Item 8.2

Section I – Items for Board of Directors Action

TO: Chair and Members of the Board of Directors
Meeting #2/19, Friday, February 22, 2019

FROM: Nick Saccone, Senior Director, Restoration and Infrastructure

RE: **DON RIVER WATERSHED HYDROLOGY STUDY**

KEY ISSUE

Approval to adopt the Don River Watershed Hydrology Study as prepared by Toronto Region Conservation Authority Engineering Services staff and AECOM Canada Limited.

RECOMMENDATION

THAT the Don River Watershed Hydrology Study (December 2018) prepared by Toronto and Region Conservation Authority (TRCA) staff and AECOM Canada Limited be approved;

THAT staff be directed to disseminate the final hydrology study results and documentation to municipal staff, and stakeholders including the development industry;

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

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

BACKGROUND

The hydrologic model for the Don River watershed was previously updated in 2004 by Marshall Macklin Monaghan using the Visual OTTHYMO computer model. Results from the 2004 hydrology update have been used to conduct a number of high profile flood remediation assessments including the Don Mouth Naturalization and Port Lands Flood Protection Project, the Eastern and Broadview Flood Protection Environmental Assessment within the City of Toronto and the Municipal Class Environmental Assessment Flood Remediation Study Yonge and Elgin Mills Road – Flood Vulnerable Area within the Town of Richmond Hill. In order to ensure accurate and reliable flow data is used for the design component of these studies, TRCA staff undertook a thorough assessment of the hydrologic processes of the Don River and developed a new updated Hydrology model. The updated model leverages new data including meteorological and stream flow information, LiDAR topography and state of the art modeling techniques.

RATIONALE

As over 14 years have passed since the previous update to the Don River watershed hydrology model, an updated hydrology model is needed to reflect new meteorological and monitoring information and improved modelling approaches. The updated model will be used to inform the development of flood remediation plans as well as land use, emergency and municipal infrastructure planning within the watershed. Further, the results of the updated Don River watershed hydrology model will be used to update floodline mapping and flood remedial plans.

In addition, the updated hydrology modeling represents the first step in assisting our municipal partners and stakeholders through their planning process in response to the updates to the 2017 Provincial Plans, including the Growth Plan, Greenbelt Plan, and Oak Ridges Moraine Conservation Plan. The Don 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

Consulting services to undertake the Don River Watershed Hydrology Study Update was awarded to AECOM Canada Limited (AECOM). TRCA selected the PCSWMM computer model for use in this study based on the urban nature of the Don River Watershed. 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 a state-of-the-art computer modelling software for hydrologic assessments, capable of long-term continuous simulation for erosion assessments and flood forecasting and warning operations, 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 Province of Ontario for establishing peak flow rates for Floodline Mapping.

Over 890 individual catchment areas were delineated, each with unique subcatchment hydrology based on land use, imperviousness, soil conditions and physical catchment attributes, like slope and shape. Catchment boundaries were based on a combination of LiDAR and development drainage plans, which were reviewed in detail and confirmed by TRCA. Once the catchment areas were reviewed and confirmed, the existing condition parameters, including percent impervious and soils information were calculated, with impervious values based on 2015 high resolution aerial photographs. A total of 648 hydraulic elements have been incorporated into the PCSWMM model to represent open watercourses, 128 hydraulic elements have been incorporated into the model to represent water crossing structures, and 1 hydraulic element incorporating the G. Ross Lord Dam. Finally, a total of 109 stormwater management facilities were incorporated into the model to represent various stormwater management ponds located throughout the watershed.

As per standard hydrologic modelling approach, the existing conditions model was calibrated to match as closely as possible with flow monitoring information collected by TRCA and Water Survey Canada for monitored storm events. Model calibration is a key process in developing a hydrology model and assists in producing a reliable and representative model which accurately represents watershed characteristics. The calibration 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 watershed;
- Match the timing of the peak runoff within the system; and
- Match the peak flows within the watercourses.

After model calibration was completed, the calibrated model was further validated by comparing the results against a different set of monitored storm events. The purpose of the model validation process is to further confirm that the final set of model parameters and results are within an acceptable range and meet standard engineering practice.

With the model calibrated and validated, peak flow values were generated to represent existing development conditions for the 2-year through 350-year design storms, and the Regional Storm event, based on Hurricane Hazel. Future land use peak flows were also generated. Given the urban nature of the Don River watershed, the future land use scenario was based on the existing condition land use scenario, with modifications made to represent Block 27 within the City of Vaughan, which is the last remaining large scale proposed greenfield development area within the watershed. The land use information for Block 27 was derived from the Secondary Plan which was collected from the development group and further reviewed by TRCA's Planning and Development division.

The final model was peer reviewed by Computational Hydraulics International (CHI) who is the developer of the PCSWMM model and has extensive water resources engineering history in the fields of hydrology and hydraulics. The peer review process included consultation between the study team and CHI. All comments provided by the peer reviewer were addressed, and CHI signed off on the updated model.

RESULTS

The Don River Watershed Hydrology Study Update ultimately produces peak flow rates for the 2-year through 350-year design storms and the Regional Storm event for existing and future conditions as outlined in municipal Official Plans. **Table 1 and Table 2** in **Attachment 1** summarizes the percent difference in peak flow rates associated with the 100-year design and Regional storm from the PCSWMM model at key locations in the watershed and compared the results to the 2004 Don River Watershed Hydrology Update. The majority of the flow node locations are showing consistently lower values for the 2018 study for Future Conditions scenario compared to the 2004 study. This is not unexpected and is consistent with past hydrology updates undertaken by TRCA staff where improved model parameterization based on physically derived parameter and improved model calibration lead to decreases in flows as watershed characteristics are fully understood. Past practice has been to use conservative estimates for model parameterization in lieu of insufficient watershed detail or physically based parameters for model development.

