Item 8.4

Section I – Items for Board of Directors Action

TO: Chair and Members of the Board of Directors
Meeting #9/18, Friday, November 30, 2018

FROM: Nick Saccone, Senior Director, Restoration and Infrastructure

RE: **ROUGE RIVER WATERSHED HYDROLOGY STUDY**

KEY ISSUE
Approval to adopt the Rouge River Watershed Hydrology Study as prepared by Toronto Region Conservation Authority Engineering Services staff and Wood Environment & Infrastructure Solutions.

RECOMMENDATION

THAT the Rouge River Watershed Hydrology Study (September 2018) prepared by Toronto and Region Conservation Authority (TRCA) staff and Wood Environment & Infrastructure Solutions be approved;

THAT staff be directed to disseminate the final watershed results and documentation to municipal staff and the development industry through an update to TRCA's Stormwater Criteria;

THAT staff be directed to apply the results from the Rouge River Watershed Hydrology Study to update floodline mapping for regulatory purposes;

AND FURTHER THAT staff be directed to use the results of the Rouge River Watershed Hydrology Study as a foundation for conducting technical hydrologic assessments of the watershed as part of future watershed/subwatershed plans and studies.

BACKGROUND
The hydrologic model for the Rouge River watershed was previously updated in 2001 by Marshall Macklin Monaghan using the Visual OTTHYMO computer model. Since the 2001 hydrology update, significant changes have occurred within the watershed, including Official Plan (OP) updates by municipalities within the watershed showing key new development communities in Richmond Hill, Markham and Whitchurch-Stouffville. In addition, new hydrologic information has been collected that has been incorporated into this model, including additional flow and rainfall data throughout the Rouge River watershed. As such, the hydrology model has been updated to reflect the proposed land use changes and improved information.

RATIONALE
As over 17 years have passed since the previous update to the Rouge River watershed hydrology model, an updated hydrology model is needed to reflect new meteorological information, new development and land use in the watershed, and updated Official Plans in order to guide development. The results of the updated Rouge River watershed hydrology model will be used to update floodline mapping and flood remedial plans. In addition, flood control criteria were developed as part of the Rouge River Watershed Hydrology Study and will be incorporated into TRCA and municipal stormwater management criteria for new development. These flood control criteria are important in achieving TRCA's goal of mitigating and reducing the risk to life and property caused by flooding.

Finally, this report represents the first step in assisting our municipal partners and stakeholders through their planning process in response to the 2017 Provincial Plans, including the Growth Plan, Greenbelt Plan, and Oak Ridges Moraine Conservation Plan. The Rouge River Watershed Hydrology Study and subsequent floodplain mapping updates will provide a foundation for future watershed plans and studies that support our partner municipalities with their ongoing watershed planning and Official Plan conformity process, including the Municipal Comprehensive Reviews (MCR).

MODEL DEVELOPMENT

The Rouge River Watershed Hydrology Study Update was awarded to Wood Environment & Infrastructure Solutions (Wood) to provide consulting services. Based on the needs of the watershed model and the layout of the Rouge River Watershed, TRCA and Wood selected the PCSWMM computer model for use in this study. PCSWMM, or Personal Computer Stormwater Management Model, is a computer model used to calculate the hydrologic characteristics of a watershed or subwatersheds, including peak flow rates and runoff volume. The PCSWMM model represents state-of-the-art computer modelling for hydrologic assessments, capable of long-term continuous simulation for erosion assessment or instantaneous design-storm assessments for specific event calculation. Further, the foundation of the computer model, EPA SWMM, is fully compatible with GIS software and is fully supported by the US EPA, allowing for a program that is rigorously and robustly supported. Finally, the model is also supported by the MNRF for establishing peak flow rates for Regulatory Floodline Mapping.

Over 840 catchment areas were delineated based on an average catchment size of approximately 40 ha in an effort to more closely reflect municipal Official Plans, with boundaries confirmed by TRCA GIS staff. Once the catchment areas were delineated, the existing condition parameters, including land use and soils information, were provided by TRCA GIS staff, with the land use data based on 2009 high resolution aerial photographs. A total of 1336 hydraulic elements have been incorporated into the PCSWMM model to represent the open watercourses, and 293 hydraulic elements have been incorporated into the model to represent the hydraulic structures. Finally, stormwater management facilities were incorporated based on catchment area.

