



**HIGH-LEVEL FLOOD MITIGATION APPROACHES AND
PRELIMINARY HYDRAULIC MODEL SCREENING
ETOBICOKE-DUNDAS SPECIAL POLICY AREA REVIEW - PHASE 1**

Prepared for:
CITY OF MISSISSAUGA

Prepared by:
MATRIX SOLUTIONS INC.

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Mississauga, Ontario

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Prepared for City of Mississauga, May 2022



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1 INTRODUCTION

The City of Mississauga retained Matrix Solutions Inc. to provide hydraulic engineering services and a pre-Environmental Assessment (EA) feasibility study concurrently with another report completed by Matrix titled *Special Policy Area Review, Phase 1: Baseline Conditions Tasks, Etobicoke-Dundas and Dixie-Dundas Areas* (Matrix 2022). The Etobicoke-Dundas Special Policy Area (SPA) is situated at Dundas Street to the west of Etobicoke Creek (Figure 1). The SPA is defined by the Regional storm floodplain of Etobicoke Creek and, as such, development potential is limited by both the Ontario Ministry of Natural Resources and Forestry (MNRF) and the Toronto and Region Conservation Authority (TRCA) policies and criteria. The objective of this report is to assess and document high-level flood mitigation approaches that are technically feasible and align with the City of Mississauga’s objectives to mitigate flooding within the SPA designation. This report will inform a potential future EA for mitigation works if determined desirable from an overall SPA context.

1.1 Scope and Objectives

This project is a pre-EA feasibility study intended to assess the technical feasibility of flood mitigation approaches for the Etobicoke-Dundas SPA and is a key component in support of the City of Mississauga’s *Dundas Connects Master Plan* (City of Mississauga et al. 2018). The envisioned growth within this master plan cannot be fully realized without detailed review and potentially reducing risks, impacts, and limits of flooding within the Etobicoke-Dundas SPA.

The project has the following objectives:

- identifying the problem and opportunity statements
- determining and documenting high-level flood mitigation approaches that may lift the SPA partially or fully
- reviewing the current SPA designation

This report summarizes the preliminary hydraulic model screening undertaken to assess the identified high-level flood mitigation approaches.

1.2 Problem and Opportunity Statements

The proposed problem and opportunity statements for the potential EA are summarized in this section.

1.2.1 Problem Statement

The lands west of the Dundas Street bridge crossing of Etobicoke Creek, referred to as “Etobicoke-Dundas” for this project, are subject to flooding during extreme events. This mixed-use urban area consists of parks and trails, commercial, industrial, and residential land uses. Etobicoke-Dundas is a designated SPA due to Regulatory floodplain extents, which pose a flood risk to existing lands and regulate future development potential. The City of Mississauga has an interest to protect existing flood-vulnerable residences and

businesses as well as to intensify Etobicoke-Dundas to fulfill the vision of growth expressed in the *Dundas Connects Master Plan* (City of Mississauga et al. 2018). This plan proposes higher-order transit along Dundas Street, and the vision cannot be fully implemented without first reviewing and updating the current floodplain and exploring opportunities to lift the SPA designation, either partially or fully.

1.2.2 Opportunity Statement

The City is undertaking the *Etobicoke-Dundas SPA Review - Phase 1* study to seek technically feasible approaches to mitigate flooding from Etobicoke Creek, to protect existing properties and enable future growth and intensification. Any acceptable flood mitigation solution will, to the extent possible, lower or maintain delineated floodlines and minimize impacts to land ownership, land use conditions, and existing and future infrastructure. Mitigation approaches, if found, will be structured toward lifting or reducing flood hazards in the SPA. A detailed review of the floodplain and SPA delineation will provide greater certainty for future development and confidence that existing assets are protected to the extent possible.

1.2.3 Summary Statement

Residences and businesses within Etobicoke-Dundas are currently vulnerable to flooding from Etobicoke Creek. *The Etobicoke-Dundas SPA Review - Phase 1* study will assess the existing SPA delineation and explore possible technical approaches to provide flood mitigation to residences and businesses and to enable future growth.

1.3 Project Area

The project area is located west of the crossing of Dundas Street West and Etobicoke Creek in Mississauga, Ontario (Figure 1). In this area, the centreline of Etobicoke Creek acts as the border between Mississauga and Toronto. The creek floods over a large portion of the built-up area and Dundas Street, for which the future high-transit corridor is planned. Flooding in the SPA occurs starting at the 10-year event; approximately 40 properties are affected in the Regional storm. Existing lands adjacent to Etobicoke Creek and through the project corridor are mixed-use with parks and trails, residential, industrial, and commercial land uses. Both sides of Dundas Street are bordered with commercial and industrial lots.

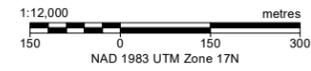


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-  Etobicoke-Dundas SPA
-  Watercourse
-  Highway
-  Road



- Notes:**
- (1) This figure is meant to be read with the attached report, Etobicoke-Dundas Special Policy Area Review – Phase 1 (July 2021), and is subject to the same limitations and conditions stated in the report.
 - (2) The Special Policy Area (SPA) is the existing and approved boundary as dictated by the Toronto and Region Conservation Authority (2016).



City of Mississauga
Etobicoke-Dundas Special Policy Area Review - Phase 1

Project Area

Date: July 2021	Project: 32391	Submitter: M. Samson	Reviewer: K. Molnar
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2 BACKGROUND REVIEW

Matrix completed a background review of data and relevant hydraulic and hydrologic work conducted in the project area to identify potential data gaps and to avoid redundancies in data collection.

2.1 Previous Studies

2.1.1 Etobicoke Creek Hydrology Update (MMM 2013)

The *Etobicoke Creek Hydrology Update* study (MMM 2013), prepared for the TRCA, updated the hydrologic models for the Etobicoke Creek watershed to assess existing and future land use conditions. The study also developed a stormwater quantity control strategy for upstream developments to improve flood risk management and to mitigate impacts caused by future conditions.

The design flows developed through the *Etobicoke Creek Hydrology Update* and applied in the 2016 HEC-RAS model are shown in Table 1. Regional storm flow rates do not include stormwater management facilities along Etobicoke Creek as per the Ontario Ministry of Natural Resources (currently MNRF) *Technical Guide, River & Stream Systems: Flooding Hazard Limit* (MNR 2002).

TABLE 1 Etobicoke Creek Design Flows

Design Storm	Peak Flow (m ³ /s)			
	HEC-RAS Cross-Section ID (Flow Change Location)			
	13.08	13.01	3.14	3.09
2-year	105	106	108	110
5-year	145	147	150	154
10-year	177	178	182	186
25-year	217	219	224	230
50-year	248	250	257	263
100-year	281	283	291	298
350-year	454	459	474	486
Regional	726	738	767	767

Source: MMM (2013)

2.1.2 Etobicoke Creek Floodplain Mapping Update (Aquafor Beech 2016)

The *Etobicoke Creek Floodplain Mapping Update* (Aquafor Beech 2016) reviewed, updated, and extended the TRCA's existing HEC-RAS hydraulic model previously developed in 2012. The model was updated with flows from the *Etobicoke Creek Hydrology Update* (MMM 2013), and for the Regional storm, future land use conditions without stormwater management storage were used as per provincial standards. The cross-section geometry was based on a digital elevation model generated from contours and provided by TRCA and was supplemented with surveyed elevations at bridges and smoothed to maintain a consistent bed profile. This model forms the basis of the hydraulic assessments completed in the current Etobicoke-Dundas study, with geometry refinements made by Matrix as discussed in Section 4.1.

The Manning's n values were maintained from the 2016 model and are based on land use, as per TRCA standards, with an additional value to represent the built-up area within the Etobicoke-Dundas SPA (Table 2).

TABLE 2 Manning's n Values

Component	Manning's n
Main Channel	0.035
Overbanks	0.080
Concrete Culverts	0.013
Etobicoke-Dundas Special Policy Area (commercial/industrial)	0.050

Source: Aquafor Beech (2016)

2.1.3 Special Policy Areas - Preliminary Flood Mitigation and Remediation Assessment Dundas Street Transportation Master Plan (AECOM 2019)

The *Dundas Street Transportation Master Plan* (AECOM 2019) reviewed potential flood mitigation measures to support eliminating or reducing the restrictions for the three SPAs along the Dundas Street corridor: the Dixie-Dundas SPA, the Applewood SPA, and the Etobicoke-Dundas SPA (referred to as the Etobicoke SPA in the AECOM report). Relevant to the current pre-EA feasibility study for Etobicoke Creek, the assessment identified that flooding from Etobicoke Creek is caused by an undersized main channel and floodplain. Four potential flood mitigation options were reviewed: do nothing, flood proofing, dykes, and bridge/culvert improvements. The flood mitigation options were determined by AECOM (2019) to be infeasible; multiple flooding ingress points make floodproofing difficult, tightly spaced buildings adjacent to the creek and natural heritage make dyke construction infeasible and replacing the current bridge would not suffice to mitigate flooding. Therefore, it was concluded that the preferred approach for the Etobicoke SPA was the do nothing option. Matrix re-evaluated these options for this study.

2.1.4 Dundas Connects Master Plan (City of Mississauga 2018)

The *Dundas Connects Master Plan* "aims to integrate transportation and land-use planning, and implement best practices along the corridor to address current and future demand" (City of Mississauga et al. 2018). The plan acknowledges that the Etobicoke-Dundas SPA (referred to as the Etobicoke SPA in the City of Mississauga master plan) was first approved by the Province of Ontario in 1988 due to the overland flood risks, and as a result, current policies limit redevelopment within the Regional storm floodplain. According to the *Mississauga Official Plan* (City of Mississauga 2016), the Etobicoke SPA is within the Dixie Employment Area and should act as the primary gateway between Mississauga and Toronto, representing the City of Mississauga with a quality image. Future works should consider an update to the SPA that can open opportunities to facilitate the transportation corridor (six lanes in this area), build up within the mixed-use land area, establish a gateway image, and better connect the trail system.

