Item 9.3.

Section III – Items for the Information of the Board

TO: Chair and Members of the Board of Directors
Meeting #5/19, Friday, May 24, 2019

FROM: Sameer Dhalla, Director, Development and Engineering Services

RE: **UNIONVILLE SPA 2D MODELLING AND FLOODPLAIN MAPPING UPDATE**

KEY ISSUE

TRCA has recently updated the flood modelling for the Unionville Special Policy Area (SPA) in the City of Markham. The study utilized state of the art two dimensional hydraulic modelling and high resolution LiDAR data to estimate flood depths and velocities for 2-350 year and Regional storm events.

RECOMMENDATION

THAT the Unionville SPA two dimensional (2D) Modelling and Floodplain Mapping Update (February 2019) prepared by Toronto and Region Conservation Authority (TRCA) staff and Valdor Engineering Inc. be received;

THAT TRCA be directed to disseminate the final floodplain mapping, modelling results, and documentation to municipal staff;

AND FURTHER THAT TRCA staff be directed to incorporate the Unionville 2D hydraulic model and updated floodplain mapping into TRCA's jurisdiction-wide floodplain mapping, and utilize this information to inform land use planning, flood emergency response and flood mitigation planning activities.

BACKGROUND

The Unionville Special Policy Area (SPA) is within the Rouge River watershed and is located within the City of Markham. The area is highly urbanized, bounded by 16th Avenue, Highway 407, Warden Avenue and McCowan Road. Due to the flood vulnerability of the community, the area has been designated by the Province as a Special Policy Area to allow for the continued viability of existing uses and to address the significant social and economic hardships to the community that would result from strict adherence to provincial policies concerning development in a floodplain.

The flood modelling and floodplain mapping for the Unionville SPA was previously updated in 2006 by Clarifica Water Resources and Environmental Solutions using HEC-RAS, a one dimensional computer model. While this approach is adequate for most of TRCA's watersheds, the traditional 1D modeling approach has limited capability to predict complex hydraulic conditions for areas where flows from extreme rainfall events are poorly confined within the watercourse and may spill out of the banks and flood urban areas. For these areas, a two dimensional (2D) hydraulic modeling tool is beneficial to provide a more realistic prediction of flood depths and velocities.

Due to the number and frequency of spills, and the extent of flooding throughout the Unionville SPA, Unionville was identified as one of the areas that would significantly benefit from 2D modelling. As part of this project, TRCA staff undertook a thorough assessment of the hydraulic processes within the Unionville SPA and developed a new updated 2D hydraulic model. The new hydraulic modelling tools allow for a better understanding of how flooding affects existing and future development within the Unionville SPA, allows for the establishment of appropriate flood proofing standards, as well as provides a detailed assessment of flood risk conditions for the purposes of emergency management and flood mitigation.

RATIONALE

The Government of Canada's National Disaster Mitigation Program (NDMP) provided TRCA staff an opportunity to leverage existing funding to undertake a number of high resolution hydraulic modelling studies. TRCA staff assessed a number of the Authority's Special Policy Areas and identified the Unionville SPA as a key candidate for 2D modelling. Unionville has a number of complex hydraulic conditions including multiple confluences and spill points which standard one-dimensional (1D) modelling cannot accurately characterize. Further, there continues to be a high volume of development and redevelopment applications within the area which would benefit from having accurate, site level, floodplain information for design purposes.

In March 2017 TRCA received approval from the NDMP to undertake the Unionville SPA 2D Modelling and Floodplain Mapping Update. Funding was provided to TRCA on the condition that 50% matching funds from the project proponent is available and that the project can be completed within a 2-year timeframe.

MODEL DEVELOPMENT

Consulting services to undertake the Unionville SPA 2D Modelling and Floodplain Mapping Update was awarded to Valdor Engineering Ltd. (Valdor). TRCA selected the MIKE FLOOD computer model for use in this study based on the flood conditions observed through previous technical studies in the area. MIKE FLOOD is an integrated hydraulic model used to calculate channel and overland flow. The MIKE FLOOD model represents state-of-the-art computer modelling software for hydraulic assessments, capable of generating a number of hydraulic parameter outputs (velocity, and depth) and high resolution mapping outputs including flood animations. Further, MIKE FLOOD is fully compatible with GIS software and is supported by the Province of Ontario for hydraulic modelling and floodline mapping.

As per standard TRCA 2D modelling procedures, LiDAR topographic information was used to represent topography within the study area. LiDAR data was further refined based on surveys completed by TRCA and Valdor to ensure the topographic data set was detailed and accurately represented overland flow conveyance systems and watercourse channels within the study area. The topographic data set was reviewed and approved by TRCA staff prior to being finalized. Once completed the topographic information was used to define the 2D overland flow mesh. The 2D overland flow mesh is the key component in 2D modelling, as it determines where flow would occur. Flow depth, direction, and velocity are then calculated at each mesh element. The Unionville SPA 2D model has over 1,500 cross-sections to represent watercourse channels, and 700,000 mesh elements to represent the 2D overland flow component.

TRCA worked closely with City of Markham staff to obtain relevant road and pedestrian water crossing as-built and design information for the study area. Further, Valdor completed site visits to each water crossing to ensure consistency between structure as-built information and site observations. In total 37 water crossings were included in the hydraulic model.

