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STORM WATER MANAGEMENT PRELIMINARY ASSESSMENT

1 Storm Water Management Criteria

Storm water management criteria have been established based on the review of MOE guidelines, Toronto and Region Conservation Authority and Lake Simcoe Region Conservation Authority comments and the background information compiled for the North Yonge Street Corridor Public Transit and Associated Road Improvements Transit Class EA.

The storm water management criteria are summarized as follows:

- There are four main watersheds – Humber River, Tannery Creek, Holland River and Western Creek - with 64 watercourses within the Yonge Street corridor study area. The fish habitat characteristics of these watercourses are summarized in Tables 6.2-1 to 6.2-4 of the Highway 7 Corridor & Vaughan North-South Link Public Transit Improvements, Environmental Assessment Report. While the fish habitat at the crossings ranges from warmwater to coldwater, MOE has recommended that enhanced (level1 – 80% total suspended solids removal) treatment for storm water be provided wherever possible throughout the study area.
- The Ministry of Environment (MOE) 2003 document Storm Water Management Planning and Design Manual provides a table of storage volume requirements for storm water quality treatment based on the level of protection for the receiving water and the level of imperviousness of the contributing drainage area. The storage volumes in the table can be used as the basis for sizing proposed facilities.
- Storm water management should treat the runoff from a total area of pavement equivalent in size to the additional pavement resulting from the rapidway facility. Where possible and economically feasible, for watercourse crossings with a high sensitivity rating, runoff from paved surfaces that are currently untreated should be included in the storm water facilities in order to enhance the existing water quality.
- Oil/grit separators are unacceptable for linear transportation facilities, however, they are acceptable for use in association with commuter parking lots, terminals and maintenance facilities.
- Catchbasin based filtration measures are not acceptable because of the high potential for plugging resulting in flooding/icing and roadway accidents.

2 Selection of Storm Water Management Alternatives

Storm water management practices suitable for roadway drainage are passive practices that rely on gravity and settling as the primary mechanism to achieve storm water management objectives. These include:

- grassed swale;

- extended detention wet pond;
- extended detention dry pond;
- extended detention constructed wetland;
- infiltration basin; and
- oil/grit separator.

Each of these alternatives is described briefly in the following.

2.1 Grassed Swale

A literature review of highway runoff water quality (MTO, 1992) shows that grassed swales of at least 60 m in length are effective in reducing pollutant levels in runoff from typical paved roadways. Bioassay experiments showed that runoff discharging from a grassed swale was not toxic to trout. Grassed swales need to be well vegetated with a relatively flat gradient and a flat bottom to minimize flow velocity, maximize contact between the runoff and the vegetation, and maximize sedimentation.

Water quality treatment with grassed swales is based on the flow velocity in the swale being less than or equal to 0.5 m/s with a maximum depth of flow of approximately 0.25 m. In addition, vegetation should be allowed to grow higher than 75 mm to enhance the filtration of suspended solids. Grassed swales are generally suitable for drainage areas up to 2 ha.

Wide flat bottoms can be used to enhance the performance of a grassed swale. The wider bottom reduces the flow depth and velocity which are important factors in promoting the settlement of suspended particles. Permanent rock flow checks along the swale can be used to promote infiltration of storm water and the settling of pollutants. These flow checks reduce the effective slope of the swale where the slope is too steep to allow the maximum design velocity (0.5 m/s) to be achieved. The ponding behind the flow checks provides treatment for a larger flow depth or rate than would be possible with a standard grassed swale. The rock flow checks can be sized to meet the specific storage criteria.

Where the overall swale slope is too steep, small drop structures or short steep sections of swale protected with rip rap can be used to flatten out the swale. Typically, a series of minor drops in the swale are better than a major structure.

2.2 Extended Detention Wet Pond

Extended detention wet ponds are a common end-of-pipe storm water management facility and are an effective means of providing water quality treatment. These facilities consist of a permanent pool and an extended detention (active) storage that fills during a runoff event. Treatment is provided by sedimentation during a runoff event and on-going sedimentation within the permanent pool between events. The water quality active storage can also be sized to provide erosion control active storage.

Wet ponds should generally be implemented for drainage areas >5 ha so there is sufficient runoff to sustain the permanent pool. The preferred drainage area for wet ponds is ≥ 10 ha. Length to width ratios of 3:1 to 5:1 are preferred and the inlet should be at the "upstream" end with the outlet at the "downstream" end. Permanent pool depth can normally range from 1 m to 2 m. Sediment forebays facilitate maintenance, improve sediment/pollutant removal, and can be

up to one-third of the total area of the pond.