2.2 Basis of Analysis

The following information was used in the hydraulic analysis and the high-level screening of flood mitigation approaches:

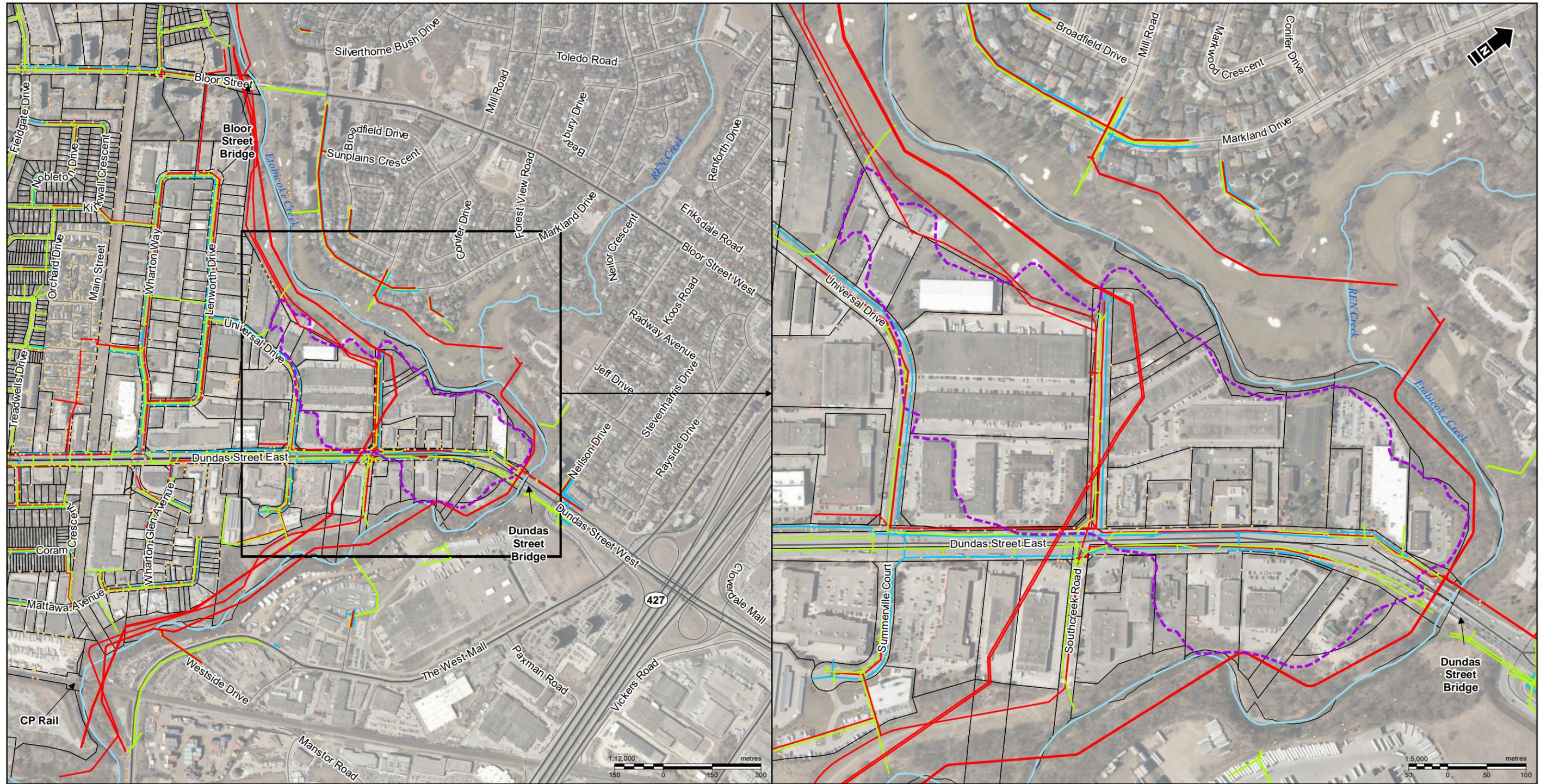
- design flows from Visual OTTHYMO hydrologic model (MMM 2013; Table 1)
- HEC-RAS model from TRCA (2016) for preliminary hydraulic screening
- LiDAR topography (TRCA 2017)
- City of Mississauga LiDAR topography (Airborne Imaging 2020)
- City of Mississauga GIS data, including storm sewers, SPA boundaries, roads, and land parcels
- City of Toronto GIS data, including land parcels and sewers
- City of Toronto open-source GIS data, including bridges, buildings, property boundaries, roads, etc.
- Regional Municipality of Peel GIS sanitary sewer, watermain, and as-builts

3 CONSTRAINTS

High-level constraint mapping was prepared for the project area using available information compiled during the background review. The constraint mapping provided on Figure 2 includes existing infrastructure (managed by the City of Mississauga and the City of Toronto), utilities, property boundaries, and was used to help identify opportunities for the mitigation approaches. It is noted that the adjacent valleylands consist of significant natural areas and archaeological potential that will require further study as part of a future EA.

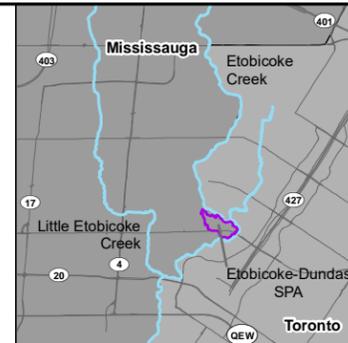
3.1 Property

In this area, Etobicoke Creek forms the jurisdiction boundary between the Mississauga to the west and the Toronto to the east. The project area mostly comprises commercial and industrial properties; however, there are a few residential homes located at the north end of Southcreek Road. There are approximately 40 buildings impacted by the Regional storm and, therefore, are subjected to the development restrictions of the SPA. The north portion of the creek within the SPA is bounded by the Markland Wood Golf Course, a privately-owned golf course with several pedestrian bridges crossing the creek.



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- Etobicoke-Dundas SPA
- Land Parcel
- Watercourse
- Highway
- Road
- Sanitary Sewer
- Storm Sewer
- Watermain
- Utility Pole



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City of Mississauga
 Etobicoke-Dundas Special Policy Area Review - Phase 1

Infrastructure Constraints

Date: July 2021 Project: 32391 Submitter: M. Samson Reviewer: K. Molnar

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References: Contains information licensed under the Open Government Licence - Ontario. City of Mississauga sanitary sewer and watermain data provided by the Region of Peel GIS data (2020); storm sewer and utilities data provided by the City of Mississauga (2019). City of Toronto sanitary sewer, storm sewer, and watermain data provided by the Engineering Drawings department at the City of Toronto (2021). Imagery (2019) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

3.2 Dundas Street Bridge

The City of Mississauga has indicated that the existing Dundas Street bridge is managed by the City of Toronto, with maintenance costs shared with the City of Mississauga. The bridge has a span of 50 m, road deck width of 32 m, and a minimum soffit elevation of 115.52 m (De Leuw 1967). Ongoing work by Metrolinx noted that the Dundas Street bridge is in poor condition and will not be able to support increased load from the future Bus Rapid Transit (BRT). The current deck width is also too narrow to accommodate the BRT; therefore, the bridge is planned to be replaced.

The existing bridge hydraulic capacity is not the primary cause of flooding; providing a wider bridge will not be sufficient on its own to reduce flood elevations within the SPA. Channel and floodplain conveyance capacity has been identified as the limiting factor; therefore, channel widening may be implemented in the future. Any proposed bridge replacement should consider the potential channel and floodplain conveyance improvements assessed as part of this study. Refer to Section 4.2 for hydraulic analysis details.

3.3 Utilities and Water Infrastructure

Impacts to infrastructure were considered in the high-level screening, both at the Dundas Street bridge crossing and along the project reach (Figure 2). No sewers or watermains appear to cross the Dundas Street right-of-way over the creek. A 250 mm diameter sanitary sewer starts before the bridge crossing. Private utility lines were not viewed at this time; however, utility poles are located along both sides of the bridge. Further investigation must be completed to confirm the presence of utility lines should the City of Mississauga pursue a detailed evaluation of a feasible flood mitigation approach.

There is other key linear infrastructure crossing Etobicoke Creek elsewhere that may limit the feasibility of flood mitigation in the project area. There are approximately six storm sewer outlets (three from the City of Mississauga and three from the City of Toronto) that discharge into Etobicoke Creek within the project area where channel and floodplain conveyance improvements have been considered. The main infrastructure constraints to potential flood mitigation are the multiple sanitary sewers crossing and parallel to the creek. There is a 2,100 mm diameter sanitary sewer managed by the Region of Peel crossing the creek just upstream of the Canadian Pacific Railway (CP) rail, and there are ten other sanitary sewers managed by the City of Toronto crossing the creek between Bloor Street and the CP rail. Many of these sanitary sewers also run parallel to the creek, as shown on Figure 2.

The Region of Peel also recently completed the East Trunk Sanitary Sewer Offline Storage Facility EA (IBI 2021) that is within the study area for the current project. As part of that project, a preferred solution was identified that includes installing an offline storage facility, replacing an abandoned energy dissipation chamber, and decommissioning an abandoned portion of the East Trunk Sanitary Sewer. These preferred works are located within the Etobicoke Creek valley adjacent to Southcreek Road. At this time there is no anticipated conflict between the East Trunk Sanitary Sewer work and the mitigation options presented in subsequent sections of this report; however, future flood mitigation efforts for Etobicoke Creek will have to consider the relocation of this infrastructure.

4 HYDRAULIC MODELLING

Matrix completed preliminary hydraulic modelling to assess high-level alternatives using the Etobicoke Creek HEC-RAS model (2016) provided by TRCA. The reach considered for this project is defined as just downstream of Bloor Street to upstream of the CP rail crossing, a total length of approximately 3.5 km. The extent of the project reach was selected with consideration of model results, focusing on the area in which potential conveyance improvements are likely to provide meaningful benefit to flooding in the SPA. For instance, the CP rail crossing was considered as the downstream limit of the model improvements for this study. Backwater is shown upstream of the CP rail bridge under the Regional storm; however, the bridge spans the Etobicoke Creek valley and water levels have a clearance of approximately 6 m from the bridge soffit. Therefore, the CP bridge was determined no hydraulic impact on the study area. The valley corridor immediately upstream of the CP rail bridge is constricted by The West Mall access road and steep valley walls, thereby causing backwater. However, Matrix concluded that any widening in this area may be impractical, as road relocation would be a significant undertaking. Moreover, this constriction is located far enough downstream that any improvements would not be sufficient to reduce water levels in the SPA.

A schematic of the project reach considered in the HEC-RAS model, including river centreline and cross-sections, is provided on Figure 3.

