FLOODPLAIN SPILL ASSESSMENT – PHASE 1A
FLOOD EVALUATION STUDY
LITTLE ETOBICOKE CREEK

Report Prepared for:
CITY OF MISSISSAUGA

Prepared by:
MATRIX SOLUTIONS INC.

Version 2.0
February 2019
Guelph, Ontario

Unit 7B, 650 Woodlawn Rd. West
Guelph, ON, Canada N1K 1B8
T 519.772.3777 F 226.314.1908
www.matrix-solutions.com

FLOODPLAIN SPILL ASSESSMENT – PHASE 1A

FLOOD EVALUATION STUDY

LITTLE ETOBICOKE CREEK

Report prepared for City of Mississauga, February 2019

Kelly Molnar, P.Eng.
Water Resources Engineer

reviewed by
Karen Hofbauer, M.A.Sc., P.Eng.
Senior Water Resources Engineer

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V1.0	25-Jan-2019	Final	24603-531 Phase 1A R 2019-01-25 final V1.0.docx	Issued to client
V2.0	21-Feb-2019	Final	24603-531 Phase 1A R 2019-02-21 final V2.0.docx	Fixed errors in risk maps (i.e. Maps X.4)

TABLE OF CONTENTS

1 INTRODUCTION 1
  1.1 Report Purpose 1
2 BACKGROUND REVIEW 3
3 MIKE FLOOD MODEL SETUP 3
  3.1 MIKE URBAN Model Development 3
    3.1.1 Urban Catchments 4
    3.1.2 Sewer Network 5
    3.1.3 Manholes and Catch Basins 6
    3.1.4 Boundary Conditions 6
      3.1.4.1 Rainfall 6
      3.1.4.2 Outfalls 6
  3.2 MIKE URBAN Coupling 6
    3.2.1 Catch Basin Inflow 7
    3.2.2 Catch Basin Surcharge 7
    3.2.3 Trunk Sewer Inlet 8
4 PHASE 1A: SPILL ASSESSMENT (DIXIE-DUNDAS) 8
  4.1 Design Storm Runs 9
  4.2 Subwatershed Spill Assessment 10
    4.2.1 CVC Hydrology Recommendations 10
  4.3 Risk Assessment 12
5 COMPARISON TO PREVIOUS MODELLING 12
  5.1 Unsteady State Simulations 12
  5.2 Steady State Simulations 14
  5.3 Summary 14
6 REFERENCES 18

LIST OF FIGURES

FIGURE 1 Study Area 2
FIGURE 2 Mississauga Watersheds Spill Assessment 11
FIGURE 3 MIKE URBAN Results – Harvest Drive Trunk Sewer 16
FIGURE 4 MIKE URBAN Results – Insley Road Trunk Sewer 17

LIST OF TABLES

TABLE 1 Urban Catchment Hydrologic Parameters 4
TABLE 2 Summary of Kinematic Wave Hydrologic Model Parameters 5
TABLE 3 Kinematic Wave Hydrologic Parameters 5
TABLE 4 Depth-Flow Curve for Trunk Sewer Inlet 8
TABLE 5 Existing Condition Model Runs 9
TABLE 6 Regional Storm Flow Balance (Unsteady State) 10
TABLE 7 Flood Risk Criteria 12
TABLE 8 Unsteady State – Comparison of Surface Flows in Phase 1A versus Phase 1 13
TABLE 9 Unsteady State – Comparison of Phase 1A versus Phase 1 Results 13
TABLE 10 Steady State – Comparison of Phase 1A versus Phase 1 Results 14

MAP SET

Map 1.1 to 1.4 Urban: 10-year, Riverine: 25-year - Steady (Depth, Velocity, Depth×Velocity, Risk)
Map 2.1 to 2.4 Urban: 10-year, Riverine: 50-year - Steady (Depth, Velocity, Depth×Velocity, Risk)
Map 3.1 to 3.4 Urban: 10-year, Riverine: 100-year - Steady (Depth, Velocity, Depth×Velocity, Risk)
Map 4.1 to 4.4 Urban: 10-year, Riverine: Regional - Steady (Depth, Velocity, Depth×Velocity, Risk)
Map 5.1 to 5.4 Urban: n/a, Riverine: 25-year - Unsteady (Depth, Velocity, Depth×Velocity, Risk)
Map 6.1 to 6.4 Urban: n/a, Riverine: 50-year - Unsteady (Depth, Velocity, Depth×Velocity, Risk)
Map 7.1 to 7.4 Urban: n/a, Riverine: 100-year - Unsteady (Depth, Velocity, Depth×Velocity, Risk)
Map 8.1 to 8.4 Urban: n/a, Riverine: Regional - Unsteady (Depth, Velocity, Depth×Velocity, Risk)

APPENDIX

Appendix A Spill Hydrographs to Applewood Creek

1 INTRODUCTION

The Little Etobicoke Creek watershed has experienced flooding and erosion concerns recorded back to at least the 1970s. The recent large flood event on July 8, 2013, which corresponded to approximately 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 in the City of Mississauga. The focus of this flood evaluation study of Little Etobicoke Creek being conducted by Matrix Solutions Inc. for the City of Mississauga is to characterize flooding and to define the extent of any spill into adjacent watersheds.

The Little Etobicoke Creek Flood Evaluation Study is being conducted in two phases. Phase 1 expands on previous studies of the overland spill from Little Etobicoke Creek and is particularly focussed on the Dixie-Dundas Special Policy Area, where flood flows spill from Toronto and Region Conservation Authority (TRCA) jurisdiction lands into Credit Valley Conservation (CVC) jurisdiction lands. The purpose of Phase 1 is to further define and characterize the extents of overland spill from Little Etobicoke Creek during major storm events. Lack of available data prevented previous studies from adequately defining this spill. Recommendations to CVC for incorporating the spill flows into their watershed are provided within this report. Phase 2 of the study is focussed 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.

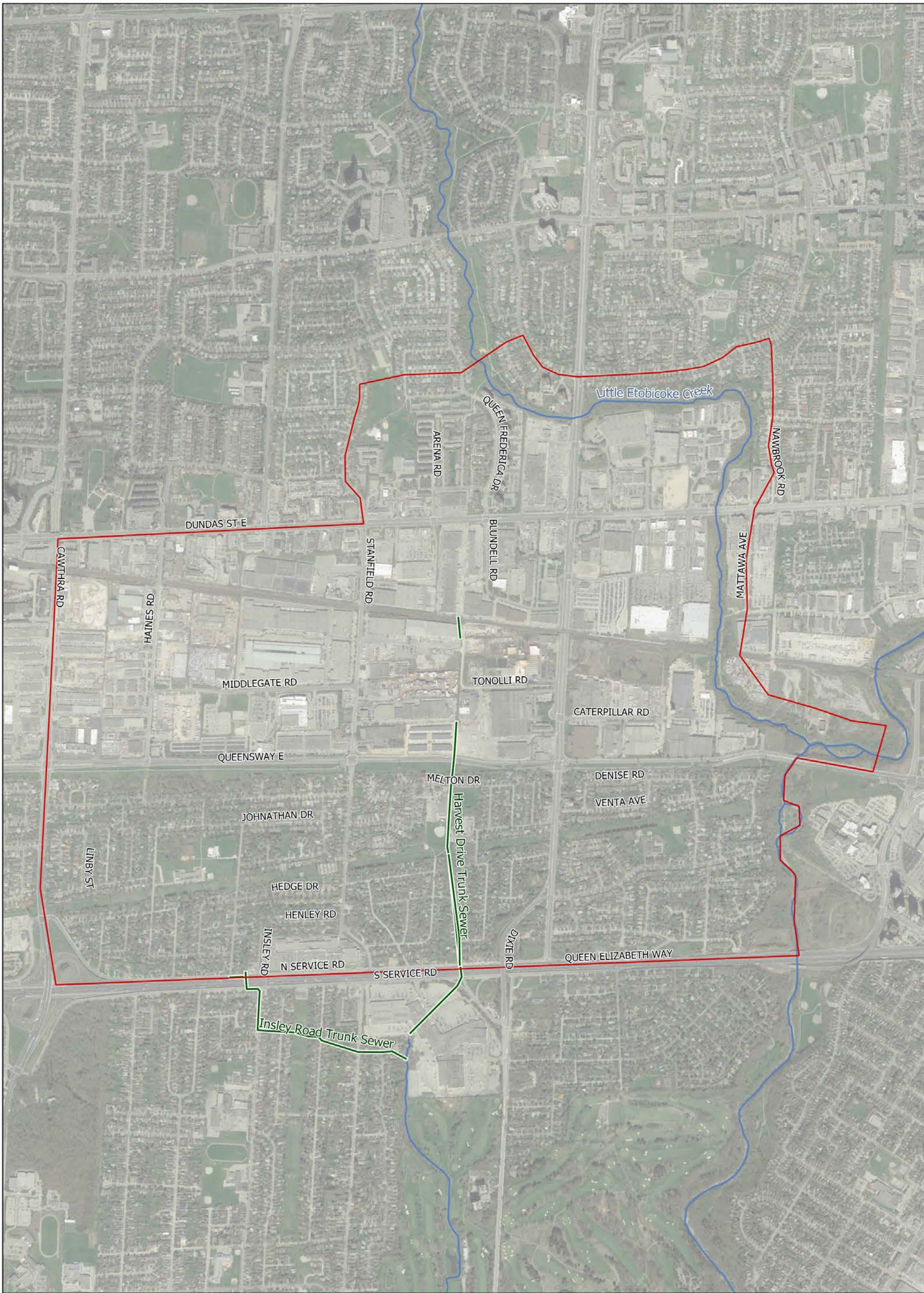
1.1 Report Purpose

The Phase 1 study was completed in January 2018 and is summarized in *Progress Report #1 – Floodplain Spill Assessment* (Matrix 2018). Since the completion of the Phase 1 study, CVC has requested that the hydraulic modelling be refined to incorporate the trunk storm sewers from Tonolli Road to Dixie Mall (Harvest Drive trunk sewer) as well as the Queen Elizabeth Way (QEW) crossing at Insley Road into the MIKE FLOOD model. This assessment includes a review of the capacity of the trunk sewer to reduce water levels north of the QEW. This assessment, herein referred to as the Phase 1A study, included the required hydrologic and hydraulic modelling components to determine the effects of this sewer on the overland flow conditions resulting from the spill from Etobicoke Creek. The study area is shown on Figure 1.

This report summarizes the work required to complete this Phase 1A assessment. The updated spill assessment was conducted for the Regional event (both steady and unsteady states) and the following design storms (both steady and unsteady states):

- 100-year 24-hour Chicago event
- 50-year 24-hour Chicago event
- 25-year 24-hour Chicago event

The spill assessment aim is to appropriately partition the spill flows for the Regional Storm event between Little Etobicoke Creek, Applewood Creek, Serson Creek, and Cooksville Creek.



Railway
Sewer
Watercourse
Study Limits

0 250 500 m

Figure Date: December 13, 2018

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A

Project #24603

Study Area

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.

K. Molnar
K. Hofbauer

Fig 1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_BaseMap.qgs

2 BACKGROUND REVIEW

All data related to the study, including hydrologic and hydraulic models, previous study reports, historical flooding information, aerial photography, light detection and ranging (LiDAR), GIS layers, and anecdotal evidence were compiled and reviewed. Further details are provided in *Progress Report #1 – Floodplain Spill Assessment* (Matrix 2018).

For the purpose of the Phase 1A study, the following data was collected and reviewed:

- GIS data including storm sewers, manholes, and catch basin locations
- design drawings for the new trunk storm sewer extension from Queensway to Tonolli Road
- CVC HEC-RAS model of Applewood Creek to establish boundary conditions for the sewer outlets

3 MIKE FLOOD MODEL SETUP

The existing MIKE FLOOD model (MMM 2015) was provided by TRCA at the outset of the project. The existing MIKE FLOOD model consists of a 1D MIKE 11 model of Little Etobicoke Creek and a 2D MIKE 21 model of the adjacent floodplain area. During the Phase 1 study, Matrix updated the MIKE FLOOD model to expand the extent of the MIKE 21 model domain. Details of these modifications are summarized in *Progress Report #1 – Floodplain Spill Assessment* (Matrix 2018).

For the Phase 1A study, a MIKE URBAN model component was prepared of the trunk sewers of interest, as described in Section 3.1. This resulted in a 3-way coupled MIKE FLOOD model including the 1D MIKE 11 model, the 1D MIKE URBAN model, and the 2D MIKE 21 model. All three components are dynamically linked to allow flow exchange between each component.

3.1 MIKE URBAN Model Development

The Harvest Drive and Insley Road trunk sewers were added to the MIKE FLOOD model using MIKE URBAN. The collector sewers are represented by their catch basins (CBs) and lumped sewershed catchments connected directly to the trunk sewer. This enables 2-way integration between the sewers and the surface at the mapped locations of the CBs without the complexities associated with modelling all sewers in the sewershed.

The development of the MIKE URBAN model includes the following steps:

- delineate and import urban catchments and assign appropriate hydrologic parameters
- compile and import sewer network data (CBs, manholes, trunk sewers, and outlets)
- connect catchments to sewer network
- assign boundary conditions at outfalls
- couple MIKE URBAN to MIKE 21

3.1.1 Urban Catchments

Lumped sewershed catchments were delineated using LiDAR data available from the Phase 1 study to each sewer main connecting to the trunk sewers. The sewersheds were manually delineated and consider both the sewer network and surface topography.

Each catchment was assigned hydrologic attributes based on aerial photography and LiDAR data. The attributes include: percent impervious area, catchment length, average catchment slope, and roughness (Manning's n) based on land use types. The catchments were subdivided into pervious and impervious land use types consistent with MIKE URBAN modelling practice and assigned the parameters as shown in Table 1.

TABLE 1 Urban Catchment Hydrologic Parameters

MIKE URBAN Land Use Type	Land Use	Manning's n
Pervious Medium	Urban Pervious (lawns) and parks	0.080
Impervious Flat	Urban Impervious (large buildings, roads, parking lots, etc.)	0.025

The urban catchment shapefile was imported to MIKE URBAN. There are four surface runoff methods available in MIKE URBAN. These methods include: a) Time/Area Method, b) Kinematic Wave (non-linear reservoir) Method, c) Linear Reservoir Method, and d) Unit Hydrograph Model.

The kinematic wave hydrologic method was used for this study to simulate rainfall runoff from the urban catchments. This method provides a comprehensive representation of the main processes influencing rainfall runoff to the stormwater collection system including losses from impervious areas and losses and infiltration from pervious areas. Surface runoff is computed as shallow, laminar sheet flow taking into account the gravitational and friction forces. The amount of runoff is controlled by the various hydrological losses and the size of the contributing area. The shape of the runoff hydrograph is controlled by the catchment parameters including the average catchment length, slope, and roughness of the catchment surface. These parameters form the basis for the kinematic wave computation using the Manning equation. A summary of the parameters used in the MIKE URBAN hydrology model is provided in Table 2.

TABLE 2 Summary of Kinematic Wave Hydrologic Model Parameters

Parameter	Description
Calculated Catchment Parameters	
Length (m)	Length of surface drainage path
Slope (%)	Average slope of surface drainage as shallow laminar sheet flow
Impervious Area (%)	Fraction of catchment surface containing impervious surfaces (industrial/commercial rooftops, roads, parking lots)
Pervious Area (%)	Fraction of catchment surface consisting of permeable surfaces (yards, parks)
Kinematic Wave Parameters	
Wetting Loss (mm)	Initial wetting of the catchment surface
Storage Loss (mm)	Precipitation depth required for filling the depressions on the catchment surface prior to occurrence of runoff
Start Infiltration (mm/hr)	The maximum rate of infiltration (Horton equation)
End Infiltration (mm/hr)	The minimum rate of infiltration (Horton equation)
Horton's Exponent (/hr)	The rate of reduction of the infiltration over time during rainfall
Inverse Horton's Exponent (/hr)	The rate of recovery of the infiltration over time after rainfall has stopped
Manning's n	Roughness of the catchment surface. *Based on TRCA Standards*

The kinematic wave parameters were defined globally for each land use type and set based on typical values as used in previous studies in the area. These parameters are provided in Table 3.

TABLE 3 Kinematic Wave Hydrologic Parameters

Land Use Type	Wetting Loss (mm)	Storage Loss (mm)	Start Infiltration (mm/hour)	End Infiltration (mm/hour)	Horton Exponent (/hour)	Inverse Horton Exp. (/hour)	Manning's n
Pervious Medium	1.0	6.0	75	3	4	1	0.08
Impervious Steep	0.1	n/a	n/a	n/a	n/a	n/a	0.015

The sewershed catchments were identified based on the trunk sewer manhole to which the associated local sewer main connects. The catchments were connected directly to these trunk sewer manholes. This approach assumes that the local sewers have adequate capacity to capture and convey the runoff from the associated catchments to the trunk sewer. This enabled the assessment to move forward without developing an all pipes model for the entire sewershed.

3.1.2 Sewer Network

The storm sewer network (CBs, manholes, pipes, and outlets) was provided by the City in GIS format. The shapefiles contained most of the required attributes for the manholes (X-coordinate, Y-coordinate, ground level) and pipes (from node, to node, length, shape, diameter, height, width, and material). One exception is the new trunk sewer extension from the Queensway to Tonolli Road. Dimensions and inverts were obtained from design drawings provided by the City.

3.1.3 Manholes and Catch Basins

The manhole (MH) and CB locations were imported to MIKE URBAN from the shapefiles provided by the City. Manhole rim and CB lid elevations were assumed equal to ground surface elevation as provided in the LiDAR-based digital elevation model (DEM). Manhole invert elevations were assumed based on the lowest connecting pipe invert elevation at each manhole. CB inverts were calculated based on lid elevations assuming a depth of 1.2 m.

Generally, manhole diameters were assumed to be 1.2 m, except where the diameter of a connecting pipe was larger. In these cases the diameter of the manhole was assumed to be equivalent to the diameter of the downstream pipe.

3.1.4 Boundary Conditions

The MIKE URBAN model boundary conditions include rainfall applied to the catchments as well as water levels at the outlets.

3.1.4.1 Rainfall

The MIKE URBAN inflow boundary conditions consist of applying a rainfall intensity time series onto the catchments and then using the MIKE URBAN rainfall runoff module to calculate the rate of runoff from each catchment. In MIKE URBAN the rainfall boundary condition is referred to as a Catchment Load boundary condition.

The rainfall time series' generated for the MIKE URBAN model for this study included the 25-, 50-, and 100-year design storms using the 24-hour Chicago rainfall distribution as well as the Regional Storm event.

3.1.4.2 Outfalls

The stormwater outfalls to Applewood Creek were assigned a Q-h rating curve boundary condition using the CVC's draft HEC-RAS model. The Harvest Drive trunk sewer outlet was applied a rating curve based on Section 12843 from the draft HEC-RAS model The Insley Road sewer outlet was applied a rating curve based on Section 12753 from the draft HEC-RAS model.

3.2 MIKE URBAN Coupling

The CBs in the MIKE URBAN model were coupled to the MIKE 21 model such that inflow and surcharge to and from the nodes can be dynamically exchanged between the two components. This allows for surcharged sewers to discharge onto the 2D overland flow model where it may either pool on the surface or flow in the direction where the topography is sloping. It also allows for flooding on the 2D surface to enter the 1D urban model via these nodes when capacity permits in the minor system.

The CBs were coupled to the 2D model grid cell coinciding with the location of the CB of interest. The rate of flow exchange between CB inflow and surcharge is detailed in the following sections.

3.2.1 Catch Basin Inflow

Each CB in the MIKE URBAN model (including single CBs, double CBs, and CB manholes) was coupled to the MIKE 21 model using a curb inlet coupling method. This process enables flow on the surface (e.g. from the riverine spill) to enter the sewer system when capacity permits.

The curb inlet method uses a depth versus flow (D-Q) relationship to control the rate at which water on the 2D surface can enter the CB. The D-Q relationship for the single and double CBs was obtained from the curves defining the inlet capacity of single and double CBs in a sag as defined in Design Chart 4.19 of the Ontario Ministry of Transportation's *Drainage Management Manual* (1997). We used the specifications for a sag for all CBs since the main focus of the study is to examine flooding during large storm events when surface flooding conditions will likely submerge many of the CBs.

The Freeboard value defines the depth of water below the ground surface at which the calculation of inflow from the MIKE 21 model into the MIKE URBAN CB begins to be suppressed, thereby allowing for a relatively smooth transition between draining conditions and surcharge conditions. This was set to 0.1 m for all CBs.

3.2.2 Catch Basin Surcharge

The outflow (surcharge) from the CBs was modelled using an orifice equation to calculate the rate at which water from the sewer will surcharge through the CB onto the MIKE 21 model. This process enables any surcharge from the trunk sewer to return to the surface through the mapped CB locations despite the lack of local collector sewers in this model.

The orifice settings for the single CBs were set as follows:

- Orifice area: 0.18 m^2 (assumed 50% open area on a CB measuring 0.6 × 0.6 m)
- Orifice discharge coefficient: 0.3 (assumes low efficiency caused by drag from many small openings)
- Maximum flow: 0.22 m^3/s (assumes the maximum rate of surcharge from the single CB would not be more than the maximum rate of drainage into the single CB)

The orifice settings for the double CBs were set as follows:

- Orifice area: 0.36 m^2 (assumed 50% open area on two CBs each measuring 0.6 × 0.6 m)
- Orifice discharge coefficient: 0.3 (assumes low efficiency caused by drag from many small openings)
- Maximum flow: 0.5 m^3/s (assumes the maximum rate of surcharge from the double CB would not be more than the maximum rate of drainage into the double CB)

3.2.3 Trunk Sewer Inlet

The upstream inlet to the Harvest Drive trunk sewer near Tonolli Drive also requires a D-Q relationship to control the inflow and surcharge between the MIKE URBAN and MIKE 21 models. An inlet relationship was developed using the CulvertMaster hydraulic modelling program and the dimensions and characteristics of the trunk sewer inlet. The rating curve is provided in Table 4.

TABLE 4 Depth-Flow Curve for Trunk Sewer Inlet

Depth (m)	Flow (m^3/s)
0	0.00
0.2	0.27
0.4	0.77
0.6	1.41
0.8	2.17
1	3.03
1.2	3.99
1.4	5.03
1.6	6.14
1.8	7.20
2	8.02
2.2	8.78
2.4	9.48
2.6	10.13
2.8	10.74
3	11.31

4 PHASE 1A: SPILL ASSESSMENT (DIXIE-DUNDAS)

In short, the risk associated with the spill from the Little Etobicoke Creek floodplain into CVC jurisdiction lands needs to be quantified. The Phase 1A assessment was conducted using the MIKE FLOOD model developed during Phase 1 with the addition of the MIKE URBAN component.

Modelling and anecdotal evidence indicate that a spill occurs at Queen Frederica Drive during high flows. This spill crosses the creek's regular watershed boundary which is maintained under normal flow conditions. The spilled flow is conveyed from the Little Etobicoke Creek watershed in TRCA jurisdiction into the Applewood Creek watershed which is within CVC jurisdiction.