Wet ponds can have a negative effect on receiving water temperature due to warming of the water within the permanent pool. Mitigative measures to minimize the impact would be:

- maximize the length to width ratio and plant vegetation around the permanent pool to provide shading;
- discharge water from the bottom (potentially cooler) portion of the permanent pool; and
- discharge through a sub-surface outlet to allow cooling of the flow.

2.3 Extended Detention Dry Pond

An extended detention dry pond detains runoff during a storm event for approximately 24 hours. Water quality treatment is provided by sedimentation while the runoff is detained in the pond.

A minimum drainage area of 5 ha is generally required in order to provide an outlet orifice of sufficient size to minimize clogging. The length to width ratio should be in the order of 3:1 to 5:1 and the inlet and outlet should be at opposite ends of the facility.

Extended detention dry ponds that operate in a continuous mode are not as effective as extended detention wet ponds in removing storm water pollutants. Generally, dry ponds should only be used when wet ponds or wetlands cannot be implemented due to constraints such as temperature and land availability. Continuous flow dry ponds are only included in the MOE (2003) Design Manual for aquatic habitat basic protection level.

2.4 Extended Detention Constructed Wetland

Extended detention constructed wetlands are similar to wet ponds in that there is a permanent pool with extended detention storage for storm event runoff. The permanent pool depth ranges from 150 mm to 300 mm and a drainage area of 5 ha or more is normally required to sustain the permanent pool. The preferred drainage area for constructed wetlands is ≥ 10 ha.

The length to width ratio along the flow path between the inlet and outlet should be a minimum 3:1. A sediment forebay provides pre-treatment for the flow and can be up to 20% of the total permanent pool volume. The planting strategy would be more extensive than for wet and dry ponds. Due to the shallow permanent pool, wetlands require 2 to 3 times the surface area of a wet pond in order to provide similar levels of treatment.

Constructed wetlands also have similar environmental impacts to wet ponds related to increased downstream water temperature which may limit their application in certain areas.

2.5 Infiltration Basin

Infiltration basins are generally shallow ponds that have been constructed in highly pervious soils. Storm runoff infiltrates through the bottom of the basin and either recharges the groundwater system or is collected by a network of perforated pipes and discharges to a downstream outlet. Infiltration basins should be implemented for small drainage areas (<5 ha) and are most suitable for residential areas. Infiltration basins are not recommended for industrial and commercial land uses where there is a high potential for groundwater

contamination from chemical spills and maintenance activities such as salting and sanding. Due to the sanding and salting of municipal roadways, infiltration basins are generally not suitable for transportation corridors.

Infiltration basins need to be located in soils with a percolation rate ≥ 60 mm/h such as loamy sand and sand. Water depth in the basin should be limited to a maximum of 0.6 m to minimize compaction of the bottom of the basin.

2.6 Oil/Grit Separator

Oil/grit separators are used to trap and retain oil and sediment in detention chambers. These are flow through systems with no attenuation of flow. Oil/grit separators are used to provide stand alone water quality treatment for small sites or as a pre-treatment device for runoff contributing to another facility such as a constructed wetland or infiltration basin. Oil/grit separators can also be sized to protect the receiving water from spills.

Oil/grit separators are typically used for areas < 2 ha and are suitable for commercial and industrial areas as well as large parking areas and transit facilities. Recent roadway widenings have included oil/grit separators as part of the treatment chain for traffic runoff. Regular maintenance is required to remove accumulated sediment and oil.

3 Evaluation Criteria

A number of criteria can be used to evaluate the various storm water management alternatives. The criteria considered for the study were:

- capital cost;
- level of treatment;
- maintenance requirements;
- space constraints;
- site specific requirements.

The best alternatives are those that are inexpensive, provide the required level of treatment, are easy to maintain and fit within the existing right-of-way lands.

4 Screening

Grassed swales generally meet all the evaluation criteria, however, the level of treatment decreases with large drainage areas and/or steeper slopes. These limitations can be mitigated by using enhanced swales - wide flat bottom and/or rock flow checks - with an associated increase in initial cost and some additional maintenance requirements. As well as providing quality treatment, rock flow checks can also be sized to provide quantity control.

Grassed swales are generally associated with a rural type roadway cross-section. Grassed swales are not appropriate where the road has an urban cross-section and there is existing development adjacent to the right-of-way.