As displayed on Table 1, the results from the 2018 Don River Hydrology Update indicate a significant reduction in 100-year design storm estimates over the 2004 model. The reduction in peak flow estimates is attributed to a number of factors including: improved model calibration, a reduction in percent impervious values due to the improved model parameterization based on physically derived data, and the inclusion of stormwater management ponds as discrete elements within the updated model. In order to validate the modelling results, AECOM completed a flood frequency analysis based on monitored stream flow data and compared the modelled design storm peak flow estimates with the flood frequency analysis. The conclusion of the assessment was that the modelled peak flow values are well within the range of the values calculated through the flood frequency analysis.

As noted on Table 2, the reduction in flow values associated with the Regional storm peak flow estimates used for regulation are not as pronounced as the reduction in flows associated with the 100-year design storm. This is mainly attributed to the exclusion of stormwater management ponds and water crossings in the Regional storm model (237 hydraulic elements from the model), which is a hydrology modelling approach mandated by the Ministry of Natural Resources and Forestry (MNRF). MNRF requires storage elements like ponds and water crossings to be removed from the Regulatory model due to the fact that these structures were not designed to the Regional storm standard and may not withstand a Regional storm type event.

A good example of a water crossing that could not withstand a major storm is the Finch Avenue West failure during the August 19, 2005 storm event. Further the removal of these storage elements ensures Regional storm flow estimates are conservative and allows for modifications and enhancements to transportation infrastructure.

A particular area of interest within the Don River Watershed is the Lower Don River through the City of Toronto where the detailed design process for the Don Mouth Naturalization and Port Lands Flood Protection Project (DMNPFP) is on-going. The Environmental Assessment and Due Diligence process completed as part of the DMNPFP project utilized results from the 2004 Don River Watershed Hydrology Update which are approximately 11% higher than the values developed as part of the 2018 update. TRCA staff has been in constant communication with the various stakeholders within the Lower Don area including the City of Toronto and Waterfront Toronto throughout the hydrology update process and have provided the detailed design team with the updated flows for use in the design process.

In order to accurately assess the impacts of updated flows on floodplain mapping, TRCA staff plan to update river hydraulic models and floodplain mapping within the Don River Watershed. The floodplain mapping updates will be completed by March 2020 utilizing secured funding from the Federal National Disaster Mitigation Program (NDMP).

FINANCIAL DETAILS

Financial contributions for the Don River Hydrology Study were provided through TRCA's Flood Line Mapping Program, account 127-90, TRCA's Flood Protection and Remedial Studies, account 107-02, York Region Stormwater Management Fund, account 107-15 and Don Mouth – TRCA DELFT Hydraulic Modelling Scenarios account, 191-22 at a cost of approximately $195,237, which included staff time, consulting fees for the model development and the peer review process.

RESOLUTIONS

TRCA staff will adopt the Don River Watershed Hydrology Study, using this model for all future studies and hydrologic analysis, including updating floodline mapping, flood remedial plans, emergency management and watershed studies. In addition, TRCA staff will begin to disseminate the final modeling results and documentation to municipal staff and the development industry. Further, TRCA staff will use the peak flow rates calculated as part of the study to update floodline mapping for the entire Don River Watershed.

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

Flow Node Location	2004 Future OP Peak Flows (cms)	2018 Current Peak Flows (cms)	2018 Future OP Peak Flows (cms)	% Change, 2001 to 2018 Future OPs
West Don River				
West Don @ Glen Shields Ave.	133.9	46.6	46.6	-65%
West Don @ Hoggs Hollow	119.9	101.3	101.3	-16%
West Don @ Confluence with East Don	489.9	388.9	388.9	-21%
German Mills Creek				
German Mills @ Confluence with East Don	287.8	134.8	134.8	-53%
Taylor Massy Creek				
Taylor Massy Creek @ Confluence with East Don	165.2	53.3	53.3	-68%
East Don River				
East Don River @ Duncan Mills	291.6	254.3	254.3	-13%
East Don River @ Confluence with West Don	343.6	269.9	269.9	-21%
Lower Don River				
Lower Don @ Brickworks	466.2	389.9	389.9	-16%
Lower Don @ Dundas St.	524.9	408.6	408.5	-22%
Don River @ Lake Ontario	494.9	402.8	402.6	-19%

Table 2 – Summary of Don River Peak Flow Rates at Specific Subwatersheds – Regional Storm

Flow Node Location	2004 Future OP Peak Flows (cms)	2018 Current Peak Flows (cms)	2018 Future OP Peak Flows (cms)	% Change, 2001 to 2018 Future OPs
West Don River				
West Don @ Glen Shields Ave.	402.3	366.6	365.4	-9%
West Don @ Hoggs Hollow	561.1	579.2	581.6	+4%
West Don @ Confluence with East Don	1860.1	1028.9	1029.1	-15%
German Mills Creek				
German Mills @ Confluence with East Don	782.7	670.3	670.3	-14%
Taylor Massy Creek				
Taylor Massy Creek @ Confluence with East Don	293.3	235.6	235.6	-20%
East Don River				
East Don River @ Duncan Mills	878.6	749.1	749.1	-15%
East Don River @ Confluence with West Don	1146.0	1028.9	1029.1	-10%
Lower Don River				
Lower Don @ Brickworks	1681.5	1497.6	1498.7	-11%
Lower Don @ Dundas St.	1644.7	1513.5	1515.29	-8%
Don River @ Lake Ontario	1694.3	1504.5	1506.4	-11%