LITTLE ETOBICOKE CREEK FLOOD EVALUATION STUDY
FLOOD CLUSTER AREAS AND GENERAL CAUSES OF FLOODING
PROGRESS REPORT NOS. 3 AND 4

Prepared for:
CITY OF MISSISSAUGA

Prepared by:
MATRIX SOLUTIONS INC.

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Guelph, Ontario

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LITTLE ETOBICOKE CREEK FLOOD EVALUATION STUDY

FLOOD CLUSTER AREAS AND GENERAL CAUSES OF FLOODING

PROGRESS REPORT NOS. 3 AND 4

Prepared for City of Mississauga, February 2021

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VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	28-Sept-2020	Draft	DRAFT_24603_LittleEtobicokeCr__PR#3_4_2018_09_28.docx	Issued to client for review
V1.0	27-Nov-2020	Final	24603-531 Progress Report 3_4 R 2020-11-27 final V1.0.docx	Issued to client
V2.0	26-Feb-2021	Revised Final	24603-531 Progress Report 3_4 R 2020-02-26 final V2.0.docx	Revisions issued to client

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1 INTRODUCTION

The Little Etobicoke Creek watershed in the City of Mississauga (the City) has experienced flooding and erosion concerns recorded back to at least the 1970s. The recent large flood event on July 8, 2013, which corresponded approximately to a 350-year storm (MMM 2015), resulted in many reports of flooding-related incidents and damage, particularly in the Dixie Road and Dundas Street area. The focus of this flood evaluation study is to characterize flooding within the Little Etobicoke Creek watershed, identify preliminary flood cluster areas, and develop flood remediation alternatives.

The Little Etobicoke Creek Flood Evaluation Study is being conducted in two phases as part of a final Master Plan for the City. Phase 1 was completed in January 2018 and expanded on previous studies of the overland spill from Little Etobicoke Creek, particularly focused on the Dixie-Dundas Special Policy Area, where flood flows spill from Toronto and Region Conservation Authority (TRCA) jurisdiction lands into Credit Valley Conservation jurisdiction lands. Phase 2 of the study is currently ongoing and is the subject of this report. Phase 2 of the study is focused on the Little Etobicoke Creek watershed as a whole and includes characterization of overland urban flood risk as well as development, assessment, and recommendations for flood mitigation measures. Figure 1 shows the study area, including the 2,260 ha Little Etobicoke Creek watershed.

1.1 Progress Report Purpose

This progress report characterizes flooding within Little Etobicoke Creek based on the existing condition PCSWMM model. Flood cluster areas were identified using the model results and were characterized to determine flood mechanisms and frequency of flooding. Given the size of the study area, the models were developed for use as high-level screening tools. Methods for prioritizing the cluster areas and recommendations for further assessment necessary to develop flood remediation options have also been included in this report.

A summary of background data review and the Phase 1 work is provided in Progress Report No. 1 (Matrix 2018). Details of the PCSWMM model development, validation, and flood risk results are summarized in Progress Report No. 2 (Matrix 2020).

Table 1 provides a summary list of previous progress reports and content.

TABLE 1 Summary of Progress Reports

Progress Report	Topic	Content
1	Floodplain Spill Assessment (Matrix 2018)	• background review • Phase 1 • one-dimensional modelling in MIKE URBAN
2	Modelling for Flood Characterization and Analysis (Matrix 2020)	• details of two-dimensional (2D) PCSWMM model development • 2D model validation • flood risk results
3 & 4	Flood Cluster Areas and General Causes of Flooding (current)	• flood characterization • flood cluster identification • identifying mechanisms of flooding • recommending flood clusters for further assessment

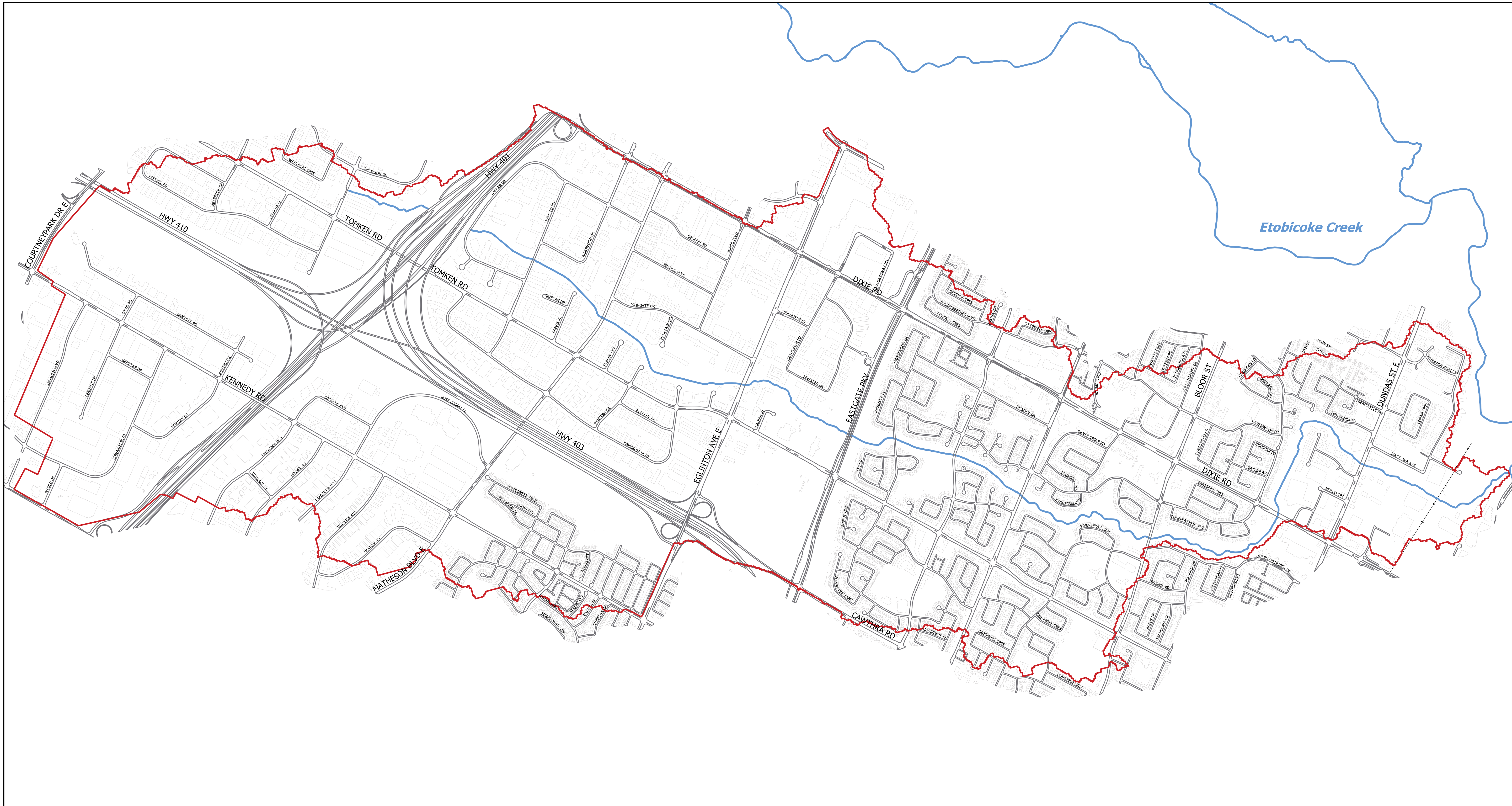

Figure Date: July 24, 2018

Little Etobicoke Catchment
Roads
Watercourse
Railway
Buildings

This drawing must be used in conjuction with the attached report, Little Etobicoke Creek Phase 2 Modelling for Flood Characterization and Analysis - Flood Evaluation Study, (July 2018) and is subject to the same limitations and conditions stated in the report.

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Little Etobicoke Creek Phase 2
Flood Evaluation Study

Project #24603

Phase 2 Study Limit

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A. MacKay
K. Hofbauer

Figure 1

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2 EXISTING CONDITION MODEL

2.1 Model Setup

Matrix prepared and validated the existing condition model during previous stages of the project. The model was developed in PCSWMM and uses an entirely two-dimensional (2D) approach due to modelling limitations associated with domain size. Some portions of a one-dimensional (1D) network are provided, as appropriate, to represent bridge and culvert crossings and to establish downstream boundary conditions.