Wet ponds and constructed wetlands can provide similar water quality benefits, however, constructed wetlands typically require larger areas to accommodate the shallow ponding

depths. Constructed wetlands and wet ponds have a much higher capital cost than grassed swales and generally require more on-going maintenance. In addition a drainage area of at least 5 ha, and preferably 10 ha, is required to sustain these facilities.

Due to the linear nature of transportation facilities, there is typically limited space within the right-of-way to accommodate a wet pond or constructed wetland. Where a large impervious area outlets to a watercourse, land outside of the right of way would be required for a wet pond or constructed wetland facility.

Dry ponds are generally not suitable for normal and enhanced protection levels. Where ponds are warranted a wet pond will provide consistent performance and can be sized for different levels of protection.

Similar to wet ponds and constructed wetlands, infiltration basins would need to be located outside the normal right-of-way. Infiltration basins also require highly pervious underlying soils such as loamy sand and sand. The majority of the study area is dominated by the Oak Ridges Moraine. Due to potential for contamination of the groundwater due to salt and oils from roadway runoff, infiltration basins are not appropriate for the Yonge Street roadway.

Oil/grit separators are appropriate for small commercial and industrial areas, or short stretches of road, and would be most appropriate at car pool parking areas and any maintenance or storage facilities.

Based on the above general evaluation, the storm water management alternatives to be used in preparing the storm water management plan are as follows:

- grassed swales to be used to treat the runoff from the transit way where the roadway has a rural cross-section and/or there is no existing development adjacent to the right-of-way;
- enhanced swale - flat bottom and rock flow check - to be used where a basic grassed swale does not meet the design criteria (velocity ≤ 0.5 m/s; depth ≤ 0.25 m) and/or to further enhance the water quality treatment;
- wet pond to be used where the contributing drainage area is greater than 5 ha and suitable space is available within the right-of-way or an adjacent undeveloped area; and
- oil/grit separator to be used for water quality treatment where no other method is available.

5 Storm Water Management Concept Plan

5.1 General Approach

The existing right-of-way widths vary quite substantially along Yonge Street due to property acquisitions for widening and redevelopment. In general, Yonge Street has a ROW varying from 35 m to 60 m wide. Similarly, the number of lanes along Yonge Street also varies from as few as 4 lanes to as many as seven lanes with the typical range being 4 to 6 lanes.

As an example, an existing four lane roadway with a centre turn lane has the following typical

geometry:

- 36.5 m right-of-way;
- sidewalks on each side – each 2.0 m wide;
- outside curb and gutter – each 0.5 m wide;
- two traffic lanes in each direction – two at 3.5 m and two at 3.75 m wide;
- centre turning lane – 4.5 m wide; and
- right-of-way is 66% impervious.

The proposed four lane roadway with the rapidway would have the following characteristics:

- 40.0 m right-of-way;
- sidewalks on each side – each 2.0 m wide;
- boulevard between sidewalks and curb and gutter – 1.4 m wide;
- outside curb and gutter – each 0.5 m wide;
- two traffic lanes in each direction – two at 3.3 m and two at 3.5 m wide;
- one transit lane in each direction – each 3.5 m wide;
- rumble strip along the outside of each transit lane – each 0.3 m wide
- raised grassed centre median – 3.0 m wide;
- median curb and gutter – each 0.5 m wide and
- right-of-way is 77% impervious.

The typical rapidway layout will increase the imperviousness within the right-of-way from 66% to 77% where the existing roadway has 4 lanes with a centre turn lane.

The runoff from the rapidway lanes will combine directly with the existing roadway drainage; i.e. a separate drainage system is not proposed for the rapidway component. Therefore, any existing or new storm water management facilities will treat the runoff from both the existing and proposed impervious areas.

It is expected that, where feasible, mitigation of impacts to the flow regime will be required (both quality and quantity control).

There are no existing storm water management facilities along the Yonge Street corridor that specifically provide treatment for runoff from Yonge Street. Currently runoff discharges uncontrolled to trunk sewers and the various watercourses that cross Yonge Street.

To meet the basic criteria of providing water quality treatment for the increase in impervious area, storm water management needs to be provided for approximately 11% of the right-of-way. The storm water management facilities to be included as part of the proposed rapidway will be developed during the detail design phase.

