in 2D and where inundation type was "adjacent", max depth values are obtained from the model raster outputs. |
| 32 | EC_C_100 | For the 100yr event, "Y" if the LOS criteria is met, and "N" if the LOS criteria is not met under existing climate |
| 33 | EC_C_50 | For the 50yr event, "Y" if the LOS criteria is met, and "N" if the LOS criteria is not met under existing climate |
| 34 | EC_C_25 | For the 25yr event, "Y" if the LOS criteria is met, and "N" if the LOS criteria is not met under existing climate |
| 35 | CC50_C_100 | For the 100yr event, "Y" if the LOS criteria is met, "N" if the LOS criteria is not met or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 36 | CC50_C_50 | For the 50yr event, "Y" if the LOS criteria is met, "N" if the LOS criteria is not met or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 37 | CC50_C_25 | For the 25yr event, "Y" if the LOS criteria is met, "N" if the LOS criteria is not met or N/A if insufficient data is available to make a determination for mid century RCP 8.5. |
| 38 | CC80_C_100 | For the 100yr event, "Y" if the LOS criteria is met, "N" if the LOS criteria is not met or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 39 | CC80_C_50 | For the 50yr event, "Y" if the LOS criteria is met, "N" if the LOS criteria is not met or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 40 | CC80_C_25 | For the 25yr event, "Y" if the LOS criteria is met, "N" if the LOS criteria is not met or N/A if insufficient data is available to make a determination for end of century RCP 8.5. |
| 41 | Notes | Notes (if any) |

# Appendix A4:
# Climate Change Memo

# Technical Memo

**Date:** October 25, 2024

**Re**: Regional Roads and Crossings Flood Vulnerability Asseassment for Roads and Watercourse Crossings - Shifting Return Periods of IDF Design Storms from Current Climate to Future Climate

**Author**: Yuestas David, Semiha Caglayan, Ziyang Zhang, Qiao Ying

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## 1 INTRODUCTION

The Toronto and Region Conservation Authority (TRCA) is conducting the Regional Roads and Crossings Flood Vulnerability Assessment for TRCA's jurisdiction within the Region of Peel (ROP). This project includes a climate change component to account for future climate conditions. This technical memorandum outlines the key elements of the scoping, background, methodology, and results, detailing how projected climate change for the mid- and end-of-century is incorporated into this assessment.

## 2 SCOPE OF WORK

The intensity, duration, and frequency (IDF) of extreme rainfall events, summarized by IDF curves, are crucial for municipal infrastructure design. Municipalities are updating these curves to account for the increasing frequency of extreme events due to climate change. Although updating IDF curves for the ROP is not within this project's scope, TRCA has been tasked with providing an approach to "shift" return periods from the current IDF curves, based on future climate scenarios. This approach answers the question, "what return period will be assigned to the current 100-year return period storm in the future?" rather than answering "What is the future 100-year return period storm?"

### 2.1 Time Horizons

The project team considers the current climate and two 30-year future horizons: mid-century and end-of-century. Future climate data is represented using the median, $10^{th}$, and $90^{th}$ percentiles from an ensemble of climate models. Current climate conditions will be shifted based on these future climate scenarios. The time horizons are defined as follows:

- **Current Climate**: IDF values derived from Environment and Climate Change Canada (ECCC) for the Toronto City Climate Station based on historical observed rainfalls.
- **Mid-Century Climate**: Scaled IDF values derived from ECCC Climate Data Portal (climatedata.ca) for 2031 to 2060.
- **End-of-Century Climate**: Scaled IDF values derived from ECCC Climate Data Portal (climatedata.ca) for 2071 to 2100.

## 2.2 Shared Socio-Economic Pathway (SSP)

The Coupled Model Intercomparison Project Phase 6 (CMIP6) Shared Socioeconomic Pathways (SSP) 5-8.5 scenario (the "high carbon emission" scenario) was chosen by the ROP to illustrate a conservative scenario and embed conservativeness within adaptation initiatives.

# 3 BACKGROUND

Climate change, fueled by the rapid buildup of greenhouse gases, is poised to disrupt historical climate patterns at an unprecedented rate. The enhanced greenhouse effect, caused by gases like carbon dioxide and methane, traps more of the Sun's energy within Earth's atmosphere, disrupting the climate equilibrium and causing a warming trend. This additional energy leads to significant changes in climate parameters, including precipitation and temperature. To confront these impending changes, it is crucial to incorporate climate projections into our planning and infrastructure development to enhance our resilience against shifting climatic impacts (IPCC, 2022).

Rainfall IDF curves are used in many water management applications, including drainage design, stormwater and watershed planning, flooding and erosion risk management, and infrastructure operations. These curves efficiently characterize a long historical record of extreme rainfall events, typically spanning 30 years, by their intensity, duration, and return period. The return period is the inverse of the storm's exceedance probability in any given year, also known as the Annual Exceedance Probability (AEP). That is, if a rainfall depth for a given storm duration has a 1% probability of being exceeded in any given year, it has a AEP of 1% and a 100-yr return period.

To ensure infrastructure resilience to climate change, it is essential to obtain IDF curves based on projected future climate conditions. Three sources of web tools that provide future IDF curves were evaluated: Western University's Intensity Duration Frequency – Climate Change (IDF-CC) web tool, Environment Canada Climate Change (ECCC)'s portal - Climatedata.ca, and Ontario Ministry of Transportation (MTO) IDF Curve Lookup Tool. The following section provides overviews of these web tools and their integration of projected climate change data.

## 3.1 Brief Overview of Web Tools Used for Updating IDF Curves for Climate Change

Below is a brief description of commonly used web tools for retrieving future IDF curves that account for climate change.

1) **IDF-CC tool version 7, by Western University**
   The IDF CC tool can generate IDF curves based on historical data as well as projected climate change scenarios extending up to the year 2100. Future IDF curves can be derived from either raw or bias corrected data from CMIP5 (24 GCMs) and the newer CMIP6 (30 GCMs) climate models. Users can select from low (RCP 2.6 or SSP1-2.6), moderate (RCP 4.5 or SSP2-4.5) and high (RCP 8.5 or SSP5-8.5) greenhouse gas emission scenarios for the CMIP5 or CMIP6 models.

   The tool applies the relative change between modelled daily rainfall in historical and future periods to scale the historical sub-daily extreme events to future periods. IDF curves can be generated for ECCC climate station locations or for ungauged locations using a gridded interpolated dataset. Additionally, users can import their own rain gauge data if available.

For more detailed information and access to the IDF CC tool, visit https://www.idf-cc-uwo.ca/

**2) Climatedata.ca, by Environment and Climate Change Canada (ECCC)**
The ECCC portal provides historical and future IDF curves extending to 2100 for all ECCC climate stations. It includes projected IDF values based on CMIP5 (24 models) and CMIP6 (26 models) GCMs for low, moderate and high emissions scenarios. Future IDF curve values are determined by a temperature scaling approach based on the Clausius Clapeyron relationship, which states that for every 1°C increase in temperature, the atmosphere's water-holding capacity increases by 7%. Therefore, the projected change in average temperature is used to adjust extreme rainfall intensity accordingly.

For more information and access to the ECCC portal, visit https://climatedata.ca/resource/idf-data-and-climate-change/

**3) IDF Curve Lookup Tool, by MTO**
This tool uses existing ECCC climate station IDF data to determine IDF curves based on the user's specified location. However, during the initial study, the project team identified several limitations compared to the other two tools. For future IDF estimates, this tool does not consider projected climate. Instead, it relies on a linear trend extrapolated from the historical period (1960-2014) to 2060, assuming that the rate of climate change will remain constant from past to future periods. The analysis combines all Ontario stations to determine the trend, which overlooks the possibility for spatial variability in trends. To obtain future IDF data, the user must specify a particular future year, as the tool does not support a range of future periods. Additionally, this tool and its data have not been updated since September 2016.

TRCA conducted detailed analyses of the three web tools and summarized the findings in a technical memo (David and Caglayan, 2023). After discussions with the project team, the ROP selected ECCC's climatedata.ca portal as the source for projected IDF curves, as it produced the most conservative future climate IDF values. Additionally, its methodology was also referenced in the CSA PLUS 4013:19 technical guideline. Consequently, the analysis detailed in this memo exclusively used the ECCC climatedata.ca portal for updating IDF curves and conducting the return period shift analysis.

## 3.2 Overview of Future Climate Projections

As outlined in the Scope of Work section, the ROP selected the CMIP6 – SSP5-8.5 scenario for this project to incorporate conservativeness into adaptation strategies. According to the Intergovernmental Panel on Climate Change (IPCC) special report (2022), the CMIP6 – SSP5-8.5 scenario reflects an increase in radiative forcing of 8.5 $W/m^2$ by 2100 and represents the highest greenhouse gas (GHG) emissions scenario among the IPCC's future climate projections.

# 4 METHODOLOGY

This section outlines the methodology used to calculate shifts in return periods/ AEPs of the rainfall intensities from the current IDF curves, based on projected climate for mid- and end-of-century time periods.

## 4.1 Concept of Shifting Return Periods

Figure 13 provides examples of IDF curves of current versus future climate conditions, visually demonstrating the process of estimating how the return periods of a given rainfall depth from the current climate IDF curve will shift to in the future. Figure 13 (a) presents the IDF curves for current and future climates for 10-year and 25-year events, showing a noticeable "shift" between the two. The differences in rainfall intensity (y-axis) indicate that, for a specific storm duration and return period, future climate conditions result in higher rainfall intensities compared to current climate conditions. This shift suggests that extreme events today will become more frequent in the future.

Our analysis focuses on this shift. Instead of finding the new intensities for the same return periods, the project team calculated new return periods for the current intensities. In Figure 13 (b), with a constant storm duration of 6 hours, the frequencies of current extreme events in future periods are calculated. For example, a 25-year event, 6-hour storm with a rainfall depth of approximately 65 mm in the current climate IDF curve is projected to occur more frequently under future climate conditions – as often as a 9-year event.