4.1 Design Storm Runs

The 3-way coupled MIKE FLOOD model was run under a variety of rainfall distributions and design rainfall event hydrographs to assess existing flood risk and spill conditions as summarized in Table 5.

The steady state Regional Storm run was required for mapping the flood extent of the Regional Storm in line with current Provincial standards. While the aim of this study is not to produce regulatory mapping, the use of steady state results is standard practice for Regional Storm flood mapping. The unsteady Regional Storm and design storm runs were used to provide hydrographs of the spill for CVC's assessment.

At the request of the City and CVC, the 24-hour Chicago rainfall distribution was used to generate design storm runs for the 25-year to 100-year events. Peak flows based on the 24-hour Chicago rainfall distribution were used for the design storm modelling as this rainfall distribution is typically used in urban areas where the peak flow is largely influenced by rainfall intensity as opposed to total rainfall depth.

To determine the impact that the urban drainage system has on overland flooding from the creek spill, two sets of assessments were done for each design storm event:

1. Steady state riverine flows with the 10-year rainfall event applied to the MIKE URBAN system. This scenario was developed to simulate a worst-case scenario as it was assumed that the local sewers (which were not included in the model) have a 10-year capacity. Steady state riverine flows were required to ensure that the peak in the urban system aligns with the peak in the riverine system.

2. Unsteady state riverine flows with the no rainfall applied to the MIKE URBAN system. This scenario simulates the event where the riverine and urban system peaks would not coincide.

TABLE 5 Existing Condition Model Runs

Run No.	Riverine Model			Urban Model		
	Storm Event	Rainfall Distribution	Flow Condition	Storm Event	Rainfall Distribution	Flow Condition
1	25-year	24-hr Chicago	Steady	10-year	24-hr Chicago	Unsteady
2	50-year	24-hr Chicago	Steady	10-year	24-hr Chicago	Unsteady
3	100-year	24-hr Chicago	Steady	10-year	24-hr Chicago	Unsteady
4	Regional	n/a	Steady	10-year	24-hr Chicago	Unsteady
5	25-year	24-hr Chicago	Unsteady	n/a	n/a	n/a
6	50-year	24-hr Chicago	Unsteady	n/a	n/a	n/a
7	100-year	24-hr Chicago	Unsteady	n/a	n/a	n/a
8	Regional	n/a	Unsteady	n/a	n/a	n/a

4.2 Subwatershed Spill Assessment

A detailed review of the Regional Storm and design storms simulations was conducted to quantify spill from Little Etobicoke Creek. To develop hydrographs of the spill the dynamic unsteady results were reviewed. The output file from the dynamic modelling includes a time series of flooding in the 2D domain including depth and velocity. A number of cross-sections along the spill path were generated using GIS as shown on Figure 2. Locations 2 and 5 were selected for the spill assessment into CVC jurisdiction as they contribute flow across the TRCA/CVC watershed boundary based on the review of the dynamic results. Using a post-processing tool in MIKE Zero, a time series of discharge values was generated from the 1D and 2D result files along the selected cross-sections for each modelled storm event (25-year through 100-year and Regional Storm) were generated.

Further confirmation of flow results are summarized in the flow balance provided in Table 6. The flow balance locations are indicated on Figure 2. This method has also been used to confirm flow balance and develop spill hydrographs from the river for all design storms which are provided in Appendix A.

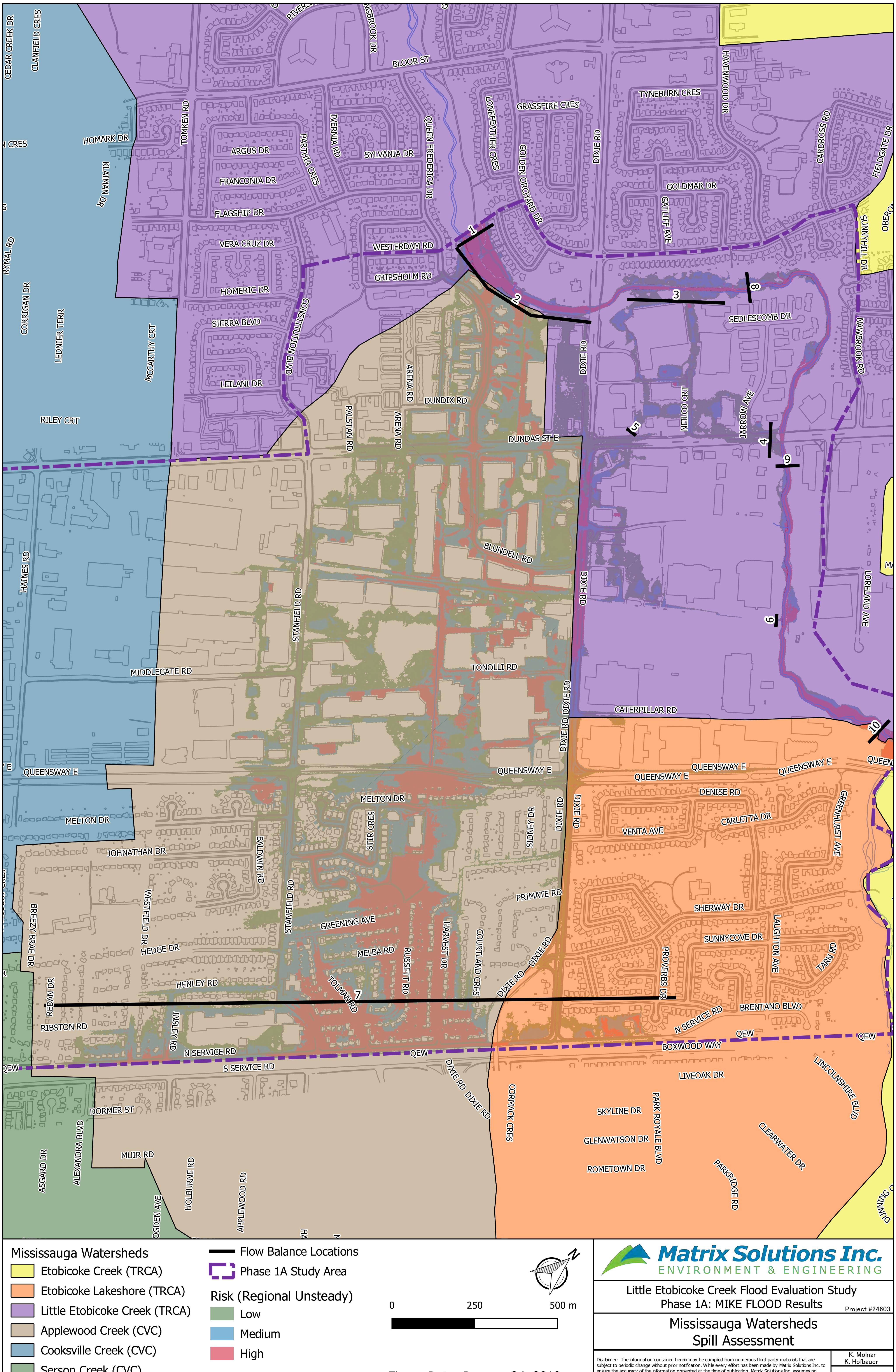
TABLE 6 Regional Storm Flow Balance (Unsteady State)

Location	Flow (m^3/s)
1	215.6
2	133.5
3	3.9
4	3.8
5	0.1
6	0.0
7	102.6
8	74.8
9	81.6
10	81.6

4.2.1 CVC Hydrology Recommendations

Based on review of the subwatershed boundaries within the City of Mississauga (Figure 2), flows spill from the Little Etobicoke Creek subwatershed into the Applewood Creek subwatershed; no spill into the Cooksville Creek or Serson Creek subwatersheds is observed based on the model results. While there is some spill is directed to TRCA's Etobicoke Lakeshore subcatchment in the vicinity of Dixie Road and the QEW, the vast majority of this flow will be conveyed back into Applewood Creek along the QEW noise barrier.

To account for the spill from TRCA into CVC jurisdiction, it is recommended that the spill hydrographs provided in Appendix A be incorporated into the Applewood Creek hydrology model at the most upstream flow node in the Applewood Creek watershed (VO ID 1018, Queen Frederica Drive from the Applewood Visual OTTHYMO Model, provided by CVC at the outset of the project).



Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Mississauga Watersheds
Spill Assessment

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.

K. Molnar
K. Hofbauer

Figure Date: January 24, 2019

Figure 2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\GIS\Phase 1\24603_MIKE FLOOD Results.qgs

4.3 Risk Assessment

A risk assessment was completed for the design storm runs with consideration of three risk factors: depth, velocity, and depth × velocity. In accordance with current Ontario Ministry of Natural Resources and Forestry (MNRF) practices, the following risk mapping criteria apply (Table 7). 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, but pedestrian ingress and egress is possible. High risk areas do not facilitate safe land 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 8 at the end of this document.

TABLE 7 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.			

5 COMPARISON TO PREVIOUS MODELLING

The results of the Phase 1A simulations were compared to those of the Phase 1 to assess similarities and differences between the models with and without the sewer network. The Phase 1A steady and unsteady runs were completed with different runoff conditions applied to the urban network so these are discussed separately in the sections below.

5.1 Unsteady State Simulations

The unsteady state runs were completed using hydrograph input to the riverine system and no runoff applied to the urban network and therefore it is assumed the sewers are empty prior to receiving surface flow from riverine spill and conveyed through the 2D overland component. During a rainfall event, the sewers will likely have some amount of flow in them and therefore the extent and depth of flooding may be higher than shown in Maps 5 to 8.

The unsteady state simulation results were compared for Phase 1A and Phase 1 by reviewing the peak flows at the locations indicated on Figure 2. The comparison is provided in Table 8.

TABLE 8 Unsteady State – Comparison of Surface Flows in Phase 1A versus Phase 1

Location	Regional (m^3/s)		100-year 24-hr Chicago (m^3/s)		50-year 24-hr Chicago (m^3/s)		25-year 24-hr Chicago (m^3/s)	
	Phase 1A	Phase 1	Phase 1A	Phase 1	Phase 1A	Phase 1	Phase 1A	Phase 1
1	215.6	215.6	129.9	129.9	114.9	114.8	100.9	100.9
2	133.5	134.1	54.4	55.1	41.7	42.0	30.2	30.4
3	3.9	3.1	0.0	0.0	0.0	0.0	0.0	0.0
4	3.8	3.8	0.0	0.0	0.0	0.0	0.0	0.0
5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	102.6	127.7	18.2	23.9	13.9	19.1	7.7	11.2
8	74.8	73.9	71.9	71.6	69.6	69.8	67.3	67.7
9	81.6	79.0	74.8	74.0	72.4	71.8	69.8	69.3
10	81.6	80.4	74.8	74.0	72.4	71.8	69.8	69.3

The flow rates on the surface at Location 7 (just upstream/north of QEW) are lower in Phase 1A compared to Phase 1 for all events. This indicates that, as expected, the addition of the sewer system in this area has reduced the amount of surface flooding north of QEW. As noted, the unsteady runs that were used to generate the spill hydrographs did not include any runoff applied to the urban system. Under this assumption, the sewers have maximum capacity to receive flow from the overland spill and therefore provide a 20 to 31% decrease in peak flows at Location 7 for the design storms. During a storm event, the sewers will likely have some amount of flow in them and therefore the flow rates on the surface that this location may be higher than shown in Table 8.

A comparison of flood extents and volumes was also done for the unsteady runs, as shown in Table 9. As expected, the addition of the sewer network reduced the extents of flooding (number of wetted cells) and also the maximum volume of water on the surface.

TABLE 9 Unsteady State – Comparison of Phase 1A versus Phase 1 Results

Parameter	Regional (m^3/s)	
	Phase 1A	Phase 1
Number of Wetted Cells	375,863	393,974
Average Depth	0.51 m	0.53 m
Volume of Water on Surface	764,038 m^3	840,865 m^3
Maximum Depth in Harvest Trunk Sewer Easement	2.60 m	2.72 m

During the Phase 1 study, concern was raised regarding the depths of flooding in the rear yards along the Harvest Drive trunk sewer easement, notably the rear yards on Russett Road and Harvest Drive south of Melba Road. As shown in Table 9, the addition of the sewer network in the unsteady state model (with no urban runoff applied) decreased water depths by 12 cm in this area. While it was anticipated that the depths in this area would decrease substantially, there are no CBs along this easement and therefore the sewer is unable to pick up surface flows in this area. This decrease is notably better than the steady state run due to the nature of the unsteady state modelling (i.e., no runoff applied to sewer system and hydrograph input as opposed to steady state).

5.2 Steady State Simulations

The steady state runs were completed by applying steady state flow inputs to the riverine system and a 10-year 24-hour Chicago rainfall event to the urban system. This setup forces the peak flow in the riverine system and the urban system to coincide to represent a reasonable "worst-case" scenario. Note that during Phase 1, steady state design storm runs (25-year to 100-year) were not included in the scope of work and therefore the only simulation available for comparison to Phase 1A is the Regional Storm event. The results of the comparison are provided in Table 10. As expected, the addition of the sewer network reduced the extents of flooding and also the maximum volume of water on the surface.

TABLE 10 Steady State – Comparison of Phase 1A versus Phase 1 Results

Parameter	Regional (m^3/s)	
	Phase 1A	Phase 1
Number of Wetted Cells	405,856	437,007
Average Depth	0.51 m	0.53 m
Volume of Water on Surface	832,144 m^3	929,708 m^3
Maximum Depth in Harvest Trunk Sewer Easement	3.69 m	3.74 m

As shown in Table 10, the addition of the sewer network in the steady state model (with 10-year runoff applied to the urban system) only decreased water depths by 5 cm in the Harvest Drive trunk sewer easement area. As with the unsteady run, it was anticipated that the depths in this area would decrease, however, due to lack of CBs in the easement the sewer is unable to pick up surface flows in this area. Additionally, once the riverine spill reaches steady state, the urban system becomes unrealistically surcharged due to the steady influx of overland flow input.

5.3 Summary

Due to the variability in event-based rainfall patterns, it is difficult to comment on the capacity that would be available in the sewer system during any particular event. The simulations completed for this study were intended to describe the bounds of potential events within the study area. In the unsteady state runs, the lack of runoff applied to the urban system may overestimate the ability of the minor system to capture overland flow. In the steady state runs, the steady influx of overland surface flow into the minor system may underestimate the ability of the minor system to capture overland flow and/or overestimate surcharge.

Both of the modelled flow scenarios (steady and unsteady state as described above) indicate that the sewer system provides minimal benefit to the maximum flow depth in the rear yards along the Harvest Drive trunk sewer easement. As these scenarios were developed to provide the potential range of expected conditions, it is concluded that the storm sewer systems in this area provide an insignificant amount flood relief during creek spill conditions. The July 8, 2013 event falls within this range of expected conditions and therefore no additional simulations are required.

While the modelled coupled model scenarios provide a range of expected conditions, the MIKE URBAN model was also run on its own (i.e., without consideration of the riverine spill) to understand and assess the available capacity in the sewer system during the 10-year and 100-year 24-hour Chicago events. The results of these simulations are shown in Figure 3 and Figure 4 for the Harvest Drive and Insley Road trunk sewers, respectively. As shown, both trunk sewers are at or near capacity during the 10-year storm event. Both sewers are in surcharge conditions for the 100-year event. This indicates that these sewers do not have adequate capacity to receive additional spill flow from Little Etobicoke Creek and therefore additional measures to reduce surface flooding (i.e., providing CBs near the QEW) may not be effective.