Many sections of the Yonge Street are urbanized and there are generally limited opportunities to provide storm water management for the Yonge Street/rapidway runoff. As such, the use of oil/grit separators for quality treatment will be examined. The existing roadway runoff has a greater impact on the downstream watercourses than the potential increase in runoff due to the proposed rapidway. Storm water management in urbanized areas should therefore be developed as part of an initiative to provide treatment on a watershed basis rather than trying to

manage the incremental change resulting from the proposed rapidway. This type of initiative would be separate from the current environmental assessment for the Yonge Street Corridor Public Transit Improvements.

There are sections of Yonge Street that have not been fully urbanized. Opportunities exist in these areas to provide grassed swales along the outside of the roadway. In addition, as the adjoining areas develop, potential may exist to incorporate the runoff from Yonge Street – both from the existing and rapidway impervious areas – in centralized storm water management facilities.

5.2 Concept Plan

The storm water management options to be considered during detail design of the rapidway are identified in the following sections. These notes should be read in conjunction with Figures 9.2 through 9.81 in the main Environmental Assessment Report.

5.2.1 Yonge Street – 19th Avenue to Tower Hill Road (Sta. 15+000 to Sta. 15+700)

The road drains longitudinally toward a local drainage swale. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

5.2.2 Yonge Street – Tower Hill Road to Summit Golf Course (Sta. 15+700 to Sta. 16+200)

The road drains south toward a local drainage swale. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

5.2.3 Yonge Street – Summit Golf Course to Stouffville Road (Sta. 16+200 to Sta. 17+050)

The road drains longitudinally toward a local drainage swale. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

5.2.4 Yonge Street – Stouffville Sideroad to Bond Lake (Sta. 17+050 to Sta. 17+700)

The road drains north and east toward a Bond Lake. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to

grassed swales along the outside of the roadway prior to discharging to the watercourses.

5.2.5 Yonge Street – Bond Lake to Old Colony Road

(Sta. 17+700 to Sta. 18+600)

The road drains south and east toward Bond Lake. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses.

5.2.6 Yonge Street – Old Colony Road to Blackforest Drive

(Sta. 18+600 to Sta. 20+300)

This section drains to the outlet from Wilcox Lake (part of the Humber River watershed) located at King Road. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.7 Yonge Street – Blackforest Drive to Hunters Glen Road

(Sta. 20+300 to Sta. 21+700)

The road drains longitudinally toward a local drainage swale. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

5.2.8 Yonge Street – Hunters Glen Road to Edward Avenue

(Sta. 21+800 to Sta. 23+900)

The road drains longitudinally toward a local drainage swale. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

5.2.9 Yonge Street – Edward Avenue to Wellington Street

(Sta. 23+900 to Sta. 25+350)

This section drains to the East Branch of Tannery Creek (part of the Holland River watershed) located at station 24+950. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

This section has the rapid transit within mixed traffic. Storm water management is not required for the rapidway.

5.2.10 Yonge Street – Wellington Street to Orchard Heights Boulevard

(Sta. 24+800 to Sta. 25+800)

This section drains to the Main Branch of Tannery Creek (part of the Holland River watershed) located at station 26+350. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

This section has the rapid transit within mixed traffic. Storm water management is not required for the rapidway.

5.2.11 Yonge Street – Orchard Heights Boulevard to Savage Road

(Sta. 25+800 to Sta. 28+700)

The road drains longitudinally toward a the Main Branch of Tannery Creek (part of the Holland River watershed) at stations 26+550 and 27+900. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

5.2.12 Yonge Street – Savage Road North to William Roe Boulevard

(Sta. 28+700 to Sta. 29+900)

This section drains longitudinally to local sewers, and east to the Holland River. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.13 Yonge Street – William Roe Boulevard to Millard Avenue

(Sta. 29+900 to Sta. 31+150)

This section drains longitudinally to Western Creek at station 30+600. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.14 Yonge Street – Millard Avenue to Kingston Road

(Sta. 31+150 to Sta. 32+300)

This section drains longitudinally to local sewers, and east to the Holland River. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities, or adding to local ponds adjacent to Yonge Street on the west side.