4.1 Hydraulic Model Refinements

Matrix reviewed the Etobicoke Creek HEC-RAS model (2016) and applied changes to the cross-sections within the study limits (Bloor Street to CP rail crossing) to reflect the latest topography (Airborne Imaging 2020). The original model was developed using a digital elevation model surface prepared from contour data. Since the completion of that model, high-resolution LiDAR data was collected for the area by TRCA (2017) and the City of Mississauga (2020). Using these datasets, Matrix updated the topographic and bathymetric data in the model to provide an appropriate level of channel and valley definition. The model update approach was accepted by the City of Mississauga and TRCA. A summary of the hydraulic model refinements completed by Matrix is provided below.

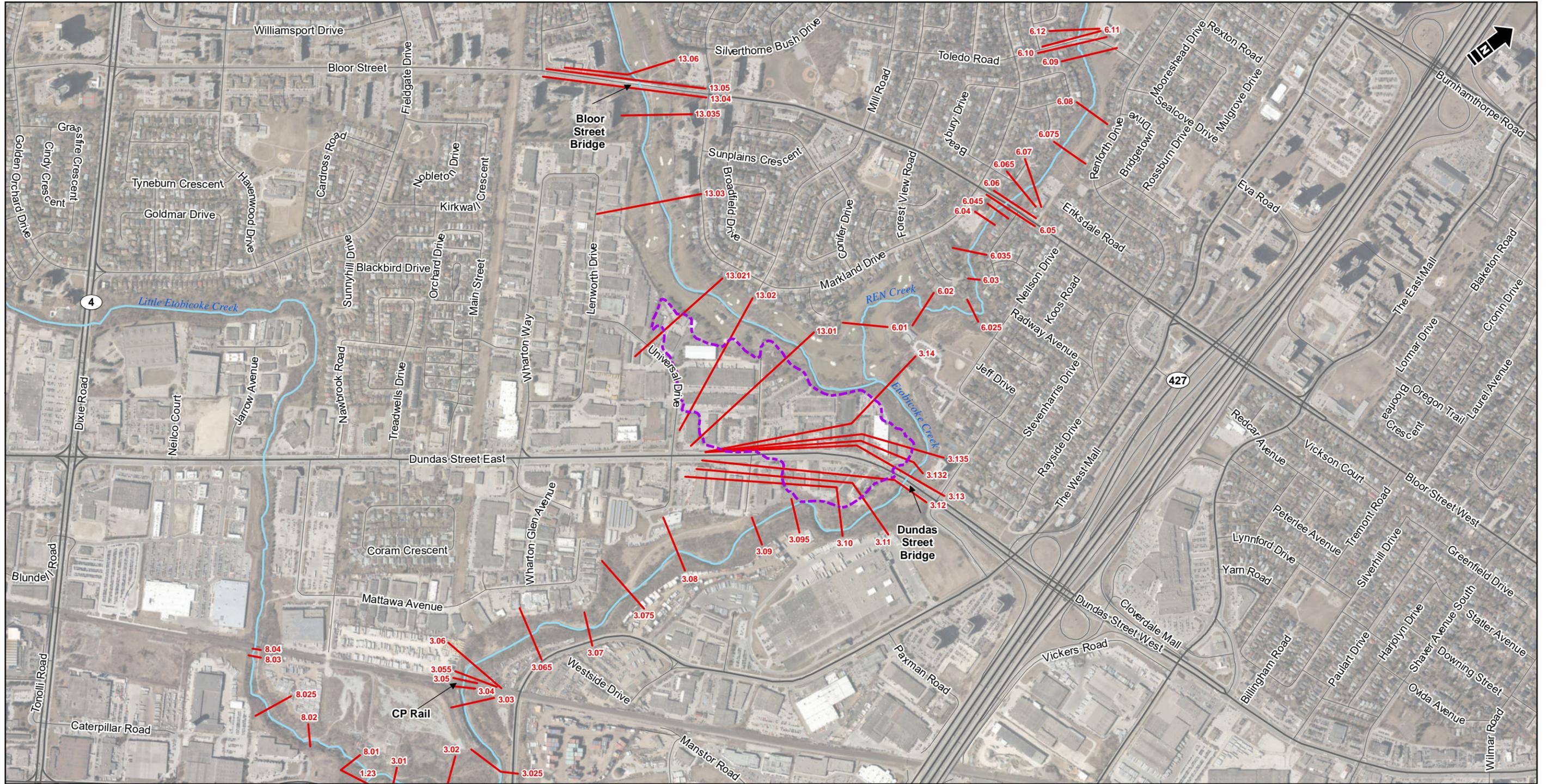
- Matrix reviewed the TRCA (2017) and City of Mississauga (2020) LiDAR datasets within the project reach, considering channel and floodplain definition. Minor differences were noted between the datasets but were deemed not hydraulically significant. The City of Mississauga (2020) dataset was adopted for model updates, as it is more current.
- A comparison was made between the City of Mississauga (2020) LiDAR data to the cross-sections in the 2016 HEC-RAS model. Differences were noted in several locations. In some areas, the LiDAR data provided a lower channel invert than the HEC-RAS model, while in other locations the modelled cross-sections reflect a lower invert. These findings were consistent with the *Floodplain Mapping Update* report (Aquafor Beech 2016), which indicated that cross-sections were refined to match

surveyed bridge inverts and smoothed in between. In the floodplain and overbanks, the City of Mississauga (2020) LiDAR data provides higher resolution and is expected to provide a more accurate understanding of flooding.

- Any notable discrepancies between the LiDAR and model data were reviewed against aerial imagery. For instance, an underpass at Bloor Street was misrepresented with no “opening” on one side of the bridge.
- The model was updated using the City of Mississauga (2020) LiDAR data within the project reach. In locations where the existing cross-sections reflect surveyed inverts, the existing channel geometry was maintained to provide a consistent slope.
- Matrix verified the bank stations and roughness of the channel and floodplain (Manning’s n) assigned to each cross-section against aerial imagery and altered as needed to represent existing conditions.

A comparison of the Regional stormwater level is provided in Figure 4. The model refinements produced lower elevations in some areas but higher in others. The maximum difference in water level ranges from 0.2 to 0.8 m, with the largest difference occurring just downstream of the Dundas Street bridge. While differences are noted, they are not substantial enough to justify updating the existing floodplain or SPA delineation based on modelling updates alone. However, the refined model provides a more accurate estimate of existing flooding conditions and, therefore, provides an appropriate basis from which to review potential SPA policy modifications as well as assess potential flood mitigation approaches.

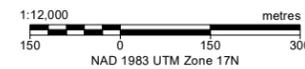
Note that the Regional storm (i.e., Hurricane Hazel) was used to establish existing conditions for the SPA and evaluate the potential flood mitigation approaches. As this is a historical storm with no statistical return period, it has not been altered to account for increased rainfall and/or flow as a result of climate change projections. Furthermore, the analysis presented herein was intended as a high-level assessment to identify whether technically feasible solutions exist to mitigate flooding in the SPA, not to prepare designs. Therefore, it is possible that the benefits of the flood mitigation alternatives presented in this report may differ if climate change projections are accounted for. Matrix recommends that any future EA work in this area consider the potential of increased peak flows due to reflect climate change.



- Etobicoke-Dundas SPA
- Watercourse
- Highway
- Road
- HEC-RAS Cross-section



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City of Mississauga
 Etobicoke-Dundas Special Policy Area Review - Phase 1

HEC-RAS 1D Model

Date: July 2021 Project: 32391 Submitter: M. Samson Reviewer: K. Molnar

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Reference: Contains information licensed under the Open Government Licence – Ontario. HEC-RAS cross-sections data obtained from the 2016 HEC-RAS model by Aquafur Beech Limited. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

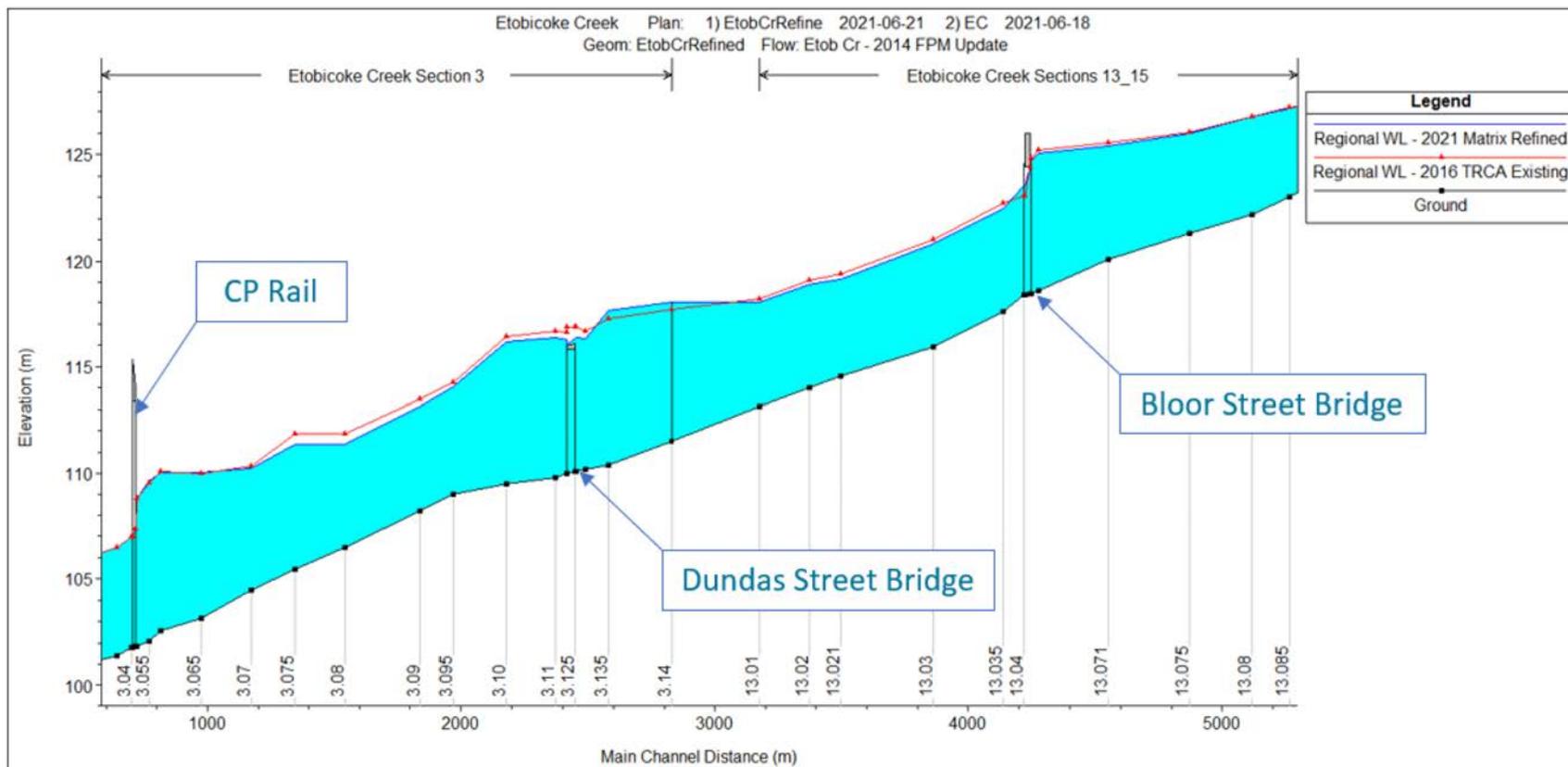


FIGURE 4 Revised HEC-RAS Model Comparison

4.2 Existing Condition Characterization

The existing Etobicoke Creek has a valley width ranging from 65 to 160 m and an average depth of 5 m. The average longitudinal slope is 0.5% within the project reach with a slightly steeper downstream profile compared to upstream. Downstream of Dundas Street, there are several locations where the valley walls are very steep and the valley width quite narrow. Urban developments exist along the top of slope on both sides of the creek creating hydraulic pinch points in the valley.