For this study, TRCA worked with the City of Markham to develop detailed land use mapping to input into the model. For 2D hydraulic modelling, land use mapping represents roughness values, a hydraulic parameter used to define a surface's ability to resist flow. Building parcels were also provided to TRCA by the City of Markham. Building location and orientation effects local flood conditions including flow movement through an area. Building footprints were simplified through a GIS process developed by TRCA staff and incorporated into the model.

Regional (Hurricane Hazel) and 2 through 350-year flow values were extracted from the recently completed 2018 Rouge River Hydrology Update, which was approved for use in floodplain mapping at Board of Directors Meeting #8/18 on November 30, 2018. Flow values were applied to the 2D model for each of the study area tributaries and key locations. In total 44 flow node locations were modelled. Model boundaries were placed at significant distance upstream and downstream of the SPA. This placement ensures that changes to the upstream or downstream conditions as a result of upcoming floodplain mapping updates will not affect the results through the Unionville SPA. Due to model size and overland flow mesh resolution, model simulations take approximately 40 hours to complete.

RESULTS

It is important to note that differences in flood extents associated with this study and previous floodplain mapping is attributed to three main factors:

1. Difference in flow values from the 2002 Rouge River Hydrology Model and the 2018 Rouge River Hydrology Update,
2. Updated topographic information based on high resolution LiDAR and survey data, and
3. The difference in modelling methodology between the 1D HEC-RAS model and the new 2D MIKE FLOOD model.

A comparison of the peak flows used in the previous 2006 floodplain mapping update (2002 hydrology) and the 2019 2D modelling study (2018 hydrology) is provided in **Table 1**.

Table 1: Comparison of 2002 and 2018 Peak Flows

Return Period	Peak Flow - Fonthill Creek		Peak Flow – Rouge River at Kennedy Road		Peak Flow – Rouge River D/S of Milne Dam	
	2002 (cms)	2018 (cms)	2002 (cms)	2018 (cms)	2002 (cms)	2018 (cms)
350-year	14.8	23.3	193.0	274.6	186.0	268.6
Regional	26.3	14.3	643.0	572.8	601.8	576.3

Attachment 1 displays the difference in Regional Storm floodline extents between the 2006 HEC-RAS model and the 2019 MIKE FLOOD model. The extent of the Regulatory floodplain remains similar between the 2006 and 2019 models with the following key exceptions:

1. Flooding upstream of the CN railroad along Fonthill Creek for the Regional Storm is considerably reduced due to the significant reduction in flows associated with the 2018 hydrology update. The main reasons for the reduction in peak flow and floodlines along Fonthill Creek include:

    - Reduced backwater effects due to lower peak flow on Bruce Creek and the Main Rouge River;
    - The upstream catchment is smaller in the 2018 hydrology update;

- A finer catchment delineation including longer average overland flow length was included in the 2018 hydrology update, and
- A change in model conceptualization, catchment connectivity and routing was included in the 2018 hydrology update.

2. The extent of flooding south of Kennedy Road in the vicinity of Unionville Gate for the Regional Storm is reduced based on the decrease in Regional Storm flow, and improved topographic information.

3. The extent of flooding in the vicinity of Highway 7 and Kennedy Road and north and south of Highway 7 at Main Street Unionville is greater based on increases in Regional Storm flows and improved topographic information.

While the floodplain extents developed from this 2D modelling study are generally similar to the 2006 HEC-RAS model, there are a number of improvements to model outputs which will be of significant interest to the City of Markham and enhance TRCA's delivery of floodplain management input within the SPA. Due to the high resolution nature of the model, detailed hydraulic information including flood depth, velocity, and direction of flow can now be provided at a lot level scale for a number of storm simulations including the 2-350 year and Regional (Hurricane Hazel) storms. 2D model results also provide detailed flood risk mapping that will assist with land use planning, emergency management and flood mitigation.

RESOLUTIONS

TRCA staff will adopt the Unionville SPA 2D Model and Floodplain Mapping Update, and incorporate this model and resulting floodplain maps into TRCA's jurisdiction-wide floodplain mapping. This new information will also be integrated into TRCA's Regulated Area mapping, and utilized for TRCA's review of planning and development applications, flood remedial plans, emergency management and watershed studies. In addition, TRCA staff will disseminate the final modeling results and documentation to municipal staff.

Relationship to Building the Living City, the TRCA 2013-2022 Strategic Plan

This report supports the following strategies set forth in the TRCA 2013-2022 Strategic Plan:
Strategy 2 – Manage our regional water resources for current and future generations

FINANCIAL DETAILS

Financial contributions for the Unionville SPA 2D Modelling and Floodplain Mapping Update were provided through TRCA's NDMP – 2 Dimensional Modelling Studies, account 107-58, matching funds were provided through TRCA's Flood Line Mapping Program, account 127-90 at a cost of approximately $77,100, which included staff time and consulting fees for the model development.

Report prepared by: Nick Lorrain, extension 5278
Email: nlorrian@trca.on.ca
For Information contact: Nick Lorrain, extension 5278
Emails: nlorrain@trca.on.ca
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Attachments: 1

Attachment 1: Unionville Regulatory Floodline