The existing conditions model was then calibrated to match as closely as possible the TRCA instream flow information for actual storm events. The calibration process assists in producing a reliable and representative hydrologic model for a watershed. The process includes adjusting specific parameters within acceptable tolerances in order for the model to match the existing instream responses as best as possible. Calibration was conducted in order to:

- Match the volume of runoff generated by the land;
- Match the timing of the peak runoff within the system; and
- Match the peak flows within the watercourses.

After the calibration was conducted based on a selection of actual storm events, the calibrated model was validated by comparing the results against a different set of actual storm events, confirming that the results were within an acceptable range.

With the model calibrated and validated, peak flow values were generated to represent current development conditions for the two-year through 100-year design storms, the 350-year design storm, and Regional Storm event, based on Hurricane Hazel. Future land use peak flows were then generated, with the future land use information gathered from municipal Official Plans. Land use planning information was also reviewed by TRCA senior planning staff, and was confirmed to be accurate to the Official Plan information and updates.

Finally, the model was peer reviewed by WSP and RBWater, companies with extensive water resources engineering history in the fields of hydrology, hydraulics and stormwater management. Comments provided by the peer reviewer were addressed, and WSP and RBWater signed off on the updated model.

RESULTS

The Rouge River Watershed Hydrology Study Update ultimately produces peak flow rates for the 2-year through 100-year design storms and the Regional Storm event for existing conditions of the watershed and future build-out conditions as outlined in municipal Official Plans. **Table 1** in **Attachment 1** summarizes the percent difference in peak flow rates associated with the 100-year design storm from the PCSWMM model compared to the 2001 Rouge River Watershed Hydrology Update at major hydrologic reference points. The majority of the flow node locations are showing consistently higher values for the 2018 study during Official Plan build out compared to the 2001 study. This is not unexpected; as urban expansion associated with updated Official Plans naturally leads to increases in peak flows within the respective subwatersheds. Further, this suggests that stormwater management controls are required in order to effectively control the impacts of development on peak flow rates up to and including the 100-year storm events. As part of this study, flood control criteria were developed and applied to the model to reduce the impacts of the development. **Table 2** in **Attachment 1** demonstrates the effectiveness of the proposed stormwater management criteria for peak flow rates associated with the 100-year design storm at specific locations during future conditions. The results show that, on average, the post development peak flows associated with the 100-year design storm are controlled to approximately 11 % below the existing peak flow rates. This result suggests that the established flood control criteria are effective in reducing flood risk as a result of future development.

The updated Rouge River Watershed Hydrology model also resulted in changes to peak flows associated with the Regional Storm. As shown in **Table 3** in **Attachment 1**, portions of the Little Rouge and Upper Rouge subwatersheds are showing decreases in peak flow rates, as advancements in modeling data collected, such as soils information, instream flow data and rainfall data, have allowed TRCA to better understand the response of the watershed to rain events. However, peak flow rates associated with the Regional Storm at the mouth of the Rouge River (Rouge Marshes @ Kingston Rd) have increased by approximately 15% due to the development occurring in upstream section of the watershed. In addition, Regional Storm peak flow rates at flow node locations within subwatersheds where intensive urbanization has occurred or is proposed to occur, including sections of Eckardt Creek, Upper Rouge and Robinson Creek are showing an increase of approximately 16.3%, 13.3% and 31.4 %, respectively, compared to the 2001 study. In many of these areas, updates to the municipal Official Plans result in increased developable land, and therefore have an impact on peak flow rates. In order to reduce the risk of flooding impacts during a Regional Storm event, the study team prepared stormwater management targets for the Regional Storm. As shown in **Table 4** in **Attachment 1**, the proposed stormwater management targets for the Regional Storm will reduce peak flow rates at most every location, resulting in an average decrease of approximately 1.2% in the peak flow rates associated with the Regional Storm. Moving forward, TRCA will use these targets to work with our Municipal partners and the development industry on developing solutions using a risk based approach that could include a number of options, including but not limited to:

- Applying the targets developed in storage facilities;
- Further investigating downstream impacts to determine appropriate stormwater management measures;
- Investigating off-site remedial works to mitigate flood risk, such as crossing infrastructure improvements; or
- A combination of the above.

It should be noted that the reduction in peak flow rates and associated risk reduction associated with Regional Storm controls will not be used in assessing the Regulatory floodlines in the Rouge River Watershed as mandated by the MNRF. Therefore, the values provided in **Table 3** of **Attachment 1** will continue to be used for establishing Regulatory floodlines.