2.2 Design Storm Runs

The validated PCSWMM 2D models (Upper Model and Lower Model) were run for the July 8, 2013 event, Regional storm event, and the following design storms:

- 100-year 4-hour Chicago event
- 50-year 4-hour Chicago event
- 25-year 4-hour Chicago event
- 10-year 4-hour Chicago event
- 5-year 4-hour Chicago event
- 2-year 4-hour Chicago event
- 100-year 4-hour Chicago event, with modified minor system capacity assumption
- 100-year 4-hour Chicago event, climate change assessment

The last two variations of the 100-year 4-hour storm event were added to the original analysis to test the sensitivity of the results. The climate change scenario tested the resiliency of the system to increasing rainfall trends. The scenario with the modified minor system capacity assumption confirmed if urban flooding would continue to occur should additional flow be conveyed by the minor system (i.e., a sensitivity assessment on the assumed minor system capacity). Further detail regarding these scenarios is presented in Progress Report No. 2 (Matrix 2020).

2.3 Determining Flood Risk

The modelled flood depth, velocity, and depth-velocity product for each storm event are provided on Sheets 1, 2, and 3, respectively, of Maps 1 through 16 for the Regional storm and design storm events (Appendix B). The flood risk mapping was provided with Progress Report No. 2 (Matrix 2020); however, the mapping is associated with the characterization and is provided again with this report for ease of reading. These results are used to identify flood mechanisms and flood cluster areas throughout the study area.

Flood risk was characterized based on depth, velocity, and the depth-velocity product. The flood risk at each grid cell in the study area was categorized as a low, medium, or high flood risk based on current Ontario Ministry of Natural Resources and Forestry practices, as per Table 2. Low risk areas are inundated, but vehicular and pedestrian ingress and egress are still feasible. Medium risk areas do not permit vehicular ingress and egress, but pedestrian ingress and egress is possible. High risk areas do not facilitate safe access of any kind. These flood risk criteria were used to develop the flood risk mapping presented as Sheet 4 in each of Maps 1 through 16 (Appendix B).

TABLE 2 Flood Risk Criteria

Parameter	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 x Velocity Product	≤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.

2.4 Flood Frequency

The frequency of flooding was considered when evaluating flooding. Tables 3 and 4 summarize the areas of low-, moderate-, and high-risk flooding simulated for each storm event in the Upper and Lower models. Note that the areas are based on the selected 2D hexagonal cells that range from 1 to 200 m^2 (average 25 m^2) and also includes the main channel of the Little Etobicoke Creek. The large areas identified as having low-risk flooding were expected, as this is representative of the intended overland drainage system function.

TABLE 3 Upper Flood Frequency Risk Assessment

Storm Event	Area of Low Risk (ha)	Area of Moderate Risk (ha)	Area of High Risk (ha)	Total Risk Area
2-year	153.4	9.9	8.6	171.9
5-year	223.4	17.1	12.9	253.4
10-year	234.5	23.4	16.2	274.1
25-year	254.3	25.6	24.0	303.9
50-year	251.4	31.8	21.1	304.3
100-year	272.7	31.1	34.2	338.0
100-year (MM)	241.4	20.5	25.6	287.4
100-year (CC)	285.8	36.2	48.2	370.2
Regional	203.1	27.0	30.0	260.1

MM - modified minor system capacity assumption
CC - climate change scenario

TABLE 4 Lower Flood Frequency Risk Assessment

Storm Event	Area of Low Risk (ha)	Area of Moderate Risk (ha)	Area of High Risk (ha)	Total Risk Area
2-year	83.8	8.3	9.5	101.6
5-year	100.3	13.1	14.3	127.7
10-year	113.5	15.6	19.8	148.9
25-year	122.6	17.2	24.4	164.2
50-year	128.8	18.8	27.8	175.4
100-year	148.8	20.3	31.1	200.2
100-year (MM)	131.3	14.0	29.4	174.9
100-year (CC)	156.8	23.2	39.0	219.0
Regional	107.8	18.2	34.7	160.7

MM - modified minor system capacity assumption
CC - climate change scenario

As anticipated, areas of low-, moderate-, and high-risk flooding increase with each storm event. In the Upper and Lower models, the majority of the high-risk areas are found in the main channel and valley corridor of Little Etobicoke Creek. In the Upper Model, additional high-risk areas are found in the stormwater management ponds and below the Highway 401 and Highway 403 overpasses (i.e., in the road sags). In the Lower Model, high-risk areas occur at low points on roads, reverse sloped driveways, and neighbourhoods adjacent to Little Etobicoke Creek.

3 FLOOD CLUSTER AREA IDENTIFICATION

Flood cluster areas were identified through flood reports, flood vulnerable areas mapping, and flood risk modelling results. Review of the data revealed a number of flood cluster areas within the Little Etobicoke Creek watershed as a result of riverine and urban flooding. The following subsections provide discussion of the flood cluster areas. Discussion of flooding mechanisms is provided in Section 4 and associated high-level potential mitigation opportunities are provided in Section 4.2.

3.1 Identify Preliminary Flood Areas

Preliminary flood areas were identified for the Little Etobicoke Creek watershed based on an overlay of the City's reported flooding for the July 8, 2013 event and the TRCA's Flood Vulnerable Areas (FVAs) mapping. Using the historical flood reports, 16 preliminary flood areas (labelled A through P) were identified, south of Highway 401. The preliminary flood areas, along with the reported flooding, FVAs, and hydraulic flood line mapping from TRCA, are provided on Figure 2.

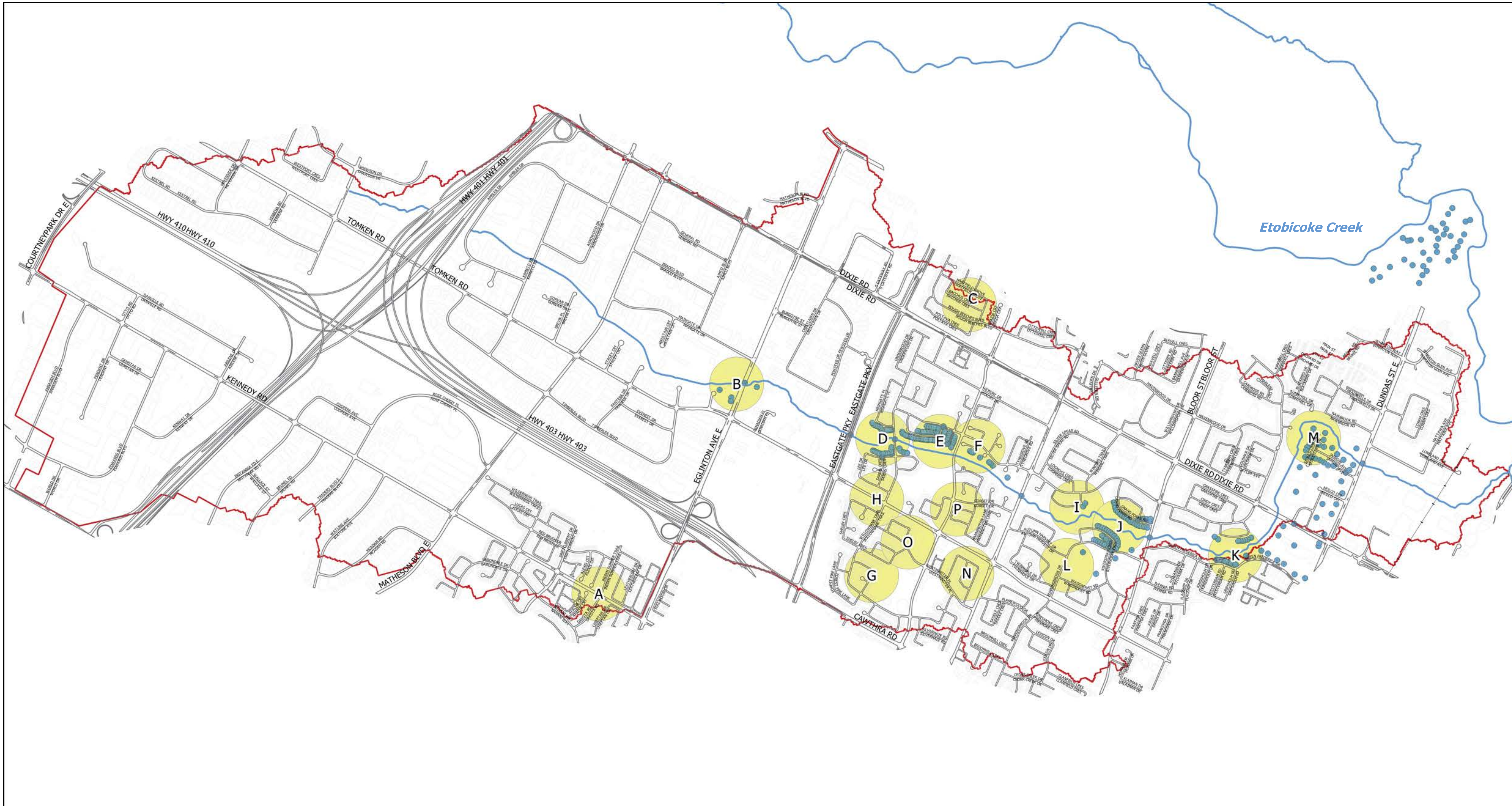

Figure Date: July 24, 2018

Legend	
Roads	Little Etobicoke Catchment
Watercourse	Flood Clusters
Railway	
Buildings	
Flood Vulnerable Sites	

This drawing must be used in conjuction with the attached report, Little Etobicoke Creek Phase 2 Modelling for Flood Characterization and Analysis - Flood Evaluation Study, (July 2018) and is subject to the same limitations and conditions stated in the report.

