APPENDIX D: VALDOR'S MODELLING REPORT: 2D FLOOD IMPACT ANALYSIS - 9900 MARKHAM RD

VALDOR ENGINEERING INC.
Municipal • Land Development • Water Resources
Site Development • Project Management • Contract Administration
Consulting Engineers – est. 1992

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06 October 2023
File: **22147**

Sunny Communities
25 Brodie Drive Unit 1-2nd Floor
Richmond Hill, ON
L4B 3K7

Attention: **Christopher O'Hanlon**
President, Managing Partner

Dear Sir:

Re: **1D/2D Flood Impact Analysis for Proposed Mixed-Use Development**
9900 Markham Road, City of Markham, Ontario

Background

Valdor Engineering Inc. was retained by Sunny Communities to complete a one-dimensional / two-dimensional (1D/2D) hydraulic analysis using MIKE FLOOD regarding a parcel of land adjacent a tributary of the Rouge River proposed to be developed for residential/commercial use. The subject site is located at 9900 Markham Road in Markham, south of Major Mackenzie Drive East. A Site Location Plan is provided in **Figure 1**. SCS Consulting Group Limited is providing civil engineering design for this assignment.

A portion of the proposed residential/commercial development lies within the Regional floodplain as identified through a coupled 1D/2D hydraulic model prepared by the TRCA and the TRCA requires a hydraulic analysis be completed using the approved MIKE FLOOD model to confirm and mitigate any off-site impacts. As per TRCA policy, worsening of the existing flooding conditions is not permitted. The watercourse that passes through the study area is a tributary of the Rouge River known as Exhibition Creek within the Rouge River Watershed.

The proposed development will consist of residential blocks and commercial buildings, including access roads, walkways, parking, landscaping, and site servicing including water, sanitary and stormwater control measures. A copy of the proposed preliminary grading plan prepared by SCS Consulting Group Limited is provided in **Figure 2**.

Existing Hydraulic Conditions

The existing hydraulic conditions for the study area and surrounding areas are presented and described in the memorandum entitled *City of Markham – Highway 48 and Major Mackenzie Spill 2D Modelling* (TRCA, 14 July 2022) and also in the *Rouge River Floodplain Map Sheet*

#10 (TRCA, 23 June 2022). A copy of the TRCA's memorandum is provided in **Attachment A** for reference. The location of the proposed residential/commercial development at 9900 Markham Road in Markham lies within the original study area associated with the July 2022 flood 2D spill analysis prepared by the TRCA.

As noted in the 14 July 2022 TRCA Memorandum, the culvert system crossing under Markham Road was modelled based on the following assumptions:

> *Highway 48 Crossing, South of Major Mackenzie*
>
> - *3 m by 1.5 m box concrete culvert at upstream side, two circular CSP with 1.5 m and 1.05 m diameter, respectively at downstream side.*
> - *To be conservative, this crossing was coded into the model as two circular CSPs with 1.5 m and 1.05 m diameter, considering 3 bend losses (for a box culvert) (i.e., 0.818) as per FEMA – Hydraulic Design of Highway Culverts (April 2012).*

The configurations assumed for the Markham Road culvert system in the current approved MIKE FLOOD hydraulic model is illustrated in **Figure 3**. The WSEL and flow direction mapping based on the current approved MIKE FLOOD model is provided in **Figures 3(a)** and **3(b)**.

Comparison between Existing MIKE FLOOD Bathymetry and Available Topographic Survey

A comparison was made between the existing 2D MIKE FLOOD bathymetry and the available topographic survey. Based on a comparison of elevations, it was determined that the existing 2D model bathymetry matched well with the topographic survey at most locations where reliable comparisons could be achieved. Typically, the elevations were found to be within 7 cm on average. A copy of the results of the comparison of elevations completed in and around the subject property is provided in **Table A.1** in **Attachment A**. A copy of the topographic survey is included in **Figure A.1(a)**. Additional topographic survey information for existing conditions is provided in the previous site servicing plans included in **Figures A.1(b)**, **A.1(c)** and **A.1(d)**.

Updated Existing Hydraulic Conditions

Field investigations were undertaken by Valdor on 05 December 2022 to confirm the configuration, dimensions and physical properties of the culvert system crossing under Markham Road adjacent the subject site. A sketch of the existing culvert configuration including dimensions and physical properties is attached in **Figure A.2**. Supporting photos are provided in **Photos A.1** through **A.4**. The dimensions were compared to those provided in the current approved MIKE FLOOD model provided by the TRCA. A sketch of the culvert configuration assumed in the TRCA model including dimensions and physical properties is provide in **Figure 3**.

Based on the field investigations, we confirmed the 1500 mm pipe under Markham Road is a corrugated steel pipe (CSP), however, the 1050 mm pipe under Markham Road consists of a smooth steel pipe, as opposed to the TRCA's assumption of a CSP. It was also noted that the pipe extensions installed to the east of the original 1500 mm and 1050 mm pipes (presumably associated with Markham Road improvements) are constructed of concrete as opposed to steel. Immediately upstream of the original 1500 mm and 1050 mm pipes on the west side of Markham

Road is a concrete box manhole that connects to the 3000 mm (span) x 1500 mm (height) box culvert that extends north to the open channel near the north limit of the subject property.

Methodology

As requested by the Client, the current approved 1D/2D MIKE FLOOD model was updated to include the field verified (*i.e.* "actual") physical properties of the culvert system crossing under Markham Road. A sketch of the culvert configuration assumed by Valdor in the updated existing conditions MIKE FLOOD model including dimensions and physical properties is attached in **Figure 4**. To simplify the modelling of the 1500 mm diameter and 1050 mm diameter pipes under Markham Road, the highest roughness value for each of the linear pipe systems was used as a conservative measure (*i.e.* the roughness values used for the 1500 mm and 1050 mm diameter pipes was 0.024 and 0.013, respectively).

To enable the coding of the complex culvert system consisting of multiple culverts in series and in parallel with varying dimensions and roughness values, the culvert system was modelled in MIKE FLOOD using the "Closed Section" approach. The "Closed Section" approach offers more flexibility when coding complex culvert systems than the "Culvert Structure" approach and, in our opinion, is warranted and appropriate in this case.

To validate the choice of methodology using the "Closed Section" approach, we completed an additional modelling scenario whereby we modelled the same culvert configuration and culvert physical properties (*i.e.* two long pipes consisting of a 1500 mm diameter CSP and a 1050 mm diameter CSP with a Manning's roughness value of 0.024) assumed by the TRCA using the "Closed Section" approach instead of the "Culvert Structure" approach.

To ensure equivalent losses (*e.g.* entrance, exit, bend) applied to the model using the "Closed Section" approach as applied to the TRCA's model using the "Culvert Structure" approach, a separate culvert model using PCSWMM was prepared. Using the PCSWMM culvert model, the TRCA's culvert properties (*i.e.* entrance, exit and bend losses) were used and the results for headwater depth and WSEL were computed. Similarly, a PCSWMM model was prepared excluding entrance/exit losses and bend losses to calculate the required increase in Manning's roughness required to account for the entrance/exit losses and bend losses that resulted in the same headwater depth and WSEL. This was completed to determine the appropriate roughness to use for the MIKE FLOOD model using the "Closed Section" approach. As shown in **Tables B.1** and **B.2** in **Attachment B**, the equivalent roughness values for the 1500 mm diameter pipe and the 1050 mm diameter pipe were calculated to be 0.0285 and 0.0269, respectively.

The results of this "validation" scenario are provided in **Figures B.1** and **B.2** and indicate generally similar results to the TRCA's model using the "Culvert Structure" approach when comparing the WSEL differences and the flood extent differences, respectively. The validation procedure and results have been reviewed and approved by the TRCA (see correspondence included in **Attachment B**).

Minor Losses

In preparing the updated existing conditions model, minor losses including entrance/exit losses, manhole losses and bend losses were considered and accounted for in coding the complex culvert system crossing Markham Road. As shown in **Figure 4**, the 3000 mm (w) x 1500 mm (h) concrete box culvert consists of three (3) bends. The bend loss coefficients used for the three bends were 0.254 at Bend 1 (north) and Bend 2 (middle) and 0.31 at Bend 3 (south), as per the existing TRCA hydraulic model. A loss coefficient of 0.05 was used at the manhole connecting the box culvert with the two circular pipes under Markham Road. An entry loss coefficient of 0.5 and an exit loss coefficient of 1.0 were applied to the inlet and outlet of the culvert system as per standard practice.

Using PCSWMM, a model was prepared for the "actual" culvert system crossing under Markham Road using the appropriate culvert property values (*i.e.* entrance, exit, manhole and bend losses and roughness). Similarly, a PCSWMM model was prepared excluding entrance/exit losses, manhole losses and bend losses to calculate the required increase in Manning's roughness required to account for these minor losses that resulted in the same headwater depth and WSEL. This was completed to determine the appropriate roughness to use for the MIKE FLOOD model for the "actual" culvert system using the "Closed Section" approach. As shown in **Table A.2**, the equivalent roughness values for the 3000 mm (w) x 1500 mm (h) box culvert, 1500 mm diameter pipe and 1050 mm diameter pipe were calculated to be 0.0186, 0.0343 and 0.0186, respectively.

Updated Hydrology (SCS Consulting)

While completing related project work, it was identified by SCS Consulting that the drainage areas and contributing peak flows north of Major Mackenzie Drive were not consistent with the peak flows used in the current approved MIKE FLOOD hydraulic model. The peak flows were found to be higher than those used in the TRCA's model. Discussions regarding this were undertaken with TRCA and it was agreed to update the MIKE FLOOD model using the new flow information to ensure appropriate floodproofing and protection for the proposed development. The updated peak flow information applied to the updated existing conditions and proposed conditions MIKE FLOOD models is provided in **Table 1** below including a comparison with the current peak flows.

Table 1: Updated Peak Flows and Regional Peak Flow Comparison (SCS Consulting)

Future Uncontrolled Scenario - Regional Flow Comparison

Node	Regional Flow - Per 2018 TRCA Modelling (m^3/s)	Regional Flow - Per 2023 SCS Modelling (m^3/s)
J5670.032	5.83	7.09
J4789.696	11.98	13.13

Results

The cumulative future uncontrolled Regional peak flow for Exhibition Creek in the vicinity of the site from Flow Node J4789.696 (chainage 1260 m) is 13.13 m^3/s. It is noted that the incremental point source flow input from Flow Node location J4789.696 is applied starting at the upstream Flow Node J5670.032 (chainage 0 m) which is conservative.

The results of the updated existing conditions model using the "Closed Section" approach to model the complex culvert system crossing under Markham Road based on the field verified configuration, dimensions and physical properties were reviewed and processed.

The Regional WSEL map, the Regional flood depth map, the Regional flood velocity map and the Regional flow direction map based on the updated approved Exhibition Creek 1D/2D hydraulic model for the study area under existing conditions are provided for reference in **Figure 5**, **Figure C.1**, **Figure C.2** and **Figure C.3**, respectively. Based on a review of the results of the updated approved existing conditions 1D/2D hydraulic model, the following observations regarding flooding are noted under existing conditions:

1. The subject site for the proposed residential/commercial development is subject to partial flooding during the Regional storm.
2. The depth of flooding during the Regional storm generally varies between 0.05 m and 0.35 m (max. = 0.57 m) within the subject property boundary.
3. The Regional WSEL within the subject property varies between 211.69 m at the upstream (north) limit of the site and 211.03 m at the downstream (south) limit of the site.
4. The flow velocity during the Regional storm is between 0.04 m/s and 0.42 m/s within the property boundary.
5. In general, the Regional WSEL to the north of the subject site (along the channel) varies between 211.73 m and 211.77 m.

<u>1D/2D Hydraulic Analysis Results – Proposed Residential/Commercial Development Grading Modifications</u>

The Regional WSEL, flood depth, flood velocity and flow direction results using the 1D/2D hydraulic model for the proposed grading alterations associated with the residential/commercial development are provided in **Figure 6**, **Figure C.4**, **Figure C.5** and **Figure C.6**, respectively. A comparison of the proposed flood WSEL and flood velocity within the study area with the existing WSEL and flood velocity (*i.e.* WSEL and velocity difference mapping) is provided in **Figures 7(a)** (localized view) and **7(b)** (expanded view) and **Figures 8(a)** (localized view) and **8(b)** (expanded view), respectively.

In general, the Regional WSEL to the north of the subject site (along the channel) varies between 211.84 m and 211.87 m.

The results of the 1D/2D MIKE FLOOD hydraulic model demonstrate that the subject property is flood free based on the proposed preliminary grading plan.

To satisfy the TRCA's typical requirements for freeboard, it is recommended that the finished floor and building opening elevations for the proposed building north of Harvard Way and the surface grading to the east, west and north of this proposed building be set at a minimum elevation of 212.17 m. This will ensure a freeboard of 0.30 m is maintained along most of the north property line regarding the proposed development.

As a result of the proposed grading on site, the flow patterns within the study area are not significantly altered except for the subject site, south of the subject site and Markham Road. Regarding the spill to the subject site, to the south of the subject site and to Markham Road that occurs under updated existing conditions, the proposed preliminary site grading plan provides an overall net benefit by limiting the extent of this spill and the lands affected. Under proposed conditions, the spill to the south of the subject site and to Markham Road is eliminated whereas flooding depths up to 0.42 m occur in these areas under updated existing conditions.

Most of the changes in flood WSEL and flood flow velocity within the study area and outside the proposed residential/commercial development grading extents are limited to less than approximately +/- 0.11 m and +/- 0.10 m/s, respectively [see **Figures 7(a)** and **7(b)** and **Figures 8(a)** and **8(b)**]. It is noted that increases in WSEL > 0.02 m are highly localized and are mostly contained within the existing valley upstream of the site under proposed conditions.

Since the proposed grading alterations (cutting/filling) for the subject site and proposed development are located in a spill area and since it is demonstrated there are no significant impacts to the floodplain characteristics regarding WSEL, depth and velocity within the study area, it is our opinion that TRCA's Living City Policy 8.5.1.10 regarding floodplain spill areas is satisfied.

Summary and Conclusions

Based on the results of the 1D/2D hydraulic investigations using MIKE FLOOD regarding the subject site located at 9900 Markham Road in the City of Markham, we offer the following summary and conclusions:

1. The preliminary grading plan for the proposed residential/commercial development prepared by SCS Consulting Group Limited provides Regional level flood protection for the subject property. The finished floor and building opening elevations along the north property limit shall be set at a minimum elevation of 212.17 m. As such, a freeboard of 0.30 m is maintained along most of the north property line regarding the proposed development.
2. The impacts of the proposed grading works associated with the residential/commercial development result in minor but not significant alterations to the flow patterns within the study area. It is noted that an overall net benefit is achieved for the study area by eliminating the flooding to Markham Road associated with the spill north of the site under the updated existing conditions.

3. As a result of the proposed site grading, Regional flooding within the subject property and along Markham Road is eliminated.
4. Based on the comparison of flood WSEL with updated existing conditions, the WSEL under proposed conditions is generally the same or shows an increase/decrease of < 0.11 m in the upstream and downstream limits of the study area outside the subject property. It is noted that the increases in WSEL > 0.02 m are highly localized and are mostly contained within the existing valley upstream of the site under proposed conditions and, as such, do not pose any significant increase in flood risk.
5. Regarding the comparison of the updated existing and proposed conditions velocity, the majority of the changes in velocity within the study area are limited to approximately +/- 0.10 m/s which is considered negligible.
6. Since the proposed grading alterations for the subject site and proposed development are located in a spill area and since it is demonstrated there are no significant impacts to the floodplain characteristics regarding WSEL, depth and velocity within the study area, it is our opinion that TRCA's Living City Policy 8.5.1.10 regarding floodplain spill areas is satisfied.

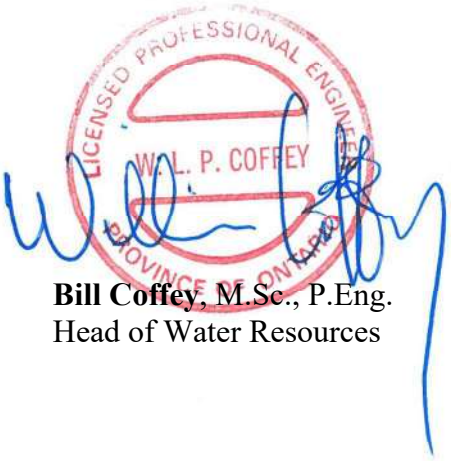
Recommendations

Based on the results of the 1D/2D hydraulic investigations using MIKE FLOOD regarding the proposed residential/commercial development, we offer the following recommendations:

1. The results of these investigations demonstrate that the proposed grading alterations associated with the proposed residential/commercial development located at 9900 Markham Road in the City of Markham do not result in any significant or extensive increases in flood depth and flow velocity and, as such, the proposed development located at 9900 Markham Road in proximity to Exhibition Creek within the Rouge River Watershed should be approved to proceed as per the proposed preliminary grading plan prepared by SCS Consulting Group Limited and including the recommendation below.
2. It is recommended that the finished floor and building opening elevations for the proposed building north of Harvard Way and the surface grading to the east, west and north of this proposed building be set at a minimum elevation of 212.17 m. This will ensure a freeboard of 0.30 m is maintained along most of the north property line and will ensure that the very localized higher WSEL's in the vicinity of the box culvert inlet will not pose a flood risk.

Respectfully submitted,

VALDOR ENGINEERING INC.



Abdul Baten, M.Sc.
Water Resources Analyst

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources

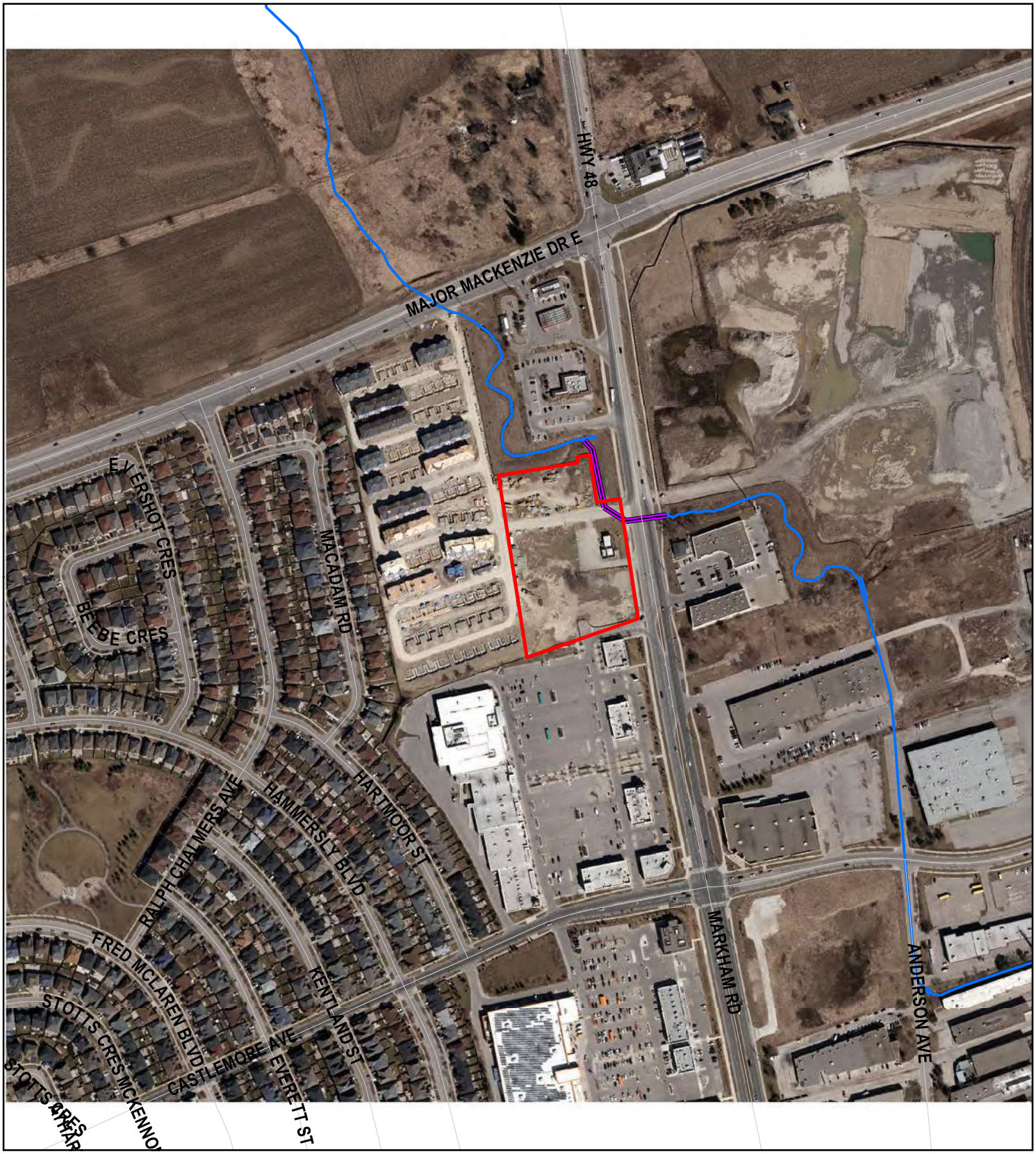


Figure 1
LOCATION MAP

0 50 100 200 Meters

26 January 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

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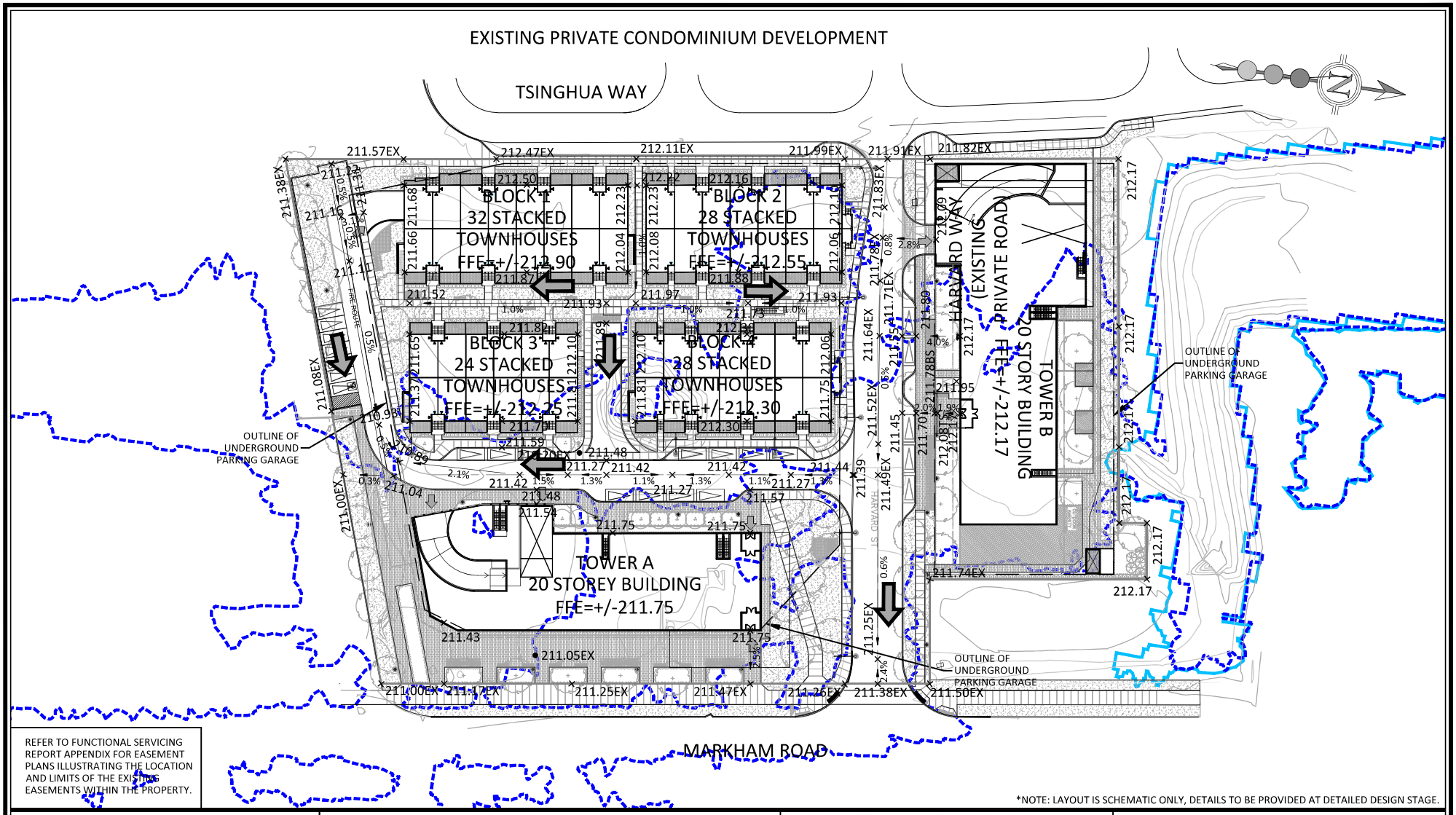
VALDOR



REFER TO FUNCTIONAL SERVICING REPORT APPENDIX FOR EASEMENT PLANS ILLUSTRATING THE LOCATION AND LIMITS OF THE EXISTING EASEMENTS WITHIN THE PROPERTY.

*NOTE: LAYOUT IS SCHEMATIC ONLY, DETAILS TO BE PROVIDED AT DETAILED DESIGN STAGE.