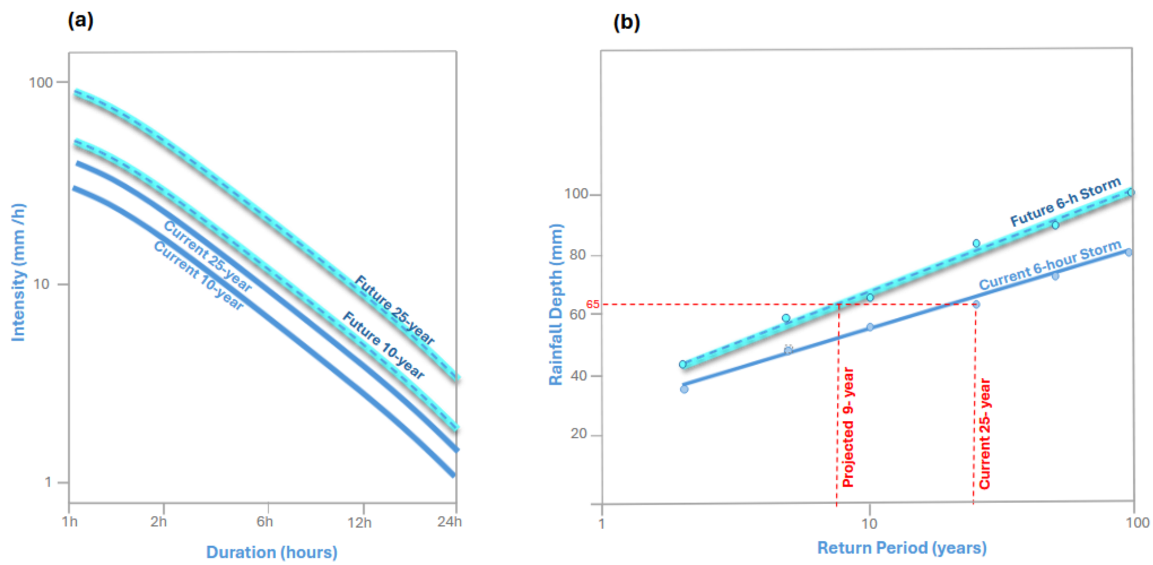


**FIGURE 13: A) EXAMPLE OF CURRENT AND FUTURE CLIMATE IDF CURVES PLOTTED TOGETHER TO SHOW CLIMATE SHIFTS. B) EXAMPLE OF CURRENT AND FUTURE CLIMATE IDF CURVES WITH 6-HOUR STORM, PLOTTED TOGETHER TO ESTIMATE FUTURE RETURN PERIODS.**

## 4.2 Steps to Estimate Future Return Periods

Figure 14 illustrates the step-by-step approach to calculate the future return periods for the rainfall intensities of current climate return period storms.

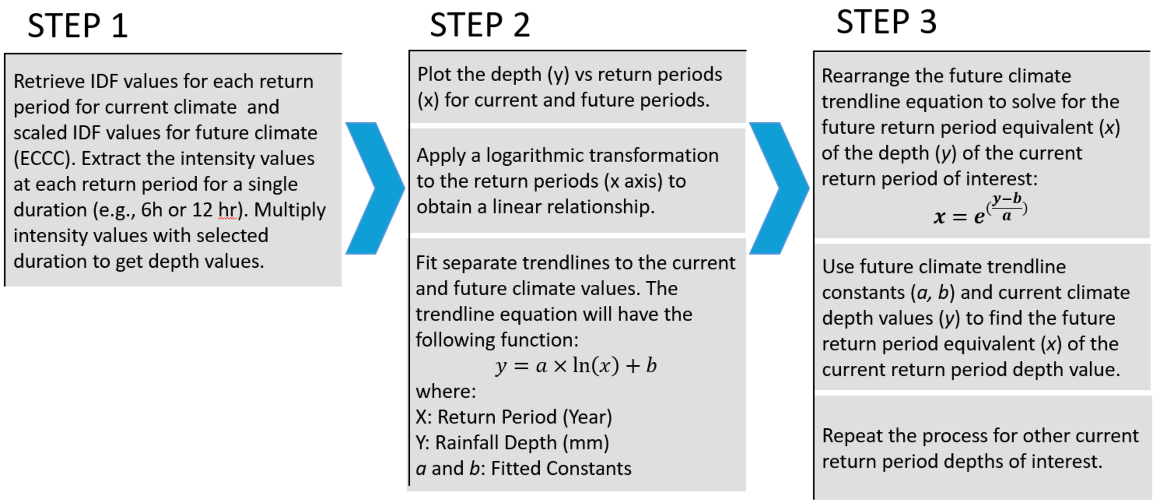


**FIGURE 14: METHODOLOGY TO ESTIMATE FUTURE RETURN PERIOD BASED ON CURRENT AND FUTURE CLIMATE IDF DATA.**

Using Figure 15 below, an example workflow is provided with calculations. The 6-hour, 100-year return period storm is 80.31 mm in the current climate IDF data derived from the Toronto City Climate Station. The regression equation for the future mid-century climate can be re-arranged to solve the future return period (X) by inserting the rainfall depth (Y) of 80.31 mm. Note the constants of the trendline from the future trendline equation, a = 14.851 and b= 33.552.

1) $X = e^{\left(\frac{Y-b}{a}\right)}$

2) $X = e^{\left(\frac{80.31-33.552}{14.851}\right)}$

3) $X = 23.3$ years

This process was applied to all return period rainfall depths from the current IDF curve to determine their corresponding shifted future return periods under future climate conditions. These steps were repeated for the 10th and 90th percentile values from the ensemble of model outputs.

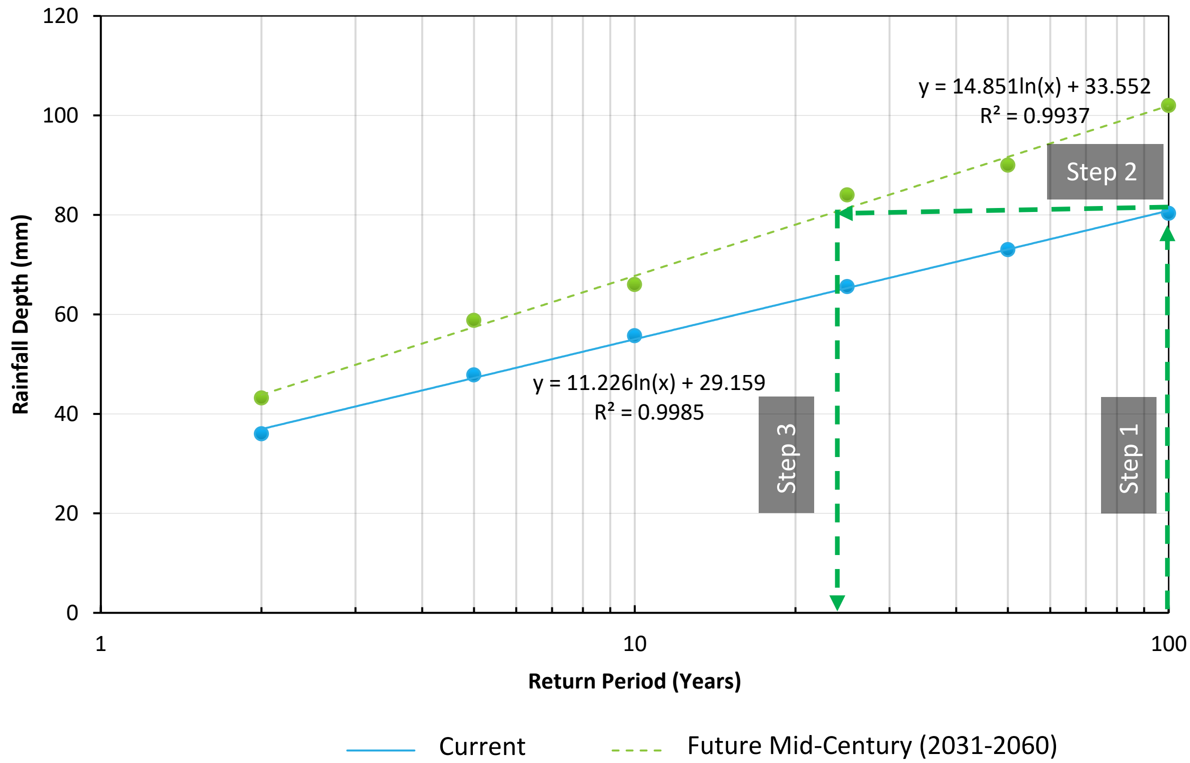


**FIGURE 15: A VISUALIZATION REPRESENTING STEPS USED TO RETRIEVE FUTURE RETURN PERIOD OF CURRENT IDF CURVE OF 100-YEAR AND 6-HOUR STORM EVENT.**

## 4.3 Data and Information

This section presents a summary of the data obtained, considered and/or used to complete the analysis.

### *Current Climate IDF Values*

The IDF curve used in TRCA's watersheds was developed based on historical observed rainfall data at ECCC Toronto City Climate Station (Station ID: 6158355 – formerly known as the Bloor Street Station) which provides the IDF return periods up to 100-year. TRCA watersheds within ROP used design storms with either 6-hour or 12-hour storm durations. Table 14 presents the design storms (i.e., rainfall depths versus return periods) for 6-hour and 12-hour storms, which is used in this memorandum to represent current climate conditions.

**TABLE 14: DESIGN STORMS (6-HOUR AND 12-HOUR DURATION) FOR CURRENT CLIMATE CONDITION, BASED ON ECCC IDF CURVE AT TORONTO CITY CLIMATE STATION.**

| | Rainfall Depth (mm) | |
|---|---|---|

| Return Period (year) | Annual Exceedance Probability | 6-hour Storm[1] | 12-hour Storm[2] |
|---|---|---|---|
| **2** | 50% | 36.00 | 42.00 |
| **5** | 20% | 47.81 | 54.38 |
| **10** | 10% | 55.69 | 62.71 |
| **25** | 4% | 65.59 | 73.1.0 |
| **50** | 2% | 73.00 | 80.82 |
| **100** | 1% | 80.31 | 88.54 |

[1] Based on TRCA Humber Creek Hydrology Update (April 2015)

[2] Based on TRCA Etobicoke Creek Hydrology Update (April 2013) and Mimico Creek Hydrology Update (December 2009)

### *Future Climate IDF Values*

Future IDF data were extracted from ECCC Climate Data Portal (climatedata.ca). A 30-year period was used to summarize climate projections for two future climate scenarios: mid-century (2031-2060) and end-of-century (2071-2100). This 30-year period is generally consistent with the infrastructure planning horizon, and beneficial to ROP for assessing impacts of climate change and ensuring long-term resilience of infrastructure and communities. For consistency, the future IDF data were extracted for the same location as the ECCC Toronto City Climate Station that was used to derive the current climate IDF values.

# 5 RESULTS

## 5.1 Projected Future IDF Values

The rainfall depths of the 6- and 12-hour storms under the future SSP5-8.5 climate scenario for mid-century (2031-2060) and end-of-century (2071-2100) are presented below, alongside current climate IDF curves (Figure 16). In all cases, both the mid-century (2031-2060) and end-of-century (2071-2100) future rainfall depth values are significantly higher across all return periods compared to the current climate values. The difference between future median values and current climate values becomes more pronounced for the higher return periods. Comparing mid-century to end-of-century values, the rainfall depth values show a noticeable increase. The wider range of values (marked by the dashed lines) at the end-of-century reflects greater uncertainty in climate models as projections extend further into the future. These results are also summarized in Table 15 (mid-century) and Table 16 (end-of-century) below.