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Little Etobicoke Creek Phase 2
Flood Evaluation Study

Project #24603

Preliminary Flood Areas

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K. Hofbauer

Figure 2

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3.2 Identification and Verification of Flood Cluster Areas

Additional flood cluster areas in the Little Etobicoke Creek watershed were identified from the existing condition model using the flood risk criteria mapping outlined in Section 2.3. Areas were flagged where high-risk flood criteria (red on the maps; Appendix B) was found during the Regional and design storm model results.

Flood cluster areas were then selected based on the following considerations:

- flooding affected residential, commercial, or industrial lots
- flooding affected roadway or pedestrian access/egress
- flooding aligned with the July 8, 2013 flood reports and/or the FVAs
- flooding was a result of the realistic conditions and not a result of modelling limitations (discussed further in Section 3.4.1)
- flooding continued to occur with the increase minor system scenario

Using these considerations, 76 flood cluster areas were identified within the study area resulting from urban or riverine flooding. These flood clusters are shown on Figures 3 and 4 for the Upper and Lower model domains, respectively. Many of the flood clusters aligned with the documented flood reports, FVAs, and known areas of flooding. An overview of each flood cluster area is discussed further in Section 4.2.

Flood risk characterization considers depth, velocity, and depth-velocity product with the following safe access limits:

- Low Risk: Vehicular and Pedestrian Access/Egress
  Maximum Depth: 0.3 m
  Maximum Velocity: 1.7 m/s
  Maximum Depth-Velocity product: 0.37 m^2/s
- Medium Risk: Pedestrian Access/Egress Only
  Maximum Depth: 0.8 m
  Maximum Velocity: 1.7 m/s
  Maximum Depth-Velocity product: 0.37 m^2/s
- High Risk: No Safe Access/Egress
  An area is considered high risk if any of the criteria is exceeded.
  Depth > 0.8 m
  Velocity > 1.7 m/s
  Depth-Velocity product > 0.37 m^2/s

Run Date: June 5, 2018
Figure Date: September 27, 2018

Flood Clusters
Roads
TRCA Floodlines
Watercourse
Buildings
Little Etobicoke Catchment
Lower Model Area
Risk
Low
Medium
High

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Little Etobicoke Creek Phase 2
Flood Evaluation Study

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Upper Model Area - Flood Cluster Areas
100-year Event Risk Mapping

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A. MacKay
K. Hofbauer

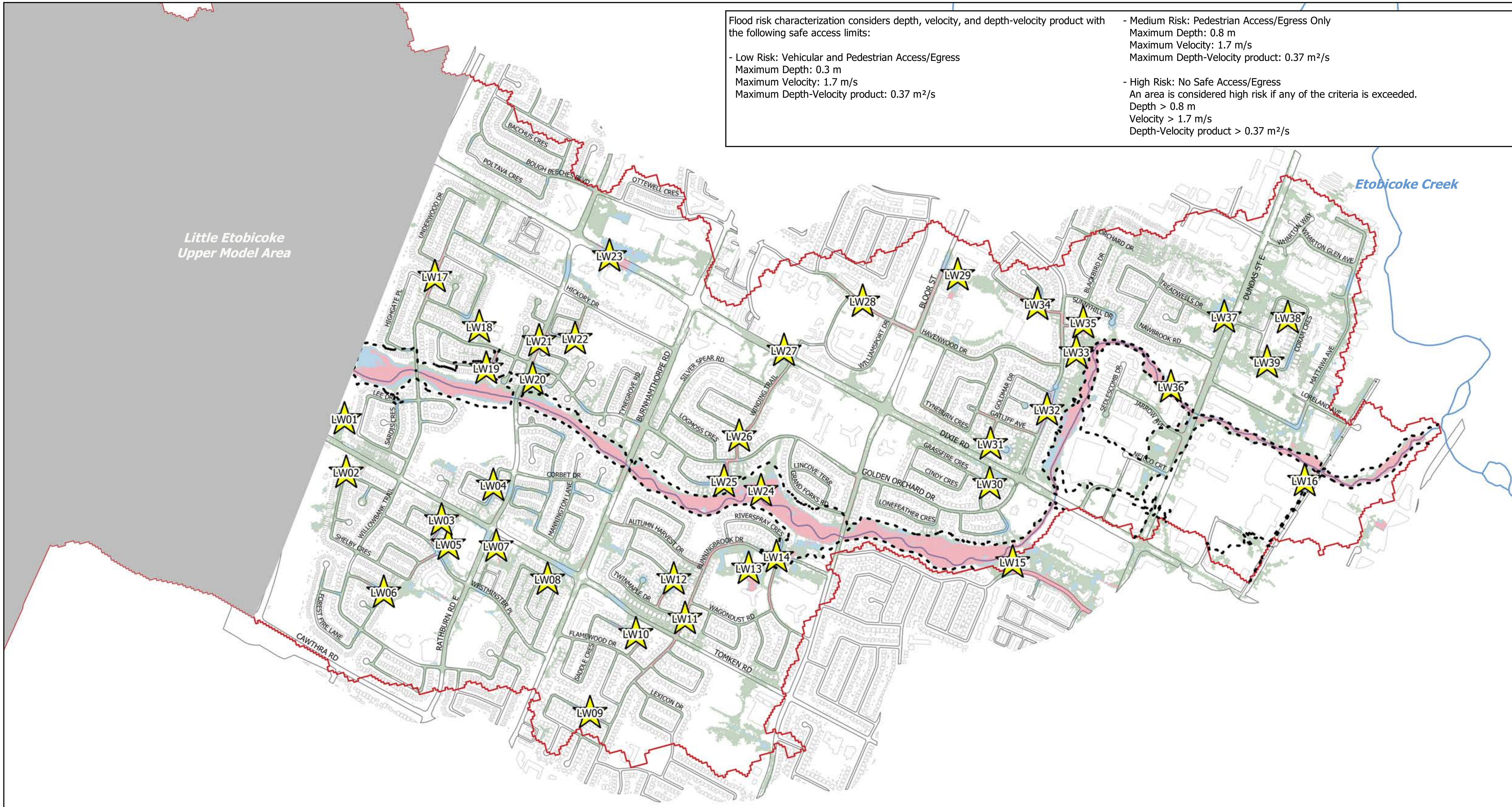
Figure 3

Flood risk characterization considers depth, velocity, and depth-velocity product with the following safe access limits:

- Low Risk: Vehicular and Pedestrian Access/Egress
  Maximum Depth: 0.3 m
  Maximum Velocity: 1.7 m/s
  Maximum Depth-Velocity product: 0.37 m^2/s

- Medium Risk: Pedestrian Access/Egress Only
  Maximum Depth: 0.8 m
  Maximum Velocity: 1.7 m/s
  Maximum Depth-Velocity product: 0.37 m^2/s

- High Risk: No Safe Access/Egress
  An area is considered high risk if any of the criteria is exceeded.
  Depth > 0.8 m
  Velocity > 1.7 m/s
  Depth-Velocity product > 0.37 m^2/s



Run Date: June 14, 2018
Figure Date: September 27, 2018

Legend	
Flood Cluster	Buildings
Railway	Little Etobicoke Catchment
Roads	Upper Model Area
TRCA Floodlines	Risk: Low
Watercourse	Risk: Medium
	Risk: High

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Little Etobicoke Creek Phase 2
Flood Evaluation Study

Project #24603

Lower Model Area - Flood Cluster Areas
100-year Event Risk Mapping

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A. MacKay
K. Hofbauer

Figure 4

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4 FLOOD MECHANISMS

4.1 General Flooding Mechanisms

Review of the flood risk mapping for the Regional and design storm events led to some general observations associated with causes of urban and riverine flooding through the Little Etobicoke Creek watershed. For example, in the Upper Model, high- and medium-risk flood areas are seen throughout the industrial development areas due to the depressions around loading bays. Other general causes of flooding include:

- major flow route deficiencies
- reversed sloped driveway locations
- properties located adjacent to the riverine system
- flow obstructions, including buildings
- undersized channel structures (culverts and bridges)
- undersized channels and floodplains
- modelling limitations (discussed further in Section 3.4.1)

These potential causes of flooding have been considered at each of the identified flood cluster areas.