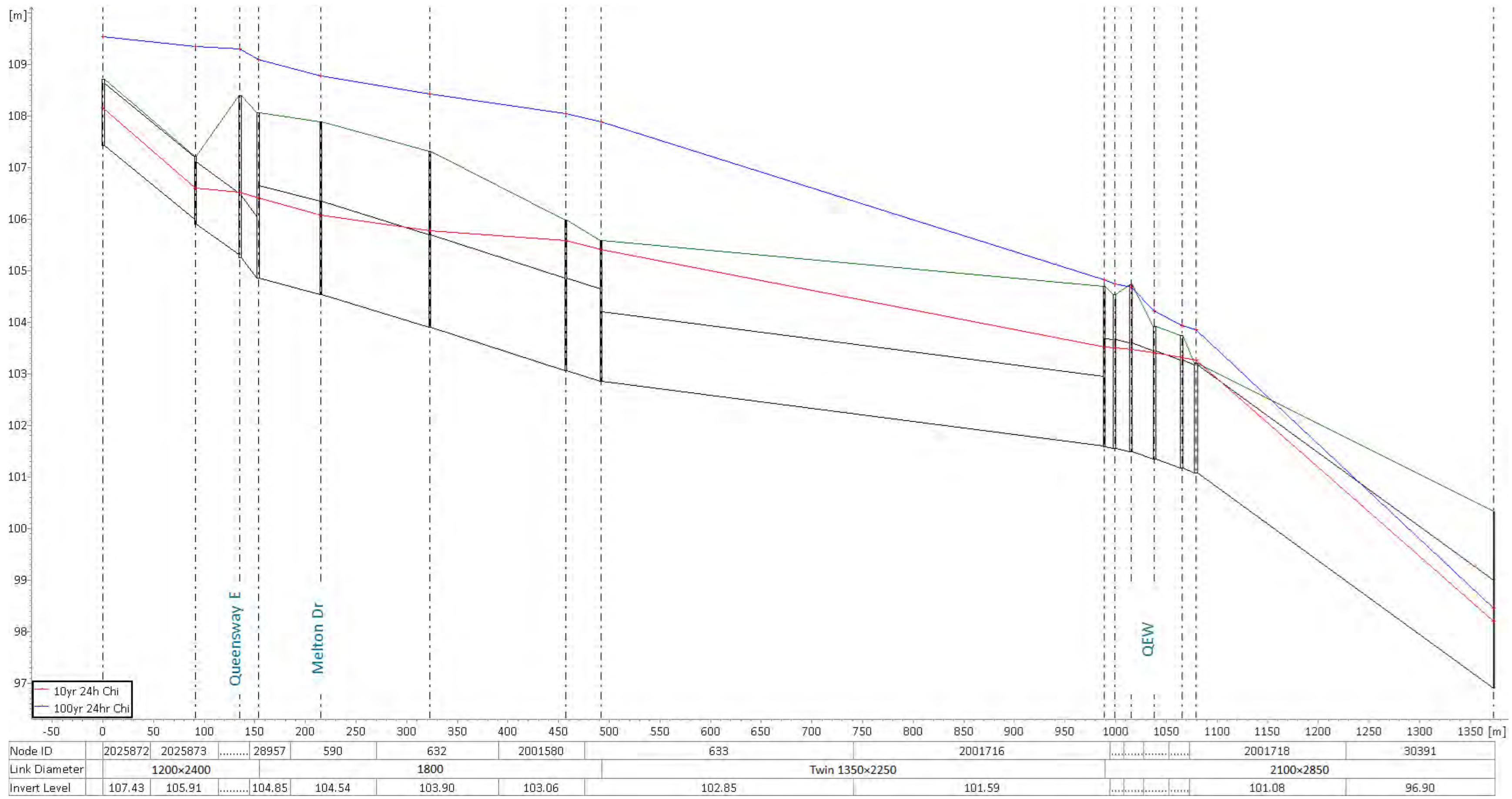


FIGURE 3 MIKE URBAN Results – Harvest Drive Trunk Sewer

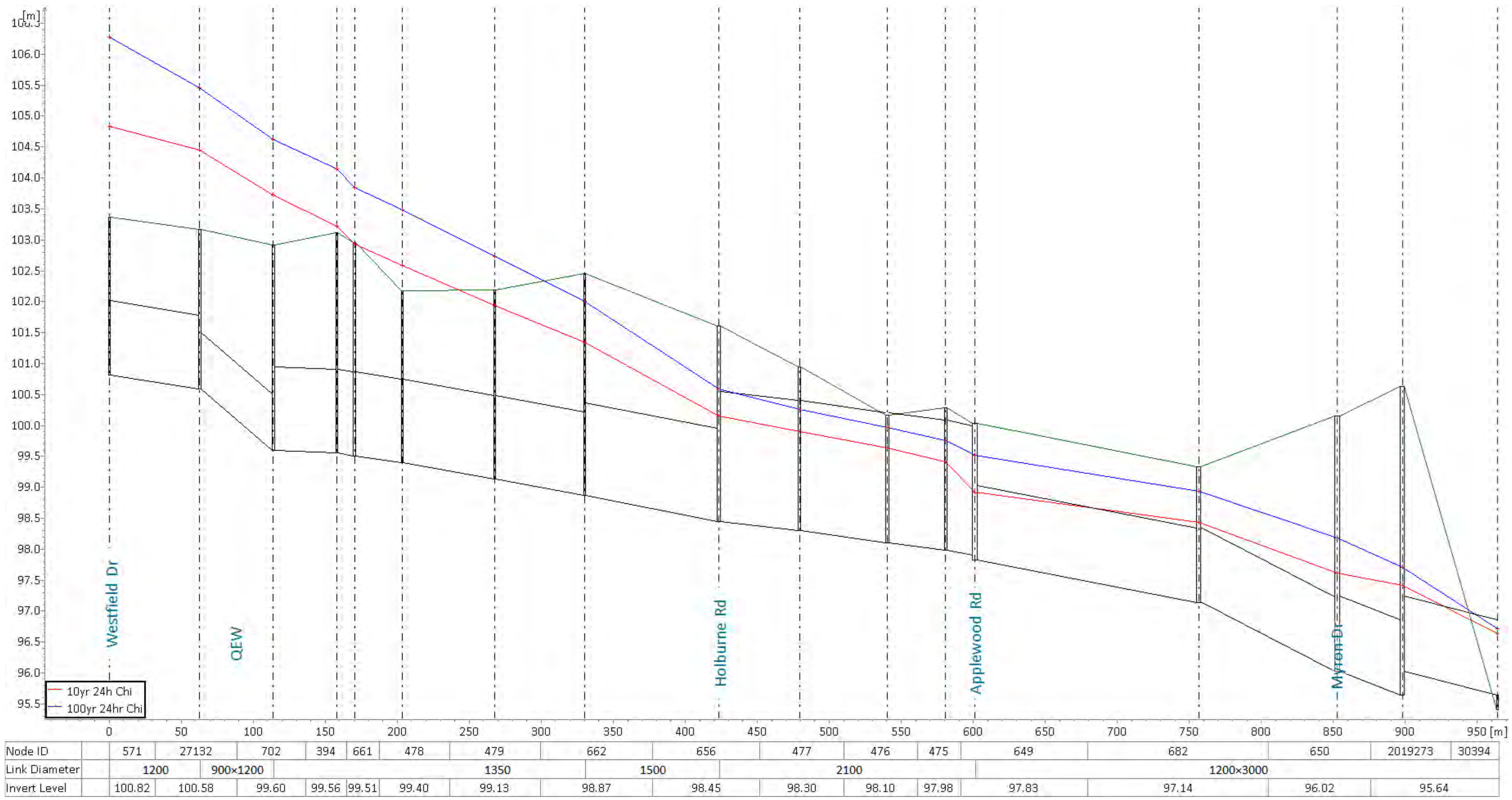


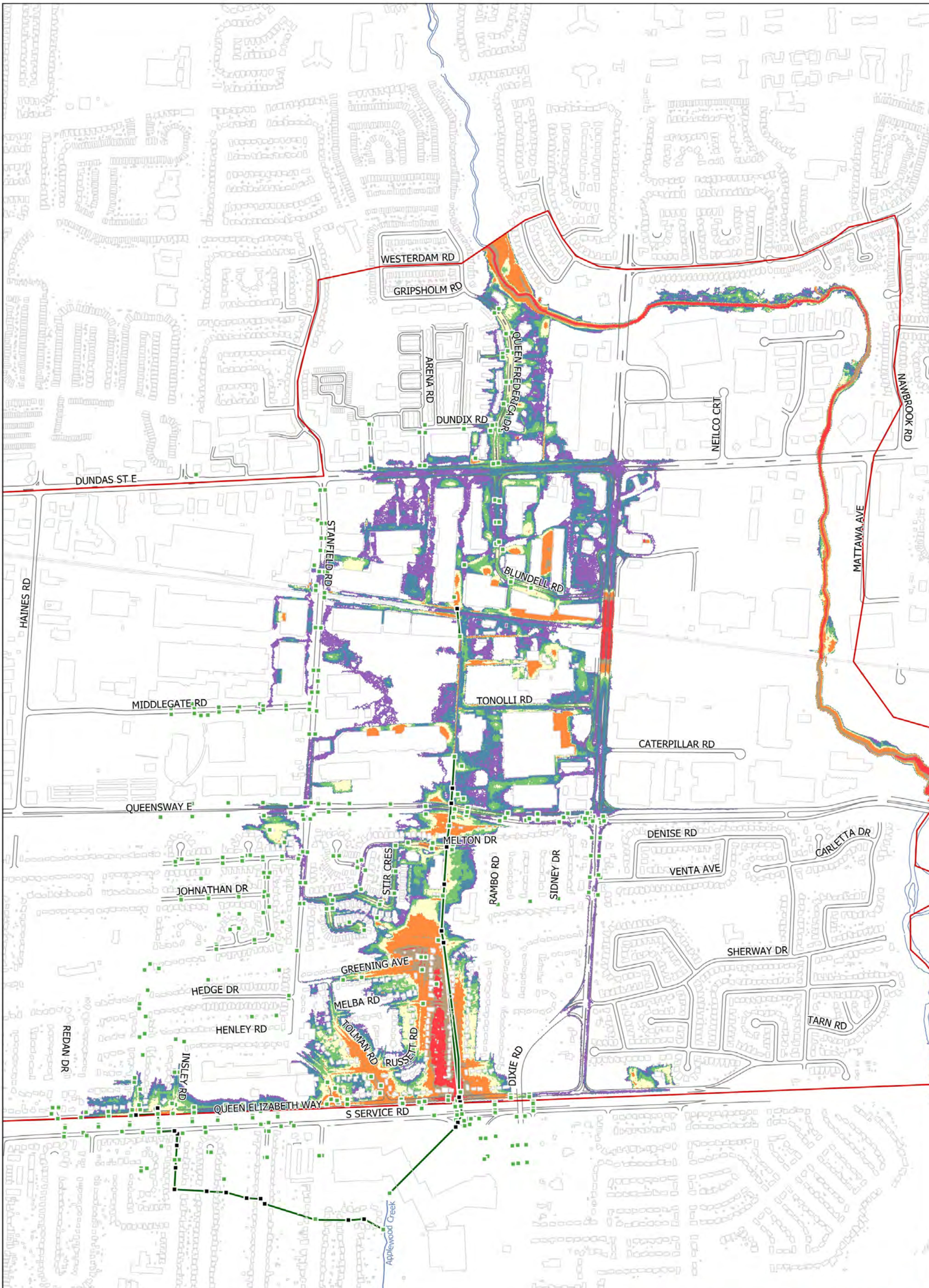
FIGURE 4 MIKE URBAN Results – Insley Road Trunk Sewer

6 REFERENCES

Matrix Solutions Inc. (Matrix). 2018. *Progress Report #1 – Floodplain Spill Assessment, Flood Evaluation Study, Little Etobicoke Creek*. Prepared for the City of Mississauga. Guelph, Ontario. October 23, 2017.

MMM Group Limited. 2015. *Floodplain Mapping in Applewood and Dundas / Dixie Special Policy Area: Little Etobicoke Creek*. Toronto and Region Conservation Authority. Mississauga, Ontario. January 2015.

Ministry of Transportation of Ontario (MTO). 1997. *MTO Drainage Management Manual.* Drainage and Hydrology Section, Transportation Engineering Branch, Quality and Standards Division. October 1997.



Catch basin	Buildings	0.30 - 0.50
Manhole	Study Limits	0.50 - 0.80
Sewer	Model Results	0.80 - 1.50
Railway	Maximum Depth (m)	1.50 - 2.00
Road	<= 0.10	> 2.00
Watercourse	0.10 - 0.30	

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 16, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

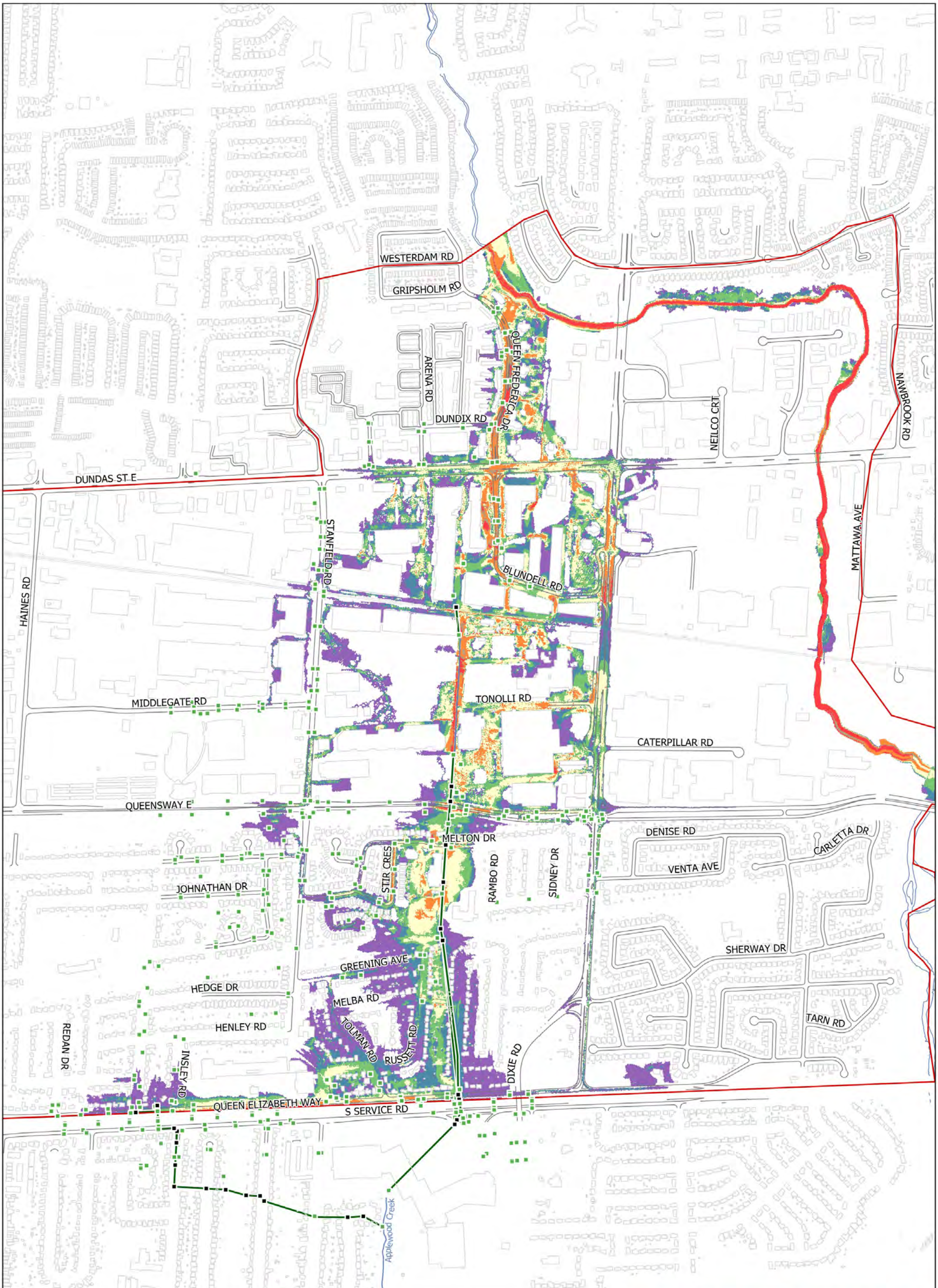
Project #24603

Urban: 10-year, Riverine: 25-year (Steady)
Depth

K. Molnar
K. Hofbauer

Fig 1.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_25SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road

Watercourse
Study Limits

Model Results

Maximum Velocity (m/s)

<= 0.10
0.10 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 1.70
1.70 - 2.00
> 2.00

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: November 16, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

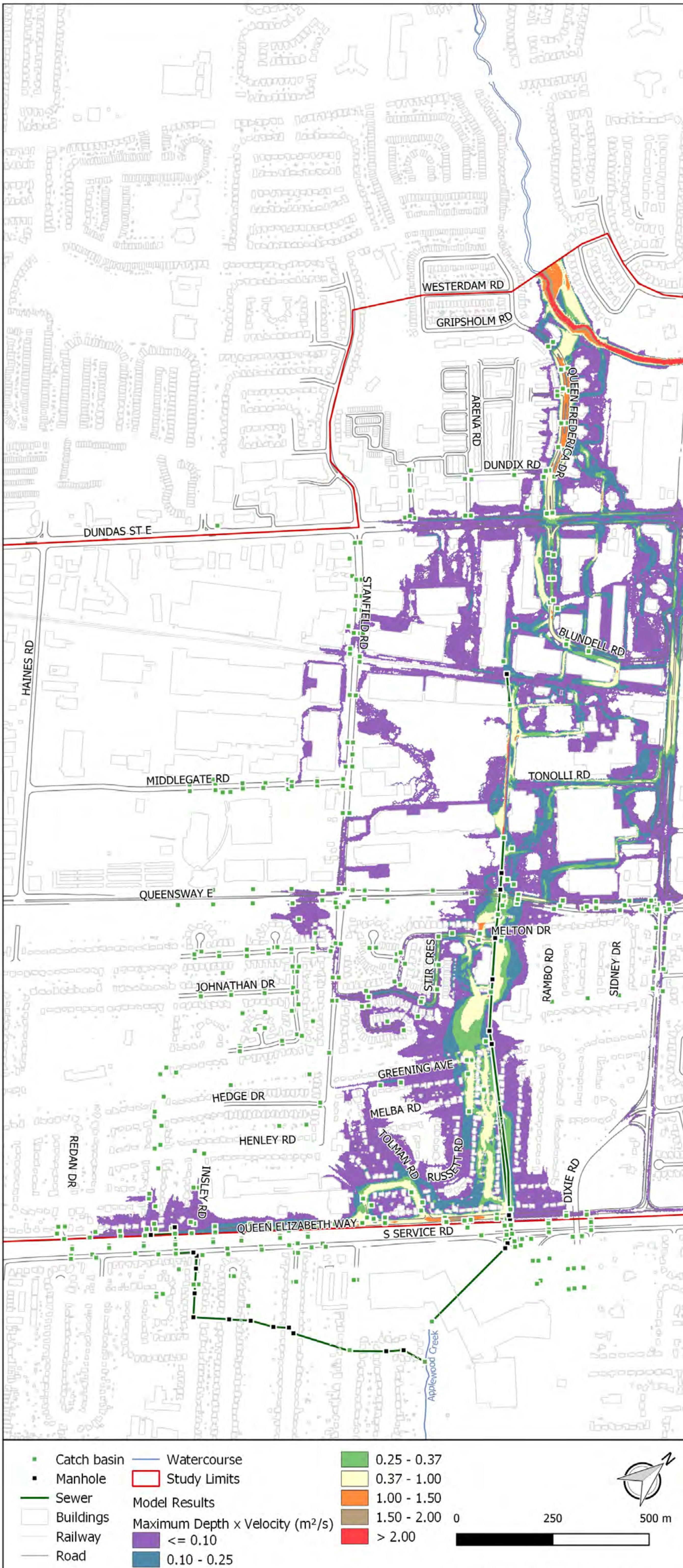
Urban: 10-year, Riverine: 25-year (Steady)
Velocity

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.

K. Molnar
K. Hofbauer

Fig 1.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_25SS_Ex.qgs



This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 16, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

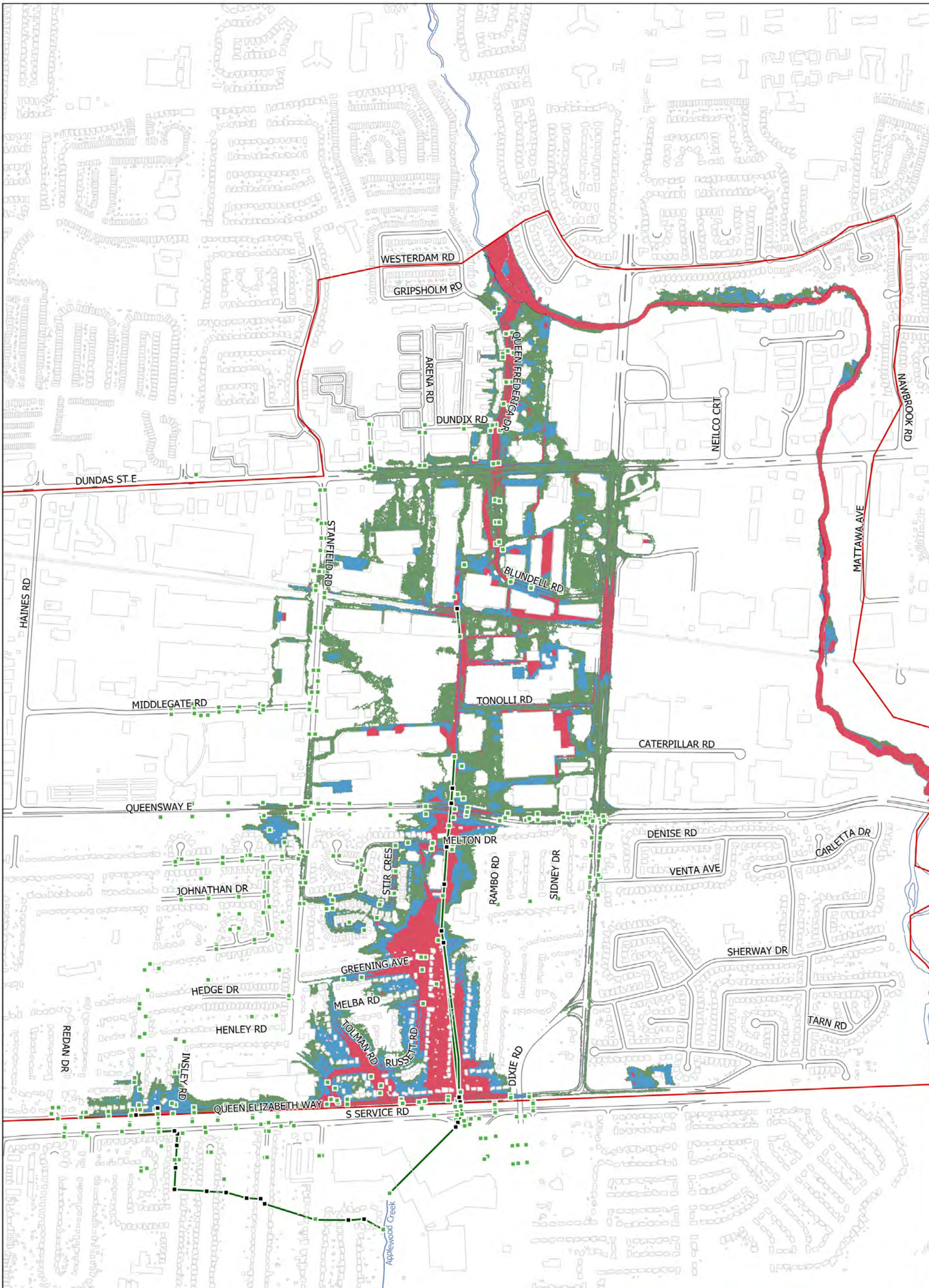
Project #24603

Urban: 10-year, Riverine: 25-year (Steady)
Depth x Velocity

K. Molnar
K. Hofbauer

Fig 1.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_25SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse

Study Limits

Model Results

Risk

Low
Medium
High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: November 16, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

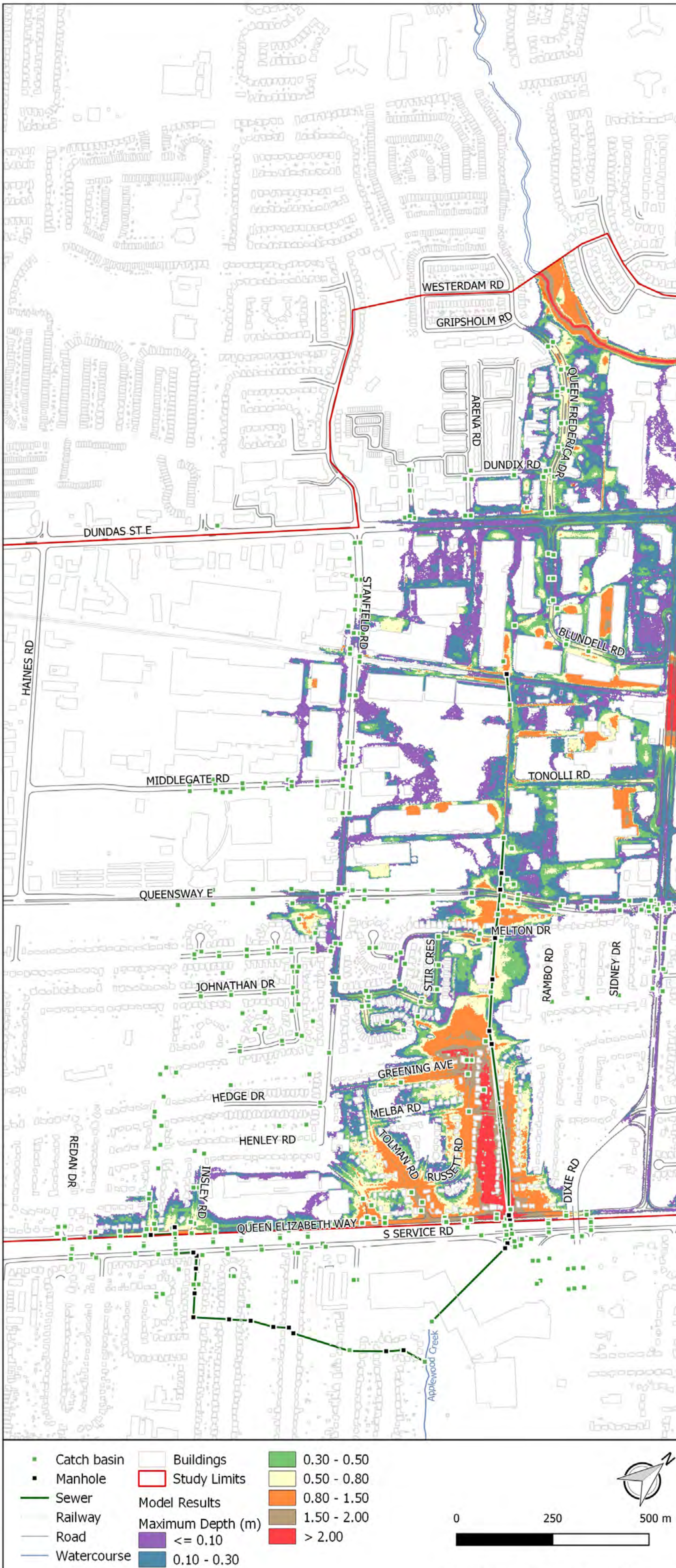
Urban: 10-year, Riverine: 25-year (Steady)
Risk

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.

K. Molnar
K. Hofbauer

Fig 1.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_25SS_Ex.qgs



This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 20, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

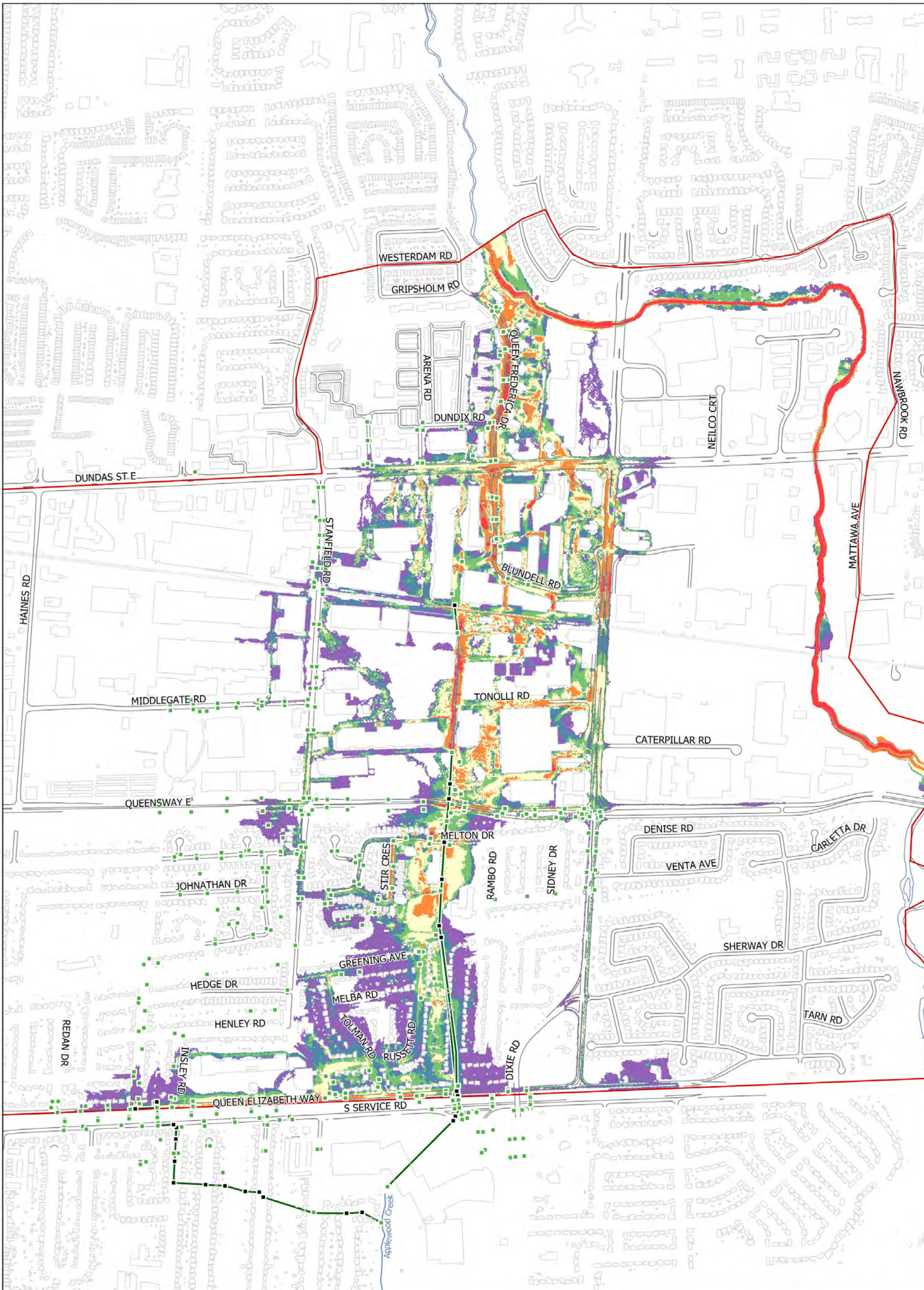
Urban: 10-year, Riverine: 50-year (Steady)
Depth

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.