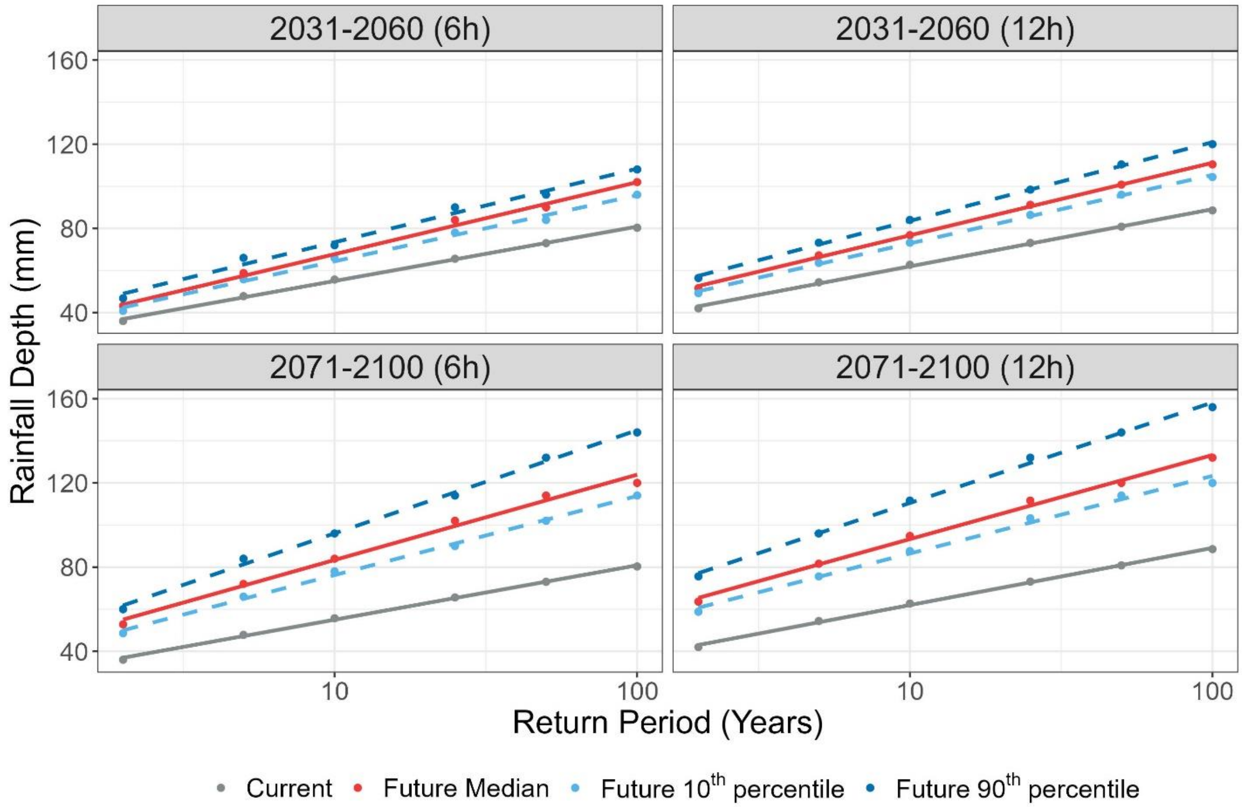


**FIGURE 16: COMPARISON OF RAINFALL DEPTHS FROM CURRENT IDF CURVE TO MID-CENTURY AND END-OF-CENTURY IDF CURVES (6-HOUR AND 12-HOUR STORMS).**

**TABLE 15: IDF CURVES (6- AND 12-HOUR DURATION) FOR FUTURE CLIMATE CONDITION: MID-CENTURY (2031-2060), BASED ON ECCC CLIMATE DATA PORTAL.**

| Return Period (year) | 6-hour Storm | | 12-hour Storm | |
|---|---|---|---|---|
| | Ensemble Median Rainfall Depth (mm) | Ensemble Range of Rainfall Depth (mm) (10th–90th) | Ensemble Median Rainfall Depth (mm) | Ensemble Range of Rainfall Depth (mm) (10th–90th) |
| **2** | 43.2 | 40.8–46.8 | 51.6 | 49.2–56.4 |
| **5** | 58.8 | 55.8–66.0 | 67.2 | 63.6–73.2 |
| **10** | 66.0 | 66.0–72.0 | 76.8 | 73.2–84.0 |
| **25** | 84.0 | 78.0–90.0 | 91.2 | 86.4–98.4 |
| **50** | 90.0 | 84.0–96.0 | 100.8 | 96.0–110.4 |
| **100** | 102.0 | 96.0–108.0 | 110.4 | 104.4–120.0 |

**Table 16: IDF curves (6- and 12-hour duration) for Future Climate Condition: End-of-Century (2071-2100), based on ECCC Climate Data Portal.**

| Return Period (year) | 6-hour Storm: Ensemble Median Rainfall Depth (mm) | 6-hour Storm: Ensemble Range of Rainfall Depths (mm) ($10^{th}$–$90^{th}$) | 12-hour Storm: Ensemble Median Rainfall Depth (mm) | 12-hour Storm: Ensemble Range of Rainfall Depths (mm) ($10^{th}$–$90^{th}$) |
|---|---|---|---|---|
| **2** | 52.8 | 48.6–60.0 | 63.6 | 58.8–75.6 |
| **5** | 72.0 | 66.0–84.0 | 81.6 | 75.6–96.0 |
| **10** | 84.0 | 78.0–96.0 | 94.8 | 87.6–111.6 |
| **25** | 102.0 | 90.0–114.0 | 111.6 | 103.2–132.0 |
| **50** | 114.0 | 102.0–132.0 | 120.0 | 114.0–144.0 |
| **100** | 120.0 | 114.0–144.0 | 132.0 | 120.0–156.0 |

## 5.2 Future Return Period Results

The rainfall depths for current climate return periods and their projected shifts for mid-century and end-of-century for the 6- and 12-hour storm durations are presented in Table 17 and Table 18, respectively. The results show that by mid-century, the rainfall depths for the current 100-year return periods shift to approximately the 23-year return period (i.e., based on medians), for both 6-hour and 12-hour storm events. By end-of-century, these same events shift further, to approximately the 8-year return period (i.e., based on medians), for both storm durations.

**Table 17: 6-hour Storm Rainfall Depths for Current Climate Return Periods and Their Mid-Century and End-of-Century Return Periods.**

| Current Climate: Rainfall Depth (mm) | Current Climate: Return Period (year) | Current Climate: AEP | Mid-Century (2031–2060): Median Return Period (year) | Mid-Century (2031–2060): AEP | Mid-Century (2031–2060): Range of Return Period ($10^{th}$–$90^{th}$) | End-of-Century (2071–2100): Median Return Period (year) | End-of-Century (2071–2100): AEP | End-of-Century (2071–2100): Range of Return Period ($10^{th}$–$90^{th}$) |
|---|---|---|---|---|---|---|---|---|
| **36.0** | 2 | 50% | 1.2 | 85% | 1.1–1.3 | 0.7 | 148% | 0.59–0.9 |
| **47.8** | 5 | 20% | 2.6 | 38% | 2.4–3.0 | 1.3 | 75% | 1.04–1.8 |
| **55.7** | 10 | 10% | 4.4 | 23% | 4.1–5.3 | 2.1 | 48% | 1.50–2.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **65.6** | 25 | 4% | 8.7 | 12% | 7.8–10.9 | 3.6 | 27% | 2.39–5.2 |
| **73.0** | 50 | 2% | 14.2 | 7% | 12.7–18.9 | 5.5 | 18% | 3.39–8.2 |
| **80.3** | 100 | 1% | 23.3 | 4% | 20.5–32.2 | 8.4 | 12% | 4.77–12.8 |

**TABLE 18: 12-HOUR STORM RAINFALL DEPTHS FOR CURRENT CLIMATE RETURN PERIODS AND THEIR MID-CENTURY AND END-OF-CENTURY RETURN PERIODS.**

| Current Climate | | | Mid-Century (2031-2060) | | | End-of-Century (2071-2100) | | |
|---|---|---|---|---|---|---|---|---|
| **Rainfall Depth (mm)** | **Return Period (year)** | **AEP** | **Median Return Period (year)** | **AEP** | **Range of Return Period ($10^{th}$–$90^{th}$)** | **Median Return Period (year)** | **AEP** | **Range of Return Period ($10^{th}$–$90^{th}$)** |
| **42.0** | 2 | 50% | 1.0 | 102% | 0.8–1.1 | 0.5 | 192% | 0.4–0.6 |
| **54.4** | 5 | 20% | 2.3 | 44% | 1.7–2.7 | 1.1 | 94% | 0.7–1.4 |
| **62.7** | 10 | 10% | 3.9 | 25% | 2.8–4.9 | 1.7 | 58% | 1.0–2.3 |
| **73.1** | 25 | 4% | 7.9 | 13% | 5.3–10.2 | 3.1 | 32% | 1.7–4.3 |
| **80.8** | 50 | 2% | 13.2 | 8% | 8.4–17.6 | 4.9 | 21% | 2.4–7.0 |
| **88.5** | 100 | 1% | 22.1 | 5% | 13.6–30.4 | 7.6 | 13% | 3.5–11.4 |

# 6 DISCUSSION

The results summarized in Table 17 and Table 18 show significant shifts in return periods from current to future climate conditions, with extreme rainfall events becoming more frequent. For example, the 6-hour rainfall depth currently associated with the 100-year return period is projected to shift to a 23-year return period by mid-century, and further to an 8-year return period by the end of the century, based on median values. This shift will have important implications for maintaining and building resilience in both current and new assets.

From the perspective of culverts and bridges, the level of service may become difficult to meet in future periods if infrastructure is designed using IDF curves based on current climate conditions. For example, a culvert designed to accommodate the 100-year return period today is projected to handle only the 23-year return period by mid-century and the 8-year return period by the end of the century. This is because extreme events are expected to occur more frequently, meaning the rainfall depth currently associated with the 100-year return period will occur more often, thus corresponding to a shorter return period. However, the required level of service for the culvert remains unchanged—it will still be expected to pass the 100-year return period storm in the future.

The method outlined in this memo leverages existing hydraulic models that were run using current climate IDF values. As a result, we do not have information on the performance of the culvert beyond the rainfall depths that were modeled (i.e., current climate). For instance, we cannot determine if the culvert will meet its level of service for the future 100-year return period storm if the current 100-year storm was the highest event modeled. However, in some cases, the infrastructure may still meet its required level of service even for future return periods.

Given the uncertainty in climate modeling, especially for projections further into the future, an ensemble of climate models was considered when retrieving future IDF curves. This ensemble provides a range of possibilities, represented by the 10th and 90th percentile values, which should be factored into infrastructure design decisions. Additionally, because the updated IDF curves are based on a scaling methodology between current and future climate conditions, rather than traditional methods using observed storm events, adaptive management and ongoing review of ground data are essential to ensure the information remains aligned with evolving climate science.