4.1.1 Model Limitations

Software limitations and modelling assumptions are inevitable in model development for this type of assessment. Several limitations were identified throughout the study. These limitations may lead to flood risk being identified in areas where, in reality, flooding would not occur or be as severe. These limitations, along with the minor system capacity assumption of 19 mm/hour make the flood risk maps a conservative representation of potential surface flooding. The modified minor system capacity assumption (i.e., where the assumed capacity of the minor system was increased) worked to address this assumption and determined whether flooding would still occur if more flow was captured in the sewers and conveyed to Little Etobicoke Creek. A comparison of Maps 6 and 14 to Maps MM-6 and MM-14 for the 100-year event (Appendix B), show that flood risk does decrease in some areas; however, most identified flood clusters remain a high-risk classification.

In addition to the modified minor system capacity assumption, there are some modelling assumptions that may lead to less accurate flood risk identifications including the following:

- **Number of catch basins**: the spatial layer provided by the City representing the storm sewer system was developed for schematic purposes and does not accurately depict the exact number of catch basins in some locations (see example on Figure 5). The City's dataset also does not include the private storm sewer systems, such as those through commercial or industrial areas. Catch basins were added by Matrix in a number of locations based on aerial imagery for the catchment delineation; however, this does not represent full coverage throughout the industrial areas.

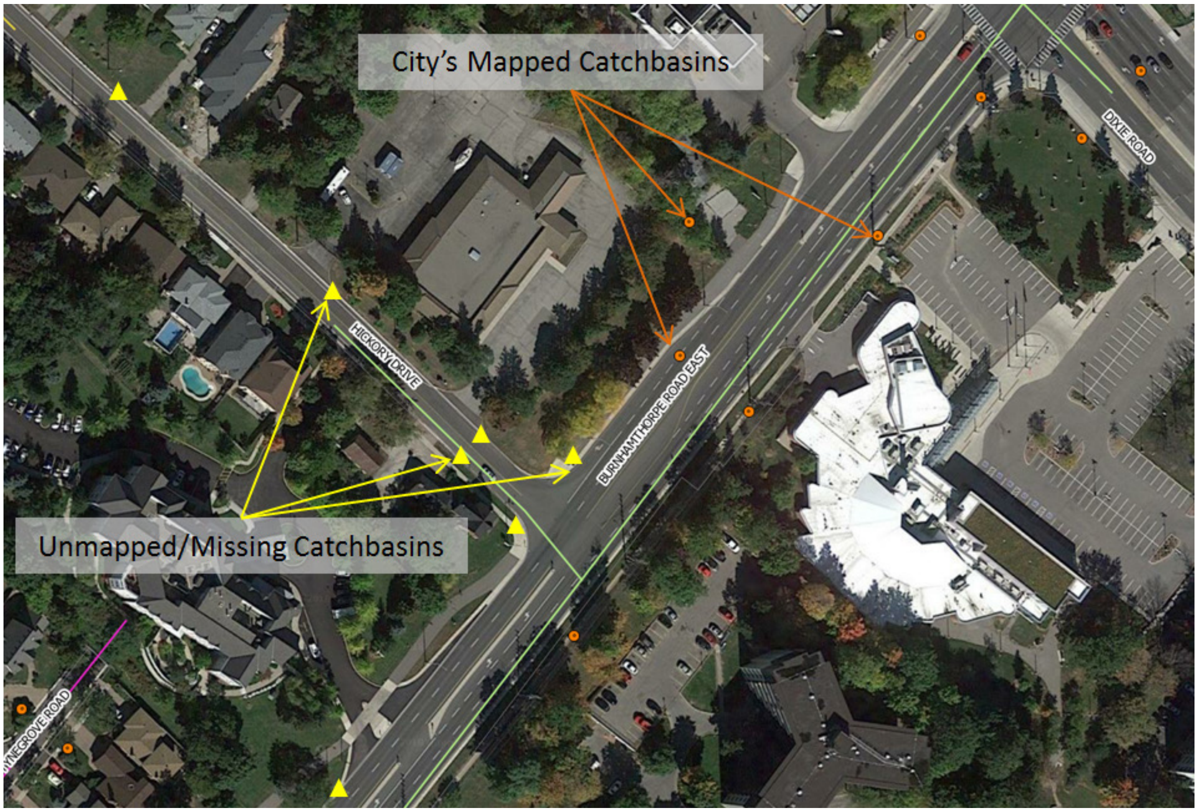

FIGURE 5 Catch Basin Locations

- **Location of catch basins**: since the spatial storm sewer layers were for schematic purposes only, the locations of catch basins along some roadways do not correspond to the low points along the curbs. As outlined in Progress Report No. 2 (Matrix 2020), catch basins were snapped to the closest road edge for the urban catchment delineation. In some areas, this led to misrepresented catch basin locations, which impacted catchment delineations. Some initial catchments only included a small amount of area (<0.01 ha) and were merged with adjacent catchments. The merging of urban catchments in some areas lead to an over representation of direct runoff to some catch basin locations.

- **Minor system capacity**: modelling assumed the minor system could convey 19 mm/hour based on an assessment of the 2-year storm event. In many areas where flood risk was identified, double catch basins were noted from the aerial imagery, which could indicate an increased ability to capture overland flows. In these areas, overland flood risk may be overestimated in the model as additional inlets are available to convey water from the surface to the storm sewers.

These model limitations were considered when selecting flood cluster areas for additional assessment.

4.1.2 Riverine and Urban Flow Interaction

The minor system and outlets were not explicitly modelled in PCSWMM (refer to Progress Report No. 2 [Matrix 2020] for modelling methods). The modelling limitations include the assumption of free outfalls at the sewer outlet because the model methodology does not allow for consideration of backwater caused by the rising creek water level during an event. This limitation is the result of not building a full 1D-2D integrated sewer model. Figure 6 demonstrates where an outfall invert is located relative to design stormwater levels in HEC-RAS. As shown, water levels overtop the outfall even during a 2-year event and prevent a free-flowing outlet to Little Etobicoke Creek.