The information provided in Tables 1, 2, 3, and 4 also show that several key areas within the watershed, including proposed new development lands, are showing significant changes in peak flow rates, and therefore may result in changes to the floodplain. In order to accurately reflect the changes determined as part of this hydrology study, TRCA staff will need to conduct floodplain mapping updates to large areas of the Rouge River watershed. This will take place base in 2019 utilizing funding from the National Disaster Mitigation Program (NDMP).

FINANCIAL DETAILS

Financial contributions for the Rouge River Hydrology Study were provided through the York Region Stormwater Management Fund account 107-15 at a cost of approximately $214,250 which included both staffing and consultant expenditures.

RESOLUTIONS

TRCA staff will adopt the Rouge River Watershed Hydrology Study, using this model for all future studies and hydrologic analysis, including updating floodline mapping, flood remedial plans, stormwater management criteria, and watershed studies. In addition, TRCA staff will begin to disseminate the final modeling results and documentation to municipal staff and the development industry through an update to TRCA's Stormwater Criteria through the winter of 2018 and into the spring of 2019. Further, TRCA staff will use the updated peak flow rates calculated as part of the update for floodline mapping exercises moving forward, and will provide updated floodline mapping for the entire Rouge River Watershed in 2019 based on the NDMP funding. Further, TRCA staff will use the flood control criteria to inform our development planning, environmental assessment review and regulatory responsibilities for development within the Rouge River Watershed. Finally, the Rouge River Watershed Hydrology Study will provide the hydrologic foundation for future watershed plans and studies and will be made available to our partner municipalities to assist with conforming to the 2017 Provincial Plans.

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Date: November 30, 2018
Attachments: 1

Item 8.4

Attachment 1

Table 1– Summary of Rouge River Peak Flow Rates at Specific Subwatersheds – 100-year Design Storm

Flow Node Location	2001 Future OP Peak Flows (cms)	2018 Current Peak Flows (cms)	2018 Future OP Peak Flows (cms)	% Change, 2001 to 2018 Future OPs
Little Rouge River Subwatershed				
Little Rouge @ Major	85.4	55.8	62.4	-27%
Little Rouge @ HWY 7	57.9	53.5	59.0	2%
Little Rouge @ Kingston Rd	57.7	70.2	86.5	50%
Upper Rouge River Subwatershed				
Upper Rouge River Sub @ Major Mackenzie	22.9	77.9	101.1	341%
Berczy Creek Subwatershed				
@ Woodbine Ave	46.6	44.4	50.2	8%
Bruce Creek Subwatershed				
@ 16th Ave close to Kennedy Rd	47.0	34.0	34.5	-27%
Beaver Creek Subwatershed				
@ N of 407	38.2	69.3	74.4	95%
Eckardt Creek Subwatershed				
Eckardt Creek Sub @ Main Street Unionville	75.1	100.6	106.2	41%
Eckardt Creek Sub @ Kennedy Rd	162.8	151.6	162.3	0%
Eckardt Creek Sub @ HWY 7	165.4	149.7	160.1	-3%
Rouge River Subwatershed				
Rouge River Sub @ N of 407	162.4	152.4	163.9	1%
Rouge River Sub @ Steeles Ave E	160.9	155.1	167.3	4%
Rouge River Sub @ Kingston Rd	151.6	158.9	172.0	13%
Rouge Marshes				
Rouge Marshes @ Kingston Rd	209.3	209.0	226.1	8%

Table 2 – Percent Difference in Future Conditions Uncontrolled and Controlled Peak Flows at Specific Locations – 100-year Design Storm

Flow Node Location	2018 Future OP Uncontrolled Peak Flows (cms)	2018 Future OP Controlled Peak Flows (cms) based on Flood Control Criteria	% Change, Controlled to Uncontrolled 2018 Future OP Peak Flows
Little Rouge River Subwatershed			
Little Rouge @ Major	62.4	54.8	-12%
Little Rouge @ HWY 7	59.0	52.5	-11%
Little Rouge @ Kingston Rd	86.5	70.5	-18%
Upper Rouge River Subwatershed			
Upper Rouge River Sub @ Major Mackenzie	101.1	96.3	-5%
Berczy Creek Subwatershed			
@ Woodbine Ave	50.2	36.7	-27%
Bruce Creek Subwatershed			
@ 16th Ave close to Kennedy Rd	34.5	34.5	0%
Beaver Creek Subwatershed			
@ N of 407	74.4	67.6	-9%
Eckardt Creek Subwatershed			
Eckardt Creek Sub @ Main Street Unionville	106.2	100.2	-6%
Eckardt Creek Sub @ Kennedy Rd	162.3	146.7	-10%
Eckardt Creek Sub @ HWY 7	160.1	143.9	-10%
Rouge River Subwatershed			
Rouge River Sub @ N of 407	163.9	146.6	-11%
Rouge River Sub @ Steeles Ave E	167.3	149.1	-11%
Rouge River Sub @ Kingston Rd	172.0	153.3	-11%
Rouge Marshes			
Rouge Marshes @ Kingston Rd	226.1	203.2	-10%