SUNNY COMMUNITIES

SCS consulting group ltd
30 CENTURIAN DRIVE, SUITE 100
MARKHAM, ONTARIO L3R 8B8
TEL: (905) 475-1900
FAX: (905) 475-8335

LEGEND:

- PROPERTY BOUNDARY
- 185.75 EXISTING CONTOUR
- × 224.35 EX EXISTING ELEVATION
- × 223.91 PROPOSED ELEVATION
- OVERLAND FLOW ARROW
- PROPOSED REGIONAL FLOODLINE (VALDOR, 2023)
- EXSITING REGIONAL FLOODLINE (VALDOR, 2023)

MACKENZIE CREEK PHASE 2
9900 MARKHAM ROAD - FSR

PRELIMINARY GRADING PLAN

DESIGNED BY: K.L.	CHECKED BY: P.G.	PROJECT No: 2333	FIGURE No: 2
SCALE: 1:750	DATE: OCTOBER 2023		

File: P:\2333 9900 Markham Road\Drawings\FSP\Fig\Report Figures\2333P-GRAD-6.1.dwg – Revised by <KLUI> : Tue, Oct 10 2023 – 10:37am

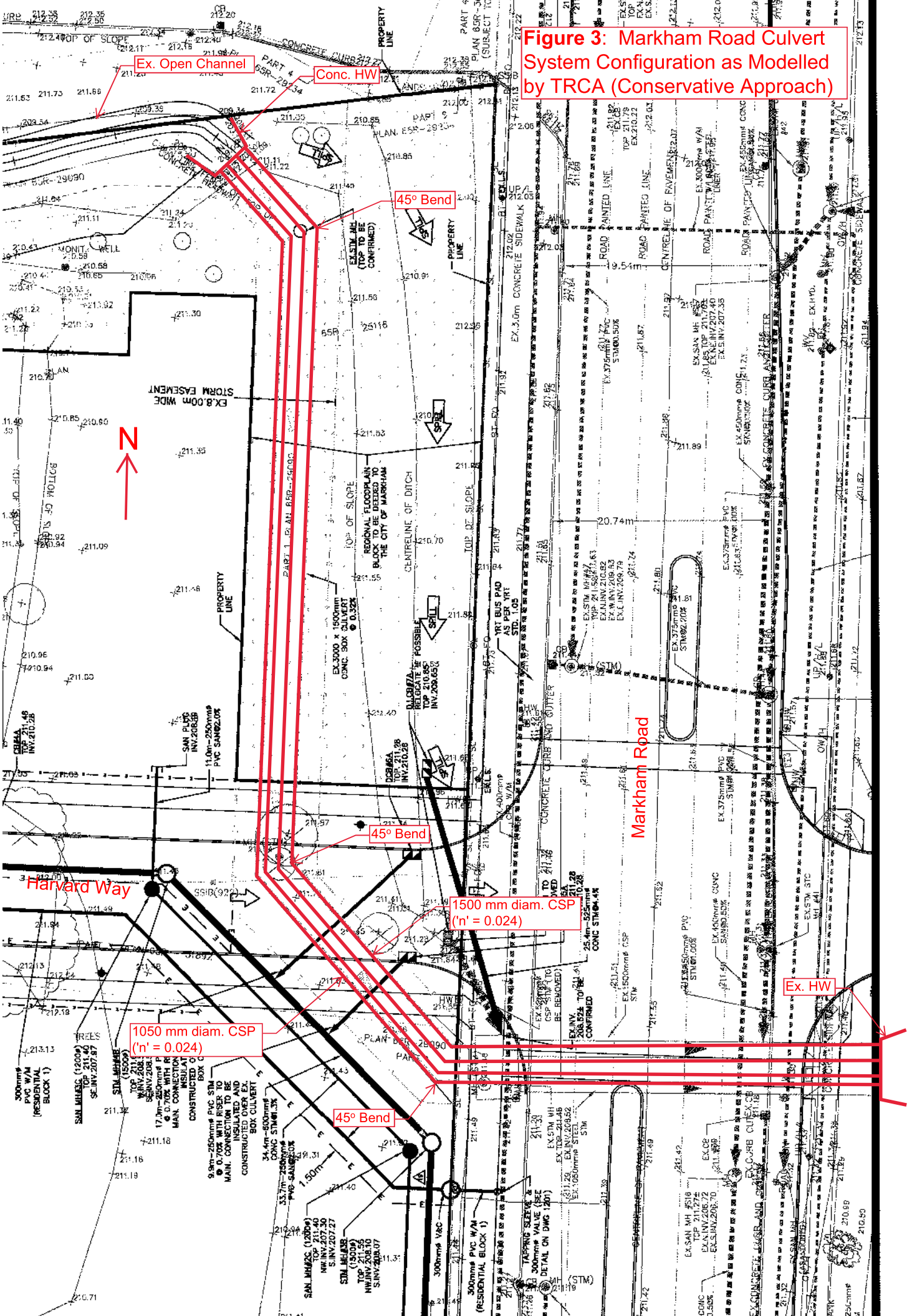


Figure 3: Markham Road Culvert System Configuration as Modelled by TRCA (Conservative Approach)

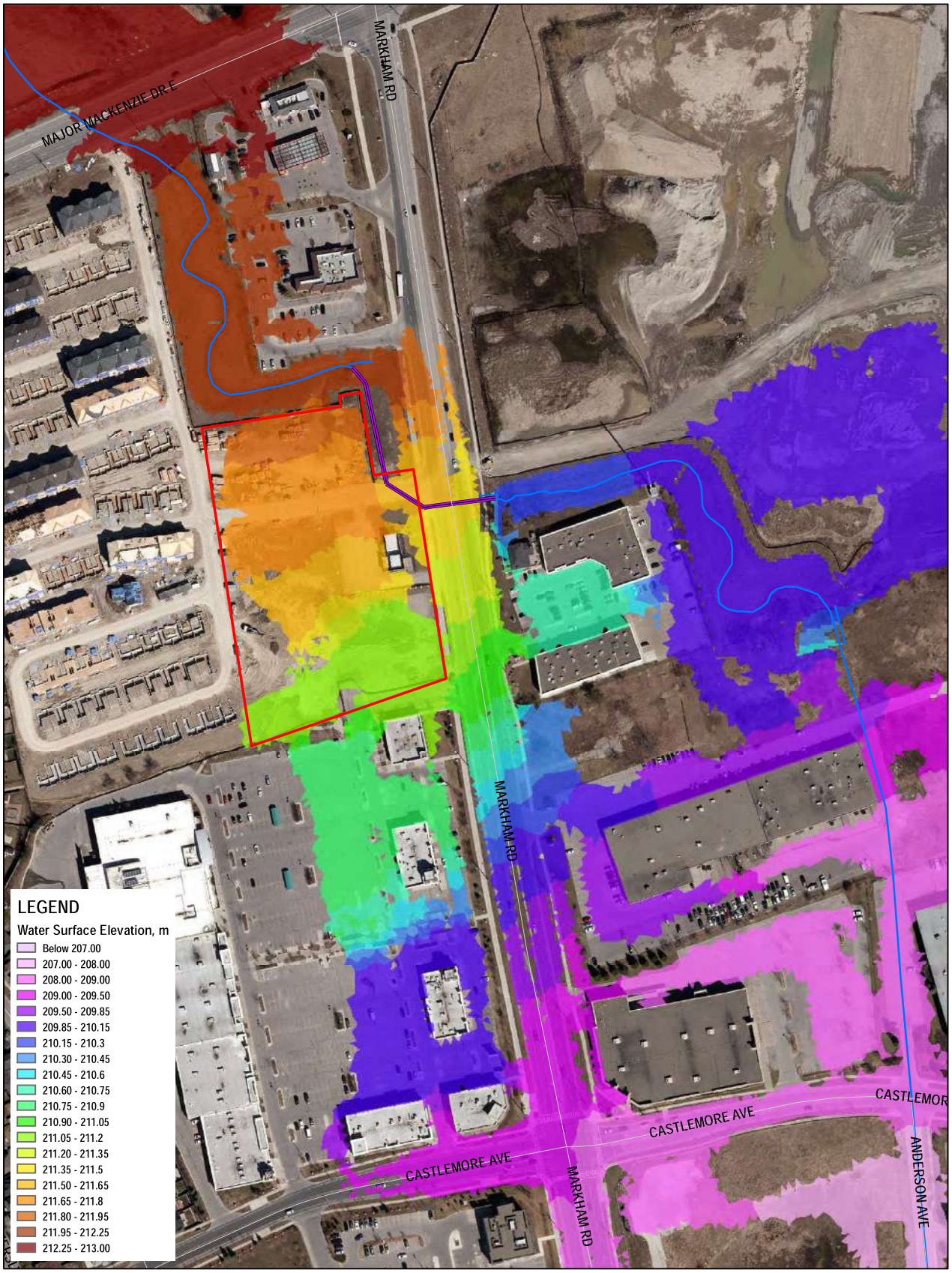


Figure 3(a)

REGIONAL WATER SURFACE ELEVATION MAP

EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

19 January 2023

Prepared By : A.B.

Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

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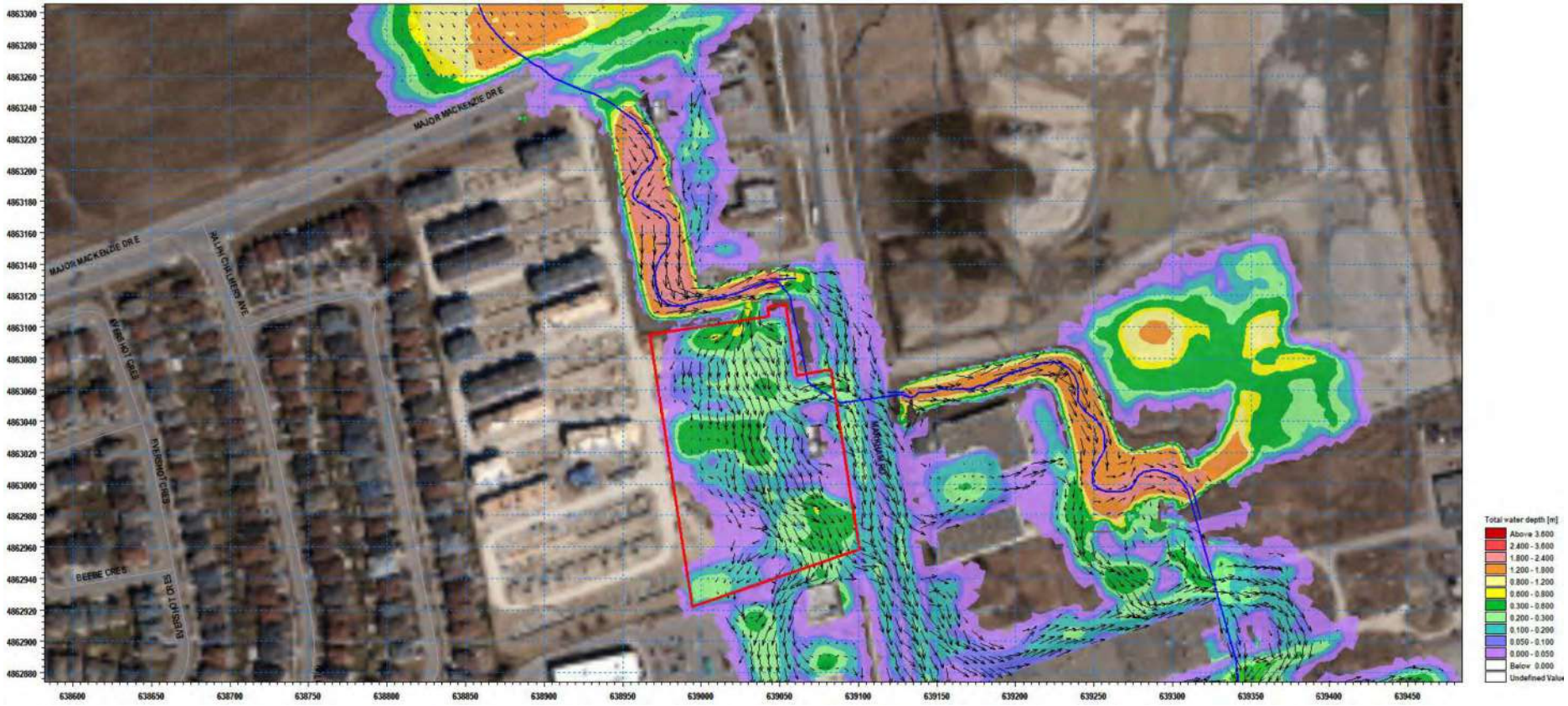
Figure 3(b) : Existing Condition Flood Flow Direction Map. Markham Road Culverts were Modelled Using Structure Approach (TRCA Model, Two Long Culverts with Roughness, n = 0.024)



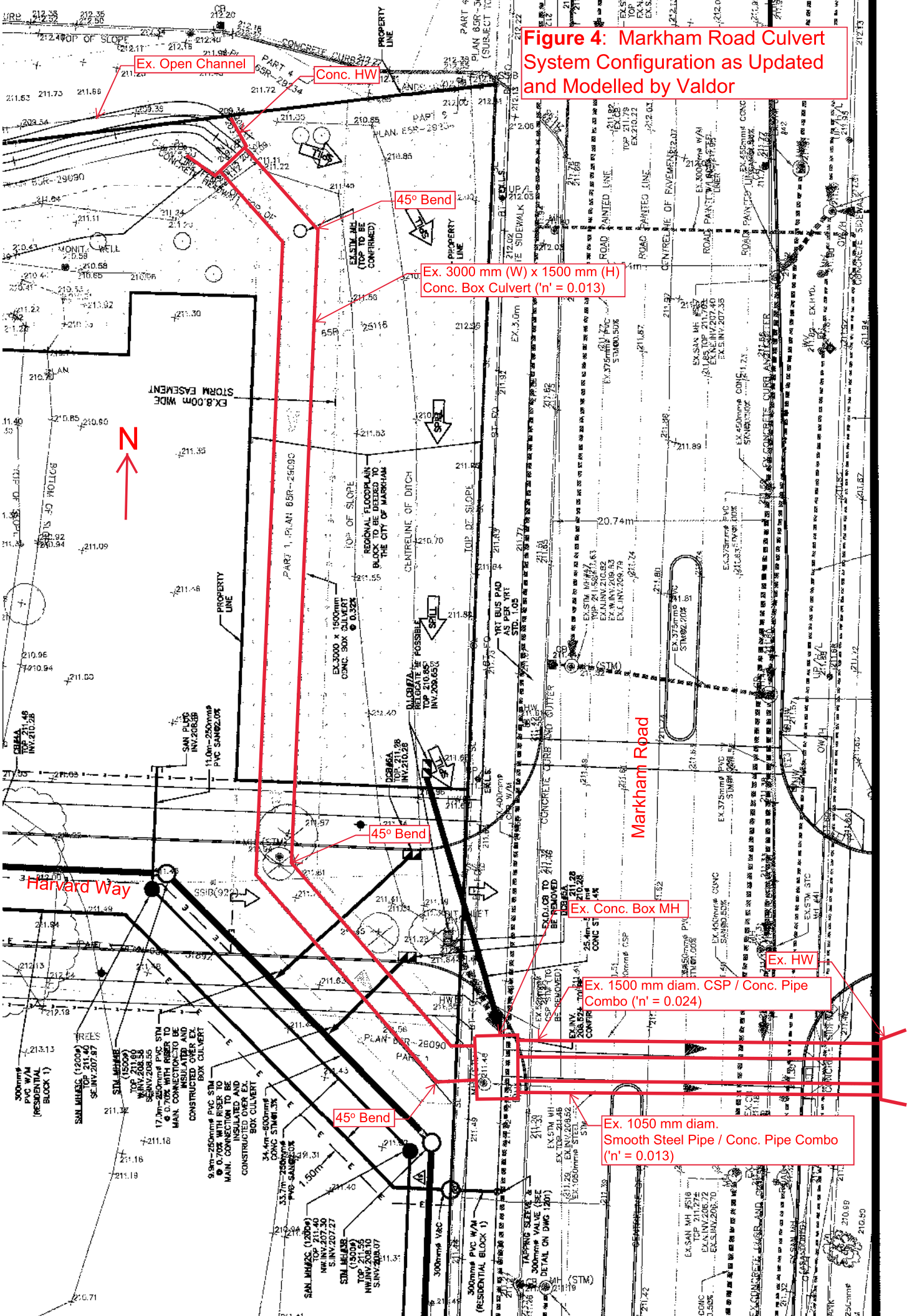


Figure 4: Markham Road Culvert System Configuration as Updated and Modelled by Valdor

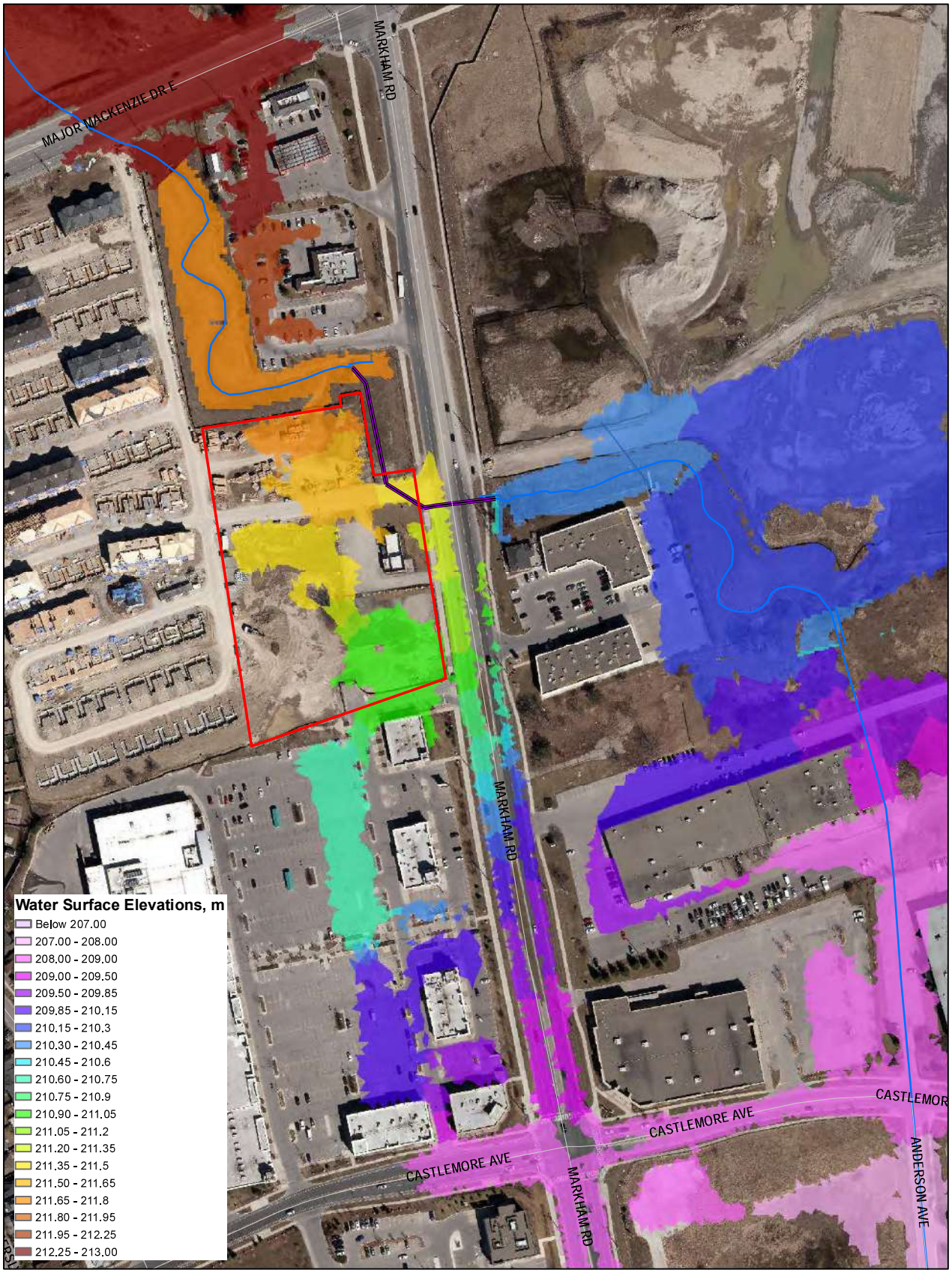


Figure 5

REGIONAL WATER SURFACE ELEVATION MAP

UPDATED EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

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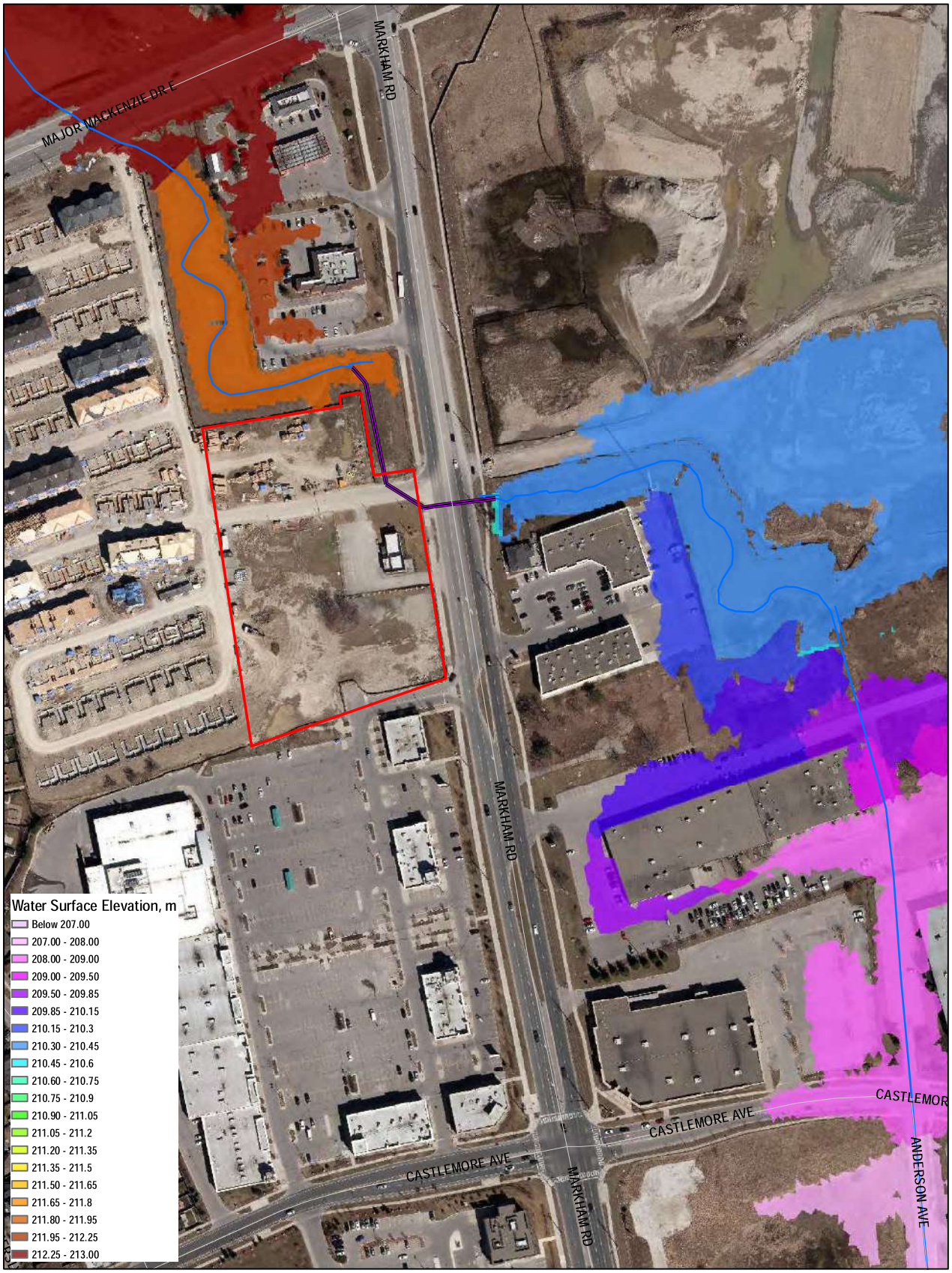

Figure 6

REGIONAL WATER SURFACE ELEVATION MAP

PROPOSED CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

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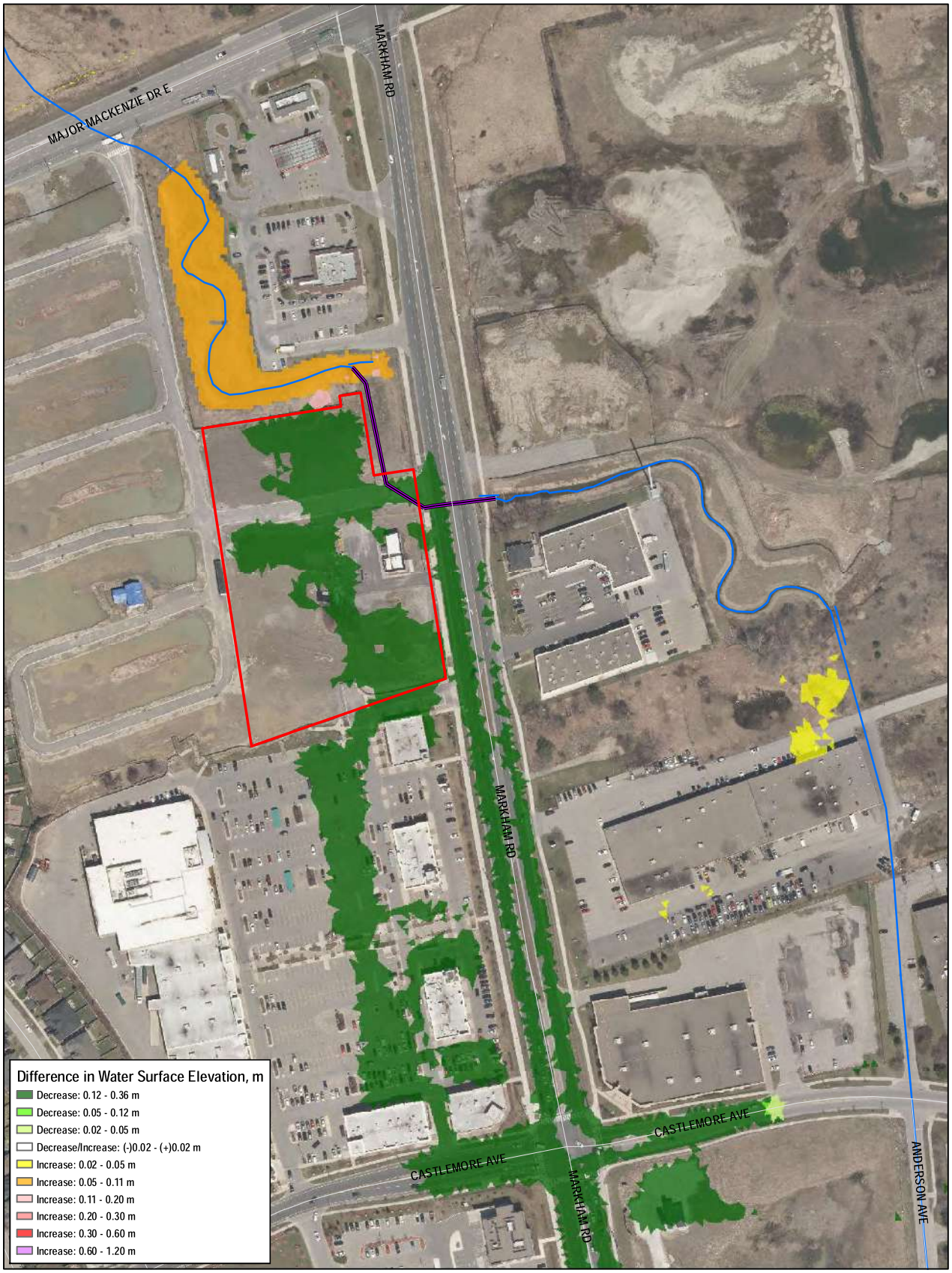

Figure 7(a)

REGIONAL WATER SURFACE ELEVATION DIFFERENCE MAP

PROPOSED VS. EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Markham Road Culvert
- Water Course

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

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Figure 7(b)

REGIONAL WATER SURFACE ELEVATION DIFFERENCE MAP

PROPOSED VS. EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 125 250 500 Meters

01 October 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Markham Road Culvert
- Water Course

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

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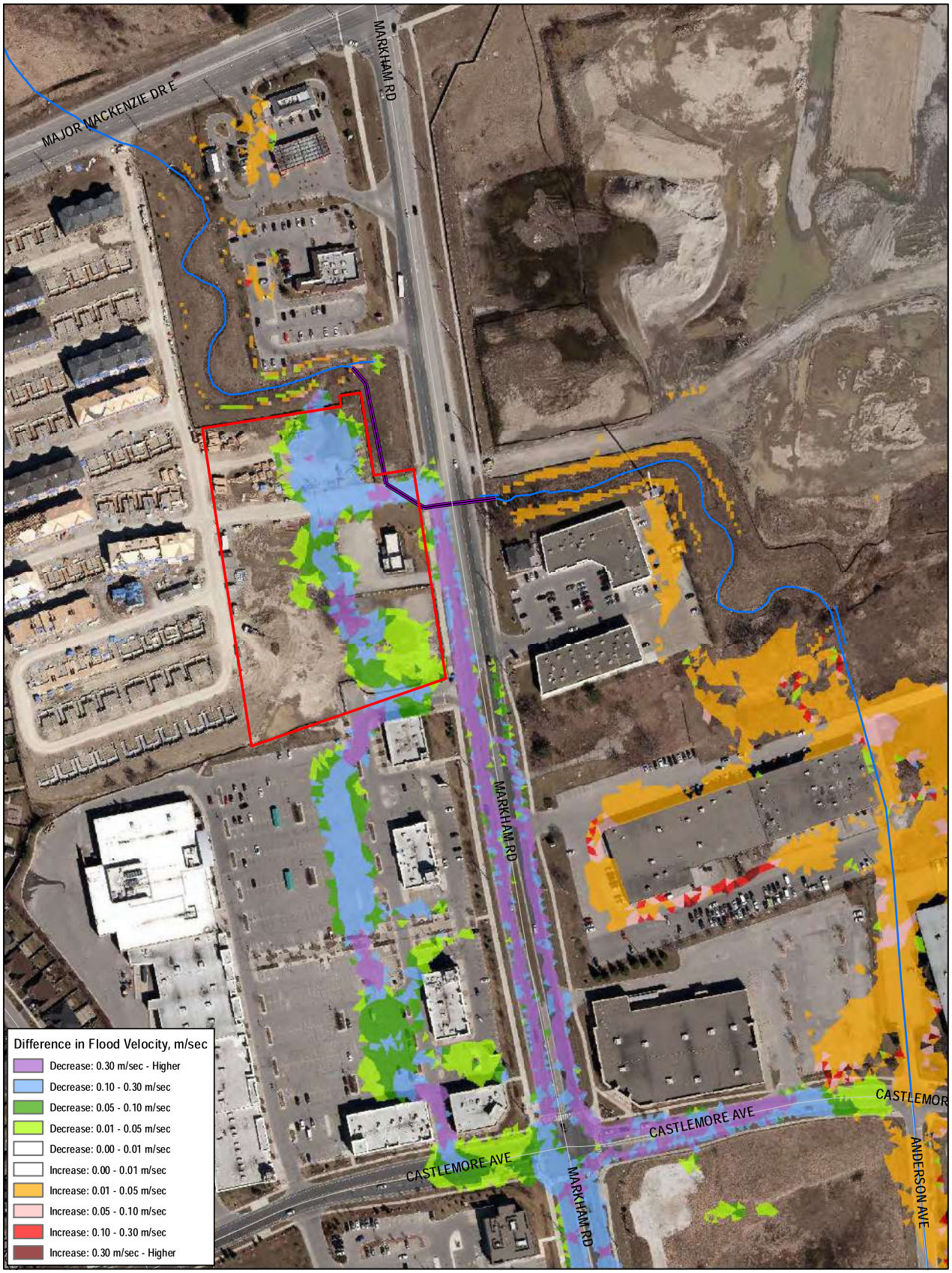

Figure 8(a)

REGIONAL FLOOD VELOCITY DIFFERENCE MAP

PROPOSED VS. EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B.

Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

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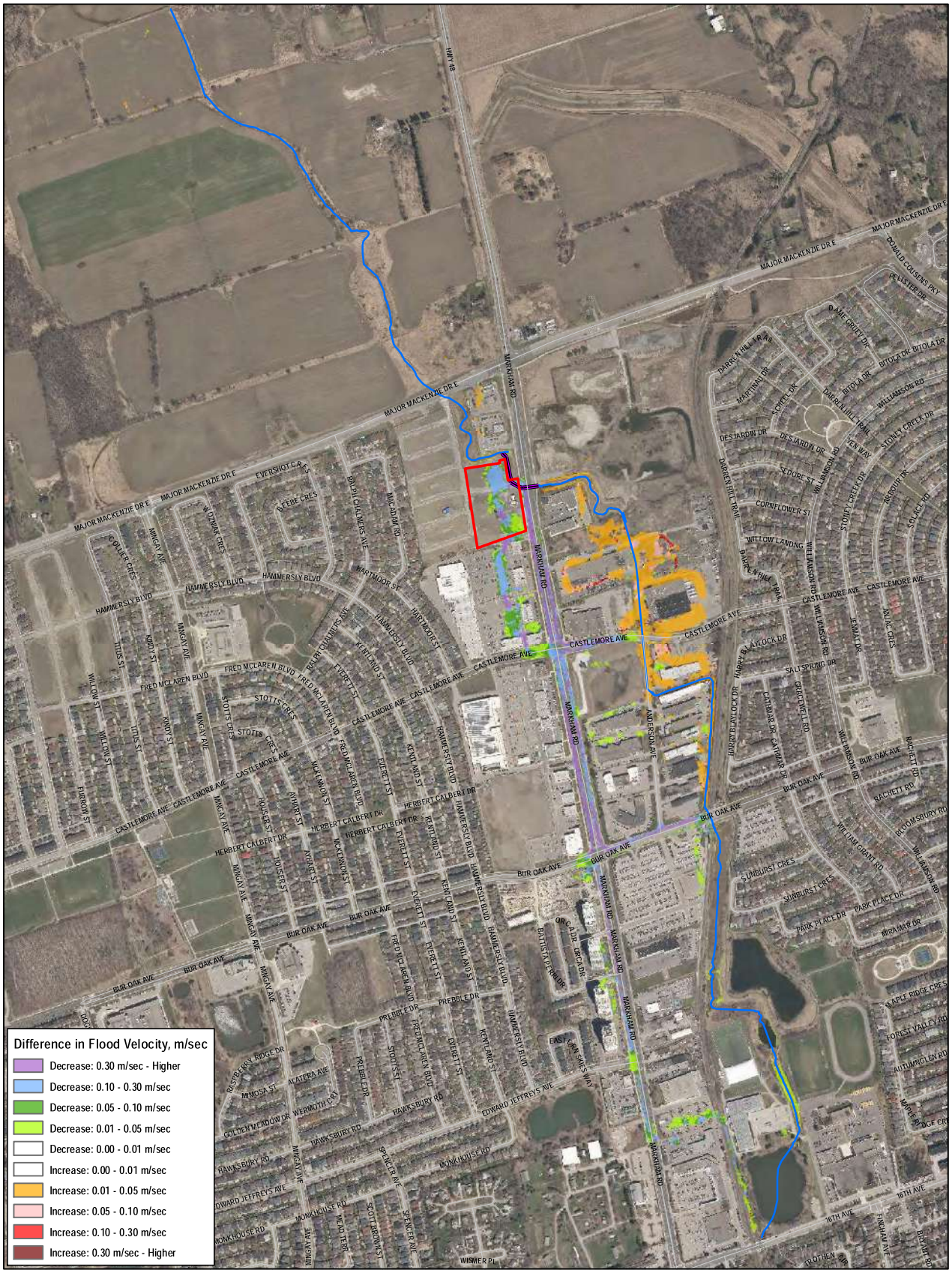


Figure 8(b)

REGIONAL FLOOD VELOCITY DIFFERENCE MAP

PROPOSED VS. EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 125 250 500 Meters

01 October 2023

Prepared By : A.B.

Checked By : B.C.

LEGEND

- Subject Site
- Markham Road Culvert
- Water Course

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

ATTACHMENT 'A'

Supporting Documentation

1D/2D Flood Impact Analysis for Proposed Development
9900 Markham Road, City of Markham

VALDOR

Toronto and Region Conservation Authority

MEMORANDUM

TO:	Nick Lorrain	DATE:	July 14, 2022
FROM:	Qiao Ying, Hyungjun Jo	CFN:	
RE:	City of Markham – Highway 48 and Major Mackenzie spill 2D Modelling		
CC:			

1.0 Introduction

The following presents the Highway 48/Major Mackenzie 2D modelling analysis completed in support of NDMP Intake 6 TRCA jurisdiction-wide spill analysis. The subject study area is located near the intersection of Highway 48 and Major Mackenzie Dr as shown in **Figure 1**.

Figure 1 – Study Area Location Map

1.1 Background

A comprehensive mapping update was completed for Rouge River in two separate stages (March 2020) by Wood Canada Limited. The current study area is at the headwater of Exhibition Creek and was not covered by recent floodplain mapping update due to its complicated flood condition. The current floodlines as shown on Figure 1 were drafted in June 2013 (from Major Mackenzie Dr to Anderson Ave) but are in draft form (yellow lines). The floodlines north of Major Mackenzie (coloured in cyan) are estimated floodlines and do not reflect any engineered model outputs. This draft model identified three spills along this tributary of the Lower Rouge River (see **Figure 2**). Based on the latest topographic area (2015 and 2019 LIDAR), these spills may go in multiple directions. Therefore, a 1D HEC-RAS model is not applicable and a 2D modelling approach is more suitable to capture the spill and characterize flood conditions within the study area.

Figure 2 – Location of Spills in the Highway 48 and Major Mackenzie Study Area

2.0 Additional Background Information

Background information on crossing structures within the study area was collected from York Region and the City of Markham. The information was supplemented by a review of various grading plans, 2015 and 2019 LIDAR, and site visits which are discussed in detail below.

2.1 Major Grading Changes

The topographic information in this study is primarily based on the 2019 LIDAR data (taken during leaf-on period). Given that this area is mostly developed, the 2019 LIDAR was deemed appropriate to be used as a base topographic map. However, certain areas (creek corridors and areas north of Major Mackenzie) used 2015 LIDAR, by splicing this information into the 2019 LIDAR as it captures the leaf-off conditions. Another reason for using 2019 LIDAR was that there were considerable grading changes that occurred in specific locations since the 2015 LIDAR was taken. The changes were due to channel-realignment and three developments within the study area. The channel alignment and development locations are depicted in **Figure 3** and these changes were discussed below in details:

Figure 3 – May 2015 Image (Left) and June 2021 (Right)

- Exhibition Creek channel realignment/Mackenzie Creek Townhouse – 9900 Markham Rd

The channel alignment west of Highway 48 was prompted by Mackenzie Creek development at 9900 Markham Road, just southwest of the Major Mackenzie Dr and Highway 48 intersection. The 2015 and 2019 LIDAR and aerial image shows a clear change in the floodplain characteristics (see **Figure 4** and **Figure 5**). The re-aligned creek exhibits a more sinusoidal shape and a wider overall landform than the 2015 conditions.

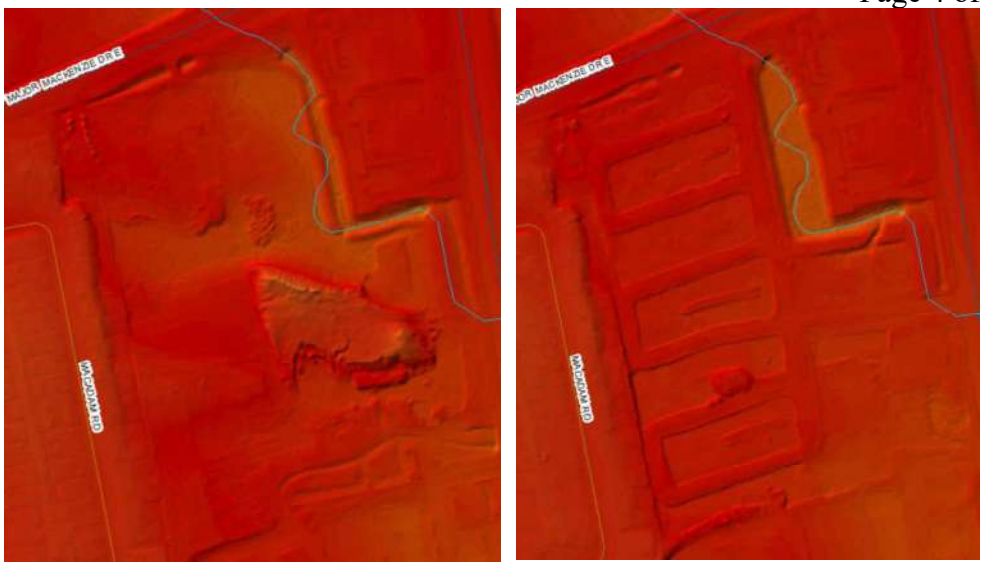


Figure 4 – 2015 (left) and 2019 (Right) LIDAR

Figure 5 – 2015 (left) and 2019 (Right) Aerial Image

- Onepiece Development – 9999 Markham Rd

Similarly, the channel alignment east of Highway 48 was impacted by the Onepiece development at 9999 Markham Road, which resulted in alterations to drainage patterns near and within the creek. **Figure 6** and **7** illustrates the changes to the land in LIDAR and aerial images. In this scenario, additional grading information was obtained in the form of a ground survey dated November 10, 2021. This information was used to supplement the 2015/2019 LIDAR by splicing it with the grading information. This ground survey indicated that a portion of the site (eastern half) was raised compared to the original 2019 LIDAR. The creek re-alignment works also incorporated a more sinusoidal form and wider overall landform.

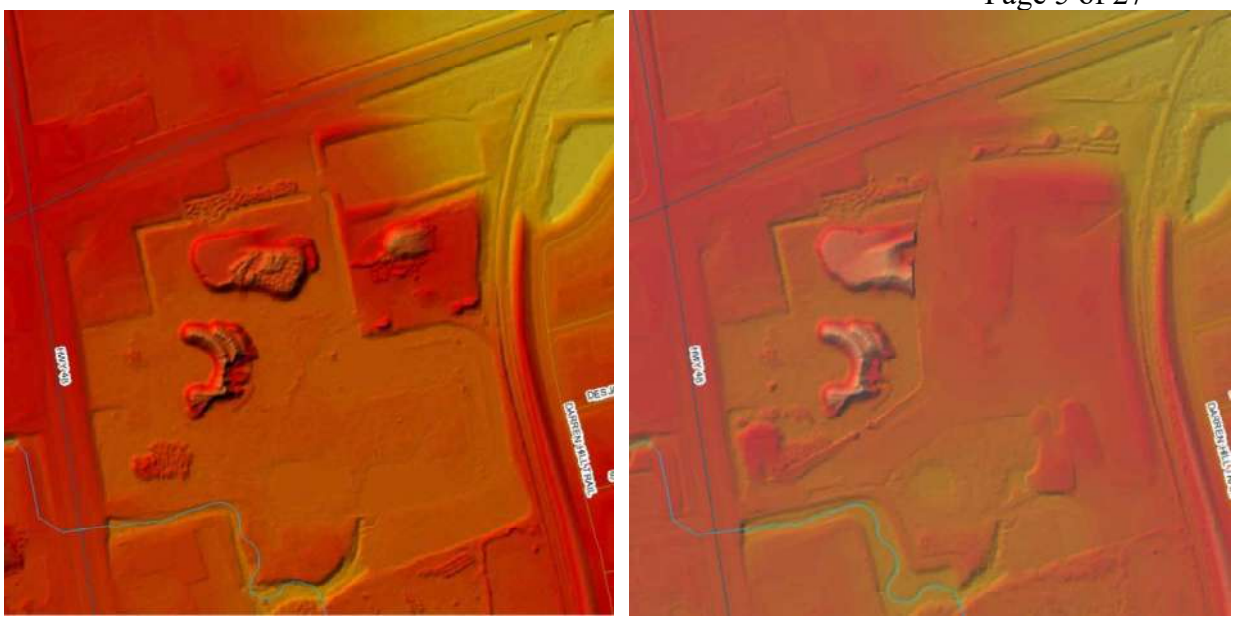


Figure 6 – 2019 (Left) and 2019 Spliced with Grading Plan (Right) LIDAR

Figure 7 – 2015 (Left) and 2021 (Right) Aerial Image

- Joy Station Condo by Liberty – 9781 Markham Rd

The last development area is the Joy Station Condo Development located at 9781 Markham Road. This development is located on the southeast corner of Castlemore Avenue and Highway 48. There is no direct impact to the creek, but the overland flow characteristic has been significantly altered by recent grading work. A grading plan dated February 2020 was spliced into the 2019 LIDAR to update this area (see **Figure 8**)**.** It clearly shows that the property has been raised compared to the original 2019 LIDAR.

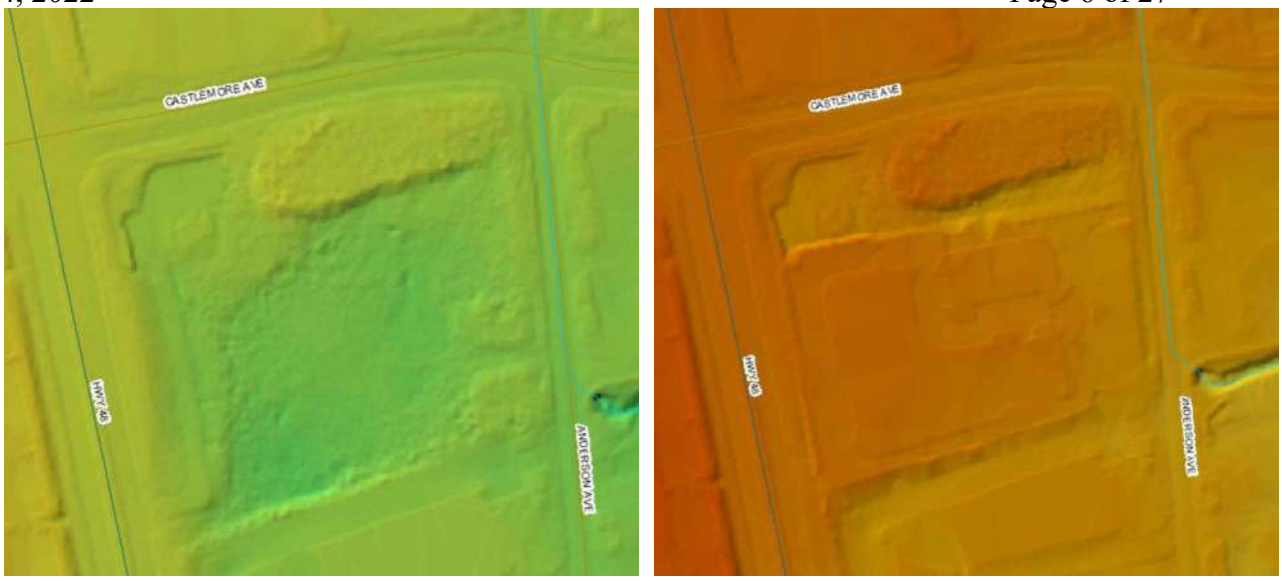


Figure 8 – 2019 (Left) and 2019 Spliced with Grading Plan (Right)

2.2 2015 LIDAR Spliced Areas

There were several areas that were identified to splice 2015 LIDAR data into the 2019 LIDAR base map. These areas are limited to natural cover areas where no changes have occurred since 2015 to avoid using 2019 LIDAR which was obtained during leaf-on period for canopy study purpose. The spliced areas are highlighted in **Figure 9**.

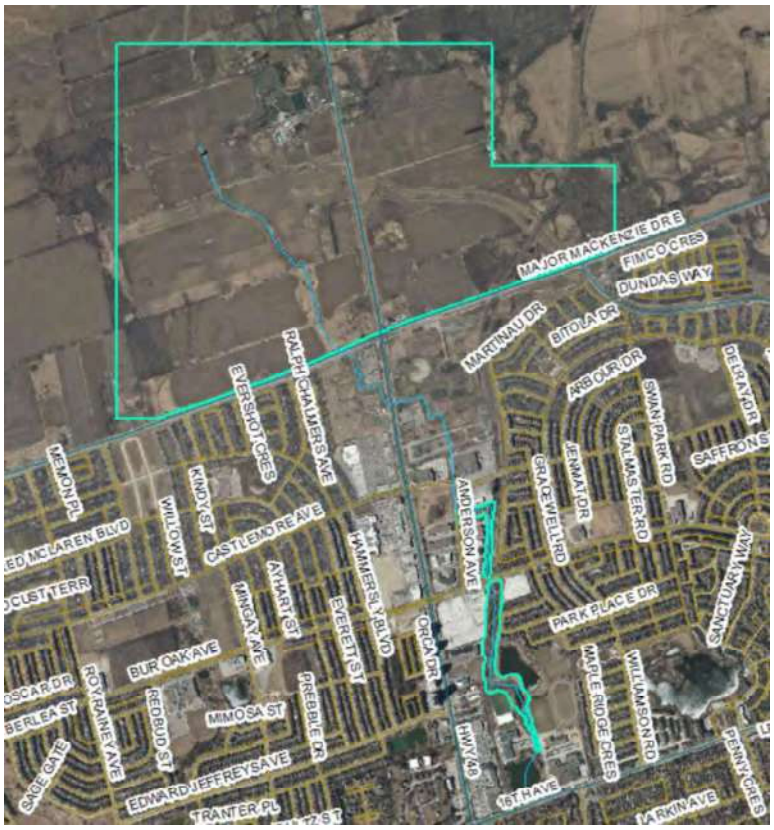


Figure 9 – Areas with 2015 LIDAR Spliced into 2019 LIDAR

2.3 Crossing Confirmation

There are three major crossings within the study area that required site confirmation to supplement the information obtained from the City and the Region. This included:

- Major Mackenzie Crossing, west of Highway 48
  - This was confirmed to be a circular corrugated steel pipe (CSP) that was 1.5 m in diameter (**Figure 10**).

Figure 10 – Crossing Location (Left) and Site Photo (Right)

- Highway 48 Crossing, south of Major Mackenzie
  - 3 m by 1.5 m box concrete culvert at upstream side, two circular CSP with 1.5 m and 1.05 m diameter, respectively at downstream side (**Figure 11** and **Figure 12**)
  - To be conservative, this crossing was coded into the model as two circular CSPs with 1.5m and 1.05m diameter, considering 3 bend losses (for a box culvert) (i.e., 0.818) as per FEMA – Hydraulic Design of Highway Culverts (April 2012)

Figure 11 – Location of Hwy 48 Crossing

Figure 12 – Upstream Face (Left) and Downstream Face (Right)

- Anderson Avenue Long Culvert
  - Two ellipse shaped corrugated steel pipe with 1.5 m span and 0.95 m rise at upstream face, one ellipse shape concrete pipe with 1.7 m span and 1.1 m rise at downstream face (see **Figure 13** and **Figure 14**)
  - To be conservative, this crossing was coded into the model as one ellipse concrete pipe with 1.7 m span and 1.1 m rise, including bend loss for one bend for pipe (i.e., 0.11) as per FEMA (April 2012)

Figure 13 – Location of Hwy 48 Crossing

Figure 14 – Upstream Face (Left) and Downstream Face (Right)

Figure 15 Hwy48/Major Mackenzie2D Model Domain

3.0 Model Setup

The study area was modelled using the MIKE Flood interface that features the dynamic coupling of the MIKE HYDRO and MIKE 21 hydrodynamic modules. River reaches and all crossings were handled using the 1D MIKE HYDRO modelling routine, with overland surfaces being modelled using the 2D MIKE 21 modelling routine. MIKE Flood integrates these two models into a single dynamically coupled model.

Figure 15 shows the Hwy 48/Major Mackenzie 2D model domain. The downstream boundary was set as a water level that were taken from cross-section 959.45 located on Reach 2 of Exhibition Creek from the HEC-RAS model developed by Wood PLC. as part of the 2019 Rouge River Floodplain Mapping Update Phase II.

3.1 MIKE HYDRO 1D River Model

Only one river reach is modeled using the MIKE HYDRO 1D hydrodynamic (HD) module, i.e., Exhibition Creek with length of 3694.55m which ends at immediately upstream of 16th Avenue at Mt Joy Lake.

Cross-sections were cut in 10-20m spacing from 1-m 2019 LiDAR spliced with 2015 Lidar and only cover the main channel, i.e., upto top of bank as overbank areas were modeled in 2D domain. High density of spacing of cross-sections allows better capturing details of riverbanks where lateral exchange flows with 2D domain occur. In total six (6) crossings were included in 1D model, and 3 crossings were coded as a composite structure. i.e., crossing opening was coded as Culvert structure and road deck was coded as Weir structure. **Figure 16** uses Major Mackenzie crossing to show an example how a crossing is coded in 1D model using

combination of Culvert structure and Weir structure.

There are 3 crossings coded in a different way, and they are rou_664, rou_705 and rou_706. These 3 crossings all have relative wide road deck or buried long pipes and grading on the road deck may be slopped, under such condition overtopped floodwater may travel away from the crossing and continue its way in multiple directions following the ground surface gradient. The approach of coding this type of crossing is to add a small reach at both upstream and downstream faces of a structure, and on each small reach add a Weir structure to represent the road deck of upstream face and downstream face and then link to 2D model using Standard Link. This approach would allow overtopped floodwater getting onto road deck from upstream face and travelling as per grading on the road deck and may return downstream channel via downstream link. **Figure 17** shows cross-sections and location of structures included in the 1D MIKE HYDRO model.

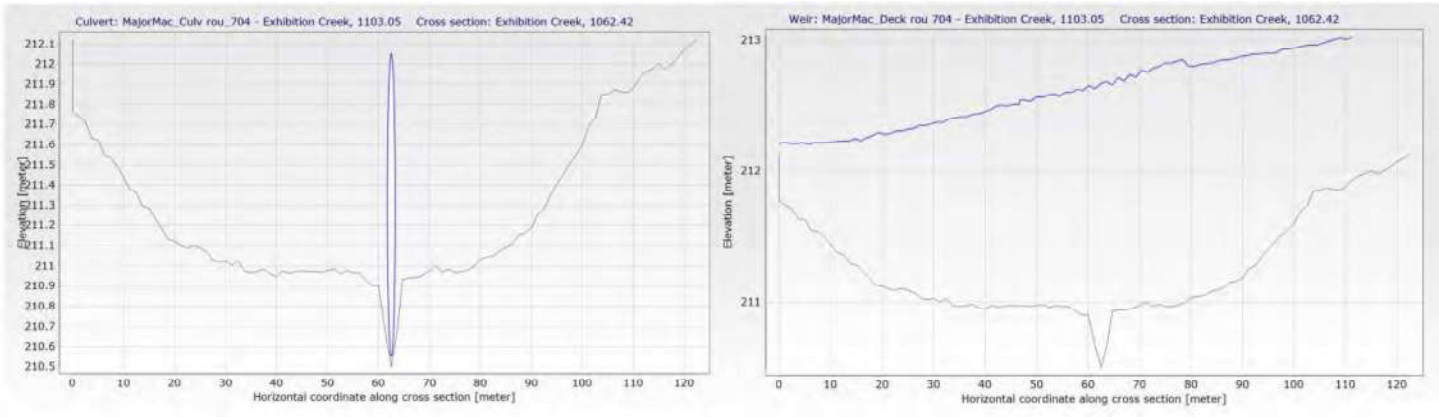


Figure 16 – Example of a composite structure of a Culvert Structure and a Weir Structure

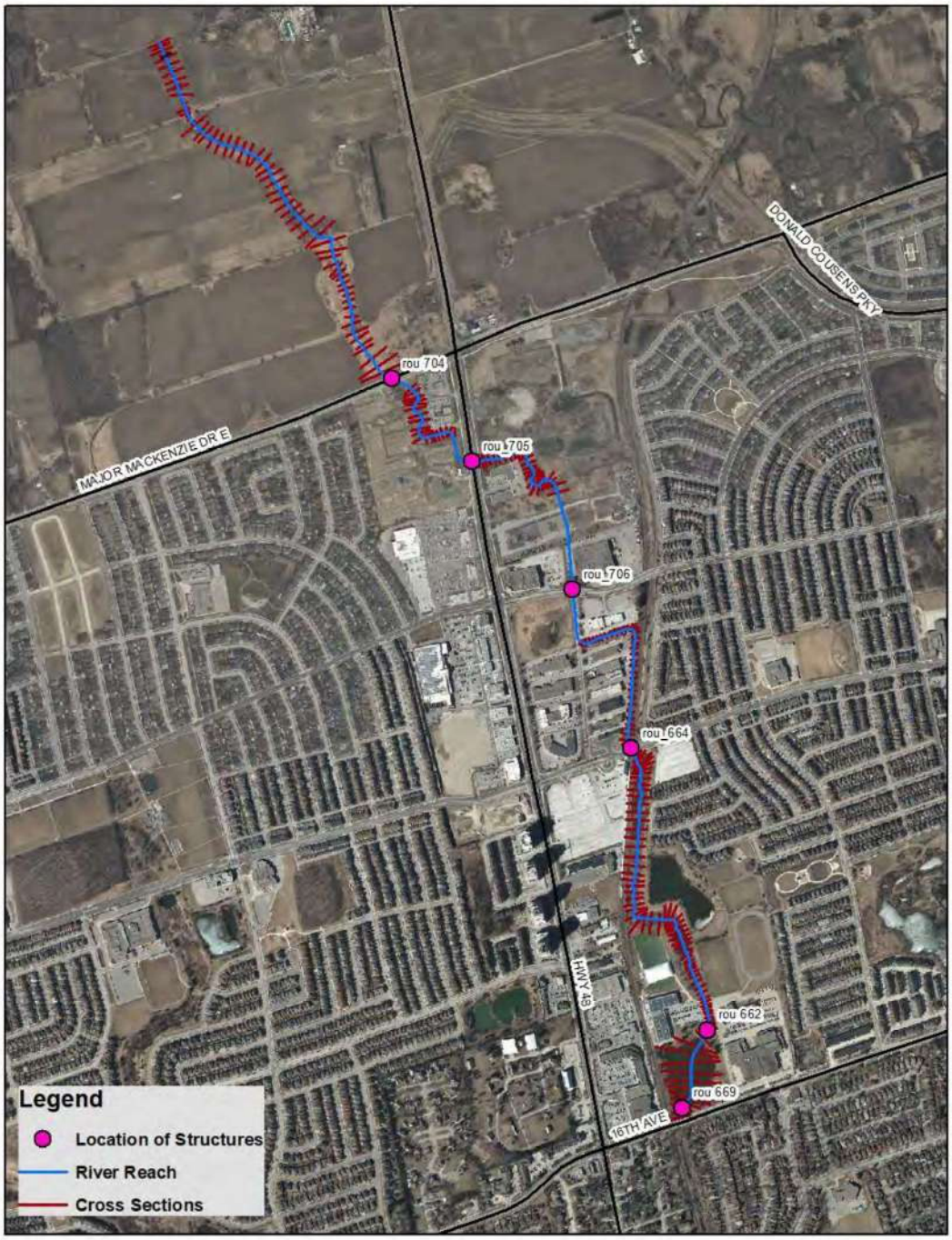


Figure 17 Location of 1D cross-sections and structures

Boundary Condition

All inflows are handled in 1D model, and total inflows were entered at the beginning of Exhibition Creek and incremental flows were entered as a point source along the reach and the steady peak flows were ramped for 1hr and then kept constant for 15hrs (see **Figure 18**). Downstream boundary is a Water Level boundary that was extracted from 2019 Rouge River HEC-RAS model as mentioned above. **Table 1** summarizes boundaries and their types, and **Figure 19** shows the location of flow nodes.