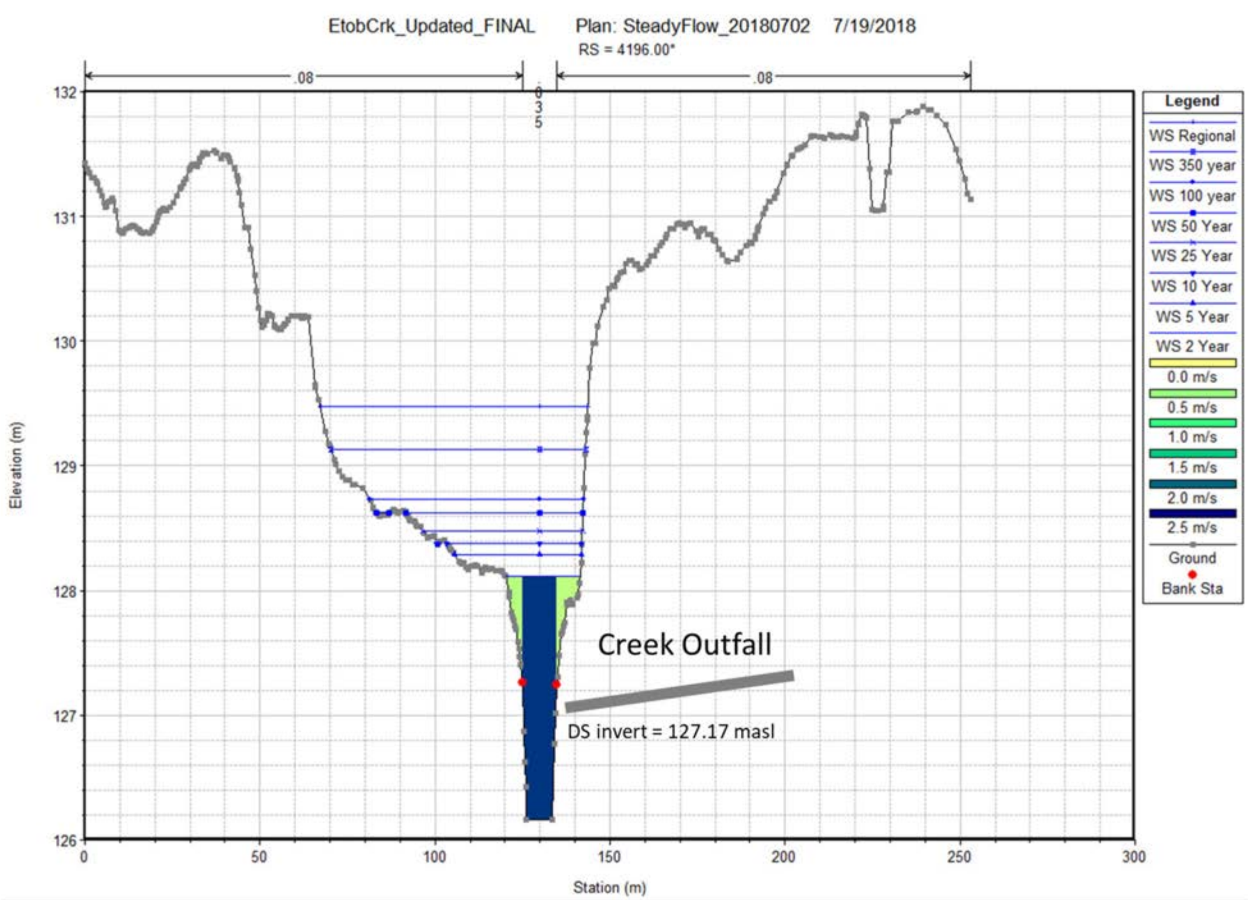

FIGURE 6 HEC-RAS Water Level Comparison to Outlet Invert - Cross Section

To understand how much flow (or to what extent the sewer system upstream of Little Etobicoke Creek) could potentially be affected by water levels in the river, a comparison of maximum water surface elevation in the PCSWMM model was compared to invert elevation of the outfall and pipes within the sewer network. Figure 7 shows the comparison in elevations using a colour ramp. The ramp was classified to change colour every 1 m. By comparing the colours in the channel to pipe invert colours, the potential extents of backwater effects are shown. For example, the highlighted Section A area of Figure 7 shows water levels at 132.1 m above sea level (asl) for the 100-year event, where the elevation of the outfall is around 129.7 m asl. The pipe invert elevations do not match or exceed the 100-year water elevation until 300 m upstream.

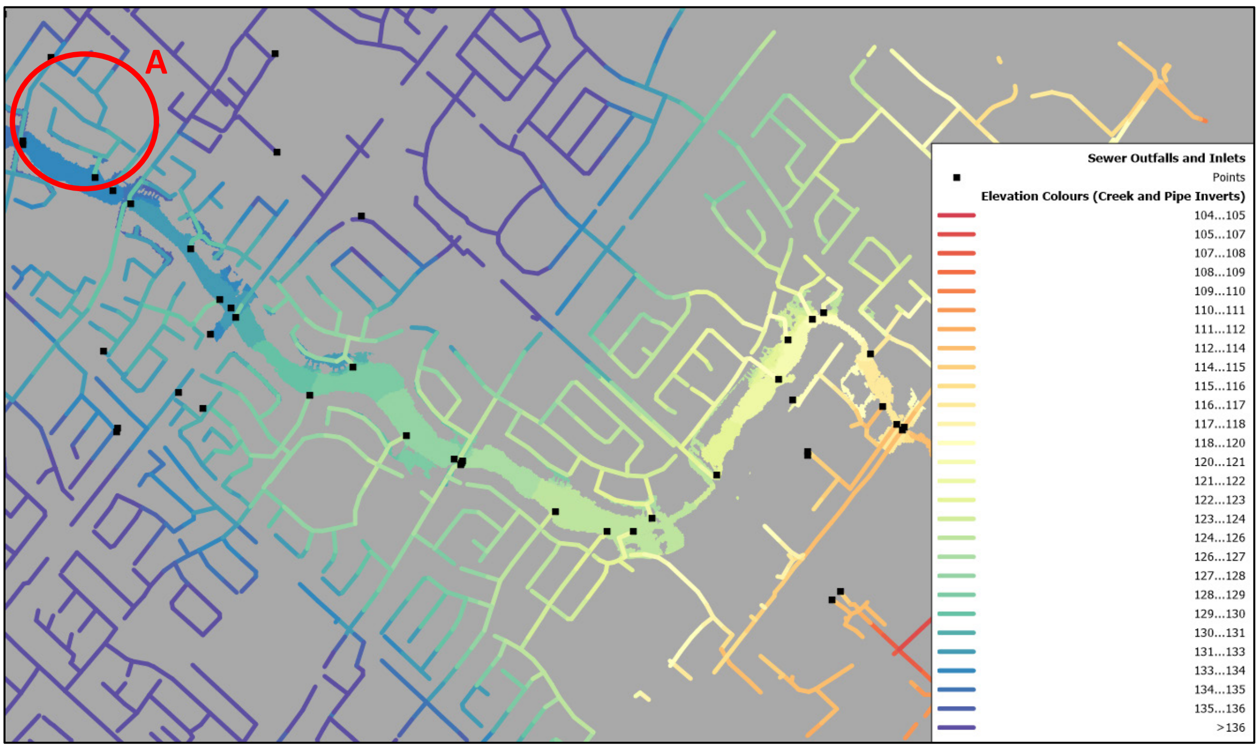

FIGURE 7 HEC-RAS Water Level Comparison to Outlet Invert - Plan View

This assessment is simply an approximation and does not account for timing variation between the pipe outflows and Little Etobicoke Creek's peak water level. However, it does provide some indication of where flows in the minor system may be impeded by water levels in the creek and reduce the anticipated sewer capacity. This limitation will be addressed during the dual drainage model setup, by creating a boundary condition on the outlet of the sewershed.

4.2 Flood Mechanisms in Primary Flood Cluster Area

Each flood cluster area shown on Figures 8 and 9 was characterized to understand the severity and causes of flooding in the area. Following the characterization, each cluster area was screened to determine whether or not the cluster required additional analysis to develop flood remediation options to satisfy the Master Plan and Schedule B Class Environmental Assessment (EA) requirements. Characterization for each cluster included:

- identifying the storm where high-risk flooding begins to occur
- defining the criteria (i.e., depth, velocity, or depth x velocity) triggering high flood risk
- determining flood mechanisms (causes of flooding)
- confirming if flooding occurs on City property (as opposed to private lands)
- checking whether urban flooding continues to occur if additional flow were conveyed by the minor system (i.e., sensitivity assessment on the assumed minor system capacity)
- determining how many buildings would be affected at each cluster or through the access/egress routes.

The findings from the characterization led to a recommended assessment approach for each flood cluster. Each cluster area fell into one of six categories:

- **Additional modelling/assessment:** requires additional modelling to understand the flooding sensitivity and assess remediation alternatives.

- **Modification to major flow route:** requires additional analysis to confirm remediation options (and ensure that the recommended modification will not cause flooding elsewhere).

- **Channel capacity:** flooding is associated with limited channel capacity. These areas are located within TRCA jurisdiction and have already been flagged through flood hazard mapping.

- **Monitor:** Matrix advises that the City not proceed to additional analysis at this time but monitor them during future flood events. This includes areas where one of the following occurs:

  - high-risk flooding is reduced with increased assumed capacity of the minor system

  - model limitations reduce the ability to accurately represent the minor or major system (thus reducing the certainty in flood severity at the given location).

- **Notification:** flooding occurs on private commercial or industrial property. The City can notify the owners, but no further action would be completed by City.

- **Separate study:** the Dixie-Dundas spill location cluster will be addressed within alternatives identified in a separate and future EA study.

The recommendations for each cluster area are shown on Figures 8 and 9. Characterization, screening, and recommendations are provided for each cluster area in Appendix A. A summary of the recommendations for the Upper and Lower models are provided in Table 5 with a summary for each model area provided in Sections 4.2.1 and 4.2.2, respectively.