# 7 CONCLUSION

This technical memorandum provides an overview of how the return periods of current IDF values shift under two future climate scenarios. Current climate IDF values are based on data from the ECCC Toronto City Climate Station, while future climate conditions were modeled for two time horizons: mid-century (2031-2060) and end-of-century (2071-2100). Future IDF values were sourced from the Climatedata.ca portal, with the SSP5-8.5 scenario chosen to represent a conservative greenhouse gas emissions pathway.

A methodology was developed to shift return periods by applying fitted equations to both current and future IDF curves. These equations were used to project how the return periods of current IDF values would shift in future time horizons.

The results indicate significant shifts in return periods for future climate conditions. Design storm events that are currently considered rare are expected to occur more frequently by mid-century and even more so by the end of the century, underscoring the need for adaptive planning and resilient infrastructure design.

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# Appendix A5:

# Criticality Ranking Factors

Based on the results of the assessment, vulnerable roads and crossings can be further prioritized based on the **criticality** of a road, bridge, or culvert. Identifying and ranking critical roads and crossings can help further prioritize flood-vulnerable roads and crossings to help inform adaptation efforts. Understanding criticality is also important for emergency management, business continuity planning, and asset management.

According to ISO 55000:2014 (Asset management – Overview, principles and terminology), a **critical asset** has the "potential to significantly impact on the achievement of the organization's objectives". The standard further notes that (*emphasis added*):

- Assets can be *safety-critical*, *environment-critical* or *performance-critical* and can relate to legal, regulatory or statutory requirements.
- Critical assets can refer to those assets necessary to provide services to *critical customers*.
- Asset systems can be distinguished as being critical in a similar manner to individual assets.

In the Government of Canada's "Renewing Canada's Approach to Critical Infrastructure Resilience: What We Heard Report" (2022), **critical** is defined as having "a decisive or crucial importance in the success, failure, or existence of something. Criticality exists on a spectrum with some infrastructure being more critical or important than others. The criticality of an infrastructure refers to its *relative importance* in terms of the *consequences* that its failure would have on the population and its vital resources" (*emphasis added*).

Taken together, a critical asset can be characterized by a high consequence of failure. It can be understood as having high socioeconomic, use/operational, and health and safety importance (ICF International, 2014). Criticality is different from risk in that an asset is critical regardless of likelihood (Canadian Network of Asset Managers, n.d.).

In Canada, transportation is one of ten critical infrastructure sectors identified in the Government of Canada's National Strategy for Critical Infrastructure (2009). Transportation is also one of nine critical infrastructure sectors identified in Ontario's Provincial Emergency Response Plan (2019). Through O. Reg. 71/22, Critical Infrastructure and Highways, the Government of Ontario further specified that critical infrastructure include:

- 400-series highways;
- Airports;
- Canals;
- Hospitals;
- Infrastructure for the supply of utilities such as water, gas, sanitation and telecommunications;
- International and interprovincial bridges and crossings;
- Locations where COVID-19 vaccines are administered;
- Ports;
- Power generation and transmission facilities; and
- Railways.

National and provincial policies affirm transportation as a critical infrastructure system. Within this system, some assets may be more critical than others, which forms the basis of the proposed criticality assessment – to identify and rank the criticality of regional roads and crossings to help inform adaptation efforts.

## Literature Review

A brief literature review was completed as part of this assessment to help identify potential criticality factors that may be relevant to the Region of Peel. This review builds upon the list of criticality factors used in a previous assessment completed for Durham Region and seeks to:

1. Identify any additional factors that would be important for the Region to consider when assessing road and crossing criticality; and
2. Gather existing scoring approaches or assessment methods for each factor.

The Durham Flood Vulnerable Road and Crossing Hydraulic Capacity Assessment was reviewed along with published studies that involved an assessment of criticality of road transportation assets, including:

- Colorado Department of Transportation Asset Criticality (2023);
- Resilience and Durability to Extreme Weather in the Houston-Galveston Area Council Region; Pilot Program Report (Houston-Galveston Area Council, 2021);
- Practical Definition of Criticality Regarding Road Infrastructure (Global Initiative on Disaster Risk Management, 2020);
- Incorporating Resilience in Infrastructure Prioritization; Application to the Road Transport Sector (World Bank Group, 2018);
- Review of methods to determine criticality of roading networks (New Zealand Transport Agency, 2016); and
- Assessing Criticality in Transportation Adaptation Planning (ICF International, 2014).

### 8.1.1 Durham Roads Criticality Assessment

As part of Durham Region's Flood Vulnerable Road and Crossing Hydraulic Capacity Assessment, a criticality assessment was undertaken by GEI Consultants to assess the relative importance of road segments based on various criticality factors independent of the flood hazard.

Eight criticality factors were included based on discussion with Durham Region and TRCA staff (**Table 19**):

1. Functional classification of roads;
2. Average Annual Daily Traffic (AADT);
3. Designated Transit Routes;
4. Goods Movement Routes;
5. Degree of redundancy;
6. Evacuation and disaster recovery;
7. Proximity to sensitive receptors; and
8. Social equity and justice.

Each road segment was scored from 1 (less important) to 5 (more important) for each criticality factor. Individual factor scores were then summed for the final criticality score, with a minimum possible score of 8 (least critical) and a maximum possible score of 40 (most critical). **Table 19** also presents available data sources that the authors are aware of to support the potential replication in Peel region. Most of these factors can be applied to bridges and culverts, except otherwise noted.

**TABLE 19. CRITICALITY FACTORS USED TO ASSESS ROAD CRITICALITY FOR DURHAM REGION**

| Criticality Factor | Scoring | Durham Data Source | Potential Peel Data Source |
|---|---|---|---|
| **1. Functional classification of roads**<br>Roads are classified based on the type of service each group is intended to provide.<br>Roads in Durham Region are classified into 7 classes: local, A arterial, B arterial, C arterial, collector, ramp, and freeway. | 1 = Local Roads<br>2 = Collector Roads<br>3 = Type C Arterial roads<br>4 = Type B Arterial roads and Rural Type A Arterial roads<br>5 = Urban Type A Arterial roads and freeways | Durham Region Open Data portal (Road Network) | Peel Region Open Data portal (Streets)<br>Bridges can also be classified based on functional classes. Culverts can be scored based on structural and non-structural culverts. |
| **2. Average Annual Daily Traffic (AADT)**<br>Average daily vehicle traffic over a year on a road section. | 1 = < 1,000 AADT<br>2 = 1,000 - 2,999 AADT<br>3 = 3,000 - 8,000 AADT<br>4 = 8,001 - 20,000 AADT<br>5 = > 20,000 AADT | Durham Region Open Data, City of Pickering, and Town of Ajax | Peel Region Open Data portal (Traffic Count Stations) |
| **3. Designated Transit Routes**<br>Durham's Regional Official Plan (ROP) identifies a Transit Priority Network that provides inter-regional and inter-municipal transit service.<br>The following elements are relevant to regional roads: Rapid Transit Spine, High Frequency Transit Network, and Other Transit Connection. | 1 = Not identified as part of Transit Priority Network<br>3 = Identified as High Frequency Transit Network or Other Transit Connection<br>5 = Identified as a Rapid Transit Spine | Durham ROP's Designated Priority Transit Network | Peel ROP's Rapid Transit Corridors (Long-term Concept) |
| **4. Goods Movement Routes**<br>Durham's ROP identifies a Strategic Goods Movement Network for preferred haul routes that are planned to accommodate commercial vehicles on a year-round basis, and which link major generators of traffic. | 1 = Not identified as a goods movement route in ROP<br>5 = Identified as a goods movement route in ROP | Durham ROP's Strategic Goods Movement Network | Peel Region Open Data portal (Strategic Goods Movement Network) |
| **5. Degree of redundancy**<br>Durham's road network was divided into 22 zones based on direction of traffic flows, municipal boundaries, major roads, railway, and watercourse features. | 1 = 16+ roads crossing a relevant screenline<br>3 = 7 - 15 roads crossing a relevant screenline<br>5 = Up to 6 roads crossing a relevant screenline | Zones were identified by Durham's Transportation Department | Similar zones can be identified by Peel Transportation or could be based on Peel's Service Delivery Areas. |

| Criticality Factor | Scoring | Durham Data Source | Potential Peel Data Source |
|---|---|---|---|
| Each zone was scored based on the number of roads crossing the boundaries (or "screenlines") of each zone. | | | Alternative methods for assessing redundancy can also be considered (e.g., Sevtsuk and Mekonnen, 2012; Wang et al., 2023). |
| **6. Evacuation and disaster recovery**<br>Based on distance from the Pickering Nuclear Generating Station.<br>Primary and secondary zones are defined in the Durham Nuclear Emergency Response Plan (2017). | 1 = Greater than 50km away from a nuclear facility (No zone)<br>3 = Between 10 to 50km away from a nuclear facility (Secondary Zone)<br>5 = Less than 10km away from a nuclear facility (Primary Zone) | Durham Nuclear Emergency Response Plan | Peel Region Open Data portal (Points of Interest) |
| **7. Proximity to sensitive receptors**<br>Based on proximity (i.e., 500 m) to key locations including schools, daycare facilities, nursing and retirement homes, and emergency services (fire halls, police stations). | Roads within 500 m of:<br>1 = Any road outside of 500m of defined key locations<br>2 = Schools or daycares/ Community centres or places of worship<br>3 = Nursing or retirement homes<br>4 = Fire halls or police stations<br>5 = Hospitals | Durham Region Open Data portal (Community Services) | Peel Region Open Data portal (Points of Interest) |
| **8. Social equity and justice**<br>Based on Durham's Health Neighbourhood data.<br>Measures assessed include low-income rate, Indigenous population, recent immigrants to the region, unemployment, visible minorities, seniors living alone, mental health. | 1 = Roads located in neighbourhoods where equity is >70th percentile (highest 30%) of equity data (e.g., highest incomes, lowest unemployment, fewest visible minorities, etc.)<br>3 = Roads located in neighbourhoods where equity is between the 30th and 70th percentile<br>5 = Roads located in neighbourhoods where equity is <30th percentile | Durham Region Open Data Portal (Health Neighbourhoods) | Peel's Neighbourhood Information Tool or Ontario Marginalization Index |

| Criticality Factor | Scoring | Durham Data Source | Potential Peel Data Source |
|---|---|---|---|
| | (e.g., lowest incomes, highest unemployment, highest visible minorities, etc.) | | |

### 8.1.2 Additional Criticality Factors for Peel Region

Through our literature review, we gathered additional criticality factors that can be assessed for roads and/or crossings (**Error! Not a valid bookmark self-reference.**). Excluded from **Error! Not a valid bookmark self-reference.** are criticality factors that do not have well-defined metrics for roads and crossings (e.g., reputational and psychological impacts; Theoharidou et al. 2009). Appendix D provides a summary of different criticality assessments and their scoring approaches.