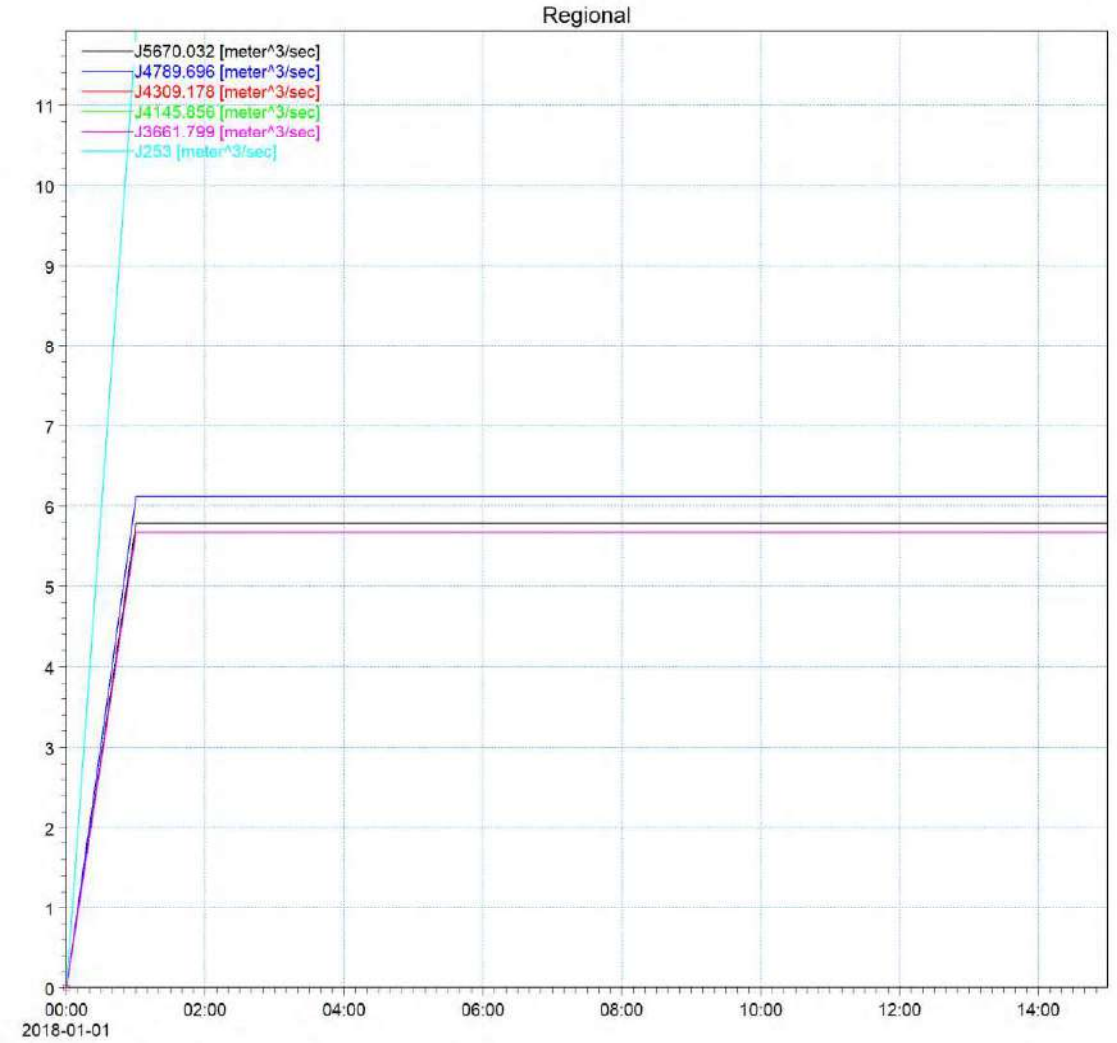


Figure 18 Regional peak flows applied in the 1D MIKE HYDRO model

Table 1 Boundary Conditions in 1D Model

Boundary ID	Flow Nodes	Boundary Type	Branch Name	Chainage (m)
Boundary 1	J5670.032	Total Inflow	Exhibition Creek	0
Boundary 11	J4789.696	Point Source	Exhibition Creek	1260
Boundary 12	J4309.178	Point Source	Exhibition Creek	2259
Boundary 13	J4145.856	Point Source	Exhibition Creek	2730
Boundary 14	J3661.799	Point Source	Exhibition Creek	2874
Boundary 15	J253	Point Source	Exhibition Creek	3443
Boundary 2		Water Level	Exhibition Creek	3694.55

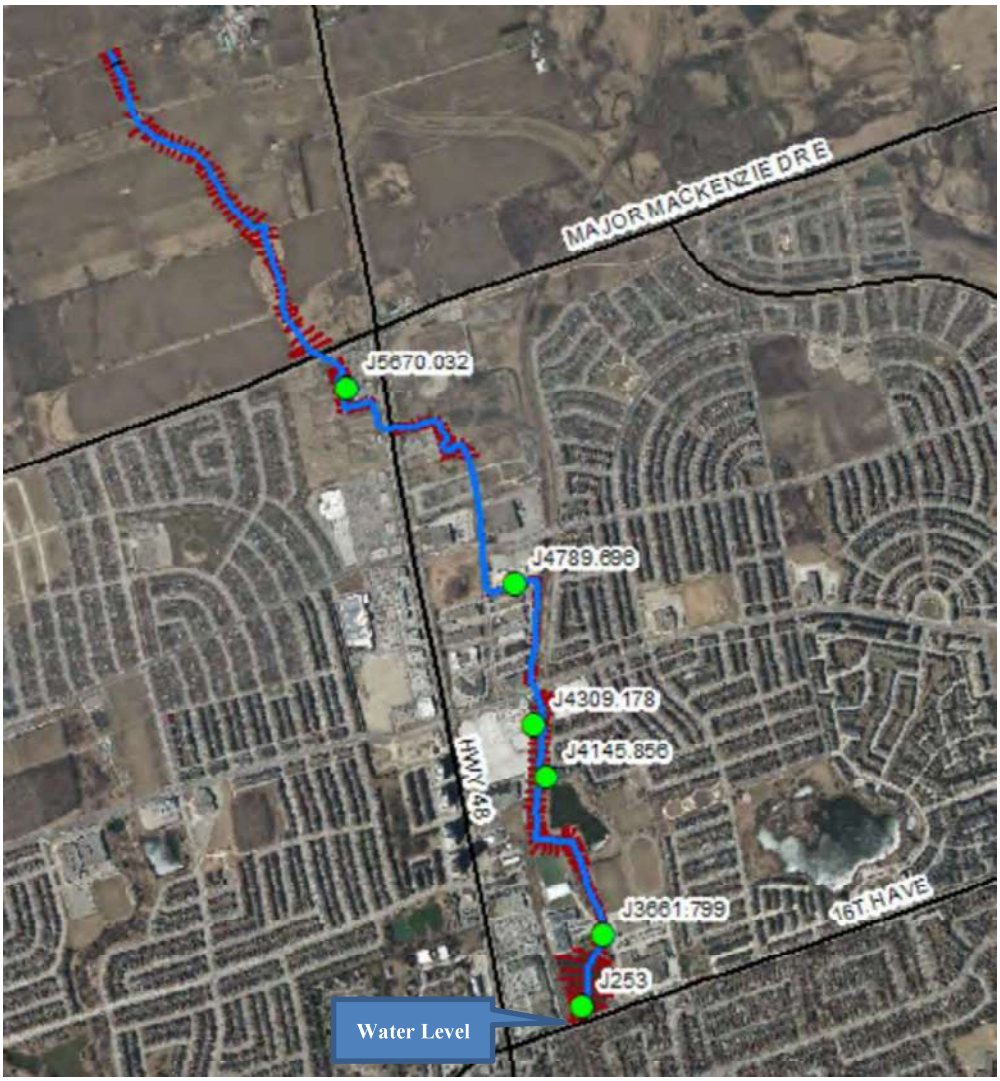


Figure 19 Location of Flow Nodes and Water Level Boundaries

3.2 MIKE 21 2D Overland Model

The overland area was modelled using MIKE 21 Flexible Mesh (FM) HD, which is a fully dynamic modelling system for 2D free-surface flows. The MIKE 21 editors were used to construct and store various basic and hydrodynamic data layers. The following are the main elements of the MIKE 21 model setup:

- Mesh Generation
- Roughness parameters
- Boundary conditions
- Model settings

Mesh Generation

MIKE 21 FM model uses a mesh-based bathymetry for hydrodynamic computations. The details and the desired accuracy of the model results depends on how the mesh has been designed. In addition, the mesh

resolution has a significant impact on the accuracy of the results. A high-resolution mesh is required to retain higher variability of the ground elevation surface. High resolution also required to represent in detail topographic features (such as channels, buildings, paved roads, walkways, retaining walls, flood walls, etc.). As such, the mesh was designed as follows:

- A high-resolution mesh size of 10m^2 was used along the roads as floodwater tends to follow the roads.
- A high-resolution mesh size of 16m^2 was used in the potential flood extent.
- A mesh size of 50m^2 was used in the rest of model area.

The building polygons were excluded from the mesh generation to avoid computational mesh triangulation from occurring within these polygons, and River reaches covered by cross-sections were also excluded from the mesh to avoid double-accounting for the conveyance, and finally 1m LiDAR data was interpolated to each mesh node (see **Figure 20** below).

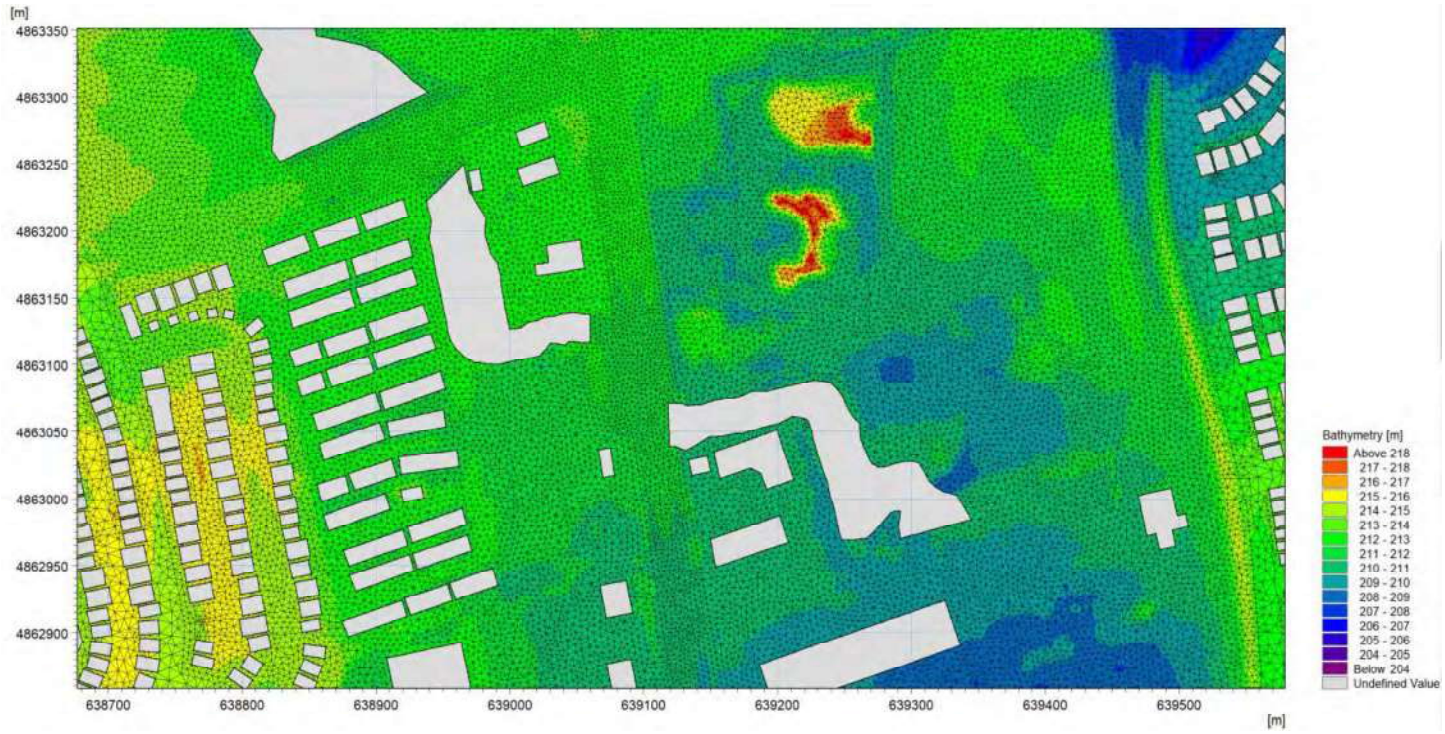


Figure 20 Close view of mesh around Hwy48/Anderson Ave. where major spills occur

Roughness Parameters

MIKE 21 uses roughness parameters for each mesh when completing computations. The land use map (see **Figure 21**) prepared using the TRCA's available land use/land cover information was converted into a MIKE 21 roughness map. In MIKE 21, the roughness was defined in terms of the MIKE system's Manning's resistance number (M), which is the inverse of the Manning's n roughness coefficient value (*i.e.,* 1/n). The Manning's resistance number (M-value) map was prepared based on the TRCA's standard roughness values; the corresponding Resistance numbers used in MIKE 21 are:

- Natural areas: 0.08 (M = 12.50)
- Roads and large parking areas: 0.025 (M = 40)
- Urban large pervious areas: 0.05 (M = 20)
- Streams/Waterbodies: 0.035 (M = 28.57)

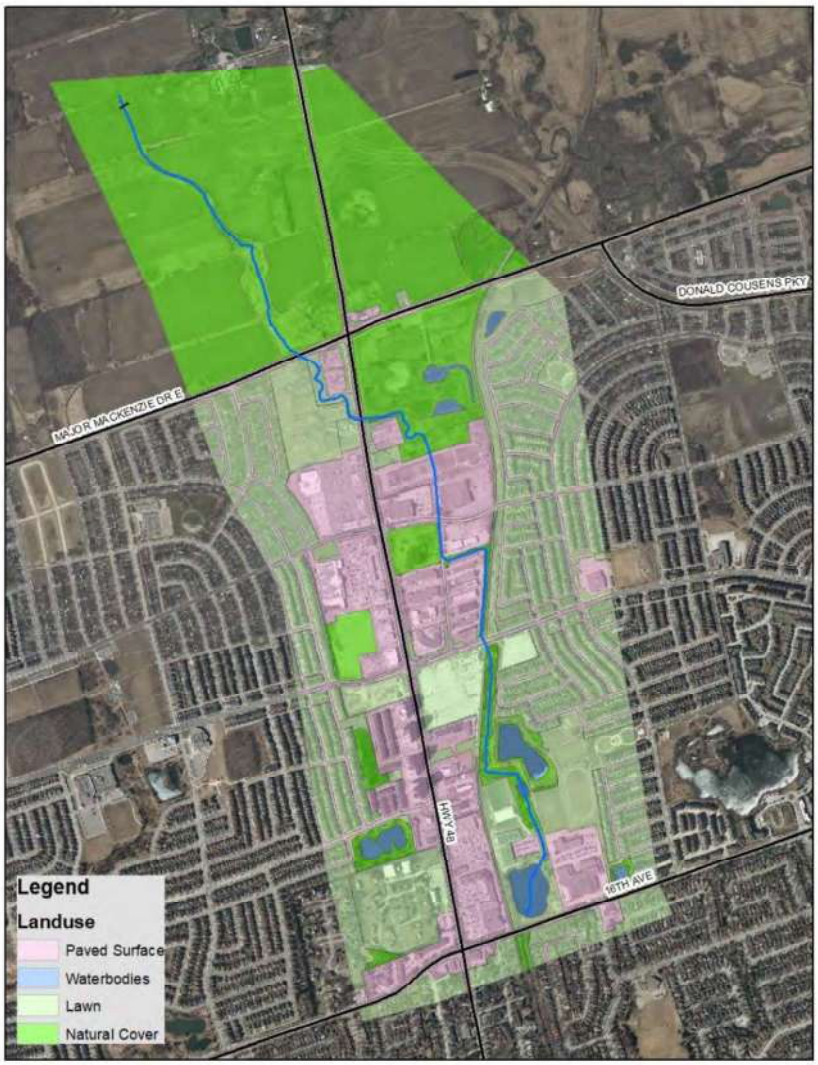


Figure 21 Landuse map in Hwy48/Major Mackenzie spill area

Boundary Conditions

Boundary conditions for the MIKE 21 model define how the flow and water levels will be controlled at the peripheral edges of the 2D model domain defined by the bathymetry limits. Since all inflows were handled in 1D model, there is no inflow boundaries defined in 2D model. Also, the outflow on Exhibition Creek was handled in 1D model using water level boundary and given that the flood condition is all contained in the model domain, so no open boundaries were defined within 2D model domain.

Model Settings

The MIKE 21 FM Flow Model setup contains descriptions of several parameters. The key parameters are simulation period, start and end time, time step interval, flooding and drying depths, output saving duration and saving interval details.

A 15-hour simulation period for both regional and design storms was used for the steady peak inflow hydrograph simulation. The simulation period was entered using an arbitrary start and end date and time with a

specified total number of time steps and time step interval. In this case, the total number of time steps was 108,000 for 2yr to 100yr and regional event with a time step interval of 0.5 seconds.

The drying and flooding depths used were 0.01m and 0.02m, respectively.

The dynamic outputs were saved with time interval of 1200 (i.e., 10min interval).

- The saving output variables were surface elevation, total water depth, U velocity (x-direction), V velocity (y-direction), and current speed.
- The dynamic output file type used was "2D (horizontal)" while the output format was selected as "Area Series" with only real wet areas that ensures the saving of specified information at every computational point.

3.3 1D and 2D Coupled Model

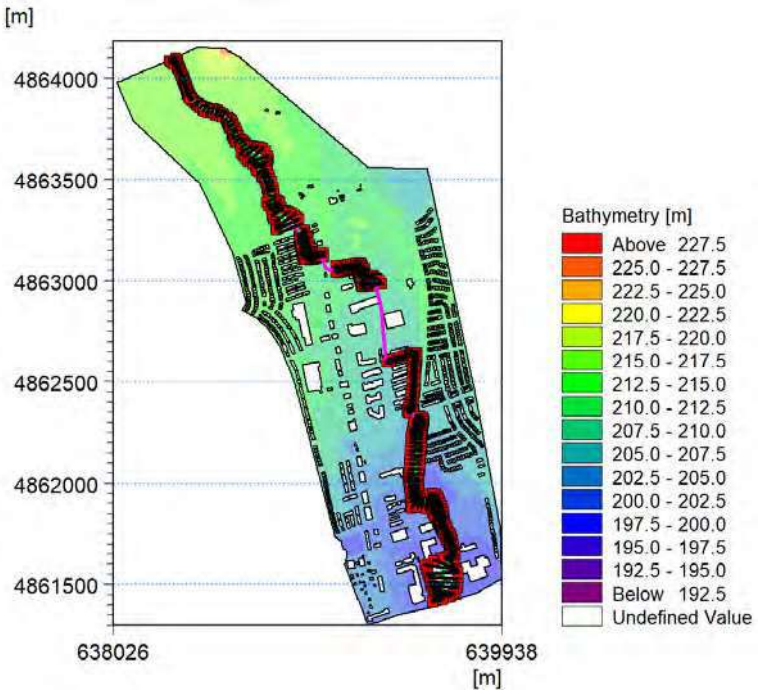


Figure 22 Lateral links used to connect 1D branch to 2D area

The final step for model setup was the integration of the 1D MIKE HYDRO model with the 2D MIKE 21 model using the MIKE Flood model interface. Lateral links were used to connect the branches in the 1D MIKE HYDRO model with the corresponding mesh elements of the 2D MIKE 21 model. A lateral link enables the coupling of the models at the left and right banks of the 1D channel with the 2D area. As mentioned in 1D River Model section, 3 crossings were coded differently using standard link to connect channel via Weir structure to 2D area (i.e. wide road deck), and a standard link would connect channel ends to few 2D elements which allows both flux and momentum transferring between 1D River and 2D Overland domains. This integration in MIKE Flood allows a seamless flow exchange between the 1D branches and the 2D area, thereby enabling the space and time-dependent dynamic simulation of flows as they would physically occur in real-world hydraulic systems.

Figure 22 (on left) shows the bathymetry of 1D and 2D coupled model, where the building areas are represented (blocked white cells) and the lateral link lines between the 1D and 2D models is shown as a series of red lines.

3.4 Model Results

Based on 2D model results, spills occur at three major locations (see **Figure 23**), and details about spill travelling routes for each spill are described as follows:

- **Spill#1: Spill at Major Mackenzie Dr. E**
  Spill starts at 25yr storm event, and the regional spill amount is about 3.46m^3/s (about 56% of total flow) which is mainly due to under-sized culvert and low point on Major Makenzie Dr. Majority of the spill would end up into downstream side of channel and only small portion of spill would get into plaza at the south-west corner of Highway48 and Major Mackenzie Dr.

- **Spill#2: Spill at west side of Highway 48 near 9900 Markham Rd**

Spill starts at 25yr storm event, and there are two major spill points: 1) spill first starts at south bank which is mainly due to low point of a swale, and the regional spill amount from this location is about 4.75m^3/s, and 2) spill later starts at north side of box-culvert inlet, and the regional amount is about 1.2m^3/s, and spill amount from these two locations accounts for 58% of total inflow (see left image for two spill locations). Majority of the spills would travel along Highway48 and end up into industrial area on the east side of Highway48 and eventually get back into creek. Only small portion of spill (about 0.27m^3/s) would get into condo area at the south-west corner of Highway48 and Bur Oak Ave. and it would continue its way southwards and eventually drains into Mont Joy Lake before 16th Ave.

- **Spill#3: Spill at inlet of long buried pipes on Anderson Ave. near south end of 9999 Markham Rd property**
  Spill starts at 5yr storm event. The regional spill amount is about 3.25 m^3/s, which would travel southwards into industrial areas along Anderson Ave. and then would join the spill coming from Spill #2 at Bur Oak Ave. and eventually drains into Mont Joy Lake before 16th Ave. This spill is mainly due to undersized buried long pipes.

Figure 24 shows the steady Regional maximum water depth, **Figure 25** shows the steady Regional maximum water surface elevation and **Figure 26** shows the steady Regional maximum velocity.