5.2.15 Yonge Street – Kingston Road to Green Lane

(Sta. 32+300 to Sta. 33+600)

This section drains longitudinally to local sewers, and east to the Holland River. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.16 Davis Drive – Yonge Street to Parkside Drive

(Sta. 31+600 to Sta. 32+200)

This section drains longitudinally to local sewers, and east to Western Creek. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.17 Davis Drive – Parkside Drive to Main Street

(Sta. 32+200 to Sta. 33+200)

This section drains longitudinally to local sewers, and to Western Creek at station 33+050. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.18 Davis Drive – Main Street to Prospect Street

(Sta. 33+200 to Sta. 33+900)

This section drains longitudinally to local sewers, and to the Holland River crossing at station 33+400. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.19 Davis Drive – Prospect Street to Leslie Avenue

(Sta. 33+900 to Sta. 35+650)

This section drains longitudinally to local sewers, and west to Eastern Creek at station 34+100. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.20 Davis Drive – Leslie Avenue to Harry Walker Parkway

(Sta. 35+650 to Sta. 36+750)

This section drains longitudinally to local sewers. The area is completely urbanized. There are no opportunities for a grassed swale or wet pond. Opportunities for quality control are limited to in-road end-of-pipe (oil / grit separator) type facilities.

5.2.21 Green Lane – Yonge to Go Terminal

(Sta. 33+600 to Sta. 35+800)

The road drains longitudinally toward unnamed tributaries of the Holland River at Stations 34+100 and 34+700. The area is currently undeveloped or under development. Opportunities exist along this section to outlet the storm drainage to grassed swales along the outside of the roadway prior to discharging to the watercourses. Future stormwater facilities (by others) may also be designed to accommodate road runoff, as the opportunity arises.

6 Hydraulic Analysis of Watercourse Crossings

6.1 Yonge Street

6.1.1 Humber River Crossings

In Richmond Hill, there are two crossings of the Humber watershed - the outlet to Lake Wilcox, at King Road, and a culvert crossing at Worthington Avenue / Blackforest Drive. It is noted that the catchment for the culvert at Worthington / Blackforest is less than 120 hectares, bounded to the north by Bloomington, west by Yonge, and east and south by Worthington.

The outlet from Lake Wilcox is controlled by a dam structure, and as such the release will be controlled to suit the needs of the municipality for flood protection of the surrounding lands and Yonge street. Any extension of this existing culvert will likely have minimal impact on the overall flooding regime.

6.1.2 Tannery Creek

In Aurora, there are four crossings of Yonge Street by Tannery Creek, three of which occur in the same area. The flow is from south to north, crossing east to west north of Reuben Street, west to east south of Orchard Heights Boulevard, then east to west north of Orchard Heights Boulevard, and finally west to east north of St. Johns Sideroad.

No change is contemplated for the crossing north of Reuben Street.

Extensions of the existing culverts were modeled based upon the HEC-RAS model as provided by the Lake Simcoe Regional Conservation Authority. Culverts were uniformly extended by 15 metres. Results for all storms are summarized below.

For the crossings of Yonge around Orchard Heights Boulevard, the level of water drops 10mm for the Regional Storm when the culvert is extended. Flood levels for the 100 and 50 year storms rise 10mm. Similarly, for the 25 year storm the flood levels rise 20mm. All these storms overtop Yonge both under current and proposed conditions.

Flood levels for the 10 year storm rise 40mm but water does not overtop Yonge Street, while there is no change for the 5 or 2 year events.

For the Tannery Creek crossing of Yonge north of St Johns, the model from the LSRCA lists only one culvert in place. LGL has confirmed in the field that there are in fact two culverts.

In order to remain consistent with current regulatory understanding of the area, it was decided that the model would be run as presented - with one culvert only.

Similar to the crossings in the Orchard Heights area, it was found that storms in excess of the 10 year storm (ie, the 25 year or greater storms) would overtop Yonge street. Further, it was

found that for the Regional and 100 year storms, there was no change in the flood levels, while the 50 and 25 year storms saw a minor increase of 10mm in flood levels.

There was no change in flood levels for the minor storms.

6.1.3 Western Creek

URS has carried out a study of the hydraulic performance of the Western Creek culvert at Eagle Drive (York Region Administrative Centre Floodplain Assessment, 2007). Their recommendation was to reconfigure the entranceway of the culvert to ensure hydraulic performance of the culvert is not impacted. Rapidway configurations for this area will be chosen to ensure that no culvert extension or reconfiguration from this recommendation is required.

6.2 Davis Drive

6.2.1 East Holland River

A preliminary analysis of the hydraulics of East Holland River at Davis Drive was carried out to see the impact of widening the bridge, and a summary of the results follow.