**TABLE 20. ADDITIONAL CRITICALITY FACTORS FOR CONSIDERATION BY PEEL REGION THAT CAN BE APPLIED TO ROADS AND/OR CROSSINGS**

| Impact | Linkage to Existing Factors | Potential Criticality Factors | Reference |
|---|---|---|---|
| **1. Population affected**<br>The number of people (and assets) affected by the loss or unavailability of the asset. | Partly captured through:<br>• Average Annual Daily Traffic (AADT)<br>• Designated Transit Routes | • Connection to urban centres<br>• Population and job density<br>• Adjacent buildings (occupied and unoccupied)<br>• Transit ridership | • Homeland Security Advisory Council, 2006<br>• Theoharidou et al. 2009<br>• Roads and Traffic Authority, 2010<br>• ICF International, 2014<br>• Global Initiative on Disaster Risk Management, 2020<br>• Government of Canada, 2022 |
| **2. Public health and safety**<br>Mass casualties, sickness, injuries, or evacuations that may result from the loss or unavailability of the asset. | Partly captured through:<br>• Functional classification of roads<br>• Evacuation and disaster recovery (proximity to nuclear generating station)<br>• Proximity to key location/infrastructures (e.g., hospitals) | • Emergency evacuation routes<br>• Crossing type (e.g., pedestrian and/or cyclists, vehicular, railway, etc.)<br>• Access to health and human services (e.g., medical, health, and safety facilities) | • Theoharidou et al. 2009<br>• Roads and Traffic Authority, 2010<br>• ICF International, 2014<br>• New Zealand Transport Agency, 2016<br>• Government of Canada, 2022 |
| **3. Remote or isolated locations affected**<br>Remote or isolated locations may require special consideration. | Partly captured through:<br>• Degree of redundancy | • Number of isolated populations<br>• Degree of isolation (e.g., distance from a city/town or to a municipal road)<br>• Presence of single points of failure (e.g., sole access road to a | • Omenzetter et al., 2015<br>• World Bank Group, 2018<br>• Global Initiative on Disaster Risk Management, 2020<br>• Government of Canada, 2022 |

| Impact | Linkage to Existing Factors | Potential Criticality Factors | Reference |
|---|---|---|---|
| | | remote community; detour more than 10 km) | |
| **4. Businesses affected**<br>The number of businesses affected by the loss or unavailability of the asset. | Partly captured through:<br>• Goods Movement Routes | • North American Industrial (NAIC) codes<br>• Serves regional economic centres/access to major employment destinations<br>• Connects to supply centre or food distribution centres | • Homeland Security Advisory Council, 2006<br>• ICF International, 2014<br>• Global Initiative on Disaster Risk Management, 2020<br>• Government of Canada, 2022 |
| **5. Economic effect**<br>Potential direct or indirect economic losses (e.g., GDP) that may result from the loss or unavailability of the asset. | Partly captured through:<br>• Goods Movement Routes<br>• Average Annual Daily Traffic (AADT) | • Average annual freight value ($)<br>• AADT-Truck<br>• Tourism revenue ($) generated per year | • Theoharidou et al. 2009<br>• Houston-Galveston Area Council, 2021<br>• Government of Canada, 2022<br>• Colorado Department of Transportation, 2023 |
| **6. Environmental effect**<br>Impact on the surrounding environment that may result from the loss or unavailability of the asset. | Partly considered through:<br>• Evacuation and disaster recovery (proximity to nuclear generating station) | • Existence of drainage works | • Theoharidou et al. 2009<br>• Global Initiative on Disaster Risk Management, 2020 |
| **7. Interdependent infrastructures affected**<br>Impact on other infrastructure that may result from the loss or unavailability of the asset. | Partly captured through:<br>• Goods Movement Routes<br>• Proximity to key location/infrastructures | • Multi-modal linkages (e.g., connection to airport, port, railway)<br>• Access to lifeline utilities (water, wastewater, power, telecom utilities) | • Homeland Security Advisory Council, 2006<br>• Theoharidou et al. 2009<br>• ICF International, 2014<br>• New Zealand Transport Agency, 2016<br>• Global Initiative on Disaster Risk Management, 2020<br>• Houston-Galveston Area Council, 2021<br>• Government of Canada, 2022 |
| **8. Restoration time/ cost**<br>The lead time for and cost of repairing/replacing the failed asset. | Partly captured through:<br>• Degree of redundancy | • Location of facilities for storing/ deploying vehicles, and providing centralized support for first responders<br>• Repair or replacement cost ($) | • Roads and Traffic Authority, 2010<br>• ICF International, 2014<br>• Government of Canada, 2022 |

| Impact | Linkage to Existing Factors | Potential Criticality Factors | Reference |
|---|---|---|---|
| | • Evacuation and disaster recovery (proximity to nuclear generating station) | | |

## Recommended Factors

### 8.1.3 The Durham Road Criticality Assessment offers a great starting point for assessing criticality of regional roads in Peel region. As illustrated in Additional Criticality Factors for Peel Region

Through our literature review, we gathered additional criticality factors that can be assessed for roads and/or crossings (**Error! Not a valid bookmark self-reference.**). Excluded from **Error! Not a valid bookmark self-reference.** are criticality factors that do not have well-defined metrics for roads and crossings (e.g., reputational and psychological impacts; Theoharidou et al. 2009). Appendix D provides a summary of different criticality assessments and their scoring approaches.

Table 20, some of the proposed additional criticality factors are partly considered through the existing factors found in the Durham Road Criticality Assessment.

Taken together, the proposed and existing criticality factors can be further divided into three broad themes (**Table 21**). Potential sub-indicators are also presented for consideration.

**TABLE 21. LIST OF PROPOSED CRITICALITY FACTORS FOR PEEL REGION BY THEME**

| Theme | Proposed Criticality Factors |
|---|---|
| **Health and Safety** | 1. Emergency evacuation routes<br>a. Crossing type (e.g., pedestrian and/or cyclists, vehicular, railway, etc.)<br>2. Degree of redundancy or presence of single points of failure (e.g., sole access road to a remote community; detour more than 10 km)<br>3. Access to health and human services (e.g., medical, health, and safety facilities), or proximity to key location/infrastructures<br>4. Access to lifeline utilities (water, wastewater, power, telecom utilities)<br>5. Existence of drainage works |
| **Use/operation** | 1. Functional classification of roads (bridges and culverts)<br>2. Average Annual Daily Traffic (AADT)<br>3. Transit ridership<br>4. Multi-modal linkages (e.g., connection to airport, port, railway)<br>5. Location of facilities for storing/deploying vehicles, and providing centralized support for first responders<br>6. Repair or replacement cost ($) |
| **Socioeconomic** | 1. Connection to urban centres<br>a. Serves regional economic centres, or access to major employment destinations<br>b. Connects to supply centre or food distribution centres<br>c. Population and job density<br>2. Proximity to vulnerable populations, or social equity<br>a. Number of isolated populations, or degree of isolation (e.g., distance from a city/town or to a municipal road)<br>3. Goods Movement Routes<br>4. Designated Transit Routes<br>5. Adjacent buildings (occupied and unoccupied)<br>a. North American Industrial (NAIC) codes |

| Theme | Proposed Criticality Factors |
|---|---|
| | 6. AADT-Truck<br>a. Average annual freight value ($)<br>7. Tourism revenue ($) generated per year |

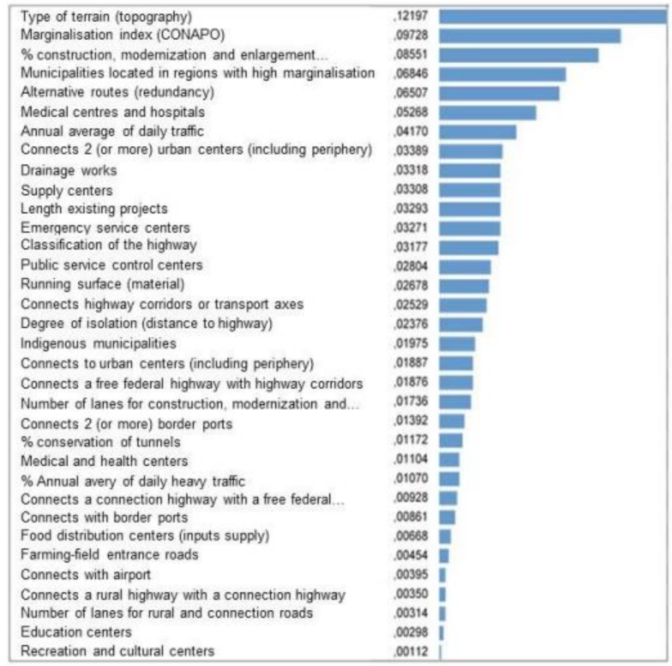
Criticality factors and scoring approaches are summarized by study. The names of criticality factors have been modified for consistency across studies. Bolded factors indicate additional factors not considered in the Durham Road Criticality Assessment.

| Study | Criticality Indicator | Scoring system |
|---|---|---|
| Colorado Department of Transportation Asset Criticality (Colorado Department of Transportation, 2023) | • Road classification<br>• AADT<br>• Degree of redundancy<br>• Equity<br>• **Freight value per ton in millions of dollars per year**<br>• **Tourism dollars generated in millions of dollars per year** | Each indicator was scored from 1-5 (less to more critical). The greater the combined score, the greater the road criticality. The final criticality score was based on the sum of all scores without weighting. |
| Assessing Criticality in Transportation Adaptation Planning (ICF International, 2014) | • Road classification<br>• AADT<br>• Degree of redundancy<br>• Proximity to key locations<br>• Evacuation Route<br>• Component of disaster relief and recovery plan<br>• **Provide access to health facility**<br>• **Defined as Priority Corridors (vital linkage to important employment/cultural centre)**<br>• **Connection to airport, port, railway**<br>• **Serve regional economic centres**<br>• **Component of the National Defense System** | A different scoring system was applied for each indicator. For example, road classification was scored between 1-6, while AADT was scored between 1-5 (less to more critical). The greater the combined score, the greater the road criticality. The final criticality score was based on the sum of all scores without weighting. |
| Practical Definition of Criticality Regarding Road Infrastructure | • Road classification<br>• AADT<br>• Degree of redundancy<br>• Equity<br>• Proximity to key locations | Indicators were weighed differently based on strategic criteria:<br>• Physical criticality = 33.3%<br>• Functional criticality = 45.8%<br>• Social criticality = 20.9% |

<table>
<tr><th>Study</th><th>Criticality Indicator</th><th>Scoring system</th></tr>
<tr>
<td>(Global Initiative on Disaster Risk Management, 2020)</td>
<td>

- **% AADT in heavy traffic**
- **Connection to airports**
- **Connection to border ports**
- **Access to recreational / cultural centres, educational centres**
- **Connection to urban centres**
- **Connects rural area with a connection highway or connects a connection road with highway**
- **Connects to supply centre or food distribution centres**
- **Farming field entrance road**
- **Length of section**
- **Number of lanes**
- **Running surface material**
- **Drainage works**
- **Bridges and tunnels**
- **Type of terrain**

</td>
<td>




Each indicator was scored from 0-1, with different scales/thresholds applied. For example, AADT was divided into a five-point scale:

<table>
<tr><th colspan="2">AADT</th></tr>
<tr><td>>20000</td><td>1</td></tr>
<tr><td>5001-20000</td><td>0.5728</td></tr>
<tr><td>3001-5000</td><td>0.2287</td></tr>
<tr><td>1500-3000</td><td>0.1418</td></tr>
<tr><td><1500</td><td>0.0701</td></tr>
</table>

For AADT between 5001-20000, the AADT score is 0.0417 x 0.5728 = 0.0239 (or 2.39%). The greater the combined score, the greater the road criticality.