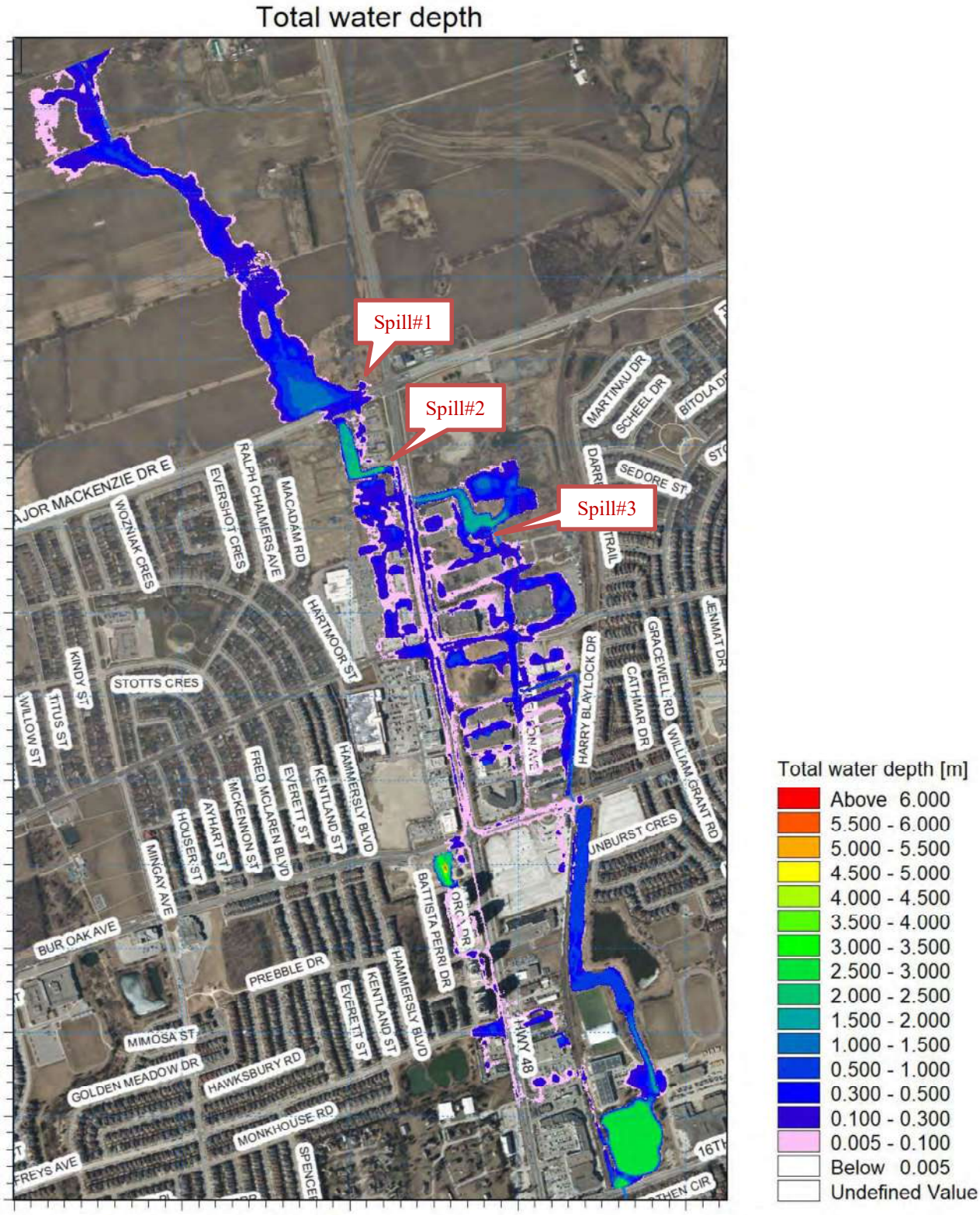


Figure 23 – Spill locations and flood depth

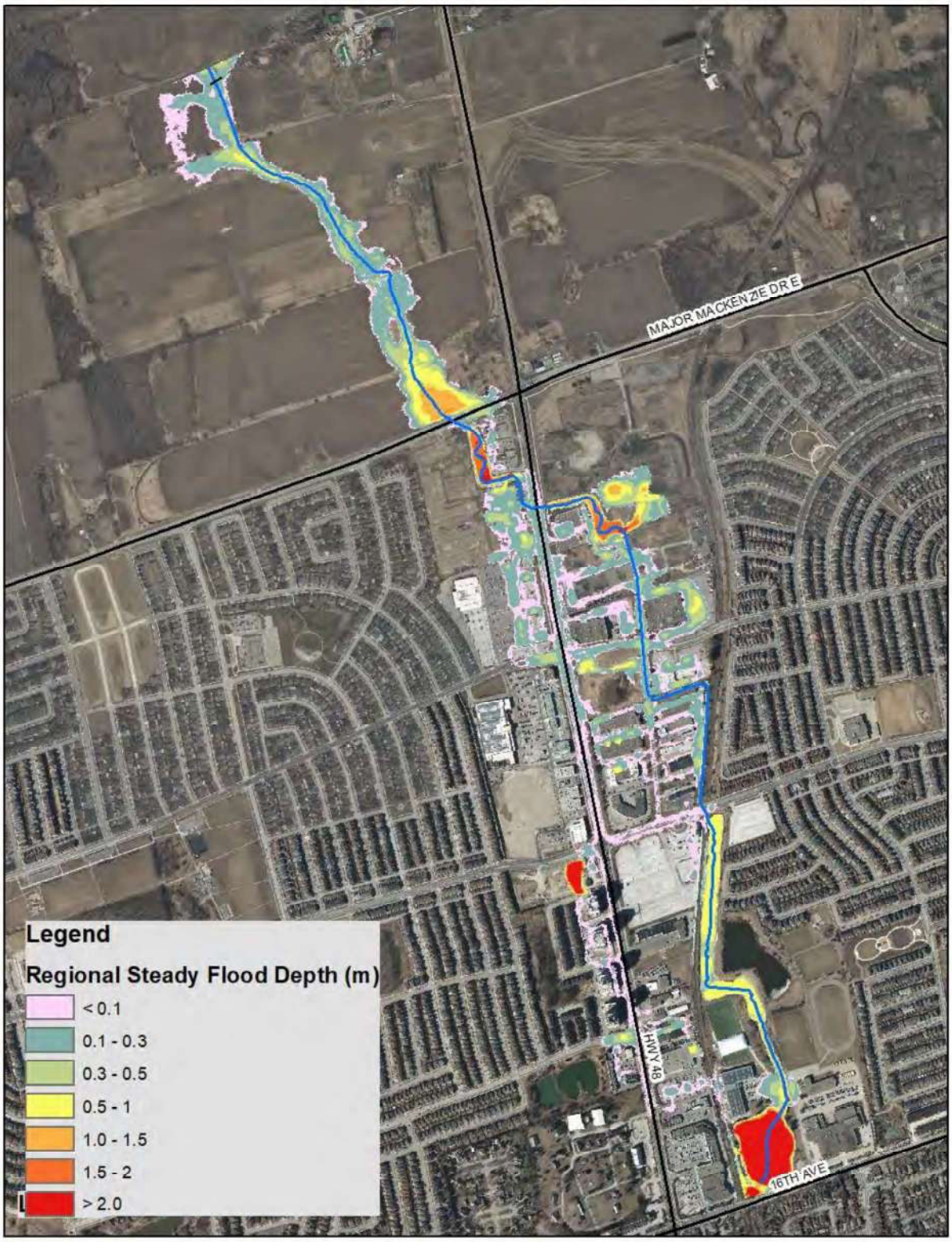


Figure 24 – Steady Regional, maximum water depth

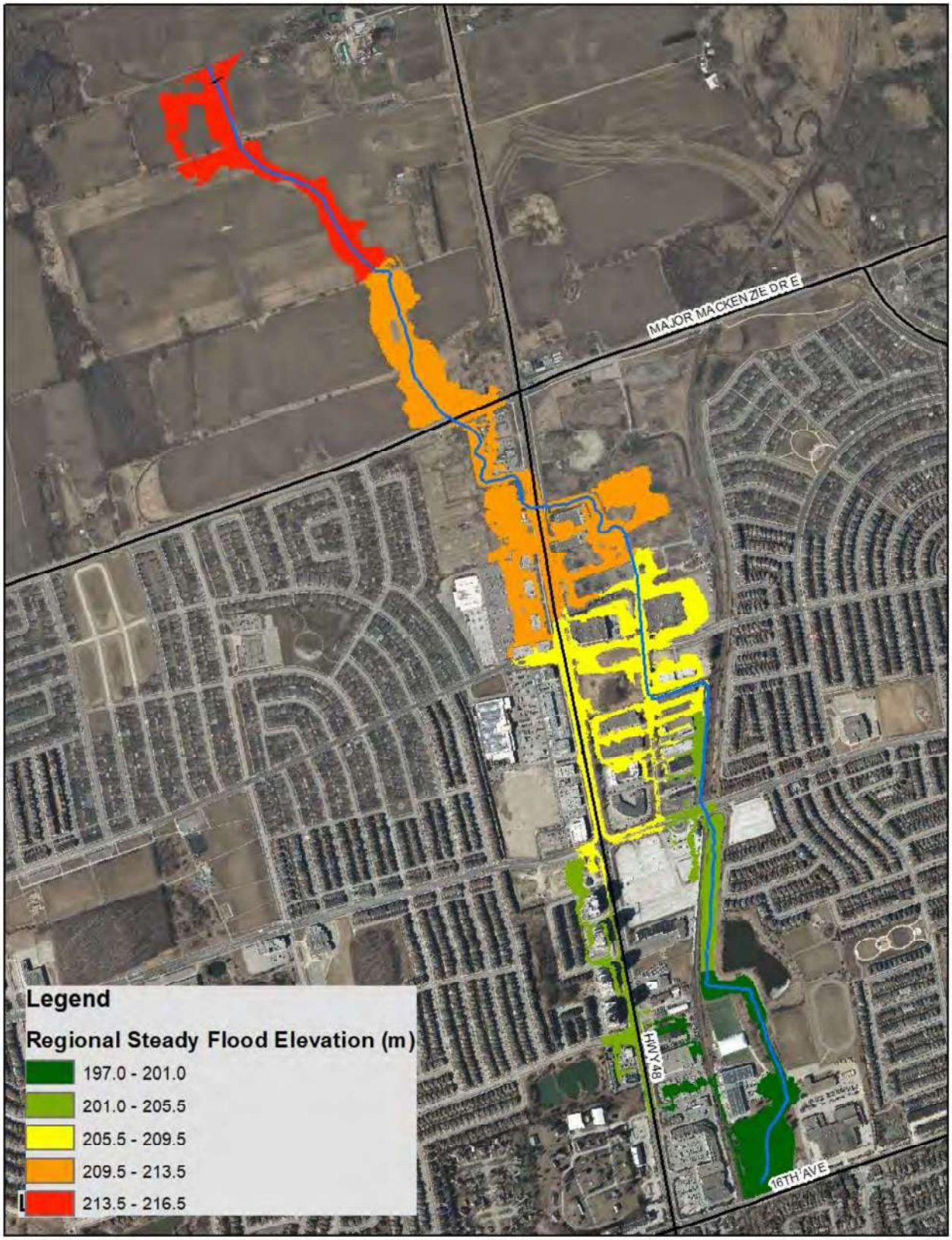


Figure 25 – Steady Regional, maximum water surface elevation

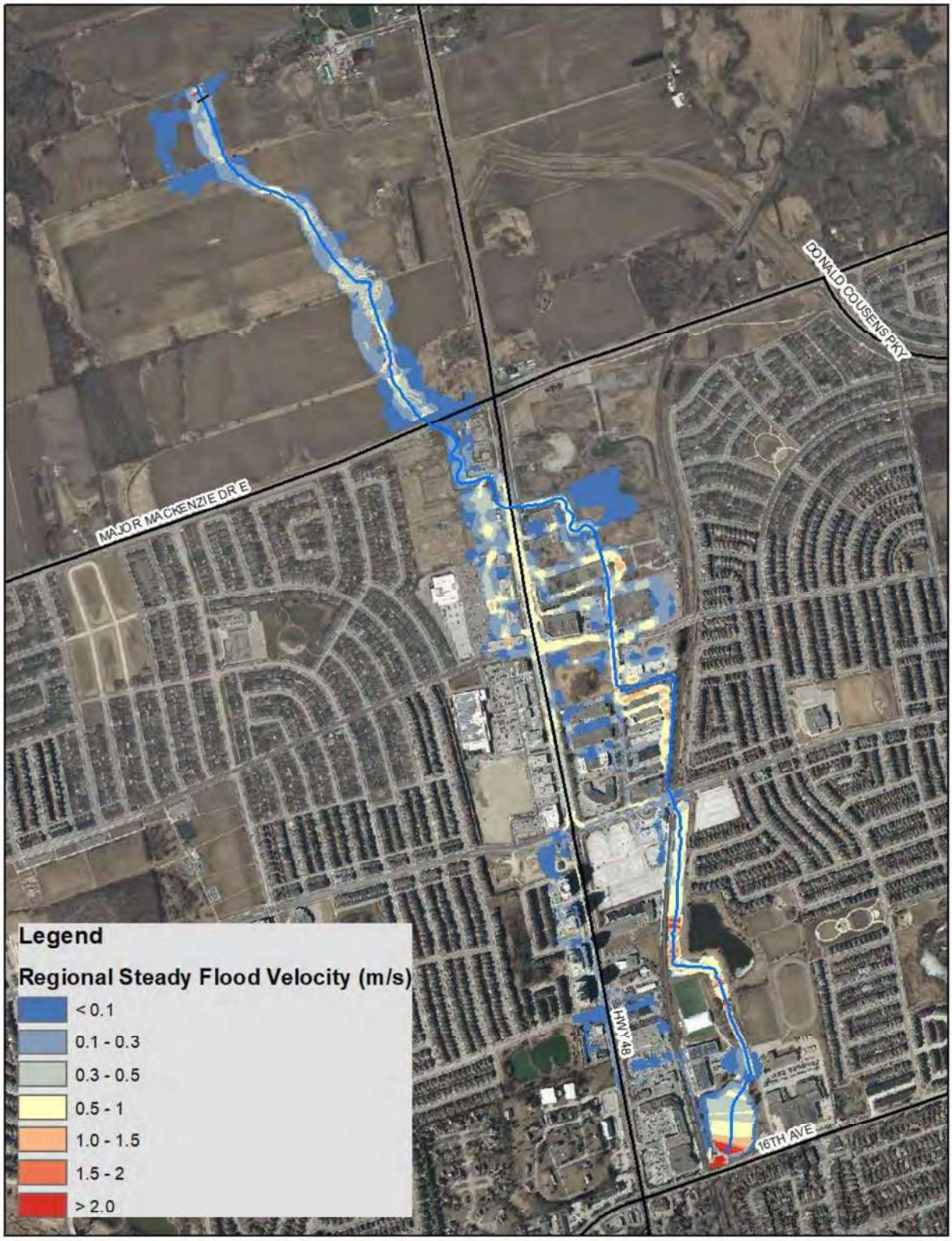


Figure 26 – Steady Regional, maximum velocity

4.0 Flood Risk Mapping

In terms of flood risk analysis, the criteria provided in the *Technical Guide River and Stream Systems: Flooding Hazard Limit* prepared by the Ontario Ministry of Natural Resources (MNR) in 2002 along with the frequency of flooding are typically used in defining and assessing flood risk. Based on work completed recently in other SPA's, the TRCA has revised the flood risk categories and how they are calculated. The revised flood risk categories are divided into low, moderate and high risk and are defined as follows:

- **Low Risk –** Vehicular and Pedestrian Access/Egress is Available (depth <0.3m),
- **Moderate Risk –** Pedestrian Access/Egress ONLY Available (Product Depth and Velocity <0.37m^2/s, Depth <0.8m and Velocity <1.7m/s,
- **High Risk** – Depth-velocity product > 0.37 m^2/s or Depth >0.8m or Velocity >1.7m/s.

Figure 27 illustrates the distribution of Low-, Moderate- and High-risk flood areas within the domain; High-risk areas are generally confined to the channel except at six areas that lie in High-risk flood areas.

Figure 28 shows the distribution of Low-, Moderate- and High-risk flood areas north of Major Mackenzie Dr E, and the High-risk flood area lies mainly in the farm field immediately upstream of Major Mackenzie Dr E.

Figure 29 shows the distribution of Low-, Moderate- and High-risk flood areas between Major Mackenzie Dr E and Bur Oak Ave. and most of areas along the major overland flow paths lies in Low – and Moderate - risk flood area. The High – risk areas mostly lie within re-aligned channel as well as the depression adjacent to the realigned channel at the south end of 9999 Markham Rd property.

Figure 30 shows the distribution of Low-, Moderate- and High-risk flood areas between Bur Oak Ave and 16th Ave. and most of areas along the major overland flow paths lies in Low – and Moderate - risk flood area. The High – risk areas mostly lie within the channel/Lake, and the depression in a condo area at south-west corner of Hwy48 and Bur Oak Ave is in the High – risk area but spill amount into this area is very small (less than 1m^3/s).

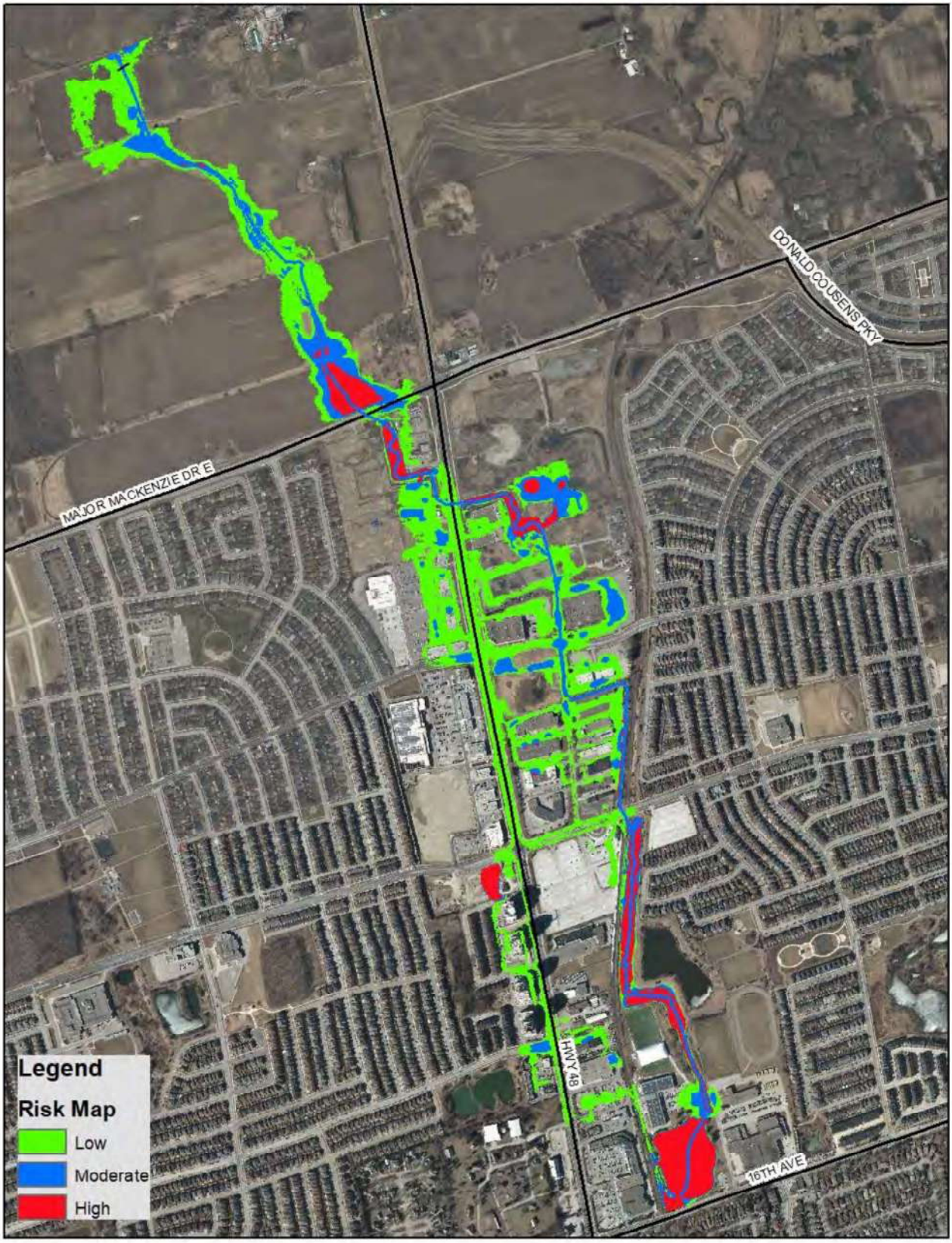


Figure 27 – Distribution of low- moderate- and high-risk flood areas

Figure 28 – Distribution of low- moderate- and high-risk areas north of Major Mackenzie Dr.

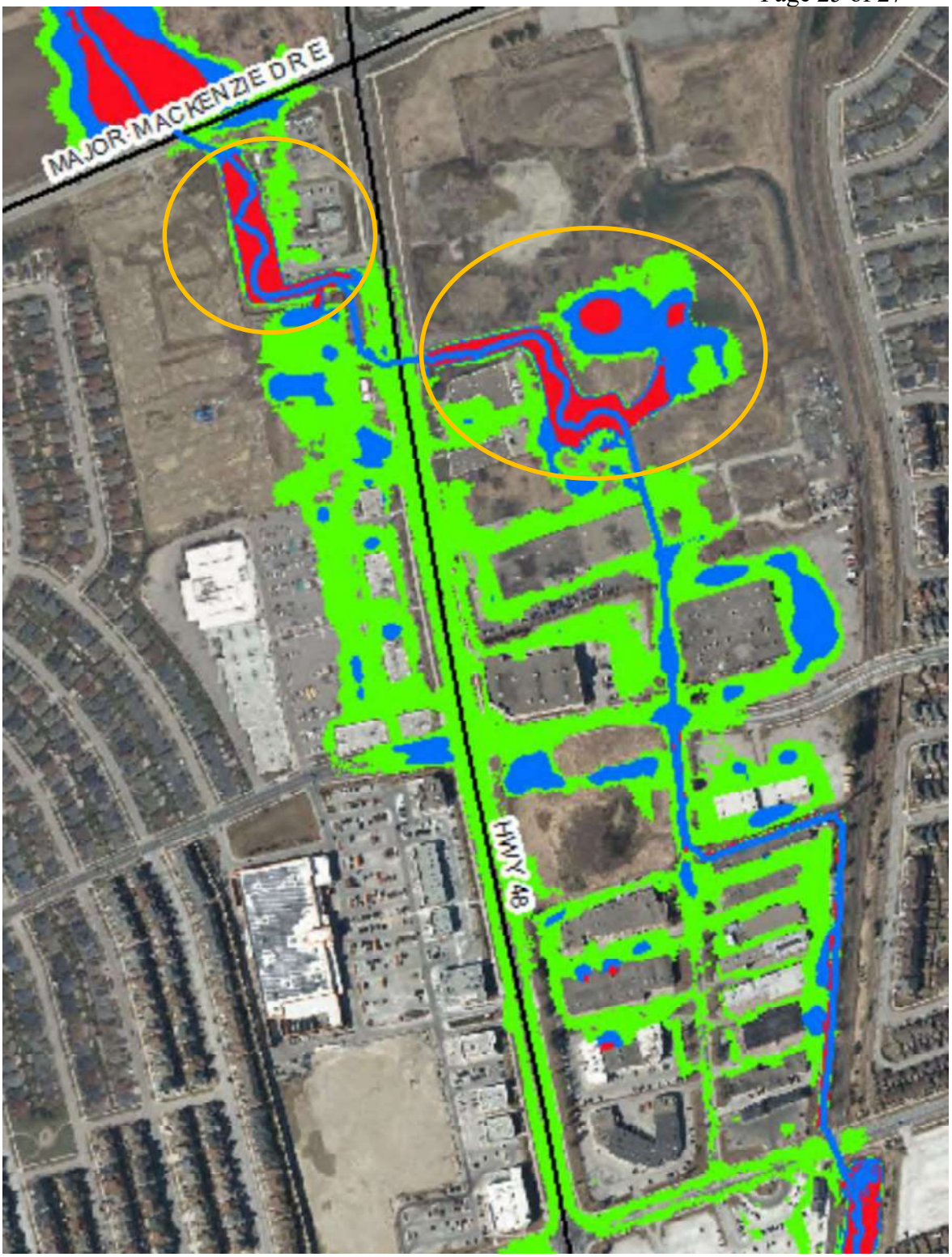


Figure 29 – Distribution of low- moderate- and high-risk flood areas along Hwy48 north of Bur Oak Ave.

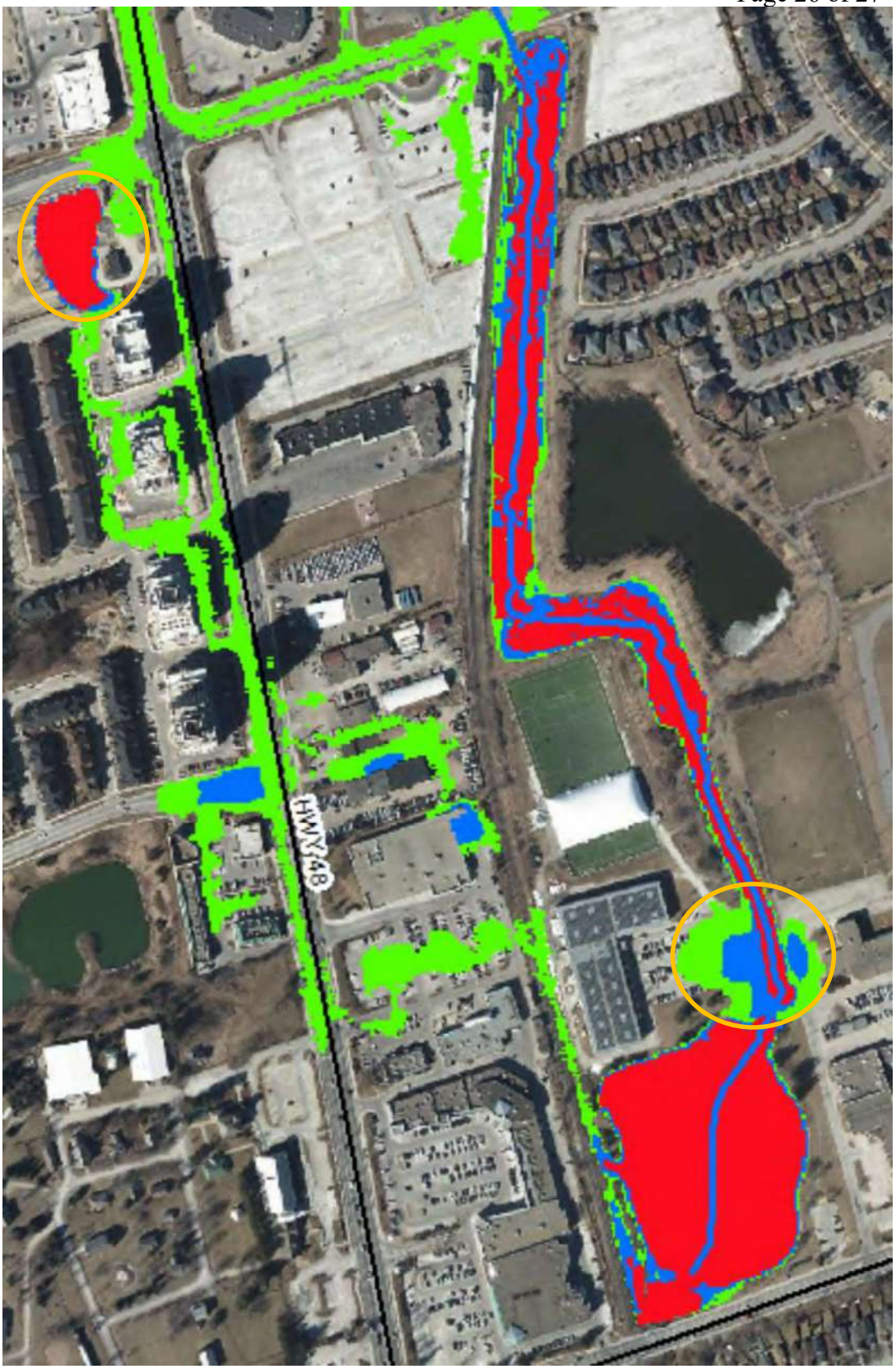


Figure 30 – Distribution of low- moderate- and high-risk flood areas alongHwy48 south of Bur Oak Ave.

5.0 Conclusions

Three spills at Hwy48 and Major Mackenzie were identified in the previous floodplain mapping update. Among these three spills and based on the topography data, spill at west side of Hwy48 near 9900 Markham Rd and spill at inlet of Anderson Ave. buried long pipes near 9999 Markham Rd would travel long way further south and may get into industrial areas and residential areas. Given this, a 2D model is more appropriate to define the spill and model shallow overland flow. Therefore, a coupled 1D and 2D MIKE Flood model was built that incorporated all crossings, TRCA 1-m 2019 LiDAR data spliced with 2015 Lidar where natural channel are present plus new grading plans in number of newly built and newly approved developments. The results from the coupled model clearly show the extent of the spill and its flow paths. For floodplain mapping purposes, flood depth and flood extent from the coupled MIKE model should be updated for reach section of the Exhibition Creek north of 16th Ave.