K. Molnar
K. Hofbauer

Fig 2.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_50SS_Ex.qgs



Catch basin	Watercourse	0.25 - 0.50
Manhole	Study Limits	0.50 - 1.00
Sewer	Model Results	1.00 - 1.70
Buildings	Maximum Velocity (m/s)	1.70 - 2.00
Railway	<= 0.10	> 2.00
Road	0.10 - 0.25	

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 20, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

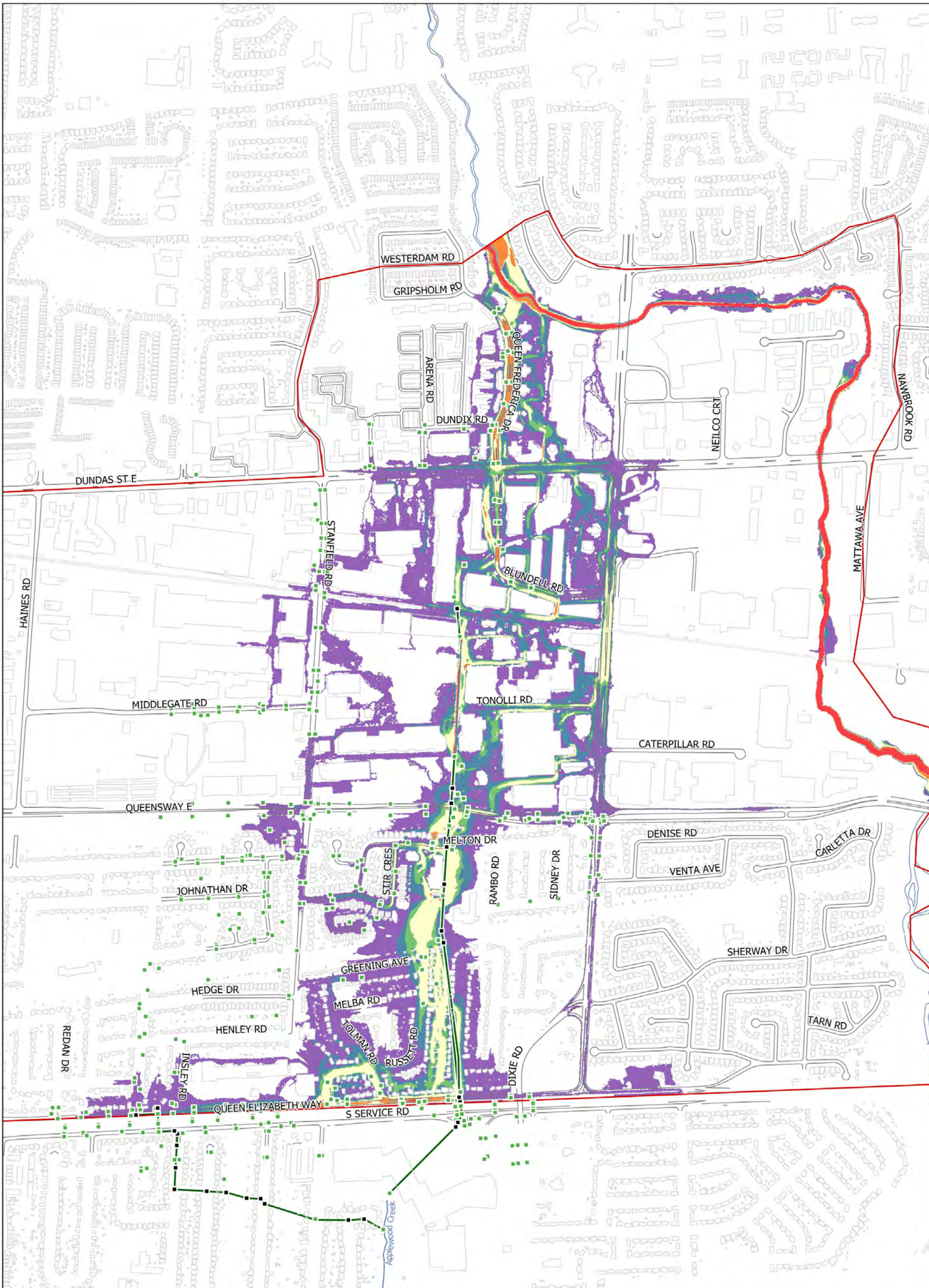
Project #24603

Urban: 10-year, Riverine: 50-year (Steady)
Velocity

K. Molnar
K. Hofbauer

Fig 2.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_50SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road

Watercourse
Study Limits

Model Results

Maximum Depth x Velocity (m^2/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.37
- 0.37 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 20, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

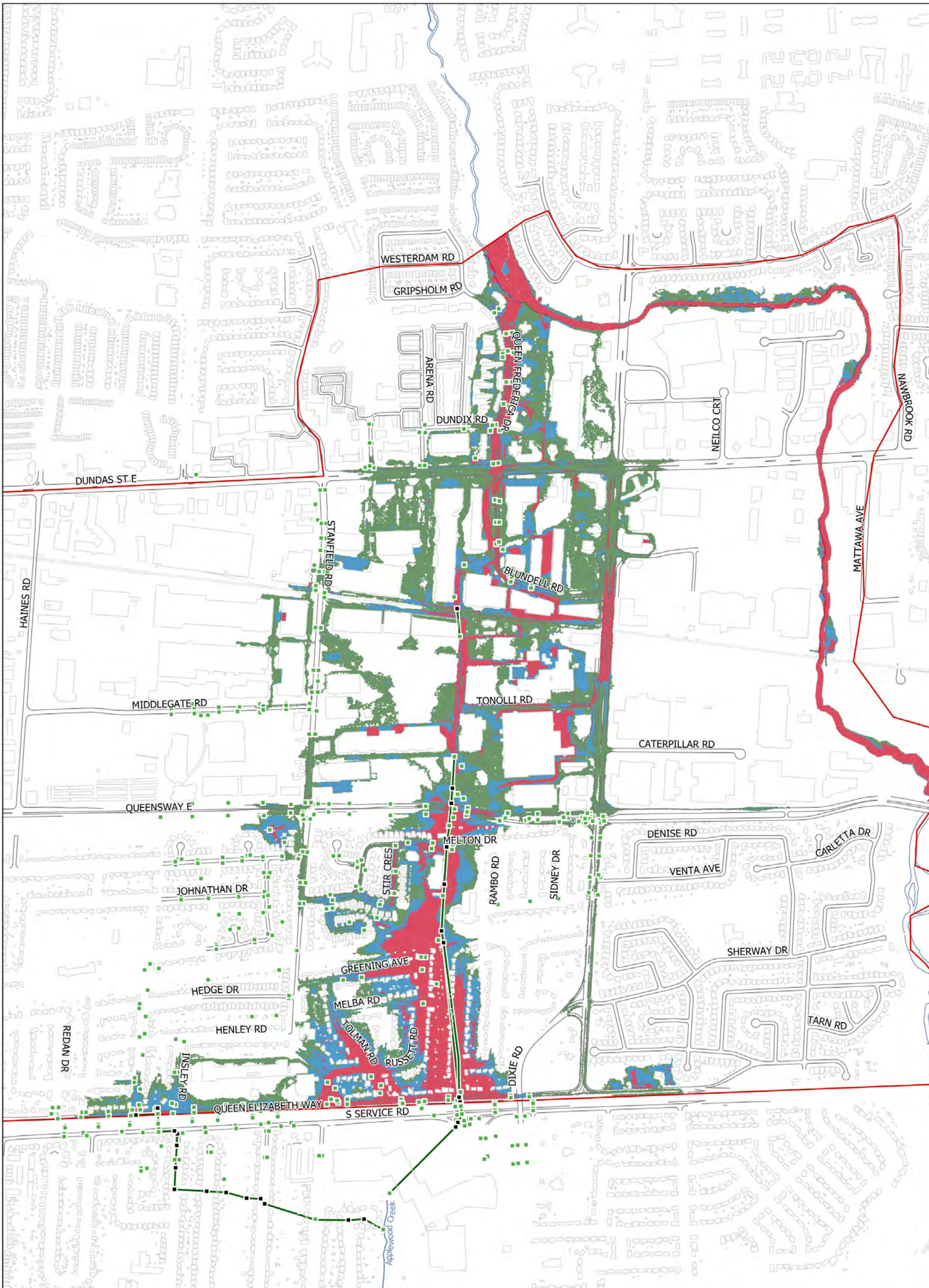
Urban: 10-year, Riverine: 50-year (Steady)
Depth x Velocity

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.

K. Molnar
K. Hofbauer

Fig 2.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_50SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse

Study Limits

Model Results

Risk

Low
Medium
High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: November 20, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

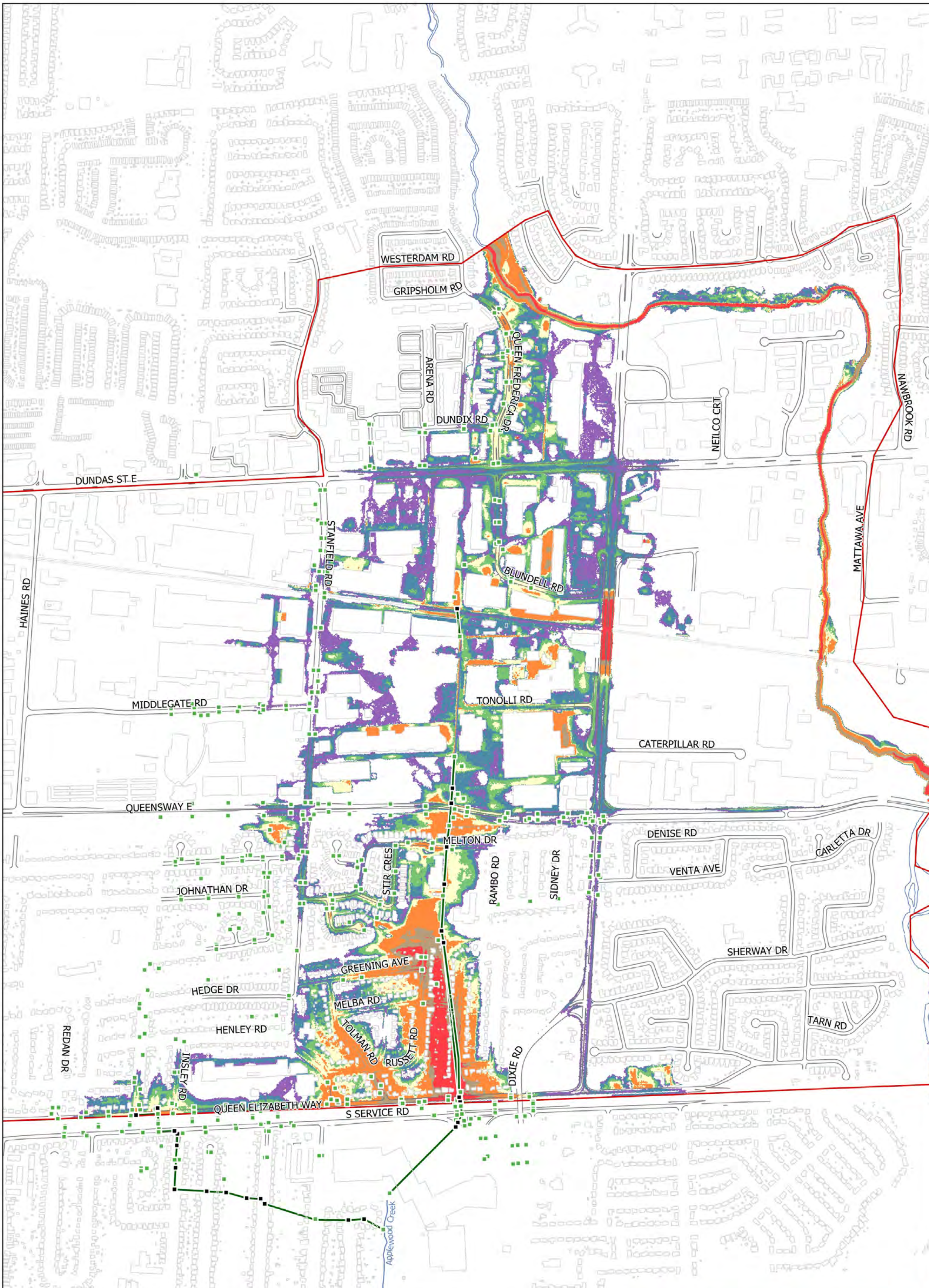
Urban: 10-year, Riverine: 50-year (Steady)
Risk

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.

K. Molnar
K. Hofbauer

Fig 2.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_50SS_Ex.qgs



Catch basin
Manhole
Sewer
Railway
Road
Watercourse

Buildings
Study Limits

Model Results

Maximum Depth (m)

- <= 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.80
- 0.80 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 6, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

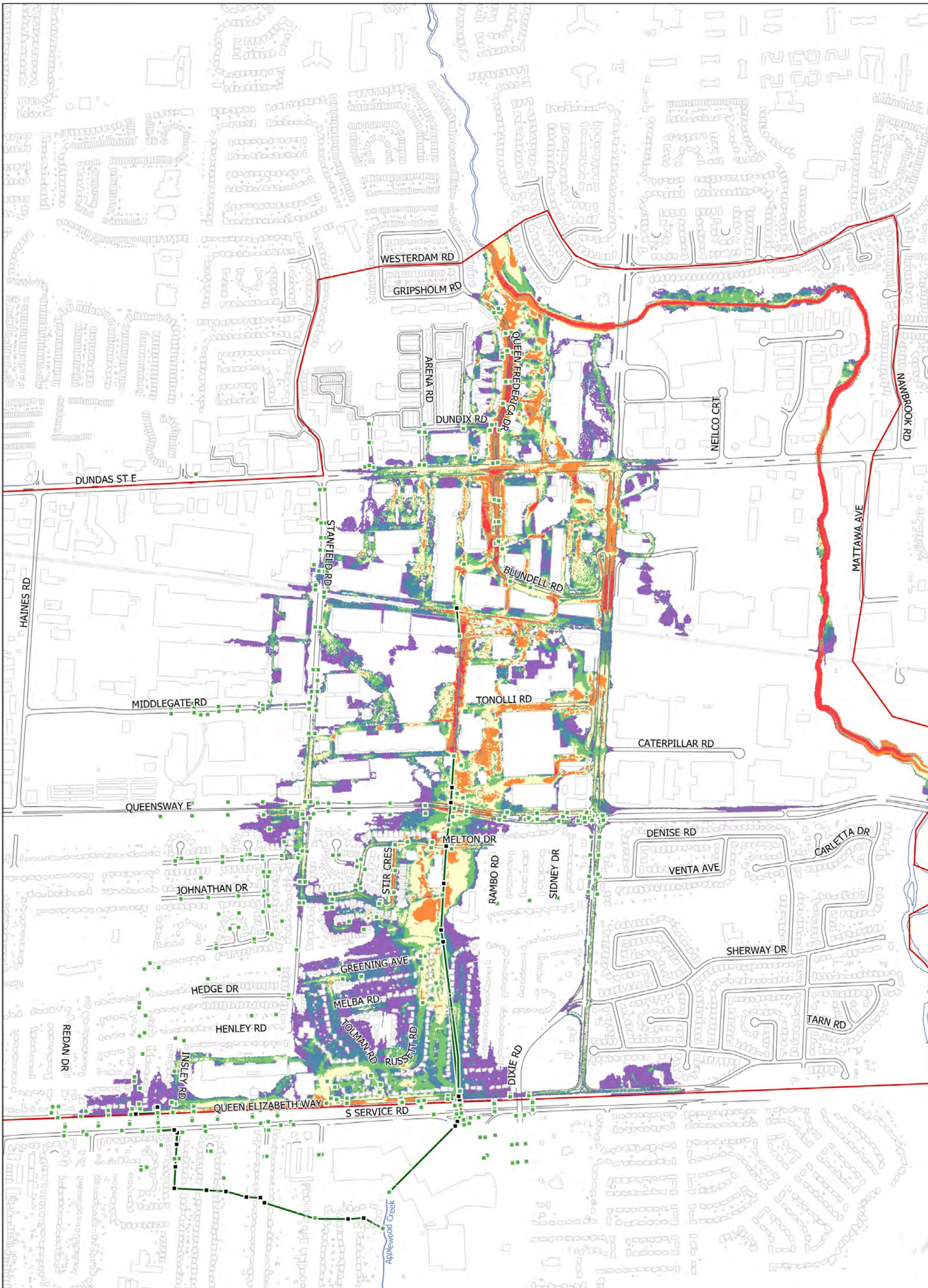
Project #24603

Urban: 10-year, Riverine: 100-year (Steady) Depth

K. Molnar
K. Hofbauer

Fig 3.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_100SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Velocity (m/s)

<= 0.10
0.10 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 1.70
1.70 - 2.00
> 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 6, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

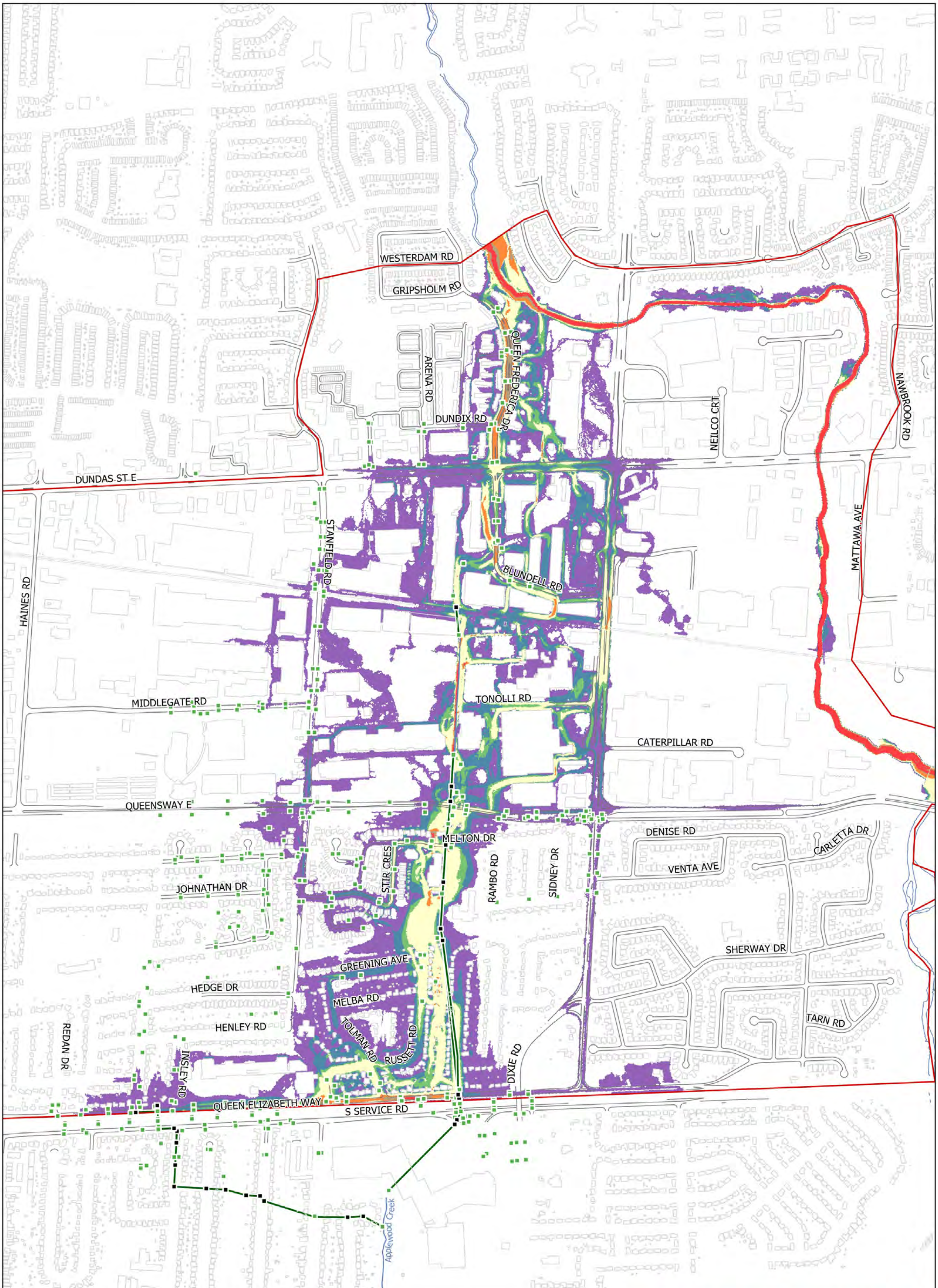
Urban: 10-year, Riverine: 100-year (Steady)
Velocity

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.