Table 3 – Summary of Rouge River Peak Flow Rates at Specific Subwatersheds – Regional Storm

Flow Node Location	2001 Future OP Peak Flows (cms)	2018 Current Peak Flows (cms)	2018 Future OP Peak Flows (cms)	% Change, 2001 to 2018 Future OPs
Little Rouge River Subwatershed				
Little Rouge Subwatershed @ Major Mackenzie Dr	388.7	214.8	224.9	-42.1%
Little Rouge @ HWY 7	291.3	239.1	247.7	-15.0%
Little Rouge @ Kingston Rd	262.0	283.7	281.1	7.3%
Upper Rouge River Subwatershed				
Upper Rouge River Sub @ Major Mackenzie Dr	229.3	252.6	259.7	13.3%
Berczy Creek Subwatershed				
@ Woodbine Ave	176.7	153.3	177.9	0.7%
Bruce Creek Subwatershed				
@ 16th Ave close to Kennedy Rd	201.6	145.6	143.8	-28.7%
Beaver Creek Subwatershed				
@ N of 407	106.0	107.8	108.3	2.2%
Eckardt Creek Subwatershed				
Eckardt Creek Sub @ Main Street Unionville	266.2	309.2	309.5	16.3%
Eckardt Creek Sub @ Kennedy Rd	643.0	565.8	564.7	-12.2%
Eckardt Creek Sub @ HWY 7	658.4	659.1	566.1	-14.0%
Rouge River Subwatershed				
Rouge River Sub @ N of 407	645.2	618.6	623.5	-3.4%
Rouge River Sub @ Steeles Ave E	634.9	641.1	654.3	3.1%
Rouge River Sub @ Kingston Rd	517.5	670.7	680.1	31.4%
Rouge Marshes				
Rouge Marshes @ Kingston Rd	761.3	871.5	878.4	15.4%

Table 4 – Percent Difference in Future Conditions Uncontrolled and Controlled Peak Flows at Specific Locations – Regional Storm

Flow Node Location	2018 Current Peak Flows (cms)	2018 Future OP Uncontrolled Peak Flows (cms)	2018 Future OP Controlled Peak Flows (cms)	% Change, 2018 Future controlled to 2018 Future uncontrolled
Little Rouge River Subwatershed				
Little Rouge Subwatershed @ Major Mackenzie Dr	214.8	224.9	214.8↓	-4.5%
Little Rouge @ HWY 7	239.1	247.7	239.1↓	-3.5%
Little Rouge @ Kingston Rd	283.7	281.1	283.6↓	0.9%
Upper Rouge River Subwatershed				
Upper Rouge River Sub @ Major Mackenzie Dr	252.6	259.7	250.9↓	-3.4%
Berczy Creek Subwatershed				
Upper Rouge River Sub @ 16th Ave close to Warden Ave	153.3	177.9	153.2↓	-13.9%
Bruce Creek Subwatershed				
Upper Rouge River Sub @ 16th Ave close to Kennedy Rd	145.6	143.8	145.6	1.3%
Beaver Creek Subwatershed				
Upper Rouge River Sub @ N of 407	107.8	108.3	107.8	-0.5%
Eckardt Creek Subwatershed				
Eckardt Creek Sub @ Main Street Unionville	309.2	309.5	308.9↓	-0.2%
Eckardt Creek Sub @ Kennedy Rd	565.8	564.7	563.9↓	-0.1%
Eckardt Creek Sub @ HWY 7	659.1	566.1	636.2↓	12.4%
Rouge River Subwatershed				
Rouge River Sub @ N of 407	618.6	623.5	617.7↓	-0.9%
Rouge River Sub @ Steeles Ave E	641.1	654.3	640.5↓	-2.1%
Rouge River Sub @ Kingston Rd	670.7	680.1	670.2↓	-1.5%
Rouge Marshes				
Rouge Marshes @ Kingston Rd	871.5	878.4	870.9↓	-0.9%