</td>
</tr>
<tr>
<td>Resilience and Durability to Extreme Weather in the Houston-Galveston Area Council Region; Pilot Program Report (Houston-Galveston Area Council, 2021)</td>
<td>

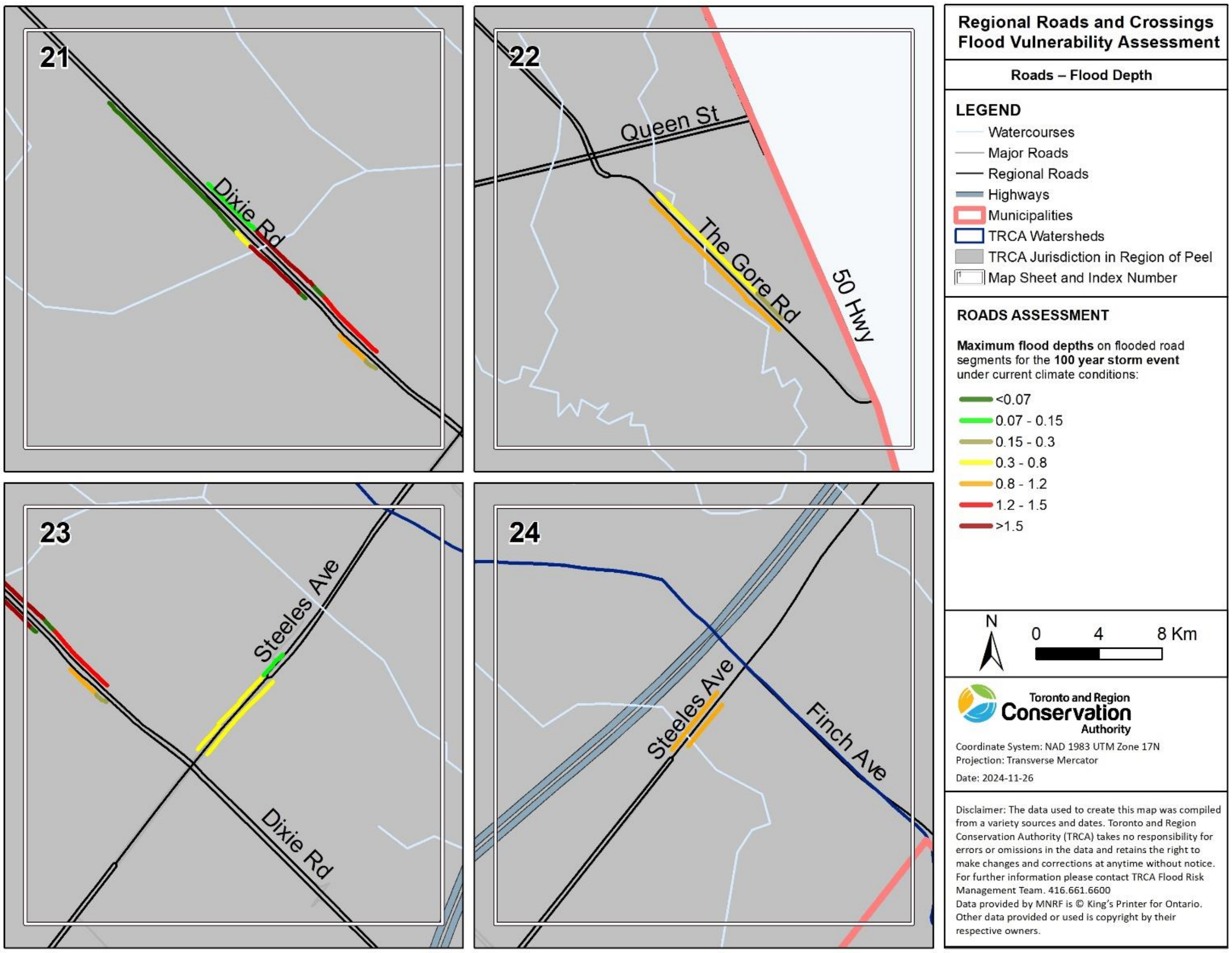
- AADT
- Transit ridership
- Linkage to hospital
- Linkage to emergency centre
- Equity
- Evacuation route
- **AADT-Truck**
- **Linkage to airport**
- **Linkage to port**
- **Access to activity population**

</td>
<td>Each indicator was scored from 0-4 (less to more critical). The greater the combined score, the greater the road criticality. The final criticality score was based on the sum of all scores without weighting.</td>
</tr>
</table>

| Study | Criticality Indicator | Scoring system |
|---|---|---|
| Incorporating Resilience in Infrastructure Prioritization; Application to the Road Transport Sector (World Bank Group, 2018) | • AADT<br>• **% of population can access hospital**<br>• **Travel time addition**<br>• **Number of isolated populations** | Estimated economic loss was determined for each road segment. The greater the combined score, the greater the road criticality. The final criticality score was based on the sum of all scores without weighting. |
| Review of methods to determine criticality of roading networks (New Zealand Transport Agency, 2016) | • Road classification<br>• Proximity to key locations<br>• **Access to lifeline utilities/evacuation route (water, wastewater, power, telecom utilities)** | Each indicator was scored from 1-5 (from less to more critical). The greater the combined score, the greater the road criticality. The final criticality score was based on the sum of all scores without weighting. |

# Appendix A6:

# Panel Maps


21
Dixie Rd
22
Queen St
The Gore Rd
50 Hwy
23
Steeles Ave
Dixie Rd
24
Steeles Ave
Finch Ave
Regional Roads and Crossings Flood Vulnerability Assessment
Roads – Flood Depth
LEGEND
Watercourses
Major Roads
Regional Roads
Highways
Municipalities
TRCA Watersheds
TRCA Jurisdiction in Region of Peel
Map Sheet and Index Number
ROADS ASSESSMENT
Maximum flood depths on flooded road segments for the 100 year storm event under current climate conditions:
<0.07
0.07 - 0.15
0.15 - 0.3
0.3 - 0.8
0.8 - 1.2
1.2 - 1.5
>1.5
N
0 4 8 Km
Toronto and Region Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N
Projection: Transverse Mercator
Date: 2024-11-26
Disclaimer: The data used to create this map was compiled from a variety sources and dates. Toronto and Region Conservation Authority (TRCA) takes no responsibility for errors or omissions in the data and retains the right to make changes and corrections at anytime without notice. For further information please contact TRCA Flood Risk Management Team. 416.661.6600
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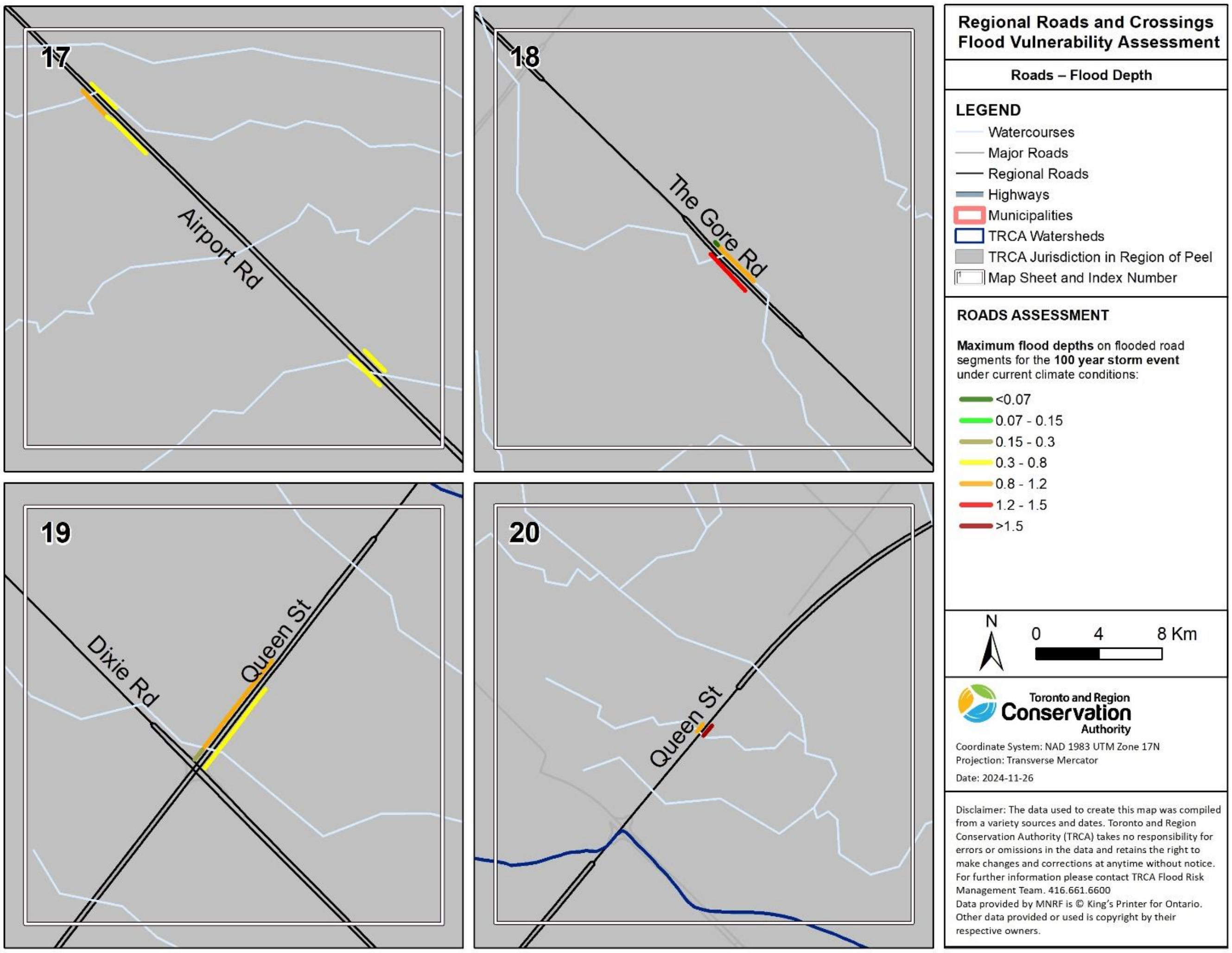