K. Molnar
K. Hofbauer

Fig 3.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_100SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Depth x Velocity (m^2/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.37
- 0.37 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 6, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

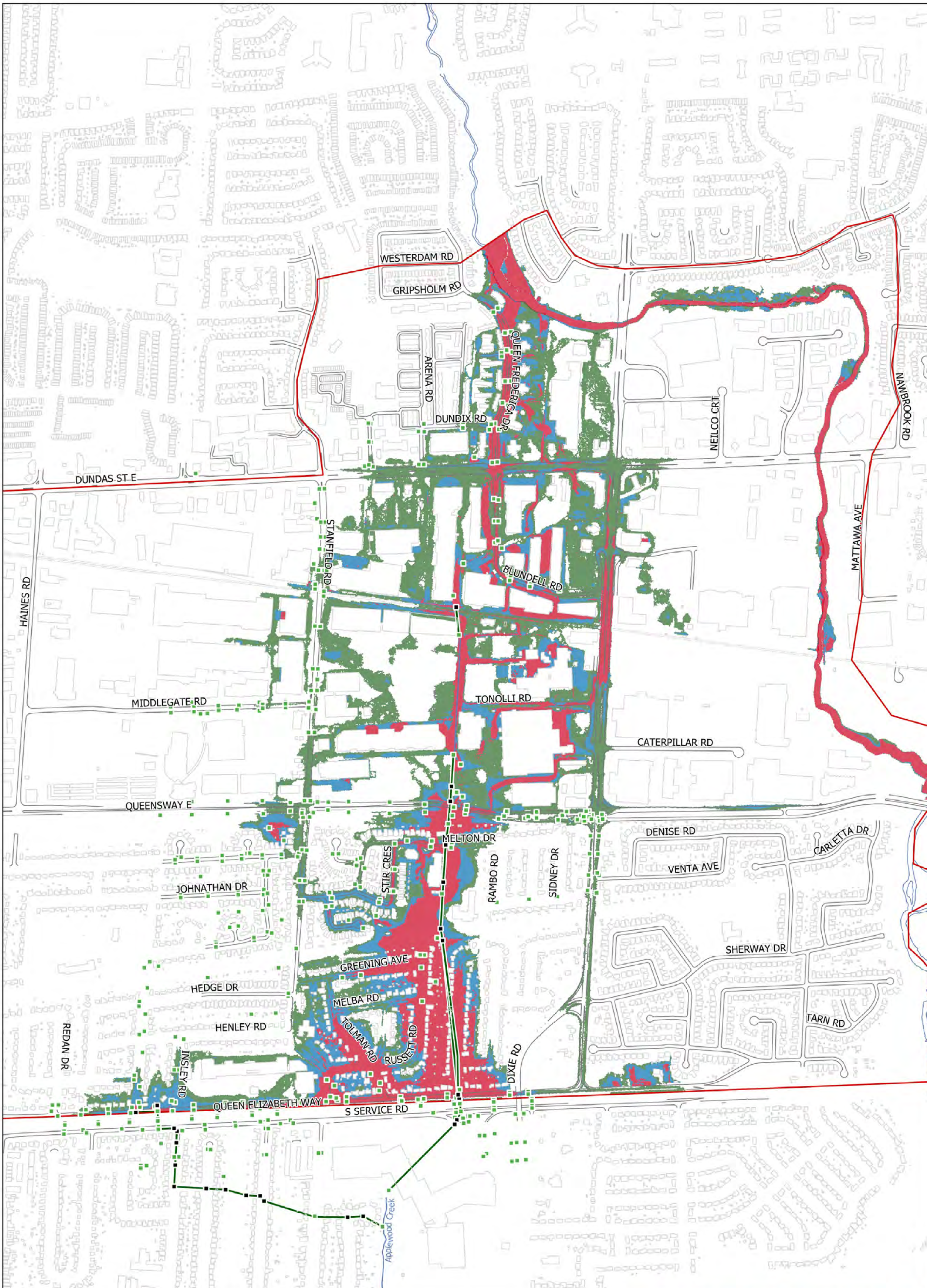
Urban: 10-year, Riverine: 100-year (Steady)
Depth x Velocity

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.

K. Molnar
K. Hofbauer

Fig 3.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_100SS_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse

Study Limits

Model Results

Risk

Low
Medium
High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: November 6, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

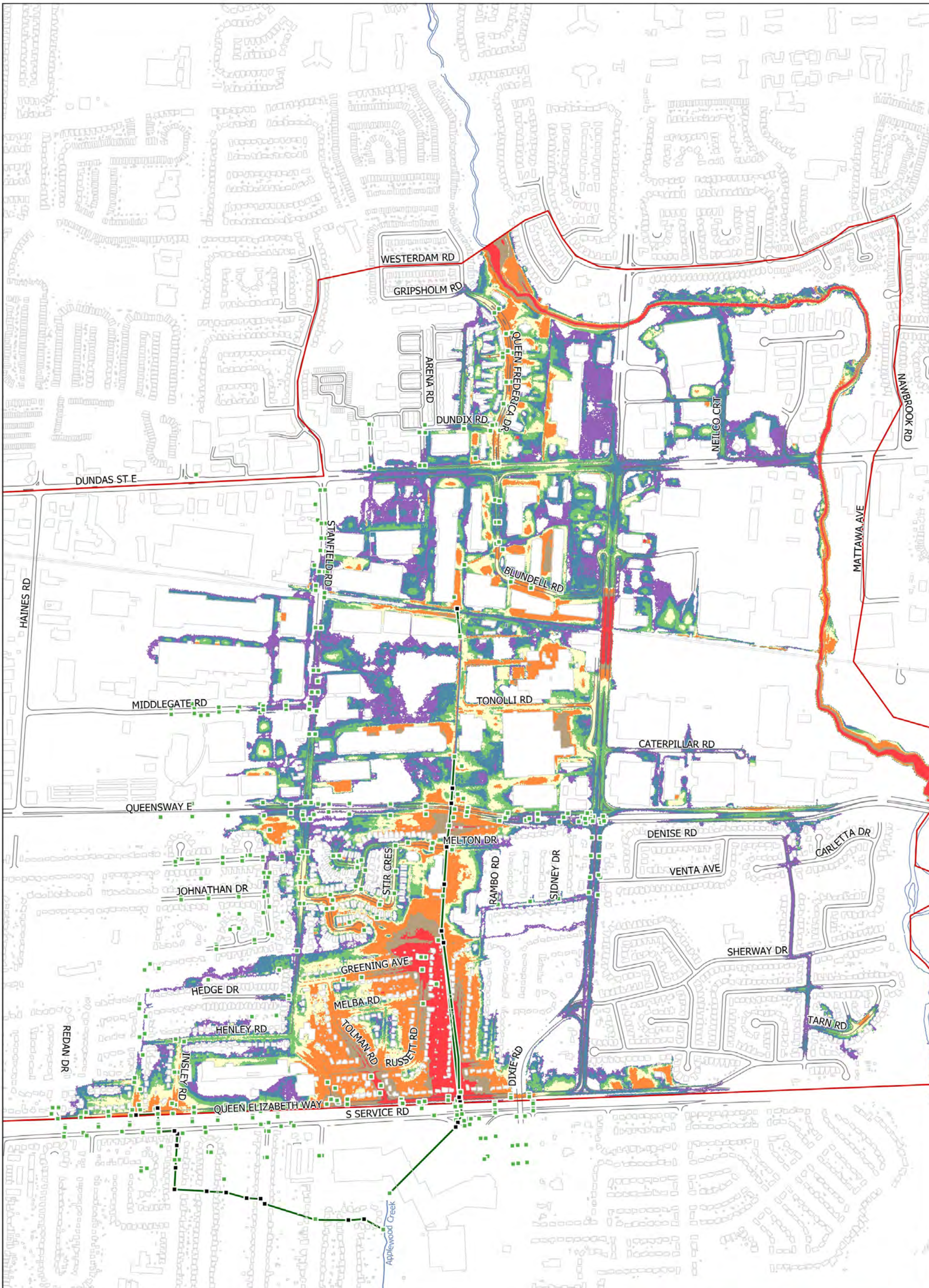
Urban: 10-year, Riverine: 100-year (Steady)
Risk

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.

K. Molnar
K. Hofbauer

Fig 3.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_100SS_Ex.qgs



Catch basin
Manhole
Sewer
Railway
Road
Watercourse

Buildings
Study Limits

Model Results

Maximum Depth (m)

<= 0.10
0.10 - 0.30
0.30 - 0.50
0.50 - 0.80
0.80 - 1.50
1.50 - 2.00
> 2.00

0 250 500 m

Run Date: January 15, 2019
Figure Date: February 21, 2019

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

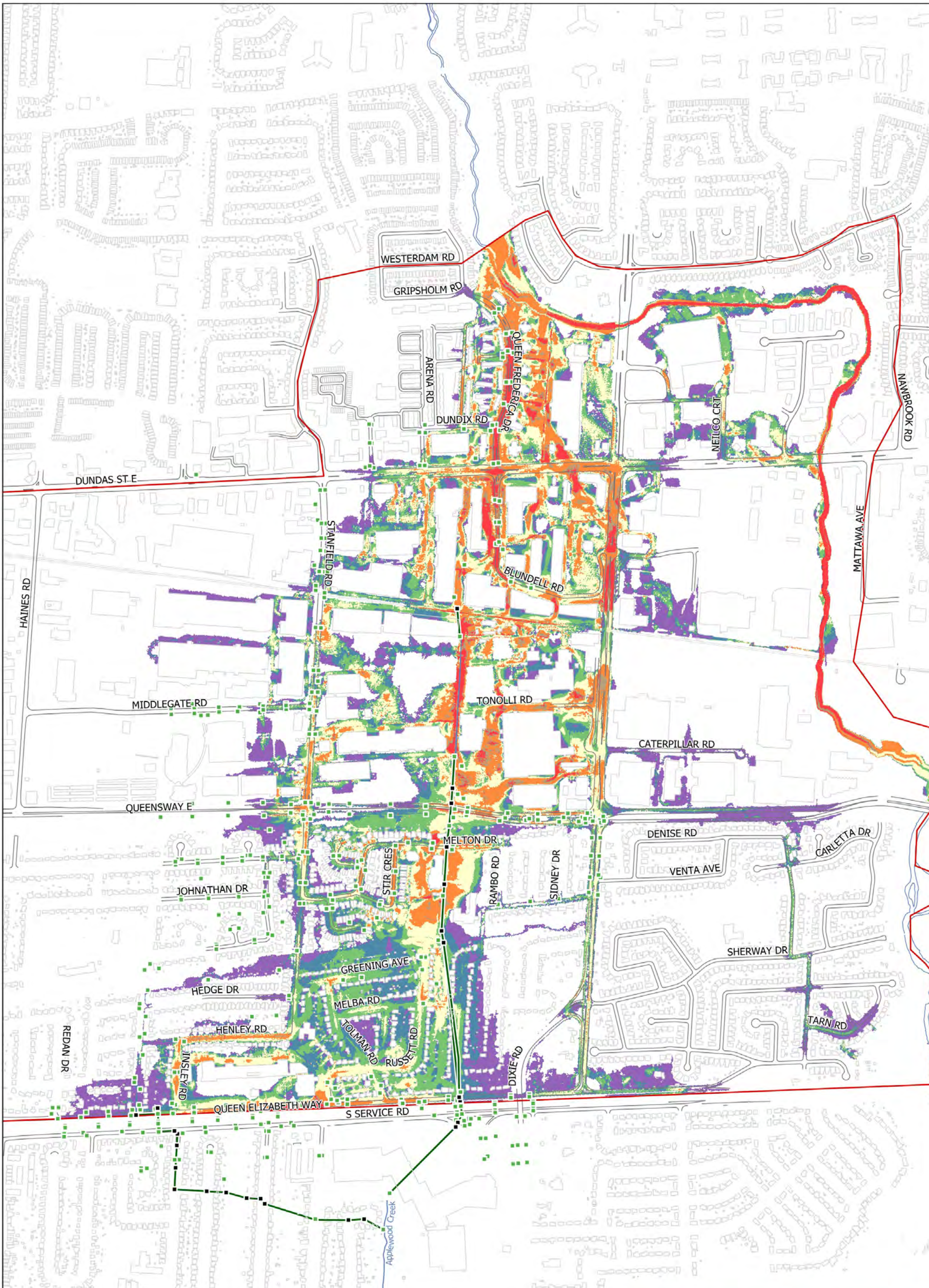
Urban: 10-year, Riverine: Regional (Steady)
Depth

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.

K. Molnar
K. Hofbauer

Fig 4.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_RegSS_NFCW.qgs



- Catch basin
- Manhole
- Sewer
- Buildings
- Railway
- Road
- Watercourse
- Study Limits

Model Results

Maximum Velocity (m/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.70
- 1.70 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: January 15, 2019
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

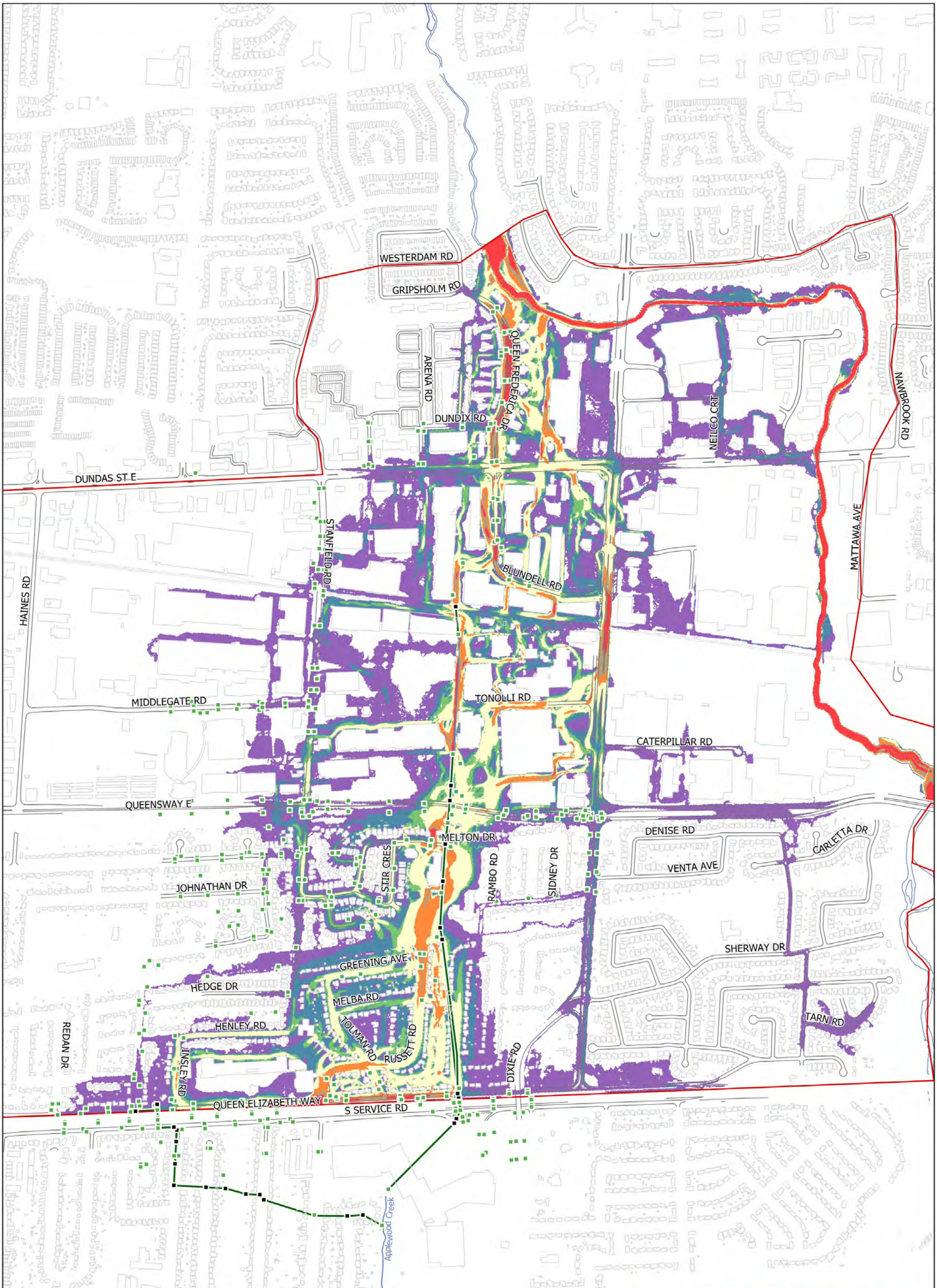
Project #24603

Urban: 10-year, Riverine: Regional (Steady)
Velocity

K. Molnar
K. Hofbauer

Fig 4.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_RegSS_NFCW.qgs



- Catch basin
- Manhole
- Sewer
- Buildings
- Railway
- Road
- Watercourse
- Study Limits

Model Results

Maximum Depth x Velocity (m^2/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.37
- 0.37 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: January 15, 2019
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

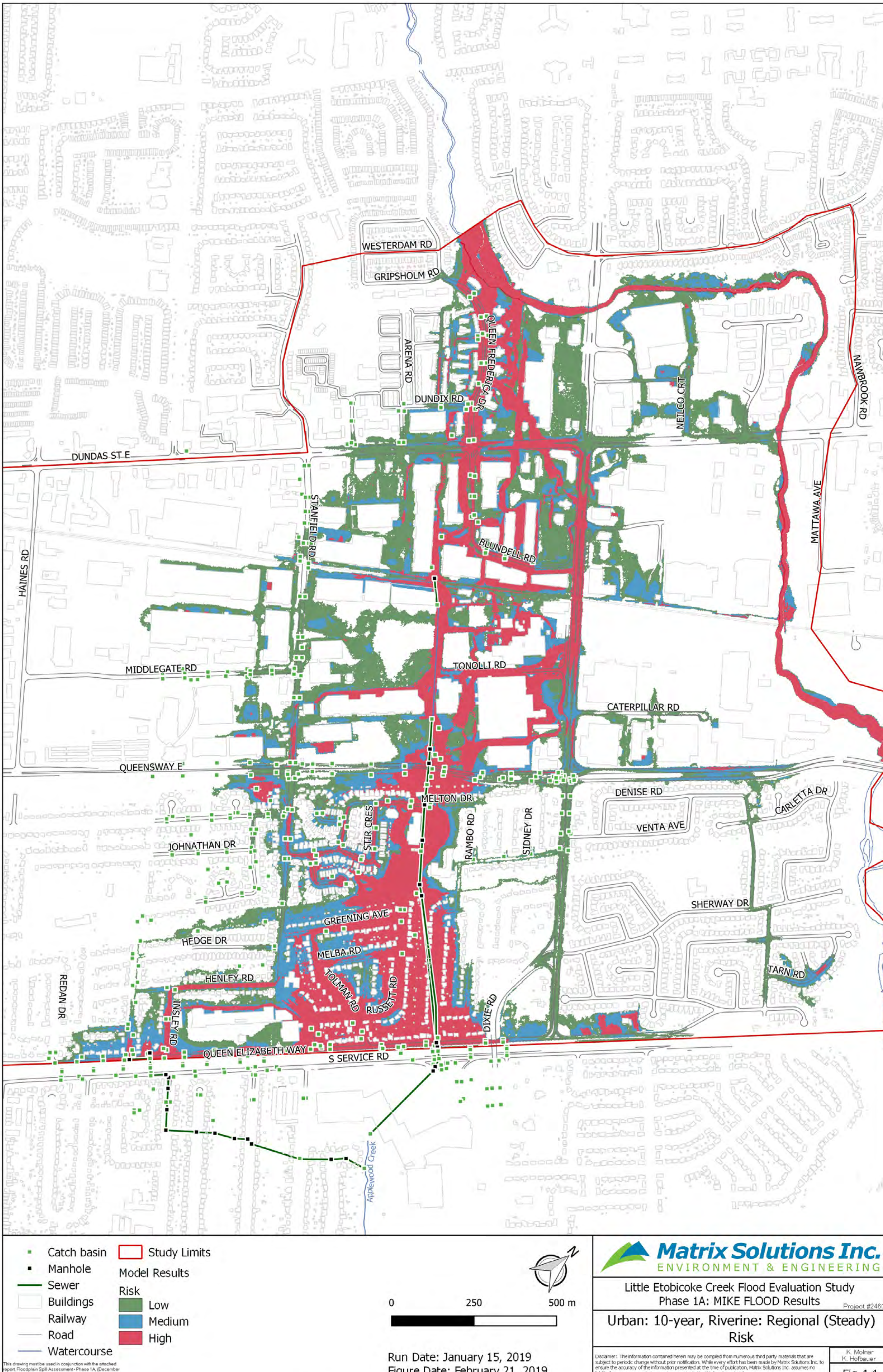
Urban: 10-year, Riverine: Regional (Steady)
Depth x Velocity

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.

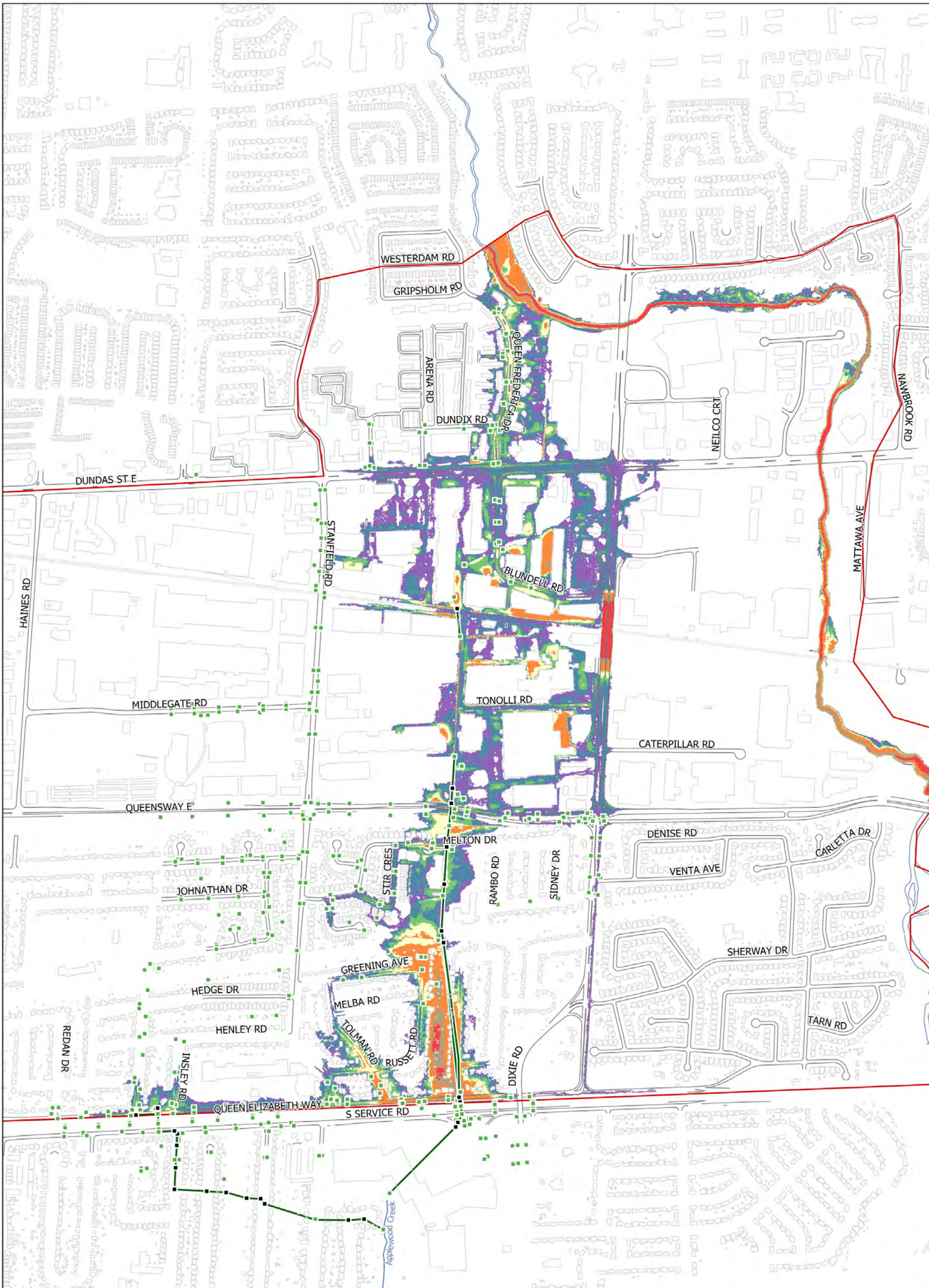
K. Molnar
K. Hofbauer

Fig 4.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_RegSS_NFCW.qgs



T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_10_RegSS_NFCW.qgs



Catch basin
Manhole
Sewer
Railway
Road
Watercourse

Buildings
Study Limits

Model Results
Maximum Depth (m)