The area is inundated during the regional storm – water elevation at the bridge is 235.96 (deck top is 235.15). Whether the bridge is 16m (as in the existing model) or 31m wide, this level remains unchanged. If the bridge is eliminated, the flooding elevation goes up upstream.

A look was taken at the 100 year and 50 year storms as well to see if and when the bridge might have any impact on the area's flooding. A summary follows:

Bridge bottom: 234.50 – Section 203.5 in the model

Flood elevations – existing / proposed

100 year storm: 233.57 / 233.66

50 year storm: 233.39 / 233.47

For these storms, the water level does rise 8-9 cm, but does not overtop the channel banks (or hit the bridge soffit). Approximately 100 metres upstream the water levels match existing values – by section 206 the 100 year storm flood level increase is down to 4 cm, and it disappears by section 208 at the Queen Street crossing.

There is one building adjacent to the river on the east side (The Newmarket Youth & Recreation Centre and the Newmarket Kinsmen Skateboard Park at 56 Charles Street) that is within the 100 year floodline as shown on the mapping provided by the LSRCA. This area has been reconstructed with a sizeable parking lot added where other buildings used to be as shown on the LSRCA map. With any bridge changes that affect the 100 year storm level through this area, measures might be needed to mitigate the additional flooding to this

building.

Additionally, more detailed modeling should be undertaken – based on more robust bridge data – to confirm these preliminary results with a focus on the 100 and 50 year flood elevations to the south of Queen. This is because there is a tributary that goes through a residential area south of Queen and north of Wellington, which should be protected from any additional flooding.

Point by point summary:

All scenarios:

1. Water levels under the Regional storm remain unchanged from existing condition.
2. For the 50 year storm, x_1 mm rise in water level at the bridge, and x_2 between Davis Drive and Queen Street; water constrained to channel.
3. Greater than 80 cm clearance from water surface to deck soffit for 100 year storm under proposed condition.
4. For the 100 year storm, y_1 mm rise in water level at the bridge, and y_2 between Davis Drive and Queen Street; water constrained to channel. Building at 56 Charles Street is within flooding extent during 100 year storm water, based on LSRCA mapping of existing conditions.

For new bridges:

Existing bridge span is for entire channel width (31m); new bridge span constrained by local topography and thus not increased.

For a bridge width of 31m $x_1=80$ mm and $y_1=90$ mm at the bridge, x_2 and y_2 are 40mm.

For a bridge width of 40m x_1 and y_1 are 130mm at the bridge, x_2 and y_2 are 60mm.

HEC-RAS modeling is available electronically on CD.

6.2.2 Western Creek

The crossing of Western Creek at Davis Drive is by a 7m span bridge structure. Western Creek crosses Davis Drive on a skew, resulting in a very long existing culvert. The current HEC-RAS model lists the width of the bridge at 35 metres, while overhead photography suggests the bridge covers in the range of 52 metres of creek.

Under existing conditions, the roadway is flooded for all storms over the 5 year storm; the 10 year storm overtops the roadway by 0.15 m and the Regional storm overtops by 0.66 m. Top of bridge deck is 237.06 in the model.

It is considered likely that Davis Drive will be significantly widened at this crossing, resulting in a lengthening of the crossing. As such, the HEC-RAS model was modified to show a bridge

widened by 40 metres. Ground profile and road profile remained unchanged.

The resulting impact of widening the road is that the 10 year storm flood elevation was increased by 0.01 metres, and that all other storms retained their flood elevation.

6.2.3 Eastern Creek

The crossing of Eastern Creek at Davis Drive is by two 1.2 m and one 0.9 m diameter steel culverts, 94 metres long.

Under existing conditions, the roadway is flooded for all storms over the 5 year storm; the 10 year storm overtops the roadway by 0.17 m and the Regional storm overtops by 0.48 m. Top of road is 240.94 in the model.

As there will be little if any culvert extension due to road widening in this area, and given that the road profile is assumed to remain the same, it is anticipated that there will be no flooding impact due to any roadwork at Eastern Creek.

6.3 Green Lane

In Newmarket, there are two tributaries that cross Green Lane flowing to the Holland River.. The flow is from south to north, crossing between Yonge Street and 2nd Concession Road (Main Street). Current Conservation Area HEC-RAS modeling shows the tributaries but does not reflect the crossings as they currently exist. Any proposed reconstruction plans for Green Lane will need to include an investigation into the existing condition via detailed survey and hydraulic / hydrologic modeling of the tributaries' crossings.