17
Airport Rd
18
The Gore Rd
19
Dixie Rd
Queen St
20
Queen St
Regional Roads and Crossings Flood Vulnerability Assessment
Roads – Flood Depth
LEGEND
Watercourses
Major Roads
Regional Roads
Highways
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TRCA Watersheds
TRCA Jurisdiction in Region of Peel
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0.3 - 0.8
0.8 - 1.2
1.2 - 1.5
>1.5
N
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4
8 Km
Toronto and Region Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N
Projection: Transverse Mercator
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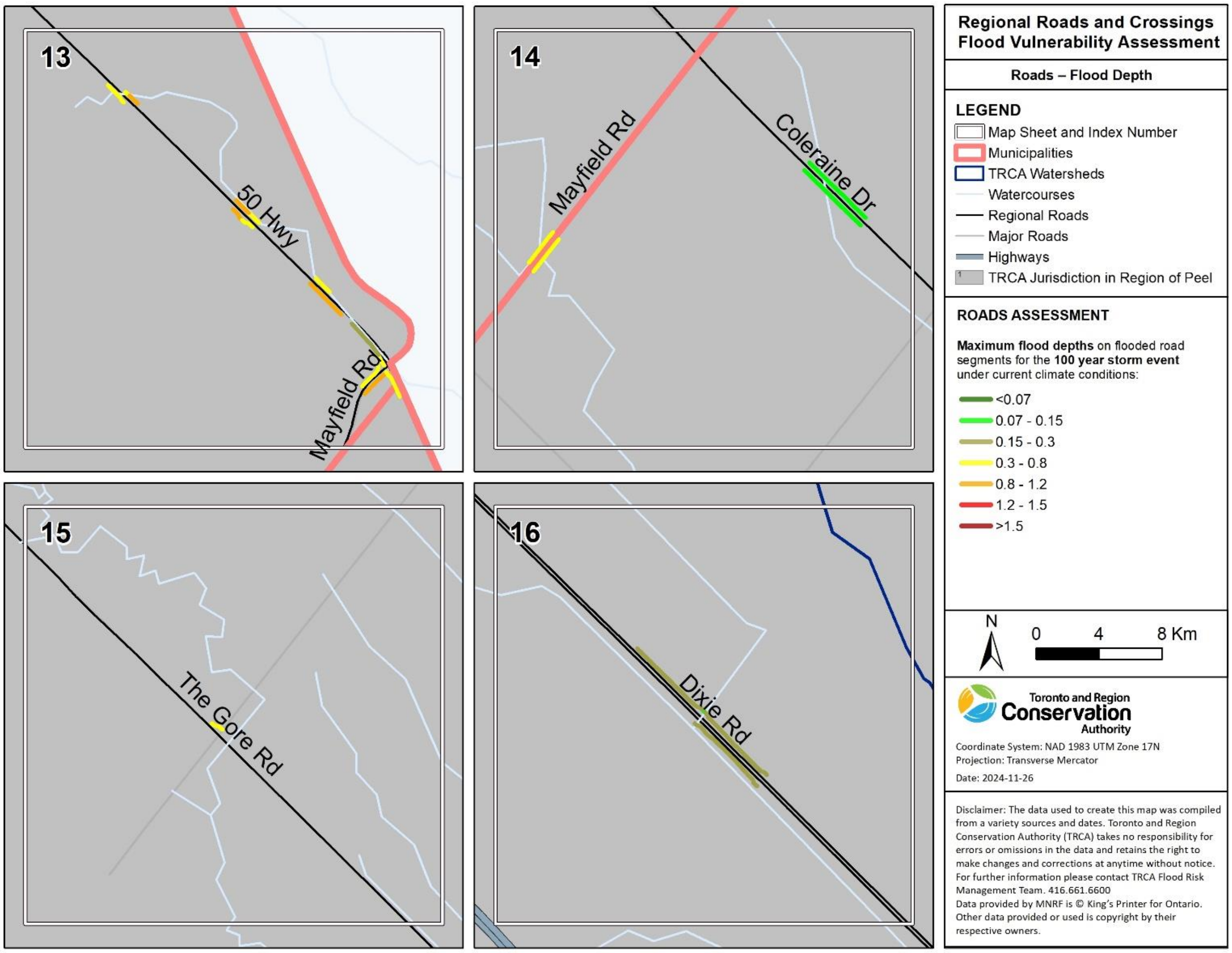
13
50 Hwy
Mayfield Rd
14
Mayfield Rd
Coleraine Dr
15
The Gore Rd
16
Dixie Rd
Regional Roads and Crossings Flood Vulnerability Assessment
Roads – Flood Depth
LEGEND
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Municipalities
TRCA Watersheds
Watercourses
Regional Roads
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TRCA Jurisdiction in Region of Peel
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0.15 - 0.3
0.3 - 0.8
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>1.5
N
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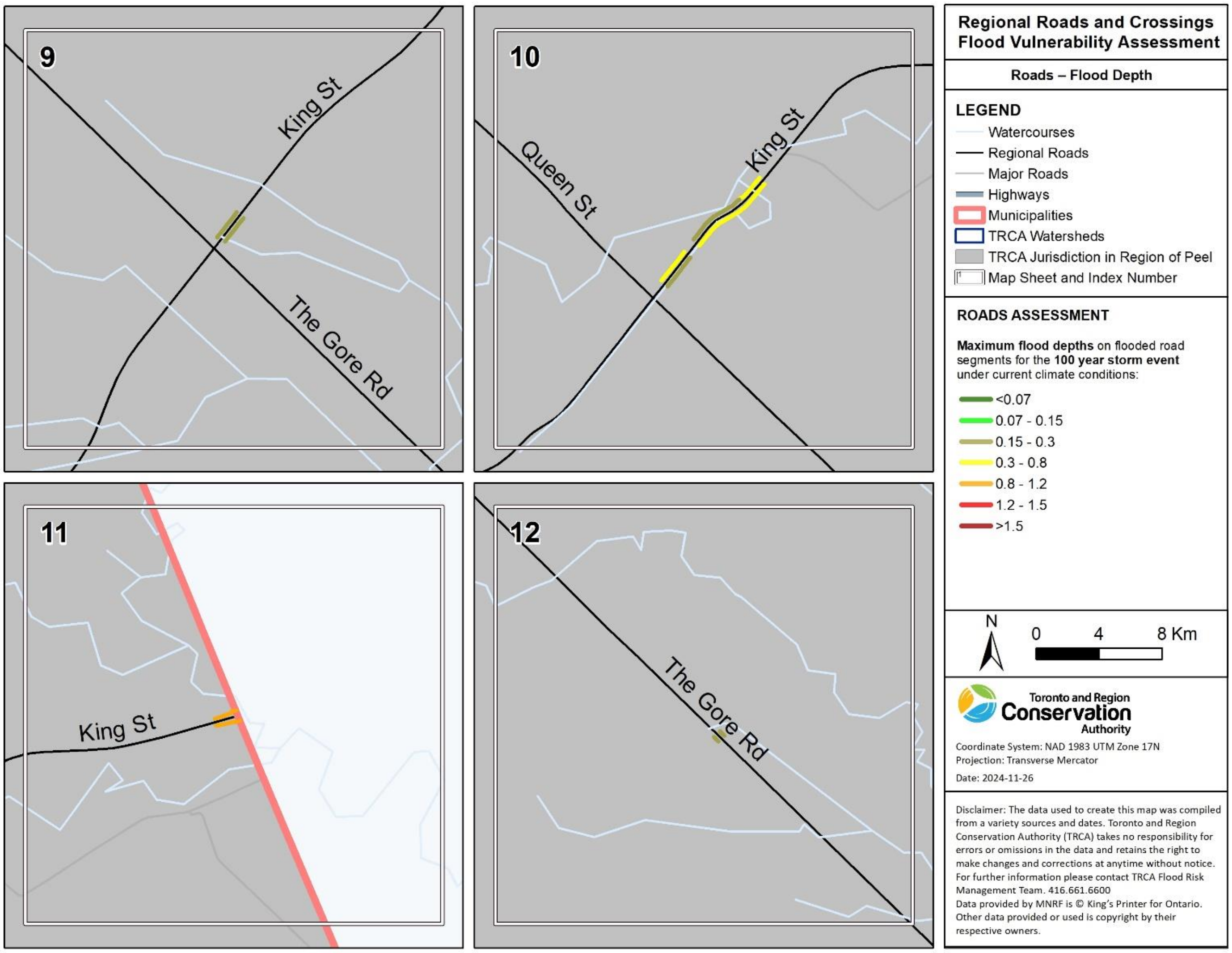
9
King St
The Gore Rd
10
Queen St
King St
11
King St
12
The Gore Rd
Regional Roads and Crossings Flood Vulnerability Assessment
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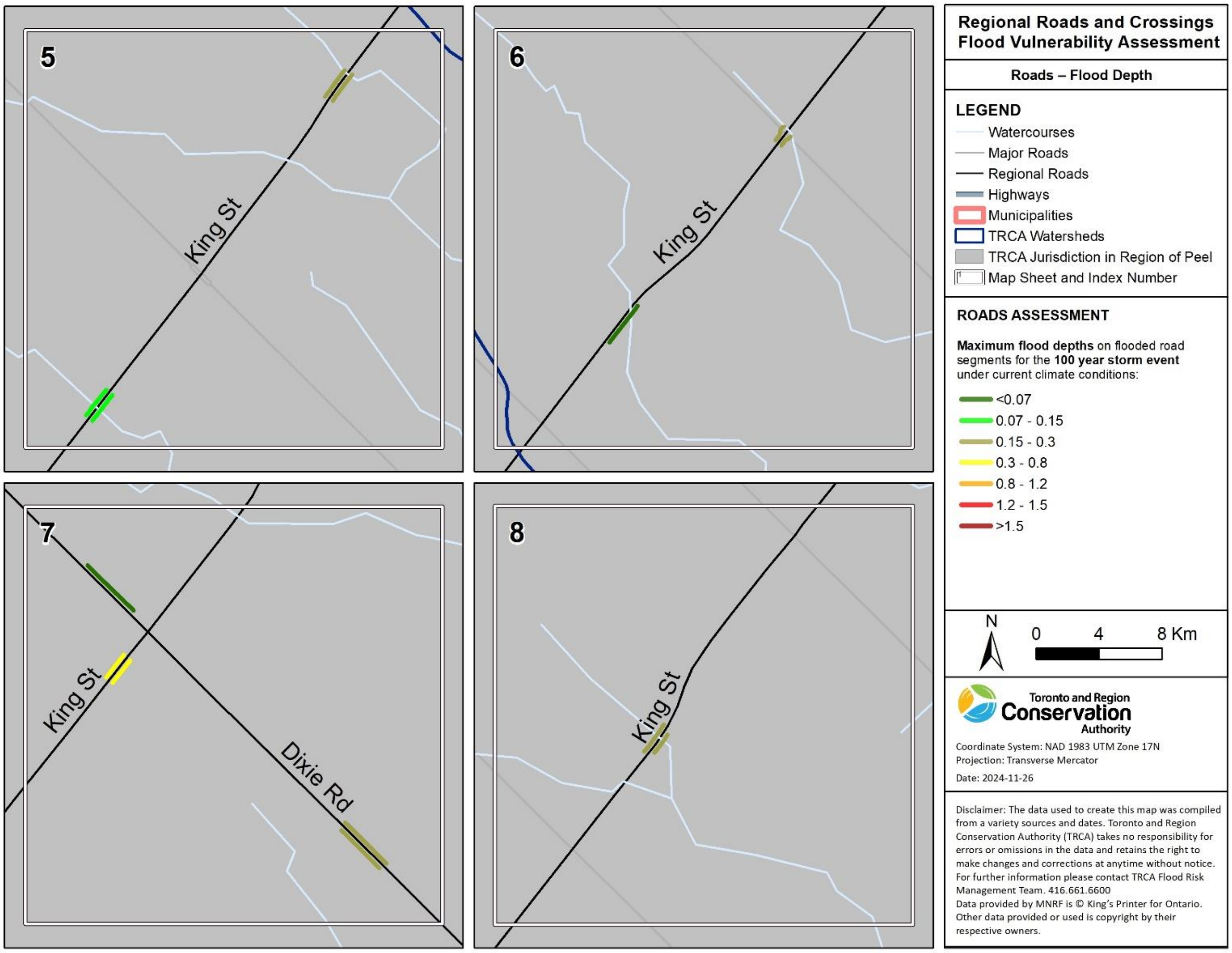