- <= 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.80
- 0.80 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: October 31, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

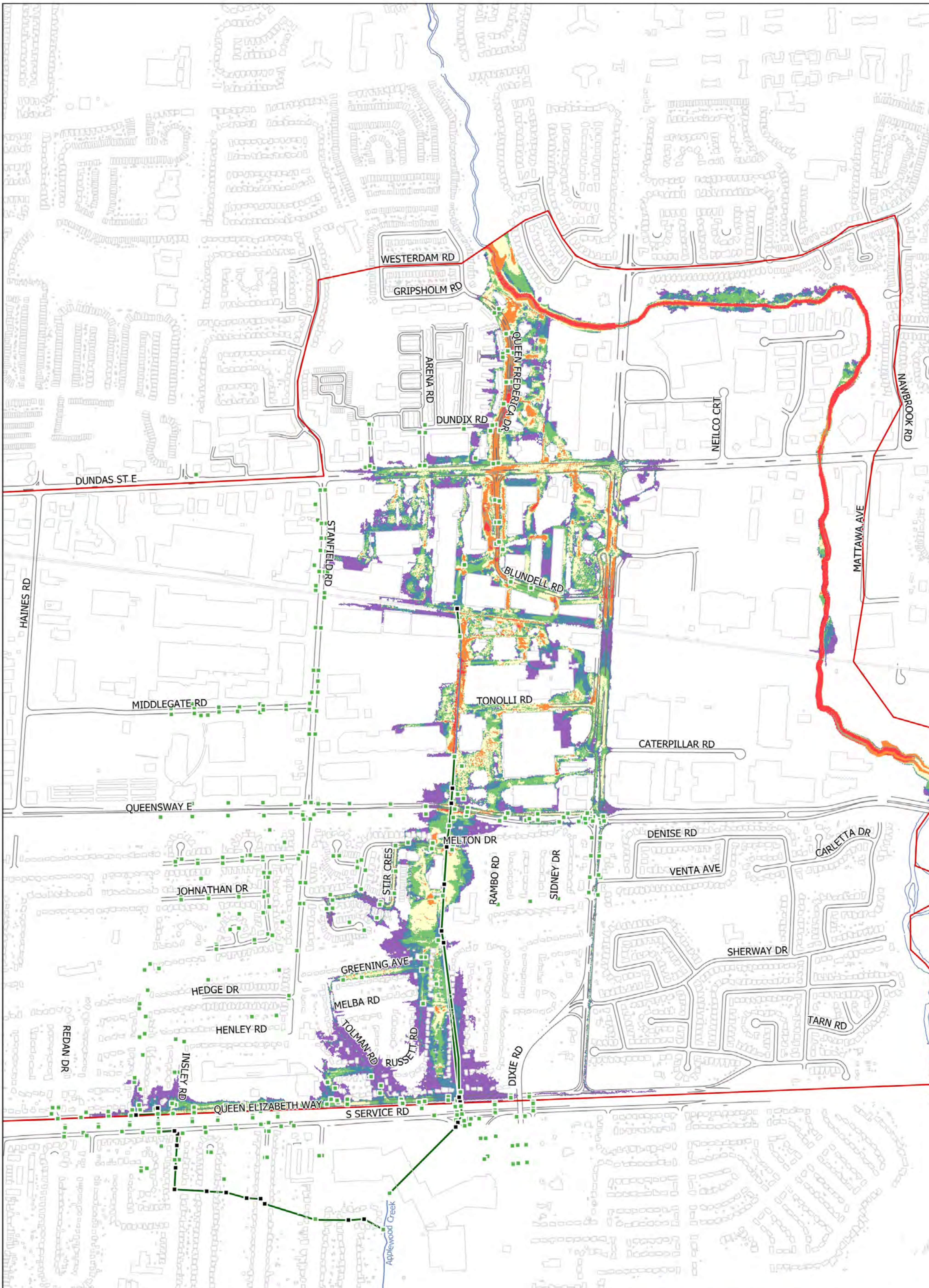
Urban: N/A, Riverine: 25-year (Unsteady)
Depth

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.

K. Molnar
K. Hofbauer

Fig 5.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_25US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Velocity (m/s)

<= 0.10
0.10 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 1.70
1.70 - 2.00
> 2.00

0 250 500 m

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Urban: N/A, Riverine: 25-year (Unsteady)
Velocity

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

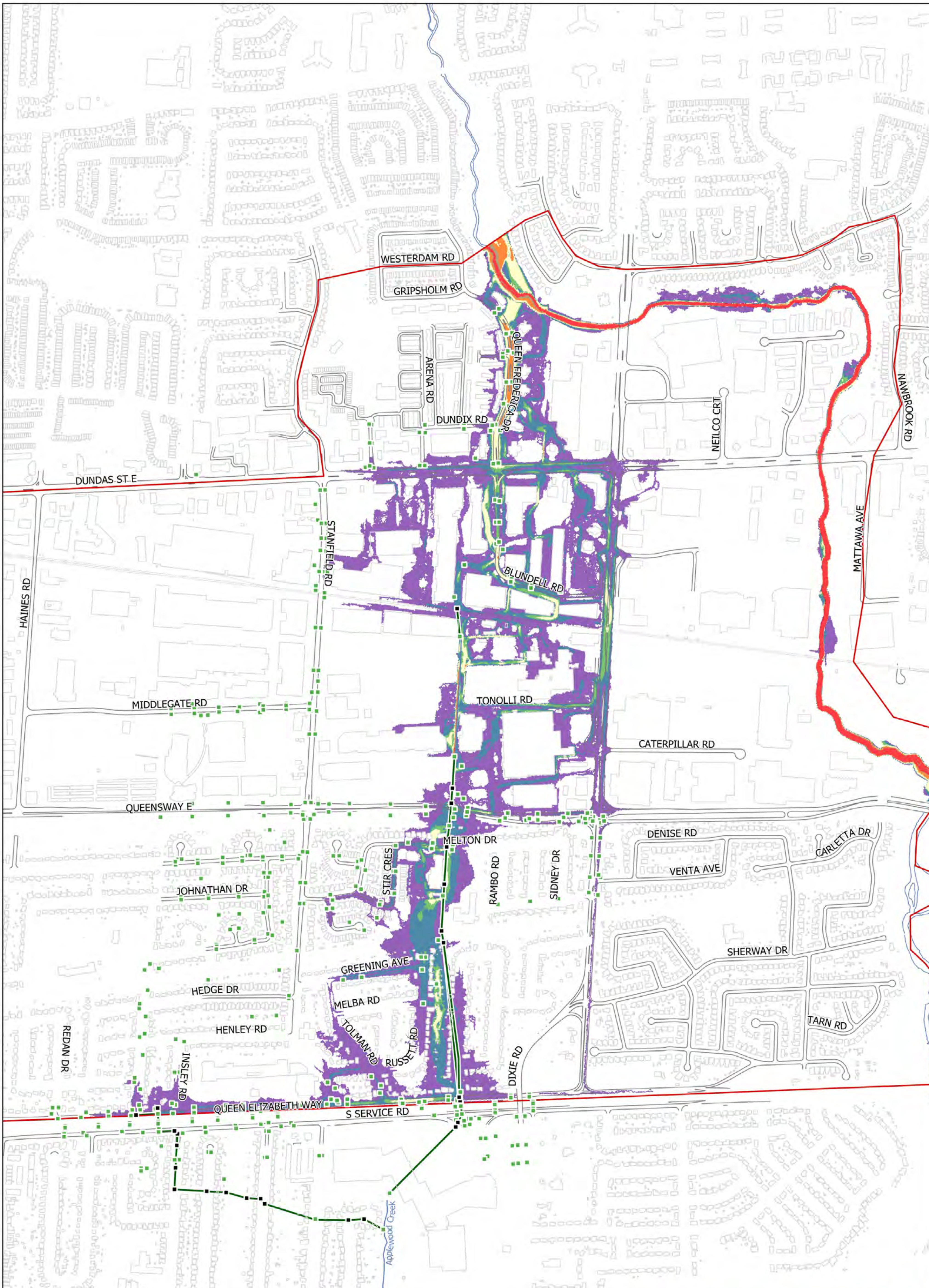
Run Date: October 31, 2018
Figure Date: February 21, 2019

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.

K. Molnar
K. Hofbauer

Fig 5.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_25US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results
Maximum Depth x Velocity (m²/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.37
- 0.37 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Urban: N/A, Riverine: 25-year (Unsteady)
Depth x Velocity

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

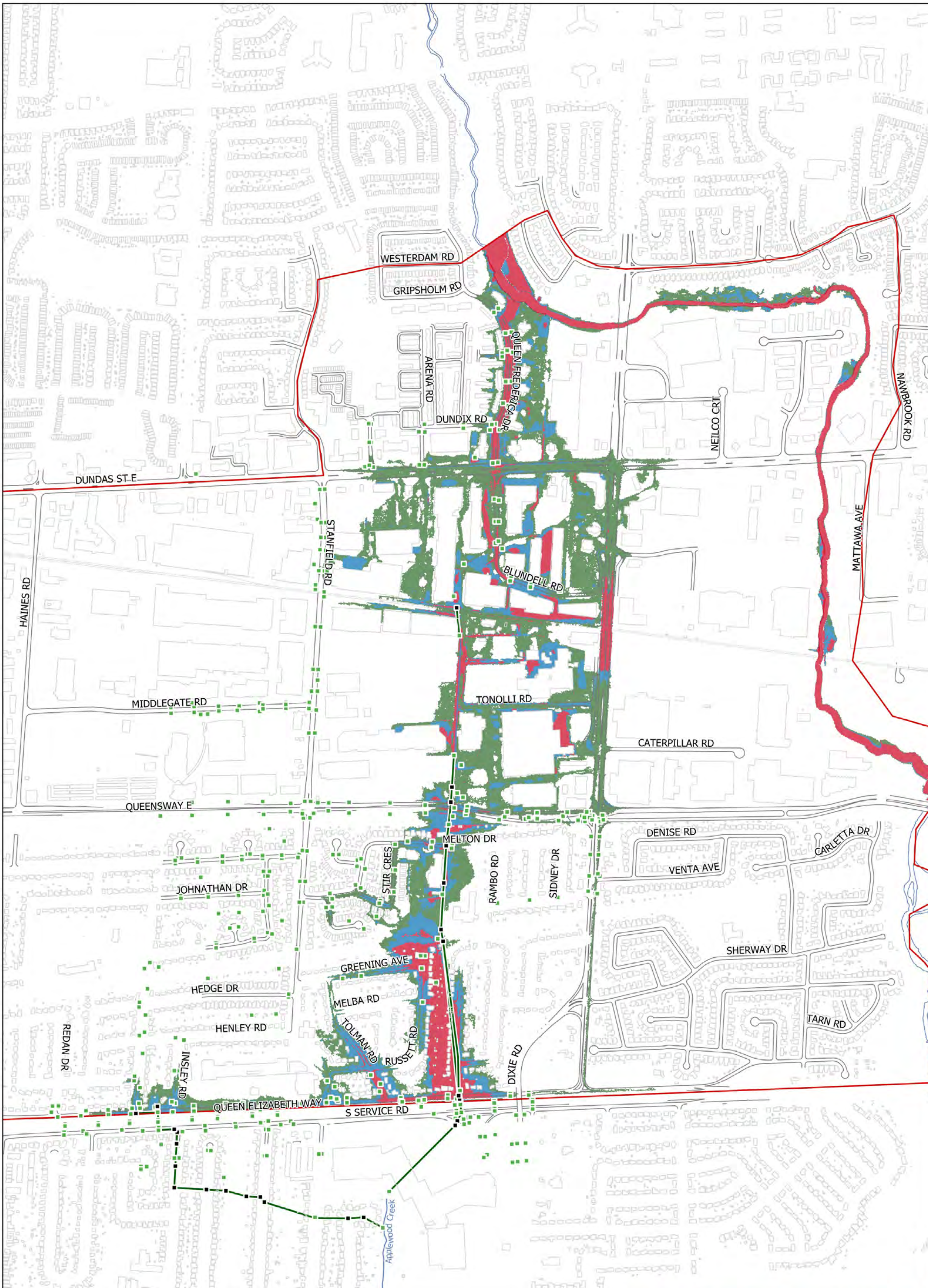
Run Date: October 31, 2018
Figure Date: February 21, 2019

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.

K. Molnar
K. Hofbauer

Fig 5.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_25US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse

Study Limits

Model Results

Risk

Low
Medium
High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: October 31, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Urban: N/A, Riverine: 25-year (Unsteady)
Risk

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.

K. Molnar
K. Hofbauer

Fig 5.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_25US_Ex.qgs

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Urban: N/A, Riverine: 50-year (Unsteady)
Depth

Run Date: November 13, 2018
Figure Date: February 21, 2019

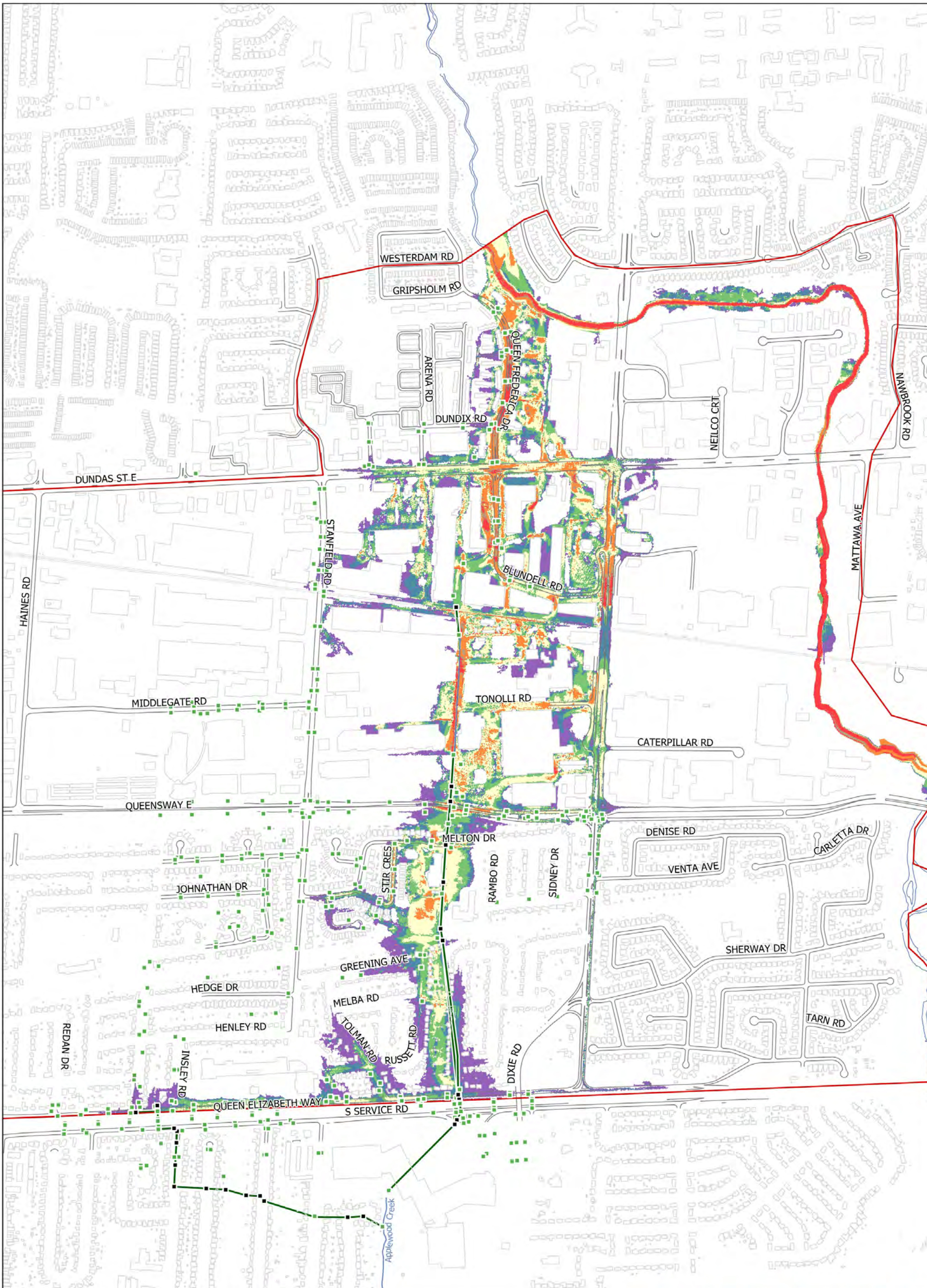
This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

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.

K. Molnar
K. Hofbauer

Fig 6.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_50US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Velocity (m/s)

<= 0.10
0.10 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 1.70
1.70 - 2.00
> 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 13, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

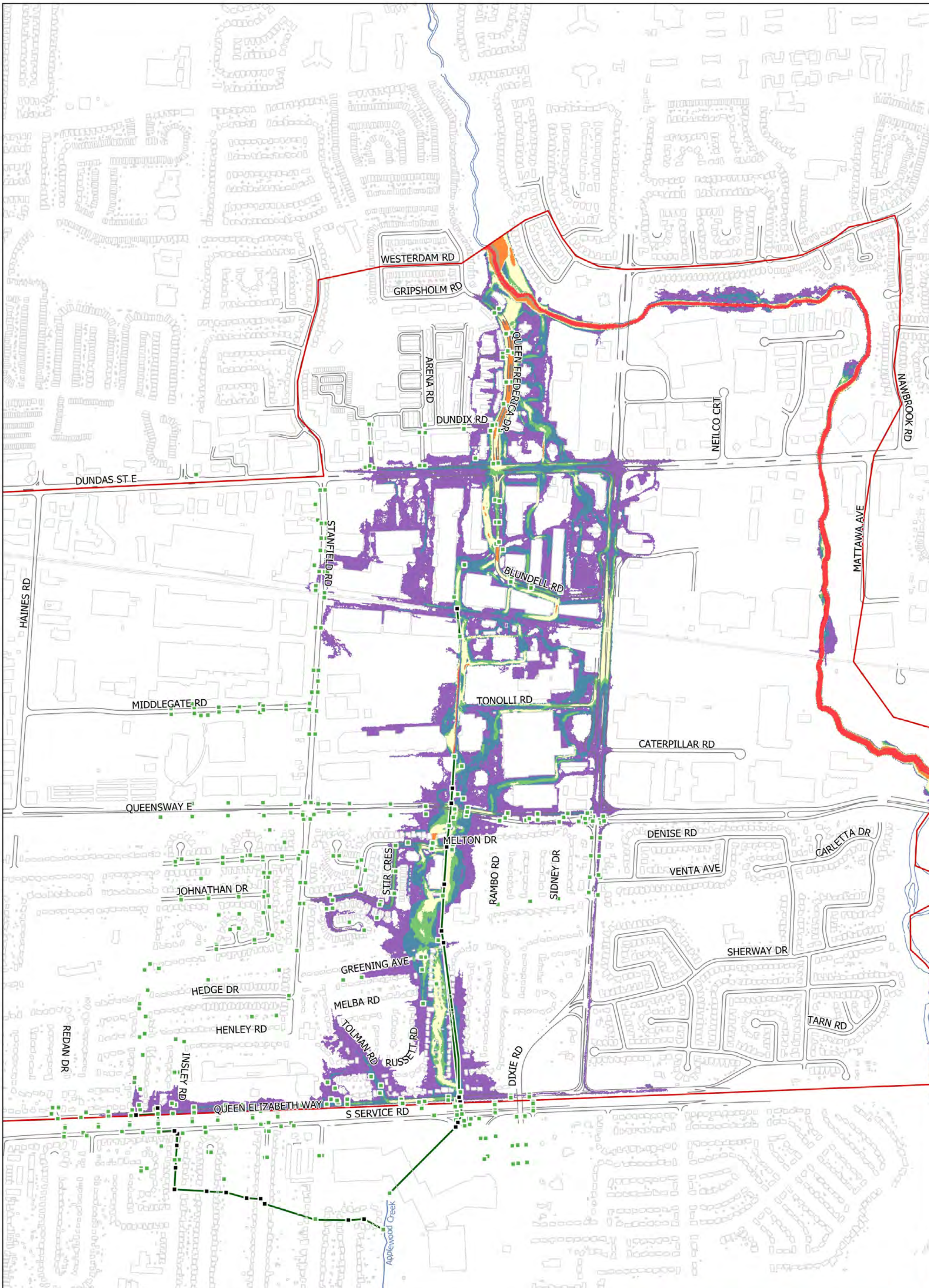
Urban: N/A, Riverine: 50-year (Unsteady)
Velocity

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.