Table A.1: Comparison of LiDAR Surface (used in existing MIKE FLOOD) with Topo Survey Elevations

File: 22147 *18 Jan 2023*

	Location	Survey Elevation, m	LiDAR (2019) Elevation, m	Difference, m	Remarks
1	Car park pavement, to the north of the site	212.21	212.13	0.08	
2	Car park pavement, to the north of the site	212.29	212.19	0.1	
3	Car park pavement, to the north of the site	212.14	212.05	0.09	
4	Car park pavement, to the north of the site	212.17	212.05	0.12	
5	Sidewalk, to the east of property, west side of Markham Road	211.94	211.87	0.07	
6	Sidewalk, to the east of property, west side of Markham Road	212.02	211.92	0.1	
7	Sidewalk, to the east of property, west side of Markham Road	211.78	211.71	0.07	
8	Sidewalk, to the east of property, west side of Markham Road	211.85	211.89	-0.04	
9	Sidewalk, to the east of property, west side of Markham Road	211.69	211.58	0.11	
10	Sidewalk, to the east of property, west side of Markham Road	211.75	211.77	-0.02	
11	Sidewalk, to the east of property, west side of Markham Road	211.49	211.38	0.11	
12	Sidewalk, to the east of property, west side of Markham Road	211.08	211.01	0.07	
13	Sidewalk, to the east of property, west side of Markham Road	211.21	211.22	-0.01	
14	Sidewalk, to the east of property, west side of Markham Road	211.25	211.18	0.07	
15	Car park, adjacent to building within the site	211.61	211.51	0.1	
16	Car park, adjacent to building within the site	211.56	211.45	0.11	
17	Car park, adjacent to building within the site	211.54	211.47	0.07	
			Average Difference	**0.071**	

Figure A.1(a): Topographic Survey
9900 Markham Road, Markham

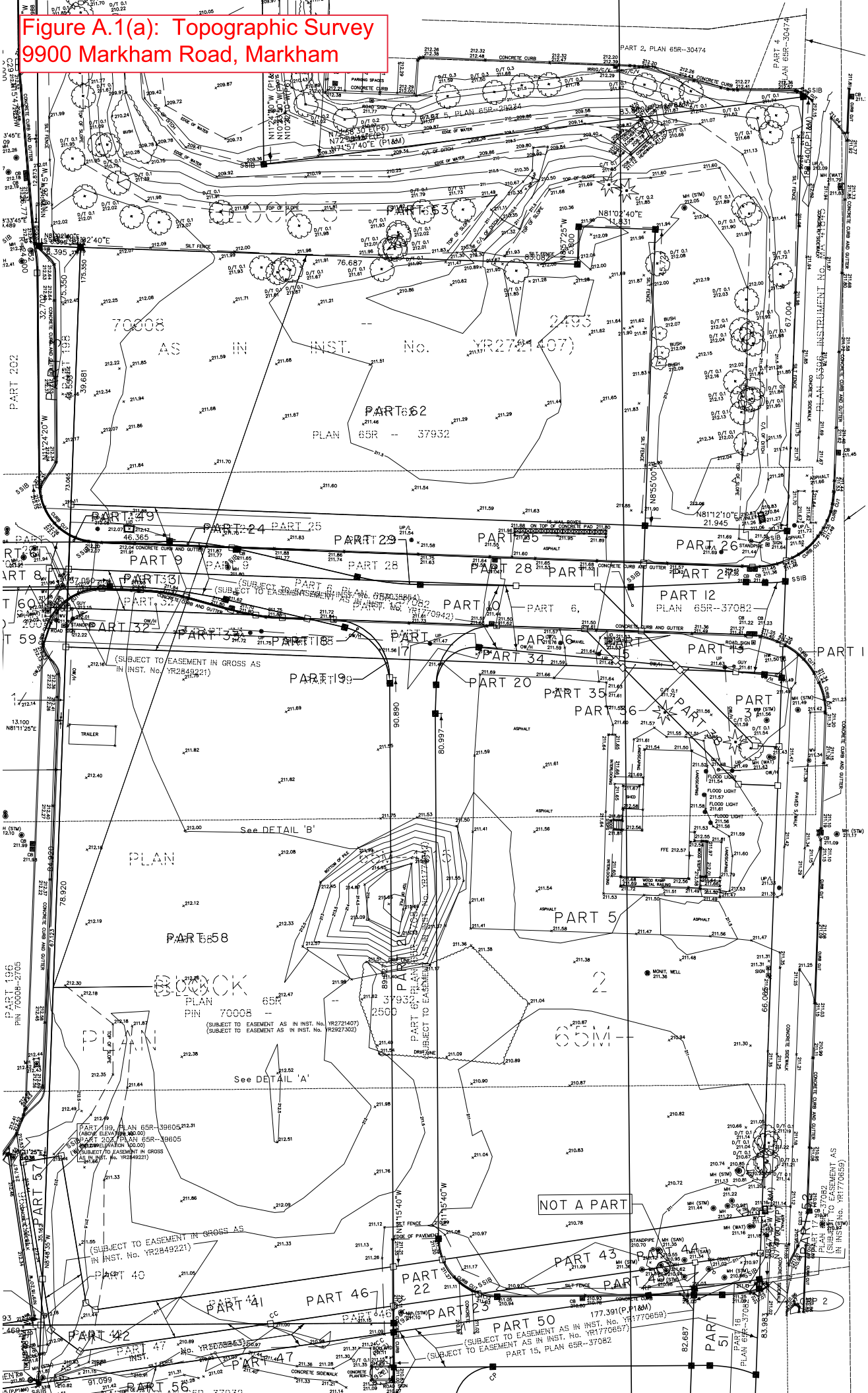


Figure A.1(b): Approved Site Servicing Plan
9900 Markham Road, Markham

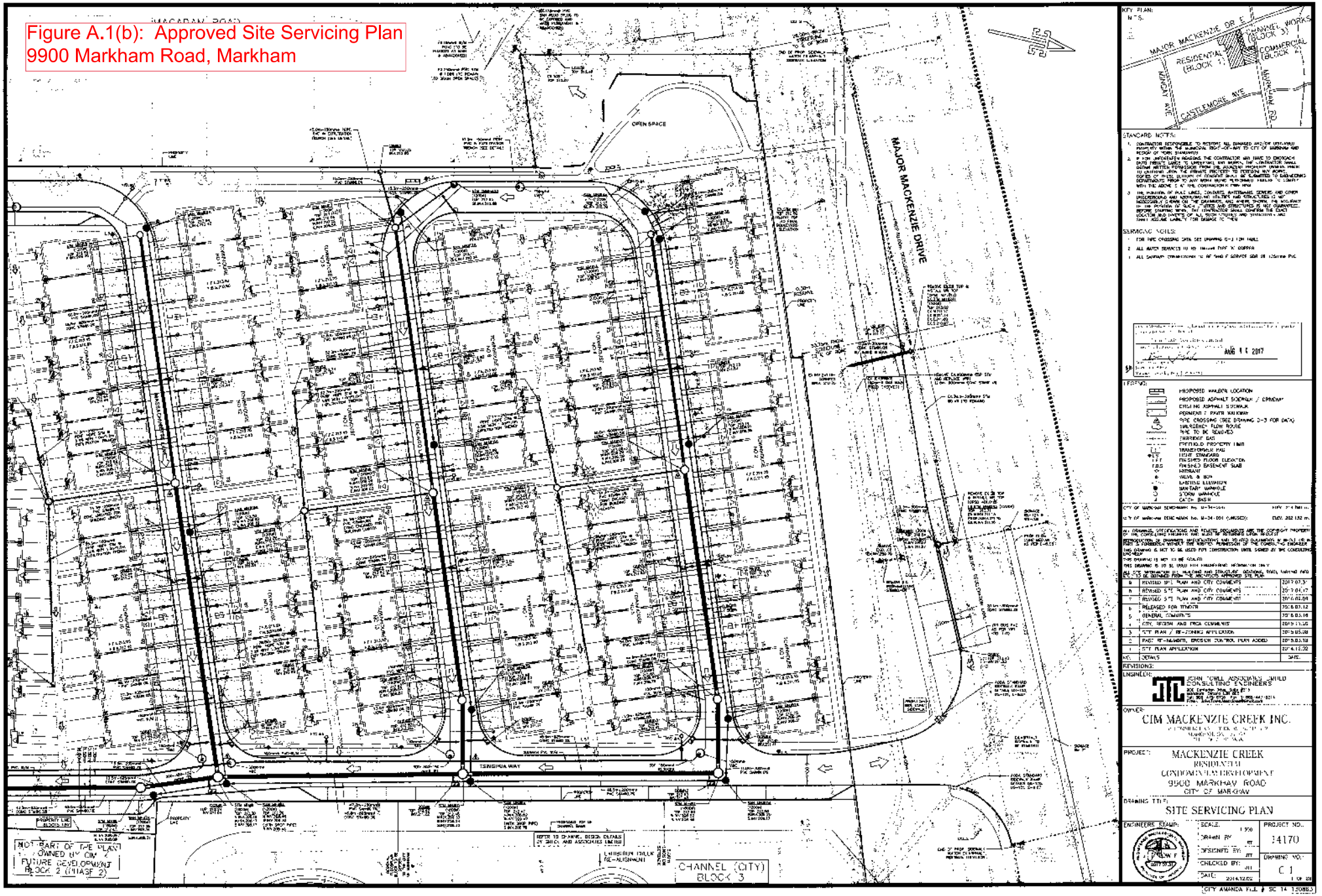


Figure A.1(c): Approved Site Servicing Plan
9900 Markham Road, Markham

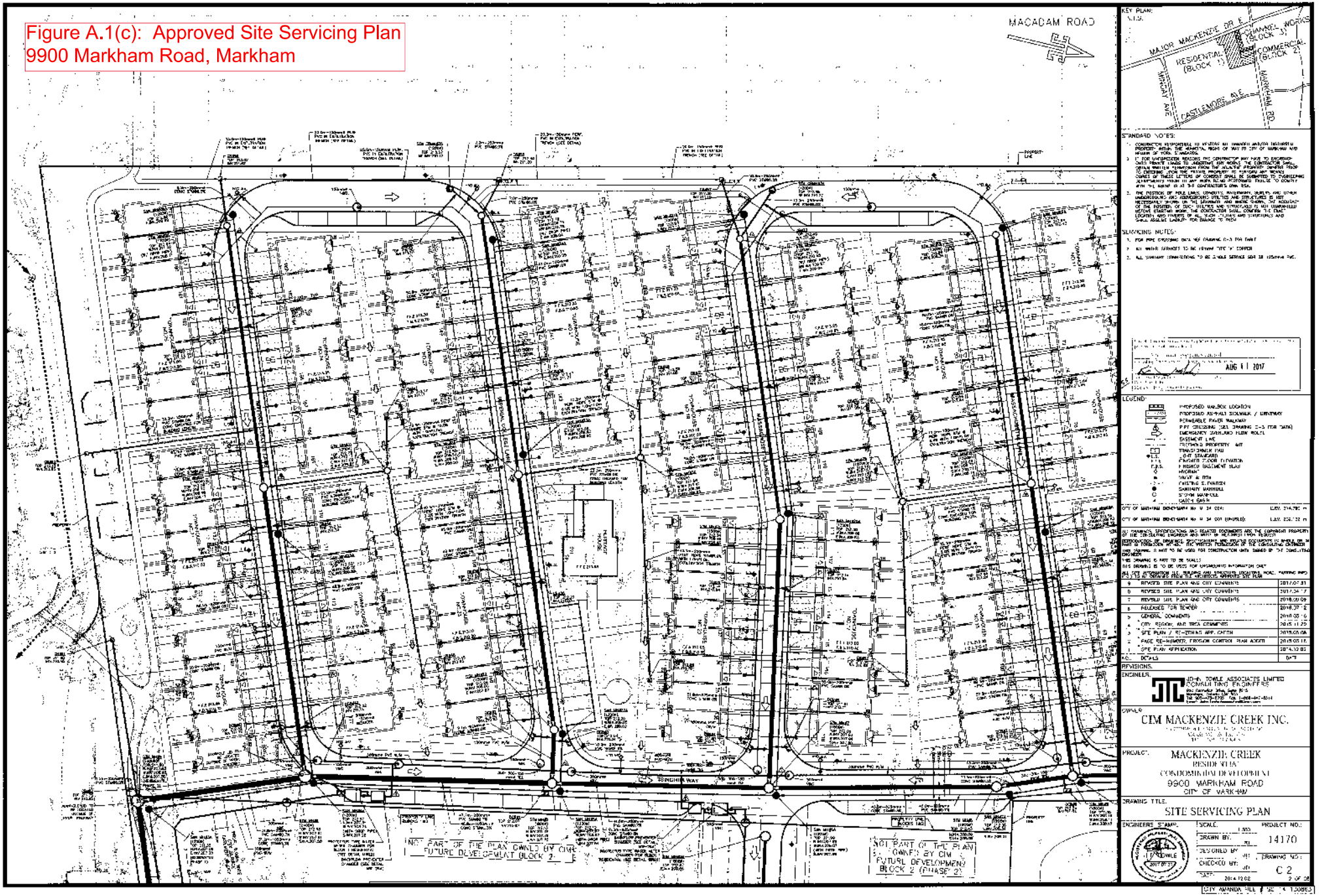
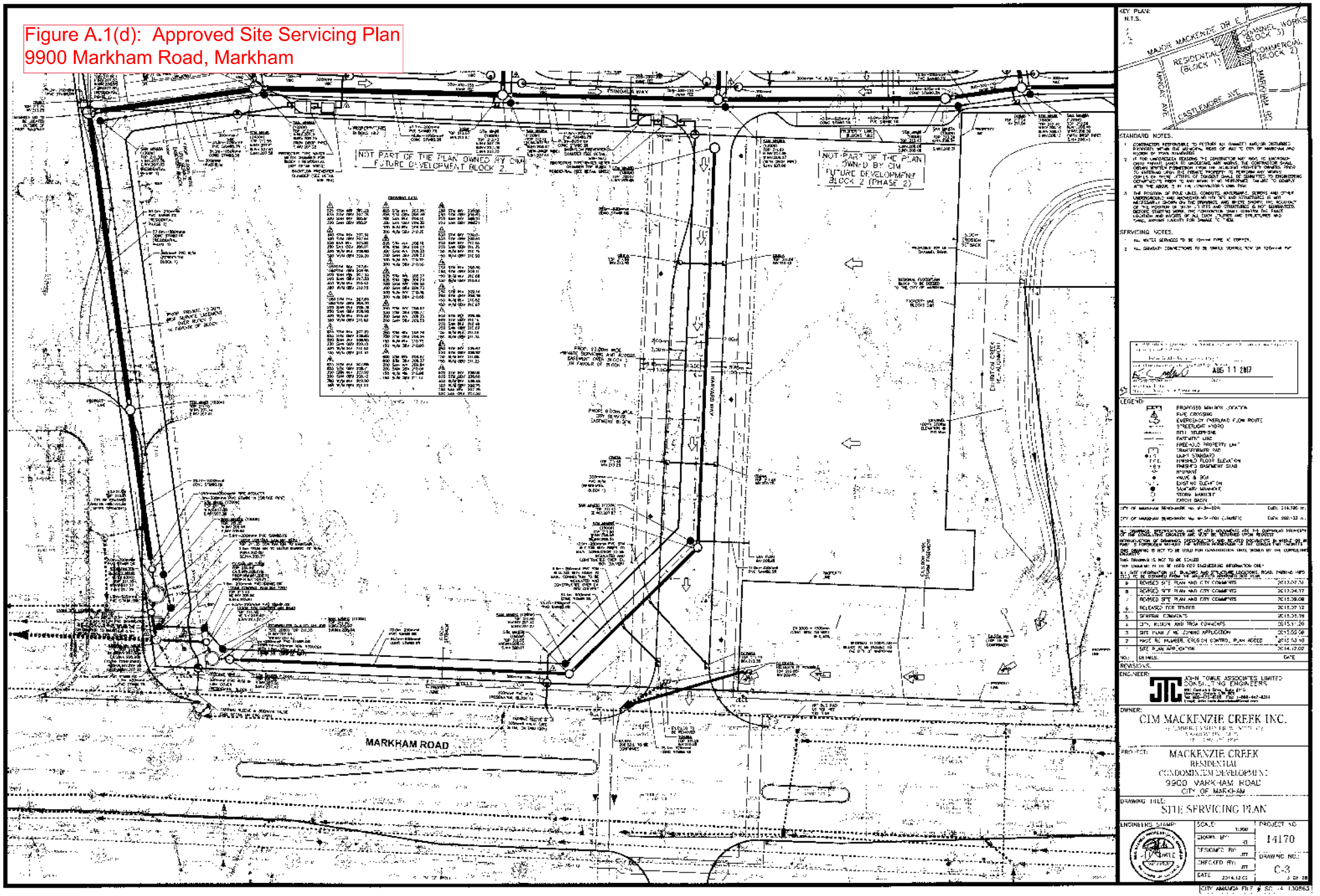


Figure A.1(d): Approved Site Servicing Plan
9900 Markham Road, Markham



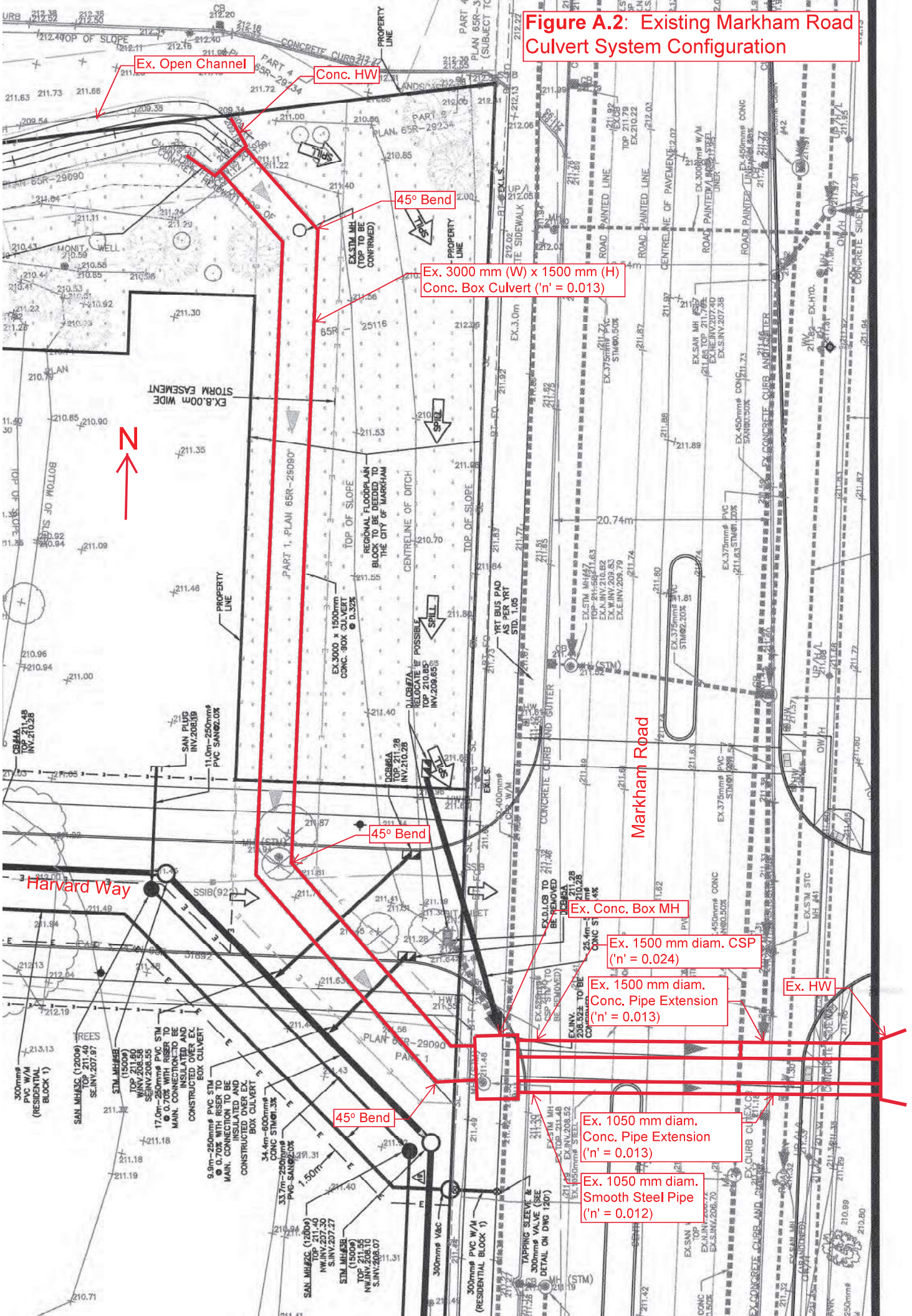


Figure A.2: Existing Markham Road Culvert System Configuration
Ex. Open Channel
Conc. HW
45° Bend
Ex. 3000 mm (W) x 1500 mm (H) Conc. Box Culvert ('n' = 0.013)
45° Bend
Harvard Way
Markham Road
Ex. Conc. Box MH
Ex. 1500 mm diam. CSP ('n' = 0.024)
Ex. 1500 mm diam. Conc. Pipe Extension ('n' = 0.013)
Ex. HW
45° Bend
Ex. 1050 mm diam. Conc. Pipe Extension ('n' = 0.013)
Ex. 1050 mm diam. Smooth Steel Pipe ('n' = 0.012)
N
PROPERTY LINE
TOP OF SLOPE
CENTRELINE OF DITCH
EX.8.00m WIDE STORM EASEMENT
REGIONAL FLOODPLAIN BLOCK TO BE DEEDED TO THE CITY OF MARKHAM
EX.3000 x 1500mm CONC. BOX CULVERT @ 0.32%
RELOCATE IF POSSIBLE TOP 210.85 INV.209.65
CONCRETE CURB AND GUTTER
ROAD PAINTED LINE
CENTRELINE OF PAVEMENT
EX.STM MH (TOP TO BE CONFIRMED)
SPILL
TREES
PART 1, PLAN 65R-29090
PLAN 65R-29234
PART 4, PLAN 65R-29234

Photo A.1: Markham Road Culvert System Inlet

Photo A.2: Markham Road Culvert System Outlet

Photo A.3: Markham Road Culvert System 1500 mm Diameter CSP

Photo A.4: Markham Road Culvert System 1050 mm Smooth Steel Pipe

Valdor Engineering Inc.
File: 22147
Date: August 08, 2023

Table A.2 : Equivalent Manning's Roughness Values for Regional Storm - Updated Existing MIKE Flood Model Culvert

Return Periods	Flow (cms)	0.5 entry loss coef. at U/S headwall 0.254 bend loss coef. at Bend 1 and 2. 0.31 bend loss coef. at Bend 3; Manhole loss of 0.05 at Junction 5 Downstream exit loss coef. 1.0					0 entry loss coef. at U/S headwall No bend loss coef. at Bend 1, 2 and 3; Manhole loss of 0 at Junction 5. Downstream exit loss coef. 0					Remarks
		3m x 1.50m Box Culvert Manning's 'n' (as in TRCA model)	1500mm Dia Culvert Manning's 'n' (as in TRCA model)	1050mm dia Culvert Manning's 'n'	Headwater Depth (m)	Max HGL at U/S (m)	3m x 1.50m Box Culvert Manning's 'n' (equivalent)	1500mm Dia Culvert Manning's 'n' (equivalent)	1050mm dia Culvert Manning's 'n' (equivalent)	Headwater Depth (m)	Max HGL at U/S (m)	
Regional Storm	11.80	0.013	0.024	0.013	4.54	213.38	0.0186 (Increased by 43%)	0.0343 (Increased by 43%)	0.0186 (Increased by 43%)	4.54	213.38	

ATTACHMENT 'B'

MIKE FLOOD Methodology Validation for Markham Road Culvert System

1D/2D Flood Impact Analysis for Proposed Development
9900 Markham Road, City of Markham

VALDOR

Valdor Engineering Inc.
File: 22147
Date: August 08, 2023

Table B.1 : Equivalent Manning's Roughness Comparison for Return Period and Regional Storms - 1500 mm Diameter Pipe

Return Periods	Flow (cms)	0.5 entry loss coef. at U/S headwall 0.254 bend loss coef. at Bend 1 and 2. 0.31 bend loss coef. at Bend 3; Downstream exit loss coef. 1.0			0 entry loss coef. at U/S headwall No bend loss coef. at Bend 1, 2 and 3; Downstream exit loss coef. 0			Remarks
		Manning's 'n' (as in TRCA model)	Headwater Depth (m)	Max HGL at U/S (m)	Manning's 'n' (equivalent)	Headwater Depth (m)	Max HGL at U/S (m)	
2 - Year	1.697	0.024	1.16	210.00	0.0299	1.16	210.00	
5 - Year	2.786	0.024	2.15	210.99	0.0287	2.15	210.99	
10 - Year	3.450	0.024	2.77	211.61	0.0285	2.77	211.61	
25 - Year	3.669	0.024	2.99	211.83	0.0285	2.99	211.83	
50 - Year	3.867	0.024	3.20	212.04	0.0286	3.20	212.04	
100 - Year	4.010	0.024	3.36	212.20	0.0285	3.35	212.19	
Regional Storm	4.171	0.024	3.57	212.41	0.0285	3.57	212.41	

Valdor Engineering Inc.
File: 22147
Date: August 08, 2023

Table B.2 : Equivalent Manning's Roughness Comparison for Return Period and Regional Storms - 1050 mm Diameter Pipe

Return Periods	Flow (cms)	0.5 entry loss coef. at U/S headwall 0.254 bend loss coef. at Bend 1 and 2. 0.31 bend loss coef. at Bend 3; Downstream exit loss coef. 1.0			0 entry loss coef. at U/S headwall No bend loss coef. at Bend 1, 2 and 3; Downstream exit loss coef. 0			Remarks
		Manning's 'n' (as in TRCA model)	Headwater Depth (m)	Max HGL at U/S (m)	Manning's 'n' (equivalent)	Headwater Depth (m)	Max HGL at U/S (m)	
2 - Year	0.983	0.024	1.27	210.11	0.0276	1.27	210.11	
5 - Year	1.227	0.024	2.32	211.16	0.0269	2.32	211.16	
10 - Year	1.409	0.024	2.76	211.60	0.0269	2.76	211.60	
25 - Year	1.494	0.024	2.97	211.81	0.0269	2.97	211.81	
50 - Year	1.546	0.024	3.10	211.94	0.0269	3.10	211.94	
100 - Year	1.639	0.024	3.35	212.19	0.0269	3.35	212.19	
Regional Storm	1.733	0.024	3.64	212.48	0.0269	3.64	212.48	

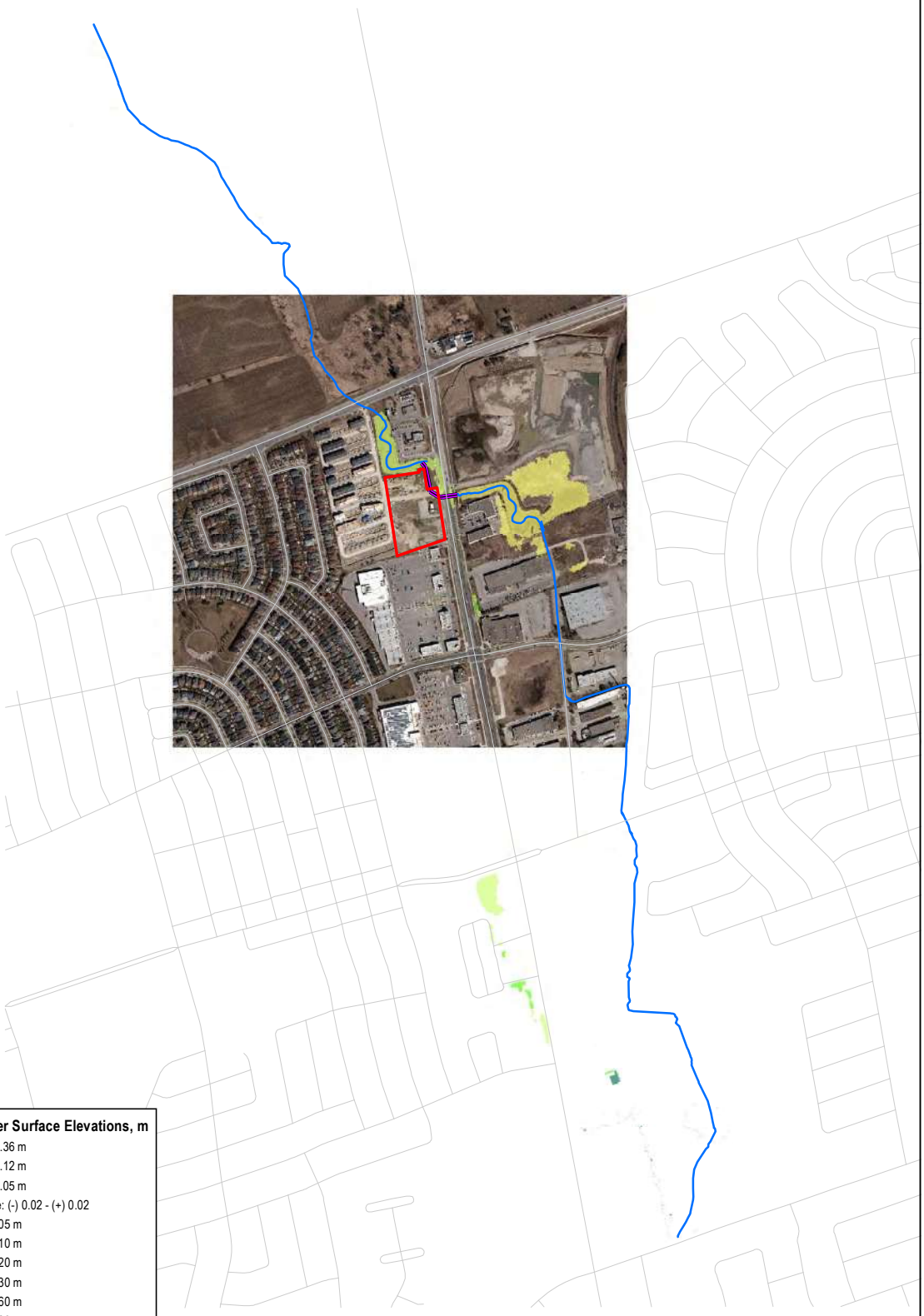


Figure B.1

REGIONAL WATER SURFACE ELEVATION DIFFERENCE MAP

EXISTING CONDITION MODELS (CLOSED SECTION APPROACH - STRUCTURE APPROACH OF MARKHAM ROAD CULVERTS)

STEADY PEAK INFLOW HYDROGRAPH (Regional STORM)

0 100 200 400 Meters

30 June 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

(Note: Markham Road Culvert Geometry is the same in both models. However, with Closed Section Approach, roughness is increased to account minor losses)