5
King St
6
King St
7
King St
Dixie Rd
8
King St
Regional Roads and Crossings
Flood Vulnerability Assessment
Roads – Flood Depth
LEGEND
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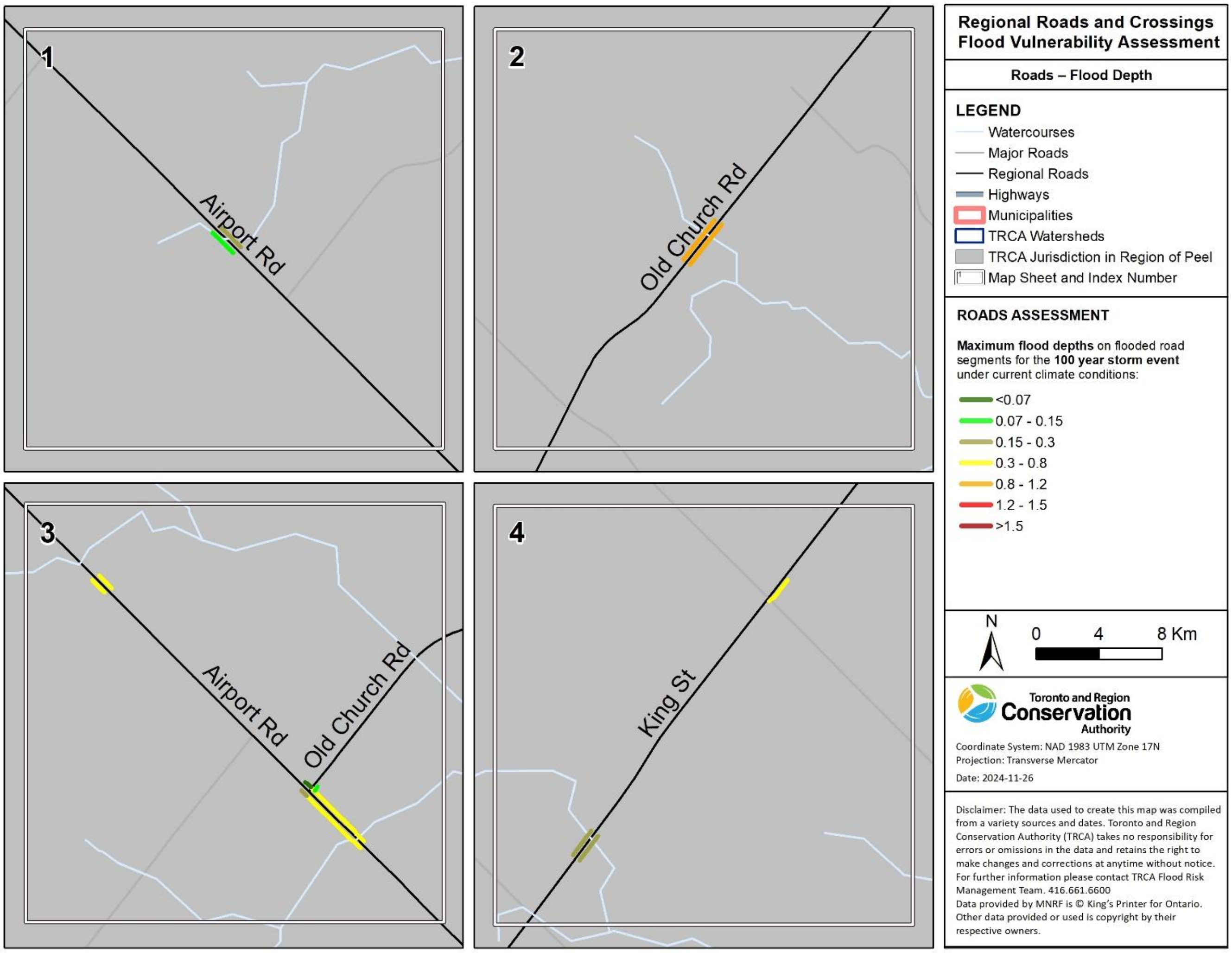
1
Airport Rd
2
Old Church Rd
3
Airport Rd
Old Church Rd
4
King St
Regional Roads and Crossings Flood Vulnerability Assessment
Roads – Flood Depth
LEGEND
Watercourses
Major Roads
Regional Roads
Highways
Municipalities
TRCA Watersheds
TRCA Jurisdiction in Region of Peel
Map Sheet and Index Number
ROADS ASSESSMENT
Maximum flood depths on flooded road segments for the 100 year storm event under current climate conditions:
<0.07
0.07 - 0.15
0.15 - 0.3
0.3 - 0.8
0.8 - 1.2
1.2 - 1.5
>1.5
N
0 4 8 Km
Toronto and Region Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N
Projection: Transverse Mercator
Date: 2024-11-26
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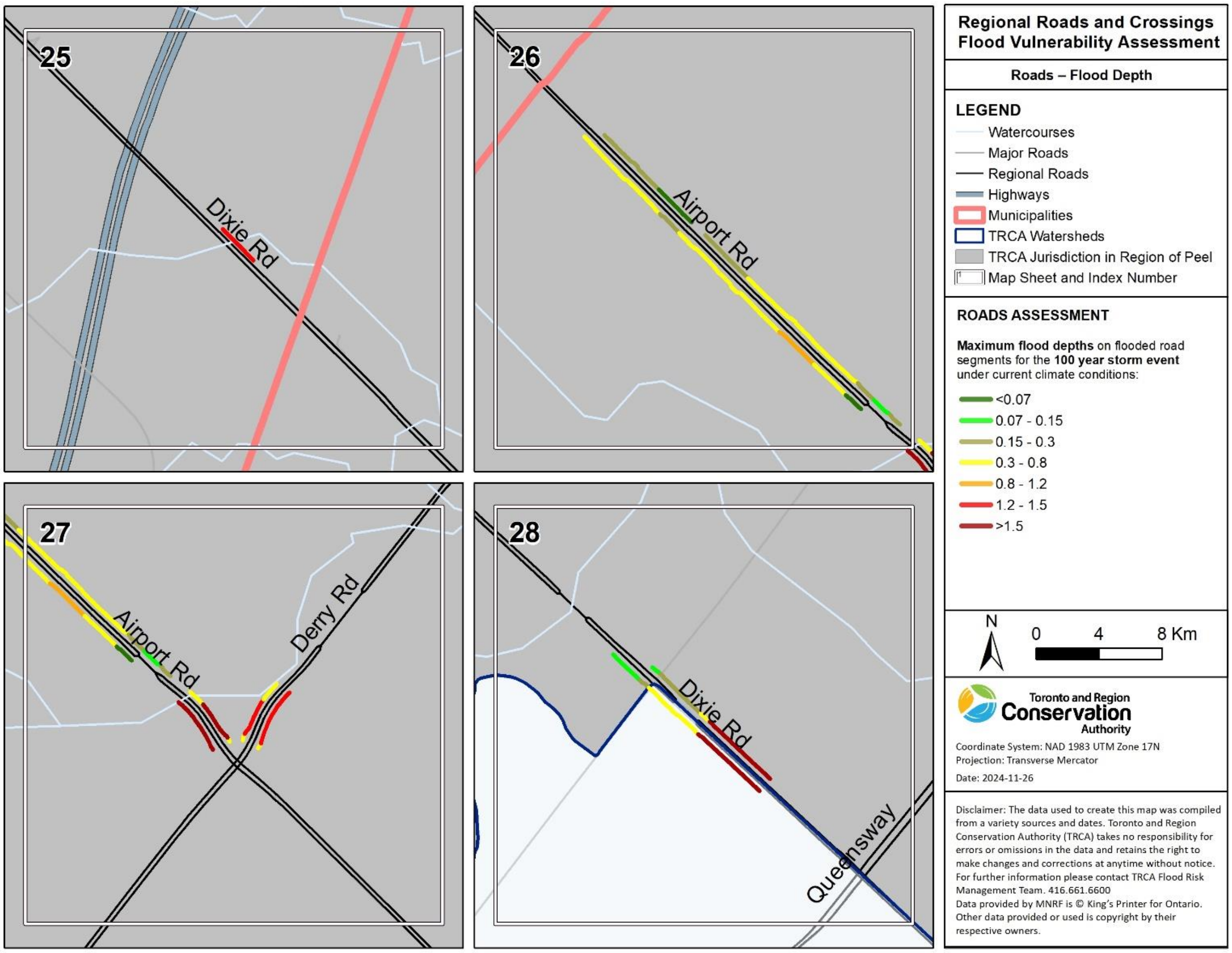
25
Dixie Rd
26
Airport Rd
27
Airport Rd
Derry Rd
28
Dixie Rd
Queensway
Regional Roads and Crossings Flood Vulnerability Assessment
Roads – Flood Depth
LEGEND
Watercourses
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0.15 - 0.3
0.3 - 0.8
0.8 - 1.2
1.2 - 1.5
>1.5
N
0
4
8 Km
Toronto and Region Conservation Authority
Coordinate System: NAD 1983 UTM Zone 17N
Projection: Transverse Mercator
Date: 2024-11-26
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