K. Molnar
K. Hofbauer

Fig 6.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_50US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Depth x Velocity (m^2/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.37
- 0.37 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 13, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

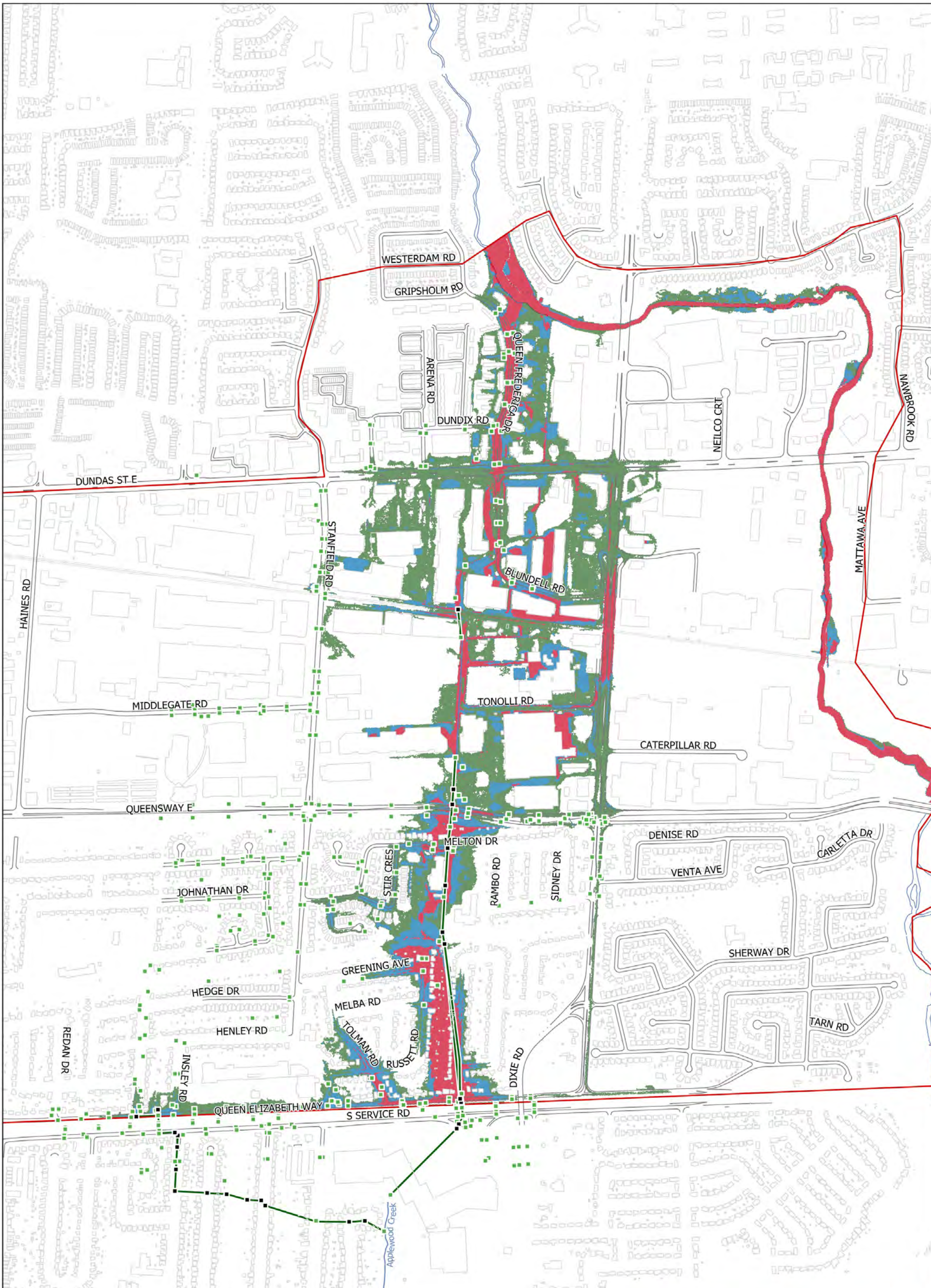
Project #24603

Urban: N/A, Riverine: 50-year (Unsteady)
Depth x Velocity

K. Molnar
K. Hofbauer

Fig 6.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_50US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse

Study Limits

Model Results

Risk

Low
Medium
High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: November 13, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

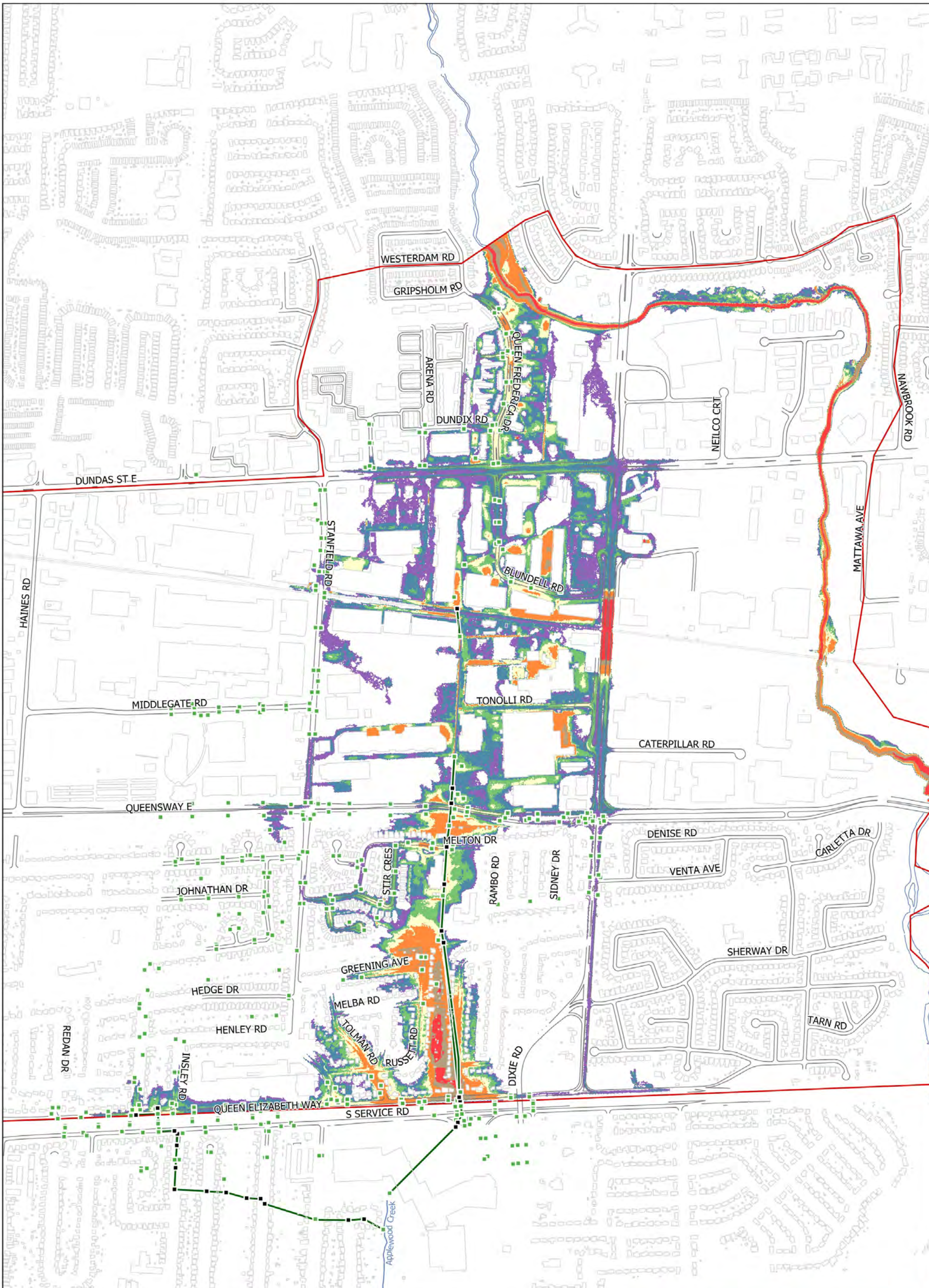
Urban: N/A, Riverine: 50-year (Unsteady)
Risk

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.

K. Molnar
K. Hofbauer

Fig 6.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_50US_Ex.qgs



Catch basin
Manhole
Sewer
Railway
Road
Watercourse

Buildings
Study Limits

Model Results
Maximum Depth (m)
<= 0.10
0.10 - 0.30
0.30 - 0.50
0.50 - 0.80
0.80 - 1.50
1.50 - 2.00
> 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 7, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results
Project #24603

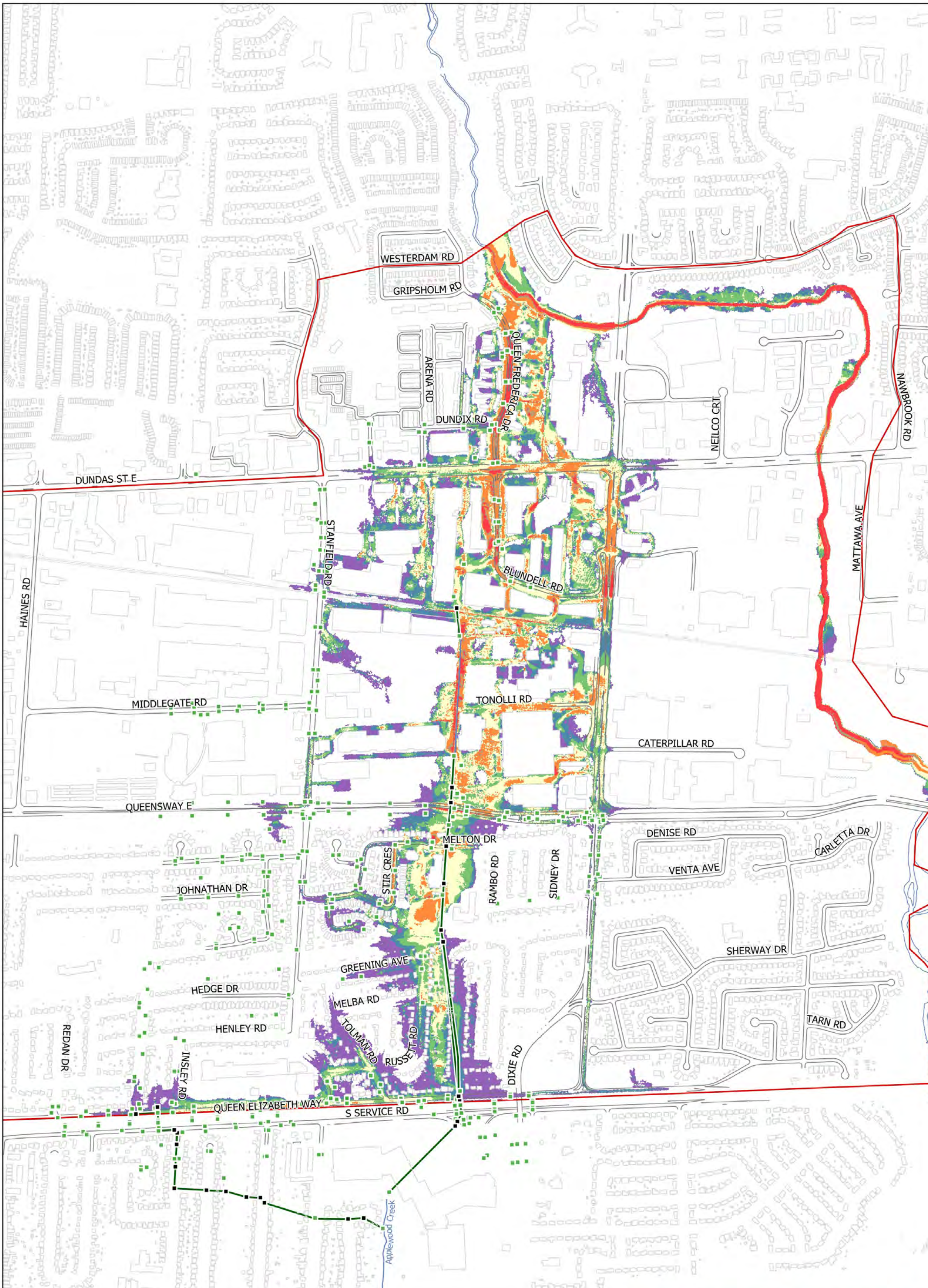
Urban: N/A, Riverine: 100-year (Unsteady)
Depth

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.

K. Molnar
K. Hofbauer

Fig 7.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_100US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Velocity (m/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.70
- 1.70 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 7, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

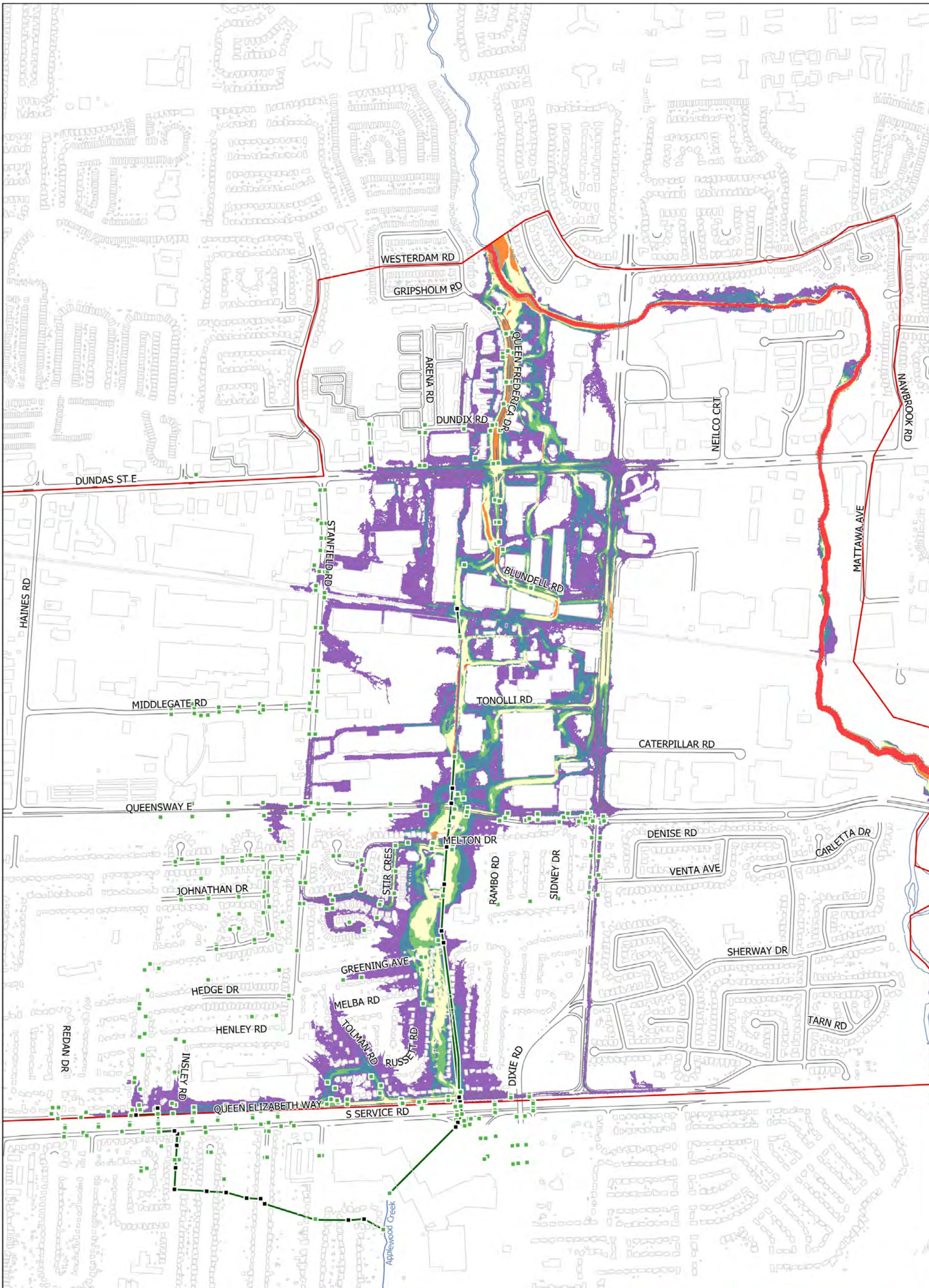
Project #24603

Urban: N/A, Riverine: 100-year (Unsteady)
Velocity

K. Molnar
K. Hofbauer

Fig 7.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_100US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road

Watercourse
Study Limits

Model Results

Maximum Depth x Velocity (m^2/s)

<= 0.10
0.10 - 0.25
0.25 - 0.37
0.37 - 1.00
1.00 - 1.50
1.50 - 2.00
> 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: November 7, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

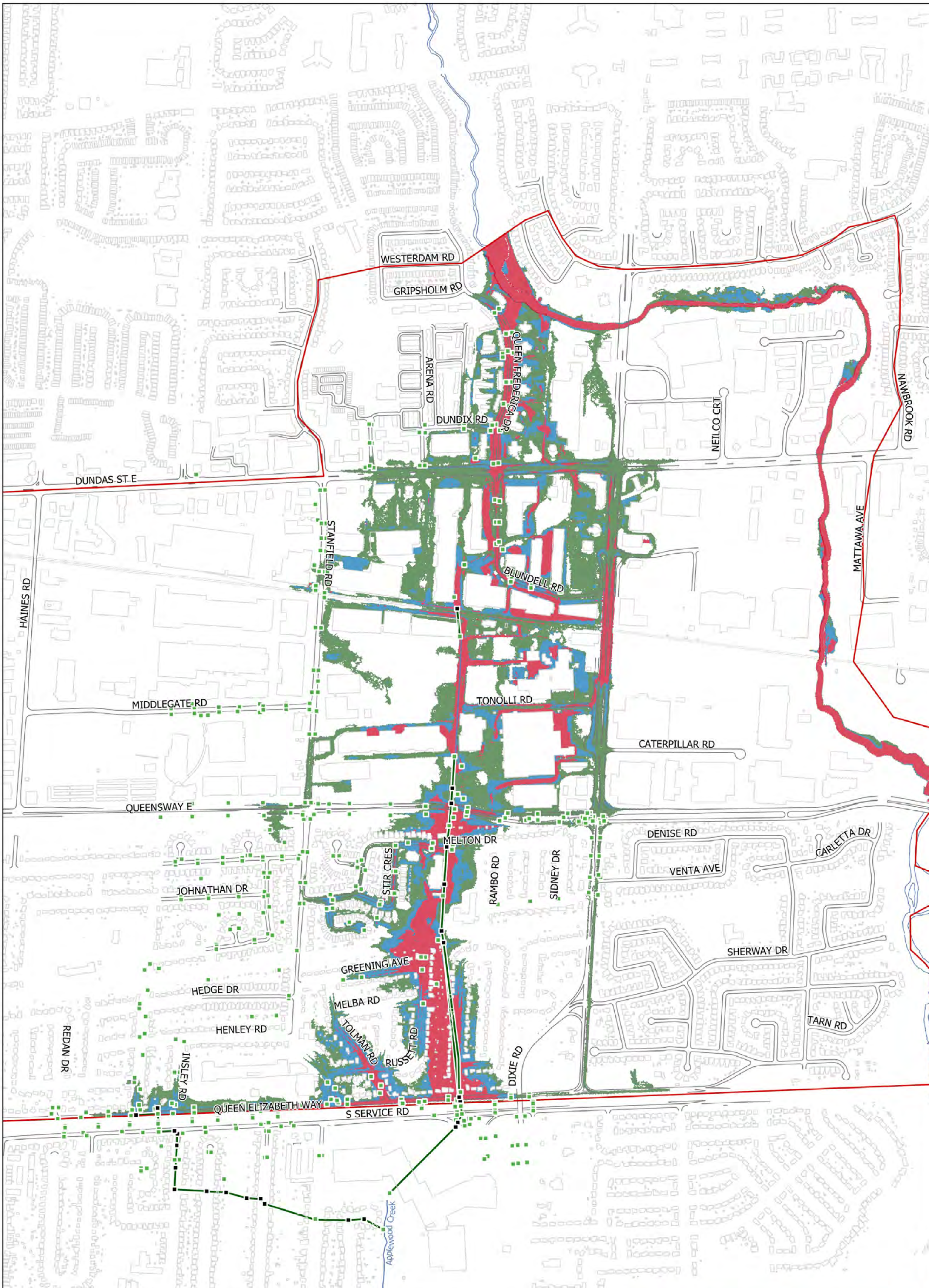
Urban: N/A, Riverine: 100-year (Unsteady)
Depth x Velocity

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.

K. Molnar
K. Hofbauer

Fig 7.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_100US_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse

Study Limits

Model Results

Risk

Low
Medium
High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: November 7, 2018
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

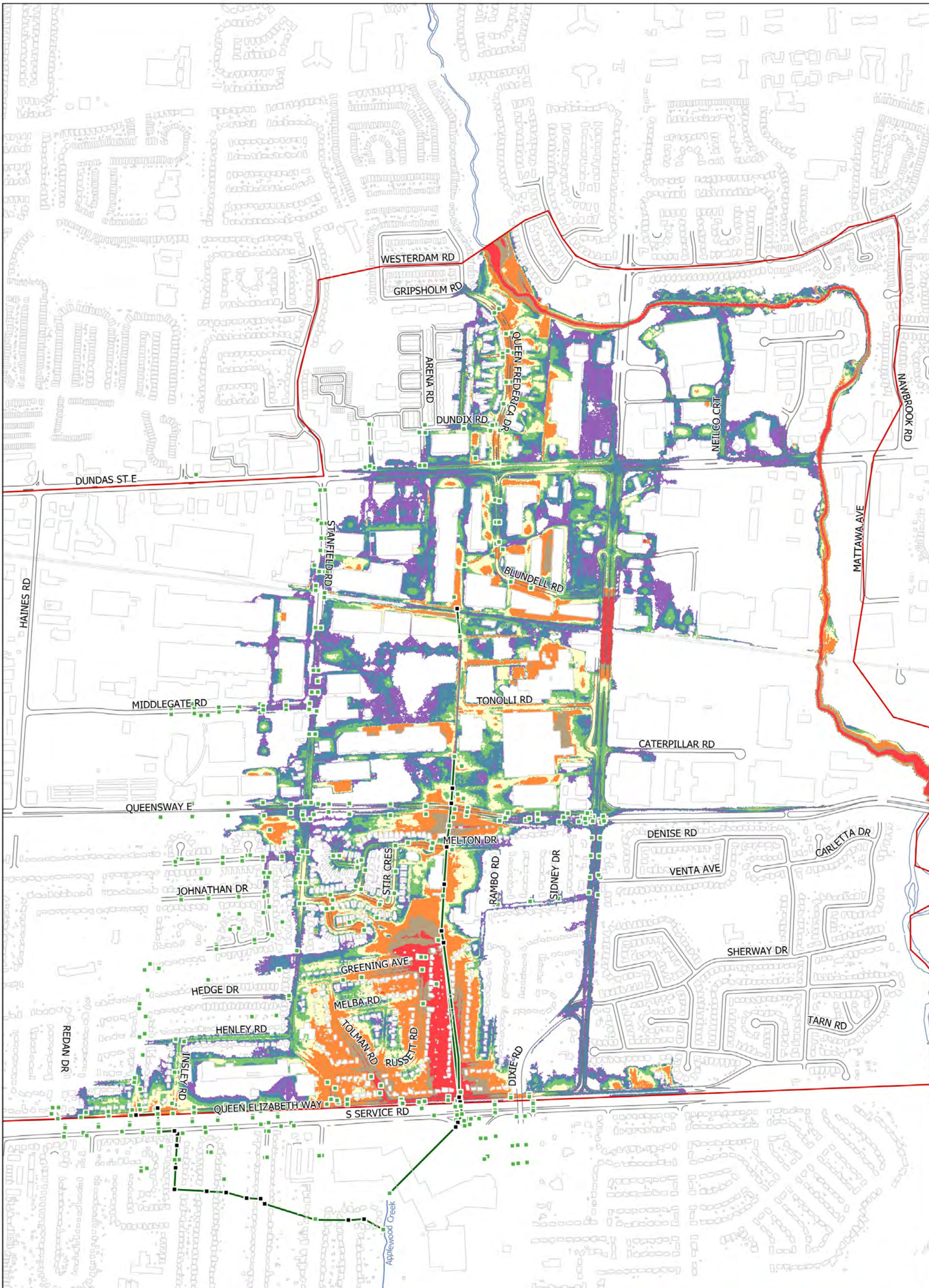
Urban: N/A, Riverine: 100-year (Unsteady) Risk

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.