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  Maximum Velocity: 1.7 m/s
  Maximum Depth-Velocity product: 0.37 m²/s

- Medium Risk: Pedestrian Access/Egress Only
  Maximum Depth: 0.8 m
  Maximum Velocity: 1.7 m/s
  Maximum Depth-Velocity product: 0.37 m²/s

- High Risk: No Safe Access/Egress
  An area is considered high risk if any of the criteria is exceeded.
  Depth > 0.8 m
  Velocity > 1.7 m/s
  Depth-Velocity product > 0.37 m²/s

Run Date: June 5, 2018
Figure Date: September 14, 2018

Flood Cluster
- Additional Modelling/Assessment
- Channel Capacity
- Modification to Major Flow Route
- Monitor
- Notification

- Roads
- TRCA Floodlines
- Watercourse
- Buildings
- Little Etobicoke Catchment

- Lower Model Area

Risk
- Low
- Medium
- High

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Little Etobicoke Creek Phase 2
Flood Evaluation Study

Project #24603

Flood Cluster Classification (Upper Model Area)
100-year Event Risk Mapping

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K. Hofbauer

Figure 8

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Flood risk characterization considers depth, velocity, and depth-velocity product with the following safe access limits:

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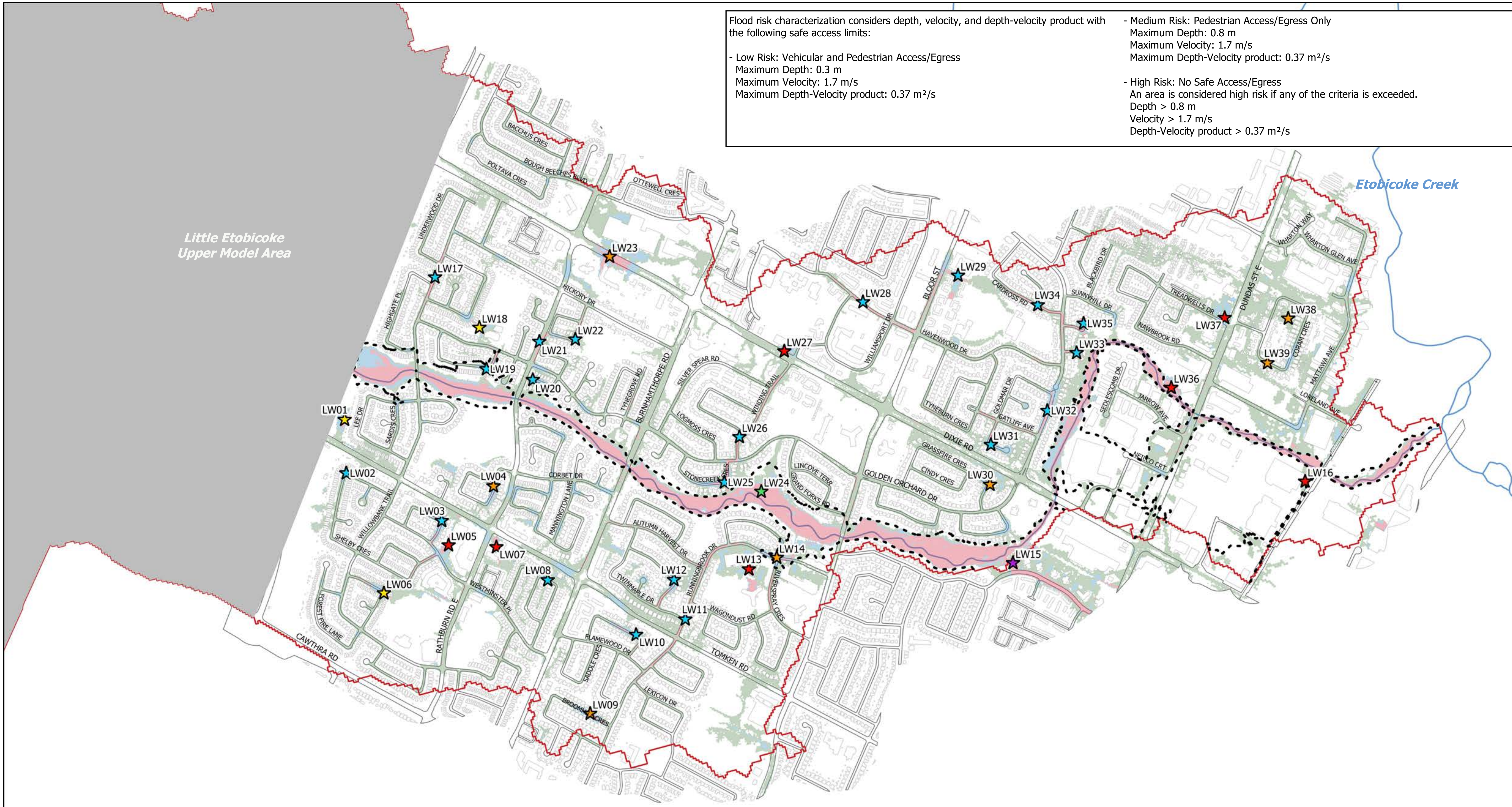

Run Date: June 14, 2018
Figure Date: September 14, 2018

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Flood Cluster
- Additional Modelling/Assessment
- Channel Capacity
- Modification to Major Flow Route
- Monitor
- Notification
- Seperate Study

- Railway
- Roads
- TRCA Floodlines
- Watercourse
- Buildings
- Little Etobicoke Catchment

- Upper Model Area

Risk
- Low
- Medium
- High

0 250 500 750 1,000 m
1:15,000

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Phase 2
Flood Evaluation Study

Project #24603

Flood Cluster Classification (Lower Model Area)
100-year Event Risk Mapping

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.

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Figure 9

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TABLE 5 Flood Cluster Classification Summary

Cluster Recommendation	Upper Model	Lower Model	Total
Additional Modelling/Assessment	1	20	21
Modification to Major Flow Route	3	3	6
Channel Capacity	2	1	3
Monitor	10	7	17
Notification	21	7	28
Separate Study	0	1	1
TOTAL	**37**	**39**	**76**

4.2.1 Upper Model Summary

In the Upper Model, the majority of flood clusters were caused by depths >0.8 m in loading bays and high velocities >1.7 m/second along the roadways. The 100-year modified minor system capacity assumption scenario reduced almost half the high-risk flood areas (17 clusters) to moderate or low risk. Given that the upper portion of the Little Etobicoke Creek watershed was developed more recently than the lower portion, it is possible that that the sewer infrastructure has increased capacity to convey larger storm event intensities. The majority of clusters in the Upper Model (22 clusters) occurred in commercial and industrial properties, where the details of private storm sewer systems are not known. These areas (with the exception of one) where marked as "notification." Monitoring was recommended to 10 areas, largely where flooding was shown to reduce through the minor system capacity sensitivity assessment or in areas that require knowledge of private sewer systems. Four locations were marked for additional analysis either though additional modelling/assessment or modification to the major flow route. Lastly, two locations were flagged as channel capacity issues (already known to TRCA based on FVAs).

The highest-priority flood clusters in the Upper Model are UP22 and UP21. Both these cluster areas show high-risk flooding during the 10-year event due to high velocities and depth x velocities. The flooding identified in UP22 affects over 50 residential houses by preventing safe egress to vehicles and pedestrians.

4.2.2 Lower Model Summary

In the Lower Model, the flood clusters were not centered on a common theme, such as the loading bays in the Upper Model. Many of the cluster areas in the Lower Model were identified as high risk due a combination of depth, velocity, and depth x velocity. Only 5 of the 39 clusters reduced from high to moderate risk through the modified minor system capacity assumption scenario. Monitoring was recommended to four of these clusters, and monitoring was also recommended to three additional areas where flood risk was already characterized as low/moderate. Notification was proposed for seven clusters, which occurred on private commercial or industrial property. The majority of areas in the Lower Model (23 clusters) require some additional analysis either through modelling or major flow route modification to determine options for flood remediation. One flood cluster was marked as a channel capacity issues, and has been flagged by TRCA as an FVA, and one cluster was marked at the Dixie-Dundas spill location and will be evaluated in a separate study.

The number of clusters in the Lower Model that require additional analysis make it difficult to prioritize clusters for additional assessment. Clusters LW11, LW26, and LW34 all affect more than 25 buildings from safe egress during a flood event. However, these clusters will need to be considered in tandem with adjacent clusters to ensure flood remediation options do not increase flooding in another area. Many flood clusters in the Lower Model have several flooding mechanisms that require the development of a dual drainage model to test the effects of different remediation options. Matrix recommends that the City review the flood clusters flagged for additional analysis and determine an approach to identify flood remediation during this study or in the future.

5 NEXT STEPS

These preliminary flood cluster areas were identified based on the flood risk characterization. A recommendation to further evaluate several cluster areas to satisfy the Master Plan and Schedule B Class EA requirements has been provided. Further review and discussion are required with the City and TRCA to determine the three areas that will be reviewed in more detail with a dual drainage model setup.