The results of the refined HEC-RAS model estimate the Regional stormwater level is 116.32 m upstream of the Dundas Street bridge with overtopping starting at the 350-year event. During the Regional storm, there is 0.10 to 0.25 m of overtopping at the low points in Dundas Street, located approximately 100 m and 450 m west of the bridge, respectively. However, as mentioned, the Dundas Street bridge capacity is not the primary flooding mechanism driving the Regional flood extents in the SPA.

Hydraulic restrictions both upstream and downstream of Dundas Street are the primary drivers of flooding within the SPA. The first hydraulic restriction in channel and floodplain capacity is located 450 m downstream of the Dundas Street bridge (Figure 5). The valley narrows to 70 m at this location (cross-section 3.095) causing backwater upstream beyond the bridge. This channel and valley pinch point leads to high water elevations at the downstream side of the bridge, thereby limiting its hydraulic effectiveness starting at the 100-year event.

Channel and floodplain capacity upstream of Dundas Street is also limiting; a second pinch point was identified 100 m upstream of the bridge at cross-section 3.135 (Figure 5). In this area, the existing valley is 65 m wide, and the upstream channel has a 100-year capacity. Beyond the 100-year event, flow spills from the channel (at cross-section 13.02) into the overbanks and flood the SPA.

Matrix conducted a preliminary flood risk assessment to provide context of flood risk for the project area. Flood hazard mapping is typically undertaken with consideration of three risk factors: depth, velocity, and depth × velocity. During the Regional storm, using the refined model results, there is approximately 21 ha of flood hazards within the SPA with 13.8 ha classified as high risk, 3.7 ha of medium risk, and 3.3 ha of low risk (Figure 6). The risk mapping criteria provided in Table 3 are based on current MNRF practices (MNR 2002), which considers the risk of flooding as a threat to life, consistent with TRCA guidelines. Low risk includes areas that are inundated but where vehicular and pedestrian ingress and egress are still feasible. Medium risk areas do not permit vehicular ingress and egress due to water depths, but pedestrian ingress and egress (by a healthy adult) is possible. High-risk areas do not facilitate safe access of any kind.

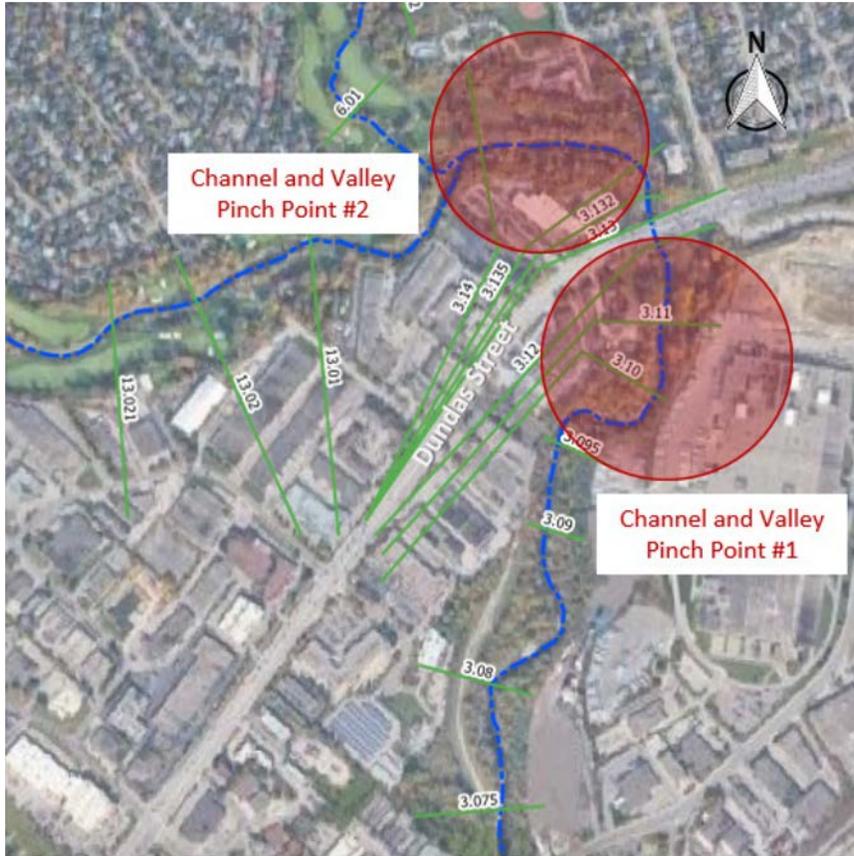
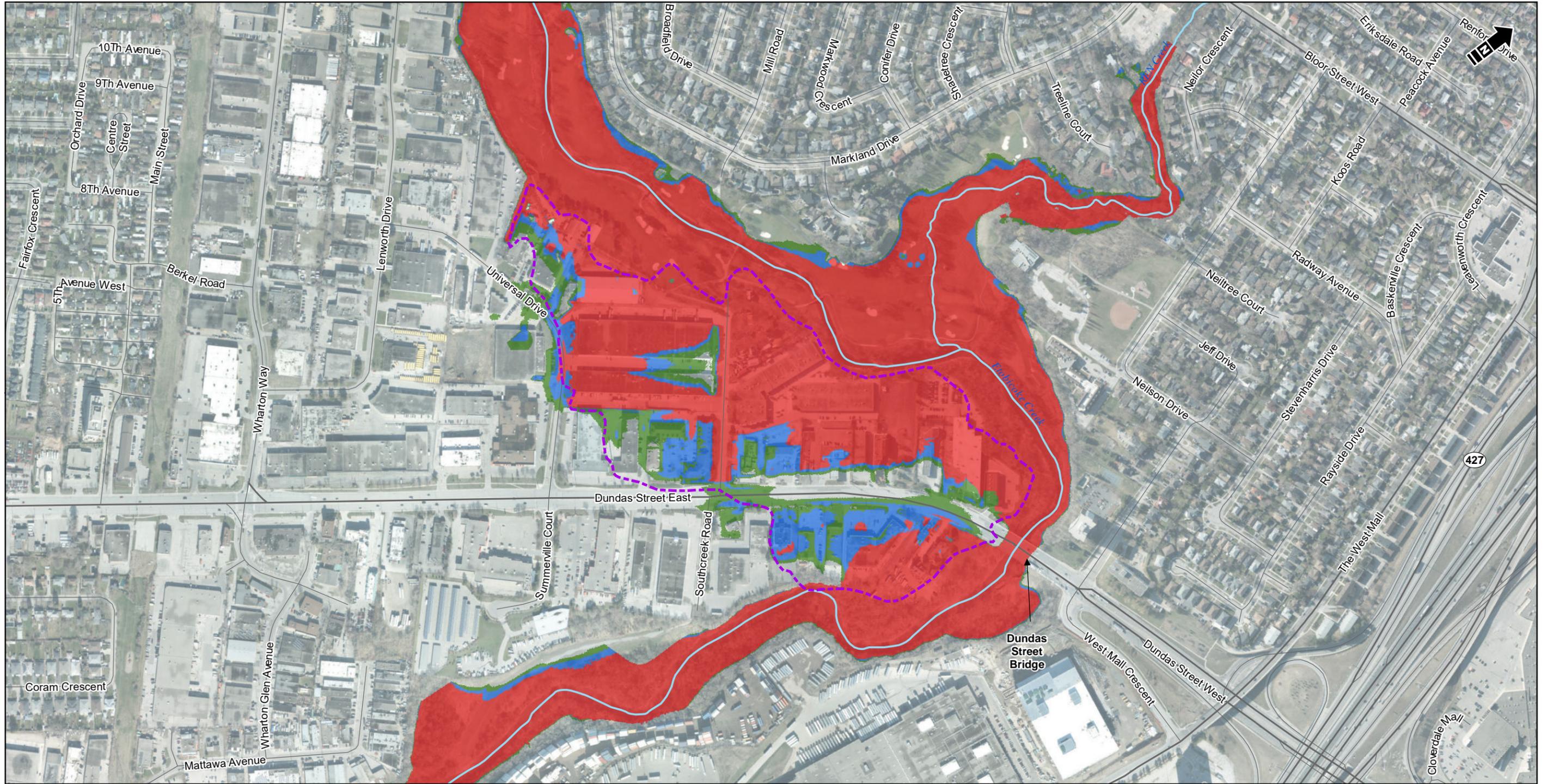


FIGURE 5 Hydraulic Pinch Points

TABLE 3 Flood Risk Criteria

Risk Level	Low	Medium	High*
Depth	≤0.3 m	>0.3 m and ≤0.8 m	>0.8 m
Velocity	≤1.7 m/s	≤1.7 m/s	>1.7 m/s
Depth × Velocity	≤0.37 m ² /s	≤0.37 m ² /s	>0.37 m ² /s

*Exceedance of any one of the criteria results in high risk.