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

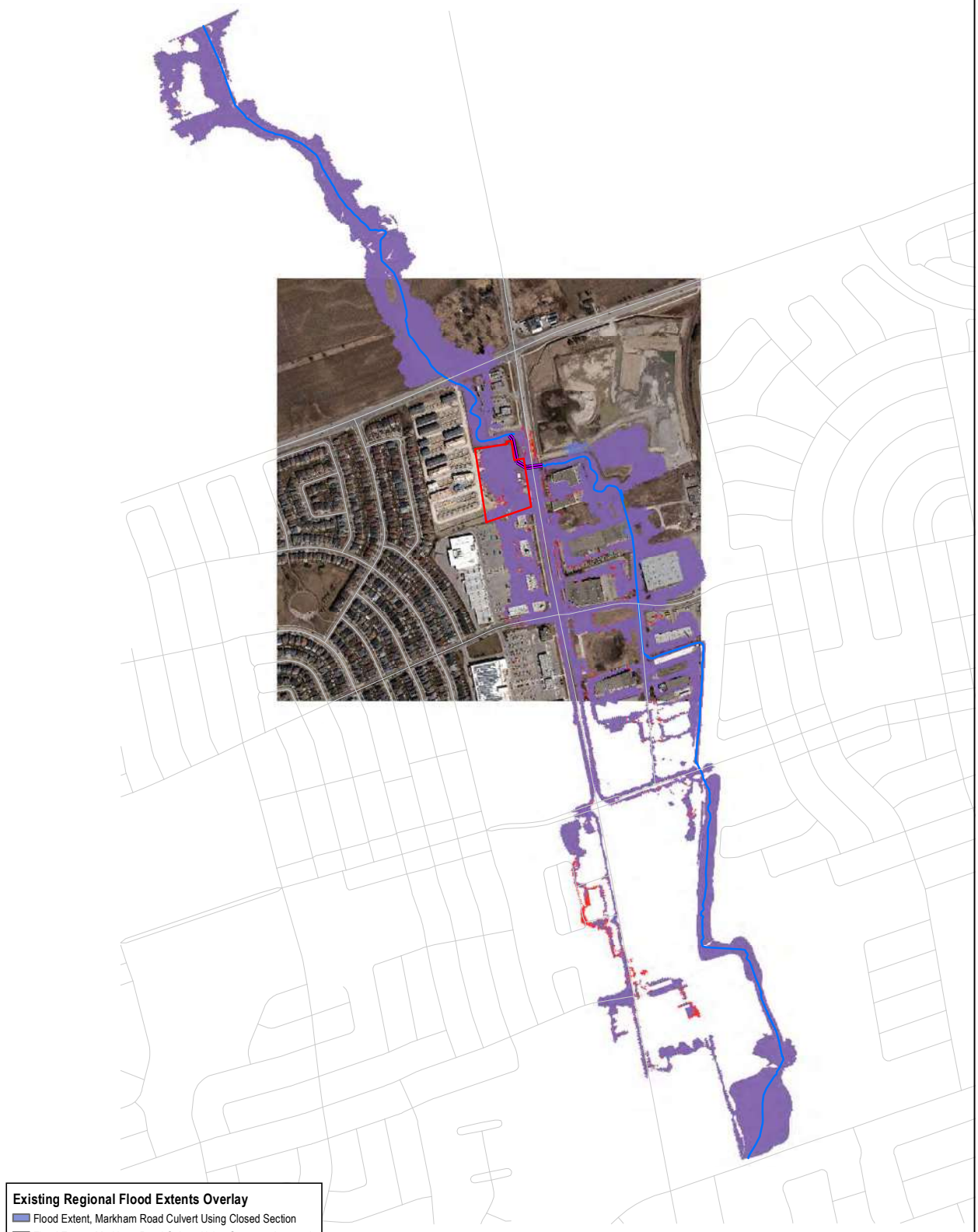


Figure B.2

EXISTING REGIONAL FLOOD EXTENTS OVERLAY MAP

EXISTING CONDITION MODELS (CLOSED SECTION APPROACH VS. STRUCTURE APPROACH OF MARKHAM ROAD CULVERTS)

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 100 200 400 Meters

30 June 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

*(Note: Markham Road Culvert Geometry is the same in both models. However, with Closed Section Approach, roughness is increased to account **minor** losses)*

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

From:	Bill Coffey
To:	Bill Coffey
Subject:	FW: 9900 Markham Road, Sunny Communities (CFN 56984.04)
Date:	October 5, 2023 5:11:42 PM
Attachments:	image002.png image007.png

From: Elyse Dickson <Elyse.Dickson@trca.ca>
Sent: Friday, August 18, 2023 2:58 PM
To: Bill Coffey <BCoffey@Valdor-Engineering.com>
Cc: Eric Wang <Eric.Wang@trca.ca>; Michelle Howorth <Michelle.Bates@trca.ca>; Knechtel, Erich <eknechtel@scsconsultinggroup.com>; Hossain, Abdullah <AHossain2@markham.ca>; Wong, Patrick <patrickwong@markham.ca>; Sito, Soran <SSito@markham.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Bill,

TRCA has no further comments on the validation exercise for the closed sections modelling approach. Please provide an updated floodplain memo including all relevant updated figures and digital copies of the revised existing conditions and proposed conditions models (PCSWMM and MIKE FLOOD) utilizing the approved methodology for all storm events (2 through Regional). Please ensure the increased flows as identified by SCS have been applied in the models.

Please let me know should you have any question or wish to discuss.

Regards,

Elyse Dickson, P.Eng. (she, her)
Engineer, Water Resources Engineering
Engineering Services | Development and Engineering Services

T: (647) 426-4487
E: elyse.dickson@trca.ca
A: 101 Exchange Avenue, Vaughan, ON, L4K 5R6 | trca.ca

Toronto and Region Conservation Authority

From: Bill Coffey <BCoffey@Valdor-Engineering.com>
Sent: Wednesday, August 9, 2023 11:51 AM
To: Elyse Dickson <Elyse.Dickson@trca.ca>
Cc: Eric Wang <Eric.Wang@trca.ca>; Qiao Ying <Qiao.Ying@trca.ca>; Michelle Howorth <Michelle.Bates@trca.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Elyse,

We have prepared the additional analyses regarding the recent comments received from TRCA. Please find below our response to comments in RED for your review. Should you have any questions, please feel free to connect at your convenience. Thank you.

Regards,

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources

VALDOR ENGINEERING INC.

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From: Elyse Dickson <Elyse.Dickson@trca.ca>
Sent: Friday, July 28, 2023 12:36 PM
To: Bill Coffey <BCoffey@Valdor-Engineering.com>
Cc: Eric Wang <Eric.Wang@trca.ca>; Qiao Ying <Qiao.Ying@trca.ca>; Michelle Howorth <Michelle.Bates@trca.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Bill,

Thank you again for the very productive call. As discussed, please find the summary and comments as follows. Please forward to Abdul, I do not have his email.

In the final formal submission, please include discussion on the flows used in the PCSWMM modelling. As discussed, we understand that the flows in each culvert from the Mike Flood model results have been applied in the PCSWMM models. **Yes, the flows used in the PCSWMM analyses are the culvert flows obtained from the MF model.**

Per discussions held between Abdul and DHI, the culvert entrance and exit losses are accounted for in the closed section approach based on the expansion and contraction coefficients. Please provide us with the correspondence from DHI indicating the losses are included in the closed section methodology. **Based on our discussions with DHI, there are many advantages to modeling complex culvert systems using closed sections, including the ability to apply multiple culvert shapes, slopes and roughness values in series and/or in parallel. In addition, when using closed sections, MIKE HYDRO is able to calculate the culvert flow using the fully dynamic wave equations (Saint-Venant Equations). The traditional structure approach of modelling culverts is**

based on the energy equation, which does not include the hydrostatic pressure gradient (force) and momentum force terms which are the governing forces causing flow. We believe the major difference (if any) in the results between the structure modelling approach and the closed section approach is due to the use of these two different equations, not due to the missing entrance/exit loss coefficient in the Saint-Venant equations to calculate the flows through closed sections. Regarding the entrance and exit losses, it is our opinion that these are mostly accounted for when a channel/culvert system is modeled using closed sections and when the changes in geometry are appropriately accounted for. Based on further clarification with Abdul, DHI was not able to provide any definitive response to what extent the entrance and exit losses may be accounted for using closed sections. DHI indicated that model calibration would be the only way to determine the extent to which entrance and exit losses are accounted for and that model calibration would be achieved by modifying the Manning's roughness value. Model calibration, however, is not something that is feasible in this case. As such, we are proposing to proceed with the analysis assuming that all minor losses, including entrance and exit losses, are not accounted for using closed sections. While this may not be entirely a correct assumption, it is conservative.

Please confirm what equivalent Manning's n value is required to mimic the same results in the PCSWMM models if the entrance and exit loss coefficients are not included. **Based on further analysis, there is an increase in the equivalent Manning's roughness value when it is assumed that the closed section approach does not account for these minor losses. The results of this additional analysis is provided for the 1500 mm diameter pipe and the 1050 mm diameter pipe in Tables 1 and 2, attached, for all return period storms including the Regional storm. As expected, the equivalent Manning's roughness value increase when it is assumed these are not accounted for using closed sections. The equivalent Manning's roughness for the Regional storm increased from 0.0257 to 0.0285 for the 1500 mm diameter pipe and from 0.0251 to 0.0269 for the 1050 mm diameter pipe. It is noted that some variability in equivalent roughness between storm events was observed, however, the maximum variability of 3% (1050mm pipe) to 5% (1500mm pipe) is not considered significant enough to warrant multiple model runs for all return period storms. A copy of the PCSWMM models used to calculate the equivalent roughness values for the 2-yr to 100-yr and the Regional storms may be downloaded via the following link:**
https://spaces.hightail.com/receive/StbfeMF87g

Similarly, please provide any correspondence from DHI regarding the transition loss from the revised existing conditions model to reflect the large box discharging to the two CSPS. **Similar to the entrance and exit losses, DHI was not able to provide any definitive response to what extent manhole losses may be accounted for using closed sections. DHI indicated that model calibration would be the only way to determine the extent to which manhole losses are accounted for. Model calibration, however, is not something that is not feasible in this case. As such, we are proposing to proceed with the analysis assuming a manhole loss of 0.05 which is reported in the literature for a straight through manhole with two pipes. We were unable to find in the literature a manhole loss value for a structure with three pipes straight through. As an additional precaution, we also completed the sensitivity analysis described below.**

Please include the sensitivity analysis including the modelling completed to demonstrate the effect

of the increased Manning's n value by 30%, 40%, and 50%. **To test the sensitivity of the results to varying equivalent Manning's roughness values for the box manhole, it was confirmed that an increase in Manning's roughness of approximately 80% resulted in no significant increase in upstream water surface elevations (see table of results provided below).**

Box Manhole Roughness (Manning n) Sensitivity Analysis:
(Markham Road culvert modelled using closed section approach)

Location at MIKE 21 2D WSEL Results	**Updated Existing Model with Box Manhole with Roughness, n= 0.013**	**Updated Existing Model with Box Manhole with Roughness, n= 0.0234**
WSEL (m) at east of Markham Road Culvert Inlet (Grid Loc.: 639065.0, 4863130.0	211.624	211.620
WSEL (m) at north of Markham Road Culvert Inlet at the spill point to the site (Grid loc.: 639020.0, 4863100.0)	211.616	211.617

As suggested, please explore opportunities to evaluate the transition loss in a PCSWMM model that incorporates the changes from the box to the CSPs. **See above response.**

To verify the culvert parameters, please provide the as built drawings used to revise the existing conditions modelling including culvert lengths, inverts, dimensions, etc. **The details regarding the culvert system crossing Markham Road were obtained from the available topographic survey and drawings and field investigations. A copy of the topographic survey (Figure 4) and a previously approved site servicing plan (Figure 5) that includes the details regarding the culvert system is attached. The dimensions and physical properties of the culvert system were verified in the field and found to generally reflect the culvert properties noted on the drawings.**

Lastly, please provide all completed modelling for TRCA review including the following:

- Mike Flood validated models for the 5 year, 25 year, 100 year, and Regional scenarios. **The MF validation models for the 5-yr, 25-yr, 100-yr and Regional storms may be downloaded via the following link: https://spaces.hightail.com/receive/YHs5FCZOIQ**
- PCSWMM modelling completed for the transition loss sensitivity analysis. **The MF models completed for the sensitivity analysis regarding the box manhole may be downloaded via the following link: https://spaces.hightail.com/receive/vO56V7DV2z**
- PCSWMM modelling completed to determine the equivalent higher Manning's n value for the concrete box in the revised existing conditions scenario. **The equivalent roughness values for the updated existing conditions were recalculated based on the assumption that entrance and exit losses are not accounted for when using closed sections and the results are attached in Table 3. Based on the updated results, the calculated equivalent roughness values for the box culvert, 1500 mm diameter pipe, and 1050 mm diameter pipe were 0.0186, 0.0343 and 0.0186, respectively. The PCSWMM models used in completing this analysis may be downloaded via the following link:**

https://spaces.hightail.com/receive/S3yQ8PM8p8

Please do not hesitate to call should you have any questions or wish to discuss further.

Regards,

Elyse Dickson, P.Eng. (she, her)
Engineer, Water Resources Engineering
Engineering Services | Development and Engineering Services

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A: 101 Exchange Avenue, Vaughan, ON, L4K 5R6 | trca.ca

Toronto and Region Conservation Authority

From: Bill Coffey <BCoffey@Valdor-Engineering.com>
Sent: Thursday, July 27, 2023 12:12 PM
To: Elyse Dickson <Elyse.Dickson@trca.ca>
Cc: Eric Wang <Eric.Wang@trca.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Elyse,

I'm available tomorrow morning anytime until about 1 pm, if that works for you. I'm generally familiar with the model setup and most details and should be able to answer your questions. Abdul who works directly with the MF model is currently on vacation and will be back next Wednesday. If I'm unable to answer any questions that require his input, I could get back to you next Wednesday. Thank you.

Regards,

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources

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From: Elyse Dickson <Elyse.Dickson@trca.ca>
Sent: Thursday, July 27, 2023 11:45 AM
To: Bill Coffey <BCoffey@Valdor-Engineering.com>
Cc: Eric Wang <Eric.Wang@trca.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Bill,

We have had a chance to review the submission materials and we have a few technical follow up questions on the modelling set up. Is there a time either tomorrow or early next week we can schedule a call?

Thank you,

Elyse Dickson, P.Eng. (she, her)
Engineer, Water Resources Engineering
Engineering Services | Development and Engineering Services

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E: elyse.dickson@trca.ca
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Toronto and Region Conservation Authority

From: Bill Coffey <BCoffey@Valdor-Engineering.com>
Sent: Thursday, July 13, 2023 2:50 PM
To: Michelle Howorth <Michelle.Bates@trca.ca>; Knechtel, Erich <eknechtel@scsconsultinggroup.com>
Cc: Eric Wang <Eric.Wang@trca.ca>; Elyse Dickson <Elyse.Dickson@trca.ca>; Aries Lobrin <aries.lobrin@sunnycommunities.com>; Christopher O'Hanlon <christopher.ohanlon@sunnycommunities.com>; Gioacchini, Paul <pgioacchini@scsconsultinggroup.com>; Sito, Soran <SSito@markham.ca>; Hossain, Abdullah <AHossain2@markham.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Michelle,

Please find attached our response to TRCA comments regarding the 2D floodplain analysis. Please note that we are working through the process with the City to obtain the orthophotos to include for the full extents covered in the TRCA's current approved model. This additional request is mostly cosmetic and does not have any impacts regarding the results. We will include the additional

orthophotos at a later time when we receive them to avoid any further delays as the Client is anxious to complete the review. Thank you.

Regards,

Bill Coffey, M.Sc., P.Eng.
Head of Water Resources

VALDOR ENGINEERING INC.

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Branch Office: Peterborough & The Kawarthas
580 The Queensway, Unit 1
Peterborough, Ontario, K9J 7H2

From: Michelle Bates <Michelle.Bates@trca.ca>
Sent: Wednesday, April 12, 2023 4:57 PM
To: Bill Coffey <BCoffey@Valdor-Engineering.com>; Knechtel, Erich <eknechtel@scsconsultinggroup.com>
Cc: Eric Wang <Eric.Wang@trca.ca>; Elyse Dickson <Elyse.Dickson@trca.ca>; Aries Lobrin <aries.lobrin@sunnycommunities.com>; Christopher O'Hanlon <christopher.ohanlon@sunnycommunities.com>; Gioacchini, Paul <pgioacchini@scsconsultinggroup.com>; Sito, Soran <SSito@markham.ca>; Hossain, Abdullah <AHossain2@markham.ca>
Subject: RE: 9900 Markham Road, Sunny Communities (CFN 56984.04)

Hi Erich,

Please find below our updated Flood Plain Management comments based on our review of the submitted flood plain analysis (materials received on March 13 & 16, 2023).

Official Plan Amendment & Zoning By-law Amendment - PLAN 21 140327 (TRCA CFN 56984.04)

Flood Plain Management

1. **Comment May 30, 2018 (1st Submission Letter):** Please indicate on all relevant plans (Site Plan, Grading Plan, Servicing Plan etc.) the updated flood plain, spill location, and associated buffer in relation to the proposed development, confirming that development is outside of the flood hazard lands and associated buffer.

   Update December 15, 2021 (2nd Submission Letter): Not addressed. Please provide a plan and/or relevant excerpts with topographic elevations/grades that clearly shows the updated flood plain and spill (including flood elevations), and associated buffers in relation to the proposed development, confirming that

development is outside of the flood hazard lands and associated buffer.
Please be advised that the flood elevations used to delineate the updated flood plain and spill will need to be based on the latest modeling and flows. The latest modelling approved by TRCA for this location was prepared by Greck and Associates Limited and the latest/updated flows are available from TRCA, which would need to be inputted into Greck's model. However, please be advised that TRCA is currently creating a 2-D flood plain model for this area. The completion date for this model has yet to be determined. The applicant has the option to update Greck's model with updated flows; however, it should be understood that this model will ultimately be superseded by TRCA's 2-D model once it is finalized. To obtain the latest flows, and for information on how the flows should be applied in Greck's model, please contact Elyse Dickson, Water Resources Engineering Technologist, at elyse.dickson@trca.ca. Please note that TRCA is uncertain of if there will be any flood plain issues as a result of updated modeling, but is willing to work with the applicant on a technical solution should issues arise.

Update December 1, 2023 (Email): We have consulted with our Director of Development Planning and Engineering Services regarding the request for TRCA to update the 2D modeling to reflect proposed fill placement on the subject property. After careful consideration it was concluded that we would be unable to undertake this analysis on behalf of the applicant due to current capacity/resources issues and potential conflict of interest challenges (TRCA modeling proposed site conditions while also being a peer reviewer and approval authority for the proposed conditions).

In order to advance the proposed development we would require that the applicant provide a 2D Flood Plain Analysis to assess the impact of proposed spill mitigation measures (for example: standard mitigation would include grading the site out of the spill to the applicable flood/spill elevation plus a minimum 0.3m freeboard) and demonstrate that the spill mitigation measures will protect the site from spill waters and not result in any adverse off-site impacts. The analysis will need to include but may not be limited to an assessment of changes in flood (water surface) elevations, velocities and flood risks/flood plain limit.

TRCA staff are prepared to work with the applicant on advancing a technical solution for this property that meets our policies. We trust the information above will assist the applicant with clarifying and streamlining the scope of the analysis and would suggest that the applicant provide the 2D Flood Plain Analysis (Report, Figures and Modeling Files) directly to TRCA to for an initial review before a full re-submission is made to the City.

Update April 12, 2023 (2D Flood Plain Analysis): Not addressed. For TRCA review, please provide the MIKE FLOOD validated modelling scenario using the "closed section" approach with the same culvert configuration as the TRCA approved hydraulic model using the "culvert structure" approach. Please provide a comparison between the results of the validated model and TRCA's model. Please ensure all relevant figures illustrating the results from both models and comparisons between the two have been included for review. **Once received and reviewed, TRCA will assess the appropriateness of the proposed methodology.**

Please note the following comments to be addressed at a later stage should the modelling methodology be accepted by the TRCA. Additional comments may be provided once all modelling has been submitted for review.

a. To ensure the proposed development does not increase the floodplain risk to the surrounding properties, please provide risk maps for the existing conditions, proposed conditions, and comparison between the existing and proposed conditions.
b. For clarity, please include contour lines and labels on the water surface elevation maps.
c. Please include a figure demonstrating the changes to the mesh to reflect the proposed grading.
d. For TRCA review, please provide the PCSWMM models completed for determining the Manning's n values to be used in the MIKE FLOOD model with the "closed section" approach. As the "closed section" approach does not account for entrance and exit losses, please ensure the Manning's n values have been chosen to reflect all losses of the existing culvert system (i.e., entrance, exits, and bends).
e. The 1500 mm diameter CSP culvert and 1050 mm diameter smooth steel pipe culvert do not appear to have been modeled with the higher Manning's n values. Please ensure the higher Manning's n values have been applied to the appropriate sections in the model.
f. Please provide the results for the revised existing and proposed conditions for all design storm events (i.e., 2 through 100 year and Regional storms).
g. Please provide all survey data used in the modelling of the "closed section" approach included but not limited to the culvert dimensions, lengths, inverts, etc.

Once the floodplain analysis has been undertaken to the satisfaction of the TRCA, the floodplain and buffer will be required on all relevant figures and drawings of the proposed development confirming that development has been located outside of the flood hazard lands and associated buffer.

Should you have any questions or would like to discuss these comments, please do not hesitate to contact me.

Regards,

Michelle Bates
Senior Planner - York East Review Area
Development Planning and Permits | Development Planning and Engineering Services

T: 437-880-2287
E: michelle.bates@trca.ca
A: 101 Exchange Avenue, Vaughan, ON, L4K 5R6 | trca.ca

Toronto and Region Conservation Authority

Please note: Digital circulations for properties in York Region can be submitted to TRCA via

June 2, 2023 CFN 56984.04

Via E-Plan

Carlson Tsang
City of Markham
101 Town Centre Boulevard
Markham, ON L3R 9W3

Dear Rick Cefaratti:

Re: Official Plan Amendment & Zoning By-law Amendment - PLAN 21 140327 (OP/ZA 17 159779) – Submission 3
9900 Markham Road, City of Markham
Owner: Sunny Communities (Markham Gold) Inc. - Christopher O'Hanlon
Applicant: Malone Given Parsons Ltd. – Rohan Sovig

This letter acknowledges receipt of materials submitted to our office on May 9, 2023 and Apil 20, 2023 in support of the above noted applications. Toronto and Region Conservation Authority (TRCA) staff have reviewed the applications and the materials listed in **Appendix 'A'** to this letter in accordance with Ontario Regulation 686/21 and Ontario Regulation 166/06.

The following comments are issued in accordance with Section 21.1(1) of the *Conservation Authorities Act,* which requires TRCA to provide programs and services related to natural hazards within its jurisdiction. The standards and requirements of such mandatory programs and services are listed under Ontario Regulation 686/21. Specifically, the regulation requires that TRCA must, acting on behalf of the Ministry of Natural Resources and Forestry (MNRF) or in its capacity as a public body under the *Planning Act*, ensure that decisions under the *Planning Act* are consistent with the natural hazard policies of the Provincial Policy Statement (PPS). In accordance with Ontario Regulation 686/21 and Ontario Regulation 596/22, TRCA's review does not include non-mandatory comments outside of our core planning mandate, such as comments pertaining to natural heritage matters.

In addition, TRCA must also ensure that where development and/or site alteration is proposed within an area regulated by the Authority under Ontario Regulation 166/06, that it conforms to the applicable tests and associated policies (Section 8 of TRCA's The Living City Policies) which are utilized by TRCA staff to evaluate a proposal's ability to meet the tests of this regulation.

Purpose of the Application

The purpose of these applications is to facilitate the development of two 20-storey apartment buildings, 112 townhomes, and associated surface and underground parking (3 levels) on the property. The Official Plan Amendment proposes to redesignate the subject property from Mixed-use Mid Rise to Mixed-Use High Rise and the Zoning By-law Amendment proposes to re-zone

the property from Major Commercial*551 (MJC*551) Zone under By-law 177-96 to Community Amenity One*XX (CA1*XX) Zone.

Application Review Fees

TRCA has received payment in the amount of $9,400 (2021 Planning Services Fee Schedule – OPA & ZBA – Standard) for these applications. Please note that this fee covers up to three submissions, after which additional fees will apply, and additional fees will be required for any additional planning or permit applications for the subject property.

Accordingly, for the next submission an additional submission fee of $1,080 (2022 Fee Schedule – Additional Submission Fee – Minor) will be required. This can be submitted by cheque or online (payment link provided upon request).

Recommendations

Based on our review of this submission we provide our comments in **Appendix 'B'** of this letter**.** While we appreciate the work undertaken by the applicant in response to new flood plain modeling, we require a revised flood plain assessment to confirm the spill limits (existing and proposed), impacts on the spill/off-site properties and that the development will be free/safe from spill waters to our satisfaction before we can recommend approval of the proposed OPA and ZBA.

Accordingly, it is the position of TRCA staff that the approval of the OPA and ZBA applications is premature at this time. TRCA requires that the applicant provide a re-submission addressing the comments in **Appendix 'B'**.

Should you have any questions or comments, please do not hesitate to contact the undersigned at 437-880-2287 or michelle.howorth@trca.ca.

TRCA requests to be notified of any decisions made by the City on this application(s), or any appeals that may be made to the Ontario Land Tribunal by any party in respect of this application(s).

Sincerely,

Michelle Bates
Senior Planner
Development Planning and Permits | Development and Engineering Services

Attachments: Appendix A - Materials Reviewed by TRCA
Appendix B - Commenting Table

Appendix 'A': Materials Reviewed by TRCA

May 9, 2023

- 2D Flood Plain Modeling Files

April 20, 2023

- Comment Response Matrix;
- Architectural Plans, prepared by Wallman Architects, revision no. 2 dated March 1, 2023.
- Draft Official Plan Amendments;
- Draft Zoning By-law Amendment;
- Functional Servicing Report, prepared by SCS Consulting Group Ltd., dated February 2023;
- Drawing No. RZL1, Concept Landscape Plan, prepared by Ferris & Associates Inc., revision no. 2 dated May 26, 2022;
- Flood Plain Analysis, prepared by Valdor Engineering, dated February 16, 2023 (reviewed by TRCA previously and comments provided by email on April 12, 2023)

Appendix 'B': Detailed Comments

Please see below for TRCA's detailed comments based on the materials identified in Appendix 'B'. TRCA reserves the right to provide additional comments as new or revised information becomes available.

#	TRCA Comment – Submission 1 - May 2018	TRCA Comment – Submission 2 – November 2021	TRCA Comment – Submission 3 – June 2023
1.	**Flood Plain Management** Please indicate on all relevant plans (Site Plan, Grading Plan, Servicing Plan etc.) the updated flood plain, spill location, and associated buffer in relation to the proposed development, confirming that development is outside of the flood hazard lands and associated buffer.	**Flood Plain Management** Not addressed. Please provide a plan and/or relevant excerpts with topographic elevations/grades that clearly shows the updated flood plain and spill (including flood elevations), and associated buffers in relation to the proposed development, confirming that development is outside of the flood hazard lands and associated buffer. Please be advised that the flood elevations used to delineate the updated flood plain and spill will need to be based on the latest modeling and flows. The latest modelling approved by TRCA for this location was prepared by Greck and Associates Limited and the latest/updated flows are available from TRCA, which would need to be inputted into Greck's model. However, please be advised that TRCA is currently creating a 2-D flood plain model for this area. The completion date for this model has yet to be determined. The applicant has the option to update Greck's model with updated flows; however, it should be understood that this model will ultimately be superseded by TRCA's 2-D model once it is finalized. To obtain the latest flows, and for information on how the flows should be applied in Greck's model, please contact Elyse Dickson, Water Resources Engineering Technologist, at elyse.dickson@trca.ca. Please note that TRCA is uncertain of if there will be any flood plain issues as a result of updated modeling, but is willing to work with the applicant on a technical solution should issues arise.	**Flood Plain Management** **Not addressed.** Through correspondence with the applicant TRCA has identified that the property is located within a spill and in order to advance the proposed development a 2D Flood Plain Analysis is required to assess the impact of proposed spill mitigation measures (for example: standard mitigation would include grading the site out of the spill to the applicable flood/spill elevation plus a minimum 0.3m freeboard) and demonstrate that the spill mitigation measures will protect the site from spill waters and not result in any adverse off-site impacts. The analysis will need to include but may not be limited to an assessment of changes in flood (water surface) elevations, velocities and flood risks/flood plain limit. Thank you for providing the validation model. Please find the comments on the submitted material below. a. For TRCA review, please provide the PCSWMM models completed to determine the iterated Manning's n roughness values. Please apply consistent bend loss coefficients in the PCSWMM model in accordance with the TRCA approved MIKE 2D model and ensure the revised Manning's n roughness values using the consistent bend loss coefficients have been applied in the validation model. Please note the following bend losses applied in the TRCA approved model.