6 REFERENCES

Matrix Solutions Inc. (Matrix). 2020. *Little Etobicoke Creek Flood Evaluation Study, Modelling for Flood Characterization and Analysis, Progress Report No. 2*. Version 2.0. Prepared for City of Mississauga. Guelph, Ontario. November 2020.

Matrix Solutions Inc. (Matrix). 2018. *Progress Report #1 - Floodplain Spill Assessment, Flood Evaluation Study, Little Etobicoke Creek*. Prepared for City of Mississauga. Guelph, Ontario. January 2018.

MMM Group Limited (MMM). 2015. *Floodplain Mapping in Applewood and Dundas/Dixie Special Policy Area, Little Etobicoke Creek*. Prepared for Toronto and Region Conservation Authority, Report No. 1412606-000. Mississauga, Ontario. January 2015.

APPENDIX A
Cluster Area Classification, Screening, and Recommendations

TABLE A1 Upper Model Cluster Area Characterization, Screening, and Recommendations

Flood Cluster ID	Storm Event Causing High Risk Level	Modelled Risk Level Trigger Criteria	Type of Flooding	Flood Mechanism	High-risk Flooding Occurs with 100-year Minor System Modification (Y/N)	Flooding is within the City's Jurisdiction (Y/N)	Number of Buildings Affected	Recommended Flood Mitigation Strategy	Notes
UP01	Regional	Depth	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Overland flow path	N	N	1	Notification	
UP02	100-year	Depth x Velocity	Urban	• Loading bay • Infrastructure capacity (sewers / inlets)	N	N	2	Notification	
UP03	25-year	Velocity, Depth x Velocity	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Overland flow path	N	N	3	Notification	
UP04	25-year	Depth	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Overland flow path	Y	N*	5	Notification	*some flooding also on adjacent Edwards Boulevard
UP05	5-year	Velocity	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Lack of catch basin representation in model • Property location adjacent to stormwater conveyance system (drainage ditch)	Y	N	4	Notification	
UP06	10-year	Depth	Urban	• Loading bay • Infrastructure capacity (sewers / inlets)	Y	N	3	Notification	
UP07	10-year	Depth	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Overland flow path	N	N	2	Notification	
UP08	25-year	Depth	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Property location adjacent to stormwater conveyance system (drainage ditch)	N	N*	4	Notification	*some flooding also on adjacent Danville Road
UP09	100-year	Depth x Velocity	Urban	• Loading bay • Lack of catch basin representation in model • Overland flow path	N	N	2	Notification	
UP10	100-year Climate Change	Depth, Depth x Velocity	Urban	• Lack of catch basin representation in model • Overland flow path	N	Y	0	Monitor	
UP11	5-year	Depth, Depth x Velocity	Urban	• Loading bay • Lack of catch basin representation in model	Y	N	7	Notification	
UP12	50-year	Depth x Velocity	Urban	• Infrastructure capacity (sewers / inlets) • Lack of catch basin representation in model	N	Y	5*	Monitor	*has potential to block access/egress but other routes available
UP13	100-year	Velocity	Urban	• Lack of catch basin representation in model • High velocities on road way	N	Y	4*	Monitor	*has potential to block access/egress but other routes available
UP14	5-year	Depth	Urban	• Topographic low • Overland flow path	N	N	1	Notification	
UP15	50-year	Depth	Urban	• Loading bay • Lack of catch basin representation in model • Overland flow path	N	N	2	Notification	
UP16	5-year	Depth x Velocity	Urban	• Topographic low • Lack of double catch basin representation in model • Infrastructure capacity (sewers / inlets)	Y	Y	6*	Monitor*	*has potential to block access/egress but other routes available. Minor system not contributing to Little Etobicoke Creek
UP17	25-year	Depth	Urban	• Loading bay • Overland flow path • Lack of catch basin representation in model	N	N	1	Notification	

Flood Cluster ID	Storm Event Causing High Risk Level	Modelled Risk Level Trigger Criteria	Type of Flooding	Flood Mechanism	High-risk Flooding Occurs with 100-year Minor System Modification (Y/N)	Flooding is within the City's Jurisdiction (Y/N)	Number of Buildings Affected	Recommended Flood Mitigation Strategy	Notes
UP18	5-year	Depth x Velocity	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Lack of catch basin representation in model	Y	N	3	Notification	
UP19	5-year	Depth x Velocity	Urban	• Loading bay • Lack of catch basin representation in model • Overland flow path	Y	N*	3	Monitor	*some flooding also on adjacent Kennedy Road
UP20	10-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets)	Y	Y	2*	Modification to Major Flow Route	*some flooding from Rose Cherry Place as flow travels through to underpass
UP21	10-year	Depth, Velocity, Depth x Velocity	Urban	• Overland flow path,	Y	Y	3	Modification to Major Flow Route	
UP22	10-year	Velocity, Depth x Velocity	Urban	• High velocities on road way (1% slope) • Infrastructure capacity (sewers / inlets)	Y	Y	>50	Additional Modelling/ Assessment	
UP23	100-year	Velocity, Depth	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets) • Lack of catch basin representation in model	N	Y	7*	Monitor	*has potential to block access/egress but other routes available. Minor system not contributing to Little Etobicoke Creek
UP24	50-year	Depth	Urban	• Topographic low • Overland flow path	N	Y	1	Modification to Major Flow Route	
UP25	100-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets) • Lack of catch basin representation in model • Overland flow path	N	Y	0*	Monitor	*not likely to block access/egress. City recommended to video sewers based on flood calls
UP26	5-year	Depth	Urban	• Loading bay • Overland flow path	Y	N*	1	Notification	*some flooding also on adjacent Timberlea Boulevard
UP27	5 year	Depth	Urban	• Loading bay • Overland flow path • Lack of catch basin representation in model	Y	N*	3	Notification	*some flooding also on adjacent Pantera Drive
UP28	5-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets) • Backwater from river (potential)	N	Y	6*	Monitor	*has potential to block access/egress but other routes available
UP29	10 year	Velocity	Urban/Riverine	• Loading bay • Overland flow path	Y	N	1	Notification	
UP30	5-year	Depth	Urban	• Loading bay • Overland flow path	Y	N	2	Notification	
UP31	10-year	Depth	Urban	• Loading bay • Overland flow path • Lack of catch basin representation in model	N	N*	1	Notification	*some flooding also on adjacent Bradco Boulevard
UP32	5 year	Depth	Urban	• Loading bay • Overland flow path	Y	N	1	Notification	
UP33	50-year	Depth x Velocity	Urban	• High velocities on road way (1% slope) • Infrastructure capacity (sewers / inlets) • Overland flow path	Y	Y	10*	Monitor	*has potential to block access/egress but other routes available. Unknown storage from catchbasin and inlets of commerical area
UP34	2-year	Depth, Velocity, Depth x Velocity	Riverine	• Channel capacity limitations • Backwater Conditions	Y	Y	8	Channel Capacity	
UP35	10-year	Velocity	Urban	• High velocities on road way (1% slope) • Infrastructure capacity (sewers / inlets) • Overland flow path	Y	Y	15*	Monitor	*has potential to block access/egress but other routes available.

Flood Cluster ID	Storm Event Causing High Risk Level	Modelled Risk Level Trigger Criteria	Type of Flooding	Flood Mechanism	High-risk Flooding Occurs with 100-year Minor System Modification (Y/N)	Flooding is within the City's Jurisdiction (Y/N)	Number of Buildings Affected	Recommended Flood Mitigation Strategy	Notes
UP36	5-year	Depth	Urban	• Loading bay • Overland flow path • Lack of catch basin representation in model	Y	N	6	Notification	
UP37	2-year	Depth, Velocity, Depth x Velocity	Riverine	• Channel capacity limitations	Y	Y	0	Channel Capacity	

Notes: * see notes column

TABLE A2 Lower Model Cluster Area Characterization, Screening, and Recommendations