K. Molnar
K. Hofbauer

Fig 7.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_100US_Ex.qgs



- Catch basin
- Manhole
- Sewer
- Railway
- Road
- Watercourse
- Buildings
- Study Limits

Model Results

Maximum Depth (m)

- <= 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 0.80
- 0.80 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Urban: N/A, Riverine: Regional (Unsteady)
Depth

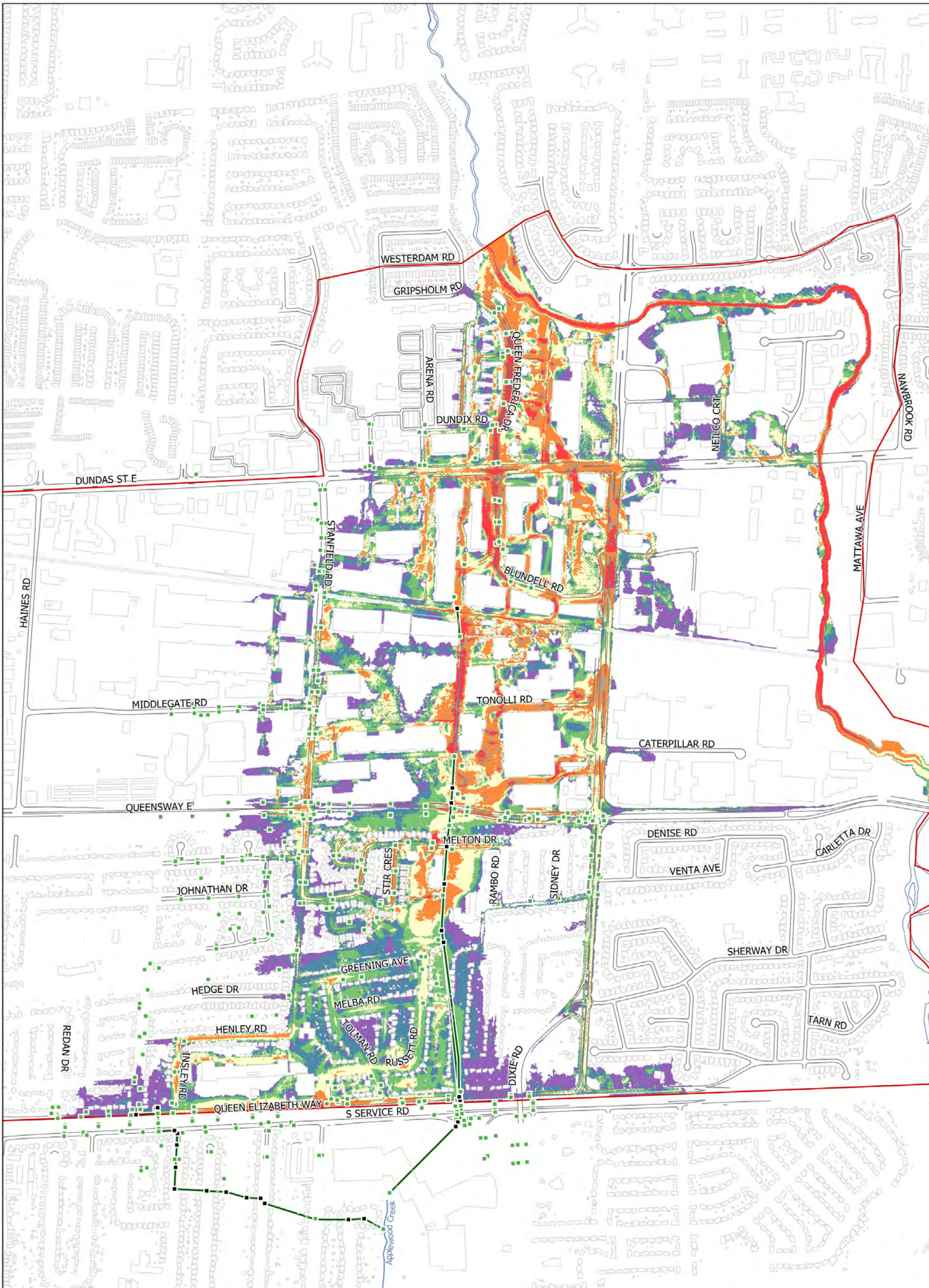
Run Date: January 16, 2019
Figure Date: February 21, 2019

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

K. Molnar
K. Hofbauer

Fig 8.1

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_RegUS_NFCW_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Velocity (m/s)

<= 0.10
0.10 - 0.25
0.25 - 0.50
0.50 - 1.00
1.00 - 1.70
1.70 - 2.00
> 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: January 16, 2019
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

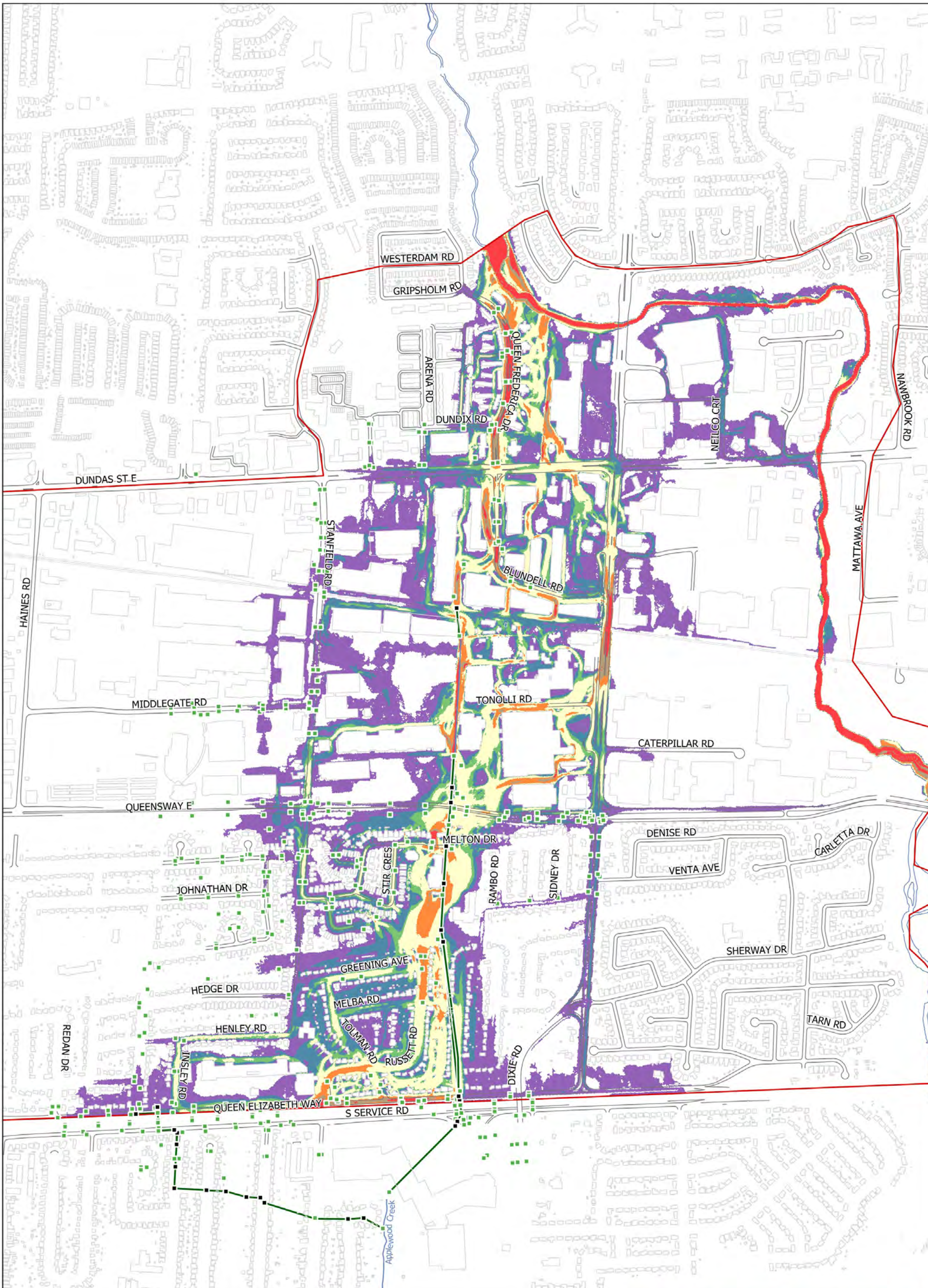
Project #24603

Urban: N/A, Riverine: Regional (Unsteady) Velocity

K. Molnar
K. Hofbauer

Fig 8.2

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_RegUS_NFCW_Ex.qgs



Catch basin
Manhole
Sewer
Buildings
Railway
Road
Watercourse
Study Limits

Model Results

Maximum Depth x Velocity (m^2/s)

- <= 0.10
- 0.10 - 0.25
- 0.25 - 0.37
- 0.37 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- > 2.00

0 250 500 m

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A (December 2018) and is subject to the same limitations and conditions stated in the report.

Run Date: January 16, 2019
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

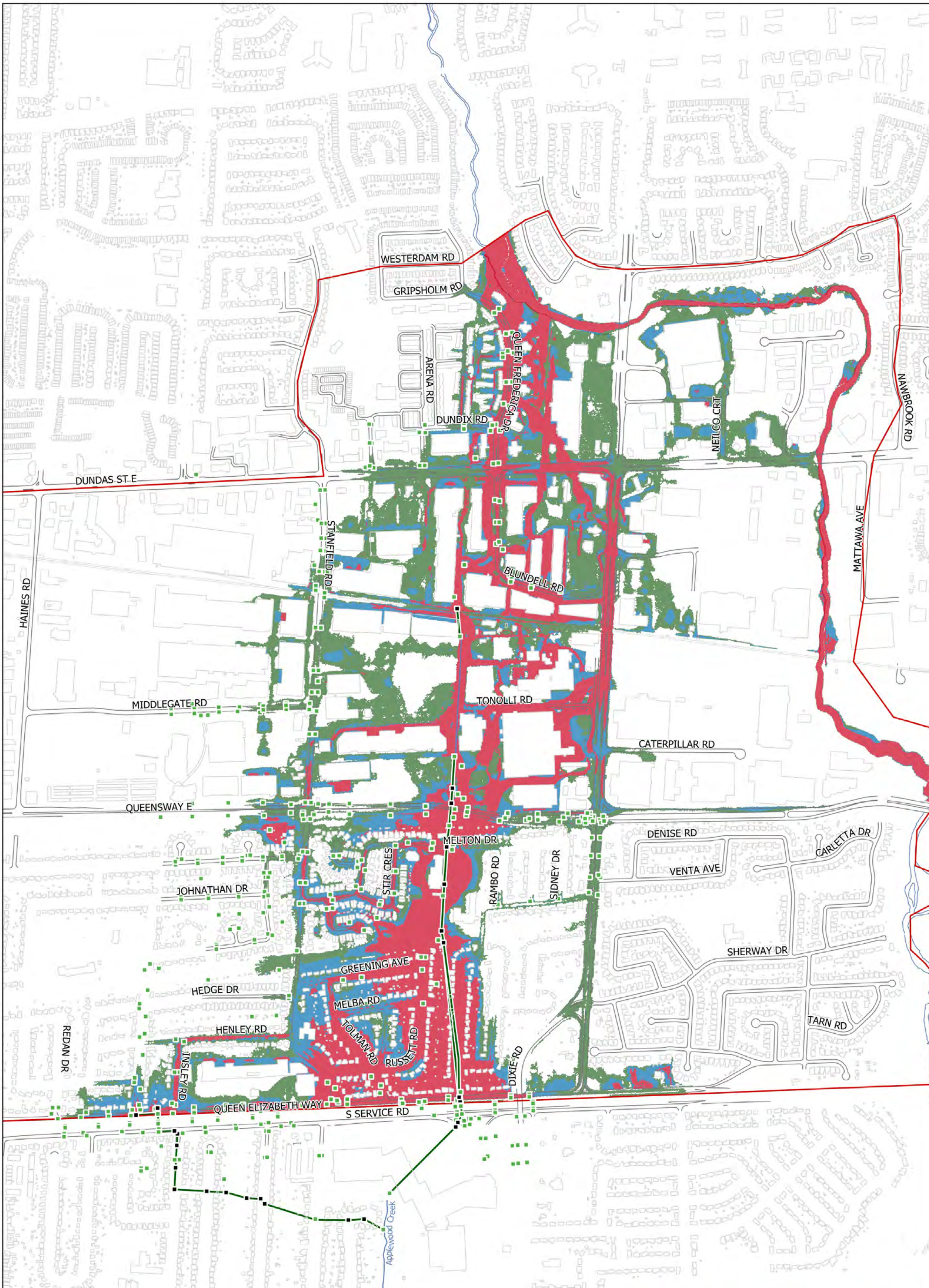
Urban: N/A, Riverine: Regional (Unsteady)
Depth x Velocity

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.

K. Molnar
K. Hofbauer

Fig 8.3

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_RegUS_NFCW_Ex.qgs



- Catch basin
- Manhole
- Sewer
- Buildings
- Railway
- Road
- Watercourse

Study Limits

Model Results

Risk

- Low
- Medium
- High

This drawing must be used in conjunction with the attached report, Floodplain Spill Assessment - Phase 1A, (December 2018) and is subject to the same limitations and conditions stated in the report.

0 250 500 m

Run Date: January 16, 2019
Figure Date: February 21, 2019

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Little Etobicoke Creek Flood Evaluation Study
Phase 1A: MIKE FLOOD Results

Project #24603

Urban: N/A, Riverine: Regional (Unsteady)
Risk

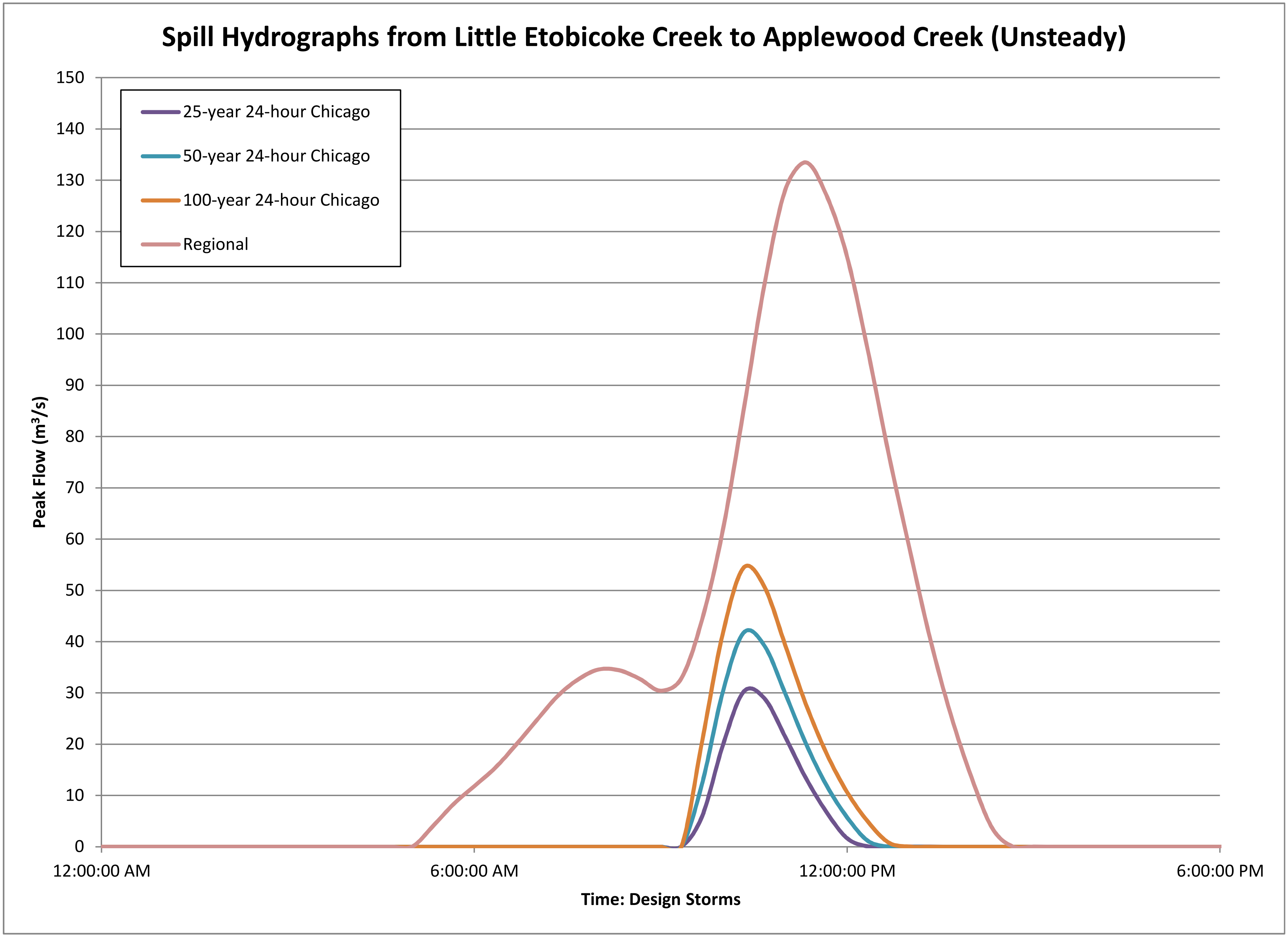
Disclaimer: The information contained herein may be compiled from numerous third party materials that are subject to periodic change without prior notification. While every effort has been made by Matrix Solutions Inc. to ensure the accuracy of the information presented at the time of publication, Matrix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

K. Molnar
K. Hofbauer

Fig 8.4

T:\24603 - Little EtobicokeCr_Flood\531\05 Analysis\Risk Mapping\Phase 1A\LEC Model Results_NA_RegUS_NFCW_Ex.qgs

APPENDIX A
Spill Hydrographs to Applewood Creek


Spill Hydrographs from Little Etobicoke Creek to Applewood Creek (Unsteady)
25-year 24-hour Chicago
50-year 24-hour Chicago
100-year 24-hour Chicago
Regional
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Peak Flow (m^3/s)
12:00:00 AM
6:00:00 AM
12:00:00 PM
6:00:00 PM
Time: Design Storms

Appendix A: Spill Hydrographs from Little Etobicoke Creek to Applewood Creek

Time: Design Storms	Unsteady State Peak Flows (m^3/s)			
	25-year	50-year	100-year	Regional
	24-hour Chicago			
1/1/2017 0:00	0.00	0.00	0.00	0.00
1/1/2017 0:20	0.00	0.00	0.00	0.00
1/1/2017 0:40	0.00	0.00	0.00	0.00
1/1/2017 1:00	0.00	0.00	0.00	0.00
1/1/2017 1:20	0.00	0.00	0.00	0.00
1/1/2017 1:40	0.00	0.00	0.00	0.00
1/1/2017 2:00	0.00	0.00	0.00	0.00
1/1/2017 2:20	0.00	0.00	0.00	0.00
1/1/2017 2:40	0.00	0.00	0.00	0.00
1/1/2017 3:00	0.00	0.00	0.00	0.00
1/1/2017 3:20	0.00	0.00	0.00	0.00
1/1/2017 3:40	0.00	0.00	0.00	0.00
1/1/2017 4:00	0.00	0.00	0.00	0.00
1/1/2017 4:20	0.00	0.00	0.00	0.00
1/1/2017 4:40	0.00	0.00	0.00	0.00
1/1/2017 5:00	0.00	0.00	0.00	0.02
1/1/2017 5:20	0.00	0.00	0.00	4.01
1/1/2017 5:40	0.00	0.00	0.00	8.31
1/1/2017 6:00	0.00	0.00	0.00	11.83
1/1/2017 6:20	0.00	0.00	0.00	15.36
1/1/2017 6:40	0.00	0.00	0.00	19.81
1/1/2017 7:00	0.00	0.00	0.00	24.60
1/1/2017 7:20	0.00	0.00	0.00	29.29
1/1/2017 7:40	0.00	0.00	0.00	32.60
1/1/2017 8:00	0.00	0.00	0.00	34.57
1/1/2017 8:20	0.00	0.00	0.00	34.41
1/1/2017 8:40	0.00	0.00	0.00	32.71
1/1/2017 9:00	0.00	0.00	0.00	30.43
1/1/2017 9:20	0.06	0.04	0.06	32.86
1/1/2017 9:40	5.95	12.35	20.58	44.35
1/1/2017 10:00	19.79	30.22	41.65	61.76
1/1/2017 10:20	30.21	41.73	54.40	85.11
1/1/2017 10:40	28.96	39.27	50.75	109.44
1/1/2017 11:00	21.53	30.00	39.48	127.97
1/1/2017 11:20	13.46	20.21	27.92	133.48
1/1/2017 11:40	6.78	12.02	18.24	127.08
1/1/2017 12:00	1.66	5.73	10.66	115.05
1/1/2017 12:20	0.07	1.16	4.91	96.83
1/1/2017 12:40	0.05	0.01	0.82	76.73
1/1/2017 13:00	0.03	0.01	0.01	58.38
1/1/2017 13:20	0.02	0.00	0.01	40.69
1/1/2017 13:40	0.01	0.00	0.00	25.81
1/1/2017 14:00	0.00	0.00	0.00	13.57
1/1/2017 14:20	0.00	0.00	0.00	3.68
1/1/2017 14:40	0.00	0.00	0.00	0.04
1/1/2017 15:00	0.00	0.00	0.00	0.01
1/1/2017 15:20	0.00	0.00	0.00	0.01
1/1/2017 15:40	0.00	0.00	0.00	0.00
1/1/2017 16:00	0.00	0.00	0.00	0.00
1/1/2017 16:20	0.00	0.00	0.00	0.00
1/1/2017 16:40	0.00	0.00	0.00	0.00
1/1/2017 17:00	0.00	0.00	0.00	0.00
1/1/2017 17:20	0.00	0.00	0.00	0.00
1/1/2017 17:40	0.00	0.00	0.00	0.00
1/1/2017 18:00	0.00	0.00	0.00	0.00
1/1/2017 18:20	0.00	0.00	0.00	0.00
1/1/2017 18:40	0.00	0.00	0.00	0.00
1/1/2017 19:00	0.00	0.00	0.00	0.00
1/1/2017 19:20	0.00	0.00	0.00	0.00
1/1/2017 19:40	0.00	0.00	0.00	0.00
1/1/2017 20:00	0.00	0.00	0.00	0.00
1/1/2017 20:20	0.00	0.00	0.00	0.00
1/1/2017 20:40	0.00	0.00	0.00	0.00
1/1/2017 21:00	0.00	0.00	0.00	0.00
1/1/2017 21:20	0.00	0.00	0.00	0.00
1/1/2017 21:40	0.00	0.00	0.00	0.00
1/1/2017 22:00	0.00	0.00	0.00	0.00
1/1/2017 22:20	0.00	0.00	0.00	0.00
1/1/2017 22:40	0.00	0.00	0.00	0.00
1/1/2017 23:00	0.00	0.00	0.00	0.00
1/1/2017 23:20	0.00	0.00	0.00	0.00
1/1/2017 23:40	0.00	0.00	0.00	0.00
1/2/2017 0:00	0.00	0.00	0.00	0.00

Spill Hydrographs - Flow Balance (Unsteady State)
PHASE 1A

Location	Flow (m^3/s)			
	Regional US	100yr 24hr Chi	50yr 24hr Chi	25yr 24hr Chi
1	215.6	129.9	114.9	100.9
2	133.5	54.4	41.7	30.2
3	3.9	0.0	0.0	0.0
4	3.8	0.0	0.0	0.0
5	0.1	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0
7	102.6	18.2	13.9	7.7
8	74.8	71.9	69.6	67.3
9	81.6	74.8	72.4	69.8
10	81.6	74.8	72.4	69.8