			• Hwy48 box-culvert+2 CSP pipes This structure has 3 bends within a box-culvert, and at the filed the first bend is clearly seen with 45 degrees, but it is not clear the bend is abrupt or gradual, so to be conservative a bend loss coefficient for abrupt bend is used. The sum of three bend loss coefficients is the input in the model.  **First bend looking from U/S structure face** | Structure Name | Bend # | Angle (degree) | Loss Coefficient (Kb) | Sum (Kb) | | Hwy48 rou_705 | 1 | 45 | 0.254 | 0.818 | | | 2 | 45 | 0.254 | | | | 3 | 50 | 0.31 | | b. Typically, TRCA downstream exit losses are modelled with a coefficient of 1 instead of 0.5. Please revise the modelling to ensure consistency with TRCA standards. c. Please provide justification for the transition loss coefficient at the junction of the box culvert to the two CSP culverts. Please provide all relevant excerpts from literature to support the parameters. d. Please ensure the validation exercise has been completed for all storm events (i.e., 2 through 100 year and Regional storms) with appropriate Manning's n values. e. It was noted that the total culvert lengths in the validation model were inconsistent with the total culvert lengths in the TRCA approved model. Please review and revise the modelling as required. f. To ensure the results from the validation model match the TRCA approved model, please provide comparison figures (water surface elevations and velocities) for all design storm events (i.e., 2 through 100 year and Regional storms) for the entire floodplain area affected. Please extend the area of the floodplain maps until the validation model matches the TRCA approved model results. g. Please provide all survey data used in the modelling of the "closed section" approach included but not limited to the culvert dimensions, lengths, inverts, etc. Once the modeling has been updated and it has been confirmed that site-specific remediation of the spill can occur without impacting off-site properties, please ensure that existing and proposed spill limits are accurately shown on the plan view drawings, and that these drawings clearly demonstrate that the proposed development will be free/safe from the spill.
2.	**Stormwater Management** Under Sections 1 and 6 – reference to the TRCA Stormwater Management Criteria document, dated August 2012 should be included and the consultant should ensure that the design meets the requirements established for the development area. *Note: quantity control and quality treatment targets are deferred to City staff.*	Addressed. The SWM report references the 2012 TRCA SWM Criteria document.	**Previously addressed.**

3.	Section 9, Water Balance – a complete water balance assessment for the site is required, including the pre-development values for the infiltration, evapotranspiration, and runoff; the post development values without mitigation; and the post development values with mitigation, confirming that best efforts are being proposed to meet the water balance target. For the calculation of the on-site retention value, the target will need to be based on capturing the first 5mm of impervious area to meet TRCA criteria. In this case, this would require on-site retention of the first 5mm of rainfall on hard surfaces and rooftop areas, approximately 1.24ha. Further, as per Figure 4.1 of the TRCA Stormwater Management Criteria, the calculation of the 5mm requirement should not include an initial abstraction for impervious surfaces. The target volume should be based on the full 5mm target of all impervious surfaces. Finally, the mitigation practice needs to clearly demonstrate how this volume will be either infiltrated, evapotranspirated, or re-used on-site. This needs to include sizing, location, uses, and confirmation that the storage volume will be emptied between storm events.	Not addressed. The SWM Report references the 5 mm retention criteria; however, the feasibility of the design to meet the TRCA's 2012 Stormwater Management Criteria must be demonstrated at this time. Based on this, please provide all relevant calculations outlining the required and provided onsite retention volume to meet the erosion control criteria. The mitigation practice needs to clearly demonstrate how this volume will be reused onsite. Please provide all relevant details including sizing, location, uses, and confirmation that the storage volume will be emptied between storm events. Should alternative LIDs be used such as infiltration measures, please ensure groundwater conditions are verified at this time (i.e. seasonally high groundwater levels, infiltration rates, groundwater soil conditions, etc.).	**Sufficiently addressed by this submission. However, the LID strategy will need to be reviewed (and may need to be updated) once seasonal high-groundwater levels are confirmed.**
4.	Figure 4 – a figure that clearly outlines the land-use types to match Table 3.1, confirming the landscaping and permeable pavement area is required	Addressed. Appendix D includes weighted imperviousness calculations for the site and permeable pavers are no longer proposed.	**Previously addressed.**
5.		**(new)** Details on the existing OGS downstream of the site including sizing and cleanout information should be provided to ensure it provides sufficient treatment for the proposed site drainage characteristics.	**Deferred to the City of Markham.**
Hydrogeology			
6.	TRCA staff supports Terrapex's hydrogeological report recommendation that the groundwater levels should be measured during wetter seasons to confirm highest probable groundwater elevations. We look forward to reviewing the revised report and recommendations once this information has been obtained.	Not addressed. The above noted information is required at this time in order to review and determine the feasibility of the proposed stormwater management and water balance strategies and the proposed underground parking.	**Recommend that this comment is be addressed at the OPA and ZBA stage, but may be deferred to the Site Plan stage.** Seasonal high groundwater levels are necessary to confirm feasibility of the proposed LID measures. Should this be deferred to the Site Plan Stage and it is determined that changes to the type, location or design of LID measures is required due to the presence of high groundwater levels, the development plan would need to be modified to accommodate those changes. Details regarding dewatering may be deferred to the Site Plan stage. Recognizing recent legislative changes and the scope of our review and depending on the dewatering details provided at the Site Plan stage, TRCA may provide further comments on the underground parking/dewatering.

7.	The hydrogeological report indicates that "Groundwater seepage will occur to the excavation during construction and ongoing to the foundation after construction, so must be controlled". The report recommends an Environmental Activity and Sector Registry (EASR) for construction dewatering. However, no information is provided for post-construction dewatering requirements. TRCA staff do not support permanent *active* dewatering and recommend that the applicant clarify the permitting requirement after construction (foundation drains) if the building is not constructed to being water-tight. The proponent is to identify the discharge rate from the foundation drains and permitting requirement including but not limited to Permit to Take Water (PTTW) requirements if the building is not constructed to being water-tight. The proponent is to note that EASR is only for construction dewatering. TRCA supports the foundation designs that require less permanent dewatering.	Not addressed. The above noted information is required at this time in order to review and determine the feasibility of the proposed underground parking. Please provide a revised hydrogeological report addressing construction and post-construction dewatering, including all calculations/rates, figures, assessment of impacts of dewatering on natural features (e.g., adjacent watercourse), and mitigation measures to avoid negatively impacting natural features.	**Details regarding dewatering may be deferred to the Site Plan stage.** Recognizing recent legislative changes and the scope of our review and depending on the dewatering details provided at the Site Plan stage, TRCA may provide further comments on the underground parking/dewatering.
8.	TRCA staff supports the Terrapex 2017's recommendations that "a monitoring well to be installed between the excavation and the gas station. The well should be screened across the water table. That well should be sampled for the presence of petroleum hydrocarbons (PHC) and volatile organic hydrocarbons, benzene, toluene, ethylbenzene and xylenes (collectively known as BTEX) which are constituents of fuel. BTEX/PHCs should be sampled prior to dewatering and at least monthly during dewatering."	Not addressed. Please provide the above noted information / demonstrate how the recommendation has been followed.	**Comment deferred to the City.**
9.	It is the TRCA expectation that pre- and post-development Site Specific Water Balance Assessments will be completed and based on the information obtained, Low Impact Development (LID) systems and/or design elements are to be planned to mitigate development related impacts to infiltration. For additional information with respect to water balance assessments please refer to TRCA webtool and guidance document, located at: https://trca.ca/conservation/drinking-water-source-protection/trspa-water-balance-tool/.	Not addressed. The above noted information is required at this time in order to review and determine the feasibility of the proposed water balance strategy.	**Sufficiently addressed or deferred to the Site Plan Application stage. See comments 3 and 6.**

ATTACHMENT 'C'

Additional MIKE FLOOD Model Results for Updated Existing and Proposed Conditions

1D/2D Flood Impact Analysis for Proposed Development
9900 Markham Road, City of Markham

VALDOR

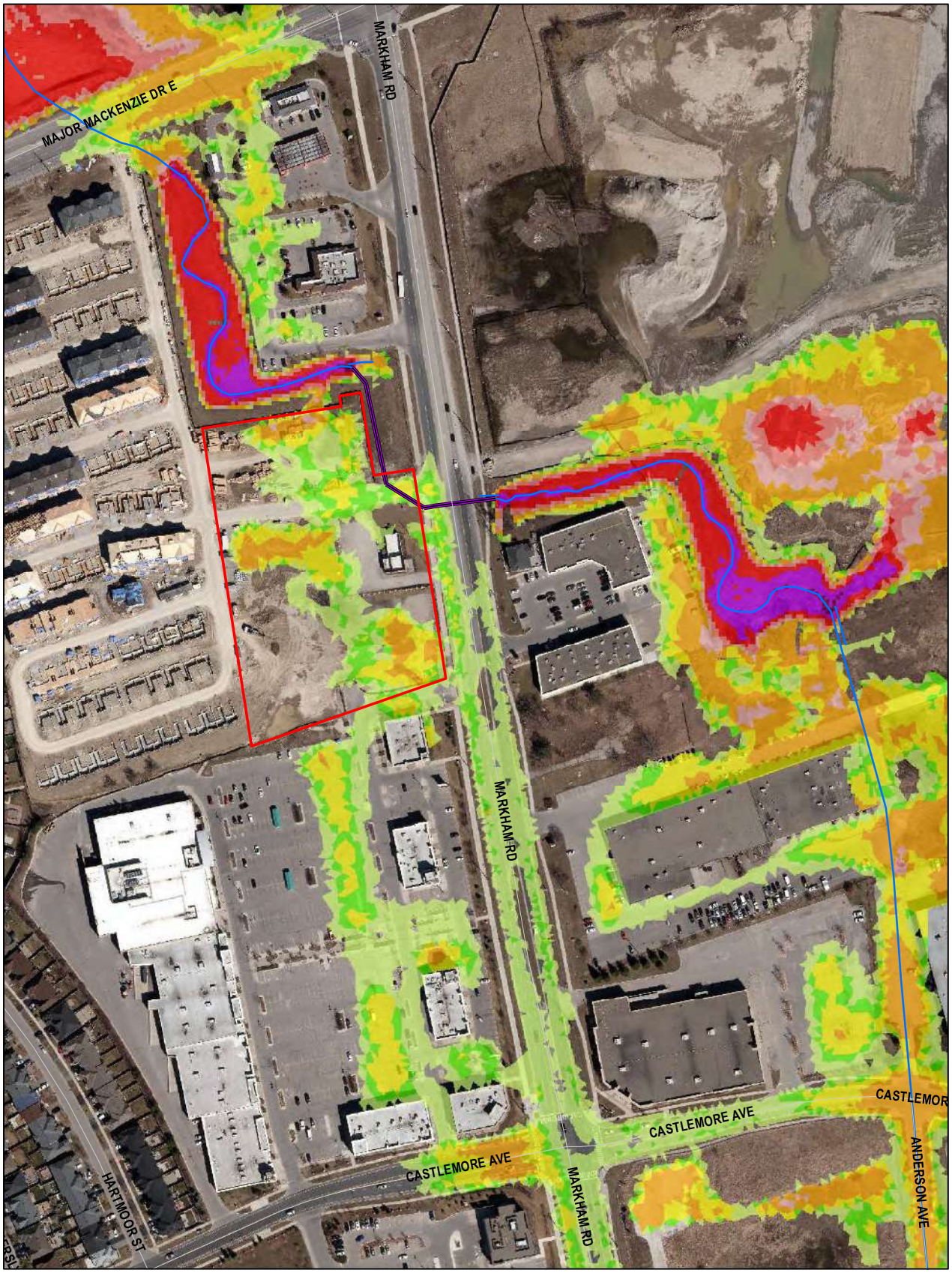


Figure C.1

REGIONAL FLOOD DEPTH MAP

UPDATED EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B.

Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - Higher

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

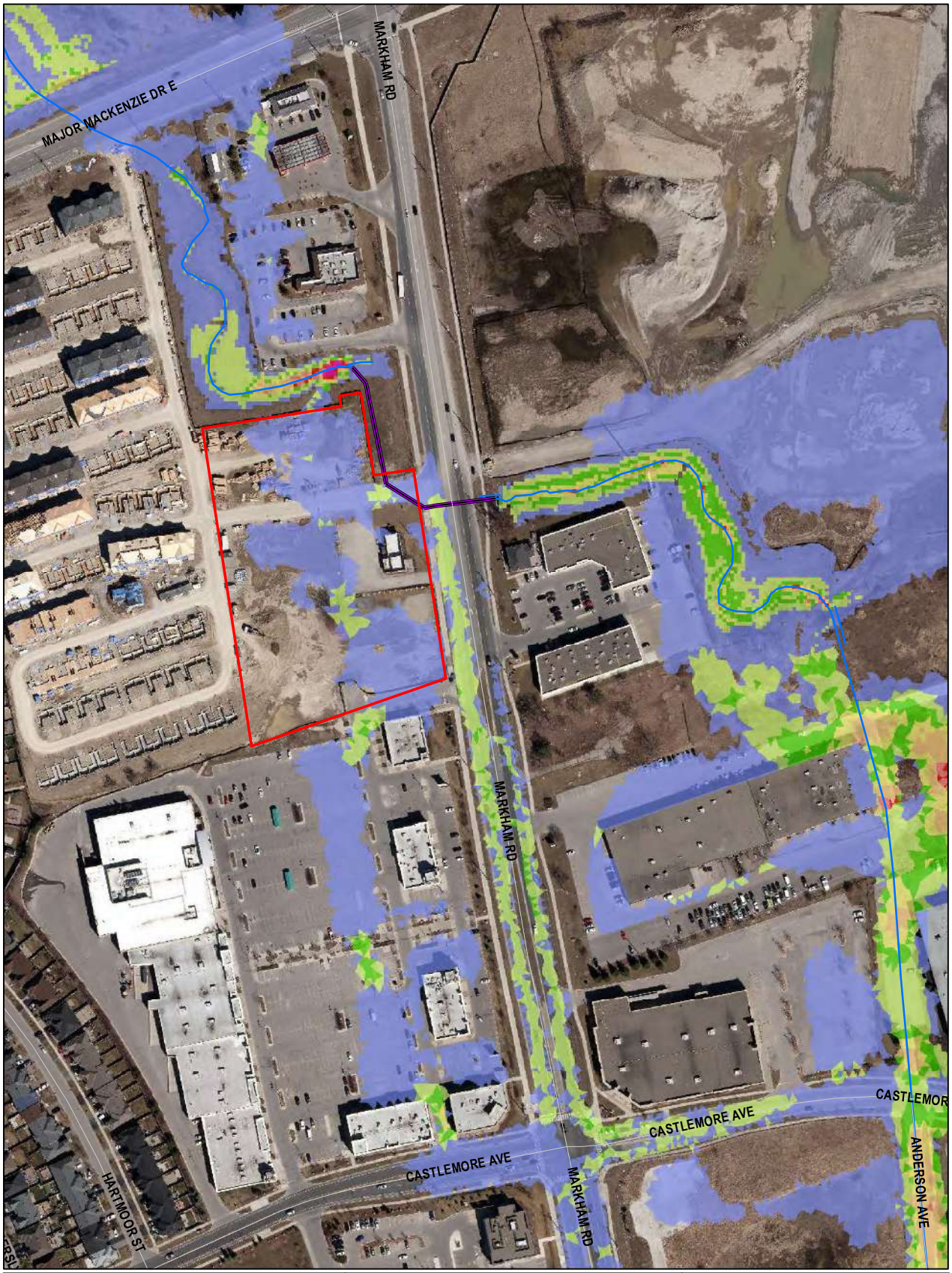


Figure C.2

REGIONAL FLOOD VELOCITY MAP

UPDATED EXISTING CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B.

Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

Velocity, m/sec

- 0.00 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.70
- 1.70 - 2.00
- 2.00 - 2.60
- 2.60 - Above

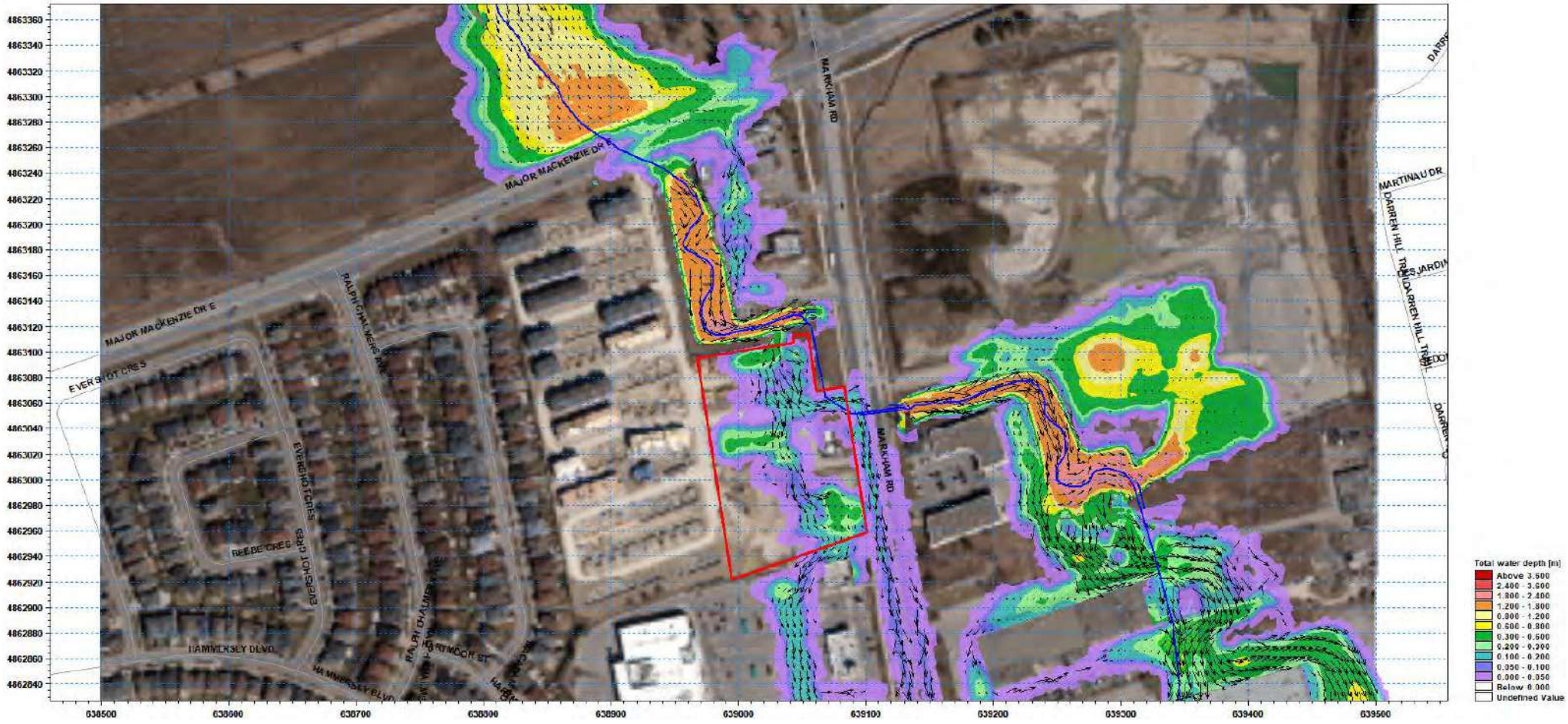
TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

Figure C.3 : Updated Existing Condition Regional Flood Flow Direction Map (sc01d)



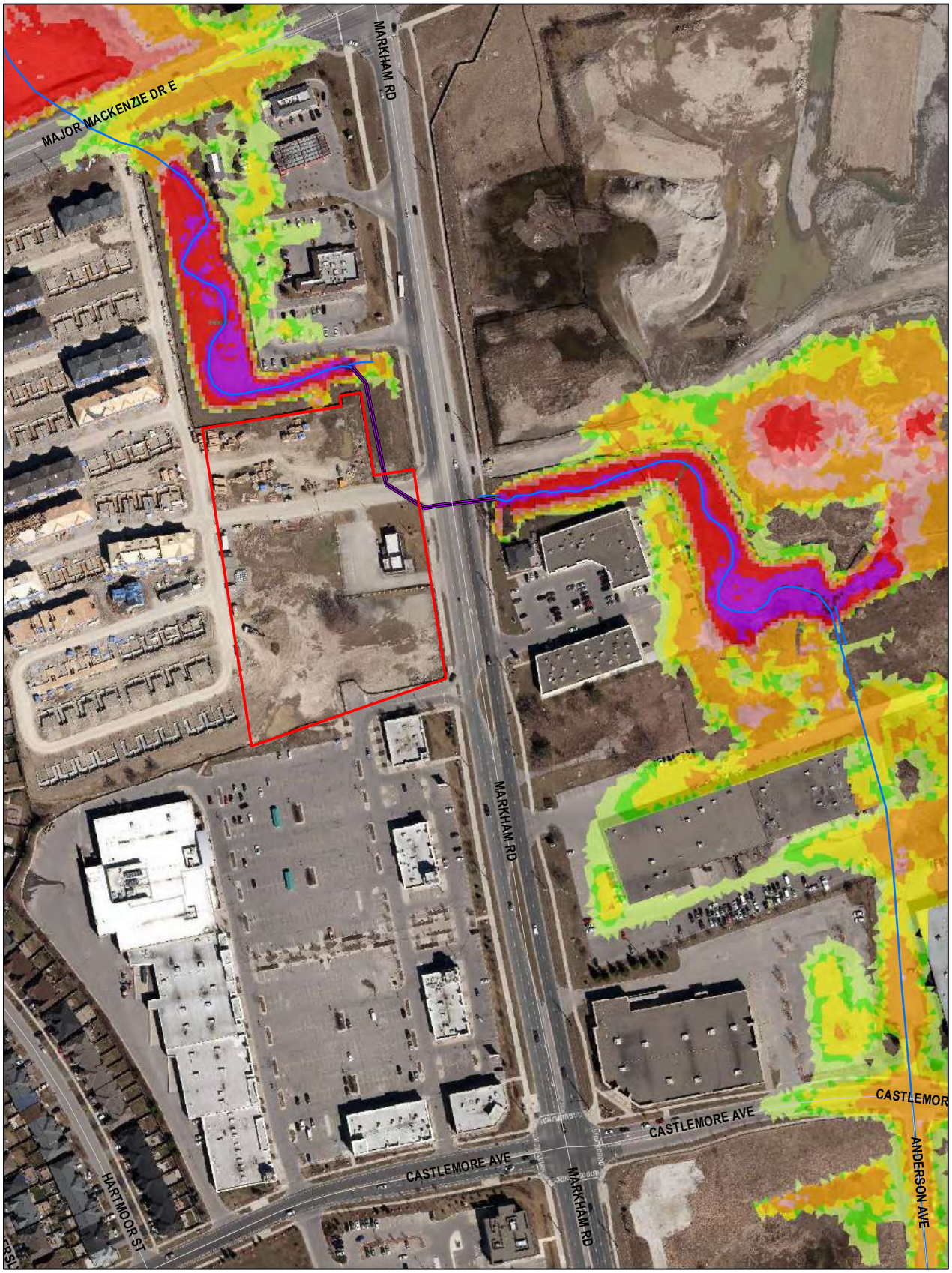


Figure C.4

REGIONAL FLOOD DEPTH MAP

PROPOSED CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

Flood Depth, m

- 0.00 - 0.10
- 0.10 - 0.15
- 0.15 - 0.30
- 0.30 - 0.60
- 0.60 - 0.80
- 0.80 - 1.20
- 1.20 - 1.80
- 1.80 - 2.40
- 2.40 - Higher

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

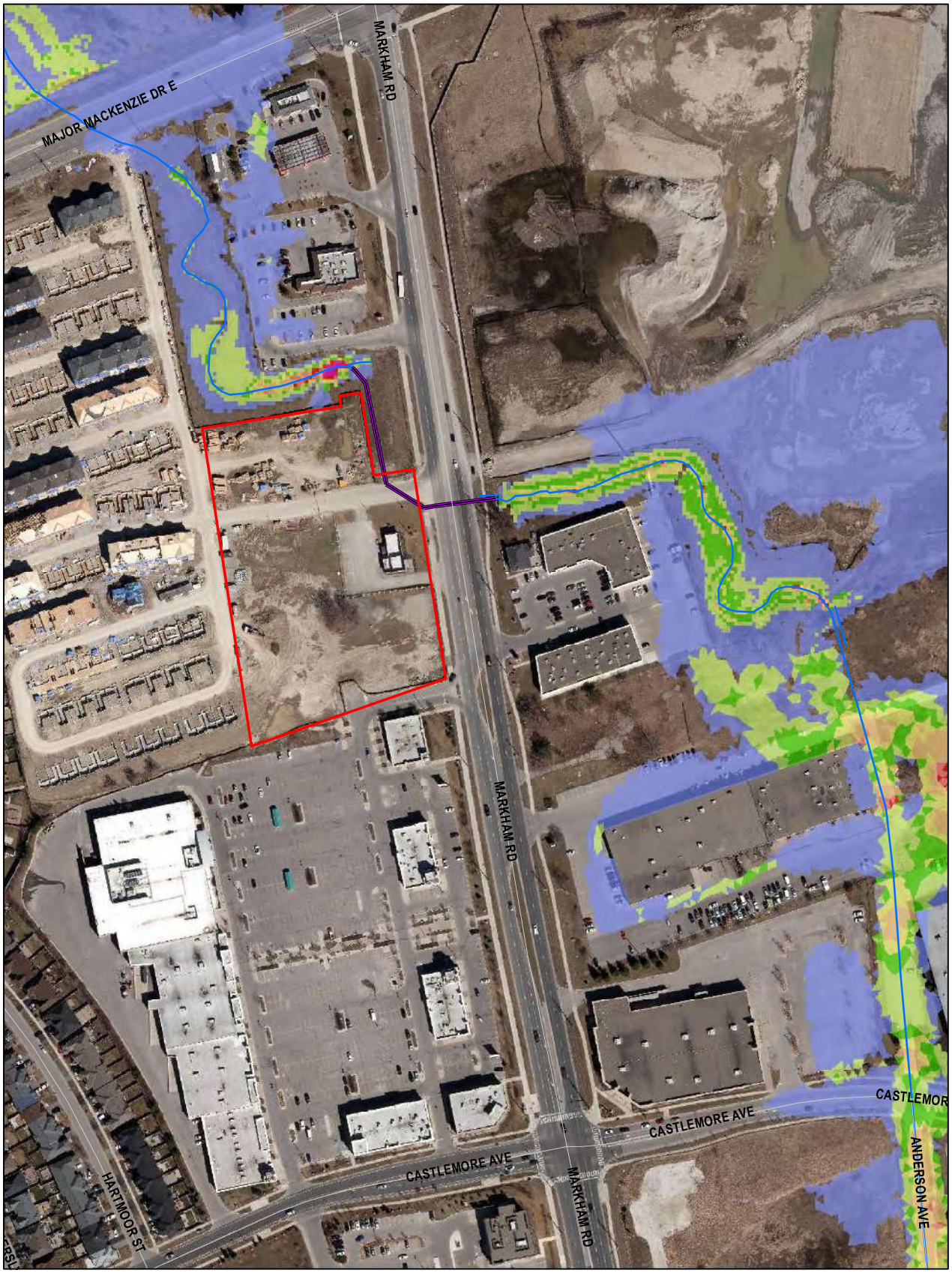


Figure C.5

REGIONAL FLOOD VELOCITY MAP

PROPOSED CONDITION

STEADY PEAK INFLOW HYDROGRAPH (HURRICANE HAZEL)

0 25 50 100 Meters

01 October 2023

Prepared By : A.B. Checked By : B.C.

LEGEND

- Subject Site
- Water Course
- Markham Road Culvert

Velocity, m/sec

- 0.00 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- 1.20 - 1.70
- 1.70 - 2.00
- 2.00 - 2.60
- 2.60 - Above

TWO-DIMENSIONAL (2D) FLOOD IMPACT ANALYSIS FOR PROPOSED DEVELOPMENT

9900 MARKHAM ROAD, MARKHAM ONTARIO

N

Est. 1992 VALDOR

Figure C.6 : Proposed Condition Regional Flood Flow Direction Map (sc02d)