Flood Cluster ID	Storm Event Causing High Risk Level	Modelled Risk Level Trigger Criteria	Type of Flooding	Flood Mechanism	High-risk Flooding Occurs with 100-year Minor System Modification (Y/N)	Flooding is within the City's Jurisdiction (Y/N)	Number of Buildings Affected	Recommended Flood Mitigation Strategy	Notes / Potential Solutions
LW01	10-year	Depth, Depth x Velocity	Urban	• Topographic low (park area) • No overland flow path	N	N	0	Modification to Major Flow Route	
LW02	100-year	Depth x Velocity	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • Overland flow path • Lack of double catch basin representation in model	N	Y	1	Additional Modelling/ Assessment	**Potential Solution:** Recommendation to home owners to provide an overland flow path from the street through yards into the MTO lands. Would require a large swale.
LW03	10-year	Depth	Urban	• Topographic low • ROW conveyance capacity • Lack of double catch basin representation in model	Y	Y	20	Additional Modelling/ Assessment	
LW04	50-year	Depth x Velocity	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • Overland flow path	N	Y	15	Monitor	
LW05	5-year	Depth x Velocity	Urban	• Loading bay • Infrastructure capacity (sewers / inlets) • Lack of catch basin representation in model	Y	N*	13	Notification	*some flooding on adjacent Shelby Crescent and Westminster Place
LW06	25-year	Depth	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • Overland flow path • ROW conveyance capacity	N	Y	24	Modification to Major Flow Route	
LW07	5-year	Depth	Urban	• Topographic low • Overland flow path	Y	N	2	Notification	
LW08	100-year (moderate risk)	Depth	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • Overland flow path	Y*	Y	8	Additional Modelling/ Assessment	*moderate risk is maintained
LW09	25-year	Depth	Urban	• Topographic low (intersection) • Lack of double catch basin representation in model	N	Y	20	Monitor	
LW10	5-year	Depth x Velocity	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • Overland flow path • Lack of double catch basin representation in model (sewer pipe from the corner of road to Tomken road 825 mm)	Y*	Y	5	Additional Modelling/ Assessment	*flooding is significantly reduced with the minor system capacity increase, high risk on some portions of road remains
LW11	10-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets)	Y	Y	>50	Additional Modelling/ Assessment	**Potential Solution:** Provide an inlet a pipe connection to the existing outlet. Would alleviate some capacity issues on the Runningbrook Sewer.
LW12	5-year	Depth	Urban	• Reserved sloped driveways • Lack of double catch basin representation in model • Overland flow path	Y	Y	17	Additional Modelling/ Assessment	
LW13	10-year	Depth	Urban	• Topographic low (underground parking)	Y	N	1	Notification	
LW14	25-year	Depth x Velocity	Urban/Riverine	• Topographic low (intersection) • Infrastructure capacity (sewers / inlets) • Overland flow path	N*	Y	10	Monitor	*flooding may still occur due to proximity to the Creek **Potential Solution:** See LW11
LW15	10-year	Depth x Velocity	Riverine	• Channel capacity limitations • Dixie/Dundas spill location	Y	Y	14	Separate Study	
LW16	5-year	Velocity	Urban	• Loading bay • Overland flow path	Y	N	1	Notification	
LW17	5-year	Velocity	Urban	• High velocities on road way (1% slope) • Infrastructure capacity (sewers / inlets)	Y	Y	13*	Additional Modelling/ Assessment	*has potential to block access/egress but other routes available.

Flood Cluster ID	Storm Event Causing High Risk Level	Modelled Risk Level Trigger Criteria	Type of Flooding	Flood Mechanism	High-risk Flooding Occurs with 100-year Minor System Modification (Y/N)	Flooding is within the City's Jurisdiction (Y/N)	Number of Buildings Affected	Recommended Flood Mitigation Strategy	Notes / Potential Solutions
LW18	25-year	Depth x Velocity	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • ROW conveyance capacity	N	Y	4	Modification to Major Flow Route	
LW19	5-year	Depth x Velocity	Urban/Riverine	• Overland flow path • ROW conveyance capacity	Y	Y	14	Additional Modelling/ Assessment	
LW20	50-year	Depth x Velocity	Urban	• Topographic low (on crescent), lower than Rathburn Road, • Lack of double catch basin representation in model • Overland flow path	N*	Y	14	Additional Modelling/ Assessment	*flooding may still occur due to proximity to the Creek, flood calls received during July 8, 2013 event **Potential Solution:** See LW22
LW21	10-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets)	Y	Y	0*	Additional Modelling/ Assessment	*has potential to block access/egress but other routes available. **Potential Solution:** See LW22
LW22	10-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets) • Topographic low (Gryphon Mews) • Lack of double catch basin representation in model	Y	Y	22	Additional Modelling/ Assessment	**Potential Solution**: Golden Orchard Park area adjacent to cluster, over 3 m of depth to work with (8,000 m2 storage in the park), could potentially connect to the sewer in northwest corner, or overland.
LW23	5-year	Depth x Velocity	Urban	• Topographic low • Overland flow path • Lack of catch basin representation in model	Y*	Y	3	Monitor	*has potential to block access/egress but other routes available. Minor system not contributing to Little Etobicoke Creek
LW24	2-year	Depth, Velocity, Depth x Velocity	Riverine	• Channel capacity limitations	Y	Y	8	Channel Capacity	**Potential Solutions:** More inlets along the roadway to reduce velocities
LW25	5-year	Depth x Velocity	Urban/Riverine	• Topographic low • ROW conveyance capacity • Backwater conditions (riverine)	Y	Y	12	Additional Modelling/ Assessment	**Potential Solutions:** See LW26, also provide a curb cut to create an overland flow path.
LW26	5-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets)	Y	Y	30*	Additional Modelling/ Assessment	*has potential to block access/egress but other routes available. **Potential Solution:** Storage in Kennedy Park, inlet from Winding Trail through the easement. Direct outlet to the Creek. Potential storage in the Park: ~4,500 m2 of area, ~6000 m3. Pond can have an emergency overflow direct to the Creek.
LW27	5-year	Depth	Urban	• Topographic low • Lack of catch basin representation in model	Y	N	1	Notification	
LW28	5-year	Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets)	Y	Y	28*	Additional Modelling/ Assessment	*has potential to block access/egress but other routes available.
LW29	5-year	Depth x Velocity	Urban	• Topographic low, walled parking lot • Overland flow path	Y	Y	6	Additional Modelling/ Assessment	**Potential Solution:** Looked at Burnhamdale Park for storage, no overland or ROW to add pipe connection from Bloor Street through private driveways.
LW30	100-year	Depth x Velocity	Urban	• Topographic low • Infrastructure capacity (sewers / inlets)	N	Y	12*	Monitor	*noise wall missing from model representation, not likely to flood.
LW31	10-year	Depth x Velocity	Urban	• Double Topographic low • Spilling from Dixie Road* • Lack of double catch basin representation in model	N	Y	24	Additional Modelling/ Assessment	*noise wall missing from model representation, not likely to spill from Dixie Road.
LW32	5-year	Depth x Velocity	Urban	• Topographic low • Infrastructure capacity (sewers / inlets) • Overland flow path • Lack of double catch basin representation in model	Y	Y	24*	Additional Modelling/ Assessment	*flooding is significantly reduced with the minor system capacity increase, high risk on some portion of road remains (no overland relief, needs a pipe upgrade)
LW33	10-year	Depth x Velocity	Urban	• Overland flow path	Y	Y	7	Additional Modelling/ Assessment	**Potential Solution:** Cut down the easement on Taviton Crescent to the Creek to allow major drainage pathway.

Flood Cluster ID	Storm Event Causing High Risk Level	Modelled Risk Level Trigger Criteria	Type of Flooding	Flood Mechanism	High-risk Flooding Occurs with 100-year Minor System Modification (Y/N)	Flooding is within the City's Jurisdiction (Y/N)	Number of Buildings Affected	Recommended Flood Mitigation Strategy	Notes / Potential Solutions
LW34	5-year	Velocity, Depth x Velocity	Urban	• High velocities on road way • Infrastructure capacity (sewers / inlets)	Y	Y	28	Additional Modelling/ Assessment	
LW35	5-year	Depth x Velocity	Urban	• Reserved sloped driveways • Lack of catch basin representation in model • Overland flow path	Y	Y	11	Additional Modelling/ Assessment	**Potential Solution:** Cut down the easement on Hedgestone Crescent to the Creek to allow major drainage pathway.
LW36	10-year	Depth	Riverine	• Channel capacity limitations • Topographic low • Backwater Conditions (Dundas Street Bridge)	Y	N	1	Notification	
LW37	100-year (moderate risk)	Depth	Urban	• Topographic low (industrial development) • Infrastructure capacity (sewers / inlets) • Overland flow path	Y - moderate risk	N	3	Notification	
LW38	100-year (low risk)	Velocity, Depth x Velocity	Urban	• Sheet flow - overland throughout this industrial area • Grading could be an issue • No direct overland flow path	Y - low risk*	Y	>50	Monitor	*general flooding through this area, that is not contained within the roads, overall risk is low
LW39	100-year (moderate risk)	Depth	Urban	• Topographic low (road is the high point), spills off the road around properties and back onto road • No direct overland flow path	Y - moderate risk	Y	26	Monitor	

Notes: * see notes column

APPENDIX B
Results Maps
(see companion digital files)