- Etobicoke-Dundas SPA
- Watercourse
- Highway
- Road
- Flood Risk Level**
- High Risk
- Medium Risk
- Low Risk

Risk Level	Low	Medium	High
Depth	≤0.3 m	>0.3 m and ≤0.8 m	>0.8 m
Velocity	≤1.7 m/s	≤1.7 m/s	>1.7 m/s
Depth × Velocity	≤0.37 m ² /s	≤0.37 m ² /s	>0.37 m ² /s

*Exceedance of any one of the criteria results in high risk.



Notes:
 (1) This figure is meant to be read with the attached report, Etobicoke-Dundas Special Policy Area Review – Phase 1 (July 2021), and is subject to the same limitations and conditions stated in the report.
 (2) The Special Policy Area (SPA) is the existing and approved boundary as dictated by the Toronto and Region Conservation Authority (2016).



City of Mississauga
 Etobicoke-Dundas Special Policy Area Review - Phase 1

Existing Flood Risk: Regional

Date: September 2021 Project: 32391 Submitter: M. Samson Reviewer: K. Molnar

Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix Solutions Inc. assumes no liability for any errors, omissions, or inaccuracies in the third party material.

I:\CityOfMississauga\32391\FiguresAndTables\SWM2021\Report\SPA\Update\Figure_X-Flood_Risk.mxd - Table 1 - 01-Sep-21, 02:24 PM - sylvan - TID004

Reference: Contains information licensed under the Open Government Licence – Ontario. Imagery (2018) Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community.

5 FLOOD MITIGATION APPROACHES

High-level alternative flood mitigation approaches for this screening-level assessment were based on the refined existing condition modelling. The following high-level flood mitigation approaches were considered for the assessment:

- conveyance improvements
- flood containment
- diversions
- storage
- policy measures

Several alternatives were assessed for each of the flood approaches. Table 4 summarizes results of hydraulic analyses and associated screening of the high-level flood mitigation approaches. The following sections discuss the screened mitigation approaches to support the summary details and results.

TABLE 4 Summary of the High-level Screening of Flood Mitigation Approaches

Solution No.	Flood Mitigation Approach	Screening Approach	Screening Hydraulic Analysis	Screening Outcome
Conveyance Improvement				
1	Floodplain Widening	<ul style="list-style-type: none"> determine limits of floodplain widening (with and without property acquisition) determine upstream and downstream extent of proposed widening along the creek identify potential constraints (i.e., property boundary, infrastructure, etc.) 	<ul style="list-style-type: none"> used HEC-RAS model to assess various channel and floodplain widths (widths varied from 60 to 200 m wide and 3H:1V valley slope to tie into existing ground) <ol style="list-style-type: none"> widening downstream of Dundas Street to minimize limits of construction and focus on mitigating backwater and high tailwater at bridge caused by pinch points in downstream channel widening upstream of Dundas Street with the optimal downstream improvements implemented 	<ul style="list-style-type: none"> widening downstream of Dundas Street only does not mitigate flooding in SPA on its own widening upstream and downstream of Dundas Street bridge does not mitigate flooding in SPA on its own an average floodplain width of 100 m throughout the entire project reach would be required to mitigate the SPA through channel widening alone and cannot be achieved without property acquisition (at least five lots including the existing golf course and residential properties, and potential easements on five additional lots) additional investigation is required in the established natural area to determine the significance of natural heritage and archaeological potential
2	Channel and Floodplain Lowering	<ul style="list-style-type: none"> review bathymetry and infrastructure in channel corridor to see if feasible determine channel depth limits determine upstream and downstream extent of proposed lowering along the creek 	<ul style="list-style-type: none"> used HEC-RAS model to assess various channel lowering scenarios <ol style="list-style-type: none"> lower channel (1 to 2 m to tie into existing ground) downstream of Dundas Street only lower channel (1 to 2 m to tie into existing ground) upstream of Dundas Street with the downstream improvements implemented 	<ul style="list-style-type: none"> lowering downstream of Dundas Street only does not mitigate flooding in SPA on its own lowering upstream and downstream of Dundas Street does not mitigate flooding in SPA on its own valley cannot be steepened further (beyond 2H:1V) to achieve the depth required to mitigate flooding without creating a safety hazard with an over-channelized corridor significant number of sanitary crossings (two between Bloor Street and Dundas Street and nine between Dundas Street and the CP rail) would result in high costs of removal/relocation)
3	Floodplain Improvement; Combination of Widening and Lowering	<ul style="list-style-type: none"> determine design for better-connected floodplain review spatial constraints and available lands adjacent to Etobicoke Creek 	<ul style="list-style-type: none"> considered floodplain improvement area (low flow channel for 2-year, floodplain shelf, and then grade at 3H:1V side slopes to tie into existing ground) <ol style="list-style-type: none"> used HEC-RAS to assess floodplain improvements downstream of Dundas Street used HEC-RAS to assess floodplain improvements upstream and downstream of Dundas Street 	<ul style="list-style-type: none"> floodplain improvements downstream of Dundas Street only does not mitigate flooding in SPA on its own but reduces flooding at properties directly along Dundas Street floodplain improvements upstream and downstream are technically feasible; however, they would require significant construction costs and infrastructure costs for potential relocation and/or accommodation of six sanitary sewer crossings, property acquisition of at least five lots (including the existing golf course and residential properties), potential easements, and a widened Dundas Street bridge (approximately 75 m) to suit the widened valley additional investigation is required in the established natural area to determine the significance of natural heritage and archaeological potential
4	Bridge Replacement	<ul style="list-style-type: none"> determine hydraulic influence of Dundas Street bridge (i.e., backwater impacts) determine hydraulic influence of CP rail 	<ul style="list-style-type: none"> ran HEC-RAS model without the Dundas Street bridge to determine that there is little to no backwater impact caused by bridge under the Regional Flood the HEC-RAS model demonstrates that the CP rail deck is well over the Regional flood water level (6 m) 	<ul style="list-style-type: none"> widening Dundas Street bridge does not mitigate flooding in SPA on its own because the bridge is not the existing driver of backwater that causes flooding in the SPA Dundas Street bridge replacement would have to be combined with floodplain improvements and sized to span the Regional event for the selected widening scenario no changes are required for the CP rail as it does not have hydraulic influence at the SPA lands

Solution No.	Flood Mitigation Approach	Screening Approach	Screening Hydraulic Analysis	Screening Outcome
Flood Containment				
5	Flood Protection Landform	<ul style="list-style-type: none"> determine the size and location of FPL identify property acquisition requirements if any 	<ul style="list-style-type: none"> used HEC-RAS model to determine location of flooding over the channel banks into SPA to inform FPL location sized an FPL to contain flooding based on TRCA's guidelines for the Don River project in the City of Toronto (MNR 2002) 	<ul style="list-style-type: none"> not feasible due to significant footprint requirements (covering 12 lots or roughly a quarter of the current SPA) additional investigation is required in the established natural area to determine the significance of natural heritage and archaeological potential may not be accepted as a permanent solution and therefore not guaranteed to mitigate flooding within the SPA (accepted once in the City of Toronto) an FPL on either side of Dundas Street with a varying height up to 3.5 m and covering approximately 12 lots (over a quarter of the current SPA) would be required along with roughly 1 km of conveyance improvements
6	Floodwall/Berm/Dyke	<ul style="list-style-type: none"> determine size and location of floodwall/berm/dyke 	<ul style="list-style-type: none"> used HEC-RAS model to determine location of flooding over the channel banks to inform floodwall/berm/dyke location determined appropriate height of floodwall/berm/dyke 	<ul style="list-style-type: none"> not a permanent solution by provincial standards; cannot mitigate flooding within the SPA and therefore would not meet project objectives of enabling growth within the Etobicoke-Dundas area
Diversions				
7	Local Flow Diversion	<ul style="list-style-type: none"> determine pathway and size of infrastructure for local flow diversion 	<ul style="list-style-type: none"> used the HEC-RAS model to determine primary location of flooding into SPA (i.e., optimal location of diversion) used Visual OTTHYMO model to determine amount of flow to divert (450 m³/second), then estimated the required size of flow diversion conduit/tunnel 	<ul style="list-style-type: none"> not feasible on its own due to significant land and pipe size requirements diversion would require an approximately 4 m × 40 m × 850 m long conduit to divert flow between (just upstream of cross-section 13.021 through the current SPA and back into Etobicoke Creek at cross-section 3.08)
Storage				
8	Regional Flood Control	<ul style="list-style-type: none"> identify storage requirements to mitigate flooding 	<ul style="list-style-type: none"> used Visual OTTHYMO model to confirm storage volume required (approximately 12.6 million cubic metres) to reduce Regional storm peak flow and mitigate flooding throughout the SPA 	<ul style="list-style-type: none"> not feasible on its own due to significant storage volume requirements not a permanent solution by provincial standards; cannot mitigate flooding within the SPA and therefore would not meet project objectives of enabling growth within the Etobicoke-Dundas area
Policy Measures				
9	SPA Boundary and Policy Adjustments	<ul style="list-style-type: none"> review SPA policies to confirm acceptable development within current land uses identify low- and medium-risk areas that have development potential update SPA boundary using results of revised HEC-RAS modelling discussed in this report (only if policy changes are warranted and pursued) 	<ul style="list-style-type: none"> existing condition HEC-RAS model was refined to better understand current floodplain extents and identify areas of high, medium, and low flood risk 	<ul style="list-style-type: none"> refined HEC-RAS model results indicate 18 land parcels within the existing SPA that contain areas of low and medium risk flooding that may permit development under existing conditions (i.e., with no mitigation implemented) additional modelling will be needed once development potential is reviewed to confirm whether applying fill in low- and medium-risk areas will alter floodplain extents
10	Improved Flood Resilient Buildings	<ul style="list-style-type: none"> confirm the number of properties in flood risk zones that will require flood proofing 	<ul style="list-style-type: none"> Regulatory mapping indicates approximately 40 properties are in the existing flood risk zones 	<ul style="list-style-type: none"> not a permanent solution by provincial standards; cannot mitigate flooding within the SPA and therefore would not meet project objectives of enabling growth within the Etobicoke-Dundas area approximately 40 buildings (spanning over 20 lots; mostly commercial/industrial) require floodproofing and/or flood hazard education
11	Land Acquisition	<ul style="list-style-type: none"> confirm the number of properties in flood risk zones possibly use in conjunction with other options 	<ul style="list-style-type: none"> Regulatory mapping indicates approximately 40 properties are in the existing flood risk zones 	<ul style="list-style-type: none"> not a permanent solution by provincial standards; cannot mitigate flooding within the SPA and therefore would not meet project objectives of enabling growth within the Etobicoke-Dundas area approximately 40 buildings (spanning over 20 lots; mostly commercial/industrial) would need to be acquired

SPA – Special Policy Area
FPL - Flood Protection Landform
CP - Canadian Pacific Railway
TRCA - Toronto and Region Conservation Authority

5.1 Conveyance Improvements

Channel conveyance improvements seek to mitigate flooding by lowering water levels with an increased channel or floodplain capacity or a combination of both. To mitigate flooding within the SPA, the river and valley would need to convey the Regional storm peak flow. The existing Dundas Street bridge has been determined in this study to not be the primary driver of existing flooding within the SPA. To evaluate conveyance improvements on their own, the bridge was removed from the model for the purpose of assessing the impact of the floodplain widening, channel and floodplain lowering, and combined floodplain improvement alternatives. Corresponding bridge characteristics required to accommodate various channel conveyance improvements are integrated into each of the conveyance options discussed.

5.1.1 Floodplain Widening

Matrix used the updated model to review widening possibilities that may contain the Regional storm. To start, widening the floodplain with consideration for property restrictions was modelled from upstream of the CP rail to downstream of Dundas Street (between cross-section 3.055 and 3.12) to release the primary hydraulic pinch point. The widening was completed from the top of the existing channel bank to the property limits at side slopes of 3H:1V for the widened floodplain. The low flow channel was maintained as is in the existing model. The resulting valley top widths vary between 60 m and 100 m along the widened reach; however, this was insufficient to mitigate flooding in the SPA.

Accordingly, another approach which was not constrained by property limits was completed. The limits of widening (using the same side slopes) were also expanded upstream of Dundas Street bridge to cross-section 13.03 to widths between 120 m and 200 m (including the existing private golf course) but were not sufficient to mitigate flooding within the SPA.

The above analyses indicate that the effectiveness of floodplain widening on its own would require property taking to provide a floodplain and valley large enough to contain Regional flows and mitigate flooding in the SPA. An average floodplain width of 100 m throughout the entire project reach between Bloor Street to the CP rail would be required to mitigate the SPA through channel widening alone. To accomplish this, many of the properties within the SPA would need to be acquired, and the infrastructure crossing parallel to or abutting the creek may need to be relocated. Due to the extensive work required and impracticality of extensive property acquisition, this option was screened out on its own.

5.1.2 Channel and Floodplain Lowering

The updated model was used to assess potential impacts and benefits of lowering the channel and floodplain to increase conveyance capacity. As with the widening approach, channel lowering was first pursued downstream of Dundas Street, with the invert and floodplain elevations lowered up to 2 m. Lowering the channel (while maintaining top width) was insufficient to clear flooding within the SPA. The limits of lowering were then extended upstream of Dundas Street (to cross-section 13.03) with

channel and floodplain depths again increased up to 2 m to tie into the existing upstream profile. The extended lowering was insufficient to clear flooding in the SPA. At the hydraulic pinch points, Etobicoke Creek acts as a confined valley (i.e., a gully) with existing steep slopes at the urban boundary; the valley cannot be steepened beyond 3H:1V to achieve the depth required to mitigate flooding without incurring significant property impacts. Therefore, this approach on its own was screened out from further review.

5.1.3 Floodplain Improvement – Combination of Widening and Lowering

Matrix explored the option of combining widening and lowering to create an improved floodplain with better connectivity between the low flow channel and valley. Using this approach provides a low flow channel containing the 2-year storm and a widened upper bench connecting to the existing floodplain (Figure 7). As with the floodplain widening approach, the valley grading assumes 3H:1V side slopes. Of the screening approaches, this channel and floodplain configuration provides the greatest flexibility for future changes in channel configuration, land use, and climate (i.e., potential flow increases).

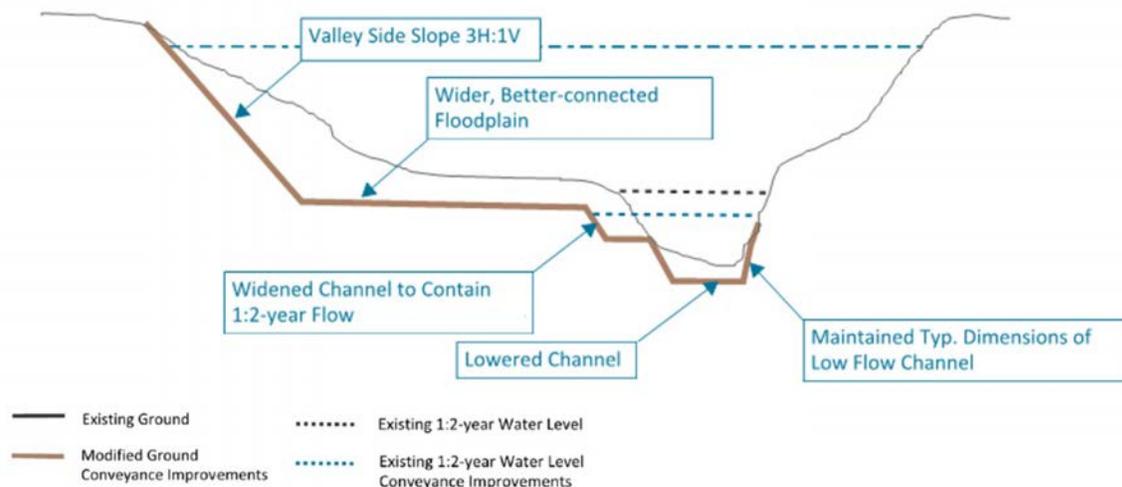


FIGURE 7 Floodplain Schematic

The floodplain improvement option was explored in further detail as follows:

- **Approach No. 1 – Channel Conveyance to Maximize Flood Improvement**
 - ✦ The concept of this approach is to create a better-connected floodplain, including channel and valley widening and lowering, from approximately 1,400 m upstream of Dundas Street to 900 m downstream.
- **Approach No. 2 – Channel Conveyance for a Partial SPA Adjustment**
 - ✦ This approach would involve the same floodplain concept as Approach No. 1, however, is focused on the downstream reach only, from Dundas Street to approximately 900 m downstream to release a hydraulic pinch point in the channel.

Approach No. 1, with floodplain works extending upstream and downstream of Dundas Street, with works restricted to/considering no property acquisition, was insufficient to completely eliminate flooding in the SPA. Accordingly, Matrix considered property acquisition for areas along the channel demonstrating hydraulic constrictions, which improved flooding within the SPA significantly and allowed removal of all flooding within. To maximize flood mitigation efforts within the SPA, property acquisition would be required for the private golf course (with potential to keep its current function), two residential buildings, and three industrial/commercial lots (Figure 8). Additional easement requirements (for both Mississauga and Toronto) may be required for properties that extend into the proposed channel improvements areas. Infrastructure would need to be relocated, and the Dundas Street bridge would need to be configured (span increased to approximately 75 m) and integrated to suit a wider channel. A thorough investigation of the valleylands would have to be conducted in a future EA for natural heritage and archaeological potential, as there is anticipated to be significant impacts on the established natural areas.

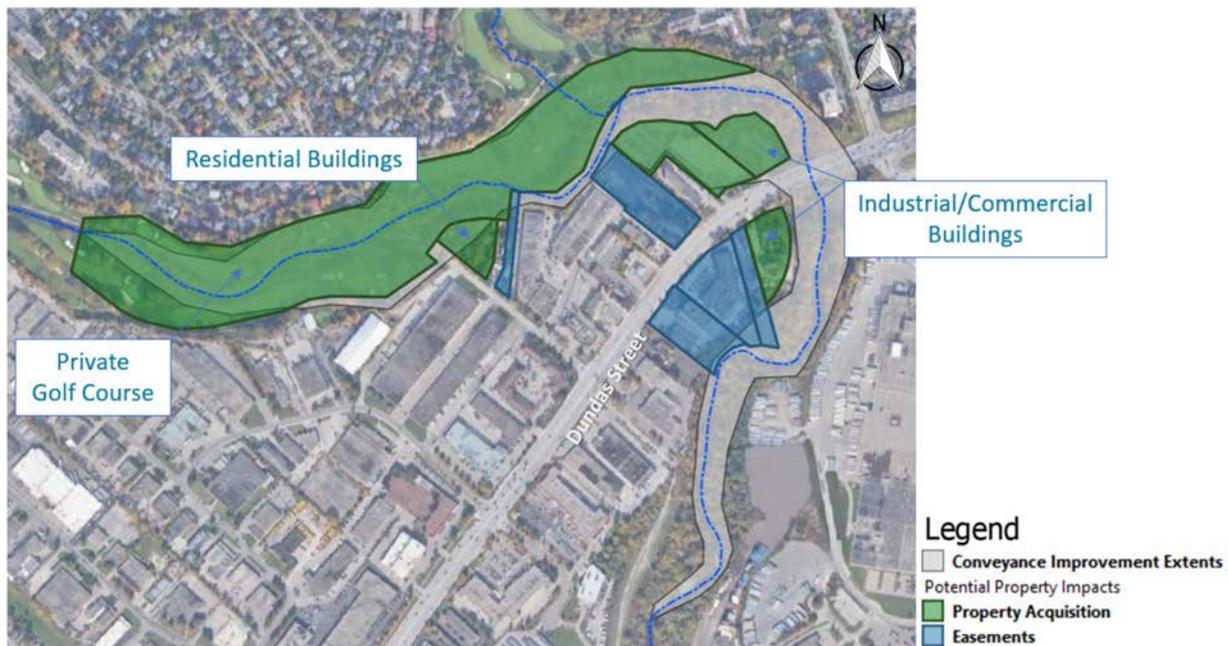


FIGURE 8 Floodplain Improvement Extents and Property Acquisition – Approach No. 1

Approach No. 2, with floodplain works applied to the hydraulic pinch point downstream of Dundas Street, does not eliminate flooding within the SPA because it does not address the upstream hydraulic restriction discussed in Section 4.2. However, Approach No. 2 is able to reduce flooding on properties directly along Dundas Street and thus, may provide an opportunity to meet project objectives. This approach requires fewer property acquisitions and a much smaller construction footprint compared to Approach No. 1 (refer to Figure 9) and is therefore more favourable from a cost and disturbance perspective. By reducing flooding to properties fronting on Dundas Street, Approach No. 2 creates a potential opportunity to modify SPA boundaries as well as policies to permit development of properties with low and medium risk flooding. The resulting risk map for Approach No. 2 is shown in Figure 10.

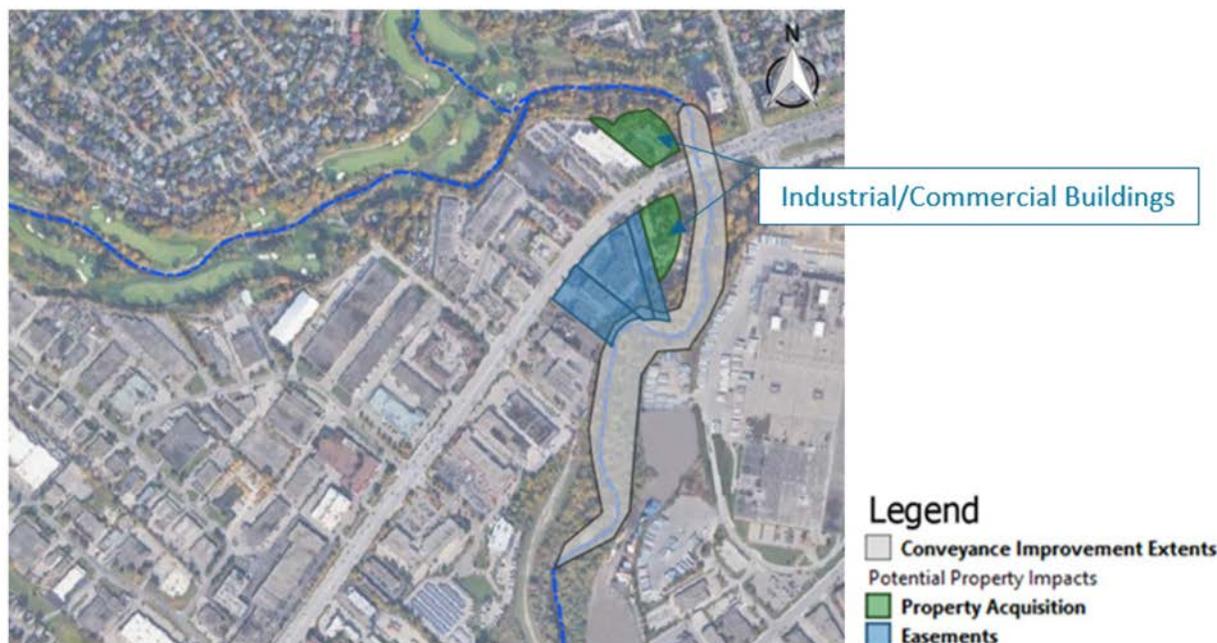


FIGURE 9 Floodplain Improvement Extents and Property Acquisition – Approach No. 2

The floodplain improvement approaches described above have been considered alongside existing conditions (i.e., Approach No. 3; the “do nothing approach”) to compare the resulting flood risk and identify property parcels that have the potential for development. Potentially developable parcels shown on Figure 10 include those with dry areas as well as areas of low and medium flood risks. For the purpose of these figures, a parcel was considered potentially developable if there was a sufficient portion that is flood-free or subject to low or medium risk flooding only.

Under existing conditions using the refined model results, there is 20.8 ha of flooding, of which 13.8 ha is high risk, 3.7 ha is medium risk, and 3.3 ha is low risk; there are 18 parcels that were identified as potentially developable. Approach No. 1 provides a significant reduction in high-risk flooding (75% reduction) leaving a total of 9.5 ha of flooding, of which 3.8 ha is high risk, 2.5 ha is medium risk, and 3.3 ha is low risk. There are 22 potentially developable properties identified under Approach No. 1; properties on Universal Drive, Southcreek Road, and along the south side of Dundas Street have been substantially cleared of flooding. Approach No. 2 provides a lesser benefit to flood risk (20% reduction in high-risk area) but reduces flooding on key properties along Dundas Street; 19 parcels were identified as potentially developable. Approach No. 2 has a total floodplain area of 15.3 ha of which 11 ha is high risk, 2.0 ha is medium risk, and 2.3 ha is low risk.



FIGURE 10 Comparison of Regional Storm Flood Risk – Existing, Approach No.1, and Approach No. 2

5.1.4 Bridge Replacement

Matrix evaluated the hydraulic impact of the Dundas Street bridge (Section 4.2). The existing Dundas Street bridge is within a backwater area and, therefore, removing it from the model, equivocally maximizing its size so there is no potential for hydraulic impact, demonstrated little to no improvements. Therefore, the replacement of Dundas Street bridge alone would not suffice to mitigate flooding within the SPA.

The Dundas Street bridge could be designed to span the entire valley associated with flood mitigation approaches being investigated, such as the 120 m valley proposed by the floodplain improvement alternative. However, in recognition of the significantly high costs associated with the large span that would be required, Matrix also evaluated the performance of the existing bridge (50 m span) within the two floodplain improvement approaches presented in Section 5.1.3. With floodplain improvements in place, the Dundas Street bridge would no longer be in an area of backwater and would then become somewhat of a hydraulic restriction. However, the practicality of replacing the bridge with a larger span must be considered in the larger context of a comprehensive flood mitigation solution, as discussed further in this section.

Approach No. 1 is hydraulically feasible; that is, implementing floodplain improvements upstream and downstream of Dundas Street as described in Section 5.1.3 has potential to fully mitigate flooding in the SPA by removing the two restrictions in the valley (refer to Section 4.2). However, realizing the full benefits of Approach No. 1 would require a larger bridge span at the Dundas Street crossing to address the additional hydraulic restriction that is created by the bridge after removing the pinch point in the downstream channel capacity. Approach No. 1 would also require a significant cost due to the large construction footprint, infrastructure relocations, and five property takings including the private golf course. Coordination with the private golf course owner has potential to create long-term delays, in addition to delays for coordination between the Cities of Mississauga and Toronto (since the creek serves as the municipal boundary). Approach No. 1 is therefore not preferred.

Under Approach No. 2, the downstream floodplain improvements releases the primary hydraulic restriction in the system and the Dundas Street bridge itself therefore becomes somewhat of a restriction. However, as presented in Section 4.2, there is an additional restriction in the channel valley further upstream of the bridge that contributes to flooding within the SPA. Modelling results indicate that expanding the bridge reduces water elevations somewhat but these benefits are not sufficient to mitigate flooding in the SPA; spill from the channel will still occur upstream. Based on these hydraulic results, increasing the bridge span is not recommended.

Further assessment of bridge replacement details are required for the purpose of the BRT bridge replacement. Proceeding with a bridge replacement as part of the BRT project that maintains the existing bridge span and overall general configuration is acceptable and is recommended. However, it should be noted that construction of a replacement with the existing span size for the bridge will limit future flood mitigation options; specifically, it will preclude Approach No. 1 from being possible in the future. Given

the high costs, potential for long-term delays, etc. as presented above, it is unlikely that Approach No. 1 would be favourable.

In summary, Matrix recommends that if the bridge is to be replaced to facilitate the BRT, the following design options should be considered:

- Maintain existing bridge span or increase span slightly if relatively little extra cost is incurred.
- Install bridge footings such that they can accommodate potential future lowering of the channel invert by approximately 1 m.
- Evaluate raising the height of the bridge low chord / top of road elevation compared to the existing bridge to minimize the depth of overtopping on Dundas Street, west of the bridge.

5.2 Flood Containment

Flood containment aims to restrict flooding away from the site of interest using a barrier such as floodwalls, berms/dykes, and flood protection landforms (FPLs). Under the current MNRF (2002) policy, most flood barriers are assumed to fail under Regulatory flow conditions. Therefore, they are not considered permanent flood protection measures and cannot be used to reduce the SPA.

An FPL is an earthen structure that incorporates design features to protect against structural failure due to water seepage and erosion. TRCA is currently developing guidelines for the siting and structural design components for FPLs in order for the MNRF to recognize these structures as providing permanent flood protection. The use of an FPL has been accepted as a permanent flood containment measure on the Don River in Toronto. The key design features that improve the structural integrity of FPLs include:

- a clay core with an elevation 0.5 m above the Regional storm elevation
- a wide crest width ranging from 3 to 5 m
- maximum 5% to 10% slopes on the wet side
- shallow slopes of 1.5% to 2.5% on the dry side
- no hydraulic connection through the FPL
- no structures or foundations within the FPL

Matrix estimated that an FPL with a varying height up to 3.5 m and covering approximately 12 lots (over a quarter of the current SPA; Figure 11) is required. The FPL would also have to include roughly 1 km of conveyance improvements (between cross-sections 13.01 and 3.10), and replacement of the Dundas Street bridge would be required to ensure water levels do not exceed existing conditions. Due to the extent of works and property impacts, this option has been screened out from further consideration.



FIGURE 11 Flood Protection Landform and Floodplain Improvement Extents and Property Acquisition

5.3 Diversions

Local flow diversion was considered to reduce the amount of flow topping the banks of Etobicoke Creek into the SPA, thereby reducing the extent of flooding in the SPA. Using flows from SWMHYMO, a flow diversion conduit was simulated along Summerville Court, from cross-section 13.021 to 3.08, in an opportune location to divert flow before flooding over the current SPA (Figure 12). To reduce the Regional flood extents, approximately 450 m³/s of flow will have to be diverted, which would require an 850 m long, 4 m × 40 m conduit. While this design approach may be feasible from a technical standpoint, the approach was ruled out in this current screening based on the potential for high costs, overall constructability challenges in a heavily urbanized area, and the potential for extensive infrastructure conflicts.

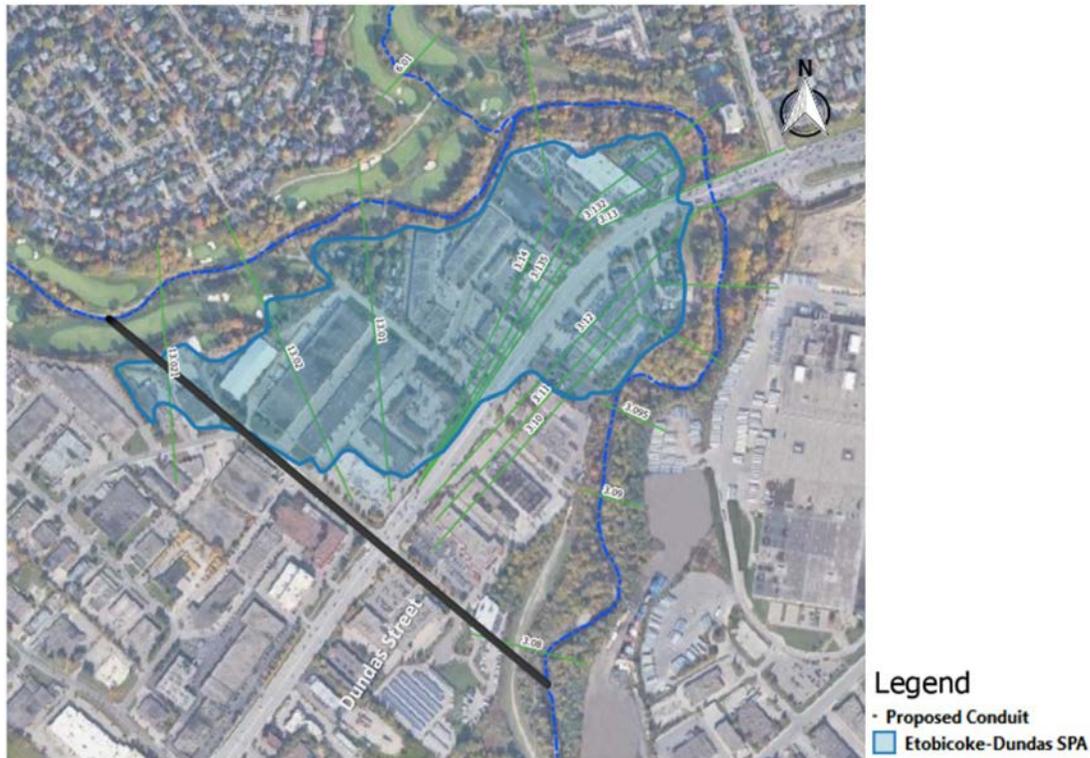


FIGURE 12 Diversion Conduit

5.4 Storage

Matrix used SWMHYMO to estimate the storage volume required to reduce the Regional event flow to the 100-year peak flow thereby preventing spill from Etobicoke Creek. The resulting storage volume is approximately 12.6 million cubic metres. Due to land availability and policy constraints, this approach is not considered feasible on its own. Regional flood control would only be considered for minor reductions in peak flows in combination with other approaches if deemed necessary to solve the spill.

5.5 Policy Measures

Policy measures for flood mitigation could include flood proofing existing buildings and land acquisition (approximately 40 buildings). These types of potential measures were considered at a high level but will not be able to achieve project objectives for flood mitigation.

Other policy measures have been considered that include potential modifications to the SPA boundary and official plan policies. The City is currently exploring options to use the updated HEC-RAS model results to refine the SPA boundary in conjunction with revising the City's Official Plan to permit development in areas of low and medium flood risk. The feasibility of this option is under review by the City with consideration for the revised flood risk assessment, calculated return on investment of potential mitigation measures, and other planning related constraints and considerations. There is a process that must be followed in order to update the SPA land use policies in the City's Official Plan, which is outlined

in the *Mississauga Special Policy Area Update - Terms of Reference* (City of Mississauga 2020). Further details of the tasks that have been reviewed as part of the current project are presented in the *Special Policy Area Review, Phase 1: Baseline Conditions Tasks, Etobicoke-Dundas and Dixie-Dundas Areas* (Matrix 2022).

6 ASSESSMENT RESULTS SUMMARY

The results of the high-level screening are summarized as follows:

- Widening the channel and floodplain alone was insufficient to mitigate flooding in the SPA and was screened out from further review.
- Lowering the channel and floodplain alone was insufficient to mitigate flooding in the SPA and was screened out from further review.
- An improved floodplain approach of combining widening and lowering has potential to significantly reduce flooding within the SPA. Details of the floodplain improvements include:
 - ✦ A low flow channel containing the 1:2-year flow, bench, and 3H:1V slope up to existing floodplain. Two approaches were considered for the extent of concurrently required floodplain improvements:
 - Approach No. 1 maximizes the level of flood mitigation by improving the floodplain from 1,400 m upstream to 900 m downstream of Dundas Street. This results in significant property acquisition requirements, including within a private golf course, two residential buildings, three industrial/commercial lots and easements on five other properties, and upsizing the Dundas Street bridge to approximately 75 m span.
 - Approach No. 2 provides a less extensive impact and cost, with floodplain improvements focused from Dundas Street to 900 m downstream. Property acquisitions would be limited to one industrial/commercial lot and easements on three other properties. Bridge upgrades are not required.
 - ✦ Increasing the Dundas Street bridge span on its own was shown to provide minimal hydraulic benefit because it is in an area of backwater. However, in combination with floodplain improvements (channel and floodplain widening and lowering), the bridge becomes somewhat of a hydraulic restriction. The following combined alternatives were considered:
 - The benefits of floodplain improvement Approach No. 1 can only be fully realized if the Dundas Street bridge is expanded to approximately 75 m span.

- With floodplain improvement Approach No. 2, expanding the Dundas Street bridge provides a minor reduction in local water levels but does not provide additional benefit to the SPA because the secondary hydraulic restriction in the system is not addressed. Under Approach No. 2, maintaining the existing bridge span is recommended.
- ✦ Designing a bridge replacement to accommodate potential future channel lowering through the bridge and/or raising the road profile should be explored in future studies (e.g., in association with the BRT) to provide flexibility to assess and/or implement future flood mitigation works.
- ✦ Infrastructure relocation would be required, most significantly sanitary sewer trunks and crossings.
- Flood containment alternatives are infeasible on their own due to policy limitations and scale of property acquisition. The construction of an FPL is feasible; however, it is not desirable nor practical due to the extent of property acquisition.
- Upstream storage is infeasible due to the volume of retention required to mitigate flooding in the SPA. Additionally, this would not be considered a permanent solution and would, therefore, be insufficient to mitigate flooding within the SPA.
- Flow diversion to Etobicoke Creek is impractical for this area and the extent of impacts indicates it should not be assessed further.
- Flood proofing and property acquisition on their own do not meet the objectives of the project and, therefore, would have to be combined with other mitigation approaches, if required.
- Policy measures including updating the SPA boundary using refined modelling results and revising the City's Official Plan to potentially permit development in areas of low and medium flood risk were considered and are being reviewed in detail by the City.

7 CONCLUSION

The goal of the hydraulic screening assessment was to identify and evaluate a long list of flood mitigation approaches to mitigate flooding within Etobicoke-Dundas SPA as much as practical. The hydraulic screening assessment has revealed that floodplain improvements consisting of a widened and lowered channel and floodplain focused downstream of Dundas Street is the most promising approach; however, it will require extensive channel works, property acquisition, and infrastructure relocation to reduce flooding within the existing SPA.

8 RECOMMENDATIONS

Matrix has also reviewed the existing Etobicoke-Dundas SPA and potential updates to the SPA policies based on the potential floodplain improvements discussed in this current report. The potential next steps to pursue this avenue is presented in the *Special Policy Area Review, Phase 1: Baseline Conditions Tasks, Etobicoke-Dundas and Dixie-Dundas Areas* (Matrix 2022).

The City should consider exploring policy options for the Etobicoke-Dundas SPA that allow for acceptably safe development in lower flood risk areas as defined by MNR guidelines.

A partial flood mitigation solution from Dundas Street to approximately 900 m downstream could provide floodplain improvements by potentially reducing risk levels throughout the area. This solution may provide an acceptable cost/benefit solution

The Dundas Street bridge has been determined to be not hydraulically sensitive; that is, increasing the bridge span does not provide significant hydraulic benefit currently, nor will it provide advantage to the feasible flood mitigation options that have been identified. Bridge replacement required otherwise to facilitate the BRT along the Dundas Street corridor should incorporate features to facilitate the more feasible floodplain improvements identified in this study. Specifically, the future bridge design should provide for future potential channel lowering and/or raising the road profile of Dundas Street. Implementing these design items would allow future flexibility to implement flood mitigation works and minimize flooding along the Dundas Street corridor.

9 REFERENCES

- AECOM Canada Ltd. (AECOM). 2019. City of Mississauga Special Policy Areas - Preliminary Flood Mitigation and Remediation Assessment, Dundas Street Transportation Master Plan. Prepared for City of Mississauga. Mississauga, Ontario. May 2019.
- Airborne Imaging. 2020. City of Mississauga LiDAR Topography. April 7, 2020.
- Aquafor Beech Limited (Aquafor Beech). 2016. Etobicoke Creek Floodplain Mapping Update. Prepared for Toronto and Region Conservation Authority. December 2016.
- City of Mississauga. 2020. Mississauga Special Policy Area Update - Terms of Reference. Originally published June 25, 2016. Reviewed by Ministry of Municipal Affairs and Housing and Ministry of Natural Resources and Forestry January 6, 2020. 2020.
- City of Mississauga et al. 2018. Dundas Connects Master Plan. City of Mississauga, AECOM, SvN, Swerhun. Mississauga, Ontario. May 24, 2018.

De Leuw, Cather & Company of Canada Limited. (De Leuw). 1967. Bridge No. 8 Dundas St. Over Etobicoke Creek Drawing Package. Drawing Nos. C-21129, C-21131 to C-21137, C-21139 to C-21142, C-21144 to C-21147, D6203-1 to D6203-22. December 1967.

IBI Group (IBI). 2021. East Trunk Sanitary Sewer Offline Storage Facility, Schedule B Class EA. Prepared for the Region of Peel. Markham, Ontario. August 26, 2021.

Matrix Solutions Inc. (Matrix). 2022. Special Policy Area Review, Phase 1: Baseline Conditions Tasks, Etobicoke-Dundas and Dixie-Dundas Areas. Version 1.0. Prepared for the City of Mississauga. Guelph, Ontario. May 2022.

MMM Group Limited (MMM). 2013. "Etobicoke Creek Hydrology Update." Draft prepared for the Toronto and Region Conservation Authority. April 2013.

Ontario Ministry of Natural Resources (MNR). 2002. Technical Guide, River & Stream Systems: Flooding Hazard Limit. Water Resources Section. <http://www.renaud.ca/public/Environmental-Regulations/MNR%20Technical%20Guide%20Flooding%20Hazard%20Limit.pdf>

The City of Mississauga (City of Mississauga). 2016. Mississauga Official Plan. Mississauga, Ontario. 2016. <http://www.mississauga.ca/portal/residents/mississaugaofficialplan>

Toronto and Region Conservation Authority (TRCA). 2017. Little Etobicoke Creek LiDAR Data